EVERYDAY PRACTICAL ELECTRONICS

MAY 1996

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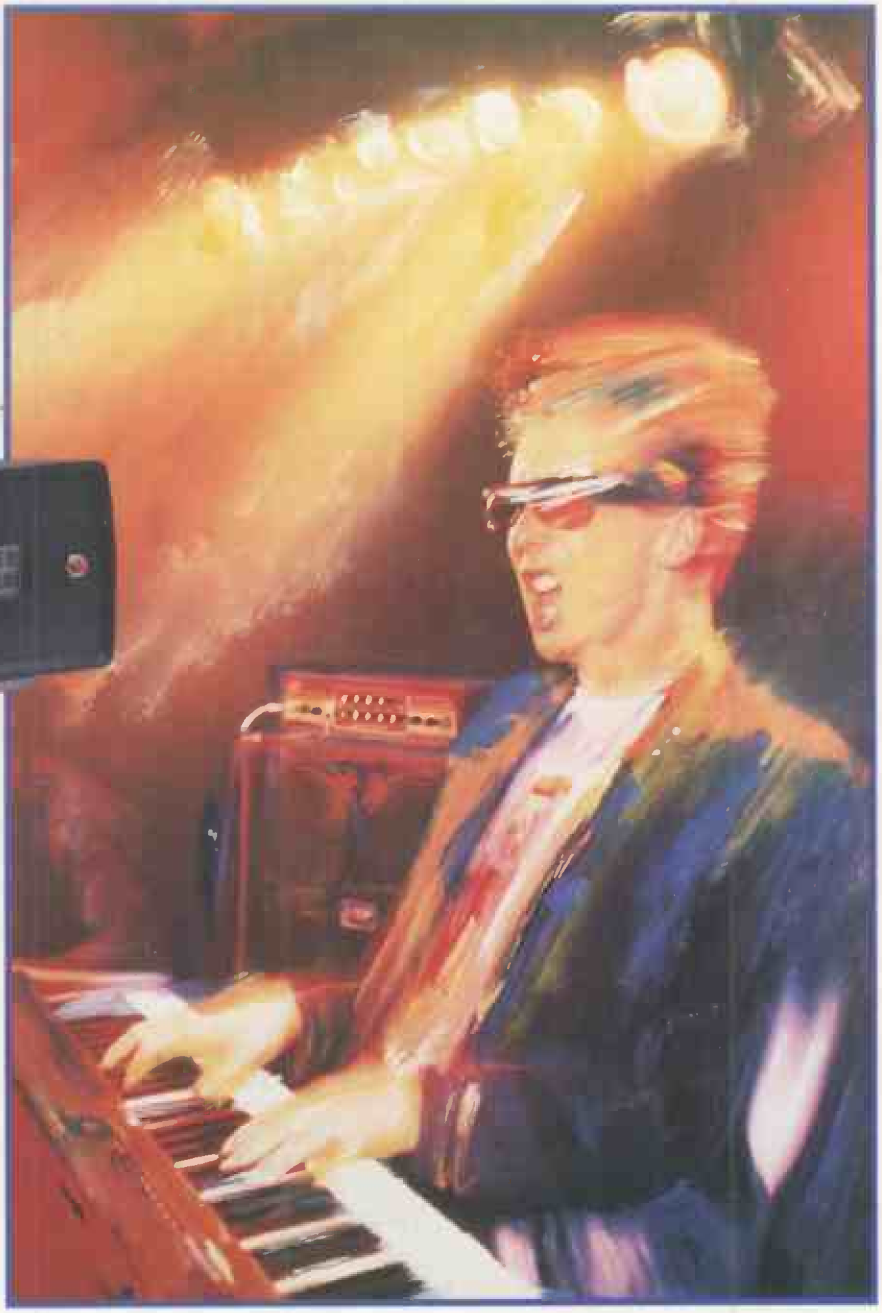
MIDI ANALYSER

'See' the commands coming from your MIDI instrument – note value, octave number, key velocity, etc.



PIR DETECTOR

Protect your property, indoors or out

COUNTDOWN TIMER

Versatile l.e.d. readout timer – a Teach-In '96 project

The history and present day uses of

CATHODE RAY TUBES

INGENUITY UNLIMITED

Readers' Circuit Ideas

THE No. 1 INDEPENDENT MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

05

9 770262 361072

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

RADIATION DETECTOR SYSTEM Designed to be wall mounted and connected into a PC, ideal for remote monitoring, whole building coverage etc. Complete with detector, cable and software. £19.95 ref BAR75.

WIRELESS VIDEO BUG KIT Transmits video and audio signals from a minature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. £9.95 REF EP79. (probably not licensable!)

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

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

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

9 WATT CHIEFTAN TANK LASERS

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

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

NEW HIGH POWER RF TRANSMITTERS AMPLIFIERS Assembled PCB transmitters, 4 types available.
12.6vdc 90 watt 1.5-30mhz 75 ohm in/out FM/AM £75 ref RF1
12.6vdc 40 watt 50-200mhz 50 ohm in/out FM/AM £65 ref RF2
28vdc 125 watt 1.5-30mhz 75 ohm in/out FM/AM £85 ref RF3
28vdc 100 watt 50-200mhz 50 ohm in/out FM/AM £75 ref RF4
A heat sink will be required, rng for price and availability.
If you intend using these as audio transmitters you will need a also need a preamp. Complex module available at £40 ref RF5.

COMPUTER/WORKSHOP/HI-FI RCB UNITS Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £9 each Ref MM5.

RADIO CONTROLLED CARS FROM £6 EACH!!!! All returns from famous manufacturer, 3 types available, single channel (left,right,forwards,backwards) £6 ref LOT1. Two channel with more features £12 ref LOT2. Two channel proportional (plug in crystals etc) £35 ref LOT3.

THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PASTEL ACCOUNTS SOFTWARE, does everything for all sizes of businesses, includes wordprocessor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (0345-326009 try before you buy!) Current retail price is £129, SALE PRICE £9.95 ref SA12. SAVE £120!!!

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

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

Check out our WEB SITE

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

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

4.5mw LASER POINTER. BRAND NEW MODEL NOW IN STOCK!, supplied in fully built form (looks like a nice pen) complete with handy pocket clip (which also acts as the on/off switch.) About 50 metres range! Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. just £39.95 ref DEC49 TRADE PRICE £28 MIN 10 PIECES

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

RUSSIAN MONOCULARS Amazing 20 times magnification, coated lenses, carrying case and shoulder strap £29.95 REF BAR73

PC PAL VGA TO TV CONVERTER Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware.. Ideal for laptops or a cheap upgrade. Supplied in kit form for home assembly. SALE PRICE £25 REF SA34

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

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

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

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

ECLATRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £6.99 REF SA15B.

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

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

MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3 P&P PLUS VAT.

PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS WELCOME (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)

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FAX 01273 323077

E-mail bull@pavilion.co.uk

24v AC 96WATT Cased power supply. New. £9.99 REF SA40

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MIXED GOODIES BOX OF MIXED COMPONENTS WEIGHING 2 KILOS YOURS FOR JUST £6.99

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

RATTLE BACKS Interesting things these, small piece of solid perspex like material that if you try to spin it on the desk it only spins one way! in fact if you spin it the 'wrong' way it stops of its own accord and go's back the other way! £1.99 ref GI/J01.

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

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

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

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

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

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

SANYO NICAD PACKS 120mmx14mm 4.8v 270 maH suitable for cordless phones etc. Pack of 2 just £5 ref EP78.

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

STEREO MICROSOPES BACK IN STOCK Russian, 200x complete with lenses, lights, filters etc etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue. Ref 95/300.

WE BUY SURPLUS STOCK FOR CASH

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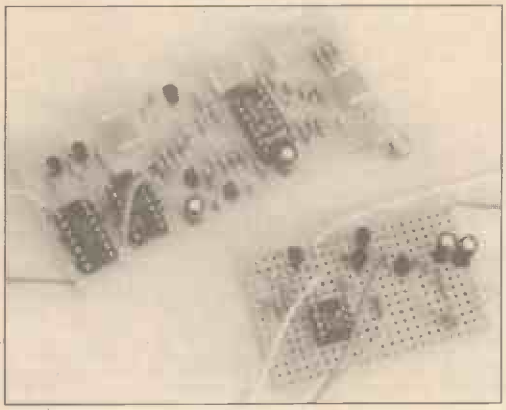
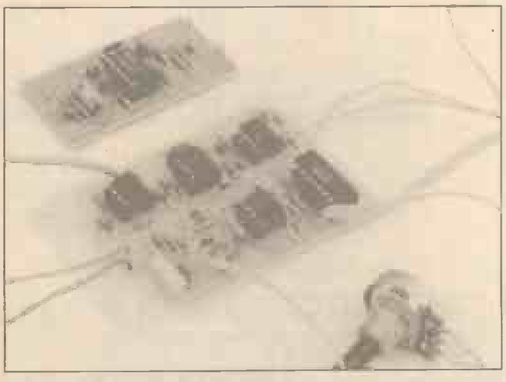
VOL. 25 No. 5 MAY 1996

EVERYDAY PRACTICAL ELECTRONICS

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





Projects

Series

Features

Our June '96 Issue will be published on Friday, 3 May 1996. *See page 331 for details.*

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THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

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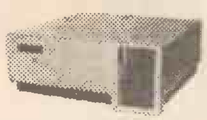
LOW COST PC's -

SPECIAL BUY

AT 286



40Mb HD + 3Mb Ram

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

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	£19.95
NE2000 Ethernet (thick, thin or twisted) network card	£39.00

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.
Many other options available - call for details. Only **£399.00** (E)

FLOPPY DISK DRIVES 3½" - 8"

5¼" or 3½" from only £18.95 !

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are *BRAND NEW* or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3½" supported on your PC).

3½" Panasonic JU363/4 720K or equivalent RFE	£24.95(B)
3½" Mitsubishi MF355C-L. 1.4 Meg. Laptops only	£25.95(B)
3½" Mitsubishi MF355C-D. 1.4 Meg. Non laptop	£18.95(B)
5¼" Teac FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5¼" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£22.95(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	Only £499.00(E)

HARD DISK DRIVES

End of line purchase scoop! Brand new NEC D2246 8" 85 Mbyte drive with industry standard SMD Interface. Ultra hi speed data transfer and access times, replaces Fujitsu equivalent model. Complete with full manual. Only £299.00 or 2 for £525.00 (E)

3½" FUJI FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" CONNER CP3024 20 mb IDE I/F (or equiv)RFE	£59.95(C)
3½" CONNER CP3044 40mb IDE I/F (or equiv.)RFE	£69.00(C)
3½" RODIME RO3057S 45mb SCSI I/F (Mac & Acorn)	£99.00(C)
3½" WESTERN DIGITAL 850mb IDE I/F *Brand New*	£185.00(C)
5¼" MINISCRIBE 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" CDC 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
8" FUJITSU M2322K 160Mb SMD I/F RFE tested	£195.00(E)
Hard disc controllers for MFM, IDE, SCSI, RLL etc. from	£16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER
*CABLE COMPATIBLE**

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

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

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

DC POWER SUPPLIES

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

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

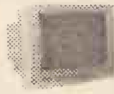
6,000,000 items EX STOCK

For *MAJOR SAVINGS* - CALL FOR SEMICONDUCTOR HOTLIST

VIDEO MONITOR SPECIALS

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

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



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

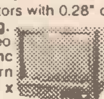
5000 Monitors from stock !!!
HERCULES, EGA, CGA, VGA, SVGA - 6 to 26"
+ Many special items - CALL with your needs !

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

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 Khz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £95** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.625 Khz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13¾" D. 240 V AC mains powered. **Only £79.00** (D)

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



20" 22" and 26" AV SPECIALS

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

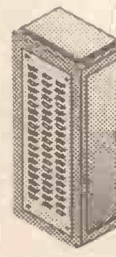
20"....£135 22"....£155 26"....£185 (F)

SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
2kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
Broadcast Electronics Inc FX30 FM exciter 80-108 MHz	£750
Stanelco STA15 15kW RF Induction heater system	£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
HP APOLLO RX700 system units	£950
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP7580A A1 8 pen HPGL high speed drum plotter	£1850
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
EG-NG Brookdeal 95035C Precision lock in amp	£650
OTC Ltd 1550 SM Stabilised IR laser calibration source	£2250
Ling Dynamics 2kW programmable vibration test system	£POA
Computar 16mm CCTV auto iris lenses 'C' mount - NEW	£125
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Roken 80-250 240v single phase flow solder machine	£1200
ICI R5030UV34 Cleanline ultrasonic cleaning system	£POA
Mann Tally MT645 High speed line printer	£2200
INTEL SBC 486/133SE Multibus 486 system. 8Mb Ram	£1200
Zeta 3220-05 A0 4 pen HPGL *fast* drum plotters	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 2998 Infrared spectrophotometer	£POA
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
Thurlby LA 160B logic analyser	£375
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
Densei MUD 0185AH 1KVa UPS system with batts NEW	£575
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

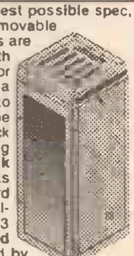


Superb quality 6 foot 40U Virtually New, Ultra Smart
Less than Half Price!

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 £19.50 (A1)
1 MB x 9 SIMM 3 chip 80 ns £23.50 or 70ns	£24.95 (A1)
1 MB x 9 SIMM 9 chip 80 ns £22.50 or 70ns	£24.00 (A1)
4 MB 70 ns 72 pin SIMM - *with parity-*	Only £95.00 (A1)
8 MB 70 ns 72 pin SIMM - no parity	£159.00 (A1)
INTEL 486-DX33 CPU £55.00 INTEL 486-DX66 CPU	£69.00 (A1)

FANS & BLOWERS

EPSON D0412 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*

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NEXT MONTH

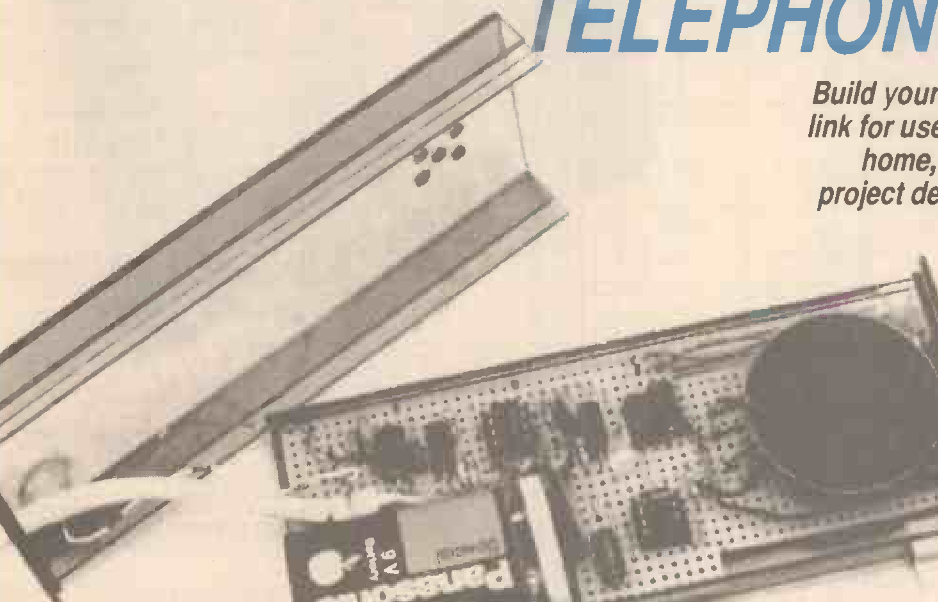
ULTRA-FAST FREQUENCY GENERATOR & COUNTER

Improve your workshop facilities with this high-speed, multi-frequency item of test gear. Designed in response to the need for a frequency generator and 8-digit counter which can cope with frequencies well in excess of 40MHz and with more than one signal generator, it's a real freq-out!

'SCOPES

Every picture tells a story and a "picture" of an electronic signal can tell you much more than a voltage, current or frequency measurement. Starting next month this short series of articles looks at the equipment that can provide the "picture" – the cathode ray oscilloscope. The series covers 'Scope Basics, Measurements, Experiments, Applications and Digital Storage 'Scopes. Don't miss this excellent insight into a very versatile piece of test gear.

TELEPHONE LINK



Build yourself a simple 'phone link for use in and around your home, workshop, etc. This project describes a neat, easy to build 'phone that can operate over distances of up to one kilometre.

SARAH'S LIGHT

So you're not afraid of the dark? Imagine the scene: It's the middle of a winter's night when you're woken up by the sound of a creaking floorboard. Pulse racing, you try to get out of your bed, but find that you can't. The hairs on the back of your neck stand up as you consider that from where you are there's no way you can turn on the light. So you crouch, trapped, staring into the darkness while your imagination parades a host of frightening possibilities. Sounds like a nightmare? It's a situation faced nightly by children who sleep in a cot – and then we wonder why kids are afraid of the dark! So the idea for Sarah's light was born, to banish fears of the dark by giving the child control over it.

EVERYDAY PRACTICAL ELECTRONICS

JUNE ISSUE ON SALE FRIDAY, MAY 3

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Semiconductors
Some memory chips, found in a parcel purchased a while ago but only just surfaced
As far as we can ascertain, they're all DRAMs.
X3919 (1429) TMS4256FML-12 256k x 1 18 pin surface mount. **50p; 100+ 0.30**
X4083 (130) 41256-12 18 pin surface mount. **50p;** 100+ 0.30
X4091 (31) TMS4416-15 18 pin surface mount. **50p.**
X4089 (93) TMS4464-12 (few -15) 18 pin surface mount. **50p.**
X3920 (74) 81257-12 256k(?) 18 pin surface mount. **50p.**
X3921 (400) D41464-12 64k x 4 18 pin surface mount **50p;** 100+ 0.30
X4088 (64) D41464-15 (we'll supply these when -12 are sold out) 64k x 4 18 pin surface mount. **50p.**
X3924 (274) M5M4256L-12 256k 16 pin DIL 0.1" pitch **50p;** 100+ 0.30
X4087 (35) M5M4C264L-12 256k 24 pin DIL 0.1" pitch. **50p.**
X4084 (198) D41264-12 24 pin DIL 0.1" pitch. **50p;** 100+ 0.30
X3922 (112) TMS4C1024D-12 1M x 1 20 pin surface mount. **£1.50;** 100+ 0.90
X3923 (17) 42C4064Z-12 1M(?) 24pin DIL 0.1" pitch **£1.50**
X4085 (73) 1259Z-15 16 pin DIL 0.1" pitch **50p**
X4092 (37) 1259EJ-12 18 pin surface mnt. **50p**
X4086 (65) 1257Z-15 16 pin DIL 0.1" pitch **50p**
X4090 (23) M5M4256-15 16 pin DIL 0.1" pitch **50p**
X4093 (24) M5M4256J -15 18 pin surface mount. **50p**
X4094 (34) MB81256-12 16 pin DIL 0.1" pitch **50p**
X4095 (7) MB81464-12 16 pin DIL 0.1" pitch **50p**
X3936 (5) Texas 256k x 9 bit SIMM, uses 3 x 4C256-80. **£5.00**
X3935 (8) Epson 256k x 9 bit 3 chip SIMM. **£5.00**
X6819 (200) 78H12ASC TO3 steel case 12V 5A voltage regulator. List 9.34 **Our Price £3.00;** 100+ 2.00
X3903 (70) ZNREF040CI TO18 case 4.0V precision reference diode. **£1.00**
X3909 (541) 7905 TO220 voltage reg. -5V 1A. **5/£1.00;**100+0.14
X3751 (5500) 1N4003 preformed and cropped for vertical PCB mntg. **100/£1.00;** 1000+ 0.006
X3732 (1600) A PNP darlington TO92 transistor with Hfe of 1000. (Not marked) **25/£1.00;** 1000+ 0.025
X3753 (2200) E-line NPN transistor UGN3076U. Hfe 140. **100/£2.50;** 1000+ 0.015

X3902 (25) Extraordinary device - Peltier effect thermo-electric module. Acts like a heat pump (18W max) - when voltage is applied, one surface heats and the other cools. Max temp difference of about 70°C Size 30x30x4.7. List Price £35.00 Supplied with data sheet. **Our Price £12.00**

Phone Index Clock X6825 (70) Natty little gadget Case 115x80 has quick find index and contained within the top is a pop-up LCD clock with large display, alarm and snooze facility. **£3.00**

OPTO First a couple of LCD modules:
X4096 (29) These are ex-equip. 24x2 dot matrix fitted with short ribbon cable with 14 way header skt. **£6.00**
X4097 (5) As above, but with back light **£8.00**
X6764 (18) Complete vacuum fluorescent display assembly, 16 digit 5x7 dot display + drivers and DC-DC converter all on PCB 162x56. 5V supply. Supplied with comprehensive data **£20**
X3762 (1400) 5mm high brightness green LED, clear case with cropped leads, right angle mntg. **20/£1.00;** 1000+ 0.025

REFERENCE BOOKS
X6777 (41) Third Generation TMS320 User's Guide (1989) 624pp 210x150mm **£3.00**
X6774 (3) 2 volumes - BA481 to SAA197; SAA199B to TDA4680. (1992) Size 227x 177 **£10.00**
X6773 (25) Phillips data handbook - Semiconductors for Television and Video Systems. Vol 1 only - BA481 to SAA197 **£4.00**
X6778 (78) Optoelectronics and Image-Sensor Data Book. All Texas Instruments devices. (1987) **£4.00**
X6771 (14) National Semiconductor DRAM Management Handbook Size 227x 177 (1989) **£8**
X6772 (97) National Semiconductor RAM Databook Size 227x 177 (1987) **£2**

HANDS FREE KITS For using portable cellular phones in cars
X9085 (84) For the Motorola MicroTAC, contains hands-free cradle with adaptor, speaker, microphone, and glass mounted antenna. **£15**
X9084 (100) For the Motorola 8000/9000 series, contains hands-free cradle with adaptor, speaker, microphone, and glass mounted antenna **£15**
X9083 (120) For the NEC P200/P300, P201/P301 and Kenwood KMP-H700 contains hands-free cradle with adaptor, speaker, microphone, and glass mounted antenna **£15**
X9082 (120) As X9084, but also 8800X LED and LCD versions, **contains** hands-free cradle with adaptor, speaker, microphone, and glass mounted antenna. **£15**
X9081 (120) As X9084, contains hands-free cradle with adaptor, speaker & microphone. **£10**
X6815 (200) Electric stapler mechanism, as fitted to some Xerox copiers. This is a nice solid bit of machinery with a 12V motor and external gear chain. It also has a hopper loaded with **5000** staples. **£6.00;** 100+ 4.00

Personal Mobile Car Adaptors
These consist of a curly cord with car plug one end (fused with LED indicator) and battery shaped moulding the other. Ask for illustrated list

Personal Mobile Cases
Good quality leather cases. Ask for illustrated List
X6714 fits Nokia Orange phone. **£3.00**

X6756 (180) MTS600 phone cradle made from steel with rubber lining for Motorola phone. Size 117x52x45mm **£1.50;** 100+ 0.85
X6754 (400) Plastic mobile phone cradle for in car use **£1.00;** 100+ 0.60

Rabbit Mobile Phone Chassis
Another mobile phone disaster! This one could be used indoors as a normal phone, and also as a mobile, providing there was a transmitter in close proximity, but only for making, not receiving calls
X6757 (400) Consists of two panels that clip together. Panel A has LCD 42x18mm with 10 digit display + several icons; mini mic and earpiece; mostly s/m components, batt holder, 15.84 xtal; Panel B has 4 xtals - 50.00, 6.4, 149.5 and another; again, lots of s/m. **Both panels for £3.00**
X6758 (2000) Panel B only. **£1.00**

MOTORS & SOLENOIDS
X3945 (3000) Geared 16V DC reversible motor (works well on 12V) size 61x33 dia 10mm dia gear on spindle. Final drive speed 200RPM. **£3.00;** 100+ 2.00
X6660 (2000) Another motor to add to those on the front page of the Winter Supplement. This one is 12V, 4000RPM, 500mA (7.5A stall), body 75x52mm, spindle 20x4mm, weight 335g **£5.00;** 100+ 3.00
X6665 (150) A most excellent Japanese mains (220V 0.12A) induction motor with integral gearbox giving a final drive speed of 180RPM to the 48x6mm spindle. Supplied with 5µF starting cap. Solid diecast ally frame 90x70x70mm. **£8.00;** 100+ 5.00
X6666 (240) Crouzet synchronous 28V ac 7W motor 47mm dia x 21mm deep with easily removed gearbox giving final drive speed of 8RPM to 11x4mm spindle. The list price on motor + gearbox is over £43! **Our Price £4.00;** 100+ 2.80
X6667 (350) Neat 12V stepper motor 44x42x42mm 24 step (15°) **£1.50;** 100+ 0.80
X6668 (450) Heavy duty solenoid 53x38x32mm Plunger 14mm dia has slot 4mm wide, 20mm travel. 24V dc continuously rated. **£2.50;** 100+ 1.40

POWER SUPPLIES
X6816 (1500) Plug in ac adaptor, 1.8m lead with 2.5mm power skt. Output 24V ac 200mA **£2.00;** 100+ 1.20; 1k+ 0.90
X6663 (64) DC adaptor - 110V in on **1m** long lead with US 2 pin plug. Output 9V 300mA on 1.8m lead with 2.5mm jack plug. Series two together and use on mains! **Price for TWO: £3.00**

MISCELLANEOUS
X6762 (160) Set of 3 shrink wrapped disk cases by Esselte. Each takes up to five 3.5" disks. **£2.00**
X6813 (96) Panoramic camera Fixed focus 35mm camera that uses standard film New and boxed. **£5**
X6812 (24) Lottery number selector. 49 coloured balls inside a clear plastic globe. Shake them up, invert the globe and 6 balls appear in a trench **£2.50**
X3939 (200) Piezo sounder 39dia x 25.5. 12V operation Like our A385, but mounting lugs cut off **80p;** 100+ 0.40
X6814 (6) Large 500µA panel meter 110x80mm face, needs 60mm hole. **£5**
X3834 (75) Alfac edge connector transfer, 0.1" pitch 69 way. Pack of 10 strips **£1.00**
X6664 (188) **Calculator** HL812E 8 digit with %, sq root and memory. 125x70x18mm. **£3.00;** 100+ 2.00

SWITCHES - Rotary
X3843 (540) 6 pin DIL mntg BCD 10 way switch by EECO, 11x11x11. **£1.50;** 100+ 0.85
FEME 5950 series for PCB or panel mntg. 10mm bush, spindle 17x6dia. (Farnell 480-472 etc)
X6759 (150) 1pole 12way List 9.45 **Our Price £2**
X6761 (200) 2pole 6way List 9.94 **Our Price £2**
X6760 (65) 4pole 6way List 13.87 **Our Price £3**
Digital
X3946 (220) Pico sub min push button 0-9 BCD 15x7x26 **£1.00;** 100+ 0.50
Rocker
X3849 (245) Min clip in type SPCO rated 2A 250V ac. **2/£1.00; X3943** (150) Std on off rocker rated 16A 250V ac. Black. **3/£1.00; X3931** (100) Std DP on off rocker rated 10A 250V ac. Black. **2/£1.00;** 100+ 0.30
Push
X3859 (900) Sub min PCB mntg **7x7x5.5**, white. **8/£1.00**
X3880 (700) Sub min PCB mntg 7x7x5.5, black. **8/£1.00**
X3916 (200) Momentary push to make, sp make contact. Needs 11.5mm dia hole. **3/£1.00;** 100+ 0.20
X6763 (250) Momentary sealed black push switch 'flexibutton'. Needs 22mm dia hole, 1 pr each no and nc contacts rated 5A 250v ac. List 5.89. **Our Price £2.00;** 100+ 1.20
X6800 (140) Std illuminated rect latching switch by RS Components Ltd. 1 no and 1 nc contacts rated 5A 250V ac. (No lamp or bezel) Their price 12.09 **Our Price £3.00;** 100+ 1.80
X6793 (354) Very sim to above but diff man'r **£3.00;** 100+ 1.80
A couple of push button banks
X6799 (120) 3 independant DPCO switches with knobs. **60p; X3877** (45) 3 independant DPCO switches without knobs. **40p;**
Microswitches
X3769 (80) Licon V4 microswitch 13A 20x9.6x6mm **2/£1.00**
X3770 (100) Lever microswitch 20.6x10.5x6.5mm 1M.1B contact rated 5A. **2/£1.00**
X3771 (80) Heavy duty microswitch 46x28.5x16.3mm by Burgess, model E19 15A 250V ac. 2 SP make contacts. **£1.00**

RELAYS
X6766 (230) Coil for contactor, 42-48V 50Hz Probably more useful for the wire - 36swg ecw. **3/£1.00;** 100+ 0.20
X3848 (143) National sealed relay 20x10x10 with SPCO contacts. 24V coil **£1.00;** 100+ 0.60
X6804 (525) 'Continental' relay, PCB mntg DPCO 1A contacts. 48V coil. **£1.00;** 100+ 0.60
X6802 (300) ITT flat pack relay 42.5x17x10 DPCO contacts. 48V coil. **£1.00;** 100+ 0.60
X3861 (25) ITT flat pack relay 42.5x31x10. 4PCO contacts. 24V coil **£2.00;** 100+ 1.20

FUSES
X3856 (3500) 20x5mm 250mA quickblow. **100/£2.00;** 1000+ 0.012
X3853 (1200) Belling Lee ceramic wire ended 15x5mm 50mA **5/£1.00;** 100+ 0.10
X3954 (480) Littlefuse SAFE-T-PLUS fuses. Radial lead, body 13.2x8 dia 62mA. **Pack of 10 £2.00**
X3741 (1000) 20x5mm quickblow ceramic sand filled rated 10A. **Pack of 10 £1.00**
X3755 (160) PCB mntg ultra fast fuse by Buss 0.5A 9x9x5mm. List 0.96 **Our Price 3 for £1.00**
X3754 (1000) Sub min PCB mntg 5A QB fuse, 6x3mm dia. List 0.48. **Our Price 6/£1;** 100+ 0.09
Some wire ended 20x5mm antisurge fuses
X3756 (800) 500mA
X3757 (300) 1A
X3758 (1000) 1.6A
All at 10 for £1.00

K931 SLEEVING PACK Back in stock after some time, this extremely popular pack contains a great many sizes of sleeving Lengths vary from 10 to 77mm with diameters from 1 to 40mm. Big variety of types and colours, too - PVC, silicone, neoprene, rubber in clear, pink, yellow, red, green, grey, black and white. **Pack of 200 £3.50**
K865 Electrolytics. 100 each of 28 different PC mntg caps from 0.1 to 1000µF. *(Full listing of values on request)* **2800 for £50.00**
K7000 Resistors. 100 each of 30 different values from 5R6 to 680k. Sub min 1/8th watt **5%** bandoliered. Body size 3.2x1.9 *(maybe one or two values larger)* **3000 for £10**
K540 Resistors. Assorted values and sizes from ¼W to 2W, all with full length leads **500 for £3.00**
K537 Integrated Circuits. Big range of linear and logic chips, all brand new and **marked**, 6 pin to 40 pin. **100 for £5.00**
K538 Diodes. Full spec small signal diodes like 1N4148. **1000 for £4.00**
K898 Terminal Strips. Screw and 0.25" tab type, mostly PCB mntg from 3 to 12 way. A total of **40 ways for £1.00**
K896 Jumper Leads. A total of 50 ribbon leads from 4 to 10 way, up to 170mm long, terminated one or both ends with PCB headers. **50 for £3.00**
K905 Ceramic Plate Caps. A pack of physically small devices in a wide range of values up to 1000pF. **200 for £2.00**
K549 Trimmer Caps. A small assortment of compresion and film trimmers. **20 for £1.75**
K930 Fuses. 20mm and 1.25" quick blow and anti surge types up to 20A rating. **100 for £4.00**

HARDWARE
A selection of metric and self tapping screws, always useful to constructors. Quantities aren't vast, so mixed packs seems the best idea
K933 M3 - Steel and stainless steel, some black in lengths from 12 to 30mm Panhead, c'sunk, buttonhead all included. All pozi. **Pack of 200 £2.00**
K934 M4 - Just 3 types - 16mm panhead pozi, 16 and 25mm buttonhead black socket screw. **Pack of 200 £2.00**
K935 Self tappers. All small, No 2 and No 4, 1/4 to 1/2" long. All pozi, some black. **Pack of 200 £2.00**
X3899 (5000) M2 panhead pozi 8mm long **200/£2.00**

A couple of knobs...
X3932 (150) 33.5dia x 18.5 with spun ally insert and black marker line. Screw fix for **6** or 6.35mm spindle. **3/£1;** 100+ 0.20
X3940 (75) Ally finish over plastic, nice quality, to fit std splined spindle. 34 dia x 18.5. **3/£1**

Connectors
Some 0.1 pitch headers and **sockets**, all for PCB mntg.
X3850 (450) Gold plated right angle plug, 18 way **4/£1.00;** 100+ 0.12
X6801 (2500) Double row right angle plug, 20x2 way. **4/£1.00;** 100+ 0.12
X6765 (750) 20 way socket. **4/£1.00;** 100+ 0.12
X3952 (3000) Sub min 0.05" 4 way PCB mntg skt. **10/£1.00;** 100+ 0.06; 1000+ 0.04
X3937 (25) Veropins - double sided 1mm for PCBs. Normally 1.38/100 **Pack of 1000 £6.00**
X3929 (60) 14 DIL IDC plug, gold plated. **4/£1.00**
X3941 (700) Surface mount metal co-ax skt, nice quality. **5/£1.00;** 100+ 0.10
X3749 (20) Disk drive connector kit - 17w ds edge conn to 34w socket + power connector. **£2.50**
X3785 (200) TNC plug, long shank **£1;** 100+ 0.60
X3801 (1050) TNC plug, short shank **£1.00;** 100+ 0.60
X3799 (112) BNC plug **£1;** 100+ 0.60
X3805 (100) N plug **£1.50**
X3818 (4000) F plug with gold plated centre contact and crimp on cable sleeve. **6/£1;** 100+ 0.09; 1k+ 0.06
We've a number of differing styles of PL259 plugs for various cables
X3809 (600) 5mm threaded entry
X3811 (200) 10mm threaded entry
X3814 (100) 4.6mm spigot
X3810 (100) 4.5mm knurled spigot & 6.5mm sleeve
X3812 (250) 4.5mm knurled spigot & 6.5mm sleeve with longer outer shell
X3813 (200) 5.6mm spigot
All above the same price, any mix:
4 for £2.00; 100+ 0.25

CABLE AND WIRE
SPECIAL DEAL ON PRINTER CABLES
X6659 (300) 25D to Centronics **1.8m** long. **ONLY £2.00;** 100+ 1.20
X6669 (150) 2.3m screened light grey cable with 36 way Centronics plugs both ends. **£2.50;** 100+ 1.50
X6670 (400) 3.9m 4 core flat white cable, terminated both ends with a modular comms plug, one end of which is plugged into 4 way skt which mates with X6671 below. **£1.00;** 100+ 0.50

X6671 (400) 3.9m 4 core flat white cable, terminated both ends with a modular comms plug, one end of which is plugged into 4 way plug that mates with X6670 above. **£1.00;** 100+ 0.50
X6718 (2000) Curly cord with car power plug one end fitted with a 2A fuse and red LED, the other end has a 2.5mm power plug **£1.00** 100+ 0.65; 1000+ 0.50
X6755 (200) Curly cord with car power plug one end fitted with a regulator circuitry (uses KA7500), 2A fuse and red LED, the other end has a mobile radio connector. **£1.50** 100+ 0.85.
X6692 (50) Curly lead that extends to 3m with fused (3A) car power plug with LED indicator one end and three way connector the other. **£1.00**
X6691 (60) 3.6m black co-ax lead terminated one end with a TNC plug, open the other end **£1.00**
X3819 (20) 140mm long black twin core cable with 3.1mm power plug one end, plastic clip the other. **4/£1.00**

Mains Leads
X3750 (25) 2 core 2m mains **lead**, open end to fig 8 Hitachi etc mains socket. **£1.00**
X6672 (400) 2m black lead with IEC socket one end and a 5A fused 13A plug the other **£2.50;** 100+ 1.40
X6673 (800) 2m black lead with IEC socket one end and IEC plug the other **£2.00;** 100+ 1.20
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Tools
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36579 11 piece combination wrench set, ring and open ended spanners: 6, 7, 8, 9, 10, 11, 12, 13, 14, 17 & 19mm. **£7.00**
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Crimp Tools
X6695 (20) 230mm long, this is for crimping hex connectors - F, BNC, TNC and N connectors. **£20**
X6693 (70) 220mm long, this has additional holes. 6.48mm, 5.4mm, 3.75mm, 2.8mm and 2.1mm. **£20**
X6694 (75) 200mm long IDC (comms) plug crimp tool. **£20**
X6676 (54) Quicktest mains block, complete with 2m mains lead with 2 pin continental plug **£8.00**

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RETRON NIGHT SIGHT Recognition of a standing man at 300m in 1/4 moonlight, hermatically sealed, runs on 2 AA batteries, 80mm F1.5 lens, 20mw infrared laser included. £325 ref RETRON.

MINI FM TRANSMITTER KIT Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

3-30V POWER SUPPLY KIT Variable, stablized power supply for lab use. Short circuit protected, suitable for profesional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

1 WATT FM TRANSMITTER KIT Supplied with piezo electric mic. 8-30vdc. At 25-30v you will get nearly 2 watts! £12 ref 1009.

FM/AM SCANNER KIT Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £15 ref 1013.

3 CHANNEL SOUND TO LIGHT KIT Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £14 Ref 1014.

4 WATT FM TRANSMITTER KIT Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £20 Ref 1028.

STROBE LIGHT KIT Adjustable from 1-60 hz (a lot faster than conventional strobes). Mains operated. £16 Ref 1037.

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COMBINATION LOCK KIT 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £10 ref 1114.

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ROBOT VOICE KIT Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

TELEPHONE BUG KIT Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £8 Ref 1135.

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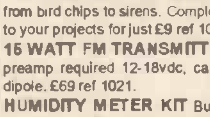
VOX SWITCH KIT Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £8 ref 1073.



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PREAMP MIXER KIT 3 input mono mixer, sep bass and treble controls plus individual level controls, 18vdc, input sens 100mA. £15 ref 1052.

METAL DETECTOR KIT Range 15-20cm, complete with case, 9vdc. £8 ref 1022.

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PC TIMER KIT Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4.1,640k, serial port, hard drive with min 100k free. £24.99

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STETHOSCOPES A fully functioning stethoscope for all those intricate projects. Enables you to listen to motors, pipes, heartbeats, walls, insects etc. £6 ref MAR6P6.

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9v DC POWER SUPPLY Standard plug in type 150ma 9v DC with lead and DC power plug. price for two is £2.99 ref AUG3P4.

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

FUTURE PC POWER SUPPLIES These are 295x135x60mm, 4 drive connectors 1 mother board connector, 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

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SHOCKING COIL KIT Build this little battery operated device into all sorts of things, also gets worms out of the ground! £7 ref 7P36.

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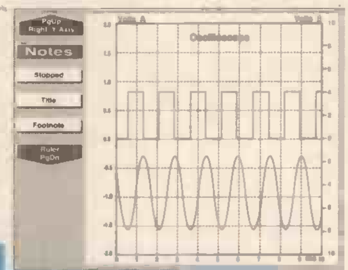

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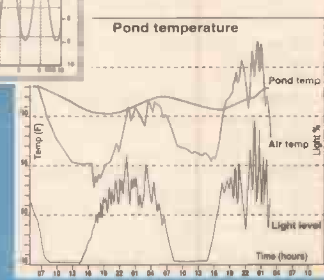

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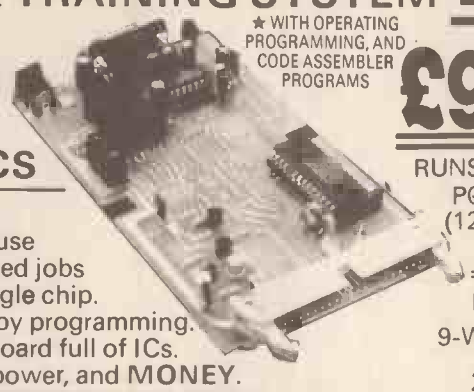

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TWENTY YEARS ON

Whilst looking at some past issues of *Everyday Electronics*, to see when a particular advertiser first started placing ads, I came to the January 1976 issue. (Indidentally the advertiser is Magenta Electronics who have regularly advertised in our pages since 1976.) What first caught my eye was a picture of yours truly holding a radio control transmitter in a project heading photograph – I must have been very young!

Further inspection of the issue revealed an *Easy to Build Digital Clock* by P. J. Fischer; that clock is still keeping perfect time in my office twenty years later. It even passed the electrical safety check, now required for office equipment, with flying colours. I wonder if any other readers have projects built twenty or more years ago still in daily use; please let me know if you have.

SUBSCRIPTIONS

Two other items in that issue are also of interest; one is the announcement of the closure of the *Everyday Electronics Subscription Service*, "due to the escalating costs on packing and postage". Although I was the Assistant Editor at that time I cannot recall this event, perhaps subscriptions were not significant then. Anyway I'm pleased to say that the service was obviously reintroduced some time later – I don't know when – and today it represents an excellent and economical way of receiving your magazine each month. In fact the subscription rate in the UK is now £5.40 less than the cover price of twelve issues.

SINCLAIR

The final item of interest in the '76 issue is a news report in *Shop Talk* (our longest running column dating from the very first issue in 1971) about the Sinclair Black Watch. Apparently one Mike Kenward, who wrote the column at that time, apologised for not publishing a review of the kit, which had still not turned up from Sinclair – not unusual as I recall.

Unfortunately, I well remember putting the kit together (it finally arrived two months later), not a particularly easy operation. I also remember the watch was bulky to wear, the angular edges of the case caught on everything and the batteries went flat after about a week if you wore the watch in bed. This was because the display would come on if there was any pressure on the watch face. In short it did not match the longevity of our clock project. All things Sinclair are the subject of a recent exhibition and a book – see our news pages for more details.

