EVERYDAY PRACTICAL ELECTRONICS

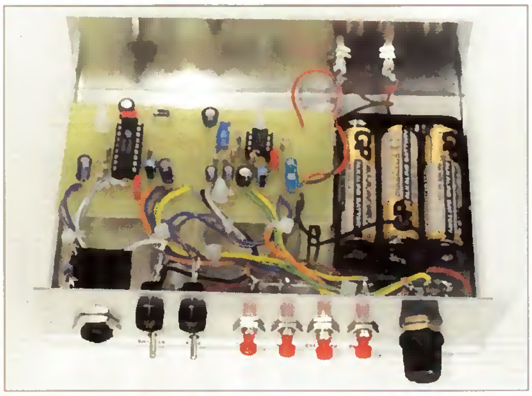
OCTOBER 1998

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

£2.65

VOICE PROCESSOR

Frequency shifting plus vibrato and robot effect



RELIABLE IR REMOTE CONTROL

Easy to use, inexpensive and versatile

PC CAPACITANCE METER

Your PC can measure capacitor values

DIGISERV

Expands radio control systems

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

PLUS Circuit Surgery - New Technology Update

Techniques - Innovations - Network

WIND GENERATORS 380 WATT 1.14 metre dia blades, carbon matrix blades, 3 year warranty, 12vdc output, 24v version available, control electronics included, brushless neodymium cubic curve alternator, only two moving parts, maintenance free, simple roof top installation, start up speed 7mph, max output (30mph) 380w £499 ref AIR1

HYDROPONICS DO YOU GROW YOUR OWN? We have a full colour hydroponics catalogue available containing nutrients, pumps, fittings, enviromental control, light fittings, plants, test

TELEKINETIC ENHANCER PLANS Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £4/set Ref F/TKE1

ELECTRONIC HYPNOSIS PLANS & DATA This data shows several ways to put subjects under your control. Included is a full volume reference text and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use as entertainment at parties etc only, by those experienced in its use. £15/set. Ref F/EH2

GRAVITY GENERATOR PLANS This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means- cause it to levitate. £10/set Ref F/GRA1.

WORLDS SMALLEST TESLA COIL/LIGHTENING DISPLAY GLOBE PLANS Produces up to 750,000 volts of discharge, experiment with extraordinary HV effects, 'Plasma in a jar', St Elmo's fire, Corona, excellent science project or conversation piece £5/set Ref F/BTC1/LG5.

VOICE SCRAMBLER PLANS Miniature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

PULSED TV JOKER PLANS Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound! works on FM too! DISCRETION ADVISED. £8/set Ref F/TJ5.

BURNING, CUTTING CO2 LASER PLANS Projects an invisible beam of heat capable of burning and melting materials over a considerable distance. This laser is one of the most efficient, converting 10% input power into useful output. Not only is this device a workhorse in welding, cutting and heat processing materials but it is also a likely candidate as an effective directed energy beam weapon against missiles, aircraft, ground-to-ground, etc. Particle beams may very well utilize a laser of this type to blast a channel in the atmosphere for a high energy stream of neutrons or other particles. The device is easily applicable to burning and etching wood, cutting, plastics, textiles etc £12/set Ref F/LC7.

ULTRASONIC BLASTER PLANS Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquides. Many cleaning uses for PC boards, jewllery, coins, small parts etc. £6/set Ref F/ULB1.

ANTI DOG FORCE FIELD PLANS Highly effective circuit produces time variable pulses of accoustical energy that dogs cannot tolerate £6/set Ref F/DOG2

LASER BOUNCE LISTENER SYSTEM PLANS Allows you to hear sounds from a premises without gaining access. £12/set Ref F/LLIST1

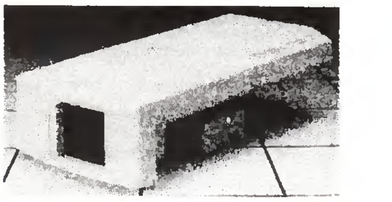
PHASOR BLAST WAVE PISTOL SERIES PLANS Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4

INFINITY TRANSMITTER PLANS Telephone line grabber/room monitor. The ultimate in home/office security and safety! simple to use! Call your home or office phone, push a secret tone on your telephone to access either: A) On premises sound and voices or B) Existing conversation with break-in capability for emergency messages. £7 Ref F/TELEGRAB.

ELECTROMAGNETIC GUN PLANS Projects a metal object a considerable distance-requires adult supervision £5 ref F/EML2.

ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND! £5/set Ref F/EMA1.

2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS Operates on 9-12vdc, many possible experiments. £10 Ref F/HVM7/TCL4



COLOUR CCTV VIDEO CAMERAS From £99

Works with most modern video's, TV's, Composite monitors, video grabber cards. Pal, 1v P-P, composite, 75ohm, 1/3" CCD, 4mm F2.8, 500x582, 12vdc, mounting bracket, auto shutter, 100x50x180mm, 3 months warranty, 1 off price £119 ref XEF150, 10 or more £99 ea 100+ £89

CIRCUIT PACKS Packs of 35 circuit diagrams covering lasers, SW radios, geigers, bugs, char etc. Pack1, Pack2, Pack3 £4.99 each.

SMOKE ALARMS Mains powered, made by the famous Gent company, easy fit next to light fittings, power point. £4.99 ref SMKX

CONVERT YOUR TV INTO A VGA MONITOR FOR £25! Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware. Ideal for laptops or a cheap upgrade. Supplied in kit form for home assembly. **SALE PRICE £25** REF SA34

***15 WATT FM TRANSMITTER** Already assembled but some RF knowledge will be useful for setting up. Preamp req'd, 4 stage 80-108mhz, 12-18vdc, can use ground plane, yagi or dipole £69 ref 1021

***4 WATT FM TRANSMITTER KIT** Small but powerful FM transmitter kit. 3 RF stages, mic & audio preamp inc. £24 ref 1028

4AH D SIZE NICADS pack of 4 £10 ref 4AHPK

ELECTRIC FENCE KIT Everything you need to build a 12vdc electric fence, complete with 200m of electric fence wire. £49 ref AR2

SENDER KIT Contains all components to build a A/V transmitter complete with case £35 ref VSXX2

UV LIGHTS 4' flourescent 340nm £38.99 ref UV23

33 KILO LIFT MAGNET Neodynium,32mm £15 ref MAG33

10 WATT SOLAR PANEL Amorphous silicon panel fitted in a anodized aluminium frame. Panel measures 3' by 1' with screw terminals for easy connection. **3' x 1' solar panel £55 ref MAG45**

Unframed 4 pack (3'x1') £58.99 ref SOLX

12V SOLAR POWERED WATER PUMP Perfect for many 12v DC uses, ranging from solar fountains to hydroponics! Small and compact yet powerful. Will work direct from our 10 watt solar panel in bright sunlight. Max head 17 ft Max flow = 8 Lpm, 1.5A Ref AC8 £18.99

SOLAR ENERGY BANK KIT 50x 6"x12" 6v solar panels(amorphous)+50 diodes £99 ref EF112

PINHOLE CAMERA MODULE WITH AUDIO! Superb board camera with on board sound! extra small just 28mm square (including microphone) ideal for covert surveillance. Can be hidden inside anything, even a matchbox! Complete with 15 metre cable, psu and tv/vcr connnectors. £73.95 ref CC6

SOLAR MOTORS Tiny motors which run quite happily on voltages from3-12vdc. Works on our 6v amorphous 6" panels and you can run them from the sun! 32mm dia 20mm thick. £1.50 each

WALKIE TALKIES 1 MILE RANGE £37/PAIR REF MAG30

DRILL OPERATED PUMP Fits to any drill in seconds, uses standard garden hose,pumps up to 40 gph! £8.99 ref DRL3

GIANT SCREEN VIEWER Turn your TV picture into a supersize screen! This high precision Fresnel lens converts even the smallest screen up to a massive 26', at a fraction ot the cost of a big TV. Easily fitted in minutes Also ideal for PC monitors etc £26.95 ref SVGA2

TELEPHONES Just in this week is a huge delivery of telephones, all brand new and boxed. Two piece construction with the following features- Illuminated keypad, tone or pulse (switchable), reacall, redial and pause, high/low and off ringer switch and quality construction. finished in a smart off white colour and is supplied with a standard international lead (same as US or modems) if you wish to have a BT lead supplied to convert the phones these are also available at £1.55 each ref BTLX **Phones £4.99 each ref PH2**

LIQUID CRYSTAL DISPLAYS Bargain prices,
20 character 2 line, 83x19mm £3.99 ref SMC2024A
16 character 4 line, 62x25mm £5.99 ref SMC1640A
40 character 1 line 154x16mm £6.00 ref SMC4011A

LM255X HITACHI LAPTOP SCREENS 240x100mm, 640x200 dots. New with data £15 ref LM2

TAL-1, 110MM NEWTONIAN REFLECTOR TELESCOPE Russian. Superb astronomical 'scope, everything you need for some serious star gazing! up to 169x magnification. Send or fax for information. 20kg, 885x800x1650mm ref TAL-1, £249

SEALED LEAD ACID BATTERIES
12V 6.5AH, NEW £12 REF BATT12
12V 6.5AH, S/HAND PACK OF 5 £20 REF EF99
12V 15AH AS NEW, £18 REF LOT8

THE ULTIMATE ENCLOSURE for your projects must be one of these! Well made ABS screw together beige case measuring 120 x 150 x 50mm. Fitted with rubber feet and front mounted LED. Inside is a pcb fitted with other bits and pieces you may find useful. Sold as a pack of five for £10 ref MD1, pack of 20 for £19.95 ref MD2

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

LOW COST CORDLESS MIC 500' range, 90 - 105mhz, 115g, 193 x 26 x 39mm, 9v PP3 battery required. £17 ref MAG15P1

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. **£12.99** REF AUG10P3.

SOLAR POWER LAB SPECIAL 2x 6"x6" 6v 130mA cells, 4 LED's, wire, buzzer, switch + 1 relay or motor. **£7.99** REF SA27

SOLAR NICAD CHARGERS 4 x AA size £9.99 ref 6P476, 2 x C size £9.99 ref 6P477

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

Interactive websites designed and hosted. bullnet.co.uk

REGISTER FOR OUR ELECTRONIC NEWSLETTERS BULL-ELECTRICAL.COM

BULL ELECTRICAL

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

MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3.50 P&P PLUS VAT.

24 HOUR SERVICE £5.00 PLUS VAT.

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

'phone orders : 01273 203500

FAX 01273 323077

Sales@bull-electrical.com

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

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

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

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

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

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

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

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

RUSSIAN BORDER GUARD BINOCULARS £1799 Probably the best binoculars in the world! ring for colour brochure.

NEW LASER POINTERS 4.5mw, 75 metre range, hand held unit runs on two AA batteries (supplied) 670nm. £29 ref DEC49

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

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

BUILD YOU OWN WINDFARM FROM SCRAP New publication gives step by step guide to building wind generators and propellors. Armed with this publication and a good local scrap yard could make you self sufficient in electricity! £12 ref LOT81

CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA, auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £49 ref EF137.

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

UK SCANNING DIRECTORY As supplied to Police, MOD, M15 and GCHQ! coverers everything from secret government frequencies, eye in the sky, prisons, military aviation etc £18.50 ref SCANB

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

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser, X K and KA bands, speed cameras, and all known speed detection systems. 360 degree coverage, front&r earwaveguides, 1.1"x2.7"x4.6" fits on visor or dash £149

CHIEFTAN TANK DOUBLE LASERS 9 WATT+3 WATT+LASER OPTICS Could be adapted for laser listener, long range communications etc Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignement. 7 mile range, no circuit diagrams due to MOD, new price £50,000? us? £199. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc. 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets. £199 Ref LOT4

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

EXTERNAL CAMERA Introducing the Bulldog model 4 vandal resistant camera in heavy steel case for interior or exterior use. Top quality case housing a 420 line camera module. Each camera is supplied with a 15m cable terminating in Scart and phono plugs. Multi angle bracket for easy installation in any situation. A 12vdc psu is also included. Easily installed in a few minutes, plugs straight into VCR or TV (phono or scart). **Bargain price £89.95 ref CC1**

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

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

LAPTOP LCD SCREENS 240x175mm, £12 ref SS51

PIR WITH BUILT IN CCTV CAMERA Module also includes an infra red strobe light, battery backup etc. 320x240 pixels, 90x65 field of view. £49.95 ea ref SS81, 3 or more £44.95 ref SS82

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

HIGH POWER DC MOTORS, PERMANENT MAGNET 12 - 24v operation, probably about 1/4 horse power, body measures 100m x 75mm with a 60mm x 5mm output shaft with a machined flat on it. Fixing is simple using the two threaded bolts protruding from the front. £22 ref MOT4

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

Online web catalogue bull-electrical.com

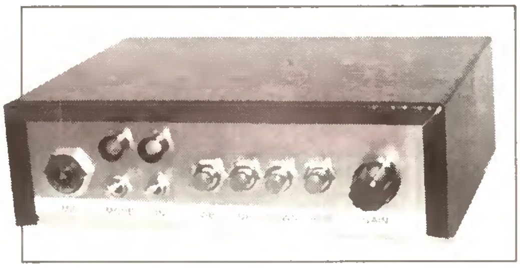
ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .
Cover Photo: J. F. Podevin, Image Bank

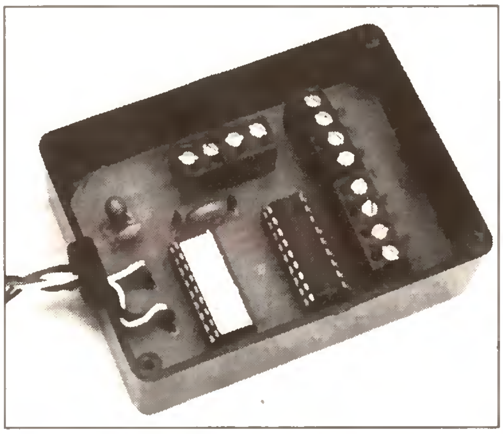
VOL. 27 No. 10 OCTOBER 1998

EVERYDAY PRACTICAL ELECTRONICS

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

The No. 1 Magazine for Electronics Technology and Computer Projects





Projects and Circuits

Series and Features

Regulars and Services

Our November '98 issue will be published on Friday, 2 October 1998. See page 699 for details.

Surplus always wanted for cash!

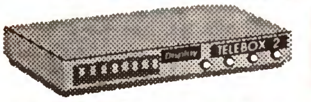
THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER
*CABLE COMPATIBLE**

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

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX STL as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6 mHz sound specification.
*For cable / hyperband signal reception Telebox MB should be connected to a cable type service. Shipping on all Teleboxe's, code (B)

NEW **State of the art** PAL (UK spec) **UHF TV tuner module** with **composite** 1V pp video & **NICAM** hi fi stereo sound outputs. **Micro electronics** all on one small PCB only 73 x 160 x 52 mm enable full software control via a **simple 2 wire link** to any IBM type computer. Supplied complete with **simple working program** and documentation. Requires +12V & + 5V DC to operate.
BRAND NEW - Order as MY00. Only £49.95 code (B)

FLOPPY DISK DRIVES 2½" - 14"

Massive purchases of standard 5¼" and 3½" 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 full 90 day guarantee. *Call* for over 2000 unlisted drives for spares or repair.

3½" **Panasonic** JU363/4 720K or equivalent RFE	£24.95(B)
3½" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only	£25.95(B)
3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£18.95(B)
5¼" **Teac** FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5¼" **Teac** FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£29.95(B)
5¼" **BRAND NEW Mitsubishi** MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5¼" Flopp or HD	£29.95(B)
8" **Shugart 800/801** 8" SS refurbished & tested	£210.00(E)
8" **Shugart 810** 8" SS HH *Brand New*	£195.00(E)
8" **Shugart 851** 8" double sided refurbished & tested	£260.00(E)
8" **Mitsubishi M2894-63** double sided *NEW*	£295.00(E)
8" **Mitsubishi M2896-63-02U** DS slimline *NEW*	£295.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

HARD DISK DRIVES

2½" **TOSHIBA.**(19 mm H) MK2101MAN 2.16 Gb. ***New***	£199.00
2½" **TOSH.**(12.5 mm H) MK1002MAV 1.1 Gb laptop. ***New***	£115.00
2½" to 3½" conversion kit for Pc's, complete with connectors	£12.95
3½" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95
3½" **CONNER** CP3024 20 mb IDE I/F (or equiv.) RFE	£59.95
3½" **CONNER** CP3044 40mb IDE I/F (or equiv.) RFE	£69.00
3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£69.00
3½" **QUANTUM 40S** Prodrive 42mb SCSI I/F, New RFE	£49.00
3½" **WESTERN DIGITAL** 850mb IDE I/F ***New***	£185.00
5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95
5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95
5¼" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95
5¼" **HP 97548** 850 Mb SCSI RFE tested	£99.00
5¼" **HP C3010** 2 Gbyte SCSI ***differential*** RFE tested	£195.00
8" **NEC D2246** 85 Mb SMD interface. ***New***	£199.00
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00
8" **FUJITSU** M2392K 2 Gb SMD I/F RFE tested	£345.00

Many other drives in stock - Shipping on all drives is code (D)

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

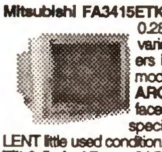
6,000,000 items EX STOCK

For ***MAJOR SAVINGS*** **- CALL OR SEE OUR WEBSITE**

VIDEO MONITOR SPECIALS

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

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



Tilt & Swivel Base £4.75 **Only £119** (E) **Order as MITS-SVGA**
VGA cable for IBM PC included.
External cables for other types of computers CALL

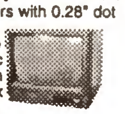
As New - Ex Demo
17" 0.28 SVGA Mitsubishi Diamond Pro monitors
Full multisync etc. Full 90 day guarantee. £325.00 (E)

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

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with **both RGB and standard composite 15.625 Khz video inputs via SCART socket** and separate phono jacks. Integral audio **power amp and speaker for all audio visual uses.** Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security** applications with **direct connection to most colour cameras.** High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £99** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13½" x 12" x 11". Good used condition. **Only £125** (E)



20" 22" and 26" AV SPECIALS

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

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

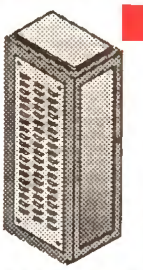
DC POWER SUPPLIES

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

LOW COST PC's

Always over 1000 PC's from stock. 1000's of spares and accessories. Call or see our web site for info.

19" RACK CABINETS



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

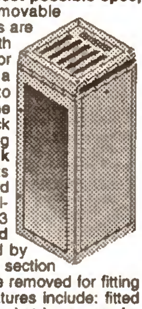
Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd.** Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the ***most versatile we have ever sold.*** Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77½" H x 32½" D x 22" W. **Order as:**

OPT Rack 1 Complete with removable side panels.	£345.00 (G)
OPT Rack 2 Rack, Less side panels	£245.00 (G)

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

32U - High Quality - All steel RakCab

Made by **Eurocraft Enclosures** Ltd to the **highest possible spec,** rack features **all steel construction** with removable side, front and back doors. Front and back doors are **hinged for easy access** and all are lockable with five **secure 5 lever barrel locks.** The front door is constructed of double walled steel with a **'designer style'** smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to **take the heaviest of 19" rack equipment.** The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A **mains distribution panel** internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin **switched utility socket.** Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvres. The top panel may be removed for fitting of **integral fans** to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in **excellent,** slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23¾" W)



Sold at LESS than a third of makers price !!

A superb buy at only £245.00 (G)

42U version of the above only £345 - CALL

BATTERY SCOOP - 50% off !!

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

RELAYS - 200,000 FROM STOCK

Save ££££'s by choosing your next relay from our Massive stocks covering types such as - Military, Octal, Cradle, Hermetically Sealed, Contactors, Time Delay, Reed, Mercury Wetted, Solid State, Printed Circuit Mounting, CALL US WITH YOUR NEEDS. Many obsolete types from stock. Save ££££'s

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with **2 Mbytes** of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. **Full data and driver disks supplied.** RFE. Fully tested and guaranteed. Windows compatible. **£59.95**

Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.
Order as: XT RAM UG. 256k. £34.95 *or* **512k £39.95**

SIMM SPECIALS

1 MB x 9 SIMM 9 chip 120ns		Only	£8.50
1 MB x 9 SIMM 3 chip 80 ns	£10.50	or 70ns	£11.95
1 MB x 9 SIMM 9 chip 80 ns	£10.50	or 70ns	£11.75
4 MB 70 ns 72 pin SIMM *-with parity-*		Only	£35.00
INTEL 486-DX33 CPU £19.95		**INTEL 486-DX66 CPU**	**£59.00**

FULL RANGE OF CO-PROCESSOR'S EX STOCK - CALL FOR £££

MOTOROLA 25 Mhz 68040 (XC68040RC25M) CPU'S £59.00

shipping charges for RAM / CPU upgrades is code B

SOFTWARE SPECIALS

NT4 WorkStation, complete with service pack 3 and licence - OEM packaged.
Special Price ONLY £99.00

Microsoft - Windows for Workgroups 3.11 & DOS 6.22. *Supplied on 3½" disks with licence & concise documentation.*	***£39.95***
DOS 5.0 on 3½" disks with concise books c/w QBasic .	***£14.95***
Wordperfect 6 for DOS supplied on 3½" disks with manual	**£24.95**

shipping charges for software is code B

TEST EQUIPMENT & SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
1kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
IBM 8230 Type 1, Token ring base unit driver	£760
Wayne Kerr RA200 Audio frequency response analyser	£2500
IBM 53F5501 Token Ring ICS 20 port lobe modules	£750
IBM MAU Token ring distribution panel 8228-23-5050N	£95
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE	£550
ALLGON 8360.11805-1880 MHz hybrid power combiners	£250
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
Marconi 2022C 10KHz-1GHz RF signal generator	£1550
Marconi 2030 opt 03 10KHz-1.3 GHz signal generator,New	£5150
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & **HP3782A** Error Detector	£POA
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP8130A opt 020 300 MHz pulse generator, GPIB etc	£8500
HP A1, A0 8 pen HPGL high speed drum plotters - from	£950
EG+G Brookdeal 95035C Precision lock in amp	£650
View Eng. Mod 1200 computerised inspection system	£POA
Sony DXC-3000A High quality CCD colour TV camera	£1100
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS - New batteries	£9500
ICI R5030UV34 Cleanline ultrasonic cleaning system	£POA
Mann Tally MT645 High speed line printer	£2200
Intel SBC 486/133SE Multibus 486 system. 8Mb Ram	£945
Siemens K4400 64Kb to 140Mb demux analyser	£2950
Intel SBC 486/125C08 Enhanced Multibus (MSA) NEW	£1450
Zeta 3220-05 A0 4 pen HPGL *fast* drum plotters	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 299B Infrared spectrophotometer A	£500
Perkin Elmer 597 Infrared spectrophotometer	£3500
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
LightBand 60 output high spec 2u rack mount Video VDA's	£495
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
Taylor Hobson Tallysurf amplifier / recorder	£750
ADC SS200 Carbon dioxide gas detector / monitor	£1450
System Video 1152 PAL waveform monitor	£485
ANRITSU 9654A Optical DC-2.5G/b waveform monitor	£5,650
ANRITSU MS9001B1 0.6-1.7 uM optical spectrum analyser	£POA
ANRITSU ML93A optical power meter	£990
ANRITSU Fibre optic characteristic test set	£POA
VISION ENGINEERING TS3 Dynascopic microscope	£1850
R&S FTDZ Dual sound unit	£650
R&S SBUF-E1 Vision modulator	£775
WILTRON 6630B 12.4 / 20GHz RF sweep generator	£5750
TEK 2445 150 MHz 4 trace oscilloscope	£1250
TEK 2465 300 MHz 300 MHz oscilloscope rack mount	£1955
TEK 1502 Portable TDR (time domain reflectometer)	£600
PHILIPS PW1730/10 XRAY generator with accessories	£POA
CLAUDE LYONS 12A 240V single phase auto. volt. regs	£325
CLAUDE LYONS 100A 240/415V 3 phase auto. volt. regs	£2900

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

DISPLAY -ELECTRONICS-

ALL MAIL & OFFICES
Open Mon - Fri 9.00 - 5:30
Dept PE , 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

LONDON SHOP
Open Mon - Sat 9:00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
Nr.Thornton Heath & Selhurst Park SR Rail Stations

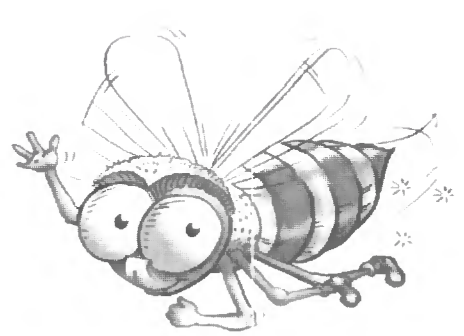
NEW **DISTEL©**
Visit our web site
www.distel.co.uk
email admin@distel.co.uk

ALL ☎ ENQUIRIES
0181 679 4414
FAX 0181 679 1927

SWITCH MasterCard VISA EST. 25 YEARS

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks, tradenames etc acknowledged. © Display Electronics 1998. E & O E. 06/98

NEXT MONTH



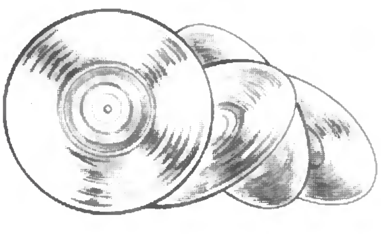
PhizzyB ★ WORLD EXCLUSIVE ★

A NEW SERIES FEATURING A UNIQUE MIXTURE OF HARDWARE AND SOFTWARE

The first construction project in this series describes how to build a simple computer called the PhizzyB, *while the software side of the project introduces the* PhizzyB *Simulator (a demonstration of this simulator is provided on the* ***FREE CD-ROM*** *– see below. In this **world exclusive** launch of the* PhizzyB *and PhizzyB Simulator, we'll show you how to create simple programs and run them in the virtual world on the PhizzyB Simulator, and to then download these programs to the* PhizzyB *and run them in the real world (note that downloading programs requires a fully-functional version of the simulator). Future issues will describe a suite of construction projects that you can connect to your real PhizzyB's input and output ports, thereby allowing the PhizzyB to sense and control things in the real world.*

This unique and innovative series will give you an in-depth understanding as to how computers perform their magic, but more importantly it'll be a mega-cool and FUN way to learn.

It's safe to say that you have NEVER seen anything like this before!



FREE CD-ROM

with every copy

Don't miss this exciting free gift, the CD-ROM contains:

- ★ ***PhizzyB*** *– multimedia introduction and demo (see above)*
- ★ *Full software for* ***25 (yes twenty-five) EPE PIC*** *and* ***8051 projects,*** *including* ***PIC TUTORIAL***
- ★ *Full software for* ***5 EPE PC projects,*** *including* ***VIRTUAL SCOPE*** *and* ***MET OFFICE***
- ★ ***EPE PIC TUTOR*** *– pre-release demo of our new CD-ROM*

PLUS

- ***DIGITAL ELECTRONICS*** *– CD-ROM demo*
- ***ELECTRONIC CIRCUITS AND COMPONENTS + THE PARTS GALLERY*** *– CD-ROM demo*
- *DEMOS OF QUICKROUTE SYSTEMS SOFTWARE –* ***The Idea Factory : Quickroute 4.0 : MExpress***
- *DEMOS OF PICO TECHNOLOGY SOFTWARE –* ***PicoScope : PicoLog : EnviroMon : osziFOX***
- *DEMO OF* ***ELECTRONICS PRINCIPLES 5.0*** *from EPT Software*
- *DEMO OF PROTEUS IV DESIGN SYSTEM –* ***ARES 4 Lite, ISIS 4 Lite*** *(shareware) and* ***LISA****, all from Labcenter Electronics*

That's over ***140 megabytes*** *of desirable digital delectation*
FREE *with the* ***NOVEMBER*** *issue.*
DON'T MISS IT, PLACE AN ORDER NOW
COPIES WILL SELL *FAST* – **You have been warned!**

PIC TAPE-MEASURE

Quite naturally, many of you will be wondering how PIC devices can be used to update some of your favourite designs. PICs are, as we are proving on frequent occasions, extremely versatile devices and can be used in many circuits to replace quite a few conventional logic chips.

Recently, the author's eye fell on his earlier L.C.D. Ultrasonic Tape Measure *(EPE Sept '92) and he began to speculate about how it, too, could be simplified using a PIC. The result (after about an hour with a soldering iron and* many *hours at the computer), is not only a PIC16C84-controlled update on the previous design, it is a quite significantly more advanced instrument.*

Taking advantage of the PIC16C84's internal EEPROM, a data store and recall facility has been programmed in as well. There is also a masking option that allows foreground echoes to be ignored.

The device can record and recall over 30 distance measurements, allowing several readings to be taken before copying them to paper – ideal when taking measurements in difficult to access locations!

NO ONE DOES IT BETTER

PLUS ALL THE REGULAR FEATURES

EVERYDAY PRACTICAL ELECTRONICS

DON'T MISS AN ISSUE – PLACE YOUR ORDER NOW!

NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 2

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60 OUTPUT 0V-260V

	Price	P&P
PANEL MOUNTING		
0·5KVA 2·5 amp max	£33.00	£6.00 (£45.83 inc VAT)
1KVA 5 amp max	£45.25	£7.00 (£61.39 inc VAT)
SHROUDED		
0·5KVA 2·5 amp max	£34.00	£6.00 (£47.00 inc VAT)
1KVA 5 amp max	£46.25	£7.00 (£62.57 inc VAT)
2KVA 10 amp max	£65.00	£8.50 (£86.36 inc VAT)
3KVA 15 amp max	£86.50	£8.50 (£111.63 inc VAT)
5KVA 25 amp max	£150.00	(+ Carriage & VAT)
10KVA 45 amp max	£300.00	(+ Carriage & VAT)
6KVA 3 PHASE Star.	£205.00	(+ Carriage & VAT)

Buy direct from the Importers. Keenest prices in the country.

500VA ISOLATION TRANSFORMER
New manuf. surplus "C Core" tropicalised with top plate and solder connections. 0-240V AC. 5-0-100-110-120V & Screen Wt 10.5K.
Size: H 195 x 155 x 135mm
Price £35.00. Carr. £7.50 (£49.94 incl.)

COMPREHENSIVE RANGE OF TRANSFORMERS–LT–ISOLATION & AUTO
110V-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

ULTRA VIOLET BLACK LIGHT BLUE FLUORESCENT TUBES
4ft 40 watt **£14.00** (callers only) (£16.45 inc VAT)
2ft 20 watt **£9.00** (callers only) (£10.58 inc VAT)
12in 8 watt **£4.80** + 75p p&p (£6.52 inc VAT)
9in 6 watt **£3.96** + 50p p&p (£5.24 inc VAT)
6in 4 watt **£3.96** + 50p p&p (£5.24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes **£6.05** + £1.40 p&p (£8.75 inc VAT)
The above Tubes are 3500/4000 angst. (350-400um) ideal for detecting security markings, effects lighting & Chemical applications. Other Wavelengths of UV TUBE available for Germicidal & Photo Sensitive applications. Please telephone your enquiries.

400 WATT BLACK LIGHT BLUE UV LAMP
GES Mercury Vapour lamp suitable for use with a 400W P.F. Ballast.
Only **£39.95** incl. p&p & VAT

RANGE OF XENON FLASHTUBES
Write/Phone your enquiries

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.

5 KVA ISOLATION TRANSFORMER
As New Ex-Equipment, fully shrouded, Line Noise Suppression, Ultra Isolation Transformer with terminal covers and knock-out cable entries. Primary 120V/240V, Secondary 120V/240V, 50/60Hz, 0·005pF Capacitance. Size, L 37cm x W 19cm x H 16cm, Weight 42 kilos. Price **£120** + VAT. Ex-warehouse. Carriage on request.

24V DC SIEMENS CONTACTOR
Type 3TH8022-0B 2 x NO and 2 x NC 230V AC 10A. Contacts. Screw or Din Rail fixing. Size H 120 x W 45 x D 75mm. Brand New Price **£7.63** incl. P&P and VAT.

240V AC WESTOOL SOLENIODS
TT2 Mod. 1 Rat. 1 Max. stroke 5/8in. Base mounting ½in. stroke 5lbs pull approx. **TT6** Mod. 1 Rat. 1 Max. stroke 1 in. Base mounting ½in. stroke 15lbs pull approx. **SERIES 400** Mod. 1 Rat. 2 Max. stroke 11/8in. Front mounting ½in. stroke 15lbs pull approx. Price incl. p&p & VAT. **TT5 £5.88, TT6 £8.81, SERIES 400 £7.64.**

AXIAL COOLING FAN
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price **£7.29** incl. P&P and VAT.
Other voltages and sizes available from stock. Please telephone your enquires.

INSTRUMENT CASE
Brand new. Manufactured by Imhof. L 31 x H 18 x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price **£16.45** incl. P&P and VAT. 2 off **£28.20** inclusive.

DIE CAST ALUMINIUM BOX
with internal PCB guides. internal size 265 x 165 x 50mm deep. Price £9.93 incl. p&p & VAT. 2 off £17.80 incl.

230V AC SYNCHRONOUS GEARED MOTORS
Brand new Ovoid Gearbox Crouzet type motors. H 65mm x W 55m x D 35mm, 4mm dia. shaft x 10mm long.
6 RPM anti cw. £9.99 incl. p&p & VAT.
20 RPM anti cw. Depth 40mm. £11.16 incl. p&p & VAT.

SOLID STATE EHT UNIT
Input 230V/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, e.g. supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS.

EPROM ERASURE KIT
Build your own **EPROM ERASURE** for a fraction of the price of a made-up unit. Kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit **£15.00** + £2.00 p&p (£19.98 inc VAT)

WASHING MACHINE WATER PUMP
Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1½in., outlet 1in. dia. Price includes p&p. & VAT. **£11.20** each or 2 for **£20.50** inclusive.

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
TEL: 0181-995 1560 FAX: 0181-995 0549
ACCOUNT CUSTOMERS MIN. ORDER £10

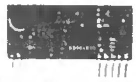
Open Monday/Friday

Ample Parking Space

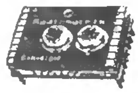
Radio - Tech

Radio Modules at Lower Prices than any catalogue, Guaranteed !

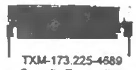
TXM-418-A or F Transmitter



SILRX-418-A or F, Receiver



BIM-418-F
Approved to MPT1340



TXM-173.225-4689
Security Transmitter

RXM-173.225-4666-60
VHF Security Receiver

Part	Catalogue RRP**	Our Price
TXM-418-A (9V) TXM-418-F (3V)	£ 14.50	£ 10.99
SILRX-418-A or SILRX-418-F	£ 29.95	£ 22.48
BIM-418-F BIM-433-F	£ 58.00	£ 49.92
TXM-173.225 (1mW) or TXM-173.225- (10mW) *	£ 42.00	£ 20.48
RXM-173-4666	£ 64.75	£ 24.65

**Typical Catalogue Company RRP effective Jan 1998 ex VAT

Prices Exclude VAT and Carriage. P & P add £1.50 for orders < £ 100.00 otherwise £6.00 of next day delivery.

Telephone Sales 01992 576107
Fax 01992 561994

http://www.radio-tech.co.uk e-mail: sales@radtec.demon.co.uk

FREE!
FREE!
FREE!
FREE!
FREE!
FREE!
FREE!

OUR 1998 CATALOGUE AND LATEST BARGAIN LIST ABSOLUTELY FREE!

PHONE, FAX OR WRITE TODAY!

GREENWELD
ELECTRONIC COMPONENTS

27D Park Road · Southampton · SO15 3UQ
TELEPHONE: 01703 236363 FAX: 01703 236307
E-Mail: greenweld@aol.com INTERNET: http://www.greenweld.co.uk

1098

ESR ELECTRONIC COMPONENTS

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

All Major Credit cards Accepted SWITCH SOLO

Prices Exclude Vat @17½%. Add £1.25 carriage & Vat to all orders. Cheques / Postal orders payable to ESR Electronic Components.

See Next/Last Months Ad. for COMPONENT ACCESSORIES

4000 Series

4000	£0.17
4001	£0.18
4002	£0.17
4006	£0.40
4007	£0.18
4008	£0.23
4009	£0.19
4010	£0.23
4011	£0.18
4012	£0.16
4013	£0.19
4014	£0.30
4015	£0.24
4016	£0.28
4017	£0.24
4018	£0.27
4019	£0.48
4020	£0.36
4021	£0.31
4022	£0.32
4023	£0.16
4024	£0.32
4025	£0.15
4026	£0.78
4027	£0.25
4028	£0.34
4029	£0.40
4030	£0.17
4031	£0.61
4034	£1.24
4035	£0.31
4040	£0.32
4041	£0.31
4042	£0.22
4043	£0.28
4044	£0.35
4046	£0.54
4047	£0.32
4048	£0.28
4049	£0.22
4050	£0.26
4051	£0.38
4052	£0.32
4053	£0.40
4054	£0.56
4055	£0.34
4060	£0.31
4063	£0.29
4066	£0.19
4067	£2.20
4068	£0.16
4069	£0.20
4070	£0.25
4071	£0.23
4072	£0.17
4073	£0.17
4075	£0.17
4076	£0.30
4077	£0.28
4078	£0.20
4081	£0.21
4082	£0.21
4085	£0.28
4086	£0.26
4089	£0.55
4093	£0.23
4094	£0.29
4095	£0.56
4097	£1.20
4098	£0.48
4099	£0.38
4502	£0.38
4503	£0.40
4508	£1.40
4510	£0.36
4511	£0.38
4512	£0.32
4514	£0.77
4515	£0.99
4516	£0.44
4518	£0.44
4520	£0.41
4521	£0.62
4526	£0.40
4527	£0.40
4528	£0.40
4529	£0.44
4532	£0.32
4534	£3.24
4536	£1.00
4538	£0.37
4541	£0.33
4543	£0.49
4555	£0.32
4556	£0.40
4560	£1.18
4566	£1.96
4572	£0.25
4584	£0.24
4585	£0.47
4724	£0.94
40106	£0.24
40109	£0.58
40163	£0.46
40174	£0.46
40175	£0.36
40193	£0.60

74 Series

7407	£0.40

74HC Series

74HC00	£0.19
74HC02	£0.21
74HC03	£0.21
74HC04	£0.17
74HC08	£0.21
74HC10	£0.16
74HC11	£0.20
74HC14	£0.22
74HC20	£0.28
74HC27	£0.16
74HC30	£0.22
74HC32	£0.20
74HC42	£0.36
74HC73	£0.40
74HC74	£0.22
74HC75	£0.40
74HC76	£0.20
74HC85	£0.24
74HC86	£0.22
74HC107	£0.40
74HC123	£0.33
74HC125	£0.26
74HC126	£0.46
74HC132	£0.37
74HC133	£0.29
74HC138	£0.25
74HC139	£0.31
74HC151	£0.33
74HC153	£0.27
74HC154	£0.85
74HC157	£0.40
74HC158	£0.23
74HC160	£0.64
74HC161	£0.28
74HC162	£0.45
74HC163	£0.26
74HC164	£0.35
74HC165	£0.35
74HC173	£0.38
74HC174	£0.27
74HC175	£0.35
74HC192	£0.72
74HC195	£0.32
74HC240	£0.37
74HC241	£0.37
74HC243	£0.48
74HC244	£0.42
74HC245	£0.46
74HC251	£0.30
74HC253	£0.25
74HC257	£0.25
74HC259	£0.57
74HC273	£0.32
74HC299	£0.64
74HC356	£0.45
74HC365	£0.34
74HC367	£0.25
74HC368	£0.25
74HC373	£0.35
74HC374	£0.40
74HC390	£0.52
74HC393	£0.38
74HC423	£0.37
74HC553	£0.42
74HC563	£0.56
74HC564	£0.48
74HC573	£0.38
74HC574	£0.45
74HC595	£0.39
74HC640	£0.73
74HC688	£0.64
74HC4002	£0.31
74HC4017	£0.64
74HC4020	£0.36
74HC4040	£0.36
74HC4049	£0.31
74HC4050	£0.25
74HC4051	£0.40
74HC4060	£0.44
74HC4075	£0.27
74HC4078	£0.32
74HC4511	£0.64
74HC4514	£0.84
74HC4538	£0.41
74HC4543	£0.90

74LS Series

74LS00	£0.23
74LS01	£0.14
74LS02	£0.26
74LS03	£0.29
74LS04	£0.21
74LS05	£0.14
74LS08	£0.23
74LS09	£0.14
74LS10	£0.14
74LS11	£0.17
74LS12	£0.14
74LS13	£0.29
74LS14	£0.21
74LS15	£0.14
74LS20	£0.16
74LS21	£0.14
74LS22	£0.14
74LS26	£0.14
74LS27	£0.14
74LS30	£0.20
74LS32	£0.21
74LS37	£0.14
74LS38	£0.19
74LS40	£0.14
74LS42	£0.42
74LS47	£0.58
74LS51	£0.24
74LS73	£0.40
74LS74	£0.32
74LS75	£0.30
74LS76	£0.40
74LS83	£0.38
74LS85	£0.48
74LS86	£0.25
74LS90	£0.48
74LS92	£0.45
74LS93	£0.42
74LS107	£0.30
74LS109	£0.21
74LS112	£0.24
74LS113	£0.21
74LS114	£0.36
74LS122	£0.31
74LS123	£0.31
74LS125	£0.27
74LS126	£0.25
74LS132	£0.21
74LS133	£0.36
74LS136	£0.23
74LS138	£0.40
74LS139	£0.24
74LS145	£0.56
74LS148	£0.64
74LS151	£0.25
74LS153	£0.40
74LS154	£0.70
74LS155	£0.25
74LS156	£0.36
74LS157	£0.22
74LS158	£0.21
74LS160	£0.48
74LS161	£0.32
74LS162	£0.44
74LS163	£0.32
74LS164	£0.24
74LS165	£0.48
74LS170	£0.30
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.60
74LS191	£0.24
74LS192	£0.60
74LS193	£0.24
74LS195	£0.24
74LS196	£0.24
74LS197	£0.24
74LS221	£0.40
74LS240	£0.32
74LS241	£0.32
74LS242	£0.32
74LS243	£0.30
74LS244	£0.32
74LS245	£0.36
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS266	£0.14
74LS273	£0.32
74LS279	£0.25
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS373	£0.33
74LS374	£0.34
74LS375	£0.34
74LS377	£0.32
74LS378	£0.62
74LS390	£0.25
74LS393	£0.24
74LS395	£0.26
74LS399	£0.62
74LS670	£0.69

Linear ICs

AD524AD	£23.04
AD548JN	£1.62
AD590JH	£5.28
AD592AN	£4.52
AD595AQ	£12.65
AD620AN	£9.88
AD625JN	£16.20
AD633JN	£8.09
AD648JN	£2.57
AD654JN	£6.73
AD708JN	£5.69
AD711JN	£1.51
AD712JN	£2.38
AD736JN	£8.75
AD797AN	£8.69
AD811N	£5.85
AD812AN	£6.32
AD817AN	£3.85
AD820AN	£3.20
AD822AN	£5.20
AD829JN	£6.41
AD830AN	£5.99
AD847JN	£5.71
AD9696KN	£7.73
ADEL2020A	£5.06
ADM222AH	£3.55
ADM232AA	£3.55
ADM485JN	£2.97
ADM690AN	£5.13
ADM691AN	£6.48
ADM695AN	£6.48
ADM699AN	£3.58
CA741CE	£0.26
CA747CE	£0.39
CA3046	£0.37
CA3059	£1.33
CA3080E	£0.73
CA3130E	£0.87
CA3140E	£0.49
CA3189E	£1.22
CA3240E	£1.12
DG211CJ	£1.55
DG212CJ	£1.55
DG411DJ	£3.11
ICL7106	£2.95
ICL7611DCP	£0.75
ICL7621	£1.70
ICL7660SCP	£1.68
ICL8038	£3.84
ICM7555	£0.32
ICM7556	£0.98
L165V	£2.72
L272M	£1.86
L293E	£4.35
L297	£5.71
L298	£6.26
L6219	£4.48
LF347N	£0.46
LF351N	£0.43
LF353N	£0.40
LF356	£0.84
LM301A	£0.25
LM308N	£0.58
LM311N-8	£0.29
LM318	£0.98
LM319N-14	£0.90
LM324	£0.24
LM335Z	£1.08
LM339N	£0.24
LM348N	£0.31
LM358N	£0.27
LM380N	£0.88
LM381N	£2.64
LM386	£0.79
LM392N	£0.79
LM393N	£0.21
LM709T	£0.79
LM748CN-8	£0.37
LM1458	£0.32
LM1881	£3.92
LM2917N8	£3.10
LM3900N	£0.72
LM3909N	£0.72
LM3914	£2.16
LM3915	£2.70
LM13600	£1.66
LMC660CN	£1.44
LMC6032IN	£1.55
LP311N	£0.74
LP324N	£0.67
LP339N	£0.73
LT1013CN8	£3.94
MAX202CPE	£2.97
MAX208CN	£6.99
MAX220CPE	£5.06
MAX222CPE	£5.06
MAX232CPE	£1.80
MAX483CP	£3.13
MAX485CP	£2.56
MAX631ACP	£4.99
MAX635ACP	£4.99
MAX1232CP	£2.96
MC1488	£0.39
MC1489	£0.39
MC3302	£0.56
MC3340P	£1.60
MC4558P	£0.33
MV601DP	£2.97
NE521N	£6.39
NE555N	£0.21
NE556N	£0.36
NE565	£1.84
NE566N	£0.90
NE567N	£0.39
NE571N	£2.47
NE592	£0.62
NE5532N	£0.45
NE5534N	£0.64
NE5539N	£4.35
OP07CN	£1.42
OP27CN	£2.90
OP77GP	£1.99
OP90GP	£3.11
OP97FP	£2.43
OP113GP	£3.44
OP176GP	£2.09
OP177GP	£1.89
OP200GP	£5.60
OP213FP	£5.20
OP275GP	£2.57
OP282GP	£2.27
OP283GP	£5.20
OP290GP	£5.40
OP297GP	£5.74
OP400GP	£11.81
OP495GP	£8.69
RC4136	£1.00
SAA1027	£4.49
SG3524N	£0.96
SG3543	£6.88
SSM2017P	£3.38
SSM2131P	£4.19
SSM2141P	£4.21
SSM2142P	£6.16
SSM2143P	£3.78
TBA120S	£0.90
TBA800	£0.70
TBA810S	£0.64
TBA820M	£0.40
TDA1170S	£4.80
TDA2004	£3.11
TDA2030	£1.18
TDA2050V	£3.12
TDA2611A	£1.88
TDA2822A	£0.86
TED3718DP	£5.03
TEA5115	£3.11
TL061CP	£0.35
TL062CP	£0.60
TL064CN	£0.72
TL071CP	£0.39
TL072CP	£0.32
TL074CN	£0.48
TL081	£0.29
TL082CP	£0.54
TL084CN	£0.50
TL494CN	£1.46
TL7705ACP	£1.62
TLC271	£0.54
TLC272	£0.88
TMP01FP	£5.60
ULN2003	£0.52
ULN2004A	£0.48
ULN2803	£0.90
ULN2804A	£1.64
XR2206	£4.22

EPROM's

2716	£4.74
2732	£4.84
2764-20	£4.26
27C64-25	£3.44
27128-20	£4.08
27C128-15	£3.02
27256-20	£4.85
27C256-20	£3.68
27C512-15	£2.56
27C1001-20	£3.02
27C4001-120	£9.76

RAM

4164-15	£1.90
6116-10	£1.56
6264-10	£3.16
41256-10	£2.80
62256-10	£4.22
514256-8	£6.80

A/D Converters Data Acquisition

AD420AN	£25.38
AD557JN	£8.75
AD574AJN	£18.48
AD775JN	£18.48
AD7528JN	£11.42
AD7545AKN	£14.04
AD7828KN	£20.33
DAC0800	£2.72
ICL7109CPL	£7.75
TLC549IP	£3.04
ZN427E	£9.25
ZN448E	£7.34

µControllers

AT89C2051	£6.43
12C508-04P	£1.22
16C54A04P	£3.07
16C54JW	£12.48
16C71-04P	£4.88
16C71JW	£17.34
16F84-04P	£3.40

PHONE FOR OTHER DEVICES

Voltage Regulators

7805	£0.29
7806	£0.32
7808	£0.35
7812	£0.38
7815	£0.38
78L05	£0.23
78L06	£0.32
78L08	£0.23
78L12	£0.23
78L15	£0.24
78L24	£0.39
78S05	£0.70
78S12	£0.70
78S15	£0.98
7905	£0.40
7912	£0.30
7915	£0.38
7924	£0.38
79L05	£0.23
79L12	£0.23
79L15	£0.20
79L24	£0.30
ADM666AN	£3.44
L200CV	£1.30
L296	£6.87
L387A	£3.24
LM2940CT	£2.30
LM317LZ	£0.30
LM317T	£0.48
LM323K	£2.84
LM334Z	£1.35
LM337T	£0.68
LM338K	£5.52
LM338T	£3.38
LM723	£0.29
LP2950CZ	£2.70
REF01CP	£3.44
REF02CP	£4.66
REF12Z	£1.28
REF195GP	£4.72
REF25Z	£1.24
REF50Z	£1.22
TL431CP	£0.45
ZN423	£1.00
ZN458B	£1.89

Diodes

1N914	£0.06
1N916	£0.06
1N4001	£0.04
1N4002	£0.04
1N4003	£0.04
1N4004	£0.04
1N4005	£0.04
1N4006	£0.04
1N4007	£0.05
1N4148	£0.05
1N4149	£0.06
1N5400	£0.09
1N5401	£0.08
1N5402	£0.08
1N5404	£0.09
1N5406	£0.10
1N5407	£0.10
1N5408	£0.11
6A05	£0.27
6A1	£0.27
6A2	£0.27
6A4	£0.28
6A6	£0.29
6A8	£0.30
6A10	£0.37
BA157	£0.10
BA158	£0.10
BA159	£0.10
BAT41	£0.24
BAT42	£0.10
BAT46	£0.20
BAT49	£0.36
BAT85	£0.17
BAV21	£0.07
BAW62	£0.07
BAX13	£0.05
BAX16	£0.05
BB405B	£0.26
BB909A	£0.36
BB909B	£0.36
BY126	£0.13
BY127	£0.18
BY133	£0.10
OA47	£0.24
OA90	£0.07
OA91	£0.26
OA200	£0.56
OA202	£0.29
Zeners 2.7 to 33V 500mW	£0.08
1.3W	£0.14

Bridge Rectifiers

1.5A 50V	£0.19
1.5A 200V	£0.20
1.5A 400V	£0.22
1.5A 600V	£0.22
1.5A 800V	£0.27
1.5A 1kV	£0.24
3A 200V	£0.36
3A 400V	£0.40
3A 600V	£0.33
6A 200V	£0.70
6A 800V	£0.59
10A 400V	£1.39
25A 200V	£1.68
25A 600V	£1.80

Thyristors

C106D	£0.30
PO102AA	£0.30
TIC116D	£0.66
TIC126D	£0.77

Triacs

ZO105DA	£0.42
TIC206D	£0.65
TIC226D	£0.94
BTA08-600B	£0.88
TIC236D	£1.12

Diac, Si. Switch

DB3, 32V	£0.16
BRY39	£1.30

Transistors

2N1613	£0.31
2N1711	£0.26
2N1893	£0.29
2N2218A	£0.28
2N2219A	£0.25
2N2222A	£0.18
2N2646	£1.12
2N2904A	£0.25
2N2905A	£0.25
2N2907A	£0.17
2N2926	£0.16
2N3053	£0.27
2N3054	£0.85
2N3055	£0.58
2N3439	£0.62
2N3440	£0.50
2N3702	£0.09
2N3703	£0.10
2N3704	£0.10
2N3705	£0.10
2N3706	£0.10
2N3771	£1.44
2N3772	£1.51
2N3773	£1.70
2N3819	£0.34
2N3820	£0.66
2N3904	£0.10
2N3905	£0.10
2N3906	£0.10
2N4036	£0.34
2N5245	£0.80
2N5296	£0.57
2N5401	£0.11
2N5460	£0.54
2N5551	£0.11
2N6107	£0.60
2N6491	£1.58
2SB548	£0.30
2SD1730	£1.44
AC126	£0.44
AC127	£0.50
AC128	£0.72
AC187	£0.68
AC188	£0.96
ACY17	£3.84
AD149	£1.67
AD161	£0.92
AD162	£0.92
BC107	£0.16
BC107B	£0.17
BC108	£0.14
BC108B	£0.16
BC108C	£0.15
BC109	£0.17
BC109C	£0.17
BC114	£0.19
BC115	£0.41
BC116	£0.41
BC118	£0.41
BC132	£0.36
BC134	£0.36
BC135	£0.36
BC140	£0.25
BC141	£0.27
BC142	£0.34
BC143	£0.38
BC149	£0.21
BC154	£0.36
BC157	£0.12
BC159	£0.17
BC160	£0.28
BC170	£0.16
BC170B	£0.16
BC171	£0.11
BC171B	£0.16
BC172	£0.13
BC172B	£0.13
BC177	£0.18
BC178	£0.18
BC179	£0.18
BC179A	£0.17
BC182	£0.11
BC182A	£0.11
BC182B	£0.12
BC182L	£0.08
BC182LB	£0.10
BC183	£0.08
BC183L	£0.08
BC183LB	£0.08
BC184	£0.08
BC184L	£0.08
BC186	£0.33
BC204C	£0.72
BC206B	£0.72
BC208	£0.72
BC209A	£0.72
BC212	£0.08
BC212L	£0.08
BC212LB	£0.08
BC213	£0.08
BC213B	£0.08
BC213LC	£0.08
BC214	£0.08
BC214L	£0.08
BC225	£0.15
BC237B	£0.09
BC238B	£0.09
BC238C	£0.09
BC239C	£0.10
BC250A	£0.15
BC252	£0.13
BC261B	£0.30
BC262B	£0.24
BC267B	£0.30
BC307	£0.10
BC308	£0.10
BC319C	£0.13
BC327	£0.10
BC327-25	£0.10
BC328	£0.10
BC328-16	£0.10
BC337	£0.10
BC337-25	£0.10
BC338	£0.10
BC338-25	£0.10
BC348B	£0.14
BC357	£0.25
BC393	£0.73
BC441	£0.40
BC461	£0.46
BC463	£0.29
BC478	£0.32
BC479	£0.32
BC516	£0.21
BC517	£0.17
BC527	£0.20
BC528	£0.20
BC537	£0.20
BC546B	£0.08
BC546C	£0.08
BC547B	£0.09
BC547C	£0.09
BC548C	£0.08
BC549C	£0.10
BC550C	£0.10
BC556A	£0.08
BC557B	£0.08
BC557C	£0.08
BC558B	£0.08
BC559C	£0.08
BC560A	£0.09
BC560B	£0.09
BC637	£0.21
BC638	£0.21
BC639	£0.21
BC640	£0.13
BCY70	£0.22
BCY71	£0.20
BCY72	£0.20
BD124P	£6.86
BD131	£0.52
BD135	£0.21
BD136	£0.21
BD137	£0.23
BD138	£0.22
BD139	£0.25
BD140	£0.25
BD150C	£0.82
BD165	£0.42
BD166	£0.35
BD187	£0.39
BD201	£0.40
BD202	£0.70
BD203	£0.70
BD204	£0.40
BD225	£0.42
BD232	£0.50
BD237	£0.32
BD238	£0.44
BD240C	£0.37
BD244A	£0.53
BD245C	£1.18
BD246	£1.18
BD246C	£1.18
BD283	£0.61
BD284	£0.61
BD400	£0.79
BD441	£0.41
BD442	£0.37
BD534	£0.47
BD535	£0.50
BD536	£0.65
BD581	£0.62
BD597	£0.92
BD646	£0.52
BD648	£0.52
BD650	£0.53
BD807	£0.80
BDX32	£1.78
BDX33C	£0.56
BDX34C	£0.50
BDX53C	£0.47
BDX54C	£0.50
BF180	£0.31
BF182	£0.31
BF185	£0.58
BF194	£0.31
BF194B	£0.19
BF195	£0.14
BF244	£0.35
BF244B	£0.35
BF244C	£0.35
BF257	£0.33
BF259	£0.33
BF337	£0.40
BF355	£0.38
BF423	£0.13
BF451	£0.19
BF459	£0.33
BF469	£0.36
BFX29	£0.29
BFX84	£0.31
BFX85	£0.32
BFY50	£0.30
BFY51	£0.24
BFY52	£0.28
BS107	£0.21
BS170	£0.23
BSW66	£1.35
BU126	£1.32
BU205	£1.41
BU208A	£1.24
BU326A	£1.40
BU500	£1.54
BU508A	£1.30
BU508D	£0.96
BU526	£1.74
BU806	£1.06
BUT11A	£0.57
BUT11AF	£1.14
BUX84	£0.78
IRF530	£0.48
IRF540	£1.26
IRF740	£1.88
MJ2501	£1.60
MJ3001	£1.80
MJ11015	£2.45
MJ11016	£2.56
MJE340	£0.40
MJE350	£0.48
MPSA05	£0.14
MPSA06	£0.11
MPSA13	£0.12
MPSA42	£0.17
MRF475	£7.28
TIP29C	£0.31
TIP30C	£0.37
TIP31C	£0.41
TIP32C	£0.41
TIP33C	£0.72
TIP41A	£0.38
TIP42C	£0.39
TIP47	£0.48
TIP48	£0.62
TIP50	£0.53
TIP121	£0.45
TIP122	£0.46
TIP125	£0.46
TIP127	£0.40
TIP132	£0.46
TIP137	£0.56
TIP142	£1.30
TIP147	£1.12
TIP2955	£0.97
TIP3055	£0.70
VN10KM	£0.48
ZTX300	£0.16
ZTX500	£0.16
ZTX653	£0.33

No Minimum Order Value

Electrolytic Radial

µF	16v	25v	40v	63v	100v
0.47	---	---	---	£0.05	---
1.0	---	---	---	£0.05	£0.05
2.2	---	---	---	£0.05	---
4.7	---	---	£0.05	£0.05	£0.05
10	£0.05	£0.05	£0.05	£0.05	£0.09
22	£0.05	£0.05	£0.05	£0.07	£0.11
33	£0.05	---	£0.05	---	---
47	£0.05	£0.05	£0.07	£0.10	£0.19
100	£0.06	£0.06	£0.10	£0.13	£0.26
220	£0.08	£0.09	£0.13	£0.25	---
330	£0.09	---	£0.19	---	---
470	£0.12	£0.17	£0.24	£0.33	---
1000	£0.21	£0.33	£0.34	£0.75	---
2200	£0.27	£0.55	£0.70	---	---
3300	---	£0.94	---	---	---
4700	£0.67	£1.05	---	---	---

Electrolytic Axial

µF	16v	25v	40v	63v	100v	250v	450v
0.47	---	---	---	---	---	---	---
1.0	---	---	---	£0.13	---	---	£0.22
2.2	---	---	---	£0.13	---	---	£0.30
4.7	---	---	---	£0.13	---	---	£0.41
10	£0.12	---	£0.12	£0.13	£0.17	£0.40	£0.67
22	£0.12	£0.13	£0.14	£0.15	£0.21	£0.52	£1.06
33	---	---	---	---	---	---	---
47	£0.13	£0.13	£0.15	£0.19	£0.32	£0.57	---
100	£0.14	£0.16	£0.19	£0.26	£0.44	---	---
220	£0.19	£0.20	£0.27	£0.39	£0.48	---	---
330	---	---	---	---	---	---	---
470	£0.24	£0.28	£0.43	£0.53	---	---	---
1000	£0.33	£0.43	£0.59	£1.08	---	---	---
2200	£0.53	£0.66	£1.11	£1.55	---	---	---
3300	---	---	---	---	---	---	---
4700	£0.86	£1.11	---	---	---	---	---

We carry a large range of capacitors in stock, including:
Ceramic Mini Disc, Dipped Ceramic Multilayer, Dipped & Boxed Polyester, Mylar Film, Polystyrene, MKT Polyester, Tantalum Bead, Sub-miniature Radial, 105 C Radial, Low Leakage Radial, Non Polarised Radial, PCB Can Electrolytics, Polypropylene & Ceramic Trimmers and Tuning, Dilecon & O Type Variable capacitors. Full technical details available.

