EVERYDAY PRACTICAL ELECTRONICS

AUGUST 1996

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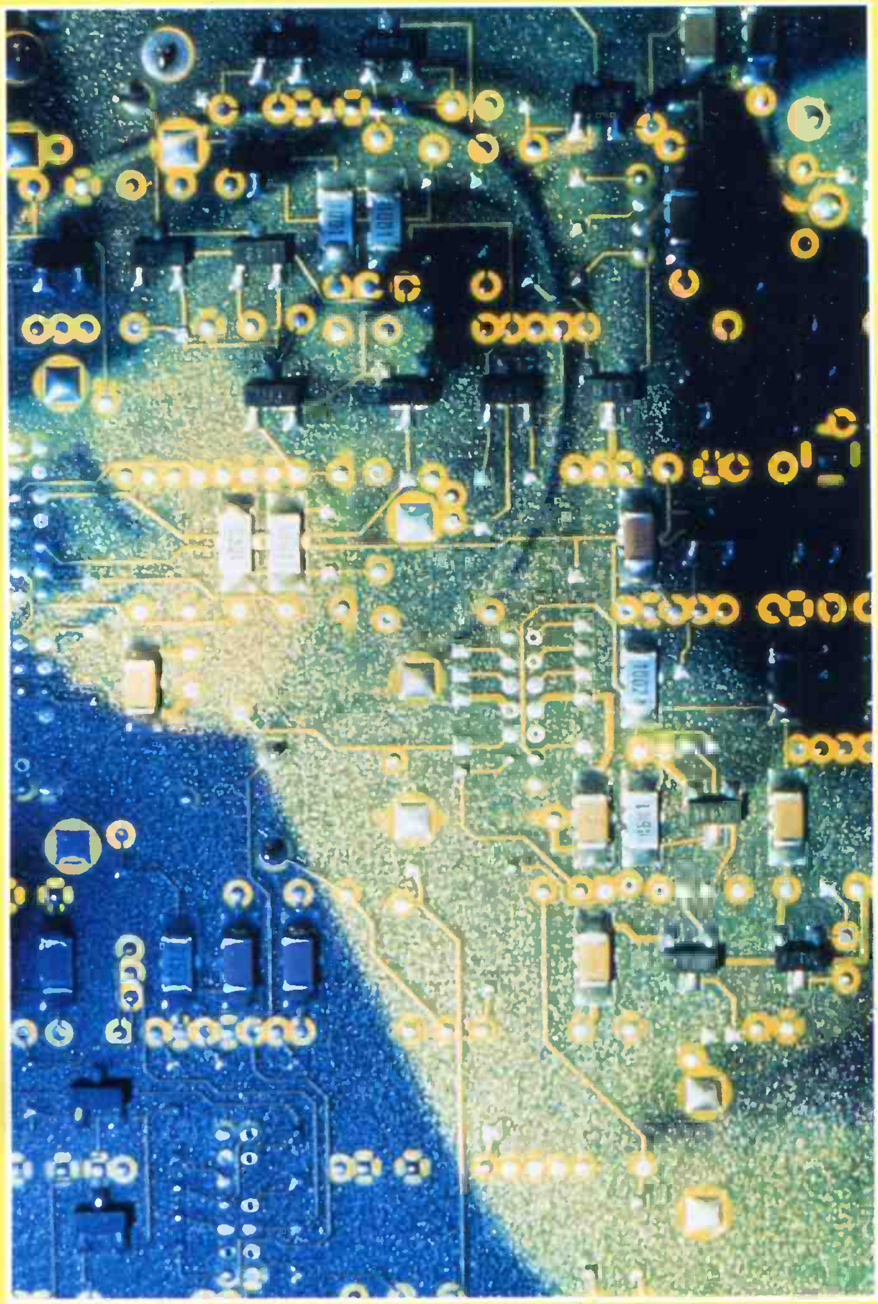
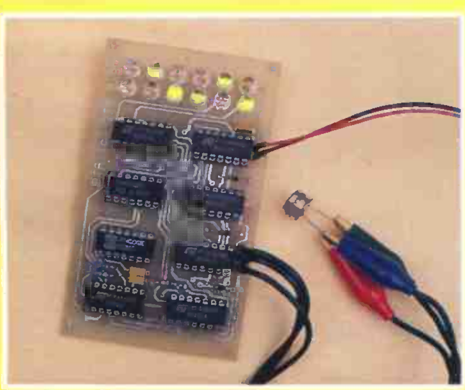
Bargraph Readout for any bicycle

MOLE-ESTER
Humane mole deterrent

THE NET
Surfing for electronics enthusiasts

COMPONENT ANALYSER
Identifies leads, pnp or npn, & tests transistors, diodes, l.e.d.s, fuses, speakers, etc.





THE No. 1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

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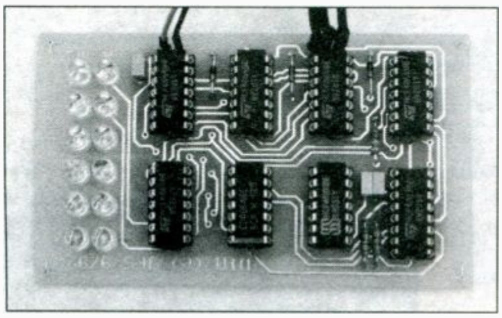
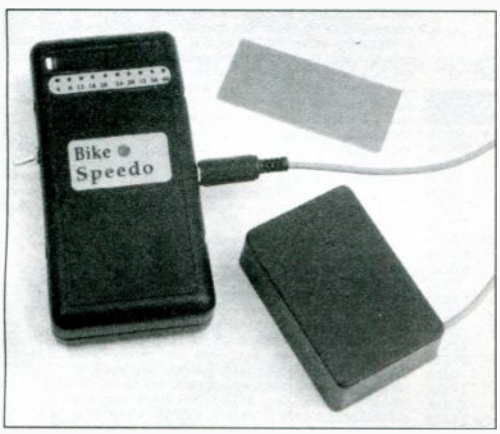
ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

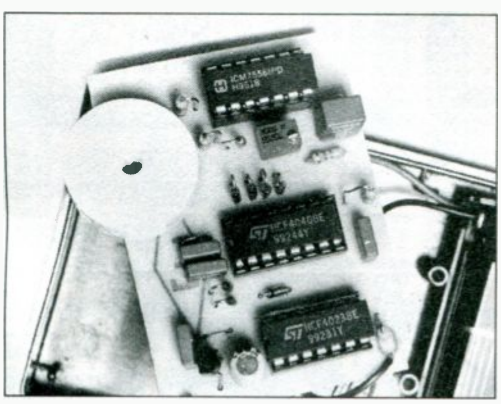
VOL. 25 No. 8 AUGUST 1996

EVERYDAY PRACTICAL ELECTRONICS

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







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Our September '96 Issue will be published on Friday, 2 August 1996. See page 579 for details.

Projects

Series

Features

THE *ORIGINAL* SURPLUS WONDERLAND!

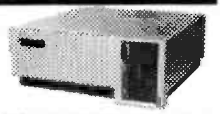
Surplus always wanted for cash!

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 mother-board, 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 avaiable - 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)

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3½" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£59.95(C)
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3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£69.00(C)
3½" **WESTERN DIGITAL** 850mb IDE I/F *Brand New*	£185.00(C)
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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** 9754B 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 EXCEL-LENT 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 13½" D. 240 V AC mains powered. **Only £79.00** (D)

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

20" 22" and 26" AV SPECIALS

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

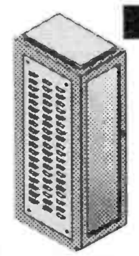
20"....£135 22"....£155 26"....£185 (F)

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 M3041O 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

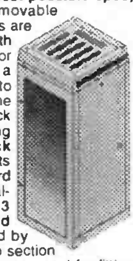


Superb quality 6 foot 40U
Virtually New, Ultra Smart
Less than Half Price!

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!

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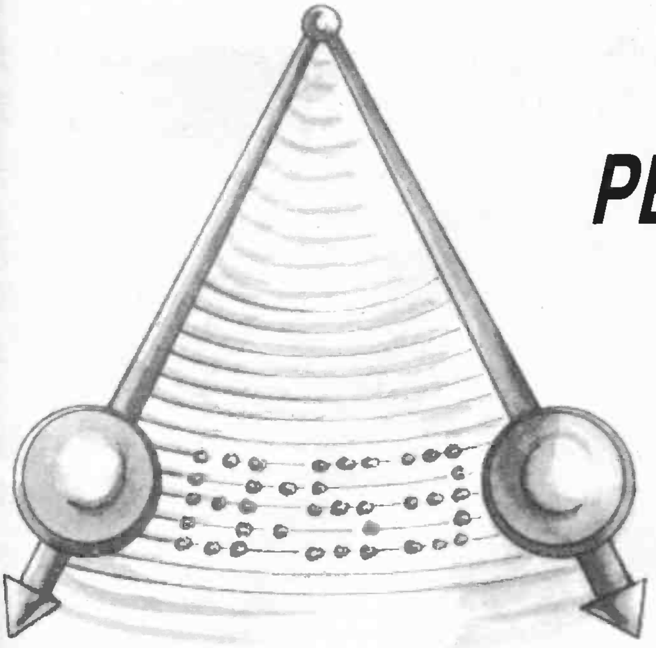
NEXT MONTH

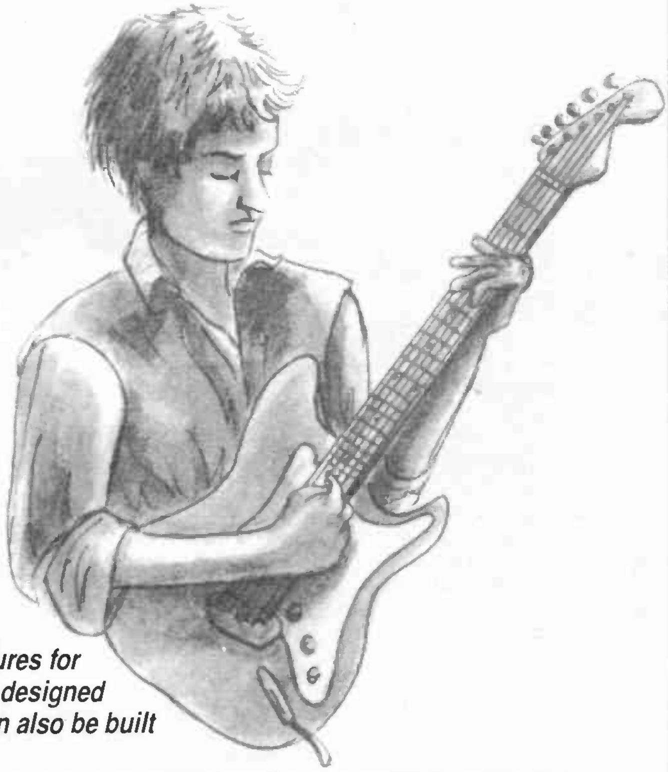


PIC-TOCK PENDULUM CLOCK

A swinging way to tell the time – writes the digits "in the air". There's 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?

MAX038 WAVEFORM GENERATOR

We take an in depth look at the new Maxim MAX038 High Frequency Waveform Generator chip which is easy to use and offers sine, square and triangular output waveforms. Maxim claim over 20MHz and it is indeed capable of this with little degradation of any of the output waveforms. At 10MHz the outputs are excellent, even the squarewave! 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. We will also describe a Function Generator project using this chip in the October issue.



ANALOGUE DELAY/FLANGER

A simple circuit that will provide guitar effects for a minimum outlay.

POWER CHECK

A three-colour "power consumption" indicator for caravans and boats. Provides instant visual indication of the power being consumed from 12V "leisure" batteries, plus an audible warning if excessive current is being drawn.

SIMPLE EXPOSURE TIMER

Make light work of timing the precision exposures for p.c.b. making or darkroom printing. Originally designed for use with ultraviolet light boxes this unit can also be built for use with photographic enlargers,

EVERYDAY PRACTICAL ELECTRONICS

SEPTEMBER ISSUE ON SALE FRIDAY, AUGUST 2

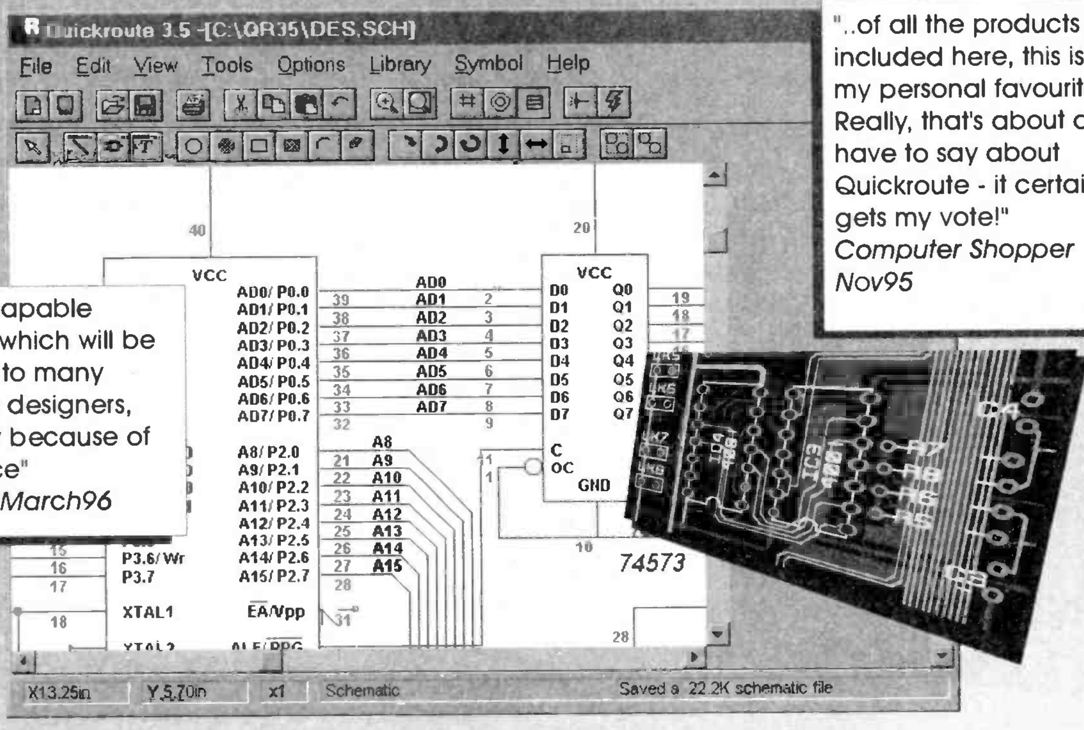
QUICKROUTE

3 Good Reasons..

CAD CAM RECOMMENDED

"..of all the products included here, this is my personal favourite... Really, that's about all I have to say about Quickroute - it certainly gets my vote!"
Computer Shopper Nov95

"..a very capable package which will be of interest to many electronic designers, especially because of its low price"
CADCAM March96



..to choose Quickroute 3.5 Designer

(apart from the price £149*)

1 Schematic Capture

Creating schematics is easy in Quickroute 3.5 Designer for Windows. Simply select the symbols you require from the libraries and connect the pins using nets. Junctions are automatically placed for you, and correct connections are indicated visually to ensure accurate schematics. Once you are finished just click on the schematic capture button to turn your schematic into a PCB rats-nest.

2 Assisted PCB Routing **NEW**

Quickroute 3.5 Designer is capable of manual PCB routing or assisted routing using Quickroute's built in RouteASSIST™ technology. To use this simply click on a start and finish node, and RouteASSIST™ does the rest. Alternatively, you can route manually with rats automatically removed using the 'rat-check' feature.

3 Design Checks

Quickroute 3.5 Designer also includes both design rule checking (DRC) and a simply connectivity check. The connectivity check compares your PCB with the original schematic and gives a pass/fail if there are any differences.

Quickroute 3.5 Designer costs just £149.00. Post & packing is £5 (UK), £8 (Europe) and £12 (Worldwide). *V.A.T must be added to the total price. Quickroute 3.5 is also available in two more powerful versions : PRO (£249) and PRO+ (£399). Contact Quickroute Systems Ltd for full details and a brochure or visit our WWW site and download a free demo.

QUICKROUTE SYSTEMS

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

Prices and specifications subject to change without notice. All trade marks are acknowledged & respected.

£1 BARGAIN PACKS – List 4

One item per pack unless otherwise stated.

IN HANDLE MAINS ON/OFF SWITCHES. Sometimes known as pistol grip switches, pack of 2, Order Ref: 839.
DOUBLE-POLE CHANGEOVER TOGGLE SWITCHES, ideal reversing DC motors. etc. pack of 2, Order Ref: 841.
3M 2-CORE CURLY LEAD, 5A, Order Ref: 846.
1M 3-CORE CURLY LEAD, 13A, Order Ref: 847.
AC SHADED POLE MAINS MOTOR with base fixing plate, Order Ref: 848.
4" PLASTIC DIAL, fits flatted ¼" spindle; transparent so dial can be underneath, pack of 2, Order Ref: 851.
2500μF 12V CAPACITORS, pack of 5, Order Ref: 853.
DELAY SWITCH on B7G base, Order Ref: 854.
3 CHANGEOVER RELAYS, 6V AC or 3V DC, 3 changeover contacts, Order Ref: 859.
3 CONTACT MICROSWITCHES, operated with slightest touch. pack of 2, Order Ref: 861.
NORMALLY ON, V3 MICROSWITCH, pack of 4, Order Ref: 862.
HIVAC NUMICATOR TUBE, Hivac ref. XN3, Order Ref: 865.
DITTO but reference XN11, Order Ref: 866.
SUB MIN NORMALLY OFF MICROSWITCH, pack of 4, Order Ref: 867.
SUB MIN CHANGEOVER MICROSWITCH, pack of 3, Order Ref: 868.
EX-GPO TELEPHONE DIAL, rotary type. Order Ref: 904.
QUARTZ LINEAR HEATING TUBES, 360W but 110V so would have to be joined in series, pack of 2, Order Ref: 907.
2" ROUND LOUDSPEAKERS, 50ohm coil, pack of 2, Order Ref: 908.
EDGE TYPE PUSH SWITCHES, BCD system, pack of 2, Order Ref: 915.
10M 4-CORE FLEX, suitable for telephone extension, Order Ref: 918.
OLD TYPE KETTLE ELEMENT, 2-pin plug, Order Ref: 925.
6V 24W HEADLAMP BULB, normal BC plug in cap. Order Ref: 928.
40 LAMP UNIT to make a figure or letter display, Order Ref: 930.
10K HORIZONTAL PRESET RESISTORS, pack of 10, Order Ref: 931.
1M 64-WAY RIBBON CABLE, Order Ref: 932.
MAINS PSU, 15V 320mA AC, Order Ref: 934.
15V+15V 1·5A POTTED PCB MAINS TRANSFORMER, Order Ref: 937.
16 OHM 3" SPEAKERS, pack of 2, Order Ref: 962.
MAINS RELAY with 15A changeover contacts, Order Ref: 965.
IN-LINE FUSEHOLDERS take 20mm fuse, just cut the flex and insert, pack of 4, Order Ref: 969.
OBLONG PANEL MOUNTING NEONS, pack of 4, Order Ref: 970.
COPPER CLAD PANELS, size 7"x4", pack of 2, Order Ref: 973.
STANDARD SIZED AUDIO PLUG adapted to take two 3mm plugs, Order Ref: 974.
3·5mm JACK PLUGS, pack of 10, Order Ref:975.
DRILL CONTROL CASE, ready punched and with control logos, Order Ref: 979.
STANDARD SIZE OLD TYPE WANDER PLUGS, pack of 10, Order Ref: 986.
8μF 350V ELECTROLYTICS, pack of 2, Order Ref: 987.
SCREW-IN NEON BULBS, pack of 4, Order Ref: 990.
VERY SMALL SLIDE SWITCH, pack of 4, Order Ref: 992.
8700μF 7V WORKING ELECTROLYTIC, Order Ref: 996.
1 MEG PRESET POTS, pack of 4, Order Ref: 998.
WHITE PROJECT BOX, 78mm x 115mm x 35mm, Order Ref: 1006.
LENGTHS PAXOLIN TUBING, ⅜" diameter, pack of 2, Order Ref. 1056.
SLIDELOCK 15A FUSES, panel mounting, pack of 3, Order Ref: 1011.
6V SOLENOIDS, good length pull, pack of 2, Order Ref: 1012.
RELAY WITH 3 SETS OF CHANGEOVER 8A CONTACTS, 24V AC, or 12V DC, 3 sets 8A changeover contacts, Order Ref: 1016.
WHITE TOGGLE SWITCH, push-in spring retain type, pack of 4, Order Ref: 1019.
2M MAINS LEADS, 2-core, black outer, pack of 4, Order Ref: 1020.
2M MAINS LEADS, 3-core, black outer, pack of 4, Order Ref: 1021.
FERRITE SLAB AERIAL with coils, pack of 2, Order Ref: 1027.
12V DC POLARISED RELAY, 2 changeover contacts, Order Ref: 1032.
12" x 12" PAXOLIN PANEL, medium thickness, Order Ref: 1033.
TUNING CAPS, solid DIA, for LW and MW, pack of 2, Order Ref: 37.
TRIMMER CAPS, screw down type, 10 assorted. Order Ref: 38.
I.F. TRANSFORMERS, 465kHz, pack of 4, Order Ref: 40.
SOCKETS for stripboard, make your own IC holders, pack of 10. Order Ref: 54.
6½" 4 OHM SPEAKER, Order Ref:137.
50K STEREO POTS, pack of 4, Order Ref: 143.
FUSEHOLDERS, chassis mounting for 20mm fuses, pack of 5, Order Ref: 144.
SOCKET COVERS, child protectors for twin 13A sockets, pack of 4, Order Ref: 149.
DITTO but for single 13A sockets, pack of 4, Order Ref: 150.
POT CORES, circular, ferrite, 54mm x 18mm, pack of 2 pairs, Order Ref: 156.
AIR-SPACED TUNER, 20pf with ¼" spindle. Order Ref: 182.
METAL BOX, slightly sloping, 8" x 3" x 4", one only, Order Ref: 209.
TELEPHONE LEADS, 5-core curly reinforced telephone leads, pack of 2, Order Ref: 213.
STEREO PRE-AMP, Mullard 9001, one only, Order Ref: 216.
PUSH ON TAGS for ¼" spades. pack of 100, Order Ref: 217.
DITTO but right-angled, pack of 100, Order Ref: 218.

Smart Kit Electronics — 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

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POWER SUPPLY for this in kit form with case is **£15,** Order Ref: 15P16, or in larger case to house tube as well, **£18.00,** Order Ref: 18P2. The larger unit, made up, tested and ready to use, complete with laser tube, **£69,** Order Ref: 69P1.

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This is a multi-range voltmeter/ammeter using the A-D converter chip 7106 to provide five ranges each of volts and amps. Supplied with full data sheet. Special snip price of **£12,** Order Ref: 12P19.

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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..
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K2100SA Series Audiophile, with extra selected components..**£112.46**

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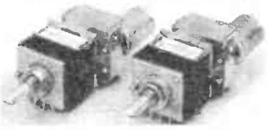
NEW BOOK
"Audio Electronics"

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.

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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**

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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
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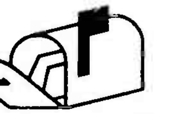

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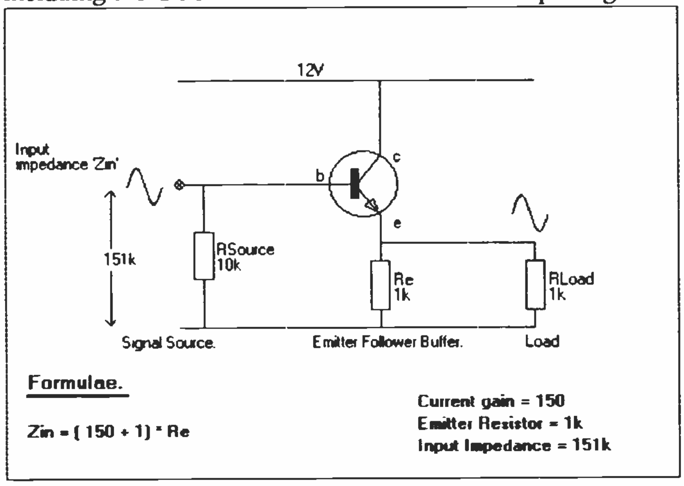

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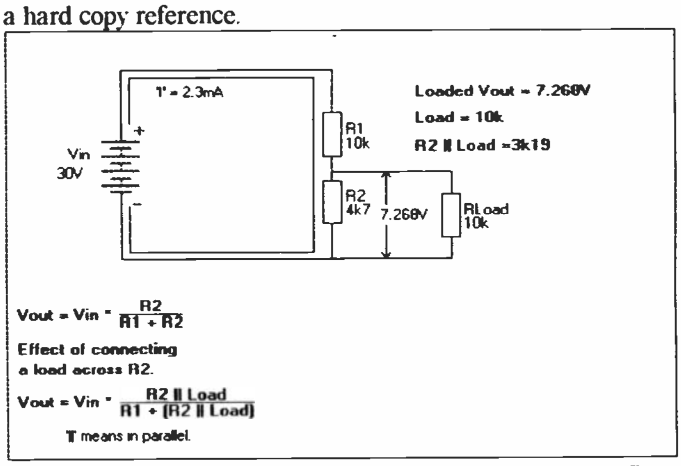

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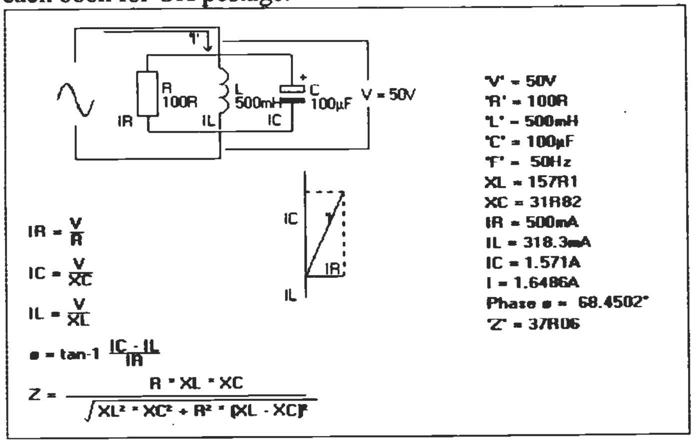

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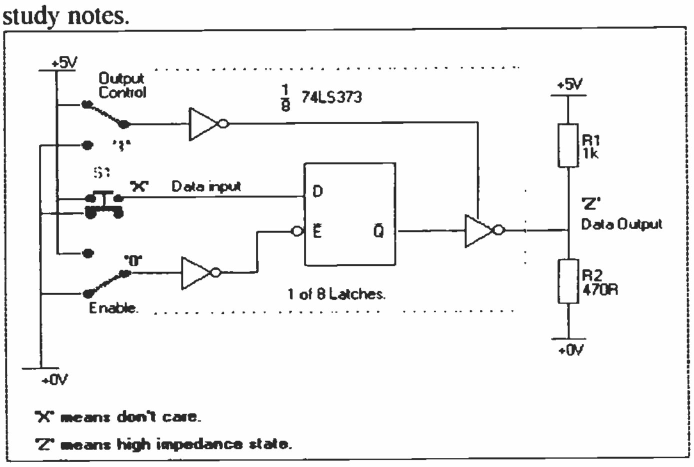

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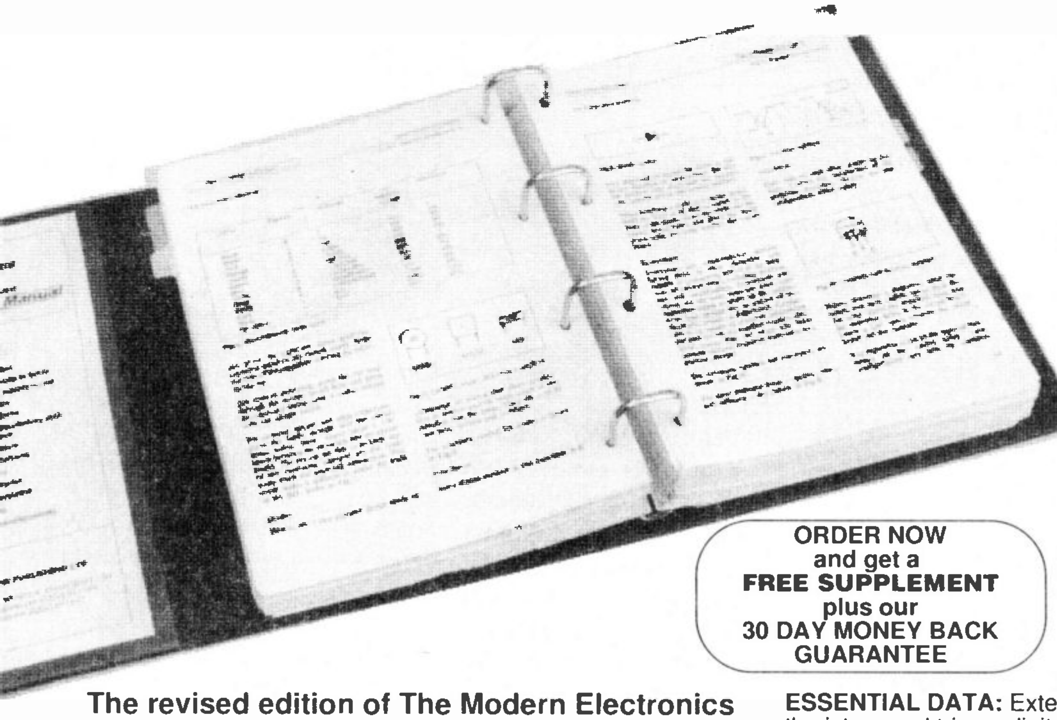

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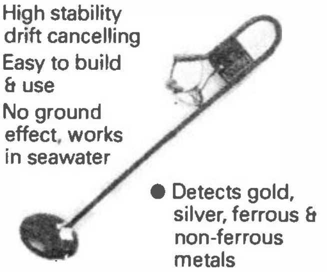

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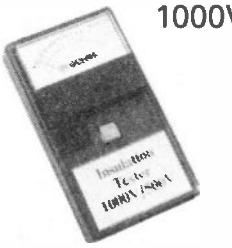

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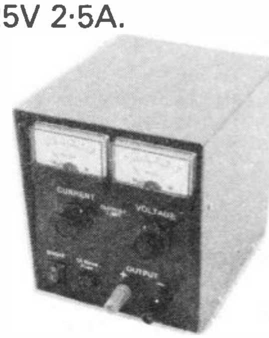

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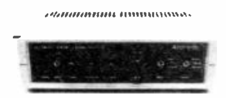

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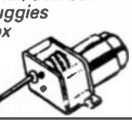

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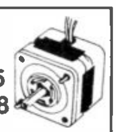

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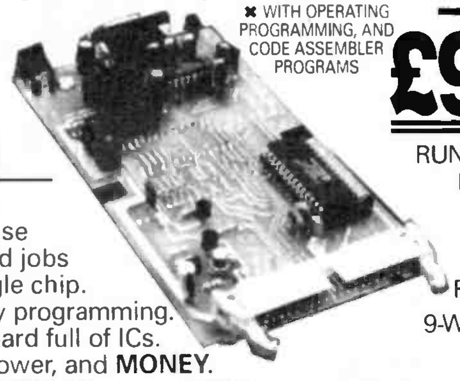

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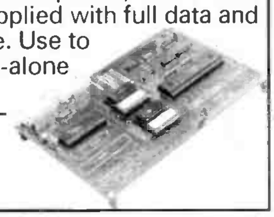

£55.00!
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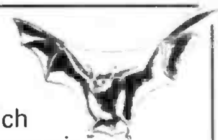
BAT DETECTOR



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

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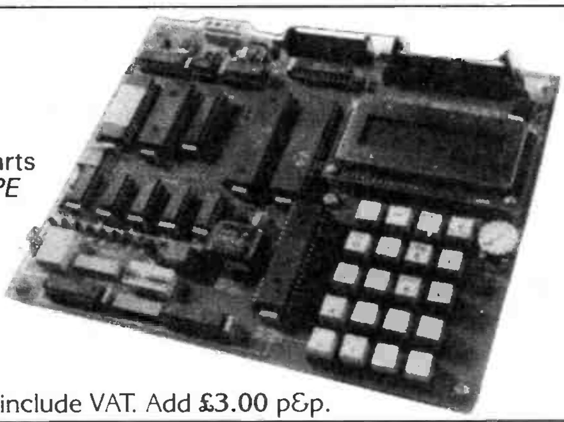
Mini-Lab & Micro Lab Electronics Teach-In 7



As featured in *EPE* and now published as Teach-In 7. All parts are supplied by Magenta. *Teach-In 7* is £3.95 from us or *EPE*
Full Mini Lab Kit – £119.95 – Power supply extra – £22.55
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2.2	—	—	—	£0.05	—
4.7	—	—	£0.05	£0.05	£0.05
10	£0.05	£0.05	£0.05	£0.05	£0.09
22	£0.05	£0.05	£0.05	£0.07	£0.11
33	£0.05	—	£0.05	—	—
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220	£0.08	£0.09	£0.13	£0.25	—
330	£0.09	—	£0.19	—	—
470	£0.12	£0.17	£0.24	£0.33	—
1000	£0.15	£0.33	£0.34	—	—
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4700	£0.67	£1.05	—	—	—

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10	—	—	£0.12	£0.12
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47	£0.10	£0.11	£0.16	£0.20
100	£0.10	£0.14	£0.21	—
220	£0.13	£0.18	£0.42	—
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INGENUITY

Last month we carried a news item on the results of the YEDA (Young Electronic Designer Awards) competition sponsored by Texas Instruments and Mercury Communications. I never cease to be impressed by the variety and ingenuity of the projects submitted. It seems that one teacher with some interest in electronics can inspire some dramatic developments from students.

Many of the teachers we come across are learning electronics along with their pupils – both learning from each other. We know of schools where the students are using PICs in a wide variety of projects, having become adept at writing the necessary software.

What a pity that we cannot get just one enthusiastic electronics teacher in every secondary school – we are sure that within a few years there would then be enough qualified electronics engineers to meet the demands of industry. If students get the chance to play around with circuit design it is apparent that a number of them soon get hooked on the subject.

This is in no way meant as a criticism of the teaching staff, indeed they have our support; many are teaching a subject in which they have had no training or background – a subject that is invariably far removed from anything they have experience of.

PROJECT DEVELOPMENT

I'm pleased to say that students at Radley College have been involved with the p.c.b. designs and development of the projects published as part of *Teach-In '96*. Indeed one of them won a top award at this year's YEDA. I also note that the designer of our *Component Analyser* project in this issue is a past winner of YEDA. Incidentally, *Everyday Electronics* was involved with starting what was then SEDAC (School Electronic Design Award Competition) back in January 1982.

It all goes to show that it's possible for anyone of any age to get involved in electronics and to learn to develop their own projects. We, of course, believe that in our own way *EPE* helps and encourages all our readers to delve deeper into this fascinating subject.

Mike Kenward

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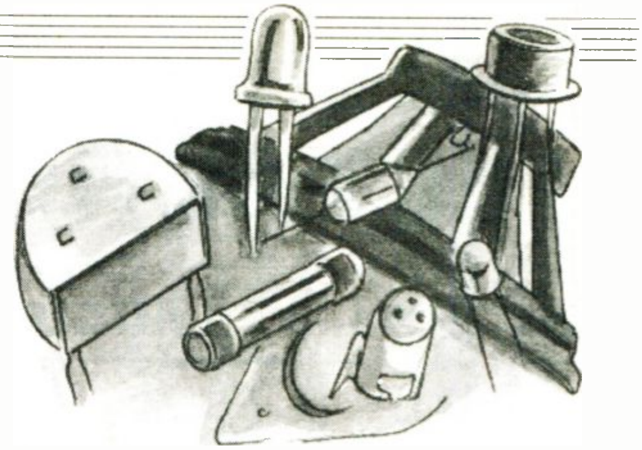


COMPONENT ANALYSER

JEREMY FRANCIS SIDDONS*

Check-out your collection of transistors, diodes and l.e.d.s.

THE PROJECT described here is certainly an unusual one. Although unusual, it will prove to be very useful to anyone who is interested in constructing and repairing electronic devices.

To put it simply, the Component Analyser will analyse and provide information about any bipolar transistor, diode and light emitting diode (l.e.d.). In addition to this it is also capable of producing test tones for speakers and also able to check for simple open or short circuits, fuses for example can be verified.

IDENTI-LEAD

The most surprising ability of this unit, is the fact that it will automatically identify *all* the leads of any transistor without you having to know which pins are which first. For example, you can connect a transistor to the Analyser any way round and the unit will tell you which lead is which, the transistor type *npn*/*pnp* and verify that the transistor is operational.

For diodes, it can instantly identify the anode (a) and cathode (k) of the device under test as well as light an l.e.d. under test regardless of polarity and regardless of which pair of test leads are used out of the three!

It is simplicity itself to use and with so few passive components in the design, it is also easy to build. The design is, in fact, based on a project submitted for the *Young Engineer For Britain Competition 1987*. The device at the time, The Digital Transistor Analyser was capable of only analysing transistors and it did so with a lot more components inside! So, it was decided to improve the design to provide a more versatile and more refined unit.

Specifications	
Supply Voltage Range:	7·5 to 9·5V
Supply Current:	10mA Typical
Test Lead Current into S/C:	4mA Peak Pulse
Test Lead Voltage into O/C:	±8V Typical Pulse

HOW IT WORKS

The core circuit of the Component Analyser is shown in Fig. 1, and the points *X*, *Y* and *Z* denote the connections to a solid-state switch matrix, made up from bilateral switch i.c.s type 4066BE, as shown in Fig. 2. Let's consider just the circuit in Fig. 1 for the time being and suppose that an *npn* transistor is connected to points *X*, *Y* and *Z*, with the base (b) on *X*, the collector (c) on *Y* and emitter (e) on *Z*.

The Schmitt inverter IC2a forms a square wave oscillator and feeds a 200Hz square wave current into *X*. With an *npn* transistor connected to *X*, *Y* and *Z* as mentioned above, then a similar square wave would appear on *Y* but 180 degrees out of phase with that on *X*. This simply means that the point *Y* is always the opposite state to that of the output of the square wave oscillator. By inverting the point *Y* with IC2b, then output pin 2 and pin 4 of IC2 would always have the *same* logic level when an *npn* transistor was connected to *X*,*Y* and *Z* in the configuration mentioned.

We can prove this by connecting two l.e.d.s in inverse parallel to these logic signals and neither l.e.d. would light despite the fact the logic levels are changing at

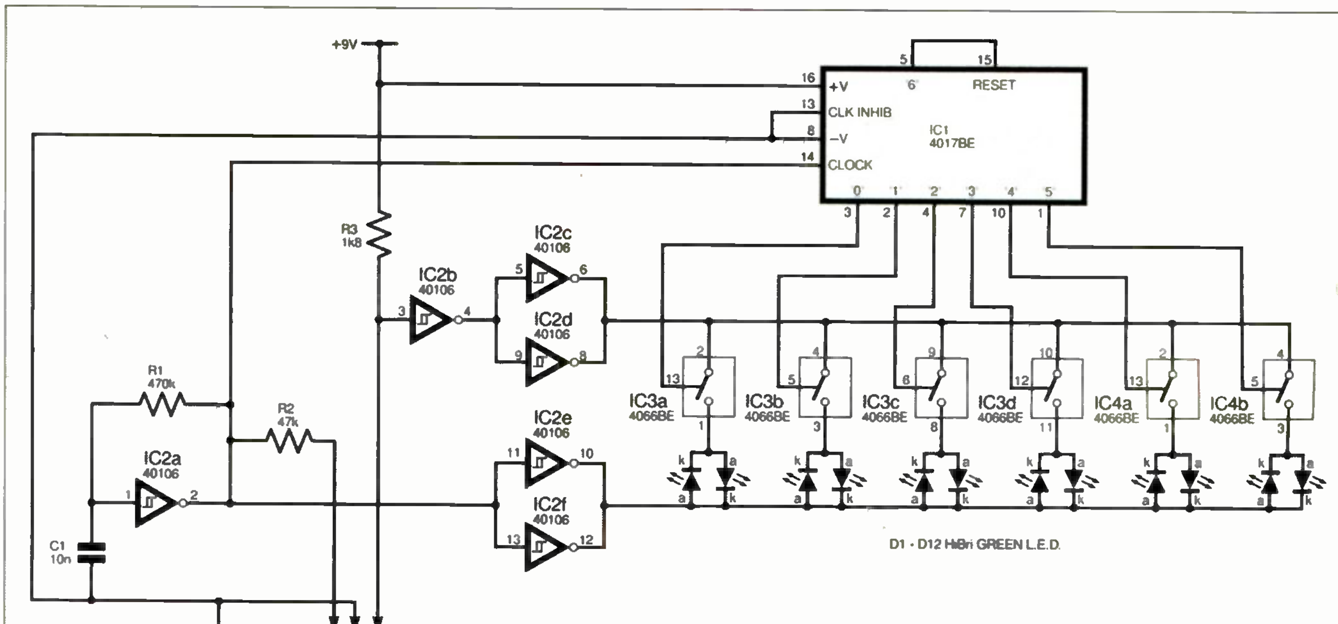


Fig. 1. Circuit diagram for the Analyser sequencer stage.

200Hz. It can be deduced that the pair of l.e.d.s would be extinguished if and only if an *npn* transistor was connected to *X*, *Y* and *Z* in the precise configuration mentioned earlier.

If a *pnp* transistor was connected to *X*, *Y* and *Z*, in this case with the base (b) on *X*, the emitter (e) on *Y* and the collector (c) on *Z* then the exact opposite situation as above would arise. The transistor would then be behaving as an *emitter follower* and pin 2 and pin 4 of IC2 would always have *opposite* logic states for both cycles of the 200Hz square wave. This would result in both of the inverse parallel l.e.d.s lighting. Again, both l.e.d.s would only light if a *pnp* transistor was connected to points *X*, *Y* and *Z* in this precise configuration.

MATRIX SWITCHING

Now we can see why the solid-state switching matrix (see Fig. 2) is required, it provides an automatic way of swapping the transistor leads around in all six possible permutations automatically, and in synchronism with the 200Hz square wave. At the same time, the pair of l.e.d.s that is driven for each permutation is incremented. That's why there are six pairs of l.e.d.s, each pair showing the result of the square wave tests for each possible lead permutation.

The main sequencer for the entire Analyser is IC1, it controls the array of "electronic" switches as well as the allocation of each l.e.d. pair. A 4017 decade counter, used for IC1, is a popular device because it provides 10 separate outputs that go high in sequence on each positive-going edge of pin 14 (CLOCK).

In this application, pin 5 (output 7) of IC1 is connected to pin 15 (RESET) so that the counter is restricted to just 1 to 6 instead of 1 to 10. Clock input pin 14 is connected to the output of the square wave oscillator IC2a so that a new lead configuration is selected after each full cycle of the square wave.

You may notice that no current limiting resistors are present for the l.e.d. pairs, this is because the electronic switches, that are responsible for switching each pair, have sufficient internal resistance to provide current limiting. What's more each l.e.d. pair is only powered for one sixth of the time and this ensures that the average current into each l.e.d. is kept very low. The signals to drive each l.e.d. are actually derived from four spare Schmitt inverter gates of the 40106, this ensures that adequate brightness is achieved for the l.e.d.s whilst isolating the l.e.d. currents from the higher impedance levels present on *X* and *Y*.

