EVERYDAY PRACTICAL ELECTRONICS

SEPTEMBER 1996

FULLY S.O.R. £2.45

PIC-TOCK PENDULUM CLOCK
Writes the time "in the air"

POWER CHECK
"Power consumption" indicator for boats, caravans, etc.

ANALOGUE DELAY/FLANGER
Simple musical effects unit

MAX038 WAVEFORM GENERATOR
In-depth look at a new chip

SIMPLE EXPOSURE TIMER
Enlarger exposure timing or p.c.b. making

Plus INGENUITY UNLIMITED
NEW TECHNOLOGY UPDATE
CIRCUIT SURGERY FOX REPORT NET WORK - *The Internet Page*

THE NO. 1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

MOONSHINE BIBLE 270 page book covering the production of alchohol from potatoes, rice, grains etc Drawings of simple home made stills right through to commercial systems. £15 ref MS1

NEW HIGH POWER MINI BUG With a range of 800 metres or more and up to 100 hours use from a PP3 this will be popular! Bug measures less than 1" square! £28 Ref LOT102.

SINCLAIR C6 MOTORS We have a new ones available without gearboxes at £50 ref LOT25

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

PC KEYBOARDS PS2 connector, top quality suitable for all 286/386/486 etc £10 ref PCKB. 10 for £65.

TRACKING TRANSMITTER range 1.5-5 miles, 5,000 hours on AA batteries, also transmits info on car direction and motion! Works with any FM radio. 1.5" square. £65 ref LOT101

ELECTRIC DOOR LOCKS Complete lock with both Yale lock and 12v operated deadlock (keys included) £10 ref LOT99

GALLIUM ARSENIDE FISHEYE PHOTO DIODES Complete with suggested circuits for long range communications\switching £12 complete.

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

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

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

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

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

9 WATT CHIEFTAN TANK LASERS

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

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

NEW LOW PRICED COMPUTER/WORKSHOP/HI-FI RCB UNITS Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £6.99 each ref LOT5. Or a pack of 10 at £49.90 ref LOT6. If you want a box of 100 you can have one for £250!

RADIO CONTROLLED CARS FROM £6 EACH!!!!

All returns from famous manufacturer, 3 types available, single channel (left,right,forwards,backwards) £6 ref LOT1. Two channel with more features £12 ref LOT2.

THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

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

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

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

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

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

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

PLASMA SCREENS 222x310mm, no data hence £4.99 ref BAR67

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

LIQUID CRYSTAL DISPLAYS Bargain prices,
16 character 2 line, 99x24mm £2.99 ref SM1623A
20 character 2 line, 83x19mm £3.99 ref SM2020A
16 character 4 line, 62x25mm £5.99 ref SMC1640A

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

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

CENTRAL POINT PC TOOLS Award winning software, 1,300 virus checker, memory optimiser, disc optimiser, file compression, low level formatting, backup scheduler, disk defragmenter, undelete, 4 calculators, Dbase, disc editor, over 40 viewers, remote computing, password protection, encryption, comprehensive manual supplied etc £25 ref lot 97 3.5" disks.

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

GOT AN EXPENSIVE ANYTHING? You need one of our cased vibration alarms, keyswitch operated, fully cased just fit it to anything from videos to caravans, provides a years protection from 1 PP3 battery, UK made. SALE PRICE £4.99 REF SA33.

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

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

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

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

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

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

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

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

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

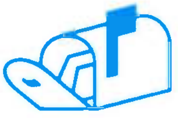
RED EYE SECURITY PROTECTOR 1,000 watt outdoor PIR switch SALE PRICE £6.99 ref EP57

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

PASTEL ACCOUNTS SOFTWARE, does everything for all sizes of businesses, Includes wordprocessor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (01342-326009 try before you buy!) Current retail price is £129, SALE PRICE £9.95 ref SA12. SAVE £120!!!

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

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



Check out our WEB SITE

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

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

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

BULL TENS UNIT Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

PC PAL VGA TO TV CONVERTER 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

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

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX . BN3 5QT. (ESTABLISHED 50 YEARS).
MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3 P&P PLUS VAT.
PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS WELCOME (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)
TEL: 01273 203500
FAX 01273 323077
E-mail bull@pavilion.co.uk

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

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

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

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

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

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

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

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

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

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

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

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

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

VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £25 REF: MAG15 12v psu is £5 extra REF: MAG5P2

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2 km in open country. Units measure 22x52x155mm. Including cases and earp'ces. 2xPP3 req'd. £30.00 pr. REF: MAG30

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

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

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

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

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. SALE PRICE £4.99 REF SA24.

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

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

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

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

HYPOTHERMIA SPACE BLANKET 215x150cm aluminised foil blanket, reflects more than 90% of body heat. Also suitable for the construction of two way mirrors! £3.99 each ref O/L041.

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

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

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

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

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

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

WE BUY SURPLUS STOCK FOR CASH

BUYERS DIRECT LINE 0802 660377

FREECATALOGUE

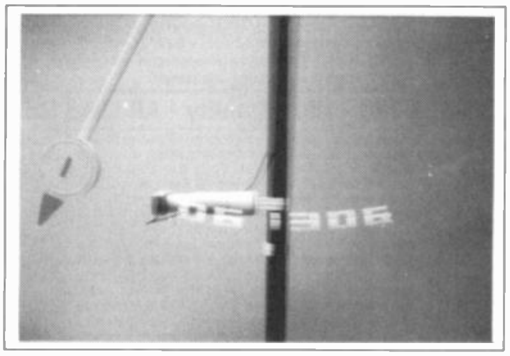
100 PAGE CATALOGUE NOW AVAILABLE, 50P STAMP OR FREE ON REQUEST WITH ORDER.

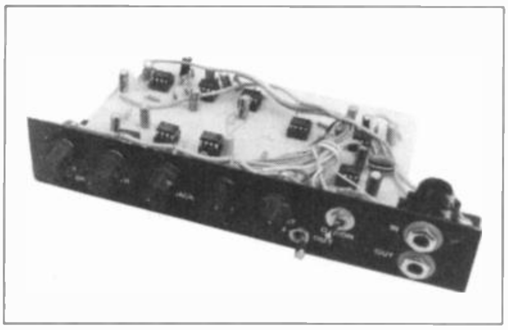
ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

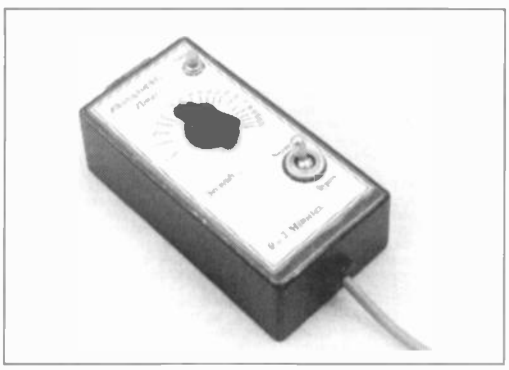
VOL. 25 No. 9 SEPTEMBER 1996

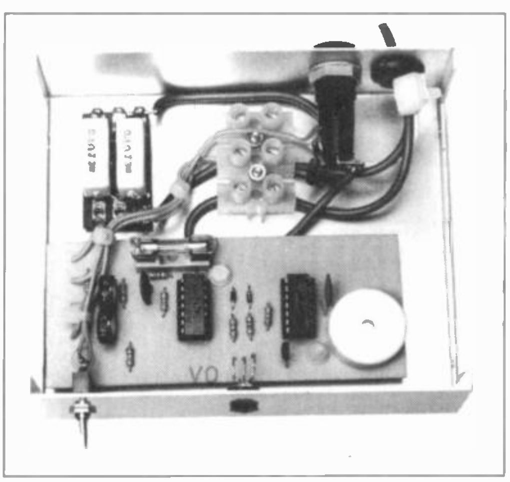
EVERYDAY PRACTICAL ELECTRONICS

The No. 1 Magazine for Electronics, Technology and Computer Projects









Projects

Series

Features

Our October '96 issue will be published on Friday, 6 September 1996. See page 659 for details.

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

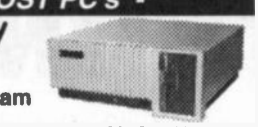
THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

LOW COST PC's -

SPECIAL BUY 'AT 286'

40Mb HD + 3Mb Ram



LIMITED QUANTITY only of these **12Mhz HI GRADE 286 systems** Made in the USA to an industrial specification, the system was designed for *total reliability*. The compact case houses the motherboard, PSU and EGA video card with single 5¼" 1.2 Mb floppy disk drive & **integral 40Mb hard disk drive** to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with **enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee.** *Ready to Run !*
Order as HIGRADE 286 ***ONLY £129.00*** (E)

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	£19.95
Wordperfect 6.0 for Dos - when 3½" FDD option ordered	£22.50
NE2000 Ethernet (thick, thin or twisted) network card	£29.00

LOW COST 486DX-33 SYSTEM

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

FLOPPY DISK DRIVES 3½" - 8"

5¼" or 3½" from only £18.95 !

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 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3½" supported on your PC).

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	£195.00(E)
8" **Shugart** 810 8" SS HH *Brand New*	£195.00(E)
8" **Shugart** 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided *NEW*	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

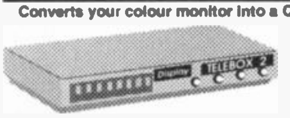
HARD DISK DRIVES

End of line purchase scoop! ***Brand new*** **NEC D2246** 8" 85 Mbyte drive with **industry standard SMD interface**, replaces Fujitsu equivalent model. Full manual. Only £299.00 or 2 for £525.00 (E)

3½" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£59.95(C)
3½" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£69.00(C)
3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£69.00(C)
3½" **WESTERN DIGITAL** 850mb IDE I/F *Brand New*	£185.00(C)
5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
5¼" **HP** 97548 850 Mb SCSI RFE tested	£89.00(C)
5¼" **HP** C3010 2 Gbyte SCSI ***differential*** RFE tested	£195.00(C)
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00(E)
Hard disc controllers for MFM , IDE, SCSI, RLL etc. from	£16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER *CABLE COMPATIBLE*

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

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

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

DC POWER SUPPLIES

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

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

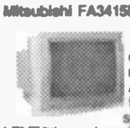
6,000,000 items EX STOCK

For *MAJOR* SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST

VIDEO MONITOR SPECIALS

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

Mitsubishi FA3415ETKL 14" SVGA **Multisync** colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including **IBM 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 - Used on film set for 1 week only!! 15" 0.28 SVGA 1024 x 768 res. colour monitors. Swivel & tilt etc. Full 90 day guarantee. £145.00 (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 £95** (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 13¾" 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.

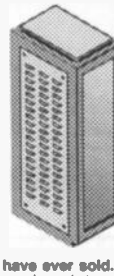
20"....£135 22"....£155 26"....£185 (F)

SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
2kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
IBM 8230 Type 1, Token ring base unit driver	£950
IBM 53F5501 Token Ring ICS 20 port lobe modules	£750
IBM MAU Token ring distribution panel 8228-23-5050N	£95
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE	£550
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & **HP3782A** Error Detector	£POA
HP APOLLO RX700 system units	£950
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP3081A Industrial workstation c/w Barcode swipe reader	£175
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP7580A A1 8 pen HPGL high speed drum plotter	£1850
EG+G Brookdeal 95035C Precision lock in amp	£650
View Eng. Mod 1200 computerised inspection system	£POA
Ling Dynamics 2kW programmable vibration test system	£POA
Computer controlled 1056 x 560 mm X Y table & controller	£1425
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS - New batts Dec.1995	£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	£1200
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 2998 Infrared spectrophotometer	£POA
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
TAYLOR HOBSON Tallysurf amplifier / recorder	£750
System Video 1152 PAL waveform monitor	£485
Test Lab - 2 mtr square quietised acoustic test cabinets	£300
Kenwood 9601 PAL Vectorscope - NEW	£650

Please call for further details on the above items

19" RACK CABINETS



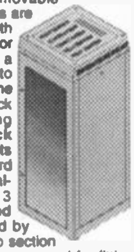
Superb quality 6 foot 40U Virtually New, Ultra Smart

Less than Half Price!

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

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

32U - High Quality - All steel 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 £195.00 (G)

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

TOUCH SCREEN SYSTEM

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

LOW COST RAM & CPU'S

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

SIMM SPECIALS

1 MB x 9 **SIMM** 9 chip 120ns		Only	£16.50 (A1)
1 MB x 9 **SIMM** 3 chip 80 ns **£19.50**	or	70ns	£22.95 (A1)
1 MB x 9 **SIMM** 9 chip 80 ns **£21.50**	or	70ns	£23.75 (A1)
4 MB 70 ns 72 pin SIMM ***-with parity-***		Only	£95.00 (A1)
INTEL 486-DX33 CPU £55.00	**INTEL 486-DX66 CPU**		**£69.00** (A1)

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

FANS & BLOWERS

EPSON DO412 40x40x20 mm 12v DC	£7.95 10 / £65
PAPST TYPE 612 60x60x25 mm 12v DC	£8.95 10 / £75
MITSUBISHI MMF-D6D12DL 60x60x25 mm 12v DC	£4.95 10 / £42
MITSUBISHI MMF-08C12DM 80x80x25 mm 12v DC	£5.25 10 / £49
MITSUBISHI MMF-09B12DH 92x92x25 mm 12v DC	£5.95 10 / £53
PANCAKE 12-3.5 92x92x18 mm 12v DC	£7.95 10 / £69

EX-EQUIP AC fans. ALL TESTED 120 x 120 x 38 mm specify 110 or 240 v £6.95. 80 x 80 x 38 mm - specify 110 or 240 v £5.95
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW £79.95
Shipping on all fans (A). Blowers (B). ***50,000 Fans Ex Stock CALL***

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

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

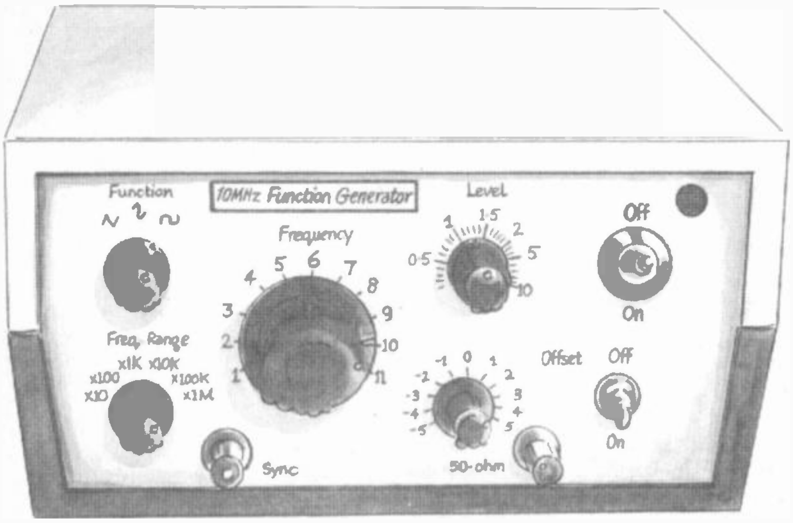
NEW **DISTEL©**
The Original
FREE On line Database
Info on 20,000 + stock items!
RETURNING SOON !

ALL ☎ ENQUIRIES
0181 679 4414
FAX 0181 679 1927

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 8 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1996. E & O E. 06/6

NEXT MONTH



10MHz FUNCTION GENERATOR

This straightforward project uses the MAX038 chip described in this issue to provide sine, square and triangle output waveforms from 10Hz to 10MHz in six switched ranges.

Together with the multimeter and the oscilloscope, a "function generator" is one of the most useful pieces of equipment an electronics enthusiast can possess. It generates signals over a wide range of frequencies, and gets its name from the fact that it can also provide various output waveforms. Usually these are triangular waves and squarewaves in addition to the basic sinewaves, and users soon discover the value of these for testing different types of circuit. Squarewaves, for example, are useful when checking for overshoot and ringing, whilst a triangular waveform is handy when looking for amplifier "crossover" distortion. Often the output can have a variable d.c. "offset" voltage added to the a.c. signal. This too has various applications, an example is a 5V squarewave output with a 2·5V positive offset which would be suitable for directly driving many logic inputs.

DIRECT CONVERSION RECEIVER FOR TOP BAND AND EIGHTY METRES

Interested in amateur radio? Want to listen in to amateur transmissions from around the world? If so this design is for you. As an introduction to shortwave listening on the amateur bands this direct conversion receiver probably represents the easiest type of d.i.y. receiver to build. It can resolve the single sideband (SSB) voice and Morse (CW) signals which most stations use.

VIDEO FADE TO WHITE

Video fader projects have appeared in EPE in the past, and these have all provided a conventional fade out to a black screen. This video fader is slightly different in that it provides a fade out to a white screen, or to a preset grey level if preferred. This gives the home video producer a few more creative possibilities from a circuit that is only marginally more complex than an equivalent fade-to-black circuit.

A BRIEF HISTORY OF GREAT EXPERIMENTERS

This fascinating series describes the work of the major electrical and magnetic experimenters, the emphasis being on the fact that experimentation was, and is, a necessary requirement for the study of any science. The series covers the work of such famous experimenters as Gilbert, Galvani, Volta, Ampere, Ohm, Faraday etc.

EVERYDAY PRACTICAL ELECTRONICS

OCTOBER ISSUE ON SALE FRIDAY, SEPTEMBER 6

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

HART KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available.
Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.
In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street.
You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.
Our list will give you full details of *all* our Audio Kits, components and special offers.

INTRODUCING
The Hart *"Chiara"*

Single-Ended Class "A" Headphone Amplifier

Most modern high fidelity amplifiers either do not have a headphone output facility, or this may not be up to the highest standard.
The new Hart "Chiara" has been introduced as an add-on unit to remedy this situation, and will provide two ultra high quality headphone outlets. This is the first unit in our 2000 Range of modules to be introduced through the year. Housed in the neat, black finished, Hart Minibox it features the wide frequency response, low-distortion and "musicality" that one associates with designs from the renowned John Linsley Hood.
Both outputs will drive any standard high quality headphones with an impedance greater than 30 ohms and the unit is ideal for use with the Sennheiser range. A signal link-through makes it easy to incorporate into your system and two extra outputs, one at output level and one adjusted by the Volume control are available on the back panel. The high level output also makes a very useful long-line driver where remote mounted power amplifiers are used. Power requirements are very simple and can be provided by either of our new "Andante" power supplies. Use the K3565 to drive the "Chiara" on its own, K3550 if driving other modules as well.
Volume and Balance controls are provided and as befits any unit with serious aspirations to quality these are the ultra high quality Alps "Blue Velvet" components.
Very easily built, even by beginners, since all components fit directly on the single printed circuit board and there is no conventional wiring whatsoever. The kit has very detailed instructions, and even comes with a roll of Hart audiograde silver solder. It can also be supplied factory assembled and tested.
Selling for less than the total cost of all the components, if they were bought separately, this unit represents incredible value for money and makes an attractive and harmonious addition to any hifi system.
K2100 The total cost of a complete set of all components to build this unit is £126.37. Our **special discount price** for all parts bought together as a kit is...
£109.50
K2100SA Series Audiophile, with extra selected components..**£112.46**

HART TC1D *Triple Purpose* TEST CASSETTE

Now available again and even better than before! Our famous triple purpose test cassette will help you set up your recorder for peak performance after fitting a new record/play head. This quality precision Test Cassette is digitally mastered in real time to give you an accurate standard to set the head azimuth, Dolby/VU level and tape speed, all easily done without test equipment.
TC1D Triple Purpose Test Cassette................£9.99

NEW BOOK
"Audio Electronics"

And now, hot off the press, yet another classic from the pen of John Linsley Hood. Following the ongoing enormous success of his "Art of Linear Electronics" the latest offering is the all-new edition of "Audio Electronics", now entirely re-written by the master himself.
Underlying audio techniques and equipment is a world of electronics that determines the quality of sound. For anyone involved in designing, adapting or using digital or analogue audio equipment understanding electronics leads to far greater control over the reproduced sound.
The subjects covered include tape recording, tuners, power output stages, digital audio, test instruments and loudspeaker crossover systems. John's lifetime of experience and personal innovation in this field allow him to apply his gift of being so familiar with his subject that he can write clearly about it and make it both interesting and comprehensible to the reader.
Containing 240 pages and over 250 line illustrations this new book represents great value for money at only £18.99 plus £2.50 postage. Send or telephone for your personal copy now.

ALPS *"Blue Velvet"*
Precision Audio Controls

To fulfil the need for ultra high quality controls we import a special range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm diam. steel shafts, except for the 50K Log which is 25mm x 6mm. Overall size of the manual pot is 27W x 24H x 27Deep, motorised versions are 72·4mm Deep from the mounting face. Mounting bush for both types is 8mm diameter.
Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability.
The motorised versions use a 5V DC motor coupled to the normal control shaft with a friction clutch so that the control can be operated manually or electrically. The idea of having electrically operated pots may seem odd, archaic even, but it is in fact the only way that remote control can be applied to any serious Hi-Fi system without loss of quality. The values chosen are the most suitable available for a low loss passive volume and balance control system, allowing armchair control of these two functions.
Our prices represent such super value for pots of this quality due to large purchases for our own kits.

MANUAL POTENTIOMETERS
2-Gang 100K Lin...£15.67
2-Gang 10K, 50K or 100K Log. £16.40
2-Gang 10K Special Balance, zero crosstalk and zero centre loss...£17.48
MOTORISED POTENTIOMETERS
2-Gang 20K Log Volume Control £26.20
2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position......£26.98

REEL TO REEL HEADS

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

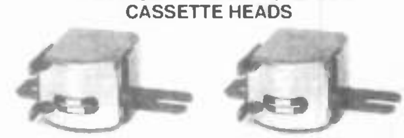
TAPE RECORDER CARE PRODUCTS

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

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

The HART K1450 Magnetic pickup preamplifier kit features a totally discrete component implementation with a specially designed low input impedance front end and the superior sound of the Shunt Feedback circuitry. High quality components fitting to an advanced double-sided printed circuit board make this a product at the leading edge of technology that you will be proud to own. Nevertheless with our step by step instructions it is very easy and satisfying to assemble. The higher current consumption of this unit means that it is best powered by our new ***Andante*** Audio Power Supply, itself an advanced piece of technology in a matching case. This supplies the superbly smoothed and stabilised supply lines needed by any sensitive preamplifer and features a fully potted Hi-grade toroidal transformer along with a special limited shift earth system for hum free operation. The K1450 is suitable for all moving coil and moving magent transducers this unit is especially recommended for, and will extract the very best from the modern generation of low output high quality moving coil transducers.
K1450 Kit, complete with all parts ready to assemble inside the fully finished 228mm x 134mm x 63mm case. Kit includes full, easy to follow, assembly instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit! **£111.58**
K1450SA Series Audiophile version with selected components...**£133.94**

HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do your tapes lack treble? A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new! Standard inductances and mountings make fitting easy on nearly all machines (Sony are special dimensions, we do not stock) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see! All our heads are suitable for use with any Dolby system and are normally available ex-stock. We also stock a wide range of special heads for home construction and industrial users.
HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome, metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!..£11.70
HRP373 Downstream monitor combi head....£62.59
HQ551A 4-Track R/P.......................................£8.75
HQ551S Sony Mount 4-Tr. R/P......................£14.90
HQR560 Rotary Base 12·5mm R/P/E...........£21.90
HQR570 Rotary Base 15mm R/P/E..............£22.59
HQR580 Rotary Base 12·5mm R/P...............£14.29

HART *Classical* CD's.

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

TECHNICAL BOOKSHELF

We stock a good range of books of interest to the electronics and audio enthusiast, including many reprinted classics from the valve era. Some were in last months advertisement, but see our list for the full range.
New this month is the GEC Valve designs book at £18.95, and the VTL Book, a modern look at valve designs, **£17.95.**

Send or 'phone for your copy of our **FREE** List of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.
Ordering is easy. Just write or telephone your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned order with your credit card number will get your order on its way to you THAT DAY.
Please add part cost of carriage and insurance as follows:–**INLAND Orders up to £20 - £1.50, Orders over £20 - £3.50. Express Courier, next working day £10.**
OVERSEAS – Please see the ordering information with our lists.

QUALITY AUDIO KITS	24 hr. SALES LINE (01691) 652894	ALL PRICES INCLUDE UK/EC VAT

HART ELECTRONIC KITS LTD
6 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

£1 BARGAIN PACKS – List 5

If you would like to receive the other four £1 lists and a lot of other lists, request these when you order or send SAE.

TEST PRODS FOR MULTIMETERS with 4mm sockets Good length very flexible lead, Ref: D86
8 **OHM PM SPEAKERS,** size 8" x 4", pack of two. These may be lightly rusty and that is why they are so cheap but are electrically OK, Ref: D102.
PAXOLIN PANELS, size 6" x 6", approximately 1/16" thick, pack of two, Ref: D103
13A SOCKET, virtually unbreakable, ideal for trailing lead, Ref: D95.
PIEZO BUZZER with electronic sounder circuit, 3V to 9V D.C. operated, Ref: D76.
DITTO but without internal electronics, pack of two, Ref: D75.
LUMINOUS ROCKER SWITCH, approximately 30mm sq, pack of two, Ref: D64.
ROTARY SWITCH, 9-pole 6-way, small size and ¼" spindle, pack of two, Ref: D54.
FERRITE RODS, 7" with coils for Long and Medium waves, pack of two, Ref: D52.
DITTO but without the coils, pack of three, Ref: D52.
SLIDE SWITCHES, SPDT, pack of 20, Ref: D50.
MAINS DP ROTARY SWITCH with ¼" control spindle, pack of five, Ref: D49.
ELECTROLYTIC CAP, 800µF at 6·4V, pack of 20, Ref: D48.
ELECTROLYTIC CAP, 1000µF + 1000µF 12V, pack of 10, Ref: D47.
MINI RELAY with 5V coil, size only 26mm x 19mm x 1mm, has two sets of changeover contacts, Ref: D42.
MAINS SUPPRESSOR CAPS 0·1µF 250V A.C., pack of 10, Ref: 1050.
TELESCOPIC AERIAL, chrome plated, extendable and folds over for improved F.M. reception, Ref: 1051.
MES LAMP HOLDERS, slide on to ¼" tag, pack of 10, Ref: 1054.
PAXOLIN TUBING, ¼" internal diameter, pack of two, 12" lengths, Ref: 1056.
ULTRA THIN DRILLS, 0·4mm, pack of 10, Ref: 1042.
20A TOGGLE SWITCHES, centre off, part spring controlled, will stay on when pushed up but will spring back when pushed down, pack of two, Ref: 1043.
HALL EFFECT DEVICES, mounted on small heatsink, pack of two, Ref: 1022
12V POLARISED RELAY, two changeover contacts, Ref: 1032.
PAXOLIN PANEL, 12" x 12" 1/16" thick, Ref: 1033.
MINI POTTED TRANSFORMER, only 1·5VA 15V-0V-15V or 30V, Ref: 964
ELECTROLYTIC CAP, 32µF at 350V and 50µF section at 25V, in aluminium can for upright mounting, pack of two, Ref: 995.
PRE-SET POTS, one megohm, pack of five, Ref: 998.
WHITE PROJECT BOX with rocker switch in top left-hand side, size 78mm x 115mm x 35mm, unprinted, Ref: 1006.
6V SOLENOID, good strong pull but quite small, pack of two, Ref: 1012.
FIGURE-8 MAINS FLEX, also makes good speaker lead, 15m, Ref: 1014.
HIGH CURRENT RELAY, 24V A.C. or 12V D.C., three changeover contacts, Ref: 1016.
LOUDSPEAKER, 8 Ohm 5W, 3·7" round, Ref: 962.
NEON PILOT LIGHTS, oblong for front panel mounting, with internal resistor for normal mains operation, pack of four, Ref: 970.
3·5MM JACK PLUGS, pack of 10, Ref: 975.
WANDER PLUGS, pack of 10, Ref: 986.
PSU, mains operated, two outputs, one 9·5V at 550mA and the other 15V at 150mA, Ref: 988.
ANOTHER PSU, mains operated, output 15V A.C. at 320mA, Ref: 989.
PHOTOCELLS, silicon chip type, pack of four, Ref: 939.
LOUDSPEAKER, 5" 4 Ohm 5W rating, Ref: 946.
230V ROD ELEMENTS, 500W terminal-ended, 10" long, pack of two, Ref: 943.
LOUDSPEAKER, 7" x 5" 4 Ohm 5W, Ref: 949.
LOUDSPEAKER, 4" circular 6 Ohm 3W, pack of 2, Ref: 951.
FERRITE POT CORES, 30mm x 15mm x 25mm, matching pair, Ref: 901.
PAXOLIN PANEL, 8½" x 3½" with electrolytics 250µF and 100µF, Ref: 905.
CAR SOCKET PLUG with P.C.B. compartment, Ref: 917.
FOUR-CORE FLEX suitable for telephone extensions, 10m, Ref: 918.
VERO OFF-CUTS, approximately 30 square inches of useful sizes, Ref: 927.
PROJECT CASE, 95mm x 66mm x 23mm with removable lid, held by four screws, pack of two, Ref: 876.
SOLENOIDS, 12V to 24V, will push or pull, pack of two, Ref: 877.
2M MAINS LEAD, 3-core with instrument plug moulded on, Ref: 879.
TELESCOPIC AERIAL, chrome plated, extendable, pack of two, Ref: 884.
MICROPHONE, dynamic with normal body for hand holding, Ref: 885
CROCODILE CLIPS, superior quality flex, can be attached without soldering, five each red and black, Ref: 886.
BATTERY CONNECTOR FOR PP3, superior quality, pack of four, Ref: 887.
LIGHTWEIGHT STEREO HEADPHONES, Ref: 898.
PRESETS, 470 Ohm and 220 kilohm, mounted on single panel, pack of 10, Ref: 849.
THERMOSTAT for ovens with ¼" spindle to take control knob, Ref: 857.
12V-0V-12V 10W MAINS TRANSFORMER, Ref: 811.
18V-0V-18V 10W MAINS TRANSFORMER, Ref: 813.
AIR-SPACED TRIMMER CAPS, 2pF to 20pF, pack of two, Ref: 818.
AMPLIFIER, 9V or 12V operated Mullard 1153, Ref: 823.
2 CIRCUIT MICROSWITCHES, licon, pack of 4, Ref: 825.
LARGE SIZE MICROSWITCHES (20mm x 6mm x 10mm) changeover contacts, pack of two, Ref: 826.
MAINS VOLTAGE PUSHSWITCH with white dolly, through panel mounting by hexagonal nut, Ref: 829.
POINTER KNOB for spindle which is just under ¼", like most thermostats, pack of four, Ref: 833.

AIR SPACED TUNING CAPACITORS

With the renewed interest in valve equipment, particularly valve radios, we are offering some very well made tuning capacitors. All have ¼" spindles:

Order Ref 3P213 is a twin 500pf with slow motion drive and approximately 2" of shaft, price **£3**.

Order Ref 3P214 is again a 500pf + 500pf direct drive with approximately 1" spindle, price **£3**.

Order Ref 2P422 has a 250pf front section and a 350pf back section, approximately 1½" of spindle with slow motion drive, price **£2**.

Order Ref 2P423 is a 150pf + 300pf with drive drum, price **£2**.

Order Ref 2P424 is a 3 section with trimmers. Front section is 230pf, middle section is 100pf and back section 150pf, ¼" spindle, approximately ½" long, price **£2**.

Order Ref 3P215 is a 5 section all with trimmers. Front section is 150pf, second section 250pf, then an FM section of 50pf, fourth section is 190pf and the final FM section is 50pf. Complete with drum drive and 1" spindle, price **£3**.

Order Ref 2P425 is a 2 gang 50µf, very wide spaced for transmitter tuning, about 1½" spindle, price **£2**.

MULTITESTER PT160

Superior pocket size multitester, 2000 ohm per volt and mirrored scale. 14 ranges, AC and DC volts up to 500, current up to 250mA, 2 ohm ranges and 2 very useful battery test positions. Complete with prods and booklet, price **£6.95**, Order Ref: 7P23.

MOBILE PHONE UNIT

In fact, except for the case and keyboard, this is almost a mobile phone. Has a PCB with all the IC's and other components, LC display and speaker. You can have all this for **£2.50**, Order Ref: 2.5P19.

VALVE CIRCUIT LOUD SPEAKER OUTPUT TRANSFORMER

Looks about 25W but we have no means of measuring, price **£2.50** each, Order Ref: 2.5P18.

SMART HIGH QUALITY ELECTRONIC KITS

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

CAT. No.	DESCRIPTION	PRICE £
1002	VU Meter, with l.e.d. display	4.60
1003	5W Electronic Siren	2.53
1004	Light Switch	3.22
1005	Touch Switch	2.87
1007	Stabilized Power Supply: 3V to 30V at 2·5A	6.90
1008	SF Function Generator	6.90
1010	5-input Stereo Mixer, with monitor output	19.31
1011	Motorbike Alarm	3.20
1012	Reverberation Unit	5.52
1016	Loudspeaker Protection Unit	3.22
1023	Dynamic head preamp	2.50
1024	Microphone preamp	2.20
1025	7W HiFi Power Amplifier	2.53
1026	Running Lights	4.60
1027	NiCad Battery Charger	3.91
1029	4 sound electronic siren	3.00
1030	Light Dimmer	2.53
1032	Stereo Tone Control	4.14
1033	60W HiFi Power Amplifier	7.82
1034	Car Battery Checker	1.61
1035	Space Sound Effects	2.30
1038	AM/FM Aerial Amplifier	1.61
1039	Stereo VU Meter	4.60
1040	10W HiFi Power Amplifier	2.76
1041	25W HiFi Power Amplifier	4.60
1042	AF Generator, 250Hz-16kHz	1.70
1043	Loudness Stereo Unit	3.22
1047	Sound Switch	5.29
1048	Electronic Thermostat	3.68
1050	3-input HiFi Stereo Pre-amplifier	12.42
1051	Touch Dimmer, with memory	4.60
1052	3-input Mono Mixer	6.21
1053	Electronic Metronome	3.22
1054	4-input Instrument Mixer	2.76
1056	8V-20V 8A Stabilized Power Supply	12.42
1057	Cassette Head Pre-amplifier	3.22
1058	Electronic Car Ignition	7.82
1059	Telephone Amplifier	4.60
1060	+40V 8A Power Supply	8.28

CAT. No.	DESCRIPTION	PRICE £
1062	5V 0·5A Stabilized Supply for TTL	2.30
1063	12V 2A Power Supply	2.30
1064	+12V 0·5A Stabilized Supply	3.22
1067	Stereo VU Meter, with l.e.d.s	9.20
1068	18V 0·5A Stabilized Power Supply	2.53
1069	Fluorescent Tube Unit from 12V d.c.	2.99
1070	HiFi Pre-amplifier	7.47
1071	4-input Selector	6.90
1074	Drill Speed Controller	2.76
1077	100W HiFi Amplifier	12.50
1080	Liquid Level Sensor – Rain Alarm	2.30
1082	Car Voltmeter, with l.e.d.s	7.36
1083	Video Signal Amplifier	2.76
1084	TV Line Amplifier	1.84
1085	DC Converter, 12V to 6V or 7·5V or 9V	2.53
1086	Music to light for your car	4.60
1087	Thyristor/Triac Tester	2.76
1088	Kitt Scanner	10.12
1089	LED Flasher/555 Tester	1.61
1090	Stress Meter	3.22
1093	Windscreen Wiper Controller	3.68
1094	Home Alarm System	12.42
1096	2V-30V 5A Stabilized Variable PSU	11.04
1098	Digital Thermometer, with l.c.d. display	11.50
1100	2 x 18W Integrated Amplifier	18.39
1103	LED Power Meter	1.84
1106	Thermometer with l.e.d.s	6.90
1107	Electronics to help win the pools	3.68
1109	40W HiFi Amplifier	7.36
1112	Loudspeaker protection, with delay	4.60
1113	2 x 18W Power Amplifier	5.98
1115	Courtesy Light Delay	2.07
1118	Time Switch with triac 0-10mins	4.14
1123	Morse Code Generator	1.84
1124	Electronic Bell	2.76
1125	Telephone Lock	3.68
1126	Microphone Pre-amplifier	4.60
1127	Microphone Tone Control	4.60
1128a	Power Flasher 12V d.c.	2.53
1130	Telephone Bug Detector	3.20
1133	Stereo Sound-to-Light	5.26

YOU SAVE £40

THE JAP MADE 12V 15AH SEALED LEAD ACID BATTERY from regular suppliers costs £50, you can have one from us for only **£10** including VAT if you collect or £12.50 if we have to send. Being sealed it can be used in any position and is maintenance free. All in tip top condition and fully guaranteed, Order Ref: 12.5P2. Or if you want a smaller one we have 12V 2.3AH, regular price **£14**, yours for only **£5**, Order Ref: 5P258.

Prices include VAT and carriage if order over £25 otherwise add £3. Send cash, uncrossed postal orders, cheque or quote credit card number.

J & N FACTORS

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

MAGENTA
ELECTRONICS LTD

135 Hunter Street
Burton-on-Trent
Staffs. DE14 2ST
Tel 01283 565435 Fax 546932

EE171

All Prices include V.A.T. Add £3.00 per order p &p

MAIL ORDER ONLY ● CALLERS BY APPOINTMENT

EPE MICROCONTROLLER P.I. TREASURE HUNTER

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

- New circuit design 1994
- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater
- Detects gold, silver, ferrous & non-ferrous metals
- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

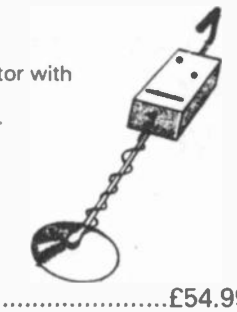
KIT 847......................£63.95

WINDICATOR

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

KIT 856..£28.00

BUCCANEER I.B. METAL DETECTOR



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

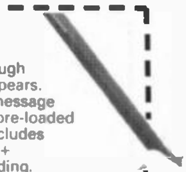
KIT 719..£54.99

1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.
Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848..................£32.95

SPACEWRITER



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

KIT 849......................£16.99

12V EPROM ERASER

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

KIT 790..........................£28.51

MOSFET 25V 2.5A POWER SUPPLY

High performance design has made this one of our classic kits. Two panel meters indicate Volts and Amps. Variable from 0-25 Volts and current limit control from 0-2·5A. Rugged power MOSFET output stage. Toroidal mains transformer.

KIT 769.......................£56.82

INSULATION TESTER

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

KIT 444.......................£22.37

DIGITAL LCD THERMOSTAT

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

KIT 841.........................£29.95

PORTABLE ULTRASONIC PEsT SCARER

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

KIT 842........................£22.56

DIGITAL CAPACITANCE METER

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

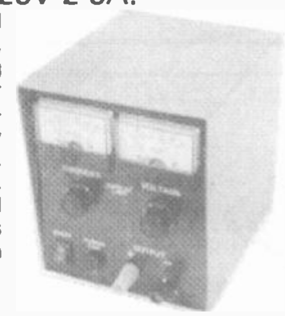
KIT 493.......................£39.95

ACOUSTIC PROBE

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

KIT 740.......................£19.98

MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2·5A.



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

KIT 845..............£64.95

ULTRASONIC PEsT SCARER

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

- KIT INCLUDES ALL COMPONENTS, PCB & CASE
- EFFICIENT 100V TRANSDUCER OUTPUT
- COMPLETELY INAUDIBLE TO HUMANS
- UP TO 4 METRES RANGE
- LOW CURRENT DRAIN

KIT 812..£14.81

DIGITAL COMBINATION LOCK

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

KIT 840..........................£19.86

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

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

- KIT INC. HEADPHONES
- EFFICIENT CMOS DESIGN
- POWERFUL COIL DRIVE
- DETECTS FERROUS AND NON-FERROUS METAL – GOLD, SILVER, COPPER ETC.
- 190mm SEARCH COIL
- NO 'GROUND EFFECT'

KIT 815.........................£45.95

DOLBY PRO-LOGIC DECODER

DOLBY SURROUND PRO·LOGIC

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

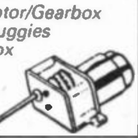
For minimum cost the "Short Form Kit" is ideal. This is complete except for the case and power transformer. It includes the switches, sockets, and pots, and is ideal for building into a custom set-up with pre-amp and power-amp modules, where power is available.

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

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

*DOLBY and the double D symbolare trademarks.

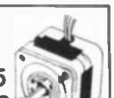
DC Motor/Gearboxes



Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1·5 to 4·5V Multi ratio gearbox gives wide range of speeds.

LARGE TYPE – MGL £6.95
SMALL – MGS – £4.77

Stepping Motors



MD38...Mini 48 step...£8.65
MD35...Std 48 step...£12.98
MD200...200 step...£16.80
MD24...Large 200 step...£22.95

EVERYDAY
PRACTICAL
ELECTRONICS

VOL. 25 No. 9 SEPTEMBER '96

Editorial Offices:
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
ALLEN HOUSE, EAST BOROUGH, WIMBORNE
DORSET BH21 1PF
Phone: Wimborne (01202) 881749
Fax: (01202) 841692. **Due to the cost we cannot reply to orders or queries by Fax.**
See notes on **Readers' Enquiries** below – we regret lengthy technical enquiries cannot be answered over the telephone.
E-mail: editorial@epemag.wimborne.co.uk
Web Site: http://www.epemag.wimborne.co.uk
Advertisement Offices:
EVERYDAY PRACTICAL ELECTRONICS
ADVERTISEMENTS
HOLLAND WOOD HOUSE, CHURCH LANE
GREAT HOLLAND, ESSEX CO13 0JS
Phone/Fax: (01255) 850596

PROJECT DEVELOPMENT . . .

The introduction to our *PIC-Tock Pendulum Clock* project this month gives some insight into how this design came about. With so many projects in each issue and the need to keep coming up with new ideas we always welcome suggestions for unusual projects. Of course we get quite a few sent in "out of the blue", or readers ask us if we have ever published anything for a thingamewotsit? Provided we feel these ideas will be of interest to a good proportion of readers then we try to publish something.

There are, of course, a number of requests that are not achievable for various reasons – for instance it is simply not worth trying to build your own video recorder or worse, camcorder. The cost of the mechanics – even if you could get hold of them – on a one off basis would outweigh the price of a new, guaranteed commercial unit and few readers would have the test gear necessary to test and fault find such an item anyway.

. . . AND REDEVELOPMENT

Of course, we do rehash ideas from time to time, particularly when we can come up with an improved, more versatile or less expensive design, etc. We are presently working on one or two of these ideas for future issues. One of them is a full specification Theremin. The *Simple Theremin* we published in the September '95 issue has been very popular and Jake Rothman is now finalising the design for a fully specified instrument with pitch and volume control. This has also led to work on an add-on MIDI interface for the instrument. We are sure that both of these projects will be very popular developments of a previous design. We expect to publish the Theremin in the November issue *if* things go to plan.

We have now published three different Mind Machines from Andy Flind, each one being a major improvement on the previous design. Andy is also now working on an improved TENS Unit (TENS stands for Transcutaneous Electrical Nerve Stimulation) that we hope will be published in the next few months. His previous *Simple TENS Unit* and *Advanced TENS Unit* have been amongst the most popular designs we have ever published and we know from your letters and comments that they have brought relief to hundereds of pain sufferers.

As technology marches on at an ever increasing pace it is possible to improve on old ideas (and to come up with new ones like the PIC-Tock) and we will continue to bring you a wide range of interesting projects.

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £24. Overseas: £30 (£47.50 airmail). Cheques or bank drafts **(in £ sterling only)** payable to *Everyday Practical Electronics* and sent to **EPE Subscriptions Dept.**, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. **E-mail:** editorial@epemag.wimborne.co.uk.

Subscriptions start with the next available issue. We accept MasterCard (Access) or Visa. (For past issues see the *Back Issues* page).

BINDERS

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

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

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

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

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

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

ADVERTISEMENTS

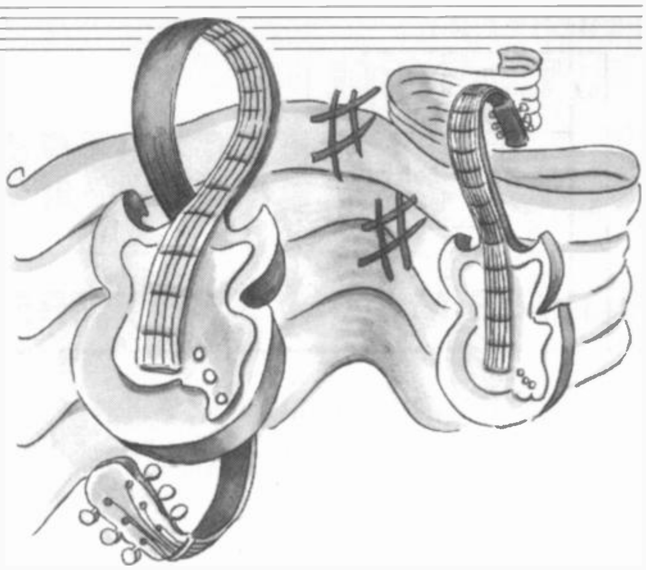
Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made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

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

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

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

Constructional Project



ANALOGUE DELAY AND FLANGER

JOHN CHATWIN

Simply add the characteristic flanging sound to your guitar effects repertoire.

IF ANY single effect characterises the sound of the modern electric guitar, it is probably the flanger. Ever since the widespread availability of cheap analogue delay lines, the effect has become realistically pedal sized. It has been taken up by guitar players in all styles, from pop to classical, and is used to enrich the sound of many other electronic instruments.

Anyone who is not sure exactly of the effect that a flanger produces will certainly have heard it used on countless records. It can range from a sort of epic tonal sweep, like phasing, through to a fast bubbling vibrato. A classic flanged guitar sound was used by Andy Summers on the 1980's *Police* records. These days it is a great basic effect, along with "chorus", which is similar, for beefing up guitars and keyboard instruments.

The original flanging effect was produced accidentally – according to the mythology – in some recording studio when an engineer inadvertently put his finger on the flange of a tape deck that was playing back onto another machine. This had the effect of slowing down the tape fractionally until he removed his finger.

When the faulty recording was played back in sync with the original, the slowed down section was, of course, played back at a relatively faster speed. This created an interesting cross modulation effect, which became known as flanging. However, until it could be produced by purely electronic means, its generation was really limited to the recording studio.

Electronic flangers work by slowing down and speeding up signals passing along a delay line. This causes the required de-tuning, which can then be mixed with a "straight" version of the sound to create the effect.

In flanging, the delay required is only very small, no more than 15ms or so, which means that relatively simple analogue delay lines can be used. Generally speaking, analogue delays are now not used much in audio applications for anything over about 50ms because of the noise and distortion they can introduce.

With the short delays needed for flanging, though, they can produce very acceptable results. It has to be said, however, that most high quality flangers and chorus pedals now employ digital delay lines, and are correspondingly quieter.

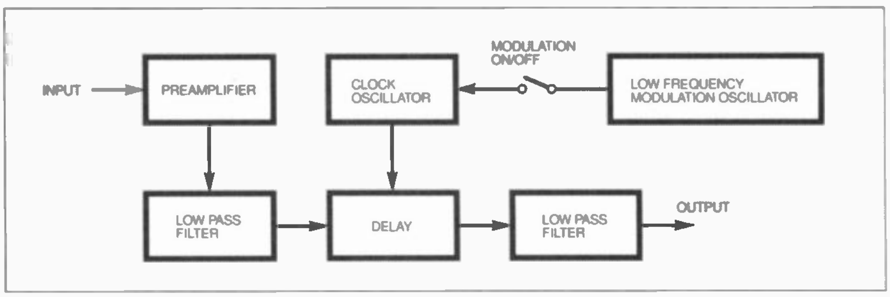


Fig. 2. Block diagram of the Analogue Delay and Flanger.

PASS THE BUCKET

Analogue delay lines operate by using a form of shift register which is driven by a timing circuit or clock. Within the shift register are tiny capacitors which store samples of charge relating to the level of an input signal. The input is fed into the first capacitor and then the charge is progressively shifted from capacitor to capacitor within the i.c. in synchronisation with the clocking signal.

This type of system is sometimes called a "bucket brigade delay" or BBD, because of the way information is passed along it. A typical BBD chip might have around 500 or 1000 stages. In this circuit, the MN3207 delay chip has 1024 stages.

Some analogue delay chips include an on-board clock but the MN3207 has a partner chip, the MN3102, which provides the clock signal and the gate supply voltage required by the MN3207. As can

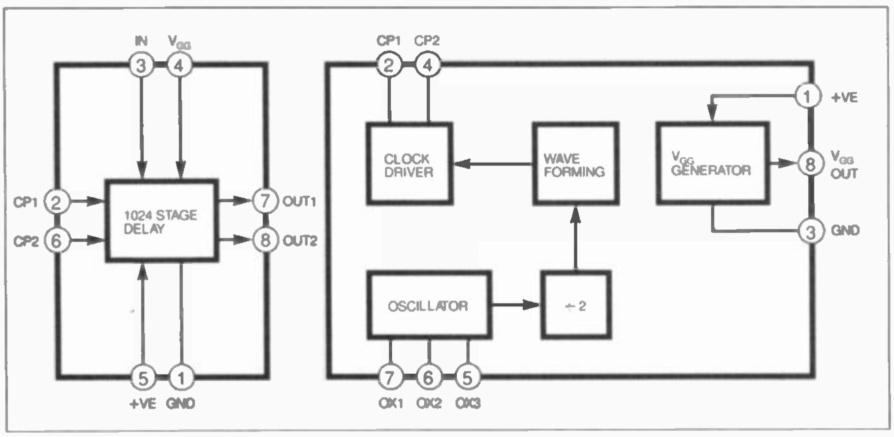


Fig. 1. Functional block diagram for the MN3207 delay line (left) and MN3102 clock generator devices.