Mike Kenward

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

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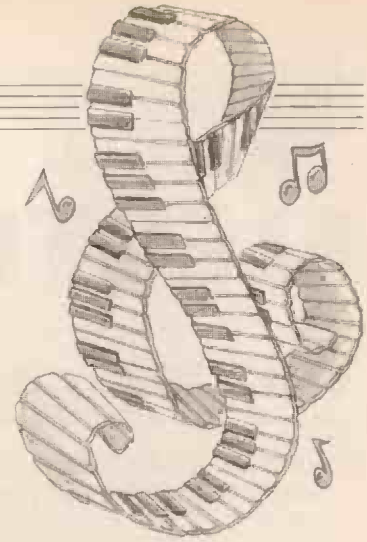
Constructional Project



MIDI ANALYSER

JULYAN ILETT and BRETT GOSSAGE

The secrets of MIDI revealed – unscrambles an instrument's control codes and outputs them to an easily-readable l.c.d. screen.

Most electronic musical instruments have a MIDI (Musical Instrument Digital Interface). This allows them to be connected together, offering facilities not available from a single unit. Perhaps most important is that a computer can be used to control a number of such instruments, including synthesisers, drum machines, samplers, and so on. MIDI also allows one master keyboard to control a number of other instruments, some of them not even having their own keyboard.

Making the connection could not be simpler, a single cable with a 5-pin DIN plug at each end links the *In* socket on one unit, to the *Out* or *Thru* socket on another. This "user-friendliness" belies the considerable complexity of the signals inside the cable, and although many musicians like it that way, the more technically-minded might actually want to know what is going on. It was this desire that inspired the MIDI Analyser project.

The idea was to provide the maximum amount of information, displayed in a clear and straightforward way, making the unit ideal for use by most musicians, whether in the studio or performing live, or by sound technicians or "roadies" with limited time available in which to set up equipment.

DISPLAY DILEMMA

The MIDI Analyser has to combine simple operation with a wealth of displayed information, so the choice of display technology was one of the most important factors affecting the design.

In order to provide the MIDI information in a clear and logical layout, the display needs to be capable of showing numbers and letters as well as symbols. Seven-segment l.e.d. (light emitting diode) displays are good with numbers, but not so good with letters of the alphabet, some looking better in upper case and some only readable in their lower case form. Try displaying the letters *W* or *M* and the problems become obvious.

On the other hand, a c.r.t. (cathode ray tube) based display is far too bulky to be used in a portable unit of this type. The solution is in the shape of the now familiar intelligent alphanumeric liquid crystal display (l.c.d.) module. These l.c.d.s have dropped in price over the last few years, to a point that makes them viable for use in a project like this. A forty-character, two-line module, one of the largest types available, is used in this design.

AT-A-GLANCE

Whether you are forging your way up the music charts, or just want to see what is coming out of the back of your Yamaha (and we are not talking carbon monoxide!), the MIDI Analyser should prove invaluable. Essential MIDI information is constantly displayed and updated, the content of the serial data stream being available "at-a-glance".

The MIDI Analyser can be set to any one of four different display screens. The first screen gives a number of MIDI parameters in numeric and symbolic form, including note value, octave number, key velocity and much more.

The second screen gives a dynamic display of key velocity and after-touch parameters. The third screen is a 16-channel monitor indicating which MIDI channels are in use. The final screen shows a five-octave keyboard with the keys "playing" in real time. Full details of all displayed information can be seen in Fig. 1.

HANDY ANALYSER

The MIDI Analyser has both In and Thru sockets and so can be placed anywhere in a MIDI chain. It is housed in a small ABS box with the Display and Screen Select switch on the front, and MIDI sockets on the back.

A PIC16C61 microcontroller is used to receive the MIDI data and drive the alphanumeric display. A pre-programmed PIC16C61 is available from the authors, see *Shop Talk* page.

WORKING IT OUT

The diagram in Fig. 2 shows the basic functional elements that make up the MIDI Analyser. Since many of the elements shown are implemented in software, much of the system is not visible in the associated circuit diagram, Fig. 4.

MIDI serial data enters the unit via the In socket, is buffered, and fed to the Thru socket, to be passed on to the next MIDI device in the chain. The data also enters a software implemented, serial data receiver. This receiver is an important part of the design and will therefore be described in some detail.

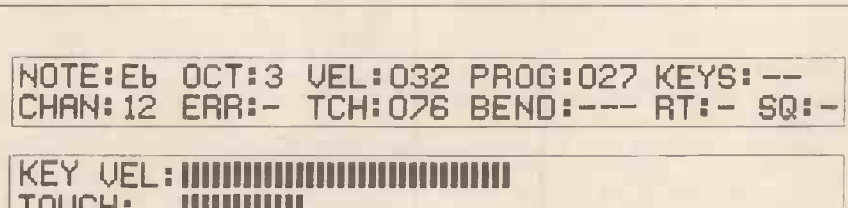


Fig. 1. Screen display options from top to bottom: MIDI information; key velocity and touch; channels active and finally, five-octave keyboard.

SERIAL DATA

The diagram in Fig. 3 shows the format of a byte of MIDI data that would be transmitted by a synthesiser or drum machine. It consists of 10 bits, a Start bit, which is always low, eight Data bits, which may be either low or high, and a Stop bit, which is always high.

Data bits are transmitted with the least significant bit (bit 0) first. The period of each bit is 32µs, so that all 10 bits are received within 320µs.

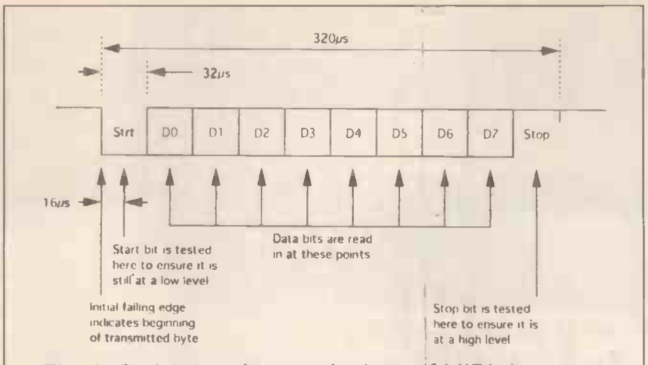


Fig. 3. Serial data format of a byte of MIDI data transmitted by a Synthesiser or Drum Machine.

The MIDI Analyser checks the received data for two types of error. A *false start bit error* occurs when the serial data input changes from high to low, but does not remain low for the full 32µs Start bit period. A *false stop bit error*, or *framing error* is detected if the Stop bit (the tenth bit) is not at a high level.

A false start bit error is usually caused by a low going spike appearing on the serial line which the receiver may initially interpret as the leading edge of a new Start bit. The framing error is normally caused by errors in timing between the transmitter and receiver.

This type of serial data is referred to as *asynchronous*, although the receiver also responds in a synchronous way. The initial falling edge of the Start bit synchronises the receiver timing to the remaining bits of the data byte. After this initial edge, the receiver first times-out a 16µs period, and then tests the logic level of the serial input.

This test should occur in the middle of the Start bit period (that is if the data is coming in at the proper rate). The eight data bits are then read in at their mid-points and finally the Stop bit is tested, again at its mid-position.

The receiver does not know where the mid-points are, it just reads the level of the serial data input at accurately timed intervals. It assumes data bits are sent by the serial data transmitter at the correct rate. Inevitably, timings will be slightly out, and with each subsequent bit, the point at which the bits are read will drift away from the bit mid-positions. This drift should be small, although the higher the data rate, the more accurate the timings need to be.

All is set right again when the receiver re-synchronises itself to the initial falling edge of the Start bit of the next byte.

INTERRUPTS

The MIDI Analyser makes use of the PIC microcontroller's interrupt system, as it needs to respond very quickly to incoming serial data. To illustrate how interrupts work, imagine your telephone has no bell. You would have to pick it up every few seconds to see if anyone was trying to get through.

So much time would be wasted doing this, you would never get anything else done. Far better to have the phone ring when a caller is trying to get through, interrupting what you are doing just for as long as it takes to answer their call.

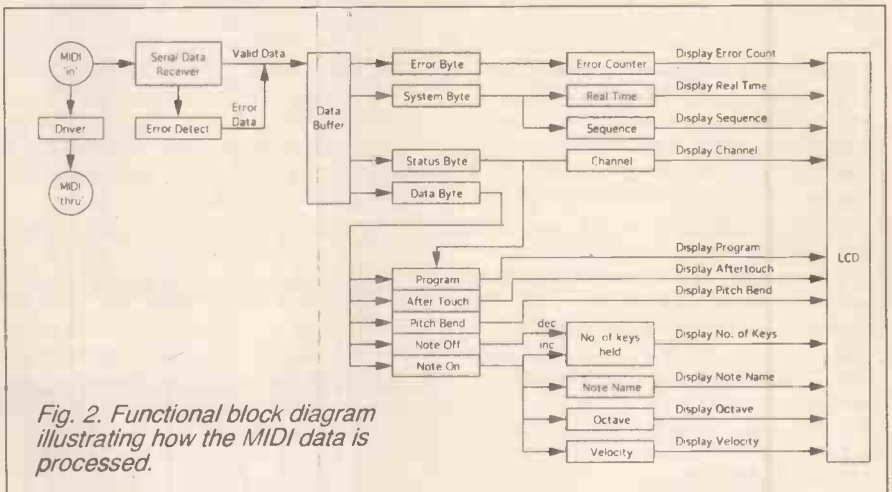


Fig. 2. Functional block diagram illustrating how the MIDI data is processed.

The telephone's bell (perhaps not actually a bell these days) is the necessary extra hardware required to generate the interrupt, and in the same way, most microprocessors have special interrupt hardware built in. A program may be interrupted, for example, if a certain input pin changes from a high to low level, or if an internal counter reaches zero when counting down.

It is precisely these two events that cause an interrupt in the MIDI Analyser. The first condition indicates the reception of a Start bit, and the second is used to time the 32µs intervals between each subsequent bit.

PROCESSING

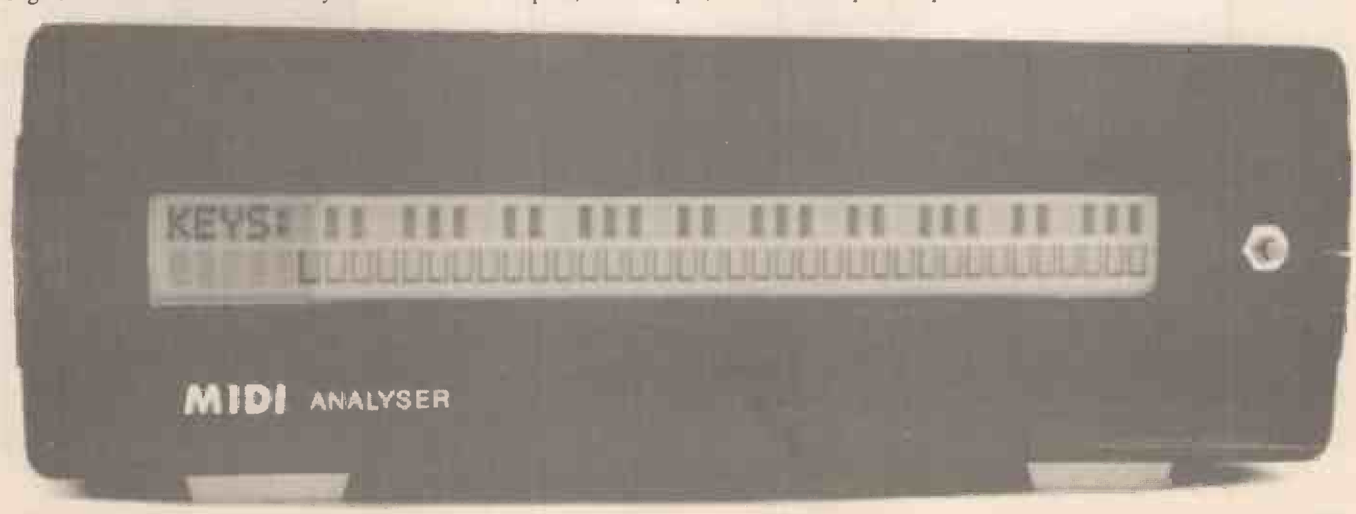
In Fig. 2 is shown a functional block diagram which illustrates how the MIDI data is processed. Once the Serial Data Receiver has all the necessary bits that make up one byte, it passes this data to a Data Buffer. This allows bursts of MIDI data to be received at a faster rate than they can be processed. Analysis of the received data now takes place.

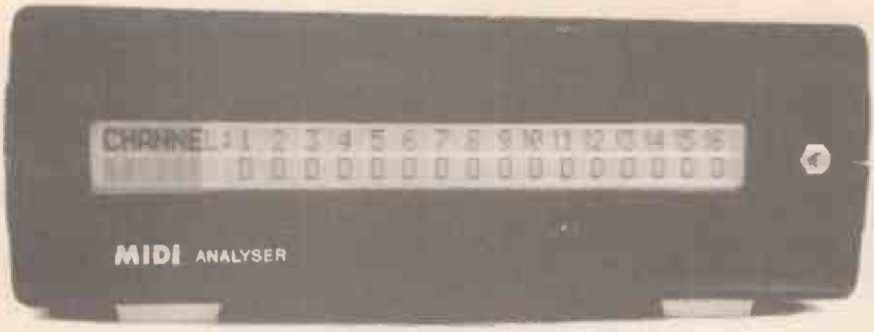
Either of the two error types, false start bit error or framing error, increment the error counter on the display, but are otherwise ignored.

System bytes, such as real-time pulses, or sequencer start/stop information, are used to control moving graphical indicators on the display.

The *Status* byte always includes channel information, which can be displayed as soon as it is received, but more importantly, it specifies which type of data is going to be sent next.

Finally, the MIDI data byte or bytes provide the actual numerical information,





Screen display for 16-Channel monitoring

which for Screen 1 is converted to decimal for presentation on the display. The Analyser's other screens present this data in different ways.

Note On and *Note Off* data are processed further. Together, they are used to increment and decrement a counter which indicates on the display the number of notes held down simultaneously (polyphony). Note On data is broken down even further to provide an actual note name, *C#*, for example, as well as the octave number and velocity information.

MIDI VARIATIONS

MIDI data is supposed to conform to a stringent specification. Different manufacturers, however, may interpret the rules in slightly different ways. For example, some synthesisers use *running status*, which uses fewer MIDI bytes by only sending one status byte followed by several data bytes, to play a sequence of notes. This can be preferable to sending a separate status byte with each individual note.

Equipment that receives MIDI data must be capable of understanding these differences, which, of course, makes their software much more complex. Provided the equipment design does not deviate from the accepted MIDI standard, there should be no problem.

CIRCUIT DESCRIPTION

The complete circuit diagram for the MIDI Analyser is shown in Fig. 4. MIDI data entering the Analyser via the In socket SK1 drives the l.e.d. in the opto-isolator, IC2, via resistor R1. Diode D1 protects IC2 against reverse polarity.

Serial MIDI data from the collector, pin 5, of the phototransistor in IC2, is fed directly into the microcontroller IC1 at its RB0 input pin 6. This signal is also buffered by transistors TR1 and TR2, before being fed to the Thru socket SK2.

The values of resistors R2 and R3 have been chosen to ensure that TR1 switches on at the same point that the microcontroller detects a logic low on the RB0 input. Resistor R4 is used to bias the phototransistor in IC2 to equalise its switch-on and switch-off times. Transistor TR2 acts as a current sink for the MIDI current loop.

Crystal X1 and capacitors C1 and C2 set the microcontroller's clock rate at 8MHz. Port B of the microcontroller is connected to the l.c.d. module, using port bits RB1 to RB7. Port A provides the l.c.d. with bit 0, from pin RA0. This arrangement has been used because bit zero of Port B (RB0) is used by the microcontroller as an interrupt source responding to incoming serial data.

Adjustment of the display contrast is provided by preset potentiometer VR1, which is connected across the power supply rails.

Power for the MIDI Analyser is supplied by four AA cells giving about 6V. Diode D2 drops this voltage by about 0·6V, which provides the l.c.d. module and microcontroller with a little over 5V.

CONSTRUCTION

The specified box has two removable plastic rectangular panels which slot into guides at the front and back. The rear panel accommodates the On/Off switch S1 and has two holes for the In and Thru sockets SK1 and SK2.

The front panel accommodates the Screen Select switch S2 and the l.c.d. module X2. The p.c.b. mounting holes should line up with four of the many pre-formed mounting studs in the base of the box.

Component positioning on the panels can be seen in the photographs. Take care cutting out the slot for the l.c.d. and leave room for switch S2 to fit alongside it. Holes for MIDI sockets SK1, SK2 are best left until the assembled p.c.b. can be used to confirm their best position. On the prototype, their centres were 19mm above the base of the panel and 38mm apart.

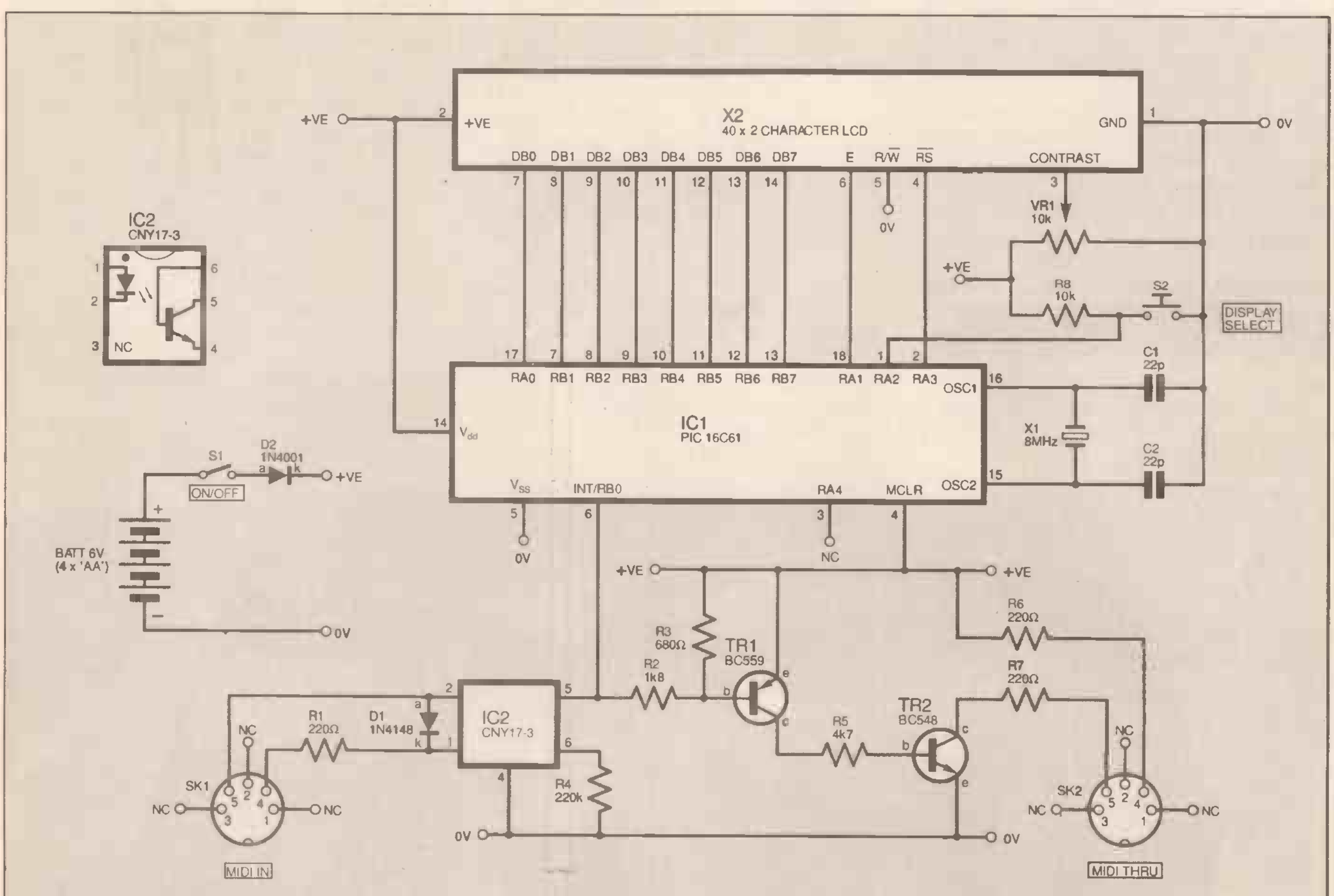


Fig. 4. Complete circuit diagram for the MIDI Analyser. Note that switch S2 is a push-to-make and release-to-break type.

MIDI ANALYSER

COMPONENTS

Resistors

R1, R6, R7	220Ω (3 off)	
R2	1k8	
R3	680Ω	
R4	220k	
R5	4k7	
R8	10k	

All 0.25W 5% carbon film

See SHOP TALK Page

Potentiometers

VR1	10k sub-min. horizontal preset, lin

Capacitors

C1, C2	22p ceramic disc (2 off)

Semiconductors

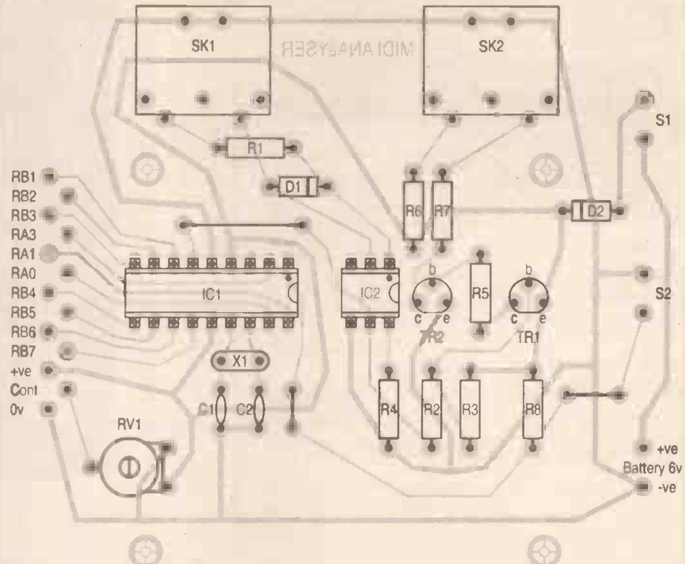
D1	1N4148 signal diode
D2	1N4001 rectifier diode
TR1	BC559 *pnp* transistor
TR2	BC548 *npn* transistor
IC1	PIC16C61 microcontroller, pre-programmed (see text)
IC2	CNY17-3 opto-isolator

Miscellaneous

X1	8MHz crystal
X2	LM018L or TLCM4021 40-character x 2-line intelligent l.c.d. module
S1	s.p.s.t. rocker switch
S2	push-to-make switch, sub-min.
SK1, SK2	p.c.b. mounting 5-pin 180° DIN socket (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 992; ABS plastic case, internal dimensions 197mm x 145mm x 55mm, removeable front and rear panels; 18-pin d.i.l. socket; 6-pin d.i.l. socket; battery holder (long type) for 4 x AA cells; battery clip (PP3 type), nuts and bolts to suit; connecting wire; cable ties; solder, etc.

Approx Cost Guidance Only £39



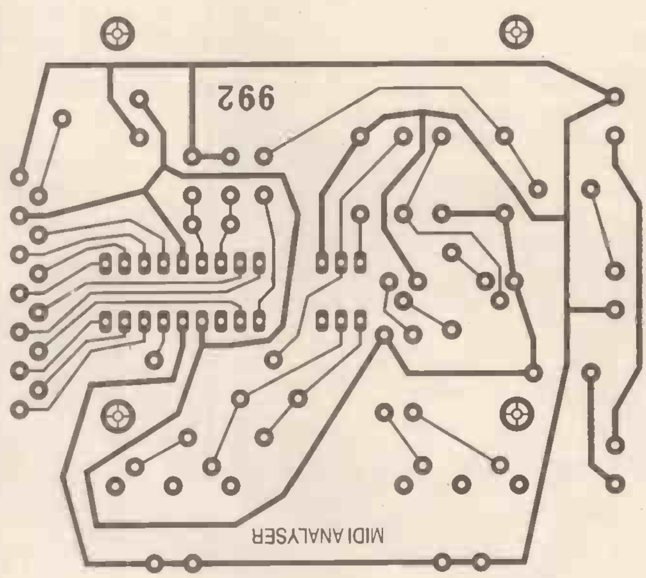
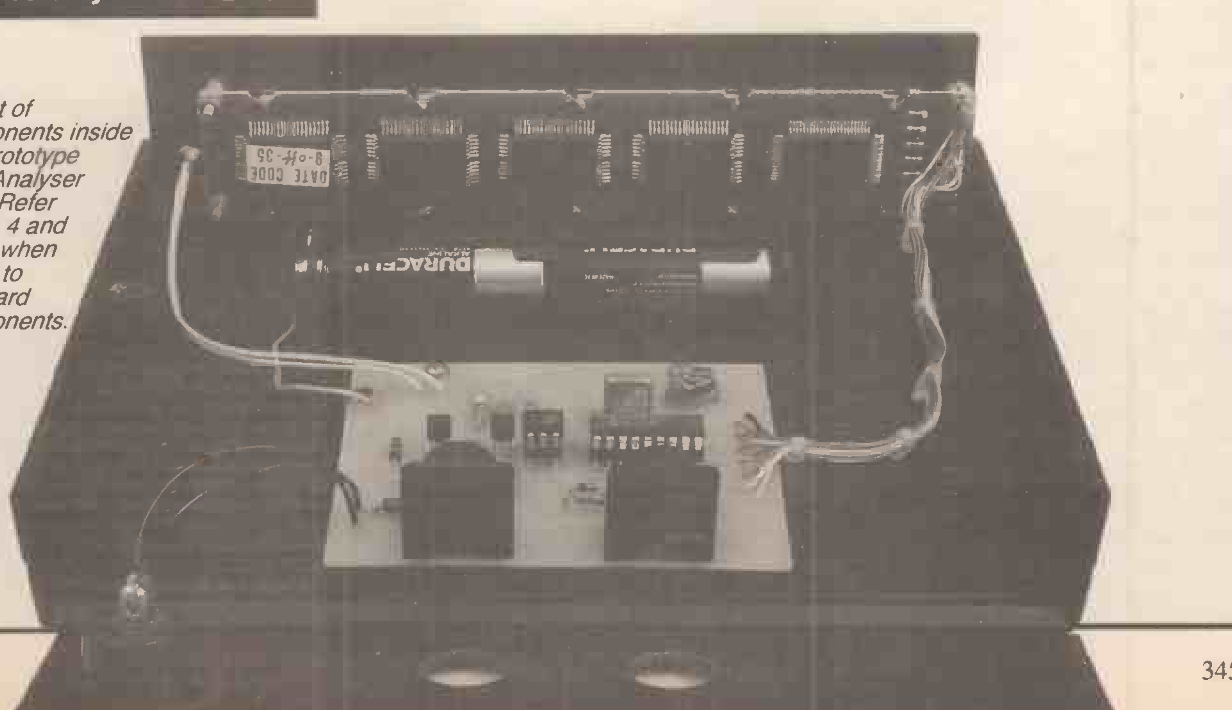


Fig. 5. Printed circuit board component layout and actual size copper foil master for the MIDI Analyser.



Layout of components inside the prototype MIDI Analyser case. Refer to Fig. 4 and Fig. 6 when wiring to off-board components.

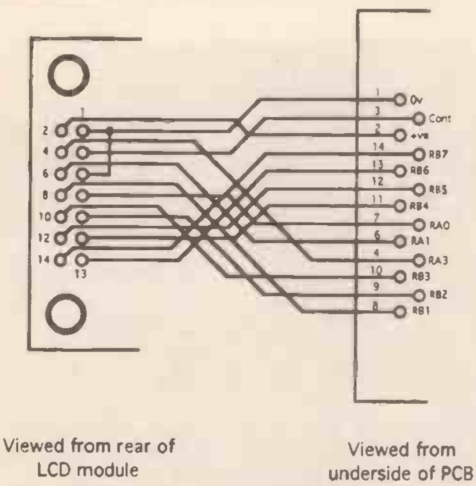
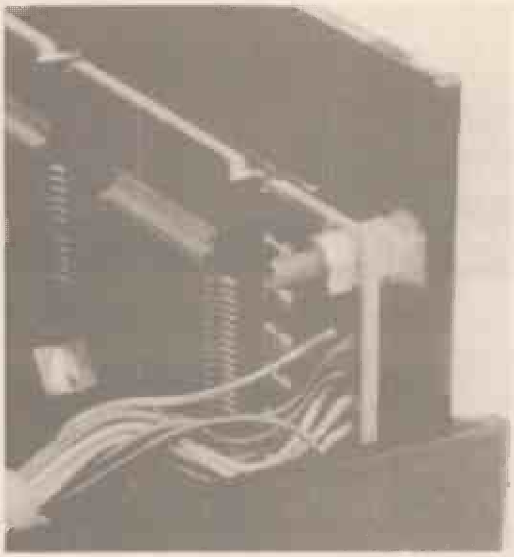


Fig. 6. Wiring the l.c.d. module to the p.c.b.

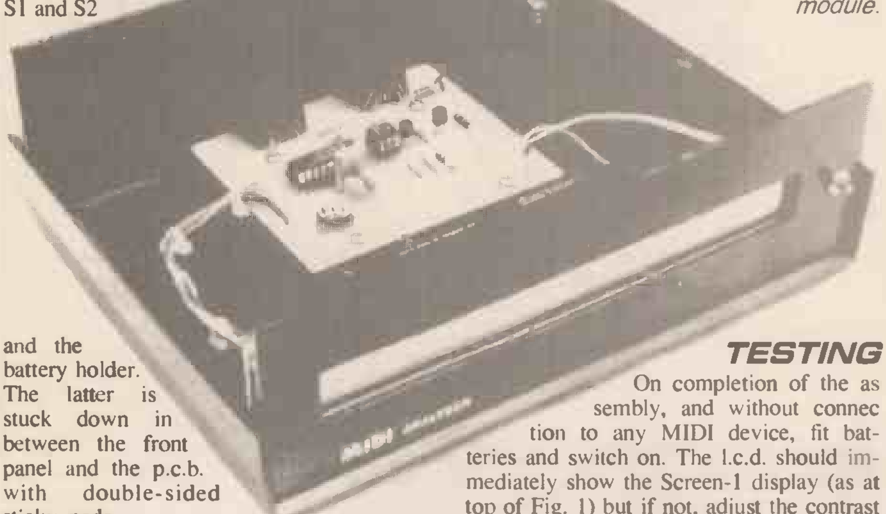


One of the display module mounting bolts glued to the rear of the front panel.

Details of the topside printed circuit board (p.c.b.) component layout and copper foil master track pattern are shown in Fig. 5. This board is available from the *EPE PCB Service*, code 992.

Assemble the board in the usual way – smaller components first, working steadily up through the large ones, paying attention to polarities where marked. Check your work thoroughly!

With the main p.c.b. fully assembled and loosely placed in position, wire the l.c.d. module to it, referring to Fig. 6. Do not forget to link together pin 1 and pin 5 on the l.c.d. module Next, wire up switches S1 and S2 and the battery holder. The latter is stuck down in between the front panel and the p.c.b. with double-sided sticky pads.



Viewing window cutout for the display readout module.

Mount the main p.c.b. with four self-tapping screws. It may be necessary to slightly raise the p.c.b. off the mounting studs with washers so that it mounts evenly, otherwise the solder on the underside may foul the other studs.

Fit the display Screen Select switch S2 and check that the l.c.d. module will fit alongside lining up with the front panel rectangular cutout. The right hand side of the l.c.d. module may need to be slightly filed down to accommodate S2 and line up with the cutout.

The l.c.d. module has to be glued onto the rear side of the front panel by four countersunk screws which are first fitted into the module's mounting holes.

Fit these four mounting screws and lock them with nuts either side of the l.c.d. module, making sure that the screw heads are roughly flush with the front of the module.

Remove the four thin plastic panel guides (two on each half of the box casing) as these will interfere with the finished panels when they are slid into the recesses of the box casing. Dab a spot of glue (e.g. *Araldite*) onto each of the screwheads and place the module onto the rear side of the front panel, making sure that it is evenly aligned with the rectangular cut out. When the glue has dried, more of it can be applied to strengthen the mounting.

TESTING

On completion of the assembly, and without connection to any MIDI device, fit batteries and switch on. The l.c.d. should immediately show the Screen-1 display (as at top of Fig. 1) but if not, adjust the contrast of the display with preset VR1.

If the screen message still does not appear, or if only the top line of the l.c.d. goes slightly dark, then remove power and recheck the assembly. Should the top line of the l.c.d. go dark, then this indicates that the l.c.d. is not being initialised by the microcontroller.

If all is well, connect the MIDI Out socket of one MIDI device (preferably a keyboard) to the MIDI In socket of the Analyser. Connecting with the power already switched on should not cause a problem.

Continuously press and release a key on the keyboard. Data will be shown in place of some of the dashes on the first display screen, such as Note name with its associated Octave and MIDI Channel number. If this is not so, then re-check cabling and connectors to the keyboard and Analyser.

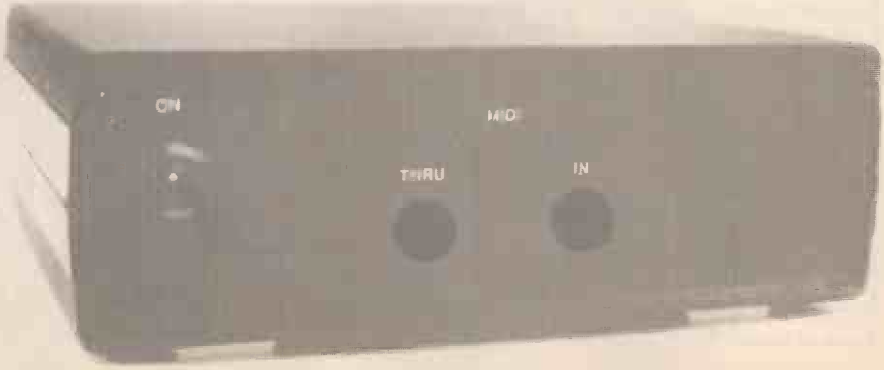
Now try connecting a cable from the MIDI Thru socket on the Analyser to the MIDI In socket on another instrument and check that the same notes are played by both instruments.

If you have access to a two-channel oscilloscope and a MIDI device that outputs real-time data continuously, such as a sequencer or a drum machine, then connect the latter to the input of the Analyser. Then connect Channel 1 of the scope to IC1 pin 3 (line RA4) and Channel 2 to IC1 pin 6 (line RB0) whilst triggering (synchronising) on Channel 2.

For this test, it is also necessary to connect a pull-up resistor between IC1 pin 3, and the positive supply. The value is not critical, but 4k7 is suitable. The resistor is required because the output RA4 on IC1 pin 3 is an open collector type.

Check for the waveforms shown in Fig. 7. If the MIDI device is correctly outputting continuous data (which should be repeated bytes of F8 hex, for "real-time" data), then the scope should trigger easily.

The top waveform in Fig. 7 shows ten pulses of very short duration. These are the ten interrupt pulses, and should line up approximately with the centres of the data



bits shown in the lower waveform. (Try superimposing the two waveforms on the oscilloscope.)

INTERCONNECTION

The MIDI Analyser can be used in several different configurations, two of which are shown in Fig. 8. In Fig. 8a, the Analyser is connected between a Sequencer (or Computer) and a Synthesiser. This allows analysis of the output of the sequencer, without the extra information that the synthesiser may generate. The MIDI Analyser though, passes information from the sequencer to the synthesiser unaffected.

In Fig. 8b, the MIDI Analyser is connected so that it simply monitors the output of a single keyboard.

The only position in a MIDI chain that the Analyser *should not* be placed is at the beginning, as it does not generate data but simply passes on any data that it receives (hence there is no MIDI Out socket).

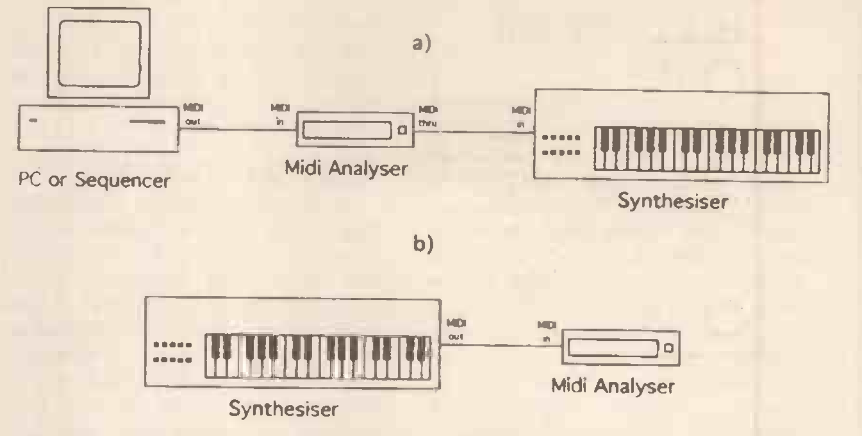


Fig. 8. Just two of the possible Analyser set-ups; (a) between a sequencer and keyboard, and (b) to a single keyboard to monitor its output.

OPERATION

On switch-on, the unit defaults to the first of the four display screens (see Fig. 1). This display shows most of the MIDI functions with a dash to indicate that no information of that type has been received yet.

As soon as a key is pressed on a Keyboard, or a Sequencer is started, data will be represented as figures, letters or graphical symbols. The Real-time data indicator may be active on power-up (a moving chevron symbol ">"), if, for example, a drum machine or sequencer is running.

To select another screen, press the push-button switch (S2). Repeated switch pressings will cycle through the four display screens.

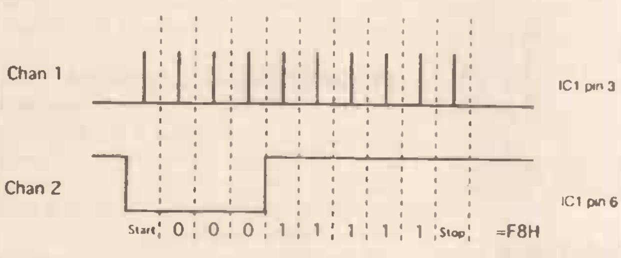


Fig. 7. Test waveforms

DISPLAY SCREEN-1

The first display screen shows the most MIDI information, and is arranged in eleven information fields. Possibly the most important is the Note field (NOTE) shown in the top left of the display. This quite simply shows the last note pressed on any connected keyboard. As this field ignores Note Off information, releasing a key on the keyboard leaves it unaltered.

The next field, Octave (OCT), fully defines the note value by showing which octave it is in. The lowest possible MIDI note has a note value of zero, and is a *C* five octaves below middle *C*. Not only is this note inaudible, having a frequency of about 8Hz, but it is unlikely that there is any MIDI keyboard that accommodates it!

Similarly, the highest note is a *G* five octaves above middle *C*, and having a note value of 127. This Octave field has a range from Octave 0 to Octave 9, with middle *C* being in Octave 5.

The next field is Key Velocity (VEL). The MIDI specification has named this rather badly, as it is better known as *loudness* or *volume*. It is called *key velocity* because in order to determine how hard the key is struck, the synthesiser measures the time for the key to move from the top of its travel to the bottom. The shorter the time, the harder the key is struck, and the higher the "Velocity" value becomes.

The velocity displayed on the analyser screen is purely the MIDI value, which ranges from 1, which is a very slowly pressed key, giving the softest sound, to 127 which is maximum key velocity, giving the loudest sound. There is a special case where the key velocity has a value of zero. This essentially turns the note off (no volume) and the majority of MIDI synthesisers use the MIDI Note On command with a key velocity of zero, to turn the note off!

Also on the top row of the first display screen is the Program field (PROG). This shows the last Voice, Patch or Program change on the MIDI device, and its range is from 0 to 127. Most modern synthesisers have several sounds arranged in various banks on the keyboard. Each of these should have its own unique MIDI Program value.

The Keys field (KEYS) is simply a counter that increases with each key press, and decreases with each key release. At a glance, it shows how many keys are held down. Some less expensive synthesisers allow only four or eight keys to be played simultaneously, so this feature can be used to check this maximum key limit.

The first field on the bottom row is the Channel field (CHAN) and has a range of 1 to 16. Each MIDI device can be allocated a channel number, and will only respond to MIDI data which incorporates that channel number. On boot-up, this field shows dashes until the first key is pressed on any connected synthesiser. The field number will change dependent on which device sends data through the analyser. (Some older MIDI devices could not have their channel number changed and were permanently given Channel 1 as their transmitter channel number.)

The Error field (ERR) shows any serial data errors received from a MIDI device (i.e. false start bit and framing errors), and displays an error count when this occurs. To reset, press the Screen Select switch S2 four times, selecting the first display screen again. This should reset the error count to zero.

A large number of errors indicated here can be used to diagnose a faulty MIDI cable. A device can sometimes send illegal MIDI codes (this is rare), but the Error field does NOT respond to these.

As with several MIDI parameters, the After-touch (TCH) field has a range of 0 to 127. After-touch is only present on the more expensive keyboards. When a key is held down, it can be pushed further into a sensitive cushion under the key adding more expression to the sound. The TCH field shows an increasing number as further pressure is applied to a key after it is held down, decreasing to zero as it is slowly released.

Next is the Bend field (BEND), and all this does is show whether pitch bend data is being received. With no pitch bend, the Bend field shows dashes. On moving the pitch wheel up, to raise the pitch, the displayed MIDI value increases from 64 (no pitch bend) to 127. On moving the

HISTORY OF THE MIDI

Long ago, well, somewhat over a quarter of a century ago, thanks to a certain Mr Moog, the Synthesiser was born, a musical instrument in which musical sounds were generated electronically. Nearly every aspect of these sounds could be altered and "shaped", to sound exactly as the owner wanted (well almost!).

However, these synthesisers were generally monophonic and very restricted, allowing only one note to be played at a time. Furthermore, a method of remotely controlling a synthesiser was needed and several analogue methods were proposed.

The most common of these was the Control Voltage Gate, called the *CV Gate*. If, for instance, a voltage of 4V was applied to the synthesiser's CV input, a middle *C* would play. A voltage of 5V would cause the *C* one octave higher to play, and 3V would cause *C* an octave below middle *C* to play.

This technique was referred to as the *one volt per octave* control system. Although other systems existed, this was the most popular.

Any intermediate voltage would generate notes, or more importantly, frequencies in between them. However, the system was fraught with problems, as the characteristics of synthesisers varied wildly, and tuning them to anything like the right values was a real feat! Slight temperature variations also caused immense problems. Even so, the first step to a universal synthesiser control had been taken.

DIGITAL TUNING

In the early 1970s, synthesisers began using digital electronics, and this solved the problems of tuning accuracy and temperature variations. For the first time, *patches* or sets of data representing a particular sound set-up could be saved in the synthesiser's memory. There was no more need to remember all those chunky knob positions to obtain your "fat sax" sound.