Resistors - Please State Value Required

per 100 of one value only

1/8W Carbon Film 5%	E12 Series	10Ω-1M0	£0.02 Each, £0.80 per 100
¼W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.60 per 100
¼W Metal Film 1%	E24 Series	10Ω-1M	£0.04 Each, £1.72 per 100
½W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.95 per 100
2.5W Wirewound 5%	E12 Series	0Ω1-220Ω	£0.23 Each

1W & 2W Carbon Film in stock - selected values only, contact sales dept. for details.

Preset Resistors - Please State Value Required

Enclosed, 10mm Square Horz / Vert.	100Ω - 1M0 0.15W	£0.15 Each
Skeleton, 10mm Dia. Horizontal.	100Ω - 1M0 0.1W	£0.11 Each
Sub-min, 6mm Dia, Horizontal	E3 200Ω-1M0 0.1W	£0.19 Each
Multiturn, 10mm Square, Top Adjust.	E3 100Ω-1M0 0.5W	£0.89 Each
Multiturn, 19mm Long, End Adjust.	E3 50Ω-1M0 0.5W	£0.60 Each

Potentiometers - Please State Value Required

Single Gang ¼" Shaft, 25mm Dia.	470Ω-2M2 Linear	£0.49 Each
Single Gang ¼" Shaft, 25mm Dia.	4k7,10k,47k,100k,1M,2M2 Log	£0.49 Each
Dual Gang ¼" Shaft, 20mm Dia.	1K0-2M2 Linear	£1.62 Each
Dual Gang ¼" Shaft, 20mm Dia.	1K0-2M2 Logarithmic	£1.71 Each
Switched ¼" Shaft, 20mm Dia.	1K0-2M2 Linear	£1.56 Each
Switched ¼" Shaft, 20mm Dia.	1K0-2M2 Logarithmic	£1.69 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω-1M0 Linear	£0.42 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω,4k7,100k,1M0 Log	£0.42 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k,100k,500k Lin	£0.85 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k,100k,500k Log	£0.85 Each

Tel: 0191 2514363 Fax: 0191 2522296 Email: sales@esr.co.uk http: //www.esr.co.uk

EVERYDAY PRACTICAL ELECTRONICS

VOL. 27 No. 10 OCTOBER '98

Editorial Offices:
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
ALLEN HOUSE, EAST BOROUGH, WIMBORNE
DORSET BH21 1PF
Phone: Wimborne (01202) 881749
Fax: (01202) 841692. **Due to the cost we cannot reply to overseas orders or queries by Fax.**
E-mail: editorial@epemag.wimborne.co.uk
Web Site: http://www.epemag.wimborne.co.uk
See notes on **Readers' Enquiries** below – we regret lengthy technical enquiries cannot be answered over the telephone.
Advertisement Offices:
EVERYDAY PRACTICAL ELECTRONICS
ADVERTISEMENTS
MILL LODGE, MILL LANE
THORPE-LE-SOKEN, ESSEX CO16 0ED
Phone/Fax: (01255) 861161

FREE

Next month we will be giving away a CD-ROM with every copy of *EPE* and, unlike some magazines which push up the cover price to cover the cost, this will be completely FREE with your copy. Of course, the fact that it's free does not mean much if it is also not very good, but our CD-ROM will be valuable to every hobbyist, student and professional with access to a PC. In addition to demo versions of seventeen different electronics related packages from various suppliers, some of which are working cut down versions of the full software, there are also full versions of the *EPE* PIC projects software for past and some future projects. That's twenty-five *EPE* PIC projects in all, plus full software for five PC based *EPE* projects including John Becker's *Virtual Scope* and *Met Office*.

The main reason for producing this CD-ROM is, however, to introduce our new *PhizzyB* series from Clive (Max) Maxfield, Alvin Brown and Alan Winstanley. This exciting "world first" series starts next month and demo software for it is also on the CD-ROM. For more information turn to page 699.

DON'T MISS OUT

With the proliferation of magazines on UK bookstalls (there are now over three thousand consumer titles to choose from), it's becoming more difficult to get specialist magazines like *EPE* into smaller newsagents. Whilst any newsagent should be able to "shop save" a copy for you – provided you ask him to – there is no guarantee that you will be able to buy a copy if you don't do this. By the way, if you do ask for a "shop save" you are under no obligation to buy the magazine if you are not happy with the content when the newsagent hands it to you. *EPE* is on full sale or return, so your newsagent can send it back if it is not sold.

Of course, with a very special gift on the front cover, magazines do tend to disappear very rapidly and we suggest that if you want to make sure of your copy next month then place an order **NOW**. Alternatively, you could subscribe, save some money against the cover price of twelve copies, make sure of your magazine every month and even get it before it appears on the bookstalls (UK copies) – you don't even have to plod down to the newsagents to pick it up!

Mike Kenward

AVAILABILITY

Copies of *EPE* are available on subscription anywhere in the world (see right), from all UK newsagents (distributed by Seymour) and from the following UK electronic component retailers: Maplin – all stores throughout the UK (and in S. Africa); Greenweld Electronics; Omni Electronics. *EPE* can also be purchased from retail magazine outlets around the world.

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £26.50. Overseas: £32.50 standard air service, £50 express airmail. Cheques or bank drafts (**in £ sterling only**) payable to *Everyday Practical Electronics* and sent to EPE Subscriptions Dept., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692. **E-mail:** subs@epemag.wimborne.co.uk. Subscriptions start with the next available issue. We accept MasterCard or Visa. (For past issues see the *Back Issues* page.)

BINDERS

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

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

READERS' ENQUIRIES

E-mail: techdept@epemag.wimborne.co.uk
We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons. Due to the cost we cannot reply to overseas 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 (see *Shoptalk*).

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

ADVERTISEMENTS

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

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

The Alternative Oscilloscope

Pico Technology provides an alternative to costly, bulky and complicated oscilloscopes. The ADC range of virtual instrumentation enables your PC to perform as an oscilloscope, spectrum analyser and digital multimeter.

- Upto 100 MS/s sampling and 50 MHz spectrum analysis
- A fraction of the price of comparable benchtop DSOs
- Simple Windows based user interface

The practical alternative

Connection to a PC gives virtual instruments the edge over traditional

"...the most powerful, flexible test equipment in my lab."

oscilloscopes: the ability to print and save waveforms is just one example. Advanced trigger modes, such as save to disk on trigger, make tracking down elusive intermittent faults easy. Combining several instruments into one small unit means it is lighter and more portable. When used with a notebook computer, field engineers can carry a complete electronics lab in their PC.

The simple alternative

Virtual instruments eradicate the need for bewildering arrays of switches and dials associated with traditional 'benchtop' scopes. The units are supplied with PicoScope for Windows software.

Controlled using the standard Windows interface, the software is easy to use with full on line help. Installation is easy and no configuration is required; simply plug into the parallel port and it is ready to go. We provide a two year guarantee and free technical support via phone, fax or E-mail.

FROM £59

The low cost alternative

The Pico range of PC based oscilloscopes work with your PC - anything from a dustbin-ready 8086 to the latest pentium. The PicoScope software utilises your monitor to display data. This gives you a larger, clearer display than any scope, at a fraction of the price.

The savings don't stop there: All those expensive upgrades needed for traditional oscilloscopes: such as FFT maths, disk drives and printers are already built into your computer. The PC has made computing affordable, now Pico has made test equipment affordable too.

Seeing is understanding

Call for a FREE demo disk or visit our web site.
Fax: (0)1954 211880 Tel: (0)1954 211716
E:mail: post@picotech.co.uk http:www.picotech.com

Broadway House 149-151 St Neots Road Hardwick Cambridge CB3 7QJ UK

pico® Technology Limited

The complete monitoring system

Temperature
Open Door
Humidity
Light

The *EnviroMon* system, from Pico Technology is one of the most versatile and cost effective monitoring systems on the market today. It can measure temperatures from -55 to 300°C, check light and humidity levels or record the position of a switched system. Its applications are endless; from food storage & preparation to energy management.

At the core of the system is the logger, which stores up to 15,000 readings and displays them from each sensor in turn. Reports can be printed on a stand-alone printer or data sent to a PC for long term storage and graphical analysis using the powerful supplied software, EnviroMon for Windows.

The EnviroMon system records data 24 hours a day, 365 days a year, even if the mains power fails. Should a parameter goes out of range, it alerts you with various alarms or a telephone message.

***EnviroMon* Starter kit ..... £395 + VAT**

Call for full product range *and* FREE demo disk or visit our web site.

Pico Technology Limited, Broadway House, 149-151 St. Neots Rd, Hardwick, Cambridge, CB3 7QJ UK
Tel: 01954 -211716 Fax: 01954 -211880
E-mail: post@picotech.co.uk http:www.picotech.com

pico® Technology Limited

The best things come in small packages

Only
£80
exc. VAT

- Up to 20 MS/s
- Sample rates from 50ns to 1ms

Oscilloscopes are becoming smaller and lighter: Now Pico Technology brings you the latest development, the **osziFOX** hand held scope.

Despite its small size, its performance can match that of a service oscilloscope. With sampling rates of up to 20 MSs, even signals in microprocessor circuits can be measured. The osziFOX is ideal for taking measurements in digital circuits, telephone installations, hobby electronics, production line tests and on-the-spot measuring.It provides the ultimate in portability and flexibility.

As with the rest of the Pico Technology range, the PC link gives the osziFOX the edge: the ability to print and save waveforms is just one example.

Complete price £98.11 including VAT + P&P (UK), cables and software included.

Tel: 01954 -211716 Fax: 01954 -211880
E-mail: post@picotech.co.uk
Visit our web site: www.picotech.com
Pico Technology Limited, Broadway House, 149-151 St. Neots Rd, Hardwick, Cambridge, CB3 7QJ

Constructional Project

VOICE PROCESSOR

TERRY de VAUX-BALBIRNIE

A fun-box that will play tricks with your voice.

THIS sound processor is designed to be used with an inexpensive microphone and domestic audio system or amplifier. It will then provide a variety of changes to the speaking or singing voice. The most important of these is frequency-shifting but there is also a Vibrato and Robot effect.

HARMONIZING

The Voice Processor circuit may be used for parties, Karaoke evenings, for special purposes such as amateur stage productions and for DJ work. A useful feature of the design is that the processed voice may be used alone or combined with the normal (unprocessed) one. The effect will then sound like two separate people or a comic voice singing along with the normal one.

This will not necessarily give accurate harmony but then the result is not meant to be taken too seriously. The performances may, of course, be recorded and this probably provides the most amusing effect of all.

Before proceeding, check that your audio system or amplifier has a suitable input. The output of this unit is at a high level so high-level input sockets such as those labelled "Aux" (auxiliary) will work well.

Although great fun to use, this unit does have limitations. The digital sampling used in the circuit has a relatively low degree of resolution and the results cannot be regarded as "professional". Having said that, the system works well and will be perfectly suitable for most purposes providing they are not taken too seriously.

CHANGING VOICES

Frequency-shifting will make the voice sound deeper or more high-pitched than it really is. In this circuit, there are six stages of frequency changing plus "normal" – that is, three higher and three lower ones. These are referred to in the text as Up 1, 2, 3 and Down 1, 2, 3.

Extreme settings (Up 3 and Down 3) will only be useful for "fun" purposes and for special applications. In practice, those which will probably be most used are the two effects above and below normal.

The result of frequency-shifting is reminiscent of playing an old vinyl disc at the wrong speed. If a disc intended for playing at 45r.p.m. were to be played at 33r.p.m., all the frequencies contained in the music would be moved downwards by a factor of 33/45 and vice versa. The musical content would, however, remain the same.

Extreme effects could be obtained by playing a 33r.p.m. disc at 78r.p.m. giving the effect of more than doubling the frequencies (that is, raising them by more than one octave). However, when playing records at the wrong speed "real time" is distorted.

It will be appreciated that one second of recorded material will be either increased or reduced in time when this is done. By contrast, this circuit works in real time so that one second of speaking or singing will still occupy one second after processing. This makes it possible to sing along with one's own normal voice.

The following gives the factors by which the original frequency is multiplied by each stage:

UP 3	2	NORMAL 1	DOWN 1	0·89
UP 2	1·6		DOWN 2	0·8
UP 1	1·33		DOWN 3	0·67

A maximum upward shift of one octave may not seem very much but, in fact, it produces a dramatic effect on the voice.

Vibrato can be applied to any of the frequency changes. This works by modulating the audio output at a frequency of 8Hz giving a slightly wobbling result.

Robot operation can only be used as it stands – it *cannot* be combined with any other effect. This really needs to be heard to be described. It provides a sound rather like the popular perception of a robot used in plays and TV programmes.

It works by "chopping" the audio signal up at a rapid rate and leaving a small gap between the sections. However, this effect is very "heavy" and is really only suitable for special purposes.

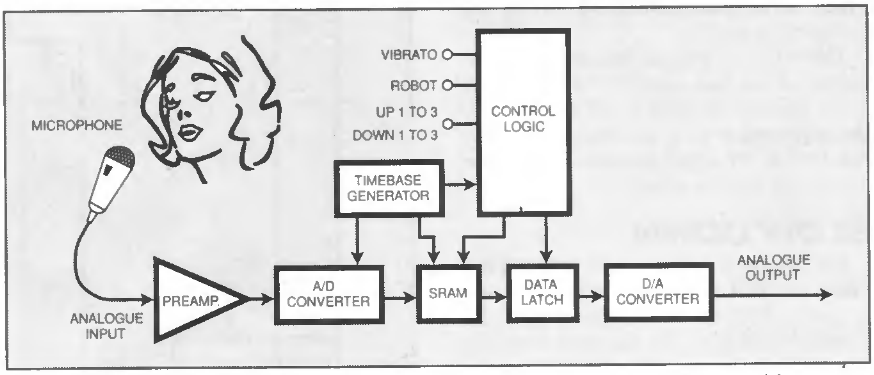


Fig.1. Simplified block diagram for the HT8950 voice modulator chip.

VOICE MODULATOR

Voice processing effects such as those described above and operating in real time were difficult to produce before the age of digital electronics. However, in this circuit all the processing is carried out by a single digital "voice modulator" integrated circuit which is encapsulated in a standard 18-pin d.i.l. package.

The specified HT8950 device uses complex large-scale integration and only a working explanation will be given here. A simplified block diagram for the HT8950 voice modulator i.c. is shown in Fig.1.

The input preamplifier boosts the microphone (analogue) signal and passes it to the A/D Converter where it is changed into digital data (a stream of ON and OFF states). The timebase generator contains an oscillator which synchronises when data is drawn out of the A/D Converter and passed on to memory (SRAM) also when data in memory is sent to the data latch.

The control logic, synchronised by signals from the timebase generator, modifies data in memory to provide vibrato and robot special effects. It also determines the rate at which data is passed through to the D/A Converter to give the various stages of frequency shifting.

The D/A Converter changes the digital data into a smoothly changing (analogue) signal which is made available at the output (analogue out).

As well as the signal processing and control circuitry there is an array of SRAM (static random access memory) and a microphone preamplifier. Thus, the device requires only a few external components to make a working system.

In this design, the output from the voice processor i.c. is input to a mixer which serves to combine the processed and unprocessed signals if required. This part will be described presently.

HOW IT WORKS

Referring to Fig.1 again, the microphone converts incoming sound into a weak analogue (smoothly changing) voltage. This is input to the preamplifier which boosts it by a factor of 120. It is then sampled at 8kHz (that is 8,000 times per second) and the result passed to an 8-bit analogue to digital (A/D) converter. The data then flows to memory for short-term storage.

For frequency-changing, the control circuit then clocks out data at a higher or lower rate than it was put in and inputs it to a data latch and hence to an 8-bit digital to analogue (D/A) converter. This changes the information back into analogue form which is then amplified and fed to the loudspeaker system.

The effect is that all frequencies in the sample of original sound are shifted either up or down in frequency. All the processing takes place very quickly so it seems that the output signal appears at the same time as the input is given.

SLOW DOWN

Unfortunately, the system has limitations. An 8kHz sampling rate is too low to give a faithful representation of music (compare this with the standard sampling rate of 44·1kHz used for a CD). However, it is sufficient for the restricted frequency range of the voice.

Also, the 8-bit resolution of the A/D and D/A converters is rather small. These are the chief reasons why hi-fi quality sound cannot be realised by this circuit.

A supply of between 2·4V and 4V is suitable for the sound processor i.c. Note that 5·5V is the *absolute maximum* voltage so on no account use a 6V or 9V battery to test the circuit.

The standby current requirement of the entire circuit (including mixer circuit) is about 20mA and this rises somewhat while speaking or singing into the microphone. In normal use, the specified battery pack will provide about 100 hours of operation.

CIRCUIT DESCRIPTION

The full circuit diagram for the Voice Processor is shown in Fig.2. IC1 is the 8950 voice modulator chip referred to earlier.

The nominal 4·5V battery pack B1, consisting of three "AA" size alkaline cells, is connected to the circuit via on-off

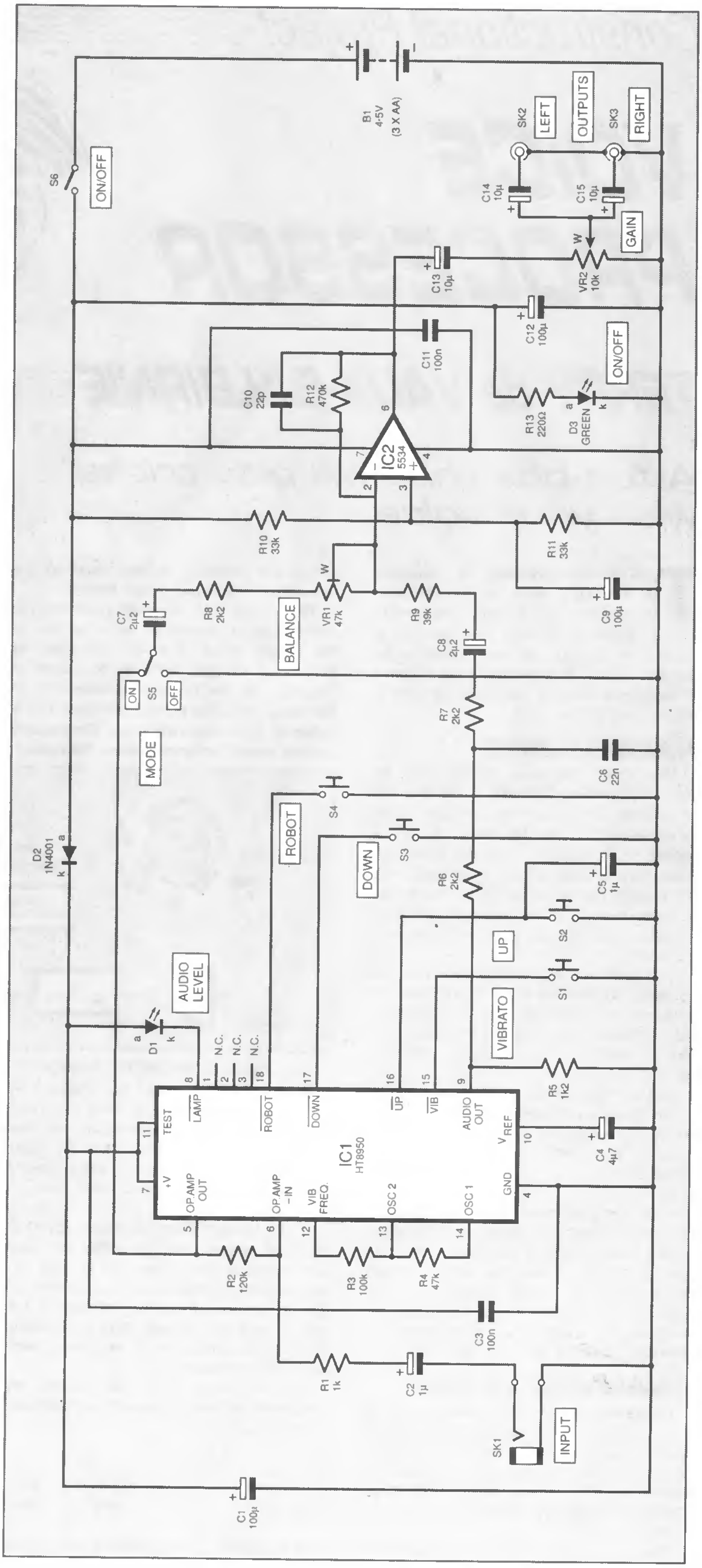


Fig.2. Complete circuit diagram for the Voice Processor.

switch S6. IC1 receives its supply via diode D2 and since this introduces a voltage drop of some 0·7V, the effective supply voltage is only 3·8V.

One of the effects of diode D2 is to split the power supply between voice processor and mixer sections of the circuit so that there is no interaction between the two. The other is to put IC1 supply voltage within the "ideal" working range. Capacitors C1 and C3 decouple the voice processor circuit.

The first three pins of IC1 are unused. These would be needed to operate the effects *direct* using external electronic circuits. Pin 7 and pin 4 are the positive and 0V supply connections respectively. Pin 11 is a test pin. This is not needed and is simply connected to the positive supply rail.

Resistor R3 connected between pins 12 and 13 controls the vibrato frequency. Resistor R4 connected between pins 13 and 14 controls the frequency of the system oscillator at some 512kHz.

The on-chip preamplifier referred to earlier, takes the form of an operational amplifier (op.amp). Pin 5 and pin 6 access its output and inverting input respectively.

By connecting an input resistor (R1) and a feedback resistor (R2), this is configured as an inverting amplifier. The gain is determined by the ratio of feedback to input resistor – that is R2/R1.

With the values specified, this is set at 120. The fact that the signal is inverted is of no consequence. If the gain is found to be unsatisfactory at the end, it could be adjusted by changing to the value of resistor R2 but this should not be necessary.

The input signal from the microphone, at socket SK1, is applied via blocking capacitor C2 to the free end of resistor R1 which is connected to the internal preamplifier input of IC1 at pin 6. An on-chip voltage reference sets a bias voltage on the op.amp non-inverting input, pin 10, and this is decoupled by capacitor C4.

DOWN THE SINK

Pin 8 sinks current into D1, a red l.e.d. (light emitting diode) from the positive supply line. It needs no series resistor because current control takes place on the chip. This is the audio level indicator.

This is useful because it is a characteristic of this type of circuit that there must be sufficient audio input for the internal A/D converter of IC1 to "see it" and therefore to produce any output at all. Also, too high an audio signal will result in distortion.

The effects (vibrato, up and down frequency-shifting plus robot) are enabled by making one of pins 15 to 18 of IC1 go *low* momentarily. This is the purpose of push-button switches S1 to S4. The pins have on-chip pull-up resistors which effectively keep the effect normally off and prevent false operation.

Capacitor C5 removes the annoying characteristic of IC1 which normally defaults to Robot mode when switched on. Robot operation will probably be the least-used effect. So, to prevent it becoming active on powering-up, C5 keeps the Up pin (pin 16), *low* for a short time.

This has the same effect as if the Up button had been pressed once. Thus, the system will start up with the lowest stage of frequency shifting (Down 3). After a short time, C5 will be fully charged via the internal pull-up resistor and its upper end remains high. It therefore has no further effect.

The audio output appears at pin 9 of IC1. This is in the form of a *current* rather than a voltage, with about 1mA flowing on silence. Resistor R5 allows the current to pass to 0V and provide a voltage across it according to Ohm's Law.

The signal then flows to the network consisting of resistors R6 and R7 in conjunction with capacitor C6 The effect is to provide a satisfactory input to one channel of the mixer. Also, capacitor C6 having a low impedance at high frequencies bypasses most of the "digital noise" which appears at IC1 output.

An unprocessed ("normal") but boosted signal is derived from the output of IC1 preamplifier at pin 5. This is applied to the other channel of the mixer via the Mode switch S5 while *on*.

MIXING IT

Now look at the audio signal mixer stage, IC2 in Fig.2, which is based around a NE5534 low-noise op.amp. The mixer uses the same power supply as that for the voice processor section. However, it receives the full nominal 4·5V since it is not subject to the voltage drop of diode D2.

The mixer also has its own decoupling capacitors, C11 and C12. Green light-emitting diode D3 is the *on* indicator with its current limited by resistor R13.

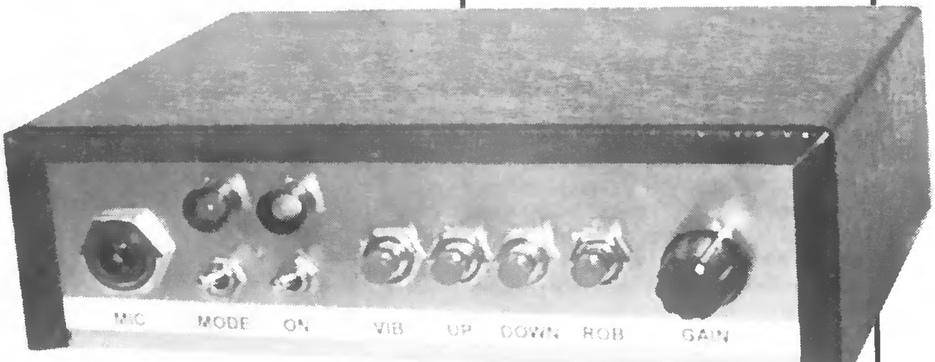
Operational amplifier IC2 has been selected for its claimed good audio performance and low noise characteristic. The supply is connected to pin 7 (+4·5V) and pin 4 (0V).

The op.amp is configured as a *summing amplifier*. Thus, it receives two independent signals at the ends of its input resistors. These are R8 in conjunction with preset potentiometer VR1 (for the first channel) and R9 (for the other one).

The common end of the input resistors is connected to IC2 inverting input (pin 2). The non-inverting input (pin 3) is biased at a voltage equal to one-half that of the supply due to the potential divider action of equal resistors R10 and R11.

As far as a.c. signals are concerned, it is virtually at 0V due to the low impedance of capacitor C9. Signals applied to the inputs are "mixed" and appear in combined form at the output (pin 6) of IC2.

The ratio of the value of feedback resistor R12 to that of the corresponding input resistor determines the voltage gain of that channel. Capacitor C10 presents a low



COMPONENTS

Resistors

R1	1k
R2	120k
R3	100k
R4	47k
R5	1k2
R6, R7, R8	2k2 (3 off)
R9	39k
R10, R11	33k (2 off)
R12	470k
R13	220Ω

All 0·25W 5% carbon film

See SHOP TALK Page

Potentiometers

VR1	47k min. enclosed carbon preset, vertical
VR2	10k min. rotary carbon, log.

Capacitors

C1, C9, C12	100μ p.c.b. mounting radial elec. 6·3V (3 off)
C2, C5	1μ p.c.b. mounting radial elec. 63V (2 off)
C3	100n polyester, 5mm pin spacing
C4	4μ7 p.c.b. mounting radial elec. 63V
C6	22n polyester, 5mm pin spacing
C7, C8	2μ2 p.c.b. mounting radial elec. 63V (2 off)
C10	22pF polystyrene
C11	100n polyester, 2·5mm pin spacing
C13, C14, C15	10μ p.c.b. mounting radial elec. 63V (3 off)

Semiconductors

D1	5mm l.e.d., red
D2	1N4001 1A 50V rect. diode
D3	5mm l.e.d., green
IC1	HT8950 voice modulator
IC2	NE5534N low-noise op.amp

Miscellaneous

SK1	6·35mm mono jack socket
SK2, SK3	single-hole fixing chassis phono socket (2 off)
S1 to S4	s.p.s.t. pushswitch, press-to-make (4 off)
S5	s.p.d.t. toggle, rocker or slide switch
S6	s.p.s.t. toggle, rocker or slide switch
B1	4·5V battery pack (3 off AA size alkaline cells) and holder

Printed circuit board available from *EPE PCB Service*, code 203; aluminium, vinyl-effect box, size 152mm × 114mm × 44mm; 8-pin d.i.l. socket; 18-pin d.i.l. socket; plastic knob; multistrand connecting wire; cable ties; plastic feet (4 off); solder tag; solder etc.

Approx Cost Guidance Only £24 excluding case & batts.

impedance to high-frequency signals and prevents any tendency of the circuit to oscillate.

BALANCING ACT

Looking at the second "processed" channel of the mixer first, the gain is 470/39 which is 12 approximately. The other "straight-through" or "unprocessed" channel has an adjustable gain according to the setting of preset VR1. At minimum adjustment, this will be 470/2·2 or about 200 and at maximum, 470/49·2 or 10 approximately.

The input signals are applied via blocking capacitors C7 and C8. The processed signal is applied via C8 and therefore receives a boost of 12 times. The unprocessed signal is applied to C7 via Mode switch S5 while *on*. This has the adjustable gain.

Preset potentiometer VR1 will be adjusted so that the processed and unprocessed signals provide a good "balanced" mixture and the result sounds "right". When S5 is switched *off*, the mixer input is connected to 0V and this prevents any unwanted noise from being picked up along the wiring and being passed to the output. The purpose of switch S5 will be explained presently.

The output from IC2 is applied to the top end of Gain control VR2, via capacitor C13. This functions as a Volume control accessible from outside the case and serves to select a proportion of the audio signal.

Signals from the sliding contact (w) of VR2 pass to the common ends of capacitors C14 and C15. The other ends of these capacitors feed the audio signals, via SK2 and SK3, to the left (L) and right (R) stereo channels of the external amplifier. Note that this is a mono circuit but the output is split equally between the left and right channels so that the sound emerges from both speakers.

The existence of control VR2 saves having to make frequent adjustments to the main amplifier Volume control. The amplifier volume is simply set so that the loudest required sound is given when VR2 is set to maximum. After that, VR2 is used to make any changes to the volume.

CONTROL PANEL

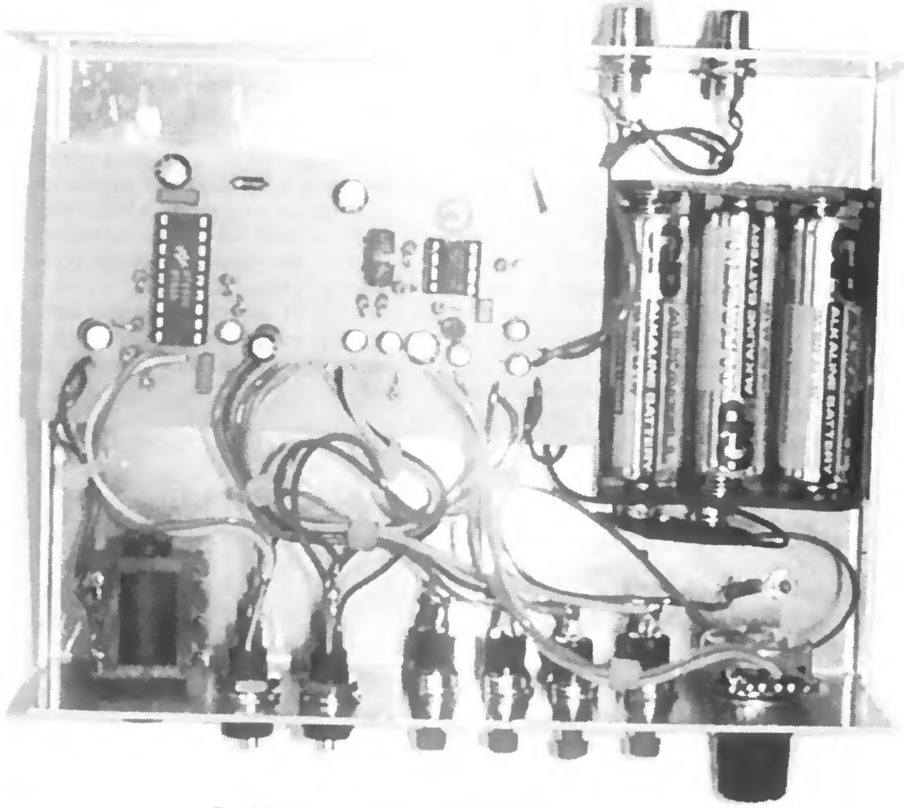
The Voice Processor appears as a small battery-powered unit (see photographs). The case has a microphone jack socket and four pushbutton switches on the front panel. The first gives Vibrato and the next two Up and Down frequency-shifting respectively.

The fourth switch provides the Robot effect. There is an on-off switch and a further ("mode") switch which may be used to select the processed signal alone or combine it with the unprocessed one.

There are also two l.e.d.s (light-emitting diodes) – the first (green) is the On-Off indicator. The other (red) one flickers when sound is picked up by the microphone. This functions as the sound level monitor referred to earlier. This enables the user to speak or sing with the microphone at the correct distance.

There are a pair of phono sockets on the back panel for connection to an external amplifier.

The Up and Down switches cycle – that is, they scan through the effects – *up*, *down* and *robot* in sequence. For example,



Positioning of components inside the case.

starting from Normal the Up switch would provide UP 1, Up 2, Up 3; Robot; Down 3, Down 2, Down 1 and back to Normal. Either switch could therefore be used to give the desired effect by pressing it the necessary number of times, but it will be reached quicker by using one or the other switch.

In practice, it is easier to produce *robot* by using its own switch. It is cancelled by pressing the Up or Down switch. The *Vibrato* effect can only be achieved by pressing the Vibrato switch. This toggles – that is, one press enables the effect, the second switches it off.

CONSTRUCTION

Note that this circuit should be constructed in a ***metal*** *case. This provides the common "earth" return for the phono*

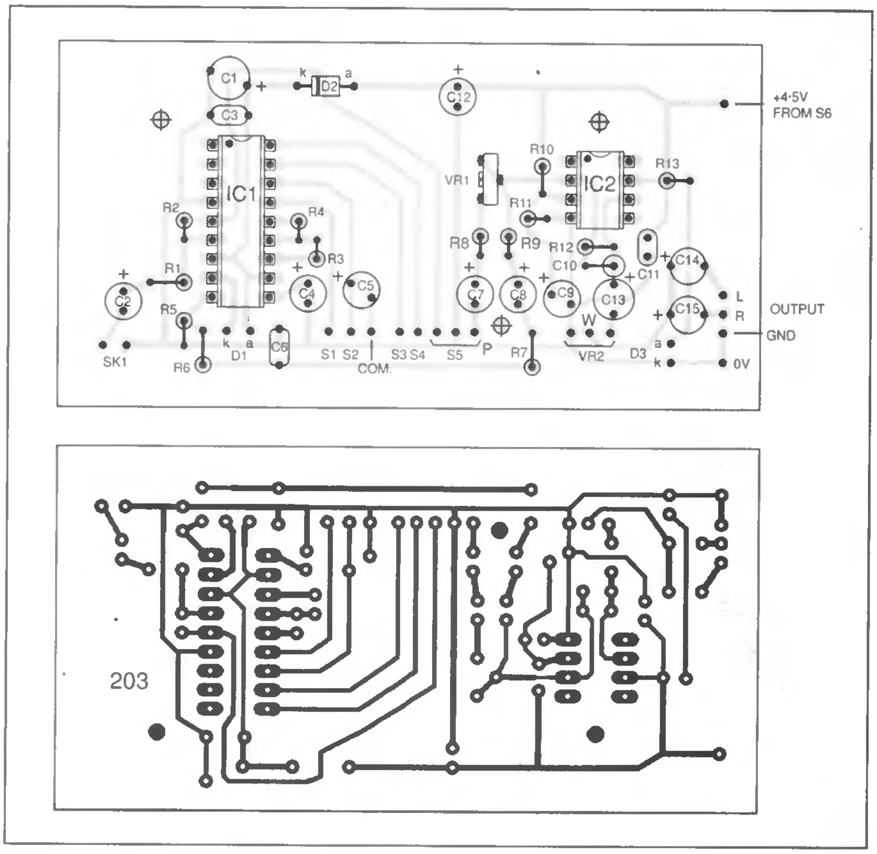


Fig.3. Printed circuit board component layout and full size underside copper foil master pattern for the Voice Processor.

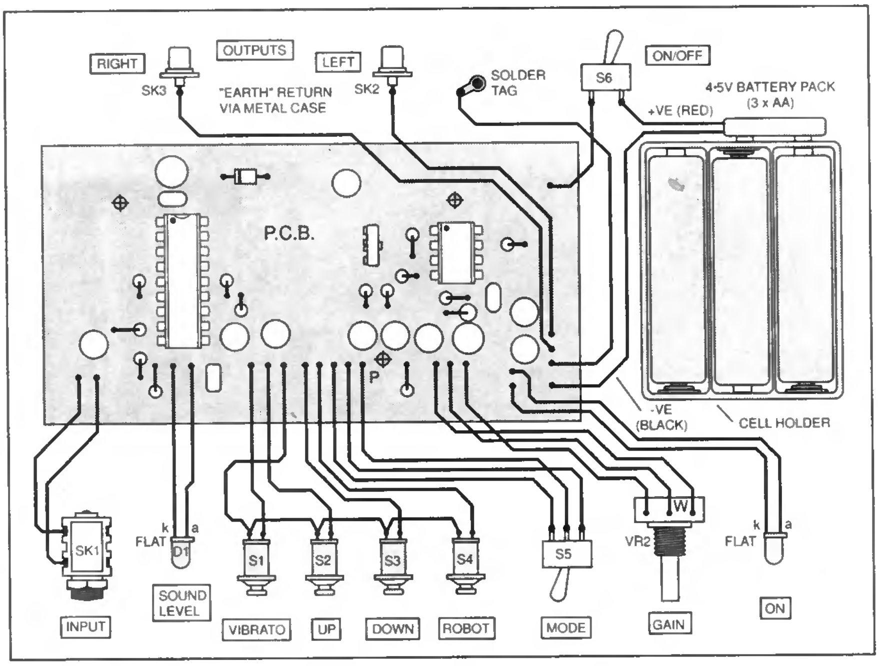


Fig.4. Interwiring from the circuit board to off-board components.

sockets SK2 and SK3. It also helps to screen the circuit from external electrical noise.

The printed circuit board (p.c.b.) component layout and full size underside copper foil master pattern for the Voice Processor are given in Fig.3. This board is available from the *EPE PCB Service*, code 203.

Begin construction by mounting and soldering the i.c. sockets in position. Follow by mounting all on-board components in place, taking care to solder diode D2 and the electrolytic capacitors with their correct polarity orientation.

Solder short pieces of light-duty stranded connecting wire to the points labelled: SK1, D1, S1, S2, Com, S3, S4, S5, VR2, D3, +4·5V and GND (ground). Solder the negative wire of the battery connector to the 0V pad.

In view of the large number of wires which lead from the circuit panel, it would be a good idea to use different colours (such as "rainbow" ribbon cable). This will reduce the chances of making a mistake when connecting them up later.

Grouping the wires into bundles using cable ties will also make them look neat and reduce the possibility of making mistakes. Adjust the sliding contact of VR1 to approximately three-quarters of its total clockwise rotation (as viewed from IC1).

Having double-checked the p.c.b. for any errors and possible solder track "bridges", insert the i.c.s into their holders, taking care over their orientation. Immediately before unpacking IC1, touch something which is earthed (such as a water tap) to remove any static charge which might have accumulated on the body.

This is a CMOS device and could be damaged if these precautions are not observed. IC2 is a bipolar device and does not require any particular care during handling.

CASE PREPARATION

Prepare the box by marking out the positions of the p.c.b. mounting holes on the base. Remember to leave space for the cell holder (see photograph). Mark the positions of the cell holder fixing holes and that for the "earthing" solder tag.

Mark the front panel with the positions of the jack socket SK1, the l.e.d. indicators, the six switches (four "effects" push switches plus the on-off and mode toggle switches) and potentiometer VR2 (see photographs). Mark the position of the phono sockets on the rear panel. Drill all these holes and mount the components.

Note that when using the specified phono sockets, the solder tags supplied with them may be discarded before fitting them since the "common" (ground) connection is made through the metalwork of the box. Mount the p.c.b. using short plastic stand-off insulators on the bolt shanks so that it stands at least 5mm above the base of the box.

INTERWIRING

Refer to Fig.4 and complete the internal wiring. Note the connection between the "GND" wire and the solder tag. This completes the return path to the outer (sleeve) connections of the phono sockets. If phono sockets of a different type are used (where the sleeve connection does not make direct contact with the metalwork), it will be necessary to make these connections by hard-wiring them to the solder tag.

When connecting the jack socket SK1, note that the tip connection is made to the copper pad leading to capacitor C2. When connecting the l.e.d indicators, take care over the polarity or they will not work.

Use pieces of sleeving on the leads if they are likely to touch anything else. Also, make sure the soldered connections are kept well separated to avoid short circuits.

When wiring the mode switch S5, make the connections in such a way that when in the *Up* positions, only the processed signal passes through. Also, note the common connection to switches S1 to S4 which is soldered to the "common" pad.

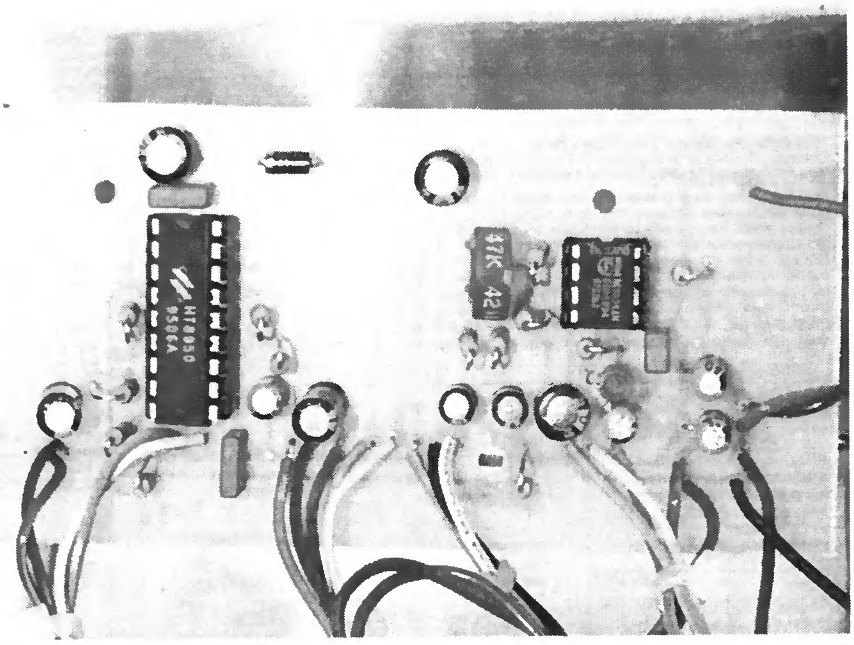
When wiring up VR2, it is important to connect the wires as shown in Fig.4. This will enable it to operate in the conventional sense – that is, clockwise rotation will increase the volume. Switch On-Off switch S6 *off*.

TESTING

Before carrying out a running test, insert the three 1·5V cells in the holder and connect it up. Turn the Gain control right down (fully anti-clockwise). Plug a microphone into the input socket SK1 (any inexpensive dynamic type having an impedance of about 600 ohms should work well). Switch S5 "off" (Up) – that is, to give the processed voice only.

Make up a connecting lead using twin-screened cable, otherwise use a ready-made lead. This should have a pair of phono plugs on one end and connectors appropriate to the main amplifier input on the other. Using this, connect the Voice Processor to the amplifier input sockets (note that it does not matter in which sense this is done because this is not true stereo).

Adjust the main amplifier Volume control to about one-quarter of its total clockwise travel and switch it on. Switch on the Voice Processor noting that the green l.e.d. (D3) lights. The red l.e.d. may also flash momentarily.



Components mounted on the finished printed circuit board.

Press the Up button three times and turn up the gain control slightly. Speak into the microphone at a distance of about 30cm. Above a certain volume, the red l.e.d. (D1) will be seen to flash. It does not actually need to be flickering for the level to be "right".

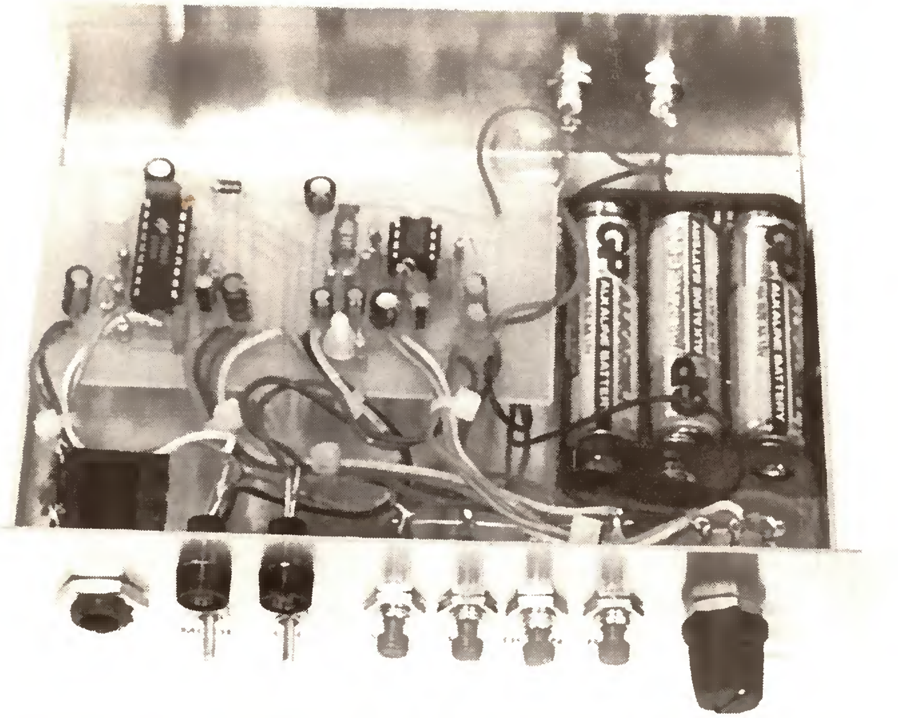
However, if it flickers too much or is on continuously, the level is too high and distortion will result. You should hear your voice emerging from the loudspeakers.

Turn up the Gain control to the point where acoustic feedback occurs then down again until it stops. If necessary, adjust the amplifier volume control.

Acoustic feedback is a nuisance with any audio system. It happens because sound from the speakers re-enters the microphone and establishes a feedback loop.

This usually manifests itself by a loud howling or squealing sound. You can minimise it by keeping the gain control turned down, speaking more closely into the microphone and using a unidirectional microphone facing away from the speakers.

Press the Up button repeatedly and note the effect each time. Try the effects of the Down, Vibrato and Robot switches. To cancel vibrato, press the switch again. To get out of Robot, press the Up or Down switch.



Components mounted on the front panel of the metal case. The phono output sockets are mounted on the rear panel.

FINISHING OFF

Now place the Mode switch S5 in the *on* position – i.e. to give processed and unprocessed voice – beware of acoustic feedback! Test, and adjust Balance preset VR1 until there is a good balance between the processed and direct voice. Clockwise rotation of the sliding contact (as viewed from IC1 position) increases the unprocessed gain.

It may be difficult to do this because you can hear your own voice direct. To make it easier to assess the results, make recordings and get the adjustment right by trial and error.

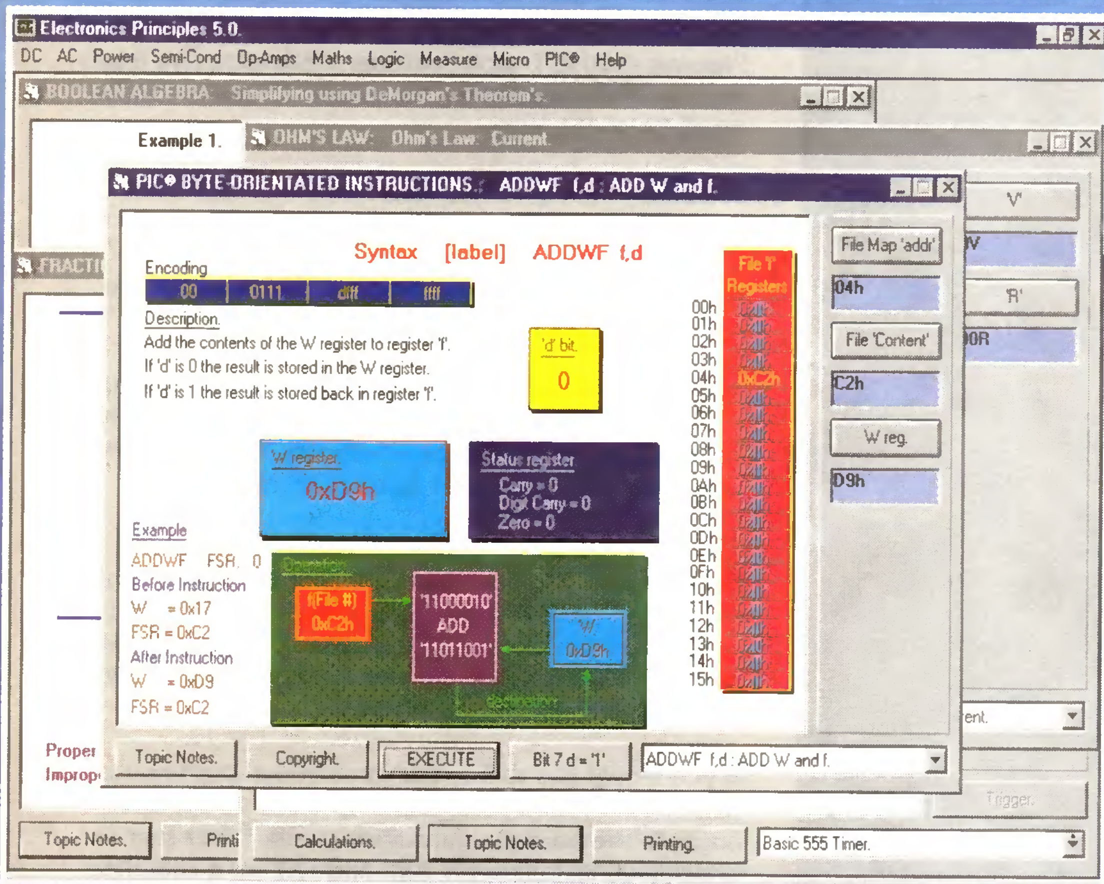
It only remains to secure the lid of the case and make labels for the controls. It would also be a good idea to fit the base of the case with self-adhesive plastic feet to protect the work surface.