The main electronic switching array, which is made up of 4066 bilateral switch i.c.s, is shown in Fig. 2. The switches are arranged in a matrix so that each node *X*, *Y* and *Z* can be individually routed to each of the test leads. The control lines for each switch are derived from the counter outputs of IC1 so that the three test leads are effectively swapped through all six permutations.

Zener diodes D13 to D15 are present to protect the circuit from static charges that may come into contact with the test leads. Under normal circumstances, the Zener diodes would not conduct and therefore can be ignored in terms of circuit operation.

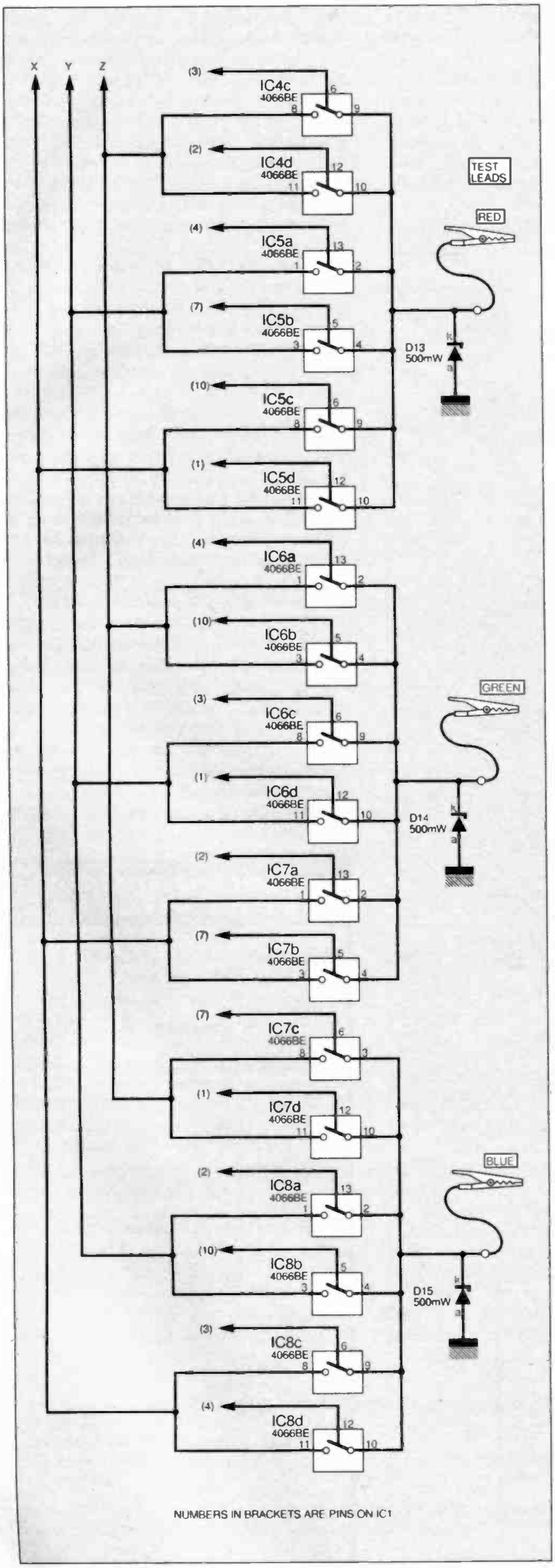
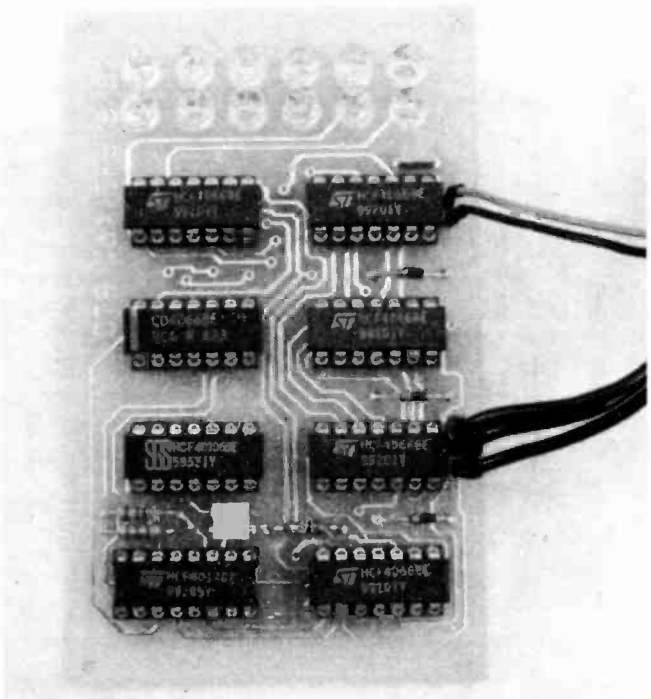


Fig. 2. Circuit diagram for the "electronic" switching array matrix.



*Young Engineer for Britain Prize Winner.

CONSTRUCTION

The Component Analyser is extremely straightforward to build because there are so few passive components to be taken into consideration. The double-sided printed circuit board (p.c.b.) simplifies the construction and enables the complex i.c. switch matrix network to be realised in a small area of board.

The p.c.b. component layout and full size top and underside copper foil master patterns are shown in Fig. 3. This double-sided, plated-through-hole (p.t.h.), board is available from the *EPE PCB Service*, code 105.

If a plated-through-hole board is not used then ensure that all components are soldered on both sides of the board. Also, ensure that the l.e.d.s are *not* mounted flush on the p.c.b., but that they stand proud so they can be soldered on each side of the board.

As usual, the passive components should be placed first. Pay particular attention to the polarity of the Zener diodes and the l.e.d.s, all other passives are not polarised. Note that the l.e.d.s should be mounted flush with the p.c.b. if a plated-through-hole board is used (see photograph), if not, now is a good time to solder p.c.b. pins through each hole (via) that is not occupied by a component.

Next, sockets for all the i.c.s should be mounted and soldered in position on the p.c.b. All i.c.s have their pin 1 uppermost to the top edge of the p.c.b., with the l.e.d.s on the right – see Fig. 3. The i.c.s should not be inserted into their holders at this stage, but left until the board has been mounted in a suitable case.

Connect the test leads to the board using solder pins as anchor points, the colours of each lead should be Red-Green-Blue soldered left to right on the p.c.b. as shown in Fig. 3. The "free" ends of the test leads should be terminated with miniature crocodile clips. The battery PP3 type clip can now be connected, via a switch preferably, again polarity on the p.c.b. is important, negative (black) lead to the left and positive (red) to the right.

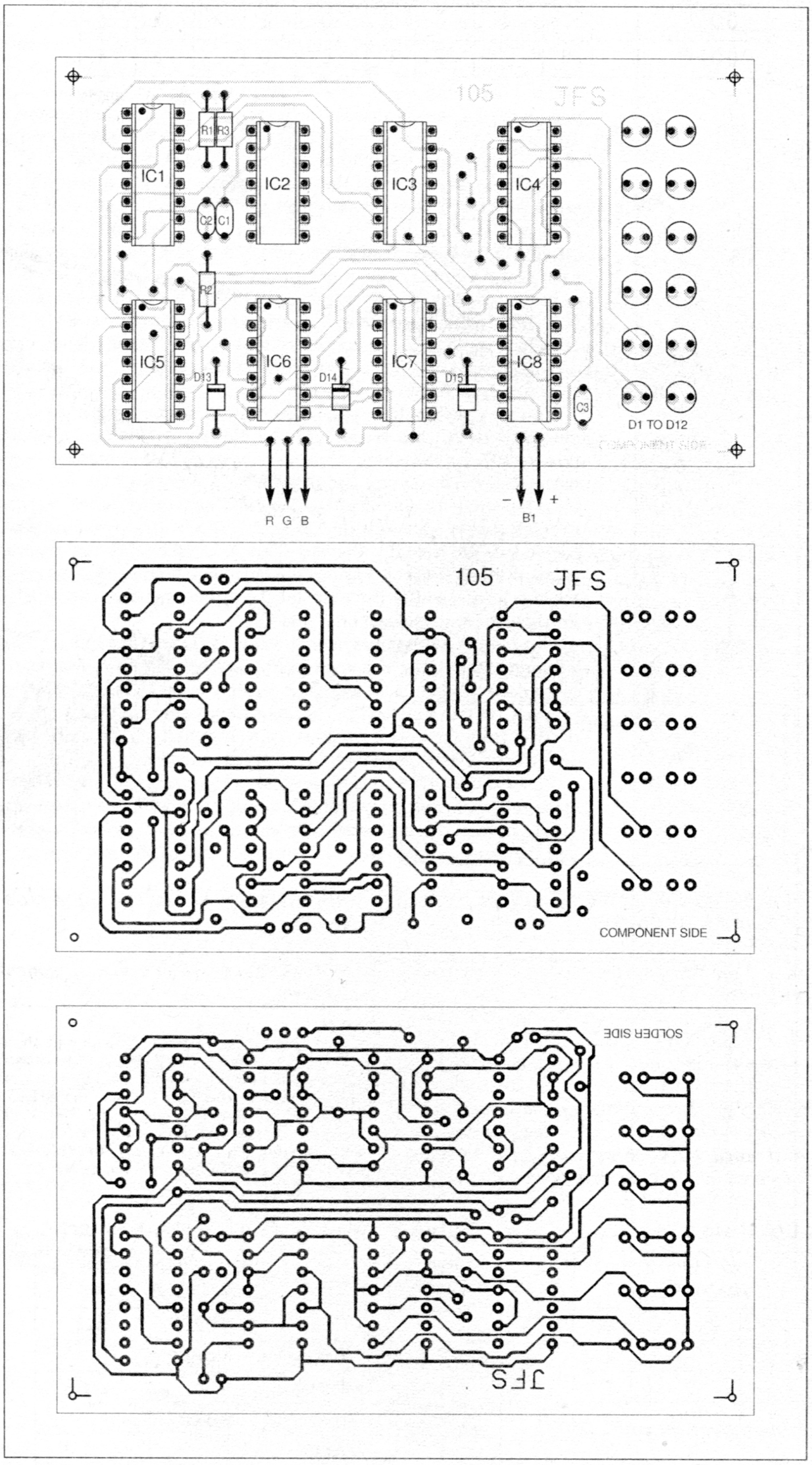


Fig. 3. Printed circuit board component layout and full size top and bottom copper master patterns. This board is a "plated-through-hole" type, see text.

CASE FOR DISPLAY

The p.c.b., together with an On/Off switch, should now be mounted in a suitable plastic case, size and type being left to individual choice. If you have mounted the l.e.d.s flush with the p.c.b., you will need to produce a small cutout viewing "window" for them in the lid of the case. Alternatively, if you have mounted them proud of the board, 12 individual holes can be drilled carefully to

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C2, C3 100n epoxy cased ceramic (2 off)

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D1 to D12 5mm high brightness clear green l.e.d. (12 off)
D13 to D15 10V 500mW Zener diode (3 off)
IC1 4017BE decade counter
IC2 40106BE h.e.x. Schmitt inverter
IC3 to IC8 4066BE quad bilateral switch array

Miscellaneous
B1 9V PP3 battery, with clip
S1 On/Off slide or toggle switch

Printed circuit board, double-sided, plated-through-hole, available from the *EPE PCB Service*, code 105; plastic case, size and choice to suit; 14-pin d.i.l. socket (7 off); 16-pin d.i.l. socket; miniature crocodile clip, with red, green and blue insulating covers (one of each); solder pins; solder etc.

Approx Cost Guidance Only £19 excluding batt.

take l.e.d. clips and the p.c.b. mounted so that the l.e.d.s only just protrude through the clips when the lid is closed down.

Finally, before closing the lid of the case, all the i.c.s should be plugged into the p.c.b. ready for testing. Once the unit has been completed, Table 1 Look-Up Chart can be copied and carefully glued on the outside lid of the case to enable interpretation of the display with out having to refer to a separate piece of paper.

ANALYSER AT WORK

This next section describes in more detail how the display should be interpreted. It may look a bit odd to start with but you will soon get the hang of it, it is extremely elegant to read once you've tried it.

Testing Bipolar Transistors

Simply connect a transistor to the test clips any way round and observe the display. The display will show an interesting pattern but you need to look for one of two possible conditions.

Look for a pair of l.e.d.s which are either both extinguished or both lit. There should be just one pair which shows this condition.

If a pair are both *extinguished* then the transistor is *NPN* and if a pair are both *lit* then the transistor is *PNP*. By noting which actual pair is showing this condition, you can deduce the actual pinout of the transistor under test from Table 2.

As an example, if a transistor was connected to the Red, Green and Blue test clips and the display showed a pair of lit l.e.d.s in Position 5, then we could deduce that it was a working *pnp* transistor and the Red lead was connected to the base (b), the Green lead was connected to the collector (c) and the Blue lead was connected to the emitter (e).

Testing Diodes L.E.D.s

A diode or l.e.d. can be tested by connecting the component to any *two* test leads and it does not matter which clips are used or which way round they are connected. For an l.e.d. the Analyser will illuminate the l.e.d. regardless of polarity.

For any diode or l.e.d. the Analyser will show on its display a single line of illuminated l.e.d.s with one l.e.d. lit in the right column. By using Table 3, one can deduce which lead is the Anode (a) and which is the Cathode (k).

OTHER COMPONENTS

The Component Analyser is capable of testing other components too. If any two leads are shorted together (SC), then two l.e.d.s in the right column will light-up, if all the leads are open circuit (OC) then no l.e.d.s in the right column will light. Fuses or light bulbs can therefore be tested in this way.

The unit is also suitable for injecting small signals into speakers or headphones, a tone will be heard if the speaker or headphones are working.

NOTE: The unit is not designed for testing components that are in-circuit and must NEVER be connected to any powered devices as damage could result to both the Analyser and the equipment under test.

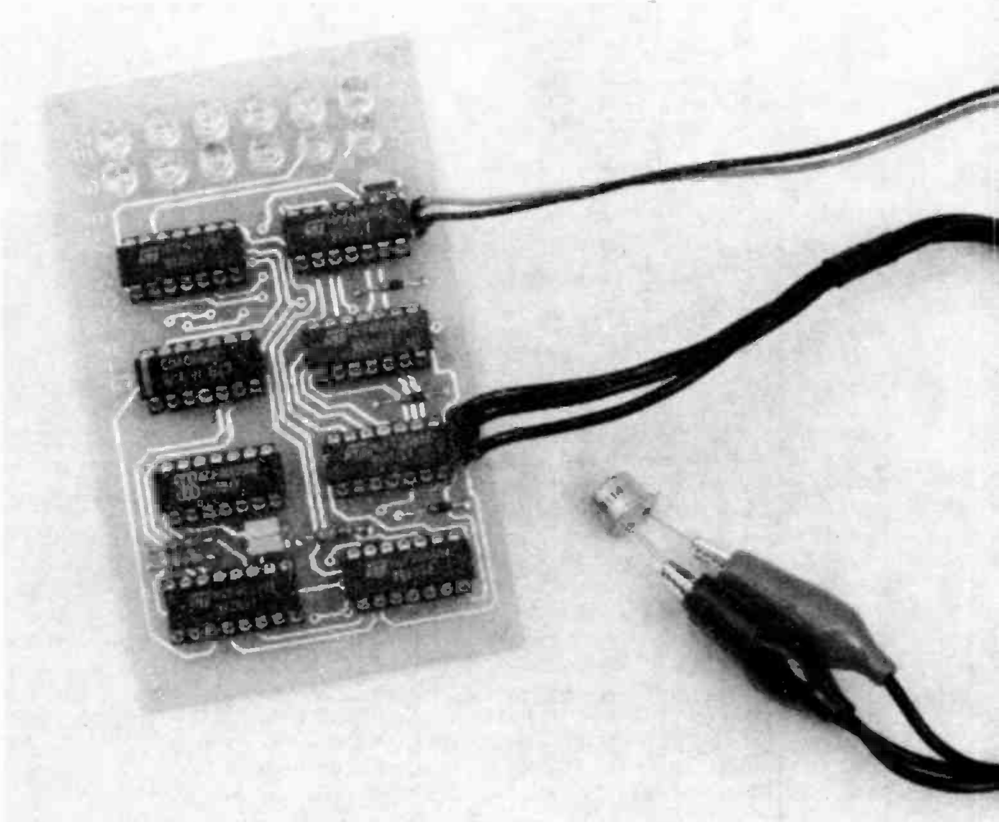
Footnote

Since designing this project, the author has been working on a more advanced design that is based on a microcontroller and has an easy to read display. The new design is called the DTA30 and is available fully built and tested from **Peak Electronic Design Ltd, Dept EPE, 70 Nunsfield Road, Buxton, SK17 7BW. *Tel. 01298 79920.* Price is £33.45, including VAT and delivery.**

Table 1: Display Look-up Chart

L.E.D. DISPLAY	PAIR NUMBER	L.E.D. PAIR EXTINGUISHED *NPN TRANSISTOR*			L.E.D. PAIR LIT *PNP TRANSISTOR*			SINGLE LIT L.E.D. IN RIGHT COLUMN *DIODE L.E.D.*		
		RED	GREEN	BLUE	RED	GREEN	BLUE	RED	GREEN	BLUE
00	1	E	C	B	C	E	B	k	a	
00	2	E	B	C	C	B	E	k		a
00	3	C	E	B	E	C	B	a	k	
00	4	C	B	E	E	B	C	a		k
00	5	B	E	C	B	C	E		k	a
00	6	B	C	E	B	E	C		a	k

k = cathode a = anode



Completed Component Analyser p.c.b. with a transistor in the "jaws" of the croc-clips ready for testing.

Table 2: Transistor Check Look-up Chart

PAIR NUMBER	L.E.D. PAIR EXTINGUISED *NPN TRANSISTOR*			L.E.D. PAIR LIT *PNP TRANSISTOR*		
	RED	GREEN	BLUE	RED	GREEN	BLUE
1	E	C	B	C	E	B
2	E	B	C	C	B	E
3	C	E	B	E	C	B
4	C	B	E	E	B	C
5	B	E	C	B	C	E
6	B	C	E	B	E	C

Table 3: Diode/L.E.D. Look-up Chart

PAIR NUMBER	SINGLE L.E.D. LIT IN RIGHT COLUMN		
	RED	GREEN	BLUE
1	Cathode (k)	Anode (a)	
2	Cathode (k)		Anode (a)
3	Anode (a)	Cathode (k)	
4	Anode (a)		Cathode (k)
5		Cathode (k)	Anode (a)
6		Anode (a)	Cathode (k)

New Technology Update

Ian Poole looks at the impact optical fibre technology is having on the telecommunications industry, and throws some light on a new type of opto-repeater amplifier.

OPTICAL fibre technology is well established in the telecommunications industry. With the increasing demand for more telephone lines and facilities, fibre optics have become an essential part of the telecommunications backbone in many countries. The cables were initially used back in the 1970s, and since then many advances have been made to the technology enabling it to be used more widely.

Optical Advantage

One of the main advantages of optical fibre is that it has a very wide bandwidth, very much wider than the more conventional radio frequency based systems. This enables more telephone conversations or other channels to be transmitted along a single cable.

In any telecommunication system signals are transmitted along a cable like a radio signal as shown in Fig. 1. By spacing them at different frequencies and stacking them one on top of the other, many channels can be carried along a single cable. Once at the far end they are reconstituted and sent out along the single lines to the individual telephones.

The number of channels is limited by the top frequency of the cable. We all know that even relatively short lengths of "coax" (coaxial cable) can introduce high levels of loss at the higher frequencies. For example a long run of coax from a TV aerial can significantly reduce the signal levels even if low-loss coax is used. However, the same coax would be no problem for a VHF FM aerial operating at a lower frequency.

Optical fibre is an answer to the problem of capacity. The fibre-optic cable has comparatively low loss and light has an exceedingly high frequency. This means that far more channels can be incorporated within an optical fibre link. The disadvantage is that it is more difficult to manipulate the optical signal.

Repeaters

Even though loss levels are relatively low, repeaters are still needed to compensate for the loss in the cable. At certain intervals along the length of the cable the signal needs boosting before it becomes too weak to decode without any undue errors in the data being transmitted.

Currently repeaters convert the optical signal back into an electronic form before amplifying it and removing noise, ready to reconvert it back into its optical format. This opto-electronic-opto conversion is expensive, and in view of the fact that many cable television companies are looking at bringing their optical fibre networks much closer to subscribers' homes, new methods of optical-only repeaters are being developed.

A number of methods have been investigated. Until recently most work has been carried out on an erbium-doped amplifier. Optical fibres doped with erbium are energised by a laser. When light photons enter the amplifier along the cable, the photons trigger the erbium doped area to emit further photons, increasing the level of light.

The drawback with this method is that it operates only at light wavelengths which are unsuitable for optical transmission. Even if they were to be used, this method would require the whole of the optical network to use a different light wavelength to the one already used.

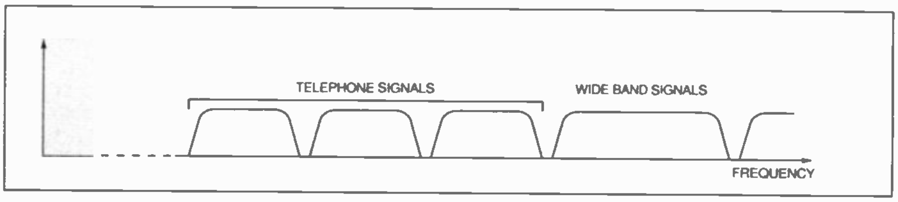


Fig. 1. Signals placed at different frequencies to send them down one link.

The new method operates within the 1310nm band, making it compatible with existing systems which operate at the more suitable frequencies. The technology was developed from the same semiconductor technology which gave rise to the semiconductor lasers which are becoming widely used in hybrid fibre systems.

Deprived Amplifier

These new amplifiers are described as lasers without feedback. In this way the structure creates multiple photons for every photon which strikes the structure, but without emitting a constant stream of light as it would if it was a laser.

In a semiconductor laser, the face of the structure from which the light is emitted is cut to reflect some light back into the device. For the amplifier, the face is not cut in this way, and the structure is deprived of this feedback.

These amplifiers have been in development since about 1991, and the first commercially produced amplifiers have been available since mid 1995. They give excellent carrier-to-noise ratios. Typically they are able to amplify a 3dBm (i.e. a signal 3dB above a milliwatt) carrier carrying a 10Gbits per second signal to 15dBm. Other devices with even more impressive performances are likely to be available in the near future.

Currently it has been possible to achieve considerable distances with these amplifiers used as repeaters. In one experimental link, data was transmitted at a rate of 10Gbits per second over a distance of over 100km.

Gain Modulation

In many respects, this solution appears to be working well. As with all new systems there are a few problems which still need attention. One of the most important with these new amplifiers is a phenomenon called "gain modulation".

This normally occurs when large signals are present. It is found that the level of the large signal changes or modulates the gain of the amplifier.

This is particularly noticeable on these amplifiers because they respond very quickly to changes. Typically, they take about a quarter of a nanosecond to recover after a large signal is removed.

In many applications, the gain modulation is not a major problem, especially as the changes are relatively small. Where digital signals are employed they are more resilient and less likely to cause the problem.

It is with analogue television signals that the major problems are experienced. Here the small gain fluctuations cause significant levels of distortion to the signal. As TV is likely to be one of the major initial uses, researchers have needed to find a solution to this problem.

This has been achieved using a system known as "gain clamping". A signal outside the required bandwidth is used to limit the gain. Being outside the required bandwidth it can be removed very easily using an optical filter, leaving the original signal amplifier without any gain modulation.

Future Possibilities

With the increased use of high bandwidth links, optical techniques are likely to become far more widespread.

In order that these links can operate with the maximum efficiency and without any significant signal degradation, optical amplifiers appear to be a major improvement over existing methods. As a result it seems likely that optical technology of this nature will infiltrate the realms of electronics and telecommunications far more in the years to come.

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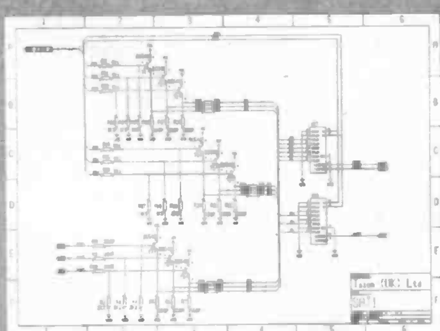

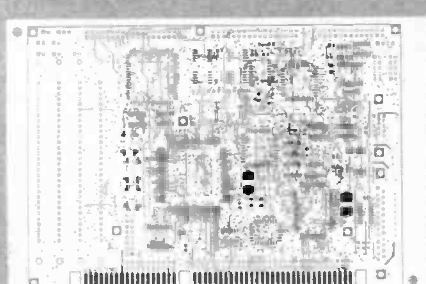

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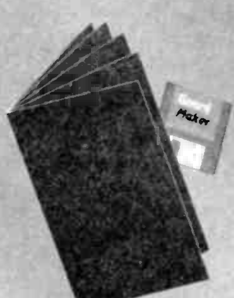

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MARVELS FOR THE MILLENNIUM

Satellites help peace, muck-spreading and the bus queue, while the zoo goes virtual and the house cannily plays nanny.

– by Hazel Cavendish

THIS MONTH I propose to take an overview of some amazing advances through which electronic science is leading us into the next century.

Ever-increasing ways of utilising satellites, the concept of "Intelligent Houses" which obey commands or sense our wishes, and news of the world's first electronic zoo in Bristol, are all schemes taking us fast forward into tomorrow's world.

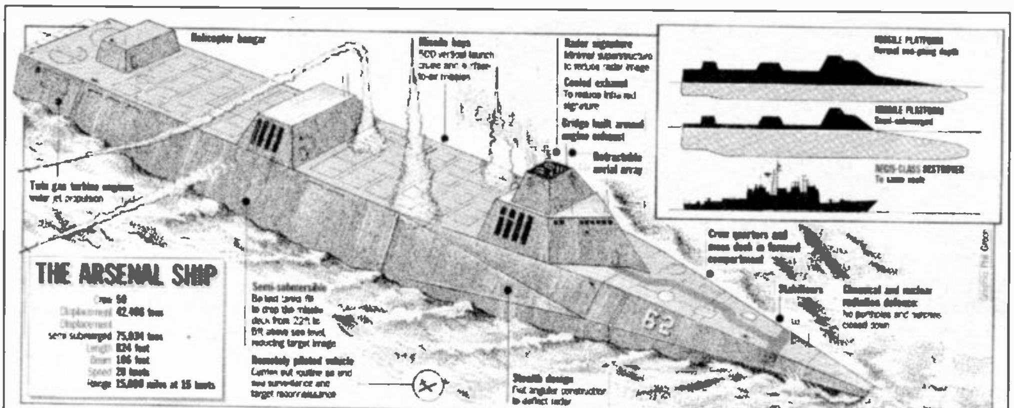
Possibly most significant is our increasing reliance on satellites. Here it must be said that America is way ahead of the UK, but where they lead we are likely to follow.

British Defence expert Peter Almond has brought us fascinating accounts of the US UAVs (unmanned aerial vehicles) which may revolutionise air reconnaissance, and could present a challenge to the entire concept of manned combat aircraft.

INVISIBLE WARSHIP

PETER ALMOND has now produced details of a Stealth warship, known as the *Arsenal Ship*, which is likely to enter US service by 2001. Writing in the *Sunday Telegraph*, he describes it as a 40,000-ton vessel with a crew of only about 50 which will be kept at sea as a huge floating weapons platform.

It is able to fire about 500 conventionally-armed missiles against distant targets, and able to flood its ballast tanks and sink down with its deck to almost wavetop height to avoid detection. Without sophisticated defences or radar targeting systems, it will depend on satellites, other warships, remote-controlled planes or ground stations to identify targets and programme its missiles.



Itself almost defenceless, the Arsenal Ship *relies on satellites for missile targeting data.*

"DARK STAR" – HOVER SPY

"DARK STAR", the brainchild of Lockheed Martin-Boeing produced at their famous "Skunk Works" in California last year, was the first of the long-endurance UAVs – long, unmanned lozenge-shaped craft able to hover high overhead, watching everything on the ground for up to 46 hours, providing information to ground controllers, and then returning to land automatically.

Designed to go into high-threat areas in critical situations, their almost total invisibility means they do not need to be controlled from the ground. With either a synthetic aperture radar, optoelectronic sensor or infra-red radar, these planes are able to identify tiny ground targets through rain, cloud or darkness and beam the images directly by satellite to a ground commander.

A second US firm, Teledyne Ryan, has produced an even larger and longer range UAV (40ft long with a 116ft wingspan) which carries a wider range of sensors. They can scan 40,000 square miles in a day, but although they lack the stealth of *Dark Star*, they are programmed to listen and sort out thousands of radio and telephone signals between troops on the ground and provide instant video links and radar images via satellite to ground forces.

These craft were largely designed for use in situations such as Bosnia, when demand for unmanned aerial reconnaissance over that country was growing after the UN removed many of its ground observers, who were vulnerable to hostage taking. Whether they were actually used there is not known, as the use of unmanned aircraft was kept secret at the time of conflict.

GPS MUCK-SPREADING!

AGRICULTURE is set to benefit from the use of satellite photographs taken in infra-red light. Due to photosynthesis, crops reflect infra-red light, and the amount that is reflected tells the farmer how well the crop is growing.

A map of good and bad land can be fed into computers installed in fertiliser spreaders, which will then spray more or less fertiliser according to what the computer indicates. GPS is used here to position the spreader accurately, using its network of satellites to tell the computer exactly where it is on the land. The system has been judged as "remarkably accurate" by a leading agricultural company in East Anglia.

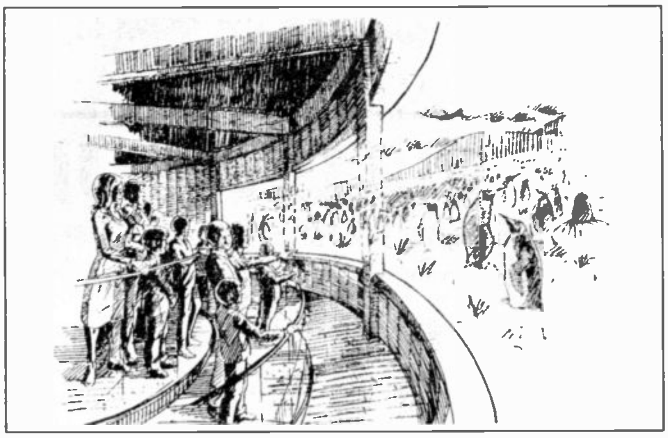
GPS BUSES

A RATHER more mundane use of satellite technology is seen in Hampshire's current trials of Ordinary and Differential Global Positioning Systems (GPS) to improve public transport in Winchester.

A company called ACIS is testing both systems in parallel in a move to improve local bus services, with the object of keeping prospective passengers informed of estimated times of arrival and departure. An efficient information system is said to show a 30 per cent increase in bus users.

The Ordinary GPS system was used to guide Cruise missiles in the Gulf War, and uses purely satellite GPS. The Differential GPS uses an additional fixed radio signal that improves accuracy to within 10 metres but gets into difficulty in built-up areas, where it may lack a clear view of all the satellites. If the trial is successful, Hampshire Council will instal the system in other parts of the county.

ELECTRONIC ZOO



The proposed "Magic Windows" for the new Bristol Zoo complex provide simulated real-time observation of the animal kingdom in its own environment.

EXCITING news of a plan to build the world's first Electronic Zoo comes from Bristol, where their Millennium Scheme known as *Bristol 2000* has been awarded £41 million by the National Lottery – 50 per cent of the total £82 million complex that will occupy a 10-acre site in the centre of the city on Bristol's Harbour-side.

An important part of the complex will be Wildscreen World which will house the Zoo, and nearby an extensive electronic archive recording endangered species and habitats worldwide, reflecting man's impact on wildlife and the planet (coyly named the ARKive).

In the same area will be a large cinema, its screen towering several stories high, where visitors will be given a "Virtual" wildlife experience of sights such as thousands of fur seals on a remote Antarctic island, enjoy a swim on a tropical reef and find themselves in a troop of mountain gorillas on a distant mountainside. The problem of "what to do at half-term" should be easily solved when Wildscreen is in place.

The real show piece will certainly be the Zoo itself, which will use State-of-the-Art technology to take visitors into the midst of the natural world. Exhibits will be grouped in themed galleries, and small live animal exhibits will be combined with "on command" video systems designed to show their behaviour in close up detail. One hopes the animals will cooperate; at which stage, one wonders, will boredom set in among the animal stars?

There will be a Walk-Through Tropical House (more virtual reality) "with free-flying insects and birds". (Count me out of that one. A childhood spent in East Africa taught me all I need to know about free-flying insects.) We are promised "Magic Windows" to provide simulated real-time observation of such sights as elephants bathing at an African water-hole or bears fishing in an Alaskan river.

Work starts at the site at the beginning of next year, and the whole scheme is planned to open to the public for the Millennium celebrations in 2000.

APOCALYPSE 2000?

THE immediate reaction of many readers to the news that countless quantities of computers will crash at midnight on 31st December 1999 is likely to be one of scepticism or belief that yet another software virus is lurking in the background.

However, it seems that software written up to 30 years ago failed to take into account the consequences of systems unable to cope with two-digit date changes from year 99 to year 00.

One supermarket chain has encountered problems because the shelf life of some products is greater than four years. At the beginning of the year it started stamping these products with an expiry date of "00". Subsequently, the computerised stock control system calculated that they were 94 years old and should be immediately destroyed!

To help combat the problem, Chase Software Solutions recently announced a Co-operative Marketing Partnership Agreement with US-based Alydaar Software Corporation to supply its *SmartCode* software re-engineering processes to solve the Y2K syndrome. Having an "artificial intelligence" design, the software provides a comprehensive tool for the required re-engineering. It is able to understand multiple programming languages and learn application-specific dialects within these languages.

If you are not sure if your computer system could give you Millennium Malfunctions, contact Chase Technology Ltd., Kiln House, 210 New Kings Road, Fulham, London SW6 4NZ. Tel: 0171 736 4455.

THE THINKING HOUSE

JUST to suggest that if you want to be truly innovative you have to be Celtic, one has to go North of the border for the two Scottish companies who are working on "Intelligent" houses of the future.

The first is highly imaginative and rather fanciful, the creation of Charles Davidson, who runs a Scottish electronics company, Intelli-Home, with his partner Jack McLaughlin. He describes it as "home automation" and definitely not "robotics".

His house, known as Alexander, responds to various spoken commands such as "Open the garage doors", "Put the lights on" "Light the gas fire" and "Draw the curtains." The house has a vocabulary of 200 words, but is also "sensitive" as well as "intelligent" so that you do not really *have* to speak to it.

If you are not in a chatty mood, a simple phrase will indicate whether you are coming in or going out, and it will do all the right things (hopefully) such as reducing the temperature, turning off the iron, and stopping the bath from overflowing if you have forgotten to turn the bath tap off. It also shuts the garage door (but one hopes it also makes sure that it hasn't shut the toddler/dog/cat in the garage).

The present sample home is a rented one, and is a pale version of what is to come. Mr Davidson is now planning a specially-built £500,000 house that does a great deal more, and is particularly concerned with Security. It even has an "intelligent" doorbell which can tell you, wherever you are – it can be 500 miles away – who the caller is by flashing you an image of the man at the door and turns him away if you are unable to recognise him.

Keen indoor gardeners will be pleased to know it waters the plants, and pet owners will be relieved to hear it feeds the fish. (It doesn't mention feeding the cat, but no doubt that is because no self-respecting cat, such as Max Fidling's Piddles, would accept such a service.)

We hope to bring you a full report of that house in due course.

MORE DOMESTIC INTELLIGENCE

A MORE seriously minded company based in Perthshire also "knows" when you are out and looks after things for you, but also keeps a sharp eye on the bawbees. It is able to predict your electricity bill, and shows you where most power is being used.

There is a clever use of sensors placed round the house which detect things like the onset of darkness and then switching lights on, or sends messages to your central heating system if the temperature drops. A Scottish energy company is presently installing it in 30 homes in a test project.

Provided in the house is an "intelligent" fuse box which contains microcontrollers for the power circuits, designed by Linburg, the Dunfermline-based electronics company.

The customer control is a Philips Screen Phone – a telephone with a small computer keyboard and a small display screen containing a microprocessor, which does various useful things like calling a neighbour if a smoke alarm goes off. (But wouldn't a call to the local Fire Brigade be wiser?)

Hydro-Electric – the firm trying it out – is hoping to find out whether their customers like it, and what aspects best please them. No doubt a Scottish public will be much influenced by its ability to save (or spend?) its money.

The Philips Screen Phone monitors your house and calls for help if needed.

REPORT

by Barry Fox

Network computers

Everyone is trying to predict the next wave of computer technology. Will it be the NC, a Network Computer that plugs between a phone line and screen to make surfing the Internet as easy as watching TV?

The NC will have no hard disk and downloads the software it needs by phone line. The high cost of phone calls in Europe is one snag. So is the poor quality of graphics and text display on an ordinary TV screen. Olivetti and ICL/Fujitsu found this out the hard way with *Envision* and *Indiana*, much publicised PCTVs that use a TV screen as a PC display. Both are now out of production.

Also, the companies currently making a mint out of PCs see the need to make them easier to use. This became clear at the annual Global Summit held mid May in Monte Carlo by publisher and market analyst the International Data Corporation.

"You have to program your computer" says US industry watcher Geoffrey Moore. "Real appliances aren't programmable. You don't have to boot up a refrigerator. You open the door get a beer and it's cold."

Easy PCs

Moore says it is irrelevant whether manufacturers' Helplines answer callers quickly and give good advice. "The customer shouldn't need to make the call. Once you get the call, you're dead".

Moore thinks that future PCs should be made so that they always re-set themselves to completely safe defaults. If the user changes settings, or a crash stops the PC working, one command will always restore it to a fail-safe working condition.

"People sat for years watching gorillas, making notes on their behaviour" said Moore. "Computer companies need to employ people to watch how people use computers."

Tim Keating, Marketing Director for Intel, the company which makes the chips for most Windows PCs, believes that "A programmable device can never be an appliance." But he predicts that future PCs will look and work like TVs. "They will start up automatically, be multicoloured, look beautiful and sit in the living room."

Bernard Vergnes, President of Microsoft Europe, says "We are working with Intel on a new operating system. PCs will be like a TV set, always on and waiting for you to push the button." The PC will effectively remain booted, but on standby.

This is how some portable PCs already work, with a feature called "resume". The notebook goes to sleep to save battery power, and wakes up still booted and in the same program.

Talk of changing the way PCs work raises an important question. Will information stored on today's computer still be accessible using future PCs?

Questionable compatibility

Anyone who wrote text into the old Amstrad word processor, which used non-standard 3-inch discs, will have learned the hard way that they cannot be used on a modern Windows or Mac PC.

One speaker at the IDG conference admitted that he had prepared his electronic slides in the USA on one version of the software called PowerPoint, and it would not talk to the different version used by his office in Europe. He predicted a "version nightmare" in the future as people try to access information stored in previous years.

Even though today's PCs are difficult to use, sales are still rising. Senior Director Simon Pearce says IDG's market research shows that 6·5 million Europeans will buy a home PC this year, with another 10 million sold for business use.

Seven out of ten PCs are bought by first time users. The pace of change is so fast that six million PCs in European homes are already ripe for replacement. But VAT, and the fragmented European market, makes them over 30 per cent more expensive than in the USA.

The solution, says Pearce, is for people to "negate the VAT effect" by buying PCs through the company that employs them. That way they also benefit from bulk purchase discounts.

Warns Bernard Vergnes "Bypassing VAT is plainly illegal and Managing Directors who try it are likely to end up in jail".

Hidden killer

Another American market research company, Forrester, reckons that there is a hidden killer for the NC. At the promised $500, which looks likely to translate to £500 in the UK, the NC "won't fly".

"The vision of millions of consumers using cheap, low overhead Internet devices is seductive" says analyst Josh Bernoff in Forrester's new report "but these gizmos won't deliver the high-paced adrenalin rush consumers have come to expect".

The hidden killer is the price of second-hand PCs. A used PC with 486/66MHz processor and 500 megabyte disk drive can already be bought for $750. Next year when NCs go on sale, new and full featured Pentium PCs will cost $1000 and used models will cost no more than an NC.

I phoned Forrester in Massachusetts for some further comment, for instance on the possible combination of video games and Internet consoles. But I got only voicemail, and heard nothing back.

So I left a message suggesting that Forrester's next research project could perhaps be on the way voicemail is crippling modern business. I've heard nothing back on that either.

Companies that predict the future of technology should first learn to use today's technology.

Flintstone Jargon?

Says Acorn of the new StrongARM computer chip "It increases performance from circa 60,000 dhrystones to over 300,000 dhrystones".

Sounds impressive. But do you know what a dhrystone is? I certainly did not. Neither did the people who put out Acorn's press release.

But I finally found someone inside Acorn who does.

It isn't a typographical error. Nor would it have been a typo or April Fool gag if the same release had gone on to refer to whetstones. It's Acorn's way of trying to get its ARM chips a fair comparison with Intel's 486 and Pentiums.

Because the ARM chip is a RISC processor, it needs fewer instructions per second than a 486 or Pentium to do useful work. So it is clocked at a lower speed. An ARM running at under 50MHz has similar processing power to a Pentium running at over 100MHz. But people who buy computers do not know that, and just look for the highest number of MHz.

Unit of work speed

This is why Acorn went back to the dhrystone, a unit for measuring the work speed of a computer first proposed in 1984 in a technical paper. This took the working speed of the old Vax 11780 mini-computer as the base line, because fifteen years ago every laboratory or office used one.

The dhrystone is a measure of speed against the Vax which processed one million instructions a second. A whetstone is a similar benchmark for floating point calculations.

Acorn did not explain this in a footnote and as far as I can see I was the only person to query it. This either makes me very stupid or it makes the rest of the press too weedy to ask. Either way it does nothing to get across Acorn's message that MHz speeds are not the be all and end all of home computing, and that the StrongARM is five times faster than previous RISC ARMs.

Intel has done a very clever marketing job with the *Intel Inside* slogan and by making MHz clock speeds the high street gold standard for PCs.

Acorn is hoping to catch the next wave of home computing, by selling ARM chips for use in Network Computers that make surfing the Internet a plug and go experience for novices. Using jargon like *dhrystones* does not seem a smart way to start.

