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APRIL 1993

INCORPORATING ELECTRONICS MONTHLY

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FREE INSIDE 32 PAGE GREENWELD SPRING CATALOGUE SUPPLEMENT

MIND MACHINE MK II

– A "Programmable" Audio/Visual Mind Entrainment Project

UNIVERSAL DATA LOGGER

FOG LIGHT ALERT

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

MICROWAVE CONTROL PANEL Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. Now only £4.00 ref 4P151. Good experimenters board.

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R or £2 a metre.

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R. Gives up to 15v.

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R. Turn your camcorder into a cordless camera!

FM TRANSMITTER Housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R. Good range device.

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases and earpieces. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR.

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £19 ref 19P14R. Ideal for listening all over the world.

CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £19.00ref 19P30

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R. Ideal for garden use or as an educational toy.

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R, 4 x D's £9.00 ref 9P12R, 1 x PP3 £6.00 ref 6P35R Pack of 10 AAA,s £4.00 ref 4P92R.

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. New ed. £20.00 ref 20P32R.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158R. 35mm square.

FM BUG Built and tested superior 9v operation £14.00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R. Limited stocks.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R 800 rpm.

ELECTRONIC SPEED CONTROL KIT for C5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R. Potentiometer control.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R. 2xC cell model £6.00.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes New low price £15.00 ref J15P4

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. **New low bargain price only £2.00 ref B2P1**

25 WATT STEREO AMPLIFIER IC. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.

12V 19A TRANSFORMER Ex equipment £20 but OK.

ULTRASONIC ALARM SYSTEM. *Once again in stock these* units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system now only £19 !!!

POWER SUPPLIES Made for the Spectrum plus 3 give +5 @ 2A, +12 @700mA & -12 @ 50mA. £8 ref Q8P3

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92R. Ideal for tea on the move!

LED PACK .50 red, 50 green, 50 yellow all 5mm £8.00 ref 8P52

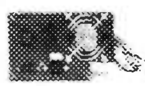
IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R. 3 metre version £6.00 ref 6P50.

COPPER CLAD STRIP BOARD 17" x 4" of 1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.

STRIP BOARD CUTTING TOOL £2.00 ref 2P352R.

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries. Complete with hand charger & solar panel 14P200R. Set of 2 AA nicads £2 ref L2P9

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A, +12 @ 5A, -12 @ .5A, -5 @ .3A. Fully cased with fan, on/off switch, IEC inlet and standard PC fly-leads. £15.00 ref F15P4



TELEPHONE HANDSETS 10 brand new handsets with mic and speaker only £3.00 for 10 ref 3P146R

BENCH POWER SUPPLIES Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R

SPEAKER WIRE Brown twin core 100 feet for £2.00 REF 2P79R

MICROSCOPE 1200X MAGNIFICATION Brand new complete with shrimp hatchery, shrimps, prepared slides, light etc. £29.00 ref J29P4.

LIGHT ALARM SYSTEM Small cased alarms that monitor a narrow beam area for sudden changes in light level. Complete with siren that sounds for a preset time when unit is triggered. £7.00 ref J7P1

720K 3 1/2" DISC DRIVE FOR £9 Brand new units made by JVC complete with tech info just £9.00!! they have a metal tab instead of a button and you may want to fit an led. Combined power and data cable easily modified to IBM standard. ref L9P2.

MONO VGA MONITORS £59 Standard IBM compatible monitor made by Amstrad. New Our price just £59. Ref 59P4RB.

CAR BATTERY CHARGER Brand new units complete with panel meter and leads. 6 or 12v output £7.00 ref J7P2.

CUSTOMER RETURNED SPECTRUM +2 Complete but sold as seen so may need attention £25.00 ref J25P1 or 2 for £40.00 ref J40P4

CUSTOMER RETURNED SPECTRUM +3 Complete but sold as seen so may need attention £25.00 ref J25P2 or 2 for £40.00 ref J40P5

AMSTRAD 1640DD BASE UNITS
BRAND NEW AND CASED
TWO BUILT IN 5 1/4" DRIVES
MOTHER BOARD WITH 640K MEMORY
KEYBOARD, MOUSE & MANUAL
OUR PRICE JUST

£79!!!!

SCART TO D TYPE LEADS Standard Scart on one end, Hi density D type (standard VGA connector) on the other. Pack of ten leads only £7.00 ref 7P2R

OZONE FRIENDLY LATEX 250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R

VIEWDATA SYSTEMS Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R

COMMODORE 64 COMPENDIUM Pack consisting of a Commodore 64 computer, power supply, data recorder and software. All for £69 ref Q69P1.

PPC MODEM CARDS Made for the Amstrad PPC1640/1512 range these are plug in modules that operate at 2400 baud. No data. £15 ref Q15P5.

AMSTRAD LQ3500 PRINTER ASSEMBLIES Entire mechanical assemblies including print head, platen, cables, stepper motors etc etc. infact everything bar the electronics and case! Our price just £10 ref Q10P3.

AMSTRAD DMP4000 PRINTER ASSEMBLIES Entire printer assemblies including print head, platen, cables, stepper motors etc. Everything bar the electronics and case. Our price just £20 ref Q20P2.

TOROIDAL TRANSFORMER 146VA with tappings at 8v, 10v and 32v will give 50v at 3A or 32 at 4A etc. Centre tapped primary. £9 ref Q9P2. Fixing kit is £2 ref Q2P1.

AERIAL BRACKETS Wall plate 7.5" sq complete with rawl bolts, 10" stand off brackets with standard tube clamps. Will take up to 2" mast. Substantial bracket (would take body weight). £7 ref Q7P1.

TV SOUND RECEIVERS Popular units that with the addition of a speaker act as a tv sound receiver. Ideal as a stand alone unit or for connecting into HI FI!. £12 ref Q12P4

2,000 COMPONENTS FOR £3 Yes thats right! just send us £3 and you can have 1,000 resistors plus 1,000 capacitors! Our choice of value. Order ref Q3P1.

ETRI FANS Mains, 11 watt 80mm diameter. £6. Ref Q6P3.

LIGHTGUNS Originally made for the Spectrum+2 but may have other uses (good stripper). £2 Ref Q2P3

GX4000 GAMES CONSOLES Complete with motor racing game, psu and joystick. £15 ref Q15P3. Extra 4 games £12 ref Q12P2

VCR RABBIT SYSTEM Lets you control your VCR from a second set using the VCR remote control. Retail £99 ours £39!!!

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

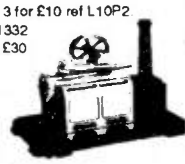
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

FAX 0273 323077

VISA

CAMERAS Customer returned units. 3 for £10 ref L10P2

STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R

HANDHELD TONE DIALLERS Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R

AMAZING TALKING COINBOX! Fully programmable talking, lockable coinbox BT approved, retail price is £79 ours is just £29! ref J29P2.

ANSWER PHONES £15 Customer returned units with 2 faults one we tell you how to fix the other you do your self! £18 ref J18P2 or 4 for £60 ref J60P3 BT approved (retail price £79.95!! each)

COMMODORE 64 MICRODRIVE SYSTEM Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The orginal price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R

90 WATT MAINS MOTORS Ex equipment but ok. Good general pupose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.

EMERGENCY LIGHTING SYSTEM Fully cased complete with 2 adjustable flood lights. All you need is a standard 6v lead acid battery. Our price is just £10 ref J10P29

AMSTRAD 464 COMPUTERS Customer returned units complete with a monitor for just £35! These units are sold as faulty and are not returnable.

WOLSEY DMAC DECODERS Made for installation in hotels etc as the main sat receiver no data but fully cased quality unit. £20 ref K20P1. Suitable psu £8 ref K8P3.

REMOTE CONTROLS Brand new infra red CONTROLS originally made for controlling WOLSEY satellite receivers. £2 ea ref K2P1 or 20 for £19 ref K19P1.

TELEPHONES Modem 1 piece phones BT approved. Last no redial. £8 ref K8P1.

386 TOWER SYSTEMS Tower case 52cmx40cmx20cm. 2 fans, speaker, 275w psu, IEC I/L and O/L, 386 m/board with onboard disc controller, ethernet, display driver, parallel and serial ports. **There are several IC's missing from the m/board plus no data! £79 ref K79P1.**

DOS PACKS Complete set of PC discs with MS DOS 3.2, Locomotive basic, gemdesktop and gem paint. No manuals, 5 1/4" discs. £10 ref K10P2

CORDLESS TIE CLIP MICROPHONE transmits between 88-108MHZ FM 5.2cm x 2cm, uses LR44 watch battery. Complete with wire aerial & battery. £16 ref K16P1.

CHASSIS MOUNT TRANSFORMERS
240v primary, 12v secondary 20VA £2 ref K2P2
240v primary, 16v secondary 10A (split winding). £10 ref L10P1

100 RED LED PACK (5MM) £5 REF K5P2

12V STEPPER MOTOR Ideal for models etc. 3" dia. £2 ref J2P14.

INFRA RED BEAM SWITCH 24v DC 5m range source & sensor housed in plastic case. £12 ref J12P1.

CAPACITOR BARGAIN PACK 100 CERAMICS £2 REF J2P2.

SPECTRUM JOYSTICKS TWO FOR £5 REF J5P2.

AMSTRAD PC CASE, POWER SUPPLY AND 720k FLOPPY DRIVE ALL THIS FOR £30 REFQ30P15

BUMPER PACK NO 1 10 of our popular £1 packs for just £5 our choice of contents.

BUMPER PACK NO 2 25 of our popular £1 packs for just £12. Our choice of contents.

LCD 1 X 32 DISPLAY Bargain price of just £3 complete with loads of data for a similar display. £3 ref L3P1.

USEFUL POWER SUPPLIES. 18v 900mA dc output (regulated) fully cased with mains cable and DC out cable. £6 ref K6P1.

UNCASED PC POWER SUPPLIES. Standard PC psu without case, fan etc. Good for spare or low cost PC!. £4 ref L4P6.

RADAR DETECTORS. Detects X and K bands (ie speed traps). Not legal in the UK so only available if you intend to 'export'it. £59 ref J59P1.

100 WATT MOSFET PAIR. Same spec as 2Sk343 and 2SJ413 (8A,140v, 100w) 1 N channel and 1 P channel. £3 a pair ref J3P9.

LOW COST CAPS. 1,000 capacitors £3 (33uf,25v) ref J3P10.

VELCRO. 1 metre length 20mm wide, blue. £2 ref J2P16.

JUG KETTLE ELEMENTS. Good general purpose heating elements just £2 ...

VERY BIG MOTOR. 200v induction 1.1kw 1410 rpm 10"x7" GEC 1" keyed shaft. Brand new. £95 ref J95P1.

BIG MOTOR. 220-240v 1425rpm 2.8A 5/8th" keyed shaft GEC 6.5" x 8" complete with mounting plate. £38 ref J38P1.

SMALL MOTOR. Electrolux 160 watt 3,000 rpm, 220-240v 5/8" shaft precision built £18 ref J18P1.

EPROMS 27C64 PACK OF 10 £7 REF M7P1.

EPROMS 27C256 PACK OF 10 £9 REF M9P1.

EPROMS 27C512 PACK OF 10 £10 REF M10P1.

MODEMS FOR £1.25? These modems are suitable for stripping only hence they are only 4 for £5 ref J5P3.

SOLAR POWERED WOODEN MODELS. Complete with solar panel, motor and full instructions. £9 ref J9P2. 3 diff £20 ref J20P3.

SOUND OPERATED LIGHT. Clap your hanus and light comes on. Turns after preset delay. (4 AA's req'd). £2 ref J2P3.

FERGUSON SRB1 REMOTE CONTROLS. Brand new units ideal for a spare or have two remotes! £4 each.

5 1/4" 360K DISC DRIVE Made for AMSTRAD 1640/1512 machines. White front. Our price just £9 ref Q9P1.

1993 CATALOGUE AVAILABLE WITH ALL ORDERS IF REQUESTED OTHERWISE A4 SAE FOR FREE COPY.

IN SUSSEX? CALL IN AND SEE US!

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

EVERYDAY WITH PRACTICAL
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

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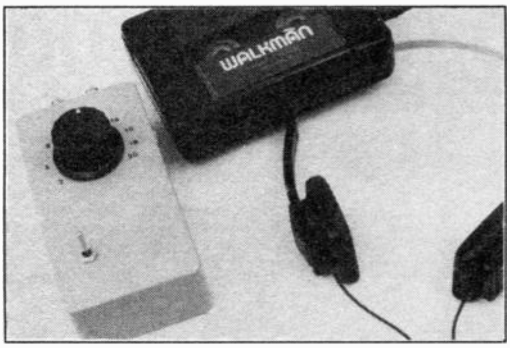
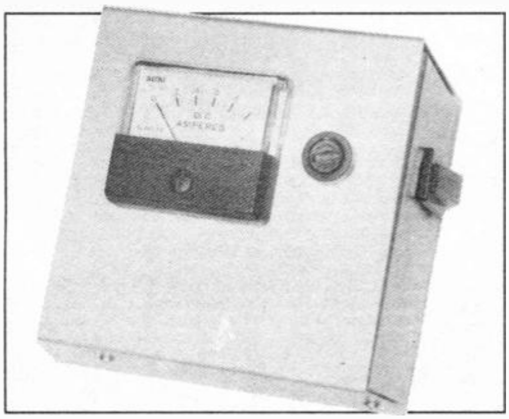
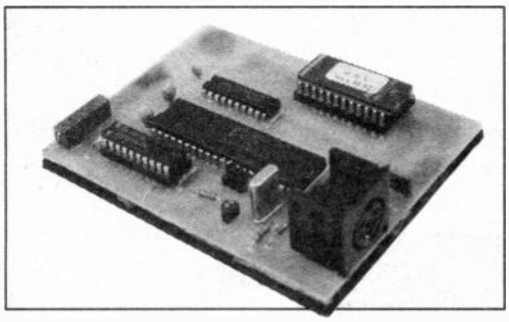
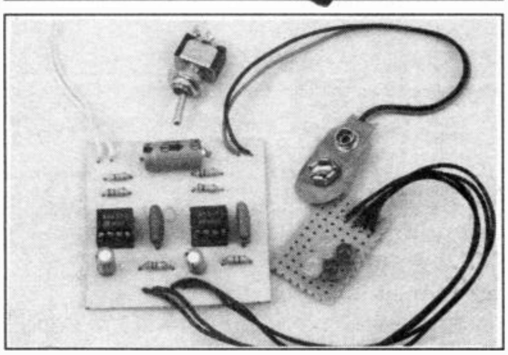
ISSN 0262 3617
PROJECTS ... THEORY ... NEWS ... COMMENT ... POPULAR FEATURES ...









Projects

Series

Features

Our May '93 issue will be published on Friday, 2 April 1993. See page 235 for details.

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THE *ORIGINAL* SURPLUS WONDERLAND!

Surplus always wanted for cash!

LOW COST PC SPECIALISTS - ALL EXPANDABLE - ALL PC COMPATIBLE

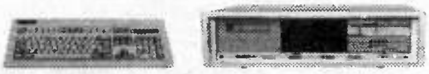
8088 XT - PC99

- 256k RAM - expandable to 640k
- 4.7 Mhz speed
- 360k 5-1/4" floppy
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Factory burnt-in
- Standard 84 key keyboard
- 12" green screen included
- In good used condition

Optional FITTED extras: 640K RAM £39. 12" CGA colour monitor with card £39. 2nd 5-1/4" 360K floppy £29.95. 20 mbyte MFM hard drive £99.

Only £99.00 (F)

286 AT - PC286



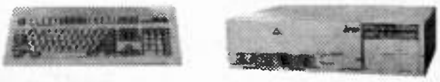
- 640k RAM expandable with standard SIMMS
- 12 Mhz Landmark speed
- 20 meg hard disk
- 1.2 meg 5-1/4" floppy
- 1.4 meg 3-1/2" floppy
- EGA driver on board
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Co-processor socket
- Enhanced 102 key keyboard
- Clock & calendar with battery back up

BRAND NEW AND BOXED!

Only £249.00 (F)

The Philips 9CM073 is suggested for the PC286 and the CM8873 for the PC386. Either may use the SVGA MTS-9600 if a suitable card is installed. We can fit this at a cost of £49.00 for the PC286 and £39.00 for the PC386.

386 AT - PC386



- 2 meg RAM expanded by slots
- 20 Mhz with 32k cache. Expandable to 64k
- 40 meg hard disk
- 1.2 meg 5-1/4" floppy
- VGA card installed
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Co-processor socket
- Enhanced 102 keyboard
- Kwik Disk Accelerator Software - FREE

BRAND NEW AND BOXED!

Only £425.00 (F)

FLOPPY DISK DRIVES

5¼" from £22.95 - 3½" from £21.95!

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are 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).

3.5" **Panasonic** JU363/4 720K or equivalent	£29.95(B)
3.5" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only*	£29.95(B)
3.5" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£29.95(B)
5.25" EXTRA SPECIAL BRAND NEW Mitsubishi MF501B 360K. Absolutely standard fits most computers	£22.95(B)

*** Data cable included in price.**

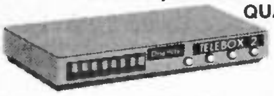
Shugart 800/801 SS refurbished & tested	£175.00(E)
Shugart 851 double sided refurbished & tested	£275.00(E)
Mitsubishi M2894-63 double sided switchable hard or soft sectors- BRAND NEW	£250.00(E)

Dual 8" drives with 2 mbyte capacity housed in a smart case with built in power supply! Ideal as exterior drives! **£499.00(F)**

End of line purchase scoop! Brand new **NEC D2246** 8" 85 megabyte of hard disk storage! Full CPU control and industry standard SMD interface. Ultra hi speed transfer and access time leaves the good old ST506 interface standing. In mint condition and comes complete with manual. Only....................£299(E)

THE *AMAZING* TELEBOX!

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER!

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

Telebox ST	for composite video input monitors	£32.95
Telebox STL	as ST but with integral speaker	£36.50
Telebox MB	as ST with Multiband tuner VHF-UHF-Cable. & hyperband For overseas PAL versions state 5.5 or 6mhz sound specification.	£69.95
Telebox RGB	for analogue RGB monitors (15khz)	£69.95

Shipping code on all Teleboxes is (B)

RGB Telebox also suitable for IBM multisync monitors with RGB analog and composite sync. Overseas versions VHF & UHF call. SECAM / NTSC not available.

No Break Uninterruptable PSU's

Brand new and boxed 230 volts uninterruptable power supplies from **Densel**. Model MUK 0565-AUAF is 0.5 kva and MUD 1085-AHBH Is 1 kva. Both have sealed lead acid batteries. MUK are internal, MUD has them in a matching case. Times from interrupt are 5 and 15 minutes respectively. Complete with full operation manuals............MUK......£249 (F) MUD.......£525 (G)

POWER SUPPLIES

Power One SPL200-5200P 200 watt (250 w peak).Semi open frame giving +5v 35a, -5v 1.5a, +12v 4a (8a peak), -12v 1.5a, +24v 4a (6a peak). All outputs fully regulated with over voltage protection on the +5v output. AC input selectable for 110/240 vac. Dims 13" x 5" x 2.5". Fully guaranteed RFE. £85.00 (B)

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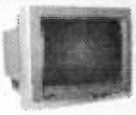
Centronics 152-2 9 x 7 dot matrix. Full width.	£149 (D)
Centronics 159-4 9 x 7 dot matrix.Serial. 9-1/2" width	£ 99 (D)

MONITORS



14" Forefront Model MTS-9600 SVGA multisync with resolution of 1024 x 768. 0.28 pitch. "Text" switch for word processing etc. Overscan switch included. Ideal for the PC-386 or PC-286 with SVGA card added. Also compatibe with BBC, Amiga, Atari (including the monochrome high resolution mode), Archimedes etc. In good used condition (possible minor screen burns). 90 day guarantee. 15" x 14" x 12". Only.............£159(E)

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Philips 9CM073 similar (not identical) to above for **EGA/CGA** PC and compats. 640 x 350 resolution. With **Text** switch with amber or green screen selection. 14" x 12" x 13-1/2"........£99(E)

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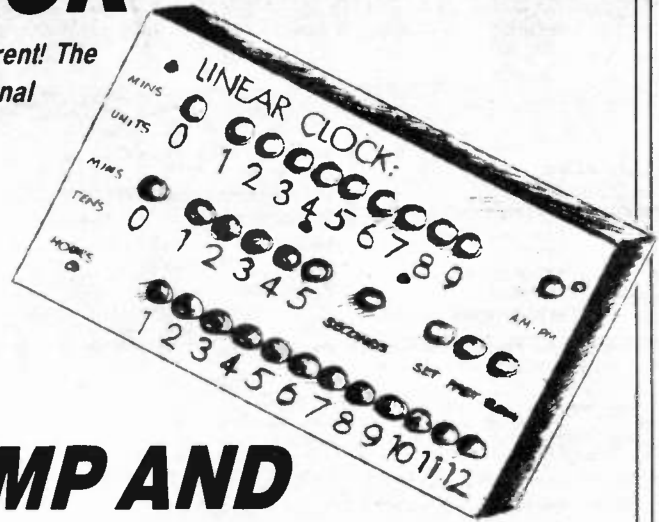
NEXT MONTH

LINEAR CLOCK

No-one needs a linear clock . . . bit it is different! The circuit offers an interesting variation on traditional displays and provides an intriguing artefact without which your collection of executive playthings is incomplete.



GUITAR PREAMP AND DISTROTION UNIT

A versatile preamp that can make you loud and clear or send you wild with distortion.

Distortion units usually come in two forms, "overdrive" and "fuzz". Though basically the same they sound subtly different. Overdrive has a raunchy feel with lots of guts, much loved by hard rock and heavy metal players, while fuzz is smoother and more round sounding.

This unit combines the best of both types of distortion and can also be used as a clean signal booster to give more power and clarity to other electric instruments.

SUPERHET RADIO CONTROL RECEIVER

A simple 27MHz radio control system was described in the February issue. This system has very limited range due to the use of a rather basic receiver circuit of the t.r.f. variety. The radio control receiver featured next month can be used in place of the original receiver design in order to obtain much greater range.

It is a superheterodyne ("superhet") receiver which is more complex than the original design. This receiver is still reasonably simple to build, and it can be setup for optimum performance without the aid of any test equipment.

JOINING THINGS TOGETHER

One of the problems for the amateur is that articles in technical magazines tend to be written by experts, who fail to explain some of the simple things which can cause problems to the novice. One of the question often asked by readers is how do I join circuits, expecially audio designs, together. Here John Linsley Hood provides some assistance.

EVERYDAY WITH PRACTICAL ELECTRONICS

MAY ISSUE ON SALE FRIDAY, 2nd APRIL

SPARKOMATIC 4 x 150 watt CAR AMPLIFIER

The SA3200 is our top of the line 4 Channel Amplifier which is extremely well specified. It is very powerful and versatile and features separate bass and treble controls which gives the user the possibility of reducing bass response to the front speakers and adding treble for better stereo imaging. The bass response can then be increased to the rear speakers which are usually larger and capable of offering better reproduction. The SA3200 features a bridge operation switch which offers the possiblity of using the amplifier in 4, 3 or 2 channel mode. The 3 channel mode is ideal for installations where rear deck speakers are used in combination with a separate subwoofer.

● 4 x 150 Watts max ● 4 x 80 Watts into 4 Ohms at less than 0.5% THD ● 2 x 80 Watts plus 1 x 160 Watts at less than 0.5% THD ● 2 x 160 Watts into 4 Ohms at less than 0.5% THD ● Separate bass and treble controls for front and rear channels ● Separate sensitivity controls for front and rear channels ● 2, 3 or 4 channel operation ● Heavy duty power wires ● Glass blasted aluminium heatsink ● High current capacity

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£32.95 plus £3.50 p&p

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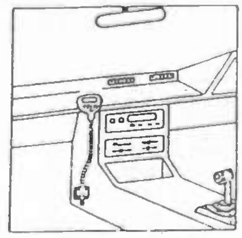

5 band graphic equalizer, 10 l.e.d. level indicator, fader control, volume control, EQ-Defeat switch, CD input jack, power on/off switch, night slide l.e.d.

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V12 12" 400W Max	Range 35Hz-3kHz	£45.95
BOSS 15" 800W Max	Range 35Hz-4kHz	£79.90
KING 18" 1200W Max	Range 20Hz-1kHz	P.O.A.

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MO21	1	60W Hifi tweeter made for *Jamo UK* size 90mm sq. £1
MO22	2	30 watt 8 ohm Hifi chassis speakers. *Made for Hitachi UK* midi systems, size 125mm sq. with large 70mm magnet **£9.00 + £2.00 p&p**
MO23	2	Pod Car Speakers. Moulded in black plastic with 15 watt 10cm *Goodmans* unit fitted **£3.95 pair + £2.50 p&p**
MO23A	1pr	40 watt Car Speakers made for Roadstar of Switzerland. Fitted with dual polypropylene cone and foam rubber surround. 8ig 70mm magent for good base response. Supplied with grills fixing screws and cable. Size 13cm, weight 1.5Kg **£11.70 pair + £3.65 p&p** or TWO pairs for **£25.00** UK post paid
MO24	2	Audax J8L 40-100watt dome tweeters. High performance 10mm Ferrofluid cooled horn loaded unit for load distortion and high output. Supplied with 1st order crossover, spec. 40 watts at 3kHz, 100 watt at 8kHz; size 51mm x 51mm x 16.5mm. Ideal for car use **£7.50 + £1 p&p**
MO25	2	33000µF 10V d.c. can type computer grade quality electrolytic *UK made* £1
MO25A	1	47µF 385V d.c. can type electrolytic. Size 350mm x 250mm. *UK made by Phillips* £1.75
MO26	2	680µF 100V d.c. can type electrolytic size 45mm x 25mm £1
MO27	3	2200µF 25V d.c. can type electrolytic size 45mm x 25mm £1
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MO35	200	Carbon resistors £1
MO36	2	Large VU meters. *Japan Made* £1
MO37	1	Large Tuning meter 125µA-0-125µA size 55mm x 47mm £1.75
MO38	1	Dual VU meter 280µA f.s.d., size 80mm x 42mm x 15mm £1.50
MO39	5	Coaxial Aerial Plugs, all metal type £1
MO40	6	Fuseholders, chassis mounting for 20mm size fuses £1
MO41	4	Fuseholders, in-line type for 20mm size fuses £1
MO42	20	5 Pin Din 180°chassis mount sockets £1
MO43	6	Double phono sockets £1
MO44	5	6.35mm (¼") Stereo Jack sockets £1
MO45	4	6.35 (¼") Mono Jack Plugs £1
MO46	12	Coax Sockets chassis mount £1
MO47	2	Case handles plated U-shape, size 97mm x 50mm £1
MO48	30	Mixed control knobs £1
MO49	1	Cassette tape transport mechanism, belt-drive, top loading, six piano key operation with knobs, stereo record/replay erase heads, heavy fly-wheel **£5.50 + £2.65 p&p**
MO50	1	Hifi stereo pre-amp. module. Input for CD Tuner record player with diagram. *Made by Mullard* £1
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MO52	3	AM I.F. modules. *Made by Mullard* £1
MO53	1	FM stereo decoder module with diagram. *Made by Mullard* £1
MO54	3	UHF Varicap tuned tuner heads unboxed, untested but complete. *Made by Mullard* £1
MO55	1	25V d.c. 150mA Mains adaptor in neat plastic box, size 80mm x 55mm x 47mm £1
MO55A	1	*ETRI* Brand new 80mm Cooling Fan. Five bladed A.C. impedance corrected motor on a cast aluminium chassis. Size 80mm x 40mm. Voltage 115V a.c. working, 130mA. *Japanese made.* **£5.95 + £1.40 p&p,** TWO for **£11.20** UK post paid
MO56	2	6V-0V-6V 4VA p.c.b. mount mains transformer 240V input, size 42mm x 33mm x 35mm. *UK Made* £1
MO56A	1	28V 15 Amp Mains Transformer. Size 80mm x 55mm x 65mm. Weight 1Kg **£3.00 each + £2.50 p&p**
MO568	1	30-0-30 Volt 3 amp mains transformer. UK made for leading Hifi manufacturer. Size 96mm x 90mm x 80mm. Weight 2.8Kg **£7.00 each + £3.75 p&p**
MO57	25	4 Volt miniature wire-ended bulbs £1
MO57A	1	SRBP Copper Clad Printed Circuit Board. Size 410mm x 360mm x2mm **£3.65 + 75 p&p**
MO58	2	Mono cassette tape heads. *Japan Made* £1
MO59	2	Sonotone stereo cartridge with 78 and LP Styl. *Japan Made* £1
MO60	8	8ridge rectifiers 1amp 24Volt £1
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MO75	1	100 yard roll of single screened quick splice cable, good quality *British Made* **£4.50 + £2 p&p**
MO76	1	100 yard 3-core 3 amp cable, coded brown, blue and green/yellow **£4.20 + £2 p&p**
MO80	2	Solar Powered Wooden Kits. Easy to build aeroplane, with revolving propeller, and an old time gramophone with music chip. Supplied with glue, solar cells, electronics and pre-cut panels. One of each for **£12.00 + £1.50 p&p**
MO81	1	Bump and Go Space Ship Kit with motor, wheels, p.c.b. wire and diagram. An ideal introduction for youngsters into the world of electronics and mechanics; goes all the way to the moon on two AA batteries **£8.95 + £1 p&p**
MO82	1	Filofax Personal Organiser Radio/Calculator. This neat little unit simply fits inside your filofax so you can listen to AM Radio with earphone or use it as a solar powered 8-digit calculator. Punched with six holes to fit all personal organisers. *UK Made* under ½ price **£7.20 + £1 p&p**
MO84	1	Multiband radio. Listen to air traffic control, aircraft, radar, public utilities VHF 54-176MHz + C8 1-80 with built in squelch control **£17.95 + £2 p&p**
MO86	1	AM, FM, LW Ross Pushbutton Radio. With this neat unit you can easily tune in to five pre-set stations of your choice without fiddling or fuss, runs off six C-cell batteries or 240V mains. Output 400mW, volume and tone control. Size 230mm x 150mm x 65mm **£9.95 each + £2.95 p&p**
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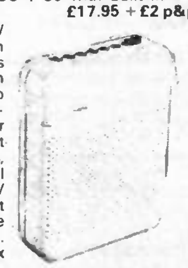

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INCORPORATING ELECTRONICS MONTHLY

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POST AND PACKING

A reader's letter published last month has resulted in some comments from advertisers to the editorial office and in a letter from Greenweld, one of the major players in mail order component supplies – see *Readout* this month. It is understandable that readers feel post and packing charges are high when they receive a small package with less than fifty pence worth of stamps on. However when one stops to consider the work behind getting that small package to you, including the back up necessary to get the items in stock in the first place, it is perhaps "a bargain" as Greenweld put it.

The letter from Greenweld puts the points very well and also indicates that charges in our "industry" are much lower than in many other mail order areas of operation. The alternative is obviously to increase the price of components so that mail order costs are hidden. In my view this would not help anyone, least of all the constructor who can get to one of the suppliers and buy components over the counter.

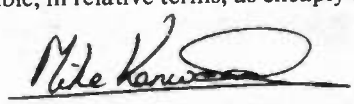
NO OVERHEADS

Some of the smaller "one man band" suppliers are able to keep costs to an absolute minimum but most suppliers in this area are operating a mail order business as a side line, they have virtually no overheads and no staff salaries to pay. Many such companies grow into larger businesses – it was in just this way that Maplin started not so very long ago.

No doubt we will hear more on this subject and well considered views would be welcome. It is no good just shouting "rip off" without thinking through what is actually happening to your order.

One final point, it pleases me that our advertisers in general are happy to explain why they have to make such charges. I visit many of them and know that in general they run complex operations in efficient and cost effective ways, they try hard to keep customers happy in an effort to make sure you come back for more.

The very nature of the industry means that there is strong competition between suppliers, and components in the UK are available, in relative terms, as cheaply as they are nearly anywhere in the world.



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BACK ISSUES

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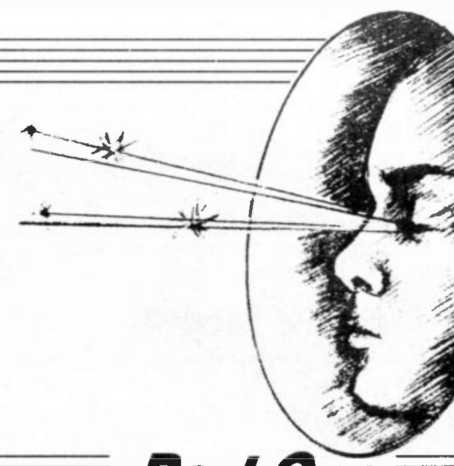


MIND MACHINE Mk II

ANDY FLIND Part One

An easy-to-build, low-cost, binaural entrainment machine – Or how to relax the mind after a traumatic day!

SINCE the original *Mind Machine* was published back in 1991, considerable effort has been made to find a simpler circuit capable of the same function. Whilst it worked well and proved popular with readers, it was complicated to construct, especially with it's programmable option. This may have deterred less experienced constructors who might otherwise enjoy experimenting in this exciting field.

For readers who missed the *Mind Machine*, it was an "entrainment" device. The human brain produces a number of electrical frequencies, which research has shown to be related to various states of mind. As these include deep relaxation, various meditative states and intense creativity, there is considerable interest in stimulating the production of these frequencies in the hope that the associated mental states will accompany them.

EARLY DAYS

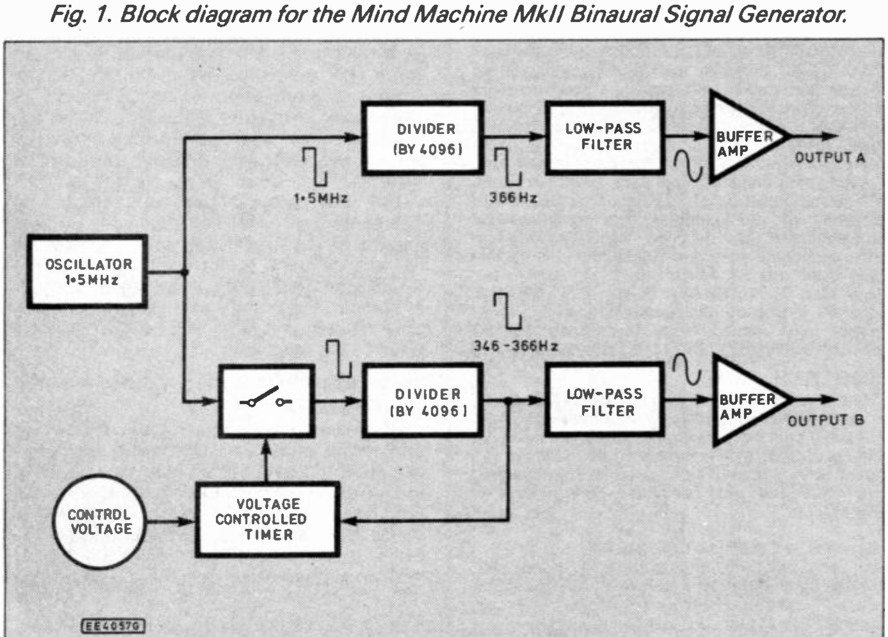
In the early days of this research, back in the 'sixties, the usual method was observing the brain's electrical activity with electrodes attached to the scalp. It was hoped that users would, by knowing when they were producing desired signals, be able to learn to produce them at will. This was known as "EEG Biofeedback", and indeed such a machine featured as an EE project back in 1989.

Since then however, the science has progressed. Today's enthusiasts try to stimulate the desired activity with external signals, usually sound and light. In America devices for doing this are readily available from retail sources, though they seem a little slow in finding their way to Britain. Also, they are still very expensive. It is possible to construct one for a fraction of the commercial cost.

BINAURAL SOUNDS

The "light" signal is usually provided by goggles fitted with l.e.d.s, whilst the most effective sound is of the type called "binaural". This can consist of two tones of a comfortable frequency somewhere between three and four hundred Hertz, one played into each ear through headphones.

Fig. 1. Block diagram for the Mind Machine MkII Binaural Signal Generator.



What makes them special is that they differ in pitch by the desired sub-audio brainwave frequency. If they were played through loudspeakers, this difference would be perceived as a "beat" effect, but when played through headphones the brain synthesises the beat internally and this is claimed to stimulate the desired electrical activity.

When used with a light stimulus at the same frequency, the effect can be quite profound. It probably won't induce instant "Zen Nirvana", but most users find it extremely relaxing, equal to or better than many forms of meditation.

BRAINWAVE

The commonly recognised "brainwave" frequencies are as follows. From fourteen to twenty-five Hertz is ***Beta***, found in normal alert consciousness. Below this is ***Alpha***, seven to fourteen Hertz, for "relaxed awareness", which was first to attract the attention of biofeedback researchers.

Next comes ***Theta***, four to seven Hertz, currently attracting interest as a possible inducer of vivid mental imagery and creativity. Below this there is ***Delta***, two to four Hertz, usually found in deep sleep. It has to be said that there is nothing like a bit of Theta stimulation for putting one to sleep!

TAPE PROGRAMMING

Programming adds much to the effect, a sequence of stimulation at some of these frequencies enhances it considerably. Various patterns can be devised for different situations, or for individual user preferences.

The original project included a binaural tone generator, a light control circuit, two audio output amplifiers, and two lamp drivers for the l.e.d.s. A second project covered a separate p.c.b. used for programmed operation, using a RAM chip with A/D and D/A conversion and lots of control logic.

It worked, but was not for faint-hearted constructors. This new version uses tape cassettes for program storage.

A special generator, the subject of this month's project, produces the "binaural" signals at a level suitable for cassette recorder "line" inputs. A tape is made of the desired sound program, which can then be used with just a player and headphones – a "Walkman" is ideal. This eliminates the programmer and audio amplifiers at a stroke.