The next challenge was to use digital electronics to connect synthesisers together. Commonly, keyboard players in touring bands had several synthesisers in their set-up, and the dream was to be able to control all of them from a "Master" keyboard, so that it was unnecessary to reach over all the other keyboards and press loads of buttons in the middle of a live performance.

This point, along with many others, was noted when the first digital control systems for keyboards were developed. There were several of these systems, but their main drawback was that there was still no compatibility between different instrument manufacturers.

UNIVERSAL INTERFACE

Sequential Circuits, an American synthesiser maker, proposed the first "all manufacturer" digital interface for synthesisers in October 1981. It was called the USI or Universal Synthesizer Interface and used a serial data communications link.

Over the next year, various refinements were introduced to the USI, such as the inclusion of opto-isolation to prevent accidental damage to incorrectly connected instruments, and to prevent mains hum. Also, an increase of serial data speed to 31250 bits per second was implemented. This rate was chosen because it was an easy division (1/32) of the 1MHz clock frequencies of computers at that time.

However, it was to be a further year before the first true MIDI instrument was born, which was Sequential Circuits' *Prophet 600* synthesiser in December 1982. A month later, the first two MIDI synthesisers from different companies were hooked up and demonstrated to an amazed audience at the meeting of the National Association of Music Merchandisers.

The original 1.0 specification for MIDI has remained unchanged since then, although, of course, many subsequent additions have been made, such as the MIDI Sample Dump standard in 1986, and MIDI Time Code messages in 1987.

pitch-wheel down, this value should decrease to zero.

Moving on, the Real-time field (RT) shows a moving chevron (>) if timing data is received from any MIDI device. Plug in a sequencer or drum machine and see if it outputs real-time data. If this field is static, or stays as a dash, then no real-time data is being received.

Similarly, the Sequence field (SQ) shows a moving chevron if a Start or Continue MIDI code is received, and a Stop code should halt the chevron movement.

DISPLAY SCREEN-2

The two rows of the second display screen show a bargraph or analogue representation of key velocity (top row), and after-touch (bottom row). This representation gives a more realistic display of these parameters.

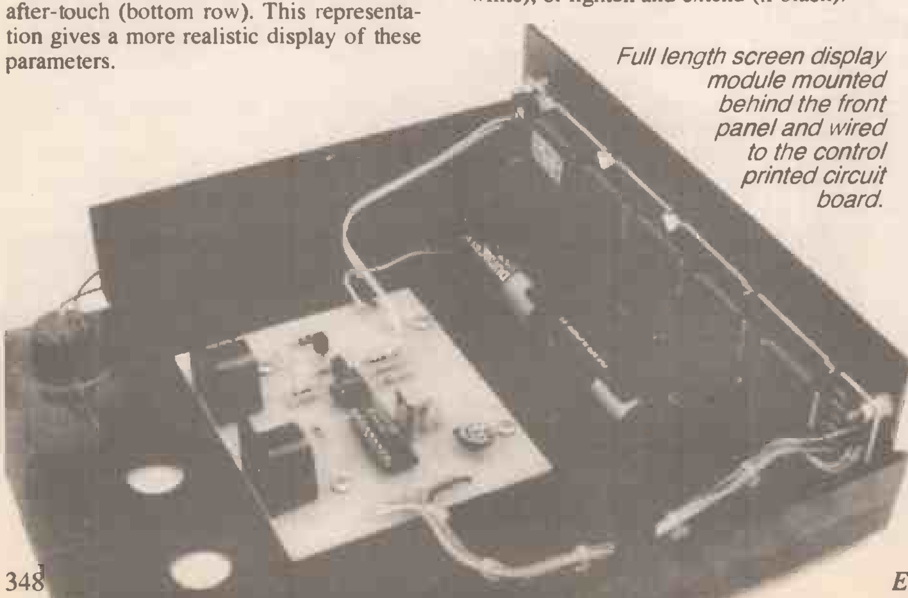
DISPLAY SCREEN-3

The third screen simply shows which MIDI channels are active. The square under the appropriate channel number darkens when MIDI data is received on that particular channel. After a preset time of about a second, the square goes light again if no more data is received on that channel.

With several devices connected in a MIDI chain, it can be useful to see how each is allocated.

DISPLAY SCREEN-4

The final display screen shows a five-octave keyboard. When keys are pressed on a connected MIDI keyboard, the corresponding keys darken and extend (if white), or lighten and extend (if black).



Full length screen display module mounted behind the front panel and wired to the control printed circuit board.

This is quite useful for demonstrating the speed and accuracy of MIDI Note On and Note Off data. Keys pressed outside the range of this keyboard display (Octaves 3 to 7 inclusive) are not shown.

PRACTICAL USES

One of the main uses of the MIDI Analyser is to ascertain what MIDI features a particular instrument has. For instance, select the second display screen, then press and release a key several times on a connected synthesiser.

If the top bargraph moves in sympathy with your playing, then that keyboard has velocity sensing, and it is very useful to see how hard you strike each key (volume).

If your synthesiser does not have velocity sensing, then the velocity bargraph will only move to the half-way point denoting a velocity value of 64, which is the default value.

Similarly, if a keyboard responds to After-touch, then the same will occur with the bottom bargraph when the key is pushed into the touch-sensitive cushion underneath it.

The Real-time chevron on the first display screen will immediately show if a Drum Machine or Sequencer is transmitting real-time data. The speed of this moving chevron indicates the rate at which Real-time data is being received.

By selecting the third display screen, it can quickly be found out on which channel a particular piece of MIDI gear is transmitting. In a complicated MIDI setup, the analyser can be an important test tool for finding out why a Synthesiser, Sequencer or Drum Machine remains coldly silent! □

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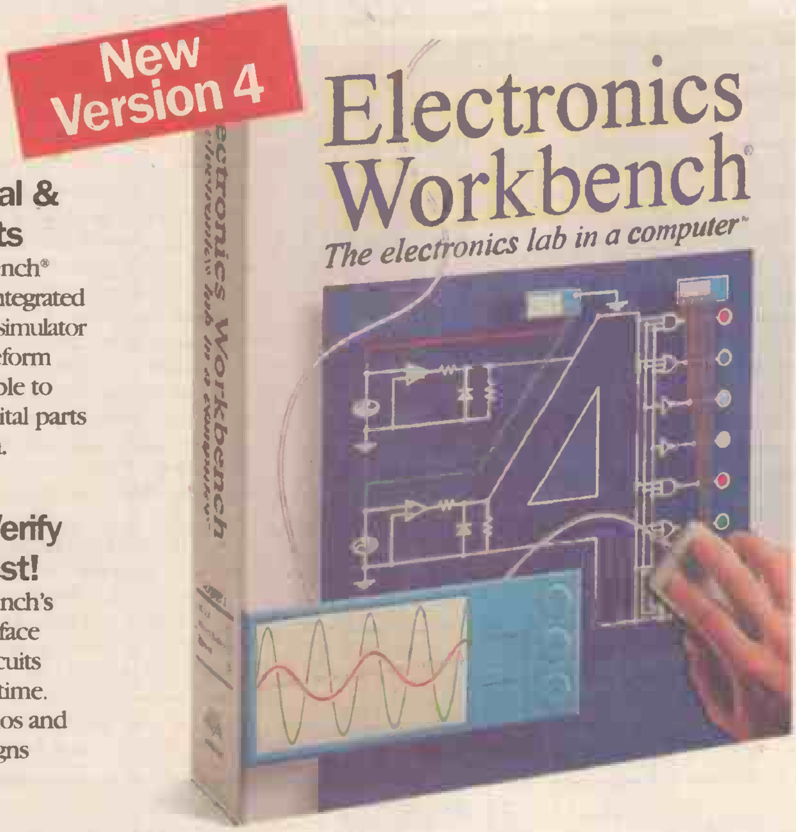

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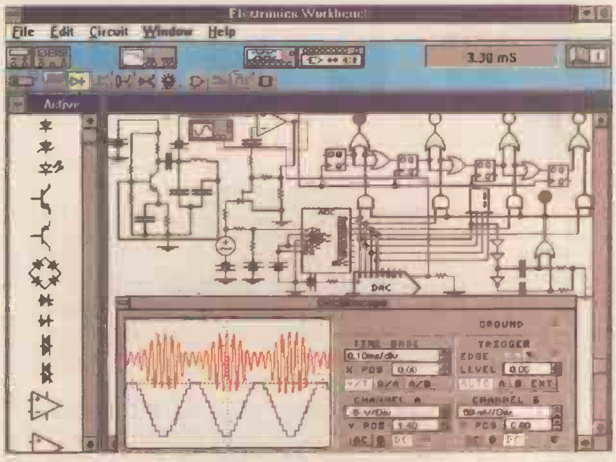

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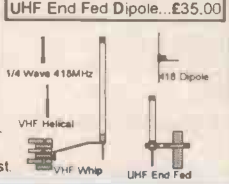

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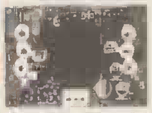

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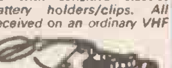

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New Technology Update

Ian Poole investigates the latest developments in micro-machines, and discovers there's even a version which runs on steam!

MINUTE machines manufactured using technology more akin to semiconductors, and sizes to suit are now becoming a reality. Even though they are still very much a laboratory phenomenon, ideas for everyday uses are coming thick and fast.

Possible uses in medicine have been suggested. They could be used to give small doses of drugs over a prolonged period of time. Although they are likely to find many good uses in this area, their possibilities stretch well beyond the confines of medicine.

Some researchers are looking to their use in shrinking integrated circuit sizes even smaller. As the limits of the current technologies are being approached, these micro-machines could be used in the manufacture of components up to a hundred times smaller than those which can be made at the moment.

Dopant Levels

To achieve this the machines could be used in a number of ways. For example, they could be used for controlling dopant levels in semiconductor materials very accurately.

One of the major features in semiconductor manufacture is the control of the dopant levels. If these could be controlled locally and accurately this would give much greater flexibility in manufacture, allowing more complicated and dense structures to be made.

In another strategy they could be used after the main high temperature processing in additional stages of manufacture. Here they could be used to actually machine areas of the i.c. structure to include items like optical modulators and other items which cannot be made using the standard techniques.

Diamond Based

Taking their use in semiconductor manufacture a stage further, these machines could be used in the manufacture of semiconductors with new substrates. Diamond is an ideal candidate. Not only is diamond the hardest substance known to man, but it is also a very good semiconductor.

One of its advantages is its high level of heat conductivity. This would enable much more heat to be generated in a small area whilst still being able to remove it so that the circuit did not run too hot.

However, diamond is not particularly easy to use. With the use of micro-machines it would be relatively easy to create substrates and locate impurities at precise points to give the required structures.

In addition to their use in i.c. manufacture, it is being proposed that the machines themselves could be built into future generations of computers.

Beginnings

Micro-machines were first investigated over 25 years ago. Since then the techniques for constructing them have been refined to a degree where they can be manufactured to give some remarkable results.

A number of micro-electro-mechanical systems or MEMS have been designed. One of the first was a complete gas chromatograph in which the system included micro-machined valves, a gas column, flow detector and finally a detector all on one chip.

In just the same way that standard integrated circuits started in a small way and grew dramatically, so the same could happen to these micro-machines.

A number of techniques are being used to make these machines. In one development researchers at Stanford University are using a reactive ion etching technique. This enables "trenches" as deep as 200 microns and with feature sizes of 20 microns to be made.

Other investigations include looking at alternative materials. Silicon is brittle when etched, and this can reduce the reliability. Furthermore, when placed in real situations these machines are likely to become contaminated and their reliability will fall.

Results

In one development by researchers at Sandia a small motor has been fabricated. Manufactured from machined polysilicon it has been shown to rotate at a speed of 300,000r.p.m.. Although the machine itself has been in existence for some while one problem was in ascertaining whether it was actually rotating at that speed and not a sub-harmonic!

Rotating at such a high speed made many people wonder about the life of the bearings. Although silicon is relatively hard (and brittle) such high speeds can wear bearings out quickly. It has been stated that the bearings are good for at least 800 million revolutions.

To manufacture the gears a number of processes are needed. Sacrificial oxide layers are used to separate the moveable layers from the stationary ones and a layer of silicon nitride placed between the moving surfaces to reduce friction. To produce the whole structure eight mask levels are required, although if more complicated machines are required it is likely more stages will be needed.

Despite the detailed knowledge of the processes involved, scientists are still baffled by the life of the bearings. Some precautions including the silicon nitride layer have been included in the process but it was never anticipated the bearing life would be so great.

Micro-Steam

One micro-machine actually runs on steam, generating a force per unit area of the machine that is an order of magnitude greater than conventional electrostatic actuators.

It consists of a small cylinder manufactured by depositing silicon onto a substrate. A spring-loaded piston is placed into the cylinder and water dropped onto the surface of the machine.

A small amount of the water is pulled into a heating area by capillary action, and the steam passed into the cylinder where it forces the piston out. When the heat is removed the pressure from the steam rapidly falls and the piston quickly returns into the cylinder.

All-Aboard

The natural extension of these micro-machines is to fabricate them on the same chip as an integrated circuit. This is not particularly easy because of the complex nature of micro-machine manufacture.

It requires the use of high temperatures to enable any stresses in the structures to be relaxed. Unfortunately, these prolonged high temperatures lead to problems in CMOS circuit manufacture.

If the micro-machine is manufactured first then this leaves the substrate unsuitable for laying down the electronic circuitry afterwards. If the CMOS circuitry is constructed first then it can be damaged. In particular, the metallisation layers are not able to withstand the high temperatures.

Currently, methods of constructing the CMOS circuitry first and then laying down the micro-machines are being investigated. In most i.c.s, aluminium is used for the metallisation, but to overcome the problems in this process, titanium is being investigated.

Whilst titanium is able to withstand the high temperatures, it creates some new problems. First, the metal reacts with the silicon to produce titanium silicides, and second, it does not adhere to the silicon surface sufficiently. Research into solving these problems is progressing.

Innovations

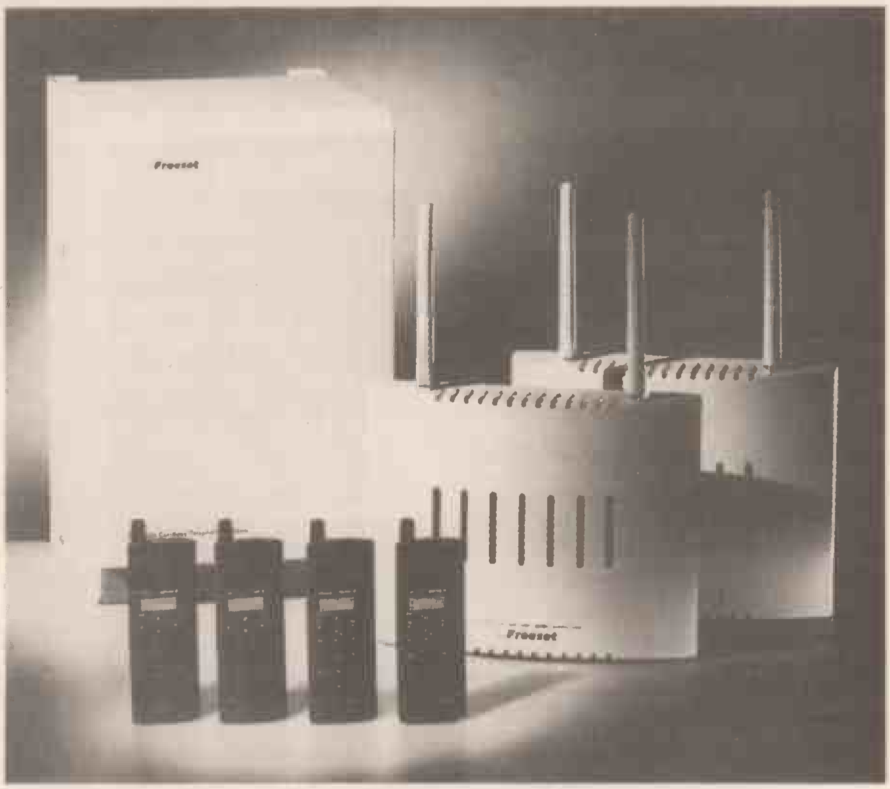
A roundup of the latest Everyday News from the world of electronics

ELECTRONICS DOWN-UNDER

Fresh back from revisiting Australia, Hazel Cavendish looks at how the Aussies are reacting to technology

WHEN I arrived for two months in Australia I thought I had a golden opportunity to collect some innovative stories for *EPE*. My journey took me from Sydney through the bush country of New South Wales to Melbourne, the Mornington Peninsula and far-flung parts of W.A., and I was fortunate in that two of my hosts had electronic interests.

Thirty years absence from the country revealed enormous progress in many spheres, notably in the development of city centres and industrial areas, and a plethora of new high-rise buildings. There was also a different aura of sophistication in the cities, generated by the large influx of European immigrants who have contributed cultural changes and national cuisines to their adopted country, as well as their scientific know-how.



Freeset is a unique digital cordless phone system comprising a radio exchange, base stations and portable handsets.

Fired with tedium

Australian newspapers all carry technical articles and publish regular scientific supplements, in which Electronics figure largely and I perused these eagerly – but with a varying degree of disillusion.

Australia must be a paradise for newspaper journalists, who appear able to publish articles of exceptional tedium, consisting largely of technological treatises and commercial hand-outs, sprinkled with over-zealous use of unexplained abbreviations in block capitals, which could only discourage the lay reader. I constantly asked my various hosts whether they read the technology sections, only to be told: "No, but they come in very handy for lighting the fire or wrapping the potato peelings."

I soon came to realise that although most Australians embrace technology – and indeed welcome it eagerly – they seldom initiate it. Just as there is an amazing absence of home manufacture of essential goods, Australians prefer to import their electronics – and then utilise them – rather than develop them themselves.

One also reads some surprising claims of "discovery" in electronic technology, backed up by statements which claim that Australia was the first to develop this or that, when one was aware that other countries got to that point quite some time ago.

Veering to Europe?

Australia has been obsessed for some time now that its future lies with the Pacific basin countries. Now there are signs of a sea-change. A prominent Australian has declared that the national obsession with Australia's push into Asia is misguided.

Mr Duncan Campbell, former secretary of the Dept. of Foreign Affairs between 1975 and 1979 and previously an Ambassador for his country in Italy – now described in their newspapers as a leading bureaucrat – has warned Australians against being mesmerised by Asia and argues that the country should appreciate and nurture its substantial ties with Europe. He points out that Australia's latest current account transactions with the European Union totalled more than $40 billion – 20 per cent of the total.

The *Australian* newspaper covered his recent speech, at a "Business in Europe" lunch, in which he said the Federal Government's foreign affairs were lopsided and bore little resemblance to the statistical reality. Cumulative European investment in Australia was well over $1 billion and almost 30 per cent of the total. He predicted a new, mature relationship with Europe in a post-republic Australia, bolstered by post-war European migrants.

Encouraging IT in Oz

Australians are keenly interested in every aspect of Information Technology, and would like to appear on the world stage. In January this year a consortium of Australian IT companies invested over half a million Australian dollars in an electronics, hardware and software manufacturing facility in Brisbane, Queensland. Oz Electronics Manufacturing sets out to provide assistance to Australian developers seeking to become internationally competitive.

"For the first time this enables innovative Australian operations with relatively small marketing muscle to compete successfully in the international arena", said MD Max Rose. "We can offer expertise in the manufacture of componentry that meets the stringent requirements of European and North American markets."

In an effort to encourage home-bred innovation, the Australian Institute of Engineers in Canberra offers "Excellence Awards" to a range of products submitted by firms every year.

Communicating importance

The importance of every aspect of this technology in a country of vast distances between cities is marked by the amount of space devoted to it in technical supplements. The Swedish firm of Ericsson claims to occupy 70 per cent of the market share in cordless business telephone systems, having introduced their cordless portable telephones to Australia three years ago. The firm quotes a forecast that the world market for these systems could be worth US $5 billion in 1998.

Ericsson Australia has supported the European movement to DECT (Digital European Cordless Telephony) as a Radio Equipment and Systems Cordless Telecommunications standard.

"Freeset" is their latest system complying to the DECT standard that can be connected to any private automatic exchange, extending the telephone services for every user over the entire premises of a large company.

The system comprises: Radio Exchange, providing radio control and interfacing to the network; Base Stations, which provide coverage in an area and support eight simultaneous calls; Portable Telephones, which provide a range of services to users.

Speech is encoded into a digital format before transmission. The coding used is the Adaptive Differential Pulse Code Modulation standard. Radio communications between the Base Stations and the Portable Telephones are based on Multiple Carrier, Time Division Multiple Access and Time Division Duplexing which provides full duplex operation.

All system communications are encrypted to ensure complete privacy and protection against eavesdropping techniques and fraud by unauthorised users.

The Freeset system provides transparent service access for up to 600 users without confining them to specific coverage areas.

Long-distance Cordless

The Ericsson company is working on a development for the future which will enable people in widely distant Australian cities to communicate with homes and businesses via their cordless portables for a local charge – an important step forward for a country in which distances are enormous.

The implementation of the open air interface for DECT, known as Generic Access Profile (GAP), will allow the use of portables of one manufacturer in an infrastructure environment of another.

Another development is known as "Radio in the Local Loop" which is defined as a radio interface into the PSTN (Public Service Telephone Network) from the end point of communication. It is thought that it will be possible to replace the last few kilometres of cable to residential addresses with radio technology (Base Stations).

This scenario would allow for three new business opportunities: Radio interface to homes with fixed handsets; Radio to homes with a repeater and cordless phones in the home; Neighbourhood mobility. The last of these is thought to be an area of great potential.

SINCLAIR ARCHEOLOGY

A legend in his own life-time, Sir Clive Sinclair has repeatedly created immense public interest in his various inventions, even though not all have received the success hoped for.

As readers who live in Sussex may well have discovered, an exhibition about Sir Clive and his products was recently on display at Hove Library. Arranged by one of Sir Clive's greatest fans, Enrico Tedeschi, it drew in not only crowds of visitors, but also Sir Clive himself.

Enrico, who is an historian and writer with an interest in radios and electronics, comments that he has been collecting examples of Sir Clive's work for many years.

Amongst the many memorabilia on display was the ill-fated C5 electric trike plus, of course, greater successes such as the Z80 computer.

Although the exhibition has now finished, Enrico is determined to keep alive the public's interest in the Sinclair Legend and has published a book which thoroughly records it all. Visiting the exhibition, Sir Clive said "I found the book astonishing. It is remarkably complete and will be a great help to me".

The book is called *Sinclair Archeology - the complete photo guide to collectable models* and Enrico not only researched, wrote and illustrated it, but he has also printed, collated and bound it.

To obtain a copy of the book, send a cheque or postal order for £12 (which includes £2 UK postage) to Hove Books, 54 Easthill Drive, Portslade, Brighton, Sussex, BN41 2FD. Orders can also be placed by phone to 01273 410749.

Sir Clive in 1989, proudly displaying the Z88 computer which, at the time, was his latest invention.

FARNELL TAKING OVER

Major British components distributor Farnell Electronics PLC of Leeds has been involved in discussions with a view to taking over the American Premier Group. It is understood that in principle all has been agreed and that only the nitty-gritty of legal arrangements has still to be completed.

Assuming that this take-over goes ahead, Farnell will become what is reckoned to be the largest catalogue-based distributor of electronic components in the world. Premier currently owns major distributors in Newark, USA.

Having realised a 1994-5 turnover of £514 million, Farnell has been disposing of its UK manufacturing operations and buying more distributor bases. It has also opened an American distribution outlet in South Carolina, primarily to service the East Coast.

As we go to press, the latest financial market news is that Farnell has received subscriptions for 94.4 per cent of its £349 million rights issue, launched as part-funding for its £1.9 billion acquisition of Premier.

Farnell are pleased to accept orders for electronic components and equipment from non-account holders and it is well worth while obtaining their catalogue. Their WWW site also contains details of their product ranges and has links to many semiconductor suppliers, the URL is: http://www.farnell.co.uk. Farnell's sales telephone number is 0113 263 6311.

CHiDEABLE QUOTES

These astonishing quotes were seen in *Transmission Lines*, the newsletter for the Friends of CHiDE, the Centre for the History of Defence Electronics:

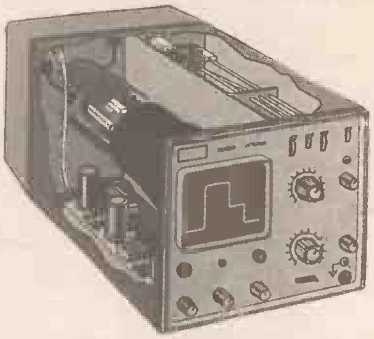
"Everything that can be invented has been invented", Charles H. Duell, Director, US Patents Office, 1899.

"Radio has no Future", Lord Kelvin, commenting on Marconi's experiments in 1897.

CHiDE was established in 1995 at Bournemouth University and is a UK pioneer in the use of advanced electronics and information technology to promote the public understanding of the history of electronics.

It creates multi-media presentations for schools, museums and libraries, travelling exhibitions and a Virtual Museum on the Internet.

To find out more about CHiDE, contact: Friends of CHiDE, The Centre for the History of Defence Electronics, Bournemouth University, Room 413, Studland House, 12 Christchurch Road, Bournemouth, Dorset BH1 3NA. Tel: 01202 503902.



THERMIONIC VALVES - THE C.R.T.

IAN POOLE

Part Two

Valves may be ancient in origin, but they are still much used, especially as cathode ray tubes.

LAST month we looked at the history of the thermionic valve and discussed some of its varieties. These were principally designed for amplification use in various forms. In this concluding article, a very different form of valve technology is examined – that of the cathode ray tube.

The cathode ray tube (c.r.t.) is one of the most extensively used display inventions ever made. It has been in widespread use for over 50 years, and despite the fact that other thermionic devices are now rarely used, the production of c.r.t.s is still increasing.

Even though many companies are spending vast amounts of money developing other forms of display, the c.r.t. still outperforms most of them. It offers high definition, full colour capability, high light output, wide angle of view and, above all, it is relatively cheap to produce.

Against this, the c.r.t. has several disadvantages. It is large and heavy, consumes a large amount of power, and requires high voltages to drive it. These disadvantages make it unsuitable for applications in portable equipment, such as laptop computers, where power consumption, size and weight are prime considerations. But, for domestic televisions and desk-top computers, the c.r.t. is still the only viable option.

ORIGINS

Work which directly led to the development of the c.r.t. can be traced back to the middle of the nineteenth century. At this time a number of people were making investigations into what we now know are electrons.

In his researches in Germany, a researcher named Hittorf discovered that the particles leaving a cathode travelled in straight lines. These emissions became known as cathode rays. During the 1870s, William Crooke established that the rays could cause fluorescence in an evacuated tube.

By the late 1870s, many properties of cathode rays were known, including the fact that they could be deflected by a magnetic field. However, it took until 1897 before J. J. Thomson, an eminent scientist at the Cavendish Laboratory in Cambridge, verified that they could be deflected by an electric field as well.

Then, in 1907, Boris Rosing in Russia used a c.r.t. to display simple images on a screen. As electronics was still in its infancy, the images were generated mechanically using moving magnets.

GROWTH OF TV

After this, much development of the c.r.t. came about with the introduction of television. Research into TV was undertaken on both sides of the Atlantic, although with surprisingly little cooperation. In the States, RCA were developing their system, first demonstrating a TV receiver which used a c.r.t. in 1932.

Meanwhile, in the UK, the EMI-Marconi system was chosen by the BBC, against fierce competition from John Logie Baird's mechanical method, with the first public TV transmission starting in 1936.

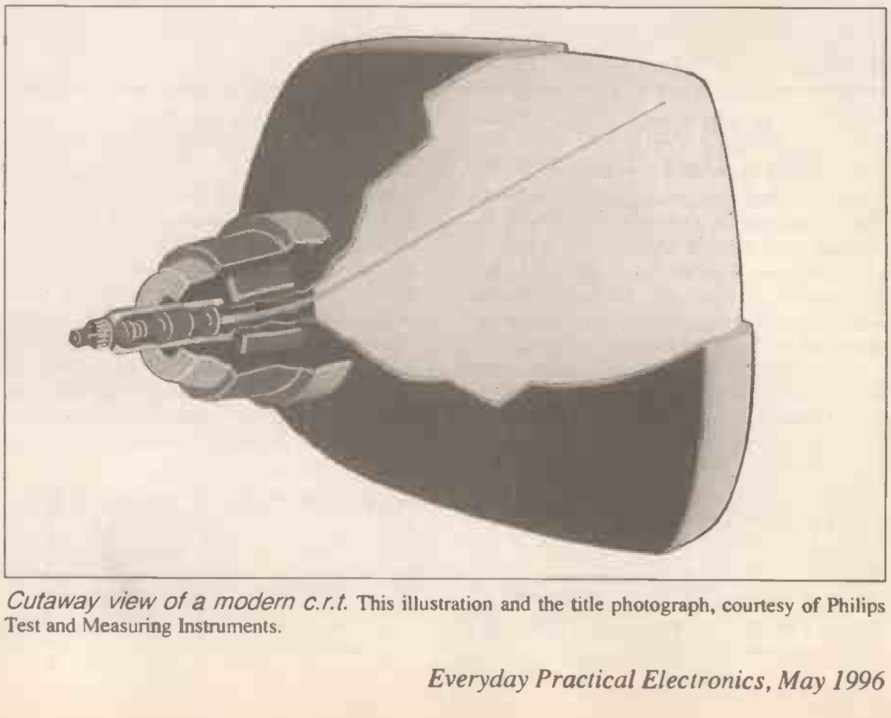
The war put a stop to much of TV development, although the c.r.t. itself was greatly improved for use in military radar systems. After the war, TV transmissions were resumed and interest started to grow again. In Britain, the Coronation was televised in 1953, and this gave an enormous boost to the acceptance of TV into daily life.

The next major development was to be able to display colour. Many systems were put forward. John Logie Baird with his characteristic inventiveness managed to display two images on one screen and then combine them optically to produce a two-colour picture. However, it was realised that this approach would not be viable for volume manufacture.

The "shadowmask" system in use today was first demonstrated at RCA by a team led by Goldsmith and Schroeder. A great deal of development was required because a large number of coloured phosphor dots were needed and these had to line up exactly with holes in a shadowmask.

Acceptance of the system was slow because of the enormous cost of the tubes. Once colour did start to become accepted, many countries quickly followed suit, the BBC in Britain starting their colour transmissions in 1967.

Colour TV gave a new lease of life to c.r.t. production around the world. Even so, this was only a forerunner to the impetus given by the introduction of the personal computer. Now sales of c.r.t.s for PC monitors far outstrip those used for TVs.



Cutaway view of a modern c.r.t. This illustration and the title photograph, courtesy of Philips Test and Measuring Instruments.

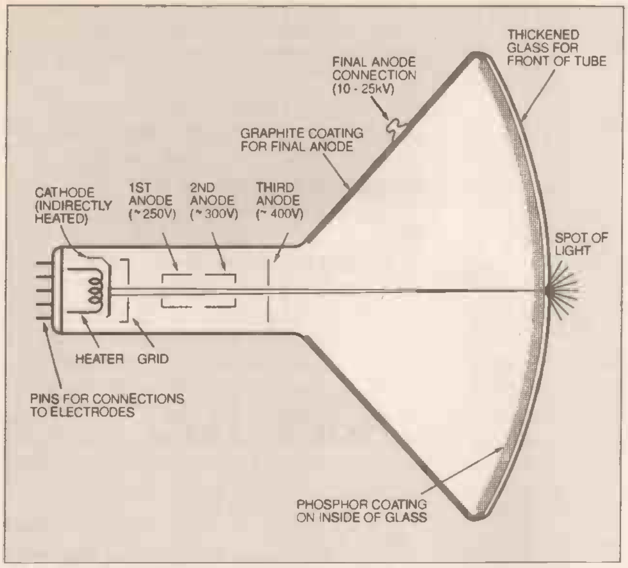


Fig. 18. Simplified diagram of a c.r.t. In essence, only one anode is required.

BASICS

The cathode ray tube, picture tube, or just "tube", is based on the thermionic valve, which was explained in Part 1.

It consists of an electron gun, the deflection circuits and the screen. The electron gun generates the electron beam, which travels towards the screen while being deflected up and down and side to side by magnetic or electrostatic fields. Once the beam hits the screen, the kinetic energy of the electrons is converted into light energy by a phosphor coating on the inside of the glass.

The electron gun consists of an assembly with a cathode, grid and one or more anodes. The cathode is indirectly heated in exactly the same way as in an ordinary valve. When the cathode reaches the operating temperature, electrons are emitted by it and are attracted, past the grid, towards the positive potential of the anodes, as shown in Fig. 18.

The grid is held at a negative potential with respect to the cathode, and by altering the level of bias on it, the number of electrons can be controlled. When a negative voltage is placed on the grid, it tends to repel the electrons moving out from the cathode because like charges repel one another. This reduces the electron flow and hence the intensity of the beam.

When the bias is reduced, i.e. made less negative, the electrons are not repelled back by the same degree and their flow towards the anodes is increased. In this way, the number of electrons reaching the screen can be controlled, allowing the level of light emitted by it to be altered.

Once the electrons pass the grid, they are accelerated by the potential on the anode, their velocity increasing the nearer they get to it. A small hole is present in each anode. Some electrons hit the anode, but others pass straight through the hole, travelling on towards the screen.

To ensure that most electrons are focused towards the anode hole, the grid is specially formed. Unlike the mesh or gauze grids found in ordinary valves, the grids found in c.r.t.s are solid cylinders with a small hole at the end. This enables a relatively narrow beam of electrons to flow out towards the anode, making best use of the total electron emission from the cathode.

A c.r.t. with a single anode cannot produce high quality display results. To achieve such results, further anodes have to be used to accelerate the electrons sufficiently to generate the required light output. They also help focus the beam to the fine point needed to achieve optimum definition, as shown in Fig. 19.

As shown in Fig. 18, the additional anodes are held at increasing voltage levels. Typically, the first anode might be at around 250V, and then the second and third ones might each be 50V to 100V above the previous one.

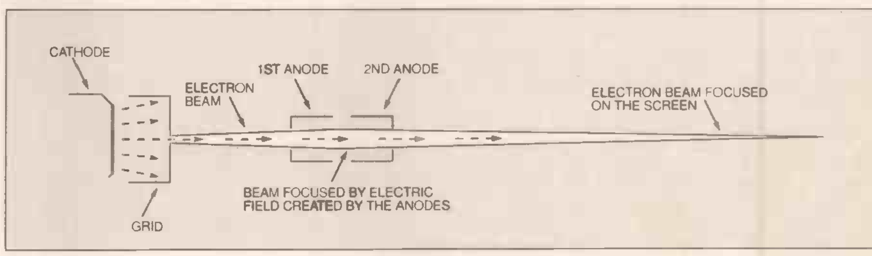


Fig. 19. Anodes in the electron gun.

SCREEN

To enable the electron beam to illuminate the screen, the screen is coated with a phosphor layer. This converts the kinetic energy of the fast moving electrons into light, in other words, it fluoresces.

The phosphor contains a mixture of phosphates, silicates and sulphides. By changing the composition of the phosphor, it is possible to change its fluorescent characteristics, including the colour.

Even though the electron gun already contains a number of anodes, a final anode is also created in the flared part of the tube, as shown in Fig. 18. The final anode is normally made by coating the inside of the glass with a carbon layer. It is usually held at a potential of several kilovolts. A typical figure might be 15kV or more.

The connection to the final anode is easily seen on a c.r.t. It is a thick well-insulated cable connected to the flared section of the tube via a robust connector, part of which is embodied into the tube. The connection has to be placed well away from all other connections to the tube in order to prevent the very high voltage from arcing over.

As the phosphors are conductive, the inner front surface of the tube is at the same potential as the graphite coating forming the final anode. This has the effect of pulling the electrons towards the screen and accelerating them even more. Once they strike the screen, the current is conducted away through the final anode connection.

Warning: Under no circumstances should the back of a television be removed except by experienced persons. Exceedingly high voltages are present which could be fatal. These can remain in the set even after it is switched off.

BEAM DEFLECTION

Positioning of the beam on the screen can be achieved in two ways. The first method is by the use of a magnetic field.

When a conductor carrying an electric current is placed within a magnetic field, a force will be exerted on it. This fact is used in a variety of applications, such as electric motors, for example. The same is true for a beam of electrons within a cathode ray tube. These behave in exactly the same way, except that they do not have a conductor to confine their flow.

Making use of this fact, coils are placed over the neck of the tube and controllable currents are fed through them, creating variable magnetic fields, as shown in Fig. 20.

There are two sets coils, orientated so that their fields are at right angles to one another. Between them, they control the vertical and horizontal deflections of the beam. In this way the dot of light created by the beam can be moved anywhere on the screen.

The advantage of magnetic deflection is that the beam can be deflected over wide angles, making it ideal for use in televisions, where large screens are needed. Its disadvantage is that it is difficult to obtain very good linearity with it.

In instruments like oscilloscopes, where accurate measurements need to be made

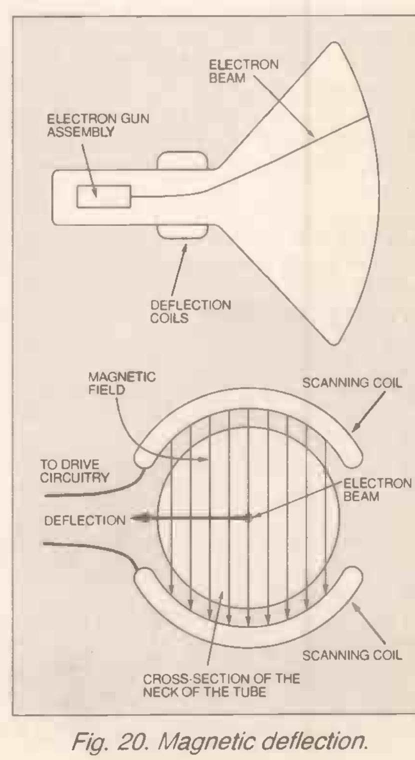


Fig. 20. Magnetic deflection.

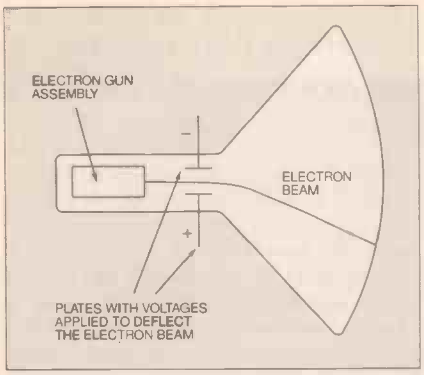


Fig. 21. Electrostatic deflection.

from the screen, electrostatic deflection is used, as shown in Fig. 21. This method is based on the fact that like-charges repel one another and unlike-charges attract.

The tube is fitted with control plates after the focus anode. One pair is required for horizontal deflection, and another for vertical. When voltages are applied to the plates, the beam deflection is proportional to the voltage applied.

The problem with electrostatic deflection is that it does not give as much deflection as magnetic. Consequently, tubes using this method of deflection have to be much longer.

When the electron beam is fired along the tube, it has to be deflected sufficiently to cover almost the entire screen, as shown in Fig. 22. For a given screen size, the shorter the tube, the wider the angle which is required. To achieve a wide deflection angle, much greater levels of drive are required. It is also more difficult to maintain the accuracy and definition over a wide angle. Despite this, most modern tubes have a scanning angle of 110 degrees.

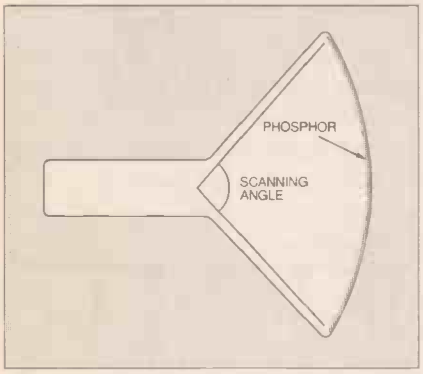


Fig. 22. Scanning angle.

TUBE SIZES

Tube sizes are now usually quoted as a single measurement in centimetres.This is the measurement across the diagonal of the active screen area, as shown in Fig. 23. Obviously, for the size to be meaningful, the ratio of the width to height must be known. For the current 625-line terrestrial transmissions, the ratio is fixed at 4:3. This means that a 51cm (20-inch) tube will have a width of 40·5cm (16 inches) and a height of 30·5cm (12 inches).

It is now accepted that to create better realism, the picture should be wider than that generally used, possibly with an aspect ratio of 2:1. With a wide screen of this ratio, stereo sound adds much more effect than it does with the current 4:3 ratio. It is likely that over the coming years wide-screen TV will become far more universally used.

SCANNING

The ability to see a television picture on a c.r.t. depends on the fact that human eyes have "persistence of vision". This means that an image projected onto the retina of the eye will continue to be perceived ("seen") briefly after the image has been removed. How this can be applied to create a meaningful picture on a TV screen is as follows:

A spot of light can be made to oscillate backwards and forwards. At slow oscillation rates, the spot will be clearly seen as it moves, but as the rate speeds up, the spot will gradually become a blur, and eventually be seen as a continuous line.

The dot can then be made to vary in intensity as it moves backwards and forwards. The eye registers these changes as areas along the line which are light and others which are dark.

Once one line has been scanned, the dot can be moved downwards slightly, rapidly returning to the other side of the screen, and another similar line displayed, and so on until the whole screen has been covered. In this way a whole picture can be displayed.

When the whole picture has been scanned, the spot can return to the beginning and trace out the whole screen again. When this cycle is performed fast enough, the eye does not perceive any flicker.

Ideally, a TV picture would need to be displayed at a scan rate of about 30 times a second for flicker to be unnoticeable. In the UK, TV pictures are refreshed 25 times a second. This is not quite fast enough to remove all the traces of flicker.

To overcome this problem, a technique called "interlacing" is used, in which all the odd-numbered lines are sent first, and then followed by the even-numbered lines, as shown in Fig. 24.

Because the even-numbered lines are interlaced between the odd-numbered lines, then, at distances from which the TV screen is normally viewed, it appears that the picture is refreshed fifty times a second and the eye does not detect any flicker. (Flicker can still be noticed, though, if the transmitted pictures have originally been recorded on film, which typically is photographed at 24 or 25 frames a second.)

COLOUR

The discovery of how to display monochrome (black and white) images on a c.r.t. was a great achievement, but it did not take long before the need arose to be able to display colour pictures. The same basic principles are used to achieve this, although several major additions are needed.