SURVEILLANCE

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HVX400 Mains Powered Room Transmitter
Connects directly to 240V A.C. supply for long-term monitoring. Size 30mm x 35mm. 500m range.......... £19.45

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

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

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

ATR2 Micro-Size Telephone Recording Interface
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line.......... £13.45

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way d.i.l. switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mmx 90mm. Both 9V operation. Range up to 200m.
Complete System (2 kits).......... £50.95
Individual Transmitter DLTX.......... £19.95
Individual Receiver DLRX.......... £37.95

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

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

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

TKX900 Signalling/Tracking Transmitter
Transmits a continuous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation.......... £22.95

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CD600 Professional Bug Detector/Locator
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation.......... £50.95

QTX180 Crystal Controlled Room Transmitter
Narrow band FM transmitter for the ultimate in privacy. Operates on 180MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range.......... £40.95

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

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

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

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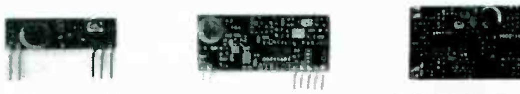

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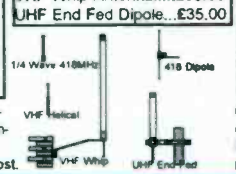

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SURVEILLANCE

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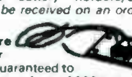

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LM383 AMPLIFIER MODULE Proven, popular building block for use in any audio project where general amplification required. Power output dependent on supply voltage & load resistance. Typical ratings: Over 10W for 15V supply & 2W speaker, 1W for 9V supply & 8W speaker. *3047-KT* ***£9.95***

LED SEQUENCE/RANDOM FLASHER. 5 ultra bright red LED's flash in sequence or random. Ideal for model railways. On/off switch. COB PCB 15x8mm (spare provided). 3V powered. *3052-KT* ***£3.95***

LED DICE The classic electronic project that never loses it's popularity. Combines a great game with an easy introduction to electronics & simple circuit analysis. 7 LED's simulate a real dice face. The dice rolls, slows down, stops on a number at random. Uses a 555 timer & counter IC. Box included. 9V operation. *3003-KT* ***£8.95***

STAIRWAY TO HEAVEN GAME This game of skill tests your hand-eye co-ordination. If you press the switch each time the green part of the bi-polar LED lights you climb higher up the stairway - but miss & you start again! Introduces you to several basic electronic circuits. Box provided. 9V operation. 78x50x19mm. Rolfe Harris NOT included! *3005-KT* ***£8.95***

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LIES AND ELECTRONICS

BARRY FOX

Ever wonder if you are being bugged? Tired of business rivals pre-empting you deals? Take a look at the world of high tech surveillance.

THE police and security services have an armoury of high tech surveillance equipment. Needless to say they do not like to talk about it. Thermal imaging cameras, which find bodies trapped in rubble after an earthquake or bomb blast, can also monitor movement in a dark room. If a laser is beamed at a window, the reflected light will be modulated by the small vibrations in the glass pane which are caused by speech in the room. The modulations are converted back into speech by a device like the readout head of a laser disc player.

All British Telecom's telephone exchanges are now fully digital. Speech passes through them as digital code and is switched by a computer. This is how BT can now offer its subscribers new services, such as itemised billing, call re-routing and conference calls where several parties are on the line at the same time. The same technology lets BT help the authorities trace the destination and origin of any call immediately it is placed, and tap into a conversation without the tell-tale clicks which often gave the game away on an analogue line.

Amateur eavesdroppers can now work almost as effectively as the professionals. A wide range of devices can either be bought over the counter, or by mail order, or be constructed by an electronic enthusiast.

EQUIPMENT AVAILABILITY

Once you know what is on sale, you realise how easy it is to be bugged without realising it. Like Gene Hackman in the movie *The Conversation*, anyone with business or personal secrets can then become paranoic, especially if they understand the technology, and know what is on sale at surprisingly low prices.

Why is that van parked down the road in the street? Who is hidden in the back, with what equipment? Is the aerial on the roof picking up a music radio station, or is it receiving signals transmitted from a bug?

Who is that out there in the garden at night? Why are they peering through a stubby looking telescope?.

For legal reasons, of which more later, we can only give general pointers to what is on sale. They are intended to alert the unwary, while not providing too much help for the would-be eavesdropper.

PHONE AND FAX TAPPING

An ordinary telephone may not be as innocent as it looks. There is no visible sign of tampering, inside or out, but it is recording everything said when a call is made. A small tape recorder, the size of packet of cigarettes, is connected to a telephone extension socket in another room, or to the junction box in the cellar, or outside on the wall.

The recorder costs only around £50. It uses miniature cassettes of the type intended for dictation, but runs them at one-half or one-third normal speed to record several hours on a single tape. The recorder has a sensor, which starts the tape running whenever the handset of any telephone on the house line is lifted. The tape stops running when the handset is replaced.

The telephone junction box also contains a miniature radio transmitter which runs off long-life batteries. It may transmit on the same VHF band that is used for FM broadcasting, so the signals can be picked up by any domestic portable radio, for instance in a car outside the house. Or it may work at higher frequencies, in the VHF band allocated to aircraft, or in the UHF band reserved for lorry fleets, so that the transmissions can only be picked up on a matching receiver. The transmitter costs anything from £50 to several hundred pounds, depending on its power and range.

Perhaps the junction box which serves the Fax machine contains an even more sinister device, bought by mail order from a supplier in Frankfurt, Germany, for DM 8500. Whenever a fax call is made or taken, the "Telefax Interception System" transmits the warble tones that the fax machines exchange. These warbles are picked up by a VHF receiver outside the house.

The receiver triggers a high fidelity tape recorder which captures the full frequency range of the rapidly changing warbles. Later the tape is replayed into a personal computer loaded with a software program which displays the text of the fax on screen. The PC either stores the text on floppy disc or prints it onto paper. The device, says the company, "fits into a briefcase" and can be used in a "parked car in a nearby street". "We have them in stock" confirms the sales representative.

GIFT NUMBERS

Your cordless phone was bought from a reputable electronics dealer for under £100. It is wholly legitimate and has not been tampered with. But by a quirk of design and government licence it also functions as a surveillance device. A base station plugs into the telephone wall socket and broadcasts speech to a handset which the owner carries round the house or garden. Some of the frequencies allocated by the UK government are at the extreme end of the AM Medium Wave band. So a portable AM radio will often be able to pick up the conversation. If the house is high on a hill, the signals may travel several kilometres.

Even without tampering, an ordinary telephone can release secrets to a caller. Unless you know how, and remember to take positive blocking steps every time you dial a number, your own number is transmitted down the line ahead of the ringing tone.

The system, called Calling Line Identification, is well-intentioned. It can curb malicious and obscene calls. But anyone who uses their own phone to make a call, e.g. in response to an advertisement, immediately makes the called party a present of their telephone number – even if it is ex-directory.

For just £50 (plus a small quarterly service fee), high street shops quite legitimately sell a CLI display device which – also quite legitimately – plugs into any phone line and automatically stores the last fifty numbers that have called it.

There is even a way of using CLI for free, and with no extra equipment needed. Using an ordinary phone, dial 1471 and hear a recorded announcement of the last number that called that phone line.

CAMERA AND SENDER

Behind a ventilation grille, or hidden inside the smoke detector, burglar alarm sensor, hifi loudspeaker or clock, there may well be a miniature video camera with a wide angle lens that is watching everything in the room. The camera connects either to a TV set, VCR or a device called a Videosender.

Use of the "sender" is illegal but it is easily purchased by mail order. Its intended use is to broadcast the output of a VCR or satellite receiver round the house, to avoid the need to lay extension wiring, but it can equally well transmit the signal from a camera.

Because the Videosender works on the ordinary UHF TV band, but can be tuned to a frequency well away from the BBC, ITV or Channel 4, its signals can be received on an ordinary TV set or VCR. Sensitive cameras, which work even in low light, cost under £200. Videosenders cost as little as £20, with more powerful models that reach down the street still costing less than £40.

An infra-red video camera can see in the dark. These are sold legitimately, e.g. for watching over babies at night. A lamp bathes the area in infra-red light. The camera uses the infra-red to form an image as if the room were well-lit. Some ordinary video camcorders will respond to infra-red. Ex-military infra-red "Dragon" lamps cost over £500, but have a filter which cuts out all visible light so that subjects do not know they are being lit up by a powerful infra-red beam.

COMPUTER TEXT

Your home or office computer is stylish because it is made of plastic. So there is no metal screening to stop its circuits radiating an electronic imprint of whatever text the computer is displaying on screen. Put a portable radio near a computer and you will hear the radiation as nuisance interference. Enough radiation will leak through the windows to reach a sensitive receiver outside. An oscillator can make it display the stolen text.

The military and security services know this only too well. This is why they use computers which are housed in metal boxes which look ugly but trap radiation. The windows in their offices are also coated with a thin metal film, similar to that used to keep out the sun's rays. It also keeps in the computers' radiation.

DISGUISE

A pen laying on the table, an ashtray or calculator; they can all house a hidden microphone and miniature transmitter. So can a multi-way adaptor plugged into the mains socket in the wall. The socket itself is a risk. It can contain a microphone and radio transmitter. The transmitter is powerful, and transmits over a longer range, because it can draw mains power. So the receiver can be hidden well away from the room. Prices start at around £60.

Ex-military "night vision" gunsights and monoculars can now be bought for £200. For an extra £100 you can get one that will clamp to a camera. Many come from Russia where the army factories are happy for any new market. One dealer alone says he has been selling several hundred a year. He boasts that his "black market goods are carefully checked". You'll also find new and guaranteed units advertised, for legitimate use, in yachting magazines.

Night sights work on the principle of image intensification. A lens forms an image of the dark scene on a light sensitive cathode. This emits electrons which fall on a fluorescent screen and generate light. By amplifying the electron flow the final image is much brighter than the natural scene. You see the effect in nature films of animals at night.

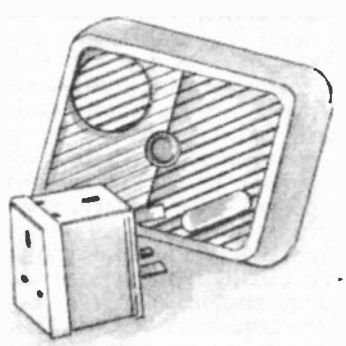
Paranoics should be especially wary of any visitor who will never lose sight of their briefcase. It cost at least a thousand pounds more than the normal shop price. This is not surprising because it hides a microphone and miniature VCR, with a video camera that peers through a pinhole in the lock. As an extra option, the video camera is hidden inside a dummy cellphone which sits innocently on the table and connects with the briefcase on the floor by microwave radio link.

TANGLED LAWS

The law should safeguard us from this kind of intrusion, but in practice it seldom does. There is no blanket control over bugging and spying. Instead there is a tangle of different laws, which often make it legal to sell bugging equipment, but illegal to use it. So the vendor is in the clear, and the customer carries the can if caught red-handed. The penalties are severe, ranging up to two years in jail and unlimited fines. But victims first have to know they are being bugged, and then help the police prove it.

The Wireless Telegraphy Act, 1949 is still in force and bans unlicensed radio reception, as well as transmission and causing interference. Licenses are not available for the frequencies used by radio bugs (the VHF band 88MHZ-108MHZ used for FM broadcast radio, the continuation of the VHF band up to 138MHz which is reserved for aircraft, and the UHF band 390MHz-450MHz allocated to public mobile radio e.g. communication between a business and its fleet of vehicles).

Neither sale nor possession of unlicensed bugs is an offence. Using a bug is obviously illegal, but there is



Objects like mains adaptors and smoke detectors can conceal microphone and video camera bugs.

Charles and Diana both had telephone conversations bugged.

often no way of proving who planted the bug or who is listening to it. Not surprisingly, shops seldom demonstrate their bugs working.

Using a "scanner" radio to eavesdrop on cellphone conversations is an offence. But the authorities can only act when they have proof of reception. The Radiocommuncations Agency of the DTI could have prosecuted newspapers which published transcripts of the "Dianagate" and "Camillagate" tapes, purportedly cellphone conversations made by Princess Diana and Prince Charles. But the RA can only act if the scanner victims complain and positively identify themselves as the voices heard. The RA never received any formal complaint from the Royals, so no prosecutions were brought.

SECTION 7

Recent updates to the Wireless Telegraphy Act let a government minister ban the sale, importation, manufacture and even possession of a particular piece of radio equipment that it is illegal to use. These so-called "Section 7 Orders" have already stopped the sale of CB radios and cordless phones that work on frequencies which are authorised in the US, but not in the UK. But the Section 7 weapon has not yet been used against bugging equipment. The Radiocommuncations Agency of the DTI is instead looking for proof of "incitement".

Installing offending equipment could very easily be encitement to break the law. Sale with advice, and a nod and wink, is risky too. ("How to bug a room" articles could also be.) The RA has already prosecuted a firm selling Videosenders. It was fined £4,800, plus over £3,000 costs. Another, selling car burglar alarms that work on unauthorised radio frequencies, was fined £2,000 with £4,000 costs.

As a result, electronics shops have recently become much more cautious about selling bugging equipment, and some have removed their window displays. The trend is towards mail order because it is then much easier to plead innocence of incitement. "All equipment is sold on the strict understanding that it will not be used in the UK and will be exported outside the EC" warns a catalogue sent recently to a UK address.

Some transmission and reception equipment is labelled "Type Approved", which means it can legitmately be used without a licence. A snooper could for instance legally use a two-way radio working in the UK's approved Citizens' Band. But if hiding the transceiver involved breaking and entering, that would be a criminal offence in its own right.

The Interception of Communications Act 1985 makes it an offence to read someone's letters or listen to their telephone calls, including cellphone calls. Anyone who thinks their communications are being intercepted by an unofficial snooper, should go to the police. The same Act allows the Home Secretary to ask BT to tap phones if crimes are suspected.

Aggrieved parties, who think their phones are being officially tapped without justification, can apply for a review by an independent Tribunal. If Princess Di really believes she is under electronic surveillance from "enemies" in the Palace, she has an easy remedy.

British Telecom can act on interception too, by accusing the culprit of stealing electricity.

The Data Protection Act 1984 makes it an offence to obtain personal data unlawfully, and store it on a computer. Storing speech as digital code could make bugging an offence under the data law.

The Department of National Heritage has for the last two years been working on new privacy laws which will make bugging, telephoto photography and electronic surveillance a criminal offence. Progress is slow because any welcome attempt at protecting people against tape recording and photography, would also have the unwelcome side effect of making it a criminal offence for a TV crew to shoot street scenes, for amateur photographers to take candid snapshots and for radio reporters to use a portable tape recorder to capture background noise in, for example, shops, offices and car parks, or for town centres to install security cameras in exhibition halls.

CELLPHONES

When Cellnet and Vodafone launched their analogue cellphone services ten years ago, the only technology available was analogue. The phones transmit speech, like ordinary broadcast radio, but at higher frequency (around 900MHz). Like a broadcast, the speech is "clear", not scrambled.

The cellphone system uses two frequencies for each call, one for outgoing speech and one for incoming speech. The cellphone operators originally tried to reassure – or fool – their customers, by saying that this meant anyone who tried to eavesdrop on a call by tuning a radio receiver in to the cellphone band would only hear one half of the conversation. In fact this is not so.

The call always travels part of its way through the wires of the public telephone system, and this mixes the two halves of the conversation together. (This is why anyone using a telephone hears their own speech in their own ear.) Anyone who tunes in to either one of the two cellphone frequencies hears both parties.

When a cellphone call is dialled, the phone grabs the first available free frequencies in the area. So there is no way of knowing what frequency a call will use, and thus no way of targetting an individual caller. But a "scanner" does the next best thing. It sweeps rapidly through a chosen radio band and stops at any frequency on which there is a strong signal. The user can then lock the receiver onto that frequency, or let it go on sweeping.

The first scanners were designed for amateurs who wanted to sweep the short wave ham bands for interesting conversation. When

A typical scanner.

ANOTHER ANGLE

As with all controversial topics there are two sides to the coin. While the activity of covert surveillance may be fraught with legal potholes and moral minefields for those involved in it, the general public lie safe in their beds at night blissfully ignorant of just what is going on behind the scenes to provide this cocoon of social and economic safety.

This framework of safety is under constant threat and attack. Overt terrorism is reported every day in the newspapers and is a global problem facing all nations. Extremist organisations have no limits to the lengths they will go to cause major social and economic disruption, and now, with the potential for obtaining nuclear material on the "black market", the consequences of this threat are almost unthinkable.

At the other end of the scale we have the Police forces facing increasingly clever and organised criminals involved in drugs, fraud, extortion etc. They may not initially appear as dangerous as the terrorist threat, but in actual fact they could potentially pose a far greater threat, as they slowly but surely eat away at the delicate fabric of our society.

This black picture would most certainly be an awful lot blacker if it were not for the constant use of information gained by the various security organisations through the use of covert surveillance, both audio and video. By making the mesh of the net tighter to catch the big fish we unfortunately snag a few of the smaller innocents. No system is perfect and that is the price we must pay for the blanket of security under which we all sleep. Those who stand in judgment of the use of this type of equipment should consider what is going on in the outside world, and just what life would be like without it.

On a far more mundane level, yet just as important to the victims involved, our everyday lives are often faced with attack from within, not necessarily physically. Very often these are situations that the Police cannot deal with for various reasons.

ACTUAL EXAMPLES

Take the case of the family who had ploughed everything into building their business up over the last twenty years. They had noticed that profits seemed to be dwindling slowly but steadily. A paperwork investigation by the accountant showed nothing obviously wrong or sinister. As things got steadily worse they decided to take action involving the use of covert audio and video surveillance and radio "tagging" of a certain number of their produced items.

What transpired was a shock to the family and almost disbelief by the Police. The appointment of a family "friend" into a position of authority two years previously had been a big mistake when he started to take away scrap by-product, rework it and sell it on at car boot sales.

The success of his venture led him to expand into taking large quantities of material to keep up with the demand. Not having the production facilities to work the material he had cleverly created a second company within the first with paperwork, orders, production and despatch all being run to his benefit.

The result of the information gained was a criminal prosecution and recovery of the company's profits. This situation could not have been dealt with by the Police, they can only act when there is evidence of a crime and then only when, with their overstretched budgets and undermanning, there are no other more pressing cases to deal with.

Then there is the case of the family who, certain that their older son was the victim of drug abuse and having watched him slide from a sparkling academic career in medicine into personal hell, made the unenviable decision to monitor his telephone calls. Only to find that their son was the subject of ongoing blackmail by a group of drug pushers who had found out about the theft, by him in desperation, of a small amount of drugs from the hospital in which he was employed and were forcing him to steal more and more for their benefit.

Unfortunately these examples are far from exhaustive and over the twenty plus years I have been in this field I have seen a portfolio of tragedy which no level-headed, right minded person would disagree required, and wholly justified, the use of surveillance equipment. Where I believe the infringement of civil liberty was utterly insignificant in comparison to the benefit to society. **Tim Jinks, Suma Designs** cellphone services began the manufacturers quickly launched new models which also covered the 900MHz band. They cost under £200 and are widely available. Sale must remain legal, so long as the scanner can tune to at least one band on which listening is legitimate. But be warned. Anyone caught with a scanner which has been programmed to sweep an unauthorised band is at legal risk.

The new digital cellphone services (Hutchison's *Orange,* Mercury's *One2One* and the pan-European *GSM* services offered by Cellnet and Vodafone) transmit speech as digital code. In itself this is no protection against eavesdropping. The coding system adheres to a published standard which any manufacturer can use to build a decoder. But in Europe the digital systems use a powerful encryption system which scrambles the digital code so that it can only be deciphered by the intended receiver. So anyone worried about eavesdropping would be best advised to use a digital service.

Because the encryption is so powerful, cellphone manufacturers cannot export to countries (e.g. in the Middle East) which are classified as hostile. The military does not want to help the enemy relay secret messages. Likewise as digital cellphone services open up across the US this year, it is likely that the speech channels will either be clear, or encrypted with only a weak encryption system. The law enforcement agencies want to eavesdrop on criminals and drug traffickers.

WORLD WIDE BUGGING

The *Iridium* digital satellite cellphone system developed by Motorola will give world cover later in the decade, without any scrambling. Anyone with a digital scanner, anywhere in the world, should then be able to eavesdrop on any satellite cellphone anywhere in their area.

It is hard to see how legislators can ever outlaw this, with any hope of enforcement. Loss of privacy is one more price we must pay for technological progress. □

Ohm Sweet Ohm

Max Fidling

Trapped in Utopia

The shack, located in my back garden, and now a local eyesore, is about the only place where the Boss won't venture. After all, nothing stops her organising the rest of the place and generally bossing me around, but Utopia will be found in my shed, I often tell the cat, where there's always something of interest happening on the bench to generally keep me out of mischief.

More recently I've had the handicap of having other unwanted little visitors to the shack, in the form of a family of mice. Certainly I've heard the patter of tiny feet on more than one occasion, and a tiny grey four-legged furry thing has been spotted scurrying around at least once recently – and I don't mean Piddles, my cat!

You would think that my mousing moggie would be interested in putting paid to these uninvited guests, but you're sadly mistaken. As lazy as ever, the puss seems content to make cringing, wailing noises at feeding time and call it a day at that, occasionally stirring in between times. Nope, if I want to catch these "meeces", I rambled while addressing the cat, I guess I'll have to do it myself!

Having cycled to my local store, I returned with a brown paper bag holding a handufl of mouse traps. Back at the shack, I spring-loaded several of these fearsome-looking things and gingerly placed them strategically around my headquarters. I didn't dare ask the Boss for some pieces of cheese, in case the truth emerged . . .

So, traps all set and in place, I plugged the soldering iron in once more, and soon the shed was swimming with the heady fragrance of good old resin-core solder, as bits of wire pinged off and flew through the air, propelled by my wire cutters.

A Call-Touch

I was, as usual, beavering away constructing a new electronics project, with a construction magazine laid on the terracotta-colour bench (the remnant of my paint-mixing exercise a few weeks ago). I ticked off the wiring diagram as I deftly stripped lengths of wire and soldered them into place.

You see, I'd decided to do something about the old home-made Intercom which connected the shed to the house. An old reel of mains cable had previously been pressed into service to rig the system up, but during a bout of gardening, the cable had been snipped by the hedge trimmer, and so drastic action was needed!

A suitable Intercom project had at last been spotted in a magazine and having finally amassed all the bits, here I was, working like Alexander Graham Bell's apprentice, in a very hot shed. One thing I liked about the intercom was its "touch-switch" feature, where bridging two touch-sensitive contacts I'd made from some screw heads, caused a "call" signal to be sent to the remote unit. Skin resistance, or something.

Meantime, Piddles rooted around in the shack, feeling the need to investigate everything as usual. A sound of scampering mice could be heard coming through the wooden floor from underneath the shed. My eyes narrowed as I anticipated a mouse trap snapping shut any second now . . . but not a bean was heard! I carried on soldering, whistling a tune.

By now it was late evening and finally the Intercom was finished, and a quick check with the talking multimeter gave the thumbs-up. Yet more cable, this time some twin-core, was laid inelegantly between the shack and the house, and our new telecommunications system sprang into life as I snapped a battery onto the connector and closed everything up.

By touching the touch-switch on the Intercom in the shed, a strangled "squawk" emitted from the remote unit back at the ranch, and thus a call-signal was made. I retired back to the house, having cleared up the bench for the day, feeling duly pleased with myself at restoring communications.

Hopping Mad

At precisely 2.45a.m., so my bedside clock stated, I was awoken to the sound of a certain squawking Intercom.

A nerve-cringing intermittent screech could be heard coming from the intercom in the kitchen downstairs, and faced with the Boss's impending wrath for wakening her, I pottered bleary-eyed downstairs in my dressing-gown to investigate. Something was obviously wrong with the Intercom's other end, I muttered, which meant a visit to the shack, guided by my Woolworth's plastic torch . . .

Unlocking the shack door, I peered round inside until the flickering torch beam fell upon the new Intercom. There, sat on the plastic box, bridging the two screw-heads of the Intercom's touch switch was . . . a mouse!

I lunged forward to shoo the fiend away, but the mouse instantly flitted out of sight! Then with a *CRACK!* my slippers trod on a spring-loaded mouse trap which snapped shut on my toe!

Youch! Pirouetting round, I hopped back up the path and retired back to bed, toe throbbing, whilst Piddles, oblivious to all the commotion, went back to sleep, wondering what all the fuss was about.

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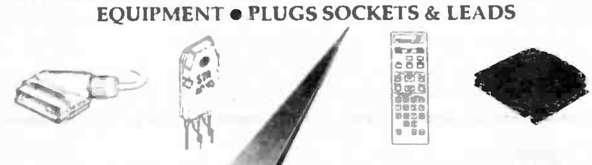

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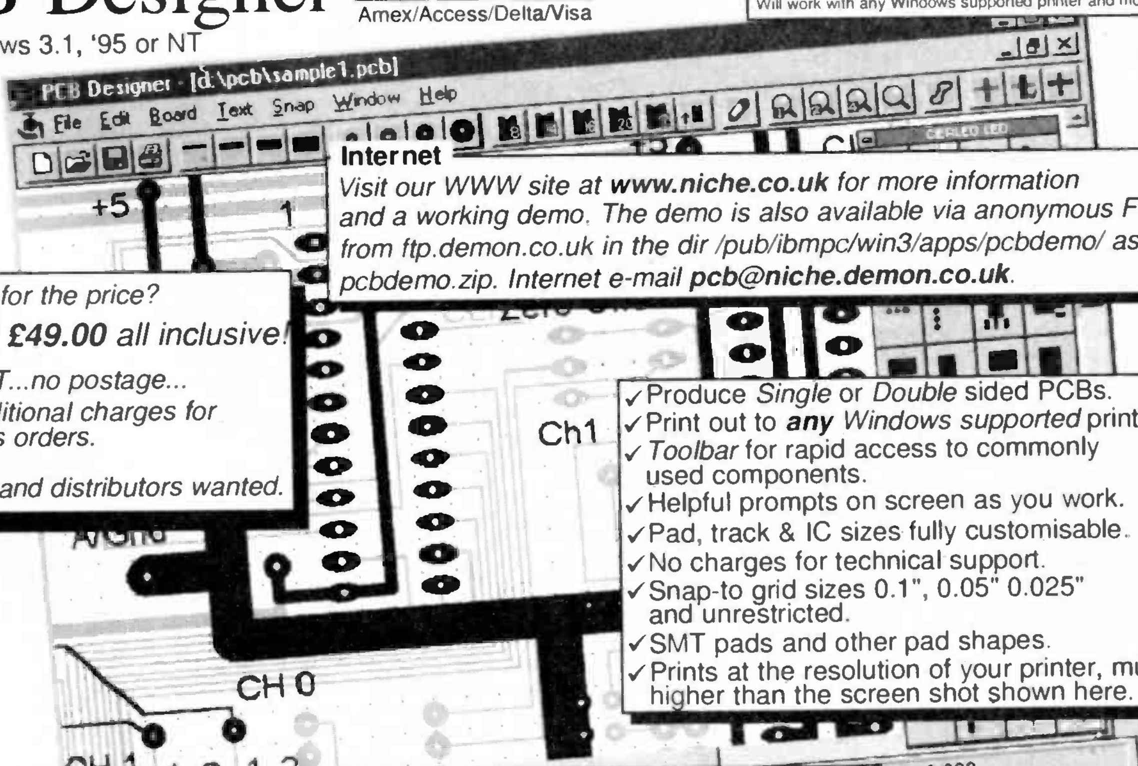

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GARDEN MOLE-ESTER

TERRY de VAUX-BALBIRNIE

Use the "green" approach to tell Mr. Mole to pack his bags!

MOLES are cute little creatures and few people would wish them any physical harm. However, damage caused by their velvety visits will try the patience of any garden lover. Some, in their frustration, will resort to the use of traps or poisoned earthworms.

ON YOUR BIKE!

This project is a humane, "green" and totally safe way of purging your garden of malingering moles. A period of use should banish your grief-stricken guests and you can get on with gardening without a constant reminder of their unwelcome visits.

In use, Mole-Ester is placed face down or buried in the ground as close as possible to any signs of activity. It does not need to be switched on – placing it with the correct orientation does this automatically.

About every 30 seconds, an audible tone is emitted for two seconds and at a frequency chosen to annoy the most tolerant of beady-eyed burrowers. The low-frequency sound conducts via the front face of the plastic enclosure through the ground.

The moles will hear this and soon decide to seek a more hospitable host for their excursions. Moving the device from one site to another will keep your non-paying guests guessing.

Using short bursts of sound rather than a continuous tone conserves the batteries. This is because the current requirement is only about 3mA between pulses but rises to 80mA average during actual operation.

It is also probably more effective this way. The internal 12V "AAA" battery pack will provide about 150 hours of service and, in practice, this means several months of occasional use.

The specified plastic enclosure used for the prototype is waterproof. The absence of a conventional on-off switch means that no holes need be drilled in it. The garden may therefore be watered in the usual way without any fear of moisture seepage ruining the circuit.

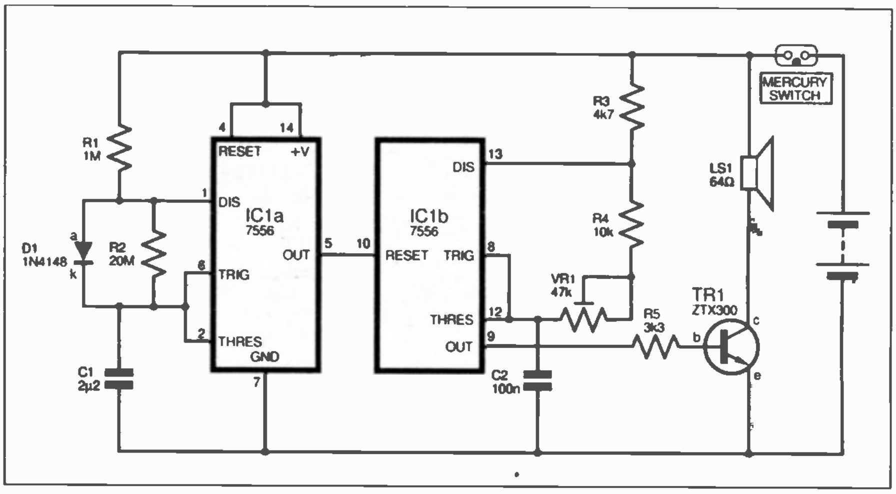


Fig. 2. Complete circuit diagram for the Mole-Ester.

CIRCUIT DESCRIPTION

The Mole-Ester circuit is illustrated in block diagram form in Fig. 1 and as a complete circuit diagram is Fig. 2. Consider Fig. 1 first. The slow astable produces pulses at half-minute intervals approximately and having a mark/space ratio of 1:15 – that is, each pulse is *on* for about two seconds or one-fifteenth of the total cycle time.

While the slow astable output is *on*, the fast astable is enabled. This latter one provides rapid output pulses at a frequency of about 330Hz. In this way, periodic short bursts at this frequency will be produced at the output of the fast astable. These pulses are input to an amplifier and hence operate a small loudspeaker which emits a deep pulsing buzzing noise.

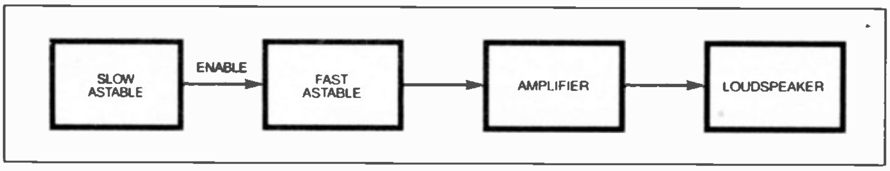


Fig. 1. Block diagram for the Mole-Ester.

SLOW PULSE

Looking at the full circuit diagram for the Mole-Ester in Fig. 2, S1 is a mercury tilt switch. When the orientation is correct, a bead of mercury inside bridges a pair of contacts and a circuit is established. This will be the case when the device is placed face-down – a supply will then be provided by battery B1 to the rest of the circuit. While the switch is horizontal (enclosure placed on its side) or upside down, the supply is cut off and no current flows.

Two halves of a dual CMOS timer IC1 form the basis of this very simple circuit. IC1a and IC1b are both configured as *astables* – IC1a being responsible for generating the slow pulses and IC1b for the rapid ones which will produce the audible tone.

The time period and mark/space ratio of IC1a are determined by fixed resistors R1 and R2 in conjunction with capacitor C1. Diode D1 is necessary to allow for a short mark/space ratio. Without it, on-chip circuitry limits the mark/space ratio to 1:1 approximately – that is, equal on and off times. With the values specified, the time period and mark/space ratio will be as stated previously.

Since these parameters are not thought to be particularly important, no adjustment is provided. However, the *on* time could be extended by increasing the value of resistor R1 and the total time period time raised by increasing R2 and vice-versa.

Output pulses are produced at pin 5 and these are applied *direct* to the reset pin of IC1b, pin 10. While "high", IC1b is enabled and while "low" it is inhibited.

The time period of IC1b is determined by fixed resistors, R3 and R4 in conjunction with preset potentiometer VR1 and capacitor C2. With preset VR1 at mid-track position, the time period will be around 3·3ms – that is, the output will pulse on and off with a frequency of about 330Hz. Preset VR1 may be used to adjust the frequency for best effect at the end of construction.

The output of IC1b (pin 9) is applied to the base (b) of transistor, TR1 through current-limiting resistor, R5. The transistor acts as a simple current amplifier and pulses of increased amplitude flow through the coil of the miniature loudspeaker, LS1, placed in the collector (c) circuit.

This then emits a pulsing tone. The loudspeaker is likely to be over-driven but this does not matter – it is not thought that moles appreciate high quality sound.

CONSTRUCTION

Construction of the Mole-Ester uses a single-sided printed circuit board (p.c.b.) The topside component layout and full size master foil pattern are illustrated in Fig. 3. This p.c.b. is available from the *EPE PCB Service*, code 106.

Note that it is essential to use the specified waterproof plastic box for this project. Other enclosures will tend to leak and this could ruin the circuit.

Begin construction by drilling the two mounting holes in the p.c.b. then solder the i.c. socket into position (but do not unpack and insert the i.c. itself at this stage). Follow with all resistors, preset potentiometer VR1 and capacitors.

Note that resistor R2 (20MΩ) consists of two ten megohm (10MΩ) components connected in series (*both* labelled "R2" in the overlay diagram, Fig. 3). This is because 10MΩ is the highest easily-obtainable value. If a single near-value resistor, say 22MΩ, is available solder it between the top and bottom pads in the "R2" position – ignore the two interconnected ones in the middle.

Solder the mercury tilt-switch, S1, into position using minimum heat from the soldering iron. When the domed top of this component points downwards it will be *on*.

Next, solder diode D1 in place taking care over the polarity (the cathode (k) end having the stripe on the body connects to IC1 pins 2 and 6). Solder in the transistor TR1, observing the orientation – the "flat" faces the right-hand edge of the circuit board.

ALL WIRE-UP

Refer to Fig. 4 which shows the off-board wiring. It seems that battery holders for eight "AAA" size cells are not listed by the popular suppliers. However, holders for four such cells are readily available so two of these will be needed. If a single holder for eight cells is available, simply solder the end leads of the PP3-type battery snap (or the appropriate type of connector for the battery holder) to the p.c.b. pads marked "B1+" and "B1–". The red wire is the *positive* or plus connection.

COMPONENTS

Resistors

R1	1M
R2	20M (2 off 10M or single 22M) – see text
R3	4k7
R4	10k
R5	3k3

All 0·25W 5% carbon film

See TALK Page

Potentiometer

VR1	47k enclosed carbon preset

Capacitors

C1	2µ2 min. metallised polyester – 5mm lead spacing
C2	100n min. metallised polyester – 5mm lead spacing

Semiconductors

D1	1N4148 signal diode
TR1	ZTX300 *npn* silicon transistor
IC1	7556 dual CMOS timer

Miscellaneous

S1	Mercury tilt-switch
LS1	64 ohm 66mm dia. loudspeaker
B1	12V battery pack (8 x AAA alkaline cells), with battery holder(s) – see text

Waterproof plastic box, size 100mm x 100mm x 50mm; printed circuit board available from *EPE PCB Service*, code 106; 14-pin d.i.l. socket; PP3 battery snap, – 1 or 2 off (or as required to connect the battery holders – see text); stranded connecting wire; quick-setting epoxy resin adhesive; self-tapping screws; solder, etc.

Approx Cost Guidance Only £19 excluding batts.

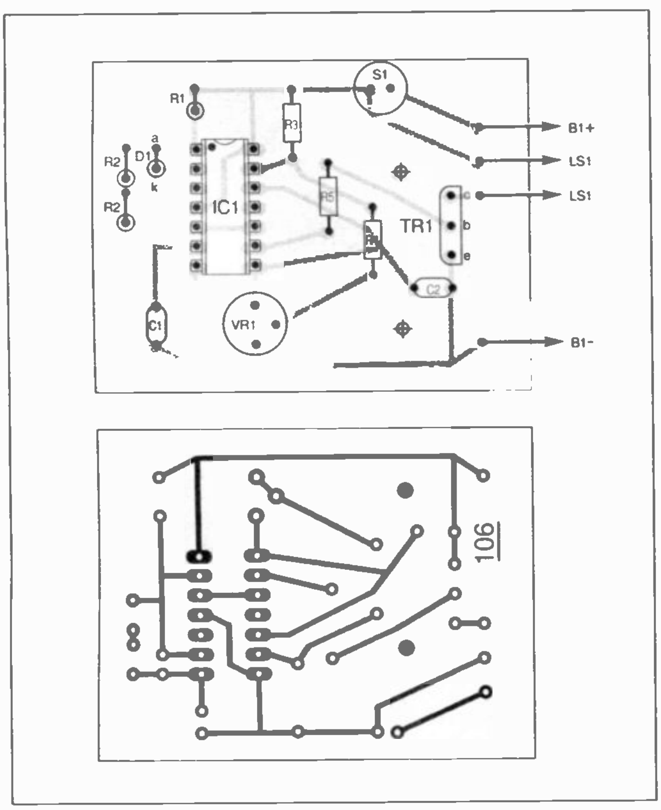
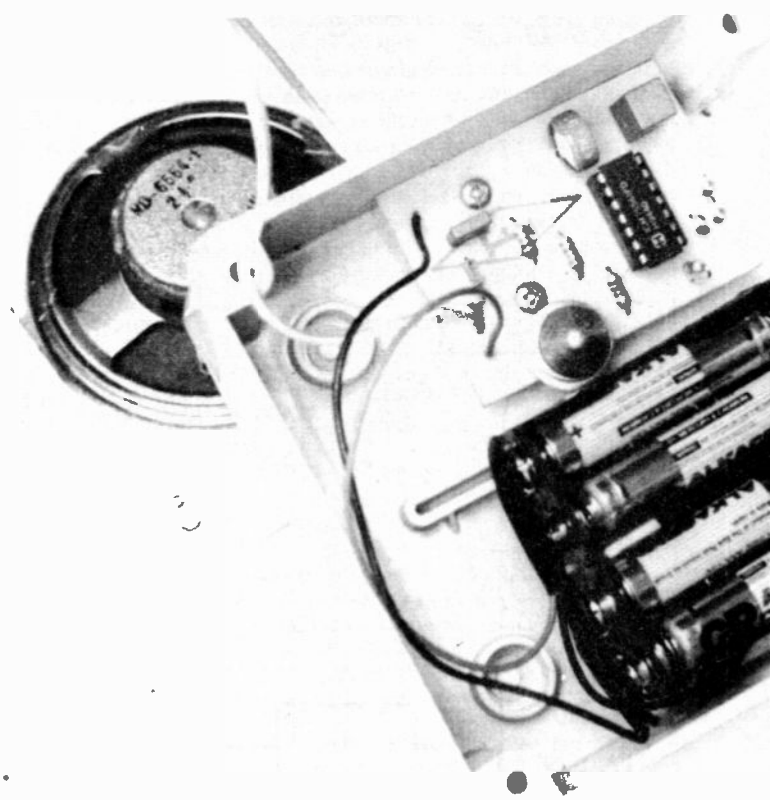
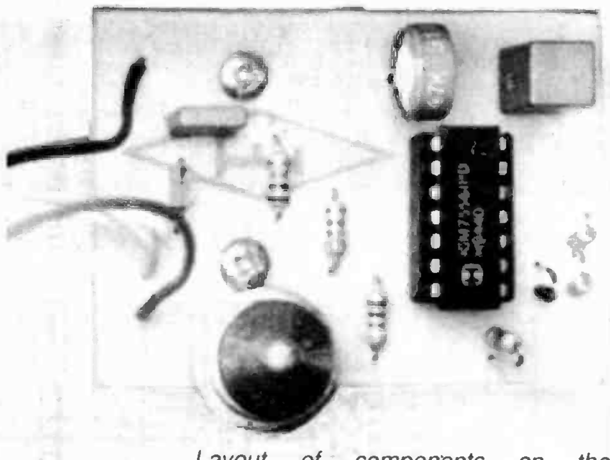


Fig. 3. Printed circuit board component layout and full size underside copper foil master pattern.



Layout of components inside the waterproof case. The loudspeaker is glued to the inside of the lid.

Burying the unit below ground, near mole activity, will soon send them packing.



Layout of components on the completed p.c.b.

If using two holders, proceed as follows (using two PP3-type battery clip leads). Solder the positive (red) lead of one of the holders to the p.c.b. pad marked "B1+" and solder the negative (black) lead of the *other* holder to the p.c.b. pad marked "B1−". Shorten the two remaining "free" ends and connect them together. Insulate the joint using a short piece of sleeving or p.v.c. tape. Fig. 4 assumes that this latter method has been used.

Solder 8cm lengths of stranded connecting wire to the two p.c.b. pads marked "LS1". Adjust preset VR1 to approximately mid-track position.

Finally, insert the i.c. observing its orientation. Since this is a CMOS component, it would be wise to touch something which is "earthed" (such as a water tap) before handling the pins. This is to dissipate any static charge which might exist on the body and which could possibly cause damage.

BOXING-UP

It is important that the attachment of internal components does not involve drilling holes in the box since this would give an opportunity for rainwater or moisture to enter. The printed circuit board is secured to the base using the existing shallow slots. These will accept *short* self-tapping screws using the holes in the p.c.b. already drilled for the purpose. Be very careful not to overtighten them.

The battery holder(s) could be held securely using a piece of foam stuck to the inside of the case lid. In this way, the batteries will be easy to replace.

Choose a position for the loudspeaker on the lid of the box where is will not foul the battery pack or anything else when in position. Attach it using a little quick-setting epoxy resin adhesive around its rim.

Solder the wires leading from the "LS1" pads on the p.c.b. on to its terminals (polarity unimportant). The loudspeaker does not need holes for the sound to pass through since it relies on the sound conducting through the face of the box and into the soil.

The sound is at a low frequency and does this well enough for the purpose. Inevitably the sound level will be reduced with the lid in position. Note that the speaker coil resistance *must* be high as specified. ***Do not use an 8Ω loudspeaker which is the more common type.***

TRIAL-RUN

Insert the batteries into their holder(s) and connect them up. Place the lid in position temporarily.

Turn the box so that the loudspeaker faces *downwards*. The circuit should operate straight away and the loudspeaker emit a loud buzzing tone for about two seconds every 30 seconds or so. Turn the box with other orientations and it should stop.

Adjust preset VR1 as required for the best operating frequency – that is, for the most effective vibration of the front face of the box. Finally, attach the lid firmly.

In some situations, placing the case flat on the ground perhaps with a weight on top will be appropriate. However, operation will be improved if it can be buried.

A period of trial will be needed to find the best position, depth, etc for the unit. Also, how long it needs to be in one place to be effective before moving it to another. The time of night and day are also worth experimenting with as is the frequency of operation.

If the device has been buried, there is no need to unearth it to check the batteries. Simply push a cane into the ground so that it touches the bottom of the case. If the ear is applied to the top of the cane, the sound should be clearly heard.

Goodbye Mr. Mole!

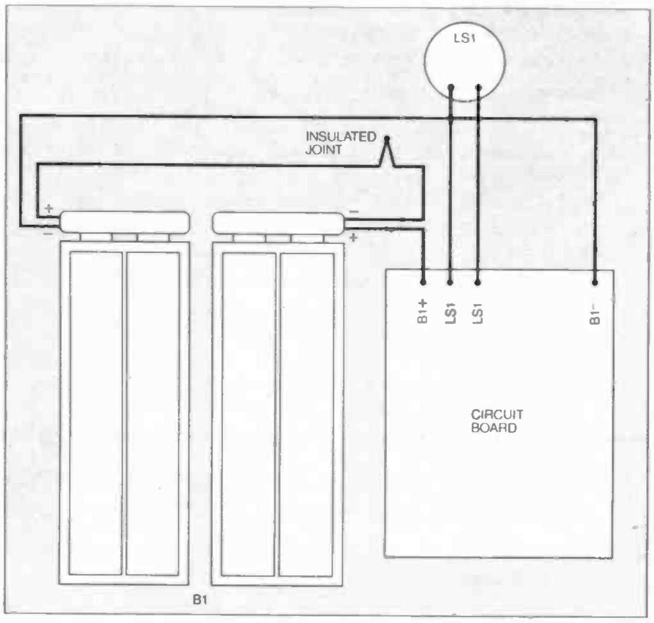


Fig. 4. Interwiring to the battery holders, speaker and circuit board.