A separate unit, to be described next month, can be connected in parallel with the headphones to generate the lights. This is also simple to construct, and is pocket-sized for portability.

HOW IT WORKS

A block diagram of the Mind Machine MkII, Binaural Signal Generator, appears in Fig.1. It is very similar to the front-end of the original project, apart from the output stages.

The "prime mover" is a crystal oscillator generating a 1·5MHz signal. At the top of the diagram, it can be seen that this is simply divided down to about 366Hz, then low-pass filtered to convert it to a reasonably pure sine-wave, and buffered to match the intended load. A sine-wave output is preferable to a squarewave for listening comfort.

The lower part of the circuit is similar save for one difference. An output from the divider is applied to the input of a voltage-controlled timer.

Each time the divider output changes state, this timer is triggered and blocks the oscillator signal briefly. The output frequency from this second divider is therefore slightly lower that that of the first, the exact difference depending upon the timer period.

The main benefit of this circuit is that the difference between the two output frequencies is easily controlled, stable and repeatable. Most other methods of producing two frequencies so close to each other would be drift-prone and very difficult to calibrate. The only snag is that the difference actually varies in steps, and to keep these small a high initial clock frequency is required, though the integrated oscillator chip simplifies this requirement.

CIRCUIT DESCRIPTION

The full circuit diagram of the Mind Machine MkII "binaural signal generator" stages is shown in Fig.2. Power is supplied by a PP3 battery which, since the overall drain is only about 5mA, provides many hours of operation.

A type LP2950 5V positive regulator IC1, with decoupling capacitors C1 to C4, feeds the entire circuit. It is similar to the 78LO5 series, but draws less quiescent current and can operate with an input below 5·5V. This saves on batteries, soon offsetting it's higher initial cost.

The 8-pin CMOS crystal oscillator, IC2, has a fundamental frequency of 12MHz, but the integral programmable divider when connected as shown gives an output from pin 2 of 1·5MHz. It MUST have a 5V supply, and the data sheet suggests that local decoupling capacitor C5 is mandatory too. It may not be, but the author was not prepared to find out!

IC3 is the first divider, dividing by 4096, with the input to pin 10, and an output of about 366Hz from pin 1. The output is a squarewave but the filter circuit around R1, C7 and IC4a converts this to a relatively pure sinewave.

The initial level is too high, so the value of resistor R1 has been chosen to reduce it to about 0·35V r.m.s. (one volt peak-peak), suitable for "line" inputs. IC4b buffers the output to ensure correct impedance matching.

The other side of the circuit is identical apart from the timer circuit around IC5 which lowers the frequency a little. This works as follows. IC5 is a comparator, not

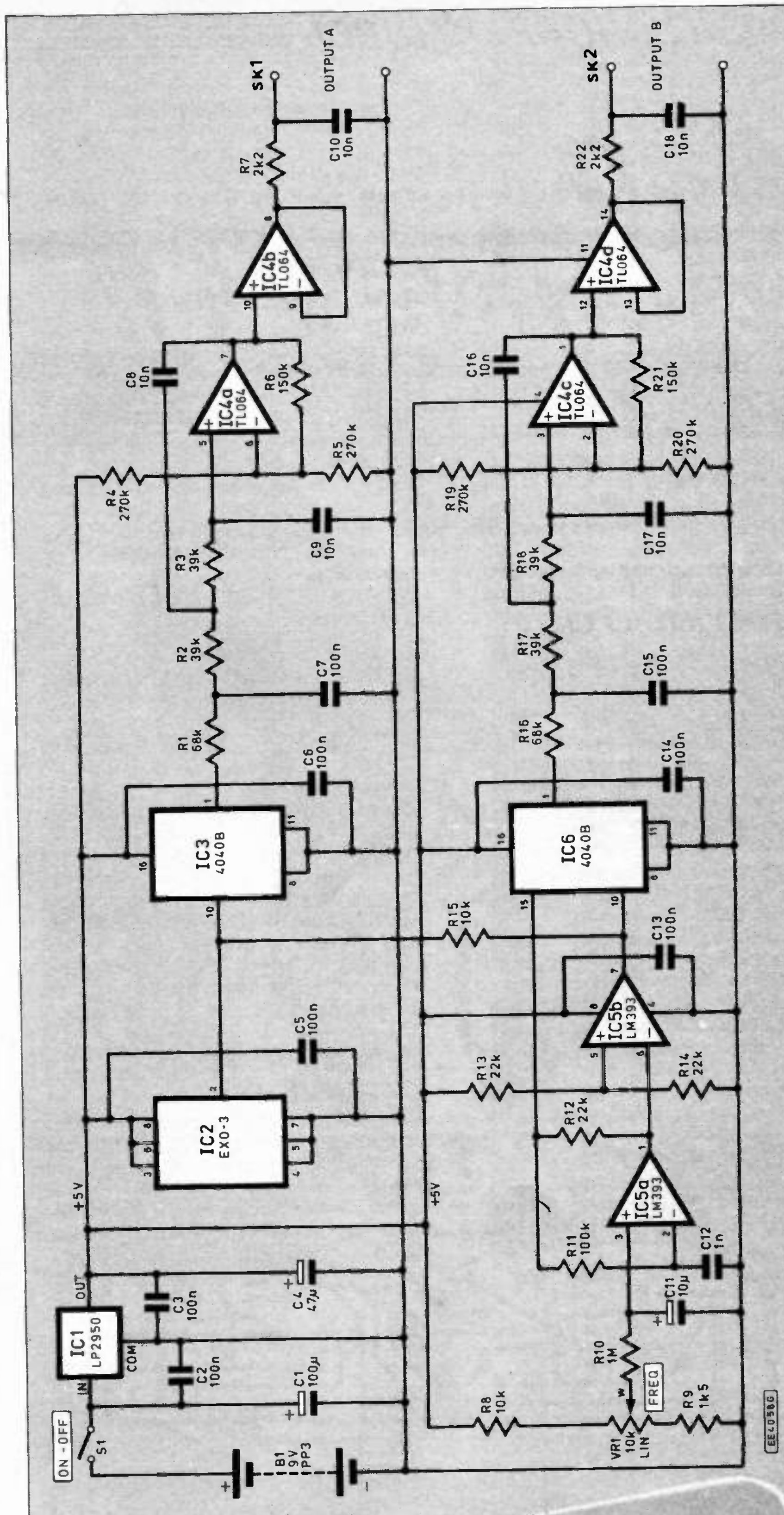
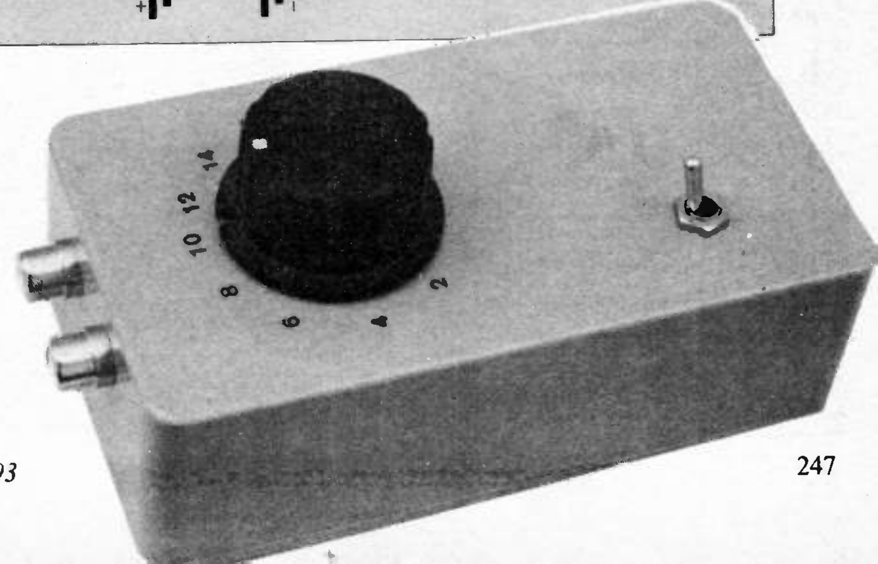


Fig. 1. Complete circuit diagram for the Binaural Signal Generator stages of the Mind Machine Mk II.



an op-amp. The difference is that each output is not a voltage or current source, it is the collector of a transistor with grounded emitter. When the inverting input of one is higher than the non-inverting, the appropriate output transistor will be "on", able to sink current to ground, but it cannot supply anything.

Pin 1 of IC6 is the last output of the divider, stage twelve. Pin 15 is the output of the stage before this, which goes high twice during each output cycle from pin 1.

Assume that pin 15 of IC6 is low, and has been for a significant period. Both non-inverting inputs to IC5 receive small positive voltages, from R13/R14 and VR1, so both output transistors are "off" and the input from the oscillator reaches IC6 unhindered through resistor R15.

If pin 15 now goes high, the immediate effect will be to take the inverting input of IC5b high, so the output transistor of this turns "on" and sinks the oscillator signal to ground, stopping the divider's input. At the same time however, capacitor C12 starts charging through resistor R11. When the voltage across it exceeds that from VR1, IC5a output turns "on" and pulls the voltage from resistor R12 to ground. This causes IC5b output to turn "off" again and so restores the input to the divider, which resumes counting.

When pin 15 returns low, C12 discharges through R11 and the circuit effectively resets. There is, therefore, a brief pause each time pin 15 goes high, the exact length of which depends upon the voltage from VR1. Sudden frequency changes, due to noise or an abrupt adjustment, would be distracting to the user of a program made with this circuit, so R10 and C11 ensure that all input voltage changes are slow.

CONSTRUCTION AND TESTING

All the components for the Binaural Signal Generator circuit are fitted to a small single-sided printed circuit board (p.c.b.), the layout being shown in Fig.3. Construction should present no special problems, though the usual CMOS handling precautions should be observed.

Sockets are suggested for all i.c.s except voltage regulator IC1, as these allow easier testing and trouble-shooting. The i.c.s should not be inserted until testing is commenced.

With power applied to the completed board, presence of the regulated 5V from IC1 should be checked across the electrolytic capacitor C4. The total current drawn by the circuit at this point should be just a fraction of a milliamp.

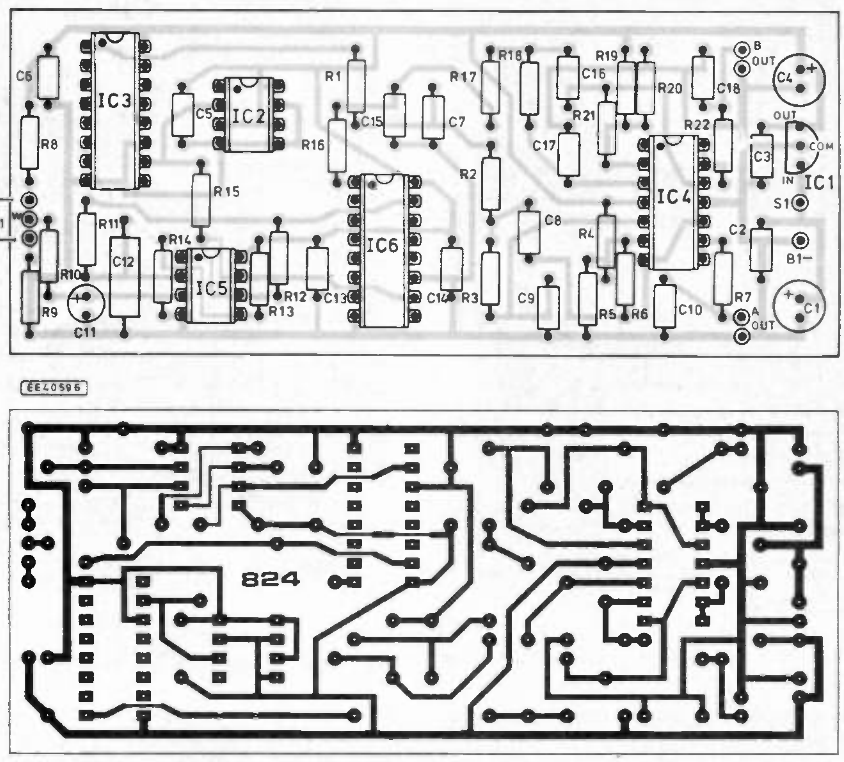
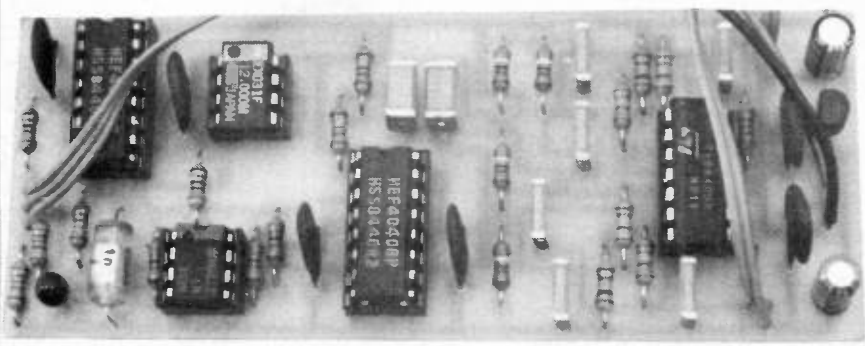


Fig. 3. Printed circuit board component layout and full size underside copper foil master pattern. The completed board is shown below.



COMPONENTS

BINAURAL SIGNAL GENERATOR

Resistors

R1, R16	68k (2 off)
R2, R3, R17, R18	39k (4 off)
R4, R5, R19, R20	270k (4 off)
R6, R21	150k (2 off)
R7, R22	2k2 (2 off)
R8, R15	10k (2 off
R9	1k5
R10	1M
R11	100k
R12, R13, R14	22k (3 off)

All 0.6W 1% metal film

Potentiometer

VR1	10k rotary carbon, linear

Capacitors

C1	100µ radial elect., 10V
C2, C3, C5, C6, C7, C13, C14, C15	100n polyester layer (8 off)
C4	47µ radial elect., 25V
C8, C9, C10, C16, C17, C18	10n polyester layer (6 off)
C11	10µ tantalum bead, 16V
C12	1n polystyrene

Semiconductors

IC1	LP2950CZ, micropower +5V regulator
IC2	EXO-3 crystal oscillator
IC3, IC6	CMOS 4040B 12-stage divider (2 off)
IC4	TL064 quad low-power op. amp.
IC5	LM393 dual comparator

Miscellaneous

B1	9V PP3 battery, with connector clips
SK1, SK2	Chassis mounting phono socket (2 off)
S1	On/off s.p.s.t. toggle switch

Printed circuit board available from the *EPE PCB Service*, code 824; ABS plastic box, size 120mm x 65mm x 40mm; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket; 16-pin d.i.l. socket (2 off); knob; connecting wire; solder, etc.

Approx cost guidance only **£24**

CALIBRATION AID

(check with text, some may not be necessary)

Resistors

R1, R3	10k (2 off)
R2	27k
R4	100k
R5	1k

All 0·6W 1% metal film

Capacitors

C1	10µ axial elect., 25V

Semiconductors

IC1	4011B CMOS quad NAND gate
IC2	CA3140E op.amp

Miscellaneous

Stripboard, 0·1in pitch, size 11 strips x 26 holes; 8-pin d.i.l. socket; 14-pin d.i.l. socket; connecting wire; solder, etc.

Approx cost guidance only **£2.50**

If this is correct, IC2 should be inserted and the circuit powered again, this time a check of the oscillating output of IC2 at pin 2, with a meter, should show an average value of about 2·5V. If so, the oscillator is probably working. Of course, constructors with oscilloscopes may view the 1·5MHz signal here, but the "average value" check is almost as good.

Next, IC3 can be inserted, and the 366Hz output from pin 1 checked as above. It is also possible to listen to this with a headphone in series with a resistor. The author found a 10 kilohm resistor in series with one side of the "Walkman" headphones to be about right. This procedure can be repeated for IC6, as without IC5 the clock signal reaches it unhindered.

Now IC4 should be inserted. The first two outputs of this are pins 7 and 1, which can be checked with the headphone as above. They will sound much quieter, as they're lower in level and sinusoidal. If they check out correctly the phones can be attached directly to both outputs, omitting the series "test" resistor as R7 and R22 will be adequate.

Finally, if the control potentiometer VR1 is hooked up and IC5 inserted, it should be possible to hear, and vary, the "beat" between the two output tones. The current drain of the complete circuit will be about 4·5mA, plus anything drawn by the headphones.

INTERWIRING

Assembly into the case is straightforward and non-critical, the general arrangement should be clear enough from the photographs. The connections to the switch, VR1, battery and the output sockets are all shown in Fig.4.

Chassis phono sockets were used on the prototype as these are generally used for "line" connections, though other types may be substituted if preferred. The prototype p.c.b. was attached to the case lid with double-sided sticky tape and the battery held in a clip formed from a bit of cable trunking, though there are obviously other ways to secure it.

CALIBRATION

Calibration of the Frequency control VR1 is the final task. Fortunately, this can be made fairly simple. For constructors not wishing to fiddle with stopwatches or connect frequency meters and calculate from the "period", here is the method.

The output frequency difference is directly proportional to the voltage controlled timer period. Since this operates at a relatively high frequency, over 700Hz, the difference can be indicated simply by measuring it's average d.c. output with a meter. Further, with suitable scaling, it's even possible to get a direct reading in Hertz. Simple, eh!

Actually, there's a little more to it than that, but not much. The output from IC5a (pin 1) is the point at which to take this measurement, but it must first be turned into a swing between two known values. It is also essential to avoid loading this point in any way.

This is achieved with a single 4011B chip connected as shown in Fig.5, which should be powered from the main circuit 5V supply; taken from capacitor C4. The simple resistive divider following this, R1 and R2, gives an output of 10mV per Hertz.

If a DVM with a suitable range is available, IC1 and the two resistors are all that is needed for a direct reading in

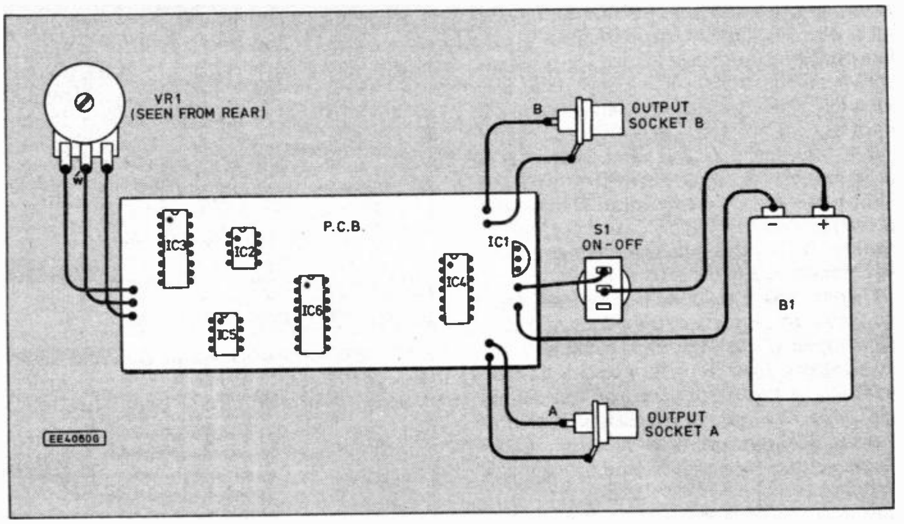


Fig. 4. Interwiring from the printed circuit board to the frequency control VR1, output sockets, switch and battery.

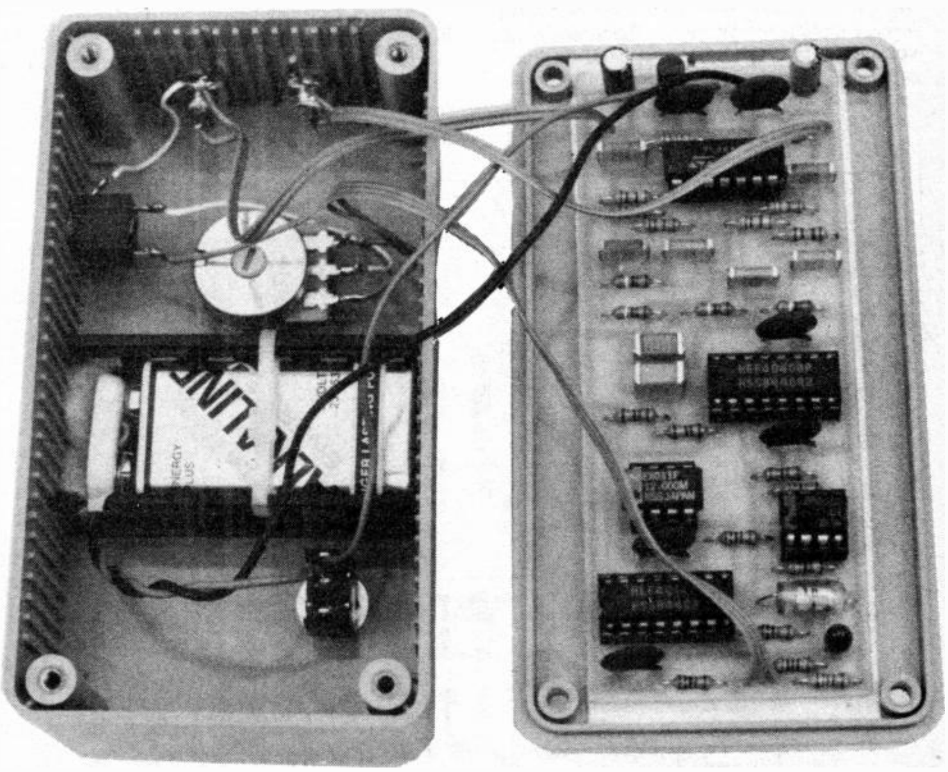
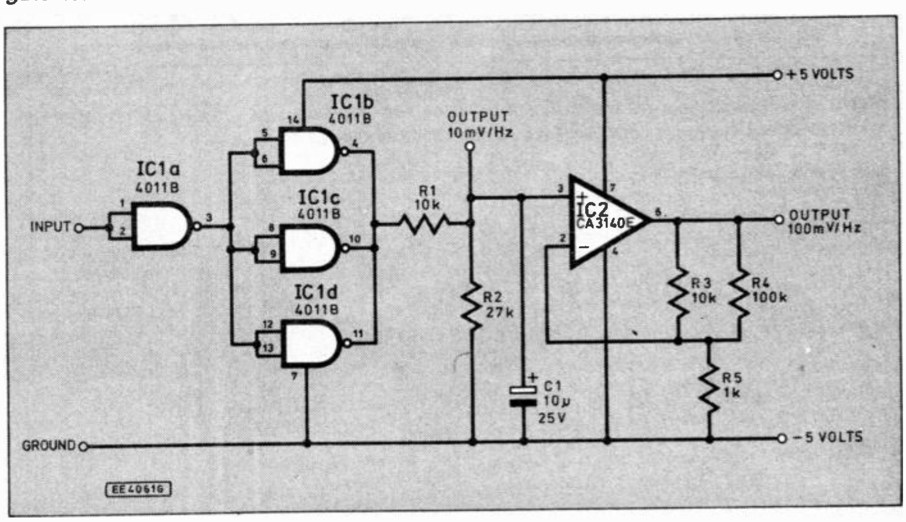


Fig. 5. Circuit diagram for a simple "calibration circuit" using a 4011B quad NAND gate i.c.



Hertz. If a moving-coil instrument is to be used, the output will need buffering and amplification, and smoothing is required before the amplifier. C1, R3 to R5 and IC2 provide a low-impedance output of 100mV per Hertz.

This circuit may be lashed up on a breadboard, but for constructors uncertain about this, a simple stripboard component layout is shown in Fig.6. If sockets are used for the i.c.s they may be salvaged for re-use when the current task is complete.

Calibration should be carried out with tantalum capacitor C11 in place, and it is recommended that the unit is initially left running at a high frequency setting for ten minutes to "form" this capacitor. Then, the calibration points are found with the meter and appropriate calibration markings made around the Frequency control VR1.

IN USE

To use the unit, first a chart is needed showing a suitable program. Fig.7. shows the kind of thing, although the actual shape of the curve will depend on the individual experimenter's preference. It is suggested that a recorded program lasts for twenty to thirty minutes.

The unit should be connected to the "line" inputs of the recorder, set to the initial frequency, and allowed to settle for thirty seconds or so before recording starts. Then the Frequency control should be adjusted every thirty seconds or so as recording progresses, until the program is complete.

The recording can be used with headphones on any suitable recorder. The effect is of a pleasant "bell-like" tone, calming to listen to, and hopefully deeply relaxing for the user.

Next month: A further project will enable lights to be added to the effect, making it as powerful as the original *Mind Machine*.

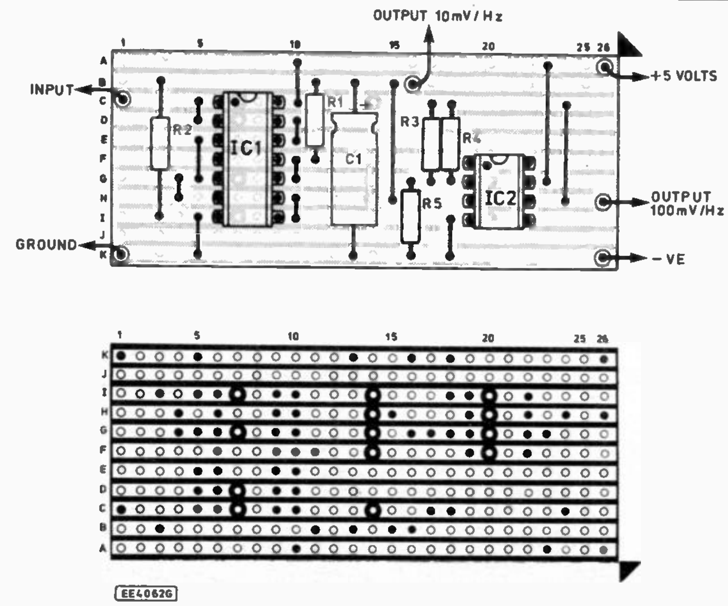


Fig. 6. Test circuit stripboard component layout and details of underside breaks in the copper tracks.

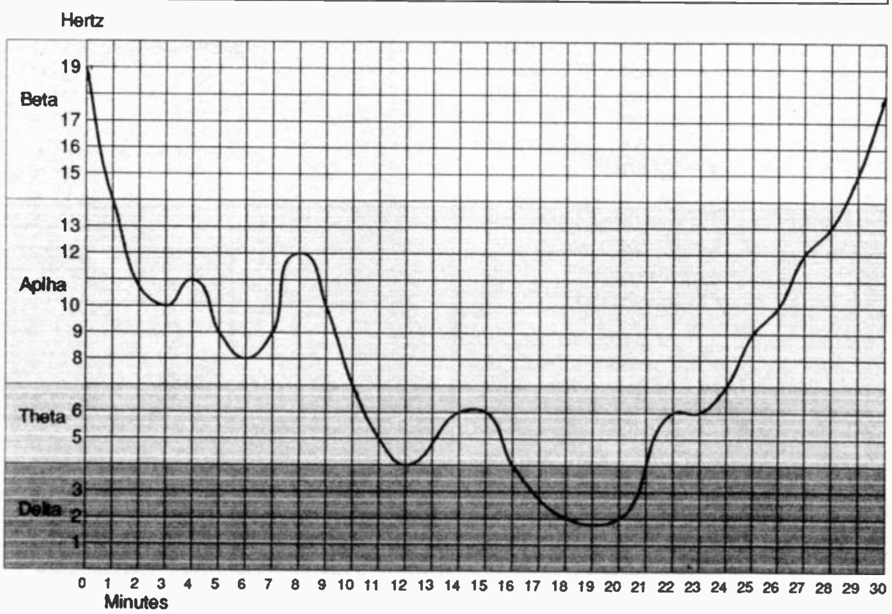


Fig. 7. Example of tape program chart using the Frequency control VR1.

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

SHARP VIEW FOR MAC

WITH professionally high resolution quality colour video projection Sharp's XG-3200S interfaces directly with the videoport of the Macintosh Quadra, without any additional equipment or accessories.

With a diagonal dimension of over 3·8 metres, the brilliant colour image projected by the Sharp XG-3200S Video Projector is claimed to open up entire new dimensions in group communications using computer-generated presentations. In additon, the new projector gives almost any company holding seminars or training courses the possibility of adding impact in terms of both colour and size.

Unlike conventional projectors, the XG-3200S requires no time-consuming adjustments to obtain a perfect image. It features an ingenious projection system that consists of three mirrors and three TFT (thin-film transistor technology) LCD panels. Each of the mirrors transmits only a single RGB component (red, green or blue), and each component is handled by a separate LCD panel with 217,945 pixels.

The system functions by breaking visible light down into its three components, modulating the visual information onto the light and then precisely recombining the three components to yield a perfectly adjusted projection beam. As the beam is also polarized, it provides sharp, brilliant colour on special projection surfaces (Sharp XU-PP60S or XU-PP40SE) even in the presence of stray light.

The projector also features a zoom lens as standard equipment, this makes it possible to vary the size of the projected image between 100cm and 380cm as a function of the size of the room. It can be set up anywhere between 1·6m and 5·6m from the projection screen. Wide-angle and telephoto lenses permit even more versatility. The XG-3200S operates on the NTSC standard, and the AN-300SC Video Converter makes it possible to use PAL, SECAM or NTSC.

COMPUTER VIRUS CONFERENCE

THE *3rd International Virus Bulletin Conference* will be held at the Krasnapolsky Hotel, Amsterdam on 9 and 10 September 1993. The conference is billed as the largest and most prestigious annual event to address the computer virus threat in Europe. The 1992 conference, held in Edinburgh, attracted over 200 delegates and 23 speakers, from more than 20 countries.

Papers for presentation and discussion are selected for their originality and appeal to a diverse audience comprising corporate computer security staff, PC support specialists, hardware and software developers, government, military, public sector and corporate IT managers and researchers.

The conference will have two streams: stream one will address the management of the virus threat, while stream two will concentrate on technical developments.

For further details contact: Virus Bulletin Ltd., Dept. EPE, 21 The Quadrant, Abingdon Science Park, Abingdon, OX14 3YS.

A PLUG FOR SAFETY

Consumer safety is given an extra plug with the publication of the Department of Trade and Industry's consultative document for draft plugs and sockets regulations – *Plugs and Sockets Etc. (Safety) Regulations 1992.*

The regulations propose that all domestic electrical appliances should be supplied fitted with an approved 13 amp plug by the end of next year.

Consumers Affairs Minister Baroness Denton said that she was delighted that many companies had already taken the initiative to fit plugs to their appliances, she hoped more would now follow suit. It was a real example of customer care.

"Already we have widespread support, both from industry and consumers. But may I remind people that rules alone don't prevent accidents – please check plugs regularly to see they remain safe," she said.

Does this mean that manufacturers will undertake the responsibility of inserting a correctly rated fuse for the appliance, instead of the bad habit some consumers have of putting a 13A fuse in 13A plugs no matter what the application?

ON THE BOARD

Tsien has released the new 2.5 version of its BoardMaker-2 PCB CAD package, adding powerful features to speed development cycles and enhance productivity. Among new facilities for the PC-based software system are functions to simplify the design of complex multi-layer p.c.b.s, plus numerous enhancements to aid production, providing an efficient and comprehensive design-to-manufacture environment for just £295.

Features are controlled via context-sensitive pop-up command menus, in conjunction with a mouse (or cursor keys) for component placement and track routing. High resolution colour graphics simplify the generation of multi-layer artwork. All tracks and pads are drawn so that "what you see is what you get".

Tracks are then drawn from pad to pad as required, using a "point and shoot" methodology which gives precise control over positioning. Designs can be generated to a user-defined grid, free-hand to a resolution of two thousandths of an inch, or both. High level editing features include block edit and rotate commands allowing you to change a component's position or orientation, while a mirror command lets you instantly switch a component to another layer.

The package is an upwards-compatible version of BoardMaker-1, which is an entry-level CAD system costing just £95. BoardMaker-1 users can upgrade by paying just the difference in price.

For further information: **Tsien (UK) Ltd, Dept EPE, Camhridge Research Laboratories, Huntingdon Road, Cambridge CB3 0DJ, UK. Tel: 0223 277777.**

To complement their range of in-car entertainment products, Radiomobile have introduced the AKB3200 Auto-reverse digital radio/cassette car radio. Offering 7W stereo (14W maximum power), it features PLL synthesised tuning; 30 station preset, with station memory and an f.m. interference rejection circuit.

To combat radio thefts, it can be removed from the vehicle when the driver has to leave it unattended.

MIDLAND MOBILE RALLY

The Mars/Drayton mobile rally is to be held at Drayton Manor Park, Tamworth, Staffs (on A4091) on Sunday 9 May. Doors open 10.30 a.m.

Usual traders – flea market bring and buy – club stands. The family rally, details from Peter G6DRN 021-443 1189. Trade stands Norman G8BHE 021-422 9787 (evenings).

ELECTRONIC INDEX FOR ARCHIMEDES USERS *Reviwed by Andy Flind*

New from M. Kay is a computer index covering the last three years' issues of *Everyday Electronics, Practical Electronics,* and the *Maplin Magazine*. It will run on any Acorn Archimedes equipped with RiscOs 2 or 3 plus the application "ArcScan 3".

For Archi users yet to encounter ArcScan, this is a database intended specifically for magazine index creation. It is fast, powerful, yet simple to use. Operating on the "wordsearch" principle, two key words or phrases may be combined in a number of different ways for efficient location of a title or subject. It is supplied with index files for all the Archimedes manuals, and extra library discs are available covering various Acorn computing magazines. Users may also compile their own indexes. If you are an Archi user without ArcScan, it might be worth considering purchasing it anyway, as the cost for all this is less than £14.00.

Mr. Kay's disc contains the new electronic magazines index. A successful search produces an easily-scanned shortlist of entries, each categorised as **Project, Series, Feature, Review** or **News.** The associated magazine's name, volume and page number are given, together with three lines of useful descriptive information. Projects are given an estimated difficulty rating and any relevant kits available are noted.

If you have an Archmiedes, ArcScan 3, and a large pile of back issues, then this product could save you a lot of tiresome searching. With over 30,000 words covering more than 1300 entires, it represents excellent value for the asking price of just a fiver. An updating service will be available, and if demand is sufficient, there is a possibility of the addition of *ETI, Elector,* and *Electronics World* at a future date.

The **Electronic Magazine Index** library is available from **M. Kay,** 69 Cobnar Road, Woodseats, Sheffield S8 8QD. Price £5 inclusive of UK p&p.

If you need **Arscan 3** it is available from **Risc Developments Ltd.,** 117 Hatfield Road, St. Albans, Herts AL1 4JS.

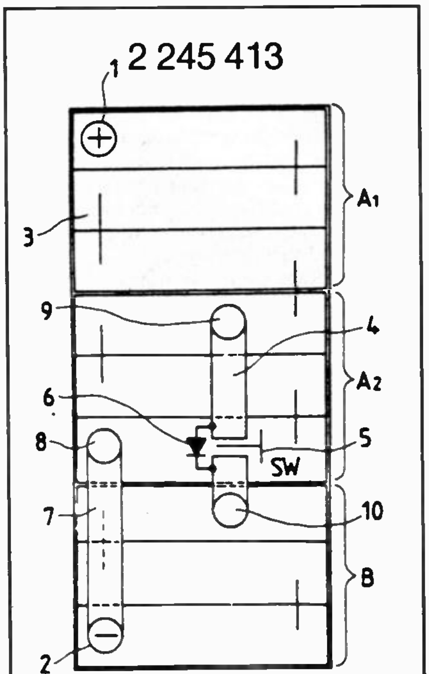
THE THINGS PEOPLE PATENT!

The following abstracts are taken from recent UK patent applications in the general electrical/electronics area. British Patent Specifications can be ordered from The Patent Office, Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, Gwent, NP1 7HZ, England.

Main Battery and Emergency Spare Battery

In UK patent 2245413. Japan Storage Battery Co. Ltd., describe a battery arrangement. The main battery A1, A2 comprises six cells connected in series. The first three, A1 of the six cells have a capacity at least 10% higher than that of the remaining three cells A2. A switch 5 is used to connect the spare battery B in parallel with the remaining three cells A2 of the main battery. A diode 6 is connected to the switch so that the spare battery is charged when the switch is open.

By decreasing the number of cells conventionally used for the spare battery from six to three, the capacity of the main battery can be increased. When the main battery is fully discharged, electricity remains in the three cells of the large capacity side, so that, by closing the switch, a voltage of six cells can still be obtained across the external load. No extra charger for the spare battery is required.



Lampholders

In UK patent 2 245 776 Ranton & Co. Ltd., describe a lampholder. It comprises a body carrying a lamp cap contacts, the body part having slideway and a blade engageable in the slideway to make electrical connection between a lamp contact and an electrical supply wire. Alternative wire accommodation for each lamp contact, entries of connection blade from either end of slideways, and lampholder cap orientations facilitate assembly.

The preferred method of gripping the electrical cord uses fingers of the cap deflected during snap-on fitting of the cap. Alternatively, fingers are formed with a base which is attached to the lampholder body by engagement with lugs. The fingers are actuated by the cap.