Electronics Principles 5.0

'A COMPLETE PC BASED ELECTRONICS COURSE'

If you are looking for an easy and enjoyable way of studying or improving your knowledge of electronics then this is the software for you.

Now includes the PIC16F84 & PIC16C71 hardware and instruction set.

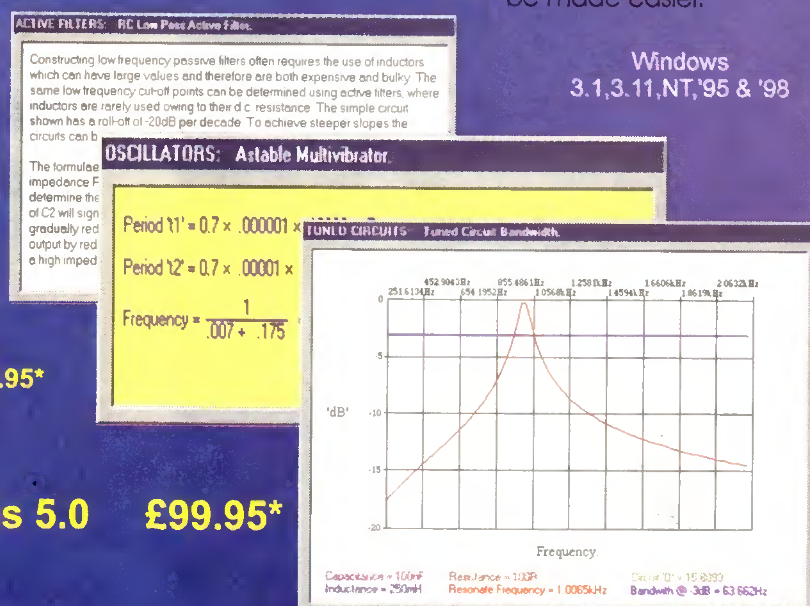


EP5.0 is a significant upgrade of our popular electronics software with even more analogue, digital and microprocessor electronics. PLUS over a hundred new engineering maths topics to further your understanding of formulae and calculations. Approved by Microchip, the PIC16F84 microcontroller hardware and instruction set has been introduced and brought to life through colourful interactive graphics where you can study the architecture of this device by changing the data values to simulate all of the registers and the complete instruction set, including direct/indirect addressing, program/data memory and input/output port configuration. In addition the analogue to digital functions of the PIC16C71 device. If you would like to learn more about the principles of these popular microcontrollers then it could not be made easier.

Electronics Principles software is currently used in hundreds of UK and overseas schools and colleges to support City & Guilds, GCSE, A-Level, BTEC and university foundation courses.

Telephone for a list of the 560 topics included.

Windows 3.1,3.11,NT,'95 & '98



Available separately as individual modules.

1. **DC Principles £19.95***
2. **AC Principles £19.95***
3. **Transistor & Op-Amp Principles £19.95***
4. **Engineering Mathematics Principles £19.95***
5. **Digital Principles £19.95***
6. **Microprocessor Principles £19.95***
7. **PIC Principles £19.95***

Complete Electronics Principles 5.0 £99.95*

EPT Educational Software. Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ.
Tel/Fax: 01376 514008. sales@eptsoft.demon.co.uk http://www.eptsoft.demon.co.uk
*UK and EC countries add £2 per order for post & packing. VAT should be added to the total.
Outside Europe £3.50 for air mail postage by return.
Switch, Delta, Visa and Mastercard orders accepted - please give card number and expiry date.
Cheques & Postal Orders should be made payable to EPT Educational software.

Innovations

A roundup of the latest Everyday News from the world of electronics

WINDOWS 98 PROBLEMS

Barry Fox reports that upgrading from Win 95 to Win 98 is causing problems for some users.

REPORTS are coming in of problems with Microsoft's Windows 98. Hardware and software vendors are issuing warnings. Microsoft remains silent on the matter because any apology or even acknowledgement of the difficulties some users are experiencing could leave the software giant open to claims for working time lost on getting PCs working again after an upgrade to Win 98. Three clear issues are emerging:

The automated upgrade process, from Windows 95 to Windows 98, can crash if the registry which Windows keeps of software previously loaded and unloaded is in anyway corrupt. Microsoft has said that this will only affect "power users" who continually try new software and hardware. But in practice most PC users are unwittingly power users, because of the free and trial software which is frequently given away with magazines or sent out as direct marketing shots.

Drivers, the software which controls peripherals such as modems, decoder cards and disk drives, fail to work. Although Microsoft pledged that drivers written for Windows 95 would also be compatible with Windows 98, this is not always the case.

The third problem relates to BIOS, the basic input/output system software which is frozen into ROM chips inside every PC to control boot-up. Whether Windows 98 works correctly often appears to depend on whether the PC's BIOS is new or old. But there is no clear definition of what is new and old BIOS.

If the BIOS dates back to pre-Windows 95 days there are very likely to be problems. If the BIOS is very recent then there may be fewer problems. It is the grey area in between which is causing the most grief. Rule of thumb suggests that any PC which was bought in the early days of Windows 95, in late 1995 or early 1996, may have BIOS which is too old for Windows 98. But there is no sure way of knowing until it is too late to avoid whatever problems Windows 98 creates.

Window Pain

Scottish hi-fi company Linn typifies the attitude of larger companies. Linn's IT department flatly refuses to upgrade their 200 PCs. "In a year's time we may consider it", they say.

Likewise Linn has not yet upgraded from Office 95 to 97, or to Internet Explorer 4. "If you upgrade one PC, you have to upgrade them all, and that means a couple of hundred site licences which are expensive".

Smaller companies are not so lucky. They have no IT department and get brain-washed into believing that business success depends on having Win 98 and the latest software.

Adaptec specializes in disk drive control and hit problems with the drivers which it provides for CD recorders. They work under Windows 95; sometimes they work with Windows 98, but sometimes not, depending on the BIOS.

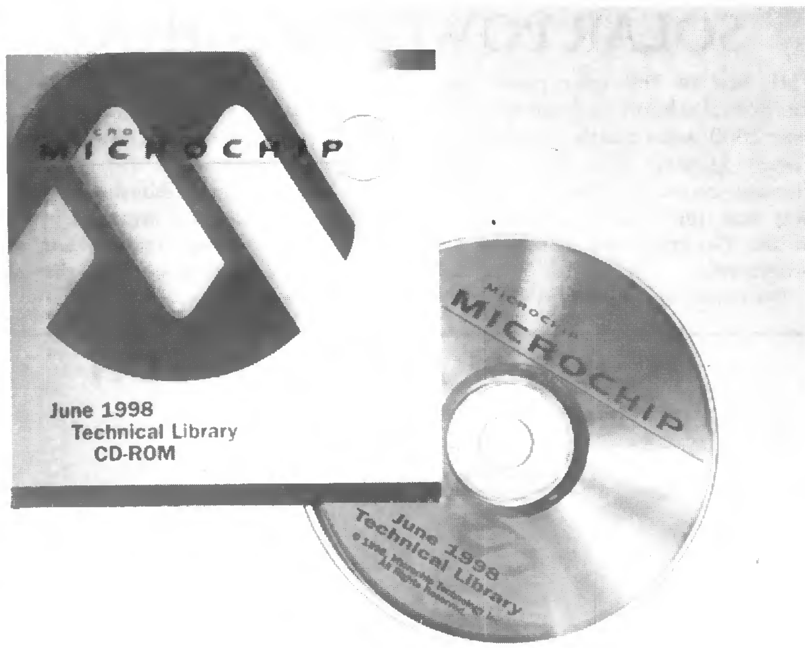
Petter Nordwall, of Adaptec's Software Products Group, freely admits that the problems he has seen Adaptec trying to solve for customers, has deterred him from upgrading his personal PC.

Helen Smith, IT Manager for the London Symphony Orchestra, installed Windows 98 on her own machine. She says that since then it has never been the same and "there is no help on the Microsoft support site".

"Thankfully I just tested 98 on my home computer", says Ms Smith, "It will be a long time before I let it go anywhere near the LSO".

If the word spreads, and more and more people stick with Windows 95, Microsoft will see its upgrade revenue stream dry up.

MICROCHIP CD-ROM



PIC fans will be pleased to know that Microchip have released their new 1998 Technical Library CD-ROM, which has the complete technical documentation for all the PIC family of microcontrollers, non-volatile memory devices, secure data products and associated development tools.

The CD contains an almost exact copy of Microchip's web site and offers a new look and feel for users. It has all the information (and more) that is contained in the two manuals to which we have referred at various times in the past (*Microchip Data Book* and *Embedded Control Handbook*).

If you are interested in PICs, you really ought to have the data that is on this CD.

For more information contact Arizona Microchip Technology Ltd., Microchip House, 505 Eskdale Road, Winnersh Triangle, Wokingham, Berks RG41 5TU. Tel: 0118 921 5858. Fax 0118 921 5835. Web: http://www.microchip.com.

BRIGHTER FUTURE FOR VIDEO PROJECTION

Improved video brightness makes expensive Fresnel lenses for rear projection screens now seem redundant – Barry Fox reports.

THROUGHOUT the 1980s Danish twins Erik and Johannes Clauson developed translucent acrylic sheets which let a projector at the rear display a video picture to an audience at the front. Because video projectors of the day generated only weak light, the Clausons moulded thousands of tiny Fresnel lenses on the rear surface of the acrylic to collect all the available light, and funnel it through the screen.

Fine particles of quartz embedded in the acrylic disperse the light to create a visible image. Lenticular lenses, narrow ridges which form a fine vertical grid on the front of the screen, widen the angle of view, so that audiences do not have to cluster in the centre of the room directly in front of the screen.

Early projectors tried to brighten the picture by using three separate picture sources and lenses, for red, green and blue light. So the different colours hit the screen from slightly different angles. To blend the colours and avoid fringing, the lenticles had be formed with angled edges. This added further to the production costs.

Dai Nippon Printing in Japan bought the patents, but 90 per cent of all rear screens are still made in Denmark, thanks to new ideas which skirted the original designs.

Embossed acrylic screens cost around £4000 for a 170cm diagonal unit. The price of projectors is now falling to a point when the screen can cost more.

As well as being expensive, moulded screens suffer from practical disadvantages. The Fresnel lenses must be matched to the focal length of the projector lens, and the projector must be at a rigidly defined, central, position at a fixed distance behind the screen. So several projectors cannot mix and switch images on the same screen, as is done with 35mm slide shows. If the screen is used in pubs, clubs and arcades, and the front surface lenticles are scuffed or marked with graffiti, they cannot be cleaned.

ECT, European Communications Technology, of Reading have worked with Dansk Akryl-Plade Fabrik, a Danish company which spun off from the Clauson brothers' work, to take advantage of the fact that modern video projectors produce so much light that the Fresnel concentrators are no longer necessary.

They also use only one lens. So the lenticles do not need to have angled edges.

With no need for Fresnels, the lenticles can be formed on the rear surface of the screen, where they still widen the angle of viewing but are protected from damage. The front surface is now smooth, and can be coated with a hard protective coating which withstands the aggressive cleaners needed to remove graffiti.

Because there are no Fresnel lenses, the rear projector can be set at any distance, and at any angle behind the screen, so several projectors can focus on the same sheet at the same time.

The production process is greatly simplified, the sheet needs only embedded quartz particles and smooth lenticles. So the price reduces to around £1000 per sheet.

Pictures, from a projector the same size as a 35mm slide unit, look bright and clear even from the extreme side. With only one surface patterned, there is less risk of moire effects when overlaid patterns interfere.

DAF have ovens which can mould single sheets which measure up to 250cm diagonally. Because there are no Fresnel patterns to align, several sheets can be seamlessly bonded side by side to make a giant screen.

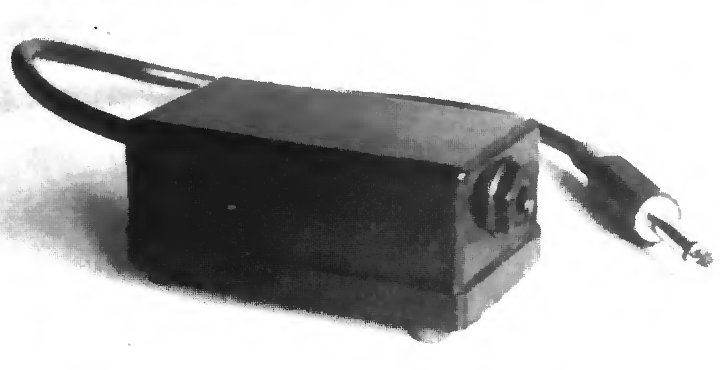
SOLAR POWERED SCHOOLS

THE first of 100 solar panel systems for British schools and colleges by the year 2000 was recently switched on by Energy Minister John Battle. Cardinal Hinsley school in Willesden, West London was the school selected as part of the Government's Foresight Scolar programme.

Participating schools will act as demonstration sites for photovoltaic technology, and serve to stimulate further interest in renewable energy in their communities.

At Cardinal Hinsley's, the solar electric panels are arranged in a canopy and will provide enough energy for a suite of computers in the school's science building.

HEADPHONE ADAPTOR



WE have received news of a headphone adaptor that has been developed to allow modern 32Ω stereo headphones to be used in high-impedance applications. Using the Isoplethics IHA1-1, an impedance of around 8kΩ is obtained.

The adaptor is said to be ideal for use with simple receivers, especially valve t.r.f.s, older valve receivers, and crystal sets. Its transformer has been designed to simulate the peaky response of metal-diaphragm headphones to give good c.w. and communications grade telephony performance. Internal filtering limits h.f. response to around 3kHz. Input and output are via "standard" 6.35mm jack connectors. The price is £14.90 inclusive of UK VAT and P&P within the EU.

For more information contact Isoplethics, Dept. EPE, 13 Greenway Close, North Walsham, Norfolk NR28 0DE. Tel: 01692 403230.

GREENWELD SALE

GREENWELD have issued their Summer Sale catalogue, a 32-page A4 illustrated production that proclaims a variety of products which any hobbyist is likely to find irresistible! How about an £84.95 digital multimeter for just £39.95, for example? Or intelligent l.c.d. modules for a mere £1.25 each? Or a 300-page book on virtual reality – £9.95 instead of £19.95? There are many more amazing offers, even everyday components such as capacitors are available at 50 per cent off.

For more information contact Greenweld Electronic Components, Dept. EPE, 27 Park Road, Southampton SO15 3UQ. Tel: 01703 236363. Fax 01703 236307. E-mail: greenweld@aol.com.: Web: http://www.herald.co.uk/clients/G/Greenweld/greenweld.html. A new web site is also under construction at http://www.greenweld.co.uk.

SEIMENS PLANT PLANS

YOU will no doubt have heard in the news that Seimens are to leave their North Tyneside semiconductor manufacturing plant. The DTI has announced that a joint task force between Seimens and the Government is to examine all possible options for the future ownership and use of the plant.

Peter Mandelson, Secretary of State for Trade and Industry expressed the hope that "we will be able to find a solution that will guarantee the long-term future of this world class facility and its highly skilled workforce.

LM335 & LM35 TEMPERATURE SENSORS

ANDY FLIND

Keep your cool with these two versatile chips

THERE are many applications in electronics where temperature sensing is required, and a wide variety of sensors are available to suit different tasks in this field. Frequently one of the LM335 or LM35 semiconductor sensors is an ideal choice, so a good working knowledge of these devices will be useful for experimenters and designers.

LM335 SENSOR

The LM335 temperature sensor is normally supplied in a TO99 plastic package with three leads. Two of these are positive (+V) and negative (−V), whilst the third is an "adjust" (Adj) terminal, as shown in Fig.1.

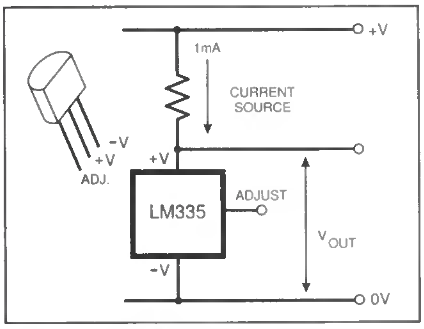


Fig.1. Basic LM335 sensor circuit and package pinout details.

In use it behaves in a similar manner to a Zener diode in that when a current passes between the positive and negative leads a voltage appears across them. This current could be supplied from a current regulating circuit or an LM334 constant current device as shown in Fig.2, but for many designs a single resistor from the positive supply will be sufficient. It should be within the range of 50µA to 5mA, with 1mA being recommended.

It is worth remembering that this current will cause a small amount of self-heating in the sensor, so it should be kept small. If a resistor is used as the current source the value is easy to calculate.

Taking a 9V supply as an example, three volts should be subtracted from this to allow for the sensor, leaving the voltage that will appear across the resistor, in this case 6V. The resistor can then be calculated from $R = V/I$, so for 1mA it will be 6k (kilohms). This value is not in any way critical however, and values between 4k7 and 8k2 will be perfectly acceptable.

The LM335 can operate over the range of −10°C to +100°C and can withstand intermittent excursions up to 125°C. The output voltage is directly proportional to temperature at the rate of 10mV per degree C, but this starts from absolute zero, or 0 degrees Kelvin. Readers may recall from their school physics that this is 273·15 degrees below 0°C, so the corresponding output is theoretically 2·7315V.

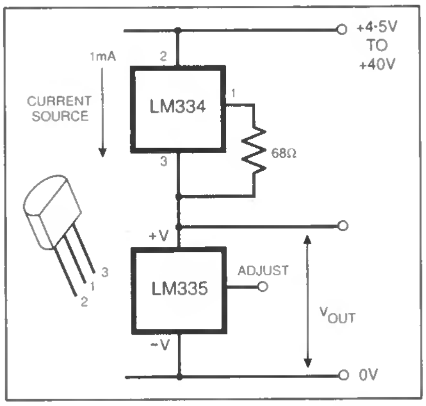


Fig.2. Sensing circuit using the LM335 and an LM334 current source.

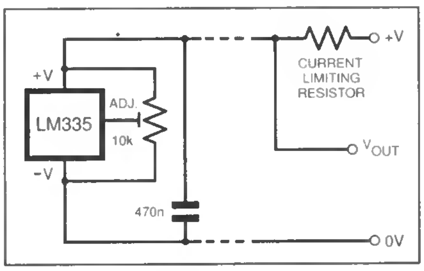


Fig.3. Circuit diagram for remote sensing and adjustment.

In practice it may not be quite as accurate as this but it does mean that there is an offset of about three volts to consider when designing with the device. The output "slope resistance" is about 0·6 ohms so small changes of current or output load will have very little effect on the output voltage, which is why a resistor is usually adequate for current setting.

REMOTE SENSING

It is not essential to make any use of the "adjust" terminal. If it is simply left open-circuit the device is claimed to have a typical accuracy within 2°C across its range.

However, the addition of a single 10k preset resistor (potentiometer) allows it to be trimmed for an accuracy within one degree. Apart from increased accuracy this can also be useful where two devices are used to obtain differential readings as better matching can be achieved. How the preset should be connected in circuit is shown in Fig.3.

The preferred method of calibration is to set the output to 2·98V at a temperature of 25°C. This, of course, assumes that the user possesses a meter capable of measuring to this degree of accuracy. The author's DVM only reads to the nearest 10mV at this level, and the scale tolerance is in any case greater than this. However, the principle of the adjustment is clear enough and some trial and error usually overcomes the problem.

It can also be seen from Fig.3 that only a two-wire connection to the device is required, which can be an advantage in applications using remotely sited sensors. In such instances it is a good idea to add a capacitor at the remote end as shown to minimise possible interference but this is probably not essential.

The LM335 is an inexpensive and robust device that is relatively easy to use, and is a good choice for many designs needing a simple temperature transducer input. However circuits using it must compensate for the large offset from zero and a suitably accurate means of calibration may be required.

LM35 SENSOR

Another widely available temperature sensor is the LM35, which is internally compensated so that the output starts at 0°C. With a similar type number (just one missing "3") and package (plastic TO99) it may appear at first to be just an LM335 without the calibration problem.

However, it is a completely different device. Unlike the LM335 it should be supplied with a voltage of between 4V and 30V to its positive and negative connections.

The current taken from the supply is virtually constant across the voltage range and is only about 50µA so the self-heating effect is negligible, and this low current also makes it more suitable for some applications, notably those using battery supplies. The output appears at the third connection and requires no calibration.

Two versions of the LM35 are readily available. LM35DZ has a range of 0°C to 100°C, whilst LM35CZ covers −40°C to 110°C with slightly greater accuracy. Both are more accurate than the LM335, though this is reflected in the somewhat greater price.

In its simplest form, the LM35 can be connected as shown in Fig.4, where it is simply provided with a suitable supply, such as a PP3 battery, and a DVM (digital voltmeter) is used to display the output. The sensor could be fitted into a "probe" to convert a DVM into a useful direct-reading electronic thermometer for the workbench, for applications such as checking heatsink temperatures.

BELOW ZERO

A disadvantage of the LM35 is that its output cannot reach all the way down to 0V in a single-supply circuit. It is claimed to get within 20mV of it, corresponding to 2°C, (although an example tested got to within 0·2mV!) but to reach zero and below a pull-down resistor from a voltage below negative supply is required.

One way to accomplish this is to use it as shown in the Simple Thermometer circuit illustrated in Fig.5. Resistors R1 and R2 divide the supply to obtain a reference of about a volt, which is buffered by IC1 for use as "ground" by the LM35 and the meter.

Resistor R3 is the "pull-down" resistor. This should have a value of about 20k for each volt below "zero", so here, for 1V, an 18k component is used. It allows the output of the LM35 to cover its full range of 0°C to 100°C (LM35DZ), or −40°C to 110°C (LM35CZ).

The output of the LM35 has a tendency to oscillate if connected to a capacitive load, so a series resistor should be used to prevent this occurring. This is the function of resistor R4 in Fig.5 and a value of one kilohm (1k) was found to be sufficient to guard against this possibility. This simple circuit could be used to make an improved and accurate general purpose thermometer which could find plenty of applications around the workshop.

ANALOGUE THERMOMETER

The final circuit diagram of Fig.6 shows a design developed for use as an Analogue Thermometer. It uses a dual op.amp, the second amplifier being arranged to buffer the output of the LM35 and convert it into a current for the meter ME1.

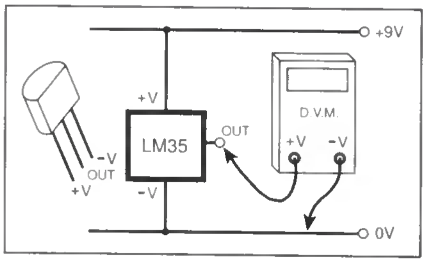


Fig.4. Basic LM35 circuit and package pinout details.

Although the two values of resistor R4 are shown for a span of 100°C for 100µA and 1mA meters, other spans can easily be obtained by adjusting the value of this resistor. A suitable value could be chosen to generate a Fahrenheit scale!

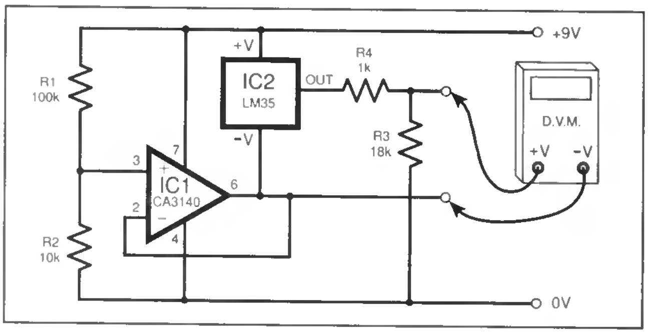


Fig.5. Circuit for reading below zero using the LM35, an op.amp and a digital voltmeter (DVM).

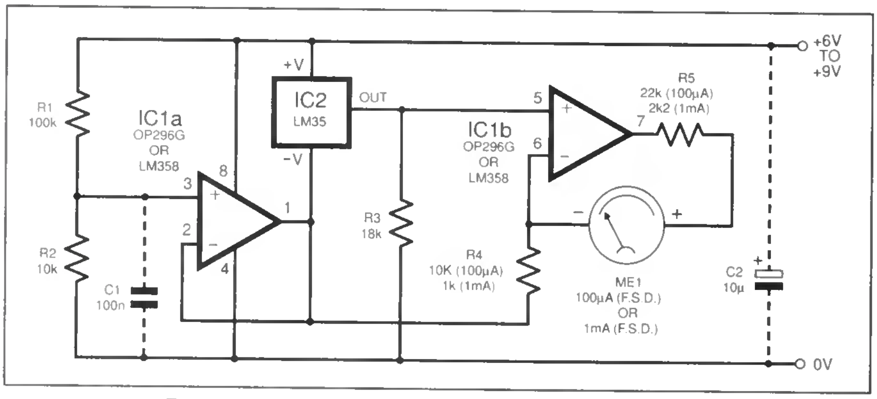


Fig.6. Circuit diagram for an Analogue Thermometer.

Resistor R5 limits the maximum current to prevent any possibility of damage to the meter. The circuit appeared to be stable without any decoupling capacitors, but the addition of C1 and C2 (shown dashed) is recommended.

With an LM358 op.amp for IC1 and a 9V supply the current taken was about 1·2mA. Replacing IC1 with an OP296G low power op.amp reduced the operating current to just 300µA and the lower offset voltages of this device also improve accuracy.

There are various methods of arranging for this circuit to read values below zero. A centre-zero meter movement could be used, or a polarity reversing switch might be added.

In many cases, if the front is unclipped from the meter, it will be possible to adjust the movement for a positive offset of ten or twenty percent. Finally, it is possible to adjust R4 to give a lower voltage to provide the offset electronically, but this results in increased complexity since a reference voltage and an extra op.amp would be needed.

ROUND-UP

For the small increase in cost the LM35 provides more accurate temperature sensing and eliminates the need for calibration. For remote sensing a three-wire connection is required instead of two, and a resistor should be placed in series with the output to prevent oscillation due to cable capacitance.

However, it may also result in simpler circuits for some designs since there is no need to supply a constant current or to compensate for a large offset voltage. The choice of device will depend upon the requirements of the designer and the circuit.

READOUT

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

WIN A DIGITAL MULTIMETER

The DMT-1010 is a 3½ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

We will give a DMT-1010 Digital Multimeter to the author of the best *Readout* letter.

★ LETTER OF THE MONTH ★

PICS THE JOB

Dear EPE,

I want to thank you! Since graduating from Dundee University last year with a degree in electronics, I've read *EPE*. It has been of great benefit in developing my knowledge of electronics. I have found you publish many articles and projects which are of a level both technical yet within reach of understanding.

The main reason for the thank you is that due to your magazine I was able to develop enough skills to land the job of my dreams.

Upon discovering your *PIC Tutorial* (March-May '98), I was introduced to the world of embedded programming. I built the development board and followed the tutorials completely. They really are brilliant and basically gifted me the skills of basic assembler and more.

With such skills as I've gained, my C.V. looked much better and I have now landed a job programming and designing circuitry part-based around the PIC series.

After spending time out of work, I still cannot believe the fact that I have finally got the job I have always wanted – programming and electronic design.

I had to write and tell you that it is down to the chances *EPE* gave me. I hope that you continue to publish a splendid magazine and do not change a thing.

Trevor White, Rubery, Birmingham

We are truly delighted to learn of your success, Trevor. Congratulations!

TWIN-PIC SOLUTION

Dear EPE,

After reading the letter from John Gray (July '98) I have also had a problem with the number of I/O lines available with the PIC16C84 in a project for multiple remote temperature sensing. However, the problem was solved by using two '84s in parallel, one for the display and the other for data collection, with a serial connection between them.

This idea came after reading an article somewhere on using PICs to replace some 7400 series devices, such as the 74C922 keyboard scanner.

Ever since your 1995 PIC programmer design, I've been totally hooked, with my latest project aimed at indexing a model railway turntable driven by a stepper motor.

Regarding TASM, I too have used it for many years with the 6502, Z80 and more recently the 16C84. It's nice to have a common interface for the different processor types.

Keep up the excellent articles and thanks for the web site support.

Richard Clark, via the Net

You probably saved a great deal of multiplexing logic by using two PICs. Like you, I too am hooked over wanting to find ever more things to do with PICs. Indications are that many readers are becoming equally obsessed!

PIC UP THE PHONE

Dear EPE,

I have just finished reading the *PIC Tutorial* (Mar-May '98) and found it excellent. It has left my head buzzing with ideas for projects. Most of these require the PIC to interface with the outside world. Could I suggest you do a short feature showing how the PIC could "read" voltage, frequency and temperature.

Also, I would like to suggest/request a project. It's a device I saw advertised in an American magazine. The circuit detects the output from a mobile phone being used within a vehicle and operates a relay which can be connected to the telephone mute input that most modern car radios now have.

Adrian Walsh, via the Net

My PIC Altimeter *of September '98 illustrates how voltage, frequency and temperature can be read by a PIC. Get a copy of its software from us (see* PCB Service *page) and examine the ASM listing. It is, though, only one way in which such things can be done. No doubt we shall publish others in the fullness of time – watch our pages!*

When it comes to telephones, I know little about mobiles, so I refrain from offering suggestions. Perhaps one of our expert designer/authors out there might give the matter some thought?

REVERSE ENGINEERING

Dear EPE,

Referring to *IU* in the August '98 issue, I am all in favour of the safety aspect of a Vehicle Reversing Alarm. What escapes me is why it should be necessary to go to such lengths to achieve the desired effect.

What practical advantage does the proposed idea have over connecting a standard sounder in parallel with the vehicle's reversing lights (other than to the contributor!)?

My maxim has always been that if it is possible to achieve a desired effect in more than one way, go for the simplest one that does so. If night-time operation could be problem, fit an isolating switch in the sounder wiring.

I.M. Tasker, Grantham, Lincs

First of all, please note that we have been informed that reversing bleepers can only be used on certain vehicles, e.g. commercial vehicles over 2,000kg, buses, etc. It is illegal to use one on a private car,.even if it is towing a trailer or caravan.

Whilst we understand the point you are making, we feel that this particular design has some ingenuity in the way the alarm can be controlled. We also know that many readers will use circuit ideas such as this for other designs, so there is always value in publishing something of this type.

I would also venture the thought that alternative ways of achieving similar ends are always worthwhile pursuing, even though the solutions may not necessarily be the best (in whatever way one chooses to define the concept of "best").

Y2K AND MICROSOFT

Dear EPE,

I was rather surprised at Barry Fox's comments in the July '98 issue about Euro support in his news item *Y2K and Microsoft*. He categorically states that the Euro symbol "is not on any existing keyboard or included in any existing computer character set".

Seimens Nixdorf have been offering a keyboard for sometime now with the Euro symbol on the "E" key in accordance with EU recommendations – see:

http://www.sni.de/pc/euro/index.htm.

Microsoft have available a Win 95 and NT 4.0 upgrade and Office fonts including the Euro symbol at

http://www.microsoft.com/office/office/euro/euro1.asp.

Win 98 and NT 5.0 will include Euro support from the start. The MS implementation does not, however, follow the EU recommendation, using "AltGr - 4" rather than "AltGr - e". Euro symbol support is also being offered by other companies.

Peter Short, via the Net

Barry Fox replies:

I'm pleased to hear that Seimens make a keyboard with the EU symbol, but I've never seen one in the shops or bundled with any PC. It takes skill to download fonts from the Internet, and the user is still stuck without a dedicated key.

It is now widely appreciated that upgrading to Windows 98 can create all manner of problems. Having done it, I would not recommend it to my worst enemy.

PEST SCARING

Dear EPE,

Regarding the *Readout* letter (Aug '98) concerning the effect of ultrasonic pest scarers on other animals. We are pestered by neighbours' cats and I have come across two devices which are presently advertised in the gardening press saying that they do not affect other animals.

I am not convinced that this is necessarily so since it does not give a list of other animals or what proof they have in order to justify this statement.

My concern is that animals such as tortoises, rabbits and hamsters which are kept "trapped" in gardens or hutches, are unable to vacate the area and it is vital to know whether they are affected by these high frequencies.

Is there any data on the hearing ranges of these types of animal – perhaps other readers may know? By the way, I have also heard that someone used one of these devices to rid a house of ants.

Alan Jones, via the Net

We don't have any info on the frequency ranges of animals. It's well known, of course, that bats depend on ultrasonic frequencies, but they can avoid areas that are (to them) noise polluted.

We would suggest, though, that you do not use this type of deterrent if there are animals around that cannot escape it. Readers, what can you tell us?

TIME AND TIDE

Dear EPE,

A very big thank you for your fabulous magazine and its contribution to our hobby. I have built numerous projects presented in *PE/EPE* over the last 20 years or so, and every one with 100 per cent success (and little or no bother).

One project was the *Tide Meter* by John Becker (*PE* July 92) which is still providing me with the required information of the tidal flow divided into 16 parts.

How about a newer version using PIC-technology – less space, lower power consumption (I have to use a mains adaptor) and possibly a more elaborate display. I am sure there are many readers who may have missed the original project and who would find such a nifty and practical device very useful.

Johan van Rooyen,
Cape Town,
South Africa

Funnily enough, I have recently just abandoned extensive programming simulations in which I was trying to produce a universal tide predictor run with a microcontroller (not necessarily a PIC).

Mathematical calculations were made, based on the precisely known (to within 10 decimal places) movements of the moon and sun across the seasons. The simulations were done in QBasic and compared and analysed with known tidal factors from a previous two year period.

Whilst tides can be readily calculated to an accuracy within about plus/minus half an hour (as proved by my/your tide predictor of '92), to do so with greater precision (I was aiming at within five minutes) proved, at this time, to be beyond my abilities. Most of the calculations actually corresponded to within less than that but, for reasons which I could not fathom, there were monthly deviations well outside that range.

For many hours, the Net was searched and many sites relating to tides examined, including the Proudman Oceanographic Laboratory (who calculate the official tide tables in the UK). A lot of information was acquired, but the solution eludes me.

Although I believe I can readily program a microcontroller to do the predictions once the base equations are known, so far they have not become apparent. Can any reader offer help?

However, prompted by your continued successful use of my original design (which, incidentally, was based on a purely mechanical – motor driven – unit I had seen some years before), I have had a chat with Editor Mike and we feel that an updated version of the one you have would be appropriate.

It will not have the precision of the one I had been aiming at, but we feel that many potential users will not require such accuracy. Mike, for example, sails a dinghy in Poole Harbour and basically only needs to know rough directions of current flow, as dictated by the approximate state of the tide. So, with this in mind, I'll see what simple unit I can come up with, based on a PIC and an l.c.d. The complex version can wait until I have more information (from readers, perhaps).

LED BY HISTORY

Dear EPE,

Alan Winstanley's comments on lighting a houseboat using "white" l.e.d.s in *EPE* August '98 (*Circuit Surgery*), reminded me of a lecture I attended at Durham University in 1980.

It was given by Professor Cyril Hilsum, who discussed the history of electroluminescence, first observed by Round in the early '20s, but later dubbed the Lossev Effect. Round observed yellow, green and blue light emissions from natural silicon carbide samples when high voltage a.c. was passed through them – the first l.e.d.s!

Later on Destrieaux observed the luminescence of zinc sulphide phosphors between the plates of a capacitor energised at 300V a.c. and invested – and lost – millions of pounds in a scheme to promote this as "shadow less" lighting panels in the workplace and home. The problem of a transparent conducting surface was fairly easily overcome using tin oxide, but not the problem of driving capacitors at high energies, which proved the downfall of the scheme.

The idea has been revisited several times in more recent years, particularly in display technology, using yttrium oxide "plates" and more complicated device structures, but has never really been commercially viable, since the devices still need high voltages and have short lifetimes as a result.

Silicon carbide has been revisited many times, including the earliest viable blue l.e.d.s (now superseded) – it makes very hardy devices, simple but electrically inefficient, with a range of available colours.

Hope this historical note might be of interest – Hilsum's lectures certainly were!

Dr Philip Miller Tate,
Kingston University, Surrey,
via the Net.

Many thanks for the interesting observations.

ARCHITECTURE

Dear EPE,

Further to J.F. Warren's letter in the July '98 issue, I greatly sympathise with the context of his letter. I must admit that I have lost a lot of interest because I feel that I am constructing glorified Meccano projects without really understanding what I am doing.

Obviously I accept what you say regarding the impossibility of showing the circuitry involved in modern chips. However, I think that it would at least generate a lot more interest if the internal architecture of i.c.s in a circuit were also to be shown alongside.

D.J. Dyer,
Morriston, Swansea

Oh yes, such architectural illustrations can be extremely interesting, but we just don't have the page space available to justify using them except in the rarest of situations. Just as interesting (and awe inspiring) are micro-photographs of the interiors of microprocessors and the like. If only we had the space to share them with you ...

HAIR BRAINED?

Dear EPE,

In view of the interest in "odd" machines for the body and mind, is there any chance of doing an article on how those battery powered hair removal (electrolysis) machines work, the basis on which they work, if they work and how to build one? As far as I can tell, hair is virtually an insulator, but maybe they use RF or something.

Brent Long, via the Net

We don't know, and are still stuck with mechanical hirsute pursuits! Readers – tell us the tale of how its done, but no shaggy dog stories please!

SUB-WOOFER

Dear EPE,

I am in a similar position to Peter Thorpe, who asked through *Readout* July '98 for info on electric fences.

I am building my own audio system and have become completely unstuck on the design for the sub-woofer filter. There are loads of designs for preamps, power amps and tone controls and I have used some of Robert Penfold's circuits with great success. However, I can find nothing on sub-woofer design in the library or on the Internet and I completely stuck.

The design I am looking for must have a variable filter cut-off from about 30Hz to 50Hz, depending on the music I am listening to. The differences are as varied as church organ music, film sound track, pop or classical music. I have an 18-inch speaker in an appropriate cabinet and a big power amplifier ready for the job, but no filter!

N.J. Skelton, via the Net

We can't help directly, but other readers might. Peter got his info this way (thanks to those who sent in details), hopefully, you might too.

Incidentally, please would any reader referring to a Readout *letter always quote the cover date of the issue in which it was published – saves me having to page through numerous back issues to find the reference!*

GHOST METER

Dear EPE,

I'm a member of a paranormal group that investigates ghosts. A gauss meter can be used to detect such activity but the cost of these meters is very high. I have seen your *50Hz Field Meter* (Nov '95) which detects electromagnetic waves. This would be ideal for our investigations except for the 50Hz filter. How can I omit the filter, and will the readings be affected by the earth's magnetic field?

Also, can you please tell me what the *Ghost Waker* project in the Oct '90 issue does?

John Newton, via the Net

Try omitting IC3 and its resistors, then take the negative side of C2 and connect it to the pin 19 position of IC3's holes. As this meter reads varying magnetic fields (i.e. a.c. fields) it will not be affected by "static" (d.c.) fields like the earth's. (Editor Mike asks if anyone knows whether ghosts are a.c. or d.c.?)

There's nothing paranormal about the intentions of Ghost Waker, *it's a Halloween project in which sound sets off flashing eyes in a Halloween mask.*

However, we think that some readers might query the basic assumptions for your research – the perceived wisdom, surely, is that magnetic fields are associated with UFOs, and that it's temperature *changes that are associated with ghosts?*

SLUGGED!

Dear EPE,

Seeing the *Electric Fence* letter in *Readout* July '98, brought to mind a gardening magazine which was investigating the ever present problem of slug control. They referred to a new "solution" called Snailaway.

Apparently a test was carried out using two of these devices – one with a battery and one without – both being filled with beer. The result was 34 drowned slugs in the non-powered version but none in the other. My suggestion would be for *EPE* to do a project which encompasses this sort of deterrent for an area larger than a single pot protector, e.g. a "fence" which could project a vegetable patch – this could prove to be cost-effective as well as eco-friendly.

Alan Jones, via the Net

'Tis almost lost for words I am! Whatever is the point, one wonders, of designing a powered device if it works without power? Anyway, as an inveterate home-brew brewer and assistant gardener to a horticulturally adept wife, I've long been aware of the power of beer over slugs, especially the yeast-filled dregs from the bottom of the barrel.

To take your suggestion to its (inebriated?) conclusion, perhaps we could design a PIC-controlled brewery-simulator based on Colin Meikle's Greenhouse Computer *(June '98) and my* Dancing Fountains *(Aug '94)!*

Incidentally, we have heard of electrified slug-fences in which an a.c. signal is supposed to repel the meandering molluscs. Could it be, though, that such things might further prove Darwin to be right: could slugs evolve to counteract this opposing environment? We've all heard of electric eels, why not electric slugs – that feed off such conveniently placed garden power lines, and then set their sights on the National Grid? What a monster movie that might make – Godzilla, look out!

Everyday Practical Electronics are pleased to be able to offer all readers these

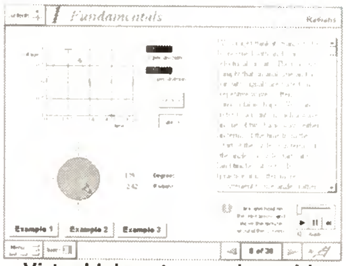
ELECTRONICS CD-ROMS

TWO APPLICATIONS ON ONE CD-ROM

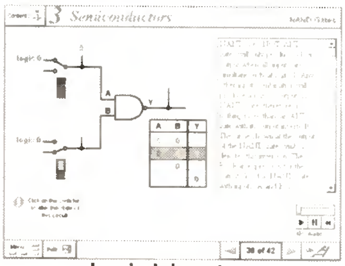
ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY
by Mike Tooley

ELECTRONIC CIRCUITS & COMPONENTS

Electronic Circuits & Components provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding as they proceed through the sections on the CD-ROM. Sections on the disk include:
Fundamentals: units & multiples, electricity, electric circuits, alternating circuits.
Passive Components: resistors, capacitors, inductors, transformers.
Semiconductors: diodes, transistors, op.amps, logic gates.
Passive Circuits
Active Circuits



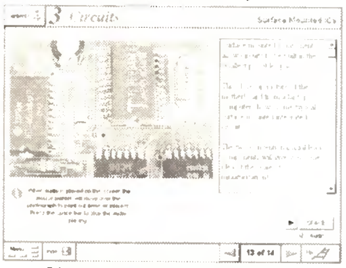
Virtual laboratory – sinusoids



Logic laboratory

THE PARTS GALLERY

Many students have a good understanding of electronic theory but still have difficulty in recognising the vast number of different types of electronic components and symbols. *The Parts Gallery* helps overcome this problem; it will help students to recognise common electronic components and their corresponding symbols in circuit diagrams.
Selections on the disk include:
Components
Components Quiz
Symbols
Symbols Quiz
Circuit Technology



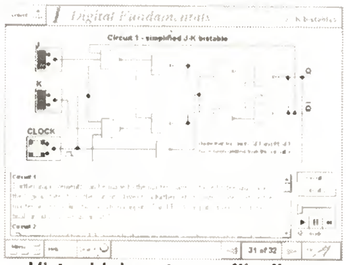
Circuit technology screen

Hobbyist/Student .... £34 inc VAT
Institutional (Schools/HE/FE/Industry) ....£89 *plus* VAT
Institutional 10 user (Network Licence) .... £169 *plus* VAT

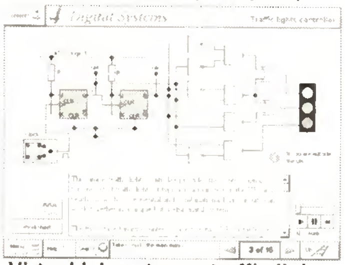
DIGITAL ELECTRONICS
by Mike Tooley

NEW

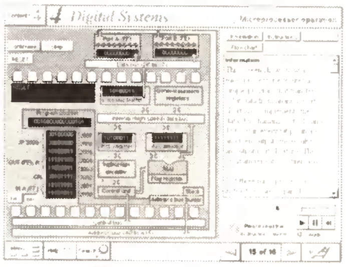
Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components*, and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.



Virtual laboratory – flip-flops



Virtual laboratory – traffic lights



Microprocessor

FUNDAMENTALS

Fundamentals introduces the basics of digital electronics including binary and hexadecimal numbering systems, ASCII, basic logic gates and their operation, monostable action and circuits, and bistables – including JK and D-type flip-flops

COMBINATIONAL LOGIC

Multiple gate circuits, equivalent logic functions and specialised logic functions such as majority vote, parity checker, scrambler, half and full adders. Includes fully interactive virtual laboratories for all circuits

SEQUENTIAL LOGIC

Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers.

DIGITAL SYSTEMS

A/D and D/A converters and their parameters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic unit.

GALLERY

A catalogue of commonly used IC schematics taken from the 74xx and 40xx series. Also includes photographs of common digital integrated circuits and circuit technology.

Hobbyist/Student .... £45 inc VAT
Institutional (Schools/HE/FE Industry) ....£99 *plus* VAT
Institutional 10 user (Network Licence) .... £199 *plus* VAT

Minimum system requirements: PC with 486/33MHz, VGA+256 colours, CD-ROM drive, 8MB RAM, 8MB hard disk space. Windows 3.1/95/NT, mouse, sound card. Demo available from Web site **http://www.MatrixMultimedia.co.uk**

CD-ROM ORDER FORM

Please send me:
☐ Electronic Circuits & Components + Parts Gallery
☐ Digital Electronics

Version required:
Hobbyist/Student ☐
Institutional ☐
Institutional 10 user ☐

Full name:...
Address:..
....
.... Post code:... Tel. No:.......................................
Signature:..
☐ I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £...........
☐ Please charge my Visa/Mastercard: £ .... Card expiry date:........................
Card No:...

ORDERING

Prices include UK postage

Student Version – price includes postage to most countries in the world
EU residents outside the UK add £5 for airmail postage per order

OVERSEAS ORDERS: Institutional Versions – overseas readers add £5 to the basic price of each CD-ROM for airmail postage (**do not add VAT** unless you live in an EU country, then add 17½% VAT or provide your official VAT registration number).

Send your order to: Direct Book Service
33 Gravel Hill, Merley Wimborne
Dorset BH21 1RW
(Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd. To order by phone ring
01202 881749. Fax: 01202 841692
We cannot reply to overseas orders by Fax
CD-ROMs are normally sent within seven days

VIDEOS ON ELECTRONICS

A range of videos (selected by EPE editorial staff) 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. 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 originate from VCR Educational Products Co, an American supplier.

(All videos are to the UK PAL standard on VHS tapes.)

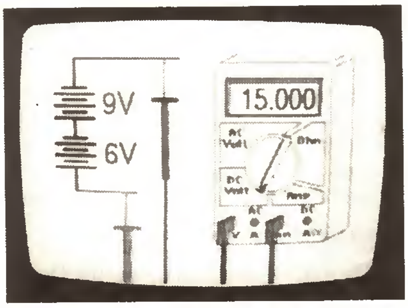
BASICS

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part One; **D.C. Circuits.** This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. **Order Code VT201**

VT202 62 minutes. Part Two; **A.C. Circuits.** This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits. **Order Code VT202**

VT203 57 minutes. Part Three; **Semiconductors.** Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained. **Order Code VT203**



VT204 56 minutes. Part Four; **Power Supplies.** Guides you step-by-step through different sections of a power supply. **Order Code VT204**

VT205 57 minutes. Part Five; **Amplifiers.** Shows you how amplifiers work as you have never seen them before. Class A, class B, class C, op.amps. etc. **Order Code VT205**

VT206 54 minutes. Part Six; **Oscillators.** Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits. **Order Code VT206**

£34·95 each inc. VAT & postage

Order 8 or more get one extra FREE
Order 16 get two extra FREE

VCR MAINTENANCE

VT102 84 minutes: Introduction to VCR Repair. Warning, not for the beginner. Through the use of block diagrams this video will take you through the various circuits found in the NTSC VHS system. You will follow the signal from the input to the audio/video heads then from the heads back to the output. **Order Code VT102**

VT103 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path. **Order Code VT103**

DIGITAL

Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.

VT301 54 minutes. Digital One; **Gates** begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation. **Order Code VT301**

VT302 55 minutes. Digital Two; **Flip Flops** will further enhance your knowledge of digital basics. You will learn about Octal and Hexadecimal notation groups, flip-flops, counters, etc. **Order Code VT302**

VT303 54 minutes. Digital Three; **Registers and Displays** is your next step in obtaining a solid understanding of the basic circuits found in today's digital designs. Gets into multiplexers, registers, display devices, etc. **Order Code VT303**

VT304 59 minutes. Digital Four; **DAC and ADC** shows you how the computer is able to communicate with the real world. You will learn about digital-to-analogue and analogue-to-digital converter circuits. **Order Code VT304**

VT305 56 minutes. Digital Five; **Memory Devices** introduces you to the technology used in many of today's memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices. **Order Code VT305**

VT306 56 minutes. Digital Six; **The CPU** gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work. **Order Code VT306**

RADIO

VT401 61 minutes. **A.M. Radio Theory.** The most complete video ever produced on a.m. radio. Begins with the basics of a.m. transmission and proceeds to the five major stages of a.m. reception. Learn how the signal is detected, converted and reproduced. Also covers the Motorola C-QUAM a.m. stereo system. **Order Code VT401**

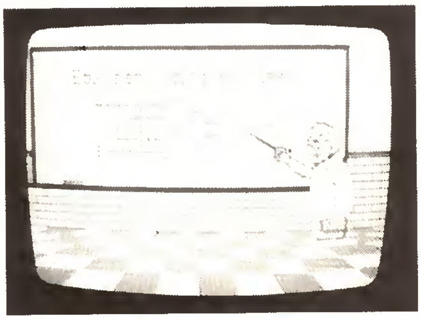
VT402 58 minutes. **F.M. Radio Part 1.** F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver. **Order Code VT402**

VT403 58 minutes. **F.M. Radio Part 2.** A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding. **Order Code VT403**

MISCELLANEOUS

VT501 58 minutes. **Fibre Optics.** From the fundamentals of fibre optic technology through cable manufacture to connectors, transmitters and receivers. **Order Code VT501**

VT502 57 minutes. **Laser Technology** A basic introduction covering some of the common uses of laser devices, plus the operation of the Ruby Rod laser, HeNe laser, CO_2 gas laser and semiconductor laser devices. Also covers the basics of CD and bar code scanning. **Order Code VT502**



VIDEO ORDER FORM

Full name:..

Address: ....

....

.... Post code: ....Telephone No.........................

Signature: ....

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD

☐ Please charge my Visa/Mastercard: Card expiry date ....

Card No: ....

Please send video order codes:..

....

Please continue on a separate sheet of paper if necessary.

ORDERING: Price includes postage to anywhere in the world.

OVERSEAS ORDERS: We use the VAT portion of the price to pay for *airmail* postage and packing, wherever you live in the world. Just send £34.95 per tape. All payments in £ sterling only (send cheque or money order drawn on a UK bank).

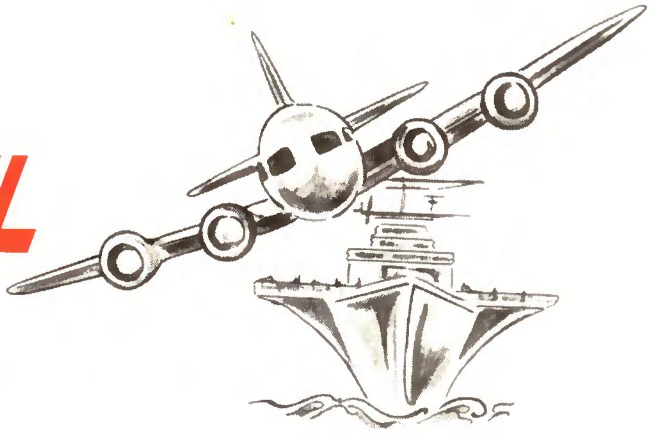
Send your order to:
Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd.
Tel: 01202 881749 Fax: 01202 841692

Videos are normally sent within seven days of receipt of order.

E22

DIGISERV R/C CHANNEL EXPANDER



TONY HART

Breathe new life into your old 2-Channel R/C system – control up to 10 functions.

HAVE you ever wished that your radio controlled model boat, vehicle or plane could have a few more controllable functions such as lights, sound effects or a water pump that you could surprise interested onlookers with. Unfortunately, the cost of radio control transmitters and receivers escalates as more channels are required.

That tired old 2-channel equipment that you picked up cheap or have had for years just isn't good enough these days. Or is it? Why not expand the use of one of the channels.

Here's how to do it with Digiserv, which can be a useful addition to any radio control system, and is particularly suitable for expanding the functionality of small 2- or 3-channel systems often used for controlling model boats or vehicles. Your existing transmitter can be used to control up to ten functions with no modification required to the transmitter.

SYSTEM

This channel expander allows one R/C channel to also control up to 10 functions that require on-off switching. On-off functions such as boat lights, winch, water pumps, radar and sound effect generators can easily be controlled using Digiserv.

The usual way of expanding a single channel is to have a cam arrangement on a servo that drives microswitches to control the on-off functions. With this mechanism only a limited number of functions can be controlled by each servo, and often they are not separately controllable as the cam must operate each switch as it passes. Digiserv is cheaper than a servo and cam arrangement and, by using a PIC microcontroller and a Darlington transistor array driver chip, it allows individual control of up to ten on-off functions without interfering with the normal use of the channel.

R/C RECEIVER OUTPUT

A typical output pulse from a Radio Control Receiver is shown in Fig.1. Most systems produce a pulse width of approximately 0·75ms to 2·25ms every 18ms to 20ms.

The width of the pulse is proportional to the movement of the Transmitter joystick such that when the joystick is centralised the pulse width is approximately 1·5ms. When the joystick is pushed fully down the pulse width will be 0·75ms to 1ms and when pushed fully up will be 2ms to 2·25ms.

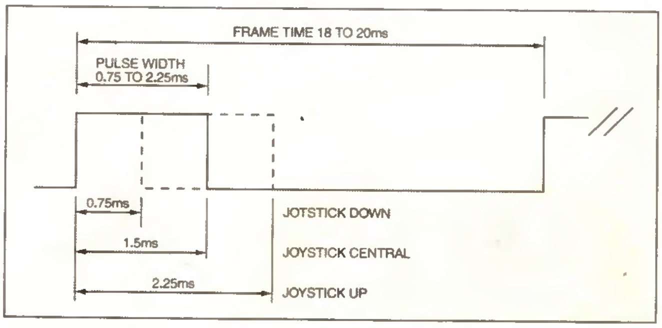


Fig.1. Typical output pulse for an R/C Receiver.