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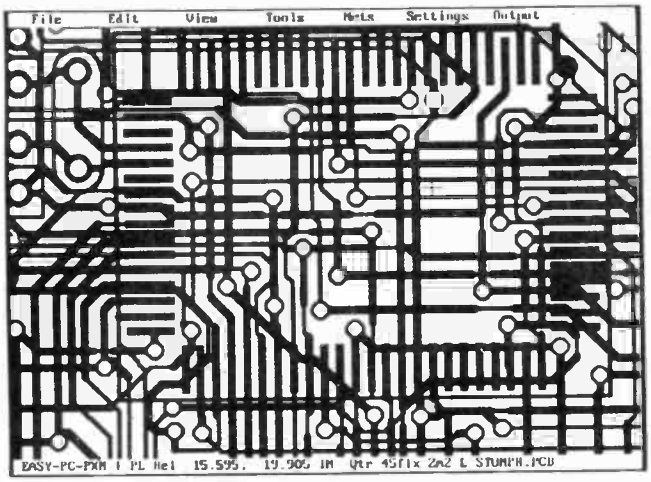

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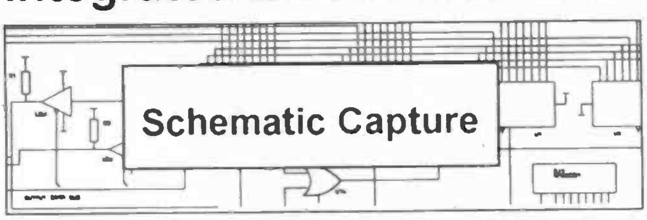

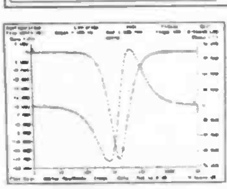

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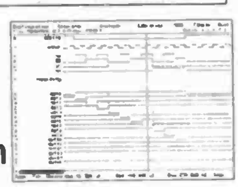

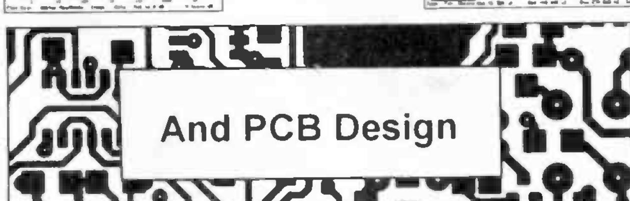

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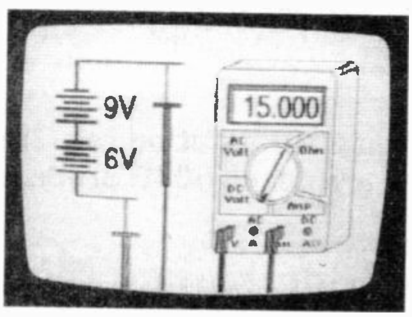

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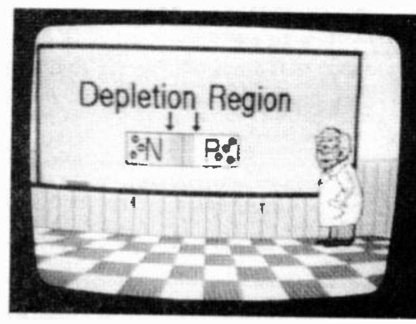

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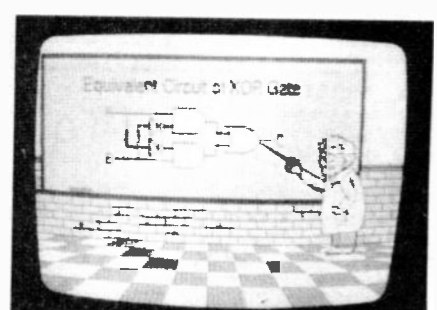

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MONO "CORDLESS" HEADPHONES

ROBERT PENFOLD

Trouble-free, easy listening, with this "personal" infra-red transmitter and receiver.

THIS "cordless" infra-red headphone system is the mono version of the stereo system described in a previous article in *Everyday Practical Electronics* (Dec 1995). It was designed primarily for use with monophonic television sets, but it should work equally well with any mono signal source that has a headphone socket.

The system consists of a Transmitter which is fed from the Headphone socket of the television (or whatever), and a personal style Receiver which picks up the modulated infra-red signal from the transmitter. This avoids having a long trailing headphone lead, which would be inconvenient and potentially dangerous.

The mono system is much simpler than the stereo version, but its level of performance is similar. The audio quality is something less than "super-fi", but a good quality audio output signal is produced provided the maximum operating range is not exceeded.

If the circuit is used with a full complement of photocells it is possible to obtain quite a large maximum range. The prototype works quite well with the Transmitter and Receiver as much as 10 metres apart.

In this respect the mono version is substantially superior to the stereo system. The finished units require no alignment or setting up of any kind.

SYSTEM OPERATION

Like the stereo system, the mono version uses frequency modulation (f.m.) to avoid problems with the pronounced nonlinearity through the photocells. In this case though, only a single carrier frequency is used, which avoids the need for the filtering and mixing used in the stereo system. This factor, plus the lack of a second channel, means that the mono version has well under half the number of components found in the stereo system.

The block diagram for the Transmitter section is shown in Fig. 1. The audio input signal is first fed to a pre-emphasis stage.

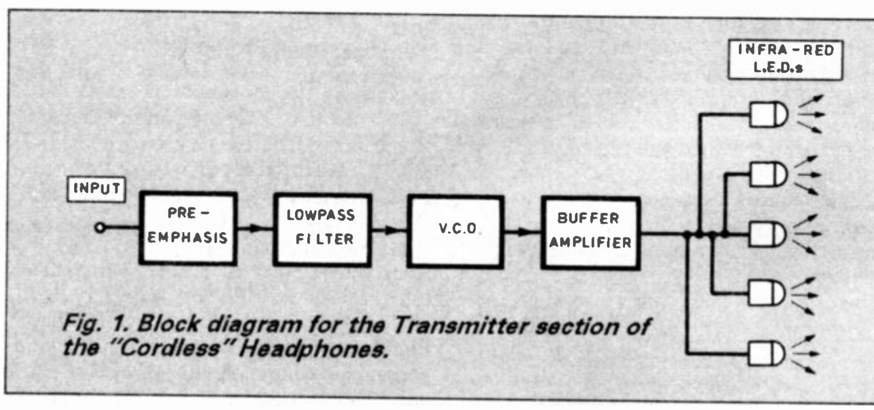


Fig. 1. Block diagram for the Transmitter section of the "Cordless" Headphones.

This applies a certain amount of high frequency boost to the signal. Complementary high frequency cut is used at the Receiver so that a flat frequency response is obtained overall.

The point of this processing is that the high frequency cut at the Receiver provides a useful reduction in the background "hiss" level. This gives a perceived improvement in the signal-to-noise ratio of about 12dB or so.

The next stage is a lowpass filter. This attenuates any high frequency components on the input signal which might otherwise react with the carrier frequency to produce heterodyne "whistles" on the audio output from the receiver.

The output from the lowpass filter is fed to the control input of a v.c.o. (voltage controlled oscillator). This generates the modulated carrier signal.

Under quiescent conditions the output frequency is about 100kHz, but positive input voltages produce an increase in the output frequency, and negative voltages produce a decrease. The higher the input voltage, the greater the increase or decrease in frequency.

As there is a single carrier frequency it is unnecessary to filter the squarewave output of the v.c.o. to produce a sinewave output signal. The Receiver circuit can deal equally well with sinewave and squarewave input signals.

The output from the v.c.o. is therefore used to drive the bank of infra-red

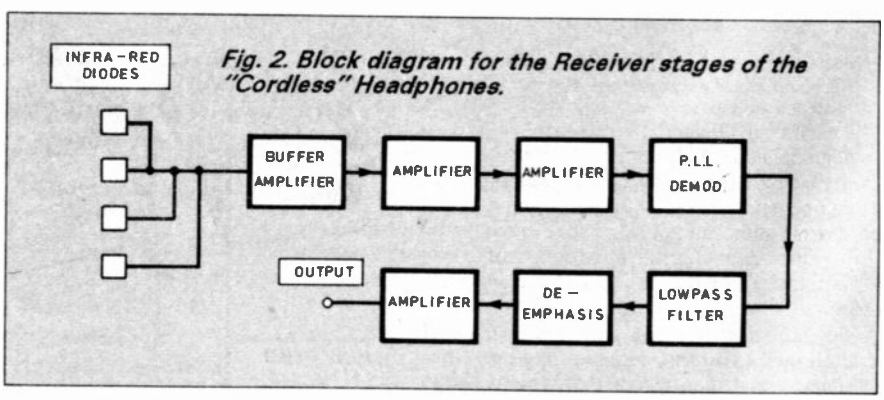


Fig. 2. Block diagram for the Receiver stages of the "Cordless" Headphones.

The total average l.e.d. current is about 250mA, and the current consumption for the entire circuit is approximately 260mA. This is too high to permit battery operation, and the unit must therefore be powered from a mains power supply unit. This must provide a well smoothed and regulated 12V output. The circuit diagram for a suggested power supply is shown in Fig. 4.

This is a conventional design having full-wave push-pull rectification provided by diodes D6 and D7. Capacitor C8 provides some smoothing, and further electronic "smoothing" and regulation is provided by IC4, which is a 12V monolithic voltage regulator.

Fuse FS1 provides protection against long term overloads, and the built-in one amp current limiting of IC4 gives short term protection.

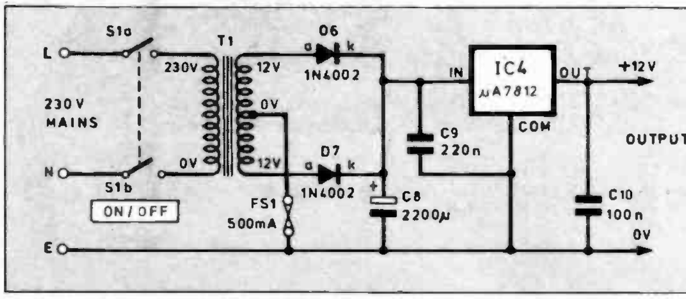


Fig. 4. Circuit diagram for the mains power supply, with regulated 12V output, for driving the Transmitter circuit.

RECEIVER CIRCUIT

The full Receiver circuit diagram appears in Fig. 5. Up to four infra-red detector diodes can be used (D1 to D4). They are wired in parallel and used in the reverse biased mode.

In other words, they are reverse biased by resistor R1, and under dark conditions only very small leakage currents flow. The pulses of infra-red from the Transmitter result in increased leakage currents, which generate small negative pulses at the cathodes (k) of the diodes.

Transistor TR1 is used as a low-noise preamplifier and buffer stage. Its voltage gain is relatively low (about 24dB) due to the local negative feedback provided by resistor R4. It provides a very worthwhile improvement in sensitivity though.

The majority of the voltage gain is provided by transistors TR2 and TR3, which are also common emitter stages. These do no have large amounts of local negative feedback, and provide a combined voltage gain of over 80dB.

The signal from TR3 is connected to one of the phase comparator inputs of IC1 (pin 14). This i.c. provides demodulation and is a CMOS 4046BE p.l.d. It is the same type of device that is used in the Transmitter, but in this case it is used as a p.l.l., and not just as a v.c.o. Resistor R10 and capacitor C6 are the timing components for the v.c.o., and they set the centre frequency at approximately 100kHz.

The output from the v.c.o. (pin 4) is connected second phase comparator input (pin 3). The phase comparator outputs are available at pins 2 and 13, but in this application it is the output from pin 2 that gives the best results.

Resistor R12 and capacitor C7 form a simple lowpass filter between the phase comparator's output at pin 2 and the input of the v.c.o at pin 9. Due to the extremely high input resistance of the v.c.o., and the relatively high carrier frequency, a single stage passive filter is perfectly adequate here.

The audio output signal is obtained from the lowpass filter via an integral source follower stage. Resistor R11 is the discrete load resistor for this stage.

Used as a third order lowpass filter, IC2 removes the residual carrier signal from the audio output. The output from IC2 is fed to resistor R16 and capacitor C12, which form a simple lowpass filter that provides the de-emphasis.

The signal is then fed to the input of IC3, which is a small class-B audio power amplifier. This provides an excessive output signal for most headphones, and resistor R17 is therefore used to attenuate the output signal. However, if the receiver is used with insensitive headphones, R17 can be reduced in value so as to boost the output signal to a suitable level.

The current consumption of the Receiver is about 12mA. This can be provided by either a "high power" PP3 size battery or six HP7 size cells in a holder.

CONSTRUCTION - TRANSMITTER

Details of the Transmitter component layout and actual size printed circuit board foil pattern are given in Fig. 6. This board together with the Receiver p.c.b. is available from the *EPE PCB Service*, codes 990 (Trans.) and 991 (Rec.).

As IC3 is a CMOS device, it therefore requires the standard anti-static handling precautions. Use a holder for this component, but do not fit it into the holder until all the components and hard wiring have been added. Try to handle the pins as little as possible. The LF351N is not a static-sensitive device, but it is still advisable to use holders for IC1 and IC2.

Fuse FS1 is fitted in a pair of printed circuit mounting fuse-clips. It must be an "anti-surge" or "time delay" fuse, and not an ordinary "quick-blow" type. A "quick-blow" fuse would tend to "blow" at switch-on, due to the high initial current flow as capacitor C8 charges up. Single-sided solder pins are fitted at the points where connections will eventually be made to mains transformer T1, jack socket SK1, etc.

Darlington transistor TR1 and regulator IC4 must be fitted with small clip-on heatsinks in order to ensure that they operate reasonably cool. Any type for use with TO220 cased devices and having a rating of about 10°C to 15°C per watt should suffice.

Resistors R9 to R13 should have a power rating of at least one watt. One watt resistors seem to be rather difficult to obtain these days, but there is sufficient space on the board to accommodate two watt resistors.

Initially, the infra-red l.e.d.s D1 to D5 are mounted vertically on the board with their leadout wires left full length, or very nearly so. Once the board has been mounted inside the case, the leadouts are carefully bent at right angles so that the l.e.d.s can be fitted into a row of 5mm diameter holes drilled in the front panel.

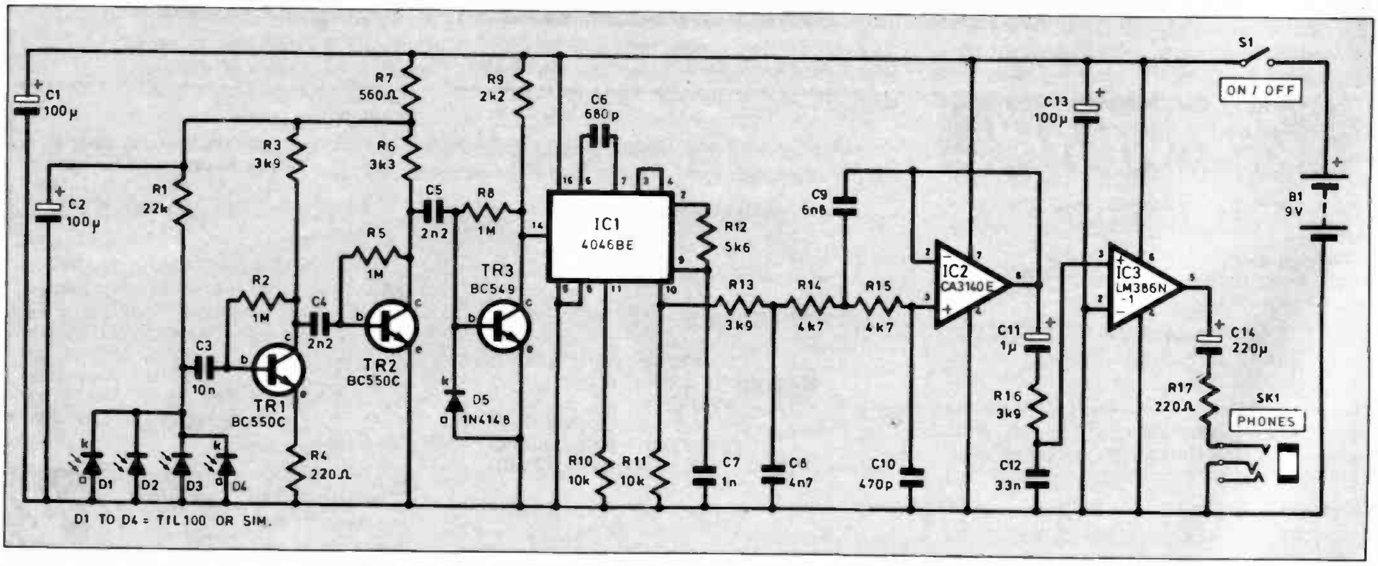


Fig. 5. Complete circuit diagram for the infra-red Receiver unit.

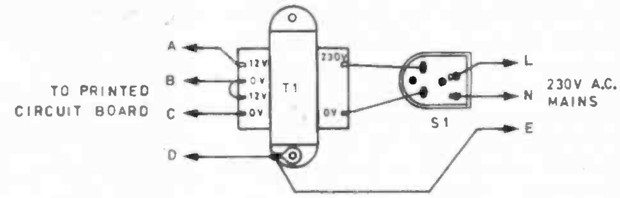


Fig. 7. Power suply wiring. Points A to D go to the p.c.b.

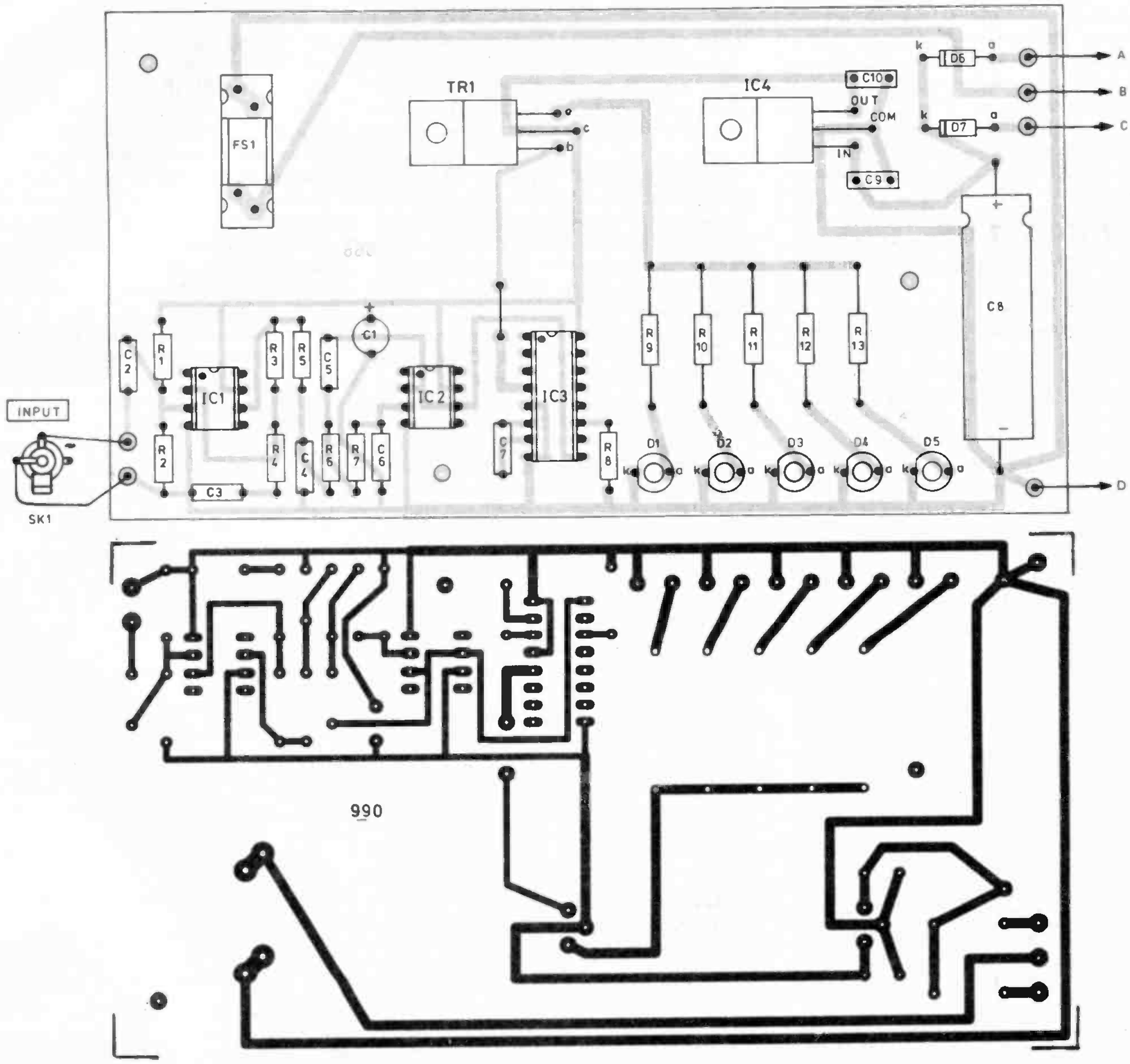


Fig. 6. Transmitter printed circuit board component layout, wiring and full size copper track master.

COMPONENTS

TRANSMITTER

Resistors

R1, R2	100k (2 off)
R3	3k9
R4	330Ω
R5, R6, R7	6k8 (3 off)
R8	10k
R9 to R13	100Ω 2W (5 off)

All 0·25W 5% carbon film, except where stated

See SHOP TALK Page

Capacitors

C1	100µ radial elect. 16V
C2	470n polyester
C3	33n polyester
C4	3n3 polyester
C5	4n7 polyester
C6	330p polyester
C7	1n polyester
C8	2,200µ axial elect. 25V
C9	220n disc ceramic
C10	100n disc ceramic

Semiconductors

D1 to D5	5mm infra-red l.e.d. (5 off)
D6, D7	1N4002 100V 1A rect. diode (2 off)
TR1	TIP121 or TIP122 *npn* power Darlington transistor
IC1, IC2	LF351N bifet op.amp (2 off)
IC3	4046BE CMOS phase-locked loop (p.l.l.)
IC4	µA7812 12V 1A positive regulator

Miscellaneous

S1	mains on/off rotary switch
SK1	3·5mm mono jack socket
T1	mains transformer, with twin 12V 500mA secondaries
FS1	20mm 500mA *anti-surge* fuse

Metal instrument case, size about 203mm x 127mm x 51mm; printed circuit board available from the *EPE PCB Service*, code 990 (Trans.); control knob; 8-pin d.i.l. holder (2 off); 16-pin d.i.l. holder; pair of 20mm fuse-clips; 6BA fixings; mains lead and plug; multistrand connecting wire; solder pins; solder, etc.

Approx Cost Guidance Only £27 excluding case

ASSEMBLY

As the Transmitter is mains powered it should be housed in a case of *all-metal* construction, and it *MUST* be reliably "earthed" to the mains Earth lead. Also, the lid or cover must be a screw fitting type, and not one that simply unclips (which would give easy access to the dangerous mains wiring). A metal instrument case about 200mm or so wide is a good choice.

The printed circuit board is mounted on the base panel of the case using 6BA or metric M3 fixings, including spacers about 6mm long to hold the connections on the underside of the board well clear of the metal case. If you use the specified case it is necessary to use longer spacers (about 12mm long) so that the board is kept well clear of one of the fixing screws for the outer casing. The board must be mounted as far towards the left-hand side of the case as possible, with the front edge of the board about eight millimetres behind the front panel.

Probably the best way of finding the correct positions for the l.e.d. mounting holes is to temporarily fit the p.c.b. in the case, and then do some careful measuring to locate the horizontal position of the left-most l.e.d. The l.e.d.s are positioned about 22mm up the panel, and have 10mm (0·4in.) spacing.

Once the board is finally installed, carefully fit the l.e.d.s into the holes in the front panel, trying to get them reasonably well aligned. It is not necessary to get them all pointing in precisely the same direction, and a small amount of divergence helps to give the transmitter a slightly wider area of coverage.

The On/Off switch is mounted well towards the right-hand end of the front panel, where it will be well clear of the circuit board. An entrance hole for the mains lead is drilled roughly opposite the On/Off switch in the rear panel. This hole should be fitted with a locking grommet to protect and secure the cable.

Input socket SK1 is mounted towards the opposite end of the rear panel. Although a 3·5mm jack socket is specified for SK1, this can be a standard jack, or any other audio connector that matches the particular signal source you will be using.

The mains transformer is mounted as far to the right and to the rear of the case as possible. A solder tag mounted on one of T1's mounting bolts provides a chassis (earth) connection point.

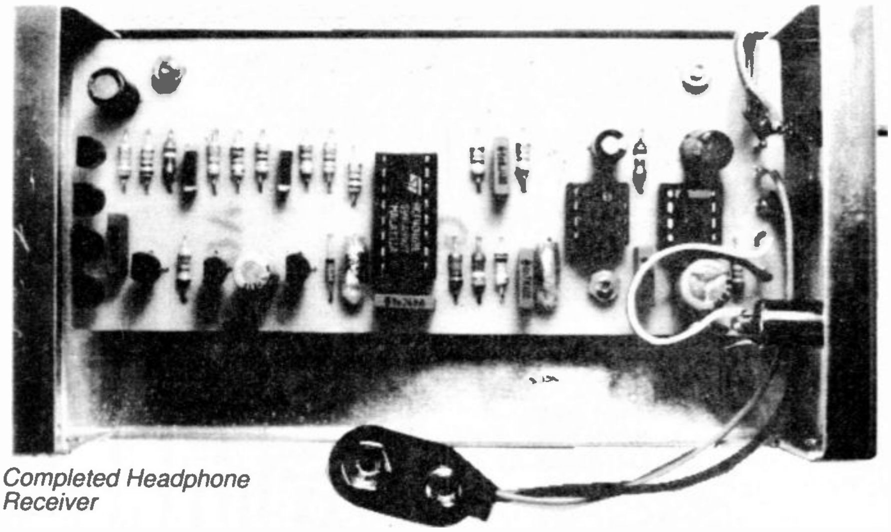
WIRING-UP

Once everything is installed in the case, add the two wires from SK1 to the p.c.b.. It is not essential to use a screened lead here, but this wiring should be kept reasonably short so that significant pick up of mains "hum" is avoided.

Details of the power supply wiring are shown in Fig. 7 and should be referred to in conjunction with Fig. 6. This is very straightforward, but as mistakes could be dangerous it is essential to be especially vigilant when adding this wiring. ***A mains powered project such as this is not suitable for beginners unless carefully supervised.***

A mains transformer having a 12V-0V-12V secondary winding is required, but transformers of the correct current rating almost invariably have twin secondary windings. Twin secondaries are perfectly suitable, and it is just a matter of wiring them in series to give what is effectively a 12V-0V-12V winding.

The wiring shown in Fig. 7 is for a twin secondary transformer. The three terminals of a genuine 12V-0V-12V secondary connect to *A*, *B*, and *C* respectively. Make sure that the mains Earth lead connects to the solder tag via a reliable soldered joint.



Completed Headphone Receiver

CONSTRUCTION - RECEIVER

The Receiver printed circuit component layout, actual size foil pattern, and hard wiring are shown in Fig. 8. This board is available from the *EPE PCB Service*, code 991 (Rec.).

Devices used for IC1 and IC2 are both MOS input types, and require the normal handling precautions. Single-sided solder pins are fitted at the points where connections to battery B1, switch S1 and jack socket SK1 will be made.

The Receiver p.c.b. will take up to four photodiodes (D1 to D4), but the use of several diodes is less important for this version than it was for the "Stereo Headphones" system. With a stereo system a stronger signal is needed for a given signal-to-noise ratio, much the same as it is for normal f.m. broadcast reception.

A single photodiode actual gives quite good results, but unless the system will only be used at short range it is worthwhile using at least two photodiodes. It is only beneficial to use all four if the system will be used over fairly long ranges of around five to 10 metres.

Although TIL100 photodiodes have been specified, any similar large area photodiodes having a built-in "daylight" filter should work equally well. Diodes of this type are not necessarily sold under a particular type number in component catalogues. They are often sold simply as "remote control photodiodes", or something similar.

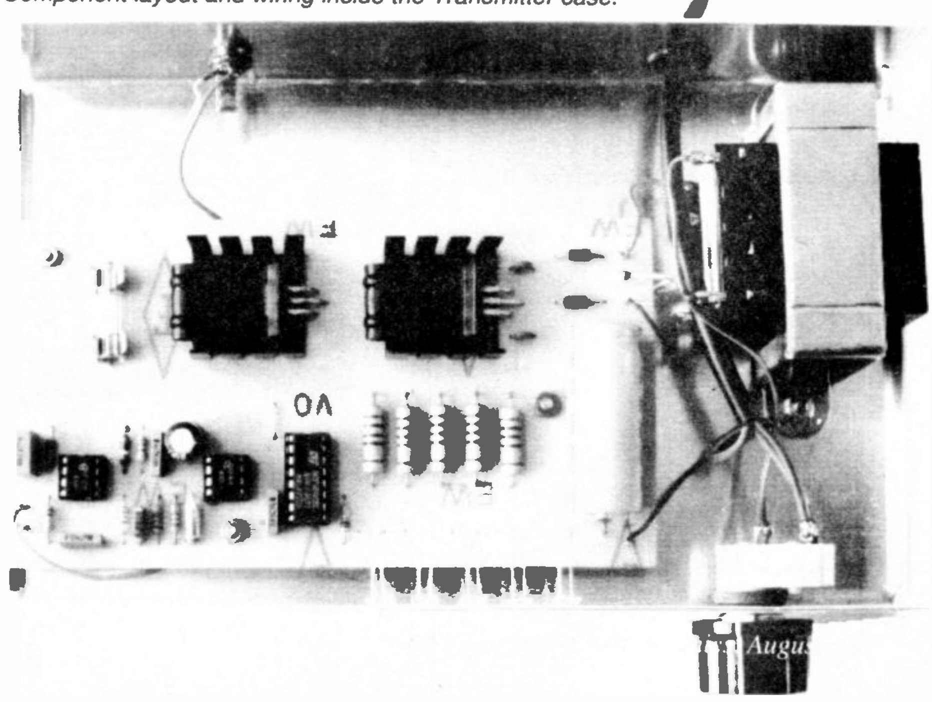
CASE

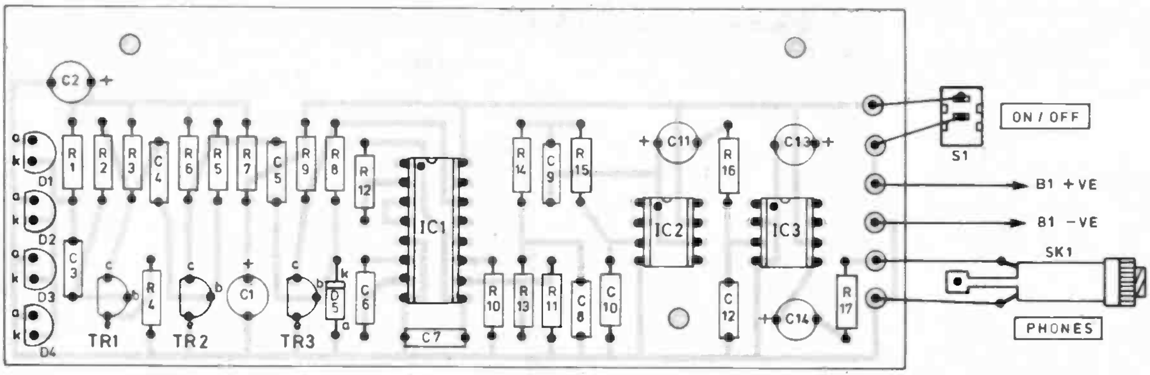
Most small to medium sized metal cases will accommodate the Receiver p.c.b. and a PP3 size battery. If you use six HP7 size cells to power the unit be careful to obtain a case that is large enough to take this relatively large battery pack.

There is some advantage in using a metal case since this will screen the sensitive input circuitry from sources of electrical interference, but a plastic case should also be suitable.

The circuit board is mounted on the base panel of the case. If the case is a metal type it is obviously essential to use short spacers over the mounting screws so that the connections on the underside board are held clear of the case.

Component layout and wiring inside the Transmitter case.





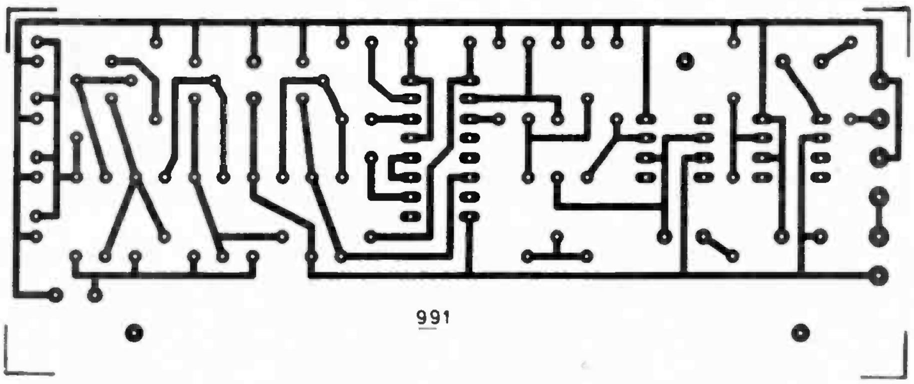


Fig. 8. (above) Circuit board component layout and wiring, and (right) actual size copper foil master for the Headphone Receiver.

COMPONENTS

RECEIVER

See SHOP TALK Page

Resistors

R1	22k
R2, R5, R8	1M (3 off)
R3, R13, R16	3k9 (3 off)
R4, R17	220Ω (2 off)
R6	3k3
R7	560Ω
R9	2k2
R10, R11	10k (2 off)
R12	5k6
R14, R15	4k7 (2 off)

All 0·25W 5% carbon film

Capacitors

C1, C2, C13	100μ radial elect. 10V (3 off)
C3	10n polyester
C4, C5	2n2 polyester (2 off)
C6	680p polystyrene
C7	1n polyester
C8	4n7 polyester
C9	6n8 polyester
C10	470p polystyrene
C11	1μ radial elect. 50V
C12	33n polyester
C14	220μ radial elect. 10V

Semiconductors

D1 to D4	TIL100 or similar (4 off, see text)
D5	1N4148 signal diode
TR1, TR2	BC550C *npn* transistor (2 off)
TR3	BC549 *npn* transistor
IC1	4046BE CMOS phase-locked loop (p.l.l.)
IC2	CA3140E PMOS op.amp
IC3	LM386N-1 audio power amp

Miscellaneous

S1	s.p.s.t. miniature toggle switch
B1	9V battery ("high power" PP3 – see text)
SK1	3·5mm stereo, chassis mounting, jack socket

Metal case, size about 133mm x 70mm x 38mm; printed circuit board available from the *EPE PCB Service*, code 991 (Rec.); PP3 type battery clip; 8-pin d.i.l. holder (2 off); 16-pin d.i.l. holder; 6BA fixings; multistrand connecting wire; solder pins; solder, etc.

Approx Cost Guidance Only £20 excluding bat.

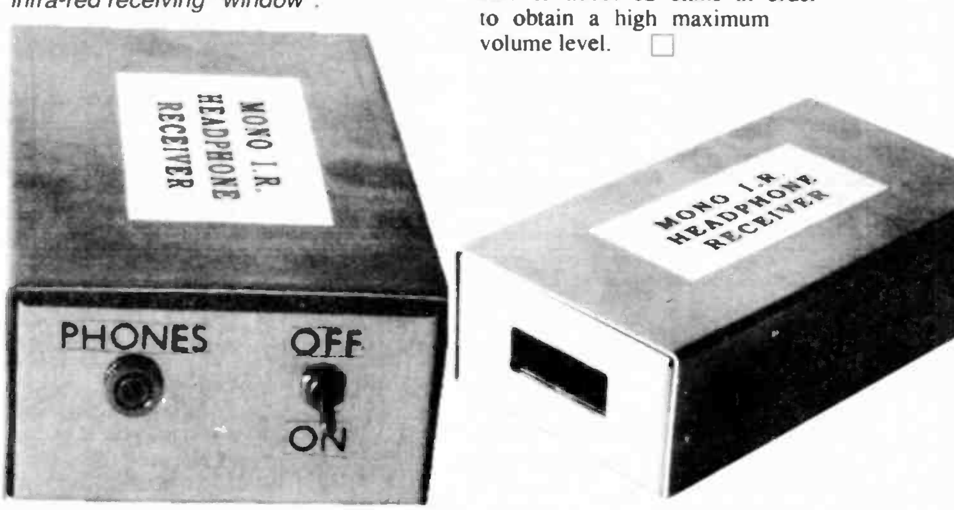
A window for the photodiodes to "look" through must be cut at the appropriate end of the case. A suitable cutout is easily made using a "needle" file, "Abrafile", etc.

It is advisable to glue a piece of transparent plastic behind the cutout. This gives a neater appearance, and keeps out dust. Switch S1 and socket SK1 are mounted at the opposite end of the case, high up on the panel where they are well clear of the circuit board.

Although the output of the Receiver is sufficient to drive virtually any headphones, the obvious choice is a pair of lightweight headphones of the type used with personal stereo units. Just like the ones given away *Free* with the March (UK only) issue.

Socket SK1 is a 3·5mm stereo jack type, which matches the plugs fitted to personal stereo headphones. The two phones are wired in series. The "earth" or common tag of SK1 is therefore ignored, and the output of the receiver is connected to the other two "channel" tags.

Opposite ends of the Receiver showing the headphone socket and the infra-red receiving "window".



IN USE

The headphone socket of the signal source, such as a TV, connects to the input socket SK1 of the Transmitter using a *screened* lead. The volume level is controlled via the Volume control of the signal source.

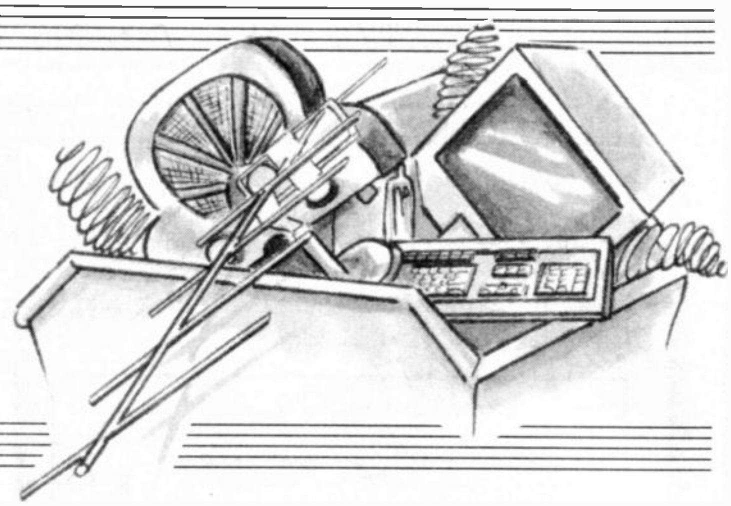
No alignment of either unit is required, so if all is well the system should provide a good quality audio link right from the start. In standard f.m. fashion, a weak signal at the receiver produces a poor signal-to-noise ratio and not a low volume level.

The Transmitter is quite directional, and it must be aimed in the general direction of the Receiver if a low noise level is to be obtained. The Receiver is less directional, but it should still be aimed roughly at the Transmitter for best results.

The specified value for resistor R17 should give good results with most headphones. If high volume levels are not required there is some advantage in using a slightly higher value (about 470 ohms). This gives a slightly lower background noise level.

If the Receiver is used with insensitive headphones it may be necessary to reduce R17 to about 82 ohms in order to obtain a high maximum volume level. □

Special Feature



THAT'S A BARGAIN!

MIKE BROWN

An expert offers tips on keeping down construction costs.

WHY let radio components burn a hole in your pocket? For a fiver, you can listen to the world. For a little more, you can talk back!

If you're a seasonably good bargain hunter, and good with your hands, you can slash pounds off constructional projects – and have a lot of fun in the process.

BOODLE-BUG

I was nine years old when the radio bug bit. World War II had eighteen more months to run. Pocket money was non-existent. I became adept at bargain hunting.

An old mains transformer was acquired. From the wire recovered, I built a tuning coil on the cardboard tube from a spent toilet roll. The remainder of the wire provided an aerial and earth system. The tuning capacitor was fashioned from two tin cans, and the detector, or "cat's whisker", was a broken razor blade.

I traded my pocket knife, six marbles, and a set of cigarette cards, for a pair of headphones. With two pieces of wood for a base and front panel, my haul was complete.

The resultant construction looked like a "Heath Robinson" special – but – it worked! The absolute thrill of listening to the BBC local radio station on my very first home built radio receiver has yet to be repeated.

A GOOD TIP

We are a little more fortunate today. Considerable quantities of redundant and obsolete electronic equipment is thrown out by various firms every day. These are usually destined for the local Council Tip. Some of it finds its way into second-hand shops. I have also seen the odd item for sale at car boot sales.

Depending upon the philosophy of your local Council, it's sometimes possible to purchase various items at the Tip. It is always worth a visit to these establishments to have a look around, and ask questions.

Industrial estates are also worth a visit. See if you can find a reasonable sized electronic firm. Seek out the Service, or Test Department Manager. Tell him of your hobby. Ask if there is any redundant, or obsolete equipment due to be thrown out in the near future.

My latest acquisition was obtained in this fashion. Seeing some likely looking equipment being hurled into a skip, I asked if a particular piece of equipment I'd spotted could be purchased.

"Oh no," was the reply, "we don't sell this stuff, but if you can make use of it, take it."

This netted me two 4-digit l.e.d. displays, an assortment of rotary and toggle switches, several control knobs and – these can be expensive to buy – a power supply unit, 240V a.c. in, 22V d.c. at 1A out. Plus, of course, a metal cabinet, measuring 450mm × 200mm × 300mm. Quite a saving!

HUNTING AND HAGGLING

Bargain hunting and haggling adds to the fun and satisfaction of home construction. Car boot sales and markets are ideal hunting grounds. For instance, a standard transistor radio will net you a tuning capacitor, ferrite rod, volume control, switches and a loudspeaker.

Unless in good condition, and only if you have the equipment for removing them, it is not worth recovering the transistors, although the I.F. transformers might save you a pound or two.

I would not suggest buying old car radios. There is little in these which is easy to use.

Don't pay the asking price straight away. Haggle. Most traders expect you to anyway. If you've paid more than a fiver for a transistor portable, you've paid too much.

I recently purchased a sorry-looking Morse key. The key was filthy, but the springs and contacts looked to be in good working order. The owner wanted £25. After a few minutes haggling, I got it for £7.50. Stripped, cleaned and polished, it made a beautiful addition to my station. I would not part with it now for £50.

CHEAP HAM

Many people have said to me they would like to take up amateur radio as a hobby, but thought it too expensive. I cannot agree. Simple receivers, transmitters and ancillary equipment can be built very cheaply.

A three-stage transistor receiver, and a four-stage transmitter giving a four to five watt output, and built for the forty metre amateur band, will give you long distance communication and, in my opinion, far more satisfaction.