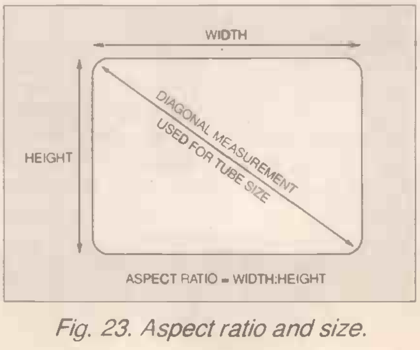


Fig. 23. Aspect ratio and size.

To display colour, c.r.t.s rely on the fact that it is possible to mix together lights of different colours to obtain the others. For example, red, green and blue light, when mixed in the correct proportions, produce white light.

By changing the colour proportions, it is possible to make any colour across the visible spectrum. Blue and red together give magenta, green and red combine to form yellow, blue and green produce cyan.

Colour production in this way is known as an *additive* technique. Note, though, that mixing coloured *lights* produces different colours to those produced when mixing *pigments* such as paint or ink, a technique which is known as *subtractive* colour mixing.

Colour cathode ray tubes use the principle of colour addition to produce all the required colours. They have three types of phosphor on the screen so that the three primary colours can be produced. By controlling the proportion of each colour relative to the others, it is possible to change the overall colour perceived (although close-up examination of the screen will show that the individual primary colours still retain their identity). By controlling the intensity of all three colours together, while still maintaining their required ratios, it is possible to control the perceived brightness.

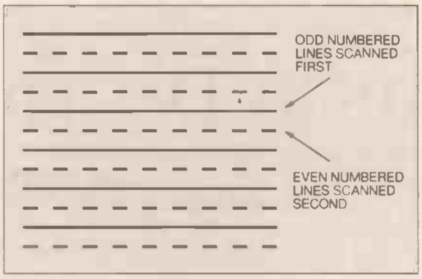


Fig. 24. Interlacing of screen scan.

TUBE CONSTRUCTION

At a first glance, a colour tube looks very similar to an ordinary monochrome one. However, on the inside it contains three separate electron guns, one for each primary colour, as shown in Fig. 25. These are all contained in the neck of the tube as before. The coloured phosphors are placed on the screen in dots or lines. The design of the tube then has to ensure that each gun can only illuminate the correct phosphor. This is achieved mechanically by placing a mask (known as a shadowmask) between the screen and the guns.

As the three guns are not in exactly the same position, it means that the three electron beams hit the screen at slightly different angles. The shadowmask allows each beam to reach its own colour, and prevents it from illuminating any other colour, as shown in Fig. 26.

In theory, it seems very easy to produce a shadowmask that only allows the correct beam to reach each type of phosphor dot. In practice, it is not quite so easy because of the very tight tolerances needed.

The first tubes which were made

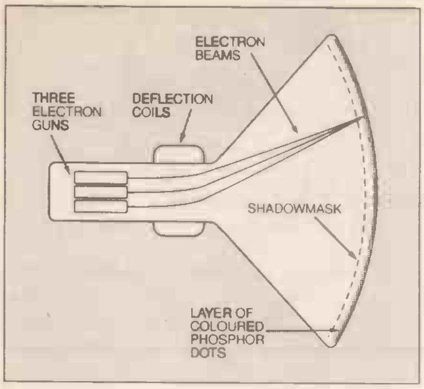


Fig. 25. Construction of a colour tube.

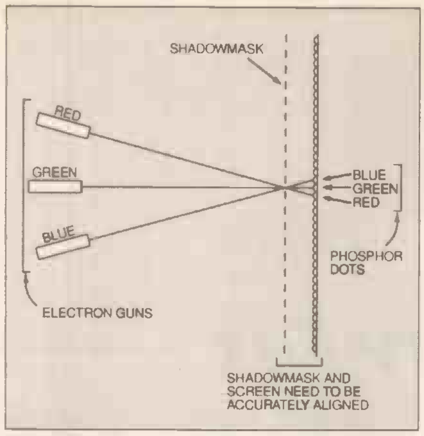


Fig. 26. Operation of the shadowmask.

used groupings of three phosphor dots ("triads"), together with electron guns in a triangle or delta shape. These were notoriously difficult to align, and it was often found that the colour in one part of the picture might not be quite right because the electron beam was influenced by an external magnetic field and would hit the wrong colour phosphor. The other problem was that the shadowmask covered up a significant portion of the screen, and this had the effect of reducing the brilliance.

To overcome these problems, most tubes are now manufactured with the scanning coils as part of the main assembly, allowing very accurate alignment during manufacture. Also, the shadowmask is often modified to have elongated dots or slots. This allows greater illumination of the front of the screen by the electron beam, resulting in greater image brilliance.

The famous Sony Trinitron tube takes this idea even further. Instead of using small phosphor strips, it uses complete strips on the tube which pass from top to bottom. The shadowmask also has similar strips. This technique produces the maximum possible screen illumination.

However, even with the enormous improvements which have been made with tube manufacture, large stray magnetic fields can still cause a problem. This is why high-fidelity loudspeakers, which normally have large magnets inside them, should be kept away from a colour television or monitor.

CONCLUSION

The Cathode Ray Tube is a highly successful invention. Most homes have at least one, and usually more; offices are full of them inside the monitors that go with computers; ships of all sizes use them with their radar systems, as do aircraft; oscilloscopes continue to benefit from their versatility; and numerous other applications exist as well, including such items as cash machines at Banks.

Other technologies have challenged their supremacy, but none have yet succeeded. The cathode ray tube is still dominant in its field. In this respect, thermionic valves continue to flourish.

The hey-day of the "ordinary" valve, though, has passed. Even so, they are not totally outdated by semiconductor technology and are still used in a wide variety of specialised applications.

It seems likely, therefore, that thermionic valves in their various guises will remain in use for many years to come. □

FOX REPORT

by Barry Fox

Hotly HiFi

As Ian Poole says (EPE April 1996), thermionic valves are still very much used. Go to any genuine hifi show (as opposed to a home entertainment bash) and the first thing that hits you is the heat. Most of the manufacturers of high end hifi now sell valve amplifiers. The high power models waste the equivalent of a two bar electric fire per channel of sound.

Bell Labs invented the transistor in 1947. Sony started to make transistorised radios in 1955. By the 1970s most home electronics used transistors instead of valves. In 1988 Bell's manufacturing company Western Electric closed its last tube production line in Kansas City. The factory went over to semiconductor manufacture. Most other Western factories had already shut down.

The first transistor amplifiers sounded very nasty. Whereas valves roll off overload signals, transistors slice off the peaks to create square waves. As designers learned to use transistors, the sound got better and there are now some very good solid state amplifiers.

Heavy Metal

A hard core of buffs has always preferred valves ("tubes" in the USA) and are happy to pay tens, even hundreds of thousands of pounds, for units too large and heavy for any shelf or table to support. The smothing capacitors are so huge that they must be pre-charged at the factory. House mains cannot deliver the current.

Factories in China and Russia have continued to make valves. They service backward telecommunications industries and the military who know that valves can withstand the electromagnetic pulse of a nuclear explosion. Hifi designers are wary of these valves as substitutes for the original favourites, notably the Westrex 300B triode amplifier valves. Genuine orginal 300Bs now change hands for $1000 each.

Taking the Tube

"Just about every manufacturer of high end hifi now sells a tube amplifier", Charles Whitener of the Westrex Tube Division in the US told me when I heard that the company was offering new 300Bs. "A year ago we decided to start production again. The original staff are using the original tools. We have just produced the first tubes ready for sale".

The new 300Bs will sell for $350 each. Westrex will make 25,000 this year, purely for the hifi market. Whitener claims the new valves will be indistingishable from the originals. We must wait for the hifi industry's judgement on that. Particularly interesting, Whitener says Westrex hopes soon to start production for Europe at a factory in the UK. He won't say who, but Western Electric was once the owner of Standard Telephones and Cables in the UK and of NEC in Japan.

BT on Superhighway

British Telecom denies press reports that it is having second thoughts on building an information superhighway. And for once I sympathise with BT. Business journalists seem to think that the only way to build a highway is to dig a trench down through the UK and lay a brand new optic fibre. In reality, as BT says, the future highway will be a network of networks, some new some existing.

Last October Labour leader Tony Blair struck a deal with BT Director Norman Tebbitt. BT would build a broad band superhighway in the UK and provide connections free for educational establishments, in return for the right to start broadcasting entertainment into homes in direct competition with the cable TV companies. The current Conservative government has refused even to consider relaxing the rules on broadcasting until the next century. So you can be sure that BT is not going to let Labour's golden promise slip through its fingers.

Who pays the Highwayman?

This leaves one very important question. How will cash-strapped schools and hospitals be able to afford to use the free connections to the information superhighway which British Telecom will give them. We now know the answer. Other people who use the telephone will pay.

"There will be a levy on consumers", Geoff Hoon, Labour's Shadow Minister responsible for Information Technology and the Superhighway told the Rights Stuff conference on media rights and payments held in London in early February.

Isn't that just another way of saying there will be a new tax?

"It is not a tax", protests Hoon. "It will be a very modest percentage paid by subscribers to the telephone networks."

Geoff Hoon admits that his wife, a teacher, immediately asked him how schools could afford to use their free connections. They must buy computers and pay experts to make them work and train students to use them. Then they must pay the price of the telephone calls, which will often be lengthy, and the cost of the information received down the line.

Hoon achnowleges that the total cost of using BT's free connections will be "very considerable". He says Labour's plans for a levy flows from an idea put forward last year by Oftel, the UK's telecoms watchdog. Oftel suggested that telecoms operators should charge educational establishements at an artifically low rate and then claim back the difference from a Universal Service Fund. The money for the fund would come from all the operators, and thus indirectly from their other users.

Don Cruickshank, Oftel's Director-General, stressed that the scheme could only go ahead if there was support from the government following full public debate. Hoon says Labour finds the idea "attractive" and takes it a lot further. Labour's fund will also pay for schools' equipment and training and the retrieval of high value information from whoever is selling it down the line.

But, when schools surf Labour's new superhighway, you and I will be picking up the tab.

Are there holes in BT's Net?

British Telecom has a terrible track record on computer services for consumers. Telecom Gold electronic mail, Prestel's messaging service, the Phone Base telephone directory and Electronic Yellow Pages were all good ideas spoiled by silly design faults. They had been developed by engineers, for engineeers, but offered for sale to the general public.

BT is moving late into the Internet, and promising that things this time will be different. BT Internet, we are assured, has "ease of use as the first priority". This may prove true. The software may install like a dream, thanks to auto-sensing of the user's modem ports, and auto-setup of the software to match the modem.

On the other hand it may not. I really don't know and neither do any of the people who have glibly regurgitated BT's publicity claims for "the access service with everything you need to help you on your way".

At the press launch we saw the system working on line, but only saw an edited video of the installation procedure.

I asked the obvious question. Could I please try the installation software myself on my own PC?

"We are trialling it now", admitted Rupert Gavin, BT's Director of Multimedia Services. "We are making final revisions".

There were no copies of the software available for the press to test. Until consumer road-tests there is no way of knowing whether BT Internet really is easy for non-engineers to use, or whether it's another Phone Base and EYP.

Constructional Project

MIND MACHINE MK III TAPE CONTROLLER

ANDY FLIND

Part Three

Build up a library of tapes with this inexpensive tape-based programmer. It will also find many other applications.

WHILST very simple and effective in use, last month's *Program Controller* for the *Mind Machine Mk III* project is a complicated and expensive item to construct. There will undoubtedly be readers who feel their experience is insufficient to tackle such a project, or would like to try programmed operation at a lower cost in terms of both cash and construction time.

A simple and inexpensive method of control will be of interest to these people and this project should fill this need. Although intended primarily for the *Mind Machine Mk III* it can be used for anything that requires a controlling voltage over a period of time, and a stereo tape could be used to give two accurately synchronised simultaneous signals. Like last month's slider potentiometer based unit, it can also be adapted for use with the earlier Mind Machine design.

RIGHT RESULT

A previous tape-based Mind Machine project used recorded stereo "binaural" sounds, which were then played back through headphones whilst an optional circuit drove the l.e.d. "light" glasses using the two signals. A problem with this was that the recording and playback equipment had to be of excellent quality since the smallest noise content was very obvious when listening to almost pure sinewave signals.

Even slightly worn tape could cause problems and all recordings had to be "first generation". High speed dubbing and copying was generally unacceptable even with Dolby noise reduction.

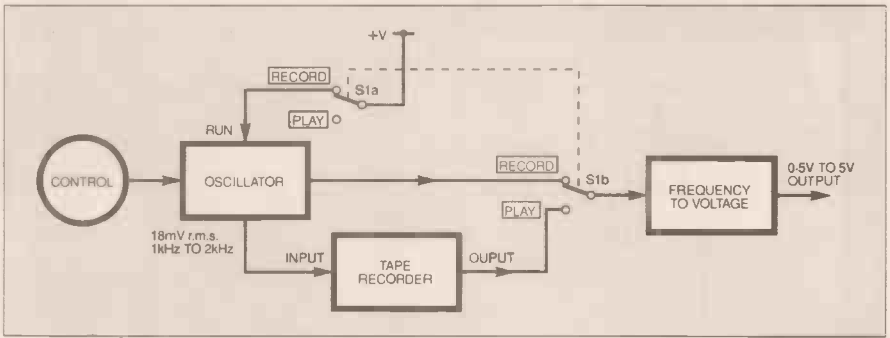


Fig. 1. Block diagram for the Tape Controller System.

This system operates in an entirely different way. A mono tone is recorded and its frequency is used to control an output voltage, which in turn controls the *Mind Machine* signal generator.

The frequency of the recorded tone is restricted to between one kiloHertz (1kHz) and two kiloHertz (2kHz), this narrow range ensuring good results with cheap monophonic equipment. In fact, results from the prototype are excellent even using a pocket micro-cassette "dictating" machine on a slow tape speed, which gives up to an hour's operation.

HOW IT WORKS

A block diagram of the Tape Controller system is shown in Fig. 1. The switch S1 is shown set to Record, for taping a program.

The oscillator provides a signal of 1kHz to 2kHz with a constant amplitude sinewave output of about 18mV from a low impedance. This is suitable for most tape recorder microphone inputs.

At the same time the signal is connected to a frequency-to-voltage converter, which changes it into a voltage of 0·5V to 5V for controlling the Mind Machine. The operator uses the system in "manual" mode, but at the same time the control sequence is recorded on tape.

For subsequent use the switch is set to Play and the tape is replayed from a headphone output to the frequency-to-voltage converter which then delivers exactly the same control sequence automatically. A library of tapes can be built up and copies may be made as needed, even using high-speed dubbing equipment, with no loss of performance.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Tape Controller is shown in Fig. 2. The oscillator, consisting of IC1 and IC2, is of the "integrator and comparator" variety.

The integrator is IC2b, and the output (pin 7) of this goes to the input of the first comparator in IC1. This is a dual

WARNING NOTICE

Photic stimulation at Alpha frequencies can cause seizures in persons suffering from Epilepsy. For this reason such people MUST NOT try the *Mind Machine*.

A user who is not a known epileptic, but when using the *Mind Machine* begins to experience an odd smell, sound or other unexplained effects, should TURN IT OFF IMMEDIATELY and seek professional medical advice.

Because of the above possibility, the *Mind Machine* should not be used while on your own.

YOU MUST TREAT THIS UNIT WITH DUE RESPECT

timer, but, wired as shown, one of the timer circuits is used as a comparator, with switching points at one-third and two-thirds of the supply voltage, whilst the other is used as an inverter to supply the correct output signal polarity for operation of the integrator.

The amount of output voltage applied to the integrator is adjustable by potentiometer VR1 to control the frequency. Carbon pots have wide manufacturing tolerance, the track resistance between individual specimens varying by as much as 20 per cent.

The arrangement of resistors R2 to R5 together with the buffer IC2a eliminate the lower range setting resistor normally used in such a circuit so that both ends of VR1 are connected to low-impedance voltage sources and variations in its overall value therefore have no effect upon the frequency range. The preset resistor (pot.) VR2 is used for trimming the output to the exact range required.

The triangle-wave output from the integrator IC2b is a.c. coupled through capacitor C2 so that the final output is symmetrical about ground. The two diodes D1 and D2 initially clamp the voltage to around 1·2V peak-to-peak, and with the resistor R9 shape it to something approaching a sinewave.

Attenuation and further shaping by resistors R10, R11 and capacitor C5 give a final output with an almost constant amplitude of 50mV peak-to-peak (about 18mV r.m.s.) and a remarkably sinusoidal shape, ideal for most tape recorder microphone inputs. Within reason, the circuit is independent of supply voltage change, and it will operate from supplies between 6V and 15V, although really intended for a nominal 9V supply.

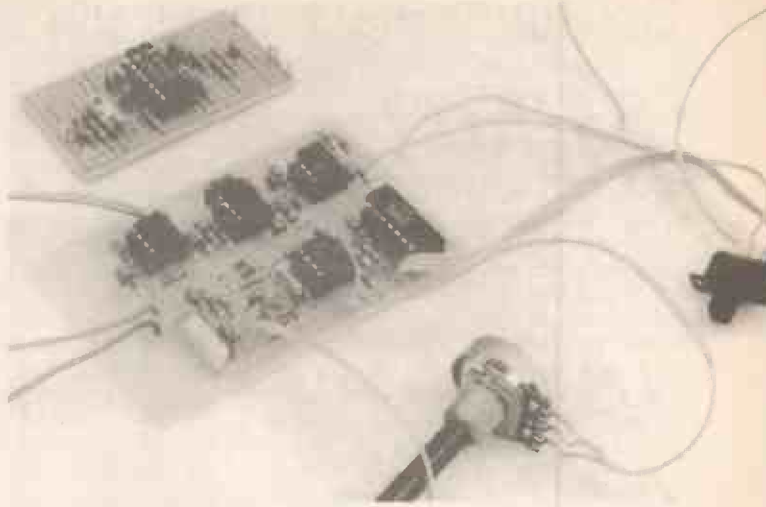
INPUT SIGNAL

On the receiving side, the input signal is a.c. coupled through capacitor C6 to the input of comparator IC3. This requires a minimum of about 200mV peak-to-peak (75mV r.m.s.) for reliable operation but happily accepts much higher levels, making it suitable for operation from most tape recorder Headphone outputs.

The positive feedback applied to this stage through resistor R16 ensures clean switching action. Capacitor C8 and resistor R17 differentiate the output from IC3 into brief negative trigger pulses for timer IC4.

The output pulses from IC4 pin 3 have a constant width of about 360µs, so the average d.c. value varies with their frequency. IC5a gives low-pass filtering to separate out this d.c. level whilst IC5b provides further filtering and a small gain, with a d.c. "offset" introduced by resistor R24 to arrive at the final output range of 0·45V to 5V (for a 9V supply) required. This output varies with supply voltage of course, but this matches the corresponding change in input required by the Mind Machine's signal generator, so where both are run from the same supply regulation is unnecessary.

The two-pole switch S1 selects Record or Play. Whilst recording, IC1 reset pin 10 is held at positive supply potential to allow the oscillator to run and a signal is taken directly from the oscillator to the input of IC3.



Completed Tape Controller board together with the Signal Level Indicator board.

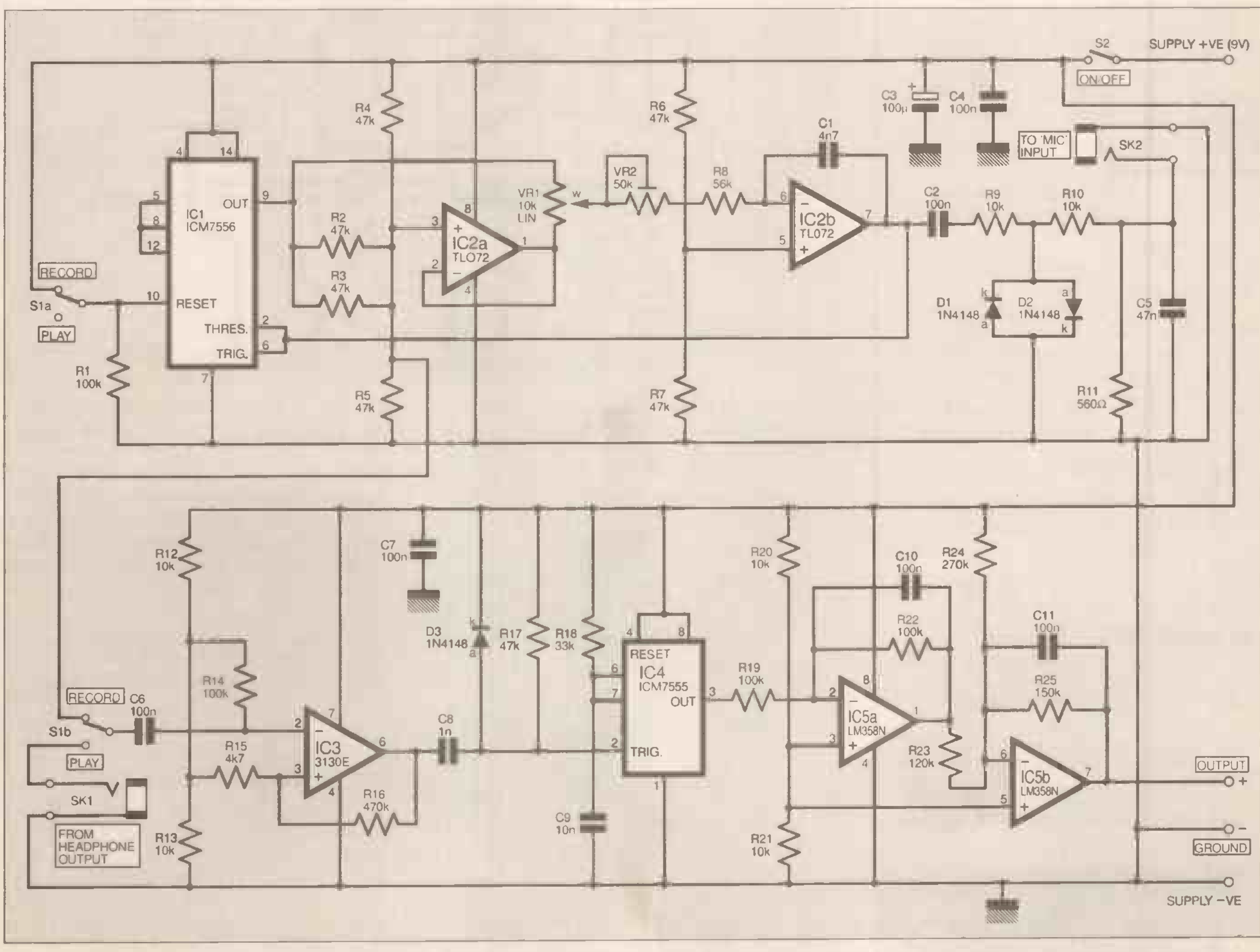


Fig. 2. Complete circuit diagram for the Tape Controller. The Record/Play switch is a double-pole "slider" type.

For playback, IC3 is connected to the Headphone input socket SK1 and resistor R1 is allowed to pull pin 10 of IC1 negative to stop the oscillator. This is not strictly necessary, but prevents any chance of interference from this source.

CONSTRUCTION

Construction of this circuit should prove straightforward. The positions of all the components on the printed circuit board (p.c.b.) are shown in Fig. 3, together with a full size copper foil master. This board is available from the *EPE PCB Service*, code 989.

First, all the small components such as resistors, capacitors and diodes should be fitted, in order of physical height for ease of working. Correct polarity, as marked in the layout diagram, is essential for capacitor C3. Since this is a radial-lead component laid horizontally for a low profile, a drop of glue applied to its body before soldering will help to secure it.

Solder pins are useful for making external connections but these may be a tight fit in the board, in which case they may have to be fitted first. Sockets are recommended for the five i.c.s as this makes testing much easier.

The board has a couple of holes to allow it to be mounted above the Mind Machine Sound/Lights signal generator board with a pair of spacers, or screws with nuts, for positioning. The case can be as suggested for the original, though it might be made into a more compact unit as this board takes up much less space than last month's slider-pot controller.

FIRST TESTS

Prior to installing the p.c.b. in its case, the completed board should be powered with 9V *before* any of the i.c.s are inserted. If it draws around 1·2mA the construction is probably OK so far.

Following this, control potentiometer VR1 should be connected, points *A* and *B* shorted together and point *C* connected to point *D* to simulate the "record" condition. The points mentioned are also shown in Fig. 4, the external wiring connections diagram.

Next, IC1 and IC2 should be fitted, and when the board is powered it should take a supply current of about 5mA. If checked with a meter for d.c. voltage, pin 9 of IC1 and pin 7 of IC2 should both be within 0·5V of half the supply voltage.

If available, an oscilloscope can be used to check the signals at these points which will be (hopefully!) a rail-to-rail

COMPONENTS

CONTROLLER

Resistors

R1, R14, R19, R22	100k (4 off)
R2, R3, R4, R5, R6, R7, R17	47k (7 off)
R8	56k
R9, R10, R12, R13, R20, R21	10k (6 off)
R11	560Ω
R15	4k7
R16	470k
R18	33k
R23	120k
R24	270k
R25	150k

All 0·6W 1% metal film

See SHOP TALK Page

Potentiometers

VR1	10k rotary carbon, lin.
VR2	50k cermet preset, horiz.

Capacitors

C1	4n7 polyester layer
C2, C4, C6, C7, C10, C11	100n resin-dipped ceramic (6 off)
C3	100μ radial elect. 25V
C5	47n resin-dipped ceramic
C8	1n ceramic plate
C9	10n polyester layer

Semiconductors

D1, D2, D3	1N4148 signal diode (3 off)
IC1	ICM7556 CMOS dual timer
IC2	TL072 dual op.amp
IC3	3130E CMOS op.amp
IC4	ICM7555 CMOS timer
IC5	LM358N dual op.amp

Miscellaneous

SK1	3mm mono jack socket (2 off)
S1	2-pole 2-way slider switch
S2	single-pole slider switch (optional)

Printed circuit board available from *EPE PCB Service*, code 989; case, size to choice – see text; 8-pin d.i.l. socket (4 off); 14-pin d.i.l. socket; control knob; multistrand connecting wire; solder pins; solder etc.

Approx Cost Guidance Only £18 excluding case

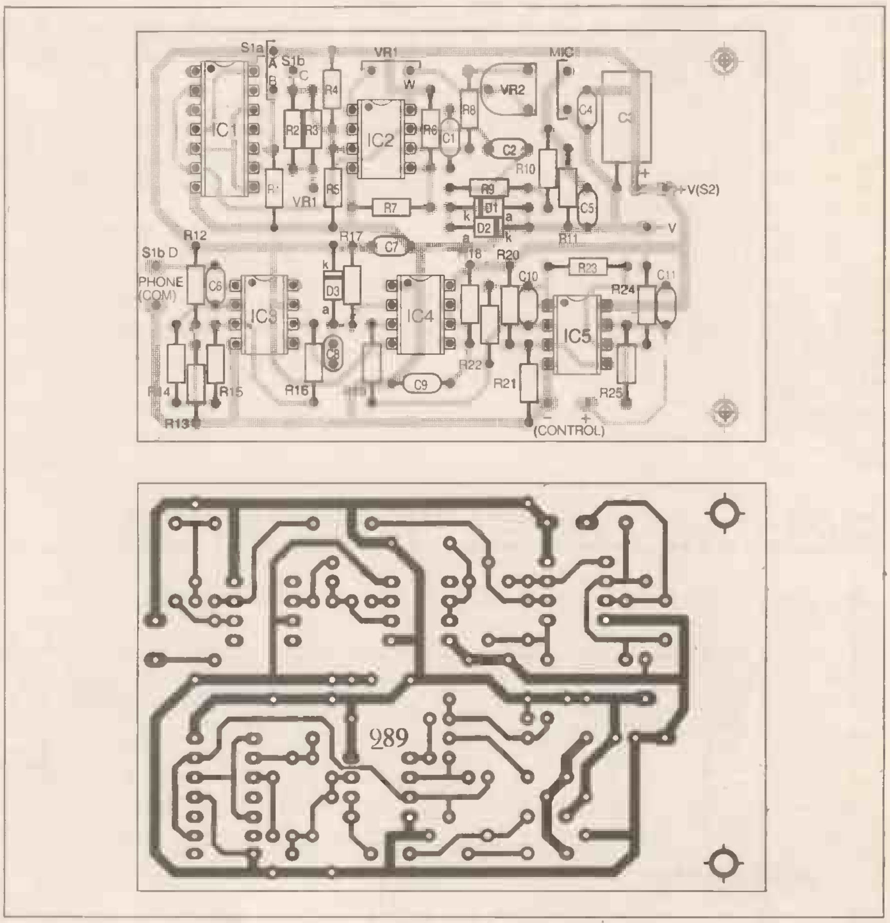
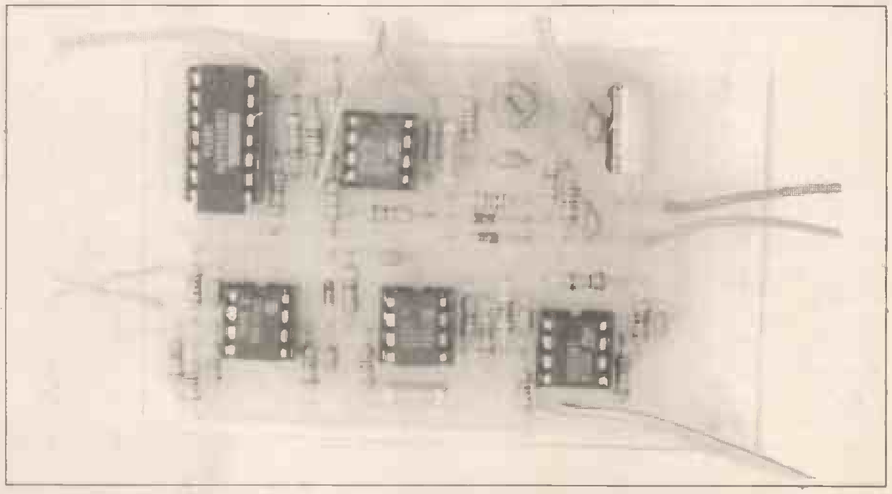


Fig. 3. Tape Controller printed circuit board component layout and full size copper foil master pattern.



Layout of components on the completed Controller p.c.b. Note the radial electrolytic capacitor is mounted flat on the board.

squarewave from IC1 and a 3V peak-to-peak triangle from IC2. An 18mV signal should be present at the output connection, which should be checkable with most DVMs. This completes the signal generation side.

Fitting IC3 should add about half a milliamp to the supply current. If points *C* and *D* are still connected IC3 will have an input, so the average d.c. voltage at its output should be around half the supply and a 'scope should show a rail-to-rail squarewave output.

Inserting IC4 in the board should add another half-milliamp to the supply for a total of about 5·5mA. The average d.c. voltage at pin 3, the output, will be somewhere around 3V to 6V, varying with the setting of VR1's wiper. It also depends on the setting of preset VR2 though, which will be set up shortly. Fitting IC5 should take the supply current to its final value of about 6·5mA and the output voltage should vary with the setting of VR1.

Final adjustment consists of re-checking that the supply is 9V, then setting VR1 to minimum and adjusting preset VR2 for an output of 0·45V. If VR1 is then turned right up the output should be around 5V.

A frequency meter can be used to check the frequency range of about 1kHz to 2kHz, though this is not really necessary. Finally, connections can be made to a tape recorder and a signal sequence recorded and replayed as a complete functional test.

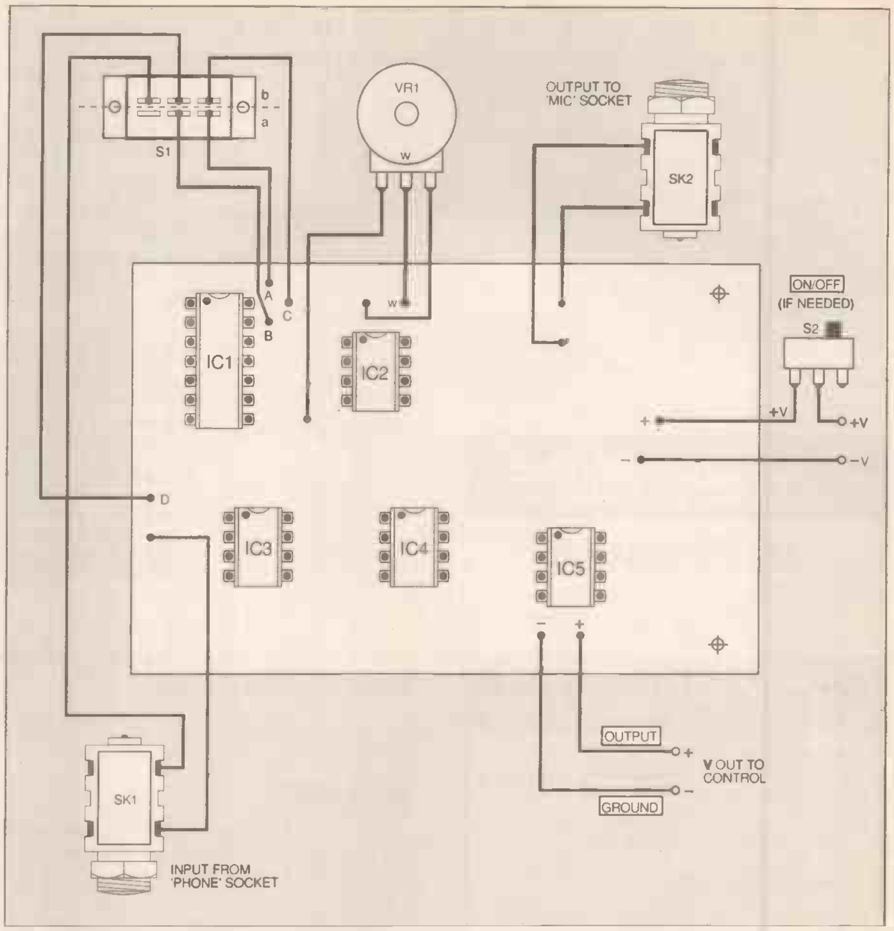


Fig. 4. Interwiring from the printed circuit board to off-board components.

SIGNAL LEVEL INDICATOR

For playback, the level supplied to the p.c.b. must be higher than about 70mV r.m.s. The easiest way to check this is to record brief periods of signal at the high and low ends of the range and play them back whilst monitoring the recorder output with a DVM on an a.c. voltage range.

The tape recorder's volume control can be set for a measured output of around 500mV r.m.s. and its setting noted for future use. With some recorders the level may vary with frequency, which is why both ends of the range should be checked.

For constructors who either don't have a DVM or who prefer a real "Rolls-Royce" job, the circuit of Fig. 5 can be incorporated into the unit to provide a continuous indication of "Input Level". This consists of an "absolute-value" circuit, or perfect full-wave rectifier, built with IC1a and IC1d followed by a voltage-to-current converter IC1c to drive the meter.

An artificial "ground" of half the supply voltage is provided by IC1b. This circuit works with supplies down to 5V, draws only a couple of milliamps and indicates up to one volt r.m.s. with a frequency coverage of about 300Hz to 10kHz.

A simple and compact stripboard layout for the Level Indicator circuit is shown in Fig. 6, together with an underside view showing breaks in the copper strips and soldered connections. The meter used is a 1mA unit, though others can be used with suitable adjustment of resistors R9 and R10. These should be chosen using the formula $R = 0{\cdot}44/I$, where I is the full-scale current of the meter used.

Power can be taken from the main supply, and the input should be connected to the headphone connection socket, so that it is disconnected during recording. These connections are also shown in Fig. 6. In

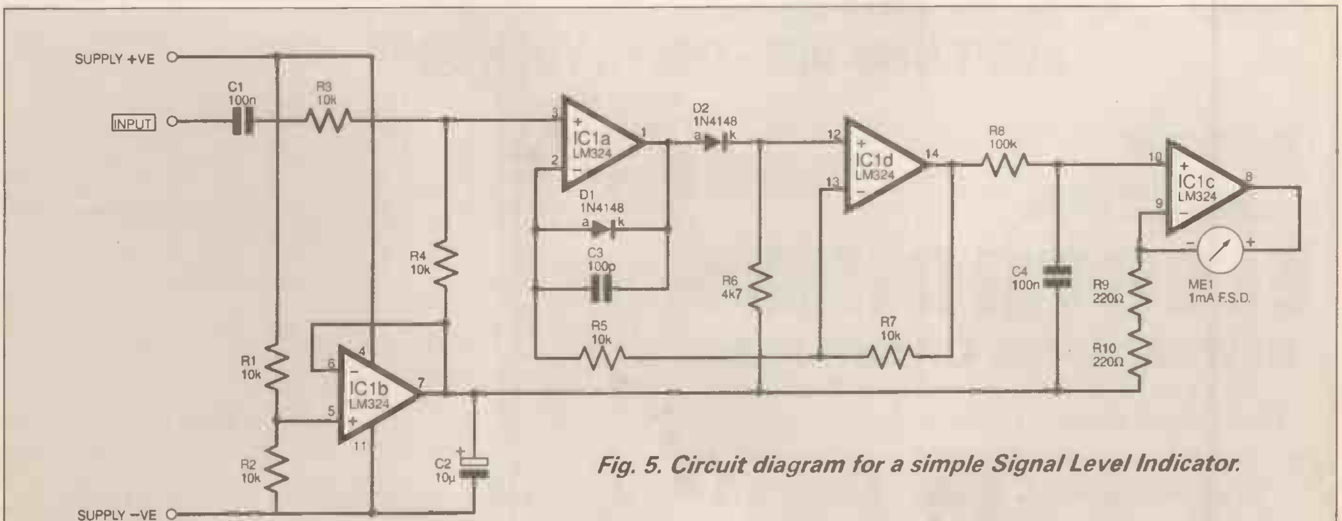
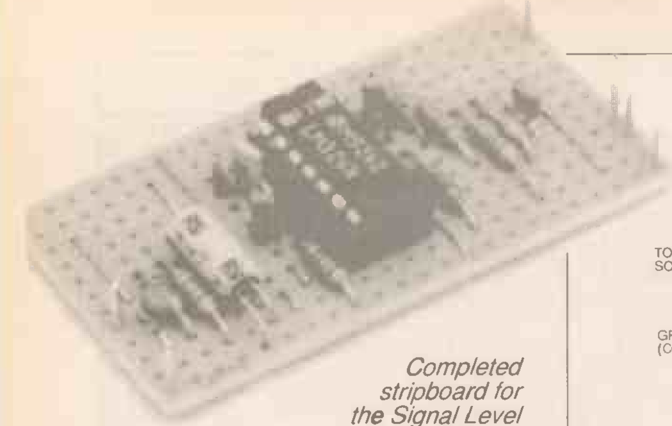


Fig. 5. Circuit diagram for a simple Signal Level Indicator.



Completed stripboard for the Signal Level Indicator.

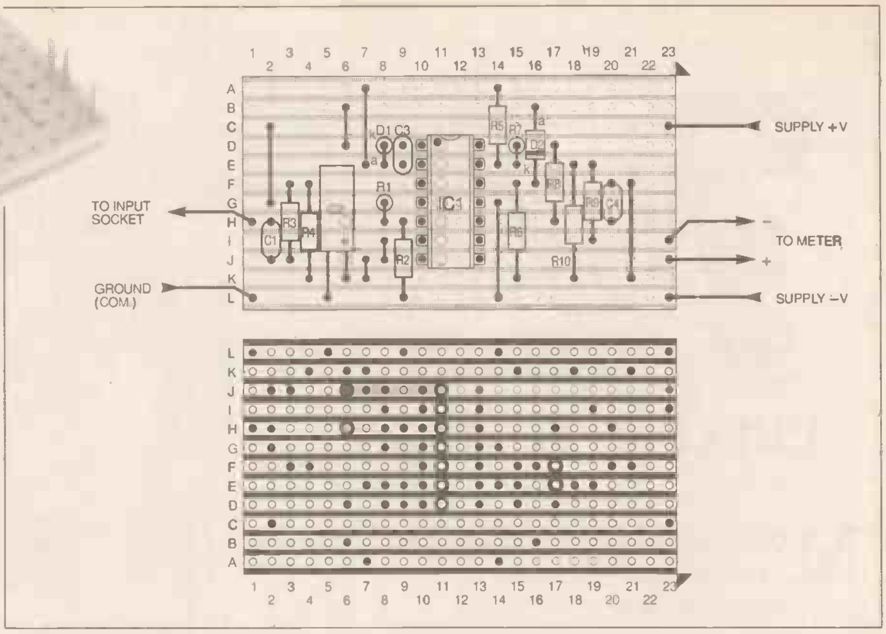


Fig. 6. Signal Level stripboard component layout and details of underside breaks required in copper tracks.

COMPONENTS

LEVEL INDICATOR

Resistors

R1, R2, R3, R4, R5, R7	10k (6 off)	See SHOP TALK Page
R6	4k7	
R8	100k	
R9, R10	220Ω (2 off)	

All 0·6W 1% metal film

Capacitors

C1, C4	100n resin-dipped ceramic (2 off)
C2	10µ radial elect. 50V
C3	100p ceramic

Semiconductors

D1, D2	1N4148 signal diode (2 off)
IC1	LM324N quad op.amp

Miscellaneous

ME1 1mA f.s.d. moving coil meter (see text)

Stripboard, 0·1in. matrix, size 12 strips × 23 holes; 14-pin d.i.l. socket; multistrand connecting wire; solder pins (6 off); solder etc.

Approx Cost Guidance Only £4 excluding meter

use, the input level should be adjusted for a meter reading of half-scale.

IN USE

The Tape Controller could be used with the original Mind Machine, the only snag being that it would need a regulated supply. Two approaches to this are possible.

The simplest would be to supply the whole circuit from a pack of eight NiCad cells, which would have a sufficiently constant output voltage to power the programmer without regulation. Another method would be to obtain a constant 10V supply from an ICL7660 used as a step-up converter, powering it from the regulated 5V supply of the original signal generator board. In both cases the output would need to be divided by two to match the input range of the old signal generator, using a pair of 10k resistors.

There must be many other applications where a controller of this type could prove useful. Different output voltage ranges and offsets can easily be arranged by altering the values of resistors R24 and R25.

With two controllers and a stereo recorder two signals could be recorded simultaneously onto the two channels. Alternatively, for portable applications, a tiny pocket dictating machine can be used as the controller.