The pulse period of 18ms to 20ms is unimportant and servos are tolerant to quite large variations. In practice the main effect of increasing the period is simply to slow down the response time of the servo.

OPERATION

Each digital output can be controlled either on or off independently of other outputs by simply pushing the transmitter joystick control up or down the number of times needed for the required output. Normally the transmitter joystick control is in its *centre* position. When pushed up or down *rapidly* N times, then output N will be set or reset respectively (N = 1 to 10).

As an example, if the transmitter control (joystick) is pushed UP three times rapidly, then Output 3 (see main circuit Fig.2) will be set to logic 1 (Darlington on). If it is pushed DOWN rapidly three times, then Output 3 will be set to logic 0 (Darlington off).

The example assumes that the transmitter control is in the normal position. If reversed then Digiserv's outputs will also be reversed.

The speed of each "push" must be less than about 0·5sec and there must be a gap of greater than 0·5 second between commands. If the number of "pushes" is greater than 10 then nothing will happen.

CIRCUIT DETAILS

The full circuit diagram for the Digiserv R/C Channel Expander is shown in Fig.2 and consists of just two chips and a handful of components. The circuit is connected to the "spare" R/C channel via the normal 3-pin servo type connector (TB1) and is powered from the R/C's supply, just like a servo would be (it only draws a few milliamps).

The controlling influence of the circuit takes place inside the PIC16C84 microcontroller IC1. As well as processing data from the receiver, it also sends control data to the Darlington driver array IC2 to select and switch-in the desired additional function.

What you cannot see in the circuit diagram, of course, is the software instructions for the PIC, which will be covered later. Also, a ready-programmed PIC is available for those readers who do not wish to program their own (see *Shoptalk* page), but just wish to "build and play".

A 4MHz resonator or crystal, X1, together with capacitors C3 and C4, is used to set the timing of IC1. No adjustments are required in this design as the normal accuracy of the timing crystal X1 is easily good enough for the software to interpret pulse width changes. The power supply lines are decoupled by capacitors C1 and C2.

The PIC software interprets changes in the received pulse widths to control the ten digital outputs. Eight of IC1 outputs, RB1 to RB7 and RA0 (Outputs 1 to 8) are buffered by Darlington transistors within IC2, and two outputs (Outputs 9 and 10) are taken *directly* from the RA1 and RA2 pins (18 and 1) of IC1.

OUTPUT CONNECTIONS

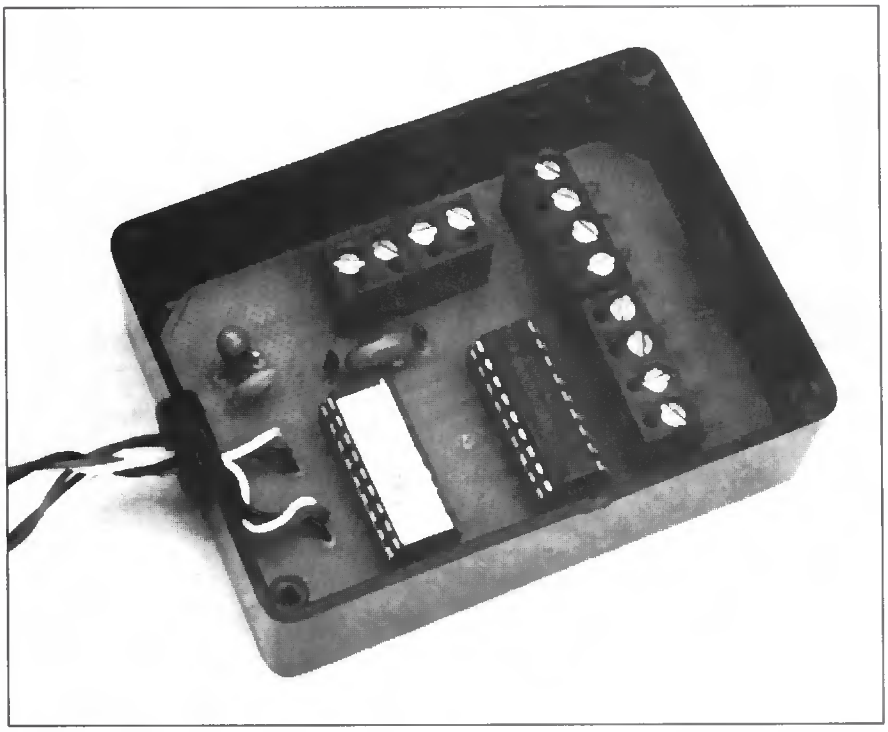
Each Darlington output from IC2 may be used to drive a relay or power a small motor for example. Up to 500mA of current can be sunk to ground by each Darlington output.

Some ways of using these outputs are indicated later in Fig.6. Note that if inductive loads, such as relays or motors, are to be switched then a reverse biased protection diode is required across the load as shown (1N4001 diodes will be suitable). Failure to provide this diode may cause failure of the respective Darlington switch when the device is switched off, due to the high voltage generated as the current is interrupted.

Direct PIC outputs can drive an l.e.d. etc as they can sink up to 25mA or source up to 20mA. However, remember that current sourced from these two outputs actually comes from the receiver power supply.

Whether or not this is acceptable depends on your own R/C system design. For example, some receivers have a built-in "BEC" or "Battery Eliminator Circuit" that may only be able to supply the receiver's current demand plus a couple of small servos. Any extra drawn by Digiserv's loads may cause voltage drops and unreliable and erratic receiver performance.

All digital outputs are available from terminal strip connectors TB3 to TB5. The smoothed receiver pulse output to drive the normal servo is available from connector TB2.



DELAYED AND SMOOTHED R/C OUTPUT

To allow the use of Digiserv in 2-channel systems where both channels are in use, for say rudder and speed control of a model boat, a smoothed R/C pulse output is provided from the PIC microcontroller IC1 at RA3 (pin 2) which is available from connector TB2/1, see Fig.2. The smoothed output is a digitally averaged version of the delayed pulse received from the receiver, the pulse being delayed by eight frames.

Effectively the fairly high speed joystick "pushes", used to control a digital output, are integrated or smoothed out and the output pulse width change will be very much smaller than the joystick movement would produce. However, over a second or so the output pulse width will slowly catch up with the input pulse width.

It is intended that the delayed and smoothed R/C output should be connected to the model's speed controller. A 2-channel transmitter's vertical joystick is usually chosen for the speed controller whilst the horizontal joystick is naturally chosen for direction control. To operate the motor speed control, the joystick is moved slowly up or down for forward or reverse motion.

To control Digiserv's digital outputs the same control is slowly centralised then pulsed rapidly up or down the number of times required for setting or resetting the output required. The control is then slowly returned to its central position to restore normal forward or reverse motion. It will be found that the output has most of the joystick pulses filtered out and fairly smooth speed control will be achieved.

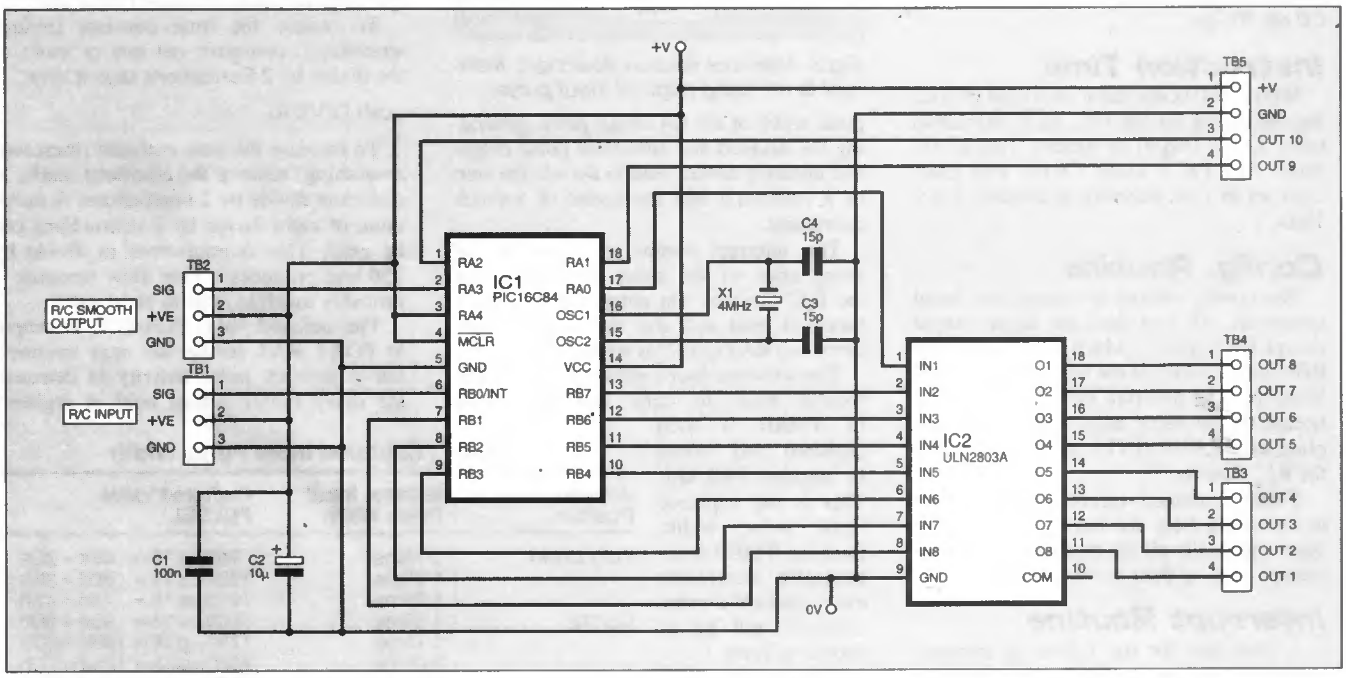


Fig.2. Full circuit diagram for the Digiserv R/C Channel Expander. Power supply is via the R/C's supply.

A bit of practice is required as sometimes if a rapid speed change is required the software can interpret the sudden pulse width change as a request to set or reset Output 1. It may even be a good idea not to allocate Output 1 as this is the most likely one to be accidentally triggered by the over-enthusiastic operator. Of course, on systems with a spare channel Digiserv can be used alone on that channel.

SMOOTHED OUTPUT ON/OFF CONTROL

The smoothed output can be switched off if required by setting an imaginary "Output 16" on by pulsing the joystick Up sixteen times. The output can be switched back on by pulsing the joystick Down sixteen times.

This feature was originally used for test purposes during the software development, but has been left in so that the user can kill the output if needed. Most speed controllers cut power to the motor completely if the input pulse is switched off. The smoothed output is always enabled when Digiserv is initially powered on.

SOFTWARE

We have now reached the stage where we start to delve into the software program requirements for the Digiserv PIC16C84 microcontroller.

For those Radio Control enthusiasts who may not be that interested in what goes on inside the PIC microcontroller, and intend to purchase a ready-programmed PIC16C84, they can skip the next few software sections and dive straight into the "Construction" work. As far as you are concerned, the PIC is just like any other i.c. (chip) and is simply plugged into a socket on the circuit board.

The PIC program for the 16C84 has been written using MPASM but may be easily modified by the user if required to TASM assembler format. *(Another good reason to build the PIC16x84 Toolkit TASM/MPASM translator described in the July '98 issue – Ed.)* When programming the PIC the fuses should be set as follows: WD on, OSC XT, CP off, PU on.

Instruction Time

With a 4MHz resonator or crystal providing the timing for the PIC, each instruction takes 1/(osc freq/4) or exactly 1µs to execute. The PIC's timer TMR0 with prescaler set to 1:16 therefore increments every 16µs.

Config. Routine

The config. routine is entered on initial power up. All port pins are set to output except RA4 (pin 3) which is not used and RB0 (pin 6) which is the input from the R/C Receiver. The interrupt system is set to interrupt on the rising edge of the signal applied to pin RB0 (INT) i.e the input from the R/C receiver.

TMR0 combined with the prescaler is set to increment from the internal clock every 16µs and finally all file registers (RAM) are cleared or set to their start values.

Interrupt Routine

A flowchart for the following interrupt routine is shown in Fig.3. The interrupt routine is responsible for measuring the pulse width of the R/C input pulse, generating the delayed and smoothed pulse output and updating timers used to decode the start of a command and the speed of joystick movement.

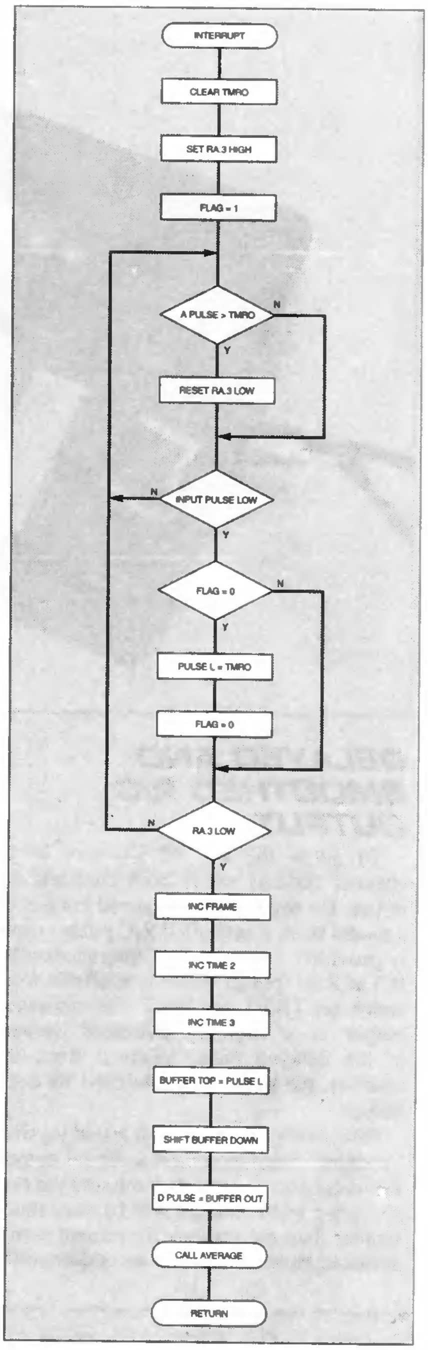


Fig.3. Interrupt routine flowchart. Interrupt is on rising edge of input pulse.

This interrupt routine is entered on the rising edge of the pulse outputted from the R/C receiver. On entry, TMR0 (PIC's timer) is reset and also the average pulse output on RA3 (pin 2) is set high.

The software loops until the input pulse returns back to zero and the value of TMR0 is then captured and stored in register PULSEL This is the captured input pulse width. Because TMR0 automatically increments every 16µs the value captured will be as shown in Table 1.

The software continues to loop within the interrupt routine until TMR0 value exceeds the average pulse width calculation APULSE. At this time the average pulse output on the PIC pin RA3 is forced low.

Next a frame counter is incremented (FRAME) and two timers TIME2 and TIME3 are incremented. These timers are therefore incremented every frame or approximately every 18ms. TIME2 is used to determine the intercommand time and TIME3 is used to measure the velocity or speed that the joystick is moved at. Both timers are used in the decode pulse routine (DECPULSE).

Every frame the contents of an 8-byte delay buffer store, formed by registers D8 to D1, are shifted down. D1 is the output register and is copied to the delayed pulse register DPULSE. D2 is copied to D1, D3 to D2 etc until D8 is copied to D7. The captured input pulse width PULSEL is then copied into the input register D8.

Finally, the AVERAGE routine is executed to produce the average of the delayed input pulse width. Therefore, after eight frames a captured PULSEL value appears as the delayed pulse value DPULSE.

Average Routine

The average routine is executed every interrupt and calculates a moving average of the delayed input pulse width. Every time this routine is executed a new average value APULSE is calculated.

The average is computed from the following equation:

APULSE(new) =
(TOTAL + DPULSE – APULSE(last))
divided by N

where DPULSE is the delayed input pulse width, APULSE(last) is the average value of pulse width calculated last frame, TOTAL is variable store and APULSE(new) is the new average value computed to output as the smoothed output pulse width.

The value of N controls the time constant or response time of the averaged output pulse width (APULSE). In this version N is set to 8, but may be modified if required to be 2,4,8,16,32,64,128 or 256.

To reduce the time constant (reduce smoothing) comment out one or more of the divide by 2 instructions shown here:

; call DIVIDE

To increase the time constant (increased smoothing) remove the comment marks to add more divide by 2 instructions. A maximum of eight divide by 2 instructions can be used. This is equivalent to divide by 256 and produces a very slow response – probably much to slow to be of use.

The delayed value APULSE is output to PORT RA3 during the next interrupt, but if joystick pulse activity is detected, the delay buffer values held in registers

Table 1: Captured Input Pulse Width

Joystick Position	Approx. Input Pulse Width	Captured value PULSEL
Fully Down	0·75ms	750µs/16 = 46d = 2Eh
	1·00ms	1000µs/16 = 62d = 3Eh
	1·25ms	1250µs/16 = 78d = 4Eh
Central	1·50ms	1500µs/16 = 93d = 5Dh
	1·75ms	1750µs/16 = 109d = 6Dh
	2·00ms	2000µs/16 = 125d = 7Dh
Fully Up	2.25ms	2250µs/16 = 140d = 8Ch

D1 to D8 are all overwritten by the current average value thus hopefully eliminating the initial joystick movement. This to a large extent removes the rapid joystick movements from the output pulses.

DECPULSE (Decode Pulse Routine)

The decode pulse (DECPULSE) routine detects "high" and "low" joystick pulses, determines the start and end of a sequence of command pulses and compiles a 10-bit word of 0s and 1s to output. The flowchart for this routine is shown in Fig.4.

The DECPULSE routine is the only routine in the main loop (except for the clear watchdog command) and is therefore re-entered as soon as it is exited, i.e the routine loops continuously except when interrupted by a low to high transition from the R/C receiver channel output.

Subroutines TESTHI and TESTLO determine the position and velocity of the joystick and subsequently whether or not a "high" or "low" joystick pulse is detected.

The joystick Up level (hi) is set to 6Dh which corresponds to a pulse width of about 1·75ms (mid-point between centre and max joystick position). If the joystick moves through the two levels hi and hi+8h in less than two frames (TIME3) then a high joystick pulse is detected.

The joystick Down level (lo) is set to 4Eh which corresponds to a pulse width of about 1·25ms (mid-point between centre and low joystick position). If the joystick moves through the two levels lo and lo − 8h in less than two frames (TIME3) then a low joystick pulse is detected.

When the joystick high or low pulse is initially detected, TIME3 is reset to zero.

When the joystick is returned to the central position and if the high or low joystick pulsed movement lasted between 3 and 20h frames (54ms to 576ms with an 18ms frame), and the timer TIME2 is greater than 20 frames (0·576 sec), then a new command is detected. Further joystick pulses are accepted and the bit position is shifted along a shift register. If the time delay after the last pulse exceeds 0·576 sec, the command is ended and the appropriate bit is forced high or low depending on the last joystick pulse being up or down.

The frame counter FRAME and timers TIME2 and TIME3 are incremented during every frame interrupt.

The software for the Digiserv is available from the Editorial Offices on a 3·5inch PC-compatible disk. See the *EPE PCB Service* page for details of how to order the disk, plus the postage charges.

The software is also available free from our Web site at:

ftp://ftp.epemag.wimborne.co.uk/pub/PICS/Digiserv.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) topside component layout and full

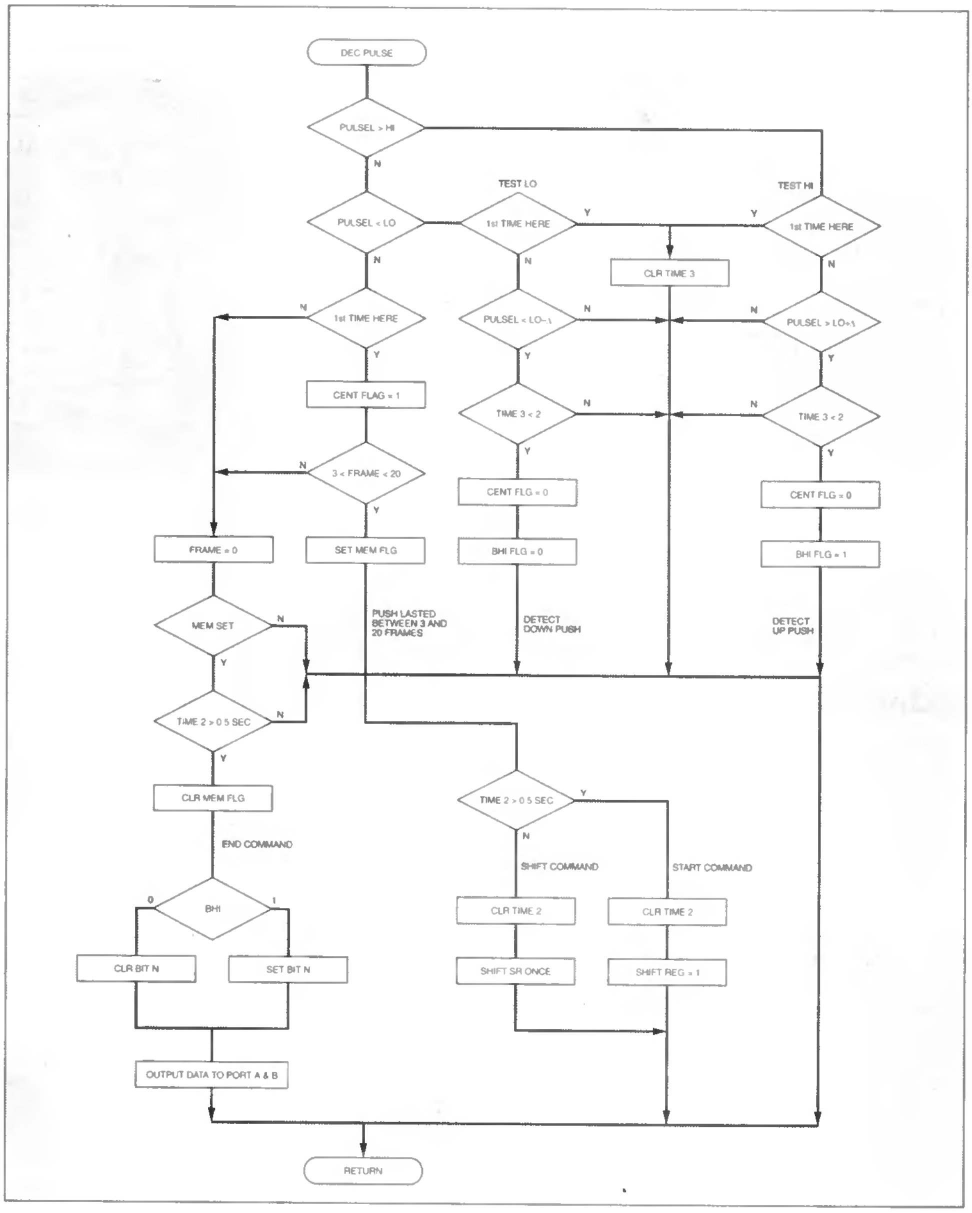
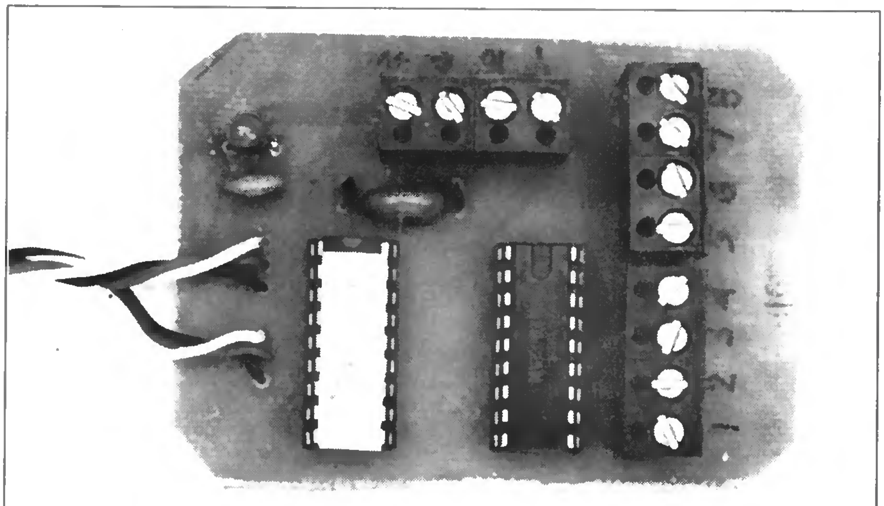


Fig.4. Flowchart representation of the Decode Pulse Routine (DECPULSE).

size underside copper foil master pattern for the Digiserv R/C Channel Expander are given in Fig.5. This board is available from the *EPE PCB Service*, code 204.

With so few components to worry about, the sequence of mounting them on the p.c.b. is largely irrelevant, but make sure you insert the tantalum capacitor on the p.c.b. with care ensuring correct polarity. Also, do not insert the PIC and Darlington driver chips in their sockets until all soldering and wiring has



Completed prototype printed circuit board. The corners have been cut off to fit the box.

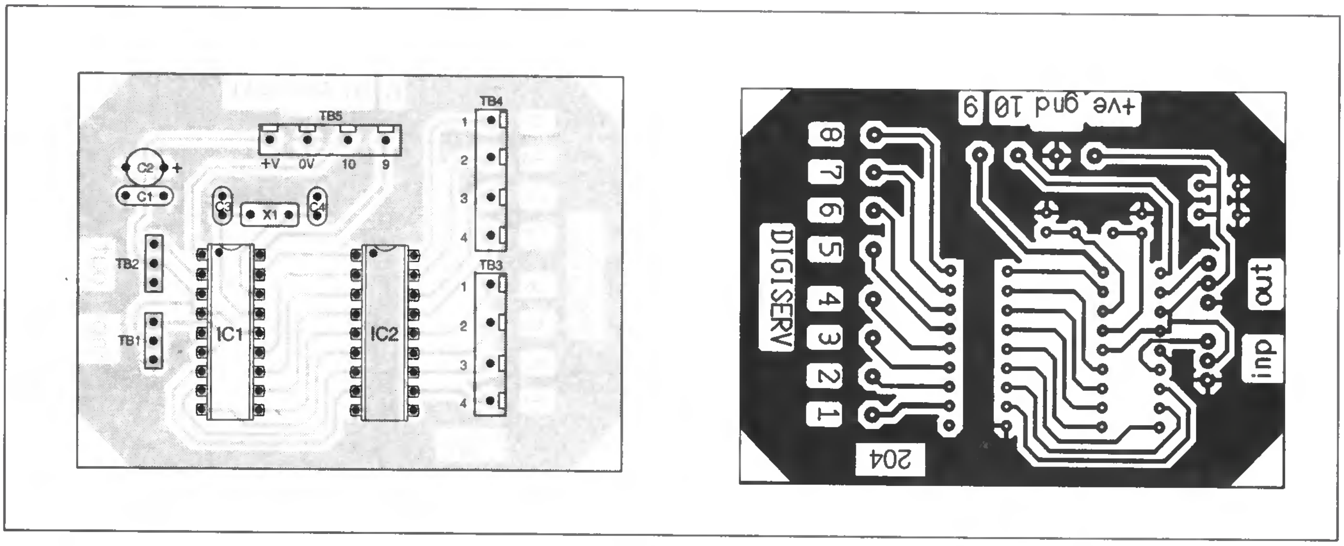


Fig.5. Digiserv printed circuit board component layout and full size copper foil master.

been completed and double-checked; again making sure that their orientation in the d.i.l. sockets is correct.

BOXING-UP

Taking the specified small plastic case, holes should be drilled and grommets fitted at both ends of the box to allow the input and output wires through. You may find you need to drill several holes at the digital output end if a lot of the outputs are used.

The R/C receiver connector lead and smoothed output lead are passed through the grommetted hole before being soldered or secured to TB1 and TB2 positions respectively. The receiver connector is actually a socket on a flying lead. It can be obtained from most model shops and is usually prewired to a black, red and white or yellow lead.

The smoothed output connector is a plug on a flying lead. The author had trouble finding a suitable plug for the smoothed output so made one up using a 3-pin 0·1in terminal or header-pin strip and heatshrink tubing. This produces a simple plug but without any polarisation.

However, providing the correct colours are used as in the receiver connector there should be little danger of connecting a servo or speed controller the wrong way round unless you are colour blind. Alternatively, the 3-pin 0·1in. terminal strip can be soldered direct to the p.c.b. pads at TB2 position although this will then require a cut-out in the plastic box to make the connector accessible.

Once the soldered connections have all been made push the p.c.b. into the box base. The p.c.b. should be a tight fit into the specified plastic box.

After all digital output connections (Outputs 1 to 10) have been passed through the box and secured to the screw terminal strips, the box lid may screwed on. It is fairly commonplace to stick Velcro to the underside of the box and onto the model where the box is required to sit so that the box can be removed easily if a wiring change is required.

TYPICAL CONNECTIONS

Some typical set-ups, as tried on the author's model boat, are shown in Fig.6. Output 2 was connected to Navigation Lights; Output 3 to Cabin Lights; Outputs 4 and 5 to Sound Effects Generators; Output 6 to a Water Pump and Output 7 to a motorised Radar Dish. Output 1 is not used here for the reasons discussed earlier, but may be used if you have more control and don't get over excited!

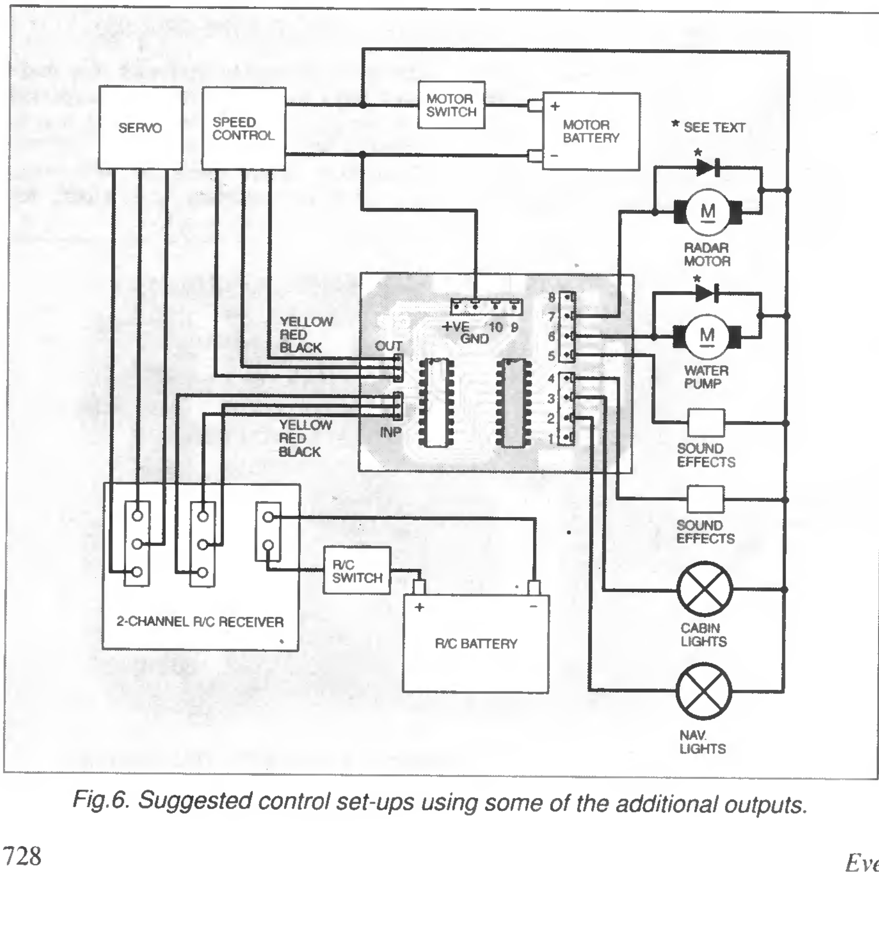


Fig.6. Suggested control set-ups using some of the additional outputs.

COMPONENTS

Capacitors

C1	100n ceramic
C2	10µ tantalum bead, 16V
C3, C4	15p ceramic (2 off)

See SHOP TALK Page

Semiconductors

IC1	PIC16C84-04 pre-programmed microcontroller, 4MHz version
IC2	ULN2803A (TTL) octal Darlington driver

Miscellaneous

X1	4MHz resonator or crystal
TB1	3-pin R/C socket on flying lead
TB2	3-pin R/C plug on flying lead or 3-pin 2·54mm (0·1in.) spacing p.c.b. header plug and socket
TB3 to TB5	4-way 5mm p.c.b. mounting screw terminal block (3 off)

Printed circuit board available from *EPE PCB Service*, code 204; plastic case, size 75mm × 56mm × 25mm; 18-pin d.i.l. socket (2 off); small (6·4mm) rubber grommet (2 off); solder etc.

Approx Cost Guidance Only £19

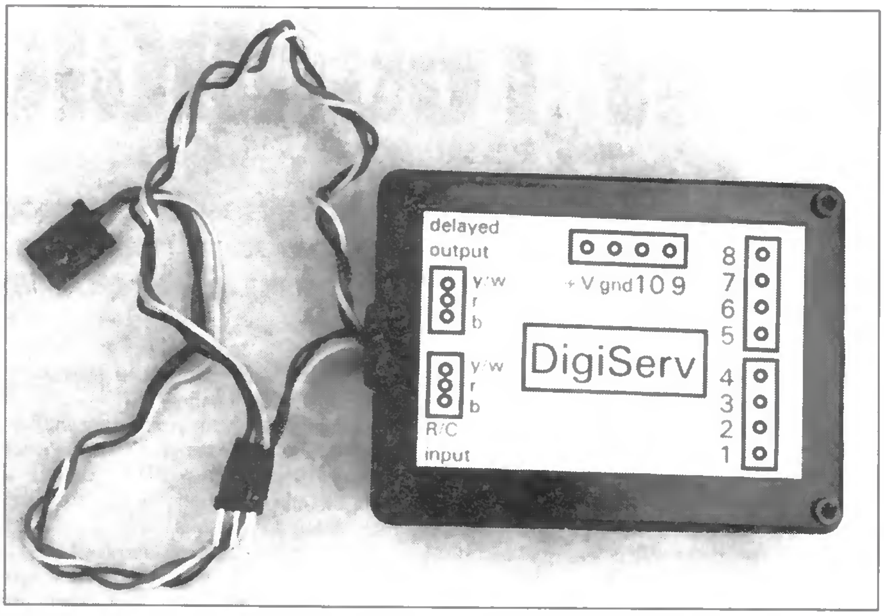
Also, for applications where a third channel is available for connecting to Digiserv then Output 1 would be used. The author's model boat was too small to add many more functions, but there is no reason why all available outputs cannot be used, other than being able to remember which output is connected to which function.

TESTING

Commence testing the system by double-checking the construction quality and check that the i.c.s have been inserted the correct way round. Simply connect TB1 to the required R/C Receiver channel, TB2 to the speed controller, if in use. Connect all outputs as required to screw terminal blocks TB3 to TB5.

The R/C Receiver power supply will not normally be used for supplying the digital outputs and is effectively separated from the speed controller supply and only the "ground" lead is shared. This allows a higher voltage drive motor battery to be used than the receiver battery and can provide some benefits such as lower interference as the receiver and main motor supplies are separated. However, everything can be powered from one battery if required.

Details on how to connect up Digiserv to the R/C Receiver, batteries, speed controller etc., and some ideas of digital output uses, are given in Fig.6. Switch the R/C Receiver and Transmitter on and check that the direction servo is operating correctly to verify they are working properly.



Finished Digiserv R/C Channel Expander with function label stuck to lid of the box.

If a speed controller is used, as shown in Fig.6, check that the model's forward and reverse motor power operates by slowly operating the joystick. If a speed control is not used then a spare servo can be connected to TB2 just to indicate that the smoothed output from Digiserv is functioning correctly. If not then switch off immediately and check all connections and circuit board details.

If all is well, give the joystick some sharp pushes up and check that the appropriate output has switched on. If that worked, then give the joystick the same number of downward pushes and check that the output is switched off again. Repeat the test on all connected outputs.

New Technology Update

In the search for eco-friendly low-cost power generation methods, plant photosynthesis techniques are considered a possibility.

GREEN issues are becoming more important, with everyone focussing on reducing the level of greenhouse emissions. Today electricity is used in vast quantities, and its production is not very efficient.

Whilst the electrical generators that convert the mechanical energy in the form of a turning shaft into electricity can be as high as 98 per cent efficient, the way in which the mechanical energy is converted from stored chemical energy in the form of coal, oil or gas is not nearly as efficient. This means that vast quantities of greenhouse gases are needlessly produced each day.

Not only this, but for some applications remote sources of power are needed. In these circumstances small generators are not always the most convenient method of generating power and other methods are required.

One method that can be used is that of converting light into electricity by the use of solar cells. Although this method is used for space applications, it is not as widely used elsewhere. The reasons for this are that solar cells are expensive and not very efficient. For space applications there are few alternatives and solar cells have to be used.

To achieve the maximum efficiency, the panels of solar cells are rotated so that the maximum amount of sunlight is received. This has to be done so that the best use is made of the cells because the levels of power required can be surprisingly high. For example, direct broadcast satellites must radiate sufficient power to enable the domestic receivers on the ground to pick up a sufficiently strong signal. Other applications, like the orbiting space station, require enough power to maintain all the on board systems.

Improving Efficiency

To raise the levels of efficiency and reduce the cost, development is being undertaken in a number of areas. Obviously the existing technologies are being improved to ensure they are operating at their maximum efficiency, but also a number of new initiatives are taking place.

Currently the best efficiency that can be obtained for solar cells is just above 10 per cent. Accordingly there is room for large levels of improvement and as a result a number of organisations are investing heavily in research into this area. In one development being undertaken by Imec in Belgium, solar cells are viewed as one of the best long-term sources of energy, and Imec are investing heavily in research into multi-crystalline silicon solar cells. They have introduced a number of new steps in the manufacturing process to improve the efficiency of solar cells.

In their process they passivate the basic crystals at a high temperature using a long hydrogenation process. This reduces the level of inter-grain defects in the material that lead to poor results.

In view of the time required for the process, it can be expensive. As a result Imec have developed a new lower cost process. The whole manufacturing process involves using six steps. The first involves removing the surface defects caused when the wafer is cut. The next is surface texturisation to prepare it for the next stages of the process and this is followed by emitter diffusion.

Then a layer of silicon nitride is deposited as shown in Fig.1. This is done using plasma-enhanced chemical vapour deposition. The final stages of the process involve the deposition of the metallisation using a screen printing process and the removal of any parasitic junctions.

The crucial stage in the whole process is the contact firing. Here the contacts penetrate the silicon nitride layer to enable the connections to be made.

It is also found that reflections are reduced using a combination of the firing process and grooves on the front surface.

The whole process has been shown to give an improvement in efficiency raising the level by three per cent to as high as 18 per cent. Although this may appear to be relatively low, it is a significant improvement on what could previously be achieved.

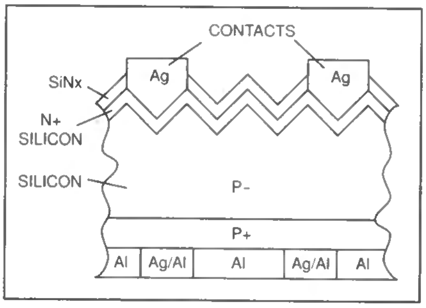


Fig. 1. The new solar cell structure.

Photosynthesis Power

In a revolutionary new approach some of the techniques found in photosynthesis are being investigated to see whether they can be used to generate electricity. The investigations for the process are based around the use of thin layers of dyes that are deposited onto a glass substrate. The materials to be used and the methods employed will ensure that the process is both simple and environmentally friendly.

The team at the Los Alamos National Laboratory in New Mexico USA are investigating the ways in which energy is transferred in the photosynthesis process and looking at how this may be applied to the generation of electricity.

The research is based around a group of molecules called porphyrins. These chemicals are dyes and fall into the same category as chlorophyll that is found in plants. This is the basis of the photosynthesis process at the heart of plant life.

The porphyrin molecule has a complicated structure. Within it there are four charged branches that radiate from a central cluster. When a light photon hits the molecule the photon is absorbed and the molecule is placed into an electrically excited state.

It is found that the molecules like to remain in the lowest stable energy state, and as a result of this the energy transferred from the photon is passed from one molecule to the next. In the plant world the energy is passed around the chlorophyll molecules until it reaches an energy trap where it is converted into chemical energy.

Energy Trap

At the moment, one area of research is directed towards enabling the energy to be passed into an energy trap where it is converted into electricity. Another line of development is associated with investigating the way in which different metal ions affect the way in which energy is transferred. At the moment it is found that the molecules react differently when they are in solution or made into a film on a substrate – the way they are currently anticipated to be used.

It is envisaged that the manufacturing process will be as simple as possible. This will make the devices cheap and easy to manufacture. It will be particularly applicable for large devices that may be used for generating significant amounts of electricity. To achieve this, the research team has concentrated on using chemicals that can be applied by simply dipping the substrate into the dye. The process is also designed to avoid the use of hazardous organic materials used in some thin film processes.

Manufacture involves first coating the substrate with a polymer that has positively charged sites, and then with one that has negatively charged sites. This process is repeated until the required number of layers has been established.

Assuming this research fulfils the hopes that have been invested in it, it could significantly aid the introduction of energy generation using totally green methods.

RELIABLE INFRA-RED REMOTE CONTROL

MAX HORSEY

PCB DESIGNS BY TOM WEBB

Part One

It has now become easy to build reliable IR systems – here's a selection of constructional ideas to prove it!

IF the author could choose one area which has caused the most frustration, it would be infra-red remote control. A number of systems have been published, including his own, and although they work when perfectly constructed, the number of variables involved make them difficult to test effectively if they fail to work in the first place. Oscilloscope testing can be helpful, though even then the interference caused by stray infra-red sources causes further annoyance.

Perhaps worst of all is the ease with which professional systems work; it is possible to zap a video recorder from anywhere in the room, and at any angle. The signal seems to bounce around *ad infinitum*!

Hence his determination to design a system which is free from interference, has few components, does not rely on specialised components available from only one source, is inexpensive, has a 10-metre range and, above all, is likely to work first time! The system to be described fulfils these requirements, and is available in the following forms:

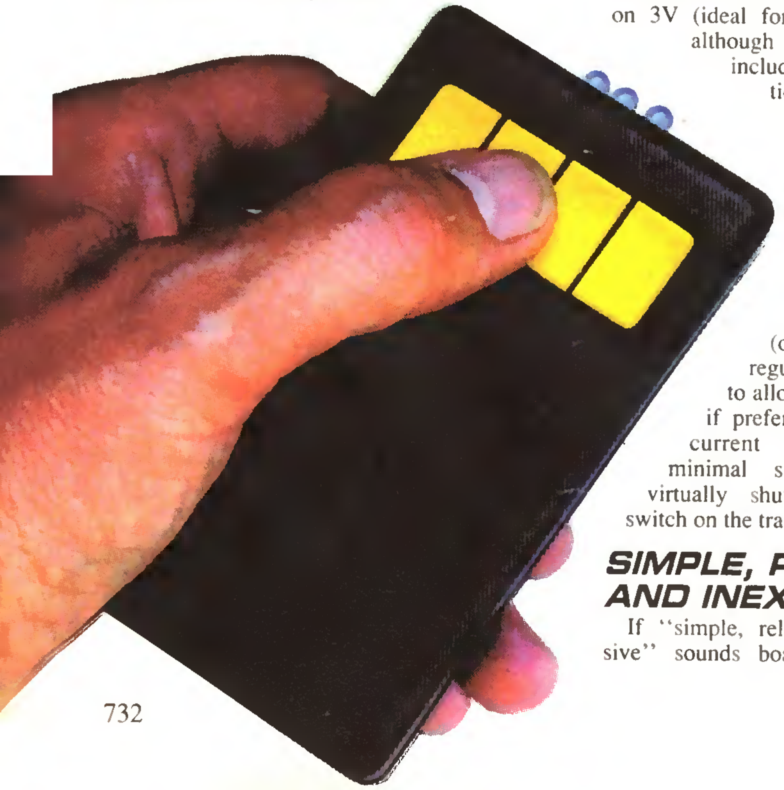
1. Momentary remote control
2. Low power single beam alarm system
3. 1 to 4-way remote control (with optional latching)
4. 15-way remote control (with optional latching)

All four systems use the same transmitter printed circuit board (p.c.b.), although option four requires an additional array of switches and diodes to convert the 15 ways into four binary inputs.

The first three systems employ the same receiver p.c.b., the fourth requires additional decoding to convert a binary output into 15 ways.

The transmitter is designed for operation on 3V (ideal for a handheld case), although a regulator i.c. is included to allow operation on 12V (or 9V) if preferred. If the system is used on 3V, a wire link is inserted into the p.c.b. in place of the regulator.

The receiver is designed for operation on 4·5V (or 5V), but again, a regulator i.c. is included to allow operation on 12V if preferred. In both cases, current consumption is minimal since the systems virtually shut down unless a switch on the transmitter is pressed.



SIMPLE, RELIABLE AND INEXPENSIVE

If "simple, reliable and inexpensive" sounds boastful, it is worth noting that all the very clever electronics is housed in the i.c.s and sensors employed!

A number of infra-red transmitting light emitting diodes (l.e.d.s) have been tried, and all work with varying degrees of efficiency. It is worth experimenting a little since new high power devices are appearing almost every week.

The receiving device is largely responsible for making the system reliable and easy to construct since it houses a sensor, amplifier and 38kHz demodulator, all in a single 3-pin package.

Note that the infra-red signal is both encoded and modulated. The signal is encoded to ensure that other systems do not react to the signal accidentally, and to deliver any data required. The encoded signal is modulated on a 38kHz carrier to make the system almost immune from interference from other infra-red sources.

CODING INFRA-RED

A system based on a continuous infra-red signal would fail, since the receiving circuit would be heavily influenced by stray background infra-red emission from lights etc. A coded infra-red signal is preferable since the receiver can be tuned to hunt for a particular code.

In practice, a complex coded signal is sent, and the code can be set (by means of wire links or tiny dual-in-line switches) so that the receiver will only respond to a particular transmitter. This ensures that a nearby TV or video recorder will not react unexpectedly when the transmitter is used. The coded signal may also include data which allows several commands to be transmitted.

A number of encoding and decoding i.c.s are available and a new range made by Holtek, and available from several suppliers, has been selected. The transmitter is based on an i.c. type HT12B. This i.c. not only encodes the signal, but also allows four data inputs (which can be combined in binary fashion to provide 15 commands), and adds a 38kHz carrier signal for greater reliability and immunity to interference. Few external components are required.

The sensor/amplifier/38kHz de-modulator i.c. provides a clean signal from its output pin, with the 38kHz carrier removed. The output can be applied to the input pin of a Holtek i.c. type HT12D.

This remarkable i.c. requires only a resistor and power supply to provide a fully decoded output.

If this sounds too easy, the only problem appears to be the need to use more than one supplier to complete the system. For example, one major catalogue (Maplin) supplies the 38kHz Holtek encoder/modulator, but nothing to demodulate the signal, i.e. to remove the 38kHz carrier.

Another supplier (RS) provides a sensor which removes the 38kHz carrier, but does not supply the HT12B i.c. or anything similar. Perhaps by the time this article is published the situation will have improved; however, all the other components required can be obtained from more than one supplier.

HT12B ENCODER/ MODULATOR

The pinouts for the HT12B encoder/modulator (transmitter) are shown in Fig.1. The inputs at pins A0 to A7 set the code to provide the unique signal which can only be decoded by a receiver with identical settings. These inputs must either remain unconnected, or a selection connected to 0V as required. In tests, the system was found to be more reliable when one or two pins were connected to 0V rather than all left open circuit.

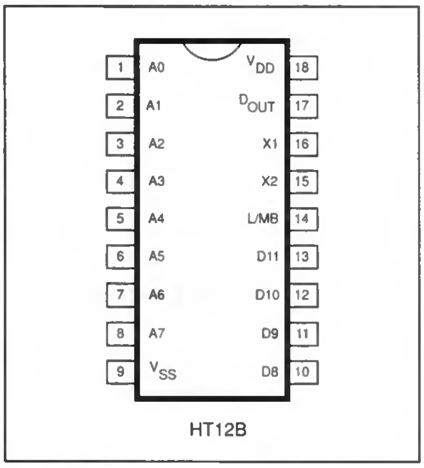


Fig.1. Pinouts for the HT12B encoder/modulator.

Pin 9 should be connected to 0V, and pin 18 connected to positive. The maximum supply is 5V. The pins labelled D8 (D for Data) to D11 allow data to be sent. Each data pin may be left unconnected (in which case it will float high), or it can be connected to 0V, in which case a similar pin at the receiver will switch to positive.

More than one data pin can be connected to 0V at the same time if required, enabling a total of 15 combinations.

The pin labelled L/MB (Latch/Momentary) is a little confusing and affects the way in which the receiver behaves. When the L/MB pin is left unconnected, the receiver data pins remain latched. In other words if, say, pin D8 at the transmitter is pulled to 0V, then pin D8 at the receiver will go positive, and remain positive even if D8 at the transmitter returns to open circuit.

The receiver's pin D8 will only unlatch if one of the other data pins is activated. This can be very useful and will be explained later in terms of a practical application. If the L/MB pin is connected to 0V then the receiver data pins work in a momentary fashion.

The pins labelled X1 and X2 set the oscillator frequency, and require a 455kHz ceramic resonator together with a resistor and two capacitors.

The output is from D_{OUT}, and a simple transistor amplifier will provide the current necessary to operate an infra-red l.e.d. The output contains the code as set, and is also modulated at 38kHz.

There is a similar transmitter i.c. type HT12A. This works in exactly the same way except that the data codes are inverted as compared with the HT12B. Hence the data outputs from the receiver are positive, but will latch at 0V when the appropriate transmitter data pin is connected to 0V for a moment.

HT12D DECODER

As the title suggests, the HT12D decoder (receiver) i.c. does not remove the 38kHz carrier (i.e. it does not demodulate the signal), and so a clean demodulated signal is required at its input pin labelled D_{IN} (Data In), as shown in Fig.2.

The chip's purpose is to decode the signal, ignoring any infra-red signals which do not conform with the exact code as set on its pins A0 to A7. Hence it is necessary to connect exactly the same pins (A0 to A7) to 0V as in the transmitter.

The code is checked three times, after which the pin labelled VT goes high, and the appropriate data output pins D8 to D11 switch their logic levels accordingly.

These pins will normally remain at 0V (assuming that the transmitter encoder is type HT12B) but will switch to positive when the appropriate transmitter data pins are switched to 0V. If the transmitter is in "momentary mode" (i.e. pin 14 on the HT12B is at 0V) then the data pins

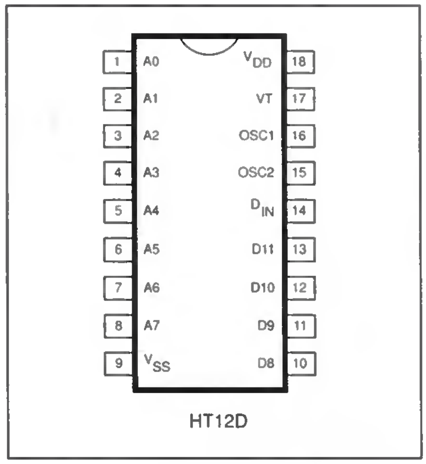


Fig.2. Pinouts for the HT12D decoder.

will return to 0V. If the transmitter is in "latch mode" (pin 14 open circuit) then the HT12D data pins will latch high. They can be reset by applying a signal to a different data pin at the transmitter.

The pins labelled OSC1 and OSC2 are used to set the oscillator speed. The recommended frequency is 150kHz, and assuming a 4·5V to 5V supply, a resistor of between 47kΩ and 51kΩ is required between pins 15 and 16. In practice, the system works with values well outside this range, and so the standard value of 47kΩ is suggested even if a 5V supply is used.

INFRA-RED RECEIVER MODULES

The IR sensor/amplifier/demodulator is housed in a package resembling a small power transistor. There are three pins, positive, 0V and output. The receiver rejects all infra-red transmissions except the required 38kHz signal, and provides a clean output easily observed on an oscilloscope.

The representation of a typical signal transmitted from the infra-red l.e.d. is shown in Fig.3. Note that the transmitted signal contains both the encoded signal and the 38kHz carrier. However, the output from the receiver contains only the encoded signal, the carrier having been removed.

There are three possible receivers, all of which have been tested in this system and perform the functions described earlier. The first is type IS1U60 made by Sharp (available from RS), the second is type PIC12043S made by Kodenshi (available from Farnell). Note that the latter has nothing to do with PIC microcontrollers.

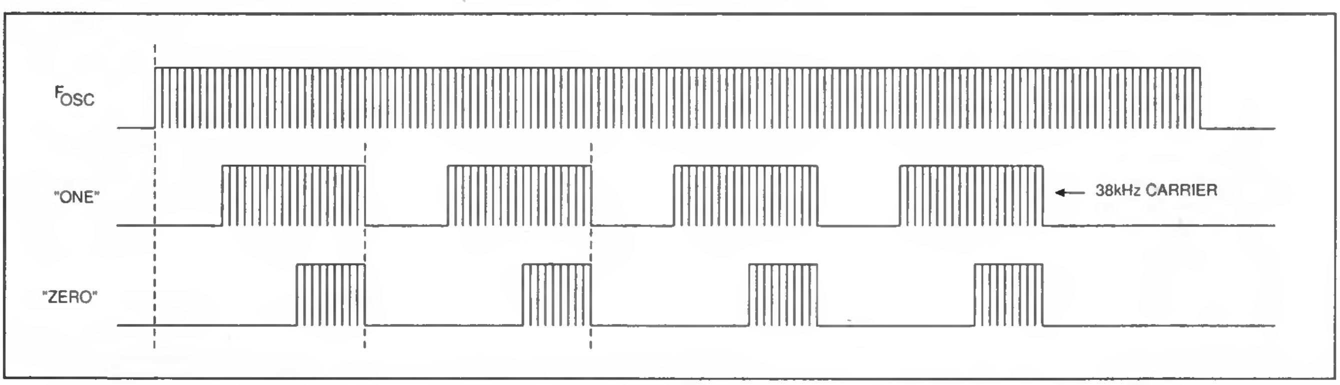


Fig.3. Representation of a typical signal transmitted from the infra-red l.e.d.