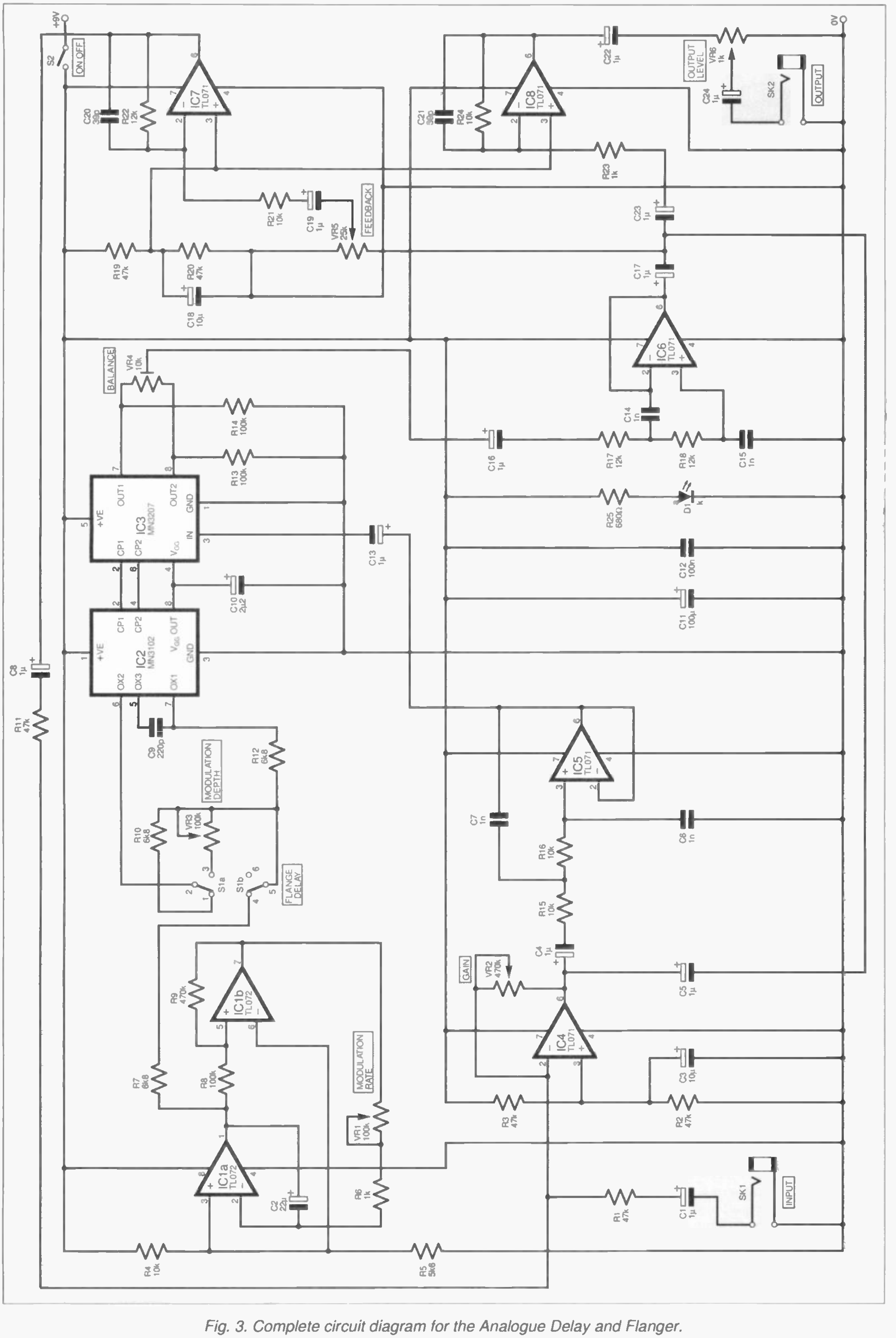
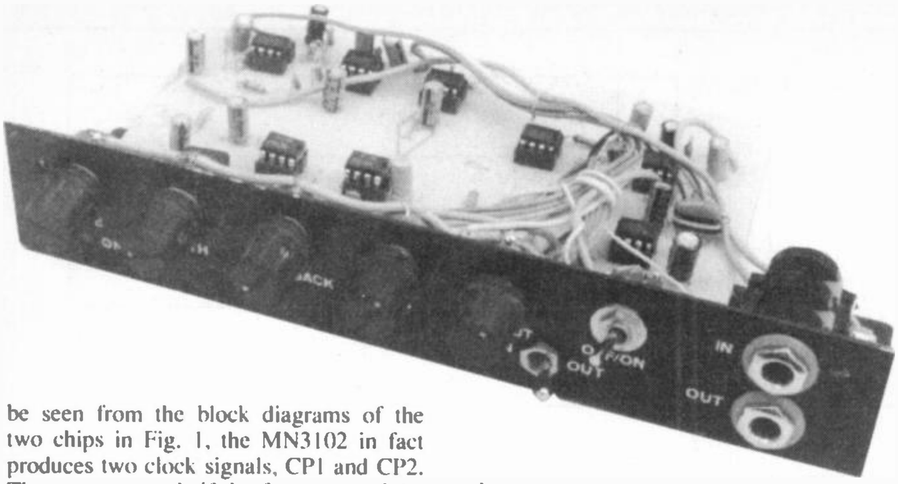


Fig. 3. Complete circuit diagram for the Analogue Delay and Flanger.



be seen from the block diagrams of the two chips in Fig. 1, the MN3102 in fact produces two clock signals, CP1 and CP2. These operate at half the frequency of the master oscillator, and are out of phase with one another.

The frequency at which the clock runs determines the delay time and, to some extent, the quality of the output signal, as it also controls the rate at which the input signal is sampled and passed along the register. The MN3102 will operate at a rate anywhere between 10kHz and 100kHz, which provides an audio signal delay of 2.56ms to 25.6ms with the MN3207. It also allows for the clock frequency to be varied according to an external modulation signal.

BLOCK DIAGRAM

It can be seen from the block diagram in Fig. 2 that the Flanger/Delay unit consists of six main parts: input preamp, input filter, delay, clock oscillator, low frequency modulation oscillator and an output filter.

The circuit diagram for the complete unit is shown in Fig. 3. Signals enter the circuit via the d.c. blocking capacitor C1 and are passed to the low noise inverting amplifier IC4.

The gain of this stage is controlled by the potentiometer VR2. In essence, this allows the circuit to be matched to a variety of input signal levels from various sources, such as guitars, keyboards or microphones. The unit could also be incorporated into a public address (PA) system or guitar amplifier effects loop.

From IC4 output pin 6, signals are fed into a two-pole 15kHz active low pass filter, based around IC5. The filter is required to remove any high frequency signals before they get to the delay line, as it would be unable to process them correctly, and they would tend to increase levels of noise and distortion.

From IC5, signals enter the delay line IC3, the MN3207 BBD chip. The MN3102 clock generator is IC2. The two clock signals from IC2 pins 2 and 4 are connected directly to IC5 pins 2 and 6, respectively. The V_{gg} gate supply voltage from IC2 pin 8 to IC3 pin 4 is decoupled by capacitor C10.

The basic clock frequency of IC2 is set by capacitor C9 between pins 5 and 7, and the resistance between pins 6 and 7. In this circuit, the timing capacitor is 220pF, but for other applications its value could range from around 39pF to 240pF.

Between them, op.amps IC1a and IC1b form the low frequency modulation oscillator (LFO) which produces a triangle wave output at a frequency controlled by potentiometer VR1 and capacitor C2. With the component values shown, VR1 enables the frequency to be varied from around 0·3Hz to about 4Hz, which gives a good usable range of fast and slow flanging.

The output from the LFO is channelled through resistor R7 to the selector switch SI. This switch allows you to use the LFO to modulate the clock frequency produced by the MN3102 – to automatically create the flanging effect – or to manually change the delay rate using VR3, thus creating an echo effect. With the switch in the modulation position, VR3 is disconnected, and the modulation voltage is applied through the potential divider formed by resistors R12 and R10.

If you do not require the echo effect option and just want to use the circuit as a flanger, the LFO can be connected as shown in Fig 4. This avoids the need for switch S1 and potentiometer VR3.

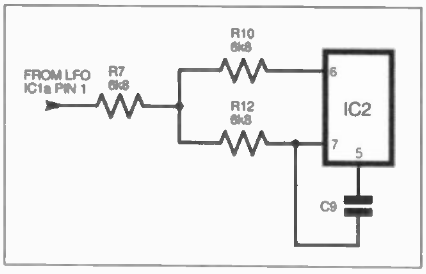


Fig. 4. Connecting the LFO without modulation switch S1.

The output from the delay line is via IC3 pins 7 and 8. Potentiometer VR4 provides a mid-point, and can be adjusted to give the best response. Correct balance of the two signals being summed at VR4 may not be a problem unless you use the clock at very low speeds. From the wiper of VR4 the signal is passed to IC6, which is another low pass filter. This removes the high frequency clock noise that is superimposed on the audio signal by the delay circuitry.

From IC6, the processed signal is sent to IC8, which is wired as a low gain (about ×10) buffer. Via capacitor C5, an unprocessed version of the audio signal from the output of the first preamp, IC4, is also fed to IC8. From IC8 the combined signal is then sent through the level control potentiometer VR6 to the output socket SK2.

Potentiometer VR5, connected to the combined signals from IC4 and IC6, is the control that sets the amount of signal routed back to the input of IC4. VR5 can be used to maximise the resonant qualities of the flanging effect, as it allows the circuit to be operated close to maximum feedback level. In the delay mode, VR5 allows the creation of repeat echoes.

POWER SUPPLY

Power for the circuit can be provided by a 9V supply, such as a PP3 battery. The actual voltage is not critical and the circuit will probably work with voltages from around 6V to 15V. The power supply lines are decoupled by capacitors C11 and C12. Light emitting diode (l.e.d.) D1 provides power-on indication, with its current limited by resistor R25.

The centre rail voltage for the non-inverting input of IC4 is provided by resistors R2 and R3. IC7 and IC8 share a mid-rail voltage provided by R19 and R20.

CONSTRUCTION

Component layout and tracking details of the printed circuit board are shown in Fig. 5. This board is available from the *EPE PCB Service*, code 111.

COMPONENTS

Resistors — See **TALK** Page

R1 to R3, R11, R19, R20	47k
R4, R15, R16, R21, R24	10k
R5	5k6
R6, R23	1k
R7, R10, R12	6k8
R8, R13, R14	100k
R9	470k
R17, R18, R22	12k
R25	680Ω

All 0·25W 5% carbon film or better.

Potentiometers

VR1, VR3	100k rotary carbon lin. (2 off) (see text)
VR2	470k rotary carbon lin.
VR4	10k preset, horiz.
VR5	25k rotary carbon log.
VR6	1k rotary carbon log.

Capacitors

C1, C4, C5, C8, C13, C16, C17, C19, C22 to C24	1µ elect. radial, 16V (11 off)
C2	22µ elect. radial, 16V
C3, C18	10µ elect. radial, 16V (2 off)
C6, C7, C14, C15	1n ceramic disc (4 off)
C9	220p ceramic disc
C10	2µ2 elect. radial, 16V
C11	100µ elect. radial, 16V
C12	100n polyester
C20, C21	39p ceramic disc (2 off)

Semiconductors

IC1	TL072
IC2	MN3102
IC3	MN3207
IC4 to IC8	TL071 (5 off)
D1	red l.e.d. and clip

Miscellaneous

S1	d.p.d.t. min. toggle switch (see text)
S2	s.p.s.t. min. toggle switch
SK1, SK2	standard mono jack socket, 0·25in (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 111; 8-pin d.i.l. socket (7 off); knob (5 off); connecting wire; solder, etc.

Approx Cost Guidance Only £28

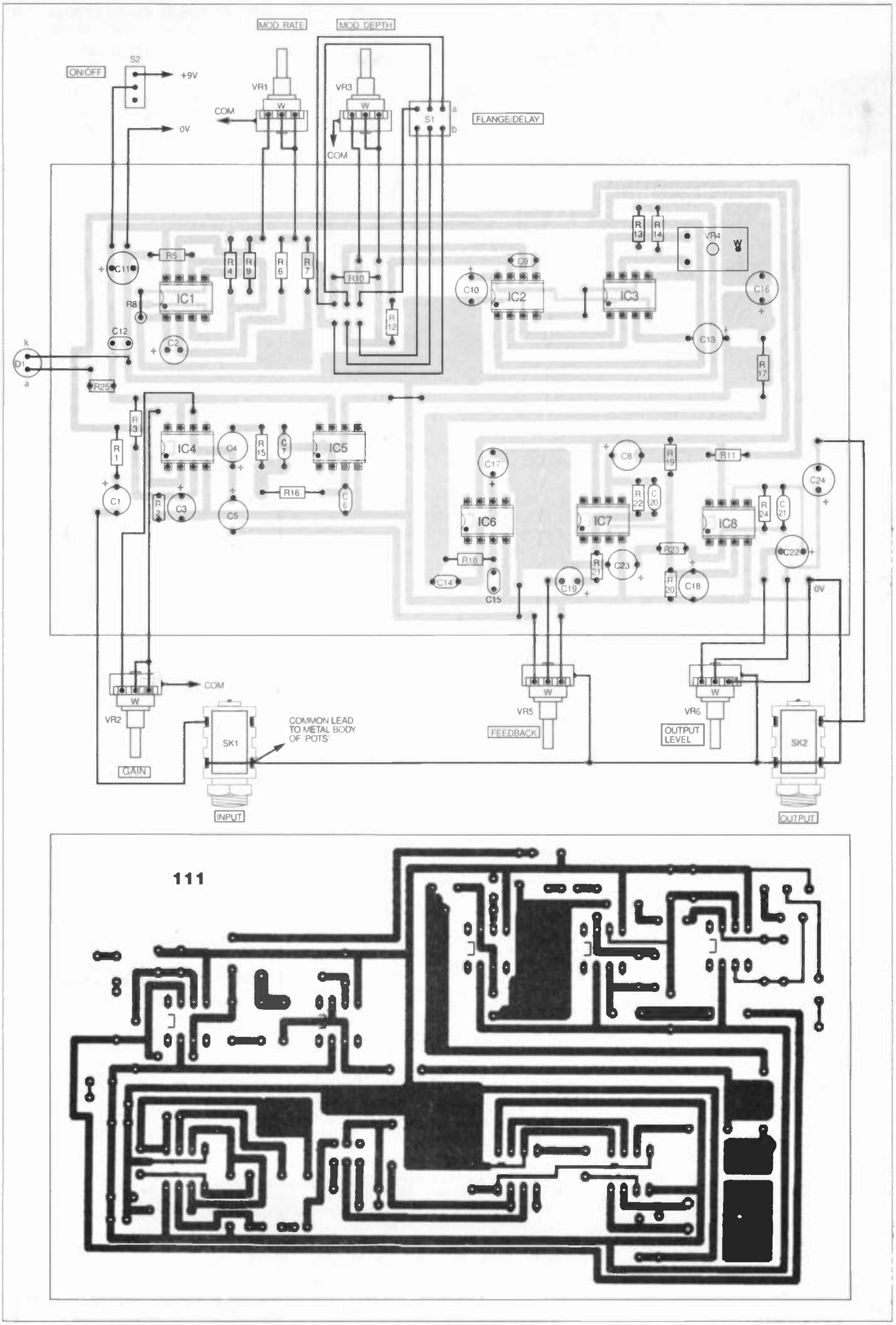
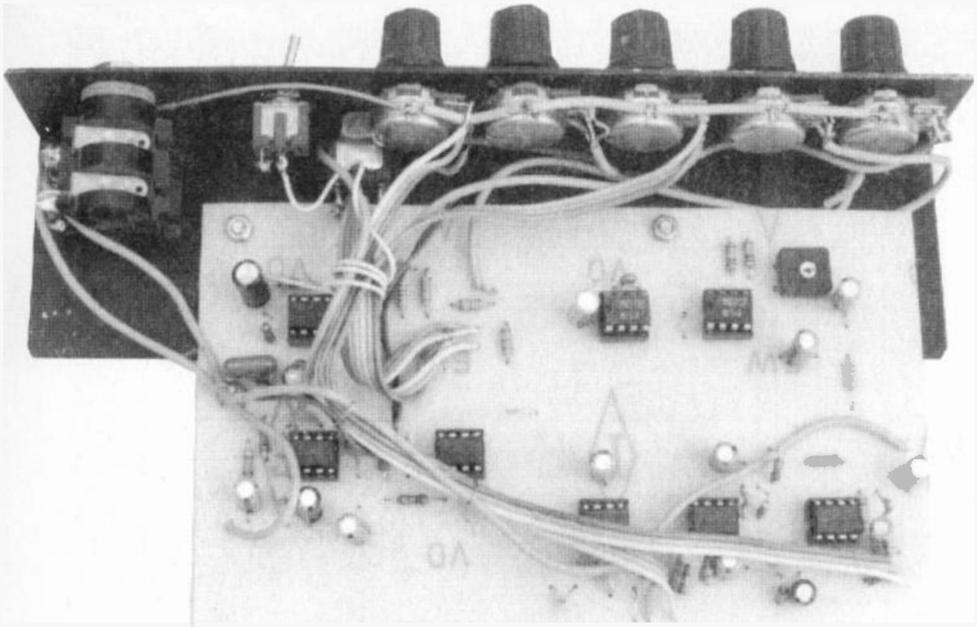


Fig. 5. Details of the printed circuit board component layout and wiring, plus full-size underside copper foil master track pattern.



The additional wiring to the potentiometer bodies ensures satisfactory screening by connecting them to the 0V point on the jack socket.

BY-PASS SWITCH

If the Flanger is going to be used as a musical effects unit, you will need a way of turning it on and off without having to disconnect the power, which can cause horrendous noise spikes unless you disconnect the output first. This can be a bit impractical!

The standard way of arranging an effects by-pass switch is shown in Fig. 6. This method disconnects both the input and output of the active circuit when the by-pass switch is operated, which eliminates switching noise.

The circuit also incorporates a stereo input jack socket wired as an overall power on/off switch. Again, this is common practice in manufactured effects pedals, and does away with the need for a power switch. When a normal mono guitar or instrument lead is plugged into the input socket, the earth sleeve shorts across the first two connections and connects the negative terminal of the battery to the negative supply rail.

The only drawback with this arrangement is that you must remember to pull out the input lead if the unit is not going to be used for a while, otherwise the battery will run down.

Assembly of the p.c.b. should be quite straightforward as the components are well spaced out. Take the usual precautions against heat damage, and solder the resistors and wire links in first. Check the polarity of the polarised components, and use sockets for all the i.c.s. The i.c.s should not be inserted until after all the other construction has been completed.

Connections to the potentiometers can be made with thin multi-strand wire. Do not use solid-core wire as it will tend to break at connection points if it is moved about too much during assembly. All connections to the p.c.b. should be as short as possible to minimise noise pick-up. However, as long as you use an earthed metal case, noise should not be too much of a problem.

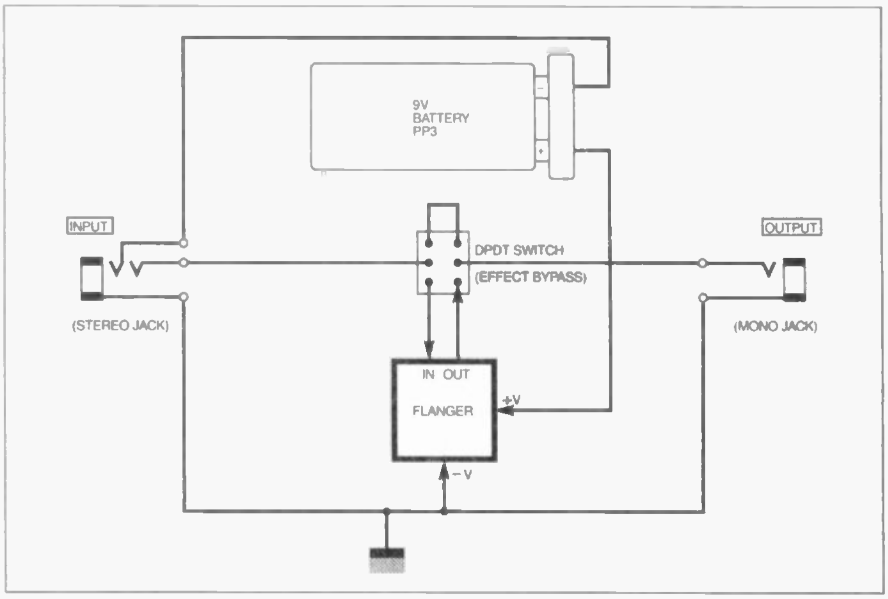


Fig. 6. How to wire the unit to a by-pass switch.

SETTING-UP

Setting up the unit is very simple. Plug a guitar into the input, and take the output to a normal guitar amplifier.

Completely turn down the volume controls on the amplifier, and the level and feedback controls on the flanger. Connect a PP3 battery to the circuit, switch on S2 and check that the l.e.d. comes on. Turn up the volume on the amplifier slightly, then bring up the output level control on the Flanger and listen for a slight background hiss. This will usually indicate that the unit is working.

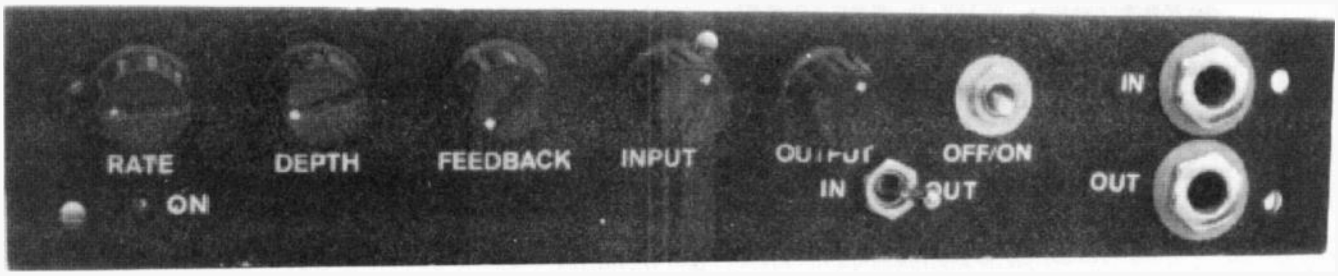
If you cannot hear anything unusual (like the sound of chips expiring!), turn up the input level and check that a signal on the input turns up at the output. With switch SI set for Delay, you should hear short echo effects, with VR3 controlling the length of the delay. In this mode, VRl has no affect.

With switch S1 set to Flanging, the flanging rate can be controlled by VR1, but with VR3 having no effect.

Use the input level, output level and feedback controls to get the best effect. If there is a background whining from the clock circuit, try adjusting the preset VR4 to balance it out, though it may still be just audible if the unit is used with a very sensitive amplifier.

CASING THE UNIT

Assuming that all is well, the unit can be mounted in a case. The prototype unit was actually mounted in a large case which also houses other effects units. A metal case is recommended so that the circuit will be well screened. If you must use a plastic case, try screening the inside with tin foil, but remember that unless the case or screen is connected to earth, it may make noise levels worse.



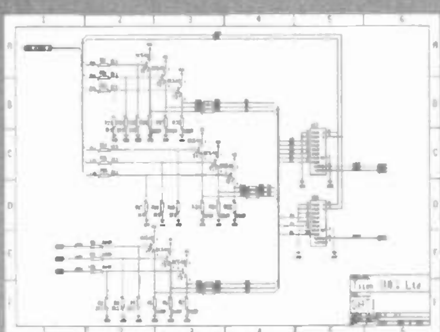
Is your PCB design package not quite as "professional" as you thought? Substantial trade-in discounts still available.

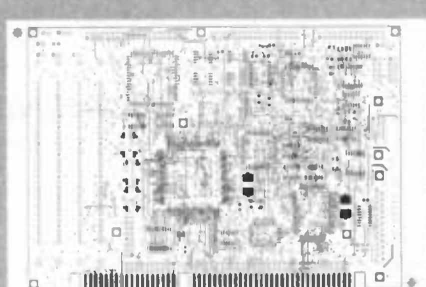
BoardCapture

Schematic Capture Design Tool

£395

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





BoardMaker

BoardMaker1 - Entry level

£95

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

BoardMaker2 - Advanced level

£395

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

BoardRouter

Gridless re-entrant autorouter

£200

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

Output drivers - Included as standard

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

All trademarks acknowledged

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

tsien

Innovations

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

MORE SPENDING ON BRITISH INNOVATIONS

CBI reports good prospects for sensors and electronic tagging

– by Hazel Cavendish

BRITISH companies spent more on innovation in the last two years than in the previous five, according to an Innovation Trends Survey run by the CBI and the NatWest Innovation and Growth Unit. 487 manufacturers and 200 non-manufacturers took part in the survey.

Manufacturers spent 6·2 per cent of their turnover on innovation last year, while non-manufacturers reported 10·6 per cent, in both cases showing a marginal drop from record 1994 figures but showing a healthy increase in the opening years of the decade. Most encouraging was the increase in collaboration between manufacturing and academics shown by an analysis of the Government's *Technology Foresight* programme.

Patents Falling

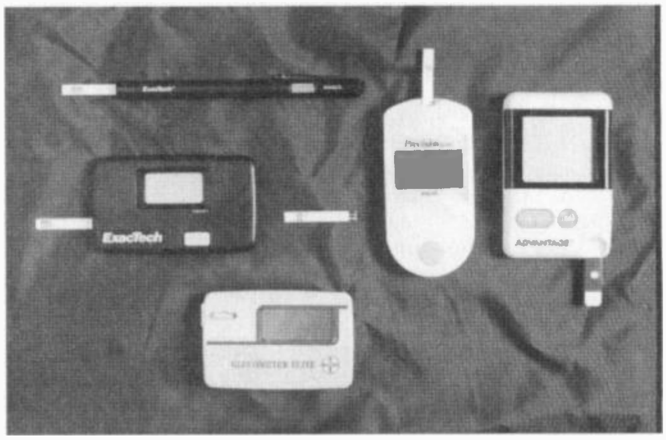
A more disappointing statistic to emerge from the survey was the significant fall in the number of manufacturers committed to patenting. This fell from 77 per cent in 1994 to 62 per cent last year and was echoed by a 10 per cent drop for non-manufacturers.

John McClelland of IBM, who took part in the Foresight exercise, had previously drawn attention to the small number of American patents registered by the UK since 1980, pointing out that this was an indication of just how badly Britain lagged because Government and Industry were spending too little on research.

He warned that, in modern industry, it is "patent or perish". Budgets had been trimmed to an unacceptable level when it took five million dollars of research to come up with one patentable notion.

Another Foresight panel urged that the amount of R&D devoted to telecommunications and information technology should be substantially increased, and the Computers panel called for greater investment in "leading-edge technologies".

As a result of the survey's sector reports, the Department of Trade and Industry is putting £36m into supporting research in six fields with long-range market opportunity and scientific potential. Two of these fields are sensor and automation technology, and communications and computers.



Biosensors for home blood-glucose measurement. None are of British manufacture, even though they could have been.

Cranfield's Sensor Success

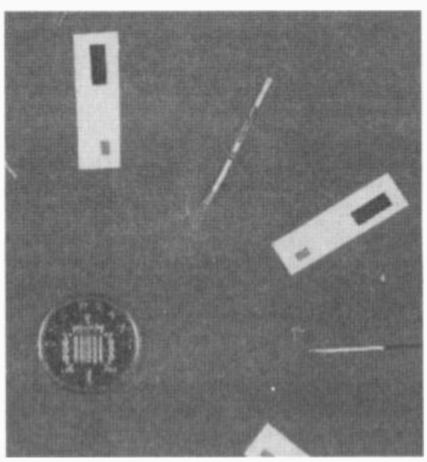
Cranfield University, which celebrates its fiftieth anniversary this year, was chosen in the '80s for a Leverhulme Trust-sponsored chair in biotechnology - the engineering of medicine – because of its excellent links with industry.

Subsequently, their Biotechnology Centre has developed sensors which detect bacteria in water, including the detection of waterborne diseases such as Legionella, and a fermentation monitor which is able to measure the growth of micro-organisms in foods such as yoghurt, bread and beer, enabling improved control of fermentation processes.

Professor Tony Turner, head of the Biotechnology Centre, says bio-sensors have a great future in health care with their ability to both detect and monitor illnesses in the early stages.

He believes tiny sensors could be used in private homes, connected to personal computers, able to throw up medical conditions which can then be reported to the patient's doctor. This will greatly reduce the doctor's load in making patients' visits necessary only when the sensor shows that something is wrong.

"In health care in future we will be looked after in our homes, secure in the power of complete diagnostic systems and continuous monitoring, all based on our computers", he says, adding that recent research with sensors has shown that improved monitoring can greatly reduce the complications of diabetes.



Prototype printed biosensors produced at Cranfield University for lactate measurement. Lactate measured in vivo *or* in vitro *gives an indication of fitness in, for example, human athletes or race horses.*

His Centre's development of sensor technologies is the basis of all three of the best-selling devices used by diabetics to measure blood sugar levels before meals, but he is disappointed that British industry's failure to follow up on his department's research has resulted in three foreign market leaders making millions of dollars annually, based on a Cranfield sensor. The sensors shown in the photograph above originated from the USA and Japan.

Tagging Growth

Electronic tagging is another growth area of considerable potential. This has many applications in addition to the familiar plastic rectangles attached to merchandise in stores which sound off a daunting alarm when we thoughtlessly pluck a garment from a rail for personal inspection.

St James's University Hospital in Leeds introduced baby-tagging following the abduction of Abbie Humphries from the Queen's Medical Centre in Nottingham in 1994.

Unfortunately this development has been beset by problems caused by interference from other equipment, or because the tagging devices were originally designed for different environments.

St James's actually abandoned the experiment and reverted to other security measures, but Queen Charlotte's Hospital in London and Edinburgh Royal Infirmary's Simpson Memorial Maternity Pavilion have expended much time and effort to fault-proof their systems. Hospitals have so much electrical machinery that innumerable things can set off the alarms, including vacuum cleaners and television sets.

Now a real opportunity for electronic tagging companies has come up as a result of the BSE problem. Europe requires a tagging system for cattle, and a National Cattle Database Working Group is considering the matter while several British electronic companies are working feverishly to produce the answer, said to be worth £42 million annually to the company that can deliver the goods with the minimum delay.

It is to be hoped that for once Britain will win this lucrative prize ahead of Europe and the Far East.

PRECISION CAPPING

THOSE needing to accurately measure capacitance values should consider the latest digital capacitance meter from Seme Ltd. The DKM190 is capable of measuring capacitors in range from 1pF to 20,000µF with an accuracy of 0.5%.

The instrument is operated from a 9V battery, with a running time of approximately 200 hours (depending on the type of battery used). If the power falls below the operating voltage, the low voltage warning symbol is displayed.

With its wide capacitance measuring range, this instrument can be employed in all fields of electrical and electronic engineering, particularly in radio and television design and repair workshops.

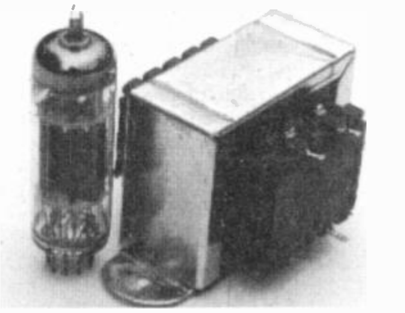
The meter is supplied with a carry bag, test leads, battery and instruction manual, at a price of £73.

For further information, contact Seme Ltd., Dept. EPE, Unit 2, Saxby Road Industrial Estate, Melton Mowbray, Leics LE13 1BS. Tel: 01664 65392.

Valve Transformers

A RANGE of transformers specially designed to meet the needs of the resurgent valve market has just been launched by Variable Voltage Technology Ltd. Aimed at the electronics and amateur radio enthusiast, the new VTM range is manufactured to traditional requirements, but using modern methods and materials, including high grade annealed copper wire and high quality grain-orientated laminations.

The VTM transformers have been designed to give a low flux density to ensure reduced external magnetic fields. They meet the requirements of EMC (electromagnetic compatibility) and low voltage directives.



Frame or vertical mounting types can be specified and are available for the following applications: mains transformers for HT circuits with or without filament windings; filament transformers; mains smoothing chokes; output transformers; grid coupling transformers.

As a specialist transformer design and manufacturing company, VVT can customise its standard range of transformers to meet non-standard requirements. For more information, contact Variable Voltage Technology Ltd., Dept. EPE, Unit 24, Samuel Whites Estate, Medina Road, Cowes, Isle of Wight, PO31 7LP. Tel: 01983 280592.

Your Flexible Friend

P.I.D.A., the Professional Instrument Distributors Association, has advised us that a new flexible a.c. current probe has been introduced. The probe is ideal for irregular shaped conductors with difficult access.

Compatible with any digital multimeter, chart recorder or oscilloscope, LEM-flex is claimed to be the most versatile measuring device of its type, providing wrap-around flexibility with two standard current ranges to each unit. Compact, light and portable, it has the added benefits of a wide bandwidth, one per cent accuracy, electrical isolation and rugged durability.

Standard models from P.I.D.A. are available in lengths of 61cm, 91cm and 122cm, with dual ranges of 30A/300A, 300A/3000A and 600A/6000A.

For further information, contact P.I.D.A., Dept. EPE, 3 Brackenley Court, Embsay, N. Yorks BD23 6PX. Tel: 01756 799737.

SCHOOLS ONLINE

The "Schools Online" project – a pilot study to promote structured education via the Internet – will be expanded from 60 to over 200 participating schools with an extra £450,000 funding from the DTI if teachers and sponsoring companies want it to go ahead, Science and Technology Minister Ian Taylor has recently announced.

Phase two will aim to further develop the Internet skills of teachers and students, provide accreditation for participating teachers, produce best practice case studies for UK-wide distribution, continue mentor support from sponsors, and disseminate the lessons to all schools in the UK.

Initial evaluation shows that the DTI's project has been a "significant contribution to understanding the information superhighway".

Speaking at the "Schools Online" conference in Birmingham, Ian Taylor said: "Information and communications technology have the potential to make a massive contribution to how our children learn and equip themselves for life and work in the next century.

"The key has been the development of software to support better use of the Internet in schools' teaching. Schools can now go on-line via the standard telephone, but higher capacity connections are now being marketed to schools."

Further information is available from Tom King, Schools Online Project Manager, tel: 01924 378111.

REVEILLEZ!

French car makers, Renault, are developing a device which will wake drivers up if they are nodding off behind the wheel. A small infra-red camera system continually monitors the driver's eyelids and measures how long they are closed. If they stay shut too long an alarm sounds.

Drowsiness is said to be the second commonest cause of accidents involving heavy lorries and coaches in France. Renault feels that its system can help prevent a significant number of accidents. The majority of drivers asked are in favour of the concept.

The system will be operational on an experimental basis early in 1997 and is likely to be adapted for cars as well.

KEELOQ CODE HOPPER

Microchip has added a further product to its family of KEELOQ code hopping devices. Keeloq devices provide rock-solid security in remote keyless-entry systems using r.f., infrared or microwave transmissions.

The new HCS200 operates over a voltage range of 3·5V to 13V and has three button inputs providing up to seven functions. Using a complex non-linear algorithm that combines a programmable 28-bit serial number with a 64-bit encryption key, the device generates a 32-bit hopping code that changes with each successive transmission and eliminates the possibility of unauthorised access.

Simultaneously announced is the *Silicon Solutions for Security* guide which provides technical solutions for a range of security applications, including remote keyless entry, alarm and access control, smart cards and personal communications products. The guide offers designers a valuable head start that can significantly reduce development time and cost.

For more information, contact Arizona Microchip Technology Ltd., Dept. EPE, Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks SL8 5AJ. Tel: 01628 851077.

TIME-BOMB 2000

Innovations in *EPE* August 1996 briefly reported on the potential problems for business computer systems which may crash with the "00" of the millennium date change.

A recently received press release from the Department of Trade and Industry (DTI) confirms that the pending problem is real and not just a media story befitting April 1st or the Summer Silly Season.

Apparently, the UK has taken the initiative over the millennium date change within Europe. The Minister for Science and Technology, Ian Taylor, says that he has "asked senior representatives of interested parties in industry and the Bank of England to discuss remedial action with me and encouraged the Computing Software and Services Association to set up a task force to examine the action that can be taken in conjunction with users.

"Government departments have also been asked to draw up an action plan to show how they will deal with the problem internally and to assess how much of a problem there might be for any industrial sectors they sponsor. Within the DTI the Information Society Initiative will provide advice for companies.

"If the time-bomb is to be stopped from exploding we all need to start planning now", he added.

The DTI advise that the Computer Services and Suppliers Association has available a directory of organisations providing specialist Millennium skills and products. To obtain the directory contact: Nicki Blinkhorn at CSSA on 0171 405 2171. Alternatively, the directory is available on the CSSA's WWW site at: http://www.cssa.co.uk/cssa/new/Mmillen.htm.

Soldering On

Vann Draper Electronics are introducing what they describe as "an extremely competitive range" of soldering stations. The range initially comprises three models, the SL20, SL30 and SL916, priced at £59, £69 and £349, respectively.

The SL20 is an electronic temperature controlled soldering station with a plug-in 24V 48W soldering pencil. Temperature is fully adjustable between 150°C to 420°C with a 12-l.e.d. bargraph indication for actual temperature and heat-on mode.

The SL30 provide similar facilities to the SL20 except with a higher temperature range of 160°C to 480°C and a digital readout of both the preset and actual temperature.

The SL916 is a combined soldering and desoldering station with independent temperature control of both the soldering iron and desoldering gun allowing simultaneous use of both.

Whilst the SL916 is probably best suited to professional electronics users, the SL20 and SL30 should be considered as possible additions to the workshop of any serious electronics hobbyist.

For more information, contact Vann Draper Electronics Ltd., Dept. EPE, Unit 5, Premier Works, Canal Street, South Wigston, Leics LE18 2PL. Tel: 0116 277 1400.

Catalogues Abound

We have received the latest catalogues from *Alpha, Mauritron* and *Rapid* all of which are worth adding to your library.

Alpha Electronics (Southern) Ltd. have a good range of electrical and electronics test and measuring equipment. They are members of the PIDA (Professional Instrument Distributors Association) and are based at Dept EPE, Unit 16, Wren Industrial Estate, Coldred Road, Parkwood, Kent, ME15 9XN. Tel: 01622 690187.

Mauritron Technical Services, as we are sure you are well aware, have an enormous range of service manuals and technical books available for most equipment, of any make, age or model, most of which are also available on CD-ROM. Mauritron are at 8 Cherry Tree Road, Chinnor, Oxon OX9 4QY. Tel: 01844 351694.

Rapid Electronics' 400+ page catalogue offers an enormous range of electronic products, right across the spectrum, including passives, actives, electro-mechanicals etc. It is another major catalogue which ought to be on your shelves. There is a £3 charge for it, but it's well worth it. Write to Rapid at Dept EPE, Heckworth Close, Severalls Industrial Estate, Colchester, Essex CO4 4TB. Tel: 01206 751166.

A fourth catalogue received is from a company whose products were previously unknown to us – Hogg Laboratory Supplies. It does not have a lot directly to do with hobbyist electronics, but is nonetheless likely to be of interest to all you broadly-inventive experimenters. Amongst the subjects covered are general laboratory apparatus, chemicals, microscopes, anatomical models, biology, environmental science etc. For more information, write to Hogg Laboratory Supplies Ltd., Dept EPE, Sloane Street, Birmingham B1 3BW. Tel: 0121 233 1972.

8-PIN PICS

More news from Microchip highlights their introduction of the world's first 8-pin microcontrollers.

The new PIC12Cxxx 4-bit one-time-programmable (OTP) microcontrollers pack Microchip's powerful RISC-based PIC16/17 architecture into an 8-pin package. As well as offering mathematical and Boolean performance not available on most 4-bit microcontrollers, the low pin count of the new OTP family makes it extremely cost-effective and flexible.

The first two family members, the PIC12C508 and PIC12C509, feature 512 words of program memory with 25 bytes of user RAM, and 1024 words of program memory with 41 bytes of user RAM, respectively.

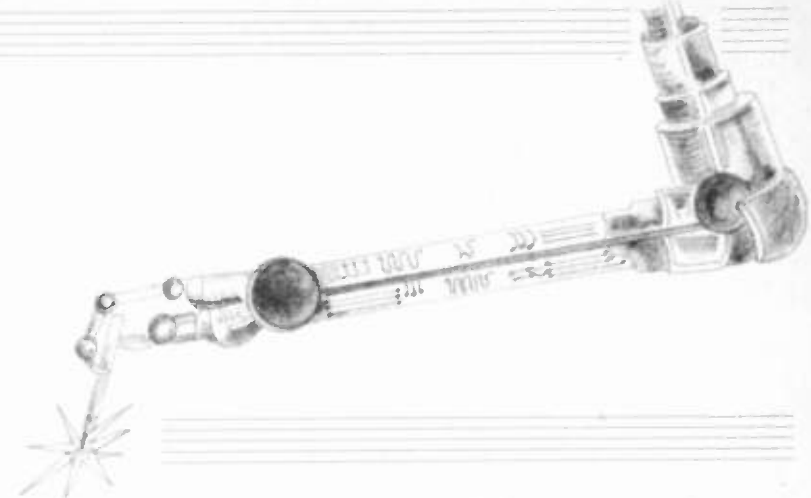
Both devices provide six I/O with on-chip oscillator, 33 single-word instructions, full-speed 1µs instruction cycle at 4MHz. There are seven special function hardware registers, 2-level deep hardware stack, 8-bit real-time clock/counter with 8-bit programmable prescaler, watchdog timer, direct l.e.d. drive, low 2·5V-5·5V operating voltage and less than 2mA power consumption at 5V/4MHz.

In other words, these are astonishingly powerful little chips. It's a shame, though, that they are not also available in EEPROM versions allowing in-circuit development of control software.

For more information, contact Arizona Microchip Technology Ltd., Dept EPE, Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks SL8 5AJ. Tel: 01628 851077.

Regular Clinic

CIRCUIT SURGERY



ALAN WINSTANLEY

Our monthly "Surgeon" gives some sound advice on handling lead-acid batteries, helps out with a boat owner's electrical woes, offers more on the chemistry of NiCad charging, and warns about over-hot batteries.

I feel a "battery special" coming up this month, so let's dip our toes into the briny with a question from *Mr. Oliver Lazarus* of Oxford, who asks:

Help! I'm moving into a boat where all electricity will be supplied by two 12V lorry batteries, powered by a petrol generator, with the help of a wind generator, too. My experiences so far of using 12V appliances on these batteries have been both smelly and expensive!

Could you give me some tips and advice so that I can safely live a life afloat, in one piece? Also, how do I connect lower voltage units to a 12V battery? With a transformer for instance? Thanks!

Connecting to a 12V lorry lead-acid battery poses many hazards. Obviously there is the immediate risk of accidentally reverse-connecting the load, this may damage an unprotected unit beyond repair (as I think you found out with your stereo).

There is *massive* capacity within a 12V car or lorry lead-acid battery to provide enormous currents (many hundreds of amps, instantaneously) and it is potentially quite easy to burn out any wiring, causing an electrical fire if the battery was wrongly connected. How well the appliance would withstand a reverse supply, depends on what protection it includes, if any. In-line fuse protection is a good idea, and the fuse should be connected as close as possible to the battery's +12V terminal so that the full length of wire is protected.

Explosive

Lead acid batteries (if not of the "sealed gel" type) may emit hydrogen gas which will become explosive when mixed with air. If you cause a spark near the battery's cells, then in *extreme* circumstances a battery explosion could result, causing serious personal injuries. (Have I put you off setting sail, yet? Sorry.)

Sparks may be caused by twiddling with the battery terminal connections when a load is already connected to the battery. It is safest to switch off all (heavy) loads, cover the battery with a damp cloth, and ensure good ventilation, when adjusting it for any reason.

Burns may also be caused by wearing a metal watch strap, for example, or using a spanner or screwdriver blade carelessly.

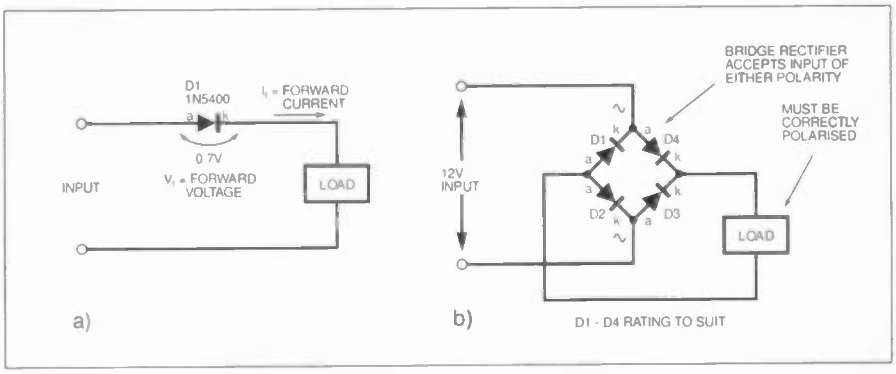


Fig. 1. Reverse polarity protection.

This may accidentally cause a short circuit through the metal, causing serious wrist burns as 200-300 amperes flow merrily through.

A rectifier, if added inside the appliance, will guarantee that no current will flow if the supply is connected the wrong way round, see Fig. 1a. The rectifier should have a "forward current rating" (symbol, I_f) to enable it to cope with the current which will be drawn under normal operation. You will lose about 0·7V across the rectifier but this shouldn't matter.

You could also consider a resettable thermal trip which acts like a fuse, but pressing a button resets it again. Maybe use one thermal trip a few inches away from your battery +12V terminal.

It's possible to add a simple "bridge rectifier" – maybe inside the appliance – which will guarantee that whichever way you connect the battery, it will work correctly. It's a neat idea but you will then lose about 1·4V, which I don't think would be a problem with, say, a stereo or other appliance. Fig. 1b shows how.

To "step down" from 12V d.c. to, say 6V or 7·5V d.c. you can't actually use a transformer since these work with pulses or a.c. only. The easiest way is to use a

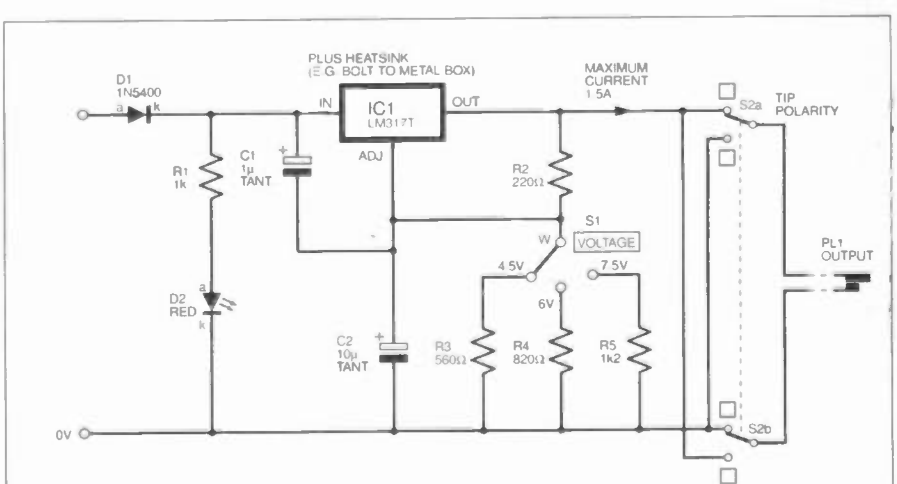


Fig. 2. Mini power source from 12V batteries.

regulator chip, see Fig. 2 which shows a unit capable of offering different voltages to operate low voltage appliances from a 12V battery. Regulators including the LM317 type are current-limiting, short circuit proof, over-heat proof though they are still not indestructible. This circuit will provide up to 1·5A. IC1 should be heat-sinked, perhaps by bolting it with an insulating kit, to a metal box.

Battery Monitor

I've sketched an l.e.d. voltmeter (Fig. 3) which may help you to keep an eye on your 12V battery. This uses an LM3914 bargraph display, IC1, adapted to measure its own supply, so you simply wire it directly across the 12V supply voltage (right way round – watch pins 2 and 3 carefully!). Ten light-emitting diodes D1 to D10 will indicate the applied battery voltage, ranging from 1·5V to 15V.

The i.c. contains ten internal comparators connected totem-pole-like, each sinking current through a light-emitting diode. They compare an internal reference voltage against the chip's input voltage, at pin 5. I've set the i.c. reference voltage with resistors R3 and R4 to just under 5V. This means that one l.e.d. will light for every 500mV (5V reference/10 stages) increase in the signal.

To enable this to be used to read a 12V battery (the chip's own supply rail, in this case), resistors R1 and R2 are included as a divider: an input of roughly +15V will cause D1 to light. When the voltage gradually falls, l.e.d.s D2-D10 will progressively illuminate. The circuit is set as a "moving dot" display. Connect pin 9 to the positive rail for a bargraph display (not recommended because of the current consumption).

Since the ten outputs are effectively constant-current sinks, the l.e.d.s. will glow at a level independent of the changes in the supply rail: they won't dim when the rail drops. However, the first two or three display l.e.d.s. (D8-D10) are superfluous in this application, because the LM3914 won't operate correctly below a rail of about +5V; I showed them only in case you want to adapt the design for other applications, otherwise you can omit them. Anything much less than 10V or so indicates you've a real problem with your battery!

Dial Light

Another feature I've added is a "Dial Light" switch. When S1 is closed, each l.e.d. is grounded through a high value resistor, and will glow faintly. One l.e.d. will glow much more brightly when it's displaying the voltage level. The value of resistor depends on the l.e.d. you use – up to 33k or so for high-brightness types is fine. Light-emitting diodes are easily discerned in murky locations but are best mounted out of direct sunlight. Different colours may be used for an at-a-glance check, too. Maybe caravanners and campers will find the circuit of use, as well. I gave more LM3914 hints and tips in December 1995's *Circuit Surgery*. The *Power Check* project in this issue might also be of interest to you.