The author has a Sanyo TRC-570M micro cassette recorder which cost only around £30, yet has sockets for external microphone and headphone, voice-activated recording and two tape speeds. The faster speed will give a half-hour recording, and the unit runs for ages on a pair of AA batteries. It works perfectly with the controller board and, needless to say, finds plenty of other uses. □

VERSATILE PIR DETECTOR ALARM

ANDY FLIND

Will protect places other systems cannot see. Ideal for remote sites.

PASSIVE infra-red (PIR) detectors are currently one of the most reliable ways to detect the presence of the human body, and are widely used in intruder alarm systems, automatic door openers and many other applications.

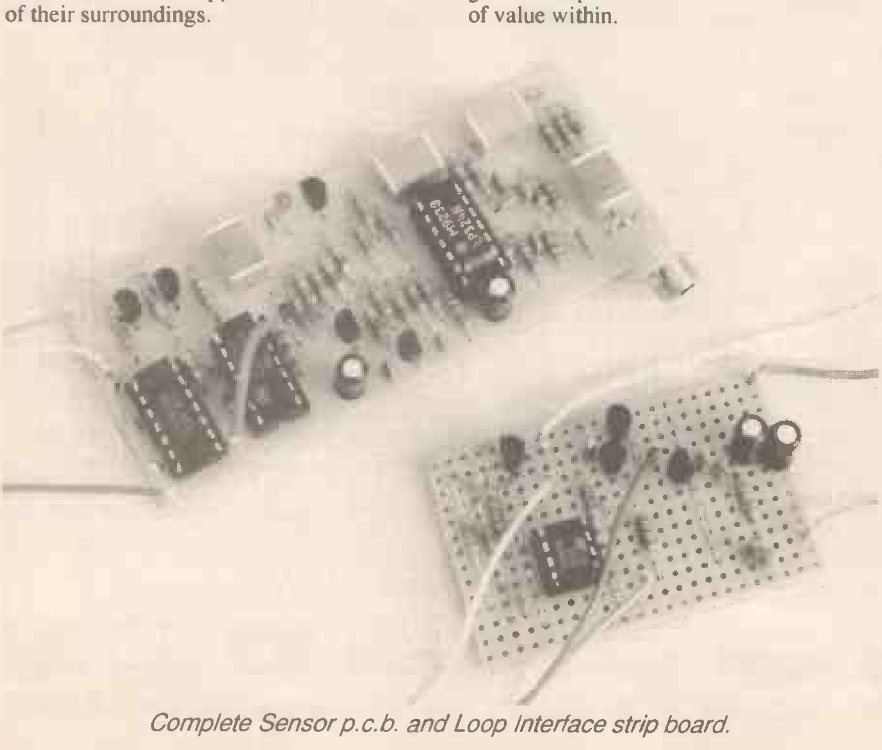
Despite the many ready-built detectors available, there are still occasions where construction from scratch may be necessary. There could be a need to build one into another piece of equipment, or to disguise it in some way, or it might be helpful to be able to adjust circuit values to alter the basic sensitivity.

"Micropower" operation, which is possible with this project, may be needed for battery operation at a remote site. Even if none of these reasons apply, there is still the fascination of working with very sensitive circuits which appear to be "aware" of their surroundings.

ON GUARD

The prototype for this project was designed to protect the author's garage, following an attempted break-in and several thefts from nearby properties. There was also a need to protect a garden shed some distance from the nearest household mains power supply, so micropower operation was desirable.

The garage door faced onto a secluded alley along which people can walk, so the circuit had to be able to distinguish the brief "blips" caused by passers-by from the more prolonged signals that would be generated by potential felons loitering in front of it. An inconspicuous sensor "eye" was preferred to avoid attracting unnecessary attention to the door, since if it was obviously protected by an alarm this might give the impression that there were articles of value within.



Complete Sensor p.c.b. and Loop Interface strip board.

Apparently a burglar, if aware of a PIR detector, is able to disable it by spraying it with aerosol foam. The sensor of this project can easily be concealed, looking out through a small hole drilled in the door at waist height, and the sensitivity can be set with a simple "pulse counting" circuit.

Two types of output are available, and where it is used as part of a system a few additional components allow the detection of any tampering with wiring connecting it to this. The basic circuit can be operated from battery supplies as it has a "standby" drain of just 200µA, making it ideal for the protection of remote sheds, garages and other locations where mains power is not readily available.

SENSOR

The sensor in a PIR device is a type of piezo-ceramic element which generates a voltage when exposed to long-wave infra-red radiation of the kind given off by the human body. This voltage is very small and is sourced from a very high capacitive impedance.

Steady signals such as those resulting from the ambient temperature have to be cancelled out, so the sensors usually have an internal discharge resistor of very high value connected across the element and a built-in f.e.t. source follower to buffer its output. A circuit designed to work with one of these sensors needs very high voltage gain at low frequency, usually below two Hertz (2Hz), with a threshold comparator to decide when the signal level corresponds to the presence of a body.

CIRCUIT DESCRIPTION

The full circuit diagram of the PIR Detector project is shown in Fig. 1. Amplification and level sensing is carried out by the upper section of the circuit, which is designed around IC2, an LP324 quad op.amp i.c.

This is the "micropower" version of the well-known LM324 and typically draws just 100µA of supply current for all four amplifiers. It's slower, but this is not a problem with this application. The LM324 can be used instead if low power consumption is not important.

Detector IC1 is the PIR sensor, with resistor R1 providing the source load for its internal f.e.t. The output from this is a.c. coupled to the first amplifier stage IC2a by capacitor C1. Resistor R2 and capacitor C2 filter out any local high-frequency interference such as nearby transmitters, mobile phones and the like.

This stage operates as an inverting amplifier with a maximum voltage gain of about 90. The frequency response is tailored by components C4, R7 and C3, R4, which give it a bandpass response centred on 1·3Hz. The half-gain bandwidth is about 0·5 to 3·2Hz, with a fairly rapid roll-off both above and below this.

The second amplifier stage, IC2b, provides further voltage gain of about 22 with more frequency response tailoring, giving a total maximum voltage gain at 1·3Hz of close to 2000. The remaining two amplifiers, IC2c and IC2d, are connected to form a window comparator which detects both positive and negative excursions beyond the preset level.

To alter the basic sensitivity the value of shunt resistor R11 can be changed, higher values will raise the threshold voltages and reduce the sensitivity. With the value shown the thresholds are ±30mV, if R11 is omitted altogether they will rise to 95mV.

STABLE SUPPLY

The very high, low-frequency gain of this part of the circuit requires an exceptionally stable supply to ensure stability. Conventional decoupling is not effective at such low frequencies so a regulator has to be relied upon to prevent any voltage fluctuation.

An LP2950 5V voltage regulator, IC3, is used here to ensure supply stability. This offers significant advantages over the more common 78L05 type. Its quiescent drain is less than 100μA, contributing to the very low overall consumption of this project.

It can operate with less than half a volt between the input and output potentials, allowing a wider range of supply voltages. Most important, it has better rejection of sudden fluctuations of input voltage.

For design purposes it was assumed that this sensor would be used with systems either using batteries or relying on battery backup from time to time. So, when an alarm is initiated, the battery voltage may take a sudden dive as it is called upon to drive a large siren or bell.

Working on the assumption that the maximum such voltage drop would be 2V, the output stability of the standard 78L05 type of regulator was found to be inadequate, passing enough of the sudden input change through to the output to cause a false alarm. The improved performance of the LP2950 eliminates this problem. Unfortunately it is more expensive but, if cost is a problem, a 317 regulator can be used provided appropriate resistors are inserted to set its output to 5V.

SIGNAL PROCESSING

The lower part of the circuit diagram (Fig. 1) is concerned with processing the

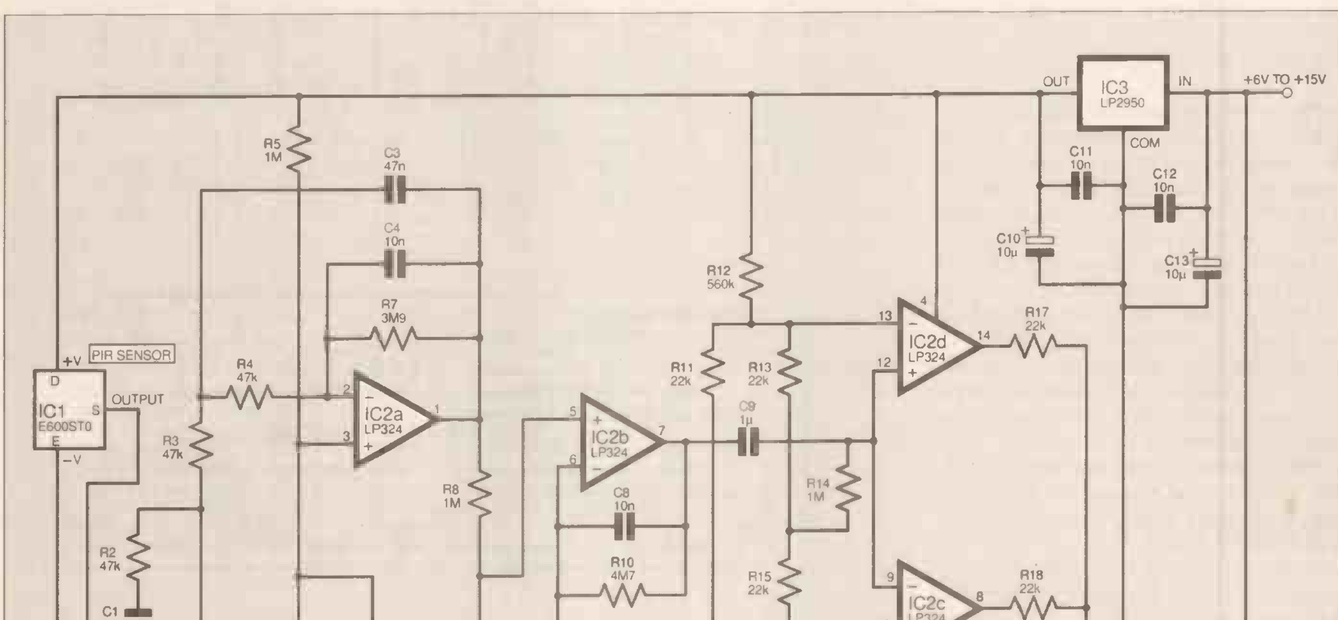


Fig. 1. Complete circuit diagram for the pulse-counting Versatile PIR Detector Alarm.

signal from the comparator and providing outputs suitable for various systems. By its nature, the output from a circuit using a PIR device consists of a series of pulses, so a good way of adjusting sensitivity is by counting a predetermined number of these pulses before initiating the alarm.

This circuit does this as follows: When either of the window comparator outputs (IC2d pin 14 and IC2c pin 8) goes high, transistor TR1 is biased into conduction. This turns on TR2, which lights the l.e.d. D1 to indicate signal detection. Transistor TR1 also discharges capacitor C15 via diode D2, taking the Reset input of the counter IC4 low so this i.c. is able to start counting.

At this point all the outputs from IC4 are "low", so IC5b has a "high" input from IC5a and can pass the output from TR2 to the Clock input of IC4. Resistor R23 and capacitor C14 delay this signal briefly so that C15 can be discharged before it arrives.

When the input from the comparator ends, TR1 turns off and C15 starts charging through R24. It takes about eight seconds to reach a level sufficient to reset IC4 and if the next pulse arrives before this, capacitor C15 is discharged again whilst the counter advances another step.

If enough pulses are received without an eight-second interval, the selected counter output will go high. This prevents further clock impulses by sending a low input to IC5b from IC5a, and the output will remain high until an eight-second break allows C15 to charge and reset IC4.

The Continuous Output is one of the two available to the user. The second is a Pulsed Output, generated by IC5d and IC5c by combining the continuous output with the signal from TR2 collector (c). Both can be used with the "Loop" option to detect any tampering with wiring to the unit, which will be explained later.

SENSITIVITY

Count advance in IC4 takes place on negative edges to the Clock input which correspond to the leading edges of the pulses from the detector IC1, so the first output, from IC4 pin 12, goes high immediately and can be used for instant response when the pulse counting is not required. The second output requires two pulses before it goes high, the third four and so on up to the seventh output from pin 3 which operates after sixty-four pulses.

The prototype is set to sixteen, pin 5, and has not so far operated "in anger" although just ten seconds spent in front of the "eye" is sufficient to trigger it. All seven outputs from the divider are available for sensitivity selection, though it is unlikely the highest will be needed. For low cost and reliability selection is made by a soldered link.

SELECTIVE SYSTEM

This is a relatively simple circuit to construct and test although its compact layout requires careful soldering. However, before commencing the construction, some of the possible options available should be considered and chosen before starting.

If the Pulse Counting feature is not required IC4 and IC5 can be omitted, along with resistors R23 and R24, diode D2 and capacitors C14 and C15. The output can then be taken from the collector of TR2, a convenient connection point being from where the top of R23 would have been.

Indicator l.e.d. D1 is not essential, it is included to assist when positioning the unit. It could be made externally visible as a warning if required, or it could be disconnected after setting up to save power.

Simple systems will probably not need the Loop components, transistors TR3 and TR4 with their four associated resistors which should be omitted anyway in micropower applications as they increase the supply current.

CONSTRUCTION

The printed circuit board component layout and full size copper foil master pattern for the PIR Sensor is given in Fig. 2. The off-board wiring is shown in Fig. 3. This board is available from the *EPE PCB Service*, code 988.

When the required configuration has been decided, it is suggested that all the resistors and diode D2 (if used) are fitted first. This should be followed by the small ceramic capacitors, sockets for IC2, IC4 and IC5, then the transistors.

Finally, the regulator IC3 and the polyester capacitors C1, C7, C9 and C15 should be soldered in place on the p.c.b. Solder pins are useful to simplify wiring to off-board connections. The circuit board should now be ready for testing.

TESTING

The first test routine is to power up the board with no i.c.s fitted save IC3, using a supply between 9V and 12V. The current drawn should be very small, perhaps a hundred microamps, and the regulated 5V supply from IC3 should be present.

This can be followed by insertion of IC2. The outputs of IC2a and IC2b (pins 1

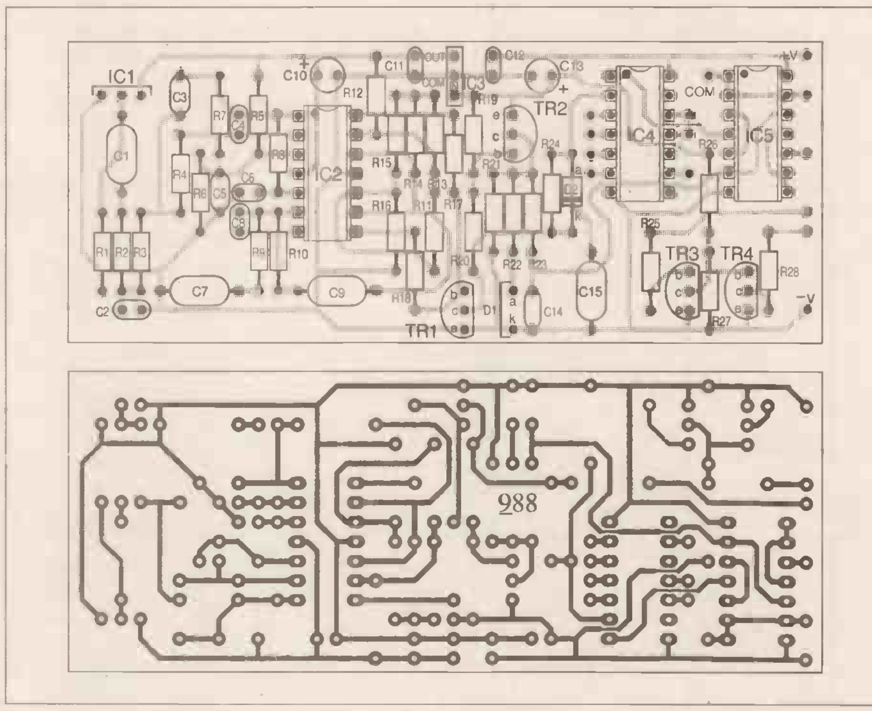


Fig. 2. Sensor printed circuit board component layout and actual size underside copper foil master pattern.

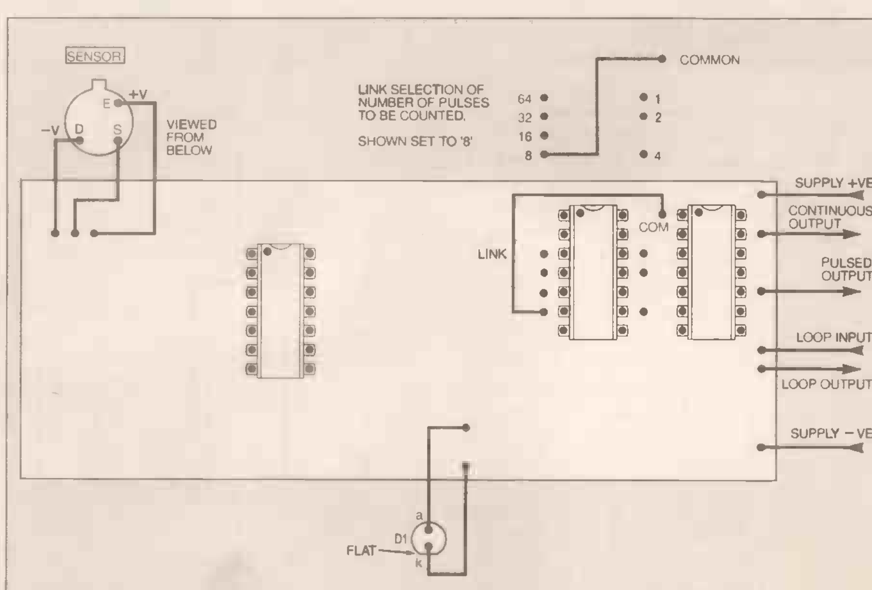
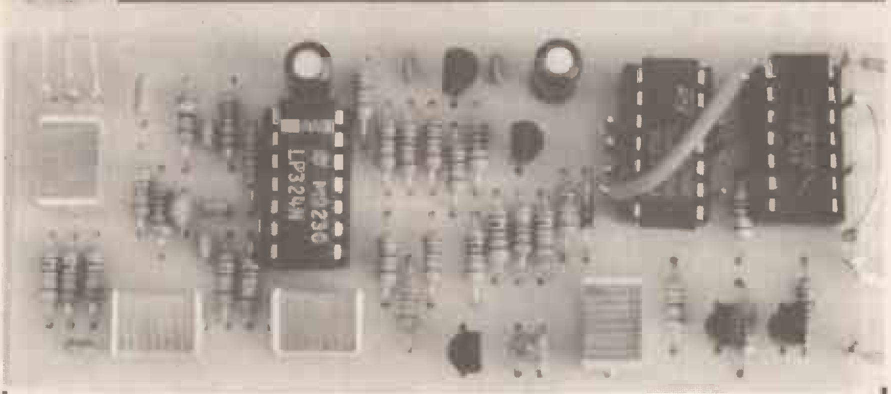


Fig. 3. Interwiring connections to Sensor board and link to select pulse count details.

COMPONENTS

Approx Cost Guidance Only **£22** excluding case



PIR Sensor Board

Resistors

R1, R23	100k (2 off)
R2, R3, R4, R25, R26, R27	47k (6 off)
R5, R6, R8, R14	1M (4 off)
R7	3M9
R9	220k
R10	4M7
R11, R13, R15, R17, R18	22k (5 off)
R12, R16	560k (2 off)
R19, R20, R21	10k (3 off)
R22	4k7
R24	10M
R28	2k7

All 0·6W 1% metal film.

See SHOP TALK Page

Capacitors

C1, C7, C9, C15	1µ polyester layer (4 off)
C2	1n resin-dipped ceramic
C3	47n resin-dipped ceramic
C4, C6, C8, C11, C12	10n resin-dipped ceramic (5 off)
C5, C14	100n resin-dipped ceramic (2 off)
C10, C13	10µ radial elect. 25V (2 off)

Semiconductors

D1	3mm red low-current (2mA) l.e.d.
D2	1N4148 signal diode
TR1, TR3, TR4	BC184L *npn* transistor (3 off)
TR2	BC214L *pnp* transistor
IC1	E600STO low-noise, infra-red detector
IC2	LP324 quad op.amp (low power version of LM324N)
IC3	LP2950CZ micropower 5V positive regulator
IC4	4024B CMOS 7-stage ripple counter
IC5	4093B CMOS quad Schmitt NAND gate

Miscellaneous

Printed circuit board available from *EPE PCB Service,* code 988; plastic or metal case, size to choice – see text; 14-pin d.i.l. socket (3 off); p.c.b. stand-off pillar (4 off); multistrand connecting wire; solder pins; solder etc.

and 7) should both have quiescent d.c. potentials of 2·5V, though it should be noted that this circuit will take several seconds to settle after switch-on. The outputs of IC2c and IC2d (pins 8 and 14) should both be at negative supply potential so the collector (c) of transistor TR1 should be high and that of TR2 low.

The l.e.d. D1 should be connected next, and the proverbial "wet finger" dabbed across the 5V positive supply and the top of C1 should cause it to flash.

If the pulse counting circuit is to be used, IC4 and IC5 should be inserted, and one of the link options connected before power is re-applied. Detail of these are shown in the connection diagram of Fig. 3. The third output, IC4 pin 9, is suggested for testing. If the continuous output is now monitored, it should go positive with the fourth flash of the l.e.d., and return to the low state about eight seconds after the l.e.d. is extinguished.

This completes functional testing, so the PIR sensor IC1 can now be connected up for a full test and any necessary sensitivity adjustments can be made. The unit is extremely sensitive, even without the fresnel lens often used with PIR devices, so it may be necessary for some purposes to increase the value of resistor R11 to reduce range.

ASSEMBLY

The type of case used will depend on the use to which the unit is to be put so the choice is left to the constructor. Connections for the infra-red sensor, l.e.d., supplies and outputs are shown in Fig. 3.

If the sensor is mounted off-board, miniature 2-core screened cable is recommended, with the screen connected to the 0V (battery – VE) point. *Note that the case of the sensor is connected to its 0V lead.* Pinout details for the PIR sensor are shown in Fig. 4, which also shows the direction of maximum detection sensitivity.

Siting the detector behind a surface with a hole will help to generate an infra-red image that moves across the element for a better response, or placing a short tube over it will make it more directional. Experiments indicate that many substances transparent to visible light seem to attenuate longwave infra-red to some extent, so the prototype was protected with polythene cut from an ordinary bag. For more demanding applications special material or a lens could be used.

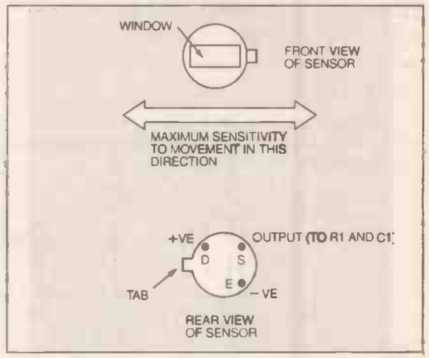


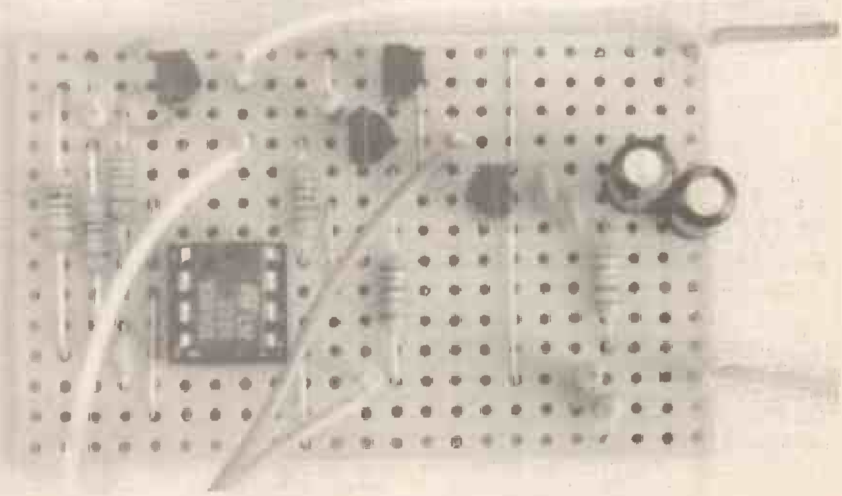
Fig. 4. Sensor pinout and sensitivity details.

Supply voltage for this project can be anywhere between 6V and 15V, making it ideal for use with the 12V supplies of most alarm systems, but also allowing operation from 9V dry battery supplies. PP3 type batteries are not recommended, but a pack of six alkaline "AA" cells should give operation for more than a year, and "C" or "D" cells even longer.

These larger cells will probably be needed in any case for powering an alarm siren in a remote location. One interesting possibility would be to supply the Sensor Board from a rechargeable PP3, using a solar panel to top this up during daylight hours.

LOOP INTERFACE

The "Loop" circuit is intended for use with larger systems, which will normally



Layout of components on the Loop Interface stripboard.

have a mains power supply, perhaps with a lead-acid backup battery. It works, as the name suggests, by detecting any variation in a small but continuous current passed around the wiring between it and the main sensor system to detect any tampering.

A three-core cable is needed, the positive and negative supplies, and one for the signal. This has 5V supplied at the system end through a 2·7 kilohm (2k7) resistor, and the assumption is that under normal conditions it will be terminated to negative at the Sensor end through another 2k7 resistor so the voltage on the "loop" wire will always be 2·5 volts. This is monitored at the system end by a window comparator, with more than half a volt of deviation either way being interpreted as an active alarm.

At the sensor end (Fig. 1), transistor TR4 is biased on by the positive supply through resistor R26, and provides the termination through R28. "Loop input" is connected to the selected output, Pulse or Continuous. If this goes high, it will turn on transistor TR3, which then turns off TR4. This, or cutting of any of the three wires, or short-circuiting any or all of them, will result in an alarm being given at the system end. The supply is also current-limited to prevent damage to the power supply in the event of a wiring short-circuit.

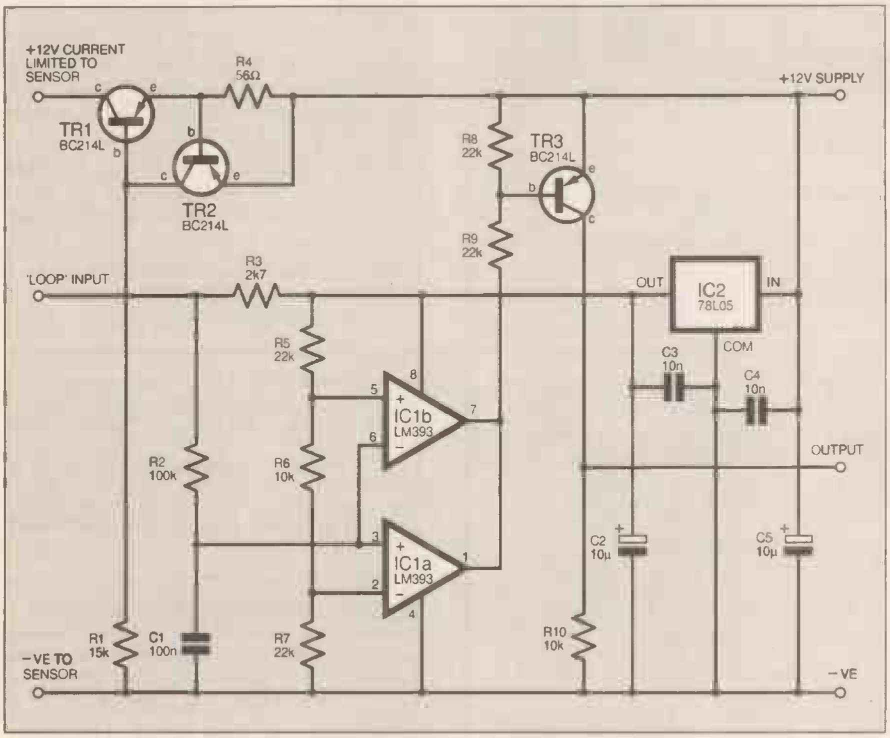


Fig. 5. Circuit diagram for the Loop Interface.

INTERFACE CIRCUIT

The Loop Interface circuit used with the prototype is shown in Fig. 5. The primary supply to this unit is a battery-backed 12V supply, actually 13·8V most of the time as this is the normal lead-acid charging voltage.

A 78L05 regulator, IC2, provides a 5V supply for the interface circuit. This goes out to the loop connection through R3 and the voltage on this wire is monitored by the window comparator IC1. Resistor R2 and capacitor C1 filter any interference from the input to the comparator.

The thresholds are set by resistors R5, R6 and R7. When either threshold is exceeded, the appropriate output sinks current from R9 to turn on transistor TR3 so the output goes positive.

Transistors TR1 and TR2 with resistor R4 limit the supply current to 10mA. For currents below this TR1 is biased on by R1 and the voltage drop across R4 is less than 0·6V. At 10mA, the voltage across the base-emitter of TR2 reaches 0·6V and TR2 turns on, drawing base current away from TR1 to limit its collector current.

The worst-case condition for this part of the circuit would be a short circuited supply, where it would still dissipate only about 120mW which it should be able to withstand indefinitely.

INTERFACE BOARD

A piece of 2·54mm (0·1in.) stripboard, size 14 strips x 23 holes is used for construction of the Loop Interface circuit. The board component layout for this interface, together with underside breaks in copper strips, is shown in Fig. 6. This is fairly

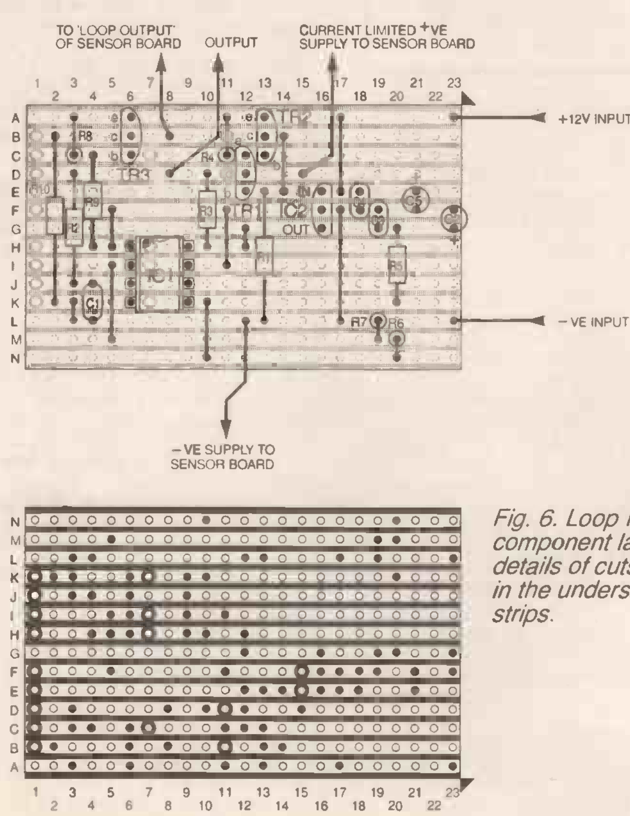


Fig. 6. Loop Interface component layout and details of cuts required in the underside copper strips.

COMPONENTS

LOOP INTERFACE

Resistors

R1	15k	See SHOP TALK Page
R2	100k	
R3	2k7	
R4	56Ω	
R5, R7, R8, R9	22k (4 off)	
R6, R10	10k (2 off)	

All 0·6W 1% metal film

Capacitors

C1	100n resin-dipped ceramic
C2, C5	10µ radial elect. 25V (2 off)
C3, C4	10n resin-dipped ceramic

Semiconductors

TR1, TR2, TR3	BC214L *pnp* transistor (3 off)
IC1	LM393 dual comparator
IC2	78L05 5V 100mA positive regulator

Miscellaneous

Stripboard, 2·54mm (0·1in.) matrix, size 14 strips x 23 holes; case, see text; 8-pin d.i.l. socket; single-core link wire (component lead off-cuts); multistrand connecting wire; solder pins; solder etc.

Approx Cost Guidance Only £4

compact as stripboards go, and to keep the links to a minimum four of the resistors are fitted in a vertical position.

Where more than one interface is required, the resistors R5, R6 and R7 together with the 5V supply and decoupling may be common to all of them. This is reflected in the layout, where the 5V and threshold voltages are generated separately by the section of the circuit to the right of the positive supply output pin, and are carried to the comparator through "bus" strips. If more interfaces are needed, only the section to the left need be duplicated.

Construction of this circuit is straightforward. The breaks in the strips should be made first as shown in Fig. 6, and a careful check of them carried out with a magnifying glass as it's very easy to leave an almost invisible sliver of copper around the edge of a stripboard break. The nine breaks at the left-hand edge will only be necessary if another Interface is added to the left of these.

The components can now be fitted, using a d.i.l. socket for comparator IC1. Solder pins are recommended for wiring to the board as they make this much easier.

With a 12V supply connected, the presence of the 5V from the voltage regulator IC2 should be checked. The action of the 10mA current limit should also be tested, this can initially be done with a 100 ohm resistor which will protect the circuit (and the testmeter!) if the limit fails to operate for some reason. IC1 can now be fitted and tested with a potentiometer connected across the 5V supply, to ensure that the output operates for input deviations of more than about half a volt from 2·5V.

SIREN ALERT

Finally, for those wanting to make a quick and easy connection to a siren, here's a way to do it. Horrendously loud sirens for 12V operation in alarm systems are available from many suppliers, so all that is needed is a power interface.

The simple way to do this is with a power MOSFET as these require virtually no drive current apart from a tiny pulse to charge and discharge the gate capacitance when changing state. The prototype uses an IRF740 power MOSFET in the circuit arrangement shown in Fig. 7.

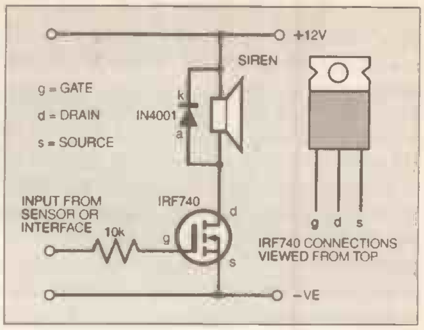


Fig. 7. Simple circuit diagram for interfacing to a warning Siren using a power MOSFET.

This can be driven directly by the Interface Loop of Fig. 5, or by either of the outputs from the Sensor board. The Continuous Output is preferable as this will give a steady output lasting for eight seconds after the intruder has left the area.

Since the MOSFET device has very little resistance in the "on" state it will dissipate very little power, even with a siren drawing an amp or more, so a heatsink will probably not be necessary. ☐

SHOP TALK
with David Barrington

MIDI Analyser

Several of the components required to make up the *MIDI Analyser* project are special items and are not likely to be available from the usual local dealer. This obviously applies to the ready programmed PIC16C61 microcontroller.

The two-piece ABS plastic case used in the model came from the **Maplin** range of Union Brothers boxes, code BZ76H. The small pushbutton switch also came from the same source (JM47B).

The diode/transistor 6-pin d.i.l. opto-isolator type CNY17-3 is fairly common and should be widely stocked. There seem to be about three versions of this device and it is the one designated with the "–3" that is used here. Some suppliers may offer an alternative which should work but they have not been tested in this set-up. The 8MHz crystal is a general purpose type and should be carried by most of our component advertisers.

Now to the two major items for the Analyser; the PIC microcontroller and the alphanumeric display. Designers, Julyan and Brett are able to supply a pre-programmed PIC16C61 microcontroller and the display module for very reasonable sums. A seperate program for the PIC is not available for this project because the Analyser may be produced commercially.

The programmed PIC16C61 is obtainable for the sum of £12 and the display module for £12. All prices include postage and packing. (Overseas readers should add £2 to the total order).

All orders should be sent to: **Julyan ILETT, 99 Telford Way, Hayes, Middlesex, UB4 9TH.** *All cheques should be made payable to J. ILETT.*

We understand that they have only 28 display modules available and are not likely to have any more. However, any type of 40-character 2-line alphanumeric l.c.d. module should function in this circuit as long as it uses the Hitachi HD44780 controller chip. A similar device is listed by Maplin but is about twice the price.

The Analyser printed circuit board is available from the *EPE PCB Service*, code 992, see page 403. You should find that 6-pin d.i.l. sockets are now stocked by advertisers, but, as suggested, it is a relatively easy task to use an 8-pin socket and lop two pins off one end.

Mind Machine Mk III – Tape Controller

We do not expect any purchasing problems to be encountered by readers tackling the *Mind Machine Mk III Tape Controller* and optional add-on Signal Level Indicator board. All components should be "off-the-shelf" parts.

Some readers have asked for the source of the case, called-up in Part One. This is a Verobox type 202-21035F, obtained from **Maplin**, code LL06G.

The Tape Controller p.c.b. is available from the *EPE PCB Service,* code 989. Once again, *all readers must heed* the "warning panel" in the article about possible side effects when using the unit with the Sound and Lights module.

Versatile PIR Detector Alarm

As "micropower" operation (about 200µA on standby) is called for in the *Versatile PIR Detector Alarm,* a couple of the components should only be ones as specified.

The LP324N quad micropower op.amp i.c. is currently listed by **Farnell** ***(Tel: 0113 262 6311)***, code LP324N, and **Electromail** ***(Tel: 01536 204555)***, code 648-646. The N-suffix should be quoted as a surface mount version is also available.

The above i.c. is the low-power version of the popular LM324 and typically draws just 100µA of supply current for *all four* internal amplifiers. The LM324 version can be used instead if low power consumption is not important, i.e. as part of a larger alarm system.

A minor problem surfaced when trying to source the low-noise, infra-red sensor or "pyroelectric IR detector", as they are sometimes listed in catalogues. The type used in the prototype model is marked E100SV1 and was originally listed by Maplin but is no longer available and no alternative source could be found. However, the E600STO detector has practically an identical specification and is listed by **Maplin**, code UR69A and **Farnell**, code 516-170.

The PIR Alarm printed circuit board is available from the *EPE PCB Service,* code 988. Micropower 5V positive regulator type LP2950CZ is now fairly common and most of our component advertisers should carry supplies.

Countdown Timer (Teach-In '96)

We do not expect any buying problems to be encountered when searching for components to build the *Countdown Timer,* this month's *Teach-In* project.

The binary coded "thumbwheel" rotary switches and 2-digit 7-segment l.e.d. displays are reasonably common devices and are stocked by most of our component advertisers. The switches are the type which can be mated side-by-side.

The plastic case, with sloping front panel, is an ABS Console type 2801. The Timer printed circuit board board is available from the *EPE PCB Service,* code 993.

Bat Band Converter B.F.O.

As the *B.F.O.* board is even smaller than last month's one used in the *Bat Band Converter,* and also uses surface mount devices (SMDs), extreme care must be taken when soldering up this board. Components which determine the frequency are critical but the rest of the devices can be changed.

Most f.e.t.s will work in this circuit, but watch the pinouts. The 1,000µH fixed inductor came from **Electromail** ***(Tel: 01536 204555)***, code 235-212. The small plastic box, which also houses the converter, is a "mountable" type from Maplin, code FK73Q.

Although SMDs are now well established, some of the traditional component suppliers may not carry a great variety of devices and you may have to shop around. Also, small orders may cost a premium as devices seem to be sold in numbers of 10 upwards.

We understand that ***Gothic Crellon*** ***(Tel: 01743 788878)*** of Wokingham are willing to supply these on a "one-off" basis, cash with order. Call them *first* for details.

The small surface mount printed circuit board is available from the *EPE PCB Service,* code 984. This includes the small Bat Band Converter board.

VIDEOS ON ELECTRONICS

A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

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

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

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

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By the time you have completed VT206 you have completed the basic electronics course and should have a good understanding of the operation of basic circuit elements.

VCR MAINTENANCE

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

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

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier.

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

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

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

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

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

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

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

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

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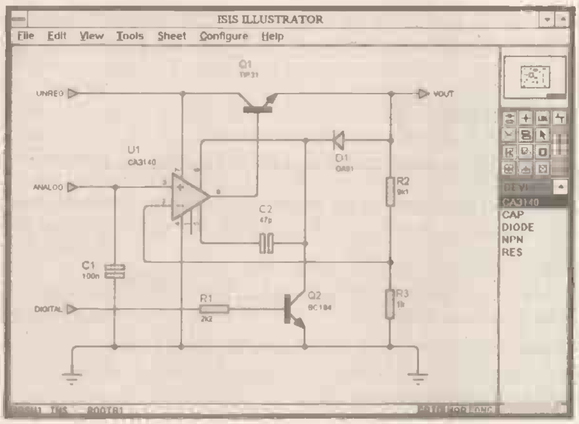

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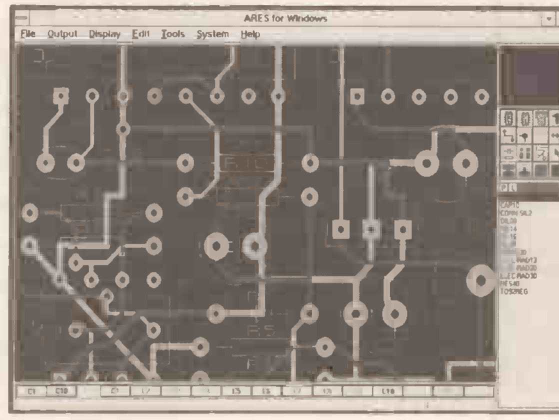

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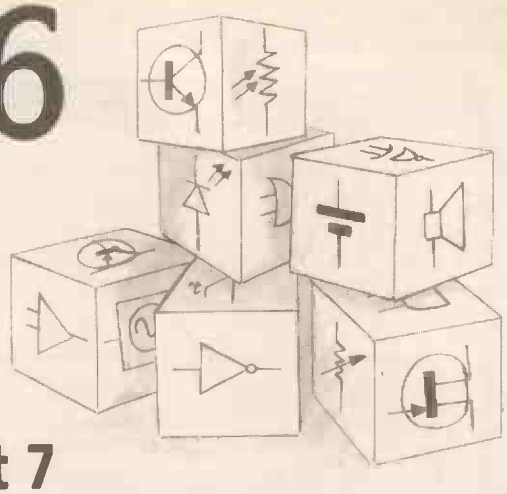


A Guide to Modular Circuit Design

Max Horsey **Part 7**

DURING this series of articles, a range of circuit modules is examined, divided into Input, Processor and Output sections. Where possible a choice of module is offered within each section.