I found it easy to work amateur radio station PT7CAW in Brazil, using 150 watts from £2000 worth of commercial equipment. It was far more satisfying to work station SM3RYG in Sweden, using only 1W of power from a home-built station costing less than £30.

IMPROVISATION

"Necessity is the Mother of Invention." Too right it is! If you can't afford to purchase a metal case, why not use wood? A stout base with plywood sides, top and front panels, and lined with aluminium baking foil, is just as effective, and easier to work with.

No room to site your equipment? Why not build it into a square-section brief case? World War II espionage operators used far less sophisticated equipment, and look at what they achieved!

Small, modern rechargeable lead acid gel batteries are quite adequate for low power equipment, so saving the need for mains operation.

No room for an aerial? Use a small magnetic loop. Commercially produced magnetic loop aerials can be very expensive, £300 to £400 upwards. So, why not make your own?

I recently purchased a length of scrap copper pipe from a breaker's yard. To this I added an old heavy three-gang tuning capacitor rescued from an ancient radiogram. The tuning capacitor was driven via a miniature gearbox obtained from the local Tip.

Two lengths of Bowden cable from another breaker's yard, a wooden base and a piece of 3in. × 3in. wood, and I had all the components needed for a loop aerial at a cost of £12.

The resultant construction was not at all Heath Robinson – and it worked! The first contact with my home built 3ft diameter magnetic loop aerial was a German amateur DL9SBO, who was driving down the autobahn in Stuttgart.

HELPING POWER

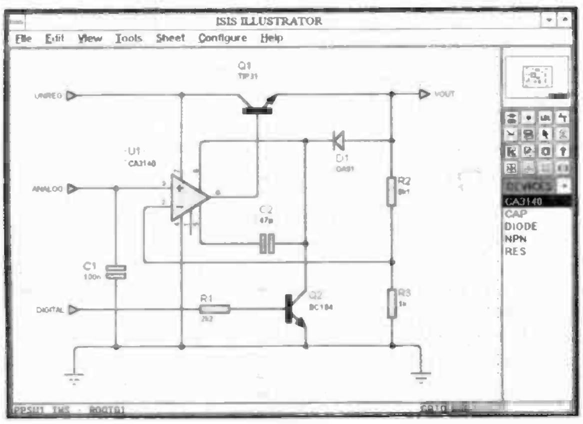
No help at hand? Join the G-QRP Club whose increasing membership is devoted to low power communication using simple, and not so simple circuitry. The Club can be contacted c/o G0BXO, Flat 7, 56 Heath Crescent, Halifax, HX1 2PW.

Finally, always remember the mnemonic KISS (Keep It Simple – Stupid!) □

PROFESSIONAL CIRCUIT AND PCB DESIGN AIDS FOR WINDOWS

CADPAK for Windows

CADPAK is especially suited to educational, hobby and small scale schematic and PCB design. CADPAK includes both schematic drawing and 32-bit PCB drafting tools but as an entry level product, there is no netlist link between them.



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

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- *Full control of appearance including line widths, fill styles, fonts, colours.*
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- *Gerber, Excellon and DXF outputs as well as output via Windows drivers. Also includes Gerber viewer.*
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CADPAK FOR WINDOWS .... £ 149
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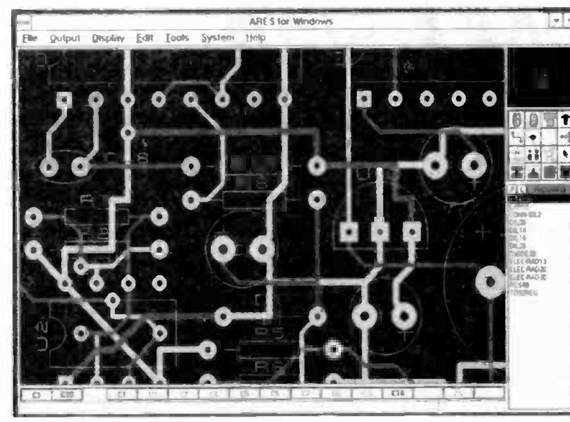
PROPAK for Windows

PROPAK has all of the features in CADPAK plus netlist based integration, automatic power plane generation and a powerful auto-router. PROPAK includes enough schematic capture and PCB design functionality for all but the most demanding applications.



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TEACH-IN '96

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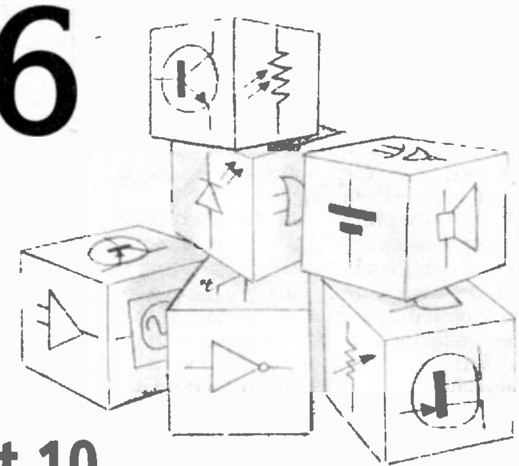

Max Horsey **Part 10**

WITH this tenth article, we come to the end of the *Teach-In* series, having examined a range of modules variously divided into Input, Processor and Output sections. Where possible a choice of module has been offered within each section.

Each of the ten parts has been accompanied by a constructional article, complete with p.c.b. design, demonstrating how a complete project may be devised by employing the modules described. Each project has been one of many possible ideas that could be implemented, and it is hoped that readers have been designing for themselves a variety of circuits by combining modules provided throughout the whole series.

The range of modules covered in the series is detailed in Part 1, Table 1.1. Each module can link easily with adjacent modules in the same part, and they may also be linked with other parts in the series.

Max Horsey is Head of Electronics at Radley College in Oxfordshire. The printed circuit boards for the first nine example projects which accompany the series were designed by some of his students.

THE FINAL part in this series examines "proximity sensing", which has applications in metal detection, or in measuring the speed of a rotating object, for example. The processor modules include two ways of converting a frequency into a voltage, and the output section reveals more about the LM3914 bargraph display i.c. already met in *Teach-In* Part 8.

The associated project is a bicycle speedometer, the *Bike Cyclo*, but which can easily be adapted to make a tachometer suitable for other applications.

PROXIMITY DETECTION

As has already been proved in other parts of the series, detecting the *position* or *presence* of an object is comparatively simple. For example, the fact that a door or window is closed can be detected by means of a micro-switch or a reed-switch and magnet as described in Parts 2 and 3, and detection of the breaking of an infra-red beam was demonstrated in Part 8.

However, detecting the *speed* of a rotating gear wheel, motor shaft or bicycle wheel is a little more awkward, particularly if a circuit is required to accurately count the number of pulses per second.

Perhaps the most obvious method of detecting the motion of a wheel is to fix one or more magnets to the wheel and allow them to pass near a fixed reed switch, detecting their presence as they do so. The distance between the magnet and reed switch is quite critical: too large and the switch will not function, too close and the switch will be shattered into oblivion.

Even if reliable switching is achieved, switch contact bounce – that awkward problem where the contacts vibrate several times whenever the magnet is moved towards or away from the switch – is a real problem. Anti-bounce circuits, such as the monostable described in Part 2 will solve the problem, but will limit the upper frequency possible.

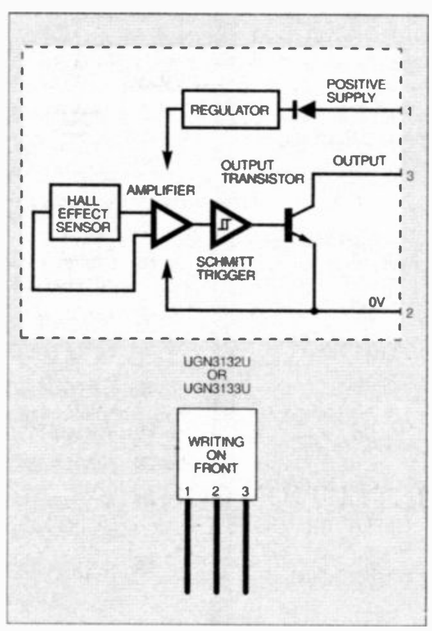

Fig. 10.1. Block diagram and pinout details for Hall effect sensors type UGN3132U and UGN3133U.

Not only that, any type of switch has a finite limit to the number of times it can be used before its contacts wear out – it is probably several hundred thousand times, but with bike wheel rotation sensing, it does not take too many miles to reach that sort of operational figure. Consequently, reed switches are best avoided in this context!

USING LIGHT

If a solid wheel has one or more holes punched through it, a beam of light (or infra-red) can be projected at the wheel, and a photodiode or phototransistor can be positioned behind the wheel, although light dependent resistors, such as the ORP12 device, are too slow.

As the wheel turns, the light will strike the sensor in pulses, the frequency of which will correspond to the rotational speed of the wheel. Indeed, the modules required to achieve this have already been described; for example, light sensors appeared in Part 1 and infra-red systems in Part 5.

A similar idea is to paint black and white stripes on a shaft or wheel, and allow a light (or infra-red) beam to reflect off the striped surface. Complete photo-reflective sensors are available which include an infra-red emitting diode and a phototransistor mounted side by side in a plastic housing.

Although these methods are well established, they are rather cumbersome, and there is always a risk of ambient light or infra-red radiation causing problems, unless coded systems are used (encoding and decoding modules appeared in Part 5).

HALL EFFECT SWITCHES

Inexpensive Hall effect switches are available, however, comprising a magnetic sensing element, voltage regulator, temperature stability circuit, amplifier, Schmitt trigger and open collector transistor all on one chip. Types UGN3132U and UGN3133U are considered here, which

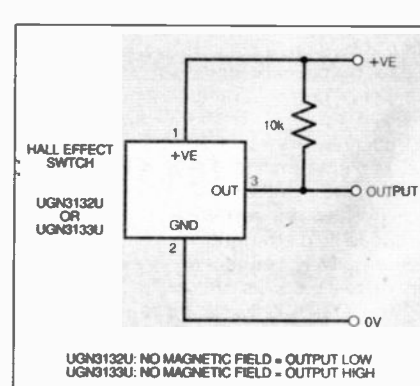

Fig. 10.2. Biasing the output.

are integrated circuits (i.c.s) and resemble a very small transistor with three leads: positive supply, 0V supply, and output. They can operate on a supply of between 4.5V and 24V d.c., and have built-in protection against reverse polarity. Above all, these devices are completely bounce free and are very sensitive. A block diagram is shown in Fig. 10.1.

Notice the open collector transistor output. Unsuspecting users might connect a voltmeter between an unconnected output and ground. and be disappointed by the lack of a reading. An open collector output is simply a transistor with its collector not connected internally. It must be connected externally to some other component through which current can be delivered to it. This can be easily achieved with a resistor as shown in Fig. 10.2.

The output can sink up to 25mA. With a 12V supply, a 1kΩ resistor allows about 12mA to flow; well within a reasonable safety margin. However, a 10kΩ resistor as shown in Fig. 10.2 will provide sufficient current (about 1·2mA) for the processor modules in this series, and is less wasteful.

Notice that opposite effects are achieved according to the choice between types 3132 and 3133. When a magnetic field is *not* present, the output from the 3132 is nearly 0V, switching to the supply voltage when a magnet is brought near. The output from the 3133 does the opposite.

Note that the magnetic field must be facing the correct way relative to the Hall effect switch. If the circuit fails to work, try holding the opposite pole of the magnet against the switch.

PROXIMITY DETECTOR CS209A

The proximity detector device CS209A, in conjunction with a few other components, is capable of detecting a variety of metals including copper and aluminium. It provides a reasonable degree of sensitivity at the expense of a more complicated circuit.

The CS209A i.c. is an 8-pin chip which can operate on a supply of between 4V and 24V and, like the Hall effect switches 3132 and 3133, has two open collector outputs. It has a variety of applications, including sensing rotational motion, sensing coins and more general metal detection, such as pipes and cables in walls. A block diagram of its internal arrangement is shown in Fig. 10.3.

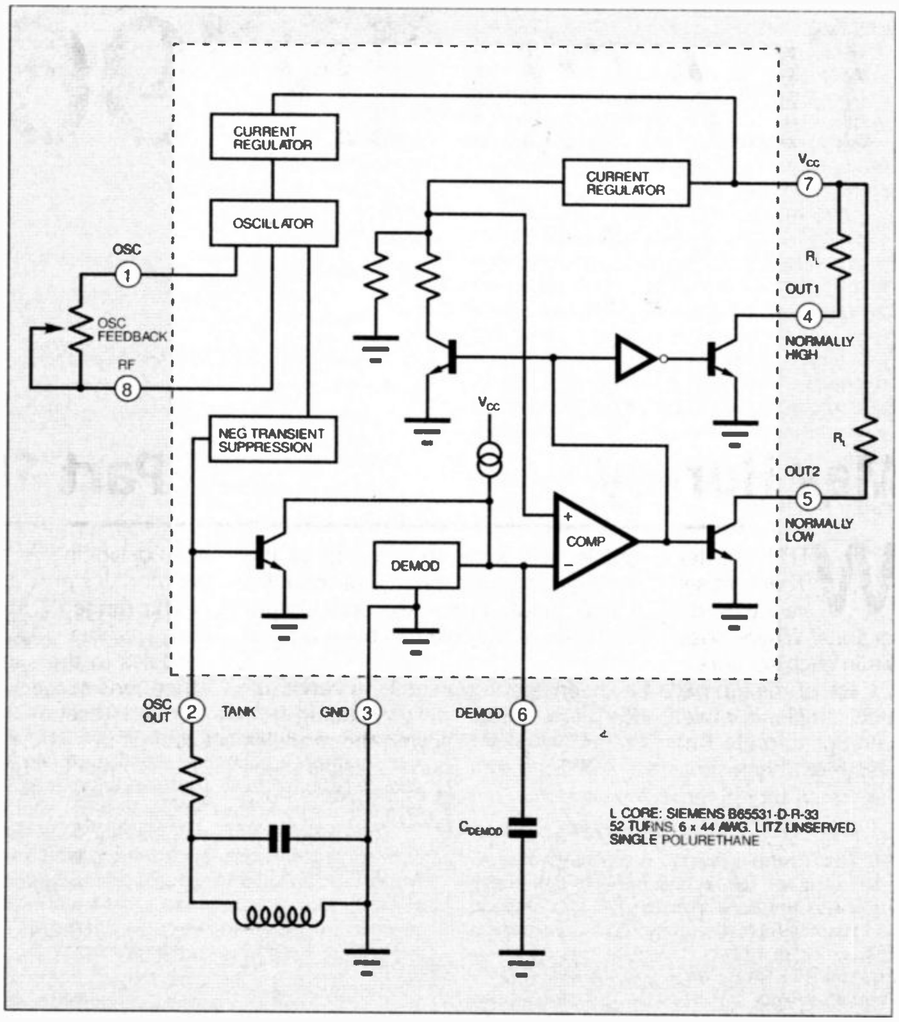

Fig. 10.3. Functional block diagram for the CS209A proximity detector.

Details of one way that the i.c. can be used in a circuit module are illustrated in Fig. 10.4. The two outputs are from pins 4 and 5. Data sheets sometimes refer to these outputs as "normally high" or "normally low". To the uninitiated, these references can seem misleading, since neither output will show any sign of life if a voltmeter is simply connected between it and 0V. Both outputs require pull-up resistors (as shown in Fig. 10.3 and implemented as R6 and R7 in Fig. 10.4) if they are to switch between 0V and positive in response to changing magnetic field strengths.

Alternatively, either or both outputs can drive l.e.d.s as shown in Fig. 10.4, D1 and D2. If only l.e.d.s are required, and the chip is not required to feed its outputs to other circuits, then resistors R6 and R7 can be omitted.

Good quality capacitors are recommended, such as close tolerance polystyrene for C1 and polyester layer for C2. Power line decoupling is not shown in Fig. 10.4, since the module will probably form part of a larger circuit, and general decoupling should be included as discussed in Part 1. But, just for reference, the circuit should at least have a 100nF capacitor across the supply rails.

DETECTION COIL

Unlike the UGN3132 and UGN3133 devices, the CS209A does not sense the presence of metals directly, but instead applies an oscillating signal through the detection coil, L1, connected to its oscillator output pin 2 via resistor R1. The latter limits the current flowing into the coil if its inductance value and the output frequency are not tuned.

Capacitor C1 assists in the tuning and shaping of the signal passing through the coil. Fine tuning of the signal frequency is set by the panel mounting control potentiometer VR1, with resistor R3 limiting the minimum resistance value. VR1 may be replaced by a preset potentiometer if preferred.

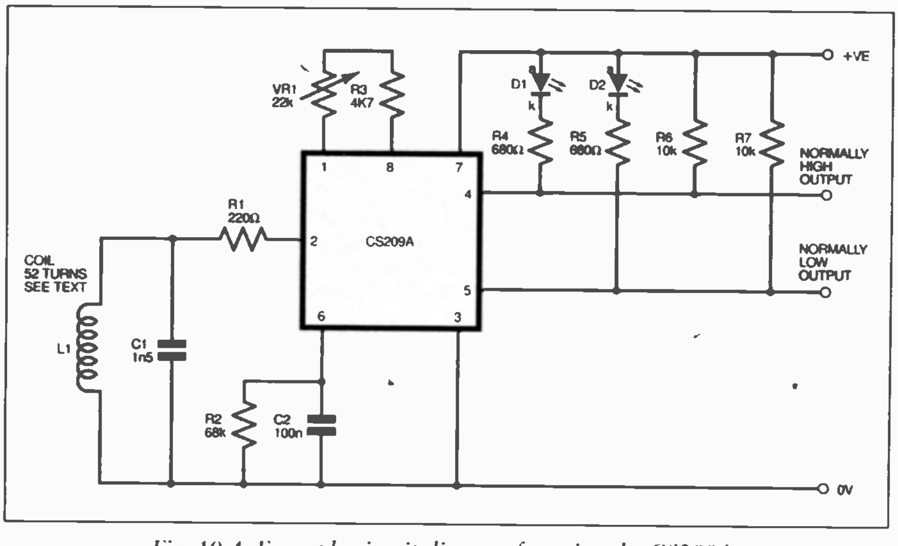

Fig. 10.4. Example circuit diagram for using the CS209A.

The amplitude of the signal passing through the coil is affected by metal objects coming close to it, and the i.c. is "tuned" to detect any change of amplitude. The coil can be purchased either as a 100µH choke or as a specially made search coil which is available from some suppliers.

Alternatively, home-made coils provide excellent results, if their larger size is not a problem. About 50 turns of insulated wire ("normal" stranded circuit assembly wire), wound around a hollow cardboard tube of about 3cm or 4cm diameter provides a good starting point. Note that thicker wire may provide a greater detection distance, and that enamel covered wire takes up less space than plastic insulated wire.

Note that in the circuit of Fig. 10.4, l.e.d. D1 is wired to light up when metal is detected. Adjust potentiometer VR1 until D1 is just off (or D2 is just on). If l.e.d.s are not included, connect a voltmeter to the normally low output (with R7 fitted), and adjust VR1 until the voltmeter just switches from the full output voltage to about 0V.

Move a metal object (such as a pair of wire strippers) near the coil. The l.e.d.s should change state or the voltmeter reading should go high again. If not, adjust VR1 more carefully.

TROUBLE SHOOTING

This module can be a bit frustrating to set up since the actual inductance of the coil and the capacitance of C1 in relation to the control frequency have a very large effect. But it can work very well, so persevere! Slight changes to the coil or its wires can affect the circuit and require VR1 to be adjusted to change the resistance between pins 1 and 8 of the i.c. Even connecting the coil via longer wires can change the switching point significantly.

With the values shown in Fig. 10.4, the total resistance between pins 1 and 8 of the i.c. can be varied by VR1 from 4k7Ω to 27kΩ. If the l.e.d.s will not change state despite the wiper of VR1 being moved from one end to the other, the problem may be due to variations in the coil, necessitating the use of a resistance outside the adjustable range.

If this is suspected, try a 100kΩ preset for VR1, and a lower value of, say, 1kΩ for R3. It should now be possible to make the l.e.d.s change state, but it will also be much more difficult to fine tune the preset.

Note that if l.e.d. D1 will not switch on, you should try increasing the total resistance (R3 plus VR1) or increasing the value of capacitor C1. if l.e.d. D1 will not switch off, try decreasing the total resistance or the value of C1.

Summary of the input modules so far discussed:

REED SWITCH

ADVANTAGE:
Straightforward

DISADVANTAGES:
Major problems with contact bounce
Unreliable in fast switching operations
Only senses magnetic fields (e.g. magnets)

LIGHT OR INFRA-RED BEAM

ADVANTAGE:
Can have a long detecting distance

DISADVANTAGE:
Cumbersome, can be power hungry and expensive

HALL EFFECT SWITCHES

ADVANTAGES:
Bounce free operation
Reliable at high speeds
Very simple to use
Inexpensive

DISADVANTAGE:
Only senses magnetic fields (e.g. magnets)

PROXIMITY DETECTOR CS209A

ADVANTAGES:
Features a much greater range of detection
Provides clean switching outputs
Detects a wide variety of metals

DISADVANTAGE:
Requires a detecting coil and other components

555-BASED TACHOMETER

To convert pulses derived from a rotary motion source into a form which can then be related to speed, a frequency-to-voltage converter can be used as a tachometer. Once again the 555 timer i.c. can appear – this time configured as a monostable, similar to the circuit which was discussed in Part 2, Fig. 2.10.

Any monostable would do, but the 555 provides consistent timings, which is important for accuracy in one respect, though, as will be seen, there can be another problem for accuracy. The principle of operation is shown in Fig. 10.5.

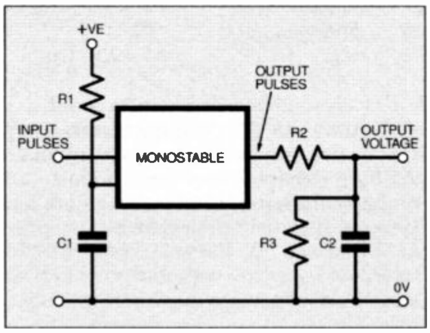

Fig. 10.5. Basic frequency to voltage conversion using a monostable.

The monostable acts as a buffer and pulse width controller. Each input pulse causes the monostable output to switch high for a fixed time. The input pulses may be short and vary in length, but the output pulses will be of a fixed width, as shown in Fig. 10.6.

However, the maximum frequency possible with this system depends upon the monostable timing period. If the frequency of the input pulses is too fast, the output will just stay permanently triggered, i.e. positive. The monostable timing period (t) can be calculated by using:

$$t = 1{\cdot}1 \times R1 \times C1$$

where t is in seconds, R1 is the timing resistance in ohms, and C1 is the timing capacitance in Farads.

As discussed in other cases where a timing formula is quoted, R must be expressed in megohms (MΩ) if C is expressed in microfarads (µF). The relationship between period (t) and frequency (f measured in hertz – Hz) is given by:

$$f = 1 / t$$

The consistency of the output pulses, both in terms of voltage and width, causes capacitor C2 to charge to a voltage which depends upon the frequency of the input pulses. The values of resistors R2 and R3 and that of C2 will affect this voltage, of course, but having fixed these values the output voltage will rise roughly in step with the input frequency.

The circuit works well if the frequency range being considered is not too wide, and some experimentation is recommended to achieve good results. If the frequency range is too great, it will be found that the output voltage does not rise in direct proportion to the frequency. This may or may not matter, depending upon the application. Also, at very low frequencies, such as below 5Hz, there will be noticeable ripple (voltage fluctuations) at the output.

555 TACHOMETER CIRCUIT

A full circuit diagram for a tachometer module based on the 555 i.c. is shown in Fig. 10.7. The first point to note is that the 555, IC1, is triggered at pin 2 by negative going pulses (i.e. as the voltage falls from positive towards 0V). The trigger threshold is at one third of the supply voltage.

To ensure that consistent results are achieved with a variety of input signals, the trigger pin 2 is a.c. coupled by means of capacitor C1. This means that the input signal must move downwards suddenly in order to trigger the i.c. The advantage offered is that the input signal supplied to the capacitor does not have to swing between any particular pair of voltages, as long as the total swing is greater than the trigger threshold range. It could, for example, swing above and below 0V on the input side of C1. A

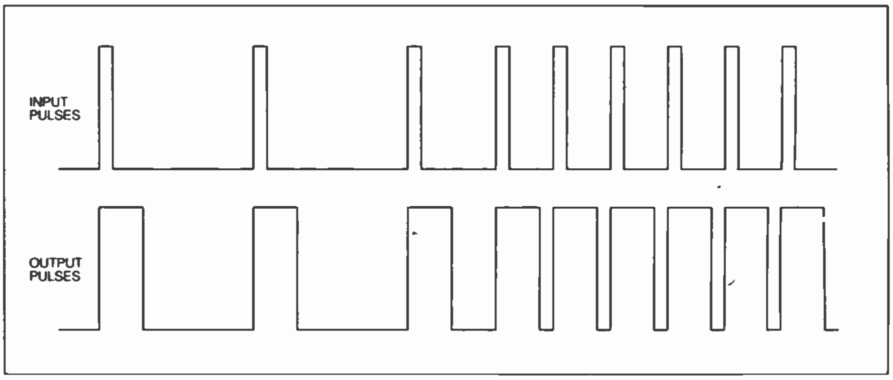

Fig. 10.6. Relationship of monostable input and output pulses.

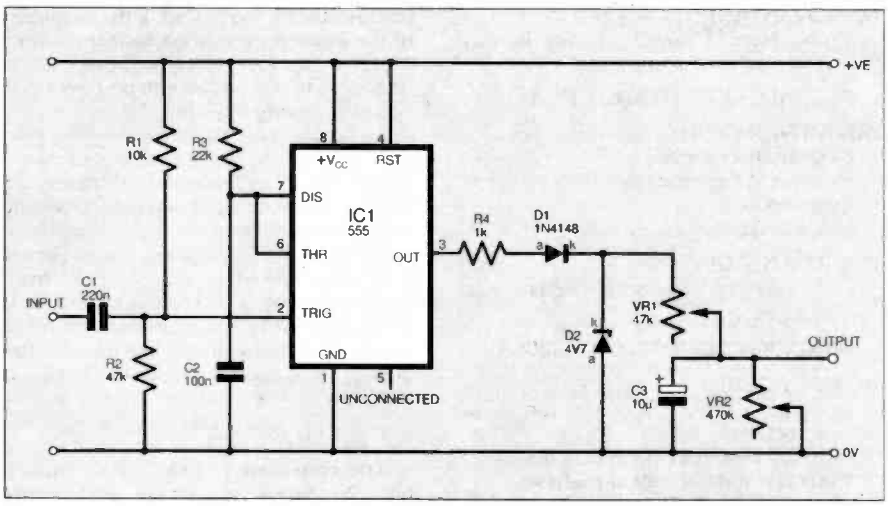

Fig. 10.7. Circuit diagram for a 555-based tachometer.

signal generator (set to square wave output) can be used to calibrate the module via this capacitive input.

The monostable timing period is set by resistor R3 and capacitor C2. The output is delivered from pin 3 to resistor R4. diodes D1 and D2, and potentiometer VR1. Diode D1 prevents current flowing back to pin 3 when the pin is low. Zener diode D2 ensures that the maximum pulse voltage presented to VR1 is consistent, regardless of voltage fluctuations elsewhere, especially changes in power supply voltage.

The actual value of the Zener diode is not particularly important, providing it is well below the supply voltage, at least 2V below. Resistor R4 prevents excessive current flowing through the Zener diode when pin 3 is high.

Potentiometer VR1 sets the current supplied to capacitor C3, across which an output voltage accumulates. Potentiometer VR2 provides a discharge path to ensure that the output voltage falls when the input frequency is reduced.

The setting of VR2 also determines the ripple present in the output voltage. It should be adjusted according to the intended frequency range; for example, at higher input frequencies. VR2 should be set to a low value to provide a fast response time. At very low frequencies (e.g. around 5Hz), VR2 will need to be set to a higher resistance in order to reduce output ripple.

A multimeter set to a suitable voltage range can be used to monitor the output voltage at the junction of C2 and the potentiometers. It is preferable to use a digital meter since these have high input impedances and will not take any significant current away from the circuit.

If a reading is required on an ordinary panel-mounting meter, one having a 1mA full scale deflection (f.s.d.) could be substituted for VR2, though this may affect the circuit response, perhaps requiring the value of capacitor C3 to be changed, probably lower, providing ripple does not then become a problem.

The output can also be fed to the bargraph display module shown in Part 8, Fig. 8.9.

LM2917 TACHOMETER

The LM2917 tachometer i.c. is specifically designed for frequency-to-voltage conversion. Two dual-in-line versions are available: the 8-pin LM2917N-8, and the 14-pin LM2917N. The extra pins on the 14-pin version allow slightly greater flexibility in circuit design, but the module to be described here is based on the 8-pin version. The internal block diagrams of the two versions are shown in Fig. 10.8.

The i.c.s can operate on power supplies of between 8V and 28V. They feature an excellent linearity of 0.3 per cent – much better than can be achieved with the previous type 555 circuit!

In Fig. 10.9 is shown how the 8-pin version is used as a tachometer, with its input a.c. coupled by capacitor C1 and resistor R1. The circuit can be used with either of the sensor circuits discussed earlier, Fig. 10.2 and Fig. 10.4.

Resistor R3 supplies power to the device's internal Zener diode which sets a reference level. Its value as shown is suited to a 9V to 12V power supply. Capacitor C2 converts the input pulse width to a standardised value. Capacitor C3 is the storage component which charges up according to the rate at which the pulses occur. Resistor R2 is the discharge path for C3. The relationship between these three components is complicated and beyond the scope of this article. It is suggested that you experiment with different values for all three if you want discover how the LM2917 devices respond to different frequency ranges.

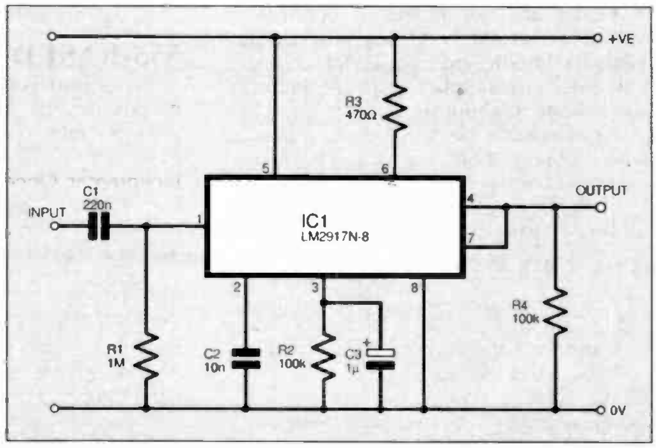

Fig. 10.9. Circuit for using the LM2917N-8 as a tachometer.

The output voltage at pin 4 is from an internal open-emitter transistor, requiring the use of the ballast resistor R4. The

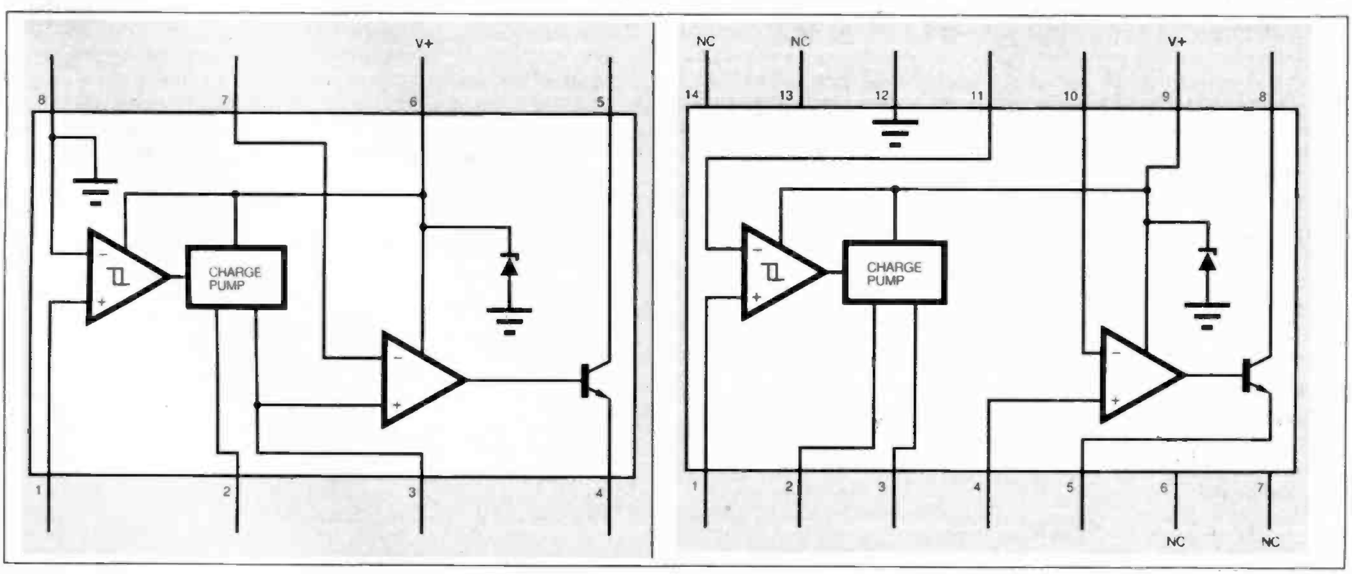

Fig. 10.8. Internal block diagrams of the LM2917N-8 (left) and LM2917N (right) tachometer i.c.s.

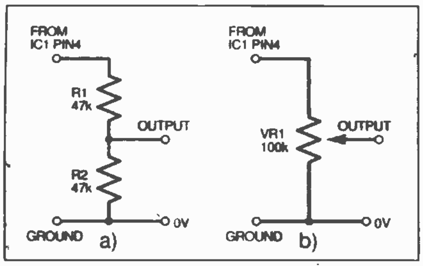

Fig. 10.10. Changing the output level from IC1 in Fig. 10.9.

output is also fed back into pin 7 where it serves as a further reference level inside the i.c.

As with the 555-based circuit, the output voltage can be monitored on a multimeter set to a suitable range. It may also be fed directly to the bargraph display module described in Part 8, Fig. 8.9.

If it is preferred to reduce the output voltage from the LM2917, a potential divider may be used in place of resistor R4, using either of the methods shown in Fig. 10.10. The circuit in Fig. 10.10a shows a fixed value potential divider, whose total resistance adds up to about 100kΩ. The ratio of the two resistors sets the output voltage available at their junction. With the equal resistance values shown, the output is half that of the original. Alternatively, a potentiometer can be connected as shown in Fig. 10.10b, allowing the voltage to be varied from nil to maximum.

The following table shows how the 14-pin version of the LM2917 can be connected as an alternative to the 8-pin version:

LM2917N-8		LM2917N
pin 1	=	pin 1
pin 2	=	pin 2
pin 3	=	pin 3 joined to pin 4
pin 4	=	pin 5
pin 5	=	pin 8
pin 6	=	pin 9
pin 7	=	pin 10
pin 8	=	pin 12 joined to pin 11

Summary of the tachometer circuits in Fig. 10.7 and Fig. 10.9:

555-TACHOMETER

ADVANTAGES:
- Inexpensive
- Straightforward

DISADVANTAGES:
- Response not linear
- Inaccurate if a wide frequency range is required
- Output dependent on resistance of load

LM2917 TACHOMETER

ADVANTAGES:
- Good linear response
- Accurate over a wide frequency range
- Output voltage not dependent on load resistance

DISADVANTAGE:
- More expensive

MORE ABOUT BARGRAPHS

The bargraph displays LM3914 (linear) and LM3915 (log) were introduced in Part 8 of this Series. The following additional information will be of interest to readers wanting to experiment with them. You are referred to Fig. 8.9 of Part 8 for the circuit diagram of the display.

Correct operation of the module requires that the input signal reaching the input of the bargraph i.c. varies from 0 to 1·25V when configured as in Part 8 Fig. 8.9. The following describes how we can deal with signals outside this range:

If the input signal varies above this range then either of the potential dividers in Fig. 10.10 can be used to reduce it.

The bargraph i.c.s themselves provide a very easy method of reacting to signal ranges of less than 1·25V. As illustrated

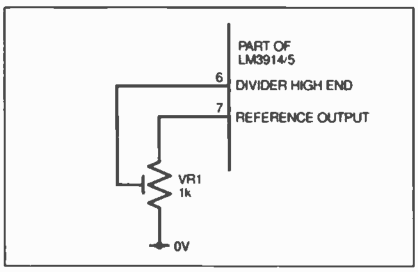

Fig. 10.11. Adjusting the bargraph response range.

in Part 8 Fig. 8.9, the chip's internal reference voltage at pin 7 is connected to the top of the resistive divider chain at pin 6. If a preset potentiometer is inserted between these two points as shown in Fig. 10.11, the reference voltage can be reduced. The effect of this is to increase the response to signals on the chip's input whose range is less than 1.25V. In other words, it is comparable to including an amplifier in the signal path.

EXAMPLE PROJECT

The *Bike Speedo* elsewhere in these pages is the example project which shows how the modules in *Teach-In* Part 10 can be combined in a practical application. The project also shows how the bargraph circuit in Part 8 can be cascaded to drive 20 l.e.d.s.

FINALLY

Here ends Part 10 of the *Teach-In* Series, and with it, the end of the series itself. It is hoped that the modules which have been described throughout the various parts have given you an insight into how different modules can be interlinked to produce a variety of circuits for different applications.

There are, of course, many more ways in which they can be linked, modified or generally used as inspiration for other modules. We trust that your imagination has been fired into dreaming up further useful or entertaining ways of using them. □

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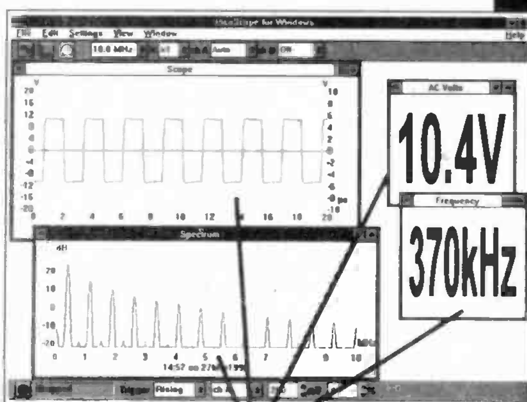

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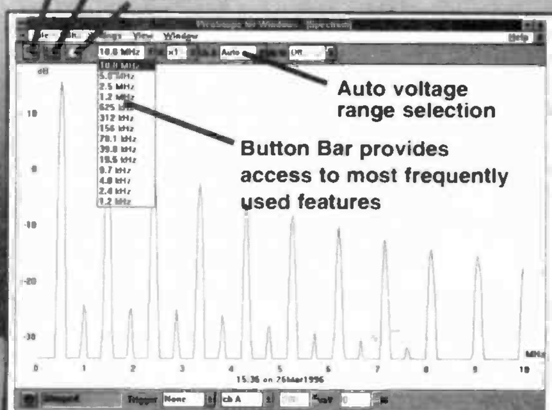

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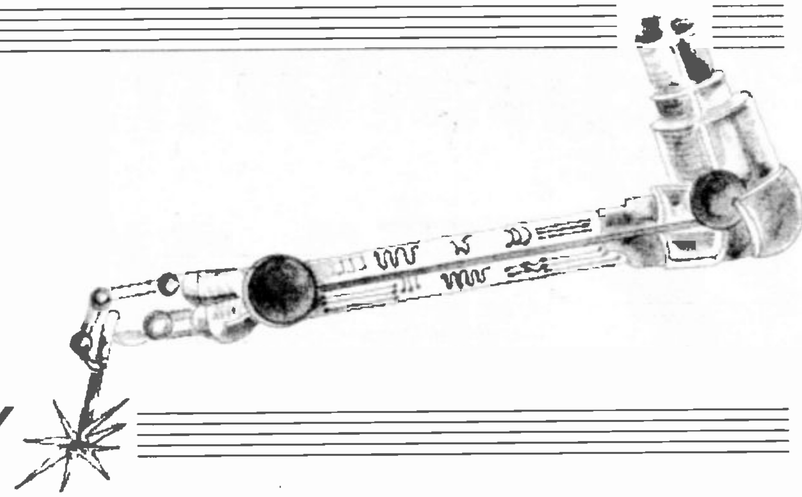


This month's* Surgery *includes a quick peek at PIC programming, filament bulb protection, constant current sources and a sawtooth oscillator using a 555 in a novel way.

LET'S kick off this month with a "pointer to PICs". ***Shahid Shabbir*** requested some advice on where to start looking if he wants to get into PIC microcontrollers.

"I'm a physics and electronics engineering student and I'm interested in looking at the use of PIC microcontrollers in a signal decoding system. I'd like to know how to carry out the programming, can you help me?"

The PIC is the brand of 8-bit RISC (Reduced Instruction Set Chip) microcontroller produced by Arizona Microchip. It easily dominates our particular market with its legendary support and it is extremely well documented with a range of comprehensive data books.

Some text sources first: you could try the book *A Beginner's Guide to the Microchip PIC*, available from **Maplin,** code AD31J, £19.95 or alternatively **Farnell Components** (Tel. ***01132 636311***) Code 489-359. This is the current 1995 edition and includes a floppy disk containing assembler, simulator and source code examples (though you may need commercial external hardware to utilise them).

Also listed by Farnell Components is the new *PIC Cookbook* by the same author. This is said to describe 40 working examples of PIC applications, and all source codes are provided on another disk. Order code 654-991, price £19.95. If you want the low-down on PIC data, there's Arizona's *Embedded Control Handbook* (Maplin AD28F, Farnell 271-330) which contains over 1,000 pages full of programming examples of all PIC chips, along with a description of their range of development tools.

Incidentally, do watch out for the year of publication of data books, there are older versions available from previous years, which may be of less use. Check out several suppliers as other books are available.

We published a highly effective project – the *Simple PIC16C84 Programmer* in February 1996 *EPE*. (Sorry, completely sold out! See our Back Numbers page for photostats). The instruction set for the PIC16C84 was also described. Full marks to author Derren Crome – you should read this extremely informative article to get to grips with programming the 16C84 PIC! Derren's programmer hooks onto the parallel port of a PC and uses TASM shareware.

The PIC16C84 contains its own 1K × 14 bit EEPROM (Electrically Erasable Programmable Read Only Memory) program memory which can be repeatedly re-programmed with suitable signals, without the need to resort to a UV eraser. **Magenta Electronics** now retail a full kit with p.c.b., see their advertisement elsewhere in this issue.

A personal computer is instrumental in "blowing" the chips. Firstly the programming instructions are written in their "mnemonic" form using a simple ASCII text editor, e.g. DOS Edit. In our design a Cross Assembler (TASM shareware, in our case) then writes this text file into binary for the chosen PIC, and finally, the resulting .OBJ file binary code is blown into the PIC via the parallel port, using a "Send" function of the software.

If you have Internet access, then PIC source codes, where available for our projects, are currently being uploaded to our brand new FTP site. At the time of writing, our domain name of ***wimborne.co.uk*** has only just been registered and the address of our site will be confirmed in next month's issue. Keep checking this site which will be updated regularly with software and PIC files, just as soon as they hit our desk! E-mail me in the interim if you would like an update.

Your Surgery

If you have any queries or comments you would like to ask, or tips which you would like to pass on to readers, 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.** Enclose an SAE for a written reply.

Don't forget to take a look at our new monthly *Net Work* column, designed with the electronics enthusiast in mind, offering hints and tips for Internet users, plus advice for those "newbies" thinking of getting on-line for the first time.