In general, almost everybody takes a lead-acid battery for granted but they make extremely dangerous foes if treated incorrectly or casually. I have seen the results of a battery explosion and the consequent burns caused to an acquaintance, so I would urge that they are treated with the utmost respect. The present range of sealed-gel batteries (e.g., as made by Yuasa) are expensive, and can't match the capacity of a car/lorry battery, but use a far safer technology in every respect. Thanks for the question and *bon voyage!*

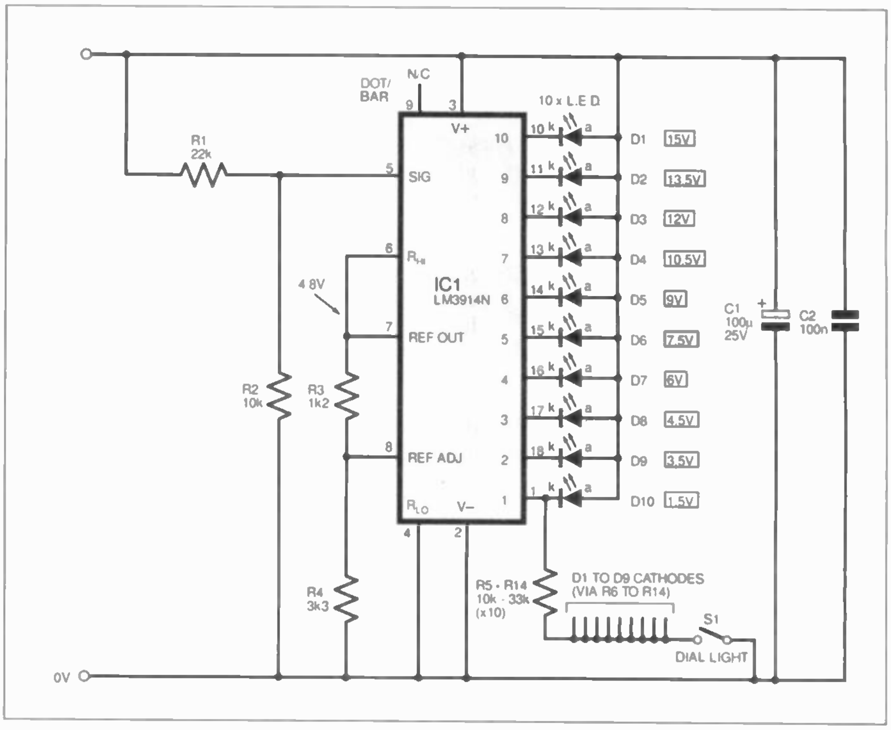


Fig. 3. Car/boat battery voltmeter.

The Great NiCad Debate

This morning, whilst preening myself in front of the mirror and wondering what to write about next, my rechargeable electric shaver went "flat". Probably the most topical subject of any, because everyone from RC modellers to mobile phone owners use them, the care and use of Nickel-Cadmium cells and batteries (multiple cells) continues to arouse debate!

Readers might recall earlier *Circuit Surgery* columns which dealt with the supposed "memory effect", more correctly called *voltage depression*. To the man in the street, it's when his NiCads go flat more quickly than they used to.

Voltage depression is caused by larger cadmium crystals forming on the cadmium electrode inside the cell when re-charging. This increases the internal resistance of the NiCad and creates an unwanted voltage drop. We'd prefer to see a *smaller* crystalline structure with smaller boundaries which lowers the internal electrical resistance. Larger cadmium crystals become progressively harder to re-form during recharging, so the problem escalates.

Although NiCads have a definite lifespan anyway, voltage depression is caused solely by a poor charge/discharge regime on the part of the user, and has been manna for mobile phone salesmen selling spare batteries.

Behaviour likely to spell doom to NiCads include: *light or partial cycling*, because the cadmium deep within the cadmium plate never fully forms into cadmium hydroxide during discharge. Recharging is supposed to convert it back again, into cadmium, but partial cycling leads to an underlying growth of those unwanted large cadmium crystals. The more you do it, the worse it gets.

Deliberate and excessive trickle charging/overcharging is bad news which also means "large crystals". Have you ever noticed how, the more you try to charge something – you leave it on overnight, then all day too, then for several days, and you *still* get less charge? Your cells have got "voltage depression".

High temperatures also spell death as this promotes the growth of larger cadmium crystals inside. Overcharging can lead to high temperatures too. Actually, temperature is probably the most overlooked factor, and very possibly the most critical one! If your cells become at all hot, you've overcharged them.

"Deep discharging" is questionable. It may help to convert some "deep" cadmium crystals, which may have grown through partial or light cycling, into cadmium hydroxide. Many say it does nothing beneficial at all.

Deliberate deep-discharging to 0V is futile and a complete waste of time, or so the current thinking says. Forget what the mobile phone salesman said about discharging your NiCad battery to "zero".

Other views say that it's good to discharge cells heavily once in a while but not fully down to 0V. Most seem to agree though, that you should never do this to a *battery* (containing several cells), because you run the risk of reverse-charging some of the cells.

Recover those NiCads

Poor performance may however be reversible. The aim of re-conditioning a "forgetful" NiCad is to destroy those large cadmium crystals and replace them with small "microcrystals" instead. If you treat them more sympathetically again, they will quite often recover.

Vary the charge/discharge cycles. Charge for no more than 15 hours or whatever the manufacturer recommends, to avoid overcharging. When you can measure it, commence recharging when the cell has fallen to absolutely no less than 0·5V per *cell*. A constant-current load may help, but it has to be used in a controlled manner.

Most importantly, do not overcharge them for long periods. Smaller discharge phases, with "proper" recharging in between, will contribute to a healthy life. In trying to recover a cell, the bottom line is – just start to use them properly again, *more often*.

According to the latest thinking, although the value of 1·0V is often quoted as the critical cut-off voltage, below which a NiCad should not fall, this figure is less "gospel" than we previously thought. I think the best current advice is not to discharge them to zero ever, (*definitely* not, in the case of a multiple-cell battery) but consider a value of about 0·5V to 0·6V per cell the minimum terminal voltage.

The problem is that during discharge, the cell's quite steady discharge curve suddenly plummets as its terminal voltage aims like a bomb towards 0V (see *Circuit Surgery*, February 1996, page 145). So if you do find yourself with a cell reading about 0·5V or so, it is unwise to continue with its use and you should commence re-charging.

I am afraid that NiCad battery owners have more of a problem, because cells need to be "re-conditioned" individually and unless you can access the 1·25V cells themselves, any battery overcharging or excessive discharging may cause an individual cell to reverse, and you may not be able to recover the battery.

The information was variously supplied by engineers at NASA, Hewlett Packard, Varta, and Steve Walz in Silicon Valley, and appeared in the **sci.electronics** newsgroups. See our *Net Work* column for more pointers to Internet sites relevant to electronics enthusiasts.

Hot Battery

From ***Jon Jacobs***, by E-mail came the following query related to alkaline batteries.

Do you know of any home-brew method of attaching those nasty tabs to alkaline batteries? Can it be done with a MIG welder for example, or simpler? Thanks for any help.

I've never actually seen *alkaline* cells with tags fitted to the terminals, though it's not unusual to see Nickel-Cadmium cells with tags. MIG welding, or any other form of welding, is a definite no-no, I'm afraid.

The intense temperatures reached in such a short time will cause great damage and it would be dangerous to attempt this. The battery terminals are, I think, nickel plated, and on NiCads at least, they seem to be spot-welded during production.

I'm afraid I can't see any way you could attach the tabs except by maybe soldering both surfaces and gingerly trying to "sweat" them together with a soldering iron. Have plenty of freezer aerosol handy! But I'm not even sure whether ordinary lead/tin solder will "take" to the surface. I do however know that you can solder wires to some batteries (such as coin cells). Maybe try soldering wires directly to the battery. ***You must take extreme care not to apply excessive heat, though. Any ideas, anyone?***

Surgery Calls

If you have any questions to ask, or comments to make, please write to Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail **alan@epemag.demon.co.uk**

We cannot guarantee an individual reply nor undertake to answer questions on commercial equipment but we try to help whenever possible. See you next month.

SHOP TALK

with David Barrington

Analogue Delay/Flanger

Looking for parts for the "bucket brigade" *Analogue Delay/Flanger* project proved to be a fairly straightforward exercise and most items are commonly stocked by component advertisers. The exceptions to this are, of course, the low voltage delay line and clock generator/driver i.c.s. which may not be carried by your local supplier.

Some analogue delay chips have an in-built clock function, but the MN3207 delay has a partner i.c. (MN3102) which provides the necessary clock signal and gate voltage. Both these i.c.s are currently stocked by **Maplin**, codes UR67X (MN3207 delay) and UR68Y (MN3102 clock/driver).

The choice of case is left to individual choice, but it should be a *metal* type to give some "screening" to the circuit and help cut down on any possible noise pick-up. Also, it is good practice with any audio circuits to use screened leads for wiring the input and output sockets to the p.c.b.

The Delay/Flanger printed circuit board is available from the *EPE PCB Service*, code 111.

Simple Exposure Timer

One or two points need to be repeated concerning the construction of the *Simple Exposure Timer*. The most important being: ***Be aware that when testing the unit potentially lethal mains voltages are present and extreme care must be taken during this operation.***

The wattage and voltage rating indicated in the "comp. list" for certain components are *minimum* ratings and must be as specified or greater. The 2W metal film resistor should be stocked by most component advertisers.

However, the "continuous" mains rated capacitor and transient suppressor may be a little difficult to find. If problems do arise, the ones in the model came from **Maplin**, codes JR36P (IS Cap) capacitor and HW13P (Supp 250L) suppressor.

When purchasing the transistor check the pinout connections as the various versions of BC184's have differing pin line-ups. One with the suffix L was used here. The printed circuit board is available from the *EPE PCB Service*, code 113 (see page 731).

PIC-Tock Pendulum Clock

A few problems could arise when searching for components for the *PIC-Tock Pendulum Clock*.

The Sharp spectrally matched infra-red emitter diode type GL380 and special detector phototransistor type PT380 are specific to this design and, as far as we are aware, no alternatives are available. These are RS devices and can be purchased through **Electromail** (***01356 20455***), their mail order operation, or any *bona-fide* RS stockists. Quote codes 195-489 (GL380) and 195-502 (PT380).

Supplies of the PIC16C84 EEPROM microcontroller are now plentiful and no problems should be encountered in obtaining this device. The same applies to the crystal.

The PIC microcontroller needs to be programmed and the *Simple PIC16C84 Programmer*, described in our Feb '96 issue, together with a PC-compatible computer is ideal for the job. (Regrettably, the Feb '96 issue, is "sold-out" and we can only supply photostats of the article – see page 722.

A software source (ASM) and object file (.OBJ) for *PIC-Tock* is available on a 3·5in disk from the *EPE* Editorial Offices for the sum of £2·50 (Overseas – surface mail £3·10; airmail £4·10). It can also be downloaded from our Internet ftp site address: //ftp.epemag.wimborne.co.uk

The small printed circuit board, which also needs cutting to provide the diode emitter p.c.b., is available from the *EPE PCB Service*, code 109. Probably your best source for the required "hardware" will be your local "plumbing" depot.

Draught Detector

Not too many problems were encountered when tracking down components for the *Draught Detector* project. The positive temperature coefficient thermistors came from **Electromail** (***01536 204555***), order code 158-272 (disc thermistor 80°C).

The potentiometer installed in the prototype model is a wirewound type usually used as a "loudspeaker volume control." This came from **Maplin**, code FX40T. The small buzzer also came from the same source, code KU58N.

The printed circuit board is available from the *EPE PCB Service*, code 112.

Power Check

It is most important that constructors stick to the 3W or greater wirewound power resistors specified in the *Power Check* project. It is also important that they be mounted separately, on a small tagboard, to the main p.c.b.

Quite a number of component advertisers still stock tagboards and tag-strips, but make sure you mount it well clear of the base of the case. Due to resistor heating, when high currents flow, a metal box should be used to house the circuit.

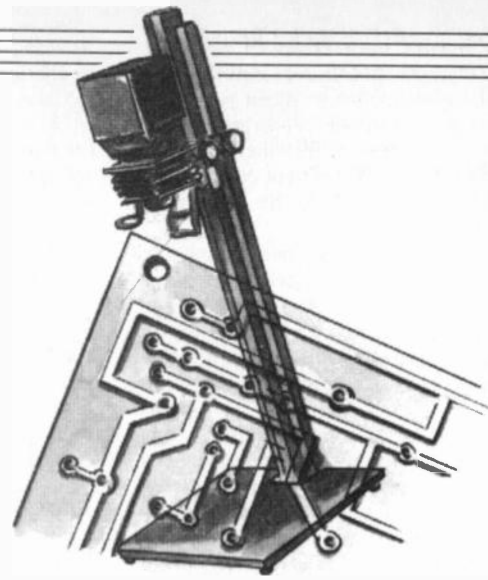
You must use 10A minimum rating wiring where indicated in the article.

Tri-colour 5mm l.e.d.s are widely stocked and should be easily obtainable. Low-voltage 3V to 24V, p.c.b. mounting, buzzers should also be readily available. Try **Maplin**, code KU58N.

The printed circuit board is obtainable from the *EPE PCB Service*, code 110.

Constructional Project

SIMPLE EXPOSURE TIMER



ANDY FLIND

Make light work of timing the precision exposures for p.c.b. making or darkroom printing.

A FREQUENT workshop task for the author is the making of small printed circuit boards. The usual procedure for this is to prepare the artwork, have it copied onto transparent acetate and then expose through this onto photo-sensitive coated board using an ultraviolet light box. Developing and etching in the usual manner then produces a finished board ready for drilling and assembly.

Since the light box was not fitted with a timer, it was decided to construct one as their use is far more convenient than standing over the process with a stopwatch, and produces more consistent results.

It should be pointed out that the presence of live mains in this circuit renders it potentially hazardous. Consequently, **it should only be built by constructors with sufficient experience to recognise and avoid the dangers.** However, practically all of it can be tested using a safe, low voltage d.c. power supply.

TIMING RANGE

Commercial light box timers usually have a range extending to at least twelve minutes. It seemed sensible to provide the home-produced one with something similar, yet the optimum exposure in most cases appears to be about two and a half minutes. Because of this, it was decided to provide an "expanded" control, with the first couple of minutes spread over half the scale for fine adjustment, with the remainder progressively compressed.

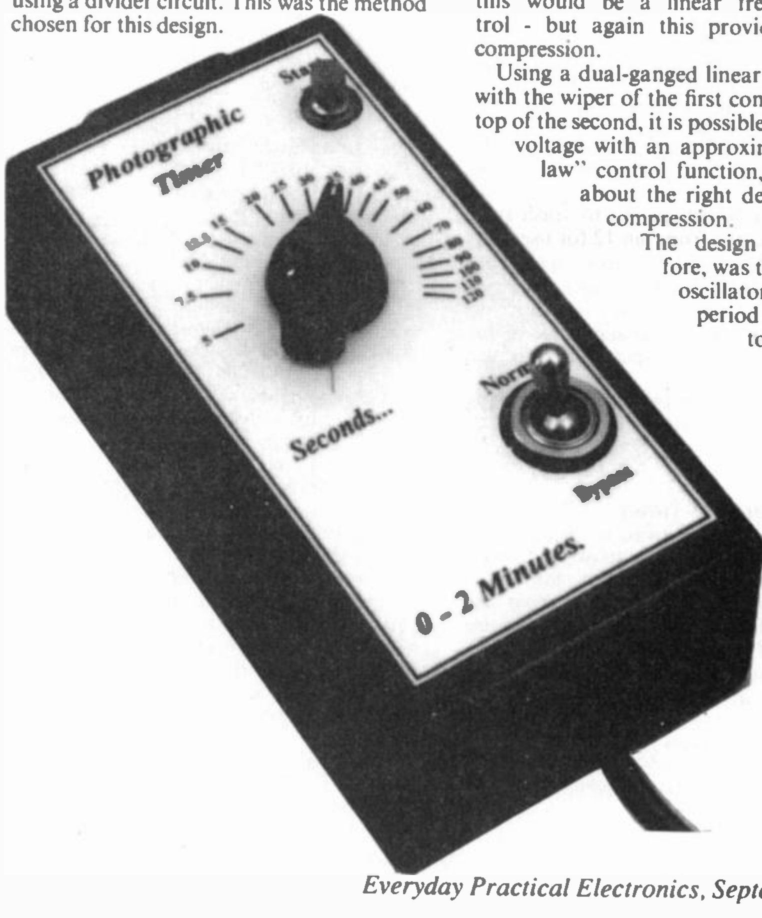
Whilst the design was in progress, the author's daughter acquired a photographic enlarger, and it soon became apparent that a small modification would result in a timer suitable for controlling this as well.

The usual exposure used in photographic printing is less than a minute, although some enlarger timers extend beyond two minutes. With the expanded control, it is possible to provide a two-minute scale with finer control over the first minute. In fact, the timer shown in the photographs is the "photographic" version, as the UV timer has been built into the light box.

TIMING ACCURACY

Although timer circuits using electrolytic capacitors for long periods are not uncommon, this is not always the best approach because of the wide tolerance in the values of these components. This makes it difficult to design a reliable and "repeatable" circuit. Additionally, the leakage currents associated with electrolytics may also affect timing performance if they are used with high-value resistors.

Where a period in excess of a minute is required, it is much better to use an oscillator with a relatively short period and then to count a set number of these periods using a divider circuit. This was the method chosen for this design.



SCALING UP

Expanding a portion of the control scale presented an interesting design challenge. A linear potentiometer produces a linear variation of period in many oscillator circuits, but substitution of a logarithmic pot produces too much expansion for this design.

An interesting point about log pots is that the "law", if measured and plotted as a graph, is not usually the smooth curve that might be expected. In fact, it often consists of just two straight-line sections with a sharp connecting "knee", presumably reflecting the fact that most manufacturers make tracks from just two types of resistive compound! Other pot laws are available, but not often to home constructors.

It is possible to construct an oscillator where the period is proportional to the reciprocal of the control position - in fact this would be a linear frequency control - but again this provides excessive compression.

Using a dual-ganged linear pot, though, with the wiper of the first connected to the top of the second, it is possible to produce a voltage with an approximate "square law" control function, which gives about the right degree of scale compression.

The design aim, therefore, was to produce an oscillator with a cycle period proportional to this voltage.

CIRCUIT DIAGRAM

The complete circuit diagram for the Simple Exposure Timer is shown in Fig. 1.

In this circuit, op.amp IC1b and timer IC2 form a voltage controlled oscillator circuit having its frequency varied by the dual-ganged potentiometer VR1.

The power supply, about 12V, is divided by two and buffered by op.amp IC1a. Between them, VR1a and VR1b then tap the output of IC1a to produce the required control voltage.

Resistor R3 effectively swamps any variations in VR1 value, preventing them from altering the lowest control voltage as set by R4 and R5. The values of these resistors are chosen to give a ratio between the highest and lowest voltages of 32·5:1, which sets the timing range from 0·4 to 13 minutes, ensuring cover of the intended range of 0·5 to 12 minutes.

The control voltage does not conform exactly to a square law because of the way in which VR1b loads VR1a, but it is fine for the purpose of this design. Resistor R7 and capacitor C2 remove any noise present on the control voltage.

COMPARATIVE REFERENCE

Op.amp IC1b is used as a comparator. Capacitor C1 charges in exponential fashion from VR2 and R6 until the voltage across it reaches the selected control voltage from VR1b. When it does so, the output of IC1b goes low, triggering timer IC2 which then delivers a 2·5ms pulse from output pin 3. This is used to discharge C1 via transistor TR1. The output from IC2 is therefore a series of pulses with the period between them controlled by the voltage from VR1.

The frequency used is quite low, between 1·5Hz and 35Hz. This means that the 2·5ms reset pulse forms only a small part of each cycle, yet is long enough to ensure complete discharge of C1. VR2 provides overall trimming adjustment for calibration.

From IC2, the output pulses are applied through resistor R10 to the clock input of binary counter IC3. This counts the pulses until the selected output goes high, thus blocking the clock signal via diode D1.

Pin 15 of IC3 is the 11th counter output, so 1024 clock pulses are counted before this goes high. Provision is made on the printed circuit board (p.c.b.) to select two other outputs, one from pin 12 for use as a two-minute timer and one from pin 4 for assisting with calibration.

GATED OUTPUT

The final output of the circuit is controlled by quad NOR gate IC4. The first two gates of this, IC4a and IC4b, are connected to form a set-reset flip-flop. When the circuit is first energised, a positive pulse from C5 via D2 to IC4a pin 1 causes IC4a output pin 3 to go low and IC4b output pin 4 to go high, the "off" state. This ensures that the output is not immediately energised when the unit is plugged in.

The high output of IC4b pin 4 charges C4 through R13. When Start switch S1 is pressed, the charge on C4 positively pulses IC4b input pin 6, causing output pin 4 to go low and output pin 3 to go high, the "on" state. At the same time, the pulse resets counter IC3 via its input pin 11.

Capacitor C4 will not be recharged until the output returns to the "off" state, ensuring that if switch S1 is held down or

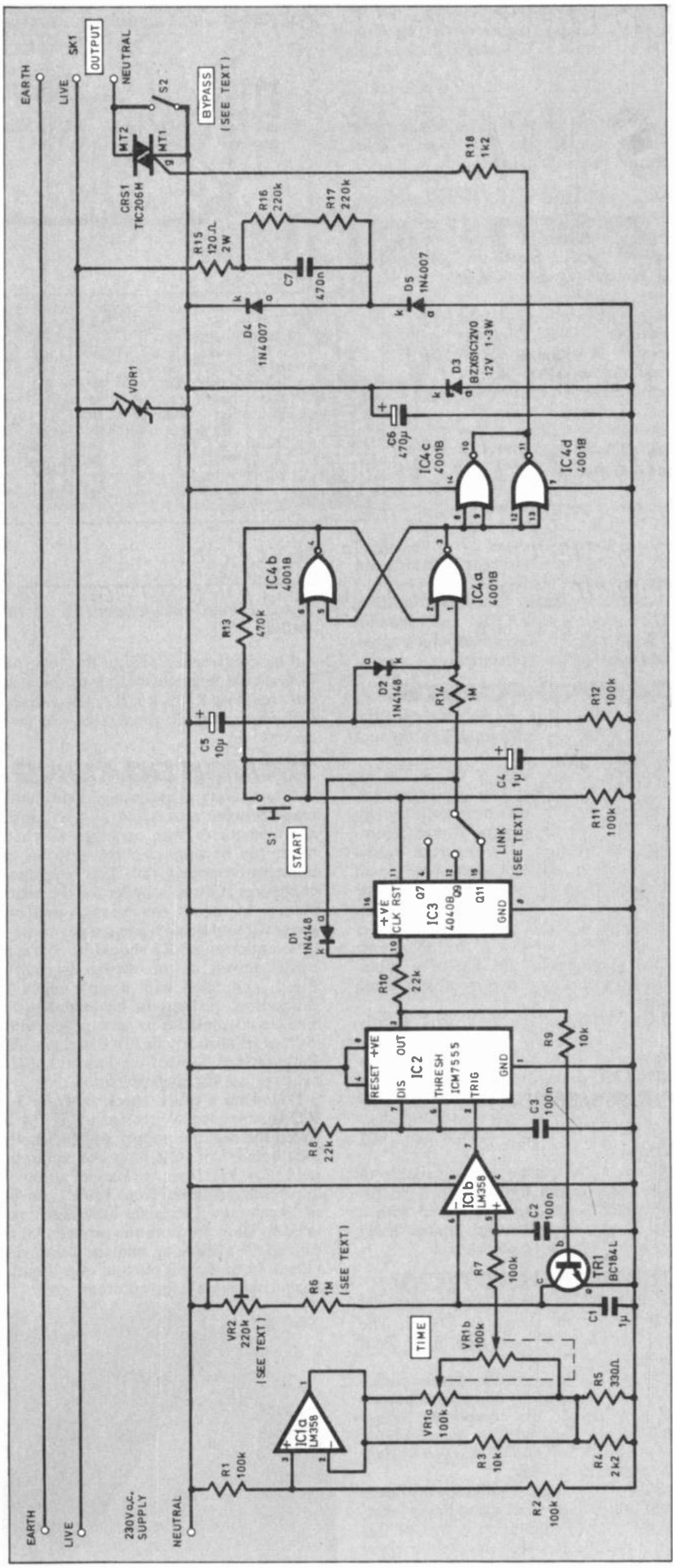


Fig. 1. Complete circuit diagram for the Simple Exposure Timer.

accidentally pressed again before timing is complete, the output time will not be affected. Timing ceases when the link-selected output of IC3 goes high and resets IC4a through R14.

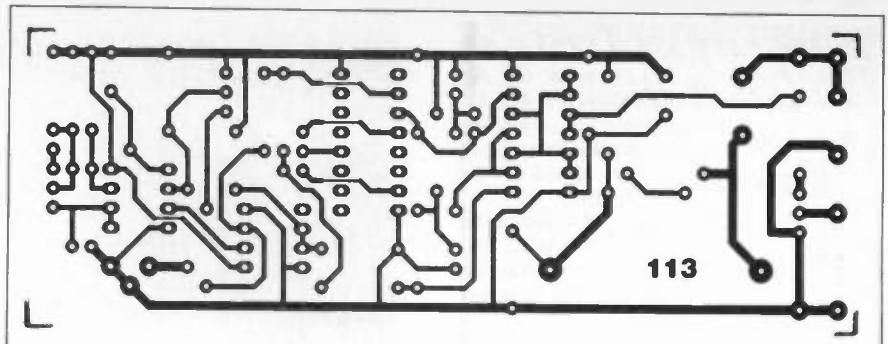
Gates IC4c and IC4d are connected in parallel as inverting buffers for driving triac CSR1 through R18. A negative gate current is used since the triac is more sensitive to this than to positive.

POWER SUPPLY

Power for the main circuit is provided by a capacitive mains dropper circuit. In essence, the a.c. current through capacitor C7 is virtually constant at about 35mA, set by the mains supply voltage and the reactance of C7. In the positive direction, this current flows through diode D4. In the negative direction, it is used to charge C6 via D5, although the voltage across this is limited to about 12V by Zener diode D3.

Apart from the small amount of power drawn by the circuit, most of the current flowing through C7 is "reactive" and does not generate heat or add to the electricity meter reading!

Varistor (voltage dependent resistor) VDR1 protects triac CSR1 and capacitor C7 from high voltage spikes which sometimes occur on the mains supply.



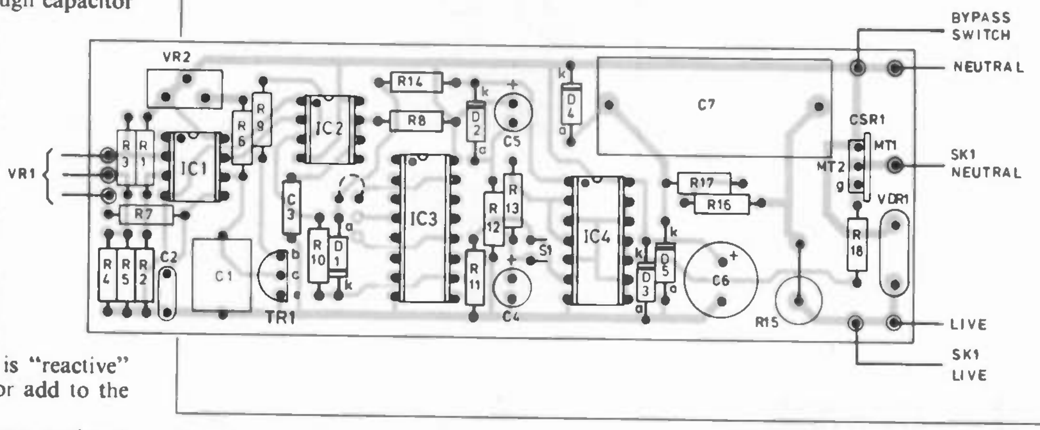


Fig. 2. Printed circuit board component layout and full size copper foil track master-details.

CASING POINTS

Before discussing p.c.b. assembly and testing, a few words about casing the unit are appropriate.

Housing of the unit is up to the individual constructor. The prototype was fitted into the UV light box itself, though with hindsight the author would recommend construction in a separate plastic case, using it with the light box as an accessory. In most instances, this would be much simpler.

Although a mains power output socket was mounted in the case of the unit shown in the photographs, the use of a cable-mounted socket may be preferable to some readers.

Many enlargers are constructed mostly of metal and likely to be used in the presence of water and chemicals. Consequently, it is important to ensure that the earth is properly connected through the unit. Also, the case used should at least be splash proof, even if not fully waterproof.

Many of the plastic cases available to home constructors have a lipped lid fitting, which could easily be sealed with a drop of silicone sealant or similar. Fully waterproof cases are also available.

CONSTRUCTION

Details of the p.c.b. components and track layouts are shown in Fig. 2. The p.c.b. is available from the *EPE PCB Service*, code 113.

The first step in construction is the choice of version required. If the twelve-minute one is required, the component values listed will be suitable. For a two-minute unit preset VR2 should be changed to 100k and resistor R6 to 680k.

Since *EPE* readers undoubtedly have better things to do than spend hours locating the control calibration points of this unit, a method has been devised for rapid calibration with a DVM (digital voltmeter) during construction. To do this, construction should begin by fitting to the board only resistors R1 to R5, R7, plus capacitor C2 and op.amp IC1 (preferably with an i.c. socket).

RANGE SCALING

A temporary connection should then be made between pins 6 and 7 of IC1 with a short length of wire arranged so that a meter can be connected between this and the negative supply rail. This temporarily configures IC1b as a buffer for the control voltage so that it can be measured by a meter without being loaded in any way.

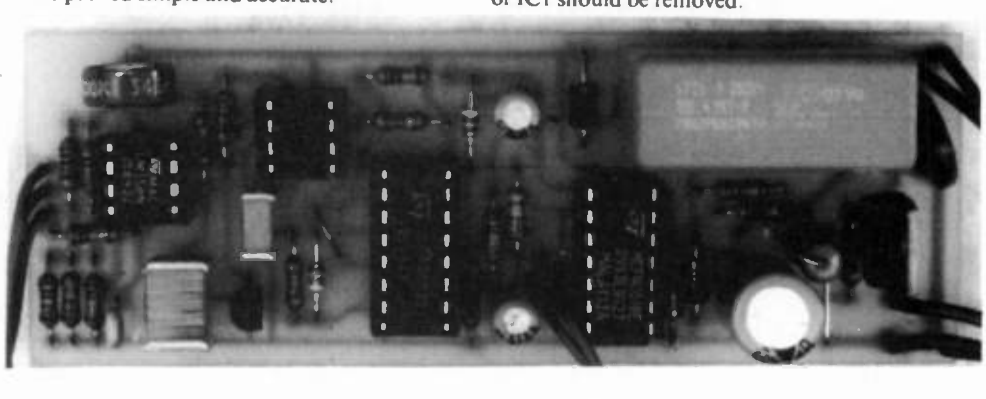
Potentiometer VR1 should be connected up as shown in the wiring diagram of Fig. 3, and fitted with a scale ready for calibration, perhaps in its final housing. The circuit should now be supplied with a voltage set as nearly to 12V d.c. as possible. Batteries can be used for this, although a bench power supply is preferable.

Following a quick check that pin 1 of IC1 is supplying 6V, connect a DVM between the negative supply and the shorted pins 6 and 7 of IC1. Now the calibration points of VR1 can be marked using the appropriate columns from Table 1, for two or 12 minutes. The tables have been calculated to allow for both the exponential nature of C1's charging and the 2·5ms reset pulses. In trials, this method of calibration has proved simple and accurate.

Timer Calibration Tables

12 minute version		2 minute version	
Mins	Volts	Secs	Volts
0·4	0·227	4	0.214
0·5	0·290	5	0.277
0·75	0·446	7·5	0.433
1	0·599	10	0.587
1·25	0·751	12·5	0.739
1·5	0·900	15	0.889
2	1·193	20	1.182
2·5	1·478	25	1.468
3	1·756	30	1.747
3·5	2·026	35	2.018
4	2·289	40	2.282
4·5	2·546	45	2.539
5	2·795	50	2.789
6	3·275	60	3.269
7	3·729	70	3.725
8	4·160	80	4.157
9	4·568	90	4.566
10	4·956	100	4.954
11	5·322	110	5.321
12	5·670	120	5.670
13	6·000	130	6.000

One "end point" of VR1's rotation should be marked so that if the knob is subsequently removed it can easily be refitted correctly. Following this procedure, the connection between pins 6 and 7 of IC1 should be removed.



COMPONENTS

Resistors See SHOP TALK Page

R1, R2, R7, R11, R12	100k (5 off)
R3, R9	10k (2 off)
R4	2k2
R5	330Ω
R6	1M (680k for 2-min timer)
R8, R10	22k (2 off)
R13	470k
R14	1M
R15	120Ω 2W metal film
R16, R17	220k (2 off)
R18	1k2

All 0·6W 1% metal film, except R15

Potentiometers

VR1	100k dual rotary, lin. carbon.
VR2	220k sub-min. preset, vertical (100k for 2-min timer)

Capacitors

C1	1µ polyester layer
C2	100n resin dipped ceramic
C3	100n polyester layer
C4	1µ radial elect., 100V
C5	10µ radial elect., 50V
C6	470µ radial elect., 35V
C7	470n suppression type, 250V a.c. working

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3	BZX61C12V0 Zener diode, 12V 1·3W
D4, D5	1N4007 rectifier diode, 1A 1000V (2 off)
TR1	BC184L *npn* transistor
CSR1	C206M triac, 4A 600V
IC1	LM358 dual op.amp
IC2	ICM7555 CMOS timer
IC3	4040B 12-stage binary ripple counter
IC4	4001B quad 2-input NOR gate

Miscellaneous

S1	min. push-to-make switch
VDR1	varistor (transient suppressor) for 250V a.c. operation

Printed circuit board, available from the *EPE PCB Service*, code 113; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket; 16-pin d.i.l. socket; plastic case, 130mm x 68mm x 45mm (see text); pointer knob; 13A mains plug and socket to suit application; optional s.p.c.o. mains-rated toggle switch (see text); connecting wire; solder, etc.

Approx cost guidance only **£18**

Excl. case and mains connector

The rest of the components can now be fitted to the board with the exception of Zener diode D3 and triac CSR1.

Note that resistor R15 is a 2-watt type. Its purpose is to limit the momentary surge that occurs if the unit is plugged in at the precise instant where the mains voltage is high, for which a reasonably rugged component is needed to withstand it.

DIVISION FACTOR

The division factor should be set with a link as shown in Fig. 4. For a two-minute timer this will be to IC3 pin 12 for a count of 256 pulses. For a twelve-minute timer, first temporarily connect the link to IC3 pin 4 for 64 pulses.

Having connected switch S1, the circuit can be powered again from the 12V supply, with a meter connected between negative and the junction of R18 and the combined output at IC4c and IC4d. The output should normally be high, going low for a time when S1 is pressed.

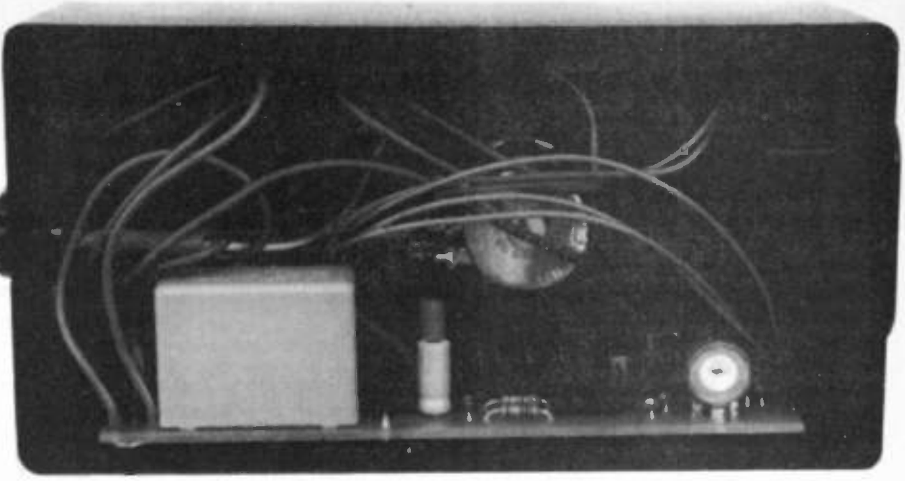
For a two minute timer, VR1 can be set to one or two minutes and VR2 adjusted to give the correct output time. For a twelve minute unit, the temporary connection to IC3 pin 4 means that all scaled values are divided by sixteen, so the 12 minute setting will actually correspond to a period of 45 seconds. This speeds the adjustment of VR2 considerably, after which the link can be fitted permanently to the "Pin 15" position for correct times.

MAINS TESTING

Following these adjustments, diode D3 and triac CSR1 can be fitted and the unit tested with a mains supply and a suitable load, such as a 100W lamp. **At this point, of course, the unit becomes potentially dangerous to handle and appropriate precautions must be observed.**

For safety reasons, a suitably rated fuse, of 3A or lower, should be used in the plug associated with the unit. Power handling is limited to a couple of hundred watts by the fact that the triac is not provided with a heatsink, but one could easily be fitted if the application required it. For most UV light boxes and enlargers though, this power will be more than adequate.

Where the timer is to be used with a photographic enlarger, bypass switch S2 will be required to allow adjustment and focusing of the enlarger. This can be connected across the triac as shown in Fig. 3. □



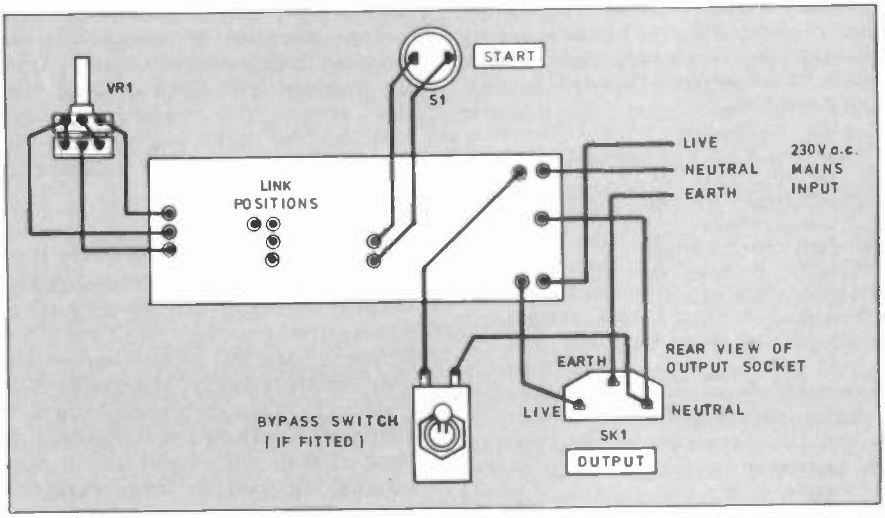


Fig. 3. P.C.B. and off-board component wiring diagram.

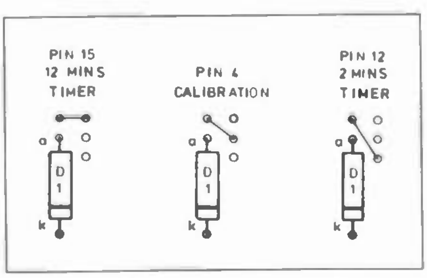
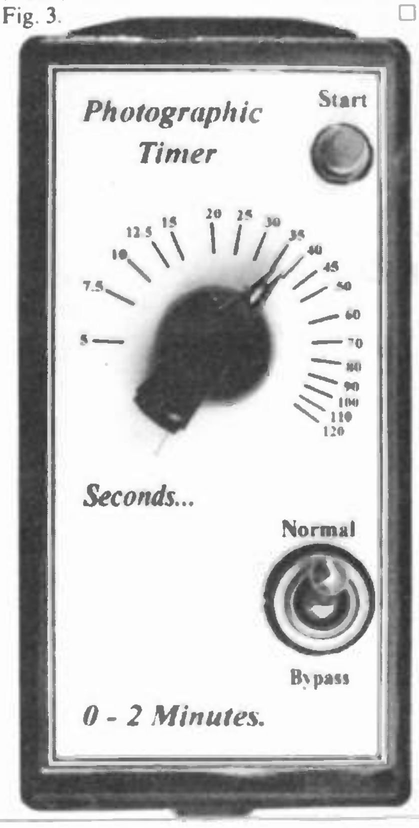


Fig. 4. Division factor links.



New Technology Update

New developments in charge coupled device technology are likely to result in further miniaturisation of electronic cameras – Ian Poole reports.

CHARGE coupled devices (c.c.d.s) are being widely used in image sensing applications. They were originally invented in the early 1970s at Bell Labs, where the transistor was invented. Since their invention, development of c.c.d.s has been led by the Japanese. As a result, their cost has fallen dramatically. Coupled to this, reliability has risen and power consumption fallen.

Now c.c.d.s are widely used in image sensing applications. Naturally one of their main uses is for camcorders where the market has grown enormously in the last few years. There is also a wide variety of other uses for these devices where visual images are needed. Everything from the new PC vision conferencing to various forms of automatic inspection and other image sensing applications.

C.C.D. arrays form an ideal method of capturing an image. Being highly integrated, they are very cost effective and occupy comparatively little space. They often enable manufacturers to miniaturise their equipment, or to build in further features.

Despite this success story there are still many areas for improvement. A number of ideas are being investigated which may enable far greater flexibility to be achieved. It may even be possible for a single chip to contain all the major electronic components for a television camera.

Operation

As the name indicates, c.c.d.s depend upon the generation and transfer of charge for their operation. They include a capacitor as part of the basic circuit. In most devices these days the capacitor is a buried channel MOS capacitor for each pixel integrated onto the chip. It is fabricated by growing an *n*-type region onto the *p*-type substrate. Other areas are also grown. The gate for the MOSFET is grown by first laying down a region of silicon dioxide and then placing some highly doped and conductive silicon on top.

When light falls onto the capacitor, the photons cause electron/hole pairs to be generated. The electrons migrate towards the *p*-type substrate whilst the holes accumulate in the capacitor.

With holes forming a charge in each of the capacitors proportional to the amount of light, it only remains for this to be transferred out. After exposure, the charge has to be transferred serially from one cell to the next in a form of shift register.

Once the charge has been transferred from the light sensitive capacitors into the shift register, the capacitors are reset, ready for their next exposure.

When the charge in the register reaches the exit point from the device it is converted to a voltage by an amplifier circuit. As the charges from the different cells reach the exit from the device the varying voltages represent the light levels across the device and the image is successively built up.

New Developments

The major problem with these charge coupled sensors is that the data has to be transferred to the end of each row before it can be passed out of the c.c.d. into any further processing electronics. Then a considerable amount of electronic manipulation is required. In view of their widespread use in camcorders, the cost of many c.c.d.s is around £10, whereas the cost of the associated processing circuitry may be around the £50 mark.

This limitation could be overcome if each pixel could be accessed individually. The main problem in achieving this is the large number of connections which would be needed.

However, if all the electronics for the camera was integrated onto the same chip, this problem would be overcome. Also, by placing all the electronics for a camera onto one chip, costs could be reduced by considerable proportions. This approach is now becoming a reality in view of the fact that connections of less than one micron can be made in a semiconductor chip.

Accessing Pixels

To achieve this, a number of new developments have been made allowing the charge of each pixel to be transferred individually. As the image sensor or photogate element generates a charge, this has to be converted to a voltage before it is interfaced to any other circuitry. In one development this is achieved using a field effect transistor circuit for each pixel. Four transistors are used for each site, and they provide all the readout, selection and reset functions.

A number of chips have been made using a 256 × 256 matrix. So far the performance has lived up to expectations giving sufficient light to voltage conversion. The only area where it cannot compete with c.c.d.s at the moment is in the resolution which has been achieved. However it is not anticipated that there will be any major problems in extending the level of integration and obtaining a larger matrix in the future as techniques are refined.

At the moment only the analogue functions are integrated onto the chip. To enable the full range of functions to be performed further work is progressing to give an analogue to digital conversion and also functions like automatic exposure and an electronic shutter.

Future Rewards

Although the initial work to enable all these functions to be contained on the one chip will cost money, the rewards are likely to be very large. The obvious use for them is within camcorders and the market for these is expanding all the time. Here, placing all the functions on one chip will reduce costs as well as the size of the cameras.

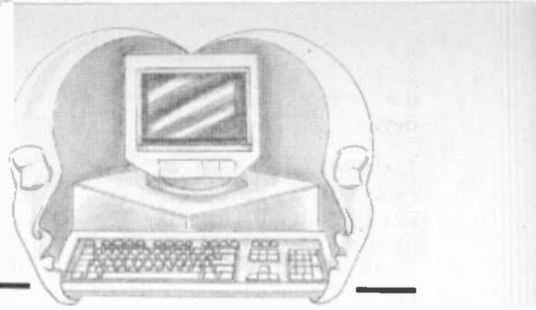
In addition to the camcorder market there are many other uses. With all the electronics on a single chip, the size of complete cameras will fall by significant amounts. This will allow cameras to be used in many monitoring applications where it might not have been possible before. They will be able to be used in a number of process monitoring applications, allowing visual inspection of different areas of a manufacturing process.

Still Cameras

They could also find uses in still cameras. Although electronic cameras are not widely used yet, their use offers many advantages in terms of flexibility. Pictures can be instantly viewed on an l.c.d. screen, down-loaded into computers and processed accordingly. Even for the home user this is likely to become more commonplace.

Prints can also be made on the variety of printers which are widely available now. It would be possible to down-load the output of a camera into a computer and print out the results without the need for sending the film off or taking it to the local chemist.

The single chip camera would help to reduce costs of the whole camera and bring them more into the reach of the public at large. All of these possibilities mean that work being undertaken on these new camera i.c.s is likely to pay large dividends in the future.



INTERFACE

Robert Penfold

MANY readers will no doubt have noticed that a growing range of so called "virtual" measuring instruments based on PCs are coming onto the market. The basic idea of a virtual instrument is to replace a complex piece of measuring equipment using some relatively simple hardware plus a PC and suitable software.

Most of the commercially produced units and software are quite complex. Typical systems on offer include twin beam storage oscilloscopes, logic analysers, and spectrum analysers, complete with on-screen controls that are operated via the mouse.

Testing, Testing

It is difficult for the do-it-yourself computer enthusiast to compete with this type of thing. The hardware part of the system is not necessarily that hard to tackle, but the software side of the system usually requires a great deal of development time and an expert programmer.

This is not to say that it is impossible to undertake test gear projects based on a PC. There are certainly plenty of possibilities for those who are willing to settle for relatively simple systems.

The piece of test equipment featured here is a transistor tester that provides digital readout via the screen of the PC. It interfaces to the host PC's printer port, and either port one or port two can be used. Both *npn* and *pnp* bipolar transistors can be tested, but the system is not usable with any form of field effect transistor (f.e.t.).

Most transistor testers operate on the basis of feeding a fixed base current to the test device, and then measuring the collector current. This is convenient in that the collector current is proportional to the current gain of the test transistor. Consequently, there is no difficulty in having direct readout of current gain on an analogue or digital display.

A drawback of this method is that the current gain is not measured at a specific collector current. The lower the gain of the component under test, the lower its collector current.

Current gain of transistors varies significantly with changes in collector current, and in general a lower operating current gives reduced gain.

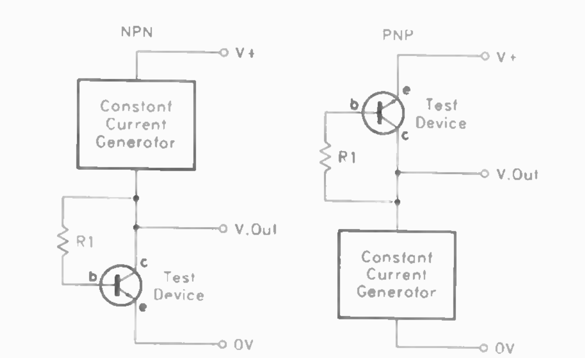


Fig. 1. Basic test methods for npn *and* pnp *transistors.*

This tends to give unrealistically low readings on low gain devices, and could give the impression that a component is sub-standard when it is actually "up to scratch".

This tester gives low gain devices a "fair hearing" by using a *fixed* collector current and a variable base current. The basic idea is to have a circuit that automatically adjusts itself to provide the base current that just supports the collector current in use. The gain of the test device can be calculated from the base current reading, but one is not directly proportional to the other. The lower the base current, the higher the current gain of the test component. The scaling is not just reverse reading, but is also non-linear.

In a computer based system this is not really of any consequence, since the software can provide a few simple calculations to provide a direct readout of current gain. It is basically just a matter of dividing the fixed collector current by the base current reading from the interface.

Self Adjusting

The basic arrangement used in the interface, which feeds into the PC's printer port via a simple analogue to digital converter, is shown in Fig. 1. If we take the *npn* circuit first, the collector (c) of the transistor is fed from a constant current generator. The current used must be one that gives reasonable gain from higher power transistors, but it must not be so high as to risk damaging low current devices. This system uses a current of 10 milliamps, which seems to give good results in practice.

The test device is biased into conduction via resistor R1 connected between its collector (c) and base (b) terminals. Provided the value of R1 is low enough, it will supply a base current that just supports the collector current set by the constant current generator circuit.