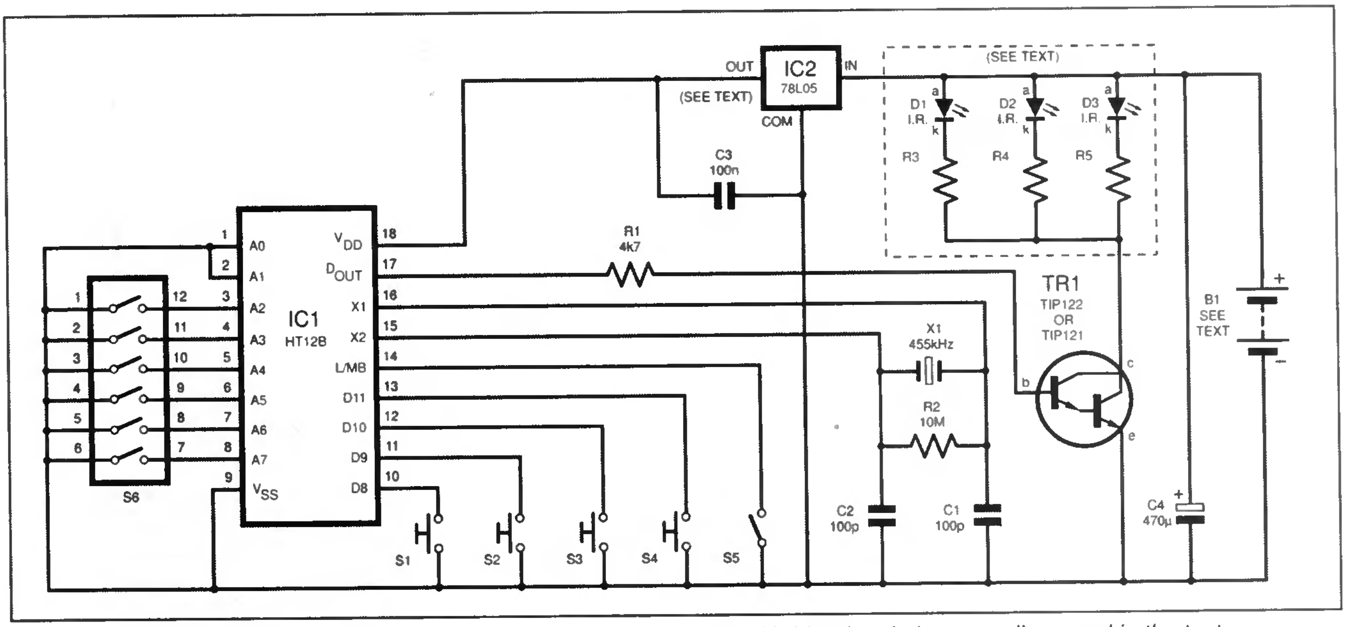


Fig.4. Circuit diagram for the complete transmitter systems. Abridged variations are discussed in the text.

In tests, the PIC12043S was a little more sensitive. This is of no consequence for the beam breaker alarm circuit, but might be important if you wish to zap over a long distance. Both receivers have the same pin layout and are about the same size.

Sharp have recently introduced another receiver type, GP1U281Q (available from RS) which is less expensive than the types above. Unfortunately, its pin layout is slightly different and care must be taken when connecting it to the p.c.b. In tests, it performed as well as the IS1U60.

COMPLETE TRANSMITTER

The circuit diagram in Fig.4 shows the complete transmitter system. The transmitter's purpose is to emit a coded infra-red signal which can be recognised by a similarly encoded receiver.

All the options are shown, though some may not be required. For example, the regulator IC2 is only required if the circuit is to be powered on a supply of more than 5V. For a 3V supply it is omitted and power is taken direct to the main circuit.

Three infra-red l.e.d.s (D1 to D3) are shown for maximum "punch", but if used as part of a beam breaker alarm, only one is required. Two values for resistors R3 to R5 are shown. The higher value (33Ω) should be used for all supplies greater than 3V. Lower value (4Ω7) is only used with a 3V supply.

Four transmission switches (S1 to S4) are shown, but in a single-way system only one or two are required (see later).

At the heart of the circuit is the HT12B encoder i.c. This clever device encodes the infra-red signal according to the state of its address pins A0 to A7, and then causes a 38kHz signal to be modulated accordingly. The six switches within the S6 module enable the code to be changed. However, it may be more convenient to fix the code with wire links rather than using switches.

Note that inputs A0 and A1 are permanently tied to 0V via the p.c.b.

The data input pins (D8 to D11) are used to control the data transmission, and to activate the i.c. The data pins float high if unconnected. When the switches are not pressed the i.c. draws virtually no current. Hence, if a 3V (or 4·5V) battery is used, and the regulator i.c. is omitted, then negligible current is used unless a switch is pressed.

LATCHING OPTION

The option to latch the transmission code applies to the 1 to 4-way system only. When pin 14 (L/MB) is unconnected, the receiver responds in "latch mode". When pin 14 is connected to 0V, either with a wire link or by closing switch S5, the receiver responds in "non-latching mode".

Note that the transmitted signal ceases when any of switches S1 to S4 are released, the latching function at the receiver is caused by the coding of the transmitted signal.

If the system is part of a beam breaker alarm, then no switches are required and a wire link should be inserted in place of S1 in order to maintain a constant signal.

The oscillator frequency is set at 455kHz by resonator X1, aided by resistor R2 and capacitors C1 and C2.

The serial data output is from pin 17, and this is fed via resistor R1 to transistor TR1. This transistor is a Darlington pair, type TIP121 or TIP122, or similar. It drives the infra-red l.e.d.s D1 to D3 via resistors R3 to R5.

As said earlier, the values of these resistors depends upon the supply voltage used and should be 4Ω7 on a 3V supply and 33Ω on a greater supply up to 12V.

The use of three l.e.d.s provides a high degree of zapping power, and only one may be required in practice. If in doubt, experiment. When used as part of a beam break alarm system, use only one l.e.d. and a series resistor of about 56Ω on 3V or about 560Ω on 12V. This will allow a beam to travel the width of a doorway. If a longer beam is required, then the value of the series resistor should be reduced to provide a greater current.

If the system is powered from a 12V supply then the regulator IC2 should be included. If powered from 3V or 4·5V the regulator must be omitted, and the in/out pads for IC2) should be connected together with a wire link.

TRANSMITTER OPTIONS

A number of transmitter options are possible, some examples of which are:

Momentary Transmitter (3V)

Include switch S1, all three l.e.d.s with 4Ω7 resistors, but omit IC2 and bridge the in/out pins of IC2 with a wire link. Omit switch S5. Note that this system cannot be set to latch since – at the receiver – only the VT output is employed, not the data outputs.

1-way (3V) Latching Transmitter

As above, but include switch S4. The data outputs are employed at the receiver so that when S1 at the transmitter is pressed, output 1 (D8) at the receiver latches *on*. When S4 is pressed, output 1 will unlatch.

1 to 4-way (3V) Transmitter

As above but include switch S2 and/or S3. If you omit S5, the receiver data outputs will always latch. If you fit and switch on S5 (or bridge its pads on the p.c.b. with a wire link), the data outputs at the receiver will not latch. Note that in latching or non-latching mode, it is possible to activate two or more data outputs at the same time by pressing two or more switches together.

Beam Break Transmitter (12V)

Omit switches S1 to S5 (but bridge S1 with a wire link), include only one l.e.d. with a series resistor of about 560Ω, and include IC2.

Mix and Match

It is possible to create further variations. or example, the momentary and 1 to 4-way transmitters can be powered from 9V or 12V if regulator IC2 is included.

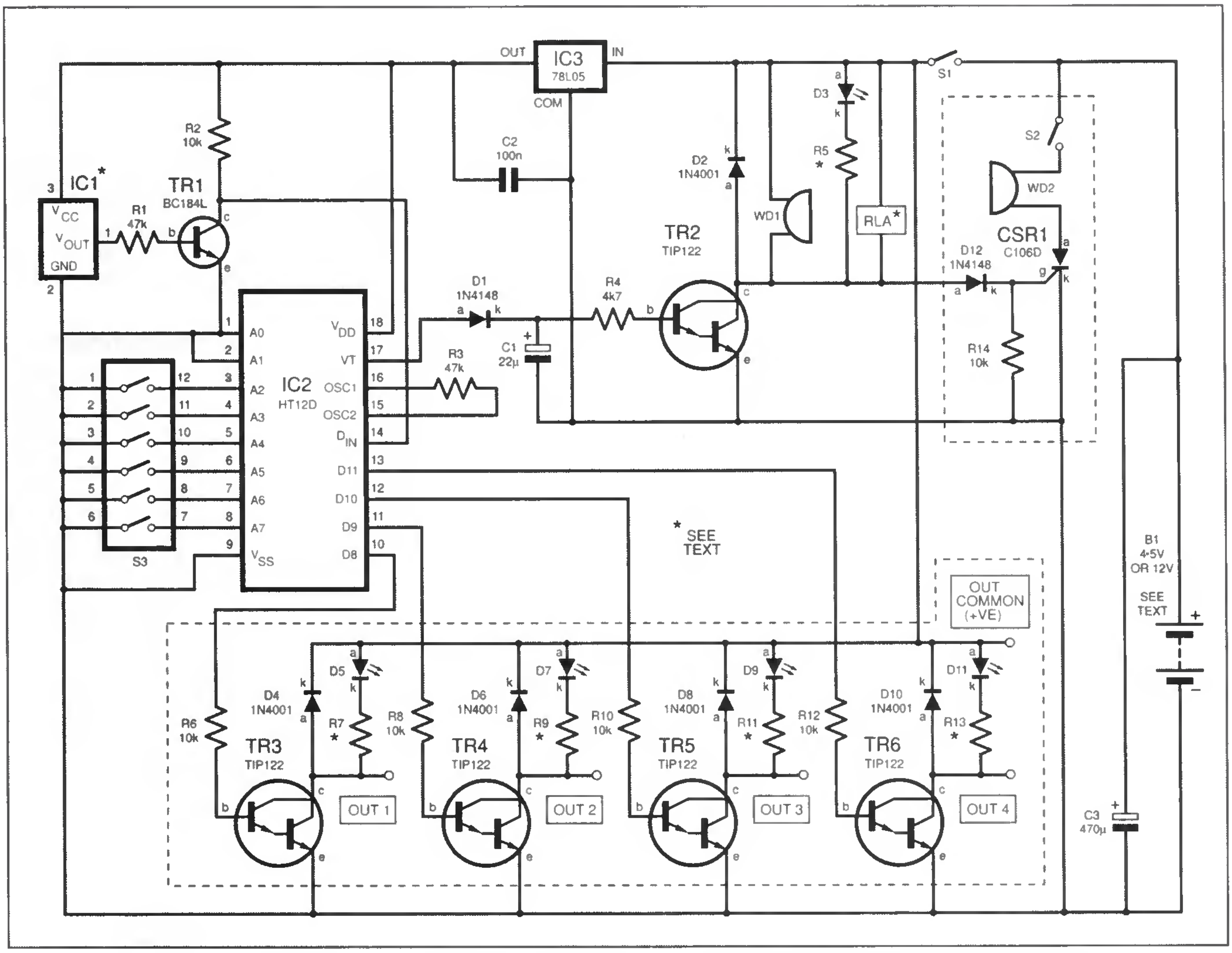


Fig.5. Circuit diagram for complete receiver systems. Abridged variations are discussed in the text.

Conversely, the beam break alarm can be powered from 3V. In both cases the value of resistors R3 to R5 should be appropriately changed as discussed earlier.

RECEIVER OPTIONS

The circuit diagram of the receiver with all options included is shown in Fig.5. The receiver module is labelled IC1; it requires a supply of between 4·5V and 5·5V, hence the need for a regulator (IC3) unless a 4·5V battery is used.

The output from IC1 is the inverse of the original transmitted signal, and so it must be inverted either by means of a logic gate or – as in this case – by transistor TR1. Very little current is available from the output of IC1, and so a high gain transistor must be employed.

The output from the collector of TR1 is an exact copy of the transmitted signal, and is fed to pin 14 (Data In) of IC2. The latter is a type HT12D, and appears very similar to the HT12B in the transmitter. Its address inputs A0 to A7 must be set up in exactly the same way as for the HT12B.

As before, a set of six switches (module S3) can be used if you need to change the code frequently, or wire links could be inserted in exactly the same pattern as at the transmitter.

The receiver's oscillator frequency is set by the value of resistor R3. This should theoretically be 51kΩ on a 5V supply, and 47kΩ on a 4·5V supply. However, in tests, values well outside this range worked perfectly, and so a value of 47kΩ can be chosen whichever of these two supplies is used.

Data outputs D8 to D11 are used for the 1 to 4-way option, and the momentary and beam break options employ the output from VT (pin 17). This "Valid Transmission" pin is normally low, but goes high when a suitably encoded signal is received. Little current is available and so this pin is connected to a Darlington pair transistor (TR2) via resistor R4.

Capacitor C1 provides a delay which may be especially helpful if the receiver is used as a beam break alarm. When the beam is detected, C1 quickly charges up via diode D1, and the transistor turns on. When the beam is broken there is a delay as C1 discharges via R4.

The result is to cause the receiver to respond for a second or so, even if a very brief "zap" is detected.

In beam break alarm mode, the delay prevents accidental detection if – for example – a fly passes through the beam. The same type of protection is provided by twin beam alarm systems – where both beams must be broken at the same time for the alarm to respond. However, the use of this simple delay created by C1 will prevent accidental triggering if a fly passes through the beam, without the expense of a second circuit.

If a longer or shorter delay is required, the value of C1 may be changed accordingly. If no delay is required then C1 can be omitted, and D1 can either remain in the circuit, or be replaced with a wire link.

There are several receiver options possible, some of which are as follows:

Momentary Option

For the momentary option, none of the components associated with the data outputs D8 to D11 (shown in the lower dotted box) are required.

Three output control options are provided and which are activated only when the infra-red signal is being received. These are buzzer WD1, l.e.d. D3 (via ballast resistor R5), and relay RLA.

Include regulator IC3 if the circuit is to be powered on a 12V supply. Otherwise link the in/out pins of IC2, and use a 4·5V battery.

Note that the output devices are connected prior to the regulator, and so their working voltages must match the chosen supply voltage.

The l.e.d. D3's series resistor R5 should be 330Ω on a 4·5V supply, and 680Ω on 12V.

Beam-break House Alarm

Fit the l.e.d. and relay components as detailed above, but omit buzzer WD1 which is unlikely to be required. Note that when the beam is detected, the relay coil will be energised, and its "normally open" contacts will be closed. Hence the relay contacts can be used with a standard alarm system in the same way as window foil, PIR detectors etc.

Portable Beam-break Alarm

Provision has also been made to sound a loud buzzer or siren when the beam is broken. This is achieved with the components in the right-hand dotted box – diode D12, thyristor CSR1, resistor R14, switch S2 and buzzer (or siren) WD2. Note that these components will upset the operation of WD1, l.e.d. D3 and relay RLA and must only be used as an *alternative*, not an *addition*. A pull-up resistor of about 10kΩ is necessary and must be fitted in place of WD1.

SCR1 is a thyristor whose gate is normally at 0V when the beam is being detected. This is because the detected beam will cause TR2 to switch on. When the beam is broken, and providing that a pull-up resistor is fitted in place of WD1, the voltage at the collector voltage will rise sufficiently to trigger the thyristor, causing it to latch and sound WD2.

When setting the alarm, first ensure that the transmitter is sending the infra-red beam. Then switch on S1 to allow the system to stabilise, before switching on S2. Once triggered, buzzer WD2 will remain on, even if S1 is switched off. It can only be turned off by switching off S2.

A little thought is needed in the placing and types of switches employed in this example system. For instance, S2 should be a key operated switch for added security.

Be aware that some sirens will cause the flow of current through SCR1 to fluctuate, preventing it from latching correctly. In this case connect a resistor of about 1kΩ in parallel with the siren.

Non-latching Beam-break Alarm

If the latching action is not required, then thyristor CSR1 may be replaced with an *npn* transistor, such as type BC184L, taking care to connect it as follows: base (b) as gate (g), collector (c) as anode (a), emitter (e) as cathode (k). Buzzer WD2 will now sound when the beam is broken, but stop sounding when the beam is restored.

1 to 4-way Receiver

The four data outputs are used as shown in Fig.5 to switch up to four Darlington transistors, TR3 to TR6.

All the components associated with the VT pin can be omitted (the components list makes this clear). However, if a "code detect" indicator is required, then components TR2, R4, R5 and l.e.d. D2 can be fitted, plus a wire link in place of diode D1, but still omit capacitor C1.

Very little current is available from the data outputs and so Darlington transistors TR3 to TR6 are used to provide sufficient current to power any device requiring an amp or so. Four l.e.d.s (D5, D7, D9, D11) are included as are diodes (D4, D6, D8, D10) to protect the transistors against back-e.m.f. if, for example, a relay or solenoid is connected to any output.

The l.e.d. ballast resistors (R7, R9, R11, R13) should have values suited to the power supply used – 330Ω for 4.5V or 680Ω for 12V.

The outputs from the Darlingtons are "active low", in other words any output device should be connected between one of these points and positive. For example, if a solenoid is to be driven from Output 1, then one side of the solenoid should be connected to that point and the other side connected to the point labelled "Common Output +VE".

Latching/Momentary

If switch S5 on the transmitter (Fig.4) is open, the data outputs latch. In other words if S1 on the transmitter is pressed, data pin D8 on the receiver (Fig.5) will go high and remain high until another switch (S2 to S4) on the transmitter is pressed.

If switch S5 on the transmitter is closed, the data outputs on the receiver will be in non-latching mode. Hence pressing any of switches S1 to S4 on the transmitter will make the appropriate data output on the receiver go high for as long as the switch is pressed.

Note that it is possible to make more than one data output switch at the same time, this allows a multiplexing arrangement which will be described in Part 2, next month.

1-way Receiver

You may not require four ways as described and if, for example, you require a single latching output, fit only the

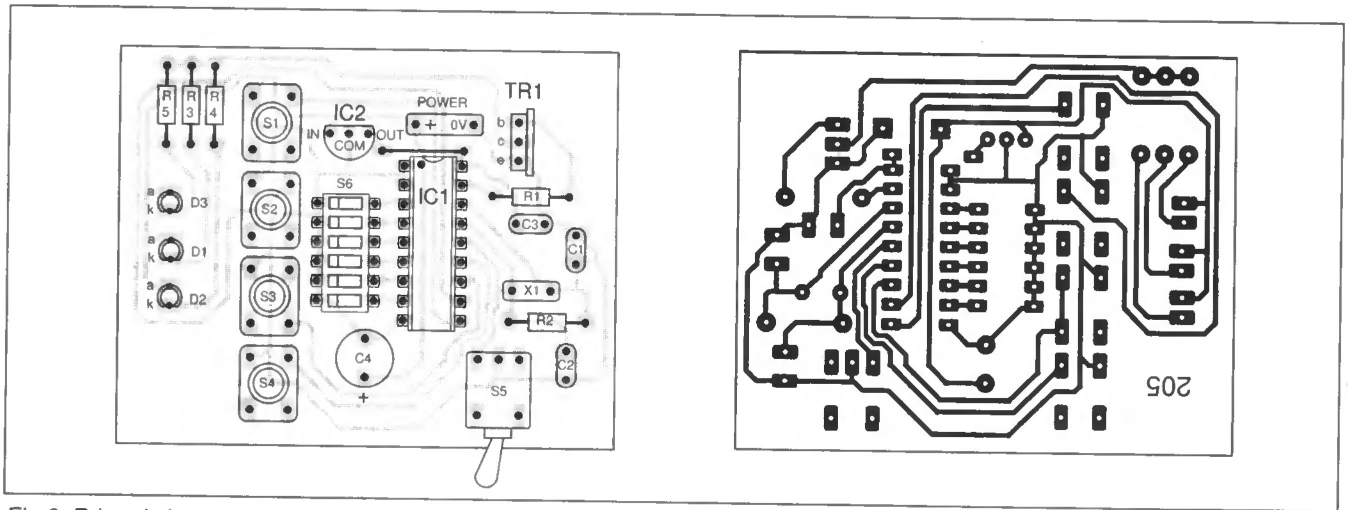
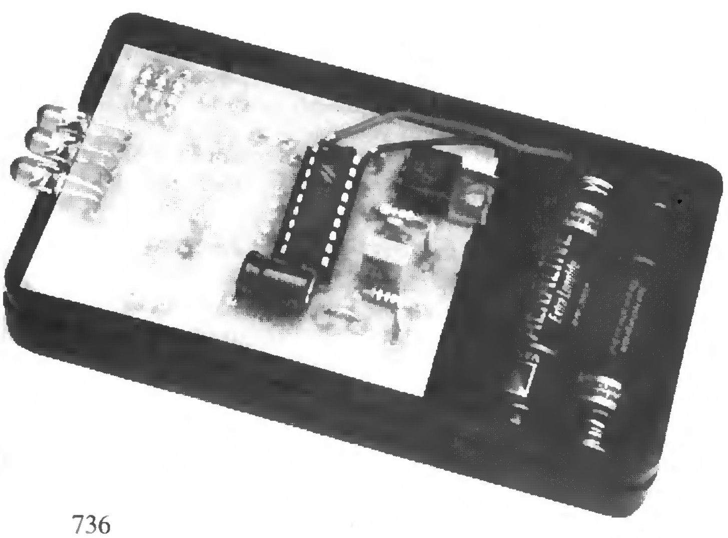
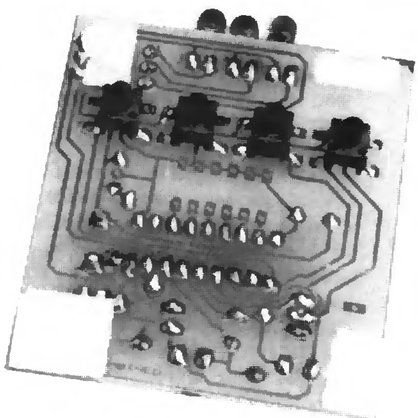


Fig.6. Printed circuit board component layout and full size copper foil track master for the general purpose I-R transmitter. Note that some components are not needed in some options.



The 1 to 4-way transmitter in its case, and (right) showing the switches mounted on the trackside.



components associated with transistor TR3 in Fig.5. When S1 is on and the transmitter is pressed TR3 will latch on. If any other switch is pressed, say S4, then TR3 will unlatch.

CONSTRUCTION

Two general-purpose printed circuit boards are available from the *EPE PCB Service*, code 205 for the full transmitter circuit (Fig.4) and code 206 for the full receiver circuit (Fig.5).

Component and track layout details of the p.c.b.s are shown in Fig.6 and Fig.7.

Several constructional options are available and it is important to select and connect the correct components with care! Select the components from the appropriate column of the tabulated components list, according to the voltage and options required. Note that the 12V options are mainly intended when a mains operated power supply is being used, since current is wasted in the regulator i.c.

If the regulator is not used (with a 3V supply), insert a wire link in the p.c.b. to bridge the in/out pins of IC2 in Fig.6.

Without the regulator i.c., the current wasted by the transmitter will be virtually zero; the only current wasted by the receiver will be that required by the infra-red sensor module, IC1. This should be less than 5mA.

Having selected the appropriate components for the option required, fit the i.c. sockets, followed by small components such as resistors. Ensure that the electrolytic capacitors are fitted the correct way round.

Note that C4 and TR1 on the transmitter should be inserted in such a way that they can be folded down against the p.c.b. to facilitate fitting in the suggested case.

Diodes and transistors must also be fitted with care; a flat mark on the side of round l.e.d.s indicates the cathode (k). This is generally the shorter lead, but (perversely) one manufacturer of infra-red l.e.d.s uses a longer lead to indicate the cathode. Go strictly by the flat mark on the l.e.d. body to ensure success!

The dual-in-line switches module may be soldered directly to the p.c.b. However, as discussed earlier, it may be just as convenient to solder individual wire links to create a code, since you are unlikely to want to change it. Ensure that exactly the same code arrangement is used in both the transmitter and receiver.

The infra-red receiver must be fitted in such a way that an IR beam can be received when the p.c.b. is housed in a case. Ideally, the i.c. should be soldered to the p.c.b. – taking care not to overheat the device, and checking that its bulge is facing outwards.

However, this assumes that the p.c.b. is housed in such a way as to allow the IR beam to reach the sensor. Otherwise, mount the sensor on rigid wires to allow placement in any convenient position.

Solder in the wire connections as shown, taking care with the wires connecting with S1 on the receiver – it is very easy to attach the wires to the pads intended for optional S2, by mistake.

For the rest of the constructional details, now follow the paragraphs related to your chosen option.

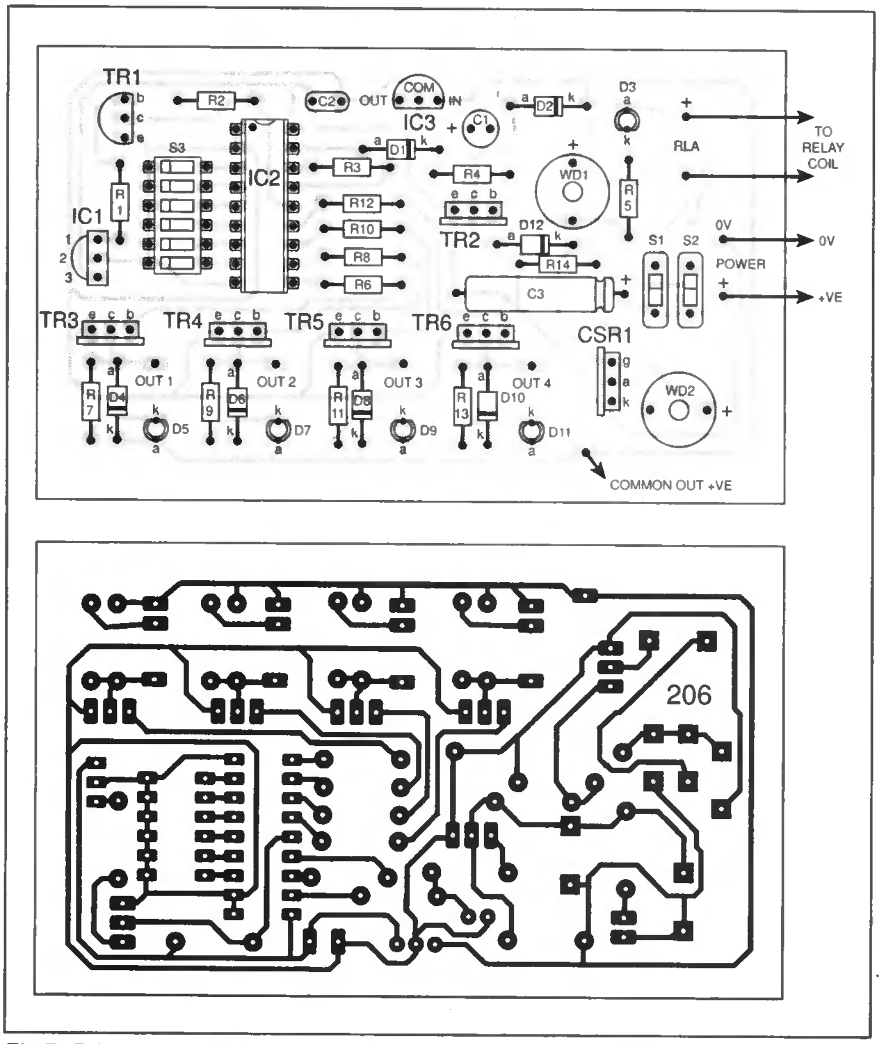
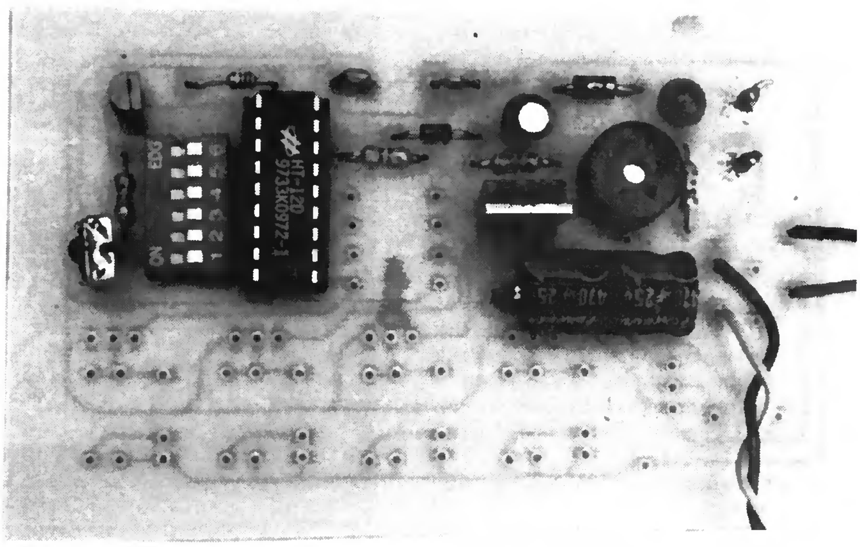


Fig.7. Printed circuit board component layout and full size copper foil track master for the general purpose I-R receiver. Note that not all components are needed in some options.



The Momentary receiver board, 4·5V version.

Momentary Transmitter

Solder the p.c.b. mounting pushswitch (S2) to the copper side of the p.c.b., if the suggested case is to be used. Connect all three infra-red l.e.d.s if maximum zapping power is required. Note that as this is a momentary system the receiver output will not latch. If you require a latching function then select the 1 to 4-way system.

Momentary Receiver

Solder in the required options, selecting between the l.e.d., D3, relay and buzzer WD1. Do not include the thyristor CSR1, D12 or R14 since these components will disrupt the other output functions. Include C1 if a slight delay is required, as described earlier.

Beam-break Transmitter

Do not include any of switches S1 to S5, but add a wire link across S1's pads

COMPONENTS

TRANSMITTERS

Column codes:
A. Infra-red Transmitter – Momentary (3V)
B. Infra-red Transmitter – Beam Break (12V)
C. Infra-red Transmitter – 1 to 4-way (3V)

Approx. cost Guidance only
£12.50
£11.00
£15.00

See SHOP TALK Page

Resistors

	A	B	C
R1 4k7	A	B	C
R2 10M	A	B	C
R3 4Ω7	A	–	C
R3 560Ω (12V)	–	B	–
R3 56Ω (3V)	–	B	–
R4, R5 4Ω7 (2 off)	A	–	C

All 0.25W 5% carbon film or better.

Capacitors

	A	B	C
C1, C2 100p ceramic disc (2 off)	A	B	C
C3 100n ceramic disc	A	B	C
C4 470µ radial elect., 16V	A	B	C

Semiconductors

	A	B	C
D1 infra-red l.e.d.	A	B	C
D2, D3 infra-red l.e.d. (2 off)	A	–	C
TR1 TIP122 or TIP121 *npn* Darlington	A	B	C
IC1 HT12B coded IR-transmitter	A	B	C
IC2 78L05 +5V regulator (see text)	–	B	–

Miscellaneous

	A	B	C
S1, S3 push-to-make switch, p.c.b. mounting (2 off)	A	–	C
S2, S4 push-to-make switch, p.c.b. mounting (2 off)	–	–	C
S5 min. s.p.d.t. toggle switch	–	–	C
S6 6–way d.i.l. s.p.d.t. slide switch module	A	B	C
X1 455kHz ceramic resonator	A	B	C
18-pin d.i.l. socket	A	B	C
Battery holder, 3V	A	–	C
B1 AAA cell (2 off)	A	–	C
B1 9V PP3 battery and clip	–	B	–
Transmitter p.c.b., available from *EPE PCB Service*, code 205	A	B	C
Plastic case 105mm x 58mm x 24mm with integral push buttons (Maplin CW26D)	A	B	C

RECEIVERS

Column codes:
A. Infra-red Receiver – Momentary
B. Infra-red Receiver – Beam Break
C. Infra-red Receiver – 1 to 4–way

Approx. cost Guidance only
£15.00
£17.00
£16.00

Resistors

	A	B	C
R1, R3 47k (2 off)	A	B	C
R2 10k	A	B	C
R4 4k7	A	B	–
R5 330Ω (4·5V) or 680Ω (12V)	A	–	C
R5 10k (see text)	–	B	–
R6, R8, R10, R12 10k (4 off)	–	–	C
R7, R9, R11, R13 330Ω (4·5V) or 680Ω (12V) (4 off)	–	–	C
R14 10K	–	B	–

All 0.25W 5% carbon film or better.

Capacitors

	A	B	C
C1 22µ radial elect., 16V	A	B	–
C2 100n ceramic disc	A	B	C
C3 470µ radial elect., 16V	A	B	C

Semiconductors

	A	B	C
D1 1N4148 signal diode	A	B	–
D2 1N4001 rectifier diode	A	B	–
D3 red l.e.d.	A	–	–
D4, D6, D8, D10 1N4001 rectifier diode (4 off)	–	–	C
D5, D7, D9, D11 red l.e.d. (4 off)	–	–	C
D12 1N4148 signal diode	–	B	–
CSR1 C106D thyristor (see text)	–	B	–
TR1 BC184L	A	B	C
TR2 TIP122 *npn* Darlington transistor	A	B	–
TR3 to TR6 TIP122 *npn* Darlington transistor (4 off)	–	–	C
IC1 IS1U60 or PIC12043S sensor/receiver (see text)	A	B	C
IC2 HT12D infra-red decoder	A	B	C
IC3 78L05 +5V voltage regulator (see text)	A	B	C

Miscellaneous

	A	B	C
B1 4·5V or 12V battery (see text) plus clip	A	B	C
RLA 12V d.p.c.o. relay	A	–	C
S1 min. s.p.d.t. toggle switch	A	B	C
S2 s.p. on/off switch, key operated	–	B	–
S3 6-way d.i.l. s.p.s.t. slide switch module	A	B	C
WD1 buzzer (see text)	A	–	C
WD2 buzzer (see text)	–	B	–
18-pin d.i.l. socket	A	B	C
Receiver p.c.b., available from *EPE PCB Service*, code 206	A	B	C
Plastic case 147mm x 98mm x 58mm	A	B	C

so that the circuit permanently transmits. The infra-red beam should not be too powerful or it may reflect from objects in the room, hence use the higher value resistor suggested, and only one infra-red l.e.d.

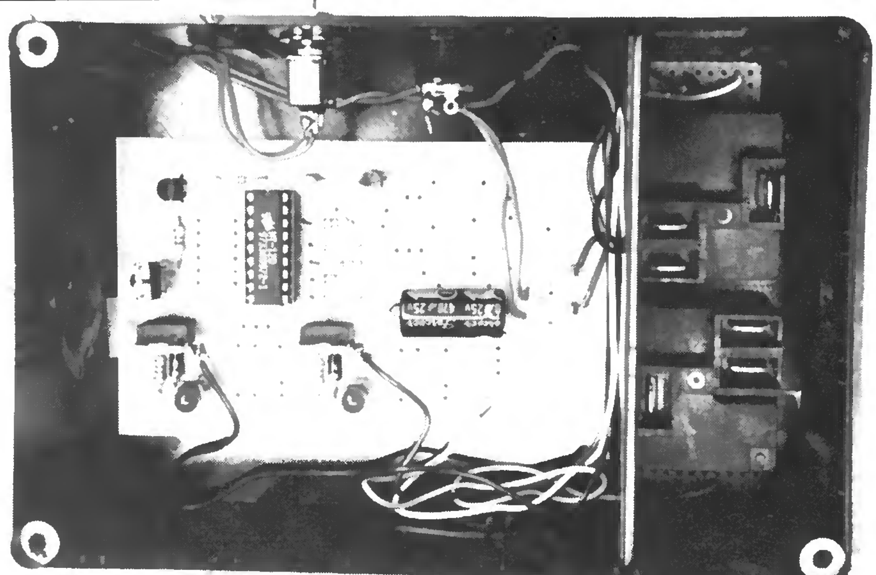
Beam-break Receiver for House Alarm

Build the circuit as shown in Fig.5, but omit buzzer WD1 unless you require an additional audible warning. Assuming that a 12V system is required, fit the regulator IC3. The link with the house alarm is provided via relay RLA. Connect its normally-open contacts to the house alarm panel.

When the beam is present the normally-open contacts will be closed. When the beam is broken, the contacts will open, hence the action will be similar to a standard PIR sensor.

Portable Beam-break Alarm

As an alternative to the House Alarm setup, use components D12, R14, CSR1, WD2 and keyswitch S2 to make a stand-alone latching alarm system. Note that R5 (as a 10kΩ value) is now fitted in place of buzzer B1. Also see the comments made earlier about this option.



Interior view of the 2-way latching receiver. Note the relays mounted to the side on their own small piece of stripboard.

When testing the system, first open S2, then switch on S1 and allow the circuit to stabilise with the beam being received. Now turn on S2. When the beam is broken the buzzer will sound. Restoring the beam, or switching off S1 will not silence the buzzer – to reset the circuit, S1 and S2 must be opened.

1 to 4-way Transmitter

A single way latching system is possible by using one switch (say S1 at the transmitter) to latch a particular output (Output 1 at the receiver) and another button (say S4) to unlatch Output 1. Solder the required switches on the copper side of the p.c.b. if the suggested case is used. For maximum zapping power install all three infra-red l.e.d.s.

Switch S5 is only required if you wish to frequently change the latching mode of the receiver. If S5 is turned off, or omitted, a particular switch on the transmitter will cause the appropriate output on the receiver to latch. If any other button on the transmitter is pressed, the previous receiver output will unlatch.

If S5 is switched on, or a wire link is fitted to bridge the appropriate pads on the p.c.b., then a receiver output will only be active whilst a switch is held pressed down on the transmitter.

1 to 4-way Receiver

Fit the required number of Darlington transistors (TR3 to TR6) according to the number of outputs needed. You may require relays to switch on other appliances, in which case each relay is connected between Common Output +VE and the appropriate output, e.g. Output 1.

The components list indicates that TR2 and its associated components are not required; however, if you wish to have a Code Received indicator, then TR2 can still be included, along with R4, R5 and D3. Diode D1 can remain, or be replaced with a wire link. Capacitor C1 is not required.

TESTING

Infra-red testing presents a chicken and egg situation. You cannot test the receiver until the transmitter is working, and you cannot test the transmitter until the receiver is working. However, it is possible to test sections of the circuits.

First, aim the transmitter l.e.d. at the front of the receiver module (there is a small bulge at the front). Place the two units about a metre apart.

Testing the latching beam break alarm is complicated by the fact that it will latch unless the IR beam is correctly received, hence it will be necessary to switch off S1 and S2 once the system latches. If in doubt, use a voltmeter or oscilloscope as follows:

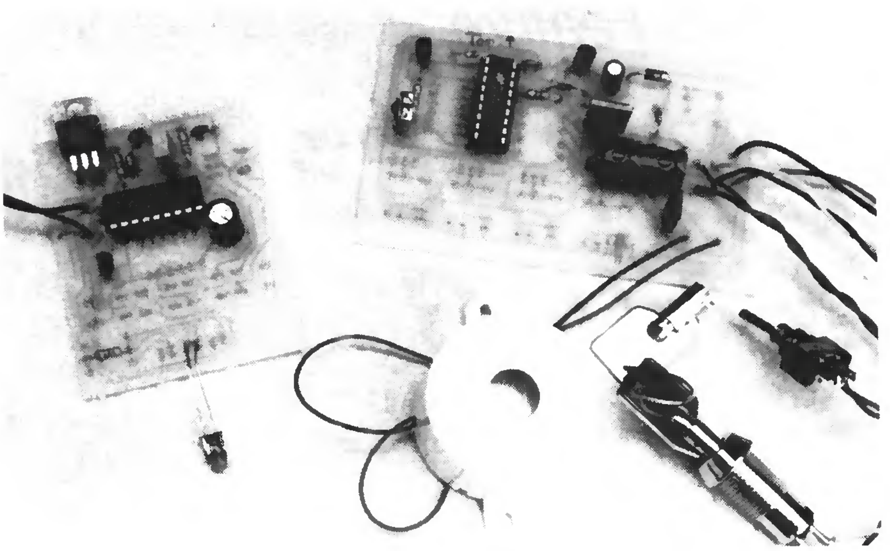
Test the voltage on the VT pin (pin 17) on IC2 of the receiver. It should be at 0V but change to about 5V when a signal is transmitted. If the VT test fails then check that the receiver module (IC1) is fitted the correct way round, with its bulge facing the outside edge of the p.c.b.

Now check the voltage on the pins of IC1. Pin 3 should be positive, and pin 2 at 0V. When a signal is not received, pin 1 (the output pin) should be at just under 4V. When a signal is received this voltage should fall by about 1V.

Note that as the signal is oscillating, a voltmeter provides a rather approximate guide to voltage. If an oscilloscope is available it should be possible to view the encoded signal, in which case the trace will rise and fall between 4V and 0V.

If this test fails, try sending a signal from a TV remote control unit. The signal will not be decoded, but you will at least know if the receiver i.c. is working and hence determine if the fault lies in the transmitter or receiver (or possibly both!).

If the output from IC1 is working, test the signal at the Data In (pin 14) of IC2 on the receiver. It should be at about 0V when no signal is received, rising to about 1·3V on a voltmeter. Again, an oscilloscope will show that the signal actually pulses to about 5V.



The twin transmitter/receiver assemblies connected as part of an intruder alarm, complete with small audible warning device and keyswitch.

If the VT pin on the receiver is working, simple voltmeter tests should establish the positions of any other faults. Try reading the appropriate section describing the action of the circuit and working through the p.c.b. with a voltmeter probe. The negative side of the voltmeter should, of course, be connected to 0V in the circuit.

TRANSMITTER TESTS

It is difficult to test the transmitter fully unless an oscilloscope is available, in which case the code can be checked at the D_{OUT} (pin 17) of IC1. A similar but inverted code should appear at the collector of TR1 and a signal will be transmitted, assuming that the IR l.e.d.s are the correct way round and the series resistors are of the correct value. An oscilloscope will also determine if the resonator is oscillating.

Voltmeter tests are confined to checking the power supply across IC1 (pins 18 and 9). This should be around 3V to 5V (depending on the power supply configuration used).

The data pins D8 to D11 should be positive unless an appropriate switch is pressed, in which case the voltage should switch to about 0V. In the Beam-Break version of the transmitter, a wire link should have been fitted across the pads intended for S1. This will keep D8 (pin 10 of IC1) permanently tied to 0V.

COMMON PROBLEMS

Typical mistakes include dry joints and bridged pads – i.e. adjacent pads accidentally joined with solder. Further mishaps include failing to insert wire links. Also check that all the components are correctly placed, and the correct way round where appropriate.

The pads for S1 (the main on/off switch) on the receiver are close to the pads for S2 – check that S1 is wired to the correct pair.

If it is difficult or impossible to set off the beam-break alarm, remember that the IR beam will bounce around the room, or even pass through your hand when testing. Try disconnecting the power supply to the transmitter to simulate a beam break.

If the beam is too strong, try placing the two units much further apart, or reduce the intensity of the beam by increasing the value of resistor R4 in the transmitter, or shield the transmitting l.e.d. and receiver, using tubes to reduce reflections.

If the beam break alarm siren fails to latch, remember that sirens often distort the flow of current, causing the associated thyristor to unlatch. The cure is to place a 1kΩ resistor in parallel (across) the connections of the siren (as discussed earlier).

TRANSMITTER CASE

The transmitter p.c.b. may be housed in an off-the-shelf remote control box, complete with battery compartment, as shown in the first photograph. The specified box includes a set of buttons, one, two or four, which – providing the p.c.b. is accurately positioned – will make contact with the push-to-make switches soldered on the copper side of the p.c.b.

The IR l.e.d.s may be bent over so that they project the beam through holes made in the end of the case.

Alternatively, the beam-break transmitter may be housed in any convenient case. If the IR l.e.d. is housed on the p.c.b., the latter can be positioned so that the l.e.d. is a few centimetres from the edge of the case. This will help produce a narrower beam.

RECEIVER CASE

For the receiver, any suitable case may be employed, the one used in the prototype is shown the photographs. If the IR sensor is mounted on the p.c.b., take care to position the p.c.b. opposite a suitable hole drilled in the case, for the IR beam to penetrate.

A red filter or red lens may be fitted over the hole on the inside of the case; this is for cosmetic rather than performance reasons. If the relays are required to operate mains equipment, a piece of insulated p.c.b. material or plastic sheet can be slotted into the case to make a separate compartment for the mains wiring.

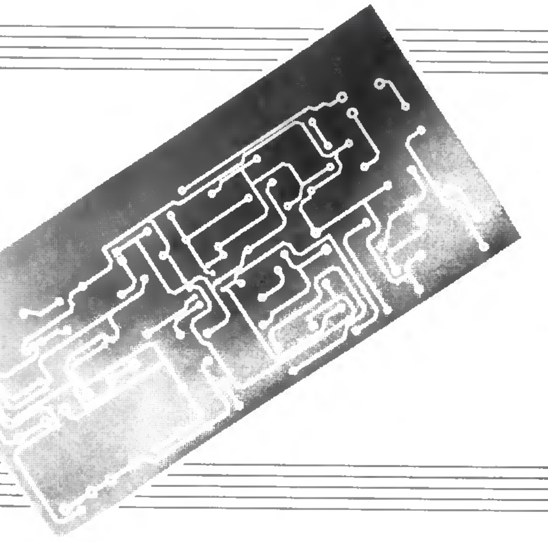
It is possible to use a much larger case with up to four mains outlet sockets installed if preferred.

NEXT MONTH

The circuits so far described can be adapted to make a 15-way remote control system. The same transmitter p.c.b. is employed, together with a 15-way encoder p.c.b., but the receiver p.c.b. is a different design which includes a 15-way decoder.

Special Feature

EASY PCB MAKING



ROD COOPER

Examining some modern alternative solutions to easily, and enjoyably, making your own p.c.b.s.

ANYONE who has made a printed circuit board by hand, using self-adhesive tape for tracks and stick-on transfer symbols for the pads, knows how difficult and time-consuming this can sometimes be.

Unless you have a keen eye and good manual skill, the result can often look very unprofessional. Moreover, artwork can easily be ruined by making a mistake, because it can be difficult to remove some types of transfer once they are in place without causing damage to the base material, and perhaps to neighbouring transfers as well.

Although some people like the process of UV (ultra violet) exposure on pre-coated copper laminate, the author finds it rather messy, slow and inconvenient and gives variable results. There are, though, two alternative methods that he discusses here which he finds makes manufacture of a one-off board not only easy but actually a pleasure to do.

PCB DESIGN PROGRAMS

If you have a PC-compatible computer then you really should use it to design your p.c.b.s. It doesn't even matter if it is as ancient as an '086 or '286, it can still produce p.c.b. designs extremely efficiently. Furthermore, there is a great feeling of accomplishment when the design comes out with a neat, professional appearance – qualities that are very difficult to produce by conventional hand-taping methods.

Once the p.c.b. layout program has been learned, drawing the tracks and pads on-screen is rapid – an order of magnitude quicker than using the old stick-on symbol method. Correcting artwork errors is very easy because you do it on-screen before it gets to the real, physical stage.

Such p.c.b. design programs can be obtained very inexpensively, but there are a few things of which you should be aware. The least expensive are those which are the PC equivalent of the conventional sticky tape and transfer symbols method, but transposed to the monitor screen. As such, these programs can offer very good value for money. You get the precision and versatility of the PC with none of the hassle of the old method – they are a giant leap away from the conventional techniques.

These simpler programs allow you to draw the tracks and pads of a p.c.b. and convert it to hard copy for making a real p.c.b. They may or may not have a section for drawing circuit diagrams, and it is a matter of personal preference if you want such a utility.

AUTOROUTERS

If you want to go one stage further and automatically produce p.c.b. designs direct from circuit diagrams, then you need a program with so-called *schematic capture*.

Schematic capture produces a *netlist*, which is a text file of all the components and connections drawn in the circuit diagram. From the netlist a *ratsnest* of component footprints and straight-line connections is produced on-screen, either automatically or sometimes interactively. The chaotic-looking ratsnest is then routed into proper p.c.b. artwork by a piece of software, the *autorouter*.

(Note that some programs that have a schematic drawing section do not necessarily have schematic capture.)

The advantage of schematic capture is that you do not have to get involved in drawing the p.c.b. artwork, unless you want to. The drawing is done for you by autorouter, although some autorouters are much better at doing this than others. For example, some autorouters cannot do single-sided boards, but can only do double-sided and multilayer boards.

This is of significant interest to amateur constructors, who may prefer single-sided p.c.b.s. Paradoxically, for an autorouter, route-finding on single-sided boards is much more difficult than double-sided.

Some schematic capture programs even allow you to transfer circuit data to simulator programs for analysing circuit performance.

Many of the lower cost programs can only be run under DOS, but do not be put off by this. There is no actual performance advantage in going over to Windows – in fact it may be a disadvantage because the screen redraws are slower in Windows. Such redraws are frequently being used (each time you pan across the screen, for example) and the faster they are the better.

TRACK TRANSFERS

Having designed your p.c.b. on the computer, if you do not want to mess about with UV exposure units and developer solutions, why not print your design out as a transfer using a laser printer, and then press the transfer straight onto the copper laminate, ready for etching?

This method has been available for years, but never really caught on in the hobbyist world. Now, it's been given a boost by the arrival of a relatively new material, called PnP Blue, which adds an extra layer of resist to the toner image for improved results during etching. It's faster than UV exposure and it can work out cheaper.

PnP Blue consists of an opaque blue plastic coating, thinly spread on a heat-resistant transparent film base. The total thickness is exactly the same as standard 80gm copier paper, so it will go through a laser printer just like paper.

Transferring the artwork image to the PnP film via the laser printer is very easy. With a few exceptions, it is almost as routine as printing out a regular sheet of typed text.

With the artwork on the PnP film, you can go to the second stage and press the film, image side down, onto bare copper laminate with an ordinary domestic iron. A temperature near the "steam" setting works well. Pressing takes just a few seconds.

Only the image of the p.c.b. artwork sticks to the copper when it cools. You then peel the film off and the board is ready for etching.

It is not only faster than UV exposure, you do not have to develop it in a chemical bath. There is also a big bonus – if you do not like the results of the transfer, you can wipe it off with acetone and the board is not wasted. You can produce a new transfer and press it on in a matter of minutes.

BLUE PRINT

Even if you do not have a laser printer you can still use PnP Blue. You first make a plain paper print of the artwork on your printer (preferably inkjet) or plotter. Put the print on the platen of a photocopier and send the PnP sheet through the copier's by-pass tray, making sure the orientation is correct. The result is the same as that obtained via a laser printer.

You might improve your chances of success with a dot-matrix printer if you print out the artwork onto paper as an enlarged image, and then reduce it down on the photocopier to actual size.

A great advantage of PnP is that you can take p.c.b. designs published in *EPE* or other magazines, and photocopy them straight onto it.

Alternatively, if you have a scanner you could scan in a magazine design and then print or plot it. You could even make a few modifications to the design on-screen during the process if you wanted.

LAMINATING

Some skill is needed for ironing on PnP. You need to sacrifice a few pieces of PnP to practice a few times and experiment with the heat settings on the iron before you succeed. You should be able to reproduce tracks down to 0·3mm wide. With skill, you could achieve even better than that.

If you are hopeless at ironing, you could instead put the PnP and copper laminate face-to-face through a desk-top pouch laminator. Certain types of laminator (those with heated rollers instead of heated shoes) give better and more uniform results, but they are expensive to buy – about £250.

If you are going to buy a laminator anyway, it really pays to get the more expensive heated-roller type. It is essential for the laminator to have either a speed control or a temperature control, or preferably both. If you use a laminator, you will need thin copper laminate. It is no use expecting a standard thickness laminate to pass through these machines.

After etching, it will be necessary to increase the thin laminate to normal thickness. This is easily done by gluing a piece of bare s.r.p.b. or FR4 fibreboard to the thin copper laminate to act as the base. The best glue to use is epoxy.

It is particularly easy to make double-sided boards with this method. You just make two thin copper laminate p.c.b.s and glue them onto opposite sides of the base material. A couple of index holes drilled through reference pads on both laminates ensures perfect alignment.

Often, using a carrier for the PnP/copper sandwich considerably improves the results of the transfer to copper laminate. A carrier, in this context, is a sort of heat-resistant pouch into which you place the materials you want to transfer, before you insert them into the jaws of the laminating machine.

After passing the carrier through the laminator, you open the pouch and remove the PnP/laminate. Naturally, you need to increase the heat setting to compensate for the presence of the carrier. The carrier can be re-used.

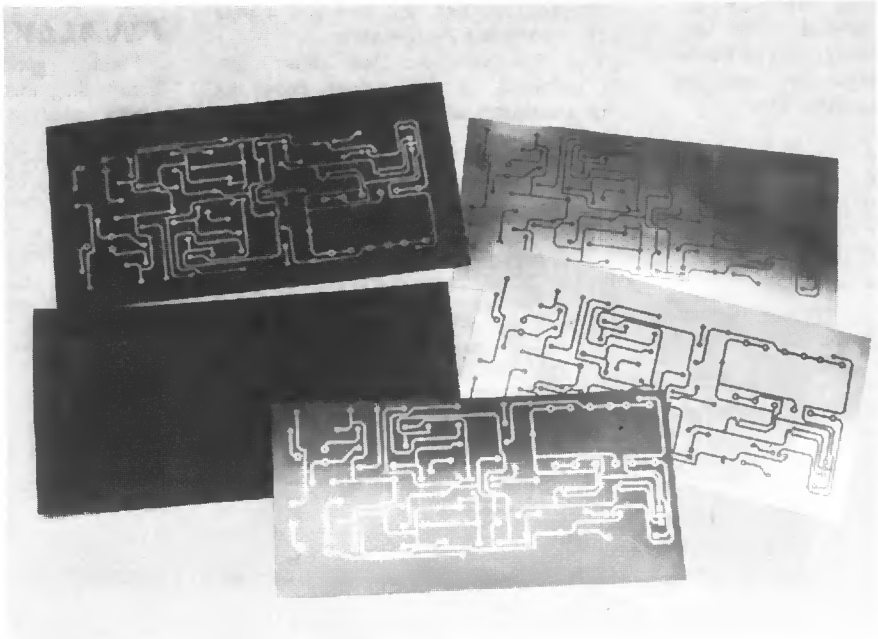
BEWARE OIL PROBLEMS

Results with PnP can be spoiled by the presence of silicone oil. The silicone oil which is used as a release agent on the rubber and p.t.f.e. rollers in the heat-fusing sections of some photocopiers and laser printers can contaminate the surface of the PnP and interfere with how well it sticks to the copper.

On some machines, where the oiling is done by a piece of oil-soaked felt rubbing against the fuser rollers, the oiling mechanism is quite easy to remove, often just by lifting it out – so if you have PnP adhesion problems, try removing it temporarily.

If you run a few blank sheets of plain paper through the machine, this will help to remove the remaining oil, then you can try again. Be warned that without release oil you are rather more likely to get a jam, so there is some risk in doing this. Don't forget to replace the oil felt when you have finished!