Wind Powered Electric Lamp

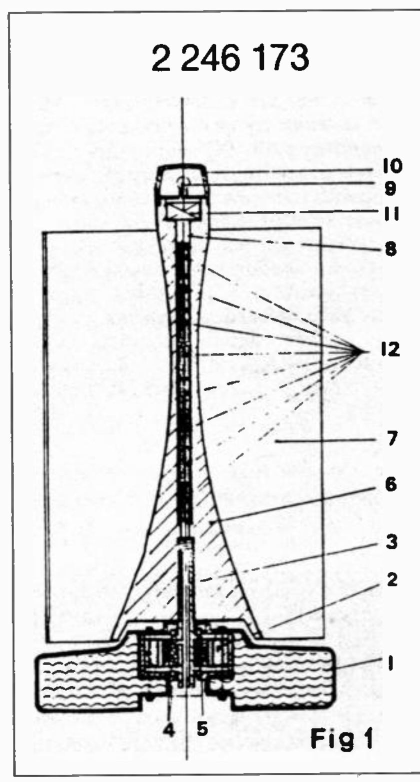
In UK patent 2246173 Brian Wellesley Temple describes a wind powered electric lamp. It comprises a specially designed structure or apparatus incorporating an electric generator 2, a wind activated propelling device 6 and an electric lamp bulb or bulbs 9. The whole is arranged and connected mechanically and electrically in such a manner that the effect of wind rotating the propelling device will operate the generator 2 and create an electric current causing the electric bulb or bulbs to illuminate.

Optionally, the apparatus may be provided with means of connection to a separate external electricity supply and of fixing or mounting onto a weighted base, such as a post, pole, frame, tower or other suitable supporting structure or on to a stabilised floating base in the form of a buoy for marine use. The apparatus may also be provided with an integral gearing system, rechargeable batteries and a number of electrical control circuits or components. These may cause the lamp to flash on and off or to disconnect current from the lamp during daylight.

Eddy Current Resistance Mechanism for Exercise Machine

In UK patent 2247183 Tunturipyora Oy describe a resistance mechanism especially for exercise devices. There is a pull rope or pedals by which the user loads the resistance mechanism. A part rotates with the movement created by the operating means. There is a counterpart positioned at a distance from the rotating part. One of these parts is provided with magnets to create eddy currents resisting the movement of the operating means.

To achieve a mechanism suitable for exercise devices of different types, the counterpart comprises an element acting on the rotating part, the element being rotated at a speed independent of that rotation of the rotating part. The counterpart may be rotated by a motor.



New Technology Update

Ian Poole reports on techniques for manufacture of multilayer i.c.s, flexible superconductors and new r.f. i.c.s.

ONE of the keys to achieving greater density on i.c. chips is the ability to make metal interconnections between different parts of the circuit on the chip. With integrated circuits now becoming increasingly complicated this is not always as simple as it may seem.

In fact similar problems are also encountered on printed circuit boards. As the complexity increased it was found increasingly difficult to route the tracks around the boards. To overcome the problem the numbers of layers on the boards were increased. Nowadays it is not uncommon for processor boards to have eight and sometimes even more layers.

Multi Layer I.C.s

A similar approach is used in integrated circuits. Different interconnecting layers are separated with layers of insulating silicon dioxide, and conductors via holes are used to make the connections where necessary. Although quite complicated to implement, the use of multiple layers greatly shortens the lengths of any interconnections.

This gives a number of advantages. It reduces the amount of unwanted resistance and capacitance, and it releases more space on the chip for additional components. These two improvements enable the performance of the chip to be improved and more functionality to be added to it.

The idea of multi-level connections on a chip is not new. However to enable the chip performance to be improved the techniques need to be developed further. Currently only a few layers are used, but it is anticipated that in about ten or twelve years time it might be necessary to use up to eight layers of metallisation.

In order that this number of levels of metallisation can be achieved it is necessary to be able to keep the surface of the silicon used for the i.c. as flat as possible. Even minute irregularities can cause major problems. This is because the photolithographic images used to define the various areas of the i.c. cannot be focused sufficiently well if there are any irregularities. Many of these irregularities are produced when the silicon wafers are sliced off the original crystal.

Optically Flat

Normally the wafer is polished or lapped to remove the irregularities. This uses a very fine abrasive which produces a flat surface, albeit with some microscopic scratches caused by the abrasive.

Chemical etching may seem to be a better alternative because it will give a better finish. However it is not used at this stage because the irregularities penetrate some distance into the surface of the silicon and the chemical action will actually increase these irregularities.

To overcome this problem a new technique for polishing or lapping the silicon blanks has been devised. It involves a mechanical/chemical process. The wafer is mounted on an arm suspended over a polishing disc. A slurry consisting of an exceedingly fine abrasive and some chemical etchant is added and the wafer is then polished or lapped to an optically flat finish. To ensure that the finish is completely perfect a final stage of etching may then be used.

By very carefully controlling all the stages of the process and using exceedingly high standards it has been possible to achieve much better standards than any which were obtained before.

During the development of this process a number of problems were encountered in ensuring that the surface was completely flat. Now that they have been overcome some i.c.s are actually being manufactured using the process. This means that the way is open for much wider use of the process and improvements in i.c. characteristics.

Flexible Superconductors

Superconductors have been available for many years. However they are seldom used, despite the enormous advantages they offer. The reason for this is the very low temperatures which they have required for operation, typically only a few degrees above absolute zero. Whilst it is possible to obtain these very low temperatures for experimental purposes they are not commercially viable.

To overcome this problem tremendous efforts have been made to develop new super-conducting materials which will be able to operate at much higher temperatures, possibly even at normal external temperatures. There is much more work to be done but the work has been very successful. A number of substances have been discovered which support the phenomenon at temperatures which are much more practicable to maintain.

Despite this success the next major hurdle was to make these new materials in a form which could be easily used. One of the major disadvantages has been that any wires made from the new materials are very brittle, so brittle that they snap easily. It has now been reported that a team of researchers has developed a technique which is able to produce wires which are five times more flexible than before.

To form the wires the super-conducting material is heated up to above its melting point. It is then passed through a small nozzle under high pressure so that it emerges very quickly. This thin wire is then cooled down very rapidly, solidifying into long fibres. Several of these thin fibres are then used to form a single wire.

It is hoped that this technique will at last help to enable superconductors to become a more attractive proposition for commercial projects. If this is so then it is likely that superconductors will start to appear in a wide variety of applications.

New R.F. I.C.s

Radio communications is an ever growing section of the electronics industry. Driven by the need for improved communications, the telecommunications industry is turning to radio for personal communications far more now than it ever used to. This is demonstrated by the high number of mobile and portable cellular phones in use these days. In addition to this there are cordless phones and radio pagers which are being used increasingly.

Designers of equipment for these applications find there are many challenges to be met. With frequencies of up to 1GHz being used and very low current consumptions needed to conserve batteries, the circuit design is not easy – particularly the r.f. sections.

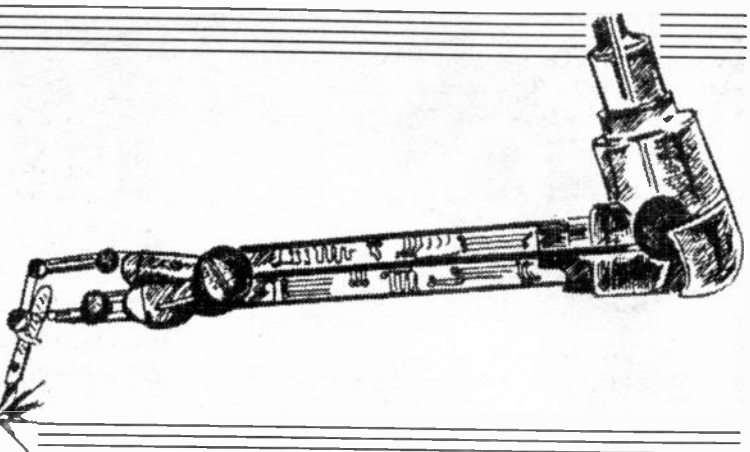
Until recently much of the r.f. circuitry required the use of many discrete components as the level of integration of many of the r.f. circuits was relatively low. Whilst some amplifier i.c.s were available for use up to these frequencies the level of integration did not extend to other circuit blocks. Now this is changing as more i.c.s designed to reduce the cost of cellular phones are being introduced.

Front End Chip

One of these i.c.s has recently been introduced by GEC Plessey Semiconductors. The new chip is the SL6444 and it is a radio receiver front end containing a low noise amplifier and mixer. All of this is housed within a 14-pin small outline surface mount package which is ideal for modern production techniques.

The chip has many advantages for the r.f. designer. Both sections of the circuit can be used either independently or together to produce a receiver front end. In addition to this the chip operates over a wide voltage range (2·7 to 6 volts). The current consumption is also low, typically just over 9mA, and there is a battery saving standby mode to further reduce battery consumption.

With i.c.s like these appearing on the market, the shape of r.f. circuit design is set to change in the near future. Not only should performance improve, but it should be possible to reduce the size of circuits as well.



CIRCUIT SURGERY

MIKE TOOLEY B.A.

In this month's Surgery we take a look at methods of reducing mains hum together with a solution which can be applied in really difficult cases. We also describe a versatile audio amplifier which is ideal for those with minor hearing difficulties or indeed anyone who needs a high quality low-power amplifier with separate bass and treble controls.

Getting Rid of Hum

Getting rid of hum can be a real headache. Given that one has taken all the usual precautions concerning earthing and screening, residual 50Hz and/or 100Hz unwanted signal components can still cause worrying problems. ***Mr J. Maunder*** writes from Addlestone on this subject:

"It is quite a while since I did the theory of filters. When recording signals from an unbalanced system was plagued with "hum" I was able to use a twin-T notch to eliminate most of the interference. However, when I tested the frequency response of the system with the filter in I really pulled my hair out! Can you include something on this in your column?"

Mr Maunder's problem is an interesting one and highlights the limitations of simple passive filters. Before taking this any further it is worth stating that adding filters to remove residual 50Hz or 100Hz noise should really only be attempted when all other measures for reducing the problem have been thoroughly explored. Such measures typically include the following:

1. Adequate screening (this is particularly important in the case of signal cables and high impedance input stages).
2. Careful location and orientation of mains transformers.
3. Careful routing of mains and other high-voltage a.c. wiring.
4. Correctly rated and properly designed power supplies.
5. Adequate decoupling of d.c. supply rails to aid ripple rejection.
6. Single-point earthing (to prevent the circulation of currents within "earth loops").
7. In extreme cases (and where a relatively modest supply voltage and current is required) consider dispensing with the a.c. power source in favour of batteries.

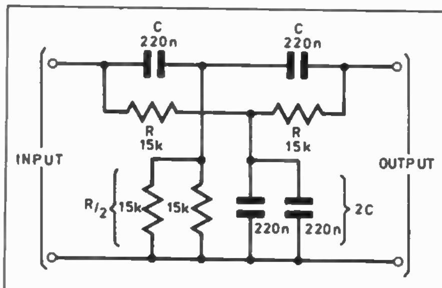


Fig. 1. 50Hz twin-T notch filter.

Given that the foregoing precautions (not all of which apply in every case) have been observed, the erstwhile designer is left no other alternative than to remove residual hum from signal paths by means of a notch filter. This form of filter should ideally provide infinite attenuation at 50Hz (or 100Hz) and zero attenuation at all other frequencies.

One simple form of notch filter (the twin-T) is shown in Fig. 1. This filter is simple to construct but has a number of disadvantages not the least of which is significant signal loss (attenuation) coupled with a relatively low Q-factor. This latter effect is the cause of the unacceptable frequency response which Mr Maunder mentions in his letter.

A much improved active notch filter is shown in Fig. 2. This filter has a nominal centre frequency of 50Hz and a Q-factor (determined by the ratio of R1:R2) of eight. This active circuit provides a very sharp notch together with minimal attenuation at all other frequencies.

As the circuit of Fig. 2 exhibits a much narrower bandwidth than its passive counterpart, it is necessary to trim the frequency of the notch so that it is closer to 50Hz. This is achieved by means of the parallel connected 33n capacitors, C1a and C2a. The rest of the filter components are not particularly critical and almost any quad operational amplifier can be used for IC1 (a TL074 or TL084 is recommended).

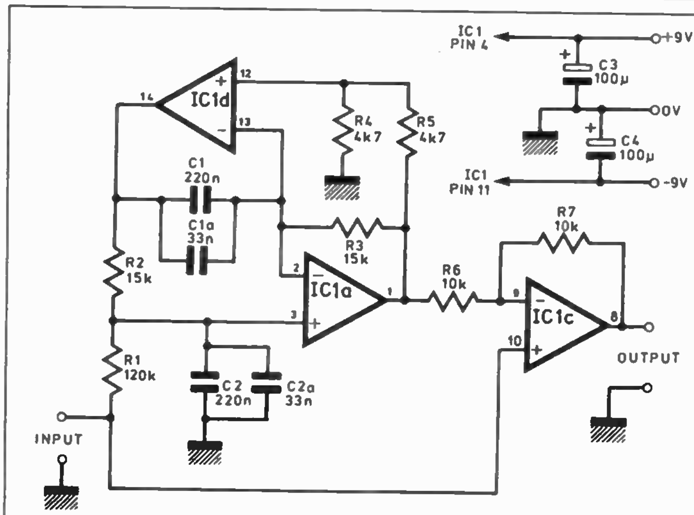


Fig. 2. Active 50Hz notch filter. IC1 can be a TL074 or TL084 low-noise op.amp i.c.

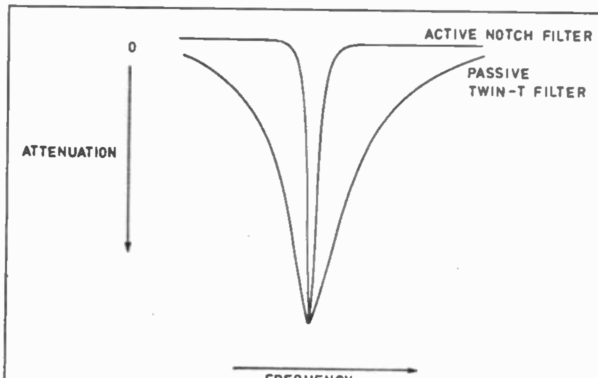


Fig. 3. Frequency response comparison between Fig. 1 and Fig. 2.

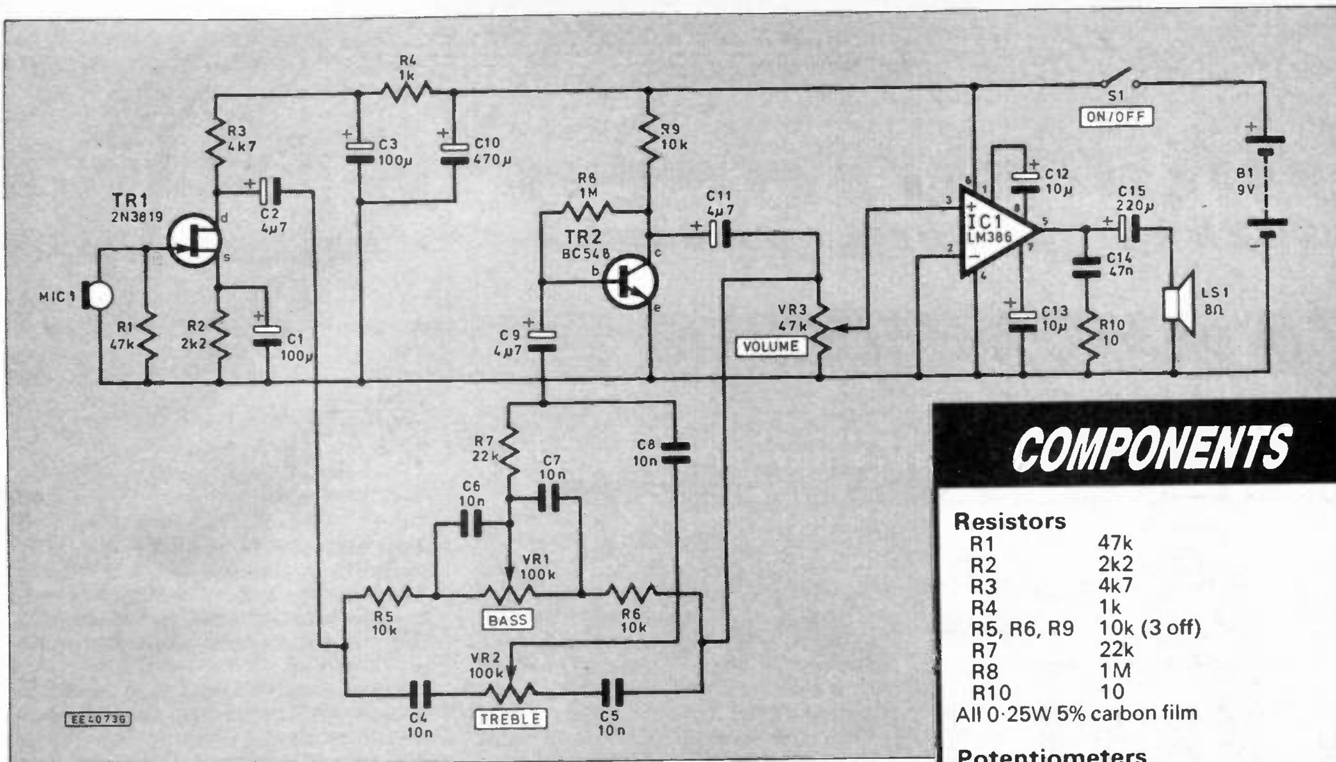


Fig. 4. Complete circuit diagram of the extension amplifier.

Making it Louder

Mike Wingfield writes from Southampton:

"Now that I am retired my hearing is not as sharp as I would wish. I wonder if you would kindly advise me concerning a simple amplifier circuit, perhaps using the LM380 or similar i.c.

Self-construction, rather than miniaturisation, is my wish. I envisage placing the device on the arm of a chair in a box of sufficient size to accommodate a good microphone and sockets for earpiece(s) and/or headphones.

In addition to a volume control I would like the option of amplifying either the whole audio frequency range or with emphasis on the lower, or the mid or the higher frequencies. Another desirable option is that of a 6V, 9V or 12V power supply."

This was one challenge I couldn't resist and Fig. 4 shows the fruits of my labour! I chose to use an LM386 rather than an LM380 as the former device operates over a much wider voltage range. TR1 provides a small amount of voltage gain coupled with an input impedance of approximately 50k. The input impedance can be changed to any desired value by simply changing the value of R1 and the circuit will provide full output for a microphone signal of around 5mV pk-pk at 1kHz.

Transistor TR2 and associated components form an active Baxandall tone control. This circuit provides for separate adjustment of the Bass and Treble response with around 10dB of boost and cut at frequencies of 100Hz and 4·5kHz.

The "flat" frequency response is from 50Hz to 50kHz at –3dB and the maximum output power is about 500mW into an 8 ohm loudspeaker or headphones. The amplifier will operate happily for many hours using a 9V PP7 or PP9 battery.

Next month: We shall be returning to a regular favourite with readers, power supply design. We also have details of a Simple Aerial Booster which can be used with most types of radio receiver.

In the meantime, if you have any comments or suggestions for inclusion in *Circuit Surgery*, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT. Please note that I cannot undertake to reply to individual queries from readers however I will do my best to answer all questions from readers through the medium of this column.

COMPONENTS

Resistors

R1	47k
R2	2k2
R3	4k7
R4	1k
R5, R6, R9	10k (3 off)
R7	22k
R8	1M
R10	10

All 0·25W 5% carbon film

Potentiometers

VR1, VR2	100k rotary carbon, lin. (2 off)
VR3	47k rotary carbon, log.

Capacitors

C1, C3	100µ radial elect. 16V (2 off)
C2, C9, C11	4µ7 axial elect. 35V (3 off)
C4 to C8	10n ceramic (5 off)
C10	470µ radial elect. 16V
C12, C13	10µ radial elect. 16V (2 off)
C14	47n ceramic
C15	220µ radial elect. 16V

Semiconductors

TR1	2N3819 f.e.t. transistor
TR2	BC548 *npn* transistor
IC1	LM386 power amp i.c.

Miscellaneous

LS1	8 ohm loudspeaker
MIC1	Microphone (see text)

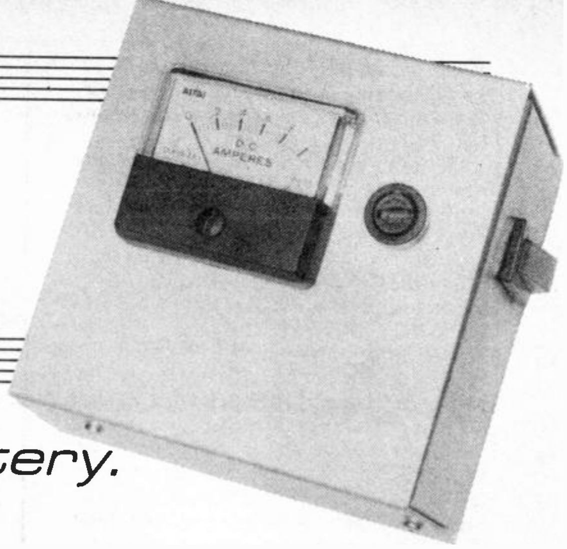
8-pin low-profile d.i.l. socket; small piece of 0·1in. matrix stripboard (approx. 50mm x 100mm); terminal pins; small ABS enclosure; PP3 battery clip; miniature toggle switch (s.p.s.t.); knobs (3 required)

Approx cost guidance only **£12** *excluding MIC*

Constructional Project

MINI-CHARGER

T.R. de VAUX-BALBIRNIE



Winter care for your car battery. You will always be in charge.

WINTER driving always puts additional strain on the car battery. This is partly due to extra use of headlights, foglamps, the heated rear windscreen and other high-current accessories.

It is also due to the additional drag of the starter motor on a cold engine and the greater demand when the engine does not start "first time". In some cases, a battery known to be in a satisfactory condition and which behaves perfectly during the summer, will run out of energy every few days in the winter.

This is not helped by the manufacturers' tendency to fit very small batteries to modern cars. It often happens that these do not have sufficient reserves of energy to cope with the heavy demands of winter motoring.

HOME AND AWAY

This miniature car battery charger is effective in keeping the battery in good condition during the winter months. Since it supplies only 1A maximum, it cannot be described as a fast charger by any means.

If, on the other hand, it is connected to the battery and left switched on all night, it will prove adequate to promote easy starting the following day. The cost of using the charger is negligible – about 1p per night.

High-current fast charging is not to be recommended except, perhaps, in an emergency since it can cause permanent damage to the battery. The Mini-Charger will not cause such problems and is small enough to be carried in the car so that it may be used away from home wherever a mains supply is available.

In use, the charger is placed in some convenient place *outside* the car and in a dry location. The output wire is then led into the car and plugged into the cigarette lighter socket. This avoids having to lift the bonnet and make connections direct to the battery terminals.

The unit is then plugged into the mains and switched on. A red neon indicator glows to show that the charger is operating and an ammeter indicates the actual charging current.

On certain cars, the cigarette lighter socket is only connected when the ignition is switched on – usually to the first (cassette player/radio) key position. This would involve leaving the key in the ignition when the charger is in use and this would obviously be a bad idea.

In such a case, it would be possible to re-wire the socket to be "live" all the time. Otherwise it will be necessary to fit crocodile clips to the output lead and connect the charger output *direct* to the battery.

Where specific instructions are given by the car manufacturer regarding the connection of a battery charger, these MUST be followed. Readers are advised to check this point in the car handbook.

ROLL OFF

In use, with a partially discharged battery, the charger will deliver the rated maximum current of 1A. As the battery approaches full charge, this "rolls off" to a trickle of 400mA or so.

It is thus impossible for the battery to be overcharged when the unit is connected continuously. The ammeter scale could be marked with coloured sectors to indicate the state of charge – *red* (poor), *yellow* (medium) and *green* (good) although this was not thought worthwhile in the prototype.

Safety Note: Constructing the Mini-Charger involves making mains connections. Anyone who is not certain of his or her ability to make a safe job must consult a qualified electrician.

In particular, the device must be built in an Earthed METAL BOX and fuses used as specified. The charger must not be used in damp conditions.

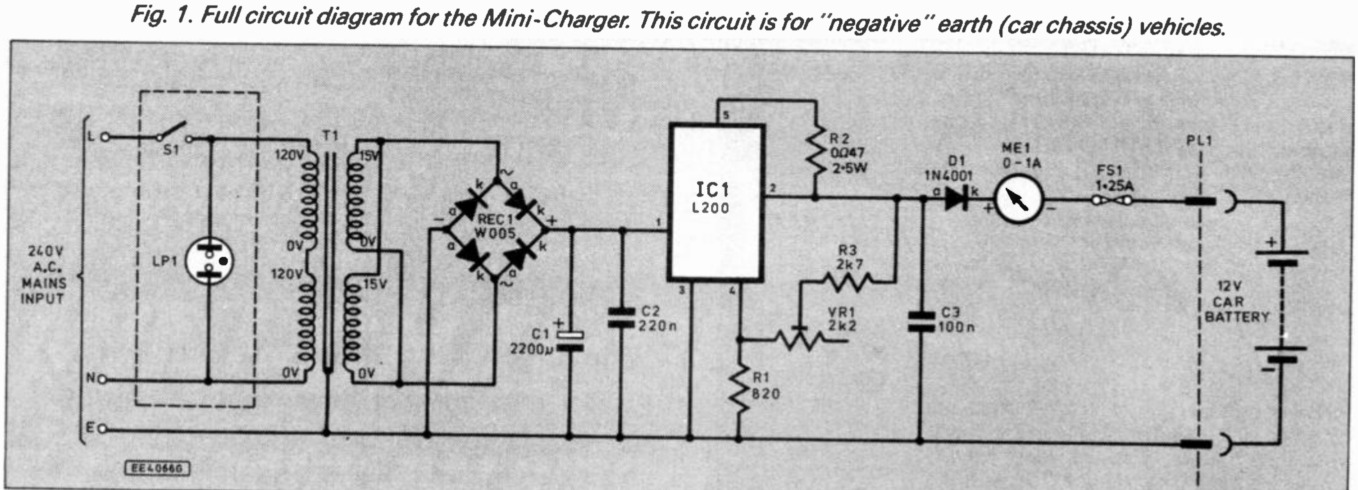
CIRCUIT DESCRIPTION

The complete circuit diagram for the Mini-Charger is shown in Fig. 1. Mains current flows through On/Off switch, S1, hence through the primary winding of the mains transformer, T1. The on state is shown by neon indicator, LP1 (which was built into S1 in the prototype unit).

The nominal 15V a.c. supply obtained from T1 secondary winding (two windings connected in parallel in the prototype) is rectified by bridge rectifier REC1 and smoothed by capacitor, C1. This is applied between the input, pin 1, and pin 3 of integrated circuit, IC1 – a combined voltage and current regulator. Fixed resistors R1 and R3, together with preset potentiometer, VR1, set the output voltage obtained between pin 5 and the common negative, pin 3.

Output current flows from pin 5 and through fixed resistor, R2 – the value of this resistor determines the maximum

Fig. 1. Full circuit diagram for the Mini-Charger. This circuit is for "negative" earth (car chassis) vehicles.



output current by the formula: $I_{MAX} = 0{\cdot}45/R2$. Using the value for R2 specified, (0·47 ohms) this gives 0·45/0·47 or almost 1A.

This value resistor is available but usually with an unnecessarily high power rating – 2·5W in the prototype. However, this does not matter since there is plenty of space for it on the circuit panel. As an alternative, a near-value (0·5 ohms) could be obtained by connecting two one ohm resistors in parallel.

Diode D1 prevents the battery from discharging back through IC1 if it were to be left connected and the mains supply switched off. Preset VR1 forms the adjustment for the voltage output and will be set for best effect at the setting-up stage. Capacitors C2 and C3 are required for correct and stable operation of the i.c.

Fuse FS1 will blow if, due to some fault developing, the output current rises much above 1A. It will also probably blow and save the i.c. if the battery is connected the wrong way round to the charger output. ME1 is the 0 to 1A ammeter which indicates the charging rate.

Car batteries are of the *lead-acid* type. The nominal output voltage of a single lead-acid cell is 2·0V. In a car battery, there are *six* such units connected together internally in series hence the nominal 12V output which a car battery is said to have.

However, this voltage depends to some extent on the state of charge. When fully charged, the voltage rises to some 2·2V per cell i.e. 13·2V total falling to 1·7V per cell or about 10·2V total or less when the state of charge is very low.

Since it is the purpose of a battery charger to drive current through the battery in the reverse direction, it follows that it is necessary for the voltage output of the charger to exceed that of the car battery by a comfortable margin. If the voltage output is set to 13·8V approximately, it will be effective in driving current through the battery until full charge is approached, whereupon the current will gradually roll off to a "trickle".

CHOICE OF TRANSFORMER

It is important to choose a good-quality component for mains transformer, T1. Readers are warned that some suppliers are optimistic in the specification of their transformers. Small, cheap components which appear to be just adequate "on paper" may well overheat in service.

A transformer said to have a regulation of seven per cent or less will work well. The regulation is a figure which relates the on-load voltage to the off-load one.

The lower this figure, the less the voltage will fall when the transformer is on load. If the voltage falls excessively in this way, a lot of heat will be developed in the transformer windings. The specified type of 25VA transformer having twin 15V secondary windings rated at 0·8A each (i.e. 1·6A when connected in parallel) proved excellent for the job – see *Shop Talk*.

CONSTRUCTION

Construction of the Mini-Charger is based on a circuit board made from a piece of 0·1 in matrix stripboard, size 10 strips x 25 holes. Fig. 2 shows the component view and details of the track breaks required on the copper strip side.

Begin construction work by cutting the stripboard to size and drilling the single mounting hole as indicated. Make all the underside track breaks and follow with the soldered on-board components. Take care over the orientation of bridge rectifier, REC1 and the polarities of capacitor C1 and diode D1.

Solder 8cm pieces of light-duty stranded connecting wire to strips *C* and *G* and a 15cm piece of similar wire to strip *A* on the circuit board as shown. An earth lead connection is also required from strip *F* to the transformer Earth (E) solder tag. (Use an off-cut from the mains cable Earth lead). After construction of the board, adjust preset VR1 sliding contact approximately one-third clockwise (as viewed from C1 position).

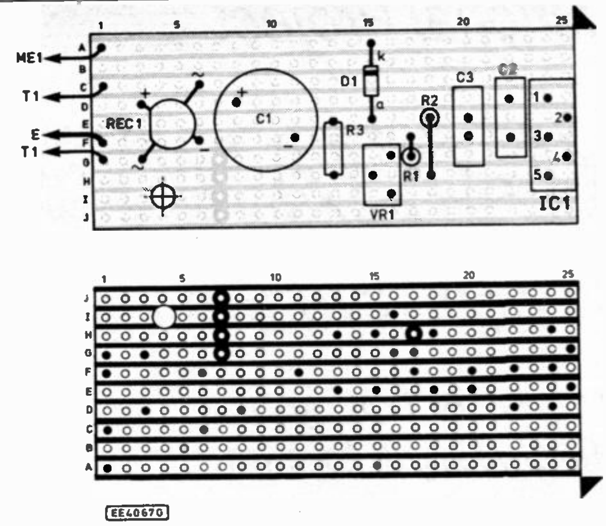
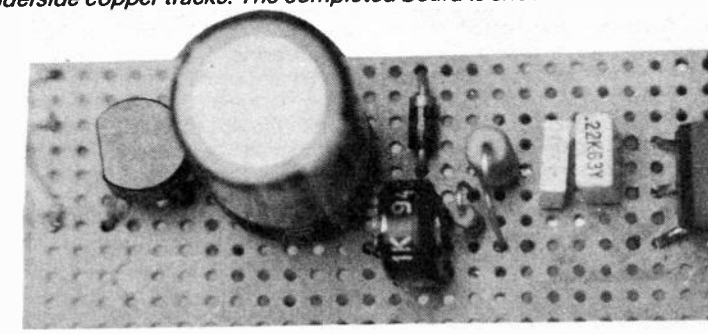
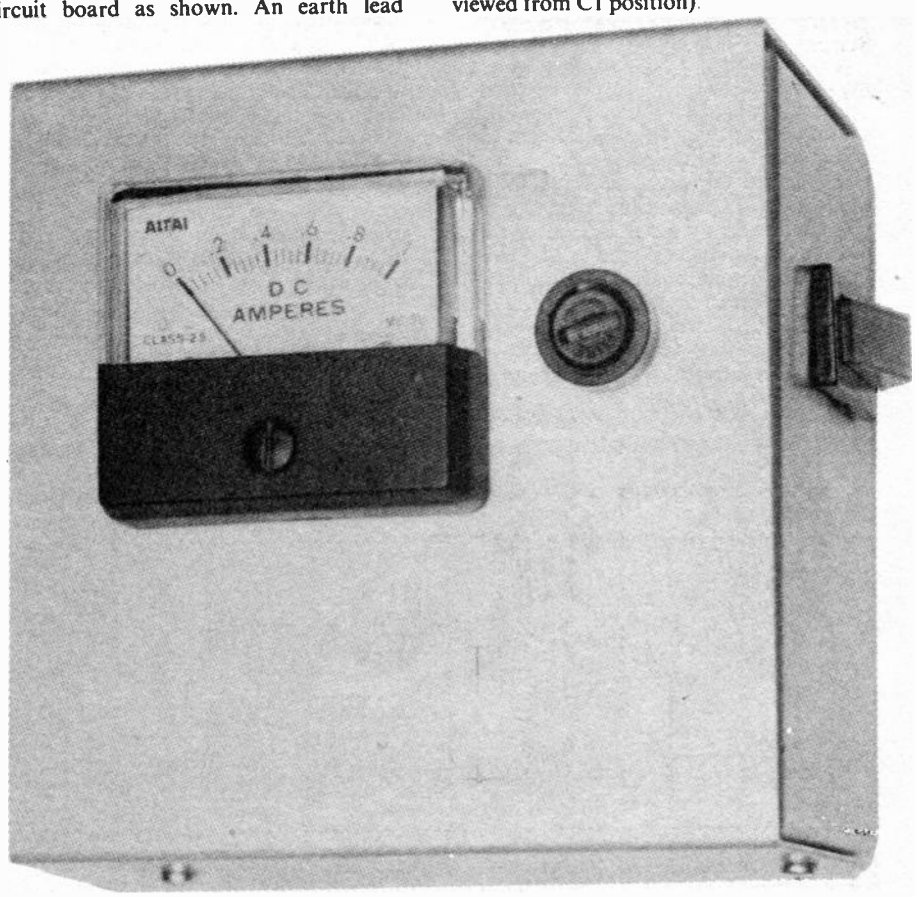


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. The completed board is shown below.





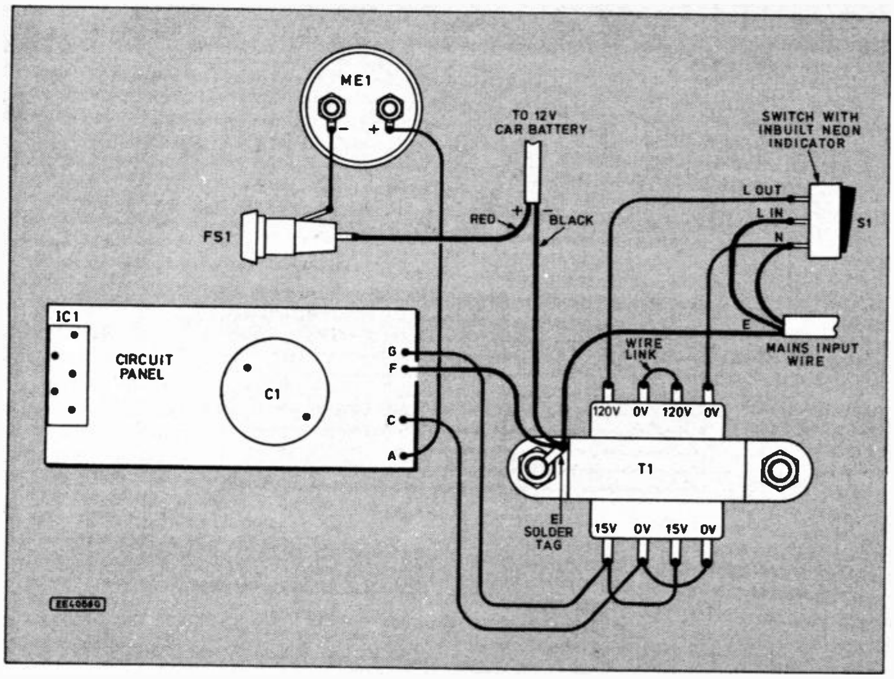


Fig. 3. Interwiring to the mains transformer, fuse, meter, on/off switch and circuit board. Use 3A (minimum) mains or auto-type cable for the output leads, preferably colour coded red and black.

METAL CASE

Locate the small holes in the flanges of the base section of the metal case which align with those in the top part, and which are used for holding the two halves of the box together. Drill new holes in the base section of the same diameter but 6mm *higher* than those already there.

When the two halves of the case are secured using the self-tapping screws supplied, but using the new holes, there will now be 6mm high ventilation slots in each side. This ventilation gap allows cooling air to circulate around the mains transformer and the voltage regulator IC1. It is normal for the case to become "hand warm" during operation.

Check the final positions of components so that these may be avoided and drill about eight ventilation holes 5mm in diameter in the base. Drill holes for transformer T1 and switch S1 mounting, also for the strain relief grommets to be used on the input and output leads later.

Hold the circuit board in position 5mm above the base of the box and, with IC1 in contact with the side, mark the positions of the hole in the circuit panel and that in IC1 tab. Remove the circuit board and drill holes in these positions.

Mount the transformer, switch and board. Fasten the circuit board on a 5mm high *metal* spacer checking that all soldered joints on the copper strip side remain well clear of the metalwork. It is necessary to use a metal spacer rather than a plastic one since the underside of the circuit panel becomes warm in operation and a plastic spacer could soften.

Secure IC1, via its metal tab, to the case using a small nut and bolt through the hole drilled for the purpose. IC1 *MUST* be firmly attached to the metalwork since this will act as a heatsink.