An excessive base current is avoided by a negative feedback action. An increased base current results in a lower collector voltage, which reduces the base current. In effect, the collector voltage automatically adjusts itself to provide

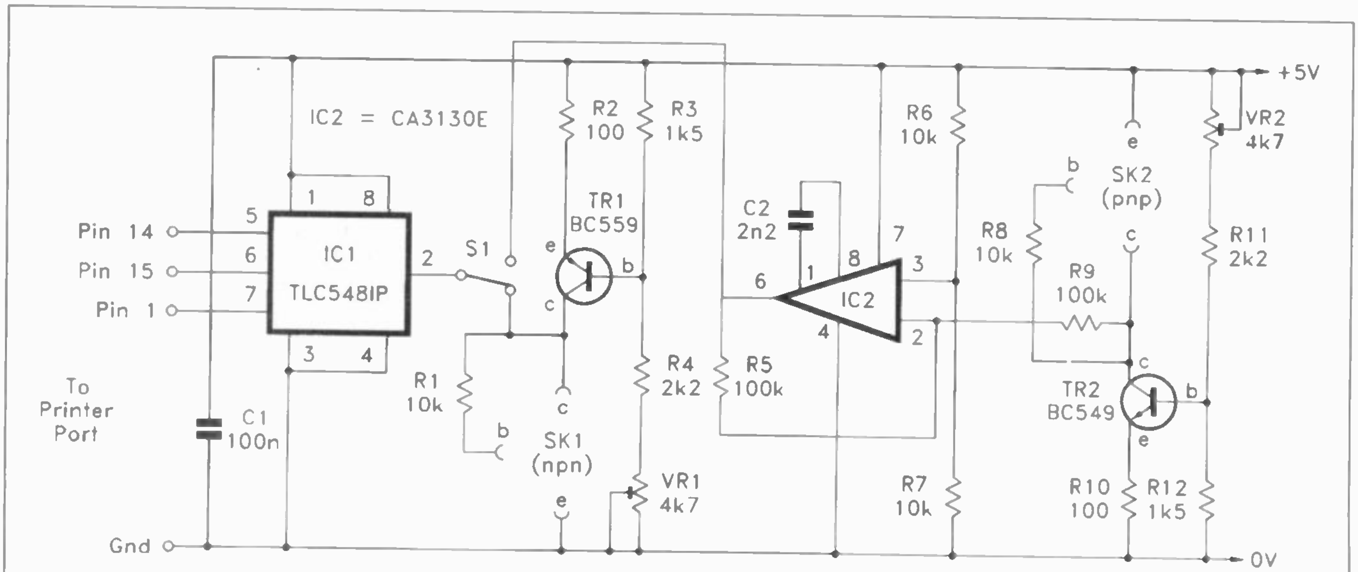


Fig. 2. The circuit diagram for the Transistor Tester Interface.

the correct base current for the test device.

Calculating Gain

In order to calculate the gain of the test transistor it is merely necessary to measure the base current, and then divide the collector current by this figure. In practice it is quite difficult to measure the current flow through resistor R1 using a computer.

It is easier to take the indirect approach and measure the collector voltage. This is equal to the voltage across R1, plus the (approximately) 0·7V developed across the base-emitter junction of the test transistor. Deducting 0·7V from the collector voltage gives the voltage across R1, and Ohm's Law can then be used to calculate the base current.

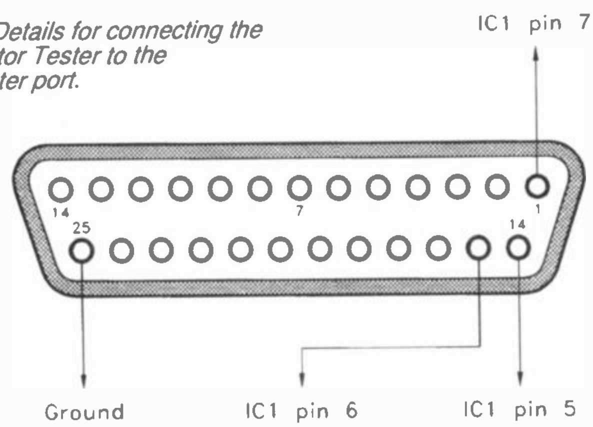
One slight flaw in this method of testing is that although the collector current is constant, the collector voltage varies significantly from one test device to another. Fortunately, this is of no great importance, since the gain of a transistor is little affected by variations in collector voltage.

The *pnp* test circuit is essentially the same as the *npn* type, but with a change of supply polarity. This brings a slight problem in that the output voltage is referenced to the positive supply rail, and not the 0V "earth" rail. This is not a major obstacle though, and either hardware or software can be used to compensate for this factor.

Listing 1: Transistor Tester Program

```
10  REM transistor tester program
    (TLC548 A/D converter)
20  CLS
30  LOCATE 8,25
40  PRINT "DC CURRENT GAIN"
50  OUT &H37A,1
60  OUT &H37A,3
70  OUT &H37A,2
80  X = INP(&H379) AND 8
90  X = X*16
100 OUT &H37A,3
110 OUT &H37A,2
120 Y = INP(&H379) AND 8
130 Y = Y*8
140 X = X + Y
150 OUT &H37A,3
160 OUT &H37A,2
170 Y = INP(&H379) AND 8
180 Y = Y * 4
190 X = X + Y
200 OUT &H37A,3
210 OUT &H37A,2
220 Y = INP(&H379) AND 8
230 Y = Y * 2
240 X = X + Y
250 OUT &H37A,3
260 OUT &H37A,2
270 Y = INP(&H379) AND 8
280 X = X + Y
290 OUT &H37A,3
300 OUT &H37A,2
310 Y = INP(&H379) AND 8
320 Y = Y/2
330 X = X + Y
340 OUT &H37A,3
350 OUT &H37A,2
360 Y = INP(&H379) AND 8
370 Y = Y/4
380 X = X + Y
390 OUT &H37A,3
400 OUT &H37A,2
410 Y = INP(&H379) AND 8
420 Y = Y/8
430 X = X + Y
440 OUT &H37A,3
450 X = X * 2
460 OUT &H37A,1
470 X = X - 69
480 X = 10000\ X
490 LOCATE 10,30
500 IF X < 25 THEN PRINT "    "
510 IF X < 25 GOTO 50
520 PRINT X
530 GOTO 50
```

Fig. 3. Details for connecting the Transistor Tester to the PC printer port.



The Circuit

The full circuit diagram for the Transistor Tester Interface appears in Fig.2. The analogue-to-digital converter is based on the TLC548 serial converter. This chip, and its use with a PC printer port, was covered in the November 1995 issue of *EPE*. Refer to the *Interface* article in that issue if you require detailed information on the converter. All you really need to know here is that it has an input voltage range of zero to five volts.

Transistor TR1 is used in the constant current generator for the *npn* test circuit. Preset potentiometer VR1 is adjusted to give one volt across resistor R2. If slightly reduced accuracy is acceptable, simply replace resistor R4 and VR1 with a fixed resistor of 3·3 kilohms (3k3) in value.

Resistor R1 is the base bias resistor, and a value of 10 kilohms is a very convenient one. If the readings from the converter are doubled, this gives a range of returned values from 0 to (roughly) 500, which equates to a base current range of 0 to 500 microamps (μA).

The *pnp* test circuit has TR2 as the constant current source. Here, preset VR2 should be adjusted to give one volt across resistor R10. A software inversion can be provided by deducting the returned value from 255.

This circuit provides a hardware inversion, which avoids the need for *npn/pnp* switching in the software. The inversion is provided by IC2 which acts as a unity gain inverting amplifier. This stage works fine using a CA3130E, but is unlikely to work at all using most other operational amplifiers. Switch S1 provides *npn/pnp* switching, and it simply switches the output of the appropriate circuit to the input of the converter.

To keep things simple, separate test sockets are used for the two types of transistor. However, an extra three poles on switch S1 would enable one socket to be shared between the two sections of the unit.

Note that IC2 is a CMOS device, and that it therefore requires the standard anti-static handling precautions. The resistors, apart from R3, R4, R11 and R12, should have a tolerance rating of one percent.

Software

The accompanying GW BASIC listing reads the port, calculates the current gain, and prints it on the screen. Most of the program is concerned with reading the port, and is essentially the same as the listing provided in the November 1995 issue (see *Back Issues* page).

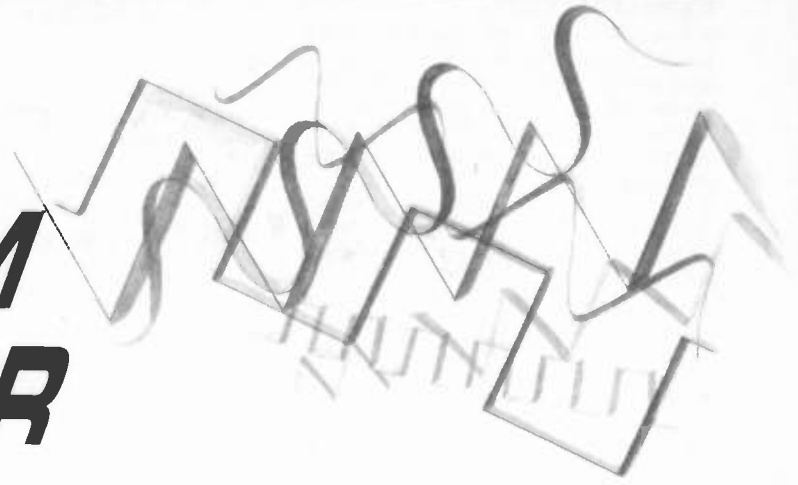
Some lines added onto the end of the original program work out the current gain, print the answer on the screen, and loop the program indefinitely. Lines 500 and 510 detect very low readings of under 25, and blank the display. This gives a blank display with no test device connected, or if the test component has a gain of under 25.

The port addresses used in the program are for printer port one. If the system is used with printer port two, addresses &H379 and &H37A should be changed to &H279 and &H27A respectively (e.g. "OUT &H27A,1" at line 50). There is no built-in means of breaking out of the loop, but the usual "Control – Break" combination will halt the program.

In use the system seems to work very well, giving more plausible results than most testers when testing lower gain and (or) higher current devices. One drawback of this system is that it has lower resolution at high gains than at low gains, but it still gives perfectly acceptable results with high gain devices.

Special Feature

MAX038 WAVEFORM GENERATOR



ANDY FLIND

At last there is a waveform generator which offers greater advantages over the familiar 8038 device.

DEDICATED waveform and "function generator" i.c.s have been around for many years now. Some of the simpler ones offer only square and triangular output waveforms but at least one, the well-known 8038, also has a sine wave output which makes it a good basis for the design of versatile signal generators.

It is fairly complex to design with, though, and a successful circuit generally needs quite a few preset adjustments for acceptable performance. In addition, its maximum frequency is quite low. Although one manufacturer quotes a top speed of 1MHz, in practice the 8038 usually begins to struggle beyond 200kHz and, where good waveforms are required, it is preferable to regard 100kHz as the maximum. A faster waveform generator i.c. has been overdue for some time.

EASY TO USE

With the introduction of their new MAX038 waveform generator i.c., Maxim have at last filled this need. Like the 8038, the MAX038 provides all three output waveforms but it is much easier to use and has some interesting new features that increase its versatility.

The most important characteristic, however, is speed. Maxim claim over 20MHz, and the author's experience shows that it is indeed capable of this with little degradation of any of the output waveforms.

At 10MHz the outputs are excellent, even the square wave! At around £15 it is not a cheap i.c., but it looks set to become the new industry standard, so in time this price may well fall. Meanwhile, it is still inexpensive in view of the performance of which it is capable.

At the time of writing, the device is available in both surface-mount and standard dual-in-line (d.i.l.) packages. The 20-pin d.i.l. version will probably be the one encountered by most readers and its pinouts are shown in Fig. 1.

OPERATIONAL TOUR

A good way to describe the operation of this new i.c. is to begin with a brief description of its internal architecture, and continue with a tour of the external connections giving detailed descriptions of their functions. A simplified diagram of the internal structure is shown in Fig. 2.

The control current regulator converts signals from three inputs to a control current which passes to the oscillator. This is of the relaxation type, where a capacitor is repeatedly charged and discharged between two preset limits, with currents set by the input control current. The outputs from the oscillator are a triangle wave from the capacitor and a square wave from the comparator used for switching between charge and discharge.

Sine waves are obtained by modifying the triangle wave in a shaping circuit. The three waveforms then go to a selection switch which is controlled by logic levels applied to two waveform control inputs, and the one chosen passes though a buffer amplifier to the output.

Three further functions are provided by the device. A very fast comparator, driven from the triangle wave, produces a logic level sync output for driving synchronised external circuitry. A phase detector with an external input can be used for phase-locking the oscillator to an external signal, possibly using division, to construct a phase-locked loop. Finally, a 2·5V reference source is provided for use in generating input control voltages for the current generator.

POWER SUPPLIES

Dual power supplies of +5V and −5V are needed, with a tolerance of 0·25V and currents of about 45mA from both. The simplest way to provide these is from 7805 and 7905 positive and negative regulators. The 1A versions are preferable to the 100mA type because they will usually dissipate a small amount of heat and it is much easier to attach heatsinks to the 1A devices.

The MAX038 has its positive supply input at pin 17 and the negative supply input at pin 20. Pins 2, 6, 9, 11, 15 and 18 are all ground connections and must all be

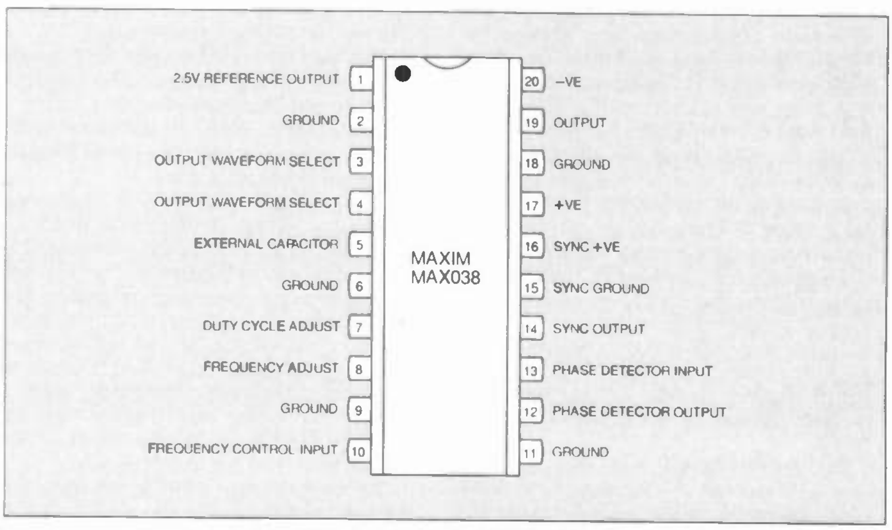


Fig. 1. Pinouts of the d.i.l. version of the MAX038.

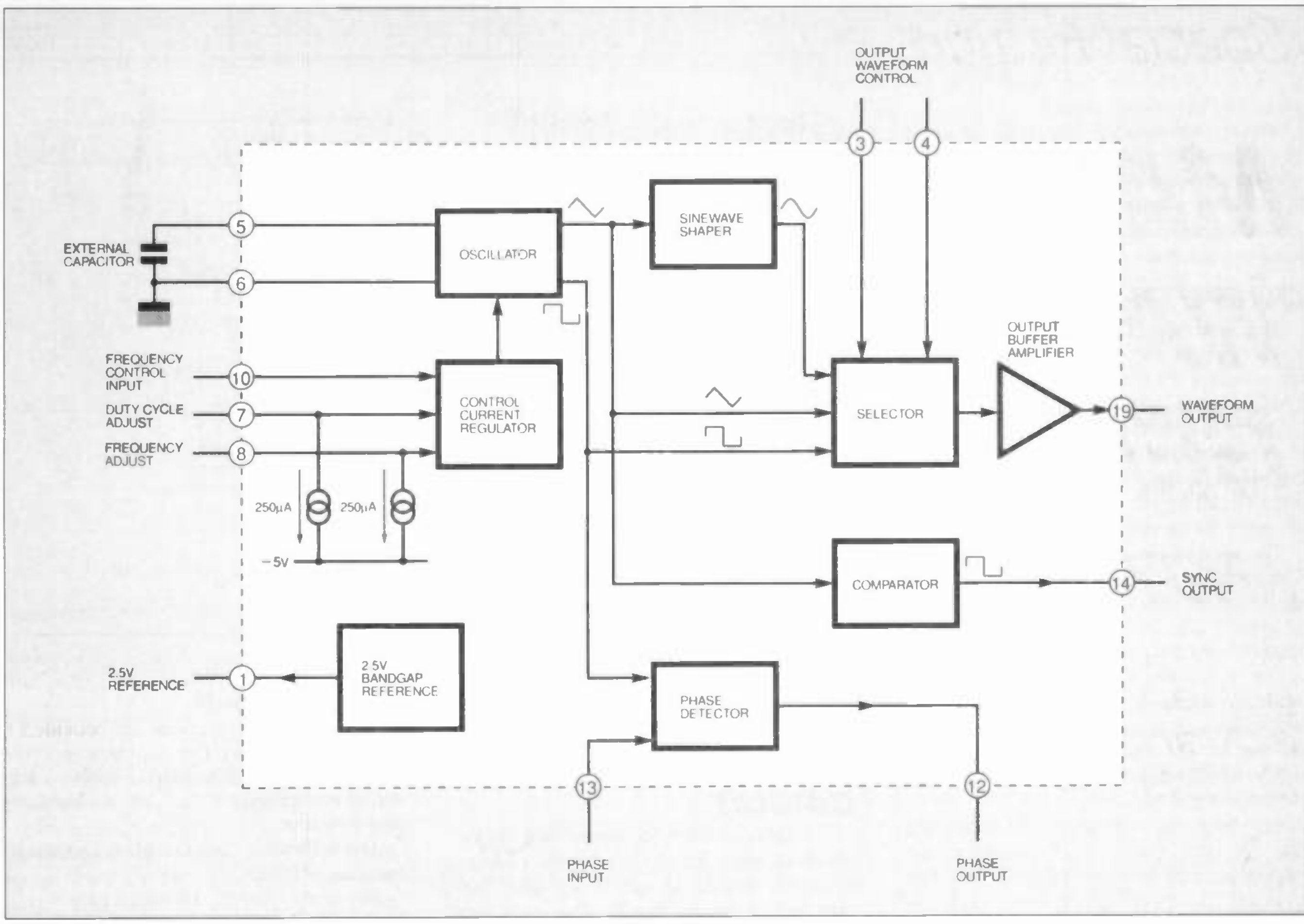


Fig. 2. Internal structure of the MAX038 waveform generator. Positive power supply input is at pin 17 and negative at pin 20.

connected to ground. Both supplies should be decoupled to ground by capacitors placed as close to the supply pins as possible. Maxim recommend the use of 1nF ceramic capacitors in parallel with 1µF tantalum bead types for decoupling.

They also suggest an alternative of 1µF ceramics, but these are large and expensive, so most designers will probably opt for the first combination.

Pins 15 and 16 are separate supply connections for the internal comparator for the sync output. If this is not needed, it can be disabled by simply leaving pin 16 unconnected, saving supply current and eliminating the possibility of stray coupling between the sync and main outputs.

It is necessary that pin 15 should always be grounded, however, otherwise the comparator will distort the triangle and sine outputs. If pin 16 is powered, a small series resistor of about 100 ohms should be used together with local decoupling capacitors.

OTHER PINS

The functions of the remaining pins are as follows:

Pin 1 provides a 2·5V d.c. output from a bandgap reference source. The data sheet states that up to 4mA can be drawn from this output but, with two examples tested by the author, currents in excess of 1mA caused a voltage drop.

This is seriously bad news since the reference is also used by the i.c.'s internal circuits and dragging it down in this way causes severe waveform distortion and frequency changes.

The message is clear; either avoid using it, or buffer it with an op.amp. With a regulated positive 5V supply available, most applications can use this instead. A small decoupling capacitor can be used between pin 1 and ground at pin 2.

Pins 3 and 4 are the output waveform selection inputs which should be held at ground (low) or +5V (high). Their input impedance is quite high, so they can be pulled high or low with 10kΩ resistors and enabled or disabled with very simple switching.

The easy way to follow their action is as follows: if both are low, the output is a squarewave; if just pin 3 is high, it is a triangle wave; but if pin 4 is high it will be a sine wave regardless of the state of pin 3.

Pin 5 is the connection for the external frequency determining capacitance. The other end of this is grounded and it should be placed as close as possible to pins 5 and 6. Many designs using pin 5 will have several frequency ranges provided by switching between suitable capacitors, so the wiring of this part should be kept as short as possible.

Pin 7 is for control of the output duty-cycle, or symmetry. It has an internal constant current "sink" to the −5V supply so it should never be left open circuit. If duty-cycle adjustment is not required, it can be connected directly to ground and the duty-cycle will then be almost exactly 50:50.

If it is needed, varying the voltage at pin 7 between ±2·3V will alter the duty cycle between 15 per cent and 85 per cent with little change of frequency. If this input is controlled through a resistor, the effect of the current sink must be taken into consideration, but it can be driven by a low impedance source, such as an op.amp output.

Pin 8 is for modulation or fine adjustment of output frequency. Its use is similar to that of pin 7 in that it also has an internal 250µA current sink and can be grounded if not required. Where it is used, compensation must be made for the effect of the sink. Varying this input between ±2·4V alters the nominal frequency by ±70 per cent.

FREQUENCY CONTROL

Pin 10 is the main frequency control input. Current fed into this pin together with the value of the capacitor at pin 5 controls the output frequency, which can be calculated roughly from:

$$F\ (\text{Hertz}) = I_{in}\ (\text{amps}) / C\ (\text{farads})$$

which translates usefully to:

$$F(\text{MHz}) = I_{in}\ (\mu\text{A}) / C\ (\text{pF})$$

Although the input to pin 10 is a current, this input behaves in a manner sometimes referred to as a "virtual earth", meaning that whatever current is fed into it, its voltage is always zero or ground potential.

This means that if a resistor is connected in series with it, the input current will be directly proportional to the applied voltage, turning it into a linear voltage-controlled input. Values of input current can be from 2µA to 750µA, with a preferred range of 10µA to 400µA.

Pins 12 and 13 are the output and external input of an exclusive-OR type phase detector. This produces rectangular pulses from pin 12 having their width dependant on the phase of the external input, as compared to the internal one. These can be converted to a d.c. voltage with a simple resistor and capacitor low-pass filter, and then coupled back to pin 8 to form a phase-locked loop for locking the frequency to an external signal.

Maxim recommend that both of these pins should be grounded if not used. This may sound odd for the output, but it appears to have only a limited current capability and grounding it probably helps avoid stray coupling to other parts of the circuit.

OUTPUTS

The sync output from pin 14 is a logic level (ground to +5V) output for driving external circuitry, especially TTL or CMOS. It has very fast rise and fall times, so where it is used careful layout is needed to avoid stray coupling into the main output. If it is not needed, it can be left open-circuit together with the positive supply point for its comparator, pin 16.

The main output is provided at pin 19. This will be a sine, square or triangle waveform as selected by the levels applied to pins 3 and 4, and it always has an amplitude of 2V peak-to-peak.

The output has a very low internal resistance, a maximum of 0·2 ohms is quoted, and it can supply up to 40mA. This allows the use of low-impedance following circuitry which makes it easier to maintain performance at high frequency.

Typically, the output may be connected into a 1kΩ carbon potentiometer for amplitude control, followed by a very fast amplifier having sufficient gain to achieve the maximum amplitude required.

TEMPERATURE COEFFICIENT

One special operating mode is worth mentioning. Apparently the internal frequency adjusting circuit behind pin 8 adds a small temperature coefficient to the operating frequency. If this pin is grounded through a 12kΩ resistor, the internal current sink will develop −3V at pin 8, which causes the internal circuit to disconnect itself.

This has two effects. Firstly, the temperature coefficient is improved. Secondly, the output frequency set by the input current and external capacitor is doubled, although the manufacturer hastens to point out that this does not double the ultimate output frequency of which the i.c. is capable! Most applications probably will not be critical enough to need this mode, however.

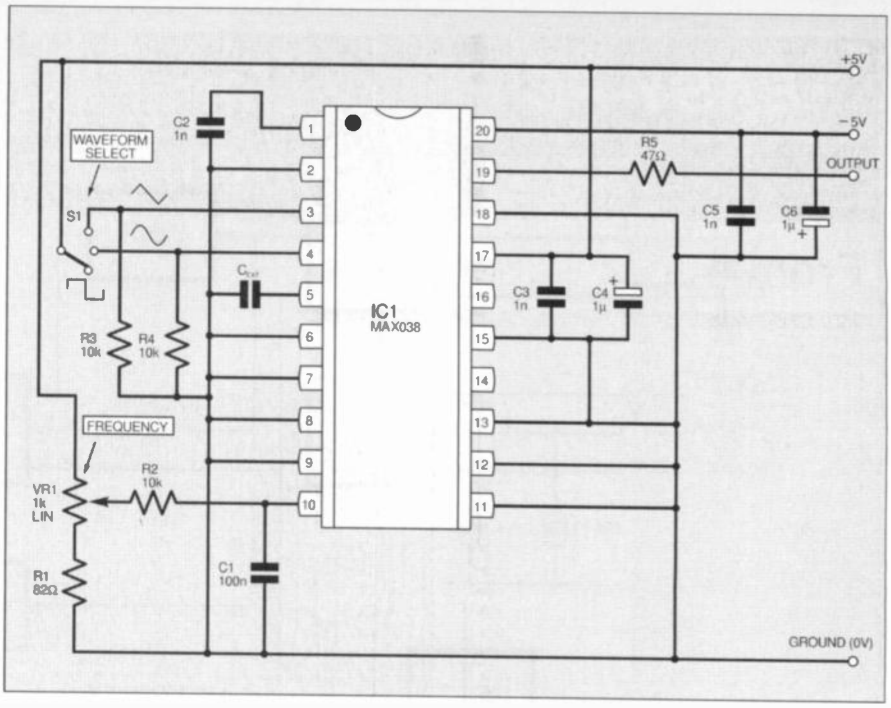


Fig. 3. Experimental circuit using the MAX038.

EXPERIMENTAL CIRCUIT

For enthusiasts who would like to experiment with this device for themselves, a simple circuit to get it up and running is shown in Fig.3. The only real problem with the MAX038 is that inherent in its sheer speed. Breadboarding can be difficult as stray coupling and reflected signals in mismatched bits of wire can produce all sorts of odd effects.

Whilst these usually disappear when the circuit is rebuilt with a good printed circuit board layout, it is possible that other more serious design defects will actually have been masked by them! This may lead to more trial and error than usual when working with this device.

Maxim suggest careful layout on a double-sided ground-plane p.c.b. for best results. In practice, a single-sided p.c.b. seems to work well, providing it has plenty of copper areas at ground potential, good decoupling and guard tracks around signal paths carrying rectangular waveforms, especially that from the sync output.

Such effort is well worthwhile, since circuits having far greater performance than those constructed with older waveform generator i.c.s are undoubtedly now possible.

The following component recommendations are offered:

Resistors – 0·6W, 1% metal film
C1, C2, C3 and C5 – ceramic disc
C4 and C6 – tantalum bead, 35V
C_{ext} – as required for frequency, between 47pF and 4µ7F, polyester or polystyrene.

SOURCE

MAX038CPP waveform generator i.c.s can be obtained from RS Components (trade only – tel: 01536 201201) or Electromail (retail outlet for RS – tel: 01536 204555), order code 810-396.

It is also available from Maplin (tel: 01702 554161) order code DT25. Maxim will also supply it directly against credit card orders (tel: 01743 303388).

NEXT MONTH

A practical and very versatile 10MHz waveform generator project using the MAX038 will be published in our October issue.

FOX REPORT

by Barry Fox

Reality of Stonehenge

Exactly as the marketing pundits predict, the Internet is turning into a marketing tool. Goods, services, magazines and entertainment are all on offer. Sometimes you pay to receive, other times you are getting advertisements for something that someone is trying to sell.

The most exciting claims and promises are made by people who have never actually set up a PC, connected to the Internet and downloaded data. If they had rolled up their sleeves and done it themselves, they could never deliver their spiel with a straight face.

English Heritage looks after Stonehenge and has tied up with Intel and Californian software company Superscape to put a "virtual reality" Stonehenge model on the Internet.

"Millions of people round the world will be able to walk virtually through the stones" promised EH Chairman Sir Jocelyn Stevens, and EH archeologists when the system was launched at the London Planetarium.

The demo did look impressive, as well it should have done. The computers used were £20,000 Intergaphs, with ganged pairs of 200MHz Pentium processors and 128MB of RAM. The Internet site was coming from a hard disc, not down a phone line.

But by being a bit pushy I did get a demo from a laptop, connected to the Internet site (www.intel.com) by phone line and 28·8K modem. It worked very well because Superscape's Viscape software plays a clever trick. Instead of relying on a constant flow of graphics data down the line, it downloads a VR model into the PC and then needs only nibbles of data to control motion.

Fit of Peak

That night I tried it at home. In fact I tried night after night for several weeks. Getting the system up and running is, I would guess, comparable to climbing Mt Everest with one leg tied behind your back.

Stonehenge works only on a Windows PC, not an Apple Mac. You can of course thank Intel's involvement for that. Superscape's Viscape software will only work with the Netscape Web Browser. Tough luck if you have Mosaic (e.g. if you use CompuServe) or Microsoft's Explorer (e.g. you are on the Microsoft Network).

If you know what you are doing, you should be able to dial into the Internet using either of these services, and then overlay Netscape. This works with MSN but not CompuServe.

The one man I found inside the whole of English Heritage who has actually set up the system himself (and not surprisingly he's in charge of EH's office computer network) thinks this is something to do with "routers being too clever".

You cannot buy Viscape on a disc. It is still in Beta version. So you must download it from Superscape's site on the Internet. This took me half an hour, even on an ISDN line. So expect it to take over an hour on an ordinary line.

Viscape will only "plug into" Netscape Version 2 or later. Last year's Ver 1.2 is no-no. So that's more downloading to do, or more discs to buy.

If you are running Windows 3.1 you will need the 16-bit version, but Windows 95 needs 32-bit. Viscape then needs the Win 32s software extension if you have 16-bit Windows 3.1.

(I hope this is all clear, because I shall be asking questions at the end!)

Just to make sure you are concentrating, Superscape has wrongly labelled the Viscape file that comes down the line. So when the instructions say Run Runme.exe, they actually mean Run Runme106.exe.

After literally weeks of carefully following instructions, spotting the Runme error and getting error messages like "Netscape not found", I finally did something wrong and got a sight of Stonehenge on my PC screen.

By then I had lost all interest in the system and wanted only to lock all EH's top management into a room with a few PCs and not let them out until they either visited Stonehenge or admitted that the system was as ready for launch as a car with the engine still packed as a kit of parts.

Games On The Line

For game playing, E-ON, "Entertainment On-Line", promises game play from the Internet (www.e-on.com) "for as little as £5.99 per month".

Subscribers get the chance to play "a range of hit games, including the very best from . . . Sony/Psygnosis, Virgin, Gametek, US Gold and Gremlin Interactive". Founder Mark Bernstein said at the UK launch in July, that the system is "as easy to use as a TV".

But this claim rang rather hollow after the show biz presenter had gone through a long puff about "doing it live, down a phone line through a modem", when the on-screen demonstration was very clearly coming from a disc. Backed by a team of experts controlling the computers he finally plucked up courage to go live on-line. Surprise, surprise, the system crashed.

Fortunately a row of PCs set up elsewhere in the room were all working live on-line, through consumer modems. Game play, for instance on *Tank Warrier*, looked surprisingly smooth.

Childs Play

"Yes, but wait and see what happens if the service is successful, and several thousand kids are all trying to access the service on Saturday morning", said one industry consultant.

Perhaps more to the point, what happens when parents start getting the bills that their kids are running up by playing games on-line, rather than off ROM disc?

The £5.99 per month subscription fee only applies if the subscriber uses one of the Internet services with which E-ON has deals. These include America On Line, Easynet, UK OnLine and Pipex Dial.

If the game player goes through any other service provider, for instance Compuserve, the price rises to £9.99 per month. Internet service providers charge at least £10 a month, often nearer £15, or up to a couple of pounds an hour after a few hours free time per month.

Then there is the cost of making the local BT call into the Internet. If the calls are made over the weekend, then the price is 60p per hour. On weekday evenings BT charges 5p for every three minutes, which is £1 per hour. If the kids are on school holiday, playing games during the day at BT's local peak rates, the cost is 5p per 75 seconds, which works out at £2.40 per hour.

Once you have subscribed and before you play games, you must download a large file of control software. E-ON warns that this will take 45 minutes even with a 28·8k modem. But at least this is a one-off load.

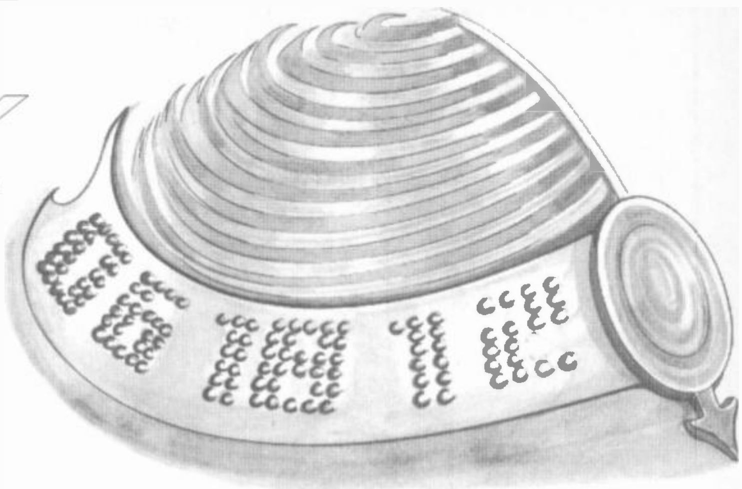
Paying the Price

Once up and running, a game addict can easily run up local call charges of £10 a week. Add to that at least £10 a month for Internet access plus at least £6 for the E-ON subscription, and you start to get a feel for the kind of money involved in accessing on-line entertainment services.

You also see why so many companies are now trying to get a slice of the action. But with so many companies looking for slices, a lot of them must fail. No-one knows who, which is why so many are trying to find a place on the bandwagon.

Constructional Project

PIC-TOCK PENDULUM CLOCK



JOHN BECKER

Have a swinging time building this "magic" clock!

THERE is no denying it, the PIC-Tock Pendulum Clock is simply a novelty! Blatantly, there are much easier ways of telling the time, most of us wear them on our wrists, or mount them on the wall. But why do things the dull way if there's a more fun way of doing them?

First design thoughts were about how the PIC-Tock could be made different to the two inspirations. As will be seen, the principal difference is that the PIC-Tock uses a suspended pendulum display. It is also programmed as a 24-hour clock.

> **Scene:** EPE HQ – Editor's office.
> **On the desk:** *EPE* December '94 open at *Spacewriter* messagemaker, and *Science Museum* catalogue advertising lever-arm clock.
> **J.B.** (queryingly): "Which, perhaps, inspired the other?"
> **M.K.** (knowingly): "Neither, the principle's historic."
> **J.B.** (memorably): "Ah!"
> **M.K.** (suggestively): "Could you design a spacewriter clock?"
> **J.B.** (technically): "Probably . . ."
> **M.K.** (directorially): "Do it!"
> So began a train of thought that led to the *PIC-Tock Pendulum Clock*.

The *Spacewriter* referred to above is a handheld "wand" waved in front of an awe-struck viewer who sees the message "MERRY XMAS" drawn in light across space. The *Science Museum* design also consists of a wand. This, though, is mounted on a stand and pivoted at the base. When the wand swings, the lighted message drawn in space shows the current time.

These are seemingly astonishing feats, since each wand is simply a tube containing a single column of light emitting diodes. When stationary, there appears no way that they could show a message.

PERSISTENT VISION

The answer lies in the phenomenon that led to the creation of the cinema, persistence of vision. The human eye "stores" an image briefly beyond the point at which the image source is removed. This can be illustrated by the large X in Fig. 1.

With the page you are now looking at well lit, hold it in your hand and stare at the X. Now close your eyes quickly. You should find that for a second or two, and sometimes longer, the image of the X remains "trapped" in the eyes. If the X is sufficiently well lit, its latent image can almost be "studied" while your eyes remain closed.

The image will quickly fade as the retina nerves of the eyes return to normal. Blinking the eyes open and closed again repeats the process. If eyelids could move fast enough, repeated rapid blinking would give the brain the sensation that the eyes are viewing a scene continuously with no intervening periods when it is shut off by the eyelids.

Eyes can't actually blink that fast and so a flickering scene of alternate brightness and semi-darkness is experienced. However, with eyes remaining open, if the room light is turned on and off more rapidly than the retina nerves allow the scene to fade, a continuous viewing of the scene will be experienced.

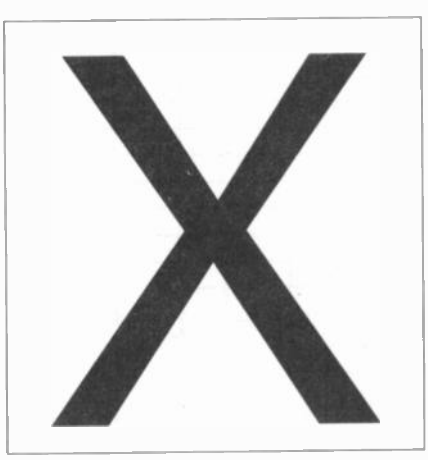


Fig. 1. Using the letter X to demonstrate "persistence of vision".

This is precisely the way that a cinema film projected onto a blank surface is viewed as a moving image, except that it is a shutter that turns the projector light on and off. On each occasion, a different stationary image is projected and any positional differences between consecutive images of almost identical scenes are seen as movement.

The *Spacewriter*, the *Science Museum Clock* and the PIC-Tock wands are designed so that when they are moved through an arc, the lights flash in different patterns at each position through the arc. Retaining the image of each pattern flash, the viewer's eyes are made to believe that the sequence of flashes is one long flash in which the several patterns are simultaneously seen as a coherent message.

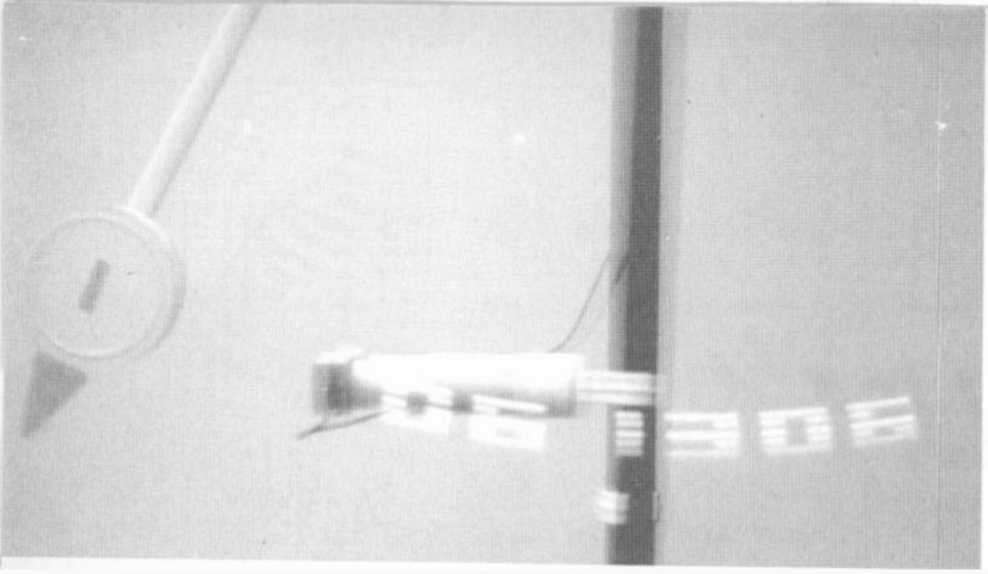
LIMITATIONS

The patterns could be arranged to show any simple message, whether it is in text or numbers. Even a simple picture could be "drawn" by a wand with enough lights. Vertically, there is no limit to the number of lights that can be used to make up the pattern, other than that imposed by practicality.

Horizontally, though, the number of flashes that can occur is dictated by the time between the start of the sequence and its end. Too long a time will result in the eye "forgetting" the starting pattern before the ending pattern is shown. Effectively, the total period should last for no more than about a *quarter* to *half* a second.

There are also limits to the distance between the positions of the starting and ending patterns. Too short a distance and the images will be too closely superimposed for the overall pattern to be distinguished. Too long a distance will result in each pattern flash appearing as streaks of light, again making the overall pattern difficult to interpret. Also, with a lengthy swing, the eye tries to follow the lights and so the effect is lost, all that is seen is a vertical line whose individual segments are flashing.

Obviously, then, these practicalities constrain the amount of data that can be



Swinging the pendulum past the infra-red beam triggers the time in "thin air".

conveyed by a horizontally moving sequence of flashing lights arranged as a single vertical column.

With the *Spacewriter*, the message had to be restricted to show "MERRY XMAS" rather than "MERRY CHRISTMAS". To simply tell the time, however, a six-digit number is perfectly readable, two digits for hours, two for minutes and two for seconds.

Thus, the technique is well suited to use as a clock display, as the PIC-Tock Pendulum Clock proves.

MICROCONTROLLER

The complete circuit diagram for the PIC-Tock Pendulum Clock is shown in Fig. 2. As can be seen, there is not a lot to it! Most of the work is done by the PIC16C84 microcontroller, IC1, and the software programmed into it.

This particular microcontroller is the EEPROM version of the PIC family manufactured by Arizona Microchip. It has previously been described in two *EPE* articles, the *Simple PIC16C84 Programmer* and the *PIC-Electric Meter*, both in the February '96 issue. *(We regret that this issue is now completely out of print and only photostat copies of these articles are available – see page 722 – Ed.).*

Being an EEPROM (Electrically Erasable Programmable Read Only Memory) device, the PIC16C84 can be repeatedly reprogrammed several thousand times. It does not need to be erased by ultra-violet light between each reprogramming routine.

It contains two input/output ports, the first having five lines, RA0 to RA4, the second having eight lines, RB0 to RB7. Any of the lines can be set through software as an input or output. As discussed in the manufacturer's data book, some of the lines can be used as interrupt inputs, although this fact is not taken advantage of in PIC-Tock.

The device can be software-configured for any one of four oscillation modes:

RC Resistor-capacitor oscillator
XT Standard crystal/resonator (100kHz to 4MHz)
HS High-speed crystal/resonator (4MHz to 10MHz)
LP Power saving low frequency crystal (32kHz to 200kHz).

Here, the *XT* mode is used, in which the oscillation frequency is generated around the 3·2768MHz crystal X1, in conjunction with capacitors C2 and C3, and resistor R6.

COUNTING TIME

Using an internal counter, the 3·2768MHz master frequency is subdivided to trigger a register flag at intervals of approximately 100th of a second. The precise count is varied periodically during the software routines to compensate for manufacturing tolerances of the exact crystal frequency.

Each time the register flag is triggered, counters representing seconds, minutes and hours are incremented as appropriate, as happens in an ordinary digital clock.

SEGMENTED TIME

The contents of the clock counters are converted to a format suitable for driving the five l.e.d.s (light emitting diodes) D1 to D5. Using an internal look-up table, at each 100th of a second count, the format is determined by which portion of the time is to be shown.

There are six digits associated with the time display: units of seconds; tens of seconds; units of minutes; tens of minutes, units of hours and tens of hours. Since the l.e.d. pattern displayed has to also take into account the fact that the time has to be viewed while the pendulum is swinging, each digit has to be split into vertical segments.

PIC-Tock has been designed so that the time is displayed when the pendulum swings from left-to-right. Consequently, the vertical segments of the digits must also be turned on and off in the same order.

For the sake of simplicity in this design, the digits have been split into three vertical segments, each consisting of five l.e.d. bits, as illustrated by the ten digits represented in Fig. 3.

The l.e.d.s are turned *on* when the output port line is taken "low", shown as a zero (0), and *off* when the line is "high", shown as a one (1). For clarity, the outline of each number is represented by the black trace line in the 15-bit block.

Take digit zero (0), for example. The left hand column of the digit consists of five 0s, therefore the l.e.d.s show a vertical line when this format is output to them.

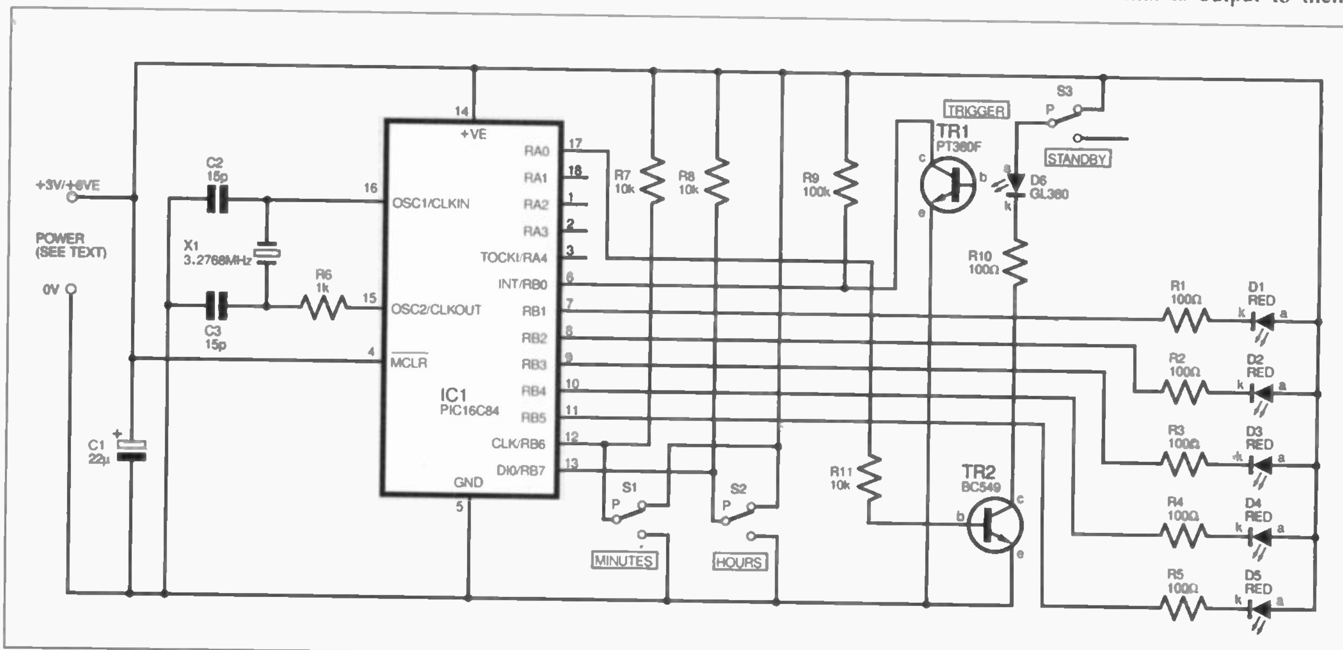


Fig. 2. Complete circuit diagram for the PIC-Tock Pendulum Clock. Note that switch S3 is optional.

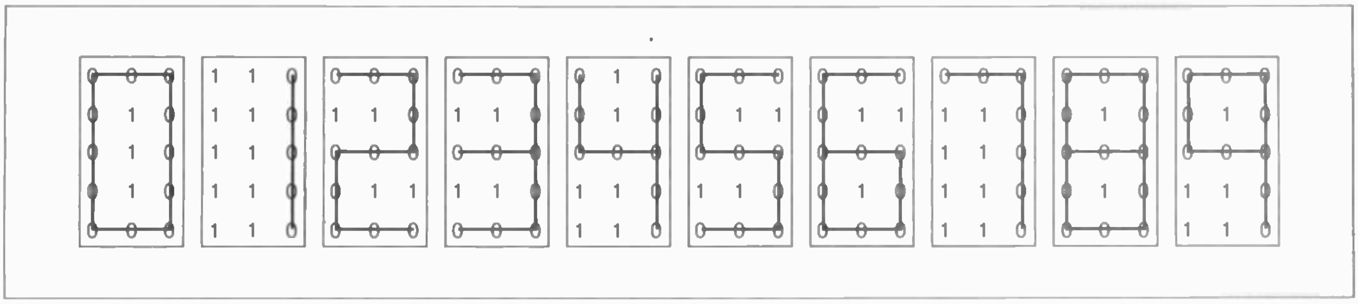


Fig. 3. Logic formatting sequence for producing the numerals zero to nine using five l.e.d.s.

In the second column, only the top and bottom l.e.d.s are turned on for this output format. Column three is the same as column one, a vertical line.

When these columns are triggered in sequence during the pendulum swing, because of "persistence of vision", the eyes respond as though they have simultaneously seen a left hand vertical line, top and bottom horizontal lines and a right hand vertical line. In other words, the outline of a zero (0) will be seen.

Studying the other blocks in Fig. 3 shows how the digits one to nine are similarly made up. For other applications, the bit patterns could be changed so that letters of the alphabet are displayed, although they would need to be a mixture of upper and lower case characters, and not all could be realistically generated using a 3-bit by 5-bit pattern.

When several digits are displayed consecutively, the program inserts a blank between them by momentarily turning off all the l.e.d.s.

SYNCHRONISATION

Obviously, the commencement of the time display sequence has to be synchronised to the pendulum swing. This is achieved by using an infra-red (IR) emitter and sensor pair. The IR emitter, diode D6, is placed at a fixed point to the left of the pendulum's vertical rest position. The sensor, TR1, is housed in the circuit box mounted at the end of the pendulum.

When the pendulum is at rest, sensor TR1 cannot detect the infra-red output from the emitter D6. However, when the pendulum is swinging, each time the sensor crosses the IR beam emitted from D6, a logic 0 (low) pulse is generated across resistor R9.

Through port line RB0 (IC1 pin 6), software continually monitors the logic status at the junction of resistor R9 and collector (c) of transistor TR1. When a logic 0 pulse is detected, the l.e.d. display routine is started.

Once triggered, the display routine triggers the l.e.d.s appropriately until all six clock digits have been displayed, at which point they are turned fully off until the next trigger pulse is received. Each l.e.d. pattern is turned on for 100th of a second, the whole sequence taking approximately 0·2 seconds.

L.E.D. SWINGING

In operation, the pendulum is first pulled, by hand, beyond the left of the emitter diode D6 position. It is then released and the display sequence is triggered as soon as the swing takes the sensor left-to-right past the emitter diode D6. The sequence is displayed fast enough so that it is complete before the pendulum reaches the end of its swing.