There is a further improvement that can sometimes be made to photocopiers, and that involves replacing the normal pressure roller (which may itself be oil-impregnated by the manufacturer) with a Microsleeve roller from Katun, assuming it does not have one fitted already as standard. The Microsleeve roller is so called because it uses a non-stick sleeve over the rubber surface of the roller. Most copier service agents can supply and fit them.



Examples of the various stages in making a p.c.b. using PnP Blue.

FLAT-BED PLOTTING

The use of a flat-bed pen-plotter is possibly the best technique of all. It is even more direct than a laser printer and is just as quick overall. There are no snags with silicone oil to be overcome, but you do need some expertise.

Fortunately, the skill in handling a plotter is rapidly acquired with a little practice. The technique is simple – the artwork is plotted straight from PC to copper using an etch-resistant ink. There is no intermediate process – when the ink is dry, you simply etch.

If you don't like the artwork, for whatever reason, you can wipe it off with acetone and re-plot it immediately, at almost no cost, and no waste of copper laminate.

New flat-bed pen-plotters are expensive, from £400 to £1000 even for a budget model, and you might dismiss the idea of buying one – but you can buy second hand plotters for very much less. If you know where to look, you can acquire a bargain for around £50 to £70. The pages of *Micro Computer Mart* are a good source. Computer fairs are another likely source.

Pen-plotters are very well engineered and will last for years, so a second-hand one is usually a sound proposition. They are also inherently more reliable and robust than most laser printers.

PLOTTER PENS

You will need a Staedtler solvent-resistant refillable pen with either a stainless steel or tungsten carbide tip to produce plots on copper, and these are fairly expensive – from about £10 to £50 depending on the type. However, with care this type of pen should last a very long time so it's really an investment.

Pens can usually be ordered from artists and drawing office suppliers, you don't have to approach Staedtler direct, unless you want to ask where their local agents are.

For each pen there is an adapter to suit various makes of pen plotter, e.g. Hewlett-Packard, Graphtec, Roland. To get the right adapter you need to consult the technical part of the Staedtler catalogue. The adapter should be solvent-resistant as well.

The special high-performance ink may seem expensive at first, but a little ink goes a very long way, and in the long run it is the cheapest way of producing one-off p.c.b.s. With the right choice of pen you should have no difficulty producing professional-looking artwork. Unlike PnP, achieving good results does not depend on your skill at ironing!

PLOTTING ARTWORK

Plotting is usually done on paper-thin copper laminate. This is later reinforced by backing it with a thicker layer of plain board material using epoxy resin to bring it up to normal thickness, so that things like nylon stand-off pillars etc. can be used.

On some of the more sophisticated plotters, the pen mechanism compensates for the thickness of the material, within limits of course, and it is possible to plot onto ordinary 1·6mm thick laminate.

Specialised driver programs for pen-plotters are usually supplied with p.c.b. CAD programs. It is better to use these than the general-purpose drivers supplied with Windows.

It might appear extravagant to buy a pen-plotter just for making p.c.b.s, but they can be used for a multitude of other things. For a start, most will take size A3, and this opens up a range of possibilities, not just making very large p.c.b.s, but for drawing things not connected with electronics, like maps, small posters and the like.

Pen plotters are excellent for doing multi-colour engineering drawings and circuit diagrams – a typical plotter may offer eight or more colours. If you intend do any of these things, then you can certainly justify buying a pen-plotter.

Plotters also produce excellent artwork originals on paper or plastic drafting film if you want to use the PnP process with a photocopier. But, most interesting of all of these side benefits as regards electronics, they can write colour decals directly onto instrument front plates. The latter can be made permanent with an overcoat of clear aerosol varnish.

Alternatively, instead of varnish, you can protect the artwork with the type of self-adhesive transparent film sold in large stationers for protecting maps and book covers.

A pen plotter will make a front panel appear very professional as it can execute both lettering and graphics in colour. Most p.c.b. programs offer a few fonts, so at a pinch you could use the same program to design your front panel as well as your p.c.b.! It has to said, though, that in some cases a dedicated drawing program might make a better job.

Although the best material for this type of front panel is thin metal plate, there are inks available which can write on plastics, such as Staedtler type 48523 SAR-9. Alternatively, the oil-based or solvent inks used for plotting on plastic drafting film are sometimes suitable; a lot depends on the plastic itself.

Another trick a plotter can do which other printing methods cannot is to put the component placement diagram directly onto the top (i.e. non-copper) side of the p.c.b. Most p.c.b. programs generate a so-called silk-screen layer for this purpose.

Also, material such as metal front plates and copper laminate is rarely wasted when using a plotter. If you don't like the artwork, you just wipe the ink off with a solvent such as acetone or IPA and start again.

ETCHING

Most failures of artwork at the etch stage are due to lack of preparation of the copper surface prior to putting down the artwork. This applies to all methods of making p.c.b.s, not just to the methods described earlier.

As in most everyday tasks where a layer of one material is stuck on another, from painting a house to applying an Elastoplast, preparation is the key to success. This fact cannot be over-emphasised.

If you take the copper laminate straight out of the pack and try to put artwork on it, you are almost guaranteed failure. It is essential to get it clinically clean first. The best method on a new piece of laminate is to wash it in acetone, wipe it with lint-free cloth and then put it in a bath of etchant for a few seconds.

For this you can use dilute ferric chloride. If the copper does not turn a uniform salmon-pink colour, then it is contaminated and must be re-cleaned. If it shows pink all over, it is clean and it can be washed and dried ready for artwork. *Never touch a cleaned copper surface with your fingers.* On anything except the most basic boards, the natural oils in a fingerprint will spoil your chances of a good etch.

When wiping with acetone, do not use paper tissues. The binders and fillers used in some paper tissues may dissolve in the acetone and leave an invisible film on the copper surface which will ruin your p.c.b. A better material is well-washed white cloth such as that from old clothes. This will have had all the oils and other residues washed out during its life as a piece of clothing i.e. after many cycles through the washing-machine.

Do not use the cheaper type of reclaimed acetone for the final wipe. Reclaimed acetone, available from some suppliers, may still have residues in it which will interfere with etching. This acetone is only suitable for preparatory wiping and for initially removing unwanted artwork. Any subsequent wipe must be done in a residue-free solvent.

If you cannot get good quality acetone, then IPA (isopropanol) is readily available. Failing this, use one of the many commercial ozone-friendly solvent cleaners, although they are expensive.

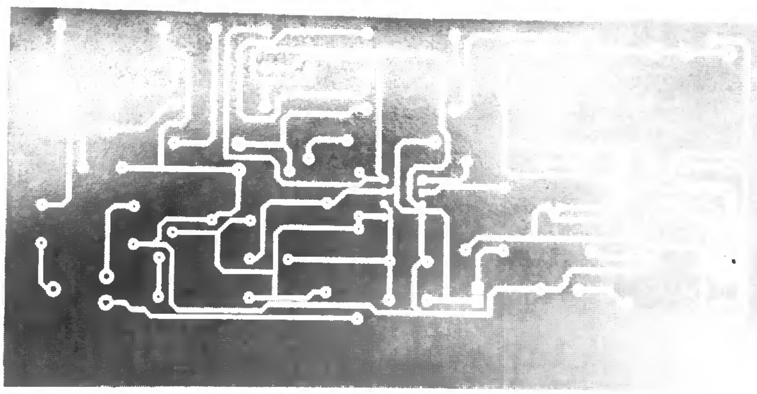
If using a piece of laminate which is visibly contaminated, or oxidised by long storage, then the use of abrasive is required. Ideally, abrasive pads intended for cleaning copper-clad p.c.b. materials should be used.

Some sources suggest that fine-grade steel wool should be used as the first step. However, this leaves scratch marks which are not desirable. 600-grit wet-and-dry, used wet, followed by crocus paper is better, but all traces of abrasive must then be removed.

Do not use a metal polish – with some types it is almost impossible to get rid of all traces of it afterwards. If you are using a pen-plotter, any trace of fine abrasive particles embedded in the soft surface of the copper will result in rapid wear on the pen tip.

FINALLY

Making good p.c.b.s, drawing neat circuit diagrams and making fine front panels need not be long-winded and tedious manual chores. The methods just described are not only quicker and cheaper and less frustrating than the conventional route, they are actually more interesting!



Photograph of etched p.c.b. made using PnP Blue.

APPENDIX

PnP Blue material, paper-thin copper laminate and etch-resistant plotter ink, are available from:

Verkonix Ltd., PO Box 6145, Sutton Coldfield B73 5PX. Send s.a.e. for lists.

Suitable Staedtler plotter pens for direct-to-copper p.c.b. work are:

Line Width	Tungsten Carbide	Stainless Steel
0·4mm	757 PL4 CS	750 PL4 CF
0·3mm	757 PL3 CS	750 PL3 CF
0·18mm	757 PL1 CS	750 PL1 CF
0·13mm	757 PL0 CS	

Note that all these pens need a holder to suit a particular brand of plotter. The solvent-resistant holder for HP plotters (the most common) is ref. 75PLO7H2PC. Ring Staedtler on 01443 237421 for the name of your local agent to order pens.

Inexpensive second-user plotters can be bought from:

Field Electric Ltd., P.O. Box 4, North Tawnton, Devon EX20 2YJ. Tel: 01837 83736

For PnP Blue work, the following copiers are relatively oil-free:

Mita: DC1205, DC1255, DC1656
Nashua: 8112, 8112RE, 3916
Triumph Adler: 2212, 2416
Ricoh: M60

ELECTRONIC PRINCIPLES 5.0

ROBERT PENFOLD

We put a new version of a well established program under the microscope.

THE range of educational software for PCs seems to grow by the day, and there are now programs to teach you about almost every subject under the sun. This includes electronics, and Electronic Principles 5.0 is a well-established program that covers an enormous range of electronic topics.

Although described by its publishers as "a complete PC based electronics course", this is perhaps slightly misleading. It is not a course in the same sense as (say) a multimedia language tutor that takes you through a series of lessons. It is supplied on three 3·5in. disks (or CD-Rom for Windows NT and '95) and it is really a conventional program rather than what would normally be accepted as multimedia software. It is basically a collection of graphics screens, with each one covering a different aspect of electronics. Most of the screens are to some extent interactive, although there are a few exceptions.

GETTING OPERATIONAL

When you load and run the program you are faced with a conventional looking Windows screen with the usual menu bar near the top. Each menu heading covers a different aspect of electronics, and gives access to a range of simple tutorials within that subject area. For example, you can select "Op-Amps" on the menu bar, and then "Basic Operational Amplifiers" from the list of four options on the pop-down menu. This brings up a window that contains the circuit diagram for a simple inverting amplifier, together with the relevant formulae for calculating its voltage gain and the output voltage.

You can change the values of the feedback resistors and the input voltage, and the appropriate output voltage will be displayed on the circuit diagram. The a.c. input and output signals are represented by sinewaves having amplitudes that automatically adjust to suit any changes you make to the circuit. In the case of the inverting amplifier these also show the phase inversion through the circuit. In other words, you are provided with a very basic circuit simulator that is relevant to the particular topic chosen.

Clicking on the Topic Notes button brings up a further window that provides notes on the current circuit. These notes are generally quite brief, but tell the student everything he or she needs to know on the subject. Clicking on the Calculations button produces a further small window that shows the calculated voltage gain and output voltage for the selected resistor values and input voltage.

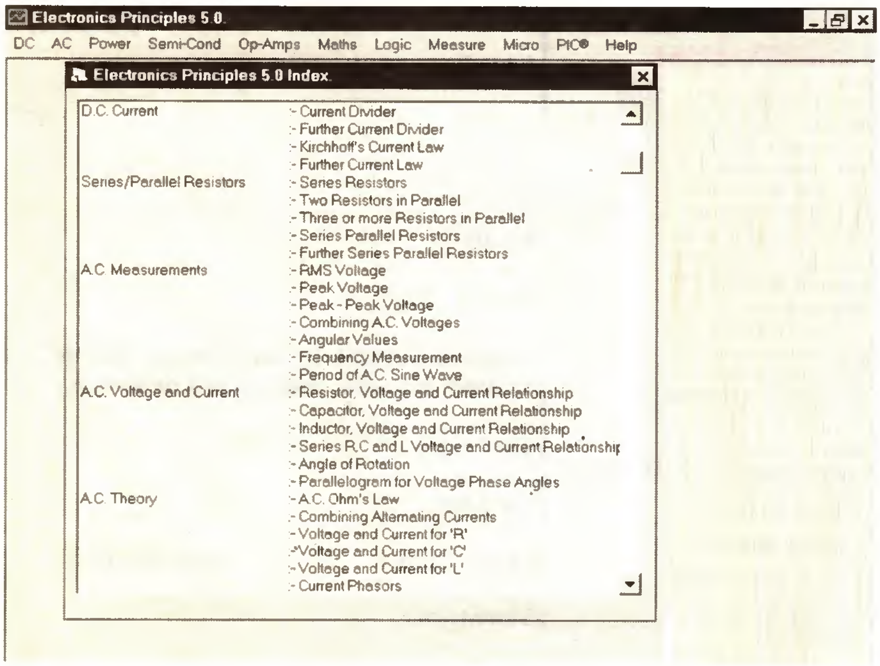
Finally, operating the button labelled Printing copies the last active window to the Windows clipboard. From here the data can be pasted into graphics programs, DTP programs, etc. and then printed out if required. Screens cannot be printed direct from the Electronic Principles program itself.

VAST RANGE

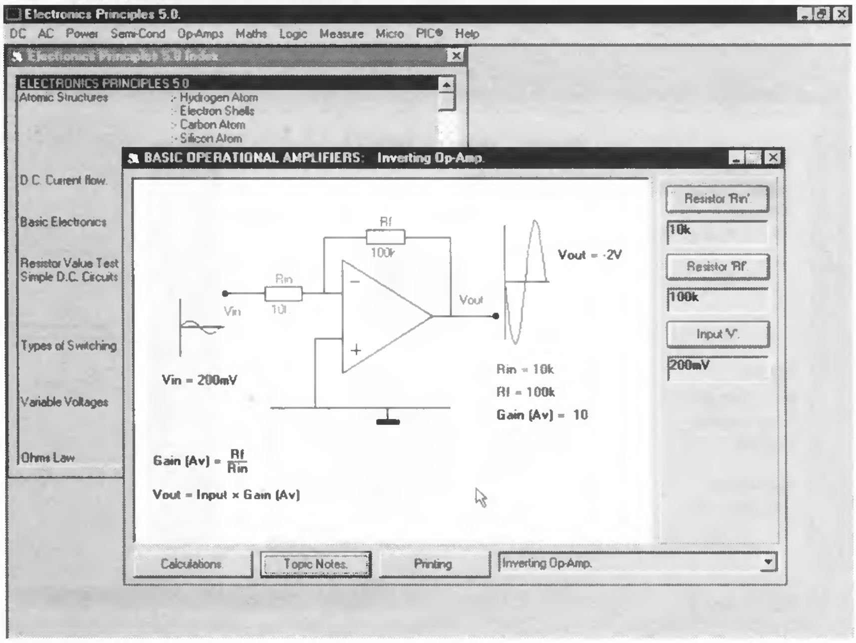
You are not limited to a single circuit under each general heading. For example, the section of the program that covers the basics of operational amplifiers includes seven circuits in addition to the inverting amplifier. A vast range of circuits is therefore included, which could make it difficult to find the one that you require. This problem is eased by a reasonably logical choice of menu headings and options under each heading. Also, when the program is first-run an index window is opened.

Having located to the topic you require from the list, simply double-clicking on the item results in the appropriate simulation being run. I found this to be a better way of accessing the various simulations than using the pull-down menus. However, the items in the index are not in alphabetical order, and this part of the program could perhaps be better organized.

The program does not only provide simple analogue circuit simulations, there are sections covering topics such as binary numbers, Morse code and atomic structure. Also, it includes the fundamentals of logic circuits, with sections on gates, flip/flops, and data latches. There are also sections dealing with the fundamentals of microprocessors, and PIC microcontrollers. The latter is a new addition in version 5.0 of the program.



The start-up screen includes an index window. The numerous graphics screens can be accessed via this, or the menu bar.



A simple simulation of an operational amplifier in the inverting mode. The input voltage and feedback resistor values are user selectable via the buttons on the right hand section of the screen. Note the input and output waveforms showing the relative phase and amplitudes of the two signals.

The section dealing with the PIC hardware enables the user to do such things as trying various C-R clock values with the output frequencies being displayed, "click" on bits of a control register to bring up details of the way in which that bit functions, and so on. There are numerous diagrams showing the program and data memory maps, the internal architecture, a pinout diagram. Apart from details of the analogue to digital converter in the PIC 16C71, all the data is for the 16F84.

PIC INSTRUCTIONS

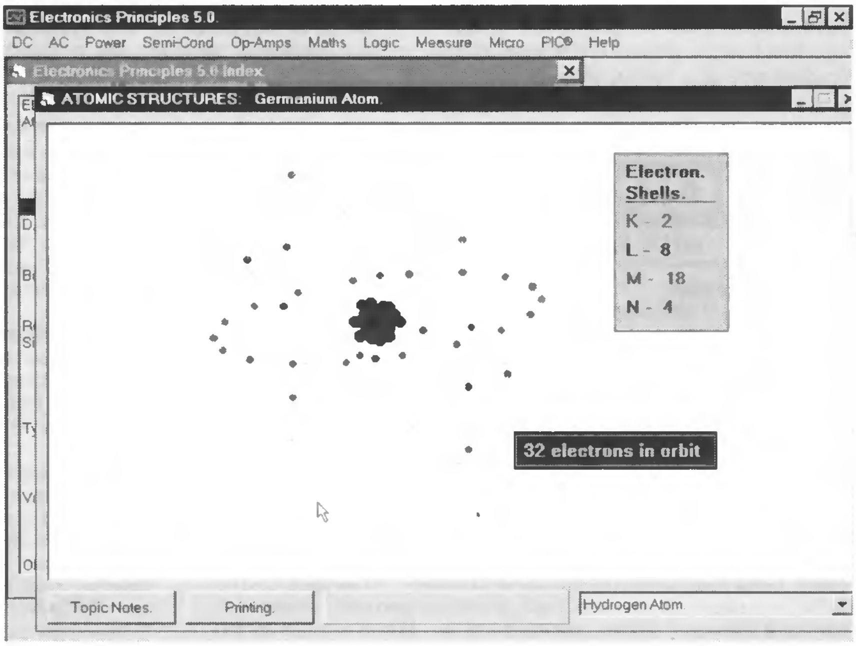
There is also a section dealing with the PIC instruction set. While it is not possible to simulate simple programs, it is possible to experiment with individual instructions. For instance, you can select the BCF (Bit Clear File) instruction, select a file number, an initial value to store in that register, and a bit to clear. The instruction is then executed by pressing an on-screen button, and the appropriate change to the selected register is then made.

If the exact function of an instruction is unclear, a little experimentation should soon clarify matters. The new sections dealing with PIC microcontrollers are a well-implemented and very worthwhile addition which keeps the program up to date.

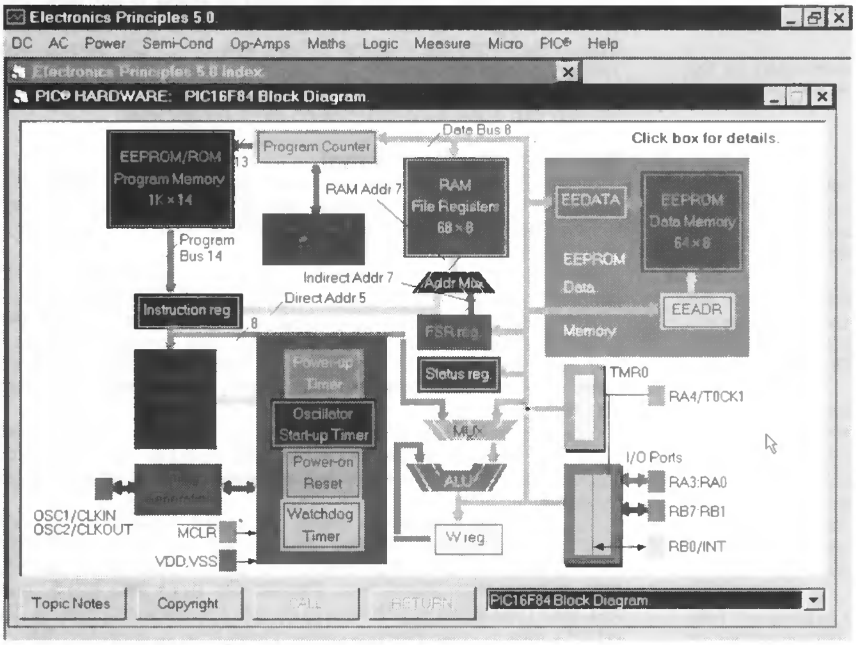
BOTTOM LINE

Electronic Principles 5.0 is primarily designed for use in educational establishments where a tutor will guide students through the various screens. However, it can be used in conjunction with the *EPE* publication *Electronics Teach-In No. 7* "A Complete Electronics Course" by Alan Winstanley and Keith Dye if it is to be used for home study. It should work very well in this guise, but the cost of the program will probably deter most would-be home users. By the standards of educational software the price of the program (£119.79) is quite reasonable, and it certainly represents a valuable teaching aid. It takes several A4 pages and small print to list all the topics covered, and this program is certainly comprehensive! It is relevant to a wide range of examination courses that include some basic electronics theory.

New software upgrades have a reputation for being something less than 100 percent reliable, but Electronic Principles 5.0 loaded without any difficulty, and gave no problems at all during the test period. No minimum requirements are stated for this software, but when tried on a 40MHz 80386 PC with 5 megabytes of RAM and a VGA screen it ran reasonably well, if a little slowly. When used with a 200MHz MMX PC with 96 megabytes of RAM and a SVGA screen it ran very quickly indeed.



Electronic Principles 5.0 is not just about circuits. This screen shows the atomic structure of a germanium atom. This is one of the screens that is not interactive.



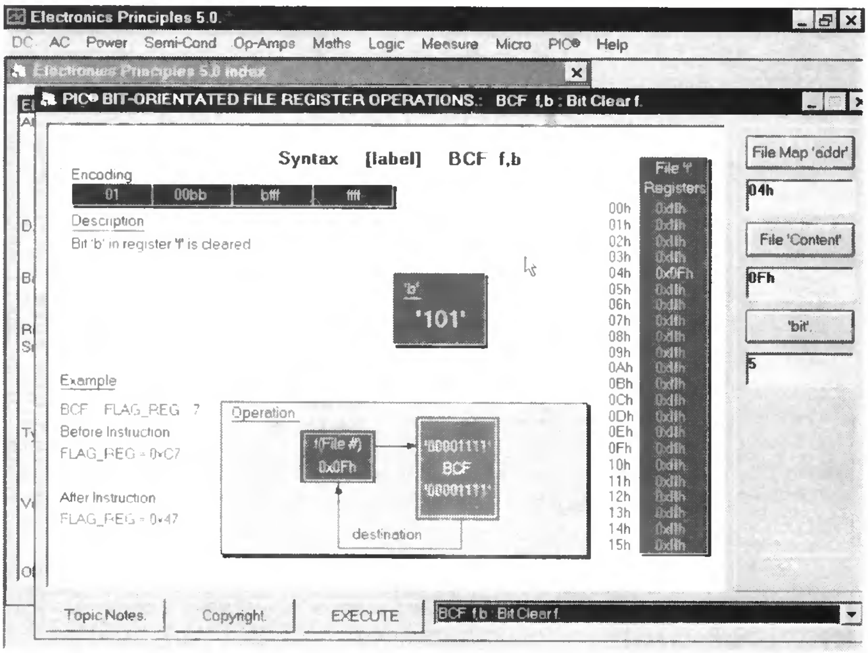
PIC hardware and software screens have been added to version 5.0 of the program. This PIC block diagram is from the PIC hardware section.

Presumably this program will run well enough on virtually any PC that is running Windows 3.1, 95, 98 or NT, and has at least a few megabytes of free hard disk space. Its minimal hardware requirements are a definite advantage in situations where modern PCs are not available. Unlike most current software, it does not even require a CD-ROM drive.

Electronics Principles 5.0 is a well thought out and comprehensive program that is also easy to install and stable in operation. It can be wholeheartedly recommended.

In EC countries the cost is £119.79 (£99.95 plus £2.00 postage and VAT). Outside the EC it costs £99.95 plus £3.50 for airmail delivery (£103.45 in total). A multi-user site license is available at cost of £470.00 (£400.00 plus £70.00 VAT). For further details contact EPT Educational Software, Dept EPE, Pump House, Lockram Lane, Witham, Essex, CM8 2BJ (Tel/Fax 01376 514008), E-mail **sales@eptsoft.demon.co.uk**. The EPT web site is at **http://www.eptsoft.demon.co.uk**.

Note: We understand that EPT are interested in talking to any University or College which might want to collaborate on the development of a formal distance learning course based on Electronics Principles.



You can experiment with individual PIC instructions, such as the BCF instruction, which is simulated by this interactive screen. Using the buttons on the right you can select a register, set a starting value in that register, and a bit to clear. Operating the EXECUTE button near the bottom of the screen then produces any necessary change to the selected register.

SHOP TALK
with David Barrington

Voice Processor

The Holtek HT8950 used in the *Voice Processor* is a single-chip digital voice modulator used for pitch shifting and was purchased from **Maplin**, code AE13P. This device has a built-in preamp, an 8-bit ADC, an internal SRAM, and an 8-bit DAC all in one chip.

The NE5534 op.amp was chosen for its claimed excellent audio performance and low-noise characteristic and is the preferred i.c. for this circuit. It should be widely available but if difficulties do arise trying to track it down locally, it is currently listed by Maplin, code YY68Y.

The choice of a *metal* case for this project is two-fold, to give some screening from external electrical noise and to provide a common "earth" return for the chassis-mounting phono sockets. This "vinyl effect" metal box came from the above company, quote code LH37S (WB2). If a plastic box is used, it will, of course, become necessary to hard-wire the outer sleeve connection of the phono sockets to the "earth" solder tag point (0V).

The Voice Processor printed circuit board is available from the *EPE PCB Service*, code 203.

Finally, a supply of between 2·4V to 4V is recommended for the voice chip and the *absolute maximum* is 5·5V. So, on no account attempt to test the unit with a 6V or 9V battery.

Digiserv R/C Channel Expander

With the prices of PIC microcontrollers tumbling over the last few months, you should not have to pay more than about £3 to £4 for an *unprogrammed* PIC16C84-04 chip when ordering parts for the *Digiserv R/C Channel Expander*. It is the 4MHz version that is required.

Most of our component advertisers should be able to supply the specified Darlington driver i.c. The ULN2803A type was chosen because the Darlington switches/amps have internal 2·7 kilohm base resistors to enable *direct* connection to TTL and 5V CMOS. It also has internal diodes for inductive loads.

The 4MHz resonator should also be readily available and not cause any local purchasing problems. The same applies to the small, 75mm × 56mm × 25mm, plastic case (Maplin KC91Y). The printed circuit board is available from the *EPE PCB Service*, code 204.

Ready-made servo leads seem to be quite expensive, so it may be worthwhile making up your own leads using header-pin strips and socket shells. Having said that, we have not checked out any model shops and ready-made lead sets may be best obtained from them.

For those readers who do not have the facilities to program their own PIC chips, a ready-programmed PIC16C84-04 microcontroller is available from **Magenta Electronics** (☎ ***01283 565435***) for the sum of £15 all inclusive.

If you do intend to do your own programming, the software listing is available from the Editorial Offices on a 3·5in. PC-compatible disk, see *EPE PCB Service* page 764. There is a nominal admin charge of £2.75 each (UK), the actual software is *Free*. For overseas readers, the charge is £3.35 surface mail and £4.35 airmail. If you are an Internet user, it can be downloaded *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/Digiserv**.

PC Capacitance Meter

Not a great deal can go wrong when sourcing components for the *PC Capacitance Meter* project as most appear to be "off-the-shelf" items. This includes the low-power version of the 555 timer and the CMOS i.c.s which should be stocked by most of our component advertisers.

Even though a single-pole 4-way rotary switch does not appear to be a standard item, it is simply a case of buying a 3-pole 4-way version and ignoring two of the poles, or using a single-pole 12-way type with an adjustable end-stop set to 4-ways.

Once again a suitable vinyl-effect instrument case is stocked by **Maplin**, code LH38R (WB3). No doubt a similar case is stocked by our other advertisers. The stripboard will have to be cut down to size from a larger piece.

If you don't want to go to the trouble of typing in the fairly short software program for the PC Capacitance Meter, it is available on a 3·5inch disk from the Editorial Offices, see *EPE PCB Service* page 764 for postage charges.

If you are an Internet user, it is also available *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/capmeter.**

Reliable IR Remote Control

A few dedicated components are called up for the *Reliable IR Remote Control* project and may not be obtainable from the usual local suppliers. As mentioned in the article, some suppliers may stock one item but not the other.

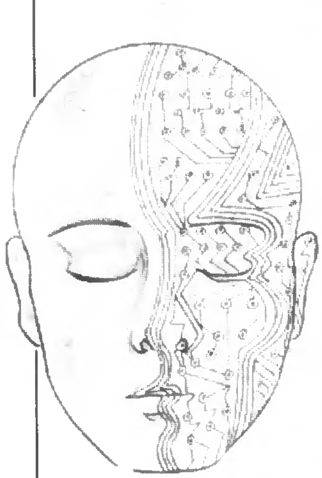
Starting with the Transmitter options, the Holtek HT12B encoder/modulator (IR transmitter) came from **Maplin**, code JA33L.

A number of infra-red light emitting diodes (l.e.d.s) were tried in the prototype model, and all worked with varying degrees of success. In the end, a Siemens SFH485 high power type was selected. This was ordered from **Rapid Electronics** (☎ ***01206 751166***), code 58-0445.

The handheld box, with buttons (code CW26D) and the p.c.b. mounting, click-effect, tactile switch (code KR91Y) both came from Maplin. The 455kHz resonator and d.i.l. switch should be fairly widely available.

Turning to the Receiver. It is only the sensor/receiver and decoder i.c.s that may prove a problem. The sensor/receiver type ISU1U60 only appears listed by **Electromail** (☎ ***01536 204555***), code 577-897 and the PIC12043S from **Farnell** (☎ ***0113 263 6311***), code 491-380. (The latter has nothing to do with PIC microcontrollers). The HT12D infra-red decoder was ordered from Maplin, code AE18U.

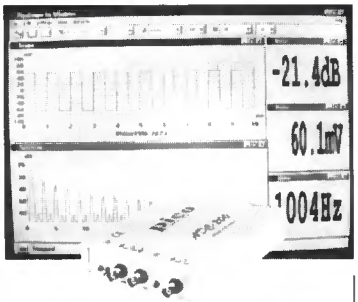
The two printed circuits for the system are available from the *EPE PCB Service*, codes 205 (Trans.) and 206 (Rec.) respectively.



INGENUITY UNLIMITED

Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas *must be the reader's own work* and **not have been submitted for publication elsewhere.** The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should preferably be typed or word-processed, with a brief circuit description (between 100 and 500 words maximum) and full circuit diagram showing all relevant component values. **Please draw all circuit schematics as clearly as possible.**

Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited,* Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF.
They could earn you some real cash **and a prize!**



WIN A PICO PC BASED OSCILLOSCOPE

- 50MSPS Dual Channel Storage Oscilloscope • 25MHz Spectrum Analyser
- Multimeter • Frequency Meter
- Signal Generator

If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC based oscilloscope could be yours.

Every six months, Pico Technology will be awarding an ADC200-50 digital storage oscilloscope for the best IU submission. In addition, two single channel ADC-40s will be presented to the runners up.

L.E.D. Cycle Rear Lamp - See where you've been

Bicycle lamps which use light-emitting diodes (l.e.d.s) have certain advantages over traditional dynamo-powered filament lighting. At low speeds they are much brighter than ordinary bulbs and much more reliable too. In the UK there are certain regulations regarding the use of l.e.d. lighting (related to British Standard BS6102/3) – in particular, when fitted to a cycle, they must be used alongside an ordinary lamp which complies with the Standard.

The circuit idea of Fig.1 uses four Hewlett Packard high power l.e.d.s (e.g. HLMP-DH08), which have a light intensity of 8cd at 20mA and are excellent alternatives to incandescent lamps. A dynamo generates approximately 6V a.c. and the l.e.d.s (D5 to D8) are wired in inverse-parallel, each l.e.d. drawing 27·5mA which is well within their maximum of 50mA.

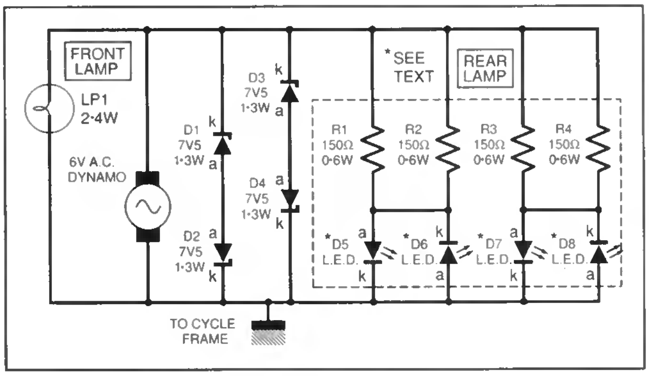


Fig.1. Circuit diagram for an L.E.D. Cycle Rear Lamp.

As each l.e.d. pair required a 75 ohm 0·6W resistor, the current-limiting resistors R1 and R2, and R3 and R4, are paralleled as shown so that their individual power dissipation is not exceeded. The dynamo powers the front (filament) lamp as usual and the four Zener diodes serve to clip the a.c. to a 9V square wave, also preventing damage if the front filament bulb blows for any reason.

Also, the circuit works with 6V d.c. battery back up systems (e.g. Ni-cads) but only two l.e.d.s will illuminate. It is a good idea to "splay" the l.e.d.s. somewhat to give a good spread of light when viewed from the rear by other road users.

Alan Bradley,
Belfast.

Audio Switching Unit – Sound, action!

Various audio switching units are available which enable several hi-fi separates to be connected to a single input of an amplifier or midi system. The design depicted in Fig.2 is a switching circuit which allows a selected audio signal to be recorded by one of two possible tape decks. One half of a suggested stereo system is shown.

An audio signal source is connected, via sockets SK1 to SK4, with S1, a four-pole selector switch, selecting the required source. The signal then passes straight through to SK5, which is conected to the audio amplifier. It also passes via a d.c. blocking capacitor C1 to a unity-gain audio amplifier based around a high-grade operational amplifier (IC1) which avoids loading the audio signal unduly.

Switch S2 has three poles which are used to select which tape deck is required, via a decoupling capacitor C3, to sockets SK6 and SK7. The switch also controls the power supply from which a split supply was derived for the op.amp using resistors R1 to R3.

Phono (RCA jack) sockets were used throughout. Note that the parts must be duplicated for the second audio channel although a second op-amp can be driven by the same power source; preferably take all "ground" wires to a single common "star" ground to reduce hum and noise, and use screened cable for the interconnections.

Mike Oliver,
Loughborough, Leics.

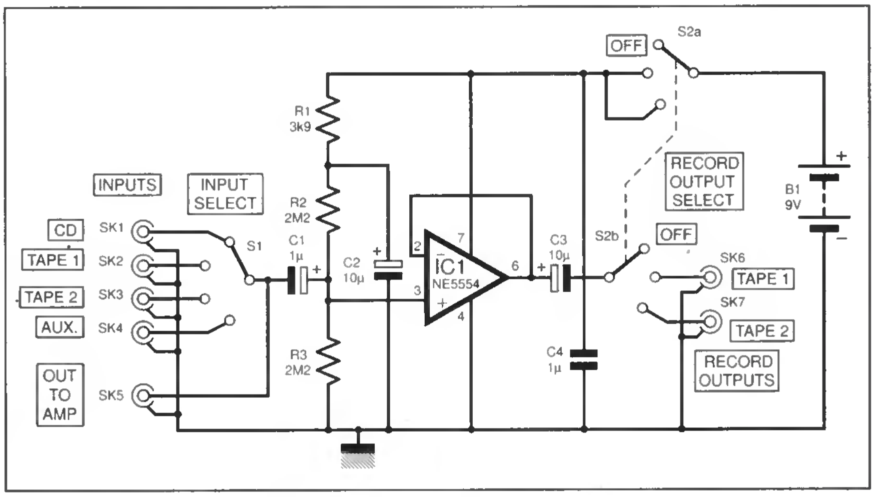


Fig.2. Circuit diagram for the Audio Switching unit.

Single-contact Touch Switch – A Neat Touch

The Touch Switch circuit of Fig.3 is intended to replace cheap but unreliable mechanical pushbutton switches, as well as providing a safe l.e.d. status indication using a minimum of front panel space.

The domestic mains supply induces a small voltage across the human body and this can be cleverly utilised to operate an electronic switch. When a finger is placed on the Touch Pad this is amplified by transistor TR1. The collector (c) of TR1 is directly coupled to emitter follower TR2, which provides a high input impedance to avoid loading TR1 which would otherwise reduce its gain. Transistor TR2 then feeds a half-wave voltage doubler rectifier made up of capacitors C1, C2 and diodes D1, D2.

In a normal domestic situation about 6V d.c. together with about one volt 50Hz a.c. ripple is developed across capacitor C2 (when the supply is +15V), which is more than enough to fully saturate transistor TR3 to output CMOS compatible levels. However, since the rise and fall times of the voltage at TR3 collector (c) are relatively slow, a Schmitt trigger (IC1) is essential for reliable operation.

As an example, the touch switch is shown as a touch ON, touch OFF device with l.e.d. status indication. One sixth of a 40106 Schmitt hex inverter feeds half of a 4013 D-type flip-flop (IC2) which is connected to toggle on successive positive-going edges at the clock input (CK).

The Q output of IC2 pin 1 can be used to operate external loads (e.g. a transistor-driven relay or similar). The l.e.d. status indication is provided by transistor TR4 driven from the $\overline{Q}$ output (pin 2).

The neatest way of providing an attractive single touch contact is to use a chromed all-metal 3mm l.e.d. panel holder to mount the l.e.d., and use the metal body of the holder as the touch contact. Of course, the holder must be mounted on an insulated panel.

Extensive testing was made on the prototype at voltages between 5V and 15V as well as with a 9V battery. There must, of course, be some mains wiring in the vicinity to act as a signal "transmitter". It is also ***essential*** that the 0V line is connected to Earth for there to be a voltage at the base (b) of TR1 when the contact is touched, although this can be quite high impedance. With battery operation, the prototype still worked when earthed via a 150pF capacitor in series with a 10M resistor!

B.J. Taylor,
Rickmansworth,
Herts.

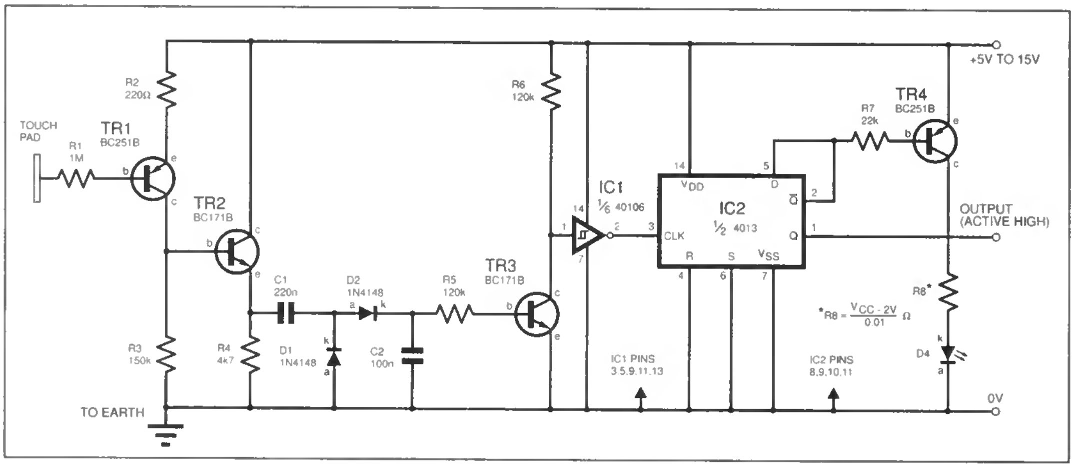


Fig.3. Single-contact Touch Switch circuit diagram.

Techniques
ACTUALLY DOING IT!
by Robert Penfold

SOME recent correspondence in *EPE* has resurrected the perennial gripe about the difficulty in obtaining the components for projects, right down to the very last nut and bolt.

When you are building your first one or two projects it is probably best to settle for doing things "the hard way", and simply order components as and when you need them. Before too long though, you will realise that life will be much easier if you have a stock of the more frequently used components.

To some extent this is a matter of convenience. Instead of having to order long lists of components each time you wish to construct a project, it is only necessary to order the more specialised items if you already have the mundane components in stock.

It is also a matter of economics. Buying small components such as resistors and capacitors one by one tends to be quite expensive. In some cases the amount of money saved by buying in larger quantities is quite small, but in others the difference is quite dramatic.

Three CMOS integrated circuits were required recently, and it was discovered that from one supplier the quantity discount meant it was actually much cheaper to buy 10 of them than it was to buy three devices!

Consumer Resistance

Having a good stock of components is a definite asset, but unless the components are chosen wisely it is also a golden opportunity to waste a lot of money. There is no point in buying components for stock unless you are likely to use them in a project before too long.

Also, it is probably not worthwhile keeping expensive components in stock. This would mean having a significant amount of money tied up, with no guarantee that the components would ever be used. The best strategy is to concentrate on inexpensive components that are used regularly and in large numbers.

Resistors are the obvious first candidates for your "sparès" box. There is probably no point in having a stock of the more exotic resistors such as close tolerance (one or two per cent) and high wattage types. These are used too infrequently in projects, and are relatively expensive.

Ordinary 0·25 watt 5 per cent tolerance carbon film resistors are a different proposition, as they are used in large numbers in practically every project and are quite cheap. The large number of different values available makes things slightly awkward, but if you buy carefully it is possible to obtain several hundred resistors for a few pounds. Some suppliers offer some form of quantity discount even when buying a mixture of values.

Quick and Easy

The quick and easy way of obtaining a stock of resistors is to buy one of the resistor "development" packs that are offered by some component retailers. These generally offer a full range of values from 10 ohms to one megohm or in some cases an even wider range of one ohm to 10 megohms. These packs generally take into account the fact that some resistor values are used much more than others. For example, a value of 10k (kilohms) tends to be used far more than either 8k2 or 12k.

In my experience of these things, the weighting in favour of the more popular values tends to be inadequate, and you still run out of these first. However, it is a step in the right direction, and ensures that you do not have vast numbers of little-used values lying around for long periods. If you do a large amount of project construction it will be worthwhile buying 100 of each of the most popular values (1k, 4k7, 10k and 100k).

A popular method of obtaining a stock of resistors in days gone by, and one that is still a good way of doing things, is to buy twice as many resistors as you actually need. If a project needs (say) five 10k resistors you would actually order 10 of them.

With this method it obviously takes some time to produce your stock of resistors, but it is relatively painless because you will barely notice the increased cost of each project. You will automatically obtain larger quantities of the more popular values, and a few of the little-used values.

This weighting of the quantities you obtain should accurately reflect the true popularity of each value, resulting in a few components that are left unused for long periods. The same method can be applied to other components, such as the cheaper capacitors and semiconductors.

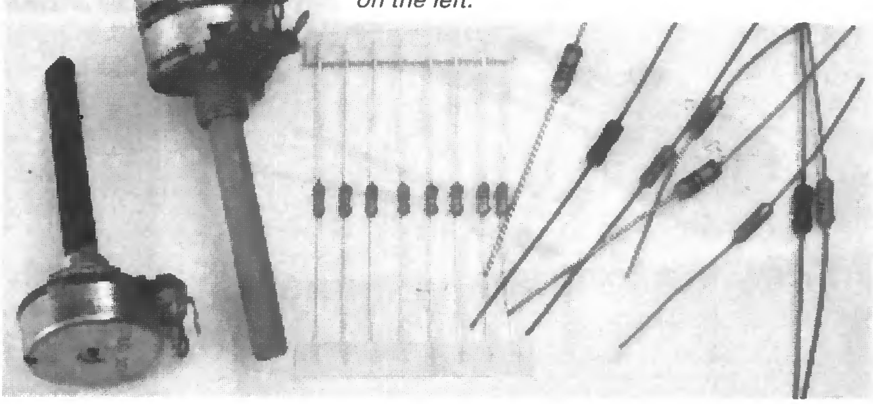
Bargain Hunting

A third way of obtaining a stock of resistors is to buy one of the "bargain" packs that are offered by some of the retailers that deal in surplus stock. These usually offer good value for money, but you may find that only a limited range of values is included. Also, the values included in the pack may not be ones that you use very often and there may be some odd values as well.

Most projects for the home constructor use resistor values in the E12 series (1, 1·2, 1·5, 1·8, 2·2, 2·7, 3·3, 3·9, 4·7, 5·6, 6·8, 8·2 and their decades). It is probably only worth stocking resistors in this series of values. Resistors are also available in the E24 series, which consists of the E12 series plus 12 intermediate values (1·1, 1·3, 1·6, 2·0, 2·4, 3·0, 3·6, 4·3, 5·1, 6·2, 7·5, 9·1 and their decades).

These additional values are little used in projects for the home constructor, and it is best to buy them only when they are needed. All sorts of odd values are used in commercial electronic products, and the components in bargain packs will not necessarily have standard values.

It would probably be possible to use something like a close tolerance 14·6k resistor instead of a 15k component, but with the low cost of resistors it would hardly seem to be worth the effort. I would advise



A couple of samples of resistive components. A single and a dual potentiometer are shown on the left.

against producing a stock of "bargain" resistors that are not modern miniature types. Older and higher wattage resistors will not fit into most modern component layouts, as they are far too big.

Potting-Up

Preset "resistors" are much more expensive than ordinary types, but obtaining a small stock of them should not cost too much because only a limited range of values is available. Again, the quick and easy method of obtaining a stock is to buy a "development" pack of these components. Incidentally, preset resistors are normally only sold in *linear* versions.

Potentiometers are a different proposition due to their much higher cost. Unlike presets they are available in both linear (lin) and logarithmic (log) versions, which effectively doubles the number of different values available. Even obtaining just a few potentiometers of each type and value is likely to cost a fair amount of money, and will not be a practical prospect unless it is a case of "money is no object".

Once you have a stock of resistors and presets it might be worthwhile stocking up with a few of the more popular types of potentiometer (4k7 lin and log, 10k lin and log, 100k lin and 1M lin). You may be able to obtain "bargain" packs of potentiometers, but as always with these packs you need to proceed carefully and read the "fine print".

Do the potentiometers have spindles of adequate length and a standard diameter (6mm or 6·35 mm)? Are they supplied complete with mounting nuts and washers?

Limited Capacity

Obtaining a really comprehensive stock of capacitors would be extremely expensive due to the very wide range of values available, and the different types in common use. While capacitors are not exactly expensive, they are not available at the "give-away" prices associated with resistors. Unless you are prepared to spend a fair amount of money on obtaining a stock of them it is necessary to make some compromises.

Higher value capacitors are normally of the electrolytic variety, and it is certainly worthwhile obtaining at least a small stock of these. Electrolytic capacitors are available in axial lead and radial (printed circuit board or p.c.b.) mounting varieties.

Most modern projects require the radial type, and in most cases a radial component will actually fit quite well in place of an axial type. Presumably because they are relatively little used these days, axial capacitors seem to be far more expensive than radial equivalents.

Electrolytic capacitors are only generally available in the E6 range of values, which is just every other value in the E12 series (1·0, 1·5, 2·2, 3·3, 4·7, 6·8 and their decades). In practice it is only every other value in this series that seems to be used to any extent (e.g. 1·0, 2·2, 4·7 and their decades).

A basic stock of electrolytic capacitors could therefore be rationalised to something like 10 each of these values/voltages:

1µF	50V to 100V	10µF 50V	100µF 16V
2µ2	50V to 100V	22µF 25V	220µF 16V
4µ7	50V to 100V	47µF 25V	470µF 16V

These nine values and voltages will cover most requirements.

Types having higher voltage ratings and (or) values tend to be quite expensive and should be bought as and when they are needed. It is worth seeking out "development" packs of these components as they often represent a very cheap way of obtaining a stock.

You need to be very careful when buying "bargain" packs of electrolytic capacitors as this type of component has "shrunk" quite significantly over the years. Components even a few years old can be very much larger than those currently being manufactured, and it could be difficult to fit them into modern project layouts.

Space Saving

Modern designs almost invariably use non-electrolytic capacitors of the printed circuit (box-shaped) variety. These are available with various lead spacings, the best compromise is 5mm (0·2 inches). Cased capacitors having this lead spacing can usually be manipulated to fit into layouts designed for 2·5mm or 7·5mm lead spacing. It is definitely not wise to use open construction capacitors with the wrong lead spacing, because the likely result is that one of the leads will break off when you try to form it to the required shape.

Either ceramic plate or polystyrene capacitors are normally used where values below 1nF are needed. Polystyrene capacitors are used where good stability is important, and ceramic plate capacitors (which are smaller and cheaper) are used in less demanding applications.

Unless you are into radio construction you will probably not use these low values very much, and it is not a good idea to stock up with large numbers of them. This is particularly the case with polystyrene capacitors, which are not exactly cheap. The development packs of ceramic plate capacitors are useful, and this is a good way of buying other types of capacitor.

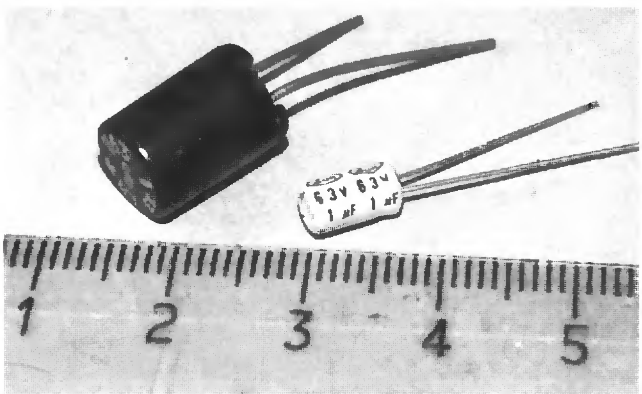
Semiconductors

With such a wide range of semiconductors available, there are relatively few that can be held in stock as standard items. One semiconductor no constructor should be without is a general-purpose silicon diode such as the 1N914 or 1N4148. These are the cheapest semiconductor components, and buying a hundred of them should not cost too much.

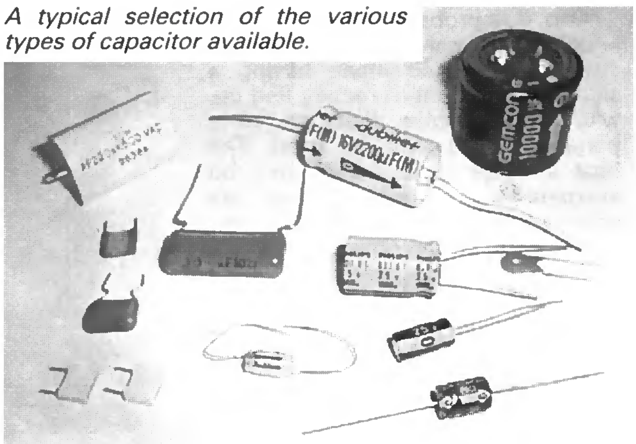
Germanium diodes such as the OA91 are still used to some extent, and it is worth having a stock of these if you can find them at the right price. These old components are beginning to get "antique" prices.

Transistors such as the BC549 (*npn*) and BC559 (*pnp*) are good general purpose devices that are used in a lot of designs. They will usually work in place of other transistors that are not of a specialised nature (e.g. high voltage or current, or for use at radio frequencies). However, unless you know what you are doing it is advisable to use the correct types rather than substitutes.

Electrolytic capacitors from a few years ago (left) tend to be much larger than modern equivalents.



A typical selection of the various types of capacitor available.



At one time I would have suggested obtaining some 2N3055 *npn* power transistors, but these seem to be used far less than they were 10 or 20 years ago. It is some years since I last used a 2N3055. Modern power circuits often require some sort of special power device, and it is best to buy these expensive components as the need arises.

It is certainly worthwhile having some 555 timer chips, and a *low power* version as well, such as the TLC555CN. The 741C is the standard operational amplifier (op.amp), but many modern circuits utilize bi-f.e.t. op.amps such as the TL071CP and LF351N.

It is a good idea to have some 741Cs and one or other of these bi-f.e.t. devices. The TL071CP is perhaps the better choice as a general purpose "stock" item as it will work in low voltage circuits that are beyond the LF351N, and it is generally slightly cheaper as well.

Logical Interest

Logic integrated circuits represent a difficult category because there are so many different types. Also, the development of new logic families over the years means that many logic devices are available in several versions (74**, 74LS**, 74HC**, etc.). Choosing devices to stock is a bit like choosing your lottery numbers! it "could be you", but the chances are that most of the components obtained would never actually be used.

The CMOS 4046BE phase-locked loop (which can also be used as a voltage controlled oscillator) appears fairly regularly in projects as does the 4017BE decade counter and some of the more simple gates (4001BE, 7400, etc.). Beyond that it is anyone's guess what you will need.

This is a type of component where the "bargain" packs probably offer the only realistic way of obtaining a stock of components. It is likely that most of the devices in the packs will never be used, but with them (almost literally) at ten a penny, this should not matter too much.

Try to obtain packs that contain a wide selection of type numbers, and avoid packs that contain a predominance of the original 74** series TTL devices, which are now obsolete. Obtain packs of "***tested***" devices. Even if you have the resources and know what you are doing, checking dozens of logic devices is difficult and very time consuming.

Inexpensive miniature chests of drawers are ideal for storing small components.

Nuts and Bolts

Do not overlook items of hardware, such as nuts, bolts, spacers, plastic stand-offs and PP3 size battery clips. With nuts, bolts, and spacers you will probably have to buy in fairly large quantities anyway. The most useful are the 6BA versions of 6·35mm, and 12·7mm bolts (plus nuts to match), and 6·35mm spacers (or the nearest metric M3 equivalents to all these).

Always have plenty of solder in stock, and if possible treat yourself to a 500g reel of 22s.w.g. (0·7mm) solder. There is nothing quite like the feeling of running out of solder just as the shops shut, with your latest masterpiece 99 per cent completed.