When mounting the mains transformer T1, leave some space all around it to allow air to circulate. Note the solder tag at one of T1 fixing lugs. This is essential for safety reasons since it is used to Earth the box and the transformer core – DO NOT use a makeshift connection method here.

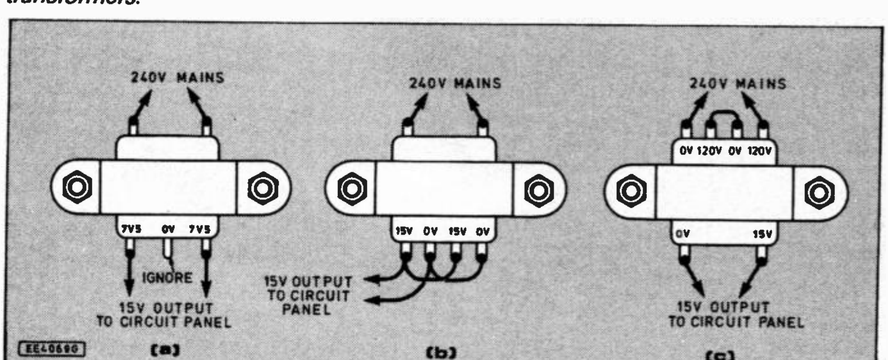
Drill the holes for meter ME1 and fuseholder FS1 in the top section of the case (see photograph). The positions of these holes are critical and need to be measured carefully so that the protruding underside of the meter remains clear of the transformer and the fuseholder connections are clear of the on-off switch terminals. Also, ensure all connections are clear of the metal case.

The best way to make the hole for the meter is to mark out its position carefully and drill a series of small holes around the circumference. These may then be joined together using a small hacksaw blade and the work smoothed off with a file.

Mounting the remaining components and, referring to Fig. 3, complete the wiring. If the transformer has a centre-tapped secondary – that is, a "7·5V-0V-7·5V" winding – ignore the centre (0V) connection, see Fig. 4a. If it has twin 15V windings, connect them in parallel, see Fig. 4b.

If the transformer has twin 120V primary windings connect them in *series* for 240V mains operation – see Fig. 4c. Use a short piece of insulated *mains-type* wire for the link.

Fig. 4. Wiring details for connecting up different combinations of mains transformers.



CONNECTING LEADS

Make up the input and output leads of adequate length. The input wire should be of 3-core flexible *mains* type of 3A rating minimum. It would be helpful if the output wire had *red* (positive) and *black* (negative) insulation – this will ensure connecting the battery with the correct polarity later. Both input and output wires should have an outer sheath thick enough to withstand the rigours of normal use – i.e. when rubbing against the garage floor, etc.

Fit one end of the mains lead with a mains plug and insert a 2A fuse. If the plug is not of the fused type, a separate 1A or 2A fuse must be provided in the box.

Fit one end of the output lead with a cigarette lighter type plug, observing the polarity, or use another appropriate connector such as crocodile clips as required. Note that in a *negative-earth* car, the tip connection of the plug is the *positive* one. Fit it with a 1A fuse if it is of the fused type.

The use of 3A twin mains-type cable will be found to work well for lengths of at least five metres. If using longer lengths, it is possible that there will be an excessive voltage drop and wire of a higher current-carrying capacity should be used.

Fit the input and output wires with the strain relief grommets and secure them into position. Refer to Fig. 3 and connect the inner ends up. Check particularly the soldered joints on the mains wires at switch S1 terminals and at the "Earth" solder tag.

Use heat-shrinkable sleeving on the exposed mains connections at the switch. The sleeving may be shrunk tightly into position using a closely-held hair dryer on its hottest setting. Heat shrinkable sleeving should also be used on the transformer primary connections. If this is too difficult, use an insulating shield instead – a piece of thick cardboard, for example.

Note that the tab of IC1 is at supply negative voltage. Since this is connected to the metalwork of the case, the box itself is at supply negative voltage also. This is why the negative output wire may be connected to the solder tag.

Close the lid of the box checking carefully that no wires are trapped and no short circuits are formed between any components and the metalwork. Secure the lid and fit the case with plastic feet. One of the purposes of these feet is to keep the base of the unit at least 3mm clear of the surface on which it stands so that air can circulate through the ventilation holes drilled in the base and out through the slots in the top.

TESTING

While the unit is connected to the mains, the lid MUST be fitted in place. All adjustments to preset VR1 MUST be made in small steps with the charger unplugged from the supply.

COMPONENTS

Resistors

R1	820
R2	0Ω47 2·5W (see text)
R3	2k7

All 0·6W 1% metal film, except R2

See SHOP TALK Page

Potentiometer

VR1	2k2 sub-min. carbon preset, vert.

Capacitors

C1	2200µ p.c.b. mounting radial elect., 25V
C2	220n ceramic
C3	100n ceramic

Semiconductors

D1	1N4001 1A 50V rect. diode
IC1	L200 adustable voltage and current regulator (*Pentawatt* package)
REC 1	W005 50V 1·5A bridge rectifier

Miscellaneous

T1	Mains transformer. Primary: 240V a.c. Secondary: 15V 1A minimum. (or twin 15V secondaries rated at 0·8A). See text
S1	Mains voltage rocker switch (with neon indicator); 1A rating minimum
ME1	Miniature panel meter (0 to 1A f.s.d.), face size 50mm x 45mm approximately
PL1	Cigarette lighter type plug (or 2 off crocodile clips) – see text
FS1	20mm panel fuseholder, fitted with 1·25A quick-blow fuse

Stripboard, 0·1in. matrix, size 10 strips x 25 holes; aluminium box, size 102mm x 102mm x 64mm; 1A fuse for PL1 if required; three-core mains cable, 3A minimum; two-core wire, 3A minimum; small fixings; stranded connecting wire; solder; solder tag; self-adhesive plastic feet; heat-shrinkable sleeving; 5mm long metal spacer; strain relief grommets (2 off).

Approx cost guidance only **£25**

Plug the Mini-Charger into the mains and switch on. The neon indicator should light up.

If a voltmeter (or multitester) is available, set this to the 0V to 15V d.c. (or higher) range and connect the probes *directly* to the output observing the polarity. The meter should read somewhere around 14V.

Initially, preset VR1 should be adjusted to provide a voltage output of 13·8V – clockwise rotation of the sliding contact (as viewed from C1 position) increases it and *vice-versa* If no meter is available, leave VR1 adjusted as it is (that is, one-third clockwise).

The output should now be short-circuited with a short piece of wire. The ammeter should read 1A approximately. Apply this test for a short time only since there will be a large voltage drop across the i.c. and quite a lot of heat will therefore be produced by it. If the current is found to be more than 1A, resistor R1 should be *increased* in value and vice-versa.

FINAL TESTING

If all is well, tests may be made under true conditions with the car battery connected. Take particular care to connect it with the correct polarity with the positive output wire connected to battery positive.

Begin with the battery known to be in a fairly poor state of charge. Plug in the unit – the meter should read 1A approximately. If it is less, increase the voltage output slightly by clockwise rotation of preset VR1 (as viewed from C1 position).

Check the meter reading every so often in the course of charging and note that it begins to fall with an end point of 400mA (0·4A) or so. If after an extended period of charging, it remains in excess of this figure, reduce the output voltage slightly so that the end-point current is set as required. If the end point is too low or falls to zero, raise the output voltage slightly.

Adjustments may now be made over the next few days to obtain the best setting for VR1. After that, the Mini-Charger may be put into permanent service.

METER SCALE

If the meter scale is to be marked with coloured sectors to show *high*, *medium* and *low* charge rates, first make sure that the plastic front cover removes easily. You will also need a very small screwdriver and a steady hand.

Remove the cover, take out the screws which attach the scale and, with great care to avoid bending the pointer, remove the scale. Using a pencil, mark the positions of the sectors.

It is suggested that poor (red) is used above 0·8A, medium (yellow) between 0·5A and 0·8A and good (green) below 0·5A. Fine fibre-tip pens could be used for the colouring-in. Replace the scale carefully and snap on the font cover checking that the small plastic adjustment peg used to zero the meter engages correctly with the fork on the movement.

OPERATING CONDITIONS

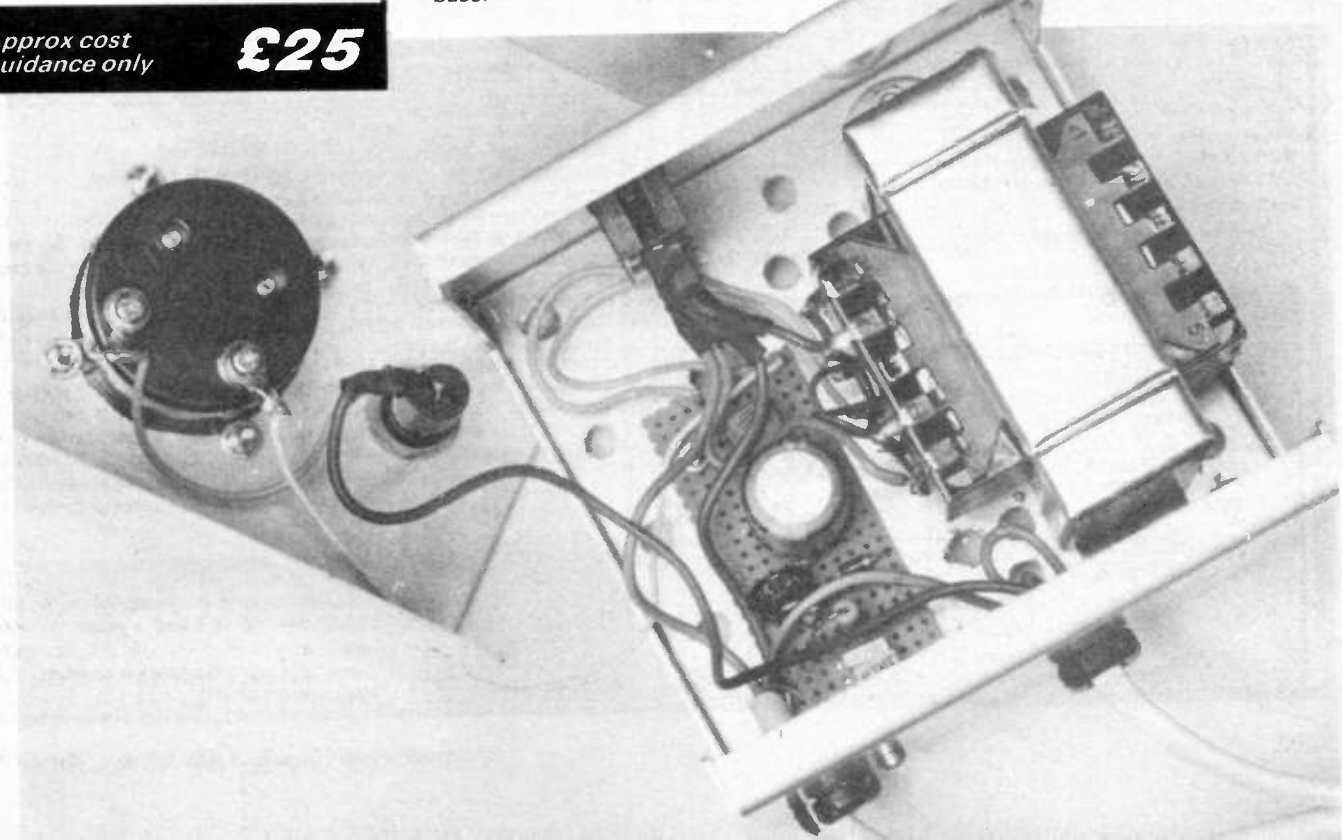
With the maximum rated current flowing, it is normal for the case to become warm in operation – there should therefore always be a free flow of air allowed to circulate around the unit. While operating, the charger should be placed on a flat surface to allow air to enter the ventilation holes in the base.

Some of the heat is produced by the transformer and some by the i.c. The amount of heat produced depends on the current flowing and the state of charge of the battery as well as other factors such as the size and quality of the mains transformer.

After several hours of operation with 1A flowing and using a battery in a poor state of charge, the prototype unit could be placed on the palm of the hand and it would feel comfortably warm but not painfully hot. If overheating proves to be a problem it could be due to an inadequate transformer or insufficient ventilation.

While charging, the battery experiences small voltage changes, it is therefore normal for the ammeter pointer to fluctuate slightly in operation. □

The completed charger showing layout of components inside the metal *case. Note the ventilation holes drilled in the base.*



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dpdt	70p each	dpdt 3 position c/off	80p each
spdt biased	60p each	spdt 3 position c/off biased both ways	70p each
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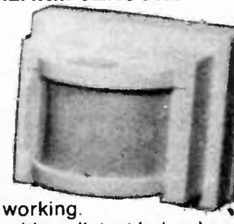

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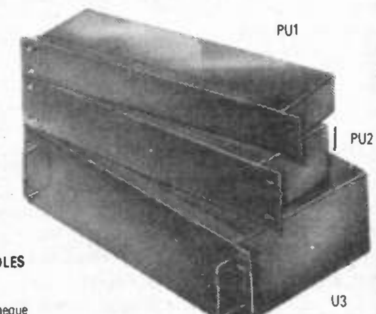

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with Alan Winstanley
and Keith Dye B.Eng(Tech)AMIEE

Part 6

Teach-In '93 continues a tradition of offering an interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels.

IN PART Five we introduced the operational amplifier, using it as an "active" component capable of processing analogue signals. We defined an analogue waveform in Part Two as a "wavy line" – a voltage having a wide range of values which vary with time. The output from a light-sensing unit (i.e. light-sensitive potential divider) is one example of an analogue signal. When designing an electronic system, itis necessary to process this analogue "information", before a useful function can be performed.

I.C. TECHNOLOGY

Integrated circuits (i.c.s) represent a complete miniaturised circuit containing many transistors (anything from dozens to millions of them), and are much more convenient, reliable, economical and compact than circuits assembled with separate "discrete" components. They are ideal when utilised in electronic systems as processing blocks: we saw how the op-amp offers a variety of functions as analogue processing units, depending on how you utilise it and how you control it with feedback.

I.C. technology has not been limited solely to operational amplifiers though, and a wide range of devices is now fabricated by manufacturers of integrated circuits which offers a huge choice for those designing electronic systems. Browse through any component supplier's catalogue under the "Semiconductors" section to see.

Whilst an op-amp is more of a general purpose device, many integrated circuits have been designed specially to fulfil a particular function, time delay generation being one of them. Some systems (e.g. an alarm unit or a photographeris darkroom timer) may require a time delay function and this can be generated by some specially-made integrated circuits which we will now demonstrate. Later on, we investigate the fascinating world of digital systems which use "computer chips". Read on!

TIMER CHIPS

Ask any electronics constructor for the name of the most popular timer i.c., and they will tell you straight away – the 555. It's been a favourite for decades, although it has been refined over the years with the advent of new technologies.

A 555 timer i.c. is specially designed and optimised to produce accurate and repeatable time periods. They are superb for use in electronic systems where time delays are needed, and they actually have two distinct modes of operation, producing either a single time delay or an accurately-timed stream of pulses.

The 555 is packaged in an 8-pin dual-in-line package, and Fig. 6.1(a) shows the pinout for this device. Fig. 6.1(b) is a circuit diagram illustrating a 555 connected in a repetitive timing mode which produces a stream of pulses. For the next demonstration, you will require a NE555 timer i.c. – they cost about 25p, so buy two or three. They're always handy to have.

You could alternatively use a similar ICM7555 which does exactly the same job, although it uses low-power CMOS technology (see later). The NE555 uses bipolar (*npn* and *pnp*) transistors on the chip, and is less refined but probably more robust than the CMOS version.

555 DEMONSTRATION

You are already familiar with the use of 8-pin d.i.l. packages – such as the op-amps we used last month – so it should be possible for you to go right ahead and construct the simple circuit yourself using the *Mini Lab*. Happily the 555 functions with a supply voltage anywhere between 5V to 15V d.c. (see the Absolute Maximum ratings given later), and will be quite at home driven by the *Mini Lab* + 12V rail.

You must however ensure that you connect the 0V and + 12V power rails the right way round or the i.c. may be destroyed. Another sure way of ruining it is to short the output to 0V for any length of time . . . !

Note the 100k preset resistor VR1 connected between pins 7 and 6/2. The capacitor value is not too critical, and anything from the spares box between 10μ to 100μ should be fine. The l.e.d. will fit directly to the breadboard and pin 5 is not connected here. Double check your interwiring to ensure that it conforms with the circuit diagram, and switch on.

Hopefully, the l.e.d. will be flashing. If not, closely check your connections to the i.c. – and is the l.e.d. the right way round? Adjust VR1 to alter the flash rate. Interesting! Now try linking the L.E.D. Voltmeter (set to 10V f.s.d.) across the timing capacitor C1 (or pins 2 or 6 of IC1) as shown, and see what happens. Dot mode is best.

When used with a 12V rail, the capacitor charges up (the Voltmeter reading rises) during which time the l.e.d. is illuminated. The instant the voltage across C1 reaches 8V, the l.e.d. switches off and the Voltmeter falls to 4V. Then the l.e.d. lights again and C1 charges up once more. So the timing capacitor is seen to be continually charging up to 2/3 the supply rail and discharging down to 1/3 of the rail. Agreed?

ASTABLE

This is another form of *relaxation oscillator* (we constructed one last month with an op-amp) which uses an RC network to control the time period. We can more accurately state that the 555 is connected as an **astable**, which is a circuit having no stable state, so it cannot settle down in one fixed condition. In Fig. 6.1(b), the i.c. oscillates at a frequency determined by the values of the RC network formed of

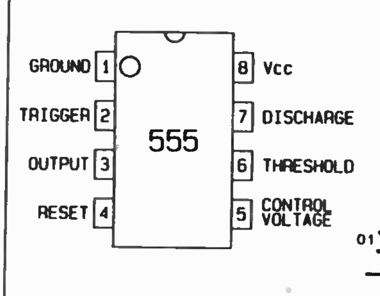


Fig. 6.1(a). Pinout for the 555 timer i.c.

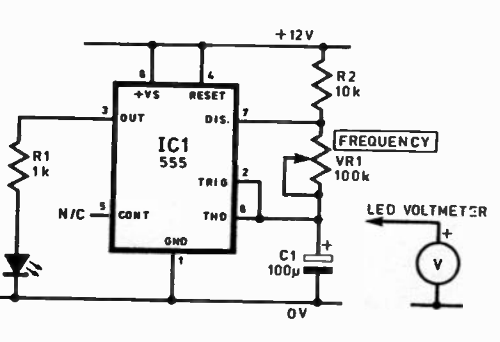


Fig. 6.1(b). 555 timer in astable mode.

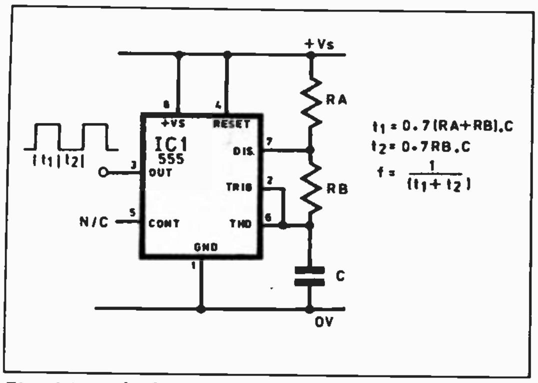


Fig. 6.2. Calculating the operating frequency of 555 astable.

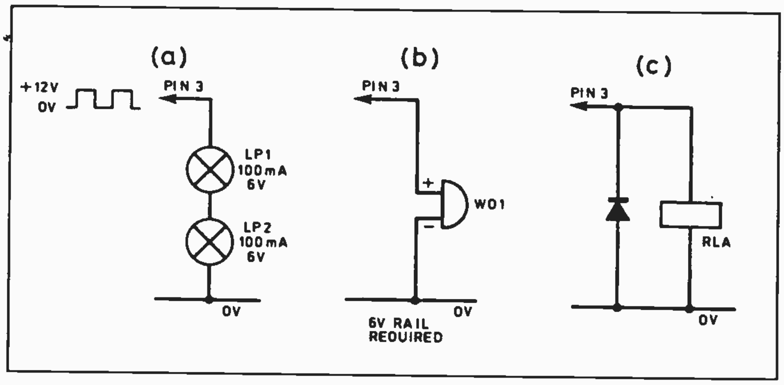


Fig. 6.3. Driving output transducers with a 555.

R2, VR1 and C1. The circuit operates as follows.

When the circuit is first powered up, C1 is initially discharged (so there is no voltage across it), and this 0V signal at pin 2 (trigger) is sufficient to cause the 555 to trigger, making the output of the i.c. (pin 3) go high – nearly to the supply rail voltage – and illuminating the light-emitting diode. The capacitor continues charging up through R2 and VR1 until the voltage across it reaches 2/3 the supply (8V), when this is sensed by pin 6 (threshold). The output switches low and the i.c. forces the capacitor to discharge through VR1 and into pin 7 (discharge).

Capacitor C1 continues discharging down into pin 7 until the trigger voltage (1/3 the supply rail) is reached once more, when it will start charging up again and so the cycle repeats. The trigger and threshold points are fixed automatically by an internal potential divider at 1/3 (or lower) and 2/3 (or higher) of the supply rails respectively, which means that the circuit operates correctly regardless of the supply voltage.

Fig. 6.2 shows the basic arrangement for a 555 astable circuit, and the formulae:

$$t_1 = 0{\cdot}7\,(R_A + R_B).C$$

$$t_2 = 0{\cdot}7R_B.C$$

give the approximate timing periods in seconds. Resistor values are in ohms and the capacitor is measured in Farads. The frequency of operation is of course:

$$f = 1\,/\,(t_1 + t_2)\ \text{Hz}$$

where f is the frequency of the square wave at the 555 output, in Hertz. It has to be remembered that if an electrolytic capacitor is used, these suffer from high leakage currents and poor tolerance, which implies that the repeatable accuracy is likely to be poor and the actual frequency is often a long way from that predicted by the formulae.

Instead of driving an l.e.d., try using the two 6V 100mA bulbs fitted to the *Mini Lab.* They must be wired in *series* as shown in Fig. 6.3(a) so that 6V will appear across each of them when driven by the 12V output of the 555. The current drawn from pin 3 will still be 100mA which is within the device ratings.

By setting the supply rail to +6V using the Variable Power Supply, you may directly drive the *Mini Lab* buzzer as shown in Fig. 6.3(b). A connection for the *Mini Lab* relay is given in Fig. 6.3(c), noting once again the need for the back-e.m.f. suppression diode which is already fitted to the p.c.b., to protect the i.c. when the relay switches off.

A good point made by our GCSE Moderator is that sometimes, circuit diagrams for the NE555 might show the output on the right-hand side of the "box" – of course, it makes no difference as long as all the components and pin numbers are interconnected correctly. Don't worry therefore if you see a 555 astable circuit drawn differently from ours.

AUDIO OSCILLATOR

The 555 will readily oscillate at audio frequencies or higher, by simply selecting appropriate values for the RC network. Exchange the timing capacitor C1 for a much smaller value, say 47n or so. The NE555 will drive a loudspeaker directly without the need for further amplification, so the loudspeaker used in the *Mini Lab* Audio Amplifier could be used as shown in Fig. 6.4 to monitor the NE555 frequency.

To do this, firstly remove both link wires which are just to the right of the LM380 i.c., to completely disconnect the loudspeaker from the LM380 chip, which isn't required itself in this application. Use an electrolytic coupling capacitor (100µ 16V or so) between the 555 astable and the loudspeaker as shown in the circuit diagram. This blocks any d.c. current which, because of the low impedance of SP1, would be so high as to damage the 555 and probably the loudspeaker too.

Connect this circuit to the +12V power rail and you will clearly hear the operating frequency of the 555 over the loudspeaker. The pitch or frequency can be adjusted by altering the 100k preset. Thus, the 555 makes an excellent audible tone generator in its own right.

One more useful feature in this simple circuit is pin 4 (reset): by connecting this to 0V (+1V at most), it will inhibit or "disable" the oscillator – useful if you wish to stop operation for any reason. To test this, try linking it to 0V instead of the positive rail. If the reset isn't required, it's best to connect it to the positive supply rail which permits the astable to run freely, rather than simply leave it "n.c." (no connection).

CONTROL VOLTAGE

Just for electronics enthusiasts, pin 5 is the "control voltage" terminal and offers an electronic means of varying the frequency without having to change the RC values. Apply a d.c. voltage of anything from 33 per cent of the supply rail or more, and you can modify the timing period within a certain range by using a suitable signal. Try it, using a 4k7 preset resistor to provide a varying control voltage. Later, we describe a siren system which uses this pin, and which is not for the faint-hearted!

The astable circuit which you have just demonstrated forms the basis for the 555 TIMER module on the *Mini Lab* p.c.b. By selecting different timing capacitors using an on-board selector shorting plug, it provides a range of four variable frequencies: 10Hz, 200Hz, 5kHz and 50kHz approximately. The output is a 12V square wave, the operating frequency of which is adjustable with a preset potentiometer.

Apart from frequency and amplitude, a square wave is capable of being defined further, as shown in Fig. 6.5. The **mark-to-space ratio** is not surprisingly the ratio of the time period during which the square wave is "high" (mark) against the period when it is low (space). Here it would be 3:2. The *frequency* remains the same even if you change the mark-to-space ratio, because the overall time period (t1 + t2) is still unchanged.

More often you may come across the term **duty cycle** which is simply the ratio of the mark against the whole time period, expressed as a percentage. In Fig. 6.5, the duty cycle is 60 per cent.

TONEBURST

The next demonstrations use the Mini Lab 555 *Timer Module – see the constructional details elsewhere in this issue.* Fig. 6.6(a) is a simple systems diagram using the 555 Timer on its 10Hz range together with the 555 audio oscillator which you assembled on the breadboard earlier. The output from the *Mini Lab* 555 Timer is

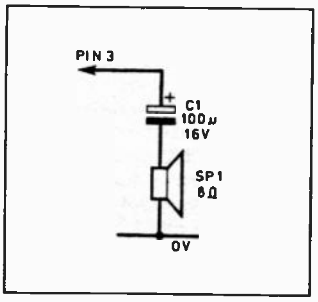


Fig. 6.4. Audio output stage for 555 astable.

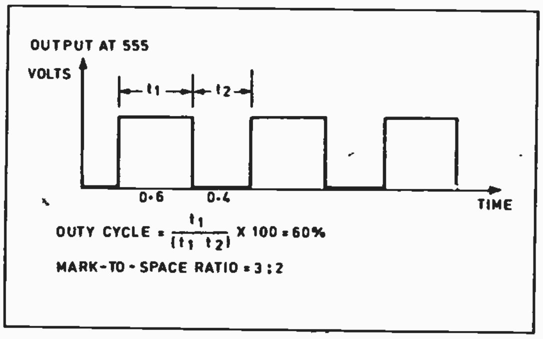
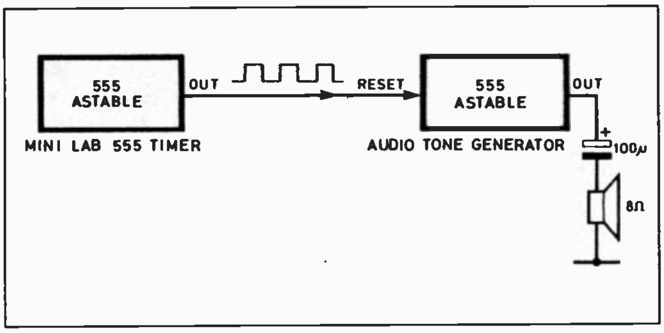


Fig. 6.5. A square wave in more detail.



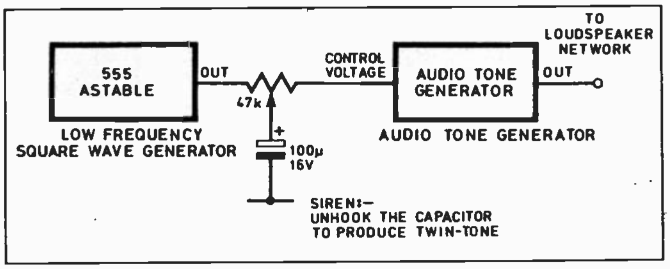


Fig. 6.6(a) (left). Bleep tone generator.

Fig. 6.6(b) (above). Siren effects generator.

coupled to the reset terminal (pin 4) of the 555 audio oscillator circuit, the output from which drives the *Mini Lab* loudspeaker.

Assembling this system on the *Mini Lab* should be an easy task. Simply hook up a link wire between the *Mini Lab* 555 Timer output and the reset pin (pin 4) of the audio oscillator which must **not** be connected to either the supply or ground rails this time. Powering up this circuit will produce a "bleeping" tone – vary the 555 Timer frequency control to adjust the repetition rate of the bleeps, and alter the 100k preset to vary the frequency of the tones.

As shown in Fig. 6.6(a), what happens is that the "breadboard" audio tone generator is alternately disabled and then enabled by the *Mini Lab* 555 Timer. When the 555 Timer output is low, this resets the audio oscillator and disables the audio tone. We say that the audio tone is *modulated* by the low frequency signal of the 555 Timer. The result is a circuit often called a **toneburst generator** – producing "bursts" of higher frequency oscillations.

SIREN

For enthusiasts, a suggested systems diagram for a highly effective U.S. type police-car siren is given in Fig. 6.6(b) which is based around the 555 circuits demonstrated so far. The *Mini Lab* 555 Timer is set to its 10Hz range, which generates a low-frequency train of 12V pulses. Connect this to the control voltage (pin 5) of a 555 astable circuit on the breadboard which operates at audio frequencies as before. The loudspeaker is driven directly by the 555 astable once again, and the reset pin isn't used so it can be connected to the positive supply.

The square wave output from the 555 Timer is modified by an RC network to provide a ramp voltage at the control pin of the audio oscillator. This *modulates* the audio tone to produce a characteristic "whooping" sound. In total three preset resistors are involved, which determine the repetition rate of the "whoop", the pitch of the tone and the blend between a pure twin-tone and siren wail. Experiment to your heart's content, but some frequencies are piercing so please consider others nearby who may find it extremely irritating.

TWIN TIMER

Apart from the NE555 chip, also readily available is a twin timer version called the NE556. This chip contains two 555-type timers both sharing the same power supply pins. One ideal application would be as a toneburst generator where, for example, one chip generates the audio tone and the other timer modulates it. Thus an alarm warning tone could be generated by a single chip. A CMOS version (the ICM7556) is also available.

You will almost certainly find many uses for the *Mini Lab* 555 Timer: utilise it whenever you need a handy source of 12V pulses, perhaps in alarm applications or for general experimentation. Bear in mind the maximum output available of 200mA for the bipolar NE555: buffer the output if necessary to drive heavier loads. It operates anywhere between low frequencies (under 10Hz) to well in excess of the sound spectrum. Also recall that the *Mini Lab* 8038 Signal Generator provides another source of square waves, this time pulled up to +5V which will be especially useful when utilised in digital circuits later in the series.

MONOSTABLE

The 555 is capable of operating in another useful mode, and its **monostable** configuration is shown in Fig. 6.7. Construct this circuit on the breadboard, noting that this time we have used two pull-up resistors R2 and R3 to bias the Reset and Trigger pins to the +12V rail. Two normally-open push switches S1 and S2 are used as shown. An l.e.d. D1 is wired to the output.

The RC network is connected in a slightly different manner to that of the astable. Now only a single timing resistor (VR1) is used. Set VR1 midway then press S2: the l.e.d. will illuminate for a timed period. How long? Pressing S1 in the meantime, will

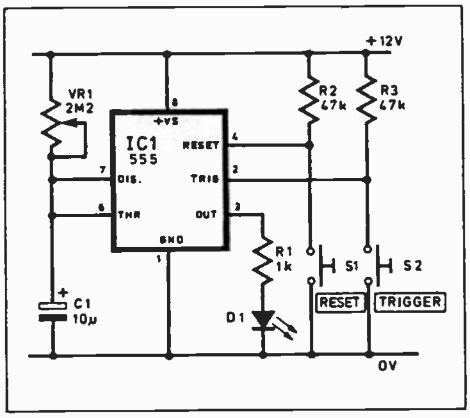


Fig. 6.7. 555 Monostable circuit.

reset the timer. Hence a monostable generates a *single pulse* only. Designers sometimes call a "one-shot".

What happens here is that when the i.c. is triggered by shorting pin 2 to 0V, C1 starts charging up through VR1 until the threshold voltage at pin 6 reaches 2/3 the supply rail, when the i.c. causes the capacitor to discharge into pin 7, halting the timing period. You can manually reset it by shunting pin 4 to 0V as shown.

In Fig. 6.7, the time period t is roughly determined by the formula:

$$t = 1{\cdot}1\,R.C$$

where t is in seconds, R (formed by VR1) is in ohms and C is in Farads.

As with the astable, the use of high-leakage electrolytic capacitors invariably results in poor and unpredictable accuracy, but you would need a large value electrolytic to generate a lengthy delay (say many minutes), so you often have to compromise between accuracy and an extended time delay. There are other methods – using digital counters – which provide much more accurate delays. Certain chips, like the ZN1034E, are specially designed for this, and could provide delays of many months or even years, if needed.

There are all sorts of applications where a monostable might be useful: an egg timer alarm, a photographer's enlarger controller, silencing a burglar alarm after a preset period, etc., and you will often see this popular i.c. appearing in EPE constructional projects.

DATA SHEETS

All manufacturers of integrated circuits produce Data Sheets for their products which are often available to hobbyists at modest cost from mail-order retailers. They can be very helpful in providing further background information so that you can gain some idea of how to utilise the devices. Data Sheets are really designed for professional engineers but some (like the Application Notes produced by National Semiconductor) are a truly excellent source of extra information for constructors which encourage you to dabble. Data Sheets generally contain at least three sections:

Absolute Maximum Ratings which warn you of the maximum limits at which the device may safely operate without damage. (Generally, voltage and temperature.)

Electrical Performance Characteristics which tell you what's happening in the chip when it's operating under typical conditions. This information could be presented in the form of test readings or graphs.

Typical Applications might give you some circuit diagrams using the chip, to give you an idea how it might typically be connected.

555 RATINGS

The Data Sheet of the 555 is quite revealing. (One helpful Data Sheet is that produced by RS/ Electromail – reference no. 2113.) It shows two versions of the timer chip – the bipolar (NE555) and the CMOS type ICM7555. Whereas *npn* bipolar transistors are used in the NE555, CMOS (Complementary Metal Oxide Silicon) FET technology is utilised in the ICM7555. The CMOS version is superior in some, but not all, areas.

The main difference, which you will notice repeatedly when discussing integrated circuits, is that CMOS chips are low-power devices, drawing much less current than the bipolar version. Extracts from the 555 Data Sheet given below, confirm this.

ABSOLUTE MAXIMUM RATINGS

	NE555	ICM7555
Max Supply Voltage	+16V	+18V
Max Output Current	200mA	100mA
MaxPower Dissipation	600mW	200mW
Operating Temp	0 to +70°C	0 to +70°C

But look at these typical operating characteristics:

ELECTRICAL CHARACTERISTICS

Supply Voltage (Min/Max)	4·5/16V	2/18V
Supply Current (typical)	6-20mA	0.06-0.24mA

The superior current consumption of the CMOS version is evident from the ratings in the Data Sheet. You might use the CMOS version with battery-operated equipment where current consumption is critical, but the bipolar NE555 might be better for driving heavier loads.

Data Sheets as well as component suppliers' catalogues are thus an essential source of information which will help you to design and specify electronic systems using integrated circuits. Note that when it comes to GCSE or GCE "A" Level coursework, though, you might lose marks for failing to acknowledge your sources of information and data. You will impress the Examiners if you clearly *list all your sources of reference* - including Data Sheets, books and magazine articles and anything else you consulted during the course of your project research, but Examiners are most unlikely to be impressed if you merely include photocopies of data.

BINARY NOTATION

This refresher might help you to "tune in" to binary number systems. We humans count with decimal numbers (probably because we have ten fingers and thumbs) which use a base of ten. Our system contains ten characters, 0 to 9 inclusive of course, and we count up in units, tens, hundreds, thousands, tens of thousands, and so on. The year 1993 is obviously represented like this:

	1000's (10^3)	100's (10^2)	10's (10^1)	1's (10^0)
e.g.	1	9	9	3

noting that $10^0=1$, $10^1=10$, $10^2=10\times10$ (=100) and $10^3=10\times10\times10$ (=1000). Mathematicians call the multiplying up every time by ten "raising by a power of ten". When counting upwards from zero in the decimal system, we "carry one over into the next column" after we have reached 9.

Binary systems work in base two, and so have only two numbers: 0 and 1. A binary number might look like this:

	64's (2^6)	32's (2^5)	16's (2^4)	8's (2^3)	4's (2^2)	2's (2^1)	1's (2^0)
e.g.	1	1	0	1	0	1	1

so the number 1 1 0 1 0 1 1 is actually a binary representation of 64+32+8+2+1=**107** in decimal base ten. Hence in binary, we raise by a power of two every time, not ten.

To convert a decimal number into binary, just keep dividing it by 2 and jot down the remainder. Decimal 18 is equal to:

18/2=9 remainder 0
9/2=4 remainder 1
4/2=2 remainder 0
2/2=1 remainder 0
1/2=0 remainder 1

which is **10010** in binary. Work it backwards to confirm. Binary addition takes some getting used to at first - simply remember these rules:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1

but 1 + 1 = 10 (= "nought, and carry one over to the next column").

However, don't confuse these rules with the special conditions met in various truth tables which describe logic gates. Certain rules exist there which depend on the function of the gate in question.

We use the hexadecimal system ("hex") of base sixteen (using 0-9 and A-F to make sixteen characters) when dealing with microprocessors and the exciting *Micro Lab*. But we'll introduce that when the time comes.