Now under control of gravity, the pendulum swings back, right-to-left, past D6 towards its release position. It then again swings from left-to-right, once more triggering the display routine. The process is repeated for as long as the pendulum's energy can take it back past the infra-red emitter.

Each swing, of course, is shorter than the last, and so the display width is seen to shrink in size. Its height remains the same, though. Eventually, the swing becomes too short for the display to be triggered, and the pendulum gradually comes to rest.

Unavoidably, each time the sensor passes the emitter on the return swing from right-to-left, the display sequence is again triggered, resulting in a flipped-over (backwards) view of the time.

Early on in the design, attempts were made to write the software so that the display would not be triggered on the return swing. The results proved to be unreliable, caused by the system's uncertainty about the triggering phase when the pendulum's energy only just managed to bring it within the vicinity of the emitter's beam.

Whilst the use of an additional sensor to detect swing direction could have overcome this problem, the extra complexity and current consumption was felt to be unjustified.

Anyway, as PIC-Tock is a novelty clock, backwards viewing of the time can be regarded as part of the novelty! Indeed, by mounting the emitter diode D6 near the pendulum's rest position, rather than well to one side, the effect can be set so that both viewing directions can be seen for similar lengths of time.

ENERGY SAVING

The "clock" may be powered from any d.c. power source, either regulated or from a battery, between 3V and 6V. In order to save power while it is not being viewed, two design features have been included, one software, the other mechanical.

The software aspect causes the infra-red emitting diode, D6, to be turned on only very briefly at each 100th of second. At this time, output line RA0 (IC1 pin 17) is taken high, switching on transistor TR2, which in turn switches on D6. The turn-on period is just slightly longer than the pulse width needed for the sensor TR1 to satisfactorily respond to the infra-red beam.

This technique cuts down the long-term power consumption by D6, to nearly one hundredth of that if it were constantly turned on. As limited by resistor R10, it draws around 30mA from a 5V supply.

Secondly, an optional Standby switch, S3, has been included so that D6 can be switched off for extended periods when the clock does not need to be viewed.

With a supply of 5V, power consumption is approximately 1·7mA when all the l.e.d.s are turned off. When turned on, each l.e.d. draws about 25mA to 30mA.

TIME SETTING

Initial setting of the time is done by switches S1 and S2. Once per second, software monitors port lines RB6 and RB7 (IC1 pins 12 and 13). With the switches in the Off position, a logic 1 (high) is present on both lines. If either switch is turned On, the corresponding port line goes low (logic 0).

When this fact is detected, the relevant minutes or hours counter is incremented by one. When the hours counter reaches 24, it resets to zero. The minutes counter resets to zero when it reaches 60. Each time the minutes are incremented, the seconds are reset to zero.

While either counter is being incremented, the l.e.d.s are turned on and display the logic values of the counter's

COMPONENTS

See **TALK** Page

Resistors
R1 to R5, R10 — 100Ω (6 off)
R6 — 1k
R7, R8, R11 — 10k (3 off)
R9 — 100k
All 0·25W 5% carbon film or better.

Capacitors
C1 — 22µ radial elect., 16V
C2, C3 — 15p polystyrene (2 off)

Semiconductors
D1 to D5 — min. 3mm red l.e.d. (5 off)
D6 — GL380 infra-red emitter diode
TR1 — PT380F infra-red receiver transistor
TR2 — BC549 *npn* transistor
IC1 — PIC16C84 EEPROM microcontroller (see text)

Miscellaneous
X1 — 3·2768MHz crystal
S1 to S3 — min. s.p.c.o. toggle switch (3 off)

Printed circuit board, available from the *EPE PCB Service*, code 109; 18-pin d.i.l. socket; plastic circular box, 68mm diameter x 26mm deep (see text); diecast box, size 89mm x 34mm x 26mm; materials for pendulum and support (see text and Fig. 5 to Fig. 7); connecting cable and wire; solder, etc.

Approx Cost Guidance Only £19 excl. hardware

first five bits, confirming that the count is being changed. The l.e.d.s remain on briefly after the controlling switch has been turned off.

If both switches are on together, priority is given to the Hours switch S2, the Minutes switch S1 being ignored.

TIMING ACCURACY

In theory, the crystal X1 should oscillate at its stated frequency, in this case 3·2768MHz. In practice, it probably will not.

This is due to several factors, such as the manufacturing tolerance, the load imposed on it by IC1, the capacitance values of C1 and C2, and temperature. All of these factors can affect the accuracy of any real-time clock.

The software has been written so that, with the exception of temperature, the disruptive factors can be compensated for.

At first, it had been assumed that by making either C1 or C2 a variable capacitor, the crystal frequency could be trimmed with fair precision. For reasons unknown, and despite experimenting with various component values and configurations, it was found that the inclusion of a variable capacitor could actually cause the oscillator to become unstable. Consequently, it was omitted from the final design and compensatory parameters were written into the software instead.

These parameters involve periodically changing the primary count length from the basic value of 100, to a value above or below it, as appropriate. For example, to perhaps occasionally count to 99 or 101 before incrementing the seconds count. This count change can be applied after so many seconds or minutes or hours, or at intervals involving all three.

Whilst it would have been possible to add additional switches to set the compensatory values while the clock was running, this would have severely increased the software complexity. It would have also required additional wires to be run up through the pendulum arm to the control box at its head. This could have proved difficult because of the restricted width of the pendulum tube.

Consequently, a less-than-ideal compromise has been adopted, which requires the microcontroller IC1 to be programmed twice. Once for an initial run of about 24 hours, and then again with compensatory values having been written into the source code when the clock's actual rate is known.

Listing 1: Correction Calculation Program

```
10 REM PICCALC4 - PIC-TOCK PENDULUM CLOCK CALCS 30DEC95
20 XTAL=3276800!:REM CHANGE THIS NUMBER FOR ANY FUTURE CORRECTION CALC
30 CLS:LOCATE 4,1:PRINT"IS CLOCK RUNNING FAST OR SLOW [F/S]?"
40 A$=INKEY$:IF A$<>"f" AND A$<>"s" THEN GOTO 40
50 IF A$="f" THEN A$="FAST":F=-1:ELSE A$="SLOW":F=1
60 PRINT "BY HOW MANY SECONDS ";A$;" IN 24 HOURS";:INPUT B$:S=VAL(B$)*F
70 T=60*60*24:B=S+T:E=B*100/T:XTALERROR=XTAL-((E*XTAL)/100)
80 XTAL=XTAL+XTALERROR:CLK=XTAL/4:SCALE=CLK/32:RTCC=SCALE/256
90 DIV=32768!:PRINT: PRINT "XTAL IS RUNNING AT";XTAL;"Hz"
100 PRINT"MAKE A NOTE OF THIS NUMBER IN CASE FURTHER CHANGE NEEDED"
110 B=INT(XTAL/(DIV*100))*(DIV*100):C=(XTAL-B)/(DIV*100)*T
120 SECERROR=XTAL:ERRORTOTAL=XTAL:DAYMULT=100*T:PRINT
130 MULT=1:A$="EACH 1 SEC=":B$="1ST":C$="CLKCNT":GOSUB 210
140 CLKCNT=SECCORRECT
150 MULT=60:A$="EACH 1 MIN=":B$="2ND":C$="MINCRT":GOSUB 210
160 MULT=60:A$="EACH 1 HR =":B$="3RD":C$="HRSCRT":GOSUB 210
170 MULT=24:A$="EACH 1 DAY=":B$="4TH":C$="DAYCRT":GOSUB 210
180 PRINT"XTAL PULSES YEAR ERROR";DAYERROR*365:PRINT
190 PRINT"NOTE THE 4 ($..) NOS & SET SOURCE CODE FILE ACCORDINGLY"
200 PRINT:END
210 SECERROR=ERRORTOTAL*MULT:SECCORRECT=INT(SECERROR/DIV)
220 C=SECCORRECT*DIV:ERRORTOTAL=SECERROR-C:DAYMULT=DAYMULT/MULT
230 DAYERROR=ERRORTOTAL*DAYMULT/DIV:HEXFACT=CLKCNT+SECCORRECT
240 PRINT"ERROR AFTER "B$;" CORRECTION :";ERRORTOTAL;"XTAL PULSES"
250 PRINT "CORRECTION ";A$;SECCORRECT,,"SET "C$" = $";HEX$(HEXFACT)
260 RETURN
```

Regrettably, this technique means that only readers who have a suitable PIC16C84 programmer can build the time corrected PIC-Tock Pendulum Clock, since it is not practical to arrange a commercial double-programming source for the chip. However, the inexpensive *Simple PIC16C84 Programmer* previously mentioned is ideal for the job and can be used by anyone having access to a PC-compatible computer.

SOFTWARE

The software source and object codes for the PIC-Tock Pendulum Clock are available on a 3·5in disk from the *EPE* Editorial offices for £2·50 (overseas £3·10 surface, £4·10 airmail). Prices include postage. Or download (free) from our Internet site: **//ftp.epemag.wimborne.co.uk.**

CORRECTION CALCULATION

To establish the correction factors needed, the program in Listing 1 should be used. It can be run from GW-Basic or QuickBasic.

First, the microcontroller IC1 is programmed with the correction factors set to a default value already written into its source code. These factors assume that the oscillator is running at precisely 3·2768MHz and that no correction is needed.

The clock is now run for a reasonable period, say 24 hours, and the number of seconds that it has gained or lost during that time noted. If the period is not exactly 24 hours, calculate the number of seconds that would be gained or lost in 24 hours. Decimal places are permitted.

Run the Correction Calculation Program. It will ask whether a gain or loss has occurred and then ask for the number of seconds by which the clock is wrong. It then calculates correction values which will be actioned at the end of four strategic intervals: every second, every minute, every hour, and every 24 hours.

The resultant values are shown in hexadecimal alongside the name of the program variable to which they relate. Note them down, then from the normal software used for writing text, substitute the values into the PIC-Tock source code (the section to look for has the label PUTCRT:)

For example, the default values are:

CLKCNT = $64, MINCRT = $64,
HRSCRT = $64, DAYCRT = $64

and the substitution values might be:

CLKCNT = $64, MINCRT = $68,
HRSCRT = $91, DAYCRT = $75

The section of source code which needs changing is shown in Listing 2, in which the default and example substitution values are tabulated.

Save the source code file, and then assemble it into an object code file (.OBJ) in the usual way. After which, reprogram the chip from this file data.

Should the clock precision later be found to be still fractionally wrong, the process can be repeated. This can be done by adding the original and later error values together and calculating accordingly.

Alternatively, when the first calculation is done, note the quoted crystal rate as calculated and shown, then substitute its value in place of the original default crystal value (XTAL = 3276800!) in the Basic program.

Listing 2:
Section of source code (label PUTCRT:) showing default and example correction timing values.

DEFAULT CODES		CORRECTED CODES	
CODE	VAL/REG	CODE	VAL/REG
movlw	$64	movlw	$64
movwf	CLKCNT	movwf	CLKCNT
movwf	CNTVAL	movwf	CNTVAL
movlw	$64	movlw	$68
movwf	MINCRT	movwf	MINCRT
movlw	$64	movlw	$91
movwf	HRSCRT	movwf	HRSCRT
movlw	$64	movlw	$75
movwf	DAYCRT	movwf	DAYCRT

Now just the latest clock seconds error (still over a 24 hour period) can be used to calculate the new correction factors.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) topside component layouts and full size copper foil track masters are shown in Fig. 4. This board is available from the *EPE PCB Service*, code 109.

Commence construction by using a small hacksaw to separate the board into its three sections: the main board; the infra-red sensor board and the unused section. If using the suggested box, trim off the corners of the main p.c.b. as indicated to allow it to fit inside the box. The four drilled holes at the corners of the p.c.b. are to ease mounting in other boxes.

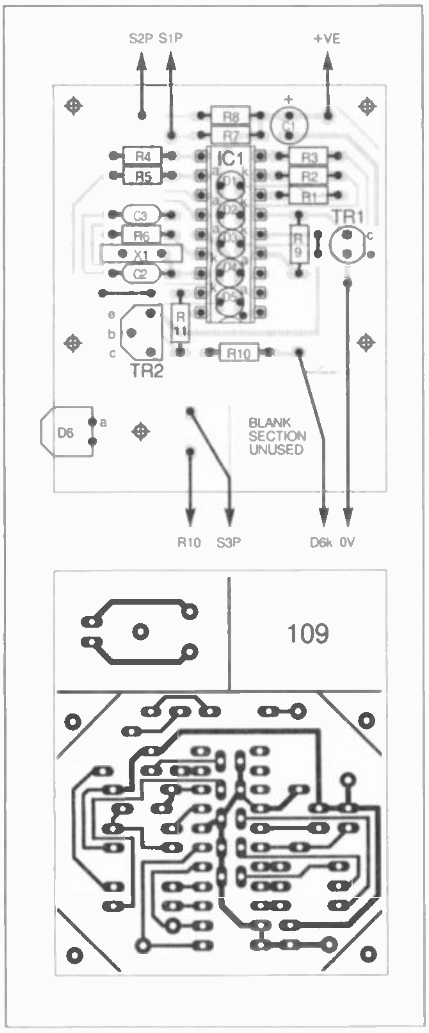
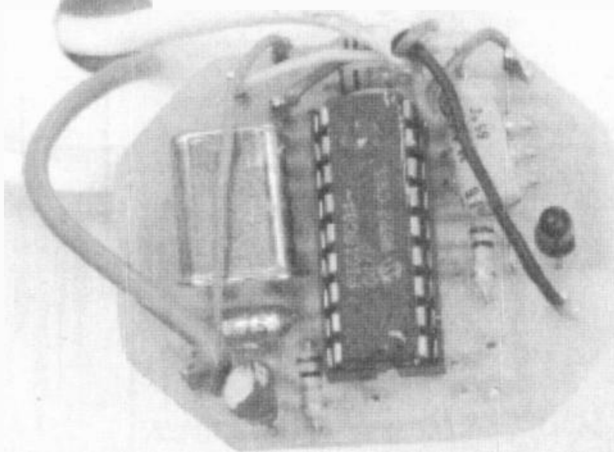


Fig. 4. Printed circuit board component, layout and full size p.c.b. foil master. This board is cut to produce two p.c.b.s.

Now assemble the main board. The l.e.d.s D1 to D5 are mounted on the ***track side*** and should be dealt with first. From the track side, push their leads into the holes as far as they can go, making sure that their polarities are correctly positioned.

With a small-tipped soldering iron, *carefully* solder them to their track pads. Just solder one side first, allowing them to be properly aligned before soldering the other side. Trim off the excess lead lengths, on the topside, very close to the board.

Fit the i.c. socket, two small on-board link wires, resistors and capacitors C2 and C3. Mount capacitor C1 (correctly polarised) and crystal X1 so that their



Completed main printed circuit board showing the crystal and small radial electrolytic carefully mounted vertically over the other components.

bodies lie flat across their neighbouring components, see photograph. Fit TR1 and TR2, again ensuring correct orientation.

Finally, insert 1mm terminal pins for the off-board wires. Thoroughly check the assembly with a magnifying glass, looking especially for problematic soldering around the l.e.d.s and i.c. socket pins.

Now solder the infra-red emitting diode D6 to its small sub-board, lying it flat with the board.

DISPLAY BOX

For the prototype model, the p.c.b. is mounted in a small circular plastic box which had previously contained a powerful "Gentleman's Relish" anchovy paste! It is available in different sizes and the one chosen measures externally about 68mm maximum diameter and is about 26mm deep.

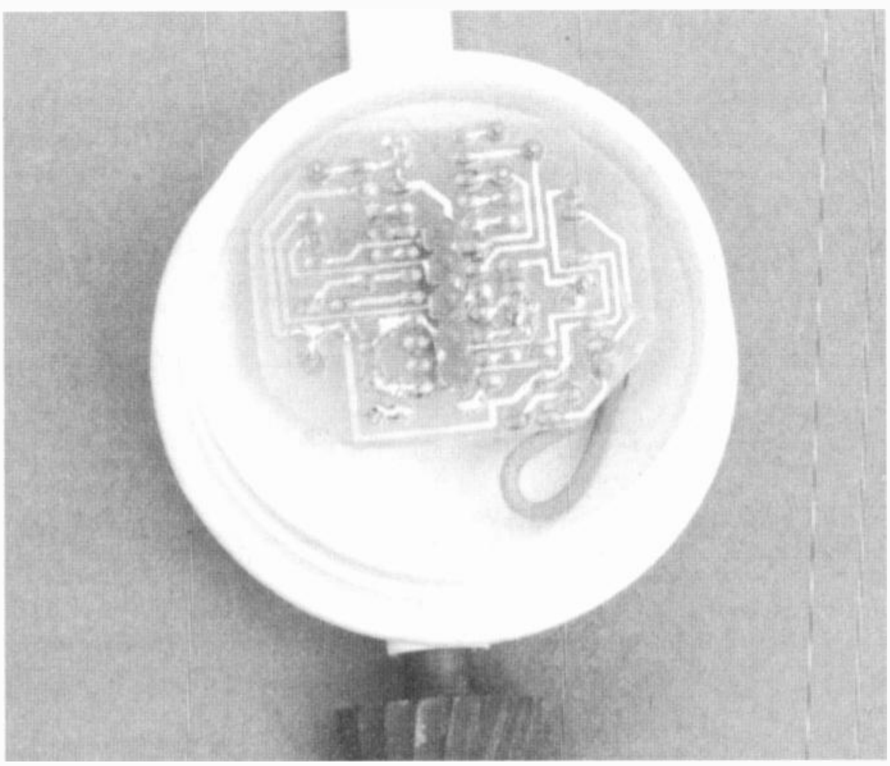
Three holes are needed in its concave base; for sensor vision, cable entry and pendulum shaft mounting. The lid needs a central slot through which the l.e.d.s protrude. The plastic is a bit brittle, so work on it with care.

Because of the unusual concave interior of the box, it was decided not to attempt bolting the p.c.b. to it. Instead, a chunk of Blu-Tack was used to hold the p.c.b. in place.

PENDULUM ARM

Look at the photographs of the pendulum assembly and then relate them to the schematic details shown in Fig. 5 to Fig. 8.

The pendulum arm itself is made from an oval metal tube. Its actual measurements, given in Fig. 5, are not critical and anything similar could be used. The



The completed p.c.b. mounted inside the circular case, using Blu-Tack, showing the l.e.d.s soldered on the track-side.

original started life as part of a *Harrison Drape Net Curtain Track*, intended for a window width of 0·61m to 1·02m (24in to 40in) – curtaining shops stock them. Just its outer slider was used, with the plastic end plug removed.

Holes were drilled in the tube, suitable for mounting-shaft insertion at the top, cable exit towards the bottom, and a nearby display-box mounting hole. Before drilling the latter, though, it is suggested that the box is temporarily stuck to the shaft with Blu-Tack until the preferred position is found, this being a matter of taste.

For added weight, in order to give greater swing momentum, a pyramidical woodworking hole enlarger was pushed into the bottom end of the pendulum shaft. Other weights could be substituted, if a suitable fixing method can be devised.

PIVOT PARTS

Mechanics are not the author's best subject! As usual, these have been done according to what spare bits there are around the house and which can be successfully bodged! Again, as usual, plumbing materials and electronic parts have been conscripted into action (both are in plentiful supply at Chez B . . .), for the pendulum's pivot and mounting support.

Details of the pivot assembly are shown in Fig. 6. The pivot shaft, which passes through the top of the pendulum arm, is the plastic shaft removed from a mono potentiometer (any value will do!).

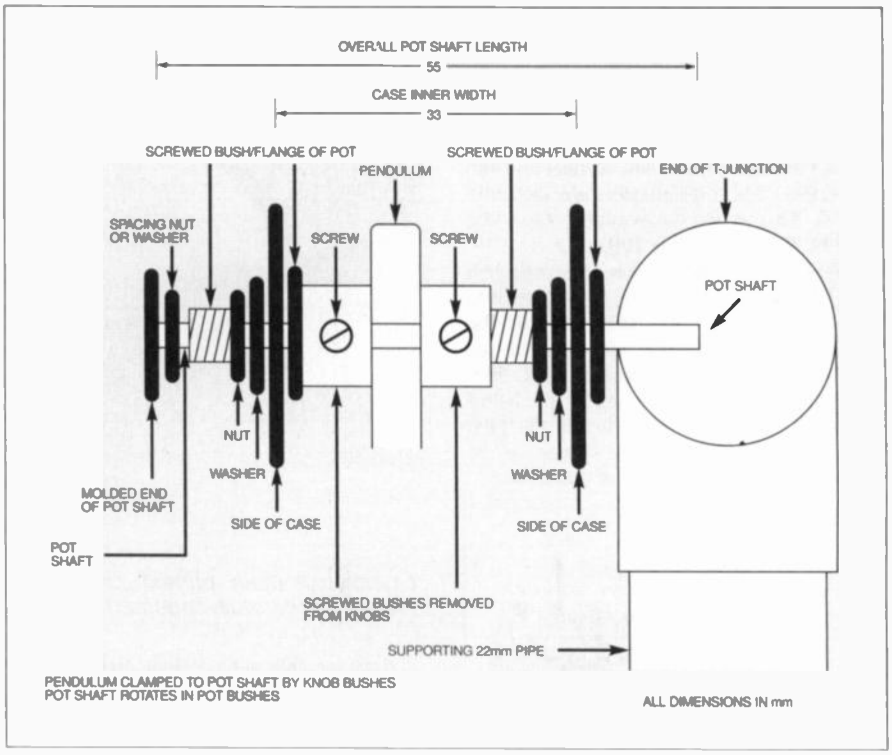


Fig. 6. Pendulum pivot head assembly and dimensions.

The flanged bushes, nuts and washers were also taken from pot assemblies. The screwed brass bushes were cut out from two spare plastic rotary knobs.

These parts were assembled inside a small, suitably drilled, diecast metal box, taking care that the arrangement swung smoothly from side to side, but with minimal sloppiness fore and aft. If better parts can be found in a local model shop, use them.

Inconveniently, the diecast box had slightly sloping sides. This required the use of thin wooden wedges (not shown in Fig. 6) between the rear side and the plastic plumbing T-tube to which the box was bolted. The wedges were cut so that the pendulum arm and its shaft were satisfactorily positioned vertically to ensure a swing with least friction (they were vandalised from clothes pegs!).

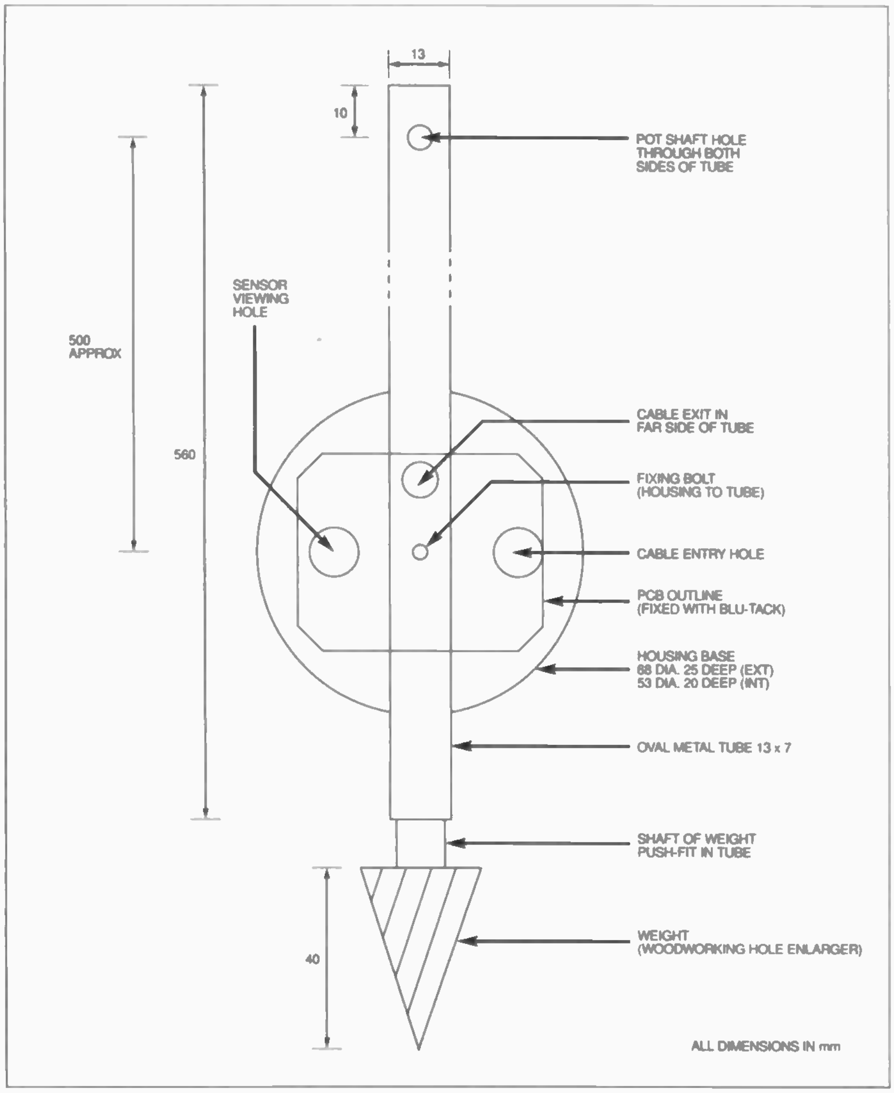


Fig. 5. Pendulum arm assembly and dimensions.

SUPPORTING STRUCTURE

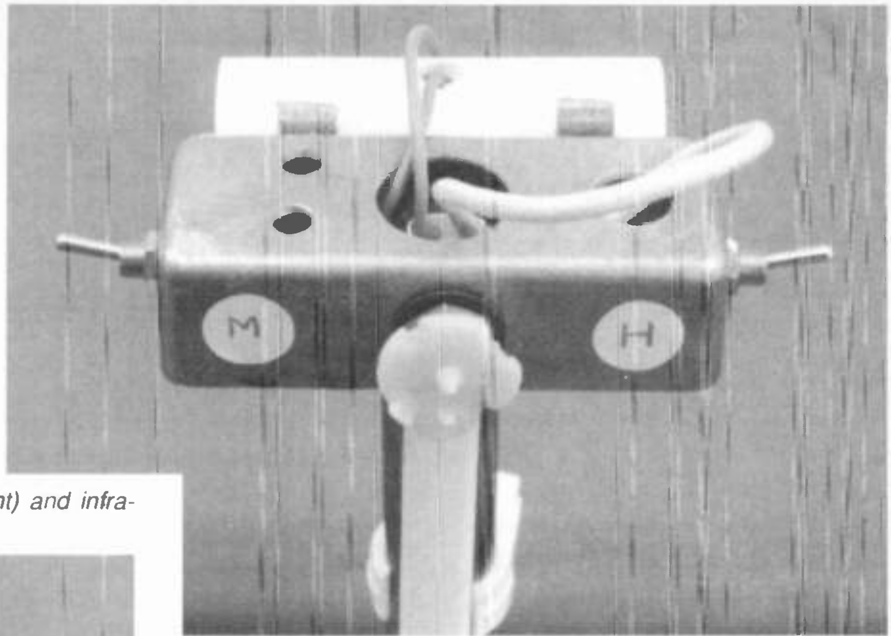
As shown in Fig. 7, the pendulum support structure is principally constructed from 22mm diameter plumbing pipe. Since the structure is only used to support the pendulum pivot mechanism at the top, plus the mount for infra-red l.e.d. D6, alternative techniques could be used. For example, the pivot box could be bolted directly to a wall, as could D6.

In the illustrated method, the pivot box is bolted to a plumbing T-junction, into which the vertical pipe is pushed. The latter is then fixed to a wall using ordinary pipe clips. The same type of clip is used in connection with mounting diode D6.

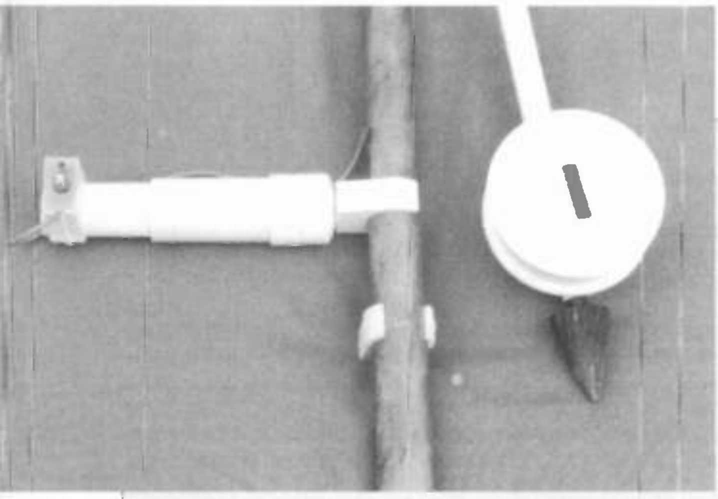
Two mounting positions for the infra-red l.e.d. D6 are shown in Fig. 7. The preference is for the position on the end of the horizontal shaft. This places emphasis on viewing the time in the normal direction and provides an amount of uniformity in the width of the display to either side of the central position. Be aware, though, this relationship varies as the pendulum swing arc shortens.

The second position, with D6 near the central column, allows the time to be read in both swing directions, with it being displayed "backwards" on the return to the left beyond the centre. Be aware here that the apparent width of the digits will be greater near the central column than towards the end of the swing. This happens because the pendulum is slowing down as it nears the end of its arc.

All plumbing parts for the pendulum support may be copper or plastic. A mixture of both was used in the prototype since they were already owned.



Prototype pendulum pivot head case (right) and infra-red emitter support arm (below).



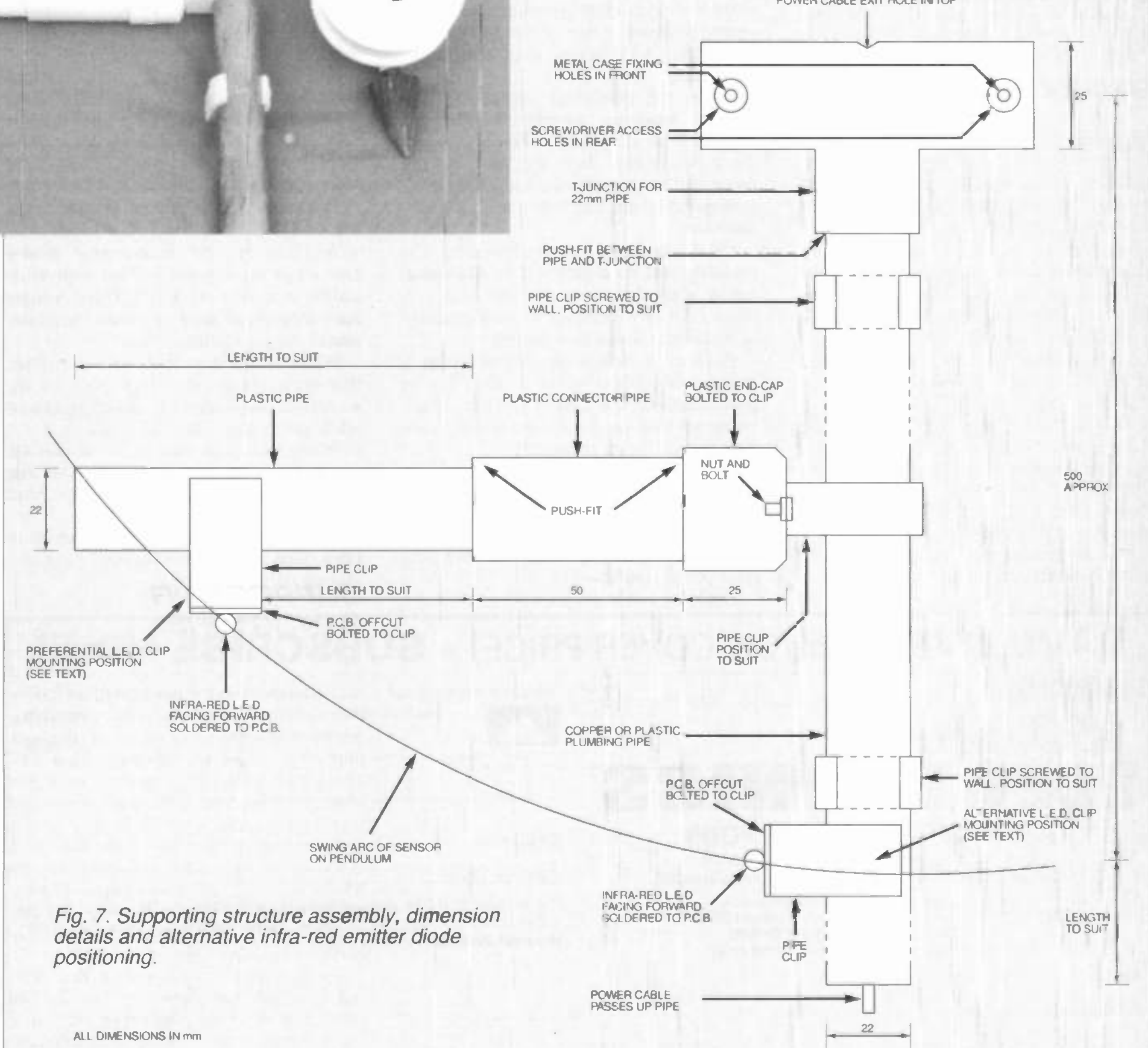


Fig. 7. Supporting structure assembly, dimension details and alternative infra-red emitter diode positioning.

WIRING-UP

As well as holding the pivot mechanism, the pivot box also holds the three switches, S1 to S3. In Fig. 8 are shown the wiring details for these, plus the positions of the holes through which cables can be passed.

Four wires are needed to connect the p.c.b. to the switches, and two for the IR l.e.d. In the prototype, a four-way cable was used, for the main p.c.b. These were fed (patiently!) through the pendulum tube from the top, fishing them out through the lower hole using a thin screwdriver and fine pliers. Having soldered the wires to their p.c.b. points, the cables were then slightly pulled back up through the tube to shorten the slack at the p.c.b. end.

At the top, sufficient length should be allowed so that the rigidity of the wiring does not impose restrictions on the pendulum's ability to swing freely. From the top, a two-way cable was fed down the main supporting tube, from where sufficient length was allowed to connect it to an existing 5V power supply.

Another two-way cable was used to connect up D6, the IR l.e.d. It is suggested that, initially, this cable is draped down the tube externally. Once the final position for D6 is known, the cable can then be passed down the main tube and out to D6 via a suitably placed hole.

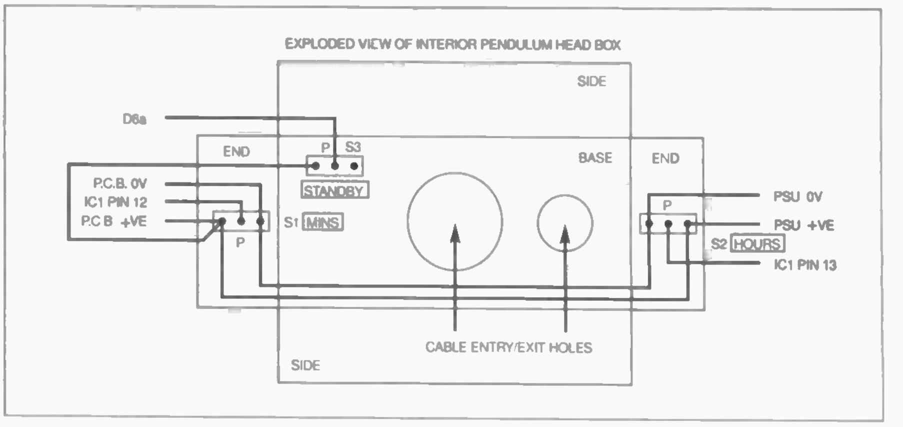


Fig. 8. Switch mounting and wiring details for the pendulum head box.

SWING TIME

When the assembly and mounting are complete, the PIC16C84 microcontroller can be programmed in the usual way. If the chip has not been programmed before, it must first be configured to match its application. This procedure is described in the *Simple PIC16C84 Programmer* article previously mentioned. Program the configuration for XT Crystal, Watchdog Timer off, Power-on Reset on.

Once the microcontroller IC1 has been fully programmed, insert it into its socket on the PIC-Tock p.c.b. Take normal static-preventive precautions when doing so.

Switch *off* S1 and S2 (Minutes and Hours), and switch *on* S3 (IR l.e.d. D6). With the pendulum stationary, watch the five display l.e.d.s and switch on the power. All five should flash for a couple of seconds and then turn off.

Pull the pendulum to the left until TR1 sensor, within the round case, has its viewing hole opposite D6, adjusting the latter's position if necessary. By hand, move the pendulum slowly back and forth past D6. On each pass, the display l.e.d.s should flash briefly, the display sequence having been triggered.

Dim the room lighting to almost nil, just sufficient to make out where the pendulum is. While standing back at arm's length, pull the pendulum left beyond the D6. Gaze with eyes slightly unfocussed on the central column at about the point where the display will swing past. Release the pendulum.

When the pendulum passes D6, the display sequence should be seen as a string of six digits. Those towards the right should show the minutes and seconds that have elapsed since the power was switched on. The hours will probably show zero.

On the first few swings, however, it is probable that no digits will be discerned, just a vertical line of flashing l.e.d.s. It takes a bit of experience to look properly at the display to see its numbers.

Eyes try to follow the pendulum as it swings and so the effect is lost. Try to concentrate on the central position of the swing so that the l.e.d.s move past your eyes without being followed.

It is a technique that needs practice. In some ways, it's rather like seeing those fascinating 3D images that are hidden within obscure patterns, except that the pendulum is easier! Keep on swinging until you get the knack!

TIME SWITCH

To set the actual hours and minutes time, swing the pendulum and switch on S1, the Minutes switch. Keeping the pendulum swinging, leave S1 switched on until the minutes display corresponds with the actual minutes time established from another clock. Switch off S1 immediately that value is reached.

Switch on S2 (Hours), and similarly correct the hours display. Immediately switch it off once the right value is reached.

It is also possible to set the clock without swinging the pendulum, switching on the relevant correction switch for the same number of seconds as the known difference value. This can be an accurate technique since the microcontroller's counter incrementation rate is one Hertz when S1 or S2 are switched on.

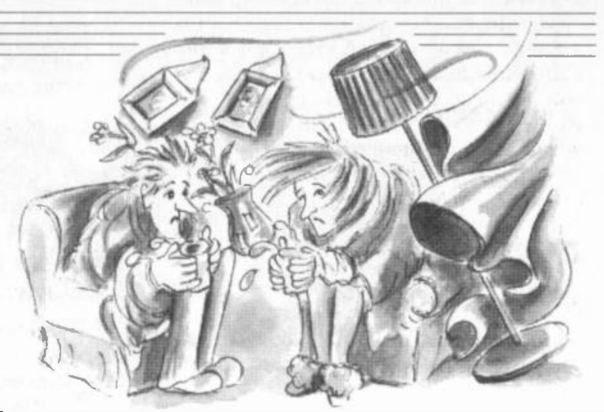
Additionally, the unswinging display l.e.d.s can be watched while a correction switch is turned on. The display changes each second and shows the first five binary bits of the appropriate counter register.

When setting the clock time, remember that when minutes are being corrected, the seconds count is automatically held at zero while the switch is turned on.

When the clock has been running for about 24 hours, any corrections to its rate can be made via the software, as described earlier.

So, there you are – a novelty clock to keep you and your friends entertained. Have a swinging time! □

Constructional Project



DRAUGHT DETECTOR

TERRY de VAUX-BALBIRNIE

Sniff out those unwanted draughts with this money-saving project.

MOST people now realize the importance of providing efficient insulation in their homes. However, the simpler expedient of eliminating draughts is often overlooked and this can represent a considerable waste of energy.

Once sources of draughts have been found, they may be sealed at very little cost using materials obtained from any DIY store.

TRICKY SITUATIONS

The project presented here is a self-contained unit which helps to locate draughts around the home. In use, the Draught Detector is moved slowly around likely places such as the edges of window frames and doors. When the sensor detects a draught, a buzzer sounds.

This is more effective than checking with the hand and is easier to use in awkward situations. The unit may even be attached to a long cane so there is no need to crawl around on the floor or to stand on a chair to reach out-of-the-way places.

The maximum sensitivity can be judged from the fact that the prototype unit is triggered by blowing at the sensor at a distance of about one metre (3ft approx.). For this reason, resourceful readers are certain to find alternative uses for this circuit.

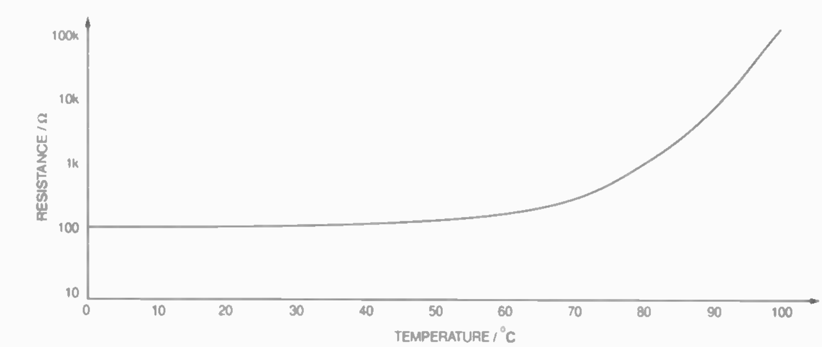


Fig. 2. Graph showing the rising resistance with an increasing temperature.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Draught Detector is shown in Fig. 1. The key components are R2 and R4 – these form a pair of identical *positive temperature coefficient* (p.t.c.) thermistors. The working substance in a p.t.c. thermistor is a mixture of barium, lead and strontium titanates.

It is essential to use this particular type of thermistor (see *Shop Talk*), the more common *negative* (n.t.c.) variety would not be suitable here. Whereas the latter type *reduces* its resistance with increasing temperature, the positive temperature coefficient one shows a *rising* resistance.

The specified thermistors have a resistance of around 100 ohms at temperatures below 60°C. Above this, the resistance rises sharply and at 100°C reaches 100 kilohms – a thousandfold increase (see Fig. 2). The temperature at which the resistance becomes about one kilohm (1kΩ) (in this case, 80°C) is called the *threshold* or *critical* temperature.

With switch S1 on, current flows from the nominal 18V supply consisting of two 9V batteries connected in *series* to the rest of the circuit. The thermistors R2 and R4 are included in a pair of potential dividers.

The first comprises fixed resistor R1 in the upper arm and thermistor R2 in the lower one. The second consists of potentiometer VR1, connected in series with fixed resistor R3, in the upper arm and thermistor R4 in the lower one.

With room temperature below 60°C, the current in the thermistors will be 150mA approximately and sufficient for them to self heat. They will then approach the threshold temperature within a few seconds.

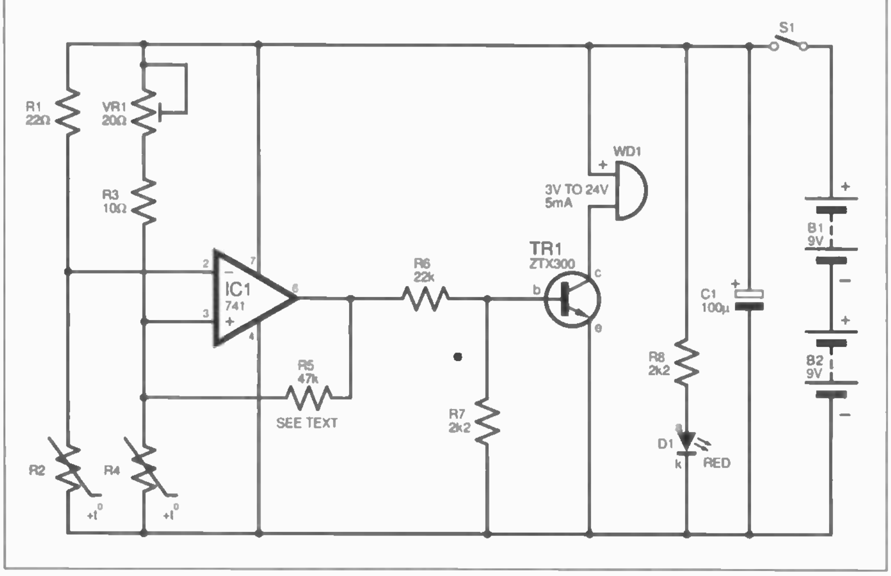
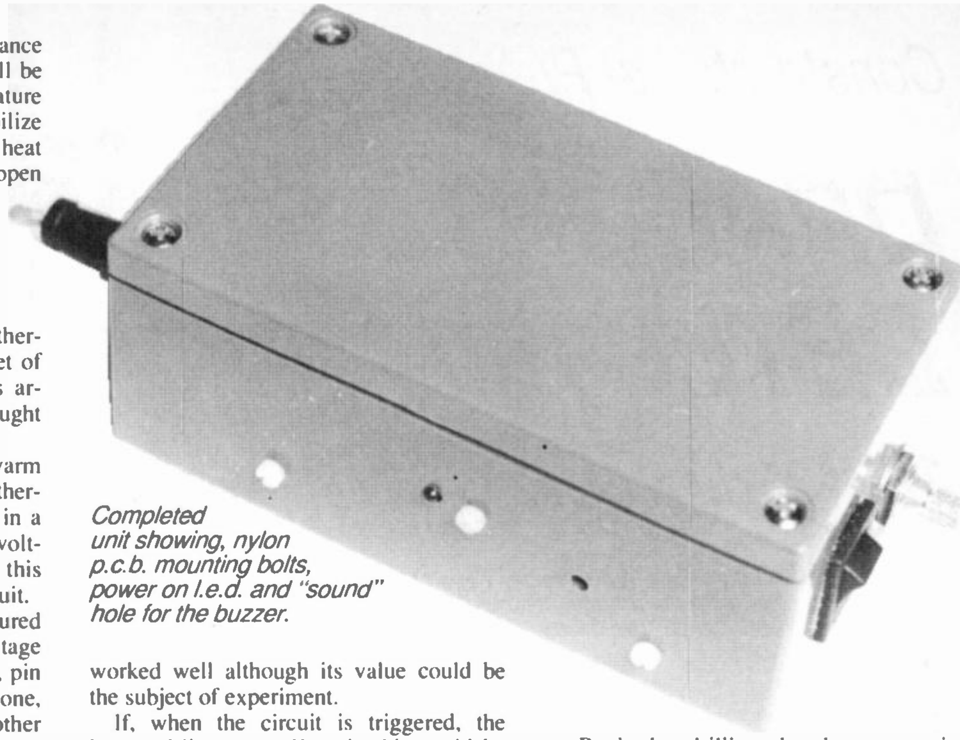


Fig. 1. Complete circuit diagram for the Draught Detector.

However, the rapidly rising resistance causes the current to fall and there will be a reduced heating effect. The temperature of the thermistors will therefore stabilize when the energy supplied equals the heat emitted from the surface. This will happen when the temperature reaches about 75°C, corresponding to a resistance of some 500 ohms.



Completed unit showing, nylon p.c.b. mounting bolts, power on l.e.d. and "sound" hole for the buzzer.

DETECTION

In the absence of a draught, each thermistor will be surrounded by a blanket of warm air. However, thermistor R4 is arranged so as not to receive any draught impinging on the detector R2.

When a draught is detected, the warm air around R2 is disturbed and this thermistor is cooled slightly. This results in a lower resistance and hence a falling voltage being developed across it. It is this voltage change which operates the circuit.

Operational amplifier IC1 is configured as a *voltage comparator*. When the voltage applied to its non-inverting (+) input, pin 3, exceeds that at the inverting (–) one, pin 2, the output (pin 6) is *high*. In other cases it is *low*. The voltage across R2 is applied to pin 2 while that across R4 is applied to pin 3.

WELL BALANCED

In use VR1 (Balance control) is adjusted so that, with no draught present, the voltage at pin 3 will lie a little below that at pin 2. The op.amp will therefore be *off* and hence transistor TR1 will be off also. With no collector (c) current flowing, the buzzer WD1 will remain silent.

When a draught is detected by R2, the voltage at pin 2 will fall below that at pin 3 and the op.amp will switch on. This *on* state will operate the transistor, with base (b) current entering via resistor R6 and WD1 sounds.

Using a pair of thermistors in a balanced circuit like this makes it reasonably immune from deviations in the operating point caused by changes in ambient temperature. It also prevents problems when the device is moved during the course of use since this will inevitably cause a draught.

Any such changes will have an equal effect on both thermistors and the voltages applied to the op.amp inputs will rise or fall in sympathy. The relative status of the inputs – in theory anyway – will therefore depend only on the cooling effect of R2 caused by draughts impinging on it.

Small changes in supply voltage due to the batteries ageing will have no effect since, again, the relative state of the inputs will remain unchanged. Of course, when the batteries run down to the point where they cannot maintain sufficient heating effect in the thermistors they will need to be replaced.

NICE AND WARM

Resistor R5 applies a little positive feedback to IC1. This helps to provide a sharp switching action. Thus, at the point where the device switches on, thermistor R2 will need to warm up a little more for it to go off again.

This causes the buzzer to begin sounding sharply instead of with a "chirp" as might otherwise happen. The value stated worked well although its value could be the subject of experiment.

If, when the circuit is triggered, the buzzer fails to go off again this could be because the resistance of R5 is too low. The value could be raised or the circuit tried with the resistor removed altogether. Light emitting diode D1 indicates the switched-on state with resistor R8 limiting the current to a safe working value.

The circuit needs a power supply of between about 14V and 18V. In the prototype, this was provided by two 9V alkaline PP3 batteries housed inside the case. These will give very good service in occasional use.

At the instant of switching on, there is a current surge of about 300mA. However, this falls rapidly and stabilises at only 50mA or so.

CONSTRUCTION

Construction of the Draught Detector project is based on a single-sided printed circuit board (p.c.b.) and the topside (component view) is shown in Fig. 3, together with the underside copper foil master. This board is available from the *EPE PCB Service*, code 112.