Each of the ten Parts of the Series is accompanied by a constructional article explaining how a complete project may be devised by employing the modules described, together with a p.c.b. design. Each project will be one of many possible ideas that could be implemented and it is hoped that readers will design for themselves a variety of circuits by combining modules provided in the whole series.

The proposed range of modules covered by the Series is detailed in Part 1, Table 1.1. Each module is chosen to link easily with adjacent modules in the same Part, but modules may also be linked with modules in other Parts of the Series.

Max Horsey is Head of Electronics at Radley College.

HERE in this seventh Part of *Teach-In*, the following Input, Processor and Output modules are examined:

INPUT MODULES: Clock pulse generator synchronised to the mains a.c. supply, crystal controlled oscillator

PROCESSOR MODULES: Diode logic gates, divide-by-100 counter, simple 7-segment counter/decoder

OUTPUT MODULE: Decoder/driver for 7-segment displays

The example project based around a selection of these modules is a Countdown Timer which obtains its timing signal from the a.c. mains supply. It provides a continuous digital readout on a bank of four 7-segment light emitting diode (l.e.d.) displays.

Another useful combination which readers could experiment with would be to use the crystal oscillator to provide the timing pulse, feeding the same processing modules as in the example project, but using a liquid crystal display (l.c.d.) instead of the l.e.d. displays to achieve a portable low current timer.

POWER SUPPLY

It is assumed that a power supply of 12V d.c. will be used with the modules, since this is commonly required for relays, sirens, solenoids, etc.

However, the clock pulse generator requires a 50Hz 9V a.c. supply to be derived from the 230V a.c. mains supply via an isolating transformer. This supply can also be converted into 12V d.c. to act as the power supply for the circuits.

Note, if an l.c.d. is used instead of a 7-segment l.e.d. display, then a 9V d.c. supply may be required since some l.c.d.s are not designed for 12V operation.

A.C. CLOCK PULSE GENERATOR

The term "clock pulse" means, in this case, a series of pulses which can be used to make other circuits respond according to certain fixed timing requirements. As has previously been seen in other Parts of the series, clock pulses can be produced by an astable circuit.

The advantage of using a 50Hz mains derived clock pulse instead of an astable derived one is that, over a 24-hour period, the frequency of the supply can be regarded as constant. This enables multiples or sub-multiples of that frequency to be used for accurate timing purposes. Typically, frequencies of 50Hz, 100Hz, one second and so on can be derived from the mains waveform, depending upon the arrangement used.

This technique can be far more accurate than most free running astables can achieve. The disadvantage is that a mains supply is essential – a battery cannot be used.

Some mains powered equipment, both commercial and published in constructional magazines, uses "direct mains drive". In other words, the mains supply is connected directly (although often via a capacitor) to the electronic circuit without a mains transformer. ***This can be a very dangerous approach for inexperienced constructors, for whom a mains transformer should be considered essential.***

It is possible to buy a mains adaptor (the plug in type) which supplies an a.c. output. This is the safest approach since all the mains parts are housed in a sealed plastic case.

DERIVING 100Hz WAVEFORMS

The circuit diagram in Fig. 7.1 shows how a waveform at a frequency of 100Hz can be derived from the 230V a.c. mains power supply. It also provides a smooth d.c. output suitable for other *Teach-In* modules.

The mains transformer T1 (or adaptor) should be chosen to provide about 9V a.c. if a 12V d.c. supply is required, or 6V a.c. for a 9V d.c. supply, depending upon the requirements of the circuit to be powered.

Note that the full-wave bridge rectifier REC1 and smoothing capacitor C1 will produce a d.c. voltage which is about 1·4 times greater than the original a.c.

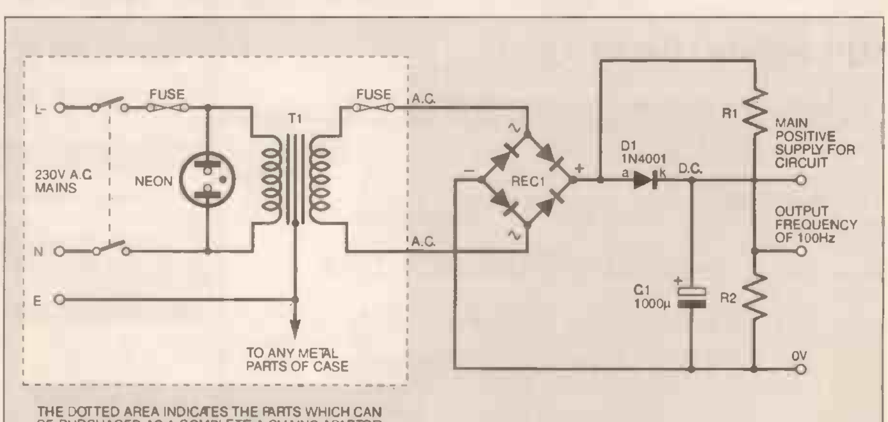


Fig. 7.1. Deriving a 100Hz signal from an a.c. power supply. Typical values for R1 and R2 would be: 10k and 47k respectively.

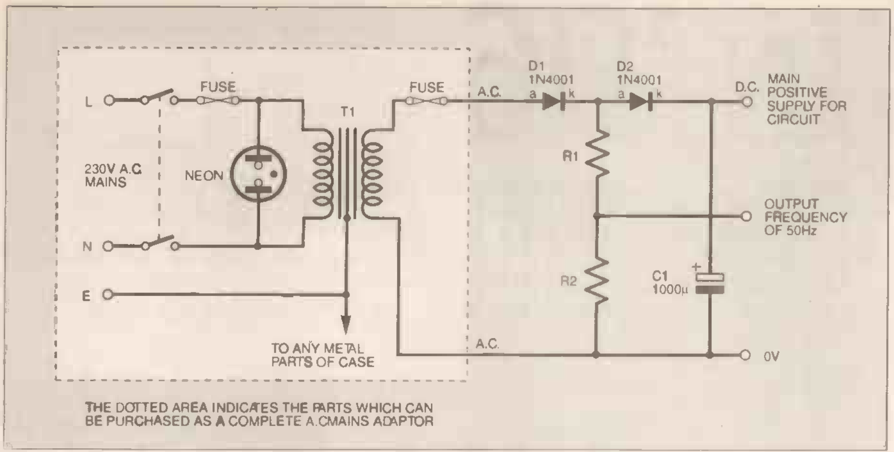


Fig. 7.2. Deriving a 50Hz signal from an a.c. power supply.

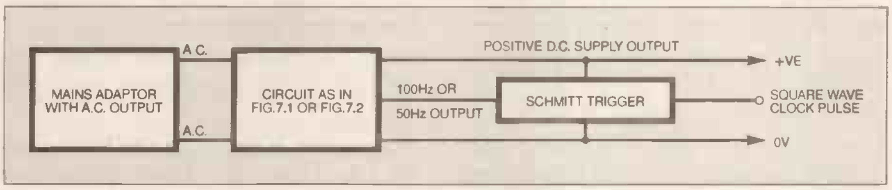


Fig. 7.3. A Schmitt trigger improves the clock waveform shape.

voltage. However, the output current available will be reduced accordingly, i.e.:

d.c. output voltage = a.c. voltage × 1·4
d.c. output current = a.c. current × 0·7

It is likely that the peak voltage of the 100Hz signal at the junction of REC1 and diode D1 will be higher than the circuit supply voltage at D1/C1. This is an unsatisfactory situation and is solved by using the potential divider consisting of resistors R1 and R2, for which typical values are: R1 = 10k, R2 = 47k.

It is important for subsequent circuits that the peak voltage at R1/R2 is never allowed to exceed the d.c. voltage at D1/C1.

DERIVING 50Hz WAVEFORMS

The circuit in Fig. 7.2 shows how the same transformer or mains adaptor can be made to produce a 50Hz output. Again it is assumed that the same transformer will supply d.c. power to the circuit. Two diodes, D1 and D2, are connected in series to form a half-wave rectifier. For various reasons beyond discussion here, this type of supply is generally less satisfactory than the circuit in Fig. 7.1, particularly if the circuit requires a substantial current.

Typical values for resistors R1 and R2 are again 10k and 47k respectively.

SQUARING THE OUTPUT

The 100Hz and 50Hz outputs from Fig. 7.1 and Fig. 7.2 are distorted portions of sine waves. As such, they are not always suitable as clock pulses for other parts of a circuit. Some circuits require clock pulses which have a very abrupt change from 0V to positive and back again.

Most counter chips will probably increment their count when a slowly changing clock input voltage crosses a predetermined threshold level. However, as discussed in other parts of the series, slowly changing voltages can cause erroneous pulses to be generated as the threshold is crossed.

Additionally, there are occasions when a clock signal needs to be capacitively coupled to the next part of the circuit. In such cases, pulses may not be generated across the coupling capacitor if the input waveform is too slow.

The solution is to use a Schmitt trigger as described in Part 1. The output from the Schmitt trigger will either be at 0V or positive, with no significant intermediate level. (In reality, the change is never truly instantaneous, but is sufficiently fast for it to be disregarded in slower speed circuits.) The block diagram for such an arrangement is shown in Fig. 7.3.

To sum up the circuits of Fig. 7.1 to Fig. 7.3:

ADVANTAGE:

Very accurate long-term timing is possible

DISADVANTAGES:

A mains supply is essential

Battery/portable operation is not possible

CRYSTAL OSCILLATOR

If a very accurate timing signal is required, but a mains a.c. source is not available, then a crystal controlled oscillator offers an excellent solution. Crystals are manufactured to vibrate at a very precise frequency, as determined during manufacture. For example, many digital watches use a crystal oscillator running at a frequency of 32768Hz.

This may seem a rather awkward number, but if divided by two, then by two again, and so on, after a total of 15 divisions the answer will be *one*. In other words:

32768Hz divided by 2^{15} = 1Hz

So if the output from this crystal oscillator is divided by two, fifteen times, the result is a precise 1Hz signal which can be used to control a timer or clock.

The crystal is normally supplied in a metal can with two leads. It can be connected either way round.

To make the crystal oscillate, an amplifier of some kind is required – ideally a CMOS logic gate, plus one or two resistors and capacitors. A typical circuit using a single CMOS inverter is shown in Fig. 7.4. There are many other circuit configurations which could be used instead.

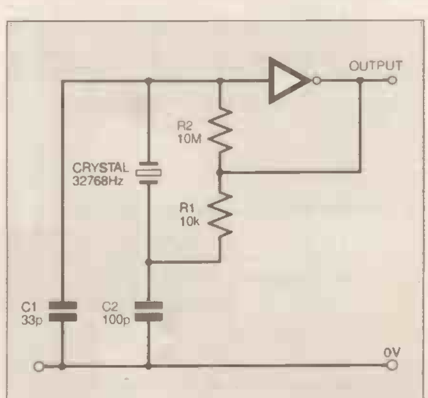


Fig. 7.4. A simple crystal oscillator circuit.

To divide a frequency by two, a T-type bistable can be used, as shown in Part 5 (Fig. 5.7). By using 15 such bistables, a 1Hz clock pulse can be produced.

If this sounds cumbersome, a study of a components catalogue will reveal a number of i.c.s packed with T-type bistables.

For example, a CMOS 4020B i.c. is available with 14 stages of division. However, for just a few more pence, a CMOS 4060B provides 14 stages *plus* the extra gate required for the crystal oscillator. It can be connected as a complete timing generator which produces a clock signal of 2Hz, as shown in Fig. 7.5.

If a 1Hz clock pulse is required, then the addition of one T-type bistable from Part 5 can be used connecting it to the output of the circuit in Fig. 7.5.

The circuit shown will operate on supplies of up to 12V with the 32768Hz "watch" crystal shown.

OTHER OUTPUTS

The 4060B i.c. has a number of outputs from various points along the chain of T-type bistables. Assuming a crystal with a frequency of 32768Hz, the following frequencies are available:

PIN	Divide by	Frequency (Hz)
3	2^{14}	2
2	2^{13}	4
1	2^{12}	8
15	2^{10}	32
13	2^{9}	64
14	2^{8}	128
6	2^{7}	256
4	2^{6}	512
5	2^{5}	1024
7	2^{4}	2048

Note that an output for 2^{11} (16Hz) is not provided.

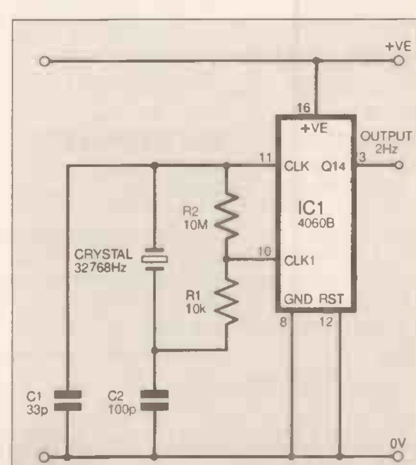


Fig. 7.5. Combined crystal oscillator and counter circuit.

Remember that the frequencies shown in this table assume that the 32768Hz crystal is used. Crystals with other frequencies will produce a different result. The output frequency can be calculated by using the "Divide by" column.

For example, divide by 2^4 means divide by: $(2 \times 2 \times 2 \times 2)$ i.e. divide by 16.

Note the usefulness of the frequency available from pin 15. If a liquid crystal display is used it will require a "back-plane" (BP) frequency of between 30Hz and 100Hz. The 32Hz square wave available from pin 15 is ideal and saves having to construct another astable.

Pin 12 of the 4060B is the Reset input. When connected to 0V as shown in Fig. 7.5 it allows the i.c. to function normally. If pin 12 is made positive, the i.c. is reset and all its outputs go low (to 0V).

DIODE LOGIC GATES

All the logic gates mentioned so far in this series have been based on the CMOS 4000 series of integrated circuits. However, other ranges of i.c.s exist and it is also possible to make gates based on op.amps, transistors or even diodes.

In Fig. 7.6 is shown how an OR gate and an AND gate may be created using a pair of diodes and a resistor. This is often very useful if only one gate is required since it saves purchasing an i.c. which contains four gates.

Of course, such a simple gate has limitations. For a start, there is the voltage drop across each diode which may be undesirable in some cases. The gate also requires a significant current at its inputs and can supply only a very tiny current. In other words, it has a low input impedance and a high output impedance.

Obviously, it cannot be described as a *good* gate! However, it can be used very effectively if driven from the outputs of normal CMOS logic, and in turn is used to drive the input of another CMOS gate.

With the OR gate, the resistor ensures that the output remains at 0V unless one or other input is positive. If either or both inputs are made positive, the output voltage will rise.

If either or both inputs of the AND gate are connected to 0V then the output will be at 0V. However, if *both* inputs are made positive the resistor will cause the output to go positive.

If a NOT gate (inverter) is required, a single *npn* transistor may be used, as shown in Fig. 7.7. Any small-signal type will do, such as BC108, BC184L, etc. The output will always be at the opposite logic level to the input. This circuit can be used, therefore, to convert an OR gate into a NOR gate, and an AND gate into a NAND gate.

DIVIDE-BY-100 COUNTER

The processing module shown in Fig. 7.8 is a divide-by-100 counter based on the CMOS 4518B i.c. The circuit provides one output pulse for every 100 input pulses. The i.c. is a dual BCD (Binary Coded Decimal) counter, which means that the output is in 4-bit binary but resets on each tenth input pulse (instead of 16 pulses).

Note that the i.c. contains two completely separate counters, A and B, which share a common power supply, pin 8 = 0V, pin 16 = +VE.

Remembering that low = logic 0 (0V) and that high = logic 1 (positive supply voltage) the pins are as follows :

Counter A	Counter B	Function
Pin	Pin	
1	9	Clock input
2	10	Enable input
3	11	Output Q1 (least significant)
4	12	Output Q2
5	13	Output Q3
6	14	Output Q4 (most significant)
7	15	Reset

Note that either the Clock input or the Enable input may be used to "clock" the counter, depending upon whether you wish to count at each rising edge of the clock signal, or each falling edge.

Taking the "clock" signal to the Clock input, the count occurs on the *rising* edges when the Enable input is held high. If the Enable input is taken low, the count stops.

Taking the "clock" signal to the Enable input, the count occurs on the *falling* edges when the Count input is held low. If the Count input is taken high, the count stops.

In the circuit of Fig. 7.8, the signal to be counted is brought into the Clock input, pin 1, of Counter A. To allow the count to proceed, the Enable input, pin 2, is held high.

The Q1 output from pin 3 will be at half the frequency of the clock signal. The Q2 output from pin 4 will be half that of pin 3, and the Q3 output from pin 5 half again. Since the device is a BCD counter, the Q4 output from pin 6 will change from low to high after the first eight clock pulses, but then switch back to 0V at the tenth pulse. In other words, Counter A will divide the input by 10.

Since the Q4 output from pin 6 switches from high to low at each tenth clock pulse, it is fed to the *Enable* input of Counter B, pin 10, which counts at each *falling* edge. Clock input pin 9 is therefore held at 0V to enable the count to proceed.

The division continues through Counter B, ending with another "divide by 10" output at pin 14 (Q4). Therefore the total division between the first clock input, pin 1, and the final output at pin 14 is 100.

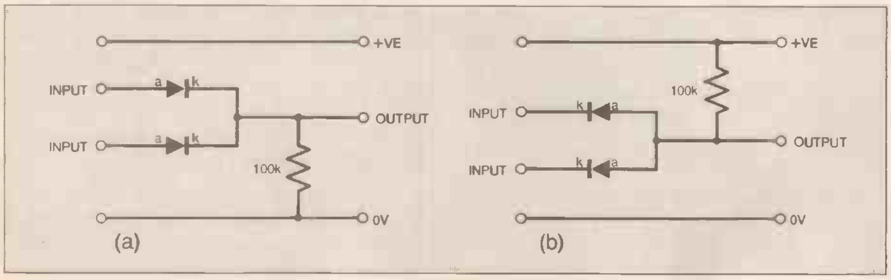


Fig. 7.6. (a) A diode OR gate. (b) A diode AND gate.

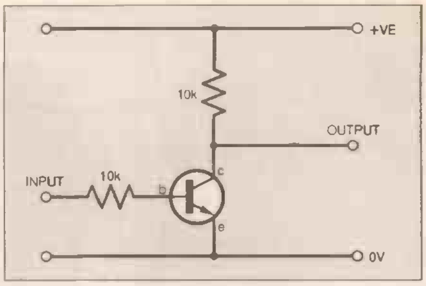


Fig. 7.7. A simple transistor inverter.

The circuit may be used to provide one-second pulses if a 100Hz pulse rate is fed into pin 1. The output pins could be used in other permutations if a another "divide by" number is required.

In the circuit as shown, Reset pins 7 and 15 are connected to 0V so that they have no effect. If a reset facility is required then, as in previous modules in the series (e.g. Part 6, Fig. 6.7), use a "tie-down" resistor connected between the Reset pins (both joined together) and the 0V line. The pins can then be connected to the reset signal source, either a switch or another circuit. (This principle is illustrated again Fig. 7.10.)

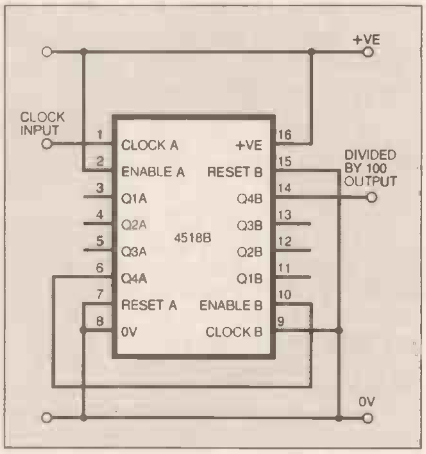


Fig. 7.8. A divide-by-100 circuit.

DISPLAYING COUNTS

If a 7-segment l.e.d. display of BCD counter values is required, the circuit in Fig. 7.9 can be used with each decade counting stage.

A variety of 7-segment (light emitting diodes) displays exists, consisting of seven l.e.d.s arranged in the well known figure-of-eight configuration. As with the l.c.d. modules described in Part 6, the l.e.d. segments are known as *a, b, c, d, e, f, g*.

Seven-segment l.e.d. displays are available as common anode and common cathode types. The type used here is a common cathode display, in other words, the cathodes of each segment are joined to a common pin connected to 0V.

The pin arrangement on l.e.d. displays can vary between types, and the catalogue from which they are obtained should be consulted to establish the pin identities. Pins not shown should be left unconnected.

Making the correct l.e.d.s light to show the required number is a little complicated, but i.c.s exist which perform this function, such as the CMOS 4511B BCD to 7-segment decoder/driver in Fig. 7.9.

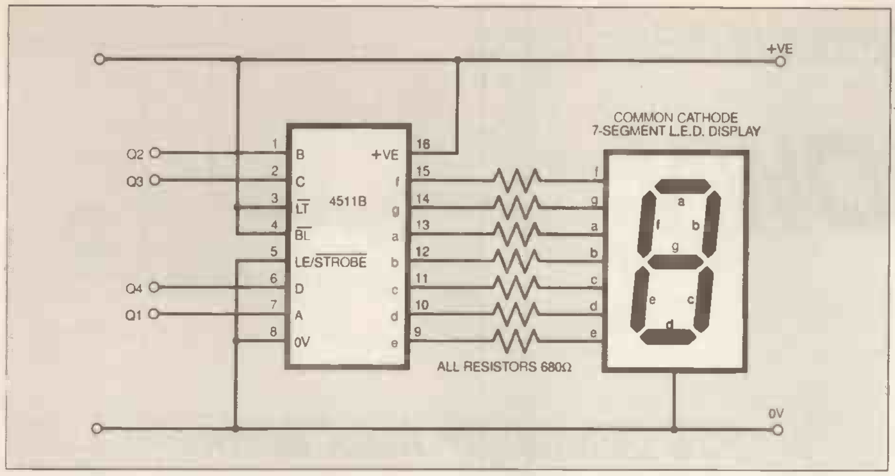


Fig. 7.9. The 4511B i.c. converts a BCD input code into a format suitable for driving a seven-segment l.e.d. display.

The binary input pins are labelled A, B, C, D and they are normally connected in order to the Q1, Q2, Q3, Q4 output pins of the driving BCD counter.

Output pins *a* to *g* feed the 7-segment l.e.d. display pins of the same letter. Note that resistors between the outputs and the display are necessary to limit the current flow.

All normal l.e.d.s require a series resistor (as discussed in Part 4, Fig. 4.15), and the values shown will provide a bright display on a 12V supply. With a 5V supply the values could be reduced to, say, 330Ω.

TRICK LIGHTING

The circuit in Fig. 7.9 indicates the most straightforward way of using the 4511B. However, it can perform some extra tricks:

When Lamp Test (LT) input pin 3 is connected to 0V, the seven outputs become positive, making all the l.e.d. segments light up for testing purposes. For normal operation, pin 3 must be connected to the positive supply.

When Blanking (BL) input pin 4 is connected to 0V, all outputs remain low, making the l.e.d. segments switch off. This would be useful in a battery powered device if you wanted the circuit to continue working, but only wished to see the display occasionally in order to prolong the battery life. For normal operation, this pin must be connected to the positive supply.

It is also possible to suppress leading zeros (e.g. 0264 would read 264) by using pin 4. For example, in the accompanying example Countdown Timer project, if pin 4 of IC11 is disconnected from the positive supply (by cutting away the track joining pin 3 to pin 4), and pin 4 joined instead to pin 7 of IC10, the tens of minutes display would switch off whenever a zero was present.

If Latch Enable (LE/Strobe) input pin 5 is made positive, the outputs latch at whatever state they are in. In other words, the number displayed "freezes", and remains so until pin 5 is returned to 0V, its normal operating condition.

COUNTER WITH DISPLAY

If a simple counter and 7-segment l.e.d. display is required, there are several i.c.s which will count and produce an output for driving a single 7-segment display in one operation. The type described here is the CMOS 4026B which can count upwards (as do most counter chips). A type 4033B is also available with slight differences, and there is also the 40110B device which can count up or down.

Details of the 4026B connections are shown in Fig. 7.10. The 7-segment display used with this i.c. must be a common cathode type.

The pins should be connected as illustrated if a straightforward counter is required. As in Fig. 7.9, pins labelled *a* to *g* are connected to the appropriate l.e.d. segments via resistors.

If a pushbutton switch is connected between the Clock input and positive, the counter will increment by one each time the switch is pressed. Of course, the problem of switch contact bounce may arise, causing the counter to accidentally increment by several counts. Switch contact bounce - and its solution - was discussed in Part 6.

If a switch is connected across the points labelled *P*, the counter will reset to zero whenever the switch is pressed.

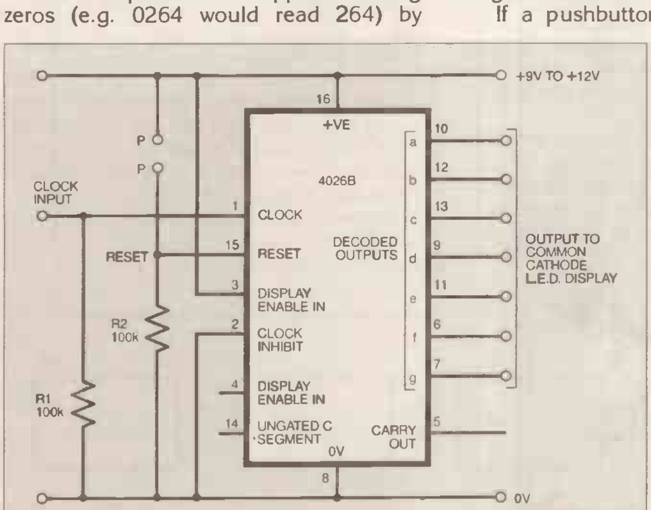


Fig. 7.10. The 4026B i.c. is a combined counter and 7-segment l.e.d. display driver. Points P *are for a reset function.*

When power is first applied, the counter may display a number other than zero. If a capacitor, say 100nF (0·1μF), is connected between points *P*, a positive pulse will occur at the Reset pin whenever power is connected, causing an automatic reset.

Both the capacitor and a manual reset switch may be connected if required. Be sure to connect them in parallel. In other words, both the capacitor and the reset switch should be connected directly to points *P*.

LINKING COUNTERS

As shown, the counter counts to nine and then resets to zero on the tenth pulse. Each time it resets, it provides a positive-going output level change at pin 5, the Carry Out pin. This pin may be linked directly to the Clock input on another 4026B to allow counting to 99.

The Reset pin 15 on the tens counter may be linked directly to pin 15 on the units counter. Further i.c.s may be cascaded in the same way to enable counting to any desired number.

Pin 2 is a Clock Inhibit pin. When it is at 0V, the counter works normally. When pin 2 is positive, the i.c. cannot count.

Pin 3 is the Display Enable pin. When it is positive, the display works normally. If pin 3 is switched to 0V, the display is blanked (turned off), even though the count can continue normally.

For information about pins 4 and 14, manufacturer's data for the 4026B should be consulted. (Ask your component supplier how to get data sheets – for this or any other i.c.) These pins should be left unconnected in this circuit.

To sum up the counter/display circuit in Fig. 7.10:

ADVANTAGE:

A simple inexpensive way of counting

DISADVANTAGE:

A rather inflexible circuit. For example, a timer requires a Carry/Reset operation at the end of each 59 seconds. This would be hard to achieve with the module shown.

If total flexibility is required, then at the expense of a little more circuitry, the counter module based on the 4029B i.c. should be used. This was examined in Part 6, and is used in the project associated with Part 7. The 4029B is also a perfect match for the output module shown in Fig. 7.9.

EXAMPLE PROJECT

The Countdown Timer is the example project (elsewhere in these pages) which shows how the modules in *Teach-In* Part 7 can be combined in a practical application.

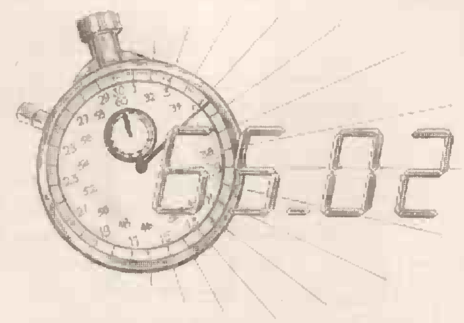
PART EIGHT

The modules to be examined in *Teach-In* Part 8 are an Audio Input, Signal Mixer, Position to Voltage Sensor, VU Processor i.c., Direct Driver. The example project is a VU Warning with Alarm.

CORRECTION

In *Teach-In* Part 4 (Feb. '96), *Vari-Speed Dice* page 138, Fig. 3, the polarity of capacitor C5 should be reversed.

COUNTDOWN TIMER



MAX HORSEY
PCB DESIGN BY ALEX SIMM

It's time to keep it under the counter, but still above board!

BASED on the information provided in *Teach-In* Part 7, this article shows how modules may be selected and combined to produce a working project.

The Countdown Timer described here includes an easy to set rotary switch control, plus an optional relay output to enable automatic control of remote equipment.

SPECIFICATION

- Four-digit 7-segment l.e.d. readout
- Maximum time 99 minutes 59 seconds
- Accurate to within 0·5 seconds
- Relay switches on during timing
- Buzzer sounds for two seconds at end of timed period
- Time set up on four rotary switches
- Pushswitches for Start and Reset
- Mains operated (via a 6V to 10V a.c. output adaptor)

ACCURACY

In theory, an astable could provide the clock pulse which keeps the timer counting at the correct rate. Clearly, though, an accurate signal is necessary and the general purpose astables outlined in *Teach-In* Part 6 would not be constant enough.

Instead, an accurate clock pulse generator was selected from *Teach-In* Part 7, Fig. 7.1. This uses the frequency of the UK a.c. mains supply which, over a 24 hour period, is rigorously controlled for an average of 50Hz. When this is full-wave rectified, a ripple-waveform with a frequency of 100Hz is obtained.

The 100Hz frequency is then shaped, divided, fed to a count-down counter which can be preset, and the results output to a decoder and display module.

MAKING CHOICES

A bewildering array of i.c.s is available which could complete the counting and display process, but it helps at this stage to select the type of display required and work backwards. A liquid crystal display (l.c.d.) consumes very little power, making it suitable for battery driven devices. However, as the project is mains driven, simpler, less expensive 7-segment l.e.d. displays were chosen.

This in turns means that the CMOS 4511B is a good choice for the decoding and driving i.c., and the CMOS 4029B makes an ideal counting companion, particularly since it can be programmed to start at any number. The 4511B decoder/driver was described in Part 7, and the 4029B counter was described Part 6.

This project also shows how the "parallel load" or "JAM" inputs on the 4029B are used to make the counter jump to a number other than zero or nine.

BLOCK DIAGRAM

The block diagram in Fig. 1 includes the following modules, full details of which may be found in the appropriate *Teach-In* Part stated:

Mains generated clock pulse	Part 7
Schmitt trigger	Part 1
Counter/divider	Part 7
Bistable (latch)	Part 3
Monostable (buzzer timer)	Part 2
Transistor output driver (for buzzer and relay)	Part 1
CMOS 4029B counter	Part 6
CMOS 4511B decoder/driver	Part 7
7-segment l.e.d. display	Part 7

The block diagram is expanded into two circuit diagrams, the first of which is shown in Fig. 2.

A.C. CONVERSION

It is essential to power the Countdown Timer from a 6V to 10V 50Hz *a.c. supply*. A normal *d.c. supply* cannot supply the required clock pulses to allow timing.

Referring to Fig. 2, the a.c. supply is converted into a 100Hz signal by the full-wave rectifier REC1. From here the supply

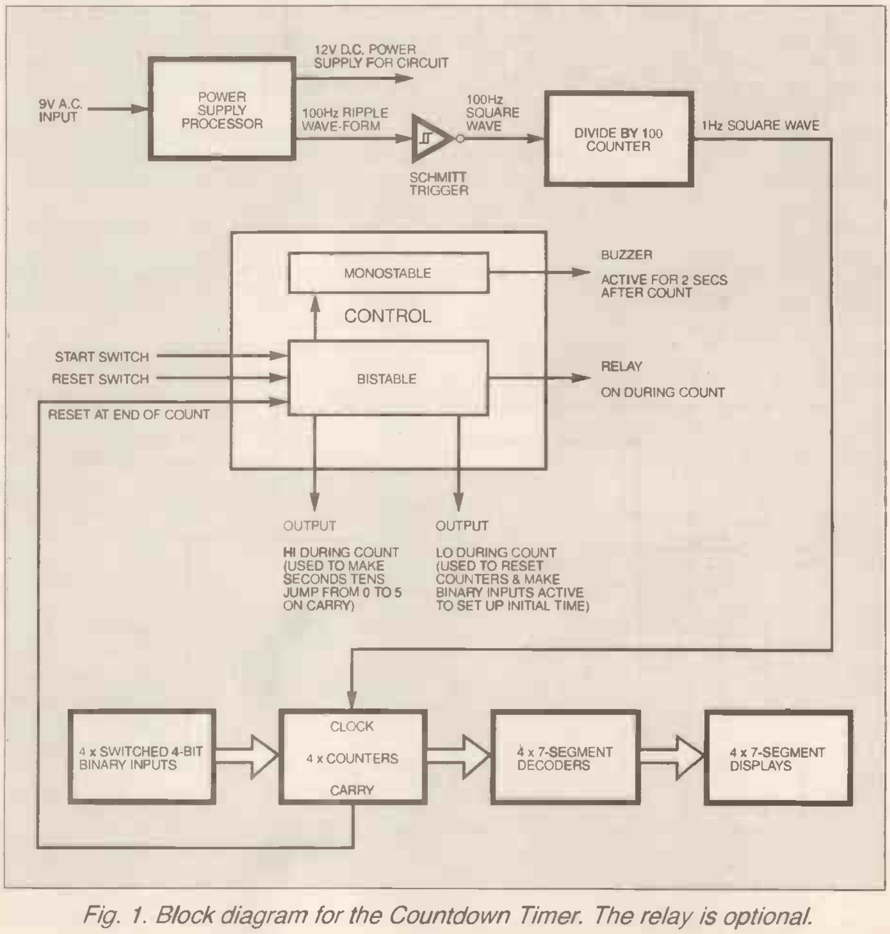


Fig. 1. Block diagram for the Countdown Timer. The relay is optional.

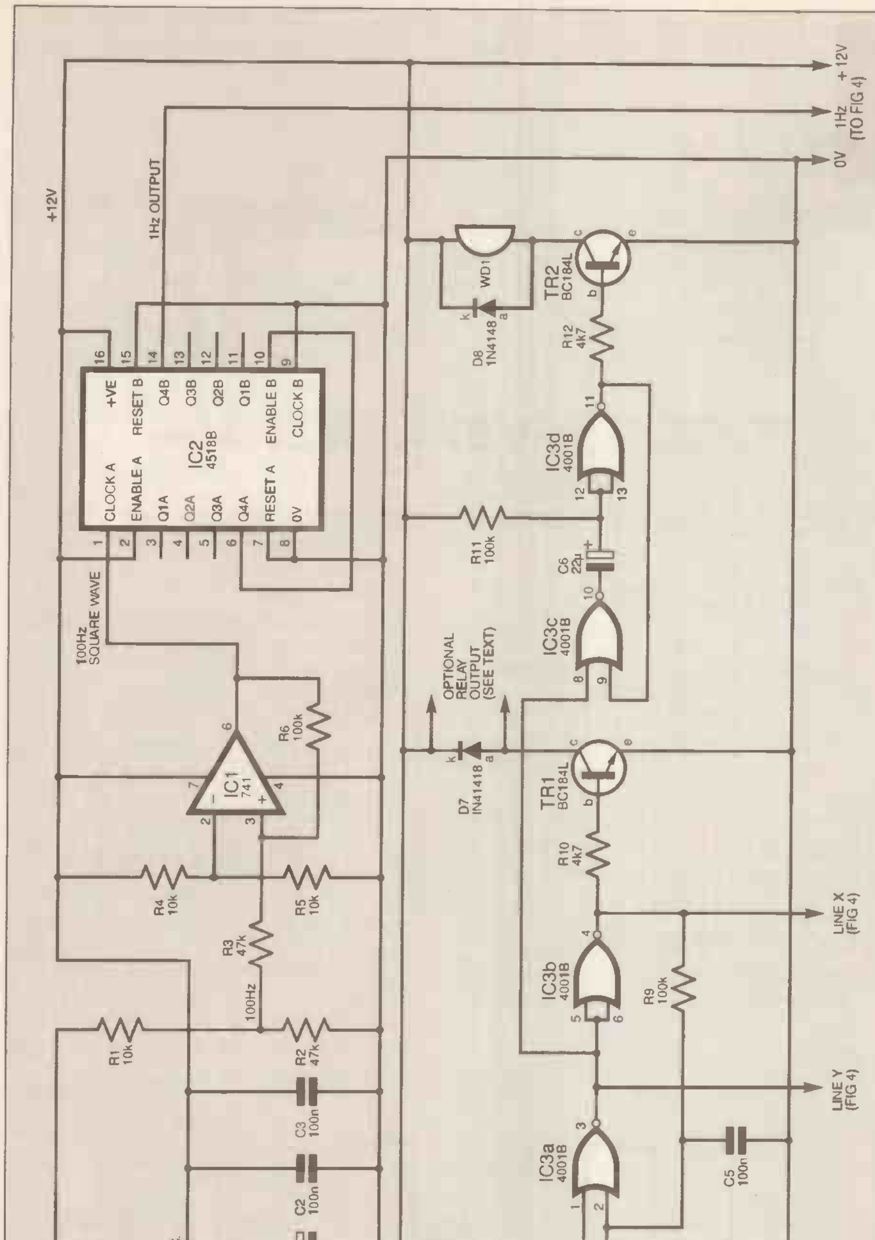


Fig. 2. Details of the power supply, clock pulse generator and basic control circuits.

divides, part of it being routed through resistor R1 to the processing circuit which shapes the 100Hz timing pulses.

Most of the supply, though, is routed via diode D1 to provide power for the circuit. The 100Hz ripple would cause havoc if present on the d.c. supply, consequently capacitor C1 is used to provide overall smoothing, then C2 and C3 remove spikes. The inclusion of diode D1 ensures that these capacitors do not smooth out the required ripple!

Capacitor C3 may appear redundant when shown next to C2. However, in the p.c.b. (printed circuit board) layout, these capacitors are at opposite ends of the board to ensure removal of the high frequency noise which the circuit may generate and impose on the power supply tracks.

When all the segments of the displays are lit (i.e. when displaying 8888) something like 120mA is required by each display, making a total of 480mA. Depending on the actual total current drawn, the value of 1000µF suggested for the smoothing capacitor C1 may be a little low in some instances. This could result in low level ripple on the d.c. supply rails.

In this application, the i.c.s are quite tolerant of a slight ripple voltage and there should be no ill effect apart from the buzzer sounding a little strangled! A larger capacitor may be used if preferred, depending upon the space available in the finished project.

Alternatively, *high efficiency* 7-segment displays could be used (at a price) in which case all the 680Ω resistors which supply each segment of each display could be increased to about 1·2 kilohms (1k2), thus halving the current consumed.

TIMING SIGNAL

The 100Hz timing signal output from the rectifier, REC1, is reduced in voltage by the potential divider formed by resistors R1 and R2. The timing signal is a series of half sine waves and these must be converted into square waves before being applied to the clock input of the first counter stage (IC2).

A Schmitt trigger based on op.amp IC1 achieves this conversion. (Schmitt triggers were discussed in Part 1, pages 869 and 870).

From IC1's output pin 6, the resulting square wave is sent to the clock input pin 1 of IC2, a CMOS 4518B counter/divider. As discussed in Part 7, Fig. 7.8, when connected as shown, the i.c. divides by 100, thus converting the 100Hz square wave into a 1Hz clock pulse.

As detailed in Fig. 4, this is applied to the clock input pin 15 of IC4, which is a 4029B presettable BCD (Binary Coded Decimal) up/down counter. Its pinouts are shown in Fig. 3.

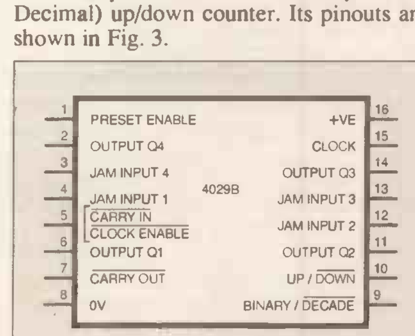


Fig. 3. Pinouts of the 4029B counter i.c.

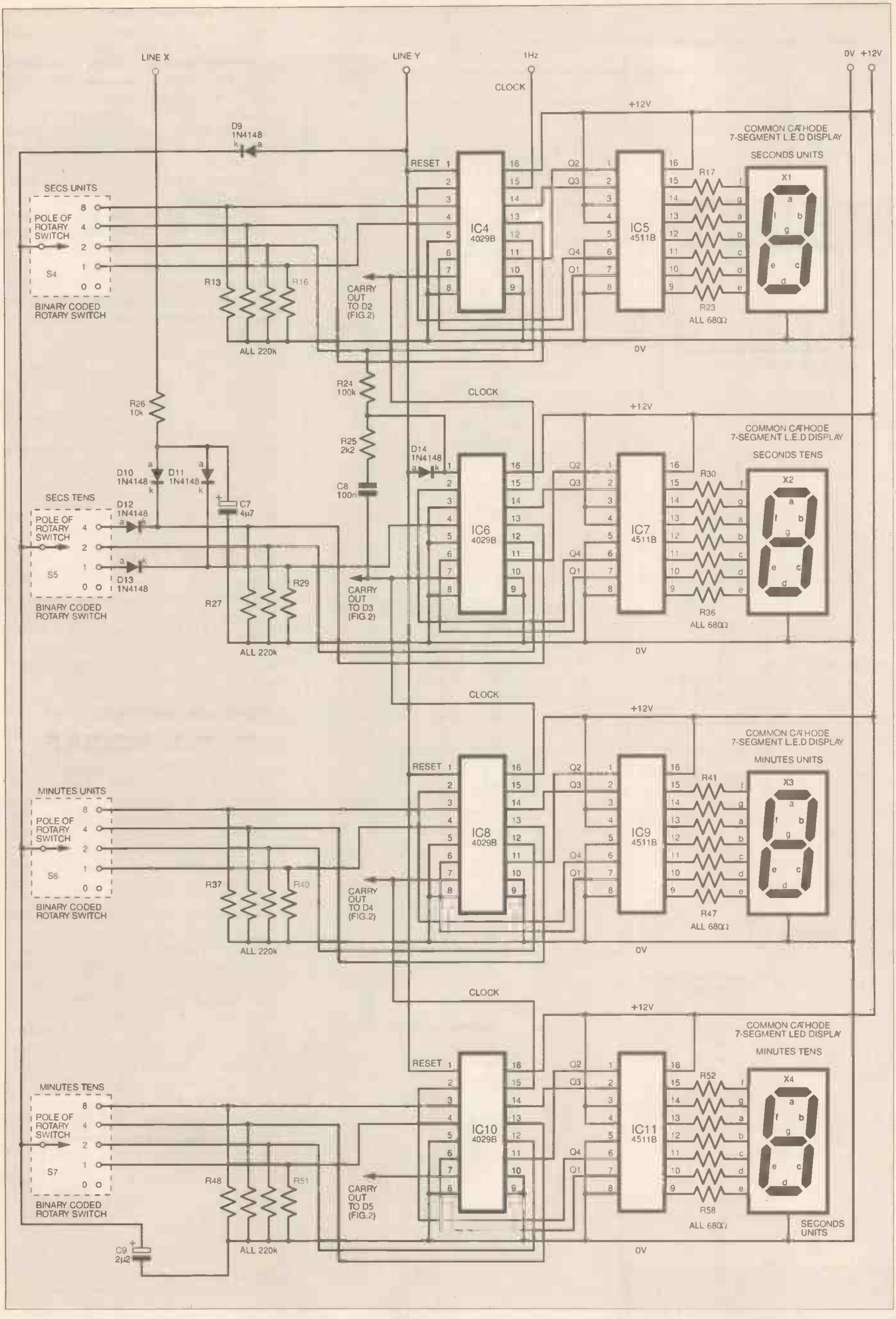


Fig. 4. Circuit diagram for the four counter display stages.