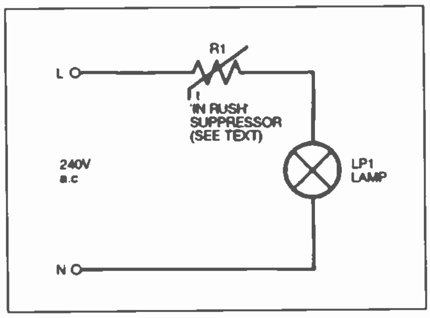


Fig. 1. Simple bulb protector.

Soft Starter

Mr. Simon Atkin continues on from my item on *RC Snubbers* (June '96) with the following E-mailed question:

"Following on from the suggestions for a snubber network across a triac circuit, can you offer advice concerning the "soft starting" of a mains-powered infra-red bulb that I use? They cost about £40 each and obviously are very expensive to replace. Do you have any pointers to a triac protection circuit, for example."

Possibly all you need is an "In-Rush Current Suppressor" which is nothing more than a thermistor placed in series with the filament lamp, see Fig. 1. This limits the current to a low level initially (when the filament has its lowest resistance so the current surge is likely to do the most damage) and as the thermistor heats, its resistance drops so that the light gradually illuminates over a period of a minute or more.

I used this to great effect with a halogen desk lamp to protect an expensive halogen capsule. **Electromail** (Tel. ***01536 204555***) stock a range of various current capacities. For example, their Stock No. 210-752 has an effective resistance of 0·128 ohms at its maximum current of 6A. They will work fine with mains voltages.

Incidentally, the devices do get *extremely hot* when they are in operation, *so beware.*

Time to Take Charge

You've all seen the classical 555 astable and monostable but there are other tricks which you can play with an ordinary 555

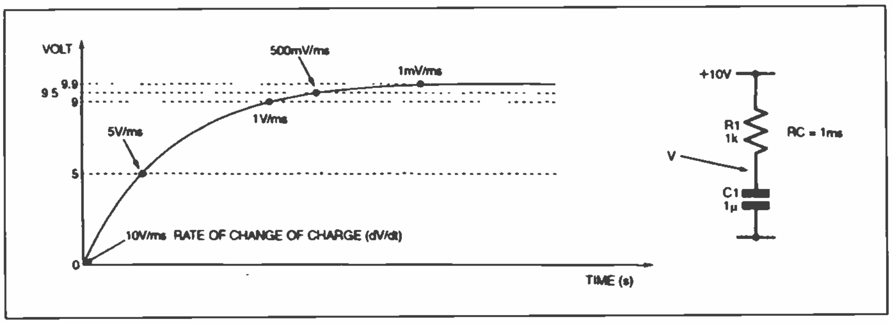


Fig. 2. Exponential charge curve of a basic R-C network.

timer. Fig. 2 shows the "exponential" curve which results when a capacitor charges up through an ordinary series resistor.

The charge current which flows is given by the formula:

$$I = C.\,dV/dt \text{ amps,}$$

$$\text{so } I/C = dV/dt \text{ (volts per second).}$$

where I is the charging current (amps), C is the capacitance (in Farads), and dV and dt represent the change in voltage (V) with time (s), respectively. The popular *Student's Manual for the Art of Electronics* (see July 1996 *Circuit Surgery* P.543 for details) has a useful description which I've expanded upon below.

To see what the formula means, imagine a 1k (kilohm) resistor and a 1µF (microfarad) capacitor, charging from +10V (Fig. 2, inset) : initially, all of the voltage appears across the resistor. The initial charging current is simply Ohm's Law: I = 10V / 1k = 10mA. Hence, from the above formula, 10mA / 1µF = dV / dt = 10,000V / second or 10V per ms. This is the initial rate of charge of the capacitor.

As the capacitor gradually charges, the voltage appearing across the resistor reduces. If 5V now appears across both components, for example, then the charge current has reduced to I = 5V / 1k = 5mA. The current has already halved. However, this means that the rate of change across the capacitor has slowed down to 5,000V / second or 5V per ms.

When 9V, say, appears across the capacitor (1V across the resistor, I = 1mA), then dV / dt has dropped further still, to 1,000V/ second or 1V per ms. With 9·5V across the capacitor, the rate of charge is 0·5V per ms. Out of interest, when 9·999V is across the capacitor, the rate is 0·001V per ms.

So, in theory, a capacitor can never reach the exact full rail voltage when charging through a resistor although it will get close enough for most applications. If the capacitor is an electrolytic type, it may take even longer to charge, due to higher leakage current through the capacitor and very poor tolerance on their values (say −50% to +100%).

There are a couple of useful rules of thumb which you may apply when dealing with these *RC* networks:

RC = time taken to charge up to 63 per cent of its final level. (1ms, in our example).
5RC = the approximate time taken to fully charge the capacitor (give or take a little).

The lack of linearity is caused by the fact that we're charging from a constant *voltage* rail. By charging from a constant *current* instead, the result will be a straight line, see Fig. 3. This has to be true because I / C = dV / dt will always be a constant value (constant current, constant capacitance) so the rate of change will also be steady. If the charge current is fixed at, say, 1mA, then for a 1µF capacitor dV/ dt = a fixed 1V per ms.

Back in Time

Back to the 555 timer i.c. This has a neat application in producing ramp waveforms rather than an exponential curve. When the timing capacitor of an ordinary 555 circuit charges up, an exponential curve across the capacitor is the result, and obviously a fast-rising square wave is seen at the output.

An accurate *ramp* voltage can be generated by the 555, though, by ignoring the square wave output and sneakily using a *constant current source* instead of the resistor charging network. Fig. 4 shows how a simple J505 constant current diode can be used to create a reasonable ramp, which will be observed across the capacitor C1.

This constant current source D1 is specified at 1mA nominal – I measured 0.95mA on a test. These devices (sometimes listed as "regulator diodes") seem a bit hard to pin down – I couldn't see any in Maplin's catalogue but Farnell obliged (Part No. J505) whilst Electromail list this one as 283-479.

Assuming the capacitor C1 is discharged initially, then after power-up the 555 triggers straight away (V trig < 1/3 Vcc) and C1 starts to charge at a fixed rate through the constant current source D1, until the threshold voltage of 2/3 Vcc is reached. Then the 555 (IC1) will rapidly (as fast as it can go) discharge the capacitor into pin 7 down to 1/3 Vcc, when the chip will trigger again.

With a 12V rail, the result is a sawtooth waveform of 4V peak-to-peak. A fast series of spikes is seen at pin 3,

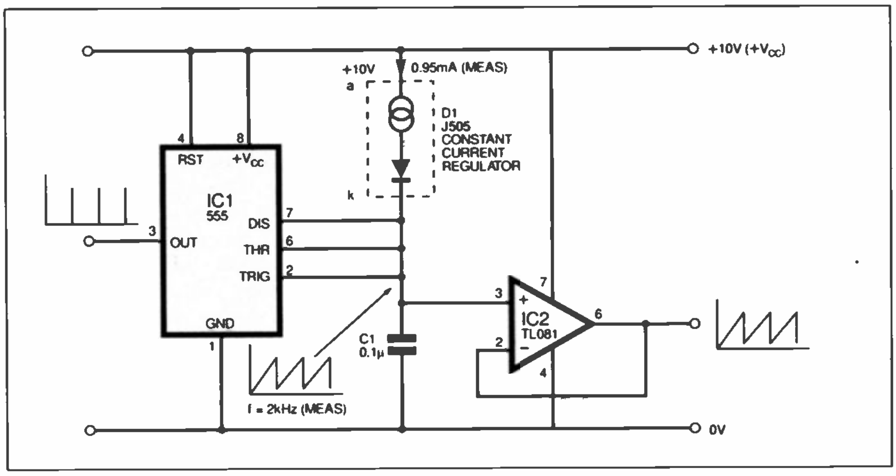


Fig. 4. Ramp generator using constant current regulator diode in a 555 oscillator.

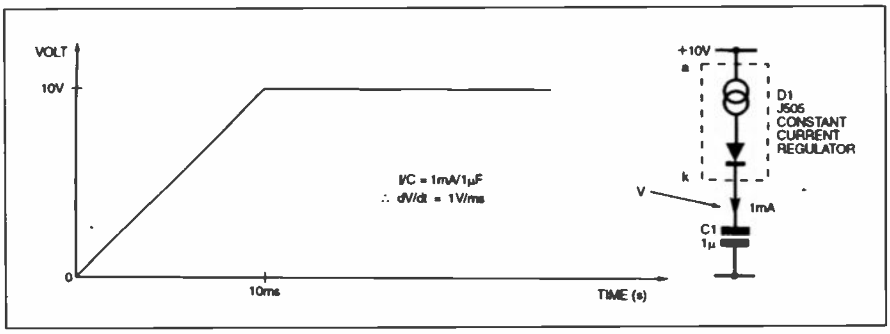
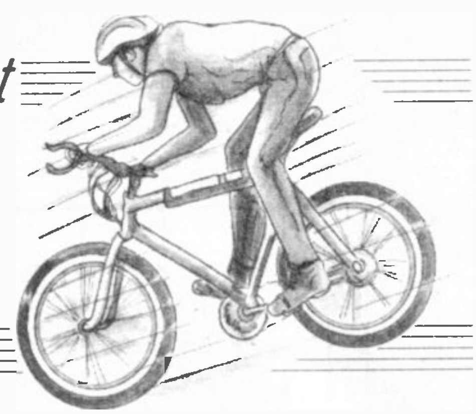


Fig. 3. Charging a capacitor through a constant current source.

incidentally – so fast my 'scope barely captured it. The prototype oscillated at just over 2kHz.

To utilise the waveform, a non-inverting unity gain op.amp can easily be added as shown, to buffer the waveform and so preserve the shape. The TL081 has a high input impedance which won't load the signal, and the sawtooth appears at the op-amp output. But any similar type of op-amp should work fine, e.g. the CA3140E which has a CMOS input and a bipolar output. Maybe you'll find an application for it.

Teach-In '96 – Constructional Project



BIKE SPEEDO

MAX HORSEY

Let the speed of light emitting bargraphs display your cyclic pedal rate.

THIS article is based on the information provided in *Teach-In* Part 10 and shows how modules may be selected and combined to produce a working project. The design can be used as a bicycle speedometer, or as a tachometer for all sorts of rotating objects.

The Bike Speedo employs a frequency-to-voltage tachometer i.c. (integrated circuit) at its heart. This i.c. can be driven from a variety of transducers, and can output to a meter or a bargraph display. The printed circuit board (p.c.b.) holds the components to build a bicycle speedometer with an analogue 20-l.e.d. (light emitting diode) bargraph output.

However, the bargraph components can be omitted if an analogue meter readout is preferred to a bargraph display. Furthermore, the p.c.b. is designed so that any of the three main sections involved can be isolated and used without the other two. For example, if a tachometer is required using a sensor which can directly feed the tachometer i.c., then the proximity module can be omitted.

SENSING WHEEL SPEED

When first considering this design, the first decision that was required was how to sense the speed of a rotating wheel. Magnetic pick-up sensors are available which will sense the speed of a metal gear wheel, but they need to be very close to the gear teeth; a light or infra-red beam system would be cumbersome and power hungry; a reed switch and magnets could be prone to error for various reasons; Hall effect sensors, although promising, require the actuating magnets to be very close to them. The latter might be possible with a brand new bike, but the slightest imperfection in the geometry of the wheel could cause sensing problems. The chosen method of sensing the rotation was to use the proximity sensor i.c. type CS209A.

In the prototype Bike Speedo, the sensing coil required for use with the CS209A was home-wound and fitted neatly inside a small black box for protection against the weather. The coil can be activated by the proximity of any piece of metal and so two small pieces of copper clad p.c.b. were used. They were fastened to the spokes of the wheel and the detection range was found to be up to four centimetres.

BLOCK DIAGRAM

The block diagram shown in Fig.1 indicates the principle behind the Bike Speedo system. The proximity detector senses the passing of the p.c.b. pieces as the wheel rotates, providing an output signal which has a clean transition between high and low voltage levels, and is ideal for triggering counting or processing circuits.

Next is the frequency-to-voltage converter and, since a reasonable degree of accuracy is required, the LM2917N-8 i.c. has been chosen. The output from this i.c. then feeds to two bargraph i.c.s which drive a 20-l.e.d. display.

CIRCUIT DIAGRAM

The complete circuit diagram for the Bike Speedo is shown in Fig.2. The wheel rotation sensor is based on the proximity module discussed in *Teach-In* Part 10, to which you are referred for more details. In Fig.2, the module comprises the sensing coil L1, proximity detector IC1, and associated components.

The use of l.e.d. D21 is to show when the coil has sensed the presence of the rotating metal plates. The l.e.d. is controlled by IC1 pin 4, an open-collector output which is turned on when metal comes near to the coil. Although not required as part of the speedo readout, the l.e.d. is essential at the setting-up stage.

IC1 pin 5 is also an open-collector output and is biased by resistor R5. Normally this output junction is low, but it goes high when metal is detected. Hence, as the wheel revolves a series of positive pulses is fed via capacitor C4 to IC2 pin 1.

IC2 is a frequency-to-voltage converter, or tachometer. The LM2917N-8 used features an internal Zener diode to maintain an accurate reference voltage. The Zener is biased by resistor R8 connected between the positive supply line and IC2 pin 6. The Zener regulation is accurate providing the supply is above 7·8V.

The tachometer's output voltage from pin 4 rises and falls according to the input frequency and is fed to preset potentiometer VR2, to allow the user to fine tune the level.

Bargraph drivers IC3 and IC4 are the linear type, LM3914, and are connected in series. The voltage at the top of IC3's internal resistor chain is set by preset VR3. This determines the maximum voltage required at IC3 pin 5 to give a full scale display. Both VR3 and VR2 can be used to set the full scale display at a given bicycle speed and the use of two presets provides

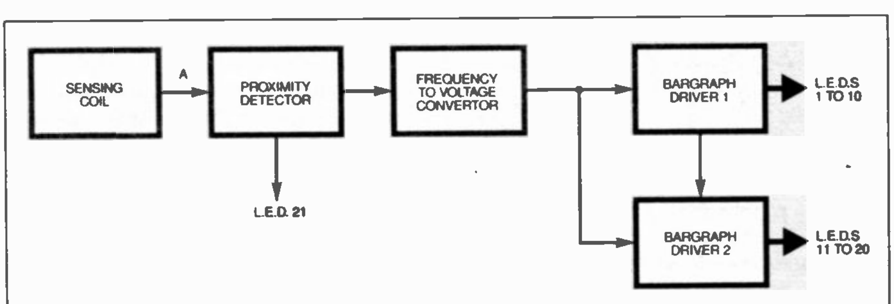


Fig. 1. Block diagram for the Bike Speedo.

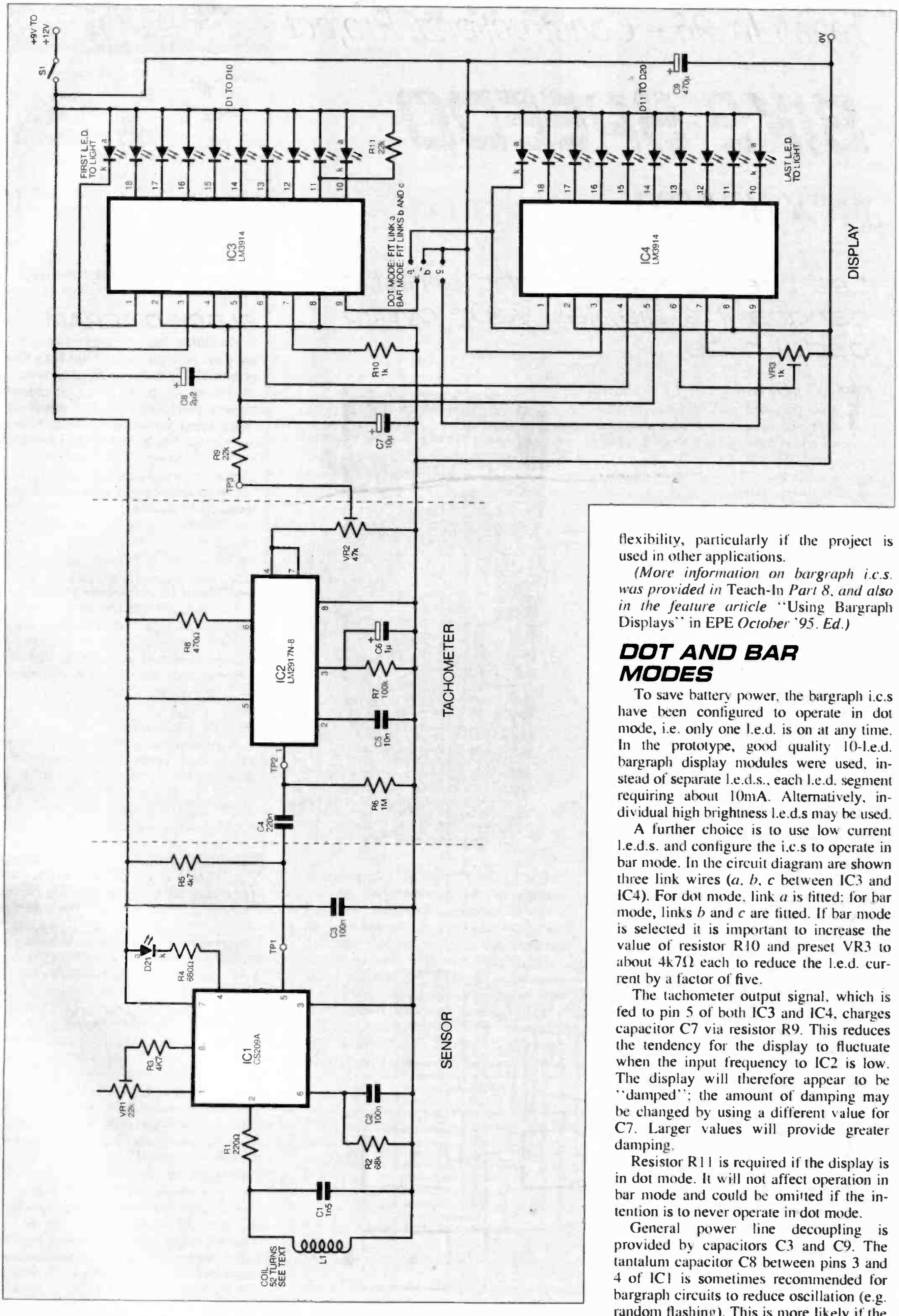


Fig. 2. Complete circuit diagram for the Bike Speedo.

flexibility, particularly if the project is used in other applications.

(More information on bargraph i.c.s. was provided in Teach-In *Part 8, and also in the feature article* "Using Bargraph Displays" in EPE *October '95. Ed.)*

DOT AND BAR MODES

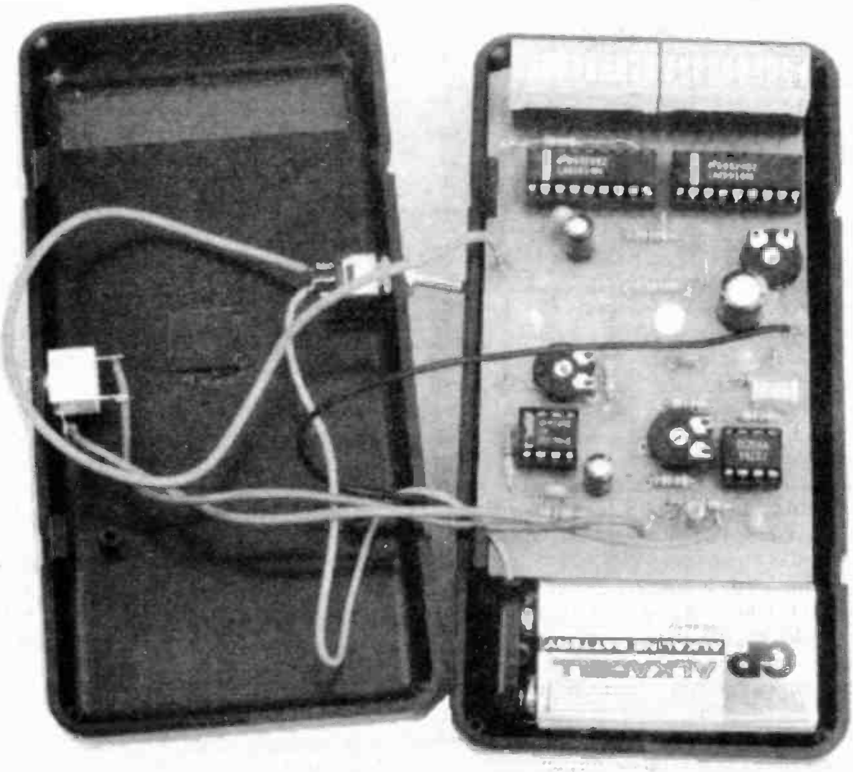
To save battery power, the bargraph i.c.s have been configured to operate in dot mode, i.e. only one l.e.d. is on at any time. In the prototype, good quality 10-l.e.d. bargraph display modules were used, instead of separate l.e.d.s., each l.e.d. segment requiring about 10mA. Alternatively, individual high brightness l.e.d.s may be used.

A further choice is to use low current l.e.d.s. and configure the i.c.s to operate in bar mode. In the circuit diagram are shown three link wires (*a, b, c* between IC3 and IC4). For dot mode, link *a* is fitted; for bar mode, links *b* and *c* are fitted. If bar mode is selected it is important to increase the value of resistor R10 and preset VR3 to about 4k7Ω each to reduce the l.e.d. current by a factor of five.

The tachometer output signal, which is fed to pin 5 of both IC3 and IC4, charges capacitor C7 via resistor R9. This reduces the tendency for the display to fluctuate when the input frequency to IC2 is low. The display will therefore appear to be "damped"; the amount of damping may be changed by using a different value for C7. Larger values will provide greater damping.

Resistor R11 is required if the display is in dot mode. It will not affect operation in bar mode and could be omitted if the intention is to never operate in dot mode.

General power line decoupling is provided by capacitors C3 and C9. The tantalum capacitor C8 between pins 3 and 4 of IC1 is sometimes recommended for bargraph circuits to reduce oscillation (e.g. random flashing). This is more likely if the l.e.d.s are in bar mode and connected via



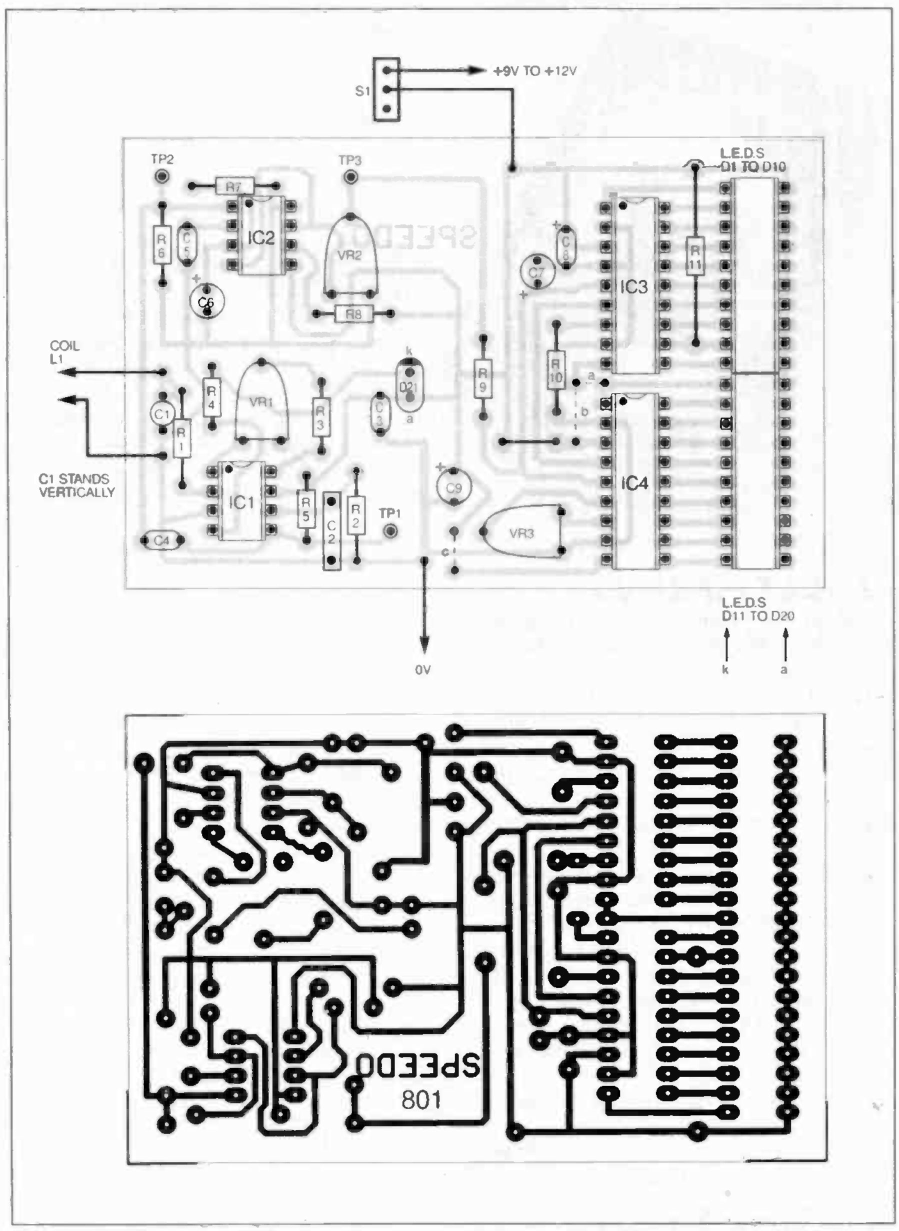


Fig. 3. Printed circuit board component layout and full-size underside copper foil master track pattern.

COMPONENTS

Resistors — See **TALK** Page

R1	220Ω
R2	68k
R3, R5	4k7 (2 off) (see text)
R4	680Ω
R6	1M
R7	100k
R8	470Ω
R10	1k
R9, R11	22k (2 off) (see text)

All 0·25W 5% carbon film, or better.

Potentiometers

VR1	22k min. horiz. preset
VR2	47k min. horiz. preset
VR3	1k min. horiz. preset (see text)

Capacitors

C1	1n5 polystyrene 1%
C2	100n polyester
C3	100n ceramic disc
C4	220n ceramic disc
C5	10n ceramic disc
C6	1µ elect. radial, 63V
C7	10µ elect. radial, 25V
C8	2µ2 tantalum bead, 16V (see text)
C9	470µ elect. radial, 16V

Semiconductors

D1 to D20	10-way l.e.d. module (2 off) (see text)
D21	red l.e.d.
IC1	CS209A proximity detector
IC2	LM2917N-8 tachometer
IC3, IC4	LM3914 linear bargraph (2 off)

Miscellaneous

L1	coil (see text)
S1	min. s.p.d.t. switch

Printed circuit board, available from the *EPE PCB Service*, code 108; 2·5mm jack socket and plug (see text); 8-pin d.i.l. socket (2 off); 18-pin d.i.l. socket (2 off); 20-pin d.i.l. socket (2 off) (see text); p.c.b. support (4 off); PP3 9V battery and clip; plastic case 131mm x 66mm x 30mm); plastic case 75mm x 50mm x 25mm); copper-clad p.c.b. off-cuts (see text); red display filter; nuts and bolts; clips to suit bike frame (see text); screened cable (see text); connecting wire; solder, etc.

Approx Cost Guidance Only £29

long wires. In this application it can probably be omitted; try the circuit without it first, only adding it if random flashing does occur.

CONSTRUCTION

Details of the printed circuit board are shown in Fig.3. This board is available from the *EPE PCB Service* code 108. Before beginning assembly of the components, check that the p.c.b. fits inside the case, with plenty of room for the battery; it is much easier to trim a p.c.b. before assembly!

Next decide which type of l.e.d.s will be used and select a value for R10 and VR3 accordingly. Begin assembly by soldering in sockets for the i.c.s, and for the 10-l.e.d. bargraph displays, if used. Now fit the smallest components, such as resistors and small capacitors. Note that C2 may be labelled 104 (meaning 100,000pF = 100nF).

Fit the larger electrolytic capacitors the correct way round, then solder in the presets, and terminal pins for the external connections including the test points labelled TP1, TP2 and TP3. For dot mode, fit link wire "a". For bar mode, fit link wires "b" and "c". Finally, connect the power supply leads, noting that the positive lead goes to the battery via switch S1.

SENSOR COIL

Although specially made "search coils" designed for use with IC1 may be available from some suppliers, a home made coil was found to provide more sensitivity with this particular application. Enamel coated wire is normally recommended for winding coils but ordinary insulated solid core connecting wire (0·6mm copper) was found to work very well. The prototype coil was wound around a cardboard tube (a loo roll) about 4cm in diameter.

Carefully wind 50 turns around the tube, not forgetting to leave several centimetres at each end for connecting the coil to the circuit. Try to allow the windings to build up, so that the coil is no more than about 2cm thick. The coil will not look very neat, but this is of no consequence since it will be hidden from view!

Slide the coil off the roll, securing a cable tie tightly around each side of the coil before the windings have a chance to spring apart.

The prototype coil was fitted into a small black case measuring 75mm × 50mm × 25mm. It was squeezed into an oval shape, then pushed firmly to the bottom of the case. Do not glue it at this stage, since the case will have to be drilled for fixing to the bicycle. Either connect the coil directly to the p.c.b. for testing, or link it via a length of twin flex or - for a neater finish - single audio screened cable. Remember that the coil will be fitted about half way down the forks of the bicycle, hence the need for the cable to link it with the main circuit.

In the prototype the screened cable was soldered to the coil, and at the other end was terminated with a 2.5mm jack plug for plugging into the speedometer. The cable may soldered directly if preferred, omitting the plug and socket. Note that one side of the coil is joined to 0V on the p.c.b.; make this the "earth" i.e. screened side of the cable.

TESTING

Before testing, check the p.c.b. carefully for mistakes, solder bridges etc., and adjust the presets to a mid-way position. Fit the bargraph display modules (or l.e.d.s) and the i.c.s into their sockets, the correct way round!

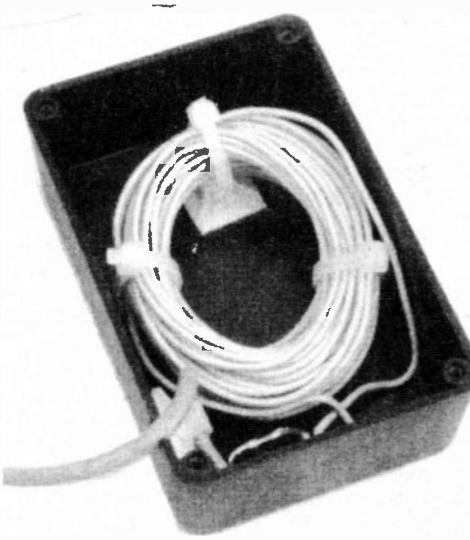
If a regulated 5V 100mA supply is available, then use it for initial testing, noting that if more than about six l.e.d.s light at once, the supply voltage may begin to fall. As mentioned earlier, it is unwise to run up to 20 high brightness l.e.d.s in bar mode since the power consumption will quickly drain a battery, and the bargraph i.c.s could be overloaded.

Having established that there are no major errors, which would cause the 100mA regulated supply to shut down, the circuit can be powered from a normal supply. Check that there is no metal near the coil L1, then establish that l.e.d. D21 can be made to switch on and off when preset VR1 is turned fully each way.

There are circumstances, caused by variations in the coil winding, when the total resistance between IC1 pins 1 and 8 may be outside the range which can be set by turning VR1. Variations include the size of the coil and the value of capacitor C1. If l.e.d. D21 refuses to switch on and off when VR1 is turned, try using a higher value for VR1 (say 47kΩ or 100kΩ) and a lower value for R3 (say 1kΩ). It should now be possible to make D21 switch on and off, unless another fault exists, of course.

Having established the range of resistance required, select for R3 the nearest convenient value below that actually required, so that VR1 can be used to "fine tune" to the exact value. Keeping the value of VR1 low will provide greater control when setting up the system.

Assuming that l.e.d. D21 can be switched on and off by turning VR1, set the preset so that the l.e.d. is just off. Move a piece of metal towards the coil; the l.e.d. should turn on. Moving the metal rapidly towards and away from the coil may cause several of the bargraph display l.e.d.s to turn on and off. Try adjusting VR2 to its maximum setting (fully anti-clockwise), and adjust VR3 to obtain a reaction on the display.



FAULT FINDING

Read the general fault finding guide in *Teach-In* Part 1 for general advice on the checks which apply to any circuit. The Bike Speedo divides neatly into modules, each one of which can be checked separately with a voltmeter.

Connect the negative probe of a voltmeter to the 0V line, and check the voltage at test point TP1. When metal is moved towards the coil this voltage should be high, i.e. equal to the positive supply voltage. When the metal is moved away, this voltage should fall to zero. Do not expect a voltmeter reading at test point TP2, unless it is set on a very low range; however, an oscilloscope should show the voltage at TP2 slightly rising above and below 0V as the metal is moved to and from the coil.

The voltage at test point TP3 should be near to 0V when the metal is stationary, but should vary by fractions of a volt when the metal is moved to and from the coil.

FURTHER TESTS

If problems persist you may become tired of continuously moving the metal to and from the coil! So, a less energetic approach may be needed:

First remove IC2 to prevent damage. Now join pin 4 of IC2's socket to the positive supply. As VR2 is adjusted, the bargraph display should react. It may be necessary to adjust VR3 as well. If this part of the circuit works, disconnect the temporary connection and reinstall IC2.

If a signal generator is available, remove IC1 and switch on the circuit's power supply. Then connect the generator to test points TP1 or TP2. Set the signal generator to square wave mode with a peak voltage less than the circuit's supply voltage. Now slowly sweep the frequency from about 1Hz to 20Hz. The bargraph display, and/or a voltmeter connected to test point TP3, should react. Try adjusting VR2.

If a signal generator is not available, a crude method of injecting signals into IC2 is to connect a temporary wire to 0V, and touch it on and off against test point TP1. Again, remove IC1 first.

CALIBRATION

In the trials so far, it should have been found that steel or copper pieces cause a good response from the coil. If the coil is home-wound as described, a thin piece of metal measuring about 6cm × 2cm should produce an excellent response. Copper clad printed circuit board is ideal, but it is possible that Veroboard might also work satisfactorily. The exact size of each piece is unimportant. Two pieces are suggested for large wheels, and one piece for smaller wheels.

There are two methods of calibrating the Bike Speedo. One is to install the system on the bicycle and adjust VR2 and VR3 whilst cycling next to a car travelling at, say, 20mph, although safety experts might rightly disagree!

The second method is safer but requires a signal generator and some calculation. First, calculate the circumference (in inches) of the wheel using the formula:

Circumference = diameter × 3·142
(i.e. $d \times \pi$)

Noting that there are 63360 inches per mile, the number of revolutions of the wheel per mile can be found by using the formula:

Number of revolutions =
63360 / circumference

Now multiply the answer by the number of actuating metal pieces fixed to the wheel to find the pulse rate per hour which corresponds to 1mph. Divide by 3600 to provide the rate per second (i.e. in hertz, Hz).

All these steps can be reduced to one formula as follows:

$f = (63360 \times n) / (d \times 3{\cdot}142 \times 3600)$ Hz (per mph)

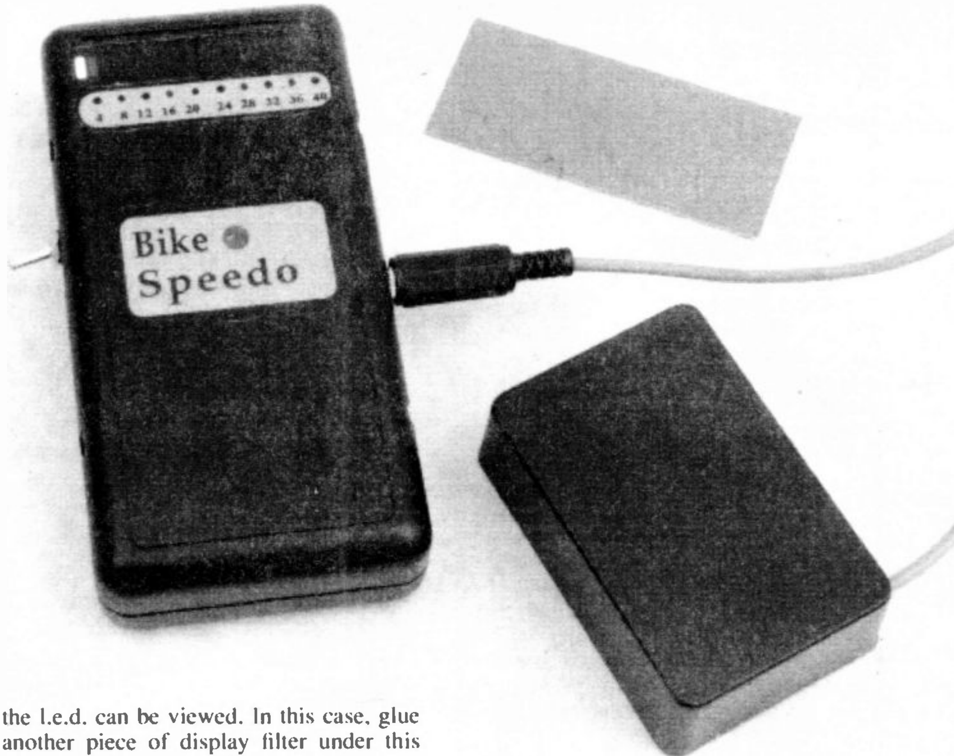
where f = frequency, n = number of metal pieces and d = wheel diameter

For example, a bicycle with a wheel diameter of 24 inches fitted with two metal pieces will provide a frequency of:

$(63360 \times 2) / (24 \times 3{\cdot}142 \times 3600) =$ 0·467Hz per mph

Before calibrating, remove IC1 from its socket, then connect the signal generator to test point TP1, with the signal generator's ground connected to 0V in the circuit. Set the signal generator to 20 times the calculated frequency (i.e. $20 \times 0{\cdot}467 = 9{\cdot}3$Hz for the above example). Adjust VR2 for the highest reading on the display, then adjust VR3 until the display corresponds to 20mph (i.e. the final l.e.d. of the first bargraph just lit).

Check for accuracy by setting the signal generator to 18·6Hz (40mph) then 4·6Hz (10mph). Remember that these figures apply only to a wheel diameter of 24 inches and two actuating metal pieces.



THE CASE

The case selected for the prototype unit was a snap-together ABS box measuring 131mm × 66mm × 30mm. The ease with which the top could be removed allowed easy adjustment of the presets. Protection may be necessary against rain.

Position the p.c.b. so that the display is at the opposite end to the battery region. Now place the top of the case over the bottom so that it will snap into place, and mark the position of the display. If a bargraph display is used, drill and file a rectangular hole so that the display shows through the top of the case.

Alternatively drill a set of holes for the l.e.d.s. Note that the l.e.d.s should not be pushed through the case; they will be more visible if soldered neatly into the p.c.b. so that they sit underneath the holes in the case.

A piece of red display filter material should be glued to the underside of the holes or slot to prevent rain entering the case and to increase the visibility of the l.e.d.s or bargraph display in bright light. Note, however, that the display must be pressed against the red filter to obtain a clear image; in the prototype, extra i.c. sockets were plugged into the existing display sockets to raise the display to the required height.

Holes are also needed for switch S1, the cabled connection between the coil and the circuit, and for mounting a clip for fixing to the handle bars. Ensure that any screws used to secure the clip do not touch the underside of the p.c.b.

When the unit has been correctly set up, l.e.d. D21 is no longer required and could be removed. Alternatively, a hole could be drilled in the top half of the case so that the l.e.d. can be viewed. In this case, glue another piece of display filter under this hole as described above.

The case housing the coil also requires holes for mounting a clip, and a hole for the cable. Single screened audio cable was used in the prototype. Although screening is not essential, screened cable provides a much neater finish than twin flex. Note that the capacitance of the cable will affect the setting required for preset VR1.

FINAL INSTALLATION

The case housing the coil may be fastened to one of the front forks of the bicycle, about half way down. If the case is mounted with its smallest side against the fork, the effect of the metal on the coil will be slight.

As stated earlier, the actuating metal plates may be p.c.b. off-cuts measuring about 6cm × 2cm. The area of these plates is much greater than that of the spokes of the wheel so allowing the circuit to be tuned to ignore the effect of the spokes. Small holes should be drilled through the plates so that they may be fastened to the spokes by means of cable ties. The cable linking the coil with the main circuit should be guided carefully up the fork to the main case, securing it with cable ties as well.

Turn the wheel and adjust preset VR1 so that l.e.d. D21 responds correctly. Finally, place the front of the main case into position on the handle bars, ensuring that the display can be viewed correctly.

ALTERNATIVE DISPLAY

As an alternative to a bargraph display, a voltmeter may be connected between the point labelled TP1 and 0V. An analogue or digital type can be used. It should be able to provide a full scale reading at about 0·5V; the exact range can be fine-tuned with VR2.

The maximum voltage available from the output of IC2 will depend upon the maximum frequency presented to pin 1. This in turn will depend upon the number of actuating metal pieces fitted to the bicycle wheel, and its diameter. If there is sufficient voltage available from pin 4 of IC2 to let 10mph cause an output of 0·1V then a voltmeter full scale deflection (f.s.d.) of 0·5V will provide readings of up to 50mph – hopefully more than sufficient!

Happy cycling.

CORRECTION

Countdown Timer (May '96). On p.c.b. Fig.5, the base (b) and collector (c) pins of TR1 and TR2 should be transposed.

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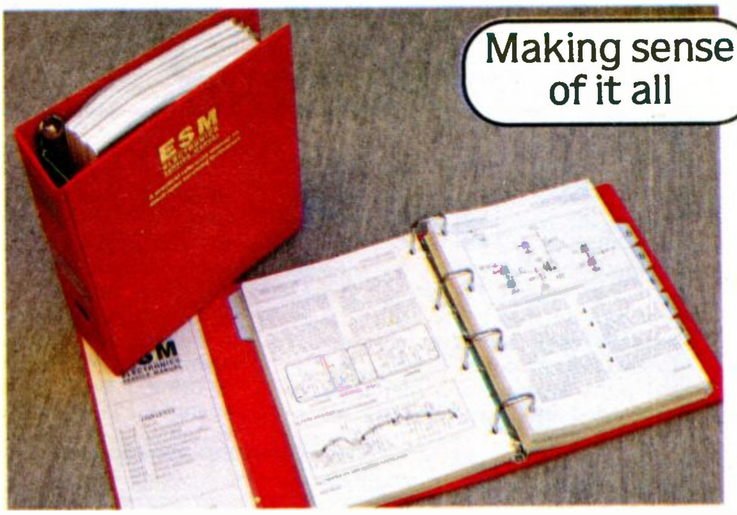

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INTERFACE

Robert Penfold

IN PREVIOUS *Interface* articles we considered the basics of interfacing your own circuits to the RS232C serial ports of computers. This month we consider the thorny subject of getting general peripheral devices connected to computer serial ports in the correct manner.

Connecting modems, printers, etc. to serial ports is something that tends to be regarded by many as more of an art than a science. It is certainly a fact that a method of connection that works well with one peripheral may fail to give satisfactory results with another. If you take a look at a list of computer leads you will probably find nearly a dozen versions of a "standard" serial lead!