ANTI-STATIC

CMOS devices may not prove to be best in every application, and they have one particular drawback: they are susceptible to damage by static electricity, which can readily gather on clothing made of man-made fibres or plastics. CMOS chips can be harmed by such a static charge, so elaborate anti-static precautions are taken by manufacturers and technicians who use these chips. Enthusiasts should follow at least some of their practices too:

Make sure that any likely static is discharged before handling CMOS chips. You could perhaps wear an anti-static wristband, which is connected to Earth. Definitely keep CMOS chips within their protective anti-static packaging (like the black anti-static foam you might see) until they are needed for installation, then insert them swiftly into their location. If you are serious enough, use an antistatic bench mat which is connected to Earth, to prevent static accumulating around the work area. Possibly adapt some tinfoil or aluminium for this purpose.

Also, for serious enthusiasts, if you are going to solder any CMOS chips instead of using sockets, it's best to use a low-leakage soldering iron which has an earthed tip, to prevent damaging the i.c.'s during soldering. Hobbyists generally don't need to take such elaborate industrial-standard precautions, though: modern CMOS chips are reasonably resilient but you should always bear the dangers of static damage in mind.

DIGITAL SYSTEMS

At last! The long awaited (maybe) delve into the world of "computer chips". From the outside, digital devices look just the same as the analogue devices which we have already met. They are usually made in dual-in-line (d.i.l.) packages, mainly 14-pin and 16-pin, but they operate with a completely different rule-book to the humble op-amp and timer chips which we have demonstrated so far.

Digital systems talk in a language of black or white: "on" or "off"; "high" or "low"; 0 or 1. There are no half-way houses and no analogue waveforms confusing the issue (though they can be made to communicate or interface with such systems). So what's the advantage of a digital system over an analogue one?

Analogue processing techniques are ideally matched for handling signals which continually vary. These could be audio or radio signals, or light-sensitive or heat-dependent units (like the thermostat we saw in Part Four) which produce varying waveforms. Or siren noises!

"Digit" is another word for "number" or "numeral". A digital clock has a clear numerical display which is impossible to misinterpret. Conversely a traditional analogue clock with hands is only as accurate as your ability to read the positions of the hands on the face – which means that in theory the hands could have an infinite number of positions.

ON OR OFF

Digital systems deal with distinctive states or conditions rather than varying analogue signals. Typical applications, of course, include computers and calculators. After all, a computer keyboard generates only two conditions: either a key is pressed or it isn't. Obviously further circuitry is needed so that the system recognises *which* key is pressed.

Other examples might include disco light sequencers: either a lamp is on or it's off. A digital system could be designed to control which lamp in the sequence is on and when. Our compliments to one reader, ***Mr. P. W. Warwick*** of Cheltenham, who wittily suggested also that digital systems either work or they don't!

Digital systems are specially designed to process numerical information, which can ultimately be broken down into two binary numbers: 0 or 1. Only these two numbers whirl around inside digital systems. Some readers may wish to refresh their knowledge of number systems by referring to the separate section dealing with binary numbers. We'll start our investigation, as always, by demonstrating the fundamental building blocks which form the foundations of digital systems.

LOGIC CHIPS

We mentioned earlier that digital systems follow some pretty hard and fast rules. The first is that they tend to run from a firm +5V supply, though some lower-voltage systems are now available. For historical reasons it's very common indeed to drive digital systems with a 5V rail, and it's no coincidence that the Power Supply section of the *Mini Lab* provides an independent, regulated 5V rail.

Secondly, digital systems consist of logic chips which are devices that operate only in terms of Logic 1 ("high", or +5V) and Logic 0 ("low" or 0V). A **logic gate** is a simple electronic switch in the form of an integrated circuit, and which uses binary codes (1's and 0's) to control whether the switch is open or closed. They're the fundamental building blocks of digital systems, and we'll be using them shortly.

Take a look at Fig. 6.8(a) which shows two switches in series with a filament bulb. The bulb LP1 will only illuminate when *both* S1 and S2 are closed. We've just described our first logic circuit and made our first logic statement!

A **truth table** is a simple chart which plots all the possible logic conditions which can arise in a logic circuit. Fig. 6.8(a) could be represented in a truth table like this:

S1	S2	LP1
open	open	off
closed	open	off
open	closed	off
closed	closed	ON

Fig. 6.8(b) shows two parallel switches connected to the bulb: if either one is closed (or both), then obviously the bulb lights. Draw the truth table for all four conditions yourself.

We have a choice of technologies to play with when building logic circuits, and

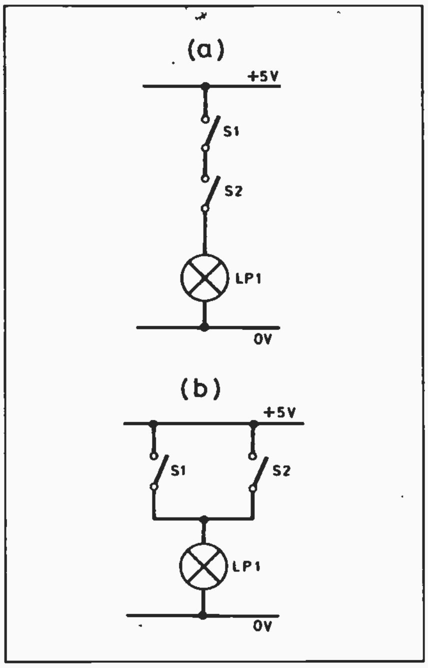


Fig. 6.8. Simple logic circuits using switches.

many are constructed with the **74-series** of integrated circuits. The range contains whole families of chips, the technology of which has gradually been upgraded with the introduction of new techniques. Look through any catalogue and you will see page after page of 74 TTL (Transistor Transistor Logic) chips. The oldest, and obsolete 74–types were replaced by 74L–, then 74LS– ranges, and more recently the 74AS– and 74ALS– types.

You may also come across the **4000B CMOS series** of logic chips, which make use of low-power CMOS FET transistors. They are static-sensitive and require suitable handling precautions but they're ideal for low-power applications (such as battery-operated equipment) where current consumption must be minimised. In addition they have a wider operating voltage range, which again makes them ideal for running from 9V battery supplies.

The principles of logic which we are about to describe, are common to both logic families. For our purposes, it is perfectly adequate to use the widely-available and less pernickety 74LS family, though the physics behind their operation will not be discussed here. We're hungry for hands-on experience instead!

The following section utilises the Mini Lab *Logic Probe which now needs to be constructed.* The Logic Probe is a useful module which helps to analyse the logic levels present in digital circuits. It is specially designed for use with 5V systems, and the three light-emitting diodes will display whether the input is high, low or a pulse transition. **A "high" (Logic 1) will now be universally taken to mean a +5V level and a "low" (Logic 0) is deemed to be 0V.** You will need to purchase a very small selection of 74 TTL chips as indicated, in order to undertake the following simple demonstrations.

AND GATE

A digital version of the simple circuit of 6.8(a) using a logic gate – part of a 74LS08 integrated circuit – is shown in Fig. 6.9(a). IC1a is an **AND gate**, the simplest form of logic gate and really easy to understand. Four of them are built into the 74LS08 which is a 14-pin d.i.l. package. Pinouts for this are shown in Fig. 6.9(b). The symbols shown inset are generally adopted by most Examining Boards, but you should check with your Tutor as at least one Board (S.E.G.) represents a logic gate with a simple box-shape.

The symbol "$+V_{CC}$" is a throwback to transistor days and in effect means "positive supply rail" whilst "GND" should be connected to 0V. Like most chips, they hate reverse voltages, so be sure to hook up the supplies the right way round, unless you like fried chips! (Sorry.)

We used just one of the AND gates within the 74LS08 to build the *Mini Lab* layout of Fig. 6.9(a), together with two of the normally-open push switches fitted to the board. (You certainly couldn't do this if you used 4000B CMOS logic – then, all unused inputs for all the other gates would need to be tied to one of the rails and not left "floating".) Two "pull-down" resistors bias the inputs at 0V (Logic 0) but closing a switch will apply a +5V level (Logic 1) instead to that input. Refer to Part One, Fig. 1.12 if you need help with this point.

Connect the output of the AND gate (pin 3) to the +I/P of the Logic Probe. As usual, all the 0V connections are already commoned by the p.c.b. so you don't need to hook up to the Logic Probe 0V input. Switch on the 12V supply for the Logic Probe, and the 5V rail for the 74LS08.

We hope that you will see the right-hand ("LOW") of the three l.e.d.s alight on the Logic Probe. This means that the output of the AND Gate is low at Logic 0. Press *either one* of the push switches: nothing should happen! Press *both* switcnes together though and the Logic Probe should show two effects: firstly, the "pulse" l.e.d. will blink briefly – that means that the Logic Probe has detected an "edge" or transition from one logic level to the other.

Secondly, the Logic Probe's centre l.e.d. ("HIGH") should be alight, which shows that

BOOLEAN ALGEBRA

Although it's specifically excluded from GCSE syllabuses, a useful form of shorthand which some might find handy when analysing logic statements is that of *Boolean Algebra*, named after the mathematician George Boole. In our case, we can make a unique Boolean statement for a two-input logic gate by stating that an output Q is a Boolean function of the two inputs A and B, like these examples:

AND should use a dot "•" in the algebraic statement, but this dot can be omitted. Thus $Q=A \bullet B$ or $Q=AB$ is the same as saying $Q=A$ AND B.

Strangely, the OR function is represented by the + symbol. So the statement $Q=A+B$ means that output Q is a function of A OR B.

The NOT function, or inversion, is signified by an overbar symbol: $Q=\overline{A}$ where output Q is an inversion of logic state A. Inverting the AND and OR functions produces of course the NAND and NOR statements respectively. Using Boolean symbology, we could state that $Q=\overline{AB}$ and $Q=\overline{A+B}$ for the NAND and NOR functions.

The EXOR (Exclusive-Or) statement is signified by the symbol, so $Q=A \oplus B$. The EXNOR inversion would be represented by $Q=\overline{A \oplus B}$

Boolean algebraic laws can be utilised to help in the design of logic systems to perform any desired function. It has to be said that designing such systems takes considerable experience and practice. The use of Boolean Algebra would help you with the art of *gate minimisation* – reducing your system to the absolute minimum number of gates needed to perform the specific function. This is a whole intellectual exercise in itself and is beyond the scope of this tutorial.

Candidates wishing to investigate Boolean Algebra in greater depth should consult a suitable textbook dealing with logic in more detail. Don't worry though if you don't follow the works of George Boole – some might find it useful, others won't!

TEACH-IN GCSE QUESTIONS

The following question is reproduced with the permission of the University of London Examinations and Assessment Council, and appeared in the 1991 Examination (1515/1) held by the London East Anglian Group.

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7. **Figure 3** shows a two input NAND gate.

Fig. 3

(a) (i) Complete the truth table for the NAND gate.

A	*B*	*Z*
0	0	
0	1	
1	0	
1	1	

(ii) If the two inputs *A* and *B* of the NAND gate were joined together, what new logic gate would this make?

....

(b) This is the truth table for a two input logic gate.

A	*B*	*Z*
0	0	1
0	1	0
1	0	0
1	1	0

(i) Name the logic gate. ....

(ii) Draw the symbol for the logic gate.

(c) Draw in the space below, a diagram to show how two, two input AND gates could be connected together to make a three input AND gate.

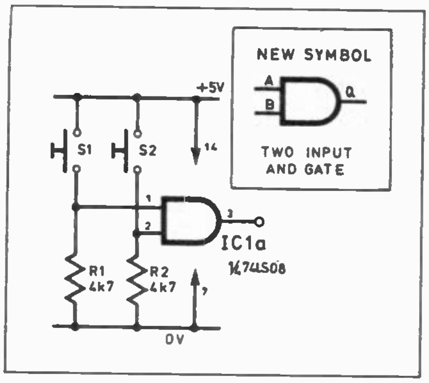


Fig. 6.9(a). Demonstration of AND gate function. Close either switch to apply Logic 1 "high" to the AND gate input.

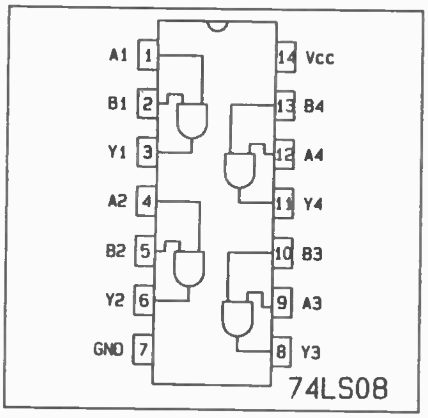


Fig. 6.9(b). 74LS08 pinout.

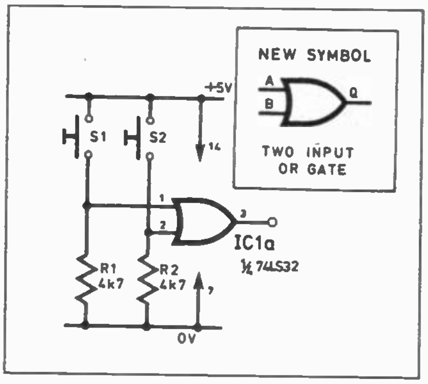


Fig. 6.10(a). OR logic funtion.

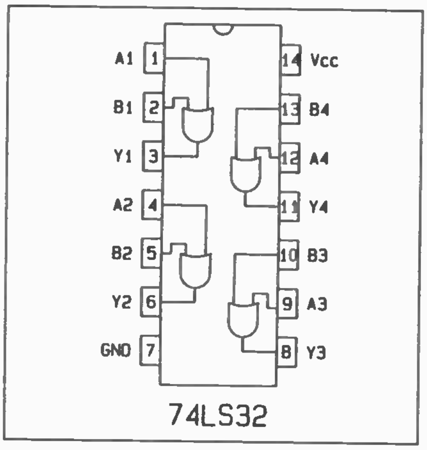


Fig. 6.10(b). 74LS32 pinout.

the AND Gate output is now high, at Logic 1. So the output only goes high when *both inputs are high.* Releasing either switch causes another output edge transition, this time in the reverse direction, so the pulse l.e.d. blinks once more and the gate output goes low to Logic 0.

The truth table for the AND Gate is given below:

INPUTS A	INPUTS B	OUTPUT Q
0	0	0
1	0	0
0	1	0
1	1	1

so the output is only Logic 1 when both inputs are at Logic 1. Make sure you understand and confirm the AND truth table above for yourself.

OR GATE

The circuit in Fig. 6.10(a) shows a logic circuit representing the switching diagram of Fig. 6.8(b). We also give the pinouts of a suitable logic device, the 74LS32 which is officially described as a quad (so there are four gates) two-input OR gate chip. Note the different symbol used for the OR gate.Using the same principles as before for guidance, go right ahead and investigate this chip on the breadboard. All you need to do is switch off and very carefully use long-nose fine point pliers, or a proper i.c. extraction tool, to remove the AND chip and exchange it pin-for-pin for the new OR chip. You can't always interchange chips as simply as this, and it's sensible to compare the pinout diagrams of the devices in question as a precaution.

Pressing a switch sends a Logic 1 to that input. Now using the Logic Probe to monitor the output state, confirm the following truth table for the OR Gate:

INPUTS A	INPUTS B	OUTPUT Q
0	0	0
1	0	1
0	1	1
1	1	1

Clearly the output is Logic 1 when either A OR B – or both – is at Logic 1. It's just like the switching diagram given earlier, when closing either one switch or the other (or both), illuminates the bulb.

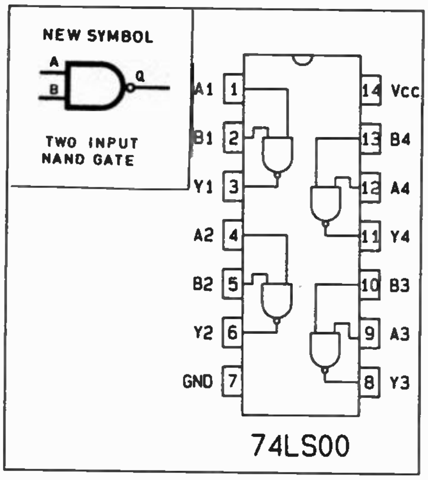


Fig. 6.11. The 74LS00 quad two-input NAND chip.

NAND GATE

The 74LS00 chip contains four **NAND** gates. The pinout is given in Fig. 6.11, along with the symbol for a NAND. You will see how they operate by exchanging the 74LS32 OR gate chip on the breadboard, directly with the new NAND chip. Apply Logic 1's to the inputs by closing the switches, and confirm the following truth table.

INPUTS A	B	OUTPUT Q
0	0	1
1	0	1
0	1	1
1	1	0

Now the output is Logic 0 only when both inputs are Logic 1. This happens to be the exact opposite of the AND Gate truth table we proved earlier. The strange "NAND" name actually means "Not And", the term "Not" in digital electronics meaning **invert**. If you look closely, you will see that the symbol for a NAND gate is similar to the AND, but there's a small circle on the NAND output: the circle means "inverted". Hence, a NAND gate operates inversely to an AND gate.

We discussed inversion when we looked at analogue systems and amplifiers. The output of an inverting circuit reduces if its input increases. In digital systems, an inverter causes an opposite logic level to be generated to that at the inverter's input. To illustrate this, look at Fig. 6.12(a) which shows a NAND Gate with both inputs connected together – it's O.K. to do this with logic gates. We used a toggle switch to alternate the input states between 0 or 1, but you might want to simply use a jumper wire.

The NAND gate is now wired as an **inverter** and the truth table for this inverting circuit is simple:

INPUT A	OUTPUT Q
0	1
1	0

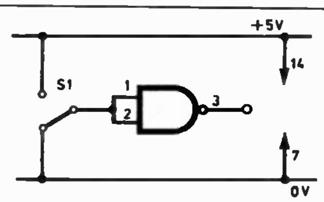
Confirm for yourself that the output of the inverter is the opposite of its input state. An inverter is sometimes called a **NOT** gate. Hence, the "Not And" or NAND gate consists of an AND gate followed by an inverter. In fact an inverter chip is available separately (the 74LS04) and has a special symbol of its own, which is shown in Fig. 6.12(b) – not to be confused with the op-amp. If a logic level at an input A is inverted, then the output is said to be "NOT A" with a symbol $\bar{A}$. Double inversion, i.e. using a second inverter after an inverter, results in a return to the original state as shown in Fig. 6.12(c).

NOR GATE

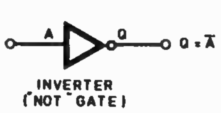
Not surprisingly, a **NOR gate** is actually a "Not Or" – an inverted OR gate. The symbol is shown in Fig. 6.13(a). Note again the small circle on the output which gives the inverting game away. A suitable NOR chip would be a 74LS02 which is a quad two-input circuit, though *note the different pinout shown for this chip* in 6.13(b), compared to the previous layouts, so you now need to modify your *Mini Lab* arrangement. Construct this on the *Mini Lab* using this chip the same way as before, to confirm the following truth table.

INPUTS A	B	OUTPUT Q
0	0	1
0	1	0
1	0	0
1	1	0

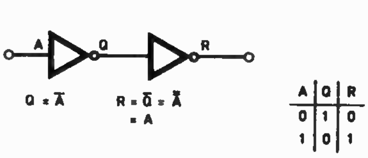
The output is low when either input is high: hence the NOR gate has a function opposite to that of the OR gate. Prove that the NOR gate too can be used as an inverter in the same way as the NAND gate. What would be the result of inverting the output of a NOR gate? (An OR gate.)



(a) NAND gate as an inverter.



(b) Inverter or NOT.



(c) Double negation results in a return to the original state.

Fig. 6.12. Inverters.

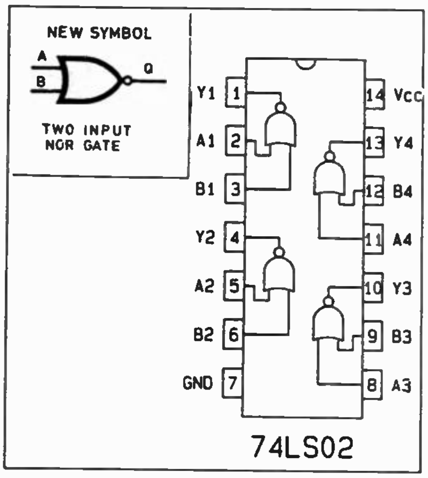


Fig. 6.13. The 74LS02 quad two-input NOR chip.

EXOR GATE

Our final demonstration of essential logic principles utilises the 74LS86 which is a quad two-input **EXOR gate.** The term "EXOR" is shorthand for "EXCLUSIVE-OR", and means that if one input, but excluding the other, is high then the output is high. In other words, if the inputs are different then the output is high. The truth table is given below, prove this for yourself by referring to the pinout of Fig. 6.14(b).

INPUTS A	B	OUTPUT Q
0	0	0
1	0	1
0	1	1
1	1	0

An **EXNOR** version (inverted EXOR) function is available in the form of the 74LS266. You have now utilised all the fundamental logic gates which form the basis of digital systems. We show in Table 6.1 a "master" truth table of logic gates which you might like to copy for future reference.

The particular area which we have just covered is concerned with **combinational logic** because the output states are determined solely by the combinations of logic levels at the inputs. Later we look at **sequential logic** which takes into account the history or sequence of certain inputs, as well as considering current input states. Sequential systems enable us to construct a variety of digital processing systems and memories, more of which next month.

It is possible to produce gate functions by interconnecting various other gates as we shall now see. For example Fig. 6.15(a) illustrates how the EXOR function could be assembled from an OR, NAND and AND gate. If you had assembled a system which required an EXOR function somewhere, then you could perhaps utilise any

Table 6.1

A	B	AND	NAND	OR	NOR	EXOR	NOT A
0	0	0	1	0	1	0	1
1	0	0	1	1	0	1	0
0	1	0	1	1	0	1	1
1	1	1	0	1	0	0	0

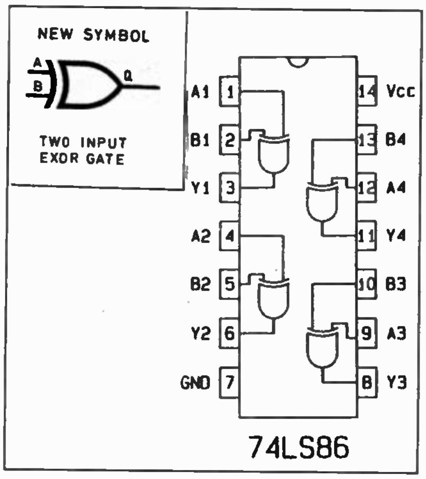


Fig. 6.14. The 74LS86 quad two-input EXOR chip.

spare gates available in the circuit to fulfil your requirements, instead of purchasing an EXOR chip specially. Prove this system by following through the truth table below.

INPUTS A	B	C	D	Q
0	0	0	1	0
1	0	1	1	1
0	1	1	1	1
1	1	1	0	0

Fig. 6.15(b) shows how to realise an OR function from three NAND gates. The truth table for this system is also shown in the diagram. Adding an inverter (using another NAND gate) to the output Q would result in the creation of a NOR gate function. Interestingly, using nothing but NAND gates, it is possible to create every other logic gate function described so far: AND, OR, NOR, EXOR and EXNOR, plus a NOT gate. That's probably why the NAND gate is at the top of the 74-series listing – the 74LS00 – it's a general-purpose gate, though of course it is often more convenient to use purpose-made gates for particular functions.

Combining various logic gates together also enables us to construct logic systems having truth tables which cannot be fulfilled by individual logic gates alone. This takes a lot of practice and experience with digital system design. Fig. 6.15(c) and (d) are given as simple exercises for you to practice analysing logic systems. You may or may not find it useful to use the *Boolean* expressions shown in the separate section, as a form of shorthand when analysing the suggested circuits. Fig. 6.15(d) represents a certain logic function, the truth table of which was given earlier. Which one?

FAN OUT

When assembling logic systems with 74 series TTL gates, you can connect one 74LS gate output to the inputs of up to ten subsequent gates. We say that these gates have a "fan out" of ten. The TTL gate output circuitry is not what you might think – they contain a push-pull output and when they are high at +5V they are not very good at *sourcing* current. Anything more than a few milliamps is difficult, so if a logic gate needs to drive a load, almost always some form of buffer is needed. We will examine suitable buffers next month when we discuss interfacing of logic systems with loads and output transducers.

TTL gate outputs are actually better at *sinking* current; they do this when they are low, when current sinks *into* the TTL output pin. Typically they could sink up to 8mA or so.

We recommend looking through a quality mail order catalogue such as the Maplin one which, unlike most, gives you all the pinouts for all the 74 series chips. You will see that there is a bewildering array of solutions available to circuit designers. You will also come across other technology families such as the 74HC series. For instance, the 74HC133 is a 13-input NAND device (not made in the "LS" family – in fact it's a CMOS chip not a TTL device). It is often possible to interface these chips in advanced designs so that different families can be made to function together properly.

Having laid the foundations, next month we investigate further aspects of logic design, looking at more complex logic functions including memories and registers which are all available on easy-to-use integrated circuits. We will also show some applications for the principles of digital systems which we have outlined so far. Plenty of practical work is in store – join us for Part Seven of *Teach-In* next month!

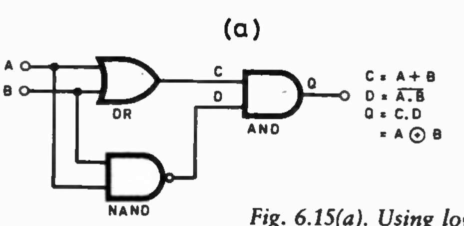
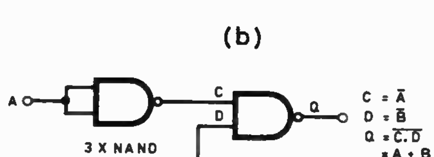
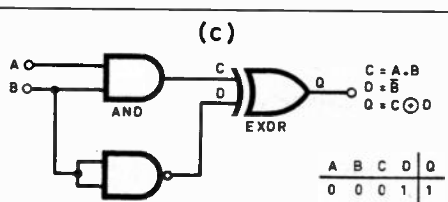


Fig. 6.15(a). Using logic gates to create more complex functions.



A	B	C	D	Q = A + B
0	0	1	1	0
1	0	0	1	1
0	1	1	0	1
1	1	0	0	1

Fig. 6.15(b). OR function created with NAND gates.



A	B	C	D	Q
0	0	0	1	1
1	0	0	1	1
0	1	0	0	0
1	1	1	0	1

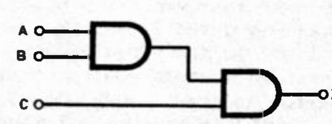
NON STANDARD LOGIC FUNCTION USING GATES

Fig. 6.15(c) Example analysis circuit.

GCSE QUESTION (see previous page)
ANSWERS

(A) (i)

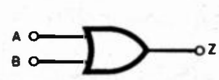
A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0



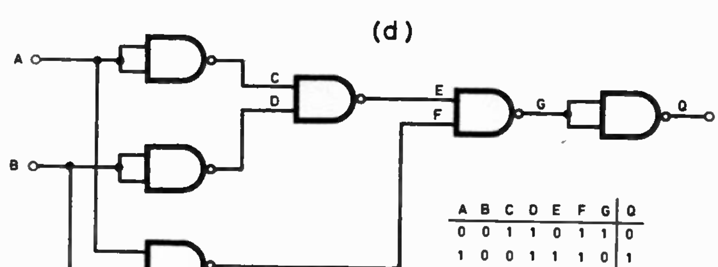
(ii) A NOT gate or inverter.

(B) (i) A NOR gate.

(ii)



TIP When trying to work out the type of gate from a given Truth Table, try looking at the *inverted gate function* as well. It's easy to spot AND or an OR function, and you might recognise this straight away if you look at the *inverted* output function. NAND and NOR are then simply inversions of AND and OR gates.



A	B	C	D	E	F	G	Q
0	0	1	1	0	1	1	0
1	0	0	1	1	1	0	1
0	1	1	0	1	1	0	1
1	1	0	0	1	0	1	0

Fig. 6.15(d) Example analysis circuit.

Home Base

Jottings of an electronics hobbyist – Terry Pinnell

Electric Detective

Handing me the bill for my new mains supply trip meter, the Seeboard engineer told me that he could not completely finish the job. "You've got a leak somewhere on your Number three fuse circuit," he said, adding encouragingly that he'd come back if I could not fix it myself.

Thinking of the unspoken rider, "at extra cost", and with my recent failure to repair a simple kitchen toaster still rankling, I resolved to track down this mysterious fault. Although it had only now made its presence known, the specification of the residual current trip meter implied that at least 100mA was somehow finding a way from the Live or Neutral lines to Earth.

My number three fuse, which protects one of the lighting circuits, had of course been removed by the engineer. Re-inserting it immediately tripped the meter with a clatter. So it was easy to confirm which specific lights were involved: the ones that would not come on, regardless of their switch setting.

Actually, I already knew what each fuse covered anyway. I imagine most people mark their fuse boxes as I do, at least at the summary level: "Downstairs lights," Upstairs bedroom sockets" and so on.

In Pursuit of a Leak

My first major objective was to draw an accurate diagram of the fuse three circuit as a basis for deciding what tests to make, which proved to be quite a substantial task. To be honest, with my usual impatience I'd started off by trying to isolate the fault without doing this. But guessing where a particular wire was going quickly induced confusion.

Unlike a project on your workbench, all you know about that clutch of mains lighting circuit wires is that they disappear into a hole in the ceiling or wall and come out somewhere else on the same circuit. You can't even pull one and hope to see something move elsewhere.

So it was a matter of studying a few library books to learn the basics, then a few hours with a screwdriver, multimeter, continuity tester and some long lengths of wire, methodically preparing the circuit shown in Fig. 1.

This example of mine (which I've slightly simplified here) could prove useful if you need to trace a leak or make some alteration to a lighting circuit, as it reflects the most common modern domestic light wiring method, called "Loop-in wiring". No matter how many light fittings are involved, they will follow the same general wiring pattern. This is best understood by studying the diagram rather than my describing it.

Wiring to the wall switches will vary in each case, depending on whether they are one-way (as shown here) or multiple-way, and there will be other differences of detail. But Fig. 1 should provide a good starting point.

By the way, even though you've removed the fuse at the main junction box, I recommend that you *always* check with a multimeter on its high a.c. setting, with one clip earthed, before working on a group of cable ends.

Our Porch Light wiring was a prime suspect, being exposed to the elements to some degree. The approach I took was simply to measure resistance from all the normally live (current-carrying) points to a sound Earth. My first choice of an Earth reference point proved to be only tenuously grounded until I cleaned and tightened it.

I had to isolate most of the wires to find the one with low resistance to Earth. In Fig. 1 all the normally Live porch light wires are therefore shown disconnected. Incidentally, don't assume there is only a single leak. Having found one, it is still worth checking the untested wires before you screw everything back together – only to find you are still tripping the meter.

On another practical point, light bulbs have low cold resistances (typically 100 ohms, 70 ohms and 40 ohms for bulbs of 40W, 60W and 100W respectively) so you could get misleading results if you leave them connected while using a continuity tester to prepare your diagram.

When I found a wire with a low resistance to Earth, where it should be virtually infinite, I realised my problems would not necessarily be over. I could be unlucky and see no visible local cause and be forced to conclude that the leak was somewhere totally inaccessible, in which case I would probably have to call in professional help to do unthinkable things to ceilings, walls or roofing.

But on this occasion my luck was in. When I measured the resistance to Earth of B1, B2, S1 and so on, all of them gave readings over 10 megohms, but L1 was around 1500 ohms – the obvious and sole source of the leak. The cause was probably a small cut in the insulation, in contact with a slightly damp board securing the lamp fitting.

After cleaning it up and carefully retesting everything I gingerly replaced the fuse – this time to the welcome sound of silence from my hypersensitive trip meter. It was an electronic thumbs-up for fuse circuit number three.

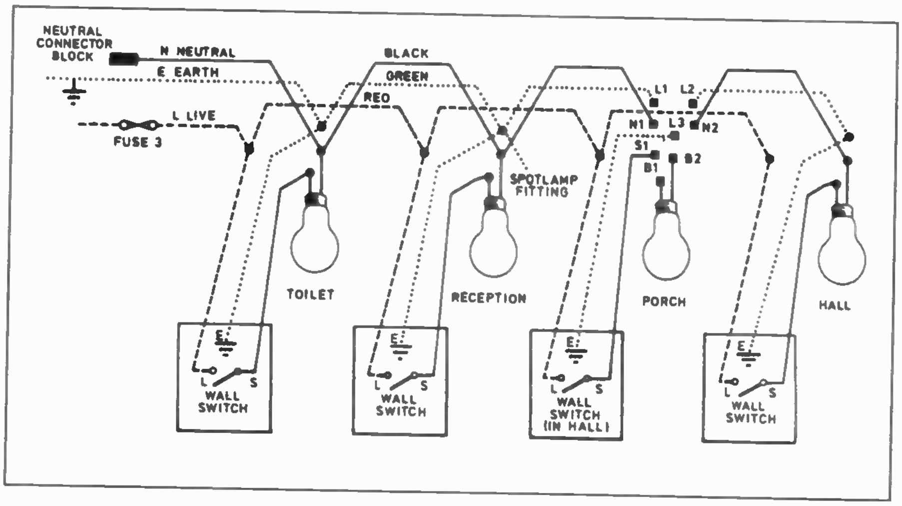


Fig. 1. Mains lighting wiring from the fuse.

VIDEOS ON ELECTRONICS

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

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

VT201 54 minutes. Part one; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more.
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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.
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VT204 56 minutes. Part four; Power Supplies. Guides you step by step through different sections of a power supply.
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VT206 56 minutes. Part six; Oscillators. Oscillators are found in both linear and digital circuits. Gives a good basic background in oscillator circuits.
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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.

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.

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

VT301 56 minutes. Digital One begins with the basics as you learn about seven of the most common gates which are used in almost every digital circuit, plus Binary notation.
Order Code VT301

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

VT303 56 minutes. Digital Three is your next step in obtaining a solid understanding of the basic circuits found in todays digital design. Gets into multiplexers, registers, display devices, etc.
Order Code VT303

VT304 57 minutes. Digital Four shows you how the computer is able to communicate with the real world. You will learn about digital to analogue and analogue to digital converter circuits.
Order Code VT304

VT305 56 minutes. Digital Five introduces you to the technology used in many of 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

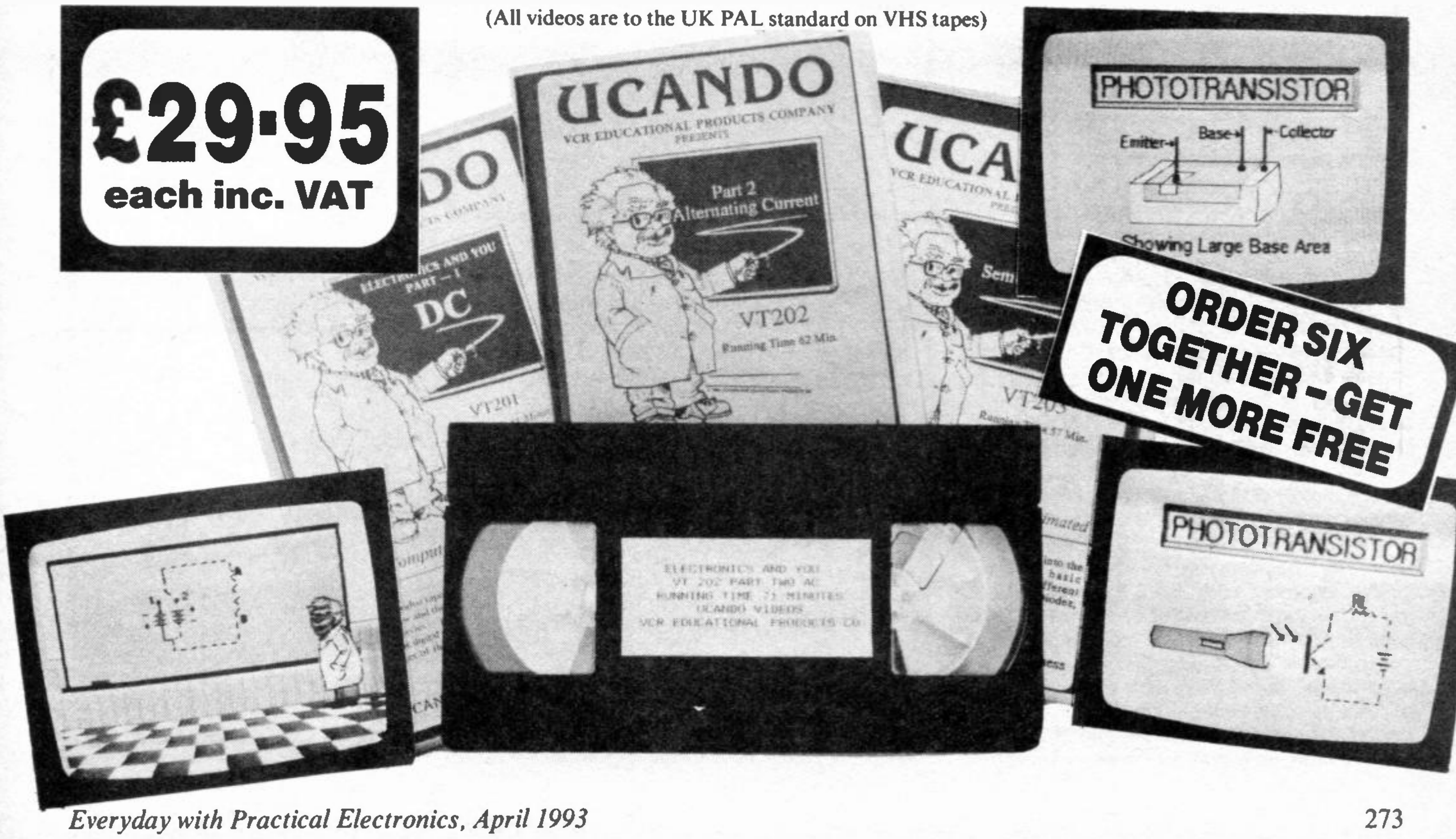
VT306 56 minutes. Digital Six gives you a thorough understanding in the basics of the central processing unit and the input/output circuits used to make the system work.
Order Code VT306

By now you should have a good understanding of computer technology and what makes computers work. This series is also invaluable to the computer technician to understand the basics and thus aid troubleshooting.