The 4029B counter i.c. can be programmed to count down by connecting pin 10 to 0V (see Part 6). Therefore the "units of seconds" stage must supply a "carry out" pulse when it changes from zero to nine. This pulse is applied to the clock input of IC6.

All four counters are similarly connected in series, the carry out signal from each providing the clock signal for the next.

COMPONENTS

Resistors

See SHOP TALK Page

R1, R4, R5, R7, R26	10k (5 off)
R2, R3	47k (2 off)
R6, R8, R9, R11, R24	100k (5 off)
R10, R12	4k7 (2 off)
R13 to R16, R27 to R29, R37 to R40, R48 to R51	220k (15 off)
R17 to R23, R30 to R36, R41 to R47, R52 to R58	680Ω (28 off)
R25	2k2

All 0·25W 5% carbon film

Capacitors

C1	1000µ elect. radial, 16V
C2 to C5, C8	100n ceramic disc (5 off)
C6	22µ elect. radial, 16V
C7	4µ7 elect. radial, 16V
C9	2µ2 elect. axial, 16V

All voltage ratings are minimum values

Semiconductors

D1	1N4001 rectifier diode
D2 to D14	1N4148 signal diode (13 off)
REC1	W005 bridge rectifier, or similar
TR1, TR2	BC184L *npn* transistor (2 off)
IC1	741 op.amp
IC2	4518B dual BCD counter
IC3	4001B quad 2-inputs NOR gate
IC4, IC6, IC8, IC10	4029B 4-bit presettable up/down counter (4 off)
IC5, IC7, IC9, IC11	4511B BCD to 7-segment decoder/driver (4 off)

Miscellaneous

S1	s.p. min. toggle switch
S2, S3	push-to-make switch (2 off)
S4 to S7	BCD rotary switch (see text) (4 off)
WD1	12V buzzer
X1 to X4	2-digit 7-segment l.e.d. display (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 993; end cap for rotary switches (2 off); a.c. mains power adaptor with 9V a.c. output (see text) plus cable-mounting power input socket to suit; 12V relay (optional – see text); plastic case with sloped panel, 194mm x 120mm x 60mm (max. height); Speedbloc connectors (2 off) (optional – see text) red filter for display; 8-pin d.i.l. socket; 14-pin d.i.l. socket; 16-pin d.i.l. socket (9 off); 24-pin d.i.l. socket (4 off) (see text); cable ties; 18-way ribbon cable; connecting wire; solder, etc.

Approx Cost Guidance Only £39
excl. case and power supply

The carry out signals are also needed for two other functions:

1. To cause the timer to stop, reset and sound a signal from the buzzer when all the counters have reached zero
2. To ensure that IC6 (the tens of seconds counter) jumps from zero to five instead of zero to nine.

DIODE AND GATE

For the sake of simplicity, the block diagram of Fig. 1 shows the final carry output connected to the Reset input of the control module. This would stop the counter as the tens of minutes count switches from zero to nine. However, it would also cause the timer to count an extra second before switching off the optional relay. Ideally, a signal is needed at the moment when the count reaches 0000 rather than a second after.

Returning to Fig. 2, this is achieved by means of a diode AND gate which creates a signal when all four counters have reached zero. To avoid using yet another i.c., an arrangement of diodes (D2 to D6) is used to simulate a logic gate.

If any of the counters is not at zero, its carry out pin will be high (logic 1) therefore holding the top end of R7 (as seen in Fig. 2) at logic 1. If all the counters are at zero the top end of R7 will fall to logic 0. This is used to cause Stop and Reset conditions as described later.

PARALLEL LOADING

The CMOS 4029B may be "parallel loaded" with a 4-bit binary number at its JAM inputs to cause the outputs to jump to any required number when Reset pin 1 is made high. When counting in decimal mode, these i.c.s happily count down 2, 1, 0, 9, 8 etc. However, in Fig. 4, counter IC6 must instead count down 2, 1, 0, 5, 4 etc.

For example, the counter might have to count down from 32m 01s to 32m 00s to 31m 59s. This is achieved by holding its pins 4 and 13 positive whilst applying a reset pulse to pin 1.

Problems arise because the parallel load inputs may already be set to a number other than five by the rotary switches. Therefore the rotary switches (fed from line Y) have to be disabled during counting, whilst pins 4 and 13 of IC6 are held high during the count via resistor R26 and diodes D10 and D11 (fed from line X).

The timer control module causes line X to be high during the countdown, and line Y to be high before or after the countdown. Capacitor C7 stops the voltage from R26 rising too quickly – to prevent the tens of seconds jumping to a value of five at the start of the countdown.

Capacitor C9 ensures that the number registered by the rotary switches is maintained at the parallel load (JAM) inputs, until the logic level at the reset pins falls to zero.

To summarise:

Before/after countdown:
X = low, Y = high, parallel load inputs cause counters to copy numbers set by switches

During countdown:
X = high, Y = low, tens of seconds counter (IC6) set to jump to five when a pulse is received at pin 1.

The carry out signal from IC6 is reduced to a brief pulse by means of C8, R25 and R24. This method of obtaining pulses by means of a series capacitor was described in Part 2 (see A.C. Coupling). Diode D14 prevents the other three counters from being reset by this pulse.

TIME SETTING

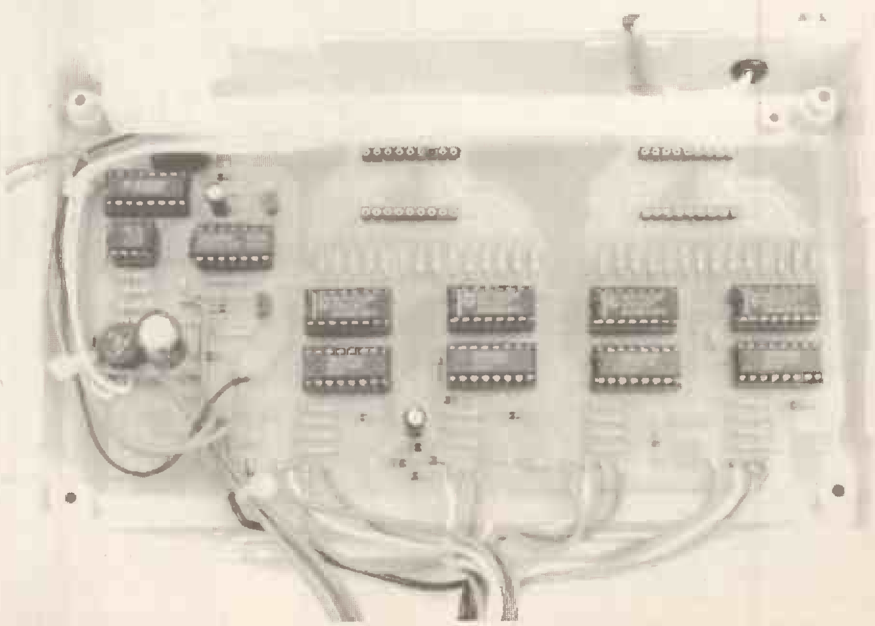
Four binary output rotary switches are used for setting up the time required.

Whenever the timer is not counting, line Y is high and suppling power to the switches via diode D9, making the Reset Enable input (pin 1) of each counter positive. The parallel load system is hence enabled, and the outputs from the counters copy the numbers set up by the switches.

CONTROL MODULE

The control module is built around the four NOR gates housed in IC3. The countdown sequence starts when switch S2 is pressed. NOR gates IC3a and IC3b form a bistable (or latch), which causes output pin 4 (line X) to be high during countdown. Output pin 3 (line Y) is high before and after countdown.

Via resistor R10, pin 4 also drives *npn* transistor TR1, which can be used



to switch on an optional relay during countdown. The bistable is unlatched by pulling down the voltage at pin 2. This is achieved either by pressing the Stop/Reset switch S3, or automatically at the count of 0000 via diode D6, as described earlier.

A monostable formed by IC3c and IC3d is used to make the buzzer WD1 sound, via transistor TR1, for about two seconds whenever output Y switches from low to high. This signals the end of the count. The buzzer-on time may be increased, if preferred, by increasing the value of R11 up to a maximum of 1MΩ, which gives about 20 seconds.

DECODER AND DISPLAY

The l.e.d. decoder/driver i.c.s are CMOS 4511B devices, which were described in Part 7 (Fig. 7.9). For the prototype, four 7-segment units were purchased as two double displays.

POWER SUPPLY

For the sake of safety, it is assumed that a commercial power adaptor will be used with this counter. However, adaptors which supply an *a.c.* output are not common. Note that an a.c. (so called) power adaptor plugs into the a.c. mains but normally supplies d.c.

It is also possible to construct a suitable power supply, and a small transformer could be purchased and housed either with the timer, or in a separate box. A suitable transformer would be a 6VA type with 230V a.c. inputs and 9V a.c. outputs. This will supply just enough current if its two 9V secondary coils are connected in parallel.

The 680Ω resistors supplying the displays could be raised to say 820Ω or even 1k2Ω if high efficiency displays are used, in order to reduce the current consumption, or a 6V 6VA transformer could be used.

If a mains adaptor is constructed in this way, observe the need for safety, such as using a double-pole mains on/off switch, plus a neon and fuse as shown in the dotted section of Fig. 2.

Note that if a 12V a.c. adaptor is used, the d.c. supply from diode D1 could rise to over 16V, possibly causing damage to the i.c.s and smoothing capacitor C1. A simple if crude method of dropping the d.c. supply is to add, say, four 1N4001 diodes in series with D1. This should knock out about 2·8V.

These extra diodes should be connected between the positive output of rectifier REC1 and diode D1. Ensure that resistor R1 remains connected directly to the anode (a) side of D1.

CONSTRUCTION

Full details of the printed circuit board are shown in Figs. 5 and 6. This board is available from the *EPE PCB Service*, code 993.

Since the timer will be in use around the home, its general appearance is particularly important. When designing the prototype p.c.b., therefore, the case was selected first and the p.c.b. made to fit. It would be wise to check that the p.c.b. *does* fit into the case before inserting any components. If any trimming is necessary, this is much simpler when performed on an unassembled p.c.b.

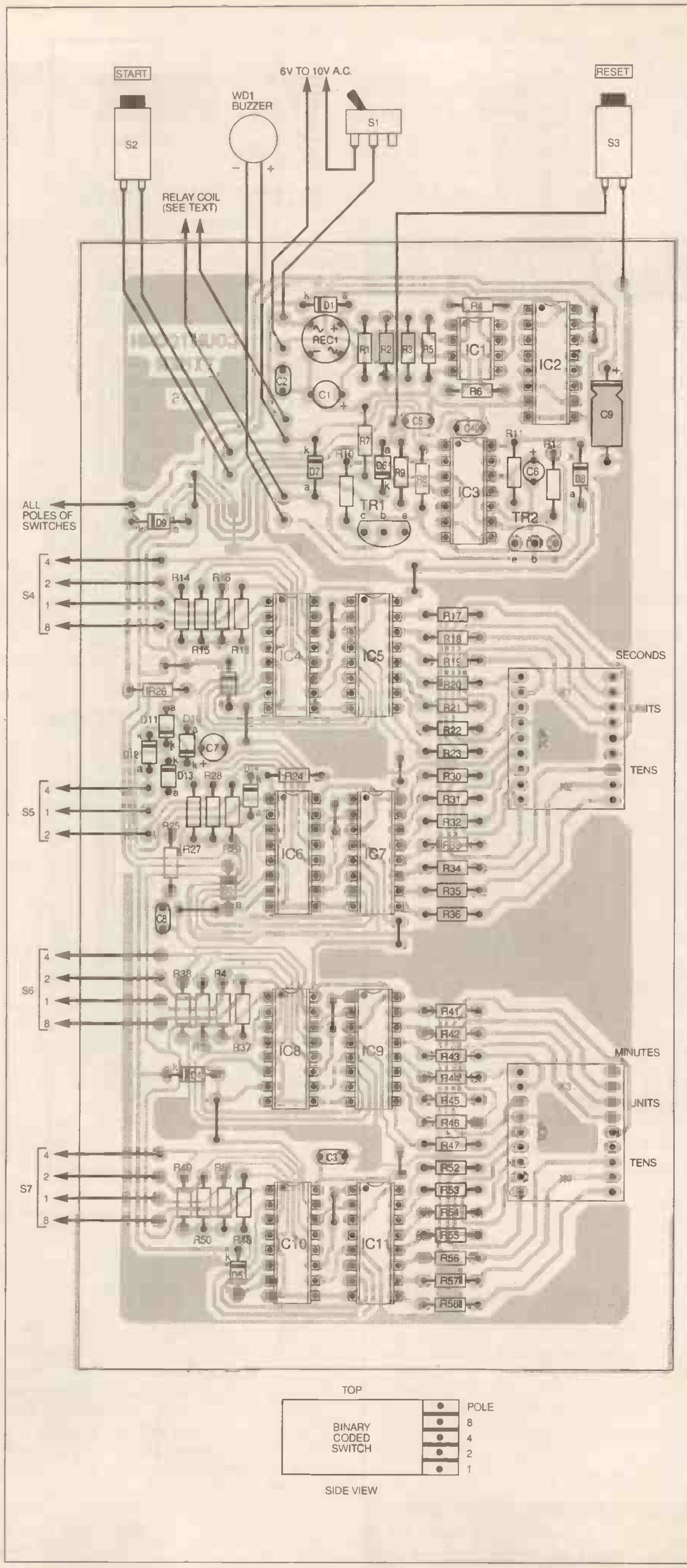


Fig. 5. Component layout on the printed circuit board.

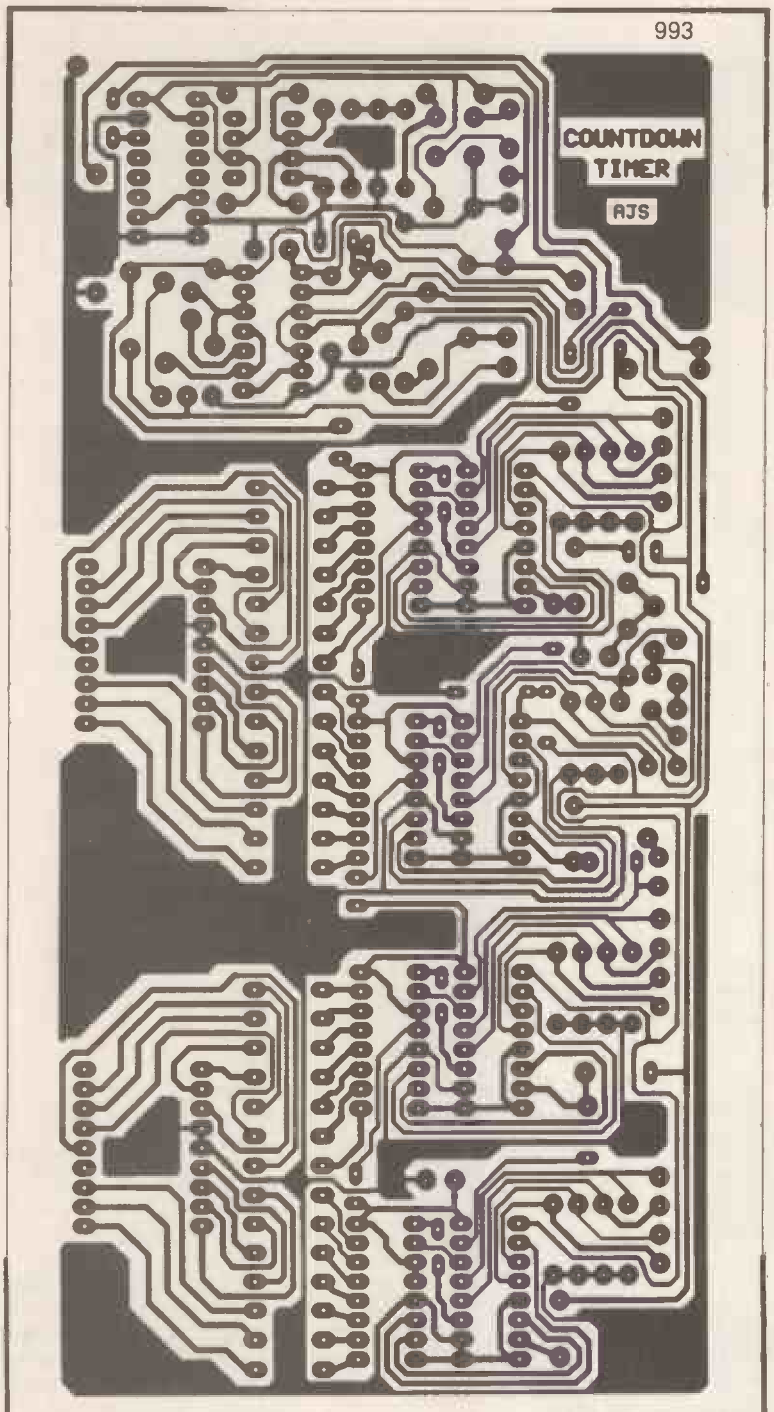


Fig. 6. Full-size underside copper foil track master pattern.

Start p.c.b. assembly by inserting the d.i.l. (dual-in-line) sockets, followed by the on-board wire links (the short bare wires used to link certain p.c.b. pads) and smallest components. As usual, check the polarity of diodes and electrolytic capacitors to ensure that they are fitted the correct way round. The bridge rectifier is labelled to ensure a correct fit.

LINKING THE DISPLAYS

The two pairs of 7-segment displays will eventually be mounted on the front panel of the case. However, provision has been made on the p.c.b. to allow d.i.l. sockets to be mounted, into which the displays may be plugged for testing.

When installed in a case, the displays can then be linked via a set of colour-coded individual wires, or by ribbon cable. For example, Speedbloc plugs are available which may be clamped onto Speedbloc ribbon cable so avoiding the need for soldering all the connections. Note that a 24-pin Speedbloc plug is likely to be the nearest to the required 18 pins.

These plugs can be inserted into the display sockets, providing a neat finish. Note, though, that Speedbloc connectors for use at the display end of the cable do not seem to be available. Consequently, the individual ribbon wires must be soldered to a standard d.i.l. socket at the display end.

This is not an easy operation, though a small piece of stripboard could be used to help with the soldering operation. A 20-way ribbon cable may be used, but care must be taken to use the appropriate connections at each end of the cable (Speedbloc ribbon cable is all-grey, i.e. not colour coded).

If all this sounds too cumbersome and costly, wires may be soldered to the p.c.b. instead of fitting sockets. In this instance, note the importance of using a variety of colours to distinguish between the different wires.

SWITCHES

Insert terminal pins for the other external connecting wires. Link the rotary time setting switches as shown, checking that the units of seconds switch is on the right hand side when viewed from the front.

Push the four switches together so that they form a single unit. End pieces are available to make a neat finish at the two sides. The pole of each switch is the top contact and all the poles connect to a single point on the p.c.b.

A quick method of joining the poles together is to push a piece of single-core bare wire straight through the set of holes in one operation. A single insulated wire can then be used to join the set of poles to the p.c.b.

Join the other contacts of the switches to the p.c.b., colour coding the wires to avoid confusion. Ignore any advice about making "a mechanically sound joint before applying the solder" – solder is quite strong enough to hold the wires on its own.

So, tin the contacts of the switches with a layer of solder, strip the insulation from the ends of the wires so that only about 2mm of bare wire shows, then tin the wire.

Now attach each wire to each contact without additional solder. This method is quick, easy, requires only two hands, and above all allows the wires to be easily disconnected when the switch unit is positioned in the case.

RELAY

The use of a relay with the Timer is optional and the choice of relay will depend on the item to be controlled. Although the circuit includes a driver for a relay with a 12V coil, the relay was not implemented in the prototype.

If mains powered equipment is to be switched by a relay, several safety points must be considered.

It is imperative that the relay is securely bolted to the case and that its mains wiring can NEVER come into contact with other parts of the circuit. The relay contacts and their wiring must be adequately rated for the current to be switched. The mains cable must be secured in its case entry hole by a suitable clamping gland.

Mains wiring should* NOT *be attempted by inexperienced persons. If in any doubt, consult a qualified electrician.

TESTING

Plug in the i.c.s the correct way round taking the usual precautions to avoid damage and static electricity "zapping". Touch an earthed metal object before handling them. Finally, insert the 7-segment displays directly into the sockets on the p.c.b. for testing.

As with all the projects in this series, it is wise to first test the circuit with a regulated 9V or 12V 100mA d.c. supply. Remember that the timer will only count when fed with an a.c. supply, but much of the initial testing can be accomplished more safely with a 100mA d.c. supply. Remember also that although 12V d.c. is acceptable for testing, a 12V a.c. supply is too high, as explained earlier.

Assuming that a d.c. supply is connected (either way round) to the "a.c. input", some segments of the displays should light. Press switch S3 (Reset) and check that the displays switch to the setting displayed by the rotary switches. Check that if the rotary switches are turned, the change is copied on the 7-segment displays.

So far, counting will not have taken place because the circuit requires an a.c. supply. Assuming that all is well, connect the a.c. supply of about 6V to 9V.

If the circuit behaved properly on the d.c. supply it should now do the same, except that counting down should occur when the Start switch (S2) is pressed. If not, an oscilloscope will confirm whether a 100Hz square wave is present at the output of IC1.

FAULT FINDING

All circuits are tedious when they do not work, and if you have made any errors, this one may be more frustrating than most! A common problem is failure of one or more display segments. This may be caused by a poor connection or a short circuit between two adjacent connections.

An unrecognisable array of lit segments which do not form proper numbers is often caused by a mix up between connections. Check that the display connectors are plugged in the correct way round.

If the rotary switches produce strange results when turned, check their connections carefully. It is particularly important to establish which contact represents the "common" pole. If in doubt, disconnect one switch and check it with a multimeter (on a low resistance range), noting that the output is in binary. In other words, when the switch is set to 0 the common pole should not connect with any other contact. When set to 1, common should connect with the first contact; when set to 2, common should connect with the second; when set to 4, the third, and when set to 8, the fourth.

Other faults can be located with the multimeter. For example the positive and negative supply voltage for each i.c. can be checked by the meter, set on a suitable d.c. voltage range (e.g. 12V or greater).

If a short circuit exists causing the supply voltage to collapse, try removing all the i.c.s and displays, and use the multimeter set to Ohms to locate the fault. When connected across the positive and negative supply pins of each i.c. socket, the meter will show a reading of an ohm or two. A lower reading indicates that you are closer to the short circuit.

If a fault still persists, see the fault finding guide in Part 1 for further hints, and use the circuit description given earlier to test each module in the circuit.

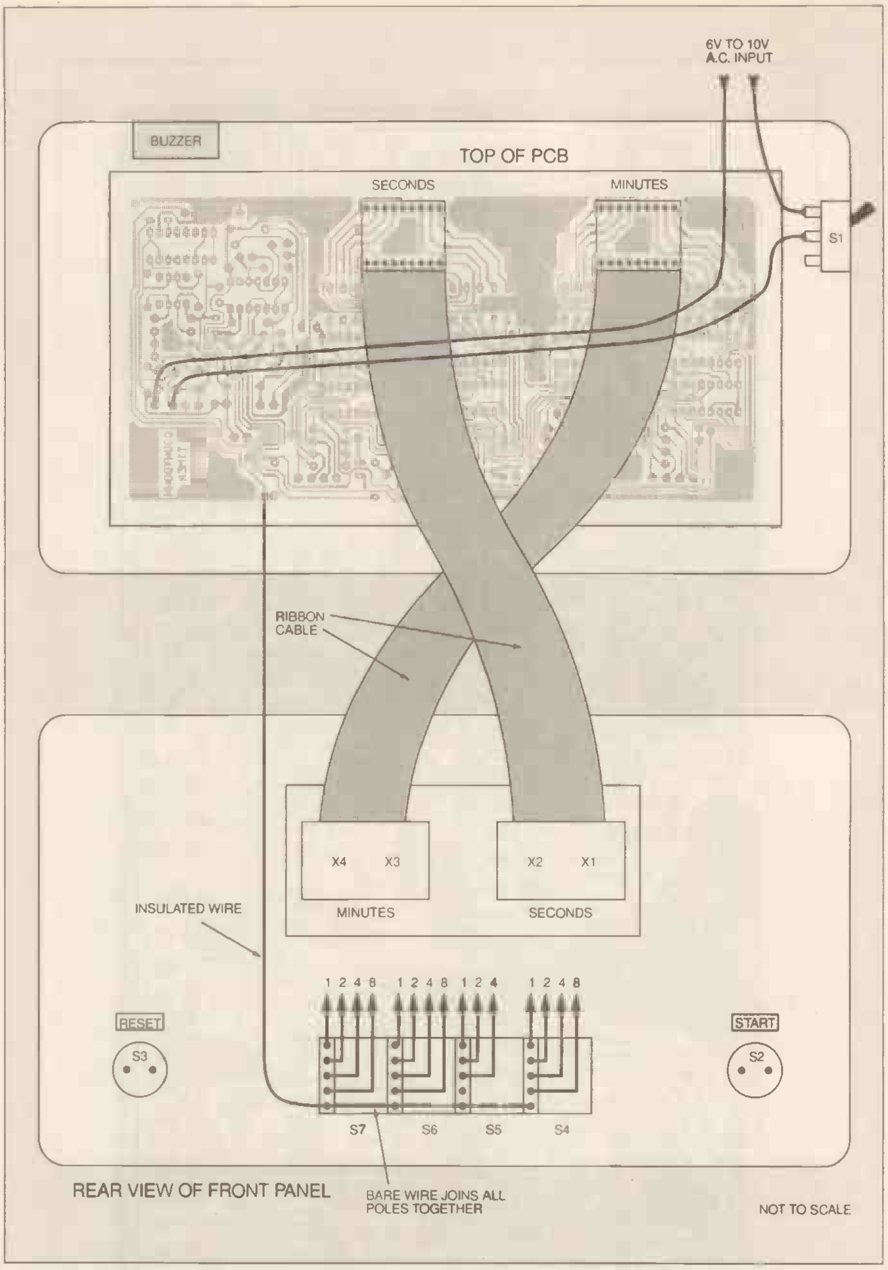
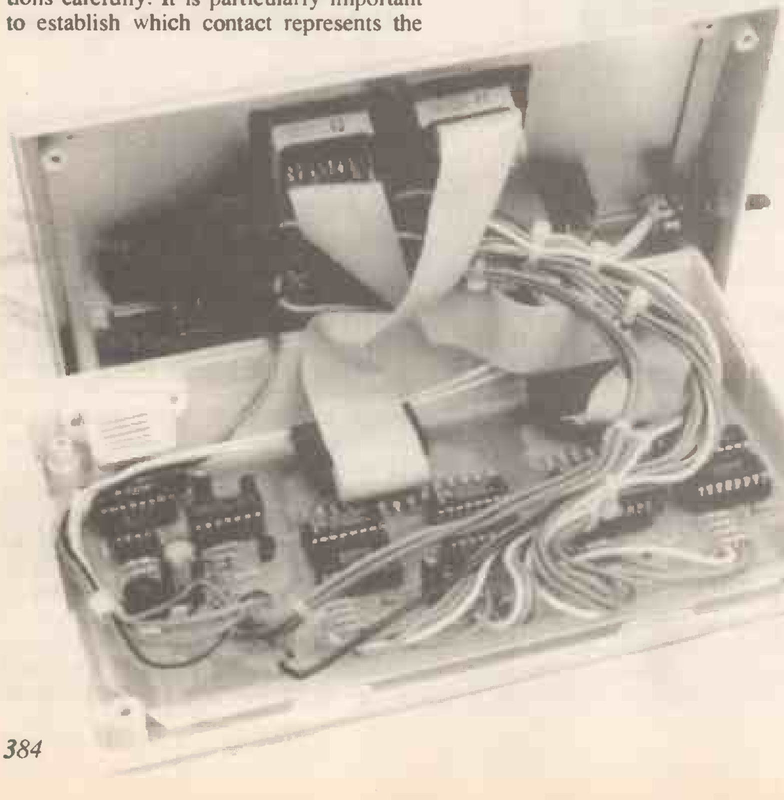


Fig. 7. Interwiring of the p.c.b. to the case-mounted components not shown in Fig. 5.

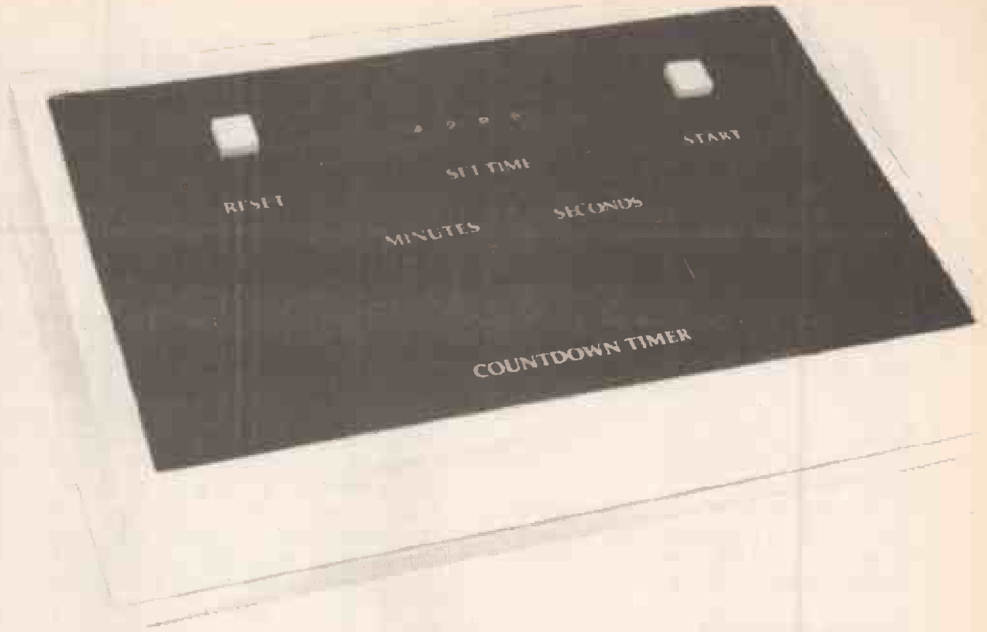


CASE DETAILS

The p.c.b. is designed to fit in a case with a sloping front panel. There is little room to spare in the specified case and so careful layout is important. Check especially that there is sufficient clearance between the front panel fittings and the p.c.b. Depending on the purchasing source for the rotary switches, they may need to be trimmed slightly. The p.c.b. should be mounted at the very bottom of the case.

The general layout of the case is shown in Fig. 7 and the photographs. Drill and file holes for all the switches, 7-segment displays, low voltage a.c. power input cable or socket, and relay if required.

A red filter for each display provides a significant improvement in readability and may be glued to the inside of the front panel. Each display may now be carefully glued to the filter, ensuring that the number is the correct way up! If the glue is applied around the sides of the displays rather than their fronts it will be hidden from view.



HARD WIRING

The rotary switch set is pushed in from the front. If the connecting wires have been attached by the method described earlier, disconnecting and reconnecting will only be a few minutes task.

Connect the displays to the p.c.b., noting that the connectors must be the correct way round. If this is difficult to work out, experiment, but do not leave the timer switched on if the display fails to light at all, since this indicates that the polarity may be the wrong way round.

Twist the connector round the opposite way at the display end. If the display lights, but does not indicate proper numbers, then assuming that it worked properly when plugged directly into the p.c.b., the plug at the p.c.b. end may have been accidentally moved sideways by one position.

If this is not the case then – unfortunately – the wires are probably mixed up. This is a difficult and frustrating situation; a multimeter on its buzzer setting will help identify which wire is which.

Finally, screw the front panel to the body of the case, checking that the wires are neatly folded. Also ensure that if a large version of the rotary switch is used, its connections do not short circuit against the p.c.b.

PART 8

The example project associated with the next part of *Teach-In* is a VU Display with Alarm.

INTERFACE

Robert Penfold

THIS month we continue with our look at serial interfacing techniques. In last month's article we considered some aspects of the receiver section of the 6402 UART. In this month's article we look further into the operation of the receiver section, and then progress to the transmitter section.

A practical serial decoder circuit based on the 6402 is then described. For pinout details of the 6402 refer to Fig. 2 in last month's *Interface* article.

Status Symbols

The receiver section of the 6402 provides three status outputs that indicate various types of error. It is not certain that the decoded data is erroneous if one or more of these outputs has been activated, but it is clearly a strong possibility. If one of these "flags" is repeatedly activated, the most likely cause is that the computer is set for the wrong baud rate or word format.

Brief details of these outputs are provided in Table 1. In each case the output is normally low, and it goes high when active. All three outputs are tristate, and are controlled by pin 16. This pin is taken low to enable the status outputs, or high to switch them to the high impedance state.

Table 1: Status Outputs

Pin No.	Function
13	Parity error
14	Framing error (no stop bit detected)
15	Over-run (new byte of data commenced before the previous byte has been dealt with)

There is a further status output at pin 19, and this is an important one in many applications. This output goes high when a complete byte of fresh data has been received. It is reset by pulsing pin 18 low.

In some applications there is no problem if a continuous stream of data appears on the eight data outputs of the receiver. For example, a digital-to-analogue converter circuit normally needs nothing more than a series of data bytes fed to its inputs.

In some applications though, it is essential that the receiving circuit knows when a fresh byte of data has been received. The status output at pin 19 can be used to automatically reset itself via pin 18 and a simple inverter/timer circuit. This process generates a pulse when a new byte of data is available, and the pulse can be used to indicate to the main circuit that fresh data is ready for processing.

Bit-by-Bit

The basic action of the transmitter section is to take eight-bit bytes of data on its parallel inputs, and to then transmit this data on its serial output, bit by bit, with stop, start, and (where appropriate) parity bits being added. The eight parallel input lines are at pins 26 to 33, and the serial output signal is available at pin 25.

Note that, in common with most serial chips, the 6402 is designed to drive an RS232C input via an inverting buffer stage. In addition to inverting the serial output signal, this stage must convert the 5V logic levels from the UART to normal RS232C drive levels of plus and minus 12V.

Although the transmitter and receiver sections of the 6402 have common control inputs, and must use the same word format, there are separate clock inputs. If required, transmitter and receiver sections can therefore operate at different baud rates. The transmitter clock input is at pin 40, and like the receiver clock input at pin 17, this input requires a clock signal at 16 times the required baud rate.

In order to get the 6402 to transmit a byte of data it is necessary to pulse the transmitter buffer register load input (pin 23) low. On the face of it this pin should not be pulsed at a rate which is higher than that at which the 6402 can transmit bytes of data.

In practice this would not result in corruption of the serial data stream, and the transmission of one byte will not be curtailed in order to start the next byte. Pulses on pin 23 are simply ignored if a byte of data is already being transmitted. This could obviously result in "lost" bytes of data in some circumstances, but in others it would be of no real importance.

The transmitter section provides two status outputs. The one at pin 22 goes high if the transmitter buffer register is empty. In other words, this output goes high if the transmitter section is ready to receive a new byte of data.

Serial data is not clocked-out direct from the parallel inputs, but is first loaded into a buffer register, and then clocked-out from there. Note that this is a tristate output which is controlled via pin 16.

The status output at pin 24 (transmitter register empty) is similar, and it goes high when the transmitter is not actually transmitting any data. This output is not a tristate type, incidentally.

Obviously both of these status outputs are potentially useful for handshaking purposes. Alternatively, the data flow can simply be kept down to a rate that the baud rate in use can comfortably handle.

Acting as the reset input for both the transmitter and receiver sections, pin 21 is the master reset input of the UART. This pin is normally low and is pulsed high in order to reset the device. In normal use a reset pulse is applied to the device at switch-on, and thereafter the master reset input is simply held low.

Receiver Circuit

A simple serial decoder circuit based on a 6402 UART (IC1) is shown in Fig. 1. The RS232C input signal is at signal levels of about plus and minus 12V, and these must be converted to standard 5V logic levels before being applied to the serial input of IC1.

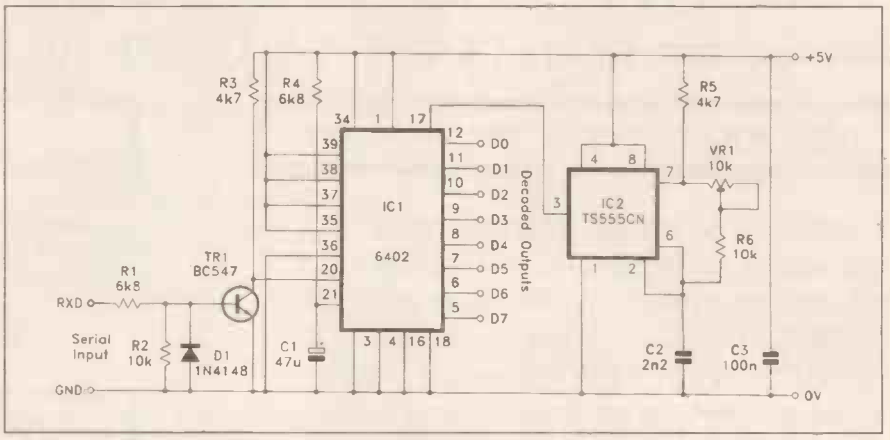


Fig. 1. Circuit diagram for the RS232C to parallel data converter.

Special RS232C receiver devices are available, but in this application the input signal should be very "clean", and something less than optimum noise handling is acceptable. A simple common emitter switching stage based on transistor TR1 is therefore used to provide the conversion to normal logic levels, and it also gives the necessary inversion of the input signal.

Resistor R4 and capacitor C1 provide IC1 with a positive reset pulse at switch-on. The inputs at pins 35 to 39 program the word format (see last month's *Interface*), and the method of connection shown in Fig. 1 provides a format of one start bit, eight data bits, one stop bit, and no parity. Pin 34 is connected to the +5V rail so that the binary pattern on pins 35 to 39 is loaded into IC1's control register.

The decoded bytes of parallel data are available at pins 5 to 12, and pin 4 is connected to the 0V rail so that these outputs are permanently enabled. In a stand-alone application the tristate capability of these outputs is not of great value, but if necessary this facility can be utilised by applying a control signal to pin 4 of IC1.

Connecting pin 16 to the 0V rail activates the status outputs. These outputs could be used to drive indicator l.e.d.s., but this is not something that I have found to be particularly useful in practice. If data is not being decoded correctly is usually pretty obvious anyway.

The data register ready input at pin 18 serves no useful purpose in a basic serial interface of this type, so it is simply wired to the 0V rail.

Clocking In

At low to medium baud rates a serial interface does not really require the precision of a crystal controlled clock generator, and a simple *C/R* oscillator gives quite good results. In this circuit a simple 555 astable circuit based on IC2 is used to provide the clock signal.

A low power CMOS 555 timer was used for IC2, but it should work equally well using a standard 555. The current consumption of the circuit will be increased from around 2mA or 3mA to about 9mA if a standard 555 is used.

The drawback of using a simple *C/R* oscillator is that it must be adjusted to give the correct output frequency before the interface will function correctly. The specified values give an output frequency that can be adjusted to 19·2kHz, which gives operation at 1200 baud. The output frequency is controlled by preset resistor VR1, which should ideally be a multi-turn "trimpot."

If possible, the output frequency at pin 3 of IC2 should be set to the correct figure with the aid of a Digital Frequency Meter. However, a suitable setting can be found by trial and error, and it is just a matter or trying various settings until you find one that gives properly decoded bytes of data. There should actually be a small range of settings that give good results, and VR1 is adjusted to the middle of this range.

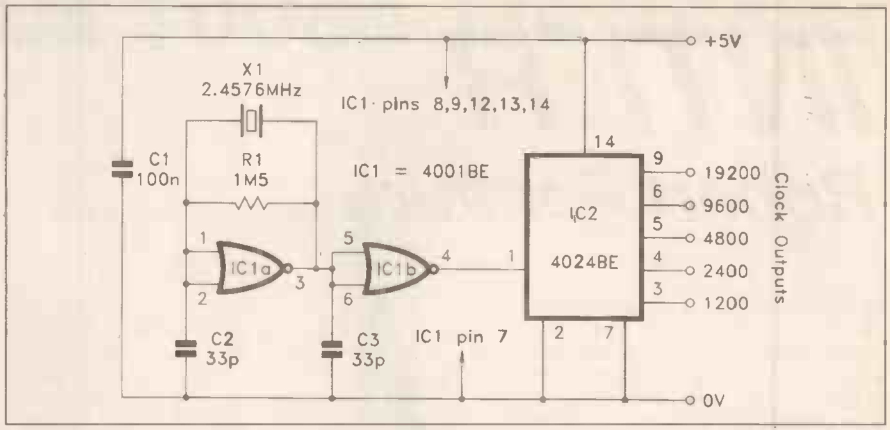


Fig. 2. Circuit diagram for a simple crystal controlled baud rate generator.