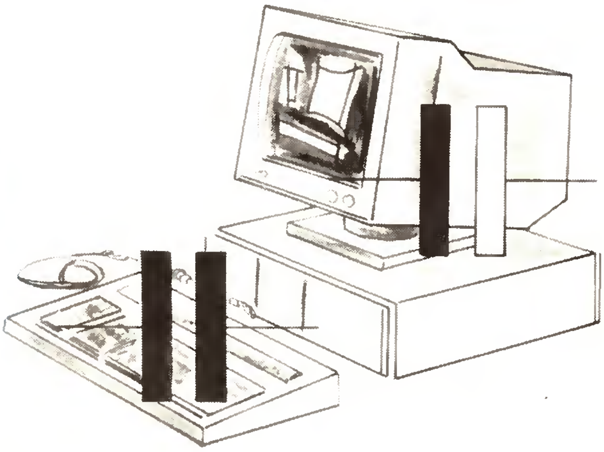
Open and Shut Case

If you build up even a modest stock of components it is important to have them stored properly, otherwise you will spend more time sorting out the right components than you will spend constructing projects. It is not difficult to build your own storage system, or to improvise with biscuit tins and the like. My preference is for the miniature chests of drawers that can be obtained from your local "Woollies" or DIY superstore, or some of our advertisers.

The cheapest plastic units are perfectly adequate for storing components. With the drawers suitably labelled it is possible to home-in almost instantly on any desired component.

Whether you use a ready-made storage system or "do your own thing", plenty of small compartments are better than a few large ones. You can then have a narrow range of values in each compartment, making it easy to find the right one.

PC CAPACITANCE METER



ROBERT PENFOLD

Put your PC to practical work with this low-cost, add-on, piece of test gear.

THIS PC Capacitance Meter interface for PCs is based on the design featured in the October 1996 issue of *EPE* (*Interface*, page 768). The original design could be used with any PC printer port, and relied on four handshake inputs to read in 8-bit bytes of data as two 4-bit nibbles.

The updated circuit featured here has been simplified somewhat, and it requires a PC printer port that has bi-directional capability so that the bytes of data can be read directly by the data lines. Any reasonably modern PC should have a printer port of this type, but adding a bi-directional printer port card to an older computer is not expensive.

RANGE FINDING

Two handshake inputs are used to read in additional bits of data, giving this "improved" version of the interface 10-bit resolution. Slightly better accuracy should be obtained when measuring certain values, and the increased resolution also raises the maximum value that can be read by the unit.

It now covers capacitance values up to 10·24µF (microfarads) instead of the 2·55µF limit of the original design. The four ranges covered are:

Range 1 *0 to 10240pF (10p resolution)*
Range 2 *0 to 102·4nF (100p resolution)*
Range 3 *0 to 1·024µF (1n resolution)*
Range 4 *0 to 10·24µF (10n resolution)*

The unit can accommodate polarised capacitors such as electrolytics. The software is a simple GW-BASIC or QBasic program that runs under MS-DOS or under Windows 95 from the "MS-DOS prompt". In either case GW-BASIC or QBasic is needed in order to run the software, since both these versions of BASIC are interpreted languages.

SYSTEM OPERATION

The PC Capacitance Meter operates using a gate and counter system. Fig.1 shows the block diagram for the interface. The clock oscillator feeds the input of an 11-bit binary "ripple" counter by way of a signal gate.

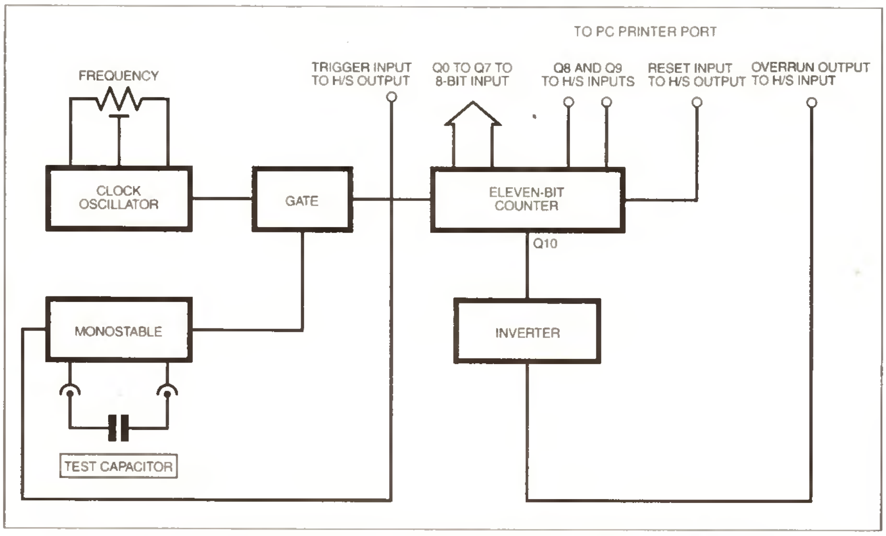


Fig.1. System block diagram for the PC Capacitance Meter.

The latter is controlled by the output of a monostable, which generates a pulse having a duration that is governed by a *C-R* timing network. The capacitor in this network is the component "under test", and the resistor is one of four switched components, one for each range.

Each measuring cycle starts with the counter being reset to zero via a pulse generated on a handshake output of the printer port. Next another handshake output generates a trigger pulse for the monostable.

The monostable then switches on the gate, and the counter starts to register the pulses from the clock oscillator. However, in normal operation the pulse from the monostable will end and halt the count before the eleventh bit of the counter is set.

The important point to note here is that the length of the output pulse from the monostable is proportional to the value of the test capacitor. Therefore, the final value in the counter is also proportional to the value of the test component.

In practice the clock frequency must be set to give a meaningful value in the counter. For example, on the 102·4nF range the clock frequency would have to be such that with a 100nF "test capacitor" 1000 clock pulses would pass through to the counter. With a 50nF test capacitor the pulse duration would be half as long, and then only 500 pulses would pass through to the counter.

In both cases it is merely necessary for the software to divide by 10 in order to produce the correct reading in nanofarads. The clock frequency is adjustable so that the unit can be set up to provide accurate results.

One minor problem with any digital counting circuit is that it can cycle through its maximum count and back to zero. The count then continues from zero again. This can result in what appears to be a valid reading from a capacitor that has an excessive value for the range in use.

In order to avoid this a handshake input is used to monitor the eleventh bit of the counter via an inverter/buffer stage. A software routine frequently checks this output while each count is in progress, and an on-screen warning is produced if an overflow occurs and the eleventh bit is set high.

CIRCUIT OPERATION

The complete circuit diagram for the PC Capacitance Meter appears in Fig.2. The clock oscillator uses a low-power 555 timer, IC1, in the conventional astable mode, and its output frequency can be adjusted by

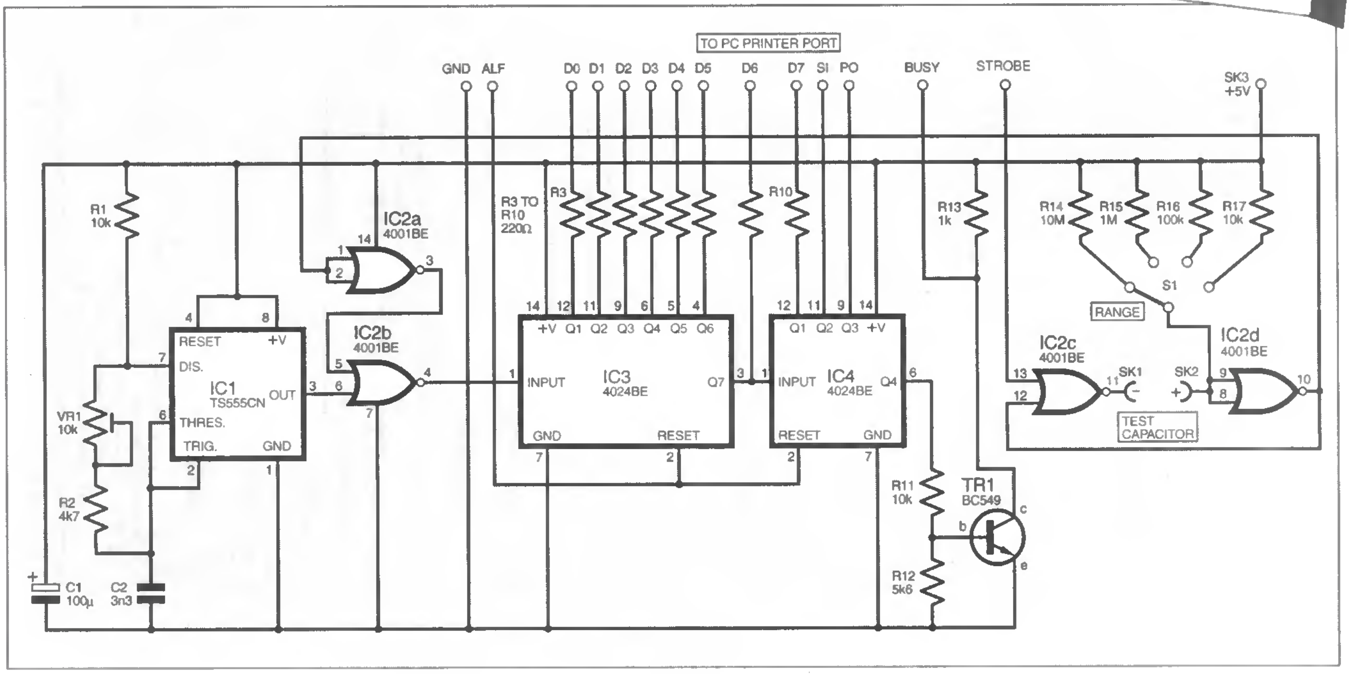


Fig.2. Complete circuit diagram for the PC Capacitance Meter interface.

means of preset potentiometer VR1. The clock frequency is typically about 15kHz. The signal gate is formed by IC2b, one quarter of a CMOS quad 2-input NOR gate.

The output of a NOR gate is low if either input is high, but is high if both inputs are low. Therefore, when pin 5 of IC2b is low, the clock signal is coupled through to the counter circuit. The clock signal undergoes an inversion, but this is of no practical consequence. Taking pin 5 high blocks the clock signal.

One of the other NOR gates, IC2a, has its inputs wired in parallel so that it acts as a simple inverter. It inverts the control signal to IC2b so that the gate is switched on when the output of the monostable is high, and switched off when it is low. This inversion is needed because the monostable produces high output pulses.

The monostable is formed from the remaining two gates in IC2, and it uses a conventional configuration. S1 is the Range switch, and R14 to R17 are the four range resistors. These must be close tolerance types if good accuracy is to be provided on all ranges.

Two 7-bit counters (IC3 and IC4), connected in series, are used to produce a 14-bit counter. Only 11 outputs are actually used though, and no connections are made to the final three outputs of IC4. The first eight outputs of the counter are read by the data inputs of the printer port.

At switch-on the data lines default to the output mode, and do not operate as inputs until the PC Capacitance Meter software is run. This results in outputs of the counter circuit being connected to outputs of the printer port.

Resistors R3 to R10 are needed to provide current limiting during the period before the data lines are set to the input mode. Their value is high enough to prevent excessive currents flowing during this period, but low enough to permit normal operation thereafter.

Transistor TR1 acts as a simple inverter/buffer stage at the output of the eleventh bit of the counter.

COMPONENTS

Resistors

See SHOP TALK Page

R1, R11	10k (2 off)
R2	4k7
R3 to R10	220Ω (8 off)
R12	5k6
R13	1k
R14	10M 0·6W 1% metal film
R15	1M 0·6W 1% metal film
R16	100k 0·6W 1% metal film
R17	10k 0·6W 1% metal film

All 0·25W 5% carbon film, except where stated

Potentiometer

VR1	10k min. enclosed carbon preset, horizontal

Capacitors

C1	100µ radial elect. 10V
C2	3n3 polyester

Semiconductors

TR1	BC549 *npn* transistor
IC1	TS555CN low-power 555 timer
IC2	4001BE CMOS quad 2-input NOR gate
IC3, IC4	4024BE CMOS 7-bit binary counter (2 off)

Miscellaneous

S1	1-pole 12-way rotary switch (set for 4-way operation)
SK1	1mm socket, black
SK2	1mm socket, red
SK3	4mm socket, red

Metal, vinyl-effect, instrument case, size about 200mm × 125mm × 50mm; 0·1inch matrix stripboard, measuring 59 holes by 32 copper strips; 25-way male D-type connector and 1m of 14-way ribbon cable; 8-pin d.i.l. socket; 14-pin d.i.l. socket (3 off); control knob; multistrand connecting wire; solder, etc.

Approx Cost Guidance Only £10 excluding case

CONSTRUCTION

The stripboard component layout, breaks required in the underside copper tracks and details of the hard wiring are provided in Fig.3. A board measuring 59 holes by 32 copper strips is required. To a large extent construction of the circuit board is straightforward, but there are a few points that require some clarification.

The usual anti-static handling precautions should be taken for the CMOS i.c.s, IC2, IC3 and IC4. Fit these devices onto the circuit board via holders, but do not plug them into place until the unit is finished in all other respects.

Until then they should be left in their anti-static packing. Touch the pins as little as possible and touch on earthed metal object before fitting them into the holders.

Although IC1 is also a CMOS device it has built-in protection circuits that render handling precautions unnecessary. However, it is still advisable to fit it in a holder. Note that IC1 has the opposite orientation to the other i.c.s, and that ***it could easily be destroyed*** if it is fitted to the board the wrong way round.

A substantial number of link-wires are required, and in some cases there are long link-wires running side-by-side. It is advisable to use p.v.c. sleeving over some of these wires so that there is no risk of accidental short circuits occurring.

IN RANGE

Range switch S1 is a standard 12-way single-pole rotary switch having an adjustable end-stop. In this case it is obviously set for four-way operation. The four range resistors (R14 to R17) are mounted directly on S1. This helps to minimise

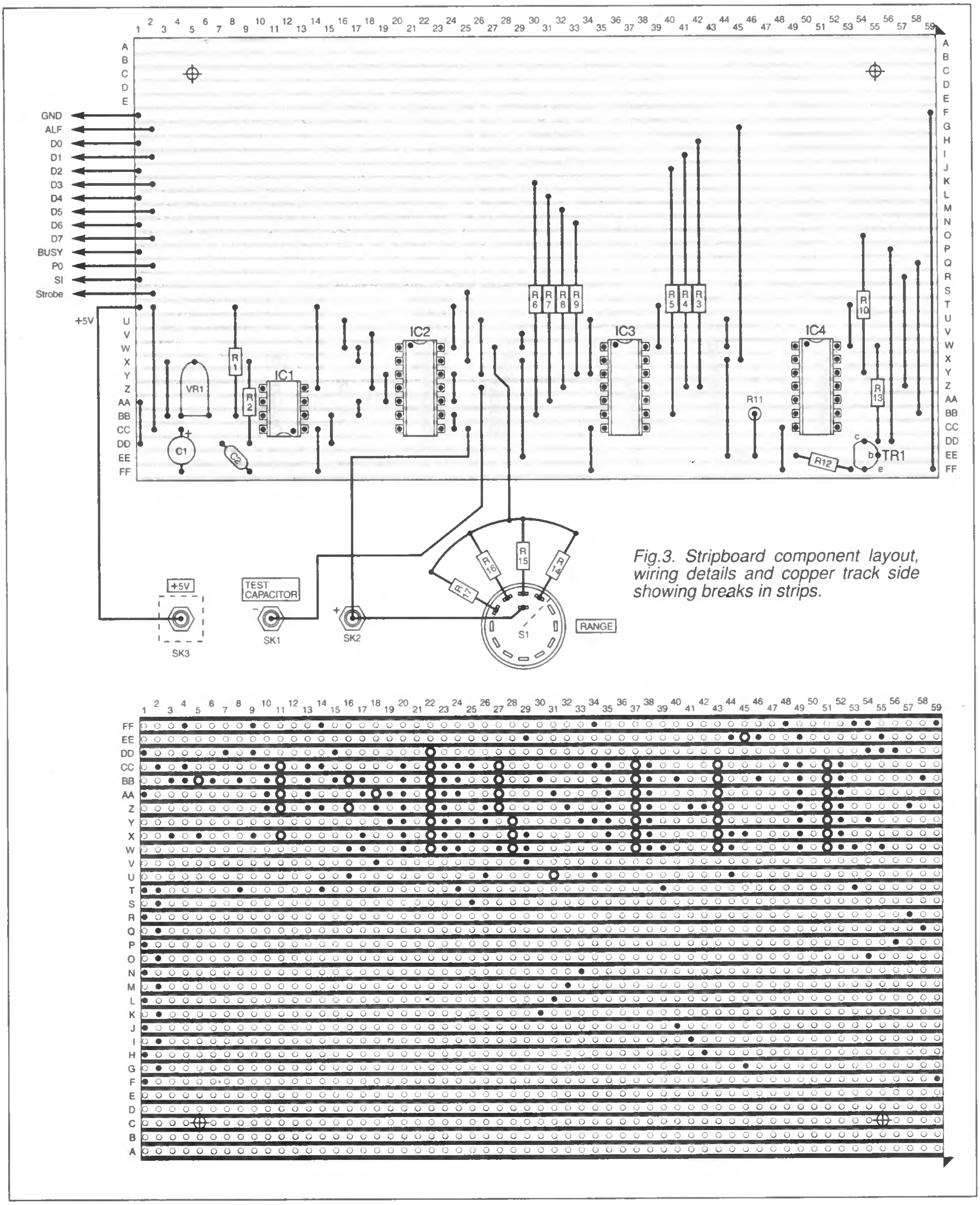
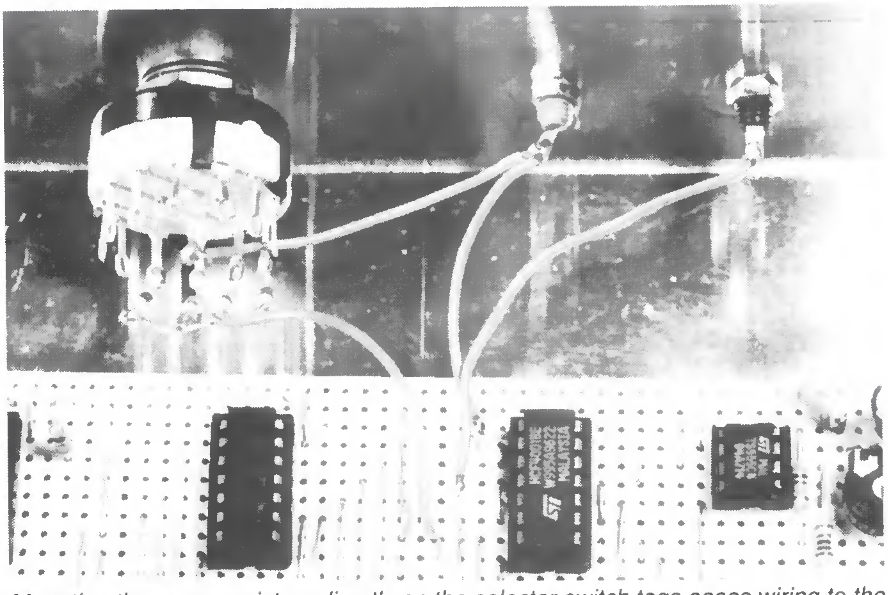


Fig.3. Stripboard component layout, wiring details and copper track side showing breaks in strips.



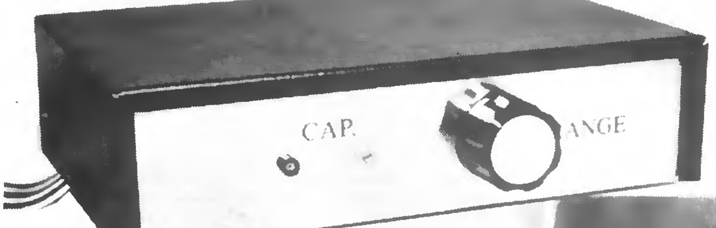
Mounting the range resistors directly on the selector switch tags eases wiring to the circuit board and limits any capacitance effect of the wires.

capacitance in the wiring and gives better results when measuring low value capacitors.

It is probably easier to fit these resistors on S1 before the switch is mounted in the case. Trim the leads of all four resistors quite short (about 5mm or 6mm will suffice), and then "tin" solder their leads (both ends) and the tags of S1 with plenty of fresh solder. It should then be easy to solder the resistors to the tags of S1, and the free ends of the resistors together.

BOXING UP

A medium size instrument case is the most appropriate enclosure for this project, but an inexpensive plastic box is also usable. Range switch S1 is mounted on the front panel, with the "test" sockets SK1 and SK2 fitted close-by (see photographs). If the two sockets are mounted close together it will be possible to connect some types of capacitor to them directly.



Front panel layout of the completed unit.

Due to the fact that modern capacitors come in a wide range of shapes and sizes, there will inevitably be many "awkward" components that can only be accommodated by using a simple set of test leads. Each lead simply consists of about 50mm of multistrand connecting wire fitted with a one-millimetre plug at one end and a small crocodile clip at the other.

MAKING CONNECTIONS

The circuit requires a 5V supply, and its current consumption is only a few milliamps. Unfortunately, there is no 5V supply output included on a PC printer port. The circuit could be powered from its own mains power supply unit or from a battery supply, but it is more practical to simply tap-off power from one of the computer's other ports.

There are two options, and one of these is to obtain power from the games port. Most modern PCs have a games (joystick) port, but these days it is usually in the form of combined games and MIDI port on a sound card. Whether you are dealing with a traditional games port or the sound card variety, a 15-way male D-type connector is required and the 5V supply is taken from pin 1 (see Fig. 4).

Power can also be obtained from the keyboard connector if a games port is not available. This is slightly more difficult because it requires a short keyboard extension lead to be made up. The lead consists of about 300mm of 5-way cable fitted with a 5-way (180 degree) DIN plug at one end and a matching line socket at the other.

Power for the interface is obtained by way of a piece of multistrand connecting wire about one metre long, which is connected to pin 5 of the plug (see Fig. 4). The other end of the lead could be connected direct to the circuit board, but it is probably better to make this connection via a 4mm plug and socket (SK3). The socket is mounted on the rear panel of the case and hard wired to the appropriate pin of the circuit board, see Fig.3.

IN PORT

The 14 connections to the printer port are made by way of a piece of ribbon cable about one metre long. It would seem that 14-way cable is unobtainable, but there is no difficulty in trimming standard 20-way cable down to size. This type of cable is designed to pull apart quite easily, and it is just a matter of tearing off a 6-way strip.

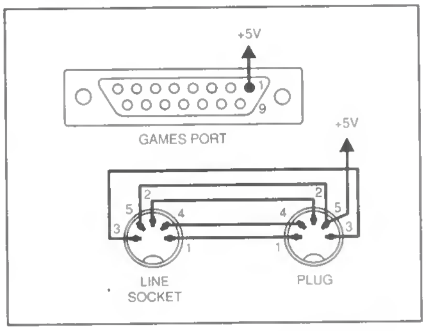
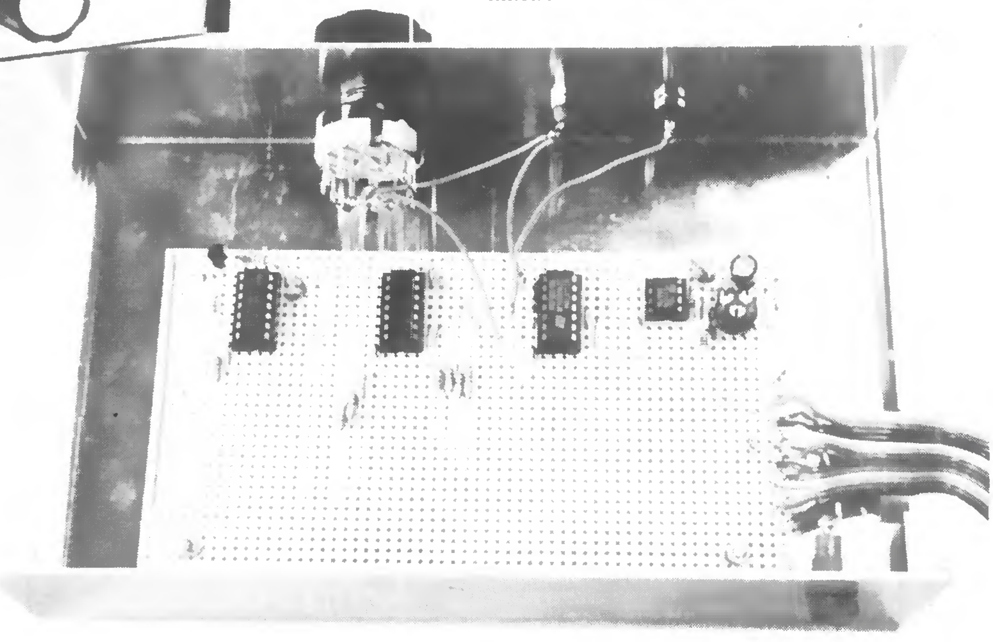


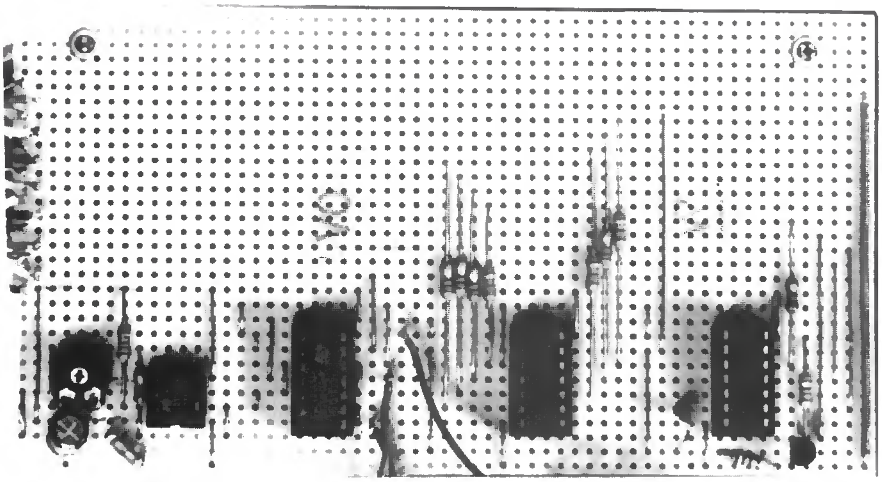
Fig.4. Tapping off the required +5V supply from the games port or the keyboard connector.

The cable is connected to solder pins fitted to the circuit board. Due to the large number of wires involved this is a little tricky, but it is not too difficult provided you go about it in the right way.

Start by separating the cable into individual leads at one end. Only about 20mm or 30mm of the cable needs to be given this treatment. Strip a few millimetres of insulation from the end of each



Positioning of components inside the metal case. The +5V input supply socket is mounted on the rear panel near the printer port ribbon cable circuit board solder pins.



Layout of components on the completed stripboard.

wire, and then "tin" the ends of the wires and the solder pins with plenty of solder.

By working methodically through the connections from one end to the other it should not be too difficult to complete them correctly. The connections on the circuit board are in a "zig-zag" pattern as this places slightly more distance between one pin and the next.

The main problem with this type of thing is in avoiding short circuits rather than getting the wires connected reliably. Make a detailed visual inspection of the finished assembly to ensure that excess solder has not produce any short circuits.

D-TYPE

The other end of the cable is connected to a 25-way male D-type connector using the method of connection shown in Fig.5. The end of the cable should be given the same treatment as before, but it is probably better to separate the wires over a slightly longer distance (say about 50mm). The 14 pins of the D-connector that are actually used should be "tinned" with solder.

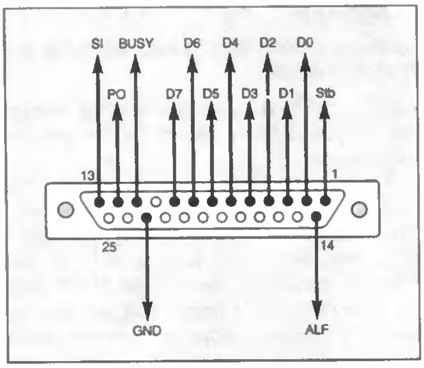


Fig.5. Details of the 14 connections to the printer port connector.

Making the connections to the plug will be very difficult unless it is secured to the worktop. It can be fitted in a miniature vice or simply "glued" to the worktop using Bostik Blu-Tack. Connecting the cable to the plug should then be reasonably straightforward, but take great care to get each wire connected to the correct tag.

The order of the connections on the circuit board matches up quite well with the connections on the plug, which makes things much easier. If you connect the Strobe (stb) line first, the others should then all fall into place nicely.

An exit hole for the cable must be cut in the case, and the best position for this hole depends on the particular case you are using. It will usually be somewhere in the base of the unit where it is out of sight. A small amount of work with a miniature file is probably all that will be required. Where appropriate, remember to thread the cable through the cut-out before connecting it to the circuit board. To prevent damage from the edges of the metal cut-out, the cable should be protected by a grommet or several thicknesses of insulating tape.

SOFTWARE

We can now turn our attention to the software requirements of the PC Capacitance Meter. It is in a simple GW-BASIC or QBasic format that runs under MS-DOS or under Windows 95 from the "MS-DOS prompt". The program is given in Listing 1.

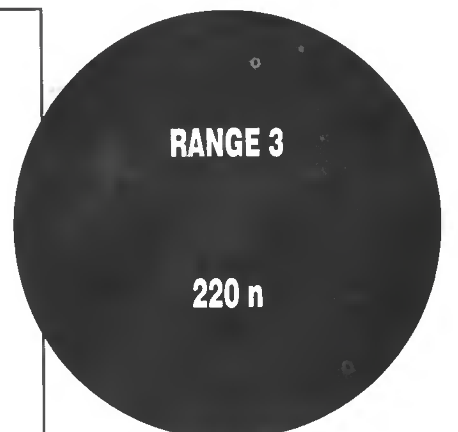
Lines 20 to 40 assign the three printer port addresses to variables PORT1, PORT2 and PORT3. The addresses used in the program will probably be correct if you are using printer port two (LPT2), but may need to be changed if the interface is connected to printer port one or your computer has three printer ports.

The other two sets of possible addresses are &H378 to &H37A, and &H3BC to &H3BE. If you do not know the correct address range for the printer port you are using, it becomes a matter of trying each address range until you find the one that establishes contact with the interface!

Next the screen is cleared and the unit is set to its default range, which is range 3. First "RANGE 3" is printed on the screen, and then variables B$ and R are set at their initial values. The value read from

Listing 1: PC Capacitance Meter program

```
10 REM capacitance meter program
20 PORT1=&H278
30 PORT2=&H279
40 PORT3=&H27A
50 CLS
60 LOCATE 7,30
70 PRINT "RANGE 3'
80 B$="n"
90 R=1
100 OUT PORT3,35
110 OUT PORT3,33
120 OUT PORT3,35
130 OUT PORT3,34
140 OUT PORT3,35
150 A$=INKEY$
160 IF A$="1" THEN GOSUB 410
170 IF A$="2" THEN GOSUB 460
180 IF A$="3" THEN GOSUB 510
190 IF A$="4" THEN GOSUB 560
200 IF A$="s" THEN END
210 T=TIMER
220 T2=T+.2
230 T=TIMER
240 OVER=INP(PORT2) AND 128
250 IF OVER=128 THEN GOSUB 380
260 IF T<T2 THEN GOTO 230
270 X=INP(PORT1)
280 Y=INP(PORT2) AND 16
290 IF Y=16 THEN X=X+256
300 Z=INP(PORT2) AND 32
310 IF Z=32 THEN X=X+512
320 X=X * R
330 LOCATE 5,30
340 PRINT "      "
350 LOCATE 10,30
360 PRINT X ;B$"   "
370 GOTO 100
380 LOCATE 5,30
390 PRINT "OVERLOAD"
400 RETURN
410 R=10
420 B$="p"
430 LOCATE 7,30
440 PRINT "RANGE 1"
450 RETURN
460 R=.1 470 :B$="n"
480 LOCATE 7,30
490 PRINT "RANGE 2"
500 RETURN
510 R=1
520 B$="n"
530 LOCATE 7,30
540 PRINT "RANGE 3"
550 RETURN
560 R=.01
570 B$="u"
580 LOCATE 7,30
590 PRINT "RANGE 4"
600 RETURN
```



Part of a typical screen display.

See Page 763

the interface is multiplied by variable R. This shifts the decimal point to the correct position for the units in use. Variable B$ is printed immediately to the right of readings and indicates the units in use (''p'', ''n'', or ''u'').

Next a series of OUT instructions generate the reset pulse and the trigger pulse on the ALF and Busy handshake outputs. The values used in these instructions are 32 higher than one would expect. This sets bit 5 of the handshake output register high, which in turn sets the eight data lines as inputs.

The next few lines read the keyboard and call up a subroutine if an appropriate key has been pressed. The subroutines make any necessary changes to variables R and B$. In order to switch the software to another range simply press the appropriate number key (e.g. press the ''2'' key in order to switch to range two). Of course, Range switch S1 of the interface must also be set to the correct range.

HOLD-OFF

It is important that the counter is not read prematurely, and a software timing loop is therefore used to provide a suitable hold-off. It typically takes under one hundred milliseconds for a count to be completed, but the timing loop provides a more than ample hold-off of 200ms.

This is achieved by reading the timer and placing the result in variable ''T''. A period of 0·2 (seconds) is then added to this value and placed in variable ''T2'', and the new timer reading is taken at line 230. The conditional instruction at line 260 loops the program back to line 230 until the timer has advanced beyond the value stored in ''T2''.

The program that accompanied the original Capacitance Meter interface used a FOR...NEXT loop to achieve this delay, but this gives inconsistent results as the delay obtained depends on the speed of the computer. This method should give consistent results across a broad range of PCs.

The eleventh bit of the counter is read on each loop of the delay routine, and if this bit is set high the program branches to a subroutine. This subroutine simply prints the overload warning message at the top of the screen.

The rest of the main program loop reads the value from the counter. This is complicated by the fact that a 10-bit value has to be read in the form of an 8-bit byte and two additional bits.

First the eight-bit value is read, and then 256 is added to this value if bit nine is high. Similarly, 512 is also added if bit 10 is high. This gives the full 10-bit value in variable ''X'', which is multiplied by variable ''R'' to adjust the position of the decimal point, and then printed on the screen with string variable ''B$''.

The program then loops back to line 100 and commences a new reading. It loops indefinitely taking a continuous string of readings, but line 200 will bring the program to an end if the ''S'' key is operated. The usual CONTROL-BREAK combination will also terminate the program.

CALIBRATION

Start the calibration routine with preset VR1 at a roughly middle setting. With everything connected up and the software running, the system should more or less work, but it will probably not provide good accuracy. The unit can be calibrated on any range, but a suitable calibration component for anything other than Range 1 is likely to prove very expensive.

The calibration capacitor should have a tolerance rating of one or two per cent and a value that represents about 50 to 100 per cent of the maximum value that can be measured on the appropriate range. For example, calibration on Range 1 requires a capacitor having a value of around 4700p to 10n (10000p).

It is just a matter of connecting the calibration component across ''test'' sockets SK1 and SK2, and then adjusting preset VR1 for the correct reading on the monitor. The system should then give good accuracy on all four ranges. Try to avoid touching the leadout wires, especially when measuring low value capacitors, as this can result in unstable readings.

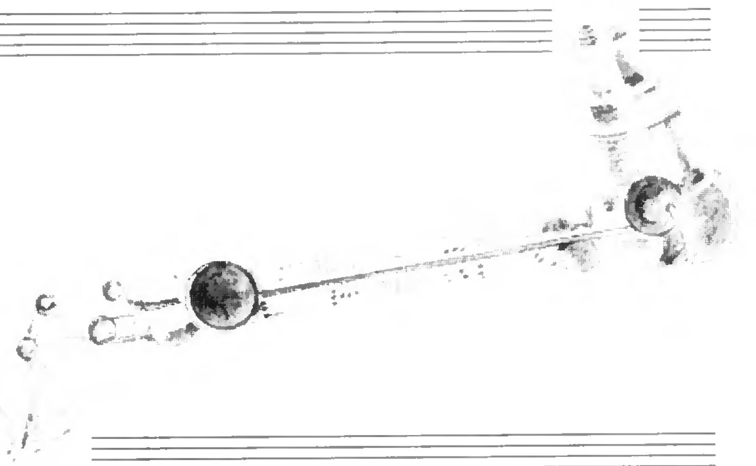
TAKE CARE

When using any capacitance meter, it is as well to bear in mind that connecting a ***charged*** capacitor to the circuit could result in it being damaged. It is therefore a good idea to discharge any ''test capacitor'' that may hold a significant charge. This is especially important with higher voltage and value components.

Capacitors that hold high voltage charges are potentially dangerous, and only those who are competent to do so should test circuits that contain them. Of course, there is *no* risk when testing new components, which should hold no significant charge.

Regular Clinic

CIRCUIT SURGERY



ALAN WINSTANLEY

Computer memory back-up systems come under the microscope at our monthly "Surgery". We also revive interest in the* Micro Lab *microprocessor demo unit.

Varta question to ask

I have a battery on which is printed "Ni-Cd. 3.6V 60mAh, 14h 6mA". It's made by Varta. I have tried my local stockist and even the Varta delivery driver to obtain information about it! I am assuming it is a Nickel Cadmium battery which gives 3.6V at up to 60mA/ hour, and it is rechargeable at 6mA for 14 hours.

My small problem is, how is it possible to recharge it? An ordinary Ni-Cad charger which I made charges AAA, AA, C, D and 9V batteries – is it possible to modify the charger, say using the 9V output? As a note, the battery is out of an Amiga A1200 computer: no aspersions or comments to downgrade to a PC, if you please! By the way, my Amiga A500 and an A500+ both have the same batteries. Help!

M.V. Robinson,
Beverley, near Hull.

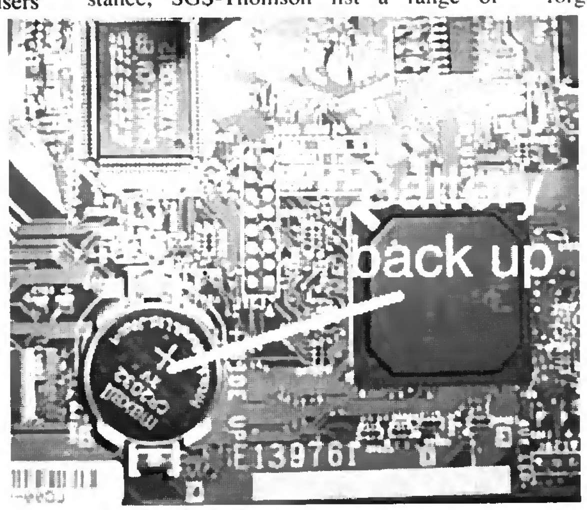
Nearly all modern desktop or home computers have an internal battery back-up system to retain essential data when the mains power is switched off. In older systems, it can cause pandemonium when the battery finally fails. Here's some essential information for computer users everywhere.

First, a run-down on computer memory back-up techniques, as used in Amigas but applicable to (whisper) PCs and AppleMacs too. Nickel-Cadmium (Ni-Cad) "cells" each have a terminal voltage of about 1.2V, so string three of them in series, shrink wrap them with an insulating sleeve, tack-weld a solder tag on each end and you have an instant 3.6V rechargeable Ni-Cad battery ready for p.c.b. mounting; note that strictly speaking, a "battery" is a collection of individual "cells". The rated capacity (the "C" value) is also given at 60mA for one hour.

You're right in your assessment of the battery. Battery manufacturers such as Varta specialise in a whole range of p.c.b. mounting batteries for "original equipment" (OE) applications, so don't be surprised if you come up against a weird and wonderful battery which no-one knows anything about. I guess yours was designed to maintain any data and the RTC (real-time clock) of your computer, so that your machine "knows" what the day and time it is even when you switch it off at the mains.

The Amiga 500 originally came with a memory cartridge of 512K, and it was possible to add a second 512K memory cartridge (the A501) which had a Ni-Cad battery back-up to retain data together with the time and date when the power was switched off. This was great for storing games data, except that some games could write to the system area of the memory and temporarily blow the machine away; at the time it also led to groundless fears that an Amiga could retain a computer virus in its memory, maintained by the back-up battery! (Impossible with mere *data.*) The Amiga 1200 had 1MB of memory with a battery back-up already on the main motherboard.

Some memory chips actually incorporate tiny batteries themselves. For instance, SGS-Thomson list a range of memory modules which include internal 10-year batteries to retain data, all in a 28-pin chip. Memory which retains its data even during power-down is called **non-volatile (NV) memory**.



A lithium "coin" cell back-up on a modern computer motherboard.

The back-up battery has a deceptive familiarity to electronics folk, but it plays a critical part in a modern desktop computer. A system's BIOS (Basic Input/ Output System) is responsible for kick-starting the computer at power-up, and the BIOS contains essential configuration data which is retained in read-only memory, maintained by the system's back-up battery. Some people refer to this data as the computer's "CMOS". It may include hard disk information, port and peripheral setup information and a checksum of the memory, so the machine knows if the memory has developed a fault. (In which case, it generates a memory parity error message and halts any further booting up. I've seen at least two PCs in this state on retail sale and the shop assistants had no idea what it meant. Translated, it means "Don't buy me!")

Incidentally, if the on-board "CMOS" battery back-up finally fails then if you have an older machine, not only will it forget the time and day, but it will lose other essential configuration information, such as the hard disk set-up. Now is the time to enter the BIOS set-up and write down your hard disk settings and everything else you can find, in case you ever have to re-input them manually after swapping the battery or the motherboard; the battery can also go flat if you don't use the PC for an extended period of time. Newest systems use a lithium-based non-rechargeable cell on the motherboard which is good for maintaining the setup for at least a decade, and there's no worry about losing the configuration either. Lithium Thionyl Chloride batteries are now also sold as 10-year memory back-ups.

Turning to your query, I need to second-guess at its ratings as I don't know the current rating of the 9V output. A rule of thumb is to allow C/10 as a recharge current, where C is the capacity of your battery, and indeed the makers quoted 60mA/10 = 6mA over 14 hours, which is a typical recharge level.

An ordinary 9V (8·4V actual) Ni-Cad is rated at 110-150mAh say, so we can assume a charge current of roughly 15mA maximum over 14 hours. I checked my Ever Ready two hour charger and this did indeed quote a current of 11mA for RX22 (PP3-style) 9V batteries. It also had an output voltage of nearly 17V, no load(!), which will drop when a battery is fitted.

On that basis, a series limiting resistor would be needed to drop 8·4 minus 3·6 = 4·8V with a charge current of 6mA: say 820 ohms, fitted in series with the charger's 9V output. Use a battery snap connector and do observe polarity, to ensure that your battery is placed across the source as "positive to positive". Check with a voltmeter. You will also need to remember to unhook it after the relevant time period.

Internet users can fetch some interesting documents from our FTP site at **ftp://ftp.epemag.wimborne.co.uk/pub/docs/nicad.txt** which tells you much more about the chemistry of these rechargeable batteries. You can also check the Varta web site at **www.varta.com**.

It is interesting to see that the popularity of Ni-Cad cells appears to be on the wane. They are increasingly being supplanted by NiMH – Nickel Metal Hydride – which overcome all of the drawbacks of using Nickel-Cadmium cells. Apart from not suffering from voltage depression ("memory effect"), they can be thrown away with more of a clear conscience, as they contain none of the toxic heavy metal polluting elements of their predecessors.

You will find a whole range of batteries and chargers of various capacities in Maplin shops or in their catalogue, and I also saw them on sale in Argos stores: the Argos Cat. No. 982/5671 is a recharger with four NiMH AA cells included for £19.99, which strikes me as particularly good value.

Finally, Mr. Robinson, on the subject of Amigas: you will be delighted to hear that my own new 350MHz desktop PC, after six weeks of refusing to run properly and driving me nuts, is currently on its way back to Ireland to be fixed, and I hope it falls into the Irish Sea *en route*. You'll never hear me knocking Amigas, Acorns, Sinclairs or any of the other platforms beloved by their owners!

Teach-In Micro Lab – new EPROM

My thanks to ***Mr. Lee Elvin*** of Dundee who writes:

I recently completed the Micro Lab *from* Teach-In No. 7, *and yes it worked first time! I have thoroughly enjoyed the course and would strongly recommend it to anyone getting started in electronics, and I would advise anyone wishing to build the* Mini Lab *or* Micro Lab *to go to Magenta Electronics who sell all the components in a series of kits. The* Mini Lab *and* Micro Lab *are an excellent introduction to electronics for the beginner, and if I can help keep it going I believe many new students will have loads of fun experimenting with it!*

Now that my Micro Lab *is running, I am hoping to expand it, can you give me details of the printer port and Robot Buggy you mentioned at the end of your book? Also, if any readers have developed any useful programs or projects that they want to share then can they be put in touch? I know that the printer port details are on the Internet but I have no access to it.*

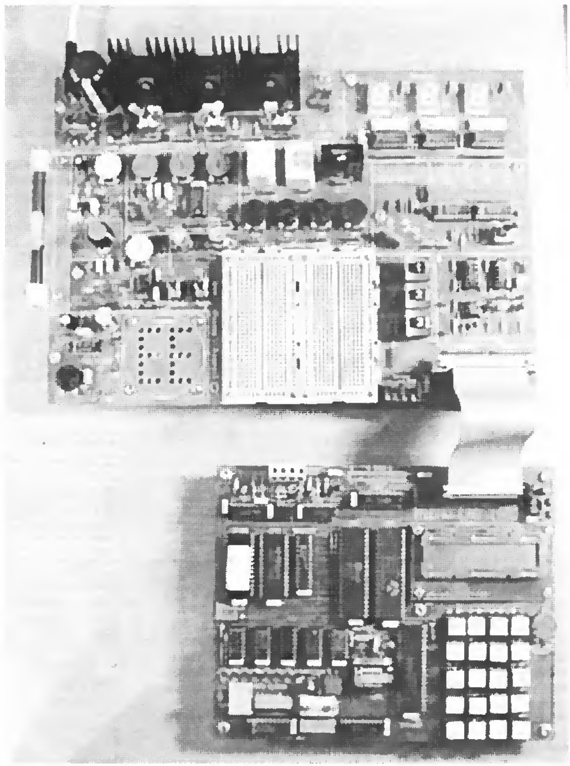
For newer readers, the Micro Lab was our microprocessor development unit published to accompany part of our highly popular series *Teach-In 93*. This series offers an all-round practical introduction to electronics, suitable for school students or hobbyists or anyone else wanting to brush up on their skills. It was subsequently re-published in book form as *Teach-In No. 7*, and is still available from the Direct Book Service (see page 760); it is also used in correspondence courses today. The *Mini Lab* contains a solderless breadboard area surrounded by some simple on-board testing and demonstration modules, all fitted on a single board about as large as this page.

The *Mini Lab* modules include a bargraph l.e.d. multi-range voltmeter, an on-board 5V, 12V and variable voltage supply, a medium-wave radio tuner, an audio amplifier, a 555 timer, a 3-digit seven segment l.e.d. display, a simple form of logic probe, plus an ensemble of switches, buzzers, relays, trimmer resistors and bulbs. Even today, the *Mini Lab* still forms a highly credible way of developing simpler circuits. The p.c.b. was designed to be foolproof to solder, and is fully solder-resist coated and silk-screen printed so you can't go wrong. As you rightly say, you can obtain a complete kit from Magenta Electronics, who tell me that the kits are still available, and will be for the foreseeable future – see their advertisement elsewhere in this issue.

The *Micro Lab* however was our ambitious attempt to produce a complete microprocessor learning aid, covering the final few chapters of the series. It's 6502-based, with a specially-written "monitor" program in 32K EPROM, plus a 32K RAM with battery backup – it's the (Varta!) battery in the logo on the *EPE* web site – to store programs during power-down. It includes an on-board keypad and l.c.d. display, and can be powered either stand-alone or from the *Mini Lab*. The *Micro Lab* monitor enables users to enter and write programs, run the built-in demos, step through and edit programs. We built ten demo programs into the chip, including a data logging demo, analogue input, voltage to frequency conversion, playing a programmable tune, sound sampling and playback.

Unfortunately it wasn't feasible to produce the extra add-ons which we suggested might be developed at the end of the series. Even though there are several hundred *Micro Lab* users, allowing for the fact that not all *Micro Lab* users would want to buy the add-ons, the final economics of developing a buggy and other possible ideas could simply not be made to add up.

However my colleague Geoff MacDonald who designed the "brains" of the *Micro Lab* does have a web site devoted to it at **http://www.pan1c.demon.co.uk/Microlab/index.html.** I'm afraid that using the Internet is virtually the only feasible way in which we can readily distribute and update information like this, but I will try to help any other readers who write in. I'm sending you a printout of the basic printer port details which Geoff managed to sort out in some spare time. There is also an updated version of the *Micro Lab* source code (V1.10) which you will need for the new printer port details. You will need to swap the EPROM for the new version and Magenta Electronics advise that they will soon be able to make this available. Contact Magenta Electronics on 01283 565435, Fax 01283 546932, E-mail **Magenta_Electronics@compuserve.com**



The Mini and Micro Labs in action.

You will need a 26-way header printer cable e.g. as used by the BBC micro, an ordinary parallel printer cable won't work. The source code of the *Micro Lab* is also freely available from the Internet for anyone able to blow it into the EPROM.

The *Micro Lab* is a uniquely powerful, fully documented learning aid and we're more than happy to try to ensure it hangs on in there. The best thing to do is check Geoff's Internet web site (e.g. try your local library or an Internet café if you don't have access yourself) but I will try to keep readers posted with *Micro Lab* news via this column.

Everyday Practical Electronics Books

TEACH-IN No. 7 plus FREE Software
ANALOGUE AND DIGITAL ELECTRONIC COURSE
(Published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE

FREE SOFTWARE

The highly acclaimed *Teach-In* series, which included the construction and use of the *Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a FREE DISC covering the first two parts of the course is included with the book.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics then this is for you. If you are teaching electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.

152 pages **Order code TI7** **£3.95**

ELECTRONICS TEACH-IN 88/89 – INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Practical Electronics*)

A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.

80 pages (A4 size) **Order code TI-88/89** **£2.45**

DIRECT BOOK SERVICE

The books listed have been selected by Everyday Practical Electronics editorial staff as being of special interest to everyone involved in electronics and computing. Books 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 the next two issues of EPE.

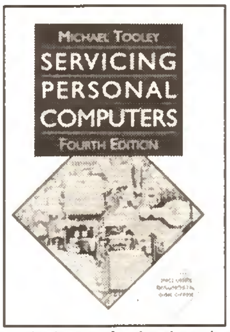
Testing and Test Gear

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**

SERVICING PERSONAL COMPUTERS – 4th EDITION
Mike Tooley BA



The revised and enlarged forth edition has been completely re-written to cover the latest technology, such as 32-bit microprocessors and serial communications servicing. It includes a diagnostic disk offer. Essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.

387 pages Hardback **Order code NE15** **£30**

Radio, TV, Satellite

BASIC RADIO PRINCIPLES AND TECHNOLOGY **NEW**
Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix – Basic Calculations.

263 pages **Order code NE30** **£14.99**

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrap to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages **Order code BP304** **£3.95**

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.

This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages **Order code BP257** **£4.99**

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold

Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to costruct, full wiring diagrams etc are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.

Contains everything you need to know in order to get started in this absorbing hobby.

88 pages **Order code BP275** **£3.95**

Computers and Computing

MULTIMEDIA ON THE PC
Ian R. Sinclair

In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.

184 pages **Order code PC112** **£11.95**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

128 pages **Order code BP282** **£4.95**

Our postage is the same no matter how many books you buy – just £1.50 in the UK.

Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

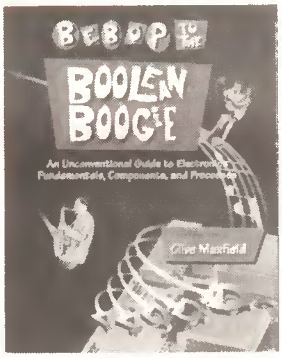
ORDER CODE BEB1

£24.95

470 pages. Large format

Specially imported by EPE – Excellent value

An Unconventional Guide to Electronics Fundamentals, Components and Processes



This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean algebra and Karnaugh maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!). Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day....

DIGITAL ELECTRONICS – A PRACTICAL APPROACH
With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)
Richard Monk

FREE SOFTWARE

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages **Order code NE28** **£16.99**

Bebop Bytes Back

FREE CD-ROM

By Clive "Max" Maxfield and Alvin Brown

ORDER CODE BEB2

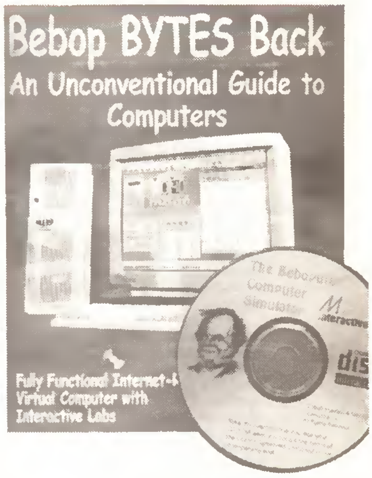
£29.95

Over 500 pages. Large format

Specially imported by EPE – Excellent value

An Unconventional Guide To Computers

Plus **FREE CD-ROM** which includes: Fully Functional Internet-Ready Virtual Computer with Interactive Labs



This follow-on to Bebop to the Boolean Boogie is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this one!

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages **Order code PC106** **£8.95**

Audio and Music

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him – or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.

148 pages **Order code BP256** **£3.99**

ACOUSTIC FEEDBACK – HOW TO AVOID IT
V. Capel

Feedback is the bane of all public address systems. While feedback cannot be completely eliminated, many things can be done to reduce it to a level at which it is no longer a problem.

Much of the trouble is often the hall itself, not the equipment, but there is a simple and practical way of greatly improving acoustics. Some microphones are prone to feedback while others are not. Certain loudspeaker systems are much better than others, and the way the units are positioned can produce a reduced 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 **Temporarily out of print**

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** **£4.99**

COMPUTERS AND MUSIC – AN INTRODUCTION
R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully

174 pages **Order code PC107** **£8.95**

ELECTRONIC PROJECTS FOR GUITAR
R. A. Penfold

This book contains a collection of guitar effects and some general purpose effects units, many of which are suitable for beginners to project building. An introductory chapter gives guidance on construction.

Each project has an introduction, an explanation of how it works, a circuit diagram, complete instructions on stripboard layout and assembly, as well as notes on setting up and using the units. Contents include: Guitar tuner; Guitar preamplifier; Guitar headphone amplifier; Soft distortion unit; Compressor; Envelope waa waa; Phaser; Dual tracking effects unit; Noise gate/expander; Treble booster; Dynamic treble booster; Envelope modifier; Tremelo unit; DI box.