ORDERING

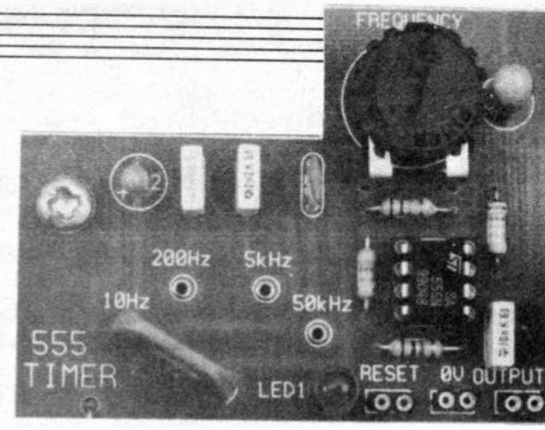
To order see our *Direct Book Service* "Ordering Details" – the postage for tapes is the same as for our range of books and you can order tapes and books at the same time and pay only one lot of postage. Each video costs £29.95 inc. VAT. If ordering any six together we will give you an extra video FREE, just indicate on your order which extra one you would like.

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



Teach-In Project

MINI LAB



Alan Winstanley & Keith Dye B.Eng(Tech)AMIEE

The Everyday with Practical Electronics Mini Lab has been created to accompany Teach-In '93, and enables the reader to assemble demonstration circuits by following the clear instructions and diagrams contained in the main text, with every chance of it working first time.

THE *Teach-In Mini Lab* gains a further *two* modules this month to help you with your experiments and doubtless proving e'er useful in the future. Firstly the 555 Timer module provides a source of variable frequency 12V pulses, and is based around a 555 timer i.c. in its astable mode. Fig. 1 is the circuit diagram of this module, and is very straightforward. IC1 is a bipolar NE555 chip, and the frequency of its operation is determined mainly by VR1, but an on-board selector link enables the user to change the timing capacitor. Hence the module functions in four range settings, 10Hz, 200Hz, 5kHz and 50kHz.

The output is seen at pin 3 and an l.e.d. pilot repeater LED1 will illuminate when the output is high; this is useful when running the module at lower frequencies, when the l.e.d. will flash. At more than a few Hertz, the l.e.d. is seen to be continually illuminated.

The reset terminal (pin 4) is brought out to an s.i.l. socket to facilitate access by an external circuit, and is pulled up to +12V so the 555 will run normally when powered up. Shunting the reset pin to near 0V will disable the chip. When the 555 Timer is not in use, disable it by linking the reset terminal to a neighbouring 0V point, to stop the l.e.d. flashing distractingly.

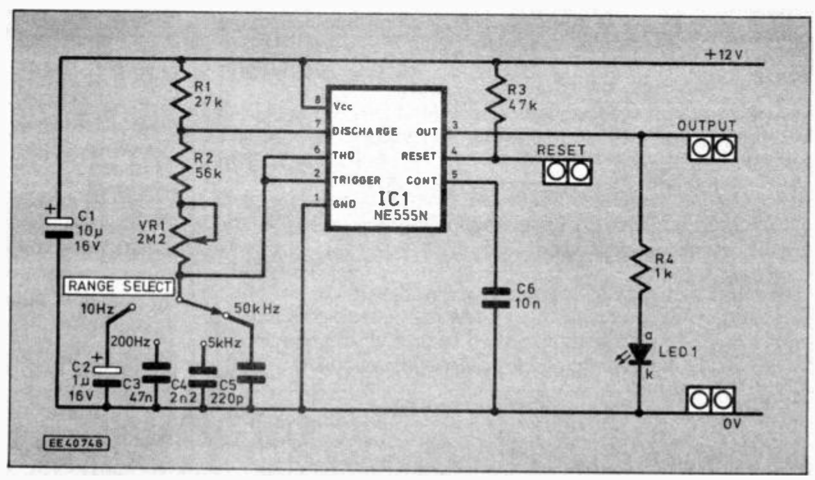
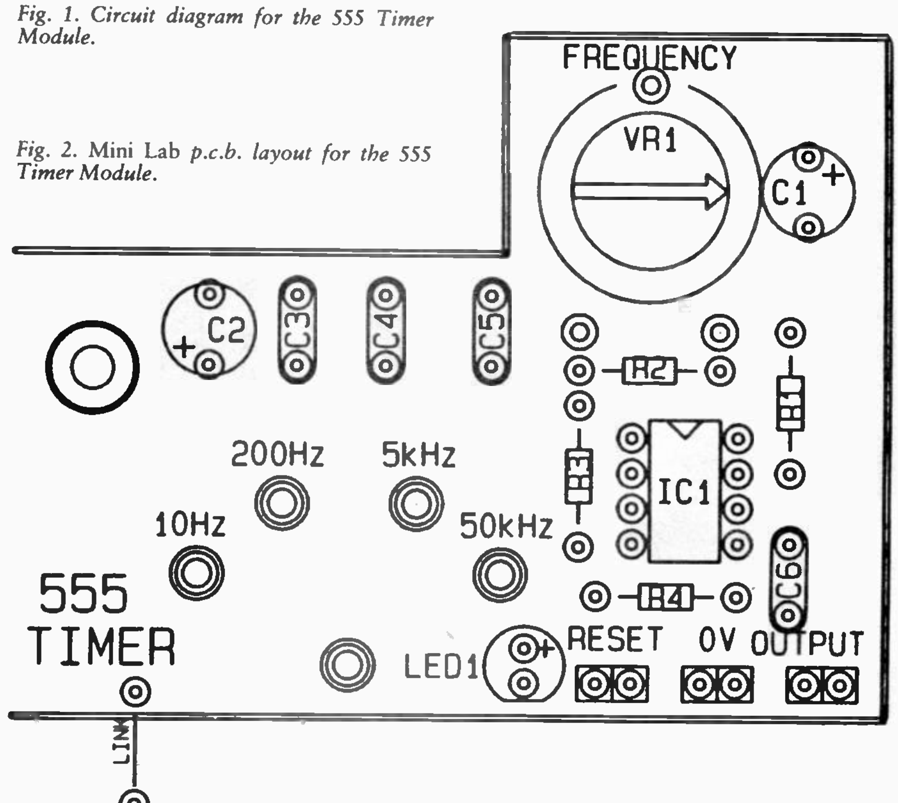


Fig. 1. Circuit diagram for the 555 Timer Module.

Fig. 2. Mini Lab p.c.b. layout for the 555 Timer Module.



CONSTRUCTION

Assembly is very straightforward, see Fig. 2. If the specified components are used then no problems whatsoever will be experienced, and the silk-screen printing and solder-resist coating of the *Mini Lab* p.c.b. should ensure success first time. The tiny capacitor C5 is either a ceramic or polystyrene type: a 5mm pitch device will fit the board perfectly, like the other polyester capacitors – see the components list.

Use an 8-pin d.i.l. socket for IC1 and ensure that the chip is inserted correctly. A dimple or notch identifies pin 1 as usual. The l.e.d. fits directly to the board and should also be polarised.

After assembly, select the 10Hz range and switch on the *Mini Lab* 12V supply. The l.e.d. should be flashing and the rate should be adjustable by moving VR1. Check the other ranges on an oscilloscope if available, or drive the loudspeaker through a blocking capacitor (refer to the tutorial) and listen to the other ranges.

Remember always that the module supplies 12V amplitude pulses, and can **source** no more than 200mA directly if the NE555 is utilised. It can also **sink** 200mA as well, so you could connect a suitable load between the 12V supply rail and the output pin. There is little to be gained by using the CMOS ICM7555 in this application. You'll soon find uses for this handy little circuit in your experiments.

LOGIC PROBE

The second module this month is the Logic Probe which monitors the state of logic circuitry. This helps you to determine the function of logic gates and to confirm their truth tables. Three light-emitting diodes are used to indicate whether the location under test is "high" (+5V) or "low" (0V). Also, a special pulse-stretching circuit indicates when a rising or falling transition or "edge" has been detected.

Often, rapid pulses pass by unnoticed because of their short duration, but the edge of the pulse triggers the pulse stretcher of the Logic Probe to generate a distinctive blink on the "pulse" l.e.d. The circuit is designed to monitor 5V TTL (e.g. 74 series logic). 5V Logic has clearly defined "thresholds" that define what is deemed to be a Logic 1 or a Logic 0. A "HIGH" Logic 1 is preferably 5V, but should be no lower than 2V. A "LOW" is defined as being no more than 0·8V. The levels in between (0·8 to 2V) are a "no mans land" or an illegal state where the logic circuit may fail to recognise a logic level consistently.

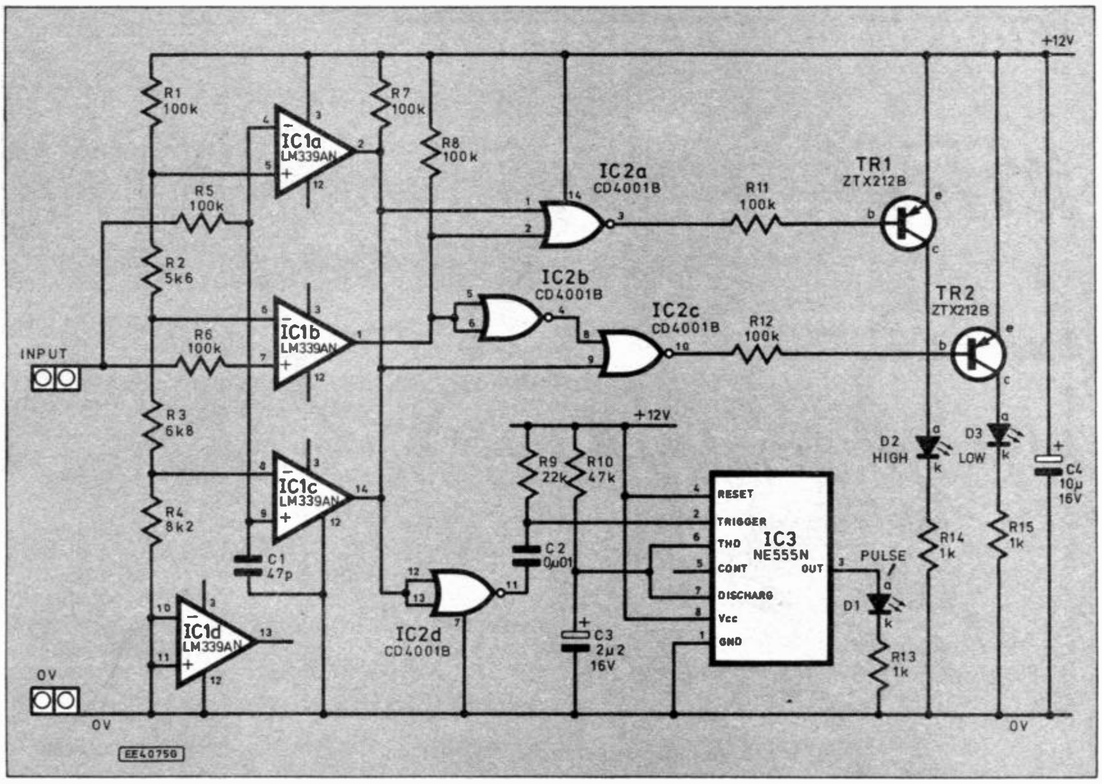


Fig. 3. Circuit diagram for the Logic Probe.

DESCRIPTION

The circuit diagram of the Logic Probe is shown in Fig. 3. The signal input is connected to three comparators IC1a to IC1c, part of an LM339 chip. A resistor network R1 to R4 sets up a series of reference voltages, namely 0·8V, 1·5V and 2V. The "open-collector" outputs of IC1a and IC1c are linked and when the Logic Probe input is between 0·8 and 2V, the outputs are high at +12V. IC1b detects if the input is above 1·5V, if so its output switches high.

The two sets of comparator outputs are used as logic inputs for IC2, a CD4001B quad two-input NOR gate. Note that this CMOS chip can operate with a supply voltage of between 5V to 15V, unlike 74-series TTL chips. IC2a output goes low when the probe input is **not** 0·8V to 2V and is **above** 1·5V – the conditions for a logic 1. When the output is low, TR1 (a *pnp* transistor) turns on and illuminates D2, the logic "HIGH" indicator.

The output of IC1b (the 1·5V level detector) is inverted by IC2b and fed to IC2c. This will have a logic 0 output when the input voltage is **not** 0.8V to 2V and is **below** 1·5V – the conditions for a Logic 0. This turns on TR2 and current flows in D3, the logic "LOW" indicator. When the input is **between** 0·8 – 2V (an "illegal state" in 5V logic) then *both* the "HIGH" and "LOW" indicators will light to warn you.

To detect short pulses or logic level transitions, the 0·8V to 2V output is inverted and triggers IC3 through C2. The NE555 is wired as a monostable to generate a pulse of 0.5 seconds, briefly lighting D1. The capacitor C1 was included to enable the Logic Probe to function with fast edges of modern logic. Without C1, the transition from below 0.8V to above 2V is so fast that it escapes detection. C1 and R5 slow down the edge of the pulse very slightly.

CONSTRUCTION

The p.c.b. layout for this module is shown in Fig. 4. By now you will have gained sufficient experience to tackle an assembly like this with confidence, so press on and solder the components into place following the diagram and silk-screen print. Do ensure

MINI LAB COMPONENTS

555 TIMER

Resistors

R1	27k
R2	56k
R3	47k
R4	1k

All 5% ¼W carbon film

See SHOP TALK Page

Potentiometer

VR1 2M2 0·25W preset with thumbwheel

Capacitors

C1	10µ tantalum bead 16V
C2	1µ tantalum bead 16V
C3	47n polyester
C4	2n2 polyester
C5	220p ceramic or polystyrene
C6	10n polyester

Semiconductors

IC1	NE555 timer i.c.
D1	0·2 inch red l.e.d.

Miscellaneous

P.C.B. mounting "jacks" (5 off); 0·5 inch insulated shorting link; s.i.l. turned pin sockets (6 off); 8-pin d.i.l. socket.

Price £3·50 Approx

LOGIC PROBE

Resistors

R1	100k
R2	5k6
R3	6k8
R4	8k2
R5 to R8	100k (4 off)
R9	22k
R10	47k
R11 to R12	100k (2 off)
R13 to R15	1k (3 off)

All 5% ¼W carbon film

Capacitors

C1	47p ceramic or polystyrene
C2	10n polyester
C3	2µ2 tantalum 16V
C4	10µ tantalum 16V

Semiconductors

IC1	LM339N quad op-amp
IC2	CD4001B quad 2-input NOR gate
IC3	NE555 timer i.c.
D1 to D3	0.2 inch l.e.d. (3 off)
TR1, TR2	ZTX212B *pnp* transistor (2 off)

Miscellaneous

14-pin d.i.l. socket (2 off); 8-pin d.i.l. socket; s.i.l. turned pin socket (4 off).

Price £3·50 Approx

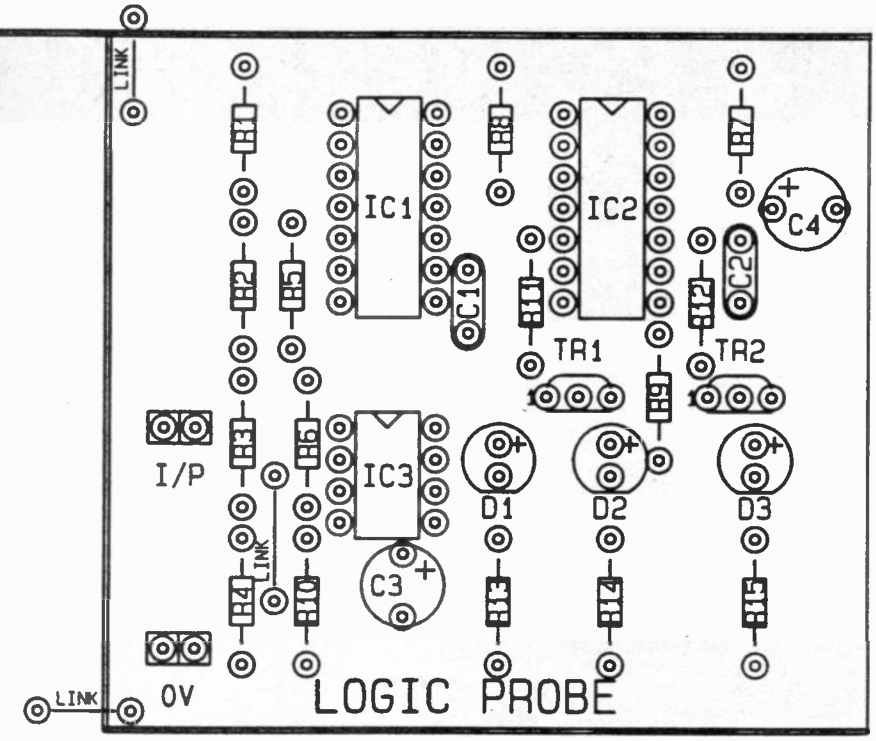
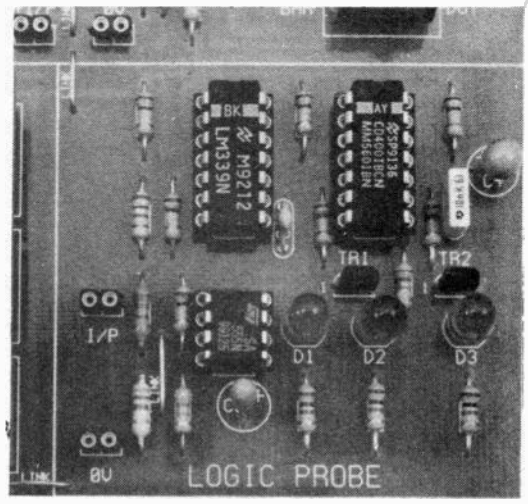


Fig. 4. P.C.B. layout of the Logic Probe.



that the small transistors are inserted correctly – study their shape carefully. The three l.e.d.'s fit directly to the p.c.b. as usual. Note the polarity of the small tantalum bead capacitors.

Dual-in-line sockets are recommended for all three chips to prevent thermal damage and to allow for easy replacement if necessary. Take great care to ensure that you neither apply excessive amounts of solder nor overheat the copper track of the board, which will damage the foil track.

NOTE that IC2 is a CMOS device, so observe basic anti-static precautions: retain it in its packaging until the board is ready to accept the device, then insert it the right way round, swiftly into its socket. You probably won't have any problems otherwise.

To test the completed Logic Probe, switch on the +12V supply and then apply alternate 0V and +5V signals to the input terminal of the newly-constructed module. The appropriate "HIGH" or "LOW" indicators should light, and the "PULSE" l.e.d will blink whenever a change of logic levels is detected. Your Logic Probe is then ready for use.

It's worth noting that if both the "HIGH" and "LOW" l.e.d.s are alight, this could be an indication of a stream of pulses, switching so quickly between 0 and 1 that the Logic Probe l.e.d.s seem to be continually alight. The "PULSE" l.e.d. should also be glowing under these conditions, to signify that logic transitions are being detected, so that you don't interpret the readings as an "illegal state".

Next month: Digital Display, the penultimate module of your *Mini Lab*. However, there is still plenty of action to come in the shape of the *Teach-In* **Micro-Lab**, our specially designed unit for demonstrating the fundamental aspects of microprocessors, for those who wish to explore this aspect of microelectronics. We'll be following up with brief **Micro-Lab applications** to help you get the most from this exciting add-on unit.

FOX REPORT

by Barry Fox

SCUPPER PCN

Both Cellnet and Vodafone are now offering cut-price cellphone tariffs for low users. Despite much grand talk about opening up the market to a wider public, their driving motive is clearly to try and scupper Mercury's launch of a PCN (Personal Communications Network) service this summer.

First, Mercury had promised smaller phones for PCN. The network uses smaller cells so battery drain is less. But conventional cellphones are now so small that there is little need for anything smaller. And working with smaller cells means building more base stations, which puts up the cost of the network and limits its area of coverage.

Despite this, Mercury also talked about lower costs for PCN. Now that edge has gone, too. Cellnet and Vodafone have built their networks and are creaming profit from around 40 million calls a week, each.

Mercury is now publicising the security of PCN. Because PCN is a digital system, calls cannot be intercepted with a simple analogue scanner. But PCN is a standard. How long before we see digital scanners? In any case Vodafone is soon to offer a service which uses the pan-European, GSM, cellular system which works very much like PCN. And Cellnet will soon launch secure scrambling for analogue calls.

This leaves Mercury's PCN service with no discernible user-benefit. Why continue to promise it? Could it be because PCN began life as the dream of Lord Young, when he was at the DTI, and is now top dog at Cable and Wireless, Mercury's parent?

TOUGH FOR RABBIT

Whatever the reason, the price cuts by Cellnet and Vodafone and the promise of Mercury's PCN, makes life even more difficult for Hutchison's Rabbit. This CT2 telepoint service is now rolling out.

Rabbit offers only one way communication. Subscribers can only make calls. To "take" a call, you need to subscribe also to a paging service, and then look for a Rabbit base station to return whatever call the pager instructs. It's a very clumsy proceedure, compared to a two-way cellphone. Why not just use a pager and look for one of the many card or cash payphones which both BT and Mercury have peppered round the country?

I went recently to buy a cordless phone and wondered about buying a Rabbit, for use at home and perhaps later with telepoints if and when Hutchison puts enough of them where there are no payphones. I like the idea of digital security but at £200 the Rabbit was around four times the price of an analogue phone. I bought neither and will wait until Hutchison is reduced to flogging them off for half price.

80's PROFIT IDEA

Or will Hutchinson perhaps unearth a clever idea for telepoint that was suggested in the mid-80s when CT2 was first planned, but seems to have been long since forgotten? The idea was to let homes and offices re-sell telepoint air time. It would work like this.

People would install a home or office CT2 system for use either as a domestic cordless phone or cordless switchboard exchange. Normally, of course, the base station only works with its own handsets. But for airtime re-sale, the base station is programmed to let anyone with an authorised handset, and within the hundred metres range of the base station, make a call. So anyone in the street or parked car outside an office or home with a base station, would be able to make a call. Authorisation would involve paying a one-off fee for a digital code which would be recognised by any base station whose owner wanted to earn a little easy money.

The authorisation code would charge the call to the owner of the handset, not the base station, but the owner of base station would get a small reward e.g. as credit from the next quarter's bill.

In other words any home or office becomes a temporary telepoint. In suburban streets this would not happen very often, but an office, or cafe in the city centre could turn an easy unearned profit. And owners of authorised handsets would have a better chance of making calls than if they have to search for a public telepoint.

Thus, although the service operator does not have to invest money in installing dedicated public base stations, the telepoint network would very quickly expand. Eventually there would be so many private base stations in homes, offices, cafes, garages and so on, that the telepoint service would offer coverage almost as wide as a cellphone service.

But somehow, this clever idea for telepoint seems to have got lost in the mess created by the offer and failure of rival CT2 services from Mercury, British Telecom and Ferranti, and the launch now of Hutchison's Rabbit.

ROYAL SCRAMBLE

I mentioned Cellnet's plan to offer a scrambling system for analogue cellphones. This is not, repeat not, the system which so-called "experts" keep demonstrating on TV when talking about the tapes of the Royals on their mobile phones. These "experts" are usually in the nicely self-perpetuating business of selling both bugging and anti-bugging equipment and they conveniently neglect to explain what is wrong with their scamblers.

What is wrong is actually quite simple. Existing phone scramblers are double-ended devices. The phone making the call scrambles the speech, and the phone receiving the call descrambles it. So the system can only be used if the two parties know in advance that they are going to talk to each other and have each spent several hundred, or thousand, pounds on electronic equipment.

Many of the existing sytems scramble speech by simple "inversion". The analogue speech frequency band is split into two halves, high and low, and the high band is converted into low frequencies, with the low band converted into high frequencies. The unit at the other end turns the frequency bands upside down again.

Interceptors hear a fuzzy sound, but a dedicated eavesdropper can learn to recognise speech. Or the eavesdropper can buy or steal a matching descrambler. As I said, the same people are often selling both bugging and anti-bugging devices.

SINGLE-ENDED PRIVACY

Cellnet has now done a deal with GEC-Marconi Secure Systems of Liverpool, on a single-ended system. There is no need for the other party to use a matching descrambler.

The CPU-100 is small black box, which connects between the handset of a car or transportable cellphone, and the transceiver. The box scrambles the signal before it is sent by radio to the telephone network. Scrambling is by Variable Split Band Inversion. The sound spectrum is split into two bands (as with existing systems) but the frequency at which the split occurs continually changes, several times a second, between 32 different values, and with no regular time pattern for the changes. If the radio signal is picked up on an unauthorised radio receiver or "scanner" of the type currently used by eavesdroppers, it sounds like the warble of a fax machine and is wholly unintelligible.

The computer "switches" which Cellnet uses to route incoming radio phone calls into BT's telephone network are equipped with matching decramblers. So when the call leaves the switch to go to its destination in an office or home phone, it is "clear". The called phone thus needs no extra electronics, unless of course it is another cellphone. Then it needs its own CPU-100.

The descrambler in the network switch must of course change its band-splitting circuits in synchronism with the circuits in the cellphone scrambler. This is done by making the cellphone send digital control signals along with the scrambled speech. The control signals are encrypted to stop an eavesdropper using them to switch a pirate descrambler. GEC claims the encryption is so secure that only someone prepared to work for months on a recording of the call, with a bank of parallel processors, can crack the code.

Cellnet began testing the system early this year and plans a commerical launch in the spring. The scrambler will cost around £600 and calls that are routed through the network descrambler will be charged at around twice the current cellphone premium rate of 33p per minute.

Cellnet does not expect many customers, but I am sure we can all guess who the first will be.

SHOP TALK

with David Barrington

Mind Machine Mk II

The 5V positive voltage regulator type LP2950CZ, called-up in the *Mind Machine Mk II* project, was chosen in preference to one of the more popular 78L05 series because of it's improved specification. It draws less quiescent current and can operate from an input voltage below 5·5V; prolonging the operating "life" of the battery. At present, the LP2950CZ only appears to be listed by **Electromail (☎ *0536 204555*)**, code 648-567.

The CMOS crystal oscillator (type number EXO-3), with programmable frequency divider is another device which can only be found listed by the above mentioned company. The 12MHz version is required and the code 296-879 should be quoted when ordering.

The Binaural Signal Generator printed circuit board is available from the *EPE PCB Service*, code 824. All components for the "calibration aid" are standard items and should not cause any sourcing problems. You will, of course, require a personal stereo to record your chosen "relaxation program" tape.

Mini Lab (Teach-In '93)

This month the *Mini Lab (Teach-In '93)* "test-bed" gains a further two modules, namely a single 555 Timer module and a Logic Probe to help in defining the function status of logic gates and to confirm their "truth tables". There should be no component buying problems for the two circuits as all parts should be readily available from our mail order component advertisers.

For best results, ensure that components align with the hole pitches of the *Mini Lab* p.c.b., capacitors are 5mm lead pitch types, and make certain the specified transistors are used. If you have not already purchased the *Mini Lab* printed circuit board it can be obtained from the *EPE PCB Service*, code MIN LAB (see page 307).

A selection of kits for the *Mini Lab* has been put together by **Magenta Electronics (☎ *0283 65435*)**. These include the single Eurobreadboard which replaces the two original Veroblocs (discontinued).

Universal Data Logger

Some of the components required to build the *Universal Data Logger* may prove difficult to locate locally. Also, to avoid any possible programming problems of the EPROM IC4, a preprogrammed chip is being made available by the author.

The multiturn preset is the "cermet" type and should be generally available. Some readers may have trouble locating a suitable 11MHz crystal. These are usually to be found under the "microprocessor crystals" sections in catalogues and are currently being listed by **Cricklewood** and **Cirkit** (see "Advertiser's Index" page 312).

The only source we have been able to find for the 6-way DIN p.c.b. socket, used on the model, is from **Farnell (☎ *0532 636311*)**. This is listed under their "DIN Audio Connectors" section, code 148-507. We cannot give an up to date indication of price, as we have been unable to obtain a "current" catalogue for some time now!

The PC data acquisition software (3½in. disc) and a preprogrammed EPROM for the microcontroller board is available from: **Mr. R. Grodzik, 53 Chelmsford Road, Bradford, BD3 8QN. (☎ *0274 662085*)**. The price is £20, inclusive of post and packing.

The printed circuit board for the data logger is available from the *EPE PCB Service*, code 826 (see page 307).

Mini Charger

The only really "special" item that needs extra attention when constructing the *Mini Charger* is the mains transformer. The panel meter is one of the standard miniature 51mm x 45mm moving coil types obtainable from most of our advertisers.

The 25VA mains transformer, having twin 15V secondary windings rated at 0·8A each (1·6A when wired in parallel), used in the prototype charger was purchased, some time ago, from **Rapid Electronics (☎ *0206 751166*)**, code 88-0300. This transformer also has two independent 120V primary windings, rated at 12·5VA each, and is wired in *series* for 240V a.c. operation. Once again no current components catalogue has been received in the office.

Other mains transformers will operate in this circuit and one of the excellent range supplied by **Jaytee Electronic Services** will certainly "foot-the-bill." Give them a ring on ***0227 375254*** for their latest listings.

Although a 2·5W resistor is specified for R2, the 3W version seems to be more readily available. These resistors are the vitreous enamel or wirwound types.

Finally, make sure you use heavy-duty cable wherever specified and that plenty of "vent" holes are drilled in the *Metal* box.

Fog Light Alert

The 12V 15mA "pulse-tone" buzzer used in the *Fog Light Alert* model was obtained from **Maplin**, code BZ55K (Pulse-tone Buzzer). Do not buy a buzzer that requires *external* drive circuitry since this will not work in this circuit.

You must use heavy-duty auto-type wire and connectors where indicated. If there is any doubt about wiring the unit into the car, then you should seek the advice of a local garage workshop and also consult the vehicle workshop manual.

Electronic Fire

We do not expect any component buying problems to be encountered by anyone who wishes to construct the *Electronic Fire* to add that touch of realism to their model setups.

All components are "off-the-shelf" items and the small printed circuit board is obtainable from the *EPE PCB Service*, code 820 (see page 307).

Ventilation Fan Timer

We cannot forsee any component purchasing trouble ahead for readers tackling the *Ventilation Fan Timer*. The miniature printed circuit board is available from the *EPE PCB Service*, code 825 (see page 307).

However, we should like to add a word of caution. Due to the presence of MAINS voltages on and around the p.c.b., anyone tackling a mains project should have a good understanding of what they are doing.

Also, the fan circuit *must* be fused. The rating will, of course, depend on the final application of the timer module.

Going Active

The XO3 Programmable 3-way Active Crossover module is the latest addition to **BK Electronics** excellent range of OMP

audio products. The XO3 is a high quality stereo crossover unit, housed in an industry-standard 19in. rack mounting case.

A removable front panel fascia allows access to a bank of d.i.l. switches for programming the module's crossover frequency points. Levels for bass, mid and top response are fully adjustable, with phase invert switches on the bass channels. The unit is claimed to be capable of achieving a 24dB per octave crossover slope.

The XO3 Programmable 3-way Active Crossover module costs £116.33 (including VAT), plus £7 delivery charge, and is obtainable from: **B.K. Electronics, Dept. EPE, Units 1 & 5 Comet Way, Southend-on-Sea, Essex, SS2 6TR. ☎ 0702 527572.**

Stop Press . . . SALE!

We have just received news of Maplin's Shop Sale. This year they claim it is their biggest ever, with hundreds of selected products being marked down; some being knocked down to half-price!

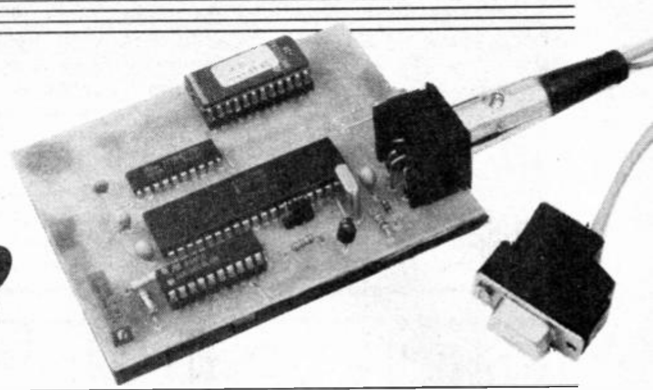
Special products on offer at their twenty-one stores include:

R.F. Power Meters; Hammer Drills; Answerphones; 2-Way Speaker Systems; Car CD Multiplay; Amplifier Kits; 3-Channel f.m. Intercom; Probe Meters; Compact Toolboxes; Casio 2·7in. LCD Colour TV; Floppy Disks; Digital Headphones; Ni-Cad Charges; and many more.

PLEASE TAKE NOTE

TV/U.H.F. Filtered Aerial Amplifier *(January 1993)*.

Readers experiencing difficulty with the operation of this unit should insert a 4p7 ceramic capacitor between the junction of C1/L2 and pin 1 of IC1. This can be done by cutting the underside p.c.b. track in the vertical section just above C1 (Fig. 2) and soldering the capacitor across the cut.



UNIVERSAL DATA LOGGER

RICHARD GRODZIK

A microcontroller based project that will convert varying d.c. voltage to an RS232 data stream, allowing data to be recorded by a PC.

THIS Project utilising a single chip micro-controller (8031) costing less than £25 to build (plus EPROM and software), provides an easy way to measure and convert a varying d.c. voltage to a RS232 serial data stream. The input voltage can be derived from virtually any transducer or source that provides a d.c. voltage which is proportional to the process variable being measured. The serial output is then fed to the serial port of a PC which provides a graphical representation of the converted data.

A software data acquisition driver for the PC is available from the author, so that the reader is left only with the task of constructing the data acquisition micro-controller based hardware.

SERIAL PORT

The advantage of using the serial port for inputting data to a computer is that it frees the parallel port which invariably is tied up to the printer. Connections to the PC's serial port only involves three connections – the data logger deriving it's power from an external 5 volt source.

Data acquisition is user selectable by a simple switch, allowing one second or one minute sampling rates to monitor an experiment over several hours or even seconds.

EXAMPLES

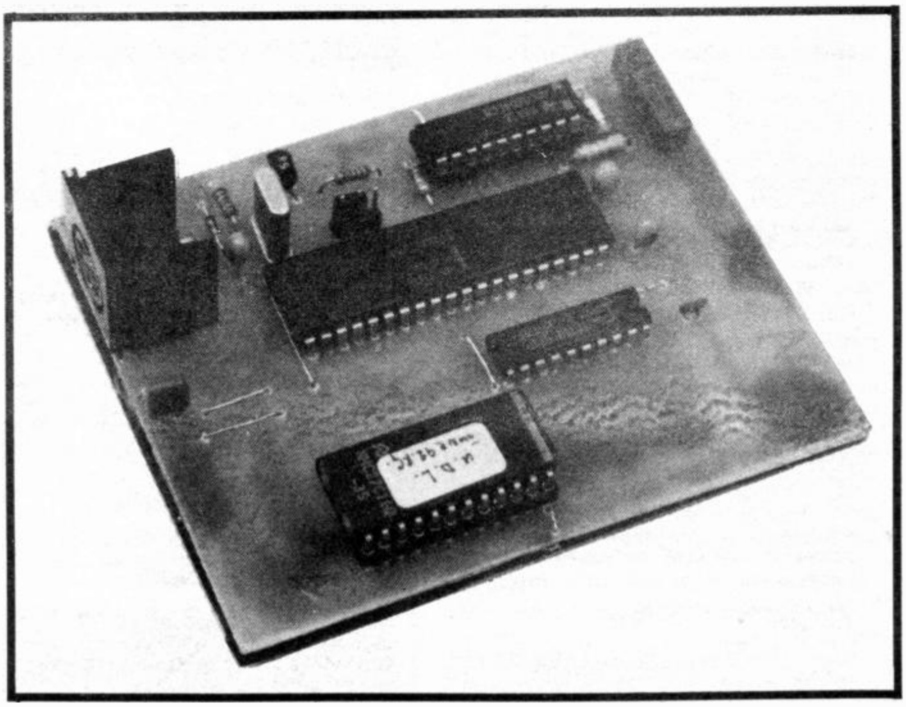
For example you could connect in a simple temperature transducer (LM35DZ) and monitor your room temperature over a 10 hour period. Reduce the room thermostat by a few degrees and repeat the monitoring. You can then set the thermostat for maximum efficiency, probably saving quite a few pounds when the next fuel bill comes in.

The uses for data logging are endless – you may want to monitor the "greenhouse" effect by measuring the incident ultra-violet radiation, or measure the level of pollutants in the atmosphere. Connect-in the relevant transducer to the board, apply power and leave the intelligent data logger to do it's work.

DATA LOGGER FEATURES

★ Uses the serial [Com1] port of a PC
★ PC system requirements – VGA video adapter, and hard disc.
★ Real-time data acquisition at one second or one minute per sample.
★ Real-time graphic display of data.
★ Continuous writing of data and time to disc during data acquisition.
★ Screen image saved to disc – date and time stamped.
★ Intelligent A-D convertor with user adjustable input voltage span.
★ 640 samples per screen.
★ User programmable scaling factor – real data displayed.