Begin by drilling the three mounting holes. Mount the i.c. socket and resistors. Follow with the electrolytic capacitor, transistor, buzzer and l.e.d. (taking care over the polarity of these latter components). The l.e.d. should be mounted using most of the length of its end leads so that its tip stands 18mm above the p.c.b.

Solder pieces of stranded connecting wire to the points labelled "VR1" and "S1". Connect the negative wire of one of the battery snap connectors to the point marked "Batt (–)".

Next, shorten the thermistor end leads – R2 to a length of about 8cm and R4 to 6cm. Solder them to the positions shown on the circuit board. Insert IC1 in its holder, observing the orientation.

CASE DETAILS

Drill three holes in one side of the box to correspond with the mounting holes in the p.c.b. Make holes for On/Off switch S1 and potentiometer VR1 in an end panel.

Drill a hole in the opposite end panel of the box for the sleeved grommet through

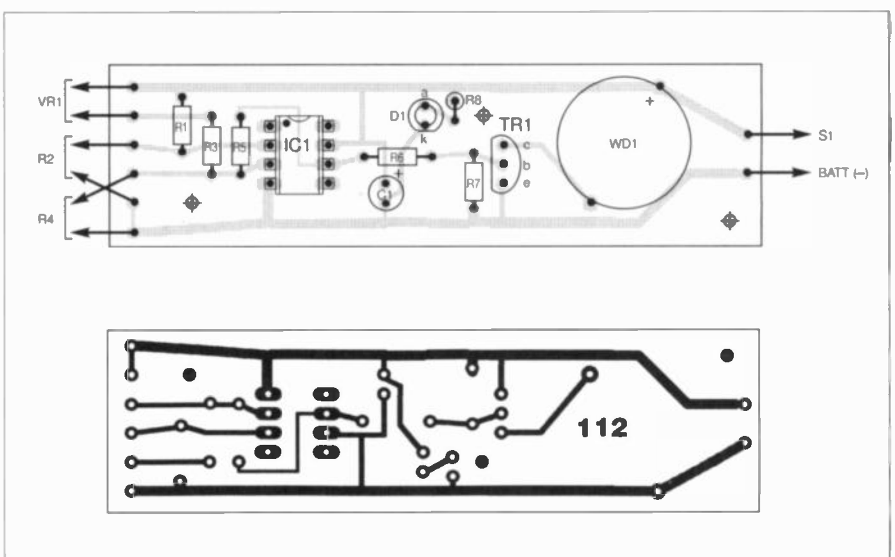
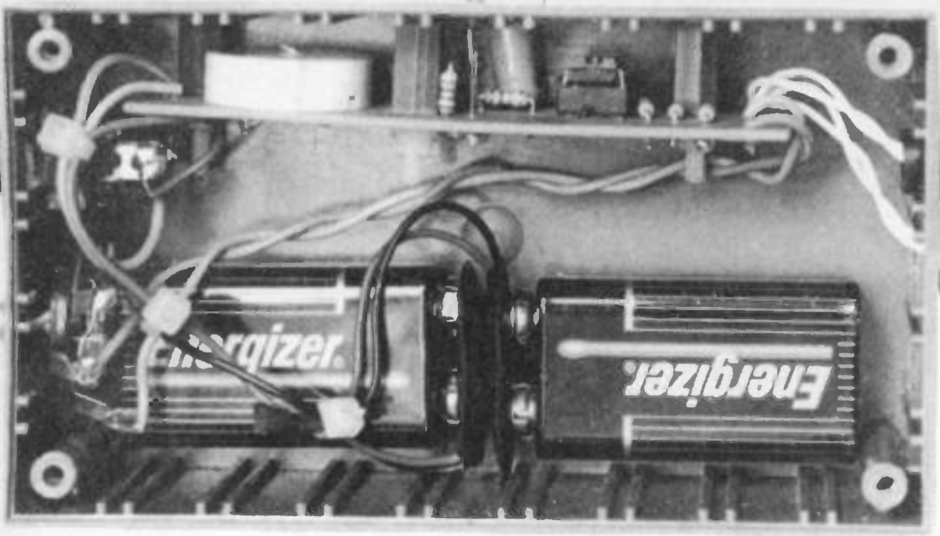


Fig. 3. Draught Detector printed circuit board component layout and full size underside copper foil master pattern.



Layout of components inside the Detector case. The two sensor thermistors can be seen on the right, with the draught "detector" R2 protruding through the sleeved exit grommet. The "balance" thermistor is carefully bent away from the detector as shown.

COMPONENTS

See **TALK** Page

Resistors
R1 22Ω
R2, R4 disc thermistor, positive temperature coefficient 80°C @ 1kΩ (2 off)
R3 10Ω
R5 47k
R6 22k
R7, R8 2k2 (2 off)
All 0·25W 5% carbon film

Potentiometer
VR1 20Ω wirewound vol. control

Capacitor
C1 100μ radial elect. 25V

Semiconductors
D1 3mm red l.e.d.
TR1 ZTX300 *npn* silicon transistor
IC1 LM741CN op.amp

Miscellaneous
WD1 piezo buzzer, p.c.b. mounting, 3V to 24V 5mA operation
B1, B2 PP3 alkaline battery and snap connector (2 off each)
S1 miniature s.p.s.t. rocker switch

Printed circuit board available from *EPE PCB Service*, code 112; plastic box, size 125mm x 70mm x 49mm; 8-pin d.i.l. socket; p.c.b. spacer (3 off); sleeve exit grommet; knob (if needed); sleeving; wire, solder, etc.

Approx Cost Guidance Only £20 excluding batts.

which thermistor R2 leads pass (see photographs). This grommet is not essential but it improves the appearance of the finished project and provides some protection. Drill a smaller hole nearby for thermistor R4 leads.

Measure the position of l.e.d. D1 and drill a hole in the side so that, when the circuit board is in position, the l.e.d. will protrude through it. Similarly, on the same side panel, measure the position of buzzer WD1 and drill a hole for the sound to pass through.

Mount the internal components. Note that the potentiometer specified for VR1 needs no control knob and may be adjusted using its knurled extension. However, it is of a standard size so a knob may be fitted if desired.

INTERWIRING

Mount the printed circuit board using 15mm long plastic stand-off insulators and nylon fixings. If metal nuts and bolts are used, take care that no short circuits are formed with the board copper tracks.

Referring to Fig. 4, complete the point-to-point wiring. Take care over the connections to the battery connectors – these are wired in series. The common connection should be insulated using p.v.c. tape or a piece of heat shrinkable sleeving.

The exact method of arranging the thermistors could be a useful subject for experiment. However, the following guidelines will be found useful.

Random air movements such as those caused by moving the unit from place to place should equally affect *both* thermistors. This means that R4 should be fairly close to R2.

It is important that the draught to be detected falls only on thermistor R2. Note that R2 should protrude through the sleeved rubber grommet sufficiently for the sensitive blue spot to show.

In the prototype unit, R4 leads were bent out of the way as shown in the photograph above. The sensitive parts of the thermistors must not touch the box, the grommet or anything else since this would disturb the self-heating effect and cause unreliable operation.

TESTING

With switch S1 in the *off* position, attach the battery connectors and secure the batteries to the base of the box using Velcro fixing pads or small brackets. Fit the lid.

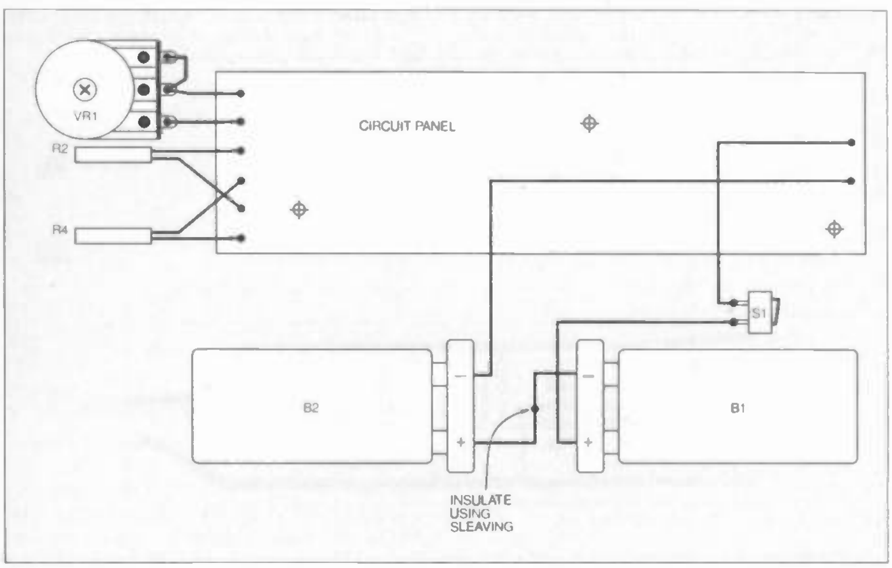


Fig. 4. Details of the interwiring from the Draught Detector printed circuit board to the off-board components.

Adjust Balanced control VR1 fully clockwise and switch on. The l.e.d. D1 should light and the buzzer remain off. If the buzzer sounds, it is likely that the outer (track) connections to VR1 have been made in the opposite sense so turn the spindle completely anti-clockwise instead.

Wait for at least 30 seconds to allow the thermistors to thermally-stabilise. Rotate Balance control VR1 slowly to the point where the buzzer sounds then take it back so that it is *just* silenced. This is the most sensitive position.

Now blow *very gently* on thermistor R2 (it may be necessary to shield R4 from the draught using a piece of paper) – the buzzer should sound and go off again a few seconds later. If this test works satisfactorily the unit may be put into service.

In use, VR1 should be kept adjusted to give the sensitivity required. If it is set too finely, once triggered the buzzer WD1 will sound for a long time or even fail to go off altogether.

Another consequence is that triggering is likely to occur with random draughts. A little practice will soon find the optimum setting.

When a harsh draught has been detected, it will take some time for the unit to recover and be ready to detect another. When there is a general lack of sensitivity and an excessive recovery time, this is a sign that the batteries need to be replaced.

Happy sniffing! □

VIDEOS ON ELECTRONICS

A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

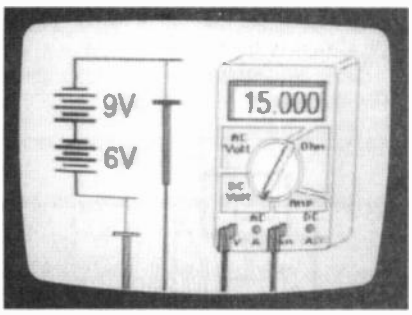
BASICS

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

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

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

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



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

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

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

£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**

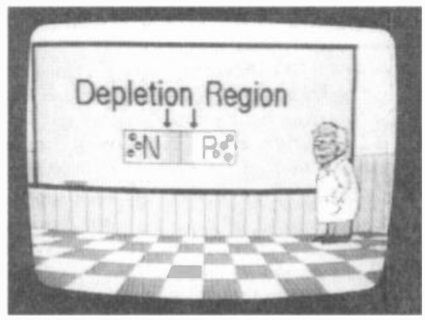
VT305 56 minutes. Digital Five; **Memory Devices** introduces you to the technology used in many of today's memory devices. You will learn all about ROM devices and then proceed into PROM, EPROM, EEPROM, SRAM, DRAM, and MBM devices. **Order Code VT305**

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**

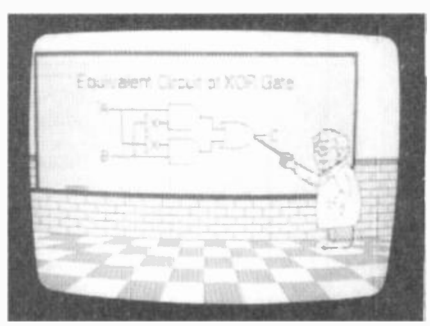


VT403 58 minutes. **F.M. Radio Part 2**. A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding. **Order Code VT403**

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**



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. (All videos are to the UK PAL standard on VHS tapes)

ORDERING: 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).

Visa and **Mastercard** orders accepted – please give card number, card expiry date and cardholder's address if different from the delivery address.

Orders are normally sent within seven days but please allow a maximum of 28 days – longer for overseas orders.

Send your order to: Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)
Direct Book Service is a division of Wimborne Publishing Ltd., Tel: 01202 881749. Fax: 01202 841692
E-mail: editorial@epemag.wimborne.co.uk

"Custom Ferrari" – for boy racers!

In order to add some realism to a model sports car, I designed the simple circuit of Fig. 4 which can be built into virtually any type of toy car, battery operated or not. The design uses a CD4020 14-stage binary counter to operate l.e.d. "Turn Indicators" (D5 to D8), "tail-lights" (D9 to D10) and "Headlights" (D11 to D12).

The counter IC1 is clocked by a unijunction oscillator based around TR1. The red tail-lights and the yellow headlights draw a small current supplied constantly by resistors R7 and R8. For added realism, this current is supplemented through resistors R1 and R2 which gives an impression of headlights "dipping" and tail-lights "braking".

The model's turn indicators flash whenever they are enabled and so the cathodes (k) of D5 to D8 are taken to another output (Q3, pin 7) of IC1. Taking their anodes (a) positive, via resistor R3/R4 and the relevant counter output, they flash at the rate determined by Q3. The result is that one set of indicator lights flash, then the other side, followed by both!

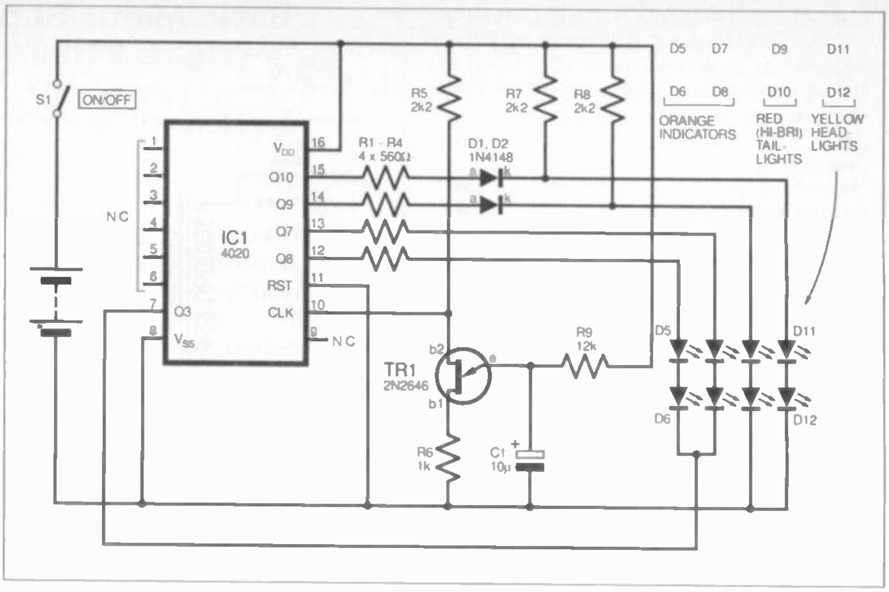


Fig. 4. Lighting and indicator circuit for model cars.

The circuit is powered by a PP3-type or MN1604 9V battery and a small slide switch S1 can be mounted on the vehicle's underside.

David Geary, Blackheath, London.

555 Astable Frequency Meter – out for a count

The circuit shown in Fig. 5 is a simple digital frequency meter which I designed to indicate the frequency in Hertz of an astable 555 timer. It could perhaps be adapted for other uses.

An *npn* transistor, TR2, is connected to the 555 astable to be measured, as shown inset, and the output signal obtained is "hooked" to the main circuit via transistor TR1 collector (c). Two CMOS 7555 timers, IC3 and IC4, are wired as monostables and these will trigger via R6/C1 when the Display switch S1 is closed. The period of IC3 is adjustable using VR1 whilst IC4 times for a fraction of a second.

Upon closing S1, IC4 sends a reset signal to IC1 and IC2, which are two decade counters each driving a 7-segment common cathode l.e.d. display directly. IC3 then drives transistor TR1, which allows pulses generated by the 555 "under test" to be fed into pin 1 (Clock) of IC2, the first decade counter.

Monostable IC3 needs to be trimmed such that it triggers for approximately 100ms. Pressing switch S1 then allows "100ms' worth" of pulses to clock up on the display, and simply multiplying the result by ten will yield the value in Hertz. It would be feasible to cascade several counters to show a higher range of frequencies.

Nick Dossis, Middlewich, Cheshire.

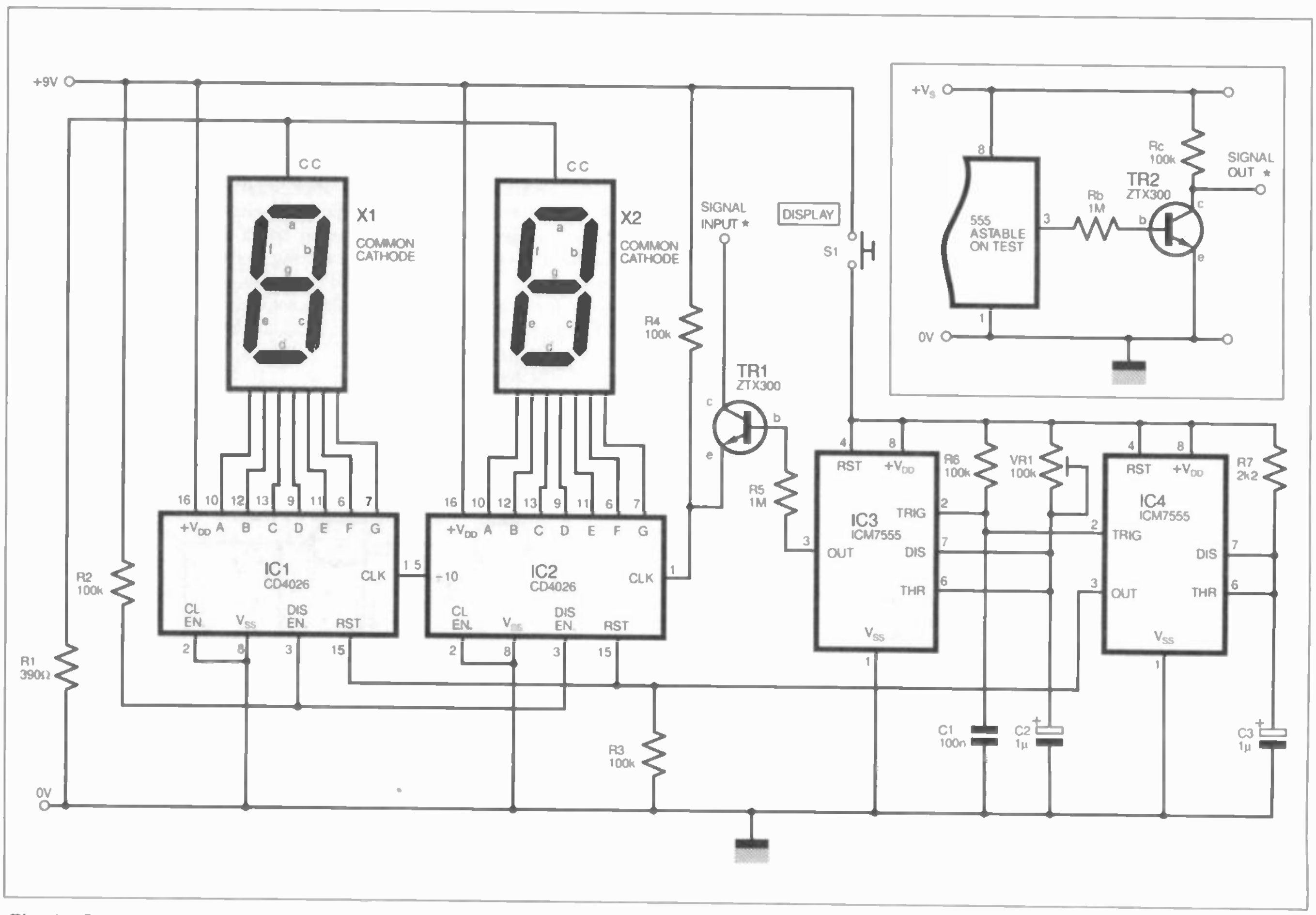


Fig. 5. Circuit diagram for a simple digital frequency meter for 555 astable.

More I/U on page 725

THE ELECTRONICS SERVICE MANUAL

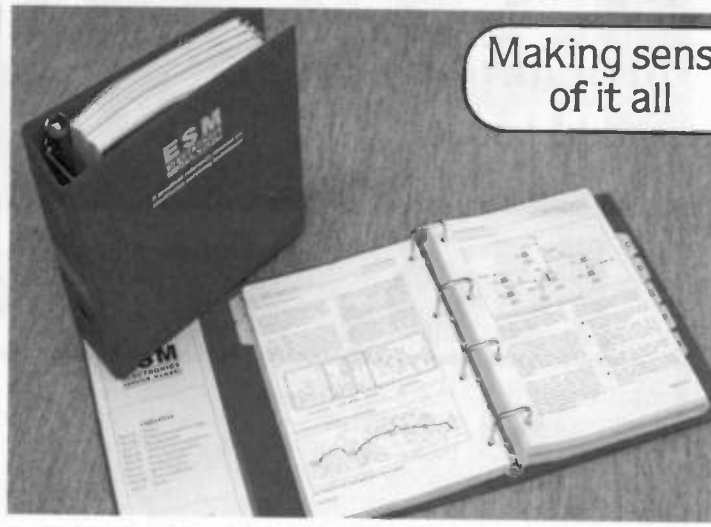
E S M — ESM IS ABOUT ELECTRONICS AND ELECTRONIC EQUIPMENT, EXPLAINING:
- What it is • How it works • How to test it • How to take it apart
- How to find faults • How to fix it

OFFERING:
- Down to earth advice • Vital data • Facts to feast on
- Knowledge at your finger-tips

T — TOPICS COVERED:
- TV • Audio • Video • Computers • Disk drives • Techniques
- Test gear • Workshops • Addresses • Pinouts • Symbols • Safety
- Logos • Tools • Data • etc

W — WHO IT'S FOR:
- Across the board appeal !
- Ideal for: Technicians • Engineers • Students • Hobbyists

L — LITERARY MERIT:
- Authoritatively written • Clearly presented • Highly readable
- A living library in words, drawings and photographs



S — SUPPLEMENTS

Detailed technical servicing notes on various types of equipment are covered in the quarterly Supplements, plus additional valuable information for other sections of the Manual

F — FREE

We will send you the latest Supplement FREE with your Manual

P — PRICES

Manual only £39.95 plus P&P

Over 850 A4 pages edited by Mike Tooley. Supplied in robust ring binder. Latest Supplement included FREE. 24-hour despatch

Supplements £23.50 plus P&P

Approximately 160 pages of facts and data in each Supplement

G — GUARANTEE

Our NO-QUIBBLE MONEY-BACK GUARANTEE gives you *complete peace of mind*. If you are not entirely happy with the Manual or its Supplements, for whatever reason, simply return to us in good condition (within 30 days for the Manual, 10 days for Supplements) and we will make a FULL REFUND of your payment. (Overseas buyers do have to pay the postage charge.)

H — HOW TO OBTAIN ESM

Order now! – just fill in the order form.
Or, to find out more about ESM, ring, fax or write to:
Wimborne Publishing Ltd, Dept Y9
Allen House, East Borough, Wimborne
Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692

ELECTRONICS SERVICE MANUAL COVERAGE AND CONTENTS

A — SAFETY
Safety practices, life-saving techniques, legal requirements

B — UNDERPINNING KNOWLEDGE
Electronics theory, component theory & functions, circuit techniques, fault diagnosis, detailed equipment principles

C — PRACTICAL SKILLS
Component identification, avoiding static, soldering & component replacement techniques

D — TOOLS AND EQUIPMENT
Choosing tools & test gear, workshop practice, optimising test equipment

E — SERVICING TECHNIQUES
The Supplements include detailed guidelines on how to service specific types of electronic equipment

F — TECHNICAL NOTES
Detailed examination of how specific types of electronic equipment work

G — REFERENCE DATA
Detailed tables of specifications for semiconductors, including pinouts

H — USEFUL ADDRESSES
Manufacturers' & suppliers' addresses, including logos

I — INDEX
Itemised key subjects in the Manual and individual Supplements

PRIORITY ORDER FORM

Full name:..
(BLOCK CAPITALS PLEASE)
Address: ....
....
....Post code:..........................
Telephone Number: ....

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD
☐ Please charge my Access (Mastercard)/Visa card. Expiry date..........................

Card No: ....
(Please advise cardholder's address if different from above)

Please send me each new quarterly Supplement when it is published. I understand that these are billed separately and that they can be returned within 10 days or discontinued at any time.

I understand that should I decide not to keep the Manual I can return it to you within 30 days for a FULL REFUND (overseas customers must pay the postage).

Signature: ....

PLEASE URGENTLY SEND ME

Item	*Cost*	*Postage*	*Total*
ESM Manual	£39.95	£	£
One Supplement free with Manual	FREE	FREE	£0.00
Payment in £ Sterling only		Total	£

POSTAGE CHARGES

Manual

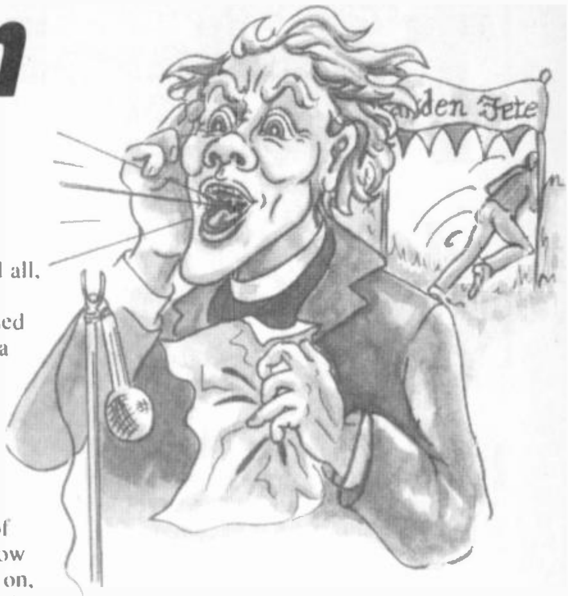
Postal Region	*Surface*	*Air*
UK	£5.50	–
Eire	–	£11
Europe (EEC)	–	£20
Europe (Non-EEC)	£20	£26
USA & Canada	£25	£32
Far East & Australia	£31	£33
Rest of World	£25	£44

NOTE: Surface mail can take over 10 weeks to some parts of the world. Each Manual weighs about 4kg when packed.

Please send this form (or a copy) to: **Wimborne Publishing Ltd, Dept. Y9, Allen House, East Borough, Wimborne, Dorset BH21 1PF**

Ohm Sweet Ohm

Max Fidling



Fatal Attraction

The month of August brings the prospect of the dreaded "Annual Garden Fete", held in the grounds of the local Vicarage. This money-raising venture has yet to hit the big time in terms of lasting entertainment value, but the Boss likes it, so that's all that matters, and I get dragged along whether I like it or not, every year.

Indeed, this rigmarole had occurred for many years now and against my better judgment I'd been volunteered by the Boss into lending a hand at this grand social event. Hence the word had eventually got round that I was a bit of an electronics boffin. This appealed especially to the Reverend, who as a sideline, operated the *Church Bells* discotheque, another of his madcap moneyspinners, and in the past I'd helped him with the odd electrical repair, bodged together resourcefully as I usually do!

This year was to be no exception, because the Rev. had asked me if I could help fix a fault on his small public address system, which he intended to use at the Fete. "No problem, Max will happily do it!" the Boss had volunteered.

So, that Sunday morning found me hurriedly finishing off the job in the shack. It would have been nice, I explained to my cat, Piddles, whilst soldering up the microphone's jack plug, and squirting *ElectroLube* into the volume control, if they'd at least tip me a few quid for my toils, but no, it's the same old story – complete mug, do it for nothing, lifetime guarantee, what's the world coming to, etc., I moaned to an unreceptive audience (one cat).

Cool Cat . . .

I switched the soldering iron off and pondered gloomily, whilst fumbling with the microphone. A quick test was, I suppose, a good idea so I plugged everything together, microphone, loudspeaker and all, and switched on.

Now for some fun. I'd always fancied myself as a singer, and now was a good time to practise. I told the moggie, as I cranked up the "level" control and warbled into the microphone with a fine rendition of *Elvis Presley*.

". . .*Yeah-aye, I'm all shook up!!*" echoed the shack to fifty watts of musical entertainment. The window rattled in sympathy but Piddles looked on, unmoved by my taste in tunes. Everything seemed fine so the P.A. was made ready for the big day out as we prepared for the Fete.

Arriving early, I hastened over to see the Reverend and between us we installed it around the garden, using an extension lead from the Vicarage for power. Everyone in the merry band of workers then received their orders from the Vicar's wife, and my eyes rolled skywards as I was handed the job of the "Mousey Mousey" Stall. The Boss smirked.

. . . Hot Mouse

Devoid of anything remotely electronic, the dreaded Mousey Mousey Stall was the pits. It consisted of a short length of drainpipe with an outlet at the bottom. The idea was that the merry "punter" for 20p, waited with a rubber mallet at the drainpipe's exit, whilst I dropped a stuffed toy mouse in at the top. The player had to clobber the mouse as soon as possible when it exited.

Little did they know that the mouse contained a quarter pound of solid lead, taken from the church roof, and would pelt out of the tube faster than a whippet on steroids! This inside knowledge was about the only satisfaction I derived from the job.

So a whole afternoon of stuffing the mouse down the drainpipe finally drew to a close as I counted up the loot and handed it in to the Rev.'s wife. The Boss looked on, proudly telling everyone how I'd just fixed the sound system in the nick of time and saved the day. Time for the day's results, as an expectant hush permeated around the villagers.

Ohm Sweet Ohm

Grabbing the microphone, the Reverend started his usual Garden Fete speech, thanking everyone individually (excluding myself, I noticed) for their help, as his voiced echoed around the garden. At precisely the point where he started to read out the profits, the sound went dead!

Tapping the microphone and twiddling the controls had no effect! The Reverend blanched, quickly switched it off then raised his voice and continued shouting the results ever more hoarsely to a hushed crowd.

The Boss glared over at me, but I'd already started to flee through the garden gate, whistling a tune and wandering in the direction of home, the shack and the cat. I mean, what do they expect for free? I ask you.

Techniques

ACTUALLY DOING IT!

by Robert Penfold

If you talk to someone who is contemplating the construction of their first project, but is a bit reluctant to actually buy the parts and give it a try, the reason for their hesitation is almost always the same. They are worried that they will not be able to get the finished unit to work, and that the money spent on the components will be wasted.

Something Simple

As I have pointed out many times before, the chances of getting modern projects to work first time are excellent. The first-time constructor needs to choose his or her project very carefully, but provided a sensible choice is made, and things are not rushed, there is little risk of the finished unit failing to work. The best type of project to choose is one which is fairly simple and straightforward. The larger the project, the greater the chances of a mistake being made.

I would also suggest that the project should be built on a ready-made custom printed circuit board (p.c.b.). This is not a cynical attempt to plug the *EPE PCB Service*. A custom printed circuit board is the easiest construction method. Making your own boards is not too difficult, but there are plenty of new skills to be learnt even without any unnecessary additions to the list. If you are interested in p.c.b. production, this can be mastered once you have some experience of project construction.

It is better to choose a project that does not present any major problems as far as the mechanical side of construction is concerned. You will have plenty to occupy your mind when dealing with the electronics. Awkward aspects of the mechanical side of construction will be an unwelcome distraction.

Only choose battery powered projects that do not involve any connections to the mains supply. The mains supply is potentially lethal, and is certainly not a suitable starting point, particularly for younger constructors.

Understandable

Make sure that you select a project which has a function that you fully understand. It is not that unknown for a letter to be received from a reader who is having problems with a project, where it soon becomes quite clear that the reader had slightly (or completely) misunderstood the purpose of the project! This is admittedly quite rare these days, but from time to time a reader still "gets hold of the wrong end of the stick". Choose something straightforward, like a simple household gadget, car project, or a very basic piece of test gear.

When you first attempt project construction there is a great temptation to start building some weird and wonderful device, but to do so would almost certainly be a mistake. It is better to start with something reasonably simply and straightforward, even if it is not of any great use to you when finished. You should learn a lot from building it, have some fun in the process, and it should be a good confidence builder.

Can't Stand the Heat

I suppose that project constructors have to regard an occasional problem project as an inevitable part of the hobby. You can minimise the number of projects that give problems by building every project carefully and methodically, but we all make mistakes from time to time. Sooner or later you are almost certain to be faced with a project that fails to work first time.

There are three main causes of newly constructed projects failing to work. An error by the constructor, an error in the article describing the project, or a faulty component. A faulty component is probably the least likely cause, since modern components are thoroughly tested and very reliable. Even if you spend many years building hundreds of projects it is quite likely that you will never be sold a "dud" component.

If there is a problem with a component, it is more likely that it has become damaged during project construction, or possibly on its way to you in the post. In most cases any physical damage will be plain to see. It is not advisable to use any component that has any physical damage beyond a few superficial scratches. Even if a damaged component is basically functioning, its accuracy and reliability will almost certainly have been impaired.

Components are most at risk when they are being soldered onto the circuit board. Beginners are often a little slow and hesitant when producing soldered joints, and this can result in overheating. Fortunately, most modern electronic components are quite resilient, and are not easily damaged by excessive heat.

Even if a resistor or capacitor is overheated to the point where it becomes discoloured, it might actually still work properly. However, if a project fails to work, it obviously makes sense to replace any components that show signs of heat damage, or any other form of physical damage.

Probably the passive components that are most at risk are the box style capacitors which do not have a plastic casing. These open style capacitors are now somewhat tougher than the original components of this type. Even so, with many of them it is not too difficult to detach one of the leadout wires.

The fact that a leadout has broken away from the case will normally be self evident, but this is not always the case. If there is outward pressure on the leadout wires when one of these capacitors is soldered into place, one of the leads can effectively be desoldered and part company with the casing. However, with both leads firmly soldered in place, everything may appear to be perfectly all right unless the component is carefully scrutinised. *(We have found polystyrene capacitors to be occasionally subject to similar problems. Ed.)*

Semiconductors

Semiconductors are the components that are most vulnerable to heat damage. It is quite possible to overheat practically any semiconductor without any physical signs of damage becoming apparent. Integrated circuits, with their numerous pins to connect, are more vulnerable than the more simple semiconductors.

Unless the designer states otherwise, a holder (i.c. socket) should always be used for integrated circuits. The holders are soldered to the circuit board, and the integrated circuits are plugged into the holders once the circuit board is otherwise complete. This avoids soldering direct to the pins of the integrated circuits, and avoids any risk of overheating them.

Germanium semiconductors are more vulnerable to heat damage than the much more common silicon variety. The only germanium devices in common use today are a few types of diode, such as the OA90 and OA91. Obviously extra care should be taken when dealing with these.

Some semiconductors, including a fair percentage of integrated circuits, are vulnerable to high voltage static charges. The article should always give a warning if a project uses static sensitive components. While many "old hands" largely ignore the standard handling precautions when dealing with the cheaper static sensitive devices, beginners should always rigidly adhere to them. Experienced constructors can soon sort out what is wrong in the event that a device is accidentally "zapped". Beginners could spend a great deal of time and effort in locating the source of the problem.

User Error

By far the most common cause of projects failing to work, including my own efforts, is an error on the part of the constructor. In theory we should all thoroughly check each newly constructed masterpiece before it is switched on. In reality we are usually too impatient to do much checking, if any. If a new project fails to work, switch off immediately and do all the meticulous checking that you should have done already!

The most likely causes of problems are components connected the wrong way round, and badly soldered joints. If a component is connected the wrong way round, checking the board against the printed circuit overlay should soon reveal the problem. Go through the lay-out component by component, making sure that every component is in the right place, and (where appropriate) fitted the right way round.

Work through the components methodically, making sure that none are overlooked. Remember to check the wiring to the off-board components, including the battery clip. It is quite easy to get a crossed-over wire here, so carefully check that each wire runs between the right two points.

Avoiding and detecting "dry" joints was covered in the January 1996 issue of *EPE*, so we will not go over the same ground again here.

Clean and Check

Accidental short circuits between copper pads due to solder splashes and trails are another common cause of problems. These are easily produced, and are less obvious than you might think, as they tend to blend-in with the numerous soldered joints.

Also, solder trails are often minute, and can be covered over by the smallest amount of excess flux. Any large pieces of solder should be easily spotted, but a close visual inspection will be needed in order to find most of these short circuits.

Start by cleaning the underside of the board. This will clear away any loose pieces of solder, together with excess flux that might otherwise obstruct your view of any solder trails. Special cleaners are available, but simply brushing the underside of the board using something like an old toothbrush seems to do the job perfectly well.

Unless you have very good close-up vision you will need a reasonably powerful magnifying glass in order to spot the smallest solder blobs and trails. Most photographic shops can supply an 8X loupe (also known as a "lupe"), and these are excellent for detailed checking of boards.

The entire underside of the board should be checked meticulously, but pay extra attention to areas of the board where there are a large number of joints in close proximity to one another. With stripboard the short circuits often seem to occur at the ends of tracks, or where there is a row of breaks in the strips, so pay extra attention to these parts of the board.

Continuity Error

Without a reasonable amount of technical knowledge and some test equipment it is not really possible to undertake comprehensive fault finding. A simple multimeter or even just a continuity tester is still "worth its weight in gold" though, and something that you should obtain sooner rather than later.

A continuity tester merely lights an l.e.d. and (or) sounds a buzzer when there is a short circuit across the test prods. Ideally you need one that is not "fooled" into indicating a short circuit by diode junctions in the circuit under test. Most modern circuits are riddled with these junctions, with many of them hidden away inside integrated circuits. Many multimeters have a continuity tester facility that can use a low test voltage so that diode junctions are ignored.

In days gone by it was common to use a continuity tester that consisted of a battery and a torch bulb, but this type of tester is not appropriate to modern circuits. The problem is simply that the current drawn by a torch bulb is high enough to "zap" many integrated circuits, and some other semiconductors. An old style continuity tester can soon inflict several pounds worth of damage on any circuit board you test with it!

Simple Tester

The simple l.e.d. equivalent shown in the circuit of Fig.1 is a much better choice. This operates at a current of only about two milliamps, which is sufficient to give reasonable brightness from a high efficiency l.e.d., but is far too low to cause any damage. The circuit will respond to forward-biased diode junctions, but the l.e.d. will switch on at only about half the normal brightness.

With a continuity tester, or a multimeter that has a built-in facility of this type, it is possible to check that there are no short circuits between tracks, or breaks in tracks, and that on/off switches open and close properly, etc. With a multimeter set to a voltage range you can check that the battery voltage is correct, and that the supply is

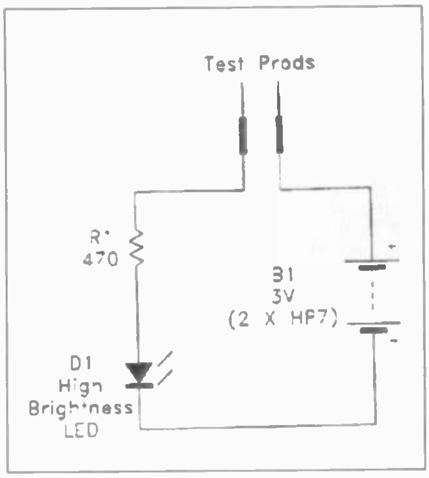


Fig. 1. Circuit for a simple but "safe" continuity tester.

getting through to each part of the circuit correctly. Basic tests of this type are usually sufficient to locate the cause of the problem.

If All Else Fails

If a couple of thorough checks of the project fails to show up any problem, the last resort is to contact the publisher or designer of the project. Mistakes in *EPE* are few and far between, but they do occur occasionally. Check for corrections in subsequent issues of the magazine, or write in with a stamped addressed envelope asking if there are any corrections. If you think that there is an anomaly in the article (two R23s and no R24 for example), contact the publisher for the correct information rather than guessing and hoping.

It is much easier to help readers locate faults if they supply us with some information, rather than simply saying "I built project X and it does not work". Does the project do anything at all? In the case of an amplifier for example, does it produce a distorted output signal, noise, a weak output signal, or nothing at all?

A multimeter is more than a little helpful here, because it enables you to provide the circuit designer with a list of test voltages at various points in the circuit. Remember to state the type of multimeter you used to take the measurements (digital, 20k/volt analogue, etc.).

Probably the most important thing when dealing with a faulty project is to be positive about it. Remember that if the components are all present and correct, and everything is wired up properly, the project *will* work.

POWER CHECK

TERRY de VAUX-BALBIRNIE

Keep costs in tow, build a tri-colour power consumption indicator for caravans and boats.

MANY outdoor enthusiasts rely on a 12V "leisure" battery as a source of energy – perhaps for a caravan or boat. As many know to their cost, indiscriminate use of power can result in a flat battery much sooner than expected.

Children, especially, tend to be as liberal in their use of battery power as they are with the mains at home.

HAPPY HOLIDAY

It is surprising how many different pieces of electronic equipment may be operated from a 12V d.c. supply and this puts greater demands than ever on a low-voltage system. It is not uncommon for people to mix business with pleasure and operate a laptop computer and printer while taking a break "away from it all". Gone are the days when the battery was used only for lighting and an electric water pump was a luxury.

This project monitors the current being drawn from the battery. By doing so, economies can be made and the time obtained from one charge maximised. Note that an indication of current may be regarded as a measure of power because the voltage is reasonably constant. This being so, power is proportional to current.

An ordinary ammeter would do the job but this does not easily attract attention and is not readily interpreted at a distance. Also, it would be difficult asking a young child to respond to its reading. In any case, *actual* current values are not needed – it is sufficient to know if the consumption is simply *low*, *medium* or *high*.

GO GREEN

In this system, the display is provided by a tri-colour l.e.d. This shows green for a low demand, yellow for a medium one (acceptable for a temporary heavy load such as a water pump) and red to indicate excessive use and the need to switch appliances off straight away. When red shows, an audible signal is also given.

The circuit is built in a small metal box with the l.e.d. mounted on the front panel. A piece of terminal block inside is used to make the connections to the external system.

This circuit must not be used in installations using more than 10A. Having said that, though, the values at which the colours operate are freely adjustable.

In the prototype unit, a current below 2A was judged to be *low*, between 2A and 4A *medium* and more than 4A *high*. With these criteria, by keeping green at least 30 hours of operation would be obtained from a standard 60Ah (amp.hour) battery.

TWO-IN-ONE

Tri-colour l.e.d.s are really two l.e.d.s in one. There is one red and one green unit contained side by side in a milky white translucent package. When *both* are illuminated, the display is yellow. This is a simple example of two primary colours being added together to produce a secondary one. Thus, the three colours mentioned earlier are made possible.

The device has three leads. One is the common cathode (k) connection while the other two (both of them anodes) are responsible for the red and green sections. Do *not* connect the device to a battery to watch it work. The current must be limited

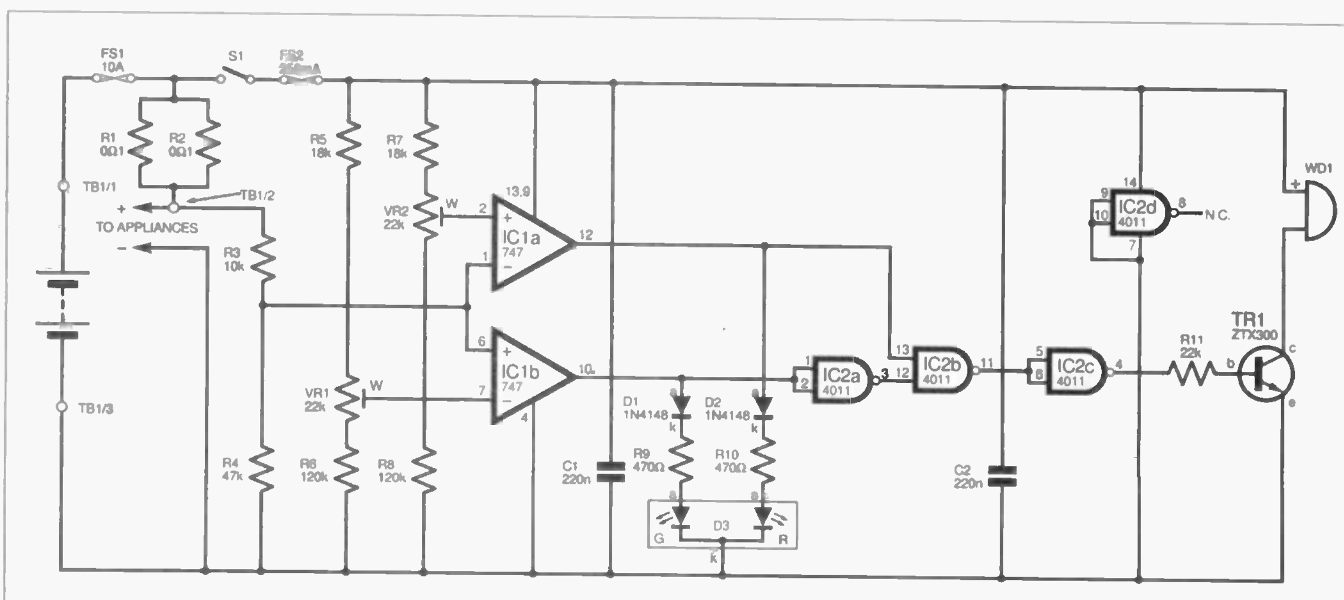


Fig. 1. Complete circuit diagram for the Power Check. Note that resistors R1 and R2 are 3W types.

to 30mA maximum and a series resistor is required for each section. The device will be ruined if it is connected directly – *you have been warned!*

CIRCUIT DESCRIPTION

The complete circuit diagram for the Power Check is shown in Fig.1. The chief component is the dual operational amplifier, IC1a and IC1b, with the two sections configured as a window comparator.

The heavy-duty battery power feeding the appliances – lights, TV, etc. – flows through fuse FS1 and resistors R1 and R2 connected in parallel. There is, therefore, a voltage drop produced across them. This is important as will be seen presently.

When the current is at the maximum allowed value (10A) the power dissipated is about 5W. The use of two resistors connected in this way provides sufficient power rating while obtaining the correct value, in this case 0·05Ω. Fuse FS1 will blow if the maximum current is exceeded.

MAKING PREDICTIONS

As predicted by Ohm's Law ($V = I \times R$), for each amp of current flowing through resistors R1 and R2, there will be 50mV dropped across them. In normal leisure use, it is not expected that much more than 5A will be drawn from the supply and for this the voltage drop would be 250mV (i.e. 0·25V). This is unavailable to the appliances but is too small to have any noticeable effect.

Suppose the supply voltage has the nominal value of 12V. With 5A flowing, this would mean that 11·75V would appear across the appliances. In fact, the supply voltage will fall as the battery discharges. This will make no difference to correct operation of the circuit and this point will be explained in further detail later.

Let the voltage drop across R1/R2 be *D*-volts. The voltage appearing across the appliances will therefore be (12-*D*) volts. This is scaled down to about 80 per cent of its value by the potential dividing action of resistors R3 and R4. The result is henceforth referred to in the text as the "monitored voltage".

MONITORED VOLTAGE

The monitored voltage is applied to both the inverting input of IC1a (pin 1) and the non-inverting input of IC1b (pin 6). Meanwhile, preset potentiometers VR1 and VR2 apply adjustable voltages to the inverting input of IC1b (pin 7) and the non-inverting input of IC1a (pin 2), respectively. Fixed resistors R5 to R8 limit the range of adjustment of the presets to that needed for correct operation.

Suppose the switching points are chosen to be those suggested earlier – green up to 2A, yellow up to 4A and red for any current higher than this. Presets VR1 and VR2 would be adjusted so that their sliding contacts (wipers) provide 9·45V to IC1b pin 7, and 9·55V to IC1a pin 2, respectively. Note that these voltages do not need to be measured – they will follow naturally during the setting-up process.

The output of an op.amp is high (on) if the non-inverting (+) input voltage exceeds the inverting (–) one. Consider the case where 1A flows, a low current as required, perhaps, by a single light. There will be a 50mV drop across resistors R1/R2 and therefore a voltage of 11·95V across the appliance, 80 per cent of which gives a monitored voltage of about 9·6V.

Since this is greater than the 9·55V already existing at IC1a pin 2, IC1a output pin 12, will be low. The red l.e.d. section, which is fed from this via diode D2 and current-limiting resistor R10, will therefore be off. The monitored voltage is also greater than that at IC1b pin 7, so IC1b output pin 10 will be high and the Green l.e.d. will be on, being fed through diode D1 and current-limiting resistor R9.

MORE OR LESS

Now, suppose a current of 3A is drawn. The voltage across the appliance will fall to 11·85V and this will result in a monitored voltage of 9·5V. This is now less than the voltage at IC1a pin 2 and so this op.amp will be on and with it the red l.e.d. However, it is still greater than the voltage at IC1b pin 7 so this op.amp will also be on and hence the green l.e.d. will also be on. With both l.e.d.s on, there will be a Yellow display.

Suppose the current now rises to 6A. The voltage across the appliance will fall to 11·7V and this gives a monitored voltage of 9·4V. Since the voltage at IC1a pin 2 exceeds this, the red l.e.d. remains on. However, it is also less than the voltage at IC1b pin 7 so this op.amp goes off, and with it the green l.e.d. This leaves a Red display.

Diodes D1 and D2 connected in series with the l.e.d. sections prevent any tendency for them to glow slightly when nominally off. This could happen because when the power supply voltage is about 12V, the low state for the outputs of a type 747 op.amp is around 2V, and this is roughly the level at which an l.e.d. will begin to operate.

The voltage across a forward-biased diode is about 0·7V so the output is effectively reduced by this amount. This brings it well below the l.e.d. turn-on voltage.