110 pages **Temporarily out of print**

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold

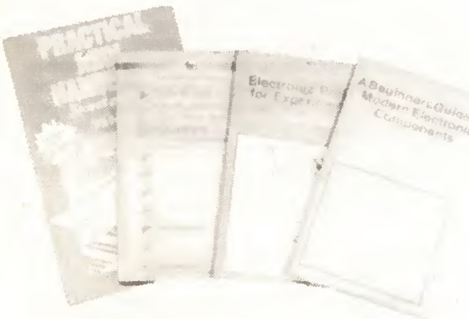
Practical construction details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. includes MOSFET and bipolar transistor designs.

96 pages **Order code BP277** **£3.99**

Circuits, Data and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop
This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.
The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.
Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.
88 pages **Order code BP299** **£4.99**

ELECTRONIC HOBBYISTS DATA BOOK
R. A. Penfold
This book should tell you everything you are ever likely to want to know about hobby electronics, but did not know where to ask or refer. Comprehensive contents pages makes it easy to quickly locate the data you require.
The subjects covered include: Common circuits, and related data (including helpful graphs and tables of values); Colour codes for resistors, capacitors and inductors; Pinout details for a wide range of CMOS and TTL devices, plus basic data on the various logic families; Pinout details and basic data for a wide range of operational amplifiers; Data and leadout information for a wide range of transistors, FETs, power FETs, triacs, thyristors, diodes, etc; General data including MIDI message coding, radio data, ASCII/Baudot coding, decibel ratios, etc.
242 pages **Order code BP396** **£5.95**



50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.
64 pages **Order code BP42** **£2.99**

BOOK 2 50 more l.e.d. circuits.
50 pages **Order code BP87** **£2.99**

CIRCUIT SOURCE BOOK 1
A. Penfold
Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.
The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.
Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
182 pages **Order code BP321** **£4.99**

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold
This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".
142 pages **Order code BP332** **£4.95**

HOW TO USE OP.AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.
160 pages **Order code BP88** **£3.99**

CIRCUIT SOURCE BOOK 2
R. A. Penfold
This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.
The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.
The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.
Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
192 pages **Order code BP322** **£4.99**

Project Building

ANDROIDS, ROBOTS AND ANIMATRONS
John Lovine
Build your own working robot or android using both off-the-shelf and workshop constructed materials and devices. Computer control gives these robots and androids two types of artificial intelligence (an expert system and a neural network). A lifelike android hand can be built and programmed to function doing repetitive tasks. A fully animated robot or android can also be built and programmed to perform a wide variety of functions.
The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.
224 pages **Order code MGH1** **£19.99**

ELECTRONIC PROJECTS FOR EXPERIMENTERS
R. A. Penfold
Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different. No doubt many of the projects featured here have practical applications, but they are all worth a try for their interest value alone.
The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.
138 pages **Order code BP371** **£4.95**

PRACTICAL FIBRE-OPTIC PROJECTS
R. A. Penfold
While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.
The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.
All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.
132 pages **Order code BP374** **£4.95**

ELECTRONIC PROJECT BUILDING FOR BEGINNERS
R. A. Penfold
This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:
Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.
In fact everything you need to know in order to get started in this absorbing and creative hobby.
135 pages **Order code BP392** **£4.95**

A BEGINNER'S GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold
The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.
166 pages **Order code BP285** **£4.99**

BOOK ORDERING DETAILS

Our postage price is the same no matter how many books you order, just add **£1.50** to your *total* order for postage and packing (overseas readers **add £3** for countries in the EEC, or **add £6** for all countries outside the EEC, surface mail postage) and send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or credit card details, Visa or Mastercard – minimum credit card order is £5 – to: **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET BH21 1RW** *(mail order only).*
Books are normally sent within seven days of receipt of order, but please allow 28 days for delivery (more for overseas orders). *Please check price and availability (see latest issue of* Everyday Practical Electronics) *before ordering from old lists.*
For a further selection of books see the next two issues of EPE.

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD. Tel 01202 881749 Fax 01202 841692. Due to the cost we cannot reply to overseas orders or queries by Fax. E-mail:dbs@epemag.wimborne.co.uk

BOOK ORDER FORM

Full name: ....

Address: ....

....

.... Post code: .... Telephone No: ....

Signature: ....

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD for £ ....

☐ Please charge my Visa/Mastercard £ .... Card expiry date ....

Card Number ....

Please send book order codes: ....

....

Please continue on separate sheet of paper if necessary

2a

EVERYDAY PRACTICAL ELECTRONICS BACK ISSUES

We can supply back issues of *EPE* by post, most issues from the past five years are available. An index for the last five years is also available – see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price.

DID YOU MISS THESE?

MAY '97

PROJECTS ● 2 Metre F.M. Receiver ● EPE PIC-A-Tuner ● Alarm Operated Car Window Winder ● Quasi-Bell Door Alert ● PIC-Agoras – 2.
FEATURES ● Ingenuity Unlimited ● Circuit Surgery ● Techniques – Actually Doing It ● Great Experimenters – 1 ● Type 7660 Voltage Converters ● Net Work.

JUNE '97

PROJECTS ● PIC Digilogue Clock ● Child Minder Protection Zone ● Pyrotechnic Controller ● Narrow Range Thermometer.
FEATURES ● Great Experimenters – 2 ● Circuit Surgery ● Interface ● Reactobot and Virtual Reality ● Ingenuity Unlimited ● Net Work.

JULY '97

PROJECTS ● Micro PEsT Scarer ● Karaoke Echo Unit ● Infra-Red Remote Repeater ● Computer Dual User Interface ● Micropower PIR Detector – 1.
FEATURES ● Ingenuity Unlimited ●Techniques – Actually Doing It ● Circuit Surgery ● Great Experimenters – 3 ● Electronics Workbench V5.0 Review ● Net Work.

AUG. '97

PROJECTS ● Variable Bench Power Supply ● PIC-olo Music Maker ● Universal Input Amplifier ● Micropower PIR Detector – 2.
FEATURES ● Interface ● Ingenuity Unlimited ● Colossus Recreated ● Circuit Surgery ● Great Experimenters – 4 ● Net Work.

SEPT '97

PROJECTS ● PIC-Noughts & Crosses Game ● Ironing Safety Device ● Active Receiving Antenna ● Soldering Iron Controller ● Micropower PIR Detector – 3.
FEATURES ● Ingenuity Unlimited ● Raising the Pressure – RC4190 Switch-Mode I.C. ● Circuit Surgery ● Techniques – Actually Doing It ● Great Experimenters – 5 ● Net Work.

OCT '97

PROJECTS ●PIC Water Descaler ● Remote Control Finder ● Multi-Station Quiz Monitor ● Rechargeable Handlamp.
FEATURES ● Ingenuity Unlimited ● It's Probably Murphy's Law ● Interface ● Circuit Surgery ● Kanda PIC Explorer Review ● Network

NOV '97

PROJECTS ● Portable 12V PSU/Charger ● Case Alarm ● Auto-Dim Bedlight ● *EPE* Time Machine.
FEATURES ● Satellite Celebration ● Ingenuity Unlimited ● TEACH-IN '98 – An Introduction to Digital Electronics–1 ● Techniques – Actually Doing It ● Circuit Surgery ● Net Work ● Free Greenweld Catalogue.

DEC '97

PROJECTS ● Safe and Sound – Security Bleeper ● Active Microphone ● Car Immobiliser ● Mini Organ.
FEATURES ● TEACH-IN '98 – An Introduction to Digital Electronics–2 ● Circuit Surgery ● Interface ● B² Spice Review ● Ingenuity Unlimited ● Alternative and Future Technologies–1 ● Net Work – The Internet ● *Free* Giant Data Chart – Formulae.

JAN '98

PROJECTS ● Disco Lights Flasher ● Simple M.W. Radio ● EPE Virtual Scope–1 ● Surface Thermometer.
FEATURES ● TEACH-IN '98 – An Introduction to Digital Electronics–3 ● Circuit Surgery ● Ingenuity Unlimited ● Alternative and Future Technologies–2 ● Net Work – The Internet ● *Free* – Giant PIC Data Chart.

FEB '98

PROJECTS ● Water Wizard ● Kissometer ● Waa-Waa Effects Pedal ● EPE Virtual Scope – 2.
FEATURES ● TEACH-IN '98 – 4 ● Ingenuity Unlimited ● Techniques–Actually Doing It ● Circuit Surgery ● Net Work – The Internet ● Chip Special – HT7630 PIR Controller.

MAR '98

PROJECTS ● Lighting-Up Reminder ● The Handy Thing ● Switch-Activated Burglar Alarm ● Audio System Remote Controller.
FEATURES ● TEACH-IN '98 – 5 ● Ingenuity Unlimited ● Interface ● Stripboard Magic Review ● Circuit Surgery ● Net Work ● *EPE* PIC Tutorial Supplement 1

APRIL '98

PROJECTS ● Simple Metal Detector ● Single or Dual Tracking Power Supply ● Experimental Piezo-Cable Projects – Distributed Microphone – Vibration Alarm ● RC-Meter.
FEATURES ● Ingenuity Unlimited ● Patent Your Invention ● TEACH-IN '98 – 6 ● Circuit Surgery ● Net Work ● Techniques – Actually Doing It ● *EPE* PIC Tutorial Supplement 2

MAY '98

PROJECTS ● Dice Lott ● Security Auto-Light ● Stereo Tone Control plus 20W Stereo Amplifier ● Improved Infra-Red Remote Repeater.
FEATURES ● TEACH-IN '98 – 7 ● Net Work ● *EPE* PIC Tutorial Supplement 3

JUNE '98

PROJECTS ● EPE Mood Changer ● Simple SW Receiver ● Atmel AT89C2051/1051 Programmer ● Reaction Timer.
FEATURES ● 8051-based EEPROM Microcontrollers ● TEACH-IN '98 – An Introduction to Digital Electronics – 8 ● Circuit Surgery ● Techniques – Actually Doing It ● Ingenuity Unlimited

JULY '98

PROJECTS ● PIC16x84 Toolkit ● Noise Cancelling Unit ● Low Battery Indicator ● Greenhouse Computer – 1.
FEATURES ● Using the L200CV Voltage Regulator ● TEACH-IN '98 – 9 ● Ingenuity Unlimited ● Circuit Surgery ● Net Work.

AUG '98

PROJECTS ● Lightbulb Saver ● Float Charger ● PC Transistor Tester ● Greenhouse Computer – 2 ● Time Machine Update.
FEATURES ● TEACH-IN '98 – 10 ● Circuit Surgery ● Techniques – Actually Doing It ● Ingenuity Unlimited ● New Technology Update ● Net Work ● IVEX PCB Cad Review.

SEPT '98

PROJECTS ● Mains Socket Tester ● Personal Stereo Amplifier ● Greenhouse Radio Link ● PIC Altimeter.
FEATURES ● TEACH-IN '98 – 11 ● Ingenuity Unlimited ● Circuit Surgery ● Interface ● Net Work ● Crocodile Clips Review.

BACK ISSUES ONLY £2.75 each inc. UK p&p.
Overseas prices £3.35 each surface mail, £4.35 each airmail.

We can also supply issues from earlier years: 1990 **(except** Jan., March, April, Oct. and Dec.), 1991 **(except** May, June, Aug., Sept. and Nov.), 1992 **(except** April and Dec.), 1993 **(except** Jan. to May and Dec.), 1994 **(except** April, May, June and Nov.), 1995 **(except** Jan., March, May, June, July, Aug., Sept., Nov. and Dec.), 1996 **(except** Feb., April, July, Aug., Nov.), 1997.
Please note we are not able to supply copies (or 'stats of articles) of *Practical Electronics* prior to the merger of the two magazines in November 1992.
Where we do not have an issue a photostat of any *one article* or *one part* of a series can be provided at the same price.

ORDER FORM – BACK ISSUES – PHOTOSTATS – INDEXES

☐ Send back issues dated ....

☐ Send photostats of (article title and issue date) ....

☐ Send copies of last five years indexes (£2.75 for five inc. p&p – Overseas £3.35 surface, £4.35 airmail)

Name ....

Address ....

....

☐ I enclose cheque/P.O./bank draft to the value of £..............................

☐ Please charge my Visa/Mastercard £..............................

Card No. .... Card Expiry Date ....

Note: Minimum order for credit cards £5. Please supply name and address of cardholder if different from that shown above.
SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**
Tel: 01202 881749. Fax: 01202 841692. (Due to the cost we cannot reply to overseas queries or orders by Fax.)
E-mail:orders@epemag.wimborne.co.uk
Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.
Send a copy of this form, or order by letter if you do not wish to cut your issue. M10/98

PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Practical Electronics,* Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749; Fax 01202 841692 (NOTE, we cannot reply to orders or queries by Fax); E-mail: orders@epemag.wimborne.co.uk .** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

PROJECT TITLE	Order Code	Cost
Ultra-Fast Frequency Generator **JULY'96**		
and Counter – Oscillator/L.C.D. Driver	994/995 (pr)	£12.72
Timed NiCad Charger	100	£6.99
Single-Station Radio 4 Tuner	101	£7.02
Twin-Beam Infra-Red Alarm –Transmitter/Receiver	102/103 (pr)	£10.50
*Games Compendium	104	£6.09
Mono "Cordless" Headphones **AUG'96**		
– Transmitter/Receiver	990/991 (pr)	£10.16
Component Analyser (double-sided p.t.h.)	105	£12.18
Garden Mole-Ester	106	£6.07
Mobile Miser	107	£6.36
Bike Speedo	108	£6.61
*PIC-Tock Pendulum Clock **SEPT'96**	109	£6.31
Power Check	110	£6.42
Analogue Delay/Flanger	111	£7.95
Draught Detector	112	£6.22
Simple Exposure Timer	113	£6.63
Video Fade-to-White **OCT'96**	114	£6.98
Direct Conversion 80m Receiver	116	£7.52
Vehicle Alert	117	£6.55
10MHz Function Generator– Main Board	118	£7.33
– PSU	119	£5.39
Tuneable Scratch Filter **NOV'96**	115	£7.83
*Central Heating Controller	120	£7.85
D.C. to D.C. Converters – Negative Supply Generator	122	£5.96
– Step-Down Regulator	123	£6.01
– Step-Up Regulator	124	£6.12
EPE Elysian Theremin **DEC'96**		
(double-sided p.t.h.)	121	£22.00
*PIC Digital/Analogue Tachometer	127	£7.23
Stereo Cassette Recorder		
Playback/PSU	128	£7.94
Record/Erase	129	£9.04
*Earth Resistivity Meter **JAN'97**		
Current Gen. – Amp/Rect.	131/132 (pr)	£12.70
Theremin MIDI/CV Interface (double-sided p.t.h.)	130 (set)	£40.00
Mains Failure Warning	126	£6.77
Pacific Waves **FEB'97**	136	£9.00
PsiCom Experimental Controller	137	£6.78
Oil Check Reminder **MAR'97**	125	£7.16
Video Negative Viewer	135	£6.75
Tri-Colour NiCad Checker	138	£6.45
Dual-Output TENS Unit (plus Free TENS info.)	139	£7.20
*PIC-Agoras – Wheelie Meter **APRIL'97**	141	£6.90
418MHz Remote Control – Transmitter	142	£5.36
– Receiver	143	£6.04
Puppy Puddle Probe	145	£6.10
MIDI Matrix – PSU	147	£5.42
– Interface	148	£5.91
Quasi-Bell Door Alert **MAY'97**	133	£6.59
2M F.M. Receiver	144	£7.69
*PIC-A-Tuner	149	£7.83
Window Closer – Trigger	150	£4.91
– Closer	151	£4.47
Child Minder Protection Zone **JUN'97**		
– Transmitter	153	£6.58
– Receiver	154	£6.42
Pyrotechnic Controller	155	£6.93
*PIC Digilogue Clock	156	£7.39
Narrow Range Thermometer	158	£6.37
Micropower PIR Detector – 1 **JULY'97**	152	£6.69
Infra-Red Remote Control Repeater		
(Multi-project P.C.B.)	932	£3.00
Karaoke Echo Unit – Echo Board	159	£6.40
– Mixer Board	160	£6.75
Computer Dual User Interface	161	£6.70
*PEsT Scarer	162	£6.60
Variable Bench Power Supply **AUG'97**	932	£3.00
Universal Input Amplifier	146	£6.55
Micropower PIR Detector – 2 Controller	163	£6.72
*PIC-OLO	164	£7.02
Active Receiving Antenna **SEPT'97**	140	£6.59
Soldering Iron Controller	157	£6.63
*PIC Noughts & Crosses Game	165	£7.82
Micropower PIR Detector – 3		
Alarm Disarm/Reset Switch	166	£5.72
Ironing Safety Device	167	£5.12
Remote Control Finder **OCT'97**	168	£6.32
Rechargeable Handlamp	169	£6.23
*PIC Water Descaler	170	£6.90

PROJECT TITLE	Order Code	Cost
*EPE Time Machine **NOV'97**	171	£8.34
Auto-Dim Bedlight	172	£6.63
Portable 12V PSU/Charger	173	£6.61
Car Immobiliser **DEC'97**	175	£7.00
Safe and Sound (Security Bleeper)	179	£7.32
Surface Thermometer **JAN'98**	174	£7.64
Disco Lights Flasher	178	£8.30
Waa-Waa Pedal (Multi-project PCB) **FEB'98**	932	£3.00
*Virtual Scope – Digital Board	176	£14.49
Analogue Board (per board)	177	£7.34
*Water Wizard	180	£7.69
Kissometer	181	£7.67
** EPE PIC Tutorial **MAR'98**	182	£7.99
The Handy Thing (Double-Sided)	183	£6.58
Lighting-Up Reminder	184	£5.90
*Audio System Remote Controller – PSU	185	£7.05
Main Board	186	£8.29
Simple Metal Detector **APR'98**		
(Multi-project PCB)	932	£3.00
Single or Dual-Tracking Power Supply	187	£7.90
*RC-Meter	188	£7.66
Security Auto-Light **MAY'98**	189	£8.10
Stereo Tone Control plus 20W Stereo Amplifier		
Tone Control	190	£7.78
20W Amplifier	191	£8.58
*Dice Lott	192	£8.05
EPE Mood Changer **JUNE'98**	193	£7.75
*AT89C2051/1051 Programmer		
Main Board	194	£8.50
Test Board	195	£8.69
*Reaction Timer **Software only**	–	–
*PIC16x84 Toolkit **JULY'98**	196	£6.96
*Greenhouse Computer		
Control Board	197	£9.08
PSU Board	198	£8.10
Float Charger **AUG'98**	199	£6.59
Lightbulb Saver	202	£3.00
Personal Stereo Amplifier **SEPT'98**	932	£3.00
(Multi-project PCB)		
*Greenhouse Radio Link	200	£8.32
*PIC Altimeter	201	£8.15
Voice Processor **OCT'98**	203	£7.18
*Digiserv R/C Expander	204	£7.69
IR Remote Control		
Transmitter	205	£3.00
Receiver	206	£3.50

EPE SOFTWARE

Software programs for *EPE* projects are available on 3.5 inch PC-compatible disks or via our Internet site. Those marked with a single asterisk * are all on one disk, order code PIC-DISK1, this disk also contains the *Simple PIC16C84 Programmer* (Feb '96). The *EPE PIC Tutorial* (**) files are on their own disk, order code PIC-TUTOR. The disks are obtainable from the *EPE PCB Service* at £2.75 each (UK) to cover our admin costs (the software itself is *free*). Overseas (each): £3.35 surface mail, £4.35 airmail. All files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code   Project   Quantity   Price

....

Name..

Address..

....

I enclose payment of £..............................(cheque/PO in **£ sterling only**) to:

Everyday Practical Electronics

Access (MasterCard) or Visa No.
Minimum order for credit cards £5

EUROCARD

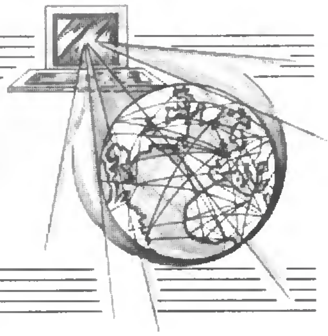
Signature..Card Exp. Date..........................

Please supply name and address of cardholder if different from the address shown

NOTE: You can order p.c.b.s via our Internet site on a *secure* server:
http://www.epemag.wimborne.co.uk

SURFING THE INTERNET

NET WORK



ALAN WINSTANLEY

NET WORK is our monthly column specially written for users of the Internet. This month we bring you up-to-date with one or two developments and continue with more queries related to our web and FTP sites which have been posed by readers, and which could possibly be classed as "Frequently Asked Questions".

First, though, this month's FTP additions – *Digiserv R/C Channel Expander* is at sub-directory **pub/PICS/Digiserv** and *PC Capacitance Meter* is at **pub/PCcapmeter**.

Now for news of the *EPE Chat Zone*, which is intended as an Internet forum where readers can chat to each other using a system of posting messages and then following up. The Zone is now undergoing testing and the Acceptable Use Policy (AUP) is being drafted. We want readers to enjoy using this new service and all those who participate will initially see the AUP page, before moving to the chat area, where they can read a list of current topics and follow-ups. Who knows?

New Addresses

Last month, we opened a number of new E-mail addresses to route your enquiry through to the correct Department:

* Editorial Department – for reader feedback, general correspondence with the magazine, article "copy" etc., please write to: **editorial@epemag.wimborne.co.uk**

* Technical Department – technical queries related to our constructional articles only: **techdept@epemag.wimborne.co.uk**. This Department cannot diagnose any other forms of technical problems or respond to general electronics-related queries. If you do need to contact us, please be concise and include all relevant information, test readings, symptoms etc. to help us isolate the problem with your *EPE* project.

* Subscription queries should be sent to the Subscriptions Dept. at **subs@epemag.wimborne.co.uk**. You can also subscribe or renew via our secure server.

* Orders Department – **orders@epemag.wimborne.co.uk**. Queries related to p.c.b.s, Back Issues, reprints, etc.

* Advertisements – Advert "copy", general enquiries and queries can be E-mailed to the Advertisement Dept. at **adverts@epemag.wimborne.co.uk**.

* Direct Book Service – for book orders or order-related questions, please contact the Direct Book Service at **dbs@epemag.wimborne.co.uk**, a division of Wimborne Publishing Ltd. An on-line order form is being prepared for the future so that you can order book titles via the Internet.

Web Site Form

Regular readers will know that we included a special fill-in form on the web site for anyone interested in attending a *Teach-In* meeting at the University of Hull. In mid August, after collating the replies we posted a note on the home page advising that, unfortunately, the meeting would not be going ahead. There were dozens of replies, but interestingly the majority of these were from readers as far away as China, Pakistan and Australia, and it was very clear that these respondents could hardly be expected to turn up for a day out somewhere in Hull!

It does prove the fact – well known amongst web site designers – that nothing involves a user more than giving them something to participate in, especially a fill-in form. This attracts people to your web site, which is a good thing. Even though most of the *Teach-In* respondents were obviously just "playing", they were interested enough to read through the entire page related to our *Teach-In* series and then fill in their name and address at the end.

Forms add interest and user interaction to any commercial web site and are relatively simple to construct in HTML. The biggest problem is preparing an interesting-looking form which is easy to understand and fill in; if you run a web site of your own there are a few pitfalls you should remember when utilising them. The main one is that the form action "mailto:" command for sending the results of a form to an E-mail address, does not work properly with Explorer. You really need an extra piece of machinery on your web space in the shape of a Form-mailer "script" in a *cgi-bin* (common gateway interface binaries) resource. Firms such as Demon Internet Service or our own ISP, do provide this.

More FAQs

Now for a further selection of queries posed by users of our web site, gathered over several years:

I can't access a web page at all

Ensure you typed the correct address (URL). These are case-sensitive. Also watch for "**.html**" if "**.htm**" is called for. Often, either will work but double check. Remember too that "Wimborne" has no "u" – see the correct spelling on the cover of every issue. Other possible causes include typing a hyphen instead of an underscore in a URL where needed, or accidentally inserting a space in the URL.

The web site seems to be out of date!

It is usually updated around the time a new issue is launched. The FTP site is usually updated a few days before the new issue goes on sale, with new project files etc. so that the FTP files are there as soon as the new magazine edition hits the doormat.

If your browser doesn't seem to "read" the new edition correctly, be sure your browser cache settings are correct, so that it refreshes on every visit, otherwise you will be still reading old pages from your disk cache. Hit SHIFT+Reload if necessary, to ensure that the browser refreshes its cache: this is an old "gotcha" which causes confusion even amongst experienced net users. If your browser settings seem correct, you may have no choice but to clear the cache from your hard disk as a last resort, especially if you have the same problems viewing other sites.

My Navigator window doesn't "see" your FTP files

You can access our FTP site by typing its URL (**ftp://ftp.epemag.wimborne.co.uk/pub**) into your browser window. You will then see a simple file-manager type display of our FTP site contents. The problem described seems to be characteristic in some versions of Navigator (I've seen it myself) which causes FTP site directory listings to appear and then disappear in the browser window, presenting you with no choice but to move "up to a higher directory". Try toggling the Reload button with your mouse to refresh the screen. The complete file listing will then reappear and you should be able to access the desired folder.

My browser can't access your Secure Server

Our secure server is distinguished from ordinary URLs by the **https://** at the start of the address, and browsers need to be configured properly to use Secure Sockets Layers (SSL). Try checking the "Security" setup of your browser, to see whether connections to secure servers (SSL2 and SSL3) have been disabled. If you are behind a firewall, your network may prohibit secure server connections. Check with your sysadmin and access the site from another location if necessary.

What is the E-mail address of... ?

Occasionally we are asked to provide the E-mail address of contributors. We cannot usually do this and it should not be assumed that contributors are able to provide support by E-mail in any case (although some are more than happy to help out this way). We will forward any queries received using letter post, and a reasonable time should be allowed for such correspondence to be dealt with: please don't expect an instant reply, and next-day "chasers" merely serve to clog our mailbox even further!

Finally, as always, a selection of noteworthy URLs are posted onto the *Net Work* section of the *EPE* web site every month. Let me know any favourites. My E-mail address is **alan@epemag.demon.co.uk**.

EVERYDAY PRACTICAL ELECTRONICS CLASSIFIED

Everyday Practical Electronics reaches nearly twice as many UK readers as any other independent monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading independent monthly magazine in this market for the last thirteen years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Mill Lodge, Mill Lane, Thorpe-le-Soken, Essex CO16 0ED. Phone/Fax (01255) 861161.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

Miscellaneous

PRINTED CIRCUIT BOARDS – QUICK SERVICE. Prototype and Production. Artwork raised from magazines or draft designs at low cost. PCBs also designed from schematics. Production assembly also undertaken. For details send to P. Agar, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast, BT5 4GX, or phone/fax 01232 738897.

G.C.S.E. ELECTRONIC KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 52 Severn Road, Clacton, CO15 3RB.

NEW AND USED COMPUTERS, spares, etc. at keenest prices, e.g.: 386 min 2MB RAM, 20MB HDD, desktop case, keyboard and cables, 12in. VGA mono monitor, £55. 486 DX33 min. 8MB RAM, 120MB HDD, desk top case, keyboard and cables, 14in. VGA colour monitor, £165. Many other systems available. Whatever you need, Phone/Fax 0181 853 3374 for prices.

ELECTRONICS KITS for all abilities, plus pre-assembled modules, electronic components, audio/video/computer accessories, and model railway electronics. Send two 1st class stamps for catalogue: Trax Controls, P.O. Box 419, Norwich NR1 3BZ.

VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel. 01788 574774.

HOMEBREWER OR STUDENT? Then the design assistant is for you. Electronics design plus calculations for your homebrew projects. Windows 3.1/95. Full details at http://members.aol.com/agegraphic/index.htm. Disk £5 only to A. G. Edwards, 8 Linnet Close, Bradwell, NR31 8JF.

CD-ROM massive servicing and troubleshooting "Technical Encyclopaedia 1997". Learn to repair everything electronic and electrical. Computers, monitors, printers to TV, VCR, Hi-Fi, domestic appliances and copiers. Over 200 volumes on one CD. RRP £99, bargain £20. 01633 283371.

SAMPLE 30 ASSORTED COMPONENTS!! L.E.D.s, resistors, capacitors, new and useful values and 12 interesting projects. 26p s.a.e.: K.I.A., 1 Regent Road, Ilkley, LS29.

PROTEUS ELECTRONICS DESIGN SYSTEM (level 1) for PC, PCB and schematic capture, as new, cost £350, will sell for £150. Tel. Dave Handford, 01239 613148.

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR, or phone Brighton 883871, fax 01273 706670.

EPE NET ADDRESSES

EPE FTP site: **ftp://ftp.epemag.wimborne.co.uk**

Access the FTP site by typing the above into your web browser, or by setting up an FTP session using appropriate FTP software, then go into quoted sub-directories:

PIC-project source code files: **/pub/PICS**

PIC projects each have their own folder; navigate to the correct folder and open it, then fetch all the files contained within. *Do not try to download the folder itself!*

EPE text files: **/pub/docs**
Basic Soldering Guide: **solder.txt**
EPE TENS Unit user advice: **tens.doc** and **tens.txt**
Ingenuity Unlimited submission guidance: **ing_unlt.txt**
New readers and subscribers info: **epe_info.txt**
Newsgroups or Usenet users advice: **usenet.txt**
Ni-Cad discussion: **nicadfaq.zip** and **nicad2.zip**
UK Sources FAQ: **uksource.zip**
Writing for *EPE* advice: **write4us.txt**

Ensure you set your FTP software to ASCII transfer when fetching text files, or they may be unreadable.

Note that any file which ends in **.zip** needs unzipping before use. Unzip utilities can be downloaded from : **http://www.winzip.com** or **http://www.pkware.com**

TRAIN TODAY FOR A BETTER FUTURE

Now you can get the skills and qualifications you need for career success with an ICS Home Study Course. Learn in the comfort of your own home at the pace and times that suit you. ICS is the world's largest, most experienced home study school. Over the past 100 years ICS have helped nearly 10 million people to improve their job prospects. Find out how we can help YOU. Post or phone today for **FREE INFORMATION** on the course of your

- Electrical Contracting & Installation
- Electrical Engineering
- C&G Basic Electronic Engineering
- C&G Basic Mechanical Engineering
- TV and Video Servicing
- Radio and Hi-Fi Servicing
- Refrigeration Heating & Air Conditioning
- Motorcycle Maintenance

FREEPHONE 0500 581 557

Or write to: International Correspondence Schools, FREEPOST 882, 8 Elliot Place, Clydeway Skypark, Glasgow, G3 8BR. Tel. 0500 581 557 or Tel/Fax: Ireland 01 285 2533.

Please send me my Free Information on your Electronics Courses.

Mr/Mrs/Ms/Miss (BLOCK CAPITALS PLEASE) Date of Birth / /

Address

Postcode

Occupation Tel. No.

From time to time, we permit other carefully screened organisations to write to you about products and services. If you would prefer not to hear from such organisations please tick box ☐ Dept. ZEEE040998

SERVICE MANUALS

Available for most equipment, from the earliest Valve Wireless to the latest Video Recorder, Television, Computer Monitor, Test Equipment, Satellite, all Audio, Amateur Radio, etc., etc. If you need a Service Manual give us a call or check out the full stock list now on our web site. Originals or Photostats supplied as available.

For your FREE catalogue of Technical Books and repair guides

PLUS full Floppy Disc Index of manuals available send 4 × first class stamps.

MAURITRON TECHNICAL SERVICES

8 Cherry Tree Road, Chinnor, Oxon, OX9 4QY

Tel: 01844-351694. Fax: 01844-352554.

E-mail: enquiries@mauritron.co.uk

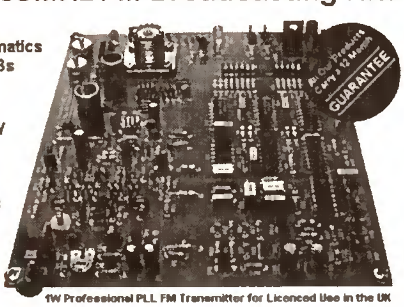
Web site at: http://www.mauritron.co.uk/mauritron/

Professional 88-108MHz FM Broadcasting Kits

All Our Kits Include
- Detailed Instructions with Schematics
- High Quality Screen Printed PCBs
- High Quality Components

Our Product Range Includes
- Transmitters from 0.05W to 220W
- FM Stereo Coders
- Audio Compressor Limiters
- Antennas RF Power Amps
- Link Transmitters and Receivers

Our Kits Are Also Available Fully Assembled And Tested



1W Professional PLL FM Transmitter for Licenced Use in the UK

MasterCard VISA

WE DELIVER WORLD-WIDE AND ACCEPT MAJOR CREDIT CARDS

Contact Us Now For A Free Brochure

Tel 01274 883434 Fax 01274 816200

email veronica@legend.co.uk

www.legend.co.uk/~veronica/

18 Victoria St, Queensbury Bradford, BD13 1AR

Veronica FM

Quad speed Toshiba 1/3rd height SCSI cd-rom drives	£20 each, 6 for £100
1 meg. 30-pin parity simms	£3.75 each, 4 for £12
4 meg. 30-pin parity simms	£13 each, 4 for £50
256k pipeline burst cache	£4.50 each
512k pipeline burst cache	£9 each
Trident 512k video cards	£12 each
Trident 1mb VLB video cards	£20 each
Internal VGA leads	£2.50 each, 10 for £20
3-device SCSI leads	£3 each
IDE leads	£2 each
Hard and floppy drive IDE controller cards	£5
14,400 internal voice/fax/data modem	£15
28,800 internal voice/fax/data modem	£28
3lb mixed component pack	£4.95
Jumbo component pack	£10
250 off mixed capacitors	£4.95
250 off i.c. sockets	£3.95
1000 off mixed ceramic caps	£7.50*
20 off mixed crystals/filters	£4.95
25 off mixed relays	£3.50
Brand new 360k 5¼" floppy drive	£4.50
5¼" to 3½" floppy drive converter leads	£1.50*
1·2MB 5¼" floppy drive	£10
12V d.c. 200 r.p.m. geared motor	£1.50 each, 10 for £12
SCSI 2 fast differential hard drives	
1 Gig	£58
2 Gig	£85
4 Gig	£145
1 Gigabyte laptop drives, 2½in. IDE	£78 each

QUANTITY DISCOUNTS AVAILABLE PLEASE RING.

We also buy all forms of electronic components, p.s.u's, disk drives etc. Lists to below address.

*ALL PRICES INCLUDE V.A.T. PLEASE ADD £2.00 p&p EXCEPT ITEMS MARKED * WHICH ARE 50P. SAE FOR BULK BUYING LIST PAYMENT WITH ORDER TO:*

Dept EE, COMPELEC, 14 Constable Road, St. Ives, Huntingdon, Cambs PE17 6EQ

Tel/Fax: 01480 300819

TECHNICAL INFORMATION SERVICES

Midlinbank Farm, Ryelands, Nr. Strathaven, ML10 6RD

Tel: 01698 883334/884585 Fax: 01698 884825

PHONE NOW FOR YOUR FREE QUOTE

We have the World's Largest Collection of

SERVICE MANUALS

Why not join Europe's fastest growing "Information Library Service"

Buy *ANY* Service Manual for £10.00 and return any manual no longer needed for a £5.00 credit

CALL/WRITE NOW FOR FURTHER DETAILS

Initial joining fee of £65 : Thereafter £20 Yearly

Join Now: Get your first Manual FREE!

NEW SPECIAL OFFERS

Amiga genlock pcb (uncased) for titling videos it has a 23pin D lead to plug into the computer and pcb pins for composite video in and out. When no video input is connected the normal computer display is shown on the composite video out when the video input is added the white areas on the screen are replaced by the video image. The pcb is powered from the computer....£19.98

WATCH SLIDES ON TV "Liesgang diatv" automatic slide viewer with built in high quality colour tv camera, composite video output with a BNC plug. In very good condition with few signs of use.... £108.00

Board cameras all with 512x582 pixels 4.4x3.3mm sensor with composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts and require 10 to 12vdc power supply.

47MIR size 60x36x27mm with 6 infra red leds (gives the same illumination as a small torch would) ....£50.00+vat=£58.7540

MP size 39x38x23mm spy camera with a fixed focus pin hole lens for hiding behind a very small hole....£57+vat=£66.98

40MC size 39x38x28mm camera for 'C' mount lens this gives a much clearer picture than with the small lenses....£68.79

Standard 'C' mount lens F1.6 16mm for 40MC ....£26.43+vat=£31.06

Waterproof camera with stylish tilt & swivel case £92.76+vat=£109.00 or 10+£89.32+vat=£104.95

DTA30 Hand held transistor analyser it tells you which lead is the base, the collector and emitter and if it is NPN or PNP or faulty. HMA20 hand held MOSFET analyser identifies gate drain and source and if P or N channel DTA30 & HMA20 ....£38.34 each

DCA50 component analyser with lcd readout identifies transistors mosfets diodes & LEDs lead connections....£69.95

Speaker cabinets 2 way speaker systems with motorola tweeters

speaker dia	15"	12"	8"
power rating	250WRMS	175WRMS	100WRMS
impedance	8ohm	8ohm	8ohm
freq. range	40hz-20khz	45hz-20khz	60hz-20khz
sensitivity(1W/1M)	97dB	94dB	92dB
size in mm	500x720x340	450x640x345	315x460x230
weight	21.1kg	16.8kg	7.4kg
price each for black			
vinyl coating	£139.95	£99.99	£54.94
grey felt coating	£159.97**	£119.97**	£64.99

(** = not normaly in stock allow 1 week for delivery)

Power amplifiers 19" rack mount with gain controls

STA150	2x160Wrms (4ohm load)	14kg	£202.11
STA300	2x190Wrms (4ohm load)	11kg	£339.00
STA900	2x490Wrms (4ohm load)	15kg	£585.00

LEDs 3mm or 5mm red or green .. 7p each yellow 11p each cable ties 1p each £5.95 per 1000 £49.50 per 10,000

Rechargable Batteries

AA(HP7) 500mAH	£0.99	AA 500mAH with solder tags	£1.55
AA 950mAH	£1.75	C(HP11) 1.2AH	£2.20
C 2AH with solder tags	£3.60	D(HP2) 1.2AH	£2.60
D 4AH with solder tags	£4.95	PP3 8.4V 110mAH	£4.95
1/2AA with solder tags	£1.55	Sub C with solder tags	£2.50
AAA (HP16) 180mAH	£1.75	1/3 AA with tags (philipsCTV)	£1.95

Nickel Metal Hydryde AA cells high capacity with no memory. If charged at 100ma and discharged at 250ma or less 1300mAH capacity (lower capacity for high discharge rates)....£2.95

Special offers please check for availability stick of 4 42x16mm nicad batteries 171mmx16mm dia with red & black leads 4.8v....£5.95

5 button cell 6V 280mAh battery with wires (Varta 5x250DK)....£2.45

Orbitel 866 battery pack 12v 1.60AH contains 10 sub C cells with solder tags (the size most commonly used in cordless screwdrivers and drills 22 diax42mm tall) it is easy to crack open and was manufactured in 1994 ....£8.77 each or 110.50 per box of 14

BCI box 190x106x50mm with slots to house a pcb the lid contains an edge connector (12 way 8mm pitch) and screw terminals to connect in wires and 5 slide in cable blanks....£2.95

7segment common anode led display 12mm....£0.45

GaAs FET low leakage current S8873 £12.95 each £9.95 10+ 7.95 100+ BC547A transistor 20 for £1.00

SL952 UHF Limiting amplifier LC 16 surface mounting package with data sheet....£1.95

DC-DC convertor Reliability model V12P5 12v in 5v 200ma out 300v input to output Isolation with data....£4.95 each or pack of 10 £39.50

Airpax A82903-C large stepping motor 14v 7.5' step 27ohm 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 250vdc 18p each 14p 100+ 9p 1000+ 1uf 250Vdc 20p each,15p 100+,10p 1000+

Polypropylene 1uf 400vdc (Wima MKP10) 27.5mm pitch 32x29x17mm case 75p each 60p 100+

Philips 123 series solid aluminium axial leads 33uf 10v & 2.2uf 40v 40p each, 25p 100+

Solid carbon resistors very low inductance ideal for RF 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.

MX180 Digital multimeter 17 ranges 1000vdc 750vac 2Mohm 200mA transistor Hfe 9v and 1.5v battery test....£9.95

Hand held ultrasonic remote control....£3.95

CV2486 gas relay 30x10mm dia with 3 wire terminals will also work as a neon light ....20p each or £8.50 per 100

Varbatim R300NH Streamer tape commonly used on nc machines and printing presses etc. it looks like a normal cassette with a slot cut out of the top ...£4.95 each (£3.75 100+)

Heatsink compound tube....£0.95

HV3-2405-E5 5-24v 50mA regulator ic 18-264vac input 8 pin DIL package....£3.49 each (100+ 2.25)

All products advertised are new and unused unless otherwise stated. Wide range of CMOS TTL 74HC 74F Linear Transistors kits, rechargable batteries, capacitors, tools etc always in stock.

Please add £1.95 towards P&P (orders from the Scottish Highlands, Northern Ireland Isle of Man, Isle of Wight and overseas may be subject to higher P&P for heavy items).VAT included in all prices.

JPG ELECTRONICS

276-278 Chatsworth Road
Chesterfield S40 2BH
Access Visa Orders:
Tel: (01246) 211202 Fax: (01246)550959
Callers welcome 9.30am to 5.30pm Monday to Saturday

FML ELECTRONICS

SPECIAL £1 PACKS ★ AUTUMN SALE ★ SPECIAL £1 PACKS

10	555 TIMERS – EQUIV. 10p EACH!
4	7555 CMOS TIMERS – EQUIV. 25p EACH!
6	741 Operational Amplifiers
1	CA3090AQ RCA STEREO DECODER – QIL
3	LF351 Operational Amplifiers
2	LM386N Low Voltage Amplifiers
3	LM748CN Quad 741 op.amps
20	Assorted 7400 series TTL – EQUIV. 5p A CHIP!
6	Assorted Voltage Regulators – LESS THAN 17p EACH!
6	Assorted Thyristors/Triacs – LESS THAN 17p EACH!
35	BC212L Transistors – LESS THAN 3p EACH!
30	BC212LB Transistors
20	BC213LB Transistors – EQUIV. 5p EACH!
10	BC309B Transistors – EQUIV. 10p EACH!
15	BC558C Transistors
15	BC559B Transistors
6	BCY70 Transistors
4	BD131 Transistors – EQUIV. 25p EACH!
2	BD243C Transistors – EQUIV. 50p EACH!
2	BF185 Transistors – EQUIV. 50P EACH.
10	BF197 Transistors – EQUIV. 10p EACH!
3	BFX29 Transistors
4	BFY52 Transistors – EQUIV. 25p EACH!
1	BU206 Power Transistor – ONLY £1!
2	TIP3055 Transistors – EQUIV. 50p EACH!
6	2N2369 Transistors
15	2N3702 Transistors
25	2N3904 Transistors – EQUIV. 4p EACH!
20	2N3906 Transistors – EQUIV. 5p EACH!
50	Assorted SIGNAL/RECTIFIER DIODES
15	18-pin DIL Sockets – LESS THAN 7p!
35	5mm L.E.D.s, specify RED or YELLOW
50	1µF 63V Axial Electrolytics
40	1µF 100V Axial Electrolytics
30	1µF 250V Axial Electrolytics
50	3·3µF 63V Axial Electrolytics
40	10µF 25V Axial Electrolytics
30	33µF 63V Axial Electrolytics
50	47µF 25V Axial Electrolytics
50	150µF 16V Axial Electrolytics
25	470µF 10V Axial Electrolytics
30	680µF 16VAxial Electrolytics
10	1000µF 15V Axial Electrolytics
10	2200µF 10V Axial Electrolytics
7	3300µF 10V Axial Electrolytics
2	2000µF + 2000µF 50V Can Electrolytics
20	0·1µF 250V Polyester Capacitors
350	Assorted RESISTORS – SPECIAL PRICE!
10	10k LINEAR POTENTIOMETERS – short shaft
10	Assorted SWITCHES – EQUIV. 10p EACH!

BUY NOW – All items subject to availability
See previous/next EPE for more FML BARGAINS
Inland UK P&P only £1 per order, No VAT.
Please send large S.A.E. for FREE Lists.
Accounts available for Govt. Depts., Schools etc.
Cheques or POs with order please to:

FML ELECTRONICS, FREEPOST NEA3627, BEDALE, NORTH YORKSHIRE, DL8 2BR.

ADVERTISERS INDEX

ADVERTISEMENT MANAGER: PETER J. MEW
ADVERTISEMENT OFFICES:
EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS,
MILL LODGE, MILL LANE, THORPE-LE-SOKEN,
ESSEX CO16 0ED.
Phone/Fax: (01255) 861161

For Editorial address and phone numbers see page 703.

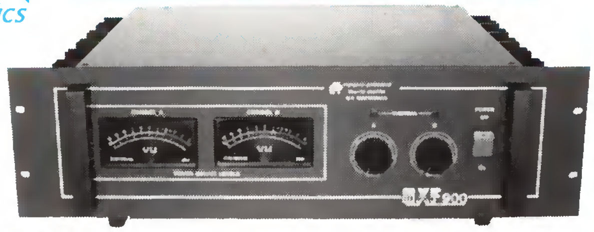
Published on approximately the first Friday of each month by Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Printed in England by Wiltshire (Bristol) Printers Ltd., Bristol, BS20 9XP. Distributed by Seymour, 86 Newman St., London W1P 3LD. Subscriptions INLAND £26.50 and OVERSEAS £32.50 standard air service (£50 express airmail) payable to "Everyday Practical Electronics", Subs Dept, Allen House, East Borough, Wimborne, Dorset BH21 1PF. **E-mail:** subs@epemag.wimborne.co.uk. EVERYDAY PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

BK ELECTRONICS

POWER AMPLIFIER MODULES-LOUDSPEAKERS-MIXERS 19 INCH STEREO AMPLIFIERS-ACTIVE CROSS/OVERS.

★PRICES INCLUDE V.A.T.★PROMPT DELIVERIES
★LARGE [A4] S.A.E. 60p STAMPED FOR CATALOGUE

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK



1000's SOLD TO PRO USERS

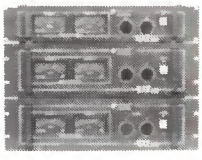
THE RENOWED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS ARE R.M.S. INTO 4 OHMS, WITH BOTH CHANNELS DRIVEN

FEATURES: ★ Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu Meters ★ Level controls ★ Illuminated on/off switch ★ Jack/XLR inputs ★ Speakon outputs ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free 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"	D11"	H3½" (2U)
MXF400	W19"	D12"	H5¼" (3U)
MXF600	W19"	D13"	H5¼" (3U)
MXF900	W19"	D14½"	H5¼" (3U)

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL. £12.50 EACH

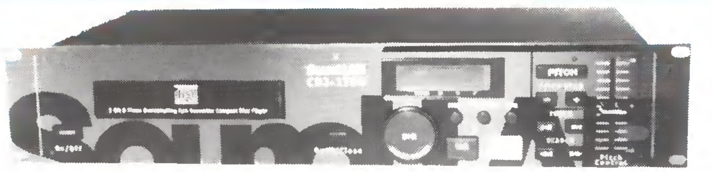
OMP XO3-S STEREO 3-WAY ACTIVE CROSS-OVER | SWITCHABLE 2-WAY

BASS / MID / TOP — CONFIGURED 3 WAY
BASS/MID / TOP — 2 WAY BASS/MID COMBINED
BASS / MID/TOP — 2 WAY MID/TOP COMBINED

FEATURES:
Advanced 3-Way Stereo Active Cross-Over (switchable two way), housed in a 19" x 1U case. Each channel has three level controls: Bass, Mid & Top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5Hz, all at 24dB per octave. The 2/3 way selector switches are also accessed by removing the front fascia. Each stereo channel can be configured separately. Bass Invert Switches are incorporated on each channel. Nominal 775mV input/output. Fully compatible with OMP Rack Amplifier and Modules.

PRICE:- £117.44 + £5.00 P&P

SOUNDLAB CDJ1700 CD PLAYER | VARIABLE SPEED

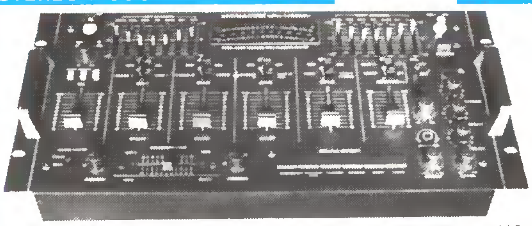


The new CDJ1700 now offers a tough build quality boasting an all new shockproof transport mechanism, frame accurate cueing and wide range pitch control. The CDJ1700 looks after the CD's while the operator looks after the sound.

FEATURES:
★19"X2U RACK MOUNTING ★FULLY VARIABLE PITCH CONTROL PLUS/MINUS 16% ★PITCH BLEND ★3 BEAM LASER PICKUP ★1 BIT 8 X OVERSAMPLING DAC ★CUE AND LOOP FACILITY ★TRACK SKIP WITH FF/REV ★DIGITAL AND ANALOGUE OUTPUTS ★CONTINUOUS/SINGLE TRACK PLAY ★CLEAR BACKLIT MULTIFUNCTION DISPLAY ★10 TRACK PROGRAM PLAY ★TRACK ELAPSED, TRACK REMAINING AND DISC REMAINING TIME DISPLAYS.

SPECIFICATION:- Freq response...20Hz-20KHz S/N ratio...>80dB THD...<0.09%(1KHz) Channel separation...>80dB(1KHz) Max output voltage...2Vrms Power...220-240Vac 50-60Hz Size...W 482 H 88 D 250mm Weight...4.18Kg **PRICE:-£225.00 + £5.00 P&P**

STEREO DISCO MIXER MPX-7700 | ECHO & SOUND EFFECTS

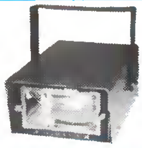


- ★ 4 STEREO INPUT CHANNELS
- ★ 2 DJ MIC INPUT CHANNELS
- ★ 2X7 BAND GRAPHIC EQUALISERS
- ★ HEADPHONE MONITOR WITH PFL
- ★ ASSIGNABLE CROSSFADE
- ★ DIGITAL ECHO

STEREO DISCO MIXER WITH:- ★2X7 GRAPHIC EQUALISERS ★2 MONO MIC INPUTS ★DJ MIC WITH FADER, TALKOVER AND VOICE CHANGER ★4 STEREO CHANNELS WITH INDIVIDUAL FADERS AND ASSIGNABLE CROSSFADE ★CHANNELS SWITCHABLE, TURNTABLE (MAG CARTRIDGE), CD, LINE, TAPE, ETC. ★ECHO WITH BALANCE, REPEAT AND DELAY ★HEADPHONE MONITOR WITH PREFADE LISTEN ★CHOICE OF 6 SOUND EFFECTS ★STEREO MONO SWITCH ★2 X LED VU METERS ★MASTER FADER ★OUTPUT 775mV ★SIZE:- 482X240X115mm ★POWER:- 230V AC 50/60Hz. **PRICE:- £169.00 + £5.00 P&P**

SOUNDLAB MINI STROBE

★ IDEAL FOR USE IN DISCO'S / RAVES.
★ EDUCATIONAL EXPERIMENTS ETC.



A top quality mini strobe with high light intensity for its size and variable flash rate adjustment. Housed in a silver/black steel case with adjustable mounting bracket. ★ Flash Rate:- Adjustable from zero to ten flashes per second ★ Mains Powered complete with plugged lead ★ 230V AC 50/60Hz ★ Size:- 125 X 84 X 52mm **PRICE:- £19.99 + £2.20 P&P**

Access

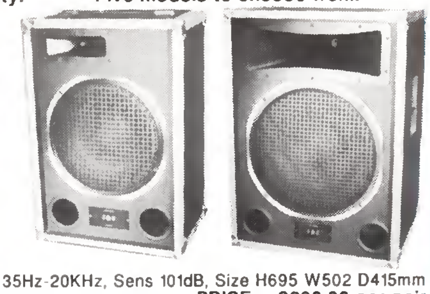
DELIVERY CHARGES:- PLEASE INCLUDE AS ABOVE,TO A MAXIMUM AMOUNT £30.00. OFFICIAL ORDERS FROM SCHOOL,COLLEGES, GOVT. BODIES,PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER.CREDIT CARD ODERS ACCEPTED BY POST PHONE OR FAX

BARCLAYCARD VISA

ibl FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest loudspeaker technology and enclosure designs. All models utilize high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon® connectors for your convenience and safety. Five models to choose from.

WEDGE MONITOR



PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET. ALL ENCLOSURES ARE 8 OHM.

15=15 inch speaker
12=12 inch speaker

ibl FC15-300 WATTS Freq Range 35Hz-20KHz, Sens 101dB, Size H695 W502 D415mm
PRICE:- £299.00 per pair

ibl FC12-300 WATTS Freq Range 45Hz-20KHz, Sens 96dB, Size H600 W405 D300mm
PRICE:- £249.00 per pair

ibl FC12-200 WATTS Freq Range 40Hz-20KHz, Sens 97dB, Size H600 W405 D300mm
PRICE:- £199.00 per pair

ibl FC12-100 WATTS Freq Range 45Hz-20KHz, Sens 100dB, Size H546 W380 D300mm
PRICE:- £179.00 per pair

ibl WM12-200 WATTS Freq Range 40Hz-20KHz, Sens 97dB, Size H418 W600 D385mm
PRICE:- £125.00 EACH

SPECIALIST CARRIER DEL:- £12.50 per pair, Wedge Monitor £7.00 each
Optional Metal Stands PRICE:- £49.00 per pair Delivery:- £6.00

ibl IN-CAR AUDIO BASS BOX 10/100 | INCREDIBLE VALUE

The new *ibl* In-Car Audio Bass Box has been designed with a sloping front to reduce internal standing waves. The bass box incorporates a 10 inch 4 ohm loudspeaker with a genuine 100 watts R.M.S. output resulting in powerful and accurate bass reproduction.
FEATURES:- ★ Cabinet manufactured from MDF and sprayed in a durable black shiny HAMMERITE finish. ★ Fitted with a 10 inch loudspeaker with rolled rubber edge and coated cone assembly ★ The top of the cabinet incorporates gold plated connection terminals. SPECIFICATION:- 100Watts R.M.S. 200 Watts Peak (Music).Ported reflex,critically tuned. Size:- H405 W455 D305mm.

PRICE:- £79.00 + £6.00P&P

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.

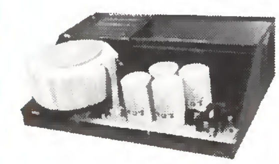
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

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. - 110dB. Size 300 x 123 x 60mm.
PRICE:- £42.85 + £4.00 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB. Size 300 x 155 x 100mm.
PRICE:- £66.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB. Size 330 x 175 x 100mm.
PRICE:- £83.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE:- £135.85 +£6.00 P&P



OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 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. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE:- £261.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC

B.K. ELECTRONICS
UNIT 1 COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR.
TEL.: 01702 527572 FAX.: 01702-420243
Web:- http://www.bkelec.com E-mail:- Sales@bkelec.com

REF 1