Full Reverse

It is important to realise that there are two types of RS232C port, which are the DTE (Data Terminal Equipment) and DCE (Data Communications Equipment) varieties. They are fundamentally the same, and it is only their method of connection to the plug or socket that is different. Computer serial ports are normally of the DTE type, and these transmit data on pin 2 (TXD), and receive it on pin 3 (RXD). DCE interfaces do things the other way round, and also have their handshake inputs and outputs swapped over.

Apparently, the point of this is that a normal RS232C link should consist of one DCE port and one DTE type, with a "straight" lead used to connect the two together. In other words, each pin on one connector is linked to the same pin on the other connector. With two ports of the same type it is necessary to have a lead that is cross-connected (e.g. pin 2 on one connector linked to pin 3 on the other). Cross-connected leads are called "null modem" leads, incidentally.

Computers normally have DTE serial ports, and it might seem reasonable to assume that most peripherals therefore have DCE ports. In reality, most printers, plotters, etc. seem to have DTE ports. Modems are the only common peripherals which normally have DCE ports.

In general, if a serial port has a male connector it is a DTE type – if it has a female connector it is of the DCE variety. There are some exceptions though, including some printers which have DTE ports with female connectors. The equipment manual should give a list of serial port pin functions. Remember that for a DTE port, data is transmitted on pin 2, and for a DCE type it is transmitted on pin 3.

Stem the Flow

Handshaking is probably the main cause of serial port difficulties. Although RS232C serial links are quite slow in general computing terms, they can still provide a flow of data that is too fast for many peripherals to digest properly. It is also possible that a peripheral device could provide data at a rate that the computer could not cope with. Handshaking enables a receiving device to temporarily halt the flow of data so that the overall rate of flow can be kept down to a manageable level.

If the link is only providing one-way operation, there may seem to be no point in using a lead that provides two way operation. However, bear in mind that you may wish to use software handshaking, or "XON-OFF" handshaking as it is sometimes called. This relies on codes sent via the transmission and reception lines, rather than using separate handshake lines for hardware handshaking. It is probably best to use a cable that provides two-way communications so that your handshake options are left open.

Boxing Clever

There seems to be no general consensus on the ideal method of interconnection, and I suppose that the only way of guaranteeing correct operation of the link is to use a custom made cable. If you are going to undertake even occasional RS232C interfacing it is more than a little useful to have a device known as a "breakout box." This is basically just a couple of 25-way D-connectors, with each one wired to a small solderless breadboard.

The idea of this is that it enables various sets of interconnections to be quickly and easily set up, in an attempt to find the "magic formula" that gives the desired result. Most breakout boxes include some l.e.d. indicators which show the logic state of each interconnection. These are often very useful when trying to sort out just what has gone wrong with a link that fails to provide handshake hold-offs, or where things simply hang-up.

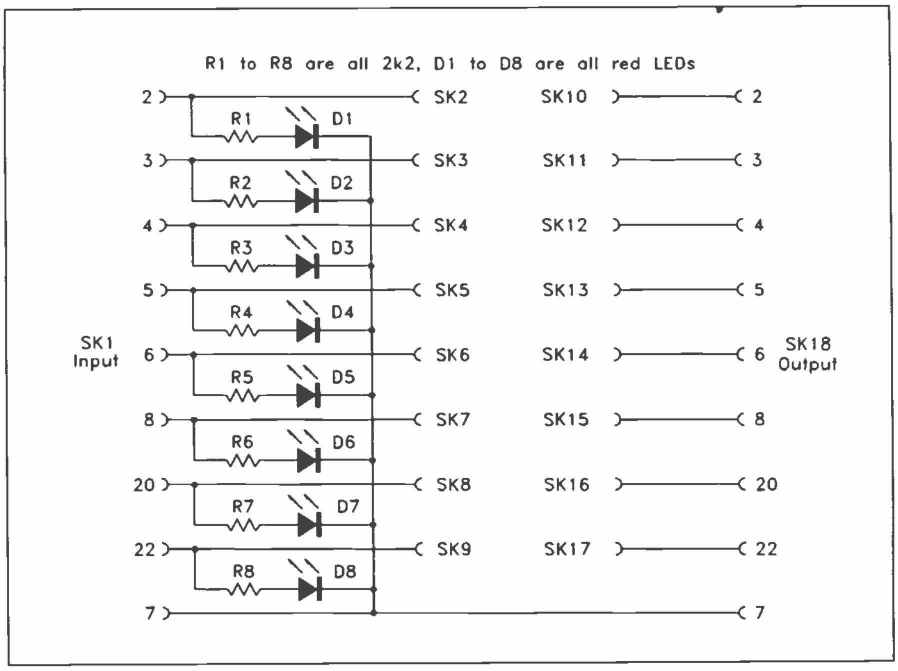


Fig. 1. The circuit diagram for a simple RS232CC breakout box.

If you examine some ready-made null modem serial leads, you are likely to find that there are minor differences from one to another. In theory it is just a matter of cross coupling the transmission and reception lines, with further cross coupling of the two pairs of handshake lines. Unfortunately, this basic method of connection does not always work properly in practice.

The problem stems from the fact that some serial ports are slightly cut-down versions of a full RS232C port, while others have one or two extra inputs or outputs. Most null modem leads seem to have a few extra links, which are used in an attempt to ensure that a hold-off is not produced simply because a handshake or status input is connected through to a non-existent output, or left unconnected at all.

Ready-made breakout boxes tend to be quite expensive, and are really intended for regular professional use. For amateur users a simple do-it-yourself version is a more practical proposition, and a basic breakout box can be built at quite low cost. Since most of the pins on a 25-way RS232C connector are unused, you do not need to have large numbers of sockets and l.e.d. indicators. A PC serial port implements eight lines plus the ground connection, and most of the serial ports on peripheral devices implement less than this.

In Fig.1 is shown the circuit diagram for a basic RS232C breakout box. SK1

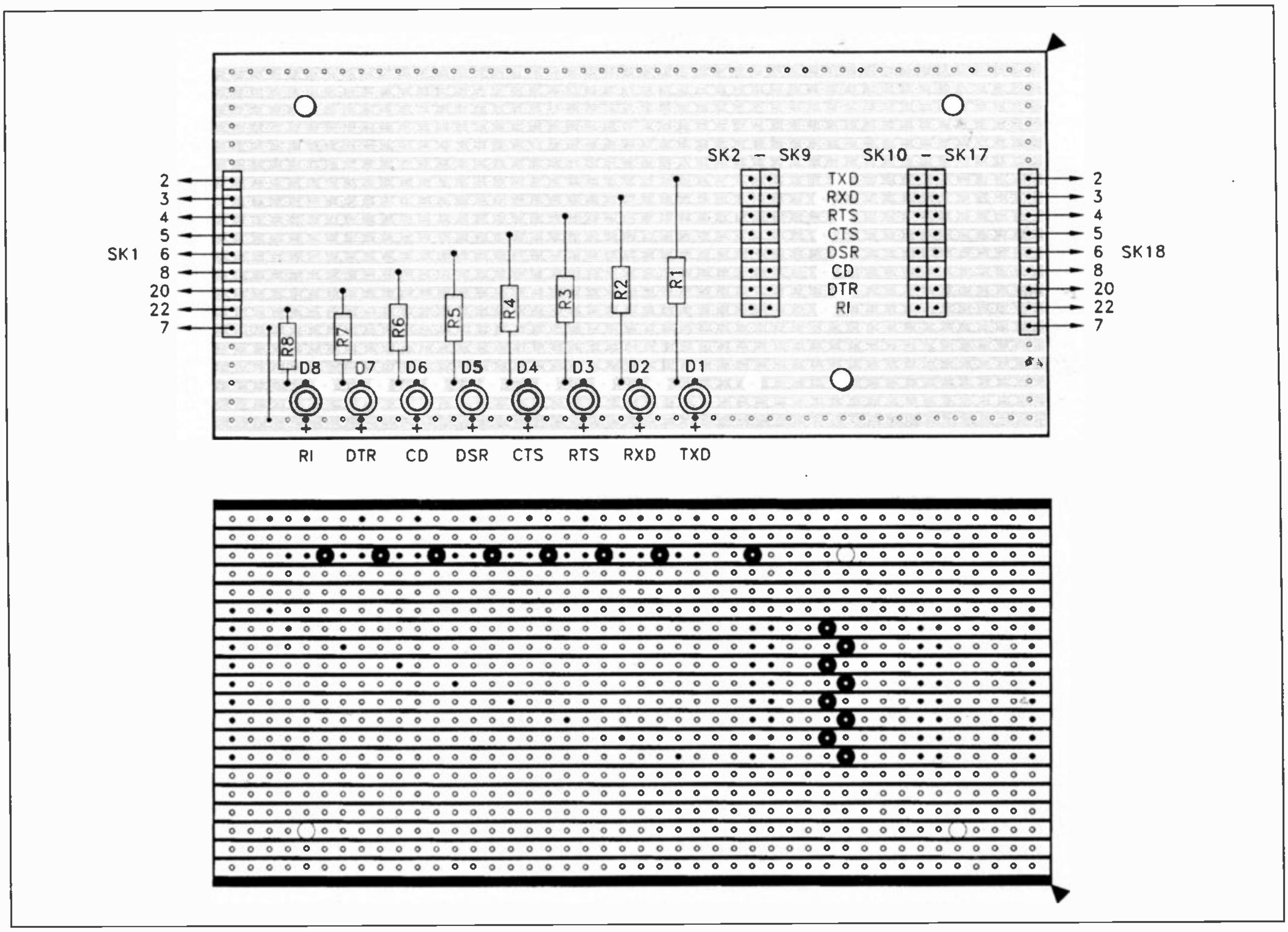


Fig. 2. Suggested stripboard construction of the circuit in Fig. 1.

and SK18 are the 25-way D-connectors which connect to the computer and the peripheral device. I generally connect SK1 to the computer and SK18 to peripheral unit, but the unit will work either way round. The eight input lines are monitored by separate l.e.d. indicators, and each of these has a series resistor which limits the loading to an acceptable level. The l.e.d. current is only a few milliamps, so it is best to use high brightness l.e.d.s.

Although very simple, a unit of this type can be a bit awkward to construct. The most simple form of construction I could devise is the stripboard design shown in Fig.2. Do not overlook the single link-wire just to the left of diode D8 and resistor R8. Sockets SK1 and SK18 are each connected to the board via a piece of 9-way ribbon cable, a metre or so long. The cables can be wired direct to the board, or via a d.i.l. (dual-in-line) connector system if preferred.

Sockets SK2 to SK19 are printed circuit mounting types having a pitch of 0·1 inches (2·54 millimetres), such as the Maplin "2·54mm strip sockets". These will take jumper leads made from 1/0·6 insulated wire, or a similar single core connecting wire. I would recommend doubling-up on both sets of sockets, so that additional links can be added if it is necessary to drive two input lines from a single output.

The unit will be easier to use if the stripboard is mounted on a baseboard of some kind, or it can bolted to the top of a plastic box. This also prevents the protruding leads on the underside of the board from scratching work-tops. At the very least it needs to be mounted on the workbench using some Bostik Blu-Tack or some Plasticine.

Missing Links

When the unit is initially connected to the PC it is unlikely that any of the l.e.d.s will light up. This is simply due to the fact that the serial port outputs are set at the inactive (negative) state under standby conditions. Things will only start to happen when data is sent to the port. If software handshaking is to be used, it should only be necessary to cross couple pins 2 and 3 of each port (the breakout box has the ground terminals permanently interconnected).

In the "real world", you might find it necessary to provide connections between the handshake lines as well. Some PC software, and a few of the more sophisticated peripheral devices, can be set up to use or ignore the handshake lines. In some cases, software handshaking will only work properly if the handshake lines have been disabled.

If software handshaking has been selected, but the system hangs-up and there is still activity on the hardware handshake lines, the problem is almost certainly due to the handshake lines having not been disabled properly. Either they must be deactivated, or the links for hardware handshaking must be implemented.

With some peripherals there is no need for any handshaking. In such cases simply cross coupling pins 2 and 3 should suffice. In practice, the PC might refuse to send data unless its handshake inputs are set to the active state. These are at pin 5 (CTS) and pin 6 (DSR). The peripheral may have one or two handshake outputs or a "dummy" handshake output that is permanently held at +12 volts. In either case it should be possible to hold the PC's handshake inputs high by implementing the appropriate links. Alternatively, wiring the PCs handshake inputs to its own handshake outputs will often prevent the port from hanging-up. In other words, link SK4 to SK5, and SK6 to SK8.

If hardware handshaking is to be implemented, the obvious starting point is a simple null modem interconnection. This requires the following links.

SK2 to SK11	SK5 to SK12
SK3 to SK10	SK6 to SK16
SK4 to SK13	SK8 to SK14

If a properly regulated flow of data is not obtained, the most likely problem is that one of the handshake outputs on the peripheral device is not implemented. A lack of response from one of the l.e.d.s should confirm this. In most cases satisfactory results will be obtained if both handshake inputs of the PC are driven from the single handshake output of the peripheral unit.

The DCD (Data Carrier Detect) and RI (Ring Indicator) lines are normally only used with modems. When set positive they respectively indicate that the modem has detected a carrier signal, and that a ringing signal has been detected. Neither are needed in general serial interfacing, but when interfacing to a modem they should obviously be connected through to the corresponding pins on the modem's connector.

MOBILE MISER

TERRY de VAUX-BALBIRNIE

Get the most out of your cellular airtime – and save money!

WARNING to analogue cellular phone users! The major UK network operators pocket some £50 million each year from the sale of *unused* air-time – to you!

Maybe you were so enthusiastic when you bought the phone that you did not look too closely at the way in which calls are charged. In most cases, you will find that the minimum charge is for *one minute*. After that, payment is made in *half-minute* increments *rounded up*.

Of course, most people make random-length calls. This will result in them paying for more airtime than is actually used – typically 30 per cent more!

To get the best value for money, it is necessary to avoid slightly overrunning a charge period. That *goodbye* made after 60 seconds is an expensive word to say. With care, it could have been made a few seconds earlier!

LITTLE BLEEPER

The Mobile Miser described here signals the user with discrete bleeps before the end of each charging period. After switching on, early warnings will be given at 48, 52 and 56 seconds. There will be a further "bleep" at one minute to mark the beginning of a new charging period. After the first minute, bleeps will be given every 18, 22, 26 and 30 seconds until the unit is switched off.

Table 1: Comparision of airtime against charge time

Peak/Off-peak*	Duration (sec)	Duration paid for	Cost (pence)
P	27	60	50
O	72	90	30
O	43	60	20
P	98	120	100
O	137	150	50
O	44	60	20
O	194	210	70
P	17	60	50
O	143	150	50
P	72	90	75
			Total cost: £5.15

*Based on 50p per min. peak and 20p per min. off-peak times.

The Mobile Miser circuit is housed in a small plastic enclosure having a clip on the rear which may be used to attach it to clothing, etc. The buzzer is high-pitched and will be easily heard above traffic and other noise without being obtrusive.

A PP3 battery is located in a separate compartment with access through a removable cover. In average use, the battery should give several years of service because the current requirement is only 4mA approximately. It is unlikely that the unit will be left on after use since the continued bleeping will act as a "nuisance" reminder to switch it off.

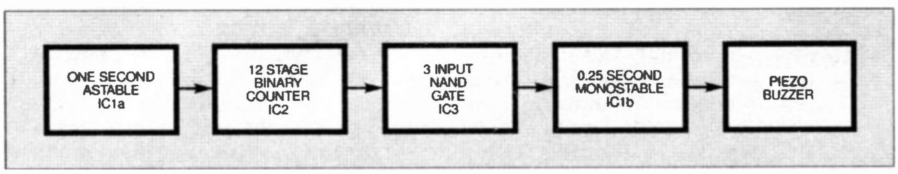


Fig. 1. Block diagram of the Mobile Miser system.

CHECK IT OUT

Before constructing the Mobile Miser, check your phone tariff. You will probably find that it follows the pattern outlined earlier.

Note that the digital networks operated by *Vodaphone, Cellnet, Orange* and *Mercury One-2-One* charge by the *second*. Subscribers to these services, would still find the circuit useful as a reminder to keep calls short.

It is also useful to note that BT charge by the second for almost all calls, including those made to mobile phones (subject to a minimum charge of 5p). BT subscribers could also find this device handy as an aid to keeping mobile (and other calls) short too – especially during peak times.

To illustrate how much air-time is likely to be wasted, Table 1 shows some hypothetical calls made by an occasional user. Prices are based on a typical low-user rate of 50p per minute at peak times and 20p per minute for off-peak calls.

The total cost is seen to be £5.15. Looking at it another way, the airtime *actually* used is only 633 seconds for off-peak and 214 seconds for peak calls.

Charged by the second, this would work out at £2.11 and £1.78 respectively – a total of £3.89. In other words, £1.26 has been charged for time which was not used. In this example, it amounts to about one quarter of the total cost.

CIRCUIT DESCRIPTION

As illustrated by the block diagram shown in Fig. 1, this circuit consists of five sections: a one-second astable, a 12-stage binary counter, a 3-input NAND gate, a 0·25 second monostable and a piezo buzzer.

The complete circuit diagram for the Mobile Miser is shown in Fig 2. The astable and monostable are based on identical timer i.c.s which are configured for their purpose using external components. These are both contained in the dual timer chip, IC1.

The sections forming the astable and monostable are shown separately and labelled IC1a and IC1b respectively. Both sections share common power supply connections, pin 14 for the positive and pin 7 for the 0V line.

SLOW PULSE

With switch S1 *on*, a supply is established from the 9V battery B1. The astable IC1a will then provide a chain of slow pulses at its output, pin 5. The frequency being dependent on the values of fixed resistors R1 and R2 in conjunction with preset potentiometer VR1 (connected as a variable resistor) and capacitor C1. At the end of construction, VR1 will be adjusted so that one pulse per second is provided (that is, a frequency of 1Hz).

The output pulses from IC1a pin 5 are applied to the clock input, pin 10, of binary counter IC2. This device has 12 stages of division and each is accessible as an output at a separate pin.

The first stage goes high every *two* input pulses (that is, every two seconds), the second every *four* the third every *eight* and so on up to the twelfth stage which goes high each 4096 pulses. Table 2 shows how the outputs change state over the first 32 clock pulses for stages 1 to 6 (2s to 64s) only.

To show the entire cycle (for all 12 stages to return to zero) would be extremely long and not very useful. This will happen when the *thirteenth* stage (if it existed) went high – that is, after 4096 seconds. This takes over an hour and will therefore be much longer than any mobile call.

Signals at the required intervals are obtained by selecting the outputs from the 4s (pin 7) and 32s (pin 3) and applying them to two of the inputs (pins 12 and 13 respectively) of triple NAND gate IC3. The relevant rows are shown in **bold** type in Table 2.

The third NAND gate input, pin 11, receives a signal from any one or more of the remaining outputs 64s to 4096s (pins 1, 2, 4, 12, 13, 14, 15). These latter stages are OR gated together using diodes D1 to D7. Resistor R4 ensures that pin 11 is kept low in the absence of a high state being applied through any one or more of these diodes.

TRIGGER DIRECT

The output of a NAND gate is *high* unless *all* of its inputs are held high whereupon it goes *low*. During the first 30 seconds, the state of pin 11 will be low and the output, pin 10, will therefore remain high.

After this time, the upper stages (64s to 4096s) will go high in various combinations and make pin 11 go high. Thereafter, a high state will be applied to all three inputs at the required intervals. Each time this happens, pin 10 will pulse low.

Incidentally, the reason for using a NAND gate for IC3 rather than an AND gate is because its low output may be used to trigger the monostable section without inversion. It is a characteristic of the type of i.c. timer used that it triggers on a *low* rather than a *high* input signal.

The trigger pulse is applied to the monostable at IC1 pin 8 via capacitor C4. When triggered, the output (pin 9) will go high for a certain time then revert to low. During this time, buzzer WD1 sounds. In the absence of a pulse, pin 8 is maintained in a high condition via resistor R5 and this prevents false triggering.

The monostable time period is dependent on the values of resistor R6 and capacitor C5. Using the values specified, it will be a little under 0·25 seconds.

No adjustment to this timing is provided since it is not thought to be particularly critical. If a longer bleep is needed, the value of R6 should be raised and vice-versa.

SOME REGULATION

It is necessary for the astable IC1a to provide reasonably accurate one-second pulses. However, the frequency of operation is somewhat dependent on the supply voltage. If the battery was used direct, the nominal 9V supply would fall in the process of ageing. This could result in a change of some five per cent.

Table 2: Output changes for stages 1 to 6.

Stage	6	5	4	3	2	1	
Divide by	64	32	16	8	4	2	Seconds
	0	0	0	0	0	0	0
	0	0	0	0	0	1	1
	0	0	0	0	1	0	2
	0	0	0	0	1	1	3
	0	0	0	1	0	0	4
	0	0	0	1	0	1	5
	0	0	1	1	1	0	6
	0	0	1	1	1	1	7
	0	0	1	0	0	0	8
	0	0	1	0	0	1	9
	0	0	1	0	1	0	10
	0	0	1	0	1	1	11
	0	0	1	1	0	0	12
	0	0	1	1	0	1	13
	0	0	1	1	1	0	14
	0	0	1	1	1	1	15
	0	1	0	0	0	0	16
	0	1	0	0	0	1	17
	0	**1**	**0**	**0**	**1**	**0**	**18**
	0	1	0	0	1	1	19
	0	1	0	1	0	0	20
	0	1	0	1	0	1	21
	0	**1**	**0**	**1**	**1**	**0**	**22**
	0	1	0	1	1	1	23
	0	1	1	0	0	0	24
	0	1	1	0	0	1	25
	0	**1**	**1**	**0**	**1**	**0**	**26**
	0	1	1	1	1	1	27
	0	1	1	1	0	0	28
	0	1	1	1	0	1	29
	0	**1**	**1**	**1**	**1**	**0**	**30**
	0	1	1	1	1	1	31
	1	0	0	0	0	0	32

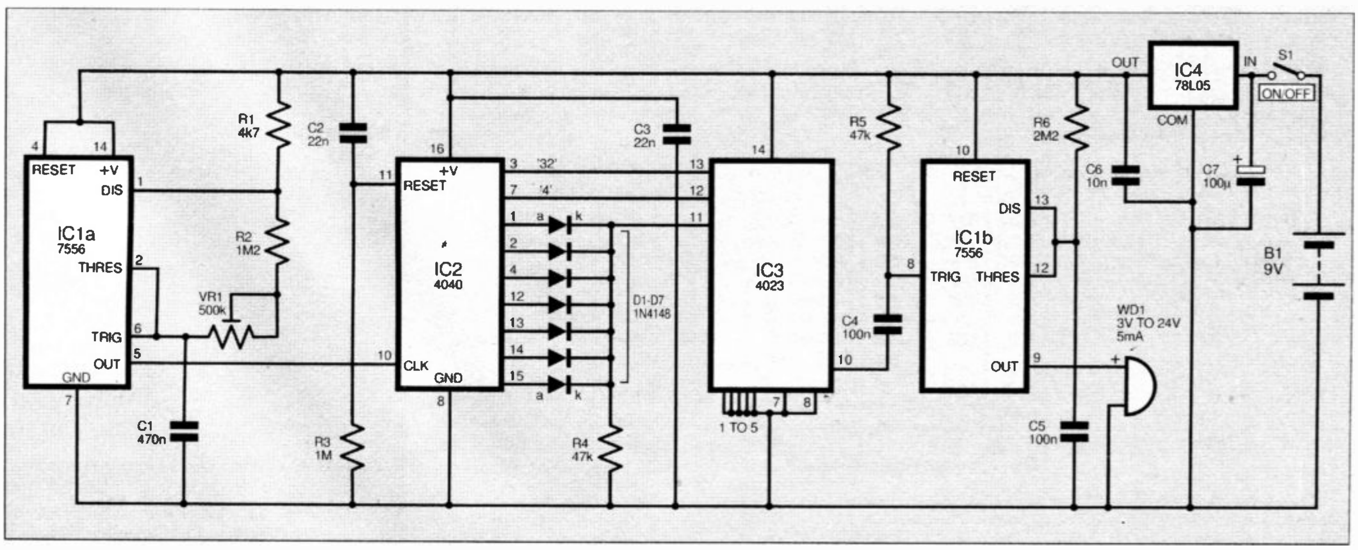
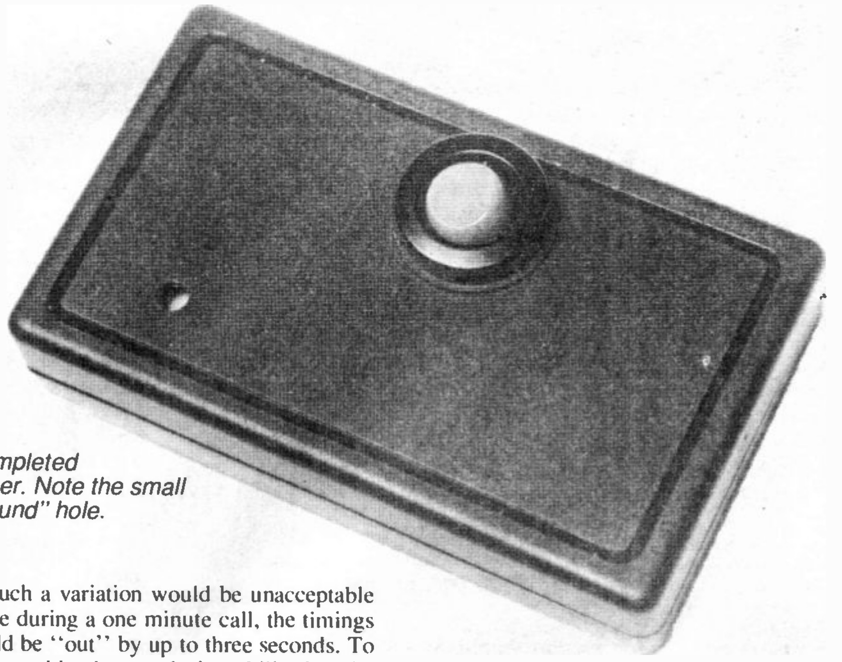


Fig. 2. Full circuit diagram, including voltage regulator, for the Mobile Miser.



Completed Miser. Note the small "sound" hole.

Such a variation would be unacceptable since during a one minute call, the timings could be "out" by up to three seconds. To prevent this, the supply is stabilised to 5V using voltage regulator IC4 in conjunction with capacitors C6 and C7. A steady output will then be maintained until the input voltage falls below 7V approximately, whereupon the battery is regarded as exhausted and will need to be replaced.

CONSTRUCTION

The printed circuit board component layout, full size copper foil master track pattern and interwiring for the Mobile Mizer are shown in Fig. 3. The p.c.b. is available from the *EPE PCB Service*, code 107.

Commence construction by mounting the i.c. sockets and soldering the three link wires in position. Follow with all resistors and capacitors including preset VR1. Note that, in the prototype, VR1 was a cermet *multiturn* preset rather than the more usual single turn variety.

Using the multiturn type is highly recommended since it makes adjustment much easier at the end of construction. It will also provide more stable timing periods over an extended period of use.

On some of these components the three pins have a triangular arrangement, others have an in-line pattern. The p.c.b. will accommodate either type. This means that only one of the holes for the sliding contact (centre) connection will be used according to type. A value of one megohm, (1M) could be used instead of the 500 kilohm (500k) component specified but it would be slightly more difficult to adjust accurately.

Take care over the polarity of electrolytic capacitor C7. Note also that capacitor C5 is mounted *flat* on the p.c.b. by first carefully bending its leads through a right-angle.

Solder the seven diodes, D1 to D7, in position taking care over their orientation. Diode D3, the one from IC2 pin 4, is mounted *flat* on the board while all the others are soldered vertically. Those to the left of IC2 have their cathode (striped) ends pointing *upwards*, those to the right of IC2 have them pointing to the *right*, see Fig. 3.

The polarity of the buzzer is marked on its underside and it is necessary to follow this as indicated in Fig. 3 or it will not work. Solder it into position so that it lies flat against capacitor C5. This means that C5 will be below the buzzer when it is mounted on the board.

Solder the regulator IC4 in place. With the specified component, the "flat" face will be closest to the top edge of the p.c.b. Certain similar regulators appear to have the input and output pins interchanged.

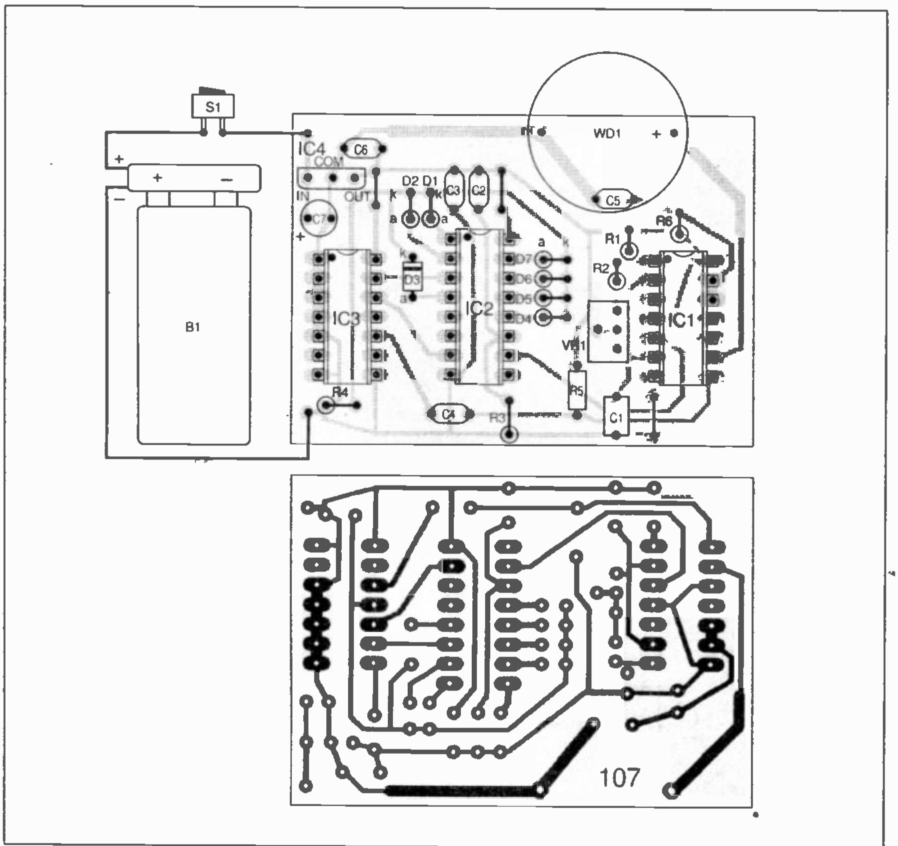


Fig. 3. Mobile Miser printed circuit board component layout, full size copper foil master pattern and switch and battery wiring.

COMPONENTS

Resistors — See TALK Page

R1, R4, R5	47k (3 off)
R2	1M2
R3	1M
R6	2M2

All 0·25W carbon film

Potentiometer

VR1	500k (or 1M) cermet multiturn preset – vert. Top adjustment. See text.

Capacitors

C1	470n
C2, C3	22n (2 off)
C4, C5	100n (2 off)
C6	10n
C7	100µ radial elect. 16V

All, except C7, miniature metallised polyester with 5mm lead spacing

Semiconductors

D1 to D7	IN4148 signal diode (7 off)
IC1	ICM7556 dual CMOS timer
IC2	4040B 12-stage CMOS counter
IC3	4023B CMOS triple 3-input NAND gate.
IC4	LM78L05ACZ +15V 100mA voltage regulator

Miscellaneous

WD1	piezoelectric buzzer, p.c.b. mounting type. Operating voltage 3V to 24V d.c. at 5mA
S1	small s.p.s.t. rocker or slide switch
B1	9V PP3 alkaline battery and snap-type connector

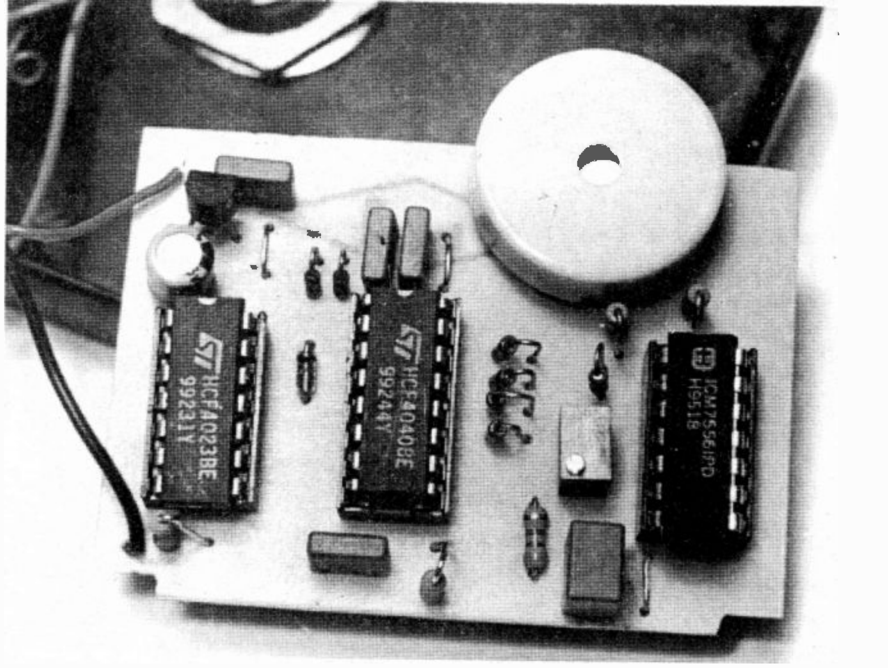
Printed circuit board available from the *EPE PCB Service*, code 107; hand-held plastic case with clip option, size 103mm x 62mm x 23 mm.; 14-pin d.i.l socket (2 off); 16-pin d.i.l. socket; multi-strand connecting wire; solder, etc.

Approx Cost Guidance Only £16 excluding case & batt.

Check with the manufacturer's or supplier's data if a different 5V 100mA voltage regulator is used.

Viewed from the component side, solder a 6cm piece of light-duty connecting wire to the top left corner p.c.b. pad (S1) and the negative (black) wire of the battery snap connector to the bottom left corner p.c.b. pad ("batt –"). These can be clearly seen in the photographs. Adjust preset VR1 to approximately mid-track position.

Insert the i.c.s taking care over their orientation. They are all CMOS components and therefore liable to be damaged by any static charge which may exist on the body. To avoid this, it would be wise to touch something which is "earthed" (such as a water tap) before handling the pins.



Layout of components on the completed p.c.b. The supply voltage leads can be seen on the left. Note the two small cutouts on the p.c.b. to ease case mounting.

JUST IN CASE

The specified case has a good appearance and will hold the circuit panel without further support. In the prototype, the battery connector clips supplied were discarded and the PP3 type snap connector referred to above used instead.

It may be necessary to file the corners of the circuit panel so that it fits snugly between the mounting pillars in the rear section (the side with the battery compartment cover). The buzzer should then lie within the case outline so that the top section may be fitted.

Various types of on-off switch may be used. Those having a good appearance tend to be larger and need more free depth than small inexpensive ones. When choosing a switch, make certain that it will be possible to fit the two sections of the case together when it lies between the top part and the p.c.b.

With some switches it will be necessary to reduce the length of the tags to provide more clearance. Take care to leave enough to make good soldered joints, however.

Choose a good position for the switch and make the hole for it. Secure it in position taking account of its orientation for "off" and "on". Refer to Fig. 4 and solder the positive (red) battery snap wire to one switch tag and the "S1" wire leading from the p.c.b. to the other one.

Some insulation (a piece of thin plastic, for example) may be needed to prevent the soldered joints at the switch tags touching any component connections on the p.c.b. *Check this point carefully.*

Attach the plastic clip (if needed) to the rear section of the case. First, drill through the existing pilot holes then secure the clip using the two self-tapping screws provided. A piece of thin plastic will be needed inside the rear section to prevent the heads of these screws touching the copper tracks on the p.c.b. *Check this point.*

SOUND CONNECTION

Carefully measure the position of the buzzer on the circuit board and mark and drill a hole in the top section of the case about 4mm in diameter to correspond with its centre. This will allow the sound to pass through. Check the route which the PP3 snap wires will follow to the battery compartment and file the plastic away as necessary so that they can pass through freely.

The case should now be assembled temporarily to make sure that the two sections fit together with everything located correctly. Reduce the length of any wires if they get in the way. Do not actually screw the case together yet since preset VR1 needs to be adjusted for correct operation.

SETTING UP

With the unit switched off, connect the battery and switch on. The monostable IC1b will self-trigger and the buzzer will bleep once. Nothing more should happen for one minute approximately whereupon there should be four equally-spaced bleeps.

It is now necessary to adjust preset VR1 to provide the correct timings. The specified multiturn preset is very straightforward to use. Clockwise rotation of the screw will *increase* the period. In the prototype it was found that each complete turn altered it by two seconds per minute approximately.

After the first minute, four bleeps should be given each 30 seconds and VR1 adjusted so that the final one arrives on time. If this is found to be impossible, reduce the value of resistor R2 to reduce the rate (increase the frequency) and vice versa.

It is possible to achieve an accuracy of less than one second per hour but there is no point in trying to do this. This is because there will be a small drift in the timings with temperature and this will be a greater effect.

Aim for a maximum error of one second in five minutes. In the prototype, the drift with temperature was about one second in five minutes measured between freezing point and room temperature. The exact variation will depend on the temperature coefficients of components R1, R2, VR1 and C1. It will also vary between individual timer i.c.s.

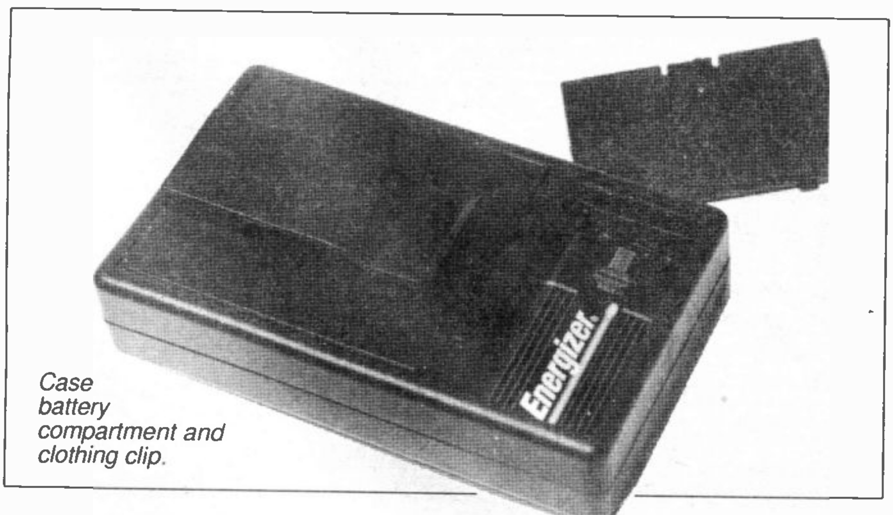
If it is assumed that ten minutes will be the maximum length of a call, this error will be insignificant. Remember, the idea is to end a call on the *third* bleep – this will allow a nominal four second safety margin before the start of a new charging period.

In the prototype, the first bleep (one minute) always occurred two seconds *early*. This is fortunate because it allows time to switch on the unit after the caller has answered. A few trials will soon determine how short the safety margin is.

With adjustment complete, the case may be assembled and the unit put into service. Every few months, check the timing. After a prolonged period of use, this will be incorrect. At that point, the battery needs to be replaced.

Note that the monostable self-triggers on powering-up. This indicates the point at which timing begins.

Happy saving!



Case battery compartment and clothing clip.

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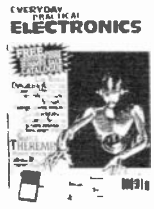

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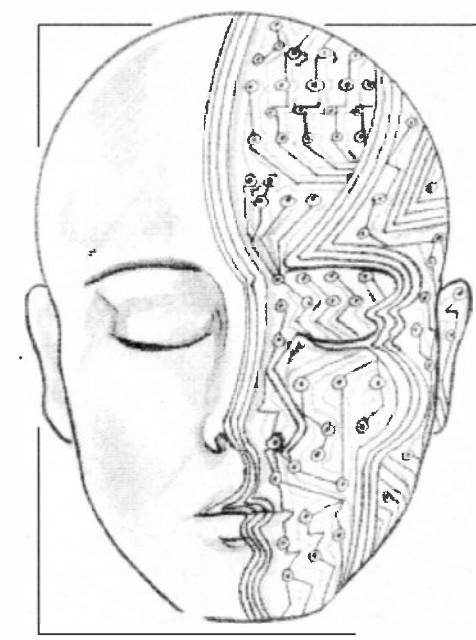

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PWM Model Train Controller – full steam ahead

DETERRED by the cost of a ready-made unit, my circuit for a PWM Model Train Controller shown in Fig. 1 offers far superior results than a traditional rheostat-type model train controller and provides better fine control of train speeds. A 555 timer chip (IC1) is configured as a free running oscillator operating at some 80kHz, but instead of using the square wave output I have used the exponential ramp waveform generated across capacitor C3. This feeds a comparator (IC2) whose threshold reference is set by a logarithmic potentiometer VR1.

Comparator IC2 output is inverted by IC3a and IC3b and drives the output stage comprising transistors TR1 and TR2; the latter can handle some 2A and dissipate 1W, more than adequate for a saturated switch operation. Diode D2 protects against back e.m.f. in the train motor.

Short circuit protection is provided with a 0·5 ohm series sense resistor (R8/R9). Transistor TR3 switches on when the current flowing, reaches approximately 1·2A. This sets the output of an S-R flip-flop (IC3c/IC3d) low. Light emitting diode (l.e.d.) D3 illuminates to indicate a fault, and TR1 is disabled by the inverters. Capacitor C4 introduces a short time period across TR3 to prevent the cut-out triggering falsely.

As a final touch, I included the normally-closed push-switch S1 as a "Kick" button. Pressing this causes a short, higher voltage burst to be applied to reluctant motors. The final cost of this circuit was about £4.50.

Richard Hunt,
Diss, Norfolk.