A real-time data acquisition system allows the logging of aperiodic variations of some physical phenomena, over a prolonged period of time. The Data Logger uses a PC to graphically display the results, and an intelligent ADC board to provide the data. A measuring time "window" of about 10 minutes or 10 hours presents the logged data in both ASCII real file format and as a graphical representation.



GENERAL DESCRIPTION

The data acquisition system consists of two parts – a microcontroller based ADC board and a host PC. First, we shall look at the hardware architecture of the board (Fig. 1); IC1 – an 8-bit analogue-to-digital (ADC) convertor converts the d.c. voltage applied to it's input (pin 6) to a parallel 8-bit digital output (pins 11 thru 18), which is presented to the microcontroller (IC2) – a type 8031.

The software resident in a type 2716 EPROM (IC4) drives the microcontroller which provides the start of conversion (SOC) signal to the ADC on pin 3. This occurs every one second or one minute dependent on the setting of switch S1. The accurate time intervals produced by a combination of software timing loops and the 8031's internal timers.

When a conversion has taken place, the ADC provides an interrupt signal on pin 5 consequently interrupting the microcontroller which then reads in the converted data. This data is then converted to RS232 serial data stream by the internal USART of the microcontroller and fed out

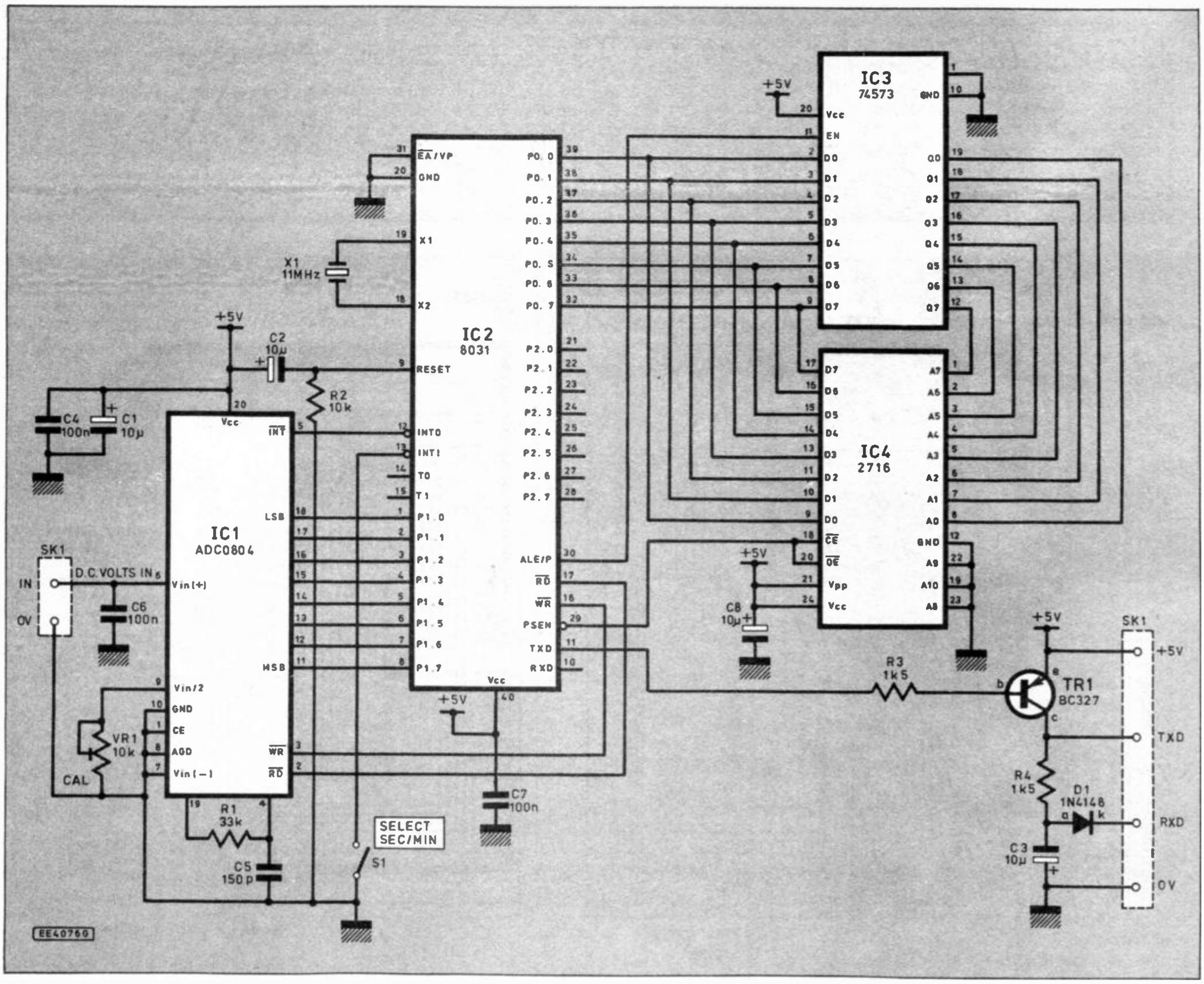


Fig. 1 Complete circuit diagram of the Universal Data Logger

of pin 11 to transistor TR1 which provides the necessary voltage level to drive the serial port of the PC.

INPUT

The input voltage requirements for the board are user adjustable to cater for a wide range of transducers. For example: an input voltage range of 0 to 2·5 volts would be converted by the 8-bit ADC, giving a value of 10mV/bit so that f.s.d. (full scale deflection) of 2·5 volts will produce FFH from the board.

Setting the required input voltage span for the A to D convertor is accomplished by a multiturn potentiometer VR1, which is adjusted to give a voltage of f.s.d./2 at pin 9 of IC1. So for a full scale voltage of 2·5 volts,the voltage at this point would be set to 1·275 volts (2·5/2).

The parallel data generated by the ADC is converted by the 8031 microcontroller into serial data with a protocol of one start bit, eight data bits, one stop bit and no parity. Transistor TR1 and it's associated components R4, D1, C3, perform a voltage level change to satisfy RS232 requirements: The transistor is given a negative (−ve) voltage bias from the RXD pin of the PC.

The serial output from the controller board is fed to the serial port (Com1), of a PC. Since the system serial communication software is interrupt driven, no hardware hand-shaking or polling is involved. The connections to the PC serial connector differ for an AT and XT PC:

9-PIN D-TYPE CONNECTOR (PC AT)
Pins 7 and 8 strapped together.
Pins 4 and 6 strapped together.
Connections to the Data Logger Board:
SK1 (TXD) to pin 2 (RXD) D type.
SK1 (RXD) to pin 3 (TXD) D type.
SK1 (0V) to pin 5 (0V) D type.

22-PIN D-TYPE CONNECTOR (PC XT)
Pins 4 and 5 strapped together.
Pins 6 and 20 strapped together.
Connections to the Data Logger Board
SK1 (TXD) to pin 3 (RXD) D type.
SK1 (RXD) to pin 2 (TXD) D type.
SK1 (0V) to pin 7 (0V) D type.

CONSTRUCTION

The complete Data Logger is constructed on a neat single-sided printed circuit board which is available from the *EPE PCB Service*, order code EPE826, see Fig. 2. Make sure the links are inserted first and be careful to observe the polarity of the tantalum capacitors, D1 and the i.c.s.

Fit the i.c.s last, on the protype some of these were soldered directly to the p.c.b. but many readers may prefer to use d.i.l. sockets. Switch S1 can be omitted and a jumper link used on the three pins provided if required, simply moving it to change the sampling rate.

SOFTWARE

The control program for the PC has been written in Turbo Pascal version 4, and assembler. The 3½inch diskette supplied

COMPONENTS

See SHOP TALK Page

Resistors

R1	33k	
R2	10k	
R3, R4	1k5 (2 off)	

All 0·25W 5% carbon film

Potentiometer

VR1	10k multiturn preset

Capacitors

C1, C2, C3, C8	10µF tantalum 16V (4 off)
C4, C6, C7	100n ceramic (3 off)
C5	150p polystyrene

Semiconductors

IC1	ADC0804 ADC
IC2	8031 microcontroller
IC3	74HC573 octal latch
IC4	2716 EPROM (see note)
T1	BC327 *npn* transistor
D1	1N4148 diode

Miscellaneous

X1	11 MHz crystal
SK1	6-way DIN p.c.b. socket
S1	s.p.s.t. switch

P.C.B. available from the *EPE PCB Service*, Order Code EPE 826; d.i.l. sockets, 40-pin, 24-pin and 20-pin (2 off); 0·1 inch jumper and header; connecting leads and plug suitable for connection to the computer used (see text).

Approx cost guidance only **£25**
plus EPROM and software

HEXDUMP

For those readers wishing to program their own EPROM the hexdump contents is shown here:

```
0000:  02 00 4b ff ff ff ff ff ff ff ff c2 8c d5 e0 03   "..K.............."
0010:  02 00 1c 75 8c 10 75 8a 00 d2 8c 32 74 0f 75 8c   "...u..u....2t.u."
0020:  10 75 8a 00 d2 8c 30 b3 1a c2 b6 d2 b6 20 b2 fd   ".u....0........."
0030:  c2 b7 85 90 99 d2 b7 d2 8e 30 99 fd c2 8e c2 99   ".........0......"
0040:  78 00 32 08 b8 3c 03 02 00 29 32 75 89 21 75 98   "x.2..<...)2u.!u."
0050:  50 c2 ab 75 8d fd 74 0f 78 00 c2 8c 75 8c 10 75   "P..u..t.x...u..u"
0060:  8a 00 d2 af d2 a9 d2 8c 02 00 68 ff ff ff ff ff   "..........h....."
0070:  ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff   "................"
```

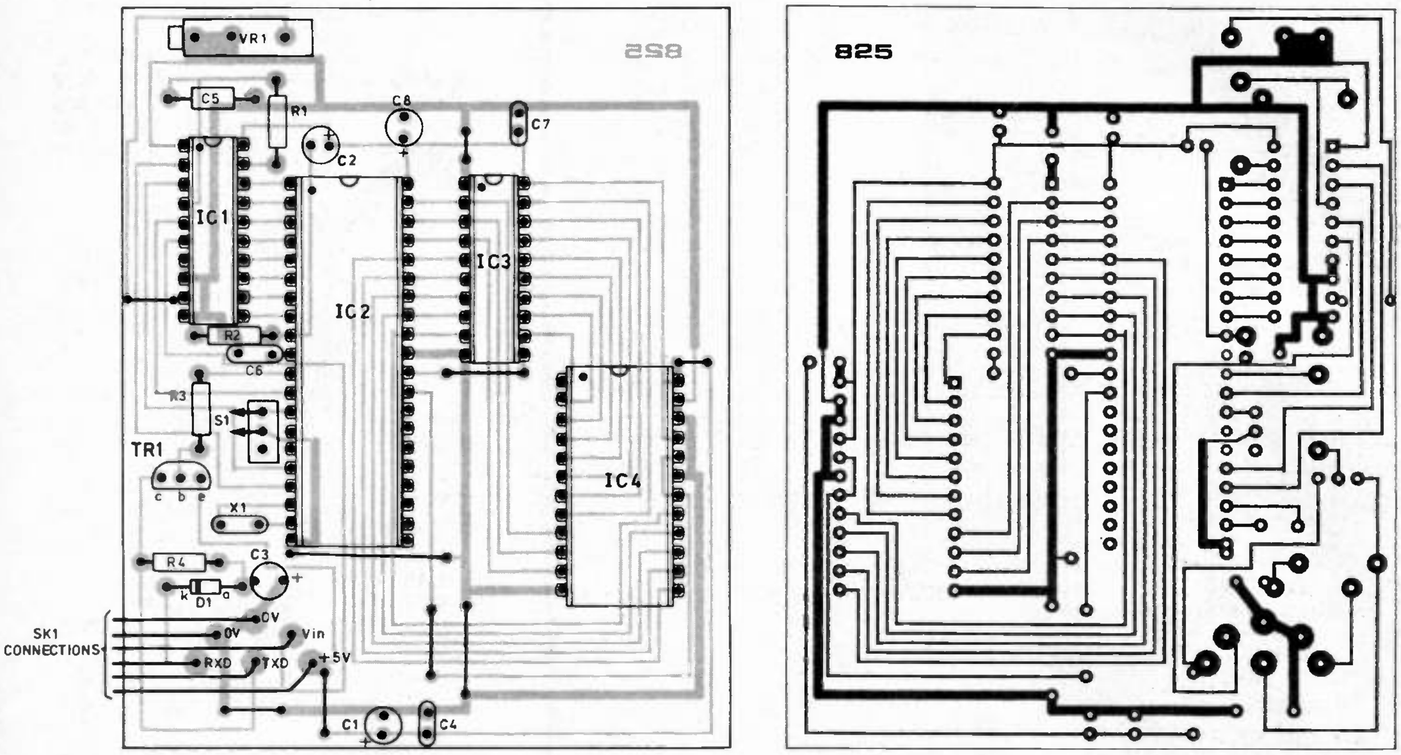


Fig. 2. Printed circuit board layout and wiring of the Universal Data Logger.

for the project has two .EXE files – VGA.EXE the main data acquisition and graphics software and PICVGA.EXE which allows the display of captured screen graphics.

A hard disc is a necessity for the software to be used. To install the software, create a subdirectory on the hard disc and copy all .EXE files from the floppy disc into this subdirectory.

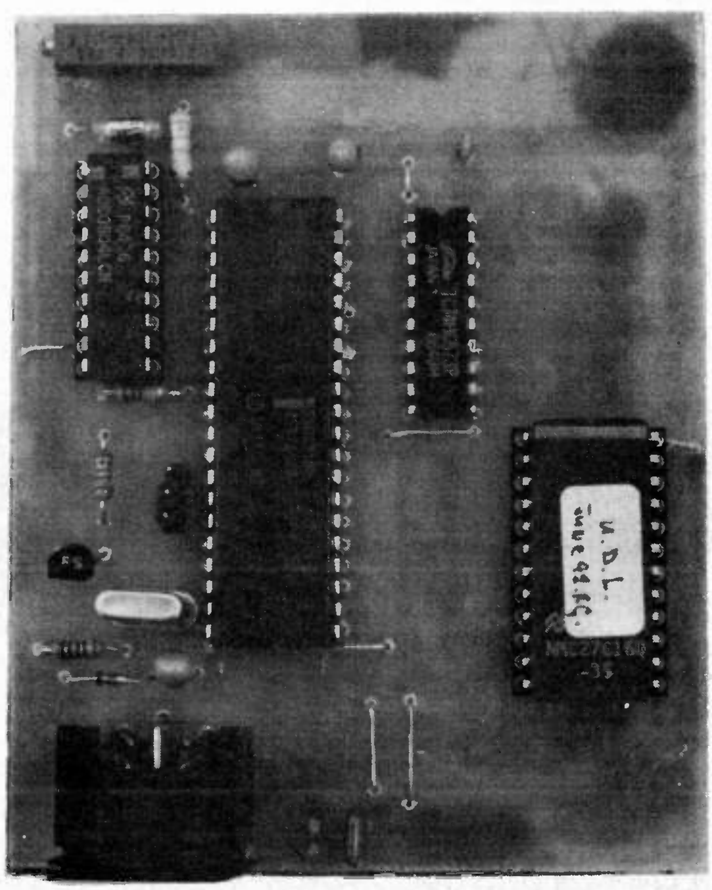
To run the software, simply type VGA [enter]. A prompt will ask for a filename, which should be of MSDOS format with no extension, since at the end of data capture an additional file (filename.P) is automatically created which contains the captured screen graphics information.

A second prompt asks for a scaling factor. This is a constant which will be used by the software to convert the raw data from the ADC - 0 to 255 (00-FFH) and print real data onto the screen. For example, a scaling factor of 2·55 will result in the 8-bit data representing a scale of 0 to 100. Once the scaling factor has been entered, (in this case 2·55) the graphic screen will be initialised and waiting for the first serial byte to enter the PC's serial port.

GRAPHICS

When data arrives, start time is displayed, the sample number increments, the real value of data is adjusted by the scaling factor and printed on the screen, together with the date and time of current sample. The data is also presented as a relative point on the screen using a vertical resolution of 255 pixels, giving 1 bit/pixel.

640 samples are taken, during which time, data is written to disc, and a graphical representation of the data is produced on the screen. At the end of 640 samples, the finish time is printed on the screen, and pressing the [enter] key will save the entire picture to disc.



SOURCE CODE

The binary object file was created with the aid of a 8031 cross-assembler, the source code listing as follows:

```
#INCLUDE SFR51.EQU
T_CO     .EQU 0BH        ;TIMER 0 INTERRUPT VECTOR
TIME     .EQU 16         ;TIMER RE-LOAD VALUE

.org 00H
LJMP INITIALISE          ;INITIALISE SYSTEM TIMER

.ORG T_CO
 CLR TRO                 ;STOP TIMER
 DJNZ A,LOOP1
 LJMP SEC

LOOP1:MOV TH0,#TIME ;RELOAD TIMER
     MOV TL0,#00
     SETB TRO
     RETI

SEC:MOV A,#15
    MOV TH0,#TIME  ;RELOAD TIMER
    MOV TL0,#00
    SETB TRO

   JNB P3.3,MIN          ;MINUTE SAMPLING SELECTED

ADC: CLR P3.6            ;START ADC CONVERSION
     SETB P3.6

LOOPX:JB P3.2,LOOPX      ;WAIT FOR INT LOW (END OF CONVERSION)

     CLR P3.7
     MOV SBUF,P1         ;READ DATA
     SETB P3.7


    SETB TR1             ;SERIAL  OUTPUT
LOOPT:JNB TI,LOOPT
    CLR TR1
    CLR TI
    MOV R0,#0
    RETI

MIN:INC R0
    CJNE R0,#60,NOTMIN
    LJMP ADC
NOTMIN:RETI

INITIALISE:
 MOV TMOD,#021H   ;16 BIT TIMER 0  AUTO RELOAD TIMER 1
 MOV SCON,#050H   ;8 BIT UART
 CLR ET1          ;DISABLE INTERRUPTS FROM TIMER 1
 MOV TH1,#0FDH    ;9600 BUAD

 MOV A,#15        ;1 SECOND COUNTER
 MOV R0,#0        ;60 SECOND COUNTER
 CLR TRO
 MOV TH0,#TIME    ;LOAD TIMER
 MOV TL0,#00
 SETB EA          ;ENABLE INTERRUPTS
 SETB ET0
 SETB TRO
HALT:LJMP HALT    ;WAIT FOR TIME-OUT

.ORG 0800H
.end
```

The entire data acquisition process can be aborted at any time by simply hitting the [enter] key. As previously, pressing the [enter] key again, will again safely save the partial screen graphics to disc.

Two files are created; a text file – the original prompted filename which contains data, time and sample number in ASCII. The graphics file (filename.P) can be re-displayed by running PICVGA.EXE. Enter filename.P at the DOS prompt. Do not forget to include the .P extension.

A travelling dot cursor is invoked by pressing the space-bar, travelling along the x-axis and displaying data, time and sample number information. Pressing the [enter] key will once again allow escape to DOS.

VIRTUAL DISC

The slowest component in any computer system is the hard disc, writing to the hard disc can take several milliseconds, even though the processor is executing its work in microseconds. This problem can be overcome by creating a "virtual disc".

Drive D is assigned a section of RAM and used by the operating system as though it is another disc. However the writing time is dramatically improved – microseconds as opposed to milliseconds.

To create the virtual disc include the following lines in the CONFIG.SYS file on your PC.

LAST DRIVE=D
DEVICE=C:\DOS ANSI.SYS
DEVICE=C:\DOS RAMDRIVE.SYS 300

and re-boot the PC by ALT-CTRL-DEL or resetting. (300Kbytes of RAM are allocated to drive D)

All the files can now be copied to drive D, i.e. copy *.* D: It was found that data samples up to 30 per second can be written to drive D – the limiting factors being the received rate (9600 baud) and the execution time of the graphics software. □

NOTE: The PC data acquisition software (3½in. disc) and a pre-programmed EPROM for the microcontroller board is available from: Mr. Richard Grodzik, 53 Chelmsford Road, Bradford BD3 8QN, England. Tel. No. 0274 662085. The price is £20.00 inclusive of post and packing.

Further reading: Microcomputer applications in measurement systems C.J. Fraser and L.S. Milne. Macmillan ISBN 0-333-51838-1.

READOUT

SORRY. . .

Whilst readers and critics have the luxury of hindsight, we're limited by a hectic publishing timetable and occasionally some matters do not receive the depth of consideration they probably merit. The *Teach-In* mnemonic which caused all the stir (*Readout* Dec. '92, Jan and March '93) was in fact a late addition to the manuscript because I had gained the impression that it was in fairly common use in this area of teaching. It was offered "nervously" which was a way of apologising in advance in the hope that this slightly *risqué* item would not offend.

Although I feel therefore that it has readily and repeatedly been taken out of context, I was dismayed to learn that some readers (and non-readers) had indeed taken offence at this *aide-memoire*. In retrospect it is now agreed that the rules have changed and its use is no longer appropriate in today's enlightened times. I am genuinely sorry for any indignation and embarrassment caused.

I was however encouraged that many of our readers and friends involved in education managed to treat the expression with a great deal of sense and diplomacy, having tactfully questioned (quite rightly) the suitably of this item. Most seem to have taken the rhyme for what it is – a simple suggestion for a memory aide. A clear and simple error of judgment, we would all now agree – but certainly nothing more than that. Apart from a storm in a teacup?

Alan Winstanley.

NOT WORTH IT

Dear Ed.,

While I was having an amusing browse through your pages of *non-risqué* colour code mnemonics, I was led to wonder, are mnemonics in general really worth the trouble? Surely, usage and a bit of hands-on experience enables things like reading colour code to become as commonplace as reading these words.

In my own experience, I have always found it more difficult to wean some students away from the use of mnemonics than to get them to make a conscious effort to "see" the colours as plainly as a printed number. Mnemonics, in other words, can often be an impediment rather than a help because they make their addicted users completely dependent upon them.

When I was on a radar course at Bury during the war I knew a lad who had twelve mnemonics allegedly covering all possible circuit relationship for negative-feedback analysis. As I remember (without a mnemonic) there were four covering current and voltage feedback, four more interlocking into these for input and output impedance variations, and four more entwined with the first eight for series and parallel arrangements of feedback.

While he was reciting the mnemonics and trying to choose which of the permutations on these suited the problem in hand, the rest of the class had usually finished. His ability to remember the twelve mnemonics as though they were Holy writ seemed completely at variance with his inability to remember the circuit systems directly, and I think this was because his enchantment with the first closed his mind to the possibilities of the second.

To tell the truth, I have never found mnemonics of any value at all. In examinations, questions can be phrased so that the information that mnemonics are supposed to provide, like a legal crib sheet, turn out to be no help at all. It would be interesting to know how many people agree with this, or how many can provide an instance where a mnemonic has definitely got them out of a scrape – and what that mnemonic was. I think this might make for some intriguing correspondence.

Steve Knight
Market Harborough

Although we might hesitate to publish some of them the idea is interesting. I certainly still use one for the colour code. - Ed.

AMSTRAD FX9600AT

Dear Ed.,

I read with much interest you editorial in Volume 22 No. 1 regarding the Amstrad Fax.

Having been told by my local dealer that it would cost me about £250 plus labour to fix mine (*approximately the same as ours – Ed.*) after a storm last spring, I decided to purchase an alternative machine.

I had the option to claim on my insurance to get the repair done but it was felt that the value of the fax did not warrant the full pay out. We therefore "scrapped" the Amstrad and the money I am still hoping to obtain from my insurers nearly covers a replacement kit involving a Samsung fax and a BT answerphone.

Two points need further consideration: Firstly, this was my second machine to be wrecked in a storm.

The first went down about two months after I purchased it from Dixons and they eventually gave me a new one as "the repair cost was too great". I assume now that the main board was involved although the people in the shop at that time were not aware of the details.

Secondly, on the plus side, the combination I now have does not give me the flexibility of the Amstrad. I have used several types of fax and answerphone and the capabilities of the FX9600AT far exceed the price tag (if one ignores minor problems of the damn thing packing up!).

I now have a machine which I would love to repair as I had in mind giving it to a local school. In fact, if I could get it working again, I would keep it and pass on the Samsung which, whilst reliable (so far), is nothing like as much use.

If you are getting anywhere in your crusade, please let me know so that I can assist with (and benefit from) your efforts.

Bill Spears
Sittingbourne

NOTORIOUS

Dear Ed.,

With regard to your editorial note about the Amstrad FX9600, these machines are notorious for their unreliability. They are always being sold off at computer auctions, in faulty condition. Having owned one I must say that I wouldn't touch another one, even a new one, with a barge pole!

Terry Blay
Romford

ANYBODY OUT THERE?

Dear Ed.

Please excuse any typing errors as I am totally blind. Until I became blind in 1986 I was an avid fan of your magazine and in fact I had bound volumes of every issue from number four.

I made up many of your projects and as a professional organist I was particularly interested in musical items like the String Machine and Clef Rhythm Box designed by Alan Boothman, which I still use.

At that time I lived in the Manchester area and Alan Boothman and I became firm friends as fellow committee members on the Electronic Organ Constructors Society NW branch. However since moving to Norfolk I have not met a single person of like interest and I would love you to publish this letter as I have many ideas for blind projects and I need help.

Don McIntosh
19 Parklands Way
Harleston
Norfolk
IP20 9DR
0379 852644

RAILWAY CONTROL

Dear Ed.,

As part of my teaching of Technology, I am starting to use a model railway as a basis for the teaching of various aspects of the syllabus.

I would be interested to hear from any of your readers who are involved in controlling models either using electronic circuits or computer control especially with BBC's.

I am looking for ideas at all levels, but especially for simple circuits which are suitable for younger pupils controlling perhaps one signal (either designed for stripboard or p.c.b. etching). The one published a few months ago is excellent but it is useful to have alternatives for pupils to compare or use in different applications.

I am planning to involve pupils in building three tracks and eventually each pupil would have their own item to control with projects easily removable to allow the next project to use the same piece of track. This will apply to electronic and computer control.

We have several BBC's with interfaces and a general control program (written by an ex. 6th former) for controlling Lego models etc., and this works quite well, but I would be very interested if anyone has a program which they use to control their own layout. I am not too hot at programming and to see how someone else has gone about it might allow us to modify our existing program.

Of course if there are any companies out there who can offer expertise or sponsorship I would love to hear from you!

Graham Long
St. Birinus School
Mereland Road
Didcot
Oxon
OX11 8AZ

A BARGAIN

Dear Ed.,

I do take exception to readers like P. McBeath *(Readout* March '93) suggesting mail order companies' make a profit out of their post and packing charges. The fact of the matter is, if all costs are taken into consideration we probably make a loss overall!

You may be able to send 200g for 41p, but you first have to buy the padded bags (and all the boxes and infill material) and allocate storage space to them; pay someone to pack the goods; record the details for the Post Office and file the order away in case of any query.

This is, of course, after you've paid someone to open the envelope containing the order in the first place; checked the contents (surprising how many people forget to sign their cheques or omit their address and have to be written to); record payment details and bank the cheque (hoping it won't bounce).

Then there are the charges for the franking machine, scales and other equipment; the cost of stationary used exclusively for mail order and the charge the PO makes for collecting mail from our premises. Don't forget also the bounced cheques, returned parcels, unauthorized credit card transactions . . . I could go on, but there wouldn't be room for any more letters!

All this for just £2.75 per order, wherever you live in the UK – it's an absolute bargain!

Remember, these costs are additional to a customer who walks into our shop and pays exactly the same amount in cash for their bits and pieces!

Anyone fancy running a mail order company for 41p a parcel?

Peter Green
Managing Director
Greenweld Electronics Ltd

RAE

Lui's letter continues from last month.

Dear Ed.,

Recently I became aware of Packet Radio. At last – I thought – worldwide communication on a Class B so I started a course at the local college. Unlike me most people were not *Everyday with Practical Electronics* readers, in fact most people knew nothing about electronics. Having spoken to them I am also of the opinion that for most people the electronic and mathematical content of the course (as well as the Morse) was what had put them off taking the Radio Amateurs Examination for years.

As most people, on passing the test, just go and buy a ready made Icom, Yaesu, Kenwood etc. what is the point in torturing them with the electronics and maths?

As an aside, I would like to draw your attention to the RSGB publication *How to pass the RAE* – my comment would be don't buy this book! It is supposed to contain sample exam papers – I have to say that the RAE I sat bore little relation to be simplicity of the RSGB book. I think the RSGB should be reprimanded for misleading people.

So what is the solution to attracting people to the hobby.

1. *For people who buy readymade equipment built to the required standards* – Cut out the unnecessary parts of the exams i.e. the Morse and a lot of the electronics and maths. What they require are the rules, regulations, some EMC information and some *practical* training on the setting up and use of a station. This would then be examined. I know exams in themselves are off-putting but a least they would be relevant.

2. *For people who wish to build and use their own transceivers* – A separate exam in electronics would be required.

3. If you want to use Morse – go ahead – feel free! But don't make everyone else suffer.

I know I've gone on a bit but you did ask. It has annoyed me for some time now that what should be an enjoyable hobby for many people is denied them because of so many irrelevant barriers.

Publish and damn me!

Lui Giacomello
Edinburgh

The need for a Morse test is the big debate within amateur radio at present, and the Radio Society of Great Britain is currently seeking the views of both licensed amateurs and shortwave listeners on the desirability or otherwise of a no-code licence for operation below 30MHz, i.e., on the main international bands.

I will pass Mr. Giacomell's letter on to the RSGB, together with any others received, to seek their comments on the points he makes. I will report any feedback in my Reporting Amateur radio *column.*

Tony Smith, G4FAI

CLIQUEY

Dear Ed.,

In my early teenage years I was introduced to radio construction when I bought from a school friend a simple one valve radio kit. Without any help I eventually pieced it together and got it working. After a couple of years experimenting in radio other attractions loomed and raising a family completely took over.

My interest, however, never totally left me. It surfaced years later when I decided to study part-time for a degree. Part of my course included electronics and before I knew it the old excitement came flooding back.

A change of career followed my graduation and I now teach secondary technology in a local comprehensive school. I consider myself very fortunate in that after 25 years in sales and distribution management I can now follow my re-discovered interest through my work.

I am now again an avid electronics hobbyist with particular interest in radio. I have taken to h.f., v.h.f. and u.h.f. listening and subscribe to any magazine which makes any mention of radio. I am in fact a perfect candidate to join the ranks of radio amateurs but as yet I have not gone down that road.

I listen to many amateur conversations, I read all about their activities yet I still cannot bring myself to join them. The examination for the licence does not deter me, apart from the Morse code I probably already know the rest, but what does put me off is the apparent cliquey nature of the hobby. Hidden behind their walls of jargon they seem not to want strangers to join in.

Locally everyone knows everyone else. They chat for hours on first name terms and I feel that even if I had a licence to transmit I could no more join in than I could break into a private conversation accidentally broken into on a telephone crossed line.

If radio amateurs are really serious about new entrants to their hobby then they need to be much more welcoming.

An open night at the local club for example, an advice desk at the annual rally or an exhibition and demonstration of equipment in the village hall are just three examples of how the gap between those on the inside and people, like me, on the outside could be bridged.

S. G. Solomon
North Humberside

HAM STRUNG

Dear Ed. and Tony,

I sympathise totally with the views and frustrations expressed by Lui Giacomello (Ham Fisted – *Readout* March '93) on the subject of the Morse Exam.

I too am a keen h.f. listener and have often heard Hams bubbling with self-righteousness on the virtues of Morse as a means of keeping the "Cowboy" element off the bands. I get the impression that the majority are ex-military who have learnt their Morse probably after endless sessions in some establishment, at the taxpayers expense.

Those of us in the real world, with its many occupational and/or social pressures, are unable for reasons of access, time or expense to persue a subject which although laudable, is nevertheless irrelevant to verbal communication over the airwaves. Surely, the time and effort necessary to obtain the "B" licence, together with the considerable investment in the equipment required to participate in h.f. radio, should be sufficient in itself to filter out any "Cowboy" element.

My view is that we are really up against that peculiarly British "Club" syndrome, where the established members on the one had proclaim the need for new members, for reasons of continuity and finance, and on the other deliberately obstruct this happening due to an overriding fear of diluting their elitism and status as members. We have all probably either witnessed or experienced this pathetic attitude in our Tennis and Golf clubs.

I am sure there are many people like myself with the competence and means to become creditable radio Hams who sadly will be lost to this great hobby which as a result will continue to decline until the Morse obstruction is finally removed.

Philip Hall
Chichester

INGENUITY

Dear Ed. and Tony,

I am inspired to write to you after your comments about weakened interest in Ham Radio.

I used to work with ZB1ZR in Malta in the 1950s and have followed a career in electronics.

I perceive that the decline in availability of Government Surplus radio equipment and the ascendance of kits which demand no technical knowledge or ingenuity for assembly, plus the TV led entertainment culture has robbed youngsters of the incentive to attempt to experiment with receiving and transmitting electronics hardware.

In addition computer advances have enabled a new generation of hobbyists to play about with software in complete ignorance of electronics and communications fundamentals.

When I was a child, I could buy an 18 set receiver for 15 shillings *(75p now – Ed.)*. An RF27 unit cost about the same and I could buy an 1154 transmitter for perhaps £5 and an 1155 receiver for £8. HRO, Collins and AR88 receivers were abundantly available for a few pounds. A single 807, a PI network and a screen grid modulator could get you all over the world on 25 watts anode power.

Almost any component could be stripped from surplus equipment and such components as coils required to be re-wound to cover the amateur bands.

Ingenuity was the name of the game and the test of ones skill. The odd 500 volts across the fingers soon engendered respect.

Basic fundamental theory was required every step of the way and supported by the *Radio Amateur's Handbook*, Scroggie's *Foundations of Wireless* and indeed the Journals *Practical Wireless* and *Practical Television. Wireless World* offered access to short wave receivers, transmitters and surplus radar systems. Companies like Henry's Radio provided kits which required some technical skill to complete and allign.

A walk down Tottenham Court Road, and Lisle Street provided for every need.

Youngsters interested in computing and digital electronics have lost the "green fingers" of the analogue experimenter. I have seen highly qualified technicians wondering why their p.c.b. prototype fails to work through ignorance of the LC and R fundamentals.

Ham radio now employs sophisticated transmitters and receivers which may be bought "off the shelf" and which use assembly techniques which are not compatible with the domestic "radio shack".

Technical training now appears to be too specialised to encourage individual freedom of decision and the easy availability of components and electronic sub-assemblies has made it unnecessary to find unorthodox solutions to problems.

Any yet the opportunities for the home constructor are immense. Computers facilitate p.c.b. layout. Analogue electronics may be cheaply simulated before assembly. Combinations of hardware and software solutions may still be worked out on the "kitchen table".

As an employer I would rush for the technician with a Ham radio background but they have "melted like snow off a dyke".

I suggest that the war and immediate post war period because of privations and access to war surplus electronic equipment brought out much ingenuity which attracted teenagers in the past. No longer is such a scope of technology at their behest which might be safely sacrificed in order to find out about the fundamental nature of the communications challenge.

I write to you simply because a generation now seems bo be missing the challenge of trying to "get things to work" and are so missing out on an important survival instinct in a technical career. As a colleague put it, "what do you do in the desert when spares run out?"

Dr Colin Watson
Edinburgh

RICH MAN'S HOBBY

Dear Ed.,

Reading your article about inviting comments regarding the R.A.E. and the falling numbers of amateurs to the hobby. This letter is to give you my opinion of the situation and what might be the cause. As you see I am a "B" license holder. Previous to this I was an ardent S.W.L. with some electrical/electronic knowledge. However when I seriously decided I would like to become an amateur my first enquiry was is there an R.A.E. course running in my vicinity. There was!! But the cost of the course put me off.

Thinking along the lines that the C.B. fraternity don't require to pass exams to get on the air almost put paid to my idea of becoming an amateur. However I have always felt that if I only become a "C.B."er, my ambitions wouldn't be fulfilled. So I approached the problem from another angle.

I decided to purchase the R.A.E. examination handbook by the R.S.G.B. Studied this over a few months at home. Then applied to take the exam about four weeks before it was due to take place at the local technical school. The exam cost far less than the course!!

Now looking at the price of equipment and transcievers etc. even for the "B" licensed amateur bands was somewhat off putting to say the least whilst h.f. equipment would almost cost an arm and a leg. Even a simple QRP rig makes one think twice about purchasing, of course the argument could be buy secondhand. Even this can be expensive and being on a limited income as many people are these days one has to think twice as the saying goes about purchasing such apparatus.

So personally I think it is heading into a rich-man's hobby which will contribute to the decline of the number of people taking up the hobby, or is it some other underlying cause which nobody has yet discovered?

Edgar Powell, GW1 TDW
South Wales

It is not often that a subject raised in one of our regular items has resulted in such a range of well written and interesting letters. There is certainly some food for thought in the above. These and others have been passed to Tony Smith. Watch his column for comments. – Ed.

NOT TOO OPTIMISTIC

Dear Ed.,

I am a subscriber to your magazine and also a keen and active electronics constructor. I am retired and have limited funds for use in this hobby.

I tend to construct projects only if they meet two criteria. The cost must be no more, and preferably significantly less than an equivalent ready made item. Alternatively the constructed item must provide some particular feature which I cannot obtain from an economically priced commercially available product.

On this basis I was very disappointed to see six pages of the Feb issue devoted to the conversion of a hand lamp to lead acid battery power at a materials only cost of £35! It is possible to buy a ready made unit for under £20.

Similarly the 5½ page project on a simple radio control produces a very limited range and application unit, without even having a relay circuit which toggles off/on. Estimated cost £30. For £8, advertised in your pages a 200ft range walkie talkie pair is available which would not be difficult to modify for relay as opposed to speech operation.