The supply voltage will fall a little in the normal course of battery discharge. However, since all the op.amp inputs are derived from potential dividers, they will all fall in unison. This means that the switching levels will remain reasonably constant.

BE LOGICAL

An audible warning is required when *only* the red l.e.d. is on (i.e. not when yellow is displayed). This is a simple logic problem and may be solved with an arrangement of logic gates. A high output is needed when IC1 pin 10 (green feed) is low and IC1 pin 12 (red feed) is high. A possible arrangement to provide this function is shown in Fig.2, but in this simple application, it is a clumsy method because it uses two different types of gate.

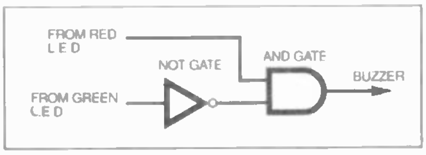


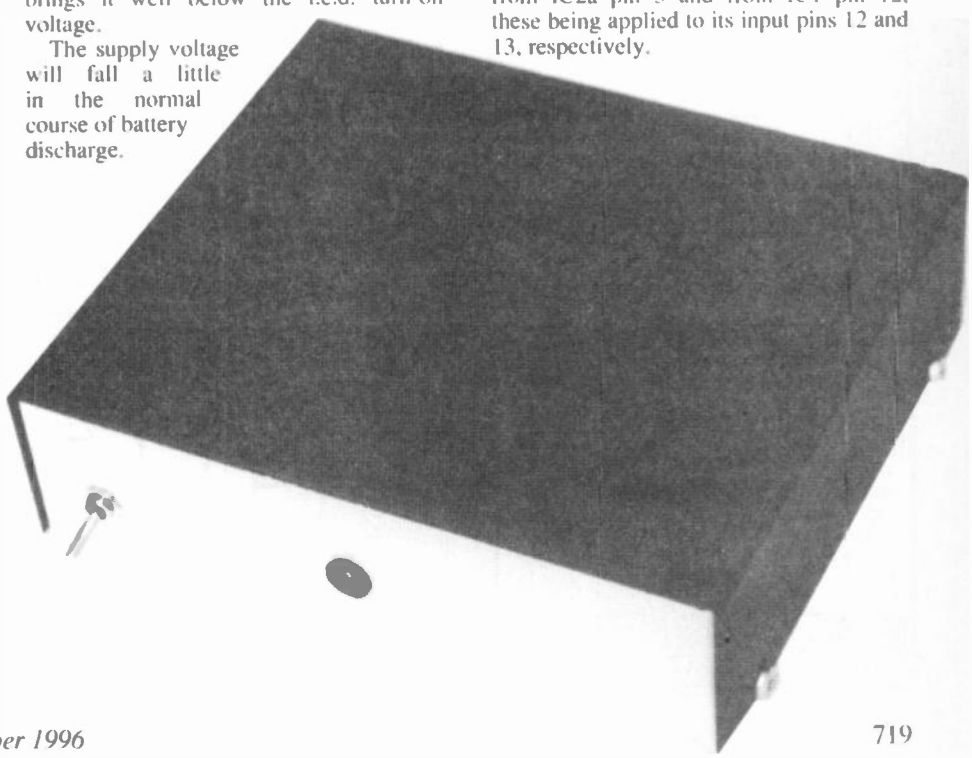
Fig. 2. One possible method of providing a logic signal to trigger the "red" warning buzzer. This uses two different types of gate and was rejected in favour of a single quad 2-input NAND gate i.c. in this circuit.

A more practical way of solving the problem is to use a single quad 2-input NAND gate chip (this contains four identical NAND gates) arranged as shown in Fig.1. Three of the gates are used (IC2a, IC2b and IC2c) and one (IC2d) is left unused.

The two inputs of IC2a (pins 1 and 2) are connected together to form an inverter (NOT gate). This inverts the incoming signal obtained from IC1 pin 10, thus, while green shows, a *low* signal is output from IC2a pin 3.

Ideally, an AND gate should now be used, but we only have NAND gates available here. So two of these are used together to create an AND function.

First, IC2b is used as a proper NAND gate, and then its output is inverted by IC2c. NAND gate IC2b receives signals from IC2a pin 3 and from IC1 pin 12, these being applied to its input pins 12 and 13, respectively.



Only if both of IC2b's input pins are high simultaneously will its output pin 11 change from high to low. This condition only prevails when the outputs of IC1a and IC1b cause the red l.e.d. to be on and the green l.e.d. to be off. In this situation, the output of IC2c at pin 4, being an inversion of IC2b's output, is high.

Output pin 4 of IC2 is fed via current-limiting resistor R11 to the base (b) of transistor TR1. When IC2c pin 4 is high, TR1 is turned on, so operating the audible warning device (solid state buzzer) WD1 in the collector (c) circuit.

The unused gate, IC2d, has its two inputs tied to the 0V line since unused CMOS inputs should not normally be left unconnected.

CONSTRUCTION

Most of the Power Check circuit is built on a single-sided printed circuit board (p.c.b.), details of which are shown in Fig.3. This board is available from the *EPE PCB Service*, code 110.

The pair of power resistors, R1 and R2, are mounted separately on a piece of tag board. This is because they become hot when a high current flows and this could damage unprotected components nearby. For this reason, ***do not use a plastic box for this project.***

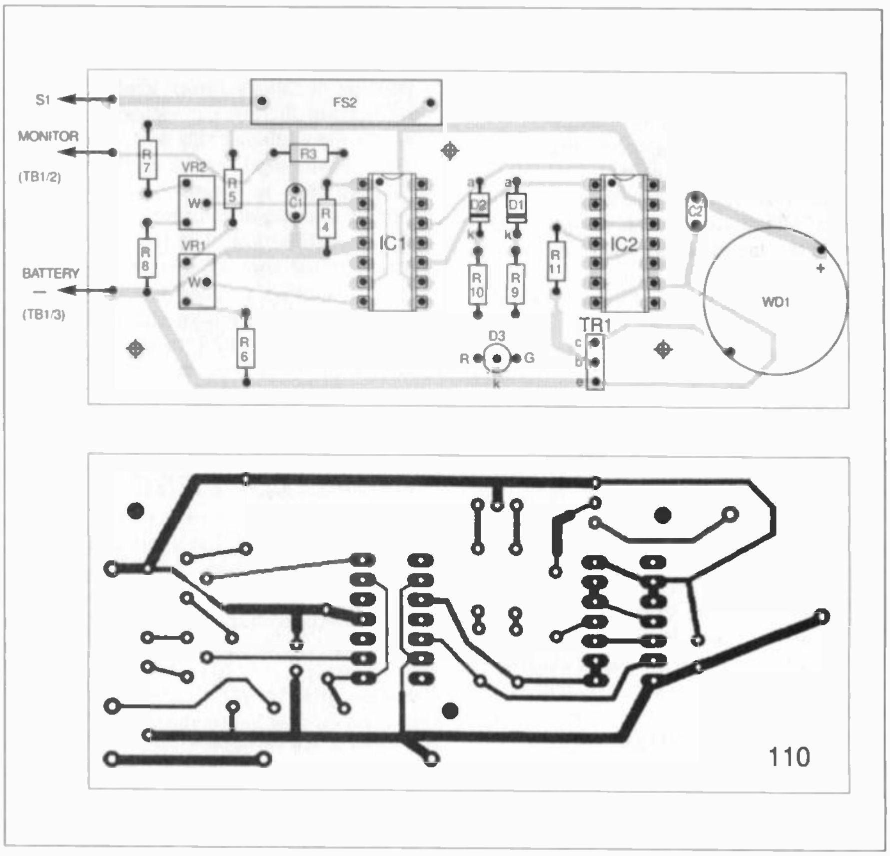


Fig. 3. Printed circuit board topside component layout and full size underside copper foil master pattern.

COMPONENTS

Resistors

R1, R2	0Ω1 (0·1 ohms) 3W (2 off)	
R3	10k	See
R4	47k	
R5, R7	18k (2 off)	**TALK**
R6, R8	120k (2 off)	Page
R9, R10	470Ω (2 off)	
R11	22k	

All 0·25W 5% carbon film, except R1 and R2.

Potentiometers

VR1, VR2 22k min. preset, vert. (2 off)

Capacitors

C1, C2 220n ceramic disc (2 off)

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3	tri-colour l.e.d., 5mm, plus mounting clip
TR1	ZTX300 *npn* transistor, or similar
IC1	LM747 dual op.amp
IC2	4011B quad 2-input NAND gate

Miscellaneous

WD1	piezo buzzer, p.c.b. mounting, 5mA 3V-24V d.c.
S1	min. toggle switch (or rocker or slide switch)
FS1	10A 20mm fuse, plus 20mm panel mounting fuseholder
FS2	250mA fuse, plus 20mm p.c.b. mounting fuseholder

Printed circuit board available from the *EPE PCB Service*, code 110; aluminium case, size 125mm x 105mm x 35mm; 14-pin d.i.l. socket (2 off); 15A screw terminal block – 3 sections required; tag board – 6 tags required; 10A rated wire; light-duty stranded connecting wire; cable ties; grommet; solder, etc.

Approx Cost Guidance Only £20

Begin construction by mounting fuse-holder FS2 and the two i.c. sockets (but do not insert the i.c.s themselves yet) on the p.c.b. Add the passive components – the resistors (including the preset potentiometers) and capacitors.

Solder the buzzer into position – this is polarity-sensitive and the correct orientation is usually marked on the plastic body underneath. Add the transistor and diodes, also being conscious of their correct polarity.

Gently bend the leads of the tri-colour l.e.d. D3 at right angles and solder them to the p.c.b. so that the body points forward as shown in the photograph. Note that the centre lead is the common connection and the shorter one operates the green section.

Adjust the wiper (sliding contact) of both presets to approximately mid-track position. Solder 10cm pieces of stranded connecting wire to the points marked "S1", "monitor" and "battery –".

CASE

Refer to the photograph and drill three holes in the base of the box to correspond with those in the circuit board. Drill holes for the terminal block and for the tag-board, to be used for mounting resistors R1 and R2.

Drill a hole in the front panel for the l.e.d. clip and one for the switch. Drill a hole in the rear panel for fuseholder FS1 and one for the wires to pass through to the terminal block via a rubber grommet.

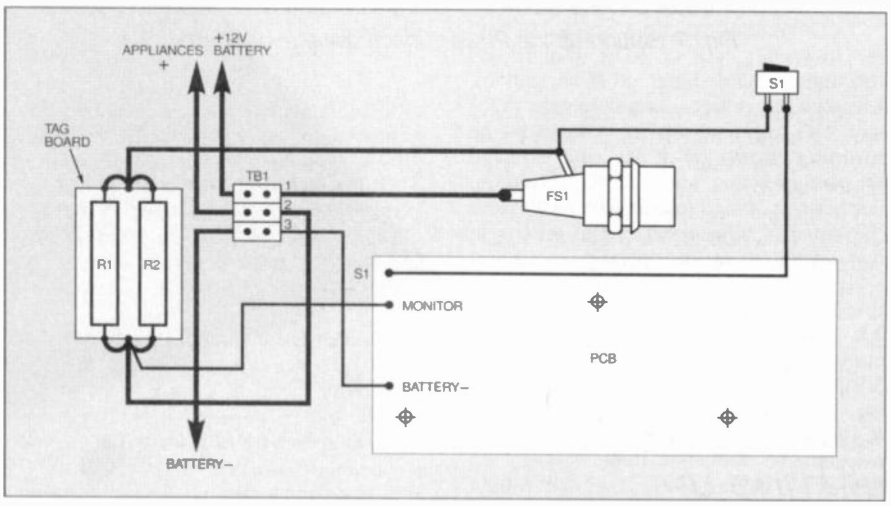


Fig. 4. Interwiring details between the printed circuit board and off-board components. Note that heavy-duty 10A wire must be used where indicated by thicker leads.

EXTENSION

Solder power resistors R1 and R2 to the piece of tagboard as shown in the photograph and Fig.4, leaving some space between them. Solder the link wires to their ends so that they are connected in parallel.

Mount the tagboard assembly on plastic stand-off insulators so that it is kept 5mm clear of the bottom of the box. This is because the tag connections on the underside are not insulated.

Mount the terminal block TB1, fuseholder FS1 and the toggle switch. Attach the circuit board using plastic stand-off insulators on the bolt shanks to keep the underside connections on the p.c.b. 5mm clear of the box. At the same time, engage the l.e.d. in its mounting clip and secure it.

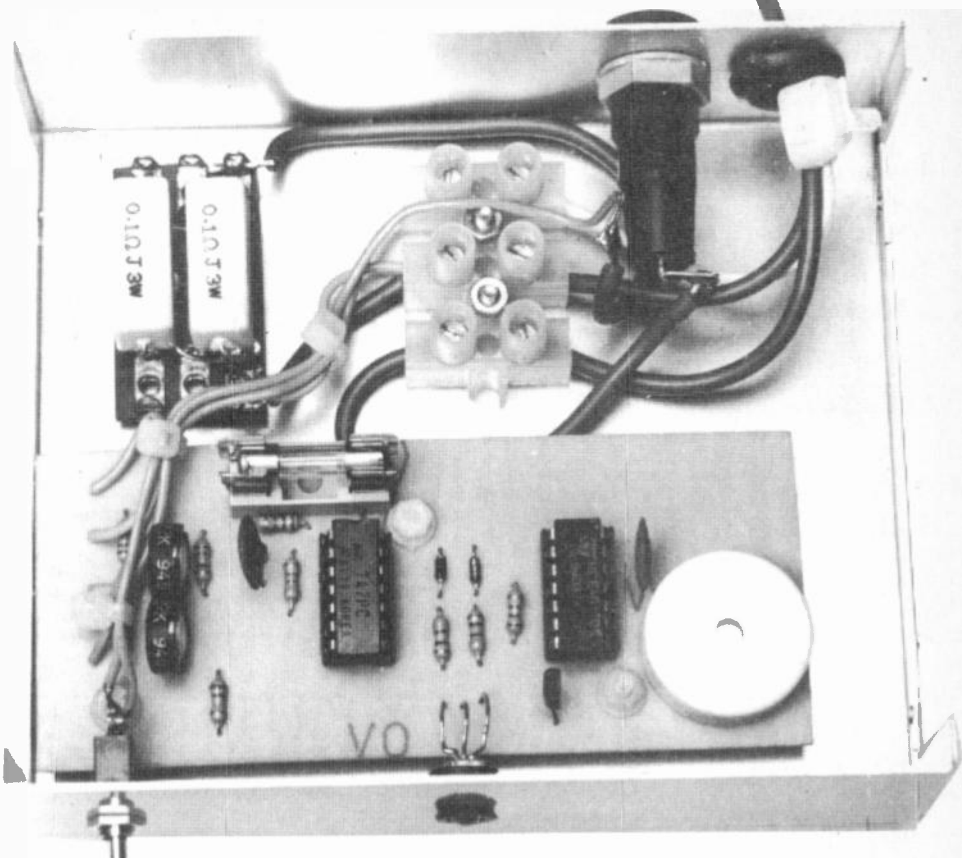
Refer to Fig.4 and complete the internal wiring. No wires should touch resistors R1 and R2 since these become hot in operation. Note that all wiring drawn with thick lines must be of 10A rating *minimum*.

You now need to locate the main feed wire from the battery positive terminal. This needs to be cut at a convenient point. The free end leading directly to the battery positive terminal is connected to the terminal block point TB1/1, while that leading to the appliances is connected to TB1/2.

The wires may be extended to reach a convenient place for the main unit but such extensions must be kept as short as possible. Also, the wire used must be appropriate to the maximum current being drawn. If this procedure is not observed, there could be an excessive voltage drop along the new wiring and a consequent reduction in current to the appliances, and the wiring could get hot!

The connection to TB1/3 is made to the battery negative terminal using light-duty stranded wire. Apply some strain relief to the wires inside the case where they enter through the grommet. In the prototype this was done by securing a large cable tie around them.

IC1 requires no particular handling precautions. However, IC2 is a CMOS device and could possibly be damaged by static charge which might exist on your body. For this reason, before unpacking IC2, touch something which is earthed (such as a water tap, or soldering iron metal parts – when cold!). This will remove the static charge. Insert both i.c.s into their holders, observing the correct orientation.



Layout of components inside the completed Power Check. The power resistor tagboard must be mounted on insulated stand-offs above the base of the case and heavy-duty wires used where indicated (thicker leads) in Fig. 4.

SETTING-UP

For adjustment to specific current values, an ammeter (multimeter set to the 10A d.c. range) will be needed. Digital meters usually have a suitable high range. If no such ammeter is available, the circuit may, of course, be set up by common sense. If using an ammeter, include it in the circuit as shown in Fig.5.

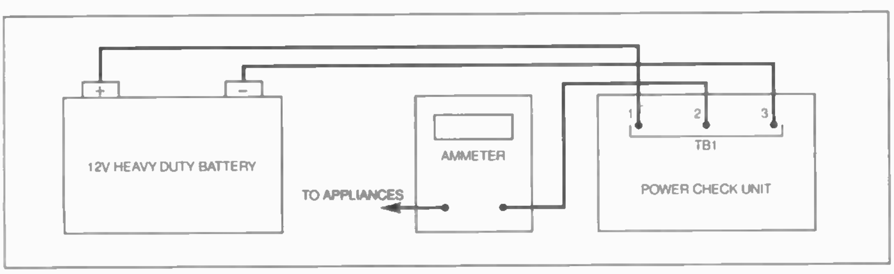


Fig. 5. Setting-up the Power Check using an ammeter.

Begin with a partially-discharged battery. Switch on S1 and operate appliances such as lights so that the required low current limit is obtained. Adjust preset VR1 so that the display just turns from green to yellow. Switch on more appliances until the upper limit is reached. Adjust preset VR2 so that the display just changes from yellow to red – the buzzer should sound. Repeat and check the settings.

Note that when an appliance is switched on it is quite usual for there to be a momentary surge of current. This is particularly true of filament lamps, fluorescent lights and motors such as those used in water pumps. Do not be surprised, therefore, if a green display gives a transient yellow response or a yellow display becomes red for an instant and the buzzer gives a "chirp".

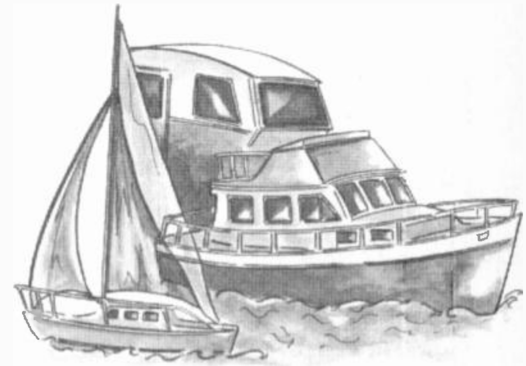
IN USE

Fit the lid of the case, checking to avoid trapped wires and short circuits. If the audible warning is not loud enough, drill a matrix of small holes in the top section of the box above buzzer WD1 position.

If the unit is operated close to its upper current limit for any significant time, resistors R1 and R2 will become very hot. This should not cause a problem, but it would be a good idea to check that the case does not become excessively hot. If necessary, drill some ventilation holes above the tag board position. Working below 5A, the case should remain cool although R1 and R2 will still become fairly hot.

Switch S1 operates the warning circuit. However, if it is switched off, the appliances will still work. This may be useful for items which may be switched on while the user is out or at night, for example.

The Power Check circuit requires a maximum of 80mA (with Yellow showing) so it imposes little load on the system. However, there is no point in using it when it is not required.



EVERYDAY PRACTICAL ELECTRONICS

BACK ISSUES

We can supply back issues of *EPE* by post, many issues from the past five years are available. An index for each year is also available – see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price.

DID YOU MISS THESE?

MARCH '95

PROJECTS ● Multi-Purpose Thermostat ● Name of the Game-1 Counterspell ● Sound Activated Switch ● Audio Amplifier ● Light Beam Communicator.
FEATURES ● Electronics from the Ground Up, Part 6 ● Understanding PIC Microcontrollers ● Visio Graphics Software Review.
FREE Multi-Project PCB with this issue.

APRIL '95

PROJECTS ● National Lottery Predictor ● Auto-Battery Charger ● Light-Activated Switch ● Switch On/Off Timer ● Continuity Tester ● Name of the Game-2 Counterspin.
FEATURES ● Electronics from the Ground Up, Part 7 ● Circuit Surgery ● The Hard Cell (Mobile Telephones).

MAY '95 Photostats Only (see below)

PROJECTS ● PIC-DATS-1 (PIC Development and Training System) ● R.F. Signal Generator – 1 ● MIDI Pedal ● Club Vote Totaliser ● Name of the Game-3, On Your Marks and Games Timer.
FEATURES ● Electronics from the Ground Up, Part 8 ● Las Vegas Show Report.

JUNE '95 Photostats Only (see below)

PROJECTS ● PIC-DATS-2 (PIC controlled 4-Channel Light Chaser) ● EPE HiFi Valve Amplifier – 1 ● R.F. Signal Generator – 2 ● AA to PP3 Converter ● Name of the Game – 4, Star-Struck!, Six-Shot Light Zapper, Wander Wands.
FEATURES ● Electronics from the Ground Up, Part 9 ● Smart Cards.

JULY '95

PROJECTS ● Windicator ● Curtain Winder ● Ramp Generator – 1 ● High Voltage Capacitor Reformer ● EPE HiFi Valve Amplifier – 2
FEATURES ● Bridge Rectification Enhanced ● Ingenuity Unlimited.

AUG '95

PROJECTS ● Solar Seeker ● Personal Practice Amplifier ● Infra-Red Remote Control Unit ● Versatile Microcontrolled 3-Digit Timer ● Ramp Generator – 2.
FEATURES ● Static ● Circuit Surgery.

SEPT '95 Photostats Only (see below)

PROJECTS ● Simple Theremin ● Low Range Ohmmeter Adaptor ● Comprehensive Security System ● Vandata ● Hum-Free Battery Eliminator.
FEATURES ● Cave Radio ● Ingenuity Unlimited.

OCT '95

PROJECTS ● Ginormous VU Meter ● Sound Switch ● Audio Sinewave Generator ● Treble Booster ● Infra-Red Controller/Alarm ● Capacitor Check ● Experimenter's Bargraph Test Board.
FEATURES ● Circuit Surgery ● Security Tagging ● Using Bargraph Displays.
FREE ● Multi-Project PCB with this issue.

NOV '95 Photostats Only (see below)

PROJECTS ● Digital Delay Line ● Video Enhancer ● 50Hz Field Meter ● Temperature Warning Alarm ● Current Tracer ● Distortion Effects Unit.
FEATURES ● Teach-In '96 Part 1 ● Developments in Radio Broadcasting Technology ● Turnpike for Windows Review ● Ingenuity Unlimited.

DEC '95 Photostats Only (see below)

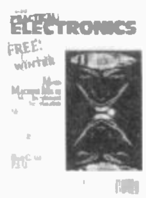
PROJECTS ● Light Operated Switch ● Stereo "Cordless" Headphones ● EPE Met Office – 1 ● Modular Alarm System ● Audio Meter and Amplifier.
FEATURES ● Teach-In '96 Part 2 ● Circuit Surgery ● Index for Volume 24.

JAN '96

PROJECTS ● Printer Sharer ● Mains Signalling Unit ● Automatic Camera Panning System ● Audio Signal Generator ● EPE Met Office – 2.
FEATURES ● Teach-In '96 Part 3 ● Ingenuity Unlimited ● European Consumer Electronics Show ● Techniques – Actually Doing It ● Maths Plus Review ● Decibels and dBm Scale.

FEB '96 Photostats Only (see below)

PROJECTS ● Simple PIC16C84 Programmer ● Mains Signalling Unit – 2 ● PIC Electric Meter – 1 ● Vari-Speed Dice ● Analogue Frequency Meter.
FEATURES ● Teach-In '96 Part 4 ● Circuit Surgery ● Making Your Own P.C.B.s ● Techniques – Actually Doing It.



MARCH '96

PROJECTS ● Mind Machine Mk III Part 1 ● High Current Stabilized Power Supply ● Multi-Purpose Mini Amplifier ● Infra-Zapper ● PIC-Electric Meter – 2.
FEATURES ● Teach-In '96 Part 5 ● Ingenuity Unlimited ● Flight PAL Trainer Review.
FREE ● Headphones (UK copies only).

URGENT?

NEED AN ARTICLE TODAY? TRY OUR FAX ON DEMAND SERVICE – see opposite for details

APRIL '96

PROJECTS ● Dolby Pro-Logic Decoder (*Free* Booklet) ● Bat-Band Converter ● Event Counter ● Mind Machine Mk III Part 2 – Programmer ● Hearing Tester.
FEATURES ● Teach-In '96 Part 6 ● Circuit Surgery ● Thermionic Valves Part 1.

MAY '96

PROJECTS ● Midi Analyser ● Mind Machine Mk III Part 3 – Tape Controller ● Versatile PIR Detector Alarm ● Countdown Timer ● Bat Band Converter B.F.O.
FEATURES ● Teach-In '96 Part 7 ● Ingenuity Unlimited ● Thermionic Valves Part 2 – The C.R.T.

JUNE '96

PROJECTS ● Sarah's Light ● Ultra-Fast Frequency Generator and Counter Part 1 ● VU Display and Alarm ● Pulstar ● Home Telephone Link.
FEATURES ● Teach-In '96 Part 8 ● More Scope for Good Measurements Part 1 ● Circuit Surgery ● Miniscope Review.

JULY '96

PROJECTS ● Advanced NiCad Chargers ● Single-Station Radio 4 Tuner ● Games Compendium ● Twin-Beam Infra-Red Alarm ● Ultra-Fast Frequency Generator and Counter – 2.
FEATURES ● Teach-In '96 Part 9 ● More Scope for Good Measurements Part 2 ● Circuit Surgery ● The Internet ● Ingenuity Unlimited.

AUGUST '96

PROJECTS ● Component Analyser ● Garden Mole-Ester ● Mono "Cordless" Headphones ● Bike-Speedo ● Mobile Miser.
FEATURES ● Teach-In '96 Part 10 ● Circuit Surgery ● Ingenuity Unlimited ● Spies, Lies and Electronics ● EPT 3.0 Review.

BACK ISSUES ONLY £2.50 each inc. UK p&p.
Overseas prices £3.10 each surface mail, £4.10 each airmail.

We can also supply issues from earlier years: 1990 (**except** March), 1991 (**except** May, June, Aug., Sept. and Nov.), 1992 (**except** April and Dec.), 1993 (**except** Jan., Feb., March, April and May), 1994 (**except** April, May, June and Nov.), 1995 (**except** Jan., May, June, Sept., Nov. and Dec.). Please note we are not able to supply copies (or 'stats of articles) of *Practical Electronics* prior to the merger of the two magazines in November 1992.
Where we do not have an issue a photostat of any *one article* or *one part* of a series can be provided at the same price.

ORDER FORM – BACK ISSUES – PHOTOSTATS – INDEXES

☐ Send back issues dated ....
☐ Send photostats of (article title and issue date) ....
☐ Send copies of last five years indexes (£2.50 for five inc. p&p – Overseas £3.10 surface, £4.10 airmail)
Name ....
Address ....
....
☐ I enclose cheque/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 high cost we cannot reply to queries or orders by Fax.)
E-mail:editorial@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.
M9/96

FAX ON DEMAND

EVERYDAY PRACTICAL ELECTRONICS ON FAX

New user friendly system at lower cost

WHY WAIT?

We Give You The Fax!

Projects and Series
From the Past Year's
Issues of *EPE*

AVAILABLE INSTANTLY!
24 HOURS A DAY!

WHAT IS EVERYDAY PRACTICAL ELECTRONICS ON FAX?

HAVE you ever wanted to get hold of a past project or part of a Teach-In series fast? *EPE ON FAX* is a service aimed at providing you with the article you need on-demand, seven days a week, 365 days a year, 24 hours a day.

All the projects and major series from the the April '95 issue onwards have been stored on computer and linked to a sophisticated selection system that uses the latest voice and Fax technology. You can select the article you require from a menu and have it downloaded to any UK Fax machine on demand.

The service will be constantly updated with new material as each issue is published, thus providing a live, instantly available, resource covering the latest *EPE* articles.

1. Call the *EPE ON FAX* system from the handset of your Fax machine or from a tone telephone. The handset must be switched to "tone".

2. Following voice prompts, select either an index of articles, or a specific article by known article number (if you have previously received the index), from the keypad on your phone or Fax handset. Then enter the phone number of the Fax machine you want the article sent to, using the handset or phone keypad.

3. *EPE ON FAX* delivers your choice of article to the Fax machine, complete with cover sheet, while you wait. We pay for sending the Fax, **you are only charged for the initial call** at £1.50 per minute.

HOW TO USE *EPE ON FAX*

- From your tone telephone or Fax machine call 0897 124 125, making sure that your handset is switched to "tone". You will then hear a series of messages, which will help to guide you through the system.
- For one of the available indexes, which contain the document numbers and the number of pages of each article, press "1" when prompted.
- To obtain a particular document, press "2" when prompted and, when requested, enter the document number you want from the keypad on your phone or Fax machine. The system will then confirm your selection.
- When you have selected the document that you require, you will then be prompted to enter the phone number of the Fax machine you want the article sent to, including the dialing code, finishing with the # key; the system will then confirm the phone number. Ring off when prompted and the Fax will automatically be sent to the given number.

HOW MUCH WILL IT COST?

EPE ON FAX service is a higher rate premium line phone service. Calls cost £1.50 a minute. First time use should cost no more than £3 per index or article. Subsequent use should only be £1.50 per article.

NOTE. Articles over six pages long are split in two, requiring two calls.

FURTHER INFORMATION

If you would like further information about how this project was put together, ring Starcomm Limited on (0113) 294 0600.

TRY IT NOW! CALL 0897 124 125

DOWN TO EARTH

George Hylton

CASCADING OPERATIONAL AMPLIFIERS

THE GAIN of an operational amplifier (op.amp) can be very high – up to several million. Very few practical applications call for such a high gain and it's usual to reduce it by applying negative feedback.

This allows the gain to be set to any required figure below the "inner" (open-loop) gain. It also increases the range of frequencies over which the gain is constant.

NOISE

The laws of physics dictate that noise is always present in practical circuits. The amount of noise depends on many factors, including temperature and bandwidth. In many practical applications (audio, radio) it's hard to make the noise at the input of an amplifier less than about a microvolt.

If the gain is one million then a microvolt at the input gives a volt at the output. To drown the noise the input signal should be a thousand times larger, say one millivolt. If this were amplified by a million the output would be a kilovolt.

Nobody needs this much (not in the average home, at least) and in practice you can't get it because the circuit overloads and limits the signals. In a word, practical, usable gains are relatively low.

Reducing gain by negative feedback can't reduce the input noise but the output noise undergoes the same reduction as the gain. Let's put in some numbers.

An audio power amplifier may need an input signal of 100mV. A typical audio signal of 1mV then needs to be preamplified by 100. Some signals may be under 1mV but gains of more than 1000 are seldom needed.

D.C. ERRORS

Trouble can arise if the d.c. gain of an op.amp is high. The amplifier has two input terminals (inverting (−) and non-inverting (+)).

Ideally these should be at exactly the same d.c. voltage. In practice they aren't. There's a difference, called the "input offset voltage".

For a cheap op.amp this might be 5mV. This acts like a d.c. input signal and gets amplified. Thus a d.c. gain of 1000 turns it into 5000mV (5V) at the output.

This is a serious shift in level. It will at the very least limit the a.c. output voltage swing and at worst may stop the amplifier from working at all.

If your supply voltage is 5V then an attempt on the circuit's part to shift the working point by the same amount just pushes the output as hard up to the supply rail voltage as it can go. Even much smaller d.c. shifts cause premature overload and consequent peak clipping. Steps must be taken to keep the d.c. gain well below the a.c. gain.

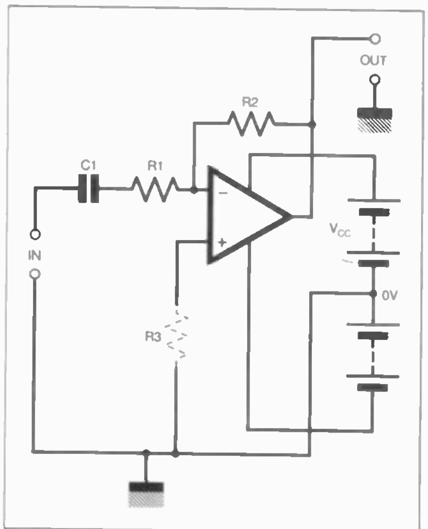


Fig. 1. Blocking capacitor C1 ensures that d.c. negative feedback is maximised.

CAPACITIVE COUPLING

The insertion of d.c. blocking capacitors in a.c. paths can reduce the effective d.c. gain drastically. In Fig. 1 capacitor C1 ensures that the full d.c. output voltage is fed back via resistor R2 to the inverting terminal. This reduces the d.c. gain to 1, which means that the d.c. error at the output is the same as at the input, which is normally negligible.

In practice the improvement may not be as much as this simple reasoning predicts. There is an additional source of error in the shape of d.c. flowing in resistor R2.

Some d.c. does flow! It's the "input bias current" and though small it has an effect when R2 is large.

In my tests, one of the four op.amps of an LM324 i.c. gave a shift in d.c. output voltage of 120mV when R2 was changed from zero to ten megohms (10M). This implies an input bias current of typical 12 nano-amps. However, the LM324 data quote a typical bias current of 20nA (which would give 200mV d.c. shift) and a maximum bias (at 25°C) of 250nA, which would give a nasty shift of 2·5V.

A remedy is to insert equal resistance in the other input lead (shown dotted in Fig. 1). When I did so the additional d.c. error at the output fell to 14mV.

In fact, 10M is ridiculously high for this op.amp. In real life you would use a much lower resistance or an op.amp with a much lower bias current, e.g. one with f.e.t. inputs.

There is a price to be paid for using the low-resistance solution. To preserve the l.f. response capacitor C1 must be made larger, increasing cost and bulk.

SPACE SAVING

Even if you don't mind the cost, the space taken by blocking capacitors can be an embarrassment on a crowded circuit board. For this reason, as well as for cost reduction designers try to minimise the number of capacitors.

The easiest way is to use op.amps with low offset voltage and low input bias current. Bias is small in f.e.t.-input amplifiers, but very low offset voltage calls for special chips which are expensive. Offsets down to about a microvolt are available, but they cost a lot more than the 30p (pence) or so you pay for an LM324.

The simplest and cheapest way of connecting one op.amp to the next is *direct coupling* (Fig. 2). Here the voltage error of the first stage is reduced by a combination of capacitive input coupling and resistance equalisation (R3).

The resulting d.c. error at its output (shown here as 5mV) is fed to the next stage. This amplifies it (tenfold) to

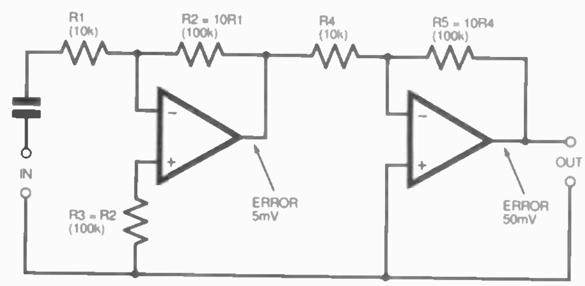


Fig. 2. One d.c. interstage coupling may be tolerable in terms of offset errors.

50mV but this may well be tolerable. Clearly, the situation is worsened if the second-stage gain is higher.

MULTISTAGE FEEDBACK

If a gain of 1000 is required, 5mV input offset error becomes 5V output error if nothing is done about it. One possibility is to use overall d.c. feedback to reduce the d.c. gain while leaving the a.c. gain at 1000.

In Fig. 3 the three cascaded inverting stages produce overall inversion, hence d.c. feedback via resistors R7 and R8 is negative. Signal frequencies are shunted off by capacitor C2.

There is one unwanted effect. Operation is delayed by a few seconds after switch-on, as C2 charges. If, to minimise the delay, C2 is reduced there is a reduction in gain at the low-frequency end. Compromise is necessary.

For the record, I found that 10µF gave a −3db point at 300Hz and 100µF gave −3dB at 20Hz. To give bass cut C2 can be made deliberately small, but may cause a hump in the l.f. response or even instability.

My initial tests used the LM7324 but it is rather noisy. The TL084 gave equally good results from the d.c. point of view (very small overall d.c. error) despite its poorer offset error.

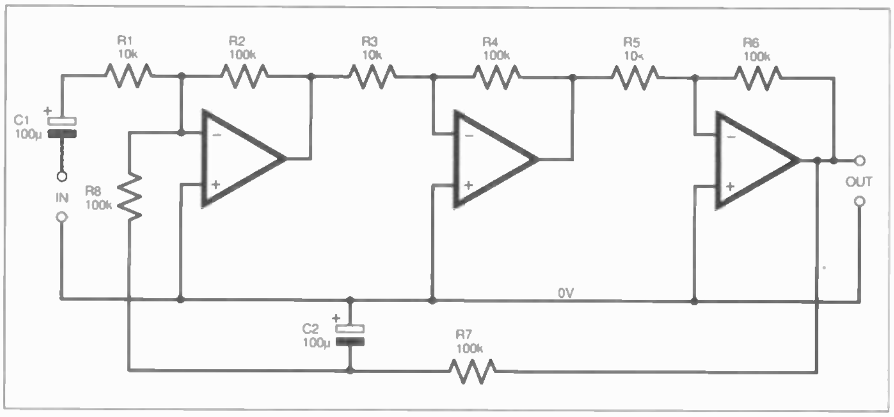


Fig. 3. Overall d.c. feedback stabilises the whole amplifier.

INGENUITY UNLIMITED

Continued from page 712

Model Fire Engine – "Blue Watch"

STILL on the theme of model vehicles, Fig. 6 was designed as a circuit to add both a blue flashing light sequence plus a two-tone siren effect, to a model fire engine. IC1 is a quad NAND Schmitt trigger and IC1a provides a low-frequency waveform which is inverted by IC1b.

Thus, complementary outputs are obtained which drive transistors TR1 and TR2. These driver transistors operate D1 and D2 which are two *blue* l.e.d.s. The model had a blue translucent moulding on its roof and yielded a surprisingly realistic effect.

The outputs from IC1a and IC1b are also used to control gated astables IC1c and IC1d, which are set to oscillate at different frequencies to simulate a typical British two-tone siren sounded by WD1, a piezo disc. Battery B1 should be an alkaline or rechargeable 9V type since the current consumption is relatively high. S1 was a slide switch fitted on the rear of the vehicle. The sounder is optional!

David Geary, Blackheath, London.

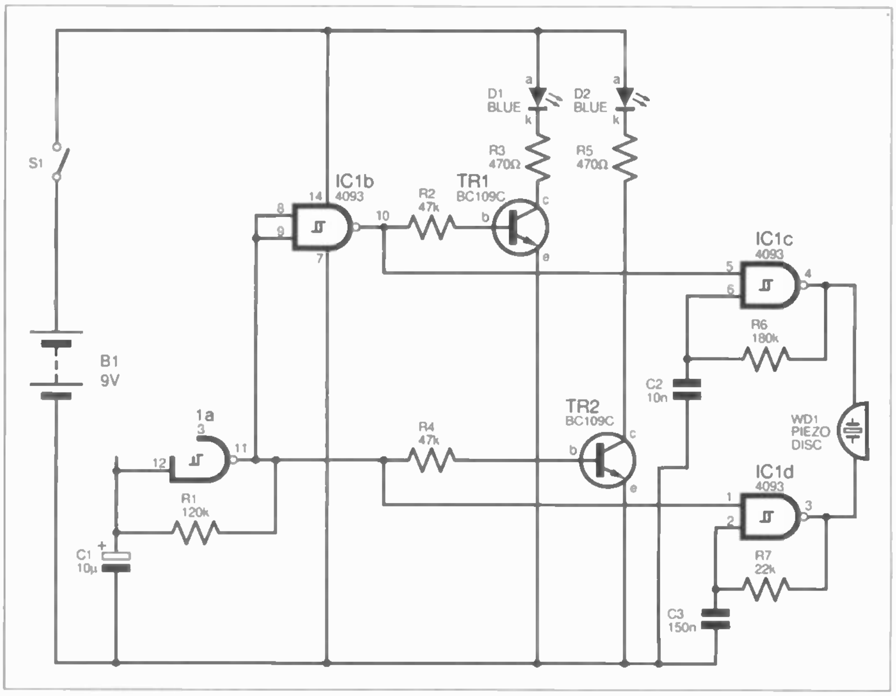
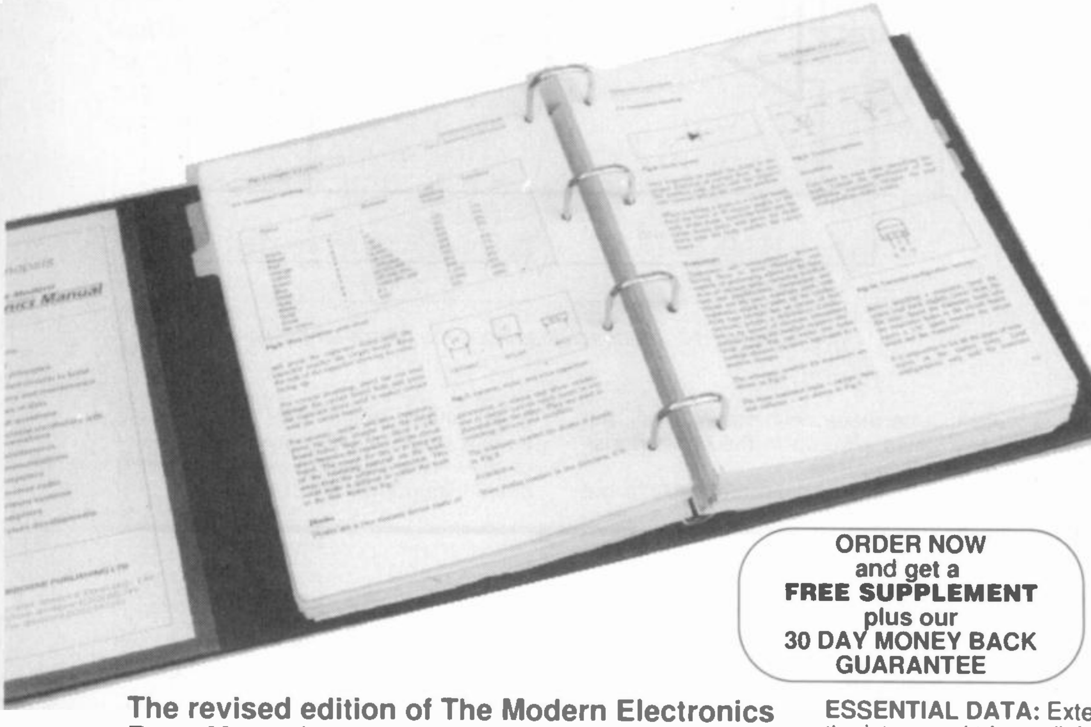


Fig. 6. Circuit for a blue l.e.d. flasher/siren for a model fire engine.

LEARN ALL ABOUT ELECTRONICS



The essential reference work

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

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

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

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

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

Guarantee

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

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

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

Wimborne Publishing Ltd., Dept. Y9
Allen House, East Borough,
Wimborne,
Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692

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

FULL NAME ....
(PLEASE PRINT)

ADDRESS..

....

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

SIGNATURE..

☐ **I enclose cheque/PO payable to Wimborne Publishing Ltd.**

☐ **Please charge my Visa/Mastercard/Access**

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

ORDER FORM

Simply complete and return the order form with your payment to the following address:
Wimborne Publishing Ltd, Dept. Y9
Allen House, East Borough, Wimborne,
Dorset BH21 1PF

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

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

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

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

DIRECT BOOK SERVICE

INTRODUCING MICROPROCESSORS
Mike Tooley B.A. (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.
Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering popular microprocessors.
And excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.
80 pages **Order code TI-88/89** **£2.45**

ELECTRONICS TEACH-IN No.6
DESIGN YOUR OWN CIRCUITS
(published by *Everyday Practical Electronics*)
Mike Tooley B.A.
This book is designed for the beginner and experienced reader alike, and aims to dispel some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.
Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs.
The subjects covered in each chapter of the book are: Introduction and Power Supplies; Small Signal Amplifiers; Power Amplifiers, Oscillators; Logic Circuits, Timers; Radio; Power Control; Optoelectronics.
The nine complete constructional projects are. Versatile Bench Power Supply, Simple Intercom; Bench Amplifier/Signal Tracer; Waveform Generator; Electronic Die; Pulse Generator, Radio Receiver; Disco Lights Controller; Optical Communications Link.
136 pages **Order code TI6** **£3.45**

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book page.
FOR ANOTHER SELECTION OF BOOKS SEE NEXT MONTH'S ISSUE.
Note our UK postage costs just £1.50 no matter how many books you order!

TEACH-IN No. 7. plus FREE SOFTWARE
ANALOGUE AND DIGITAL ELECTRONICS COURSE
(published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE
This highly acclaimed *EPE Teach-In series, which included the construction and use of the Mini Lab and Micro Lab* test and development units, has been put together in book form. Additionally, EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a FREE DISKC 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 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.
160 pages **Order code TI7** **£3.95**

ELECTRONIC PROJECTS BOOK 1
(published by *Everyday Practical Electronics* in association with Magenta Electronics)
Contains twenty projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesizer, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three-Channel Sound to Light, BBC 16K sideways RAM, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser, Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages **Order code EP1** **£2.45**

RADIO / TV / VIDEO

ELECTRONIC PROJECTS FOR VIDEO ENTHUSIASTS
R. A. Penfold
This book provides a number of practical designs for video accessories that will help you get the best results from your camcorder and VCR. All the projects use inexpensive components that are readily available, and they are easy to construct. Full construction details are provided, including stripboard layouts and wiring diagrams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.
The projects covered in this book include: Four channel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit.
109 pages **Order code BP356** **£4.95**

SETTING UP AN AMATEUR RADIO STATION
I. D. Poole
The aim of this book is to give guidance on the decisions which have to be made when setting up any amateur radio or short wave listening station. Often the experience which is needed is learned by one's mistakes, however, this can be expensive. To help overcome this, guidance is given on many aspects of setting up and running an efficient station. It then proceeds to the steps that need to be taken in gaining a full transmitting licence.
Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.
An essential addition to the library of all those taking their first steps in amateur radio.
86 pages **Order code BP300** **£3.95**

EXPERIMENTAL ANTENNA TOPICS
H. C. Wright
Although nearly a century has passed since Marconi's first demonstration or radio communication, there is still research and experiment to be carried out in the field of antenna design and behaviour.
The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc. These materials are, in general, cheap to obtain and easily worked with simple tools, encouraging the trial-and-error philosophy which leads to innovation and discovery.
Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.
72 pages **Order code BP278** **£3.50**

25 SIMPLE INDOOR AND WINDOW AERIALS
E. M. Noll
Many people live in flats and apartments or other types of accommodation where outdoor aerials are prohibited, or a lack of garden space etc. prevents aerials from being erected. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out along the skirting board of a room can produce acceptable results. However, with some additional effort and experimentation one may well be able to improve performance further.
This concise book tells the story, and shows the reader how to construct and use 25 indoor and window aerials that the author has proven to be sure performers.
Much information is also given on shortwave bands, aerial directivity, time zones, dimensions etc.
50 pages **Order code BP136** **£1.75**

PROJECT COSTRUCTION

TEST EQUIPMENT CONSTRUCTION
R. A. Penfold
This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.
The following designs are included:–
AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Mullivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe.
The designs are suitable for both newcomers and more experienced hobbyists.
104 pages **Order code BP248** **£3.99**

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 slected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.
166 pages **Order code BP285** **£3.95**

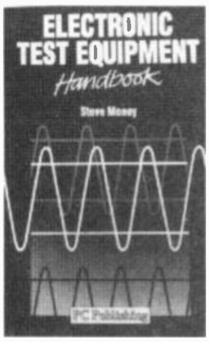
HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books, and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold
The purpose of this book is to provide the reader with a wide range of preamplifier and power amplifier designs that will, it is hoped, cover most normal requirements.
The preamplifier circuits include low noise microphone and RIAA types, a tape head preamplifier, a guitar preamplifier and various tone controls. The power amplifier designs range from low power battery operation to 100W MOSFET types and also include a 12 volt bridge amplifier capable of giving up to 18W output.
All the circuits are relatively easy to construct using the p.c.b. or stripboard designs given. Where necessary any setting-up procedures are described, but in most cases no setting-up or test gear is required in order to successfully complete the project.
100 pages **Order code BP122** **£2.95**

DESIGN YOUR OWN CIRCUITS
See ELECTRONICS TEACH IN No. 6 above left.