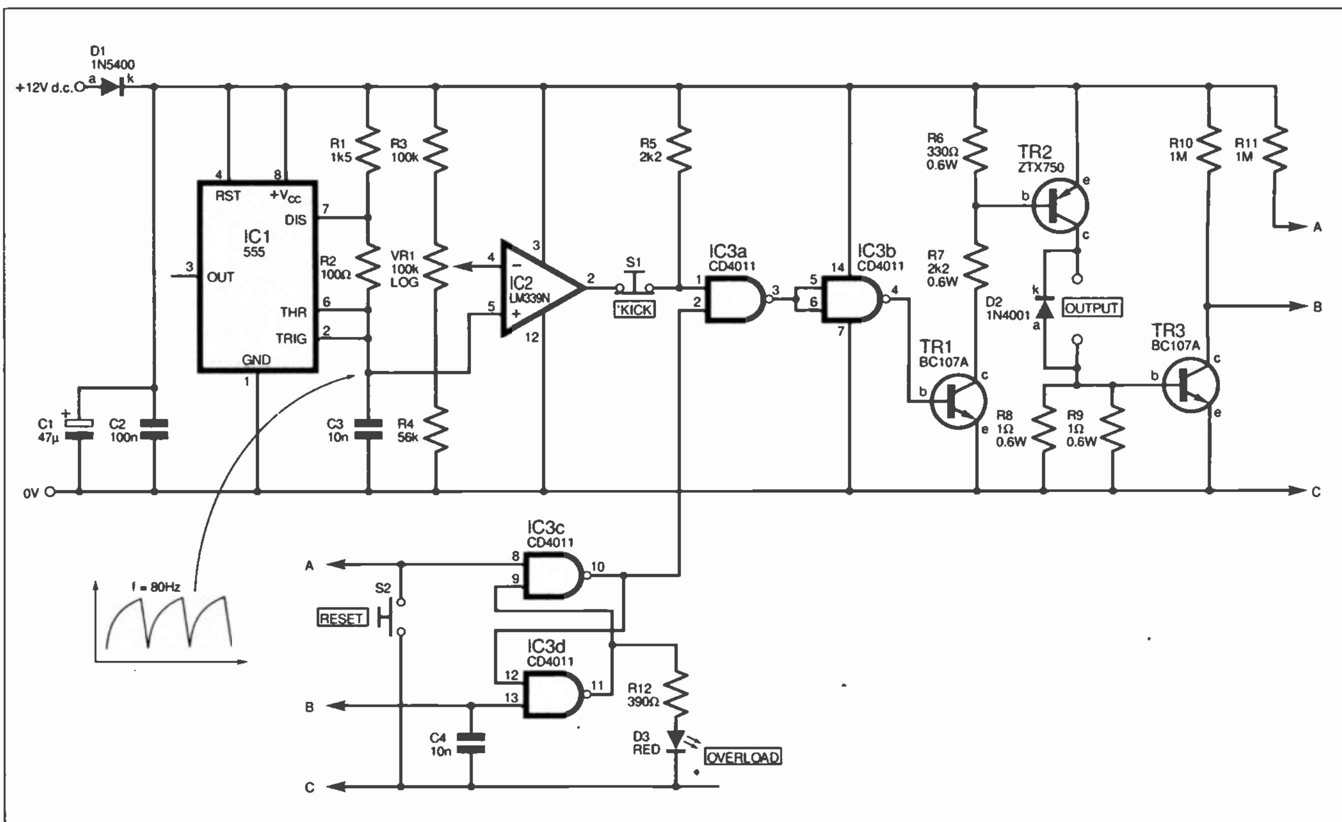


Fig. 1. Circuit diagram for the PWM Model Train Controller.

Grand Prix Starting Lights – pole position

DESIGNED as an accessory for my grandson's model racing car set, Fig. 2 shows a circuit design for a "starting gantry" with three red and three green starting lights. It can be powered from the racing set's mains operated power supply unit. A 12V regulator (IC1) provides a stabilised supply for the circuit, and diode D1 prevents accidental reverse connection by the young motor racing enthusiast.

The circuit uses a system of relays to start and stop the sequence. When Start switch S1 is pressed, relay contacts RLA1 close and this applies +12V to the sequencer and also latches the relay. Contacts RLA2, across capacitor C3, open.

Three comparators are used (IC2a, IC2b, IC2c) and their non-inverting (+) terminals each have a reference voltage set by a potential divider at about +2·10V, +2·75V and +4·75V respectively. Either an LM339 quad comparator or an LM324 quad op-amp can be used.

When capacitor C3 charges in excess of +1·75V, transistor TR1 conducts and the red l.e.d.s. D4 to D6 illuminate. At +2·75V, TR2 conducts and the green l.e.d.s D7 to D9 light. IC2a also swings high, via resistor R6, so the red lamps extinguish.

When capacitor C1 reaches +4.75V, transistor TR3 conducts and completes the circuit to relay RLB. Contacts RLB1 (normally closed) now open and disconnect relay RLA. Also, contacts RLA2 then close which discharges the timing capacitor C1, ready for next time.

Ray Lewis,
Sutton Coldfield,
West Midlands.

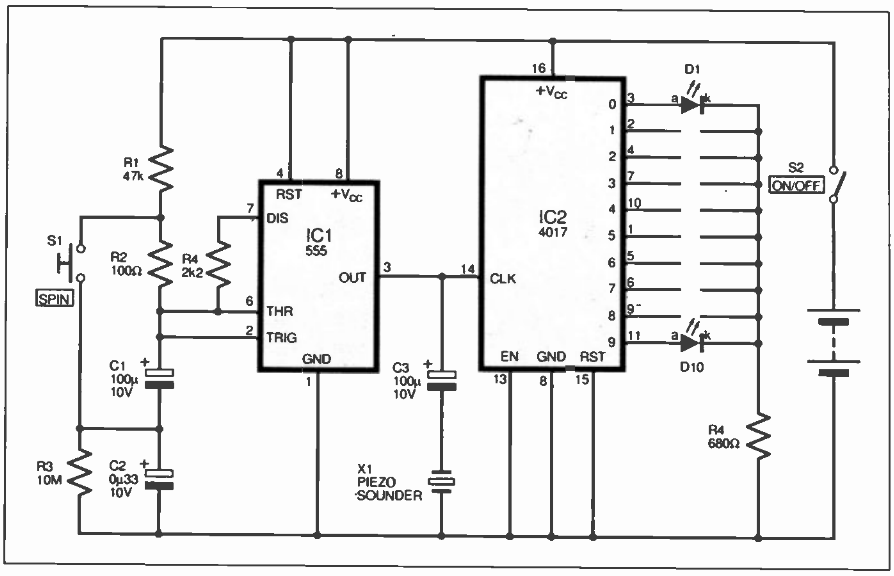


Fig. 3. The simple but flashy Mini Roulette circuit diagram.

Mini Roulette – led to a flutter

A CIRCUIT diagram for a mini battery-powered version of Roulette is shown in Fig. 3. This circuit uses a 4017 decade counter (IC2) driving 10 l.e.d.s. Since only one l.e.d. is ever illuminated at any one time, a common limiting resistor R4 is used. They may also be placed in alternating red/ green order for added effect.

The counter IC2 is clocked by IC1, a classic 555 timer connected as an astable. When the "Spin" button is pressed and then released, full speed is achieved and then the display gradually slows down until it stops on a single number. Capacitor C2 governs the oscillator speed and resistor R3 prevents instability when the l.e.d. rotation stops. The piezo disc transducer, X1, is placed on the output of the oscillator to provide a sound effect.

S.M. Spencer,
Sleaford, Lincs.

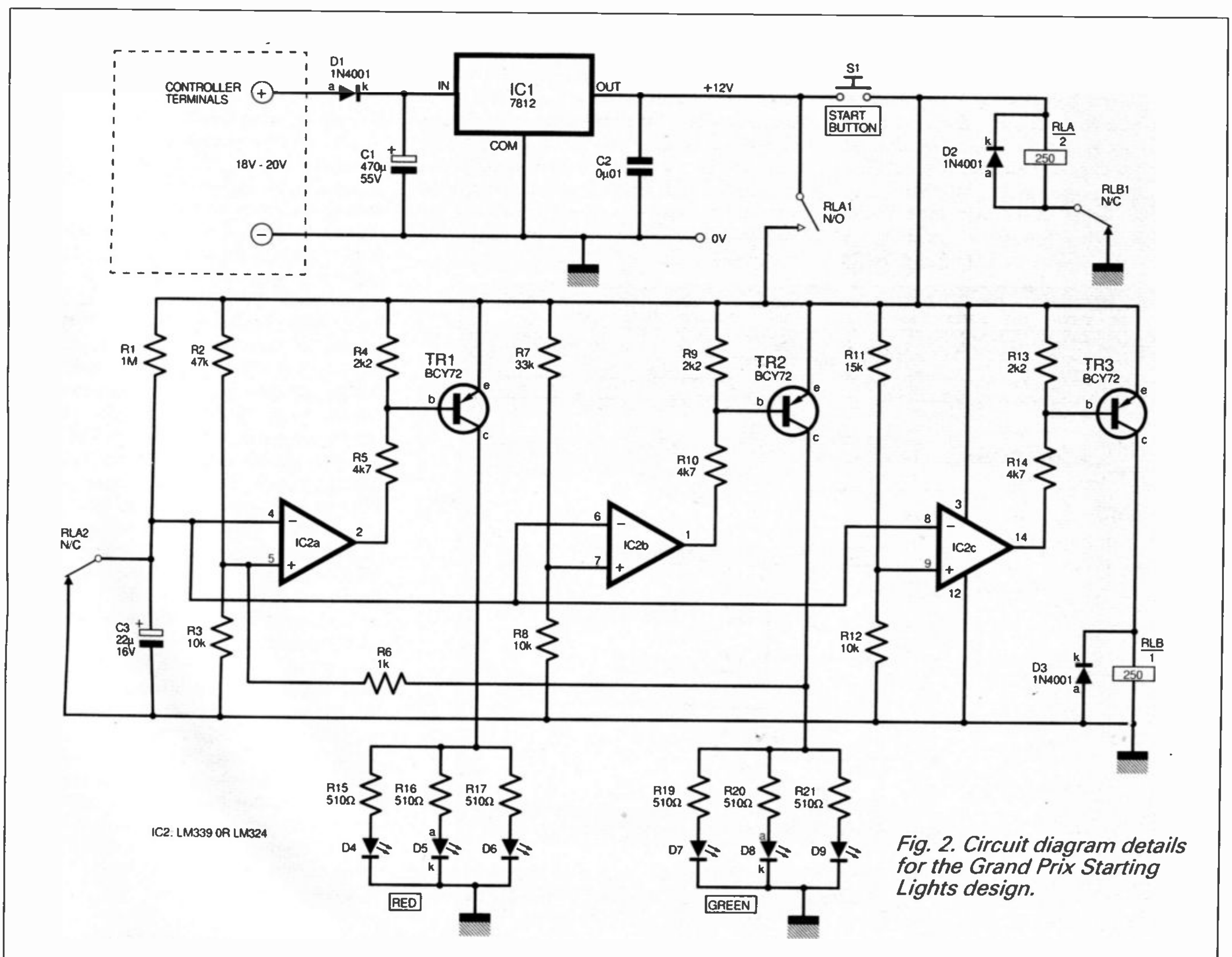


Fig. 2. Circuit diagram details for the Grand Prix Starting Lights design.

Special Review

ELECTRONICS PRINCIPLES 3.0

ALAN WINSTANLEY

A review of the latest release of educational electronics software from EPT.

INDEPENDENT software house EPT Educational Software recently announced their latest update – Version 3.0 – of the *Electronics Principles* software which spearheads an expanding range of software products aimed at those currently involved in electronics education, studying at GCSE or higher levels.

The software is particularly popular in schools, say EPT, and it runs on an IBM-compatible PC under Windows 3.1, Windows 95 or even Windows NT. It is likely to appeal to school students as well as hobbyists and enthusiasts wishing to consolidate their knowledge of electronics.

FIRST PRINCIPLES

Electronics Principles 3.0 is supplied on two 3·5-inch high density disks and the package can be installed into any desired directory, always a welcome feature. The program takes just over 2Mb hard disk space. The floppy disks also include the extra files called for when installing in Windows 95, which is likely to have a more appealing visual presentation; it was not tested for the purpose of this review. The software should run perfectly well even on modest machines using Windows 3.1, and certainly a state-of-the-art Pentium computer is not at all a prerequisite.

Double clicking on the newly-created "oscillograph" icon opens a clutter-free screen where desired topics are selected from a menu and the tutorial on that subject then commences. In many instances, one window leads to others which can be toggled using "radio" buttons.

This method is used to display other views on the topic – perhaps graphs of various characteristics using the same component values; this is especially useful when dealing with alternating current (a.c.) subjects where other aspects of a particular circuit can be explored and displayed. The software is not intended as a multimedia experience and sound is not supported, so you must study in silence, probably no bad thing looking at the more advanced sections!

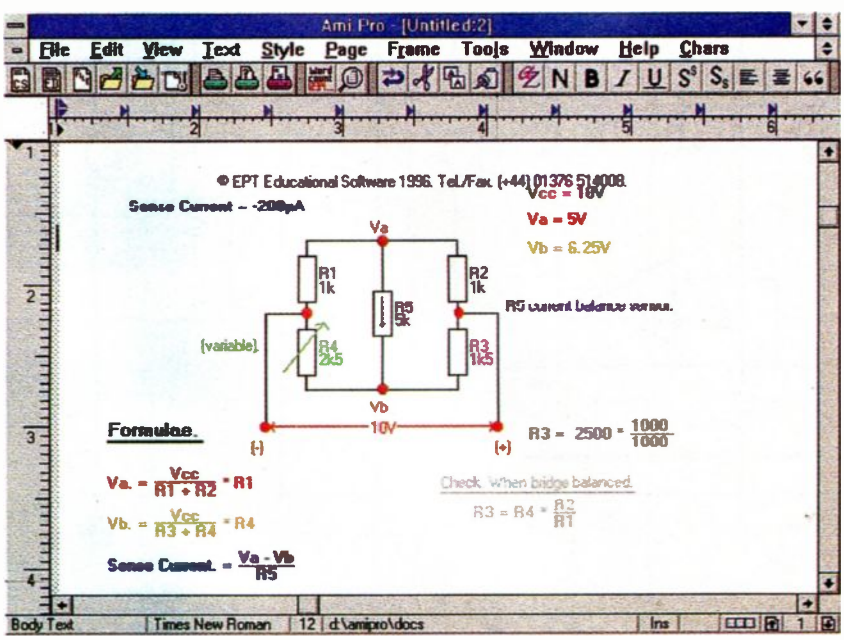


Fig. 1. Importing a graphic from Electronics Principles *into a Windows word processor is easy.*

WIDE-RANGING TUTORIALS

Designed as an on-screen interactive tutorial, *Electronics Principles 3.0* covers a wide variety of fundamental electronics topics, commencing with the basic physics of electricity, insulators and conductors, then moving on to the principles of resistance and current flow. The topics of a.c. and d.c. follow, then basic semiconductor circuits, field effect transistors (a particularly neat display of MOSFET physics is included) and op.amp configurations.

A more advanced analysis of a.c. applications is there, which displays phasor diagrams plus the effects of using resistors, capacitors and inductors in various ways. Some topics go well beyond GCSE Electronics but will appeal to intermediate-level students.

A basic introduction to digital logic is to be found, too, along with interactive logic gate systems which show logic levels throughout the system (with logic changes shown rippling though the system accordingly, when a circuit is "clocked"). The fundamentals of binary notation are displayed and an excellent number base conversion program, dealing with binary, octal, decimal and hexadecimal conversions, is also incorporated as part of the introduction to logic systems.

In total, EPT have included no less than 284 individual windows relating to analogue and digital electronic techniques to explore. All subjects are presented as a series of on-screen tutorials, showing a circuit schematic and accompanying formulae plus component values. The circuits themselves are simple and straightforward, using just a handful of components to illustrate, *er*, electronics principles.

In this respect, the software accomplishes everything it sets out to do. The screens are generally no-frills, with neither over-elaborate nor distracting graphics, although the most advanced of the topics do start to look a little cramped on-screen.

I found that the software was happiest at a video setting of 640 × 480 (256 colours), and a higher resolution (800 × 600) on a 14-inch SVGA monitor became hard work on vision. The windows themselves are movable by dragging the title bar in the usual manner, though the windows cannot be "sized". This has the benefit, though, of dispensing with the need for scroll bars.

COLOURFUL PRESENTATION

The circuits are presented in colour, and Version 3.0 now introduces the facility to copy screens to the Windows clipboard, from which they may be pasted into other applications. This enables printed copies to be prepared using, for example, a word processor package (see Fig.1); your own text can then be wrapped around the imported graphic.

A colour printer is almost essential for printing some of the more complex waveforms seen later in the tutorial, if they are to be at all meaningful. A software site licence is available where hard copies are to be distributed.

Each screen is accompanied by a concise "Theory" window which can be toggled on or off (see Fig 2). Similarly, where appropriate, a "Calculations" window can be called up which shows exactly how the results displayed on the schematic were arrived at. This will be a welcome feature for those who may perhaps lack the initial confidence in mathematics and wish to see how the values are actually derived.

There were occasionally one or two inconsistencies evident, with voltages being expressed as 6·5946V, for example, but nearby resistance values shown as 180R18 where the *R* indicates the decimal point in time-honoured fashion. This is probably connected with the technical difficulty of showing the Omega character on screen.

Overall, the EPT team has worked hard to make the display as informative as possible and generally the displays are orderly and clear, and should boost the confidence of the student. To get the best out of the software, the student needs to understand the circuit schematics, read the component values and understand how they are derived, using the Calculations window when necessary.

INTERACTIVE HAPPENINGS

Where circuits have "interaction", it is possible to make things happen on-screen, by clicking on an appropriate button with the mouse. Switches can be made to change over (Fig.3), diodes may be reverse-biased, bulbs may be illuminated, and voltages may be varied, sometimes using a Windows-style slider control, other times by typing in differing values. The use of colour helps the student to relate to the principles of the circuit being demonstrated (Fig.4).

In addition, *Electronics Principles 3.0* includes a means of applying component values and circuit conditions manually using a separate dialogue box (Fig.5). The software cleverly recognises multipliers and will convert, as an example, 1000 ohms to 1k. The end results are again computed on-screen and the accompanying Calculations window shows how their values have been derived.

A couple of minor "undocumented features" were noted, in particular the fact that the Calculations screen, if closed by double-clicking the top-left hand icon as usual (or ALT + F4), caused the Calculations box to be blanked out if called up again. Only by exiting and re-opening the window were normal affairs restored: using the "Clear Calculations" button, however, proved satisfactory and this

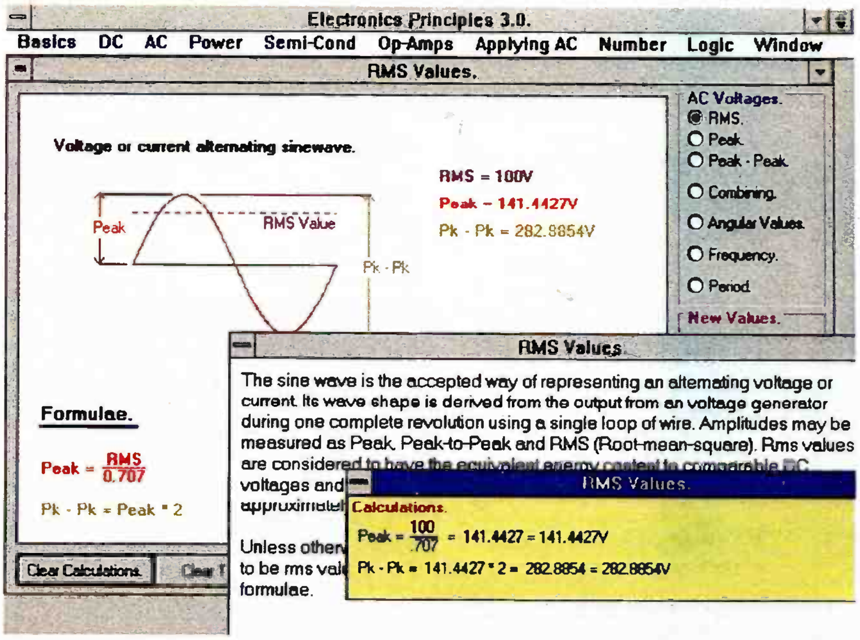


Fig. 2. Theory and calculation screens accompany every window.

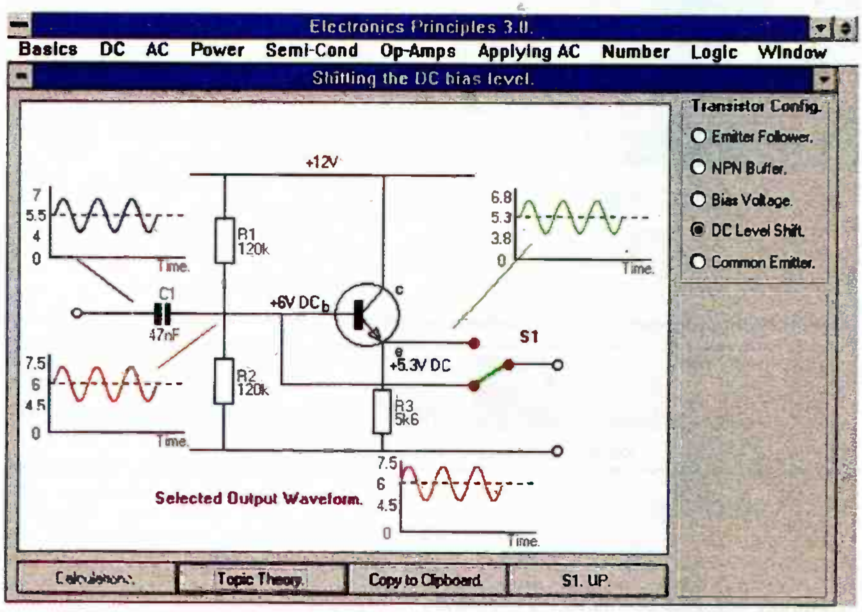
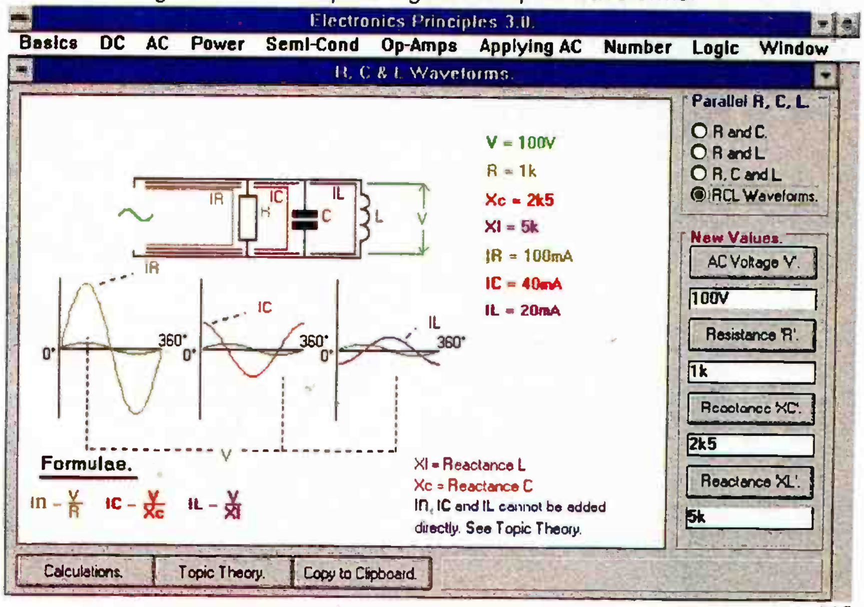


Fig. 3. Interactive screens feature movable switches.

Fig. 4. Colours help distinguish complex waveforms.



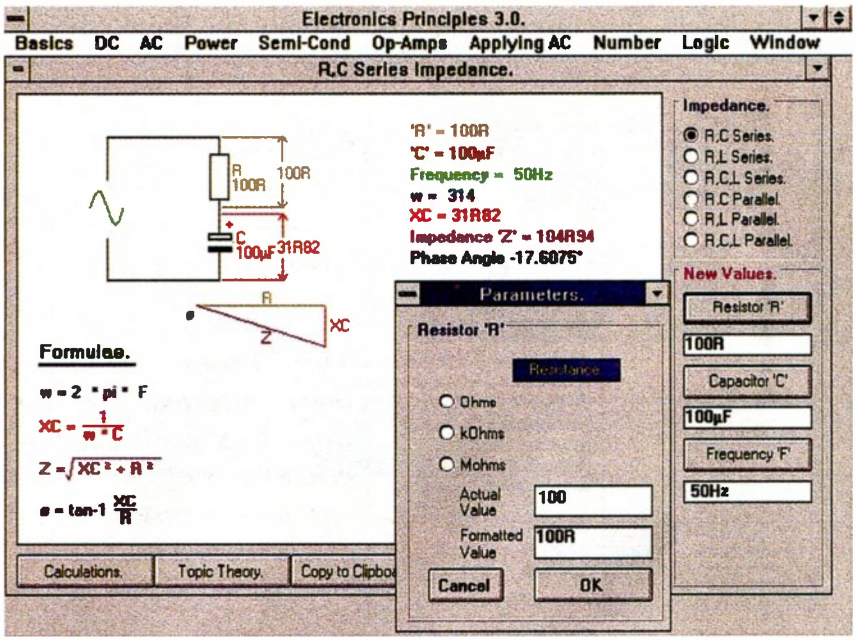


Fig. 5. Component values can be manually input via a dialogue box.

caused no further trouble. There were a very minor number of spelling errors and one technical misprint noted (a reversed transistor), but generally the technical standards are very high.

SUMMING-UP

Electronics Principles 3.0 follows on from our popular *Teach-In '93* GCSE Electronics series, but takes the subject further. There is no doubt that the use of simple, crisp and functional graphics offers an improved means of displaying information and techniques, over the traditional printed version.

A few very minor niggles should not detract from what is the latest, and best, in a well-established line of software which should certainly prove beneficial in educational and hobbyist circles.

EPT offer a high level of (*free*) support to users. A demonstration disk is available which allows the user to explore (though component value changes are disabled) for £2.00 or eight first class stamps.

Also available from EPT is their latest release of *Electronics Toolbox 3.0*, a selection of electronics-specific formulae which will calculate over 100 commonly-used values; the price is £19.95. The company also offers *Mathematics Principles 3.0* covering over 150 topics (including many GCSE subjects) in the same colourful and interactive style, for £49.95. All software runs under Microsoft Windows.

OBTAINING ELECTRONICS PRINCIPLES 3.0

Electronics Principles 3.0 costs £49.95 plus £2 per order for P&P (UK).

For more information, contact EPT Educational Software, Pump House, Lockram Lane, Witham, Essex, CM8 2BJ. Tel/Fax: 01376 514008. E-mail: *sales@eptsoft.demon.co.uk*. World Wide web pages on: *http://www.octacon.co.uk/ext/ept/software.htm*. Also see their advert elsewhere in this issue. Site licences are available, overseas orders are welcomed, and Visa/ Mastercard payment is accepted.

SHOP TALK
with David Barrington

Garden Mole-Ester

Most of the components required to build the *Garden Mole-Ester* should be readily available.

A suitable mercury-loaded tilt switch is currently stocked by **Maplin**, order code FA77J, 79 degree tip-over switch.

Under no circumstance use or purchase a "surplus" glass envelope type; these are fragile and mercury is poisonous!

The loudspeaker must have a coil resistance of 64 ohms, an eight-ohm type is not suitable here. These are available from Maplin, code WF57M and **Greenweld** (☎ *01703 236363*). The Maplin 66mm diameter speaker came from their "Lo-Z" range, but you will not find any entry in their current catalogue. However, we can confirm that they are still stocked.

Readers having difficulty finding a suitable waterproof box can purchase one from Maplin, code YM90X. As mentioned in the article, single 8-cell AAA size holders are hard to come by so it is advised that two 4-cell holders be used instead.

The small single-sided printed circuit board is available from the *EPE PCB Service*, code 106.

Mono "Cordless" Headphones

All the semiconductor devices called for in the *Mono "Cordless" Headphones* should be readily available from most of our component advertisers. Ordinary 5mm infra-red diodes, of the type used in remote control systems, are used in the Transmitter and appear to be sold simply as infra-red l.e.d.s.

Practically any small clip-on heatsink, of the type used with TO220 cased devices having a rating of about 10°C to 15°C per watt should be OK for the Darlington transistor and voltage regulator used in the Transmitter.

Although TIL100 photodiodes have been specified for the Receiver, any similar large area photodiodes having a built-in "daylight" filter should work equally well. Diodes of this type are not necessarily sold under a particular type number in component catalogues. They are often sold simply as "remote control photodiodes", or something similar.

There is some advantage in using a metal case for the Receiver since this will "screen" the sensitive input stage from sources of electrical interference. However, a plastic case should also be suitable.

The printed circuit boards for the Headphones are available as a pair from the *EPE PCB Service*, codes 990 (Trans.) and 991 (Rec.).

Component Analyser

The only item that is likely to cause any concern when ordering parts for the *Component Analyser* is the display l.e.d.

This is a 5mm High Brightness "clear" green type l.e.d. The ones used to make up the "test display" on the model came from **Maplin**, code CK39N.

The "plated-through-hole (p.t.h.)" version of the printed circuit board is available from the *EPE PCB Service*, code 105. The choice of case is left to the individual, but choose one that is of sufficient size to cater for the p.c.b. and will also have room on the front to take the test "Display Look-up Chart."

Mobile Miser

We do not anticipate any component buying problems to be encountered by anyone undertaking the construction of the *Mobile Miser* project.

The case used in the prototype was obtained from **Maplin**, code KC95D. Any miniature slide or rocker switch (such as the Maplin "round-faced rocker type FG47B) may be used for S1, provided it is "low-profile" and it fits the case without fouling the p.c.b. The 3V to 24V p.c.b. mounting buzzer also came from the same source, code KU58N. Most of our components stockists should also be able to supply a similar buzzer.

The Miser printed circuit board is available from the *EPE PCB Service*, code 107.

Bike Speedo (Teach-In '96)

The only source we have been able to locate for the **8-pin** LM2917N-8 tachometer i.c. specified for the *Bike Speedo*, this month's concluding *Teach-In* project, is **Electromail** (☎ *01536 204555*), code 302-047. The p.c.b. for this project has been designed around the 8-pin version.

The CS209A electro-magnetic proximity detector i.c. is currently listed by **Maplin**, code UH59P. If you wish to use the same ABS plastic case as the prototype model this came from **Rapid Electronics** (☎ *01206 751166*), code 301910.

The printed circuit board for the *Bike Speedo* is available from the *EPE PCB Service*, code 108.

PLEASE TAKE NOTE

Countdown Timer (May '96)

On p.c.b. Fig. 5, the base (b) and collector (c) pins of transistors TR1 and TR2 should be transposed.

Everyday Practical Electronics Books

ELECTRONIC PROJECTS – BOOK 1
Published by *Everyday Practical Electronics* in association with Magenta Electronics.
Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages (A4 size) **Order code EP1** **£2.45**

ELECTRONICS TEACH-IN 88/89 – INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Practical Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

ELECTRONICS TEACH-IN No. 6
DESIGN YOUR OWN CIRCUITS
(Published by *Everyday Practical Electronics*)
Mike Tooley BA
This book is designed for the beginner and experienced reader alike, and aims to dispel some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.
Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs. The practical projects have each been designed to stand on their own as complete items of equipment. P.C.B.s for all the modules and projects are available by mail order.
The subjects covered in each chapter of the book are: Introduction and Power Supplies: Small Signal 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 (A4 size) **Order code T16** **£3.45**

TEACH-IN No. 7 plus FREE Software
ANALOGUE AND DIGITAL ELECTRONIC COURSE
(Published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE
The highly acclaimed *Teach-In* series, which included the construction and use of the *Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally **EPT** Educational Software have developed a GCSE Electronics software program to compliment the course and a FREE DISC covering the first two parts of the course is included with the book.

DIRECT BOOK SERVICE

The books listed have been selected by Everyday Practical Electronics editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.
If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics then this is for you. If you are teaching electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.
152 pages (A4 size) **Order code T17** **£3.95**

Computers and Computing

HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM
D. Weale
This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms.
The text contains many useful tips and some warnings (which could save much effort and expense).
114 pages **Order code BP323** **£4.95**

MAKING MS-DOS WORK FOR YOU (covers version 6.2)
N. Kantanis & P. R. M. Oliver
This book was written with the busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the book has also been designed to be circular, which means that you don't have to start at the beginning and go to the end.
The book explains: How to write customised batch files which allow you to display what you want on your screen, and in the form and order you want it, instead of being forced to use the DOS prompt on a blank screen. How to design and set up a fast interactive and professional looking menu system, so that you or anyone else can run utility applications or commercial software packages easily. How the ANSI.SYS display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters or change their colour. How the Edit screen editor or the Edlin line editor can be used to enter ESCape (ANSI.SYS) commands into simple ASCII files to allow control of both your screen display and your printer. How to control the operation of the two main types of printers in use today, Epson compatible dot matrix and HP compatible laser printers. How to use several routines, such as moving and finding files, protecting files from accidental erasure, a simplified backup process, a screen saver, and a disc cataloguing system.
The Debug' program and how it can be used to create, see and change the contents of any file, including those of programs written in assembler code. This includes how to find your way around the names and tasks of the CPU registers and the meeting of some simple assembler mnemonics.
182 pages **Order code BP319** **£4.95**

MULTIMEDIA ON THE PC
Ian R. Sinclair
In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.
184 pages **Order code PC112** **£11.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
(Revised Edition Covers Version 6.2)
This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nevertheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
176 pages **Order code BP232** **£3.95**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.
This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!
128 pages **Order code BP282** **£4.95**

AN INTRODUCTION TO 6800 ASSEMBLY LANGUAGE
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Obtain a vast increase in running speed by writing programs for 6800 based micros such as the Commodore, Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
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Circuits and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop
This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.
The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.
Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.
88 pages **Order code BP299** £4.95

ELECTRONIC ALARM CIRCUITS MANUAL
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One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.
Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.
124 pages **Order code NE11** £13.95

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.
Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.
200 pages **Order code PC106** £8.95

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kit and a wide range of mechanical components available. The microcontroller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.
92 pages **Order code BP179** £2.95

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.
64 pages **Order code BP42** £1.95

BOOK 2 50 more l.e.d. circuits.
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CIRCUIT SOURCE BOOK 1
A. Penfold
Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.
The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.
Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
182 pages **Order code BP321** £4.95

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold
This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world"
142 pages **Order code BP332** £4.95

CIRCUIT SOURCE BOOK 2
R. A. Penfold
This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.
The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.
The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.
Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
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The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.
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The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.
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R. A. Penfold
The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.
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Various chapters cover: Digital Arithmetic, Electronic Logic, Conversions between Analogue and Digital Structures, Transmission Systems. Several Appendices explain some of the concepts more fully and a glossary of terms is included. Altogether a useful foray into the digital world both for newcomers and also for those who need some revision or updating.
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This book is in effect more than just a dictionary of practical electronics terms, it goes a stage further in also getting down to fundamentals. Accordingly the number of terms may be limited but the explanations of the many which are included are designed to leave the reader more competent and satisfied – and this is without the use of complicated mathematics which often on first reading can be confusing.
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The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.
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A. Pickford
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There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.
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P. Shore
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Audio and Music

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V. Capel
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This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.
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R. A. Penfold
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Vertical Wiper	917	£6.35
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Audio Amplifier		
Light Beam Communicator (2 boards required)		
Multi-Project PCB **APR'95**	932	£3.00
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Switch On/Off Timer		
Continuity Tester		
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EPE Met Office – **JAN'96**		
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SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY

WELCOME, internauts everywhere, to *EPE's* very first *Net Work* column! In this new feature we'll try to help electronics enthusiasts to get the best out of using the Internet. There are enormous amounts of electronics-related sites available, and *Net Work* will point you in the direction of those sources of information relating to educational and hobby electronics, and more besides.

Covered in *Net Work* will be a variety of topics, including news, Web sites, FTP goldmines, service provider information, Usenet newsgroups, together with browser tips and tricks to help squeeze every last penny out of the time you'll spend on-line. It's written specially for readers of this magazine, some of whom will only recently have gained access: fear not, *Net Work* will have something for net novices, too!

All URLs and E-mail addresses quoted are believed to be current at the time of writing but may sometimes relocate. Readers' comments are always welcomed. E-mail to **alan@epemag.demon.co.uk** or write to me at the Editorial address.

Beware - Modems!

In order to access the Internet, you need a computer and a phone line together with a ***modem***, which is the box of tricks that goes between the two. Ponder your PC carefully before selecting a particular modem. Your first question should be whether to select an ***internal*** or an ***external*** modem. What's the difference?

I personally chose an *internal* Fax/Modem with good reason, and I installed it into an ISA slot of an older 486 machine. A telephone line then plugs directly into the PC. You do, of course, need a spare expansion slot on the motherboard, but otherwise they're reasonably straightforward to install.

External modems plug into an unused serial port of your computer, so they take up more space on the desk top, there are more wires (power, phone and serial connection) and they can generally get in the way. Here's another rub: older machines (earlier 486s or lower) might not have a fast enough serial port to accommodate the higher speeds of modern Internet transmissions anyway.

The type of UART chip fitted to the motherboard determines how well your serial port will perform, and is critical. The way to find out what type of UART your machine has, is to type MSD (Microsoft Diagnostics) at the DOS prompt. Then click on the "Com Ports" dialogue box and look for "UART chip used".

Breaking the Bottleneck

An 8250 (as on my Internet machine) is likely to be fitted to older PCs, and may produce errors or bottlenecks if you attempt to use an external modem. An internal modem overcomes this because it doesn't access the slower serial port on the PC's motherboard.

Some sources advocate swapping out the 8250 chip for a faster one, as an alternative – not for the faint-hearted. A 16550 UART is the thing to look for if you want to hook an external modem onto your PC. These are fitted as standard to all current PCs.

One advantage of an external modem is that a row of l.e.d. indicator lights displays activity (or not) to give you a visual clue of current events. I have to say I personally don't miss this feature at all, but others may prefer it. But for best results only use an external modem if you are sure your PC's serial port is fast enough.

A *fax/modem* enables you to send faxes from a word processing package since it's treated just like a printer. Instead of printing the job conventionally, send it to the fax modem and the fax software (e.g. *Delrina WinFax Pro* or *Procomm for Windows V2.1*) will handle the dialling and transmission, and you can also *receive* faxes directly to disk if your PC software is running and connected.

It's best to choose the faster 28·8k modem if you can afford it, though cheaper 14·4k units are still plentiful. Preferably look for B.A.B.T. Approval – "the green dot" – and check the REN (Ring Equivalence Number – my internal type has a REN of 3), since a total load on your phone line of more than 4 REN may cause some phones on the circuit not to ring properly, if at all, though they *will* probably still work. Other than that, many modems are "much of a muchness" and you should shop around for the best price, picking a popular brand such as Zoom or U.S. Robotics for instance.

After that, your communications software needs configuring to run with the chosen modem. A well-known modem offers fewer installation headaches, since the software will probably recognise a popular modem automatically. Otherwise, a little bit of experimentation may be needed to "tune" your modem. *Windows '95* users can look at Settings/Control Panel/Modems/Diagnostics, too.

Netscape Navigator

Netscape is easily the most popular World Wide Web browser. Version 2.01 is currently the one to go for but version 3.0 (codenamed *Atlas*) has been released as a time-limited beta. At the time of writing, it's some 5.5Mb maximum and is currently available by anonymous FTP from **sunsite.doc.ic.ac.uk/computing/information-systems/www/Netscape/pub/navigator/3.0/3.0b4/windows.**

Not everyone thinks it's yet worth the download; you may be better sticking with 2.0 or even 1.22 if you're less discerning, though you will miss out on some of the later features used on some sites (e.g. animated graphics or frames) which don't display on earlier browsers. If you want the latest plug-in compatibility, *Cool Talk* audio and video conferencing, and 3D, then *Navigator 3.0* may be for you – depends on how much of a webaholic you are!

Netscape 3.0 beta 4 stops working after August 15, 1996 and you can expect a string of beta updates before the final shrink-wrapped version goes on sale. Incidentally, those who are unfamiliar with FTP (File Transfer Protocol), fear not – it will be covered in a forthcoming *Net Work*.

CE Compliance

If you're stuck in the rut of trying to ensure your products carry CE-approval, I have good news – you are not alone! Join in the fun by subscribing to the newsgroup **sci.engr.electrical.compliance** where shoulders are available for crying upon!

Credit goes to Bill Lyons, of the IEEE for establishing this new self-help newsgroup, whom I thank for keeping me posted.

PIC Sites and More

Microcontrollers, especially the Arizona Microchip PIC, are becoming increasingly popular and there are plenty of PIC-related sites presently available on the WWW. Academic sites are a good place to hunt, where various PIC-happy folks have built personal resources to help fellow PIC users.

Try **http://www.lancs.ac.uk/people/cpaame/pic/pic.htm** as an enthusiastic resource of PIC-related material. Also, **http://www.wmin.ac.uk/~nguyenc/ELEC_DIR.html** is *"Chu's Guide To Electronic Companies"*, a good site linking to many semiconductor manufacturers.

Microchip themselves will be found at **http://www.ultranet.com/biz/mchip.** Data Sheets and information are available in *Adobe Acrobat* PDF format from there (fetch a PDF reader from **http://www.adobe.com/acrobat/main.html).** Finally, point your browser at **http://www.cera2.com/** for the *Electronic Engineer's Toolbox*, a resource handling embedded systems and more.

***I'll be highlighting more interesting sites every month – be with you next month for more* Net Work.**

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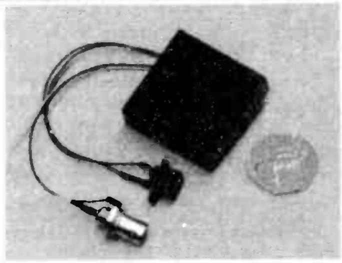

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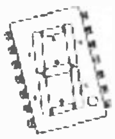

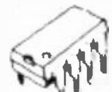

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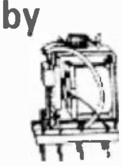

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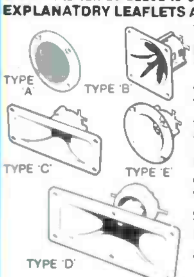

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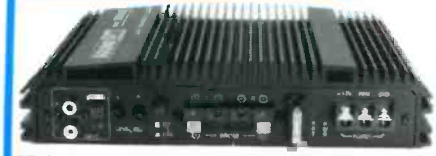
SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

IN-CAR STEREO BOOSTER AMPS



THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
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ALL POWERS INTO 4 OHMS
Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

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SUPPLIED READY BUILT AND TESTED.

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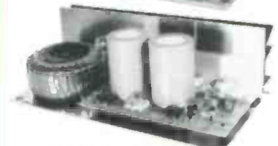
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P



OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

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RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P
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RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P
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RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P
8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P
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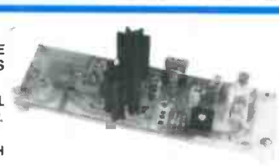

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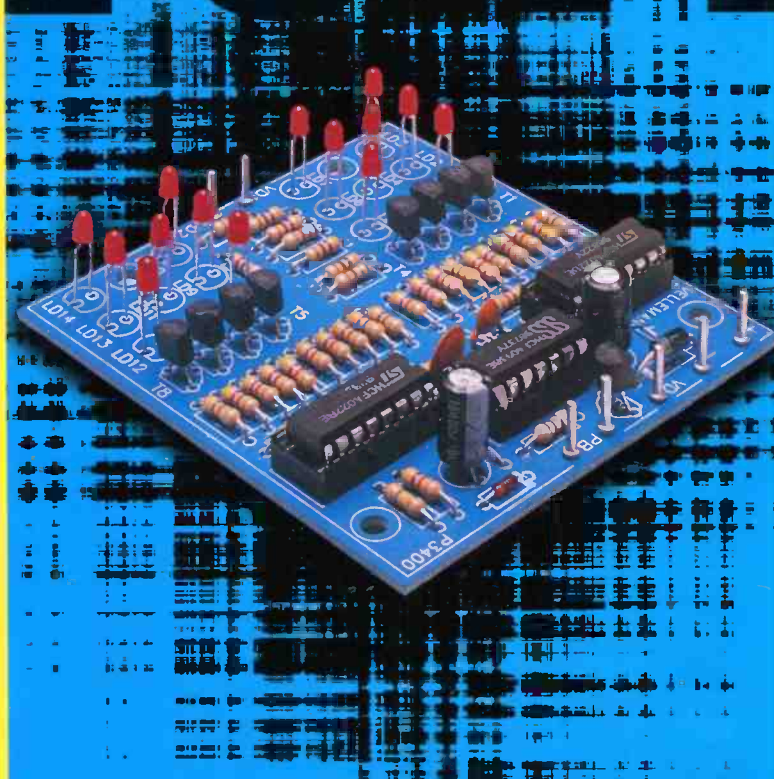

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