This circuit can handle other baud rates if the value of timing capacitor C2 is altered to suit. The output frequency is inversely proportional to the value of C2. A value of 1nF would therefore permit operation at 2400 baud, and a value of 4n7F would provide operation at 600 baud.

Remember that it takes at least ten clock cycles per byte, and that the maximum rate at which data can be received is only about one tenth of the baud rate. A baud rate of 1200 baud therefore supports a data flow of up to about 120 bytes per second.

Crystal Clear

A crystal controlled clock circuit is perhaps a better choice for high baud rates where relatively high clock frequencies are required. A circuit of this type does not have to be particularly complex, but it is inevitably more expensive due to the cost of the crystal.

A 2·4576MHz crystal is the most readily available type for baud rate generation, and Fig. 2 shows the circuit diagram for a baud rate generator based on a crystal having this operating frequency.

A CMOS 4001BE quad 2-input NOR gate is used for IC1, but in this application only two of the gates are actually used, and their inputs are wired together so that they operate as simple inverters. The unused gates have their inputs connected to the +5V rail so that they are not left vulnerable to static charges.

Gate IC1a is used in a conventional crystal oscillator circuit, and IC1b acts as a buffer stage. IC2 is a CMOS 4024BE seven stage binary counter, and its clock input is fed with the 2·4576MHz signal from IC1b.

The first two stages of IC2 are not used, but the other five outputs provide baud rates from 1200 to 19200 baud. Of course, the clock frequency is 16 times the baud rate, and the output frequencies from IC2 range from 19·2kHz to 307·2kHz.

Taking Advantage

If the crystal controlled baud rate generator is used, omit IC2, R5, R6, VR1, and C2 from the main circuit. Pin 17 of the 6402 UART is then driven from the appropriate output of the baud rate generator.

An advantage of the crystal controlled clock circuit is that there is no need for any setting up. With the computer sending at the right baud rate and with the correct word format, properly decoded bytes should always be produced.

However, do make quite sure that the computer's serial interface is set correctly, as many of the problems encountered with serial interfacing seem to be due to an inadvertent mismatch in the baud rate or word format.

Next Month: A circuit for serial transmission will be provided, plus details of how to use these circuits with a PC.

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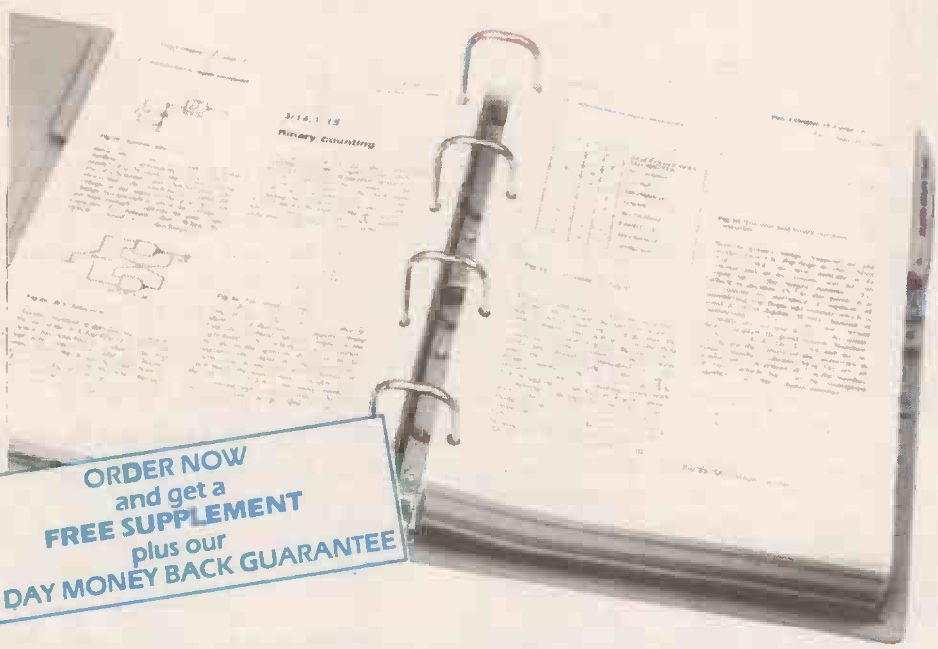

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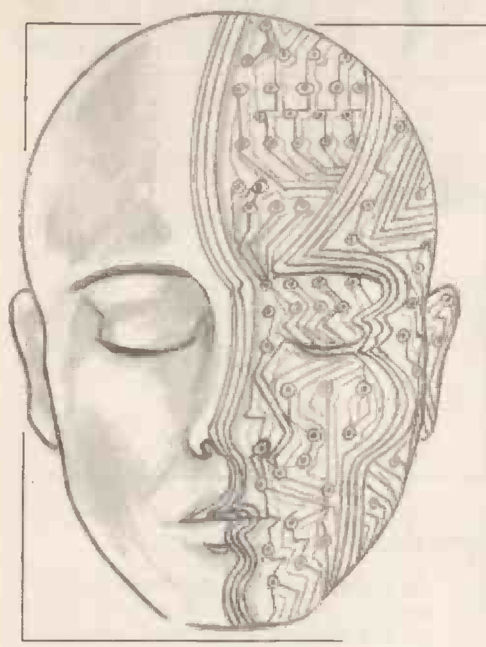

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D.C. Lamp Dimmer - let there be light

THE D.C. Lamp Dimmer circuit outlined in Fig. 1 will adjust the brightness of a d.c. lamp or the speed of a suitable d.c. motor. An oscillator is formed around the Schmitt inverter IC1a, and is buffered by IC1b. This in turn drives TR1 which is a Darlington power transistor.

The lamp LP1 forms the collector (c) load for the transistor and this is driven at a nominal 330Hz. The duty cycle is, however, fully variable using potentiometer VR1, and consequently the power delivered to the load can be controlled between 5 per cent and 95 per cent, approximately. No flicker will be apparent at this frequency. The circuit consumes little power itself and is ideal for controlling car instrument panel lights.

Martin Campbell,
Undercliffe,
Bradford, W. Yorks.

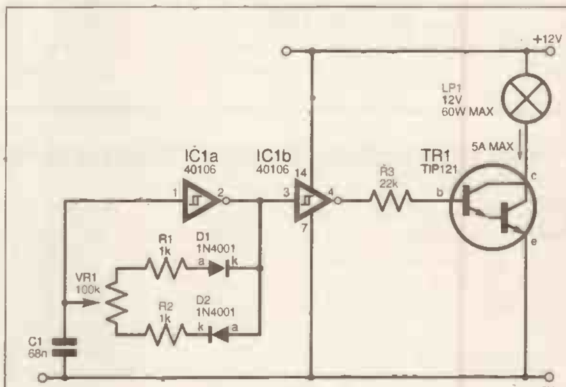

Fig. 1.

Infra-Red Headphone Link – cordless cans

ALTHOUGH not hi-fi, with my simple infra-red circuit it is possible to use headphones with no direct connection to the audio source. Fig. 2(a) illustrates a simple transmitter circuit suitable for connecting to an audio source. Diodes D1 to D3 are three infra-red light-emitting diodes in series, driven by TR2 an *n*-channel MOSFET transistor with a drain current rating of 500mA maximum. *(Listed in the Cricklewood Catalogue, Tel. 0181 450 0995 – A.W.).* The illumination of the l.e.d.s is modulated by the audio signal applied, with TR1 current-limiting and shunting the bias of TR2 to ground when TR2 source current exceeds roughly 100mA.

Potentiometer VR1 should be adjusted for best results. A 9V power supply is best used in this circuit due to the sustained level of current consumption. The transmitter range is about one to two metres but this can be extended by using reflectors behind the diodes.

A suggested receiver circuit, using an infra-red photodiode, D4, to detect the IR light, is shown in Fig. 2b. The received signal is a.c. coupled to TR3, another MOSFET.

The output is taken from the drain terminal via capacitor C5. Bias can be adjusted with pot. VR2, and this circuit will run from a PP3 size battery. The circuit could be adapted for other applications.

Upake de Silva, Age 15,
Nugegoda, Sri Lanka.

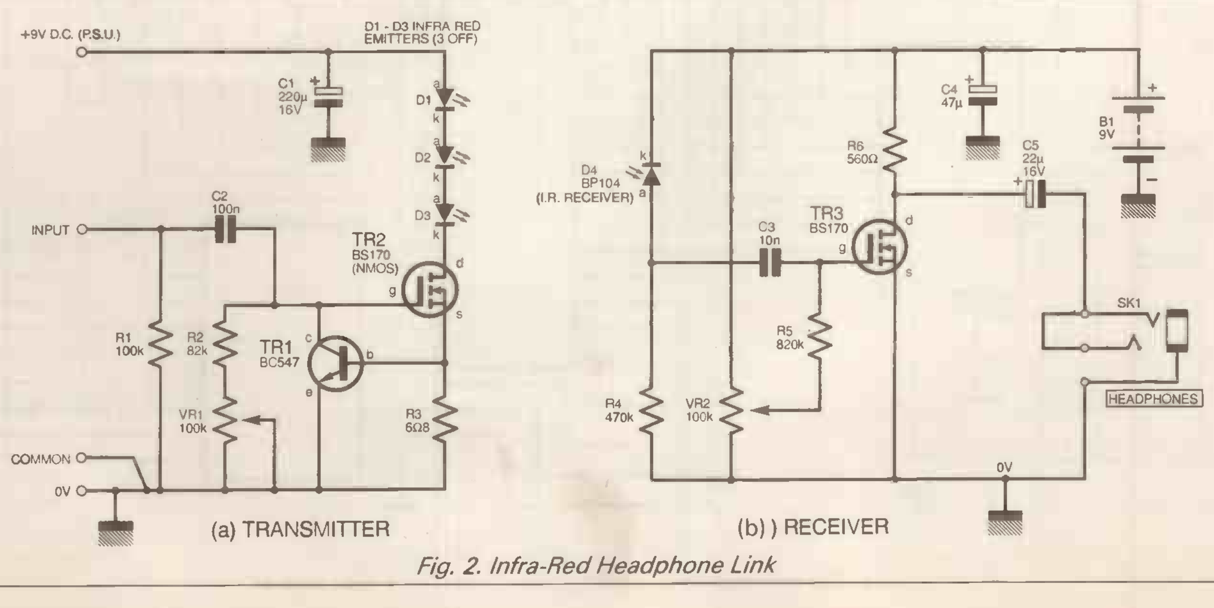

Fig. 2. Infra-Red Headphone Link

Remote Handset Tester

– check it out

THE DEVICE in Fig. 3 arose due to the constant number of requests I receive to help repair infra-red controllers for televisions and VCRs. This Remote Handset Tester is very useful and convenient, and could quickly pay for itself by helping to recover faulty remote handsets.

Pulsed infra-red light generated by the handset falls upon D1 which creates a pulse waveform across R1. This is capacitively coupled to TR1 base and an amplified signal is coupled by C2 to a pulse-stretching circuit based around TR2, C3 and associated components. Hence the driver transistor TR3 conducts and illuminates the l.e.d. D2 whenever infra-red light is received by D1.

A functional remote controller with fresh batteries will operate the tester from approximately 500mm whilst one with near exhausted batteries may only work over a few centimetres. Coincidentally, the design also self-tests its own battery by giving an initial flash of D1 when the switch S1 is first closed. The IR photodiode should be roughly a 940 nanometre type, whilst the transistor types themselves are not critical. The circuit will operate from a 6V to 12V rail (e.g. a 12V battery) and C4 decouples the power supply rails.

As a footnote, remote controls which have been dropped very often have a leg broken on the quartz crystal (usually 455kHz) or breaks between the IR emitter and driver transistor. Remotes contaminated by liquid spillage should be cleaned thoroughly with isopropyl alcohol or similar, using a lint-free cloth.

Kenneth G. Cargill,
Strathfoyle, Northern Ireland.

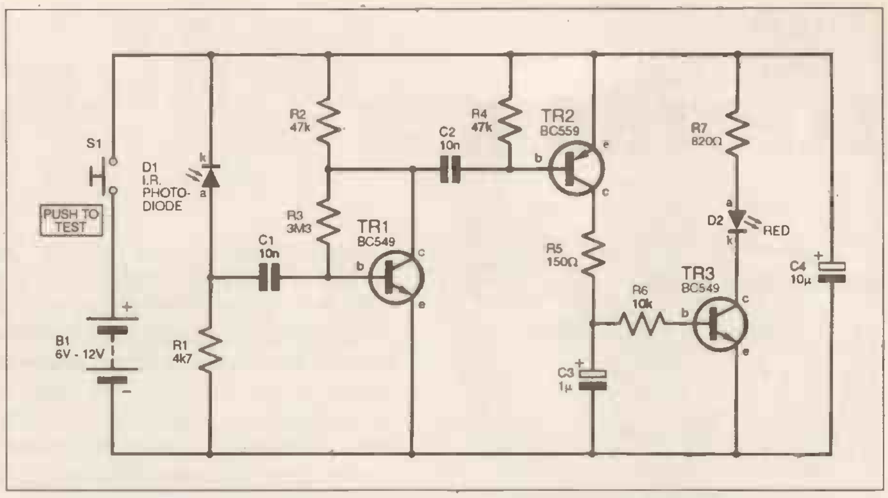

Fig. 3. Circuit diagram for the Remote Handset Tester.

Programmable Timer/Sequencer - done to a turn!

DESIGNED originally to assist with an exercise course for boxing practice, the circuit diagram of the Programmable Sequencer shown in Fig. 4 could be applied in a number of other timing uses. In my own application, the number of rounds and the duration of each round is selectable.

Prior to the start of each round, an audible tone is generated and a seven-segment l.e.d. display shows the round number. Prior to the end of that round, the buzzer sounds again. It could alternatively be used as an egg timer, for example, sounding before the eggs are "done" and the display can indicate soft, medium or hard.

In Fig. 4, IC1 is a 2240 timer/counter device which clocks up to 256 periods, the durations of which are determined by resistor R1 and capacitor C1. The 2240 has its reset and trigger pins (10 and 11) wired via a pushswitch S1.

The timer is used to operate a memory chip, IC2. I used a 27C64 64K (8K × 8) type which was adequate for boxing practice, but the device can be exchanged for other variants depending on the program required.

The first eight addressed bits are used by the timer/counter to step through the 256 steps available for each program. The other six bits are selected by an external switch network S2 to S7 which permits up to 2^6 programs, each of 256 steps. The 27C64 has eight outputs which was enough for a single digit l.e.d. display plus a piezo buzzer.

Access to an EPROM programmer is necessary, and working out the code to drive the display and buzzer can be tricky because each display bit is considered individually: any character possible with 7-bits can be used. I found it easy to set up the individual output codes as "labels" which were then used in the program. To write "1" to display, 00000011 was required so the label "One" was set up as this.

The EPROM requires a 5V rail which was derived from a 7805 voltage regulator running from a 12V battery, making it quite portable. An eight-Darlington buffer, IC3 was utilised to drive the l.e.d. display and sounder (WD1) directly. IC3 has open collectors which can be returned to a higher voltage than the +5V rail used, so it could power other loads.

David Dawson,
Barlaston, Stoke-on-Trent.

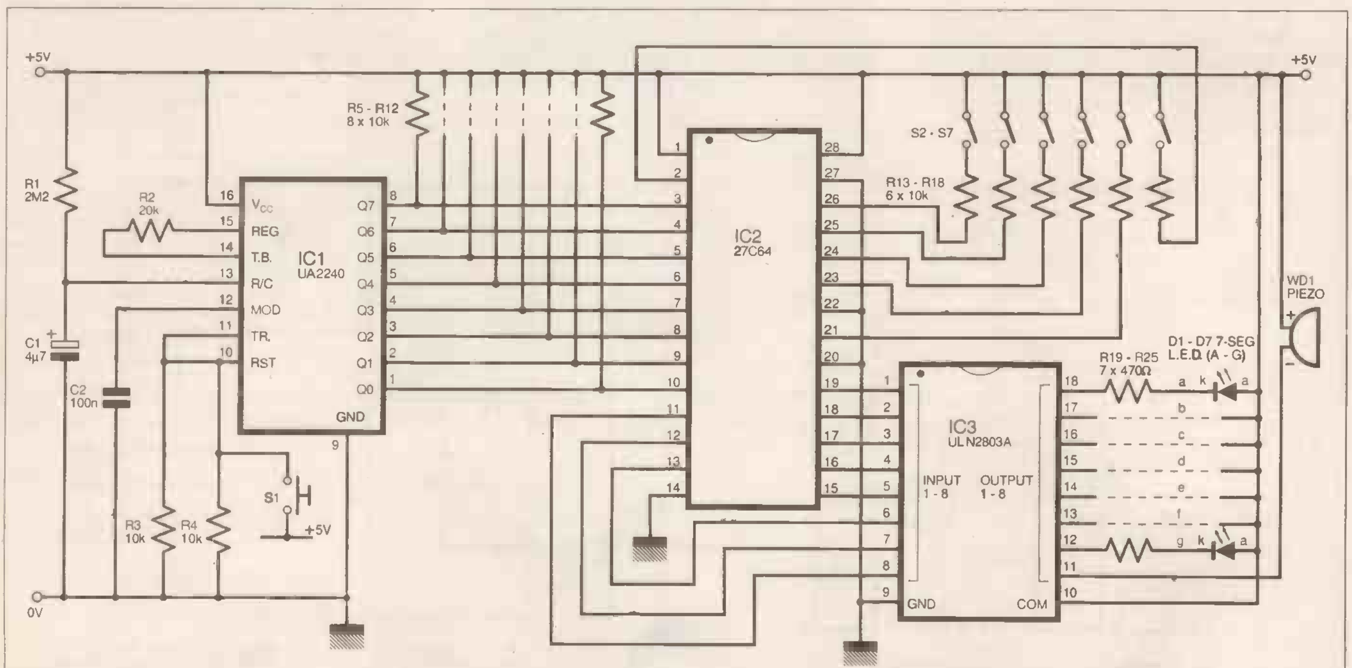

Fig. 4. Circuit diagram for a Programmable Timer/Sequencer.

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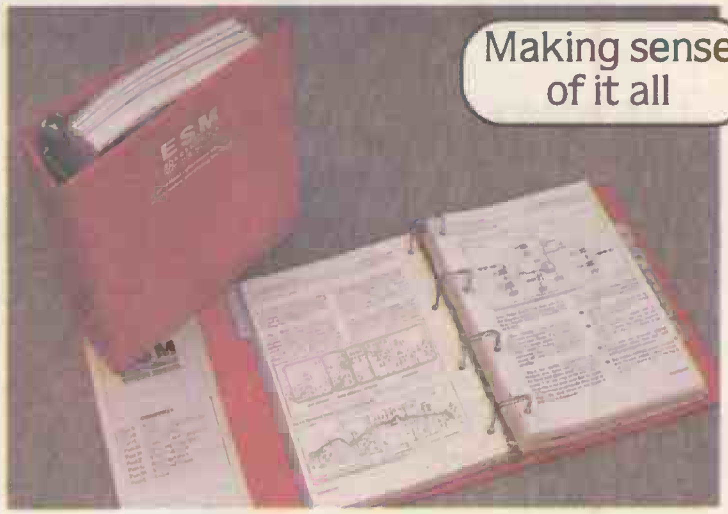

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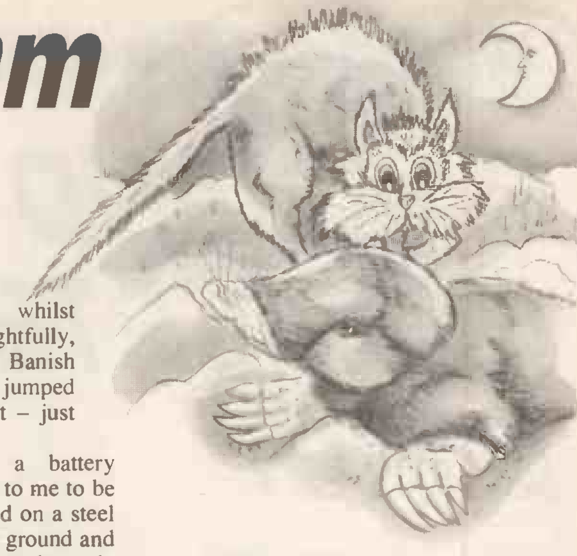
Ohm Sweet Ohm

Max Fidling



Buzz Off

Improvisation is one attribute which every electronics constructor possesses, and yours truly is no exception. Indeed, I see a great challenge in dreaming up a home-spun solution to the thorniest of problems, especially if it will save me money... and if I can recycle some of the junk which I've amassed in the workshop over the years, even better! (And the Boss will agree.)

One morning, having just awoken, I threw open the curtains in order to survey my prized garden in the morning sunshine, though at this time of the year it looks somewhat tatty, having been ravaged by a typical British Spring (i.e. wind, rain and more rain).

Peeking through the window at the lawn, I spotted a mound of freshly excavated soil – and another – *and another!* Dang it! A mole had struck in the middle of the night! Priding myself as I did on my horticultural expertise, this was seriously bad news, and meant war!

Armageddon Tough With It!

One trip to my garden centre later, I purchased a veritable armoury of anti-mole ballistic equipment, smoke bombs, and funny-smelling pellets. (I wasn't sure whether you're supposed to chuck the pellets at the mole or let him take a whiff of them; I presumed the latter.)

Back home, I started my hunt for the pesky pest. The mole smoke bomb didn't work, since I failed to seal up the molehill properly, and a plume of thick yellow smoke erupted out of the ground and engulfed me instead! The funny pellets clearly encouraged the mole to do more dastardly digging, judging by the state of the lawn the following day.

Over breakfast, in amongst the Sunday colour supplements I'd spotted one of those catalogues of mail order offers, and being gadget mad, I was flicking through the pages whilst munching my cornflakes thoughtfully, pondering my mole problem. Banish Moles Forever! The headline jumped out and registered a direct hit – just what I was looking for!.

The catalogue described a battery operated gadget which seemed to me to be like a vibrating buzzer mounted on a steel spike. This was driven into the ground and the sound would hopefully annoy the mole and drive him away. The downside was that they expected me to pay for this gadget with real money, which went against the grain! I started to ponder further.

Molecular Wait

I shuffled over to the workshop, munching some toast thoughtfully. I could soon make a buzzer-type vibrating thingy, and stick this in a box, I reckoned, and I could fix on a small length of copper pipe (surplus from my plumbing project in the attic).

A plan formed. Rooting around, I found a reel of enamelled copper wire and a large six inch nail, and a tin can... in five minutes I'd made an electromagnet using the nail and wire, and then I fashioned some contacts out of the tinplate: in fact I'd made a traditional electro-mechanical buzzer.

The tinplate was formed such that the electrical supply would flow through the contacts and activate the electromagnet, which would attract the tinplate contact and open it; this turned off the coil supply and released the contact again. This recurring opening and closing action produced a healthy buzzing noise, together with a fearsome green arc across the points, when I hooked it up to a battery for a test. A few adjustments to the contacts, and we were in business.

Timely Departure

A little more improvisation on my part produced a 555 timer circuit, driving a relay, which turned the buzzer on and off. I'd added an l.e.d. as a finishing touch, since no project was complete without one. Mounting the whole kit into a plastic box, with six inches of copper pipe protruding from the underside, and we were ready for battle!

The "Fidling Electronic Mole Repeller" was soon in place, as I plunged the gadget into the lawn next to the latest molehill, and flicked the switch. It started buzzing and flashing at intervals, to my intense satisfaction.

Next morning, I scurried into the garden to survey the battlefield; the gizmo was still flashing and buzzing, albeit more faintly, and there were some fresh earthworks heading in my neighbour's direction. I suddenly had a horrible thought – I peeped discretely over the garden fence into my neighbour's garden – my home-made repeller had indeed done its job because a large, fresh molehill was evident in his lawn instead! I went back in to feed the cat, trying to think of an excuse to get me off the hook for ruining Albert's croquet lawn.

Piddles, though, was back in the garden, felinely enjoying the convenience of freshly dug soil!

Constructional Project

BAT BAND CONVERTER B.F.O.

BILL MOONEY

Translate "bat talk" to a more realistic sound by adding this small board to last month's Bat Band Converter.

ENVELOPE detection as used in last month's Bat Band Converter is a very satisfactory method of generating an audible representation of the ultrasound produced by bats.

Faithful translation of the bat pulses to our audio range in a product detector/mixer results in on/off pulse tones. However, the pulse length is so short that we only hear a series of clicks in most cases. The characteristics are nonetheless different to envelope detection.

Adding a Beat Frequency Oscillator (B.F.O.) to the Bat Band Converter/Radio set-up results in a degree of product detection and restores some tonal information to the envelope. The effect is to add colour to the sound and it certainly makes the translation seem more realistic.

If the ultrasound signal is random noise there is little difference in sound quality. But when a pure tone is involved from, say, a watch crystal at 32·768kHz or a combination of simple resonances from the jingle of coins, the effect is quite impressive.

As for bat detection, the sound is certainly more impressive with a B.F.O. and the lower pulse rates in particular are more plausible. As the bat pulse may sweep across the radio pass band and only produces an audible heterodyne when it is close to the B.F.O. frequency, say plus or minus 10kHz, we never get a Morse code-like on/off bleep.

In keeping with the Bat Band Converter, no electrical connection is required to the Radio Receiver and there is plenty of room in the present Converter box lid to take the miniature, printed circuit board – see photograph.

CIRCUIT DESCRIPTION

The full B.F.O. circuit diagram is shown in Fig. 1. It uses a surface mount field effect transistor (f.e.t.) to make up a basic Colpitts oscillator. The high inductance to capacitance ratio means that it can be tuned from about 400kHz to 500kHz using the trimmer capacitor TC1. This will cover any radio i.f. likely to be encountered.

Total current consumption is about 1·5mA depending on the spread in f.e.t. characteristics. The power supply will normally be the same as that used for last month's Converter and therefore, since the B.F.O. will go on working down below 4V, a very long life can be expected from a PP3 battery.

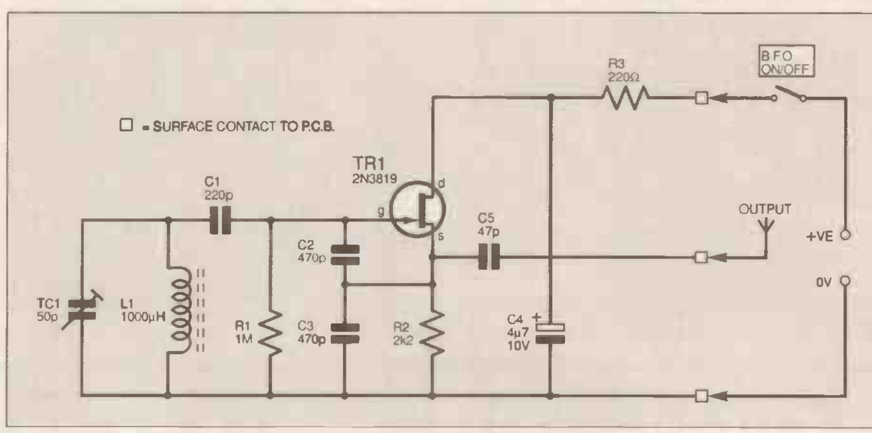


Fig. 1. Complete circuit diagram for the B.F.O.

The output from the B.F.O. is taken from the source (s) terminal of TR1 through C5. A small aerial may or may not be needed depending on how effectively the radio i.f. amplifier is screened. The r.f. output at C5 is about 2V peak and the aerial should not need to be longer than about 30cm.

CONSTRUCTION

A simple circuit of this type is easily put together, with a little patience, in a compact form using SMDs (Surface Mount Devices). In fact, the B.F.O. is built up on a very small double-sided (only one side etched), surface mount p.c.b. This board is available from the *EPE PCB Service*, code 984a/b. (It was combined with last month's Bat Band Converter p.c.b.).

The board component layout and full size copper foil track master pattern are shown in Fig. 2. When it comes to making up this p.c.b. the f.e.t. TR1 should be placed last.

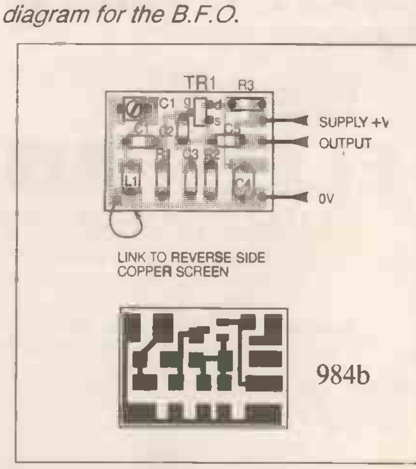


Fig. 2. Printed circuit board component layout and copper foil master pattern.

The output capacitor C5 crosses a track and it needs to be placed squarely on its pads. Don't forget to connect the reverse side copper as a "screen", a small loop of Kynar wire snugly fitted around one edge of the p.c.b. will suffice. The supply decoupling capacitor C4 is not at all critical as long as it has a case size "B" to fit on the copper pad sizes given.

The type 3204 sealed trimmer capacitors

COMPONENTS

B.F.O.

See SHOP TALK Page

Resistors
R1 1M (EIA code 105)
R2 2k2 (EIA code 222)
R3 220Ω (EIA code 222)
All surface mount (SMD), size 1206

Capacitors
C1 220p COG dielectric, 50V
C2, C3 470p COG dielectric, 50V (2 off)
C5 47p COG dielectric, 50V
All above SMD size 1206
C4 4μ7 SMD tantalum 10V, case size B
TC1 50p sealed SMD trimmer, type 3204

Semiconductor
TR1 2N3819 j-f.e.t. in SMD SOT23 package

Miscellaneous
L1 1000μH fixed (10%), SMD type CM45 or similar
S1 min. on/off toggle switch
Printed circuit board available from *EPE PCB Service,* code 984a/b (combined with Converter p.c.b.); 1mm socket and plug; Kynar (wirewrapping) insulated wire; multistrand connecting wire; solder etc.

Approx Cost Guidance Only **£12** *including p.c.b.*

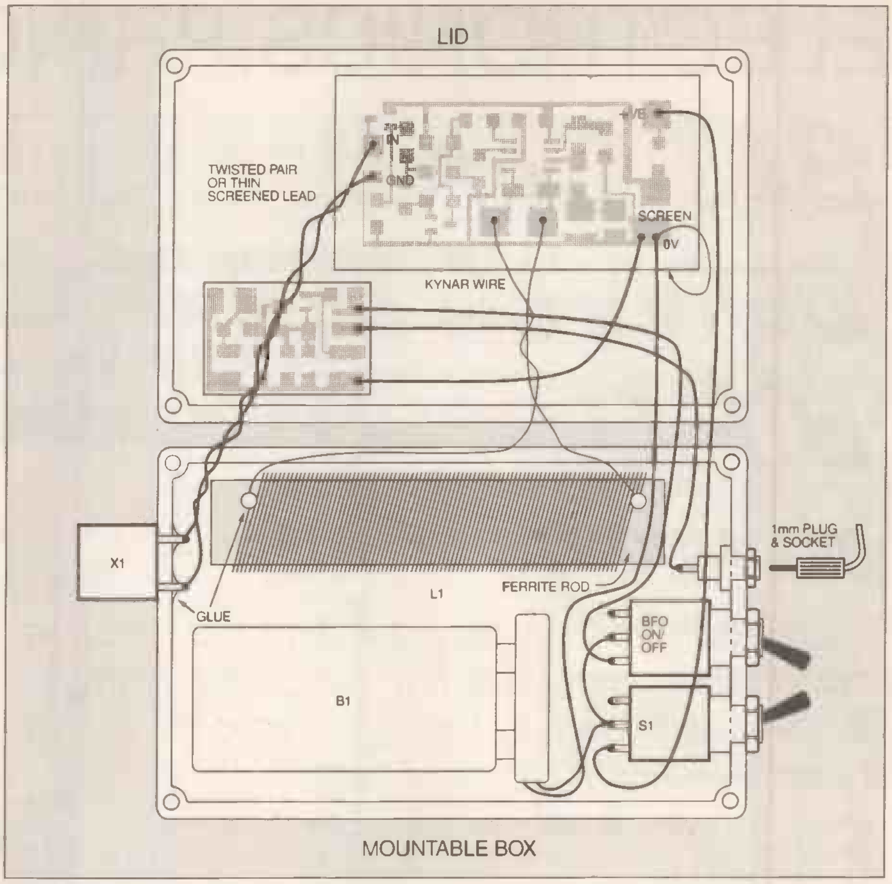


Fig. 3. Wiring the B.F.O. board, additional switch and output socket into last month's small Bat Band Converter case.

have a small blob of silicone rubber on top to prevent ingress of solder during wave soldering. This is best removed with a pair of tweezers as it tends to cause a little backlash.

Even with the 1206 sized SMD chips, commonly used for hand working, this unit is quite small and in particular it has a very low profile. It could be slotted inside a portable radio where it may have other uses when not bat spotting. This option may be preferred if it is difficult to get enough injection of the carrier with a particular receiver or where it has a short wave band.

However, for this project it will fit neatly in the lid of the Converter box, see photograph. The output is taken to a 1mm socket and it will need its own on/off switch. The full wiring diagram is shown in Fig. 3.

TESTING

To get the B.F.O. up and running, first check that the current is around 1·5mA. This can be done by measuring the voltage drop across resistor R3, about 0·35V.

Tune the radio to a weak station at the low frequency end of the medium wave. With the B.F.O. close-by a strong heterodyne should be heard. If the beat frequency is very weak you will need to increase the level of injection by connecting a short length of wire to the B.F.O. output, trailing it over the receiver.

Next, adjust trimmer capacitor TC1 for zero beat. Check that all stations on the band produce a heterodyne. The second harmonic of the B.F.O. will appear between 910kHz and 940kHz.

Finally, switch on the Bat Converter and tune the radio to the maximum sensitivity position. Whilst rattling some keys or coins, switch on the B.F.O. The sound should become more realistic and metallic.

Excessive B.F.O. injection will begin to operate the radio's a.g.c. (automatic gain control). This will reduce the sensitivity of the system but it may be used as a means of controlling the system gain.

The continuous tone from a quartz watch or clock crystal makes little impression on the envelope detector but you should be able to detect it as a whistle with the B.F.O. switched on. It is not always very strong so that the transducer needs to be placed quite close to the clock mechanism.

The signal should appear just below the high sensitivity peak at 40kHz on the carrier side. There may be one or two heterodynes from distant medium wave stations so that care is required to find the correct signal. □

First prototype B.F.O. board installed in the lid of the Bat Band Converter (last month).

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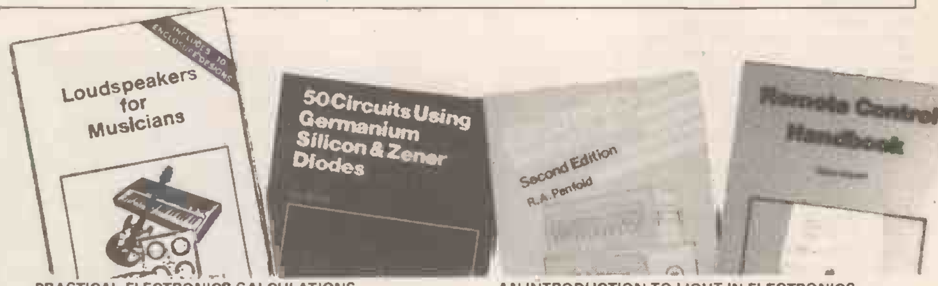

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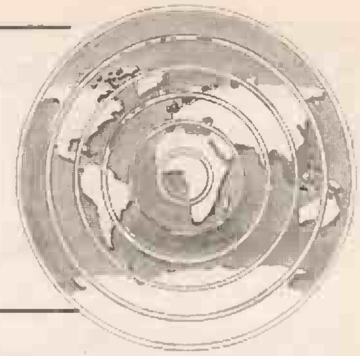

Tony Smith G4FAI

FREQUENCY CLASH

The Radio Society of Great Britain has issued a statement about the possibility of a clash between a number of services sharing the same frequency allocation and radio operated remote controlled car keys, which have been allocated a frequency of 433·92MHz throughout Europe. This frequency lies within a band allocated to UK Government services as primary users, which is also allocated to licensed radio amateurs on a secondary basis.

A clash can occur, says the RSGB, because designers of vehicle security systems do not appear to have taken sufficient account of the fact that the frequency allocated to vehicle radio keys is on a "secondary unprotected" basis. This means that users of such devices may suffer interference from other authorised radio users.

Vehicle immobilisers which set themselves automatically, and can only be turned off by using a radio key, are a recent development and are likely to suffer problems in certain locations where the radio key cannot be used, and the vehicle has to be towed away.

Although such problems may be caused by licensed amateur radio transmitters, they have also been reported to have been caused by non-amateur transmissions in locations such as Portsmouth Harbour, Crystal Palace and Fylingdales.

The RSGB observes that blocking of radio operated keys would be much less likely if designers took the following steps. It has put all of these points to the Radiocommunications Agency:

Use better quality receivers as some types cannot distinguish between the wanted signal from the key and signals from other sources on nearby frequencies.

Use radio keys that transmit higher power. Those currently in use typically only transmit a hundredth of the maximum power they are allowed to use.

Put the receiving aerial inside the car window instead of burying it inside the car's wiring harness. This would allow the driver to hold the key right next to the aerial if necessary.

An alternative frequency allocation for radio operated vehicle keys would be welcomed by the RSGB, but by far the best solution to the problem would be to use infra-red keys instead of radio operated keys.

BAND STATUS

Although amateur bands are allocated on a primary or a secondary basis, amateur stations themselves, apart from beacons and repeaters, have no protection from undue interference from other authorised services.

Additionally, amateur stations using frequencies allocated on a secondary basis must not cause undue interference to other stations of a primary or permitted service to which frequencies have been assigned.

However, the "secondary unprotected" basis of the frequency allocated for vehicle radio keys means that radio amateurs are under no obligation to avoid that frequency. It is the responsibility of manufacturers to ensure that their products cannot be adversely affected by interference from other radio sources.

RSGB SURVEY

By the time this appears in print, the RSGB's planned survey of all radio amateurs and other interested parties, may have been announced. As reported previously, its purpose is to obtain the views of all concerned (not just RSGB members) on the future qualifications and licensing structure of the UK Amateur Service.

At the same time, the International Amateur Radio Union's "Future of the Amateur Service ad-hoc Committee" (FASC), is looking at the international regulations to decide what changes, if any, are needed to take amateur radio into the next century.

The RSGB's survey is being organised by its Licensing Advisory Committee. According to the committee's chairman, Ian Suart GM4AUP, the information obtained will allow the RSGB to be well briefed on UK opinion in time for the IARU Region 1 conference in Tel Aviv later this year.

ONLY OPPORTUNITY

The RSGB survey is vitally important. It could result in fundamental changes, altering the image of amateur radio for ever. After years of controversy, it offers an opportunity to finally establish the views of the UK amateur community on the future structure of the hobby.

Discussions will continue round the world over the next three years, and decisions will finally be taken at the ITU *World Radio Conference in* 1999.

Because of the IARU 3-year regional conference cycle, however, discussion and input from Region 1, which includes the UK, must take place this year.

MILLENNIUM COMMITTEE

Yet another consultative process has been announced by Peter Sheppard G4EJP, RSGB President for 1996, whose presidential theme is "consultation."

Whilst the core activities of the Society will remain unchanged, he feels that new developments such as computers, data, the Internet, novice operation, the trend to use commercial equipment and the imminent *Phase 3D* satellite launch, will all have a bearing on the everyday activities of the Society and its members.

He has formed a Millennium Committee "with the objective of laying the groundwork for the Society during the period 1996 to 2000 and beyond." RSGB members who feel strongly about any matter relating to amateur radio have been invited to submit their views.

It will be interesting to see the results of both the survey and the conclusions of the Millennium Committee. Much revolves around the use of computers in radio communication. Some amateurs see the future linked more and more with computing, and argue that today's computer enthusiasts represent a vast source of recruitment to amateur radio, particularly if the entrance requirements can be relaxed.

Others see that route as detrimental. They forecast that amateur radio could eventually become just a branch of computing, and that the hobby as they know it today, with its many varied activities, would be lost forever.

ROLE OF THE IARU

In all these discussions, the International Amateur Radio Union has a vital role to play in formulating the future pattern of amateur radio.

The IARU is a worldwide association of national radio societies, with its secretariat located at the ARRL HQ in the United States, and is subdivided into three Regions.

Region 1, of which the UK is a member, covers Europe, Africa, the Middle East and the C.I.S., and has a membership of over 70 countries. *Region 2* covers North and South America, while *Region 3* covers Australasia and most of Asia.

Each Region holds a conference once every three years. The next Region 1 conference will be later this year, and the other Regions will meet over the following two years. So by 1998 all Regions will have considered and discussed the FASC proposals ready for the *World Radio Conference* in 1999.

The IARU cannot attend WRCs by right, only by invitation. However, the ITU does recognize the interest of the IARU in any proposed change to the regulations affecting amateur radio. That was why *WRC-95* decided to defer until 1999 the proposal by New Zealand to abolish the amateur Morse test.

This delay gives the IARU time to consult all member societies and decide on its position before the proposal is debated. It wants the discussion at *WRC-99* to extend beyond the Morse issue, to cover all regulatory aspects of amateur radio. That is why it is so important for all amateurs to express their views in the forthcoming consultation exercises.

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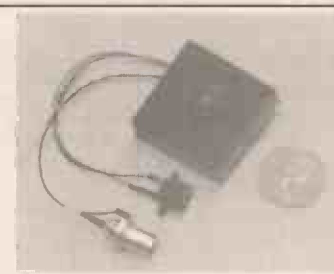

This super quality CCD camera can be connected into your existing TV or video using the AV channel and can be used for discrete surveillance or observing your property externally using a suitable weatherproof housing. Can accommodate lighting levels ranging from daylight to street lighting using its built in electronic shutter. Excellent when using with an infra red source. Built in wide angle fixed focus lens the camera has a resolution of 380 TVL. Can be housed inside an empty floodlight case, (extra).

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That's the CDJ2600 from Soundlab! It's the twin CD for DJ's that does just about everything you could possibly ever need.

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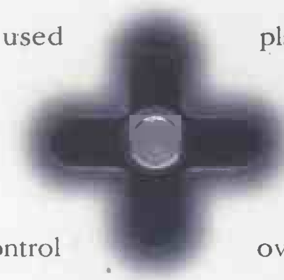

An innovative joystick gives you total control over the comprehensive loop facilities: simply pushing the stick upwards memorises the loop start point and pulling it downwards marks the end point, giving a single repeat. Should you then pull the joystick down during the loop, it will repeat continuously.

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