Finally on the plant watering system, assuming a double wound transformer, adequate earthing, and preferably an earth leakage trip why limit the unit to battery only operation. The cost of eight Duracells would go a long way towards component costs.

Since this letter is critical of your magazine and in general you tend to be (usually justifiably) fairly self praising, I am not too optimistic about publication, but you do now know one readers views. As too whether I remain a reader if this months issue becomes the "norm" that's another matter.

I. M. Tasker
Grantham

P.S. I note from the front cover the magazine is "Fully SOR" interesting but meaningless!

There are a number of published projects which simply cannot be built for less than the cost of commercial units, but for many readers this is not the main criteria. Electronic construction is after all a hobby with a great deal of satisfaction coming from the construction work and the "I built it myself element."

I should also make the point that our Radio Control Unit could easily use a latching relay for the output and that the cheap walkie talkies are not usually licenceable for use in the UK.

The "Fully S.O.R." on our front cover is for the newsagents benefit, it tells him the magazine is on sale or return.

Other readers opinions would be welcome. – Ed.

PATENT ABSTRACTS

Dear Ed.,

I was delighted to see the above item in the latest issue of *Everyday with Practical Electronics* referring to patent literature. This is a much neglected source of information for electronics enthusiasts.

There are a couple of points which I feel should be made clear to readers in future issues. First of all, none of the documents referred to were patents; they were all unexamined patent applications. A published patent application is the text as filed by an applicant before any examination.

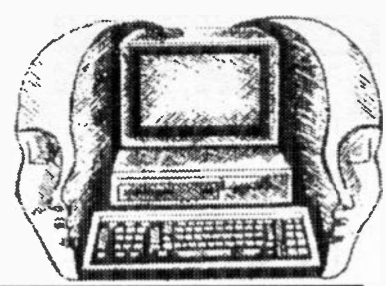
The grant of a patent, if ever, involves careful examination of a patent application which takes place in the years following publication; many applications fall by the wayside. The records show that all the documents to which the article refers were published early in 1992 and no patent has been granted on any of them.

Some time ago the Patent Office was relocated in Wales. The correct address for obtaining copies of British patent applications is now: The Patent Office, Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, Gwent. NP1 7HZ

Guy Selby-Lowndes
Billingshurst

Thank you for the information we have now changed our introduction to this item. – Ed.

INTERFACE



Robert Penfold

IN A previous *Interface* article I briefly mentioned the interface boards for PCs that are available from R. Bartlett, and often advertised in the pages of *Everyday With Practical Electronics*. These are fairly simple, low cost boards, which are attractive propositions for amateur and educational users. Unfortunately, most of the analogue boards, etc. that are available for PCs are still very expensive, with specifications that go well beyond the requirements of most non-commercial users.

The Bartlett PC interface boards can be used in education to demonstrate basic interfacing techniques, or they can be used as the basis for do-it-yourself weather stations, computer controlled model railways, or whatever. In this month's article we will take a look at the various boards that are available.

In Control

The board that is of most interest, and the one on which the whole system is based, is the control port. This provides a number of functions, one of which is to provide an eight-bit latched output port. This port is provided by a 74LS273, which obviously provides TTL compatible outputs.

There is also an eight-bit input port. This is again TTL compatible, and is based on a 74LS244. Some handshake lines would have been useful, but a lot can be accomplished using basic eight-bit input and output ports.

Analogue input and output ports are also provided. The input port is based on a Ferranti ZN448E analogue-to-digital converter, which will probably be familiar to many *Interface* readers. This is an eight-bit successive approximation type which has an input sensitivity of about five volts full scale. Each conversion takes about 12 microseconds.

The analogue output is provided by another Ferranti chip, the ZN559E. I am not familiar with this device, but it appears to be similar to the ZN428E. The resolution is eight bits, and it gives a nominal output voltage of 10 millivolts per l.s.b. (2·55 volts full scale).

Address decoding is provided by a circuit which is similar to one featured in an *Interface* article some time ago. It is built around a 74LS138 3-to-8 line decoder, which breaks up the standard &H300 to &H31F address range into eight blocks of four addresses.

Two of these address blocks are used for reading data, and two more are used for writing data. A fifth is used to initiate conversions from the analogue to digital converter. This leaves a block of twelve addresses free for other user add-ons.

All the inputs and outputs are made available at a 26-way IDC connector. This connects to the outside world via a 25-way lead terminated with a 25-way D-plug. Some useful lines are available in addition to the basic input and output lines. The extra lines are +5 volt and –5 volt supplies, IRQ5, and the three unused address decoder outputs.

Presumably the three address decoder outputs could be used with some additional circuitry to effectively give more input or output ports (digital or analogue). They could also be used as strobe outputs for handshaking purposes.

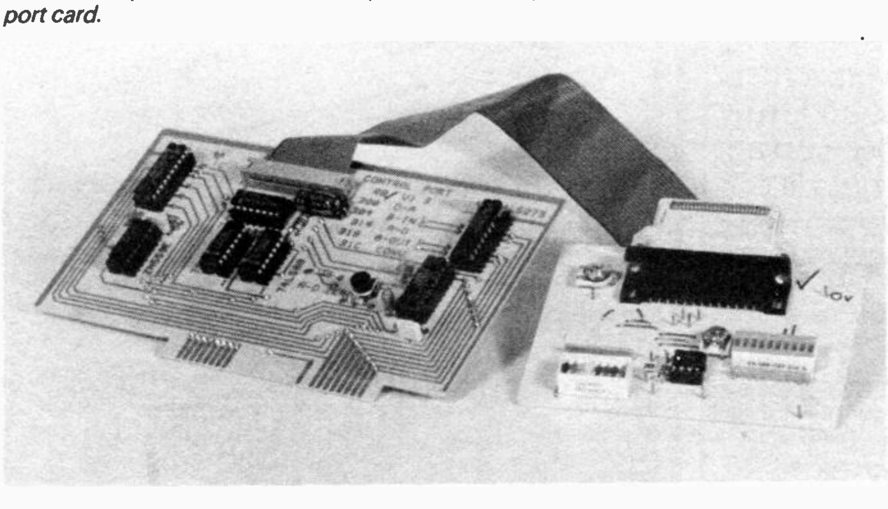
Test Pod

A "test pod" is available, and this is a small board which is useful for testing the control port board. For educational users it should also be useful for demonstration purposes.

The test board has a bank of l.e.d.s which are controlled by the digital output port, and eight d.i.l. switches that feed into the digital inputs. Writing data to the outputs should produce the appropriate binary patterns on the l.e.d.s, and setting a binary value on the d.i.l. switches should result in the same value being read from the input port.

There is an operational amplifier buffer stage at the output of the digital-to-analogue converter, and a couple of resistors can be added here to provide some voltage gain. There is a preset resistor which can produce a variable input voltage for the analogue-to-digital converter.

The control port card and the test pod unit. The system is built around the control port card.



Results

The control port board is available as a ready-made unit, or as a plain (undrilled) printed circuit board. The plain board is aimed mainly at electronics do-it-yourself enthusiasts, while the ready-made unit is intended more for educational users.

It is the ready-made version that was received for this review. The test pod unit is only available in ready-made form, and is something that would probably only be worthwhile for educational users, as it is a rather expensive just for one-off test purposes.

The quality of the printed circuit boards is not the highest I have seen, but they are considerably more than adequate. There is no metal fixing bracket for the board, but I do not regard this as an major omission. The control port board has large pads, wide tracks, and wide track spacing, which should help to make life easier for those who opt for the do-it- yourself approach.

Test Routines

When used in a DAN Technology 80386 33MHz PC and a home assembled 10MHz XT machine the control port board and test pod units both functioned perfectly. For beginners there are some GW BASIC test routines in the documentation, plus a couple of GW BASIC test programs on a disk, which should help to get them started. One of the on-disk programs is a data acquisition and logging program for the analogue-to-digital converter.

The documentation is rather basic, and some of it is in the form of ASCII disk files. However, everything you need to know about the control port seems to be included, and bearing in mind the low cost of these products it would be unreasonable to expect a lot of glossy, full colour manuals.

Both the plain board and the ready-made control port units offer excellent value for money. In fact the ready-made version represents exceptional value for money.

It has to be pointed out that the control port board merely provides basic digital and analogue ports, and that it does not do anything particularly useful on its own. You will need to make up your own train controller circuit, relay driver board, or whatever.

The board does take care of the most difficult task though, which is getting the basic signals in and out of the computer. With this board added to a PC it becomes quite easy to use the PC in general measurement and control applications.

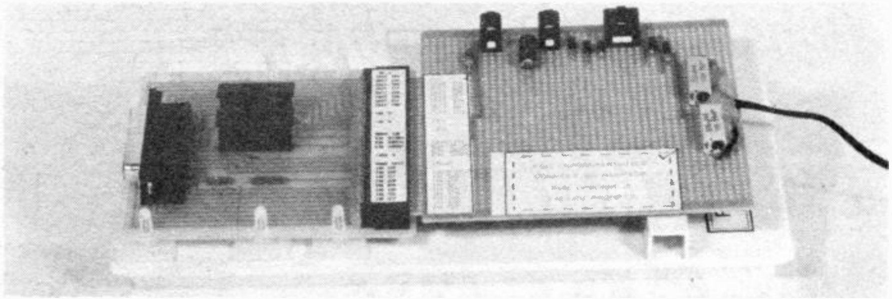
Proto Adaptor

To aid the development of your own circuits for use with the control port, a "proto card adaptor" unit is available. This can also be used with some add-on boards which are available from R. Bartlett.

Basically, this unit is just a board which acts as an adaptor from a 25-way D-socket to a 31-way single-sided edge connector. The control port unit plugs into the D-socket, and your add-on circuits connect to the edge connector. The adaptor is fitted onto a simple but effective baseboard assembly.

The prototype cards can be single-sided printed circuits boards, but the main idea of the system is that it permits suitably shaped stripboards to be connected to the control port unit. This enables prototype cards to be quickly built and tested. If desired, proven designs can then be transferred to custom printed circuit boards.

The edge connector of the proto adaptor unit is fitted with a label which shows the function of each connector, and similar labels to fit onto the prototype stripboards are supplied with the unit. This should make designing boards using the "as you go along" method much easier, and should help to avoid mistakes.



The adaptor unit fitted with the the PSU demo card.

Value

I did not have an opportunity to extensively test this prototyping system, but it seems to be neat and effective. If you require a low cost PC prototyping system you are not exactly "spoilt for choice". The alternatives seem to be rather more sophisticated than this system, but have prices which are generally around ten times higher.

This prototyping system provides sufficient facilities for most home and educational users, and at a price which is very affordable. It offers really excellent value for money.

Probably most home users will wish to develop their own cards for use with this system, but a range of ready-made cards are available for those who need them. These include a PSU demo card (for investigating basic mains power supply design), an input board having an opto-isolator at each input, and a relay card which has four relays.

Prices

The control port card cost £12-00 as a plain board, or £29-00 ready built and tested. The test pod board is only available ready made, and costs £17-00. The proto card adaptor unit is also only available in ready-made form, and it costs £14-00.

All prices include postage, these units are only available via mail order. For more details contact: ***R. Bartlett, Dept EPE, 17 Lime Tree Avenue, Tile Hill, Coventry, CV4 9EY.***

NEW STYLE EPE BINDERS

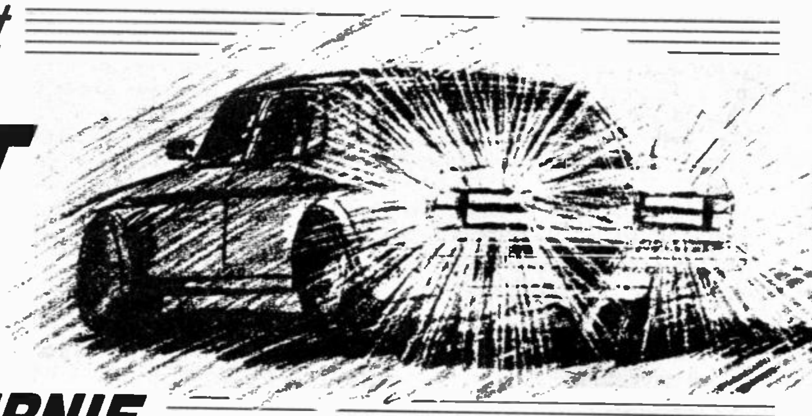
A totally new type of binder is now available to hold and protect twelve issues of *Everyday with Practical Electronics*. This new ring binder uses a special system to allow the issues to be easily removed and reinserted without any damage. A nylon strip slips over each issue and this passes over the four rings, thus holding the magazines in place (see photo).

The new binders are finished in hard wearing royal blue p.v.c. with the magazine logo in gold on the spine. We were hoping to keep the price the same as the previous binders but unfortunately the postage cost has defeated us as they are much heavier than the previous ones. The price is £4.95 plus £3.00 post and packing (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50).

Send your payment in £'s sterling to Everyday with Practical Electronics, 6 Church St., Wimborne, Dorset, BH21 1JH. Tel: 0202 881749 Fax: 0202 841692.

We also accept credit card payments Mastercard (Access) or Visa (minimium credit card order £5). Send your card number and card expiry date plus cardholders address (if different to the delivery address).

We can also supply back numbers of the magazine should you be missing any – see the foot of the Editorial page for details.



FOG LIGHT ALERT

T.R. de VAUX-BALBIRNIE

Have you left your rear fog lights switched on? This low-cost audible alarm will soon tell you!

HIGH-INTENSITY rear fog lights are effective in warning a following car of your presence in conditions of poor visibility. The trouble is, they are easily left switched on by mistake.

This means that when the headlights are next used, the fog lights will come on too. Leaving fog lights on in this way is bad practice – the *Highway Code* reminds us they should only be used when visibility is seriously affected – i.e. less than 100 metres.

Although the fog light switch itself usually has a built-in warning light, this is easily missed. In the author's car, for example, the light is obscured by the steering wheel rim.

This project provides an *audible* warning in the form of a loud bleeping tone if the fog light switch has been left on. This warning will normally be given when the headlights are next operated.

If the fog light switch has been left on intentionally, the warning is simply ignored since it will stop after a few seconds. If the fog lights are switched off, the warning stops immediately. If they are switched on in the usual way – that is, *after* the headlights, no warning is given.

NORMAL PRACTICE

The correct method of wiring rear fog lights is so that they operate only when the headlights are on. If the car has been fitted with fog lights from new, then the standard procedure will have been followed.

If they have been fitted later as an accessory, they may have been wired with a switch which will operate them whether the lights are on or not. Another possibility is that they may have been connected to operate when only the side lights are on.

Before constructing this circuit, readers are advised to re-wire the fog lights in the correct way. There is some further information given in the final paragraph and this should be read *before* commencing construction work. The Fog Light Alert may be used whether a single or a pair of fog lights are fitted.

The Fog Light Alert is built in a small plastic box which houses the circuit panel, solid-state buzzer and fuse. A piece of screw terminal block for the external connections is mounted on the side.

The box may be sited in any convenient place under the dashboard – it need not be on view since the sound is loud enough to be heard wherever it is placed. Reasonably simple access will be required to the fog light switch or to the wiring leading to it so check this point before beginning construction work.

CIRCUIT DESCRIPTION

The existing circuit for the headlights and rear fog lamps (to the right of the dotted line) and also the additional circuit to be constructed is shown in Fig. 1. Note that the headlight arrangement has been simplified (only main-beam filaments shown) and existing fuses have been omitted.

Most of the new "alarm" circuit receives current from the fog light circuit through the existing switch S1 and fuse, FS1. Note that the fuse is placed in the negative supply line – this provides the best protection in this particular circuit.

The Fog Light Alert circuit is based on IC1, a bipolar 555 timer. This is connected as a *monostable*. Thus, when triggered by applying a *low* (supply negative) pulse to trigger input, pin 2 (by a method to be described presently), the output, pin 3, will go high (positive battery voltage) for a certain time then revert to low.

The time during which it remains high is determined by the values of fixed resistor R5, preset potentiometer VR1 and capacitor C3. With the values specified the operating period may be preset between limits of less than one second and 10 seconds approximately by suitable adjustment to VR1. While pin 3 is high, base current flows to transistor, TR2, and this operates the pulse-tone solid state buzzer, WD1 in its collector circuit.

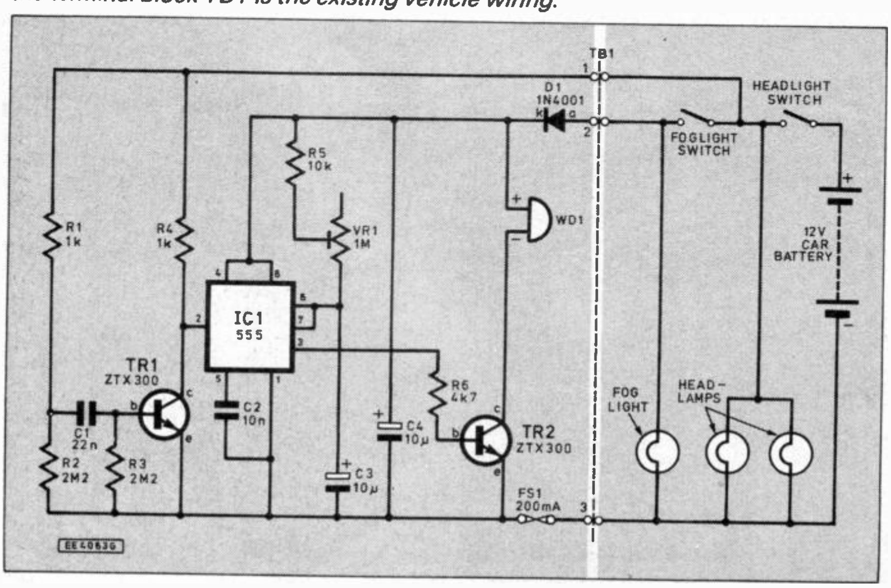
TRIGGERING

The trigger pulse for IC1 is derived from the headlight supply. Suppose the fog light switch S1 has been left on and the headlights are now operated. The circuit will receive current via the fog light switch and, at the same time, a current pulse flows to the base of transistor TR1 through resistor R1 and capacitor, C1.

The transistor now turns on momentarily and the collector goes *low*. This state is applied to IC1 pin 2 (trigger input). Thus, IC1 operates and the buzzer will sound.

The warning will stop after the preset time or immediately if the fog lights are switched off. The trigger pulse will have no effect if the fog light is switched off since IC1 receives no current.

Fig. 1. Complete circuit diagram for the Fog Light Alert. The circuit to the right of the terminal block TB1 is the existing vehicle wiring.



If the headlights are already on when the fog light switch is operated – i.e. intentional use of the fog light – there will be no trigger pulse. This is because capacitor C1 is left charged and cannot therefore pass a further pulse until discharged. This will happen when the circuit is switched off then on again.

Resistors, R2 and R3 allow C1 to discharge in a short time ready for further operation. R3 also keeps TR1 base normally low and therefore off. In the absence of a trigger pulse, resistor, R4 keeps IC1 pin 2 high while the headlights are on and this prevents possible false triggering.

Capacitor, C4, is necessary for correct operation of this i.c. Also, in conjunction with diode, D1, it smooths the "noisy" supply obtained from the car electrical system when the engine is running.

Capacitor C2 is also necessary when using this type of i.c. Fuse FS1 provides protection in the event of a short circuit due to incorrect connections or faulty wiring.

Audible warning device, WD1, is the special *pulse-tone buzzer* specified in the components list. It would be possible to use a standard solid-state buzzer but the sound would be *continuous* that is, it would not bleep. A bleeping sound is more "professional" and is also better at attracting attention. Do not buy a buzzer which requires *external* drive circuitry since this would not work in the present circuit.

CONSTRUCTION

Construction of the Fog Light Alert is based on a main circuit panel made from a piece of 0·1in. matrix stripboard, size 10 strips x 25 holes. The topside component layout and details of the underside breaks required in the copper tracks is shown in Fig. 2. Begin by cutting the material to size, drilling the two mounting holes (2mm in diameter) and making all track breaks and inter-strip links as indicated.

Mount and solder the i.c. socket and all on-board components in position. Take particular care over the polarities of diode D1 and electolytic capacitors, C3 and C4. If electrolytic capacitors are connected the wrong way round in a circuit, they can, in certain extreme situations, explode. Do not insert IC1 into the socket at this stage.

Make a careful check for errors then solder 8cm pieces of light-duty stranded connecting wire to strip *B* on the left-hand side and to strips *B* and *I* on the right-hand side as shown. Solder the pulse-tone buzzer WD1 connecting wires to strips *A* (positive) and *G* (negative). Adjust preset VR1 for minimum timing by rotating the sliding contact clockwise (as viewed from IC1 position).

CASE

Hold the circuit board in position inside the box (see photograph) and mark the positions of the mounting holes. remove the board and drill holes 2mm in diameter in the marked positions.

Drill holes also for fuseholder FS1, terminal block, TB1 and for audible warning device, WD1 mounting (see photograph). Drill a hole near TB1 position to accommodate the wires passing through from the circuit panel.

Drill a matrix of large holes in the side of the box at WD1 position for the sound to pass through. It may be found that WD1 is sensitive to the size of these holes – if they are too small it may not work properly.

Insert IC1 into its socket and mount the circuit panel and all remaining components. Place a piece of cardboard underneath the circuit panel to provide some padding. Mount WD1 using 25mm long 6 BA nylon fixings.

COMPONENTS

Resistors
R1, R4 1k (2 off)
R2, R3 2M2 (2 off)
R5 10k
R6 4k7
All 0·5W 5% or 0·6W 1% metal film

See SHOP TALK Page

Potentiometer
VR1 1M min. carbon preset, vert.

Capacitors
C1 22n ceramic
C2 10n ceramic
C3, C4 10μ radial elect., 25V (2 off)

Semiconductors
D1 1N4001 1A 50V rect. diode
TR1, TR2 ZTX300 *npn* silicon transistor (2 off)
IC1 NE555V bipolar timer

Miscellaneous
WD1 Pulse-tone buzzer, 12V 15mA operation
FS1 20mm chassis fuseholder and matching 200mA quick-blow fuse
TB1 2A 3-way screw terminal block

Stripboard 0·1in. matrix, size 10 strips x 25 holes; ABS plastic box, size 79mm x 61mm x 40mm (external); light-duty stranded connecting wire; auto-type wire, 3A rating minimum; auto-type connectors as required; small fixings; solder etc.

Approx cost guidance only **£10**

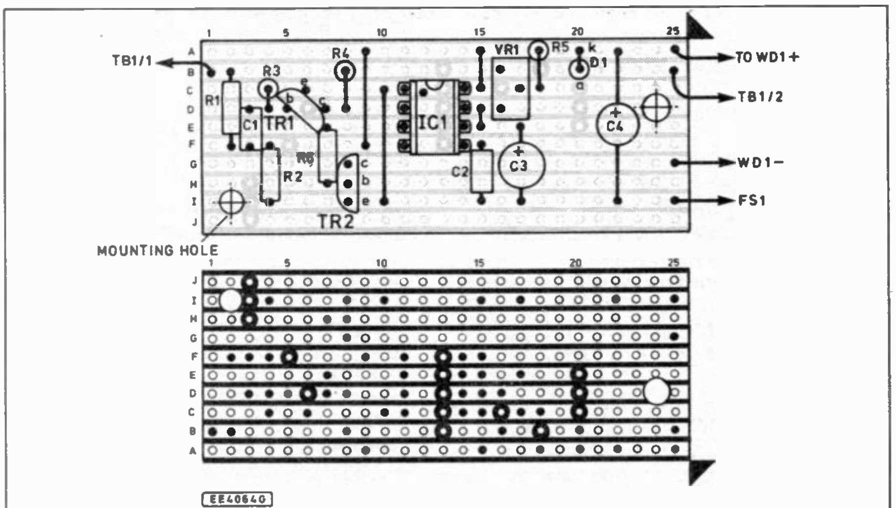
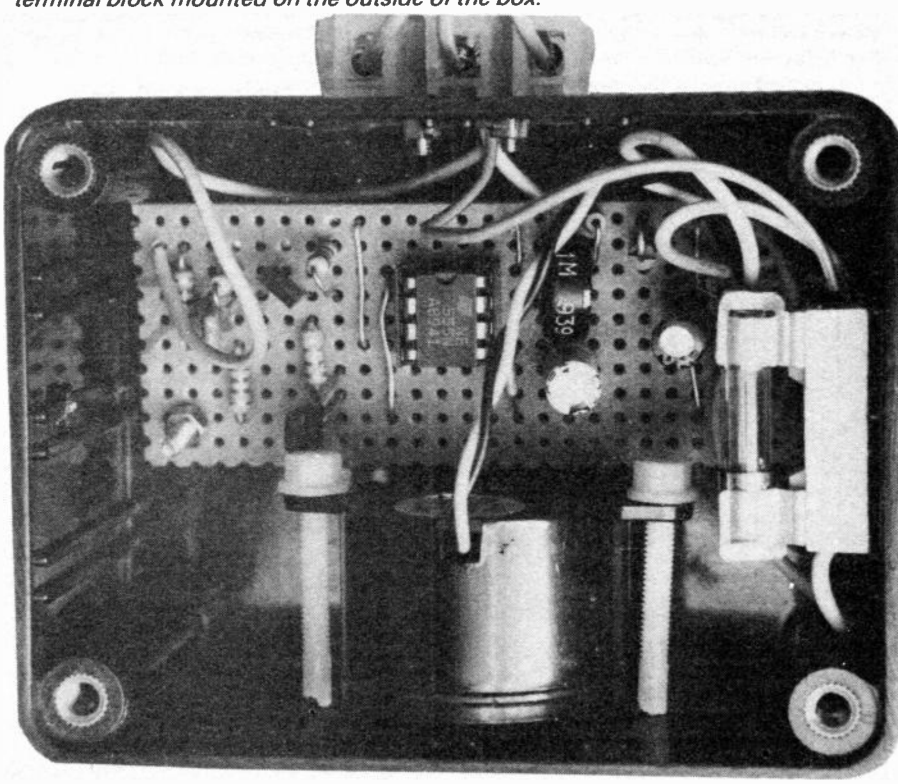
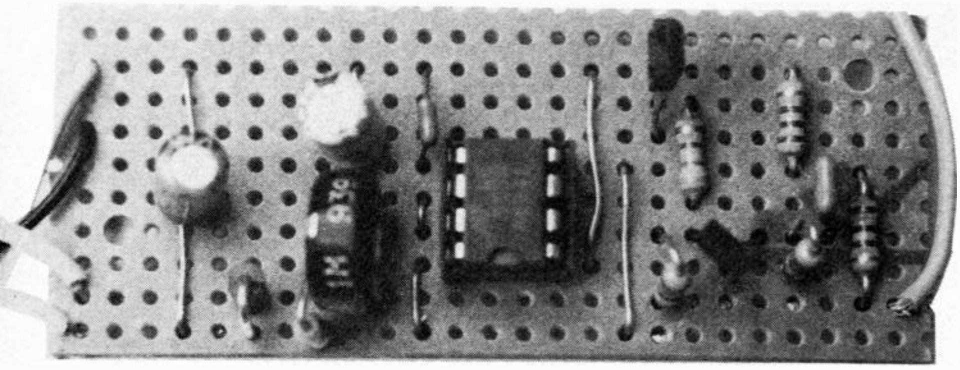


Fig. 2. Stripboard component layout and details of the breaks required in the underside copper tracks.

Layout of components inside the small plastic case and the interconnecting screw-terminal block mounted on the outside of the box.





Refering to Fig. 3, complete all internal wiring. Pass the wires leading from inside the box to the terminal block through the hole drilled for the purpose and, shortening them as necessary, connect them as shown. Insert a 200mA fuse into FS1 fuseholder.

TESTING

It will be found convenient to test the unit using a *small battery first* since then any problems may be resolved before connecting it to the car electrical system. A PP3 battery – or any other 9V battery – is suitable for testing.

Connect short light-duty wires to the three terminals of TB1. A basic test is provided as follows. Connect the wire leading to TB1/3 to the battery negative terminal. Twist together the other two wires and hold them on to the battery positive terminal.

This represents the headlights being switched on with the fog light switch already having been left on. The circuit should trigger and the buzzer sound for a short time (although not as loudly as it will in the car due to the lower voltage of the supply, 9V instead of 12V).

Repeat the procedure and adjust preset VR1 to provide the required operating time – anti-clockwise rotation (as viewed from IC1 position) increases the timing. A short warning will probably be sufficient – the prototype unit was adjusted to provide three bleeps.

Now, with terminal block lead TB1/3 still connected to the battery negative, connect TB1/1 to the battery positive terminal (representing the headlights being on) and touch the wire leading to TB1/2 on to the battery positive terminal (fog lights switched on). Nothing should happen.

If all is well, the lid of the box may be secured and the unit connected to the car electrical system.

DETECTIVE WORK

If the circuit doesn't work, first check the fuse. If this has blown, there must be a short-circuit and this should be investigated – connections to wrong copper strips or debris between the tracks could be the cause.

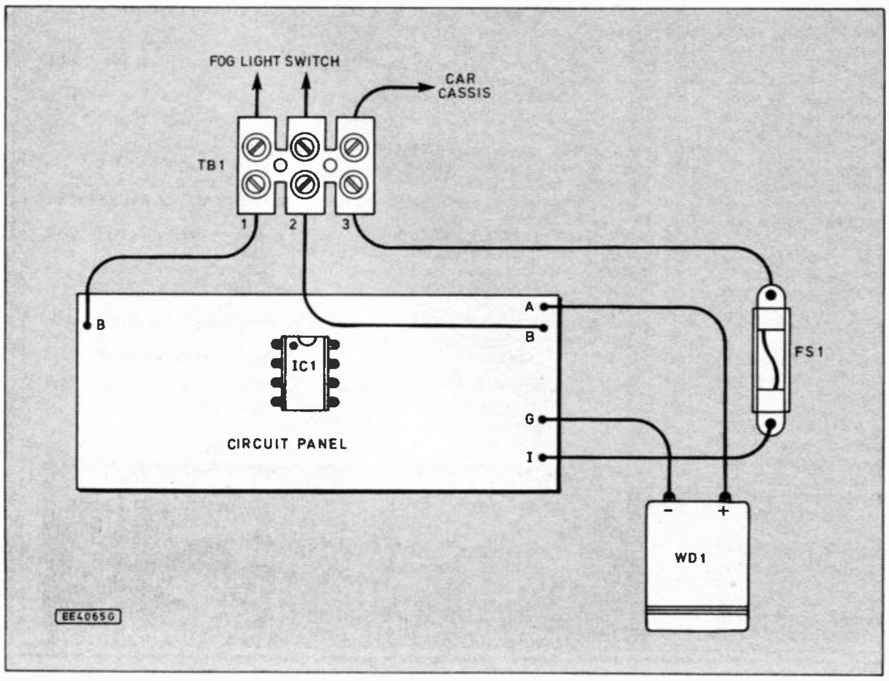
If the fuse is still working check that the buzzer has been connected with the correct polarity as indicated in Fig. 3. Check that the wires connected to TB1 terminals are really making connection – sometimes the lead is pushed in too far and the screw base presses on the plastic insulation instead of the bare copper wires.

Check that the i.c. has been inserted the correct way round in the socket. Check also that all pins are inserted – it often happens that one pin bends under the device.

Examine the copper strip side of the circuit board very carefully using a magnifying glass. Make sure that no copper tracks have been bridged with solder or pieces of copper have lodged between tracks. At the same time, check that "broken" tracks really are *completely* cut through.

Check that all breaks indicated in Fig. 2 have been made – note particularly that the row of tracks between the i.c. pins have been cut – this point is easily missed. Make sure that all soldered joints are sound and that the odd connection has not been missed by the soldering iron.

Fig. 3. Interwiring from the circuit board to all off-board components.



Another possible cause of malfunction is a cracked copper track usually caused by bending the board. This can be almost impossible to see without close scrutiny. This fault often shows itself by intermittent operation.

If WD1 sounds strangely, it may be that the holes drilled for the sound to pass through are too small. It is also possible that the fixings attaching it to the box are too tight and distorting the body slightly. Do not assume that any components are at fault until you are certain about the foregoing.

INSTALLATION

Before beginning installation work, you must disconnect the car battery and remove it.

You will need some connectors of the appropriate type (see below) and some *auto-type wire* of 3A rating minimum. It is important to use the correct type of wire for car installation work. Auto-type wire and connectors are available from car accessory shops.

The easiest way to wire the new unit is by using the input and output wires on the existing fog light switch – one side leads to the supply (i.e. the headlight circuit) and the other to the fog light(s). Identify which wire is which.

If the switch has a warning light fitted, there will also be an earth (ground) terminal on the switch. This will be useful for making the earth connection to the unit.

If the switch has the usual type of spade connectors, it may be possible to use "piggy-back" convertors to make the additional connections. Otherwise use Scotchlok connectors on the wires themselves. Scotchloks enable connections to be made to existing wires without actually breaking them. ***Do not use makeshift methods here – for example, taped joints.***

Make a connection between TB1/1 and the supply (live) side of the switch (that is, the terminal which is live when the headlights are on). Make a similar connection between TB1/2 and the terminal of the switch leading to the fog light.

Finally, connect TB1/3 to an earth point (which may be a terminal on the fog light switch as mentioned previously). If there is no such earth terminal, find an earth point nearby or drill a small hole in a metal part and use an eyelet secured with a self-tapping screw.

It only remains to connect the car battery and test the system. On certain cars, the fog light works only when *dipped beam* headlights are used. In this case, a warning will be given whenever the headlights are switched between main and dipped beam. This also seems to happen with some cars even where the fog light can operate on either main or dipped-beam.

Also, on some cars, a warning is given when the headlight flasher is used and perhaps when the ignition is switched on (and sometimes off) when the fog light switch has been left on. Such operation, although accidental, gives a timely reminder that the fog light is on and is thought to be a good point.

On some cars, a slightly warbling tone may be heard from the buzzer when the engine is running. This is due to the unsmooth supply provided by the car charging system and is of no consequence.

The unit may be secured in position using a self-tapping screw through a hole in the back or a small bracket. You will never be guilty of annoying following road users with the Fog Light Alert! □

BARGAINS – Many New Ones This Month

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STEPPER MOTOR BARGAIN. This is just a mini motor, 12V operated and 7.5° step angle. Offered at the very low price of only £1, Order Ref. 910.

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MINI CASSETTE MOTOR but will operate from 1V upwards as it is so well made. Speed, of course, increases with voltage and is speed regulated at 9V. £1, Order Ref. 540.

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SOLAR KIT BARGAIN. A recent lucky purchase enables us to offer 2 solar models at approximately half price. The Aeroplane kit comprises all the parts to make a model aeroplane, solar cell and solar motor to drive its propellor. The kit was £7.50 but can be yours for only £3.75, Order Ref. 3.75P1. The second one is the Vintage Gramophone. Again, all the parts to make the model, the solar cell which drives the module which plays the tune. Again, the kit was £7.50, now only **£3.75**, Order Ref. 3.75P2.

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GENERAL PURPOSE FAN KIT comprises beautifully made "Boxer" fan, transformer and switch to give dual speed and off from the mains. Complete with perforated front panel which, if bent, could make a suitable stand for a desk fan, etc. Or, it could be used as a general purpose blower or for fume extraction in cooker hood, etc. Complete kit £6, Order Ref. 6P28.

DOUBLE HEADPHONE OUTLET. A standard type stereo plug with 2 leads coming out, each terminating with a standard size stereo socket thus enabling 2 people to listen from the one outlet. Very well made. Price £2, Order Ref. 2P312.

12V POWER SUPPLY. Plugs into 13A socket and gives 200mA d.c. out. Price £2, Order Ref. 2P313.

ASTEC 135W PSU. Mains input, 3 outputs;- +12V at 4A, +5V at 16A, and −12V at ½A. In plated steel case, brand new, £9.50, Order Ref. 9.5P4.

DIMMER SWITCH on standard electrical plate to replace normal wall switch. 500W, slightly coloured but takes emulsion. Only £2, Order Ref. 2P309.

INFRA RED RECEIVER CONTROLLER made by Thorn to channel switch their T.V. receivers. Mounted on panel with luminous channel indicator, mains on/off switch, leads and plugs all yours for £2, Order Ref. 2P304.

HIGH QUALITY KEY SWITCH single pole on/off or changeover through panel mounted by hexagonal nut. Complete with 2 keys. Regular price £3, our price **£1.50**, Order Ref. 1.5P12.

DIGITAL MULTI TESTER M3800 single switching covers 32 ranges including 20A a.c. and d.c. 10 meg input impedence, 3½ LCD display. Complete with carrying case and lead. Currently advertised by many dealers at nearly £40, our price only **£25**, Order Ref. 25P14.

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EXTRA LIGHTWEIGHT STEREO HEADPHONES. Adjustable headband. Suitable for use with all types of cassette players and radios, only £1 per pair, Order Ref. 898.

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20W 4 OHM SPEAKER made by Goodmans for Ford, this is mounted on a panel and has an anodized cone protector cover but can be easily removed from this. It's a beautiful reproducer and the replacement price is nearly £20. Yours for only **£3**, Order Ref. 3P145.

20W 4 OHM TWEETER also made by Goodmans for Ford, mounted on a baffle but easily unscrewed from this. Yours for £1.50, Order Ref. 1.5P9.

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are only described in our newsletter. Many appear in our current issue. If you order something this month you will receive this and the next issue posted to you.

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Fully user documented and including software.
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35mm Ballrace, complete with spindle, but this can be removed. 4 for **£1** Order Ref. 912.

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SOLAR ENERGY EDUCATIONAL KIT an ideal present for electronics students. Kit comprises 8 solar cells, one solar motor, fan blades to fit motor and metal frame to hold it to complete a free-standing electric fan. A really well written instruction manual makes this a lovely little present. Price £8, Order Ref. 8P12