TESTING, THEORY, DATA AND REFERENCE

TRANSISTOR DATA TABLES
Hans-Günther Steidle
The continually growing number and variety of semiconductor components mean ever greater problems for the user. It is difficult to gain an overall picture of the types which may be suitable for a particular application, from those currently available. However, as a starting point, the electrical parameters of a device are usually sufficient.
The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.
A book of this size is of necessity restricted in its scope, and the individual transistor types cannot therefore be described in the sort of detail that maybe found in some larger and considerably more expensive data books. However, the list of manufacturers' addresses will make it easier for the prospective user to obtain further information, if necessary.
Lists over 8,000 different transistors, including f.e.t.s.
200 pages **Order code BP401** **£5.95**



ELECTRONIC TEST EQUIPMENT HANDBOOK
Steve Money
The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.
Everything from Oscillators, through R, C & L measurements (and much more) to Waveform Generators and testing Zeners.
206 pages **Order code PC109** **£8.95**

A REFERENCE GUIDE TO BASIC ELECTRONICS TERMS
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
The wonders of electronics multiply unceasingly and electronic devices are creeping relentlessly into all walks of modern life. As with most professions, ours too has a language of its own, ever expanding and now encompassing several thousands of terms. This book picks out and explains some of the more important fundamental terms (over 700), making the explanations as easy to understand as can be expected of a complicated subject and avoiding high-level mathematics.
Through its system of references, each term is backed up by a list of other relevant or more fundamental terms so that a chosen subject can be studied to any depth required.
472 pages **Order code BP286** **£5.95**

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**

ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components – resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op.amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.
At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuit you build.
120 pages **Order code PC103** **£6.95**

NEWNES ELECTRONICS TOOLKIT
Geoff Phillips
The author has used his 30 years experience in industry to draw together the basic information that is constantly demanded. Facts, formulae, data and charts are presented to help the engineer when designing, developing, evaluating, fault finding and repairing electronic circuits. The result is this handy workmate volume: a memory aid, tutor and reference source which is recommended to all electronics engineers, students and technicians.
Have you ever wished for a concise and comprehensive guide to electronics concepts and rules of thumb? Have you ever been unable to source a component, or choose between two alternatives for a particular application? How much time do you spend searching for basic facts or manufacturer's specifications? This book is the answer, it covers resistors, capacitors, inductors, semiconductors, logic circuits, EMC, audio, electronics and music, telephones, electronics in lighting, thermal considerations, connections, reference data.
158 pages **Order code NE20** **£12.95**

MORE ADVANCED USES OF THE MULTIMETER
R. A. Penfold

This book is primarily intended as a follow-up to BP239, (see below), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in Chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.
While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in Chapter 2 extended the capabilities of a multimeter to make it even more useful.
84 pages **Order code BP265** **£2.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias – tedious and higher mathematics have been avoided where possible and many tables have been included.
The book is divided into six basic sections: Units and Constants, Direct-Current Circuits, Passive Components, Alternating-Current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

AN INTRODUCTION TO LIGHT IN ELECTRONICS
F. A. Wilson
Marconi first bridged the Atlantic with radio waves, then of a mere 200 kilohertz. Since then for communication we have moved up the frequency scale through megahertz and microwaves and are now probing light waves. Accordingly no self-respecting electronics engineer can afford not to be conversant with light and its uses in electronics since development of opto-electronic devices and communication systems is proceeding at a truly explosive rate.
This book is not for the expert but neither is it for the completely uninitiated. It is assumed the reader has some basic knowledge of electronics. After dealing with subjects like Fundamamentals, Waves and Particles and The Nature of Light such things as Emitters, Detectors and Displays are discussed. Chapter 7 details four different types of Lasers before concluding with a chapter on Fibre Optics.
161 pages **Order code BP359** **£4.95**

PRACTICAL ELECTRONIC DESIGN DATA
Owen Bishop
This book is a comprehensive ready-reference manual for electronics enthusiasts of all levels, be they hobbyists, students or professionals. A helpful major section covers the main kinds of component, including surface-mounted devices. For each sort, it lists the most useful and readily available types, complete with details of their electronic characteristics, pin-outs and other essential information.
Basic electronic units are defined, backed up by a compendium of the most often required formulae, fully explained. There are five more extensive sections devoted to circuit design, covering analogue, digital, radio, display, and power supply circuits. Over 150 practical circuit diagrams cover a broad range of functions. The reader is shown how to adapt these basic designs to a variety of applications. Many of the circuit descriptions include step-by-step instructions for using most of the standard types of integrated circuit such as operational amplifiers, comparators, filters, voltage converters and switched-mode power supply devices, as well as the principal logic circuits.
328 pages **Temporarily out of print**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages **Order code BP85** **£3.95**

COMPUTING

WINDOWS 95 EXPLAINED
P. R. M. Oliver and N. Kantaris
If you would like to get up and running, as soon as possible, with the new Windows 95 operating system, then this is the book for you.
The book was written with the non-expert, busy person in mind. It explains the hardware that you need in order to run Windows 95 successfully, and how to install and optimize your system's resources. It presents an overview of the Windows 95 environment.
Later chapters cover how to work with programs, folders and documents; how to control Windows 95 and use the many accessories that come with it; how to use DOS programs and, if necessary, DOS commands and how to communicate with the rest of the electronic world.
170 pages **Order code BP400** **£5.95**

INTERFACING PCs AND COMPATIBLES
R. A. Penfold
Once you know how, PC interfacing is less involved than interfacing many eight-bit machines, which have tended to use some unusual interfacing methods.
This book gives you: A detailed description of the lines present on the PC expansion bus. A detailed discussion of the physical characteristics of PC expansion cards. The I/O map and details of the areas where your add-on can be fitted. A discussion of address decoding techniques. Practical address decoder circuits. Simple TTL 8-bit input and output ports. Details of using the 8255 parallel interface adaptor. Digital to analogue converter circuits. In fact everything you need to know in order to produce successful PC add-ons.
80 pages **Order code BP272** **£3.95**

HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM
D. Weale
This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs, and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms. The text contains many useful tips and some warnings (which could save much effort and expense). After having read this book you should have a better idea of what is suitable for your needs, how to obtain it and how to ensure that the system is operated with the minimum of difficulty.
144 pages **Order code BP323** **£4.95**

HOW TO EXPAND, MODERNISE AND REPAIR PCs AND COMPATIBLES (Revised Edition)
R. A. Penfold
Not only are PC and compatible computers very expandable, but before long most users actually wish to take advantage of that expandability and start upgrading their PC system. Some aspects of PC upgrading can be a bit confusing, but this book provides advice and guidance on the popular forms of internal PC expansion, and should help to make things reasonably straightforward and painless. Little knowledge of computing is assumed. The only assumption is that you can operate a standard PC of some kind (PC, PC XT, PC AT, or an 80386 based PC).
The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.
156 pages **Order code BP271** **£5.95**

THE PRE-BASIC BOOK
F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.
Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
192 pages **Order code BP146** **£2.95**

SERVICING PERSONAL COMPUTERS – 3rd EDITION
Mike Tooley BA
The revised and enlarged third edition contains a new chapter on servicing 68000 based microcomputers. It has been updated throughout and includes many new photos and diagrams. It is essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.
240 pages **Order code NE15** **£25**

EASY PC INTERFACING
R. A. Penfold
PCs and compatibles are the "standard" choice for anyone who is interested in practically any aspect of computing, including those who like to experiment with do-it-yourself hardware addons. Although the internal expansion slots provide full access to the computer's buses, and are suitable for user add-ons, making your own expansion cards requires a fair amount of expertise and equipment. The built-in ports provide what is often a much easier and hassle-free way of interfacing your own circuits to a PC. In particlar, a PC printer port plus a small amount of external hardware provides a surprisingly versatile input/output port. The PC "games" port is less useful for general interfacing purposes, but it can be useful in some applications.
This book provides a number of useful PC add-on circuits including the following: Digital input/output ports; Analogue to digital converter; Digital-to-Analogue Converter; Voltage and current measurement circuits; Resistance meter; Capacitance meter; Temperature measurement interface; Biofeedback monitor; Constant voltage model train controller; Pulsed model train controllers; Position sensor (optical, Hall effect, etc.); Stepper motor Interface; Relay and LED drivers; Triac mains switching interface.
179 pages **Order code BP385** **£4.95**

CIRCUITS AND DESIGN

REMOTE CONTROL HANDBOOK (Revised Edition)
Owen Bishop
Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.
240 pages **Order code BP240** £3.95

COIL DESIGN AND CONSTRUCTIONAL MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now twenty years old, with the exception of toroids and pulse transformers little has changed in coil design since it was written.
96 pages **Order code 160** £3.95

PRACTICAL ELECTRONICS HANDBOOK – Fourth Edition. Ian Sinclair
Contains all of the everyday information that anyone working in electronics will need.

It provides a practical and comprehensive collection of circuits, rules of thumb and design data for professional engineers, students and enthusaists, and therefore enough background to allow the understanding and development of a range of basic circuits.

Contents: Passive components, Active discrete components, Discrete component circuits, Sensing components, Linear I.C.s, Digital I.C.s, Microprocessors and microprocessor systems, Transferring digital data, Digital-analogue conversions, Computer aids in electronics, Hardware components and practical work, Standard metric wire table, Bibliography, The HEX scale, Index.
440 pages **Order code NE21** £12.99

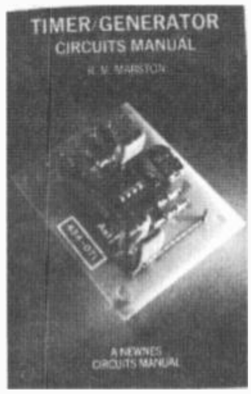
AUDIO IC CIRCUITS MANUAL
R. M. Marston
A vast range of audio and audio-associated i.c.s are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay lines etc.
168 pages **Order code NE13** £13.95

50 CIRCUITS USING GERMANIUM, SILICON AND ZENER DIODES
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components – the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.
64 pages **Order code BP36** £1.95

A BEGINNERS GUIDE TO CMOS DIGITAL ICs
R. A. Penfold
Getting started with logic circuits can be difficult, since many of the fundamental concepts of digital design tend to seem rather abstract, and remote from obviously useful applications. This book covers the basic theory of digital electronics and the use of CMOS integrated circuits, but does not lose sight of the fact that digital electronics has numerous "real world" applications.

The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decade counters and display drivers.

The emphasis is on a practical treatment of the subject, and all the circuits are based on "real" CMOS devices. A number of the circuits demonstrate the use of CMOS logic i.c.s in practical applications.
119 pages **Order code BP333** £4.95



TIMER/GENERATOR CIRCUITS MANUAL
R. M. Marston
This manual is concerned mainly with waveform generator techniques and circuits. Waveform generators are used somewhere or other in most types of electronic equipment, and thus form one of the most widely used classes of circuit. They may be designed to produce outputs with sine, square, triangle, ramp, pulse, staircase, or a variety of other forms. The generators may produce modulated or unmodulated outputs, and the outputs may be of single or multiple form.

Waveform generator circuits may be built using transistors, op.amps, standard digital i.c.s, or dedicated waveform or "function" generator i.c.s.

The manual is divided into eleven chapters, and presents over 300 practical circuits, diagrams and tables. The subjects covered include: Basic principles; Sine wave generators; Square wave generators; Pulse generator circuits; "Timer i.c." generator circuits; Triangle and sawtooth generators; Multi-waveform generation; Waveform synthesizer i.c.s; Special waveform generators; Phaselocked loop circuits; Miscellaneous "555" circuits.
267 pages **Order code NE18** £13.95

OPTOELECTRONICS CIRCUITS MANUAL
R. M. Marston
A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.
182 pages **Order code NE14** £13.95

OPERATIONAL AMPLIFIER USER'S HANDBOOK
R. A. Penfold
The first part of this book covers standard operational amplifer based "building blocks" (integrator, precision rectifier, function generator, amplifiers, etc), and considers the ways in which modern devices can be used to give superior performance in each one. The second part describes a number of practical circuits that exploit modern operational amplifiers, such as high slew-rate, ultra low noise, and low input offset devices. The projects include: Low noise tape preamplifier, low noise RIAA preamplifier, audio power amplifiers, d.c. power controllers, opto-isolator audio link, audio millivolt meter, temperature monitor, low distortion audio signal generator, simple video fader, and many more.
120 pages **Order code BP335** £4.95

AUDIO AND MUSIC

INTRODUCTION TO DIGITAL AUDIO (Second Edition)
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.

All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.

This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product.
128 pages **Order code PC102** £7.95

PROJECTS FOR THE ELECTRIC GUITAR
J. Chatwin
This book is for anyone interested in the electric guitar. It explains how the electronic functions of the instrument work together, and includes information on the various pickups and transducers that can be fitted. There are complete circuit diagrams for the major types of instrument, as well as a selection of wiring modifications and pickup switching circuits. These can be used to help you create your own custom wiring.

Along with the electric guitar, sections are also included relating to acoustic instruments. The function of specialised piezoelectric pickups is explained and there are detailed instructions on how to make your own contact and bridge transducers. The projects range from simple preamps and tone boosters, to complete active controls and equaliser units.
92 pages **Order code BP358** £4.95

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems – amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order code BP111** £3.95

MIDI SURVIVAL GUIDE
Vic Lennard
Whether you're a beginner or a seasoned pro, the MIDI Survival Guide shows you the way. No maths, no MIDI theory, just practical advice on starting up, setting up and ending up with a working MIDI system.

Over 40 cabling diagrams. Connect synths, sound modules, sequencers, drum machines and multitracks. How to budget and buy secondhand. Using switch, thru and merger boxes. Transfer songs between different sequencers. Get the best out of General MIDI. Understand MIDI implementation charts. No MIDI theory.
104 pages **Order code PC111** £6.95

PRACTICAL ELECTRONIC MUSICAL EFFECTS UNITS
R. A. Penfold
This book provides practical circuits for a number of electronic musical effects units. All can be built at a relatively low cost, and use standard, readily available components. The projects covered include: Waa-Waa Units; Distortion Units; Phaser; Guitar Envelope Shaper; Compressor; Tremolo Unit; Metal Effects Unit; Bass and Treble Boosters; Graphic Equaliser; Parametric Equaliser. The projects cover a range of complexities, but most are well within the capabilities of the average electronics hobbyist. None of them require the use of test equipment and several are suitable for near beginners.
102 pages **Order code BP368** £4.95

LOUDSPEAKERS FOR MUSICIANS
Vivan Capel
This book contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, when and where to use wadding, and when not to, what fittings are available, finishing, how to ensure they travel well, how to connect multi-speaker arrays and much more.

Ten practical enclosure designs with plans and comments are given in the last chapter, but by the time you've read that far you should be able to design your own!
164 pages **Order code BP297** £3.95

DIRECT BOOK SERVICE
ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

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 (including card expiry date), Visa or Mastercard – minimum credit card order is £5 – quoting your name and address, the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET BH21 1RW** *(mail order only).*

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of Everyday Practical Electronics) before ordering from old lists.

For a further selection of books see next month's issue.

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.
Tel 01202 881749 Fax 01202 814692

BABANI BOOKS

We now supply *all* the books published by Bernard Babani (Publishing) Ltd. We have always supplied a selected list of Babani books and you will find many of them described on the previous pages or in next month's issue of *Everyday Practical Electronics* (all books with a BP prefix to the order code are Babani books). Many readers have asked us to also supply various other Babani books, which have a reputation for value for money.

Our customers tell us they appreciate our speedy service and low postage charge and they would like to be able to purchase all the books from us and thus keep the postage charge to an absolute minimum **(£1.50 for UK p&p no matter how many books you buy)**. We are pleased to be able to respond; we are now able to meet all your requirements for Babani books.

Code	Title	Price
BP37	50 Projects using Relays, SCRs and TRIACs	£2.95
BP44	IC 555 Projects	£2.95
BP48	Electronic Projects for Beginners	£1.95
BP76	Power Supply Projects	£3.99
BP78	Practical Computer Experiments	£1.75
BP90	Audio Projects	£2.50
BP115	The Pre-computer Book	£1.95
BP125	25 Simple Amateur Band Aerials	£1.95
BP132	25 Simple SW Broadcast Band Aerials	£1.95
BP144	Further Practical Electronics Calculations & Formulae	£5.95
BP145	25 Simple Tropical and MW Band Aerials	£1.75
BP147	An Introduction to 6502 Machine Code	£2.95
BP171	Easy Add-on Projects for Amstrad CPC 464, 664, 6128 and MSX Computers	£2.95
BP182	MIDI Projects	£2.95
BP192	More Advanced Power Supply Projects	£2.95
BP193	LOGO for Beginners	£2.95
BP198	An Introduction to Antenna Theory	O.O.P.
BP245	Digital Audio Projects	£2.95
BP246	Musical Applications of the Atari ST's	£5.95
BP249	More Advanced Test Equipment Construction	£3.50
BP250	Programming in FORTRAN 77	£4.95
BP251	Computer Hobbyists Handbook	£5.95
BP258	Learning to Program in C (revised edition)	£4.95
BP259	A Concise Introduction to UNIX – Revised Edition	£4.95
BP261	A Concise Introduction to Lotus 1-2-3 (revised edition)	£3.95
BP262	A Concise Introduction to WordPerfect (revised edition)	£3.95
BP264	A Concise Advanced User's Guide to MS-DOS (revised edition – covers version 6.2)	£4.95
BP273	Practical Electronic Sensors	£4.95
BP274	A Concise Introduction to SuperCalc5	£4.95
BP276	Short Wave Superhet Receiver Construction	£2.95
BP281	An Induction to UHF/VHF for Radio Amateurs	£4.99
BP284	Programming in QuickBASIC	£4.95
BP292	Public Address Loudspeaker Systems	£3.95
BP293	An Introduction to Radio Wave Propagation	£3.95
BP294	A Concise Introduction to Microsoft Works (revised edition)	£4.95
BP298	A Concise Introduction to the Mac System & Finder	£3.95
BP301	Antennas for VHF and UHF	£4.95
BP305	Learning CAD with AutoSketch for Windows	£5.95
BP306	A Concise Intoduction to AmiPro 3	£5.95
BP311	An Introduction to Scanners and Scanning	£4.99
BP312	An Introduction to Microwaves	£3.95
BP313	A Concise Introduction to Sage	£3.95
BP315	An Introduction to the Electromagnetic Wave	£4.95
BP317	Practical Electronic Timing	£4.95
BP320	Electronic Projects for Your PC	£3.99
BP324	The Art of Soldering	£3.95
BP325	A Concise Users Guide to Windows 3.1	£4.95
BP326	An Introduction to Satellite Communications	£5.95
BP327	DOS One Step at a Time (covers Version 6.2)	£4.99
BP328	Sage Explained	£5.95
BP329	Electronic Music Learning Projects	£4.95
BP330	A Concise User's Guide to Lotus 1-2-3 Release 2.4	£4.95
BP331	A Beginners Guide to MIDI	£4.95
BP334	Magic Electronics Projects	£4.95
BP336	A Concise Users Guide to Lotus 1-2-3 Release 3.4	£5.95
BP337	A Concise Users Guide to Lotus 1-2-3 for Windows	£5.95
BP341	MS-DOS 6 Explained (covers V6.2)	£5.95
BP343	A Concise Introduction to Microsoft Works for Windows	£5.95
BP345	Getting Started in Practical Electronics	£4.95
BP346	Programming in Visual BASIC for Windows	£5.95
BP349	Practical Opto-Electronic Projects	£4.95
BP350	Electronic Board Games	£4.95
BP351	WordPerfect 6 Explained	£5.95
BP352	Excel 5 Explained	£5.95
BP353	WordPerfect 6.0 for Windows Explained	£5.95
BP354	Word 6 for Windows Explained	£5.95
BP357	A Concise Introduction to Pressworks	£5.95
BP360	A Practical Introduction to Sage Sterling +2 for Windows	£4.95
BP361	Sage Sterling +2 for Windows Explained	£5.95
BP362	Access One Step at a Time	£4.95
BP363	Practical Electronic Music Projects	£4.95
BP364	A Concise Introduction to Designworks 2	£5.95
BP367	Electronic Projects for the Garden	£4.95
BP370	The Superhet Radio Handbook	£4.95
BP372	CA-SuperCalc for Windows Explained	£5.95
BP373	An Introduction to Networks for PC and Mac Users	£5.95
BP375	The Novice Radio Amateurs Examination Handbook	£4.95
BP380	Advanced Projects For The Electric Guitar	£4.99
BP385	Easy PC Interfacing	£4.95
BP387	Windows One Step at a Time	£4.95
BP388	Why Not Personalise Your PC	£4.95
BP389	Power Point for Windows Explained	£5.95
BP393	Practical Oscillator Circuits	£4.99
BP396	Electronics Hobbyists Data Book	£5.95
BP398	Sage Instant Accounting Explained	£5.95
BP399	Windows '95 One Step at a Time	£4.95
BP400	Windows 95 Explained	£5.95
BP401	Transistor Data Tables	£5.95
BP402	MS – Office One Step at a Time	£5.95
BP403	The Internet and World Wide Web Explained	£5.95
BP405	MS Works for Windows 95 explained	£5.95
BP409	MS Office 95 one step at a time	£6.99

IF NO PRICE IS SHOWN THE BOOK IS OUT OF PRINT (O.O.P.)

SEE PREVIOUS PAGE FOR FULL ORDERING DETAILS

PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remitances should be sent to **The PCB Service, *Everyday Practical Electronics*, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749.** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

Special KNOCK DOWN SALE of PCBs.

£1.00 EACH Inc. VAT and p&p

We have a few p.c.b.s left from past projects these are being offered at the knock down price of **£1.00** each – *no matter what size they are* **(some of these boards are worth over £9.00 each)** while stocks last. This price includes VAT and UK post – overseas orders please add 50p postage (or £1 per board for airmail postage).

Audio Lead Tester 641; Hand Tally, main board 699 and display board 700; Modular Disco Lights – Masterlink 752 – Dimmer Interface 765; Knockerbox 775; Auto Nightlight 779; Car Electric Window Enhancer, 821; Electronic Fire, 820; Electronic Snooker Scoreboard, 832; Bike Odometer (pair of boards), 836/7; Amstrad PCW A to D Converter (double-sided), 838; Kettle Alert, 843; Linear Power Supply (double-sided), 844; Microphone Pre-Amp module, 846; RIAA Pre-Amp module, 847; 20 Metre Receiver, 848; 1W Stereo Amplifier, 851; Auto Alarm, 854; 10W+10W Stereo Power Amplifier Amplifier, 852a – Power Supply, 852b; Whistle Controlled Light Switch, 860; Battery to Mains Inverter – U.P.S. charger board, 862.

Any of the above for just £1 each inc. VAT and p&p.

Back numbers or photostats of articles are available see the *Back Issues* page for details.

PROJECT TITLE		Order Code	Cost
Experimental Electronic Pipe Descaler	AUG'93	839	£5.50
Visual Doorbell	MAR'94	863	£5.80
CCD TV Camera – Control Board (double-sided, plated-through-hole)		865	£15.00
Telephone Ring Detector	APR'94	864	£4.72
CCD TV Camera			
Combined Video, Test & Ext Plug Boards		866a/e	£11.00
Frame Grab Control (double-sided p.t.h.)		867	£15.00
EPE SounDAC PC Sound Board		868	£4.77
L.E.D. Matrix Message Display Unit	MAY'94		
Display Board		870	£18.00
CPU Board		871	£7.20
Stereo Noise Gate		873	£6.14
Simple TENS Unit		875	£5.84
Capacitance/Inductance Meter		876	£6.44
Advanced TENS Unit	JUN'94	877	£6.56
Digital Water Meter – Scaler		878	£11.19
Counter/Display		879	pair
L.E.D. Matrix Message Display Unit			
Keypad		872	£5.19
PC Interface		880	£5.82
Microprocessor Smartswitch		881	£5.61
Microcontroller P.I. Treasure Hunter		882	£6.60
Print Timer	JULY'94	874	£5.82
Watering Wizard		883	£6.60
Simple NiCad Charger		884	£4.98
Stereo HiFi Controller – 1 Power Supply		886	£5.66
Stereo HiFi Controller – 2	AUG'94		
Main Board		887	£7.39
Expansion/Display Boards (pair)		888	£9.80
Dancing Fountains – 1 Pre.amp		889	£5.28
Pump Controller		890	£5.41
Filter		891	£5.23
6802 Microprocessor Development Board		894	£9.15
Dancing Fountains – 2	SEPT'94		
PC-Compatible Interface (double-sided)		892	£10.90
Automatic Greenhouse Watering System		895	£5.33
Seismograph – 1 Sensor/Filter		896	£6.23
Clock/Mixer		897	£5.87
3-Channel Lamp Controller		899	£8.17
Seismograph – 2	OCT'94		
PC-Compatible Interface (double-sided)		898	£10.72
Visual/Audio Guitar Tuner		900	£7.55
Digilogue Clock		901	£12.50
Hobby Power Supply		902	£5.00
Audio Auxiplexer – Control Board		903	£7.72
Receiver		904	£6.24

PROJECT TITLE	Order Code	Cost
Power Controller **NOV'94**	905	£4.99
1000V/500V Insulation Tester	906	£5.78
Active Guitar Tone Control	907	£4.50
TV Off-er (pair)	908/909	£7.25
Video Modules – 1 Simple Fader	910	£5.12
Improved Fader	911	£6.37
Video Enhancer	912	£5.15
Rodent Repeller **DEC'94**	913	£6.26
EPE Fruit Machine	914	£8.14
Video Modules –2 Horizontal Wiper	916	£6.23
Vertical Wiper	917	£6.35
4-Channel Audio Mixer	918	£6.20
Spacewriter Wand	921	£4.00
Universal Digital Code Lock	922	£6.25
Video Modules – 3 **JAN'95**		
Dynamic Noise Limiter	919	£5.92
System Mains Power Supply	920	£4.98
Magnetic Field Detector	923	£5.77
Model Railway Track Cleaner	924	£5.11
Moving Display Metronome	925	£6.24
The Ultimate Screen Saver **FEB'95**	927	£5.66
Foot-Operated Drill Controller	928	£5.73
Model Railway Signals	929	£5.96
12V 35W PA Amplifier	930	£12.25
Multi-Purpose Thermostat **MAR'95**	931	£6.30
Multi-Project PCB	932	£3.00
Sound-Activated Switch		
Audio Amplifier		
Light Beam Communicator (2 boards required)		
Multi-Project PCB **APR'95**	932	£3.00
Light-Activated Switch		
Switch On/Off Timer		
Continuity Tester		
Auto Battery Charger	934	£5.36
National Lottery Predictor	935	£5.34
R.F. Signal Generator - R.F./Mod. **MAY'95**	936	£6.48
Coil & Power Supply (pair)	937a/b	£6.10
MIDI Pedal	938	£7.78
Club Vote Totaliser	939	£6.05
PIC-DATS Development System		
(double-sided p.t.h.)	940	£9.90
EPE HiFi Valve Amplifier – **JUNE'95**		
Phase splitter	941	£6.71
PIC-DATS 4 -channel Light Chaser	942	£7.90
HV Capacitor Reformer **JULY'95**	943	£5.60
Ramp Generator		
Logic Board (double-sided p.t.h.) & Analogue		
board (pair)	944/5	£32.00
Automatic Curtain Winder	946	£6.75
Windicator	947	£4.10
Microcontrolled 3-Digit Timer **AUG'95**	933	£6.61
IR Remote Control – Transmitter	948	£5.76
– Receiver	949	£6.14
Personal Practice Amplifier	950	£6.09
Low-Range Ohmmeter Adaptor **SEPT'95**	926	£5.55
Simple Theremin	952	£6.68
Vandata		
Boot Control Unit	953	£10.52
Display Unit	954	£6.61
Sound Switch **OCT'95**	915	£6.55
Multiple Project PCB	932	£3.00
Audio Sinewave Generator		
Treble Booster		
Infra-Red Controller/Alarm (2 boards required)		
Capacitor Check	955	£5.76
Ginormous VU Meter	956	£9.31
Multiple Project PCB **NOV'95**	932	£3.00
Video Enhancer		
Current Tracer		
Distortion Effects Unit		
Digital Delay Line	958	£8.04
50Hz Field Meter	959	£8.32
Temperature Warning Alarm (Teach-In '96)	960	£6.15
Stereo "Cordless " Headphones **DEC'95**		
Transmitter	961	£8.04
Receiver	962	£7.66
EPE Met Office – Sensor/Rainfall/Vane	963/965	£11.33
Spiral transparency free with above p.c.b.		
Light-Operated Switch	966	£6.37
Modular Alarm System (Teach-In '96)	967a/b	£7.12
Audio Meter and Amplifier	968	£5.99

PROJECT TITLE	Order Code	Cost
EPE Met Office – **JAN'96**		
Computer Interface (double-sided)	964	£7.69
Audio Signal Generator	969	£6.58
Mains Signalling Unit, Transmitter and Receiver	970/971 (pr)	£9.09
Automatic Camera Panning (Teach-In '96)	972	£6.63
Printer Sharer	973	£9.93
Analogue Frequency Meter **FEB'96**	957	£6.70
Vari-Speed Dice (Teach-In '96)	974	£5.69
Mains Signalling Unit – 2		
12V Capacitive PSU	975	£6.07
PIC-Electric Meter – Sensor/PSU– Control/Display	977/978 (pr)	£9.90
Multi-Purpose Mini Amplifier **MAR'96**	976	£6.12
PIC-Electric – Sensor/PSU – Control/Display	977/978 (pr)	£9.90
High Current Stabilised Power Supply	979	£6.62
Mind Machine Mk III – Sound and Lights	980	£7.39
Infra-Zapper Transmitter/Receiver (Teach-In '96)	981/982 (pr)	£8.01
Mind Machine Mk III – Programmer **APRIL'96**	983	£7.36
Bat Band Converter/B.F.O.	984a/b	£5.80
Hearing Tester	985	£6.87
Event Counter (Teach-In '96)	986	£8.39
B.F.O. and Bat Band Converter **MAY'96**	984a/b	£5.80
Versatile PIR Detector Alarm	988	£6.76
Mind machine Mk III – Tape Controller	989	£6.70
Midi Analyser	992	£6.74
Countdown Timer (Teach-In '96)	993	£9.44
Sarah's Light **JUNE'96**	996	£7.17
Home Telephone Link	997 (pr)	£10.72
PulStar	998	£6.60
VU Display and Alarm	999	£7.02
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

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code Project Quantity Price

....

Name...

Address...

....

....

I enclose payment of £..............................(cheque/PO in **£ sterling only**) to:

VISA Access

Everyday Practical Electronics

Access (MasterCard) or Visa No.
Minimum order for credit cards £5

Signature...Card Exp. Date.........................

Please supply name and address of cardholder if different from the address shown

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY

AT LAST! We have more and more readers gaining access to the Internet and we also receive numerous enquiries, especially from the USA, asking about us, who we are, what kind of material we carry and how much we cost. A World Wide Web site is often the best way to answer these and other queries and so we're pleased to announce the opening of our own WWW pages, which will be found on **http://www.epemag.wimborne.co.uk.** This will just have opened up by the time you read this.

We plan to "grow" the site to meet the needs of our readers. The site will be constantly updated with new material as it takes shape, including back issue information, subscription and ordering details, plus pointers to other sites which we hope will help readers everywhere.

We are also uploading PIC source files to our new file area **ftp://ftp.epemag.wimborne.co.uk** where you will also find the very latest version of my own UK Sources FAQ, a file of well over 200 names, addresses, URL's, phone numbers etc. of UK based electronics related products and services.

In association with the Dept. of Electronic Engineering, the University of Hull, England, we plan to link with the University to bring you the latest developments in research and education over at Hull, which will be of interest to students and hobbyists worldwide.

Every year students at Hull undertake a "design and build" project. This year the students will be working in "companies" to design and build a computer-controlled "Mouse Organ". All resources for the project will be web based, and we'll post a running commentary on how the "companies" are going. Last year's project, to design a digital telephone, resulted in a formation of a company called "Lemon" (after the "Orange" mobile 'phone network) with the catch phrase "The Future is Bleak, the Future is Lemon".

It's going to be great fun! Please join us and keep checking our progress regularly. We'll keep you posted with developments, in *Net Work* and immediately on our web site itself. And of course, if you have any comments, let us know. E-mail to **alan@epemag.demon.co.uk** or write to us at the Editorial address.

Turnpike Trauma

When choosing an Internet Service Provider (ISP), it's well worth investigating the type of mail on offer, and confirming what particular software package an ISP might recommend for you to handle their mail service. Some service providers (e.g. BT Internet, CompuServe, Pipex and AOL) provide you with their own access software as part of the package, so there's no problem for most users. With others, e.g. Demon, you're on your own to choose whichever package you prefer.

E-mail comes in two flavours, and you'll hear both names mentioned from time to time. SMTP (Simple Mail Transfer Protocol) is favoured by some ISP's including Demon Internet Services. The good part is that SMTP mail is formatted as **<username>@domain.name**. With my own domain name of **epemag.demon.co.uk**, I can set up as many usernames as I wish, at no extra cost, and my SMTP software will sort it all out on my PC when received. Mail delivery is controlled by your ISP you (hopefully) get the lot when you dial in – but it is sorted by your software.

POP3 (Post Office Protocol) mail just sits on the ISP's server, and you dial in to download it onto your own machine. POP3 mail generally stays on the server until you decide to delete it.

The free software *Pegasus* is excellent at choosing and handling incoming POP3 mail: but it doesn't handle incoming SMTP mail. Many folks prefer to use SMTP (or, are given it anyway) but POP3 is useful in applications where one user needs one mailbox only, or where users need to dial in from other locations.

Mail-lite

Turnpike software is supposedly capable of handling "multiple" mailboxes (usernames). Or so they said on their Web pages, in their manuals and in their software Help files. What they fail to tell you is that it doesn't handle *multiple* POP3 mailboxes but only one single one.

When it came to the crunch, Turnpike let us down badly when we configured an E-mail system for our new domain. We expected Turnpike to handle all of our POP3 mailboxes just as it does SMTP mail. When we actually pressed the "Add" button to add the next POP3 username onto the system, up popped a message saying "Multiple mailbox collection – sorry not yet". No greyed out or disabled button, nothing.

We were peeved to find buried deep in the small print of one Turnpike Help screen, a note saying "Add not available in this version." Turnpike offered our money back "if we thought we had been misled".

Turnpike is an odd package, seemingly aimed at network users, but with various bits disabled as they adapt it for single user, single machine use. They wouldn't say when (or even if) it will handle multiple POP3 mail, and they respectfully suggested that I should have read the disclaimer label on the box, which says that "it does what it does".

Perhaps Turnpike should have changed its Web site and Help files accordingly to say what it doesn't do, as well. None the less, I still recommend it for use with SMTP mail including Demon's, or single user POP3 mail. It includes Netscape V1.22 as well. More interestingly, Turnpike (a.k.a. Locomotive Software – remember the Amstrad PCW?) was purchased by Demon Internet Services last December, and Locomotive was hived off.

On another note, there is a lot to be said for picking a smaller, local ISP and we're glad to say we're very happy with Total Connectivity Providers Ltd. in Southampton (tel. 01703 393392) who have national local dial-in and provide our E-mail and newly launched world wide web and ftp sites. POP3 is their mail standard, by the way. See **http://www.tcp.co.uk**.

Browsing

Time to fire up your WWW browser – check these URL's! As always, addresses were checked at the time of going to press but may sometimes move. Engineers dealing with EMC and other thorny regulations might try the web page of *Approval* Magazine which resides at **http://www.compulink.co.uk/~Approval.** It gives one or two pointers. Also the Institute of Electrical Engineers have their own web page at **http://www.iee.org.uk**.

A very impressive World Wide Web site handling almost anything to do with integrated circuits, is the famous *Chip Directory*, which you should definitely bookmark as a resource. It's at **http://xs4all.nl/~ganswijk/chipdir/chip dir.html.** An increasing number of semiconductor data sheets are available on-line (needing Adobe Acrobat reader) from *Premier Farnell* in Leeds, now the world's largest catalogue-based component distributor, who will be found on **http://www.farnell.co.uk**.

Batteries are next, and **http://www.duracell.com** is where you'll find technical data on those famous copper-coloured tops, button cells, photography batteries and more. It's a slow, graphics laden site but well worth the stopover. I found the (American) Energiser site less worthwhile; **http://www.eveready.com** describes their latest battery tester product but is again graphics-heavy.

Still on batteries, to go hand-in-hand with this month's *Circuit Surgery*, get the NiCad FAQ from Steve Walz's FTP site at **ftp://ftp.armory.com/pub/user/rstevew/nicadfaq.zip** (13k). You'll see other interesting files there too.

Finally, welcome aboard to *Henry's Radio* in London, very old established component suppliers whose modest web site is on **http://www.henrys.co.uk**. See you next month for more *Net Work*.

DC TO DC CONVERTERS
DRM58 input 10-40vdc output 5v 8A £15
DRM128 input 17-40vdc output 12v 8A £50
DRM158 input 20-40vdc output 15v 8A £50
DRM248 input 29-40vdc output 24v 8A £40
DRS123 input 17-40vdc output 12v 3A £20
DRS153 input 20-40vdc output 15v 3A £20
DRS243 input 29-40vdc output 24v 3A £15

SOLID STATE RELAYS
CMP-DC-200P 3-32vdc operation, 0-200vdc 1A £2.50
SMT20000/3 3-24vdc operation, 28-280vac 3A £4.50
SMT20000/4 3-24vdc operation, 28-280vac 4A £5.00
ZRA6025F 28-280vd/ac operation, 28-280vac 25A £7.00

200 WATT INVERTERS Nicely cased units 12v input 240v output 150watt continuous, 200 max. £49 ref LOT62.

6.8MW HELIUM NEON LASERS New units, £65 ref LOT33

COINSLOT TOKENS You may have a use for these? mixed bag of 100 tokens £10 ref LOT20.

PORTABLE X RAY MACHINE PLANS Easy to construct plans on a simple and cheap way to build a home X-ray machine! Effective device, X-ray sealed assemblies, can be used for experimental purposes. Not a toy or for minors! £6/set. Ref F/XP1.

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

COPPER VAPOUR LASER PLANS Produces 100mw of visible green light. High coherency and spectral quality similar to Argon laser but easier and less costly to build yet far more efficient. This particular design was developed at the Atomic Energy Commision of NEGEV in Israel. £10/set Ref F/CVL1.

VOICE SCRAMBLER PLANS Minature 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.

BODYHEAT TELESCOPE PLANS Highly directional long range device uses recent technology to detect the presence of living bodies, warm and hot spots, heat leaks etc. Intended for security, law enforcement, research and development, etc. Excellent security device or very interesting science project. £8/set Ref F/BHT1.

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

MYSTERY ANTI GRAVITY DEVICE PLANS Uses simple concept. Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or science project. £6/ set Ref F/ANT1K.

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

ULTRAHIGH GAIN AMP/STETHOSCOPIC MIKE/SOUND AND VIBRATION DETECTOR PLANS Ultrasensitive device enables one to hear a whole new world of sounds. Listen through walls, windows, floors etc. Many applications shown, from law enforcement, nature listening, medical heartbeat, to mechanical devices. £6/set Ref F/HGA7.

ANTI DOG FORCE FIELD PLANS Highly effective circuit produces time variable pulses of 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

LASER LIGHT SHOW PLANS Do it yourself plans show three methods, £6 Ref F/LLS1

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

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

BUG DETECTOR PLANS Is that someone getting the goods on you? Easy to construct device locates any hidden source of radio energy! Sniffs out and finds bugs and other sources of bothersome interference. Detects low, high and UHF frequencies. £5/set Ref F/ BD1.

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

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

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

PARABOLIC DISH MICROPHONE PLANS Listen to distant sounds and voices, open windows, sound sources in 'hard to get' or hostile premises. Uses satellite technology to gather distant sounds and focus them to our ultra sensitive electronics. Plans also show an optional wireless link system. £8/set ref F/PM5

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

INFINITY TRANSMITTERS The ultimate 'bug' fits to any phone or line, undetectable, listen to the conversations in the room from anywhere in the world! 24 hours a day 7 days a week! just call the number and press a button on the mini controller (supplied) and you can hear everything! Monitor conversations for as long as you choose £249 each, complete with leads and mini controller! Ref LOT9. Undetectable with normal RF detectors, fitted in seconds, no batteries required, lasts forever!

SWITCHED MODE PSU'S 244 watt, +5 32A, +12 6A, -5 0.2A, -12 0.2A. There is also an optional 3.3v 25A rail available. 120/240v I/ P. Cased, 175x90x145mm. IEC inlet Suitable for PC use (6 d/drive connectors 1 m/board). £10 ref PSU1.

VIDEO PROCESSOR UNITS?/6v 10AH BATTS/12V 8A TX Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear. Inside 2x6v 10AH sealed lead acid batts, pcb's and a 8A? 12v torroidial transformer (mains in). Condition not known, may have one or two broken knobs due to poor storage. £17.50 ref VP2

RETRON NIGHT SIGHT Recognition of a standing man at 300m in 1/4 moonlight, hermatically sealed, runs on 2 AA batteries, 80mm F1.5 lens, 20mw infrared laser included. £325 ref RETRON.

MINI FM TRANSMITTER KIT Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

3-30V POWER SUPPLY KIT Variable, stabilized power supply for lab use. Short circuit protected, suitable for profesional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

1 WATT FM TRANSMITTER KIT Supplied with piezo electric mic. 8-30vdc. At 25-30v you will get nearly 2 watts! £12 ref 1009.

FM/AM SCANNER KIT Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £15 ref 1013.

3 CHANNEL SOUND TO LIGHT KIT Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £14 Ref 1014.

4 WATT FM TRANSMITTER KIT Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £20 Ref 1028.

STROBE LIGHT KIT Adjustable from 1-60 hz (a lot faster than conventional strobes). Mains operated. £16 Ref 1037.

COMBINATION LOCK KIT 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £10 ref 1114.

PHONE BUG DETECTOR KIT This device will warn you if somebody is eavesdropping on your line. £6 ref 1130.

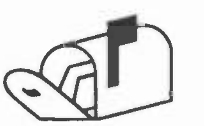
ROBOT VOICE KIT Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

TELEPHONE BUG KIT Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £8 Ref 1135.

3 CHANNEL LIGHT CHASER KIT 800 watts per channel, speed and direction controls supplied with 12 LEDS (you can fit triacs instead to make kit mains, not supplied) 9-12vdc £17 ref 1026.

12V FLOURESCENT LAMP DRIVER KIT Light up 4 foot tubes from your car battery! 9v 2a transformer also required. £8 ref 1069.

VOX SWITCH KIT Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £8 ref 1073.



Check out our WEB SITE

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

PREAMP MIXER KIT 3 input mono mixer, sep bass and treble controls plus individual level controls, 18vdc, input sens 100mA. £15 ref 1052.

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL
250 PORTLAND ROAD, HOVE, SUSSEX. BN3 5QT. (ESTABLISHED 50 YEARS).
MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3 P&P PLUS VAT.
PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS WELCOME (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)
TEL: 01273 203500
FAX 01273 323077
E-mail bull@pavilion.co.uk

SOUND EFFECTS GENERATOR KIT Produces sounds ranging from bird chirps to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045.

15 WATT FM TRANSMITTER (BUILT) 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

HUMIDITY METER KIT Builds into a precision LCD humidity meter, 9 ic design, pcb, lcd display and all components included. £29

PC TIMER KIT Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4.1,640k, serial port, hard drive with min 100k free. £24.99

FM CORDLESS MICROPHONE This unit is an FM broadcasting station in minature, 3 transistor transmitter with electret condenser mic+fet amp design result in maximum sensitivity and broad frequency response. 90-105mhz, 50-1500hz, 500 foot range in open country! PP3 battery required. £15.00 ref 15P42A

MAGNETIC MARBLES They have been around for a number of years but still give rise to curiosity and amazement. A pack of 12 is just £3.99 ref GI/R20

NICKEL PLATING KIT Proffesional electroplating kit that will transform rusting parts into showpieces in 3 hours! Will plate onto steel, iron, bronze, gunmetal, copper, welded, silver soldered or brazed joints. Kit includes enough to plate 1,000 sq inches. You will also need a 12v supply, a container and 2 12v light bulbs. £39.99 ref NIK39

Minature adjustable timers, 4 pole c/o output 3A 240v,
HY1230S, 12vDC adjustable from 0-30 secs. £4.99
HY1260M, 12vDC adjustable from 0-60 mins. £4.99
HY2405S, 240v adjustable from 0-5 secs. £4.99
HY24060m, 240v adjustable from 0-60 mins. £6.99

BUGGING TAPE RECORDER Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

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

9v DC POWER SUPPLY Standard plug in type 150ma 9v DC with lead and DC power plug. price for two is £2.99 ref AUG3P4

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

FUTURE PC POWER SUPPLIES These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

VENUS FLYTRAP KIT Grow your own carnivorous plant with this simple kit £3 ref EF34.

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

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

ROCK LIGHTS Unusual things these, two pieces of rock that glow when rubbed together! belived to cause rain! £3 a pair Ref EF29.

3' by 1' AMORPHOUS SOLAR PANELS 14.5v, 700mA 10 watts, aluminium frame, screw terminals. £44.95 ref MAG45.

ELECTRONIC ACCUPUNCTURE KIT Builds into an electronic version instead of needles! good to experiment with. £7 ref 7P30

SHOCKING COIL KIT Build this little battery operated device into all sorts of things, also gets worms out of the ground! £7 ref 7P36.

FLYING PARROTS Easily assembled kit that builds a parrot that actually flaps its wings and flies! 50 m range £6 ref EF2.

HIGH POWER CATAPULTS Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles per hour! Range of over 200 metres! £7.99 ref R/9.

BALLON MANUFACTURING KIT British made, small bloo blows into a large, longlasting balloon, hours of fun! £3.99 ref GI/E99R

9-0-9V 4A TRANSFORMERS, chassis mount. £7 ref LOT19A

2.5 KILOWATT INVERTERS, Packed with batteries etc but as they weigh about 100kg CALLERS ONLY! £120.

MEGA LED DISPLAYS Build your self a clock or something with these mega 7 seg displays 55mm high, 38mm wide. 5 on a pcb for just £4.99 ref LOT16 or a bumper pack of 50 displays for just £29 ref LOT17.

CLEARANCE SECTION, MINIMUM ORDER £15, NO TECHNICAL DETAILS AVAILABLE, NO RETURNS, TRADE WELCOME.
2000 RESISTORS ON A REEL (SAME VALUE) 99P REF BAR340
AT LEAST 200 CAPACITORS (SAME VALUE 99P REF BAR342
INFRA RED REMOTE CONTROLS JUST 99P REF BAR333
CIRCUIT BREAKERS, OUR CHOICE TO CLEAR 99P REF BAR335
MICROWAVE CONTROL PANELS TO CLEAR £2 REF BAR 329
2 TUBES OF CHIPS(2 TYPES OUR CHOICE) 90P REF BAR305
LOTTERY PREDICTOR MACHINE!! JUST £1.50 REF BAR313
HELLA/ROVER ELECTRIC H/LAMP LEVELLER £2 REF BAR311
SINCLAIR C5 16" TYRES TO CLEAR AT JUST 75P REF BAR318
LARGE MAINS MOTORS (NEW) TO CLEAR AT 75P REF BAR310
MODEMS ETC FOR STRIPPING £2.50 EACH REF BAR324
110V LARGE MOTORS (NEW) TO CLEAR AT 50P REF BAR332
MODULATOR UNITS UNKNOWN SPEC JUST 50P REF BAR323
GX4000 GAMES COSOLES JUST £4 REF BAR320
SMART CASED MEMORY STORAGE DEVICE, LOADS OF BITS INSIDE, PCB, MOTOR, CASE ETC. BUMPER PACK OF 5 COMPLETE UNITS TO CLEAR AT £2.50(FOR 5) REF BAR 330.
2 CORE MAINS CABLE 2M LENGTHS PACK OF 4 £1 REF BAR337
PC USER/BASIC MANUALS, LOADS OF INFO. £1 REF BAR304
PCB STRIPPERS TO CLEAR AT 2 FOR 99P REF BAR341
3 M 3CORE MAINS CABLE AND 13A PLUG. 60P REF BAR325

WE BUY SURPLUS STOCK FOR CASH
BUYERS DIRECT LINE 0802 660377

FREE CATALOGUE
100 PAGE CATALOGUE NOW AVAILABLE, 45P STAMPS.

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 eleven years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Holland Wood House, Church Lane, Great Holland, Essex CO13 0JS. Phone/Fax (01255) 850596.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

Miscellaneous

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR, or phone Brighton 883871.

G.C.S.E. ELECTRONICS KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 70 Oxford Road, Clacton, CO15 3TE.

VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel: 01788 574774.

PRINTED CIRCUIT BOARDS – QUICK SERVICE. Prototype and Production. Artwork raised from magazines or draft designs at low cost. PCBs also designed from schematics. Production assembly also undertaken. For details send to P. Agar, 36 Woodcot Avenue, Belfast, BT5 5JA or phone 01232 473533 (7 days).

PCB SCHEMATIC AND ARTWORK LAYOUT, customised product design, surface-mount component sourcing and much more. Contact ULTRA-TECH, Tel/Fax: 0181 472 8213, Mobile: 0850 973555.

SELLING DUE TO ILL HEALTH. Approx. 1,000 service manuals, TV, Videos, Hi-Fi etc., £150. Also selling test equipment, Hameg scope, Fluke bench meter, frequency counter etc. Ring for details, London (0181) 441 8098.

30 ASSORTED CAPACITORS + catalogue, 75p. K.I.A., 1 Regent Road, Ilkley. Power supplies, variable 12V-40V D.C., regulated + electronic protection, £5. Stereos 30W + 30W, £9.95.

PCBs FROM PHOTOCOPIES, printouts, sketches. Low cost. One offs. SAE to: Williams, 29 Albert Rd., Mexborough, S. Yorks. S64 9BZ.

SOLARTRON OSCILLOSCOPE, type CD1014-2, with manual and two spare valves, £55. Tel: 0181 9794348.

SAVE OVER £5 – SUBSCRIBE NOW!

EVERYDAY PRACTICAL ELECTRONICS

SUBSCRIPTION ORDER FORM

Annual subscription rates (1996/7):
UK £24.00.
Overseas £30.00 standard air service, £47.50 express airmail.

To:
Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF
Tel: 01202 881749
Fax: 01202 841692

Name ....

Address ....

....

....

....

I enclose payment of £..

(cheque/PO in £ sterling only, payable to Everyday Practical Electronics).
Alternatively send Access or Visa number and card expiry date.

Signature ....

Please supply name and address of cardholder if different from the subscription address shown above. **Subscriptions can only start with the next available issue.** For back numbers see the Back Issues page.

M9/96

ADVERTISERS INDEX

ADVERTISEMENT MANAGER: PETER J. MEW
ADVERTISEMENT OFFICES:
EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE, GREAT HOLLAND, ESSEX CO13 0JS.
Phone/Fax: (01255) 850596

For Editorial address and phone numbers see page 669.

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, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Subscriptions INLAND £24 and OVERSEAS £30 (£47.50 airmail) payable to "Everyday Practical Electronics", Subs Dept, Allen House, East Borough, Wimborne, Dorset BH21 1PF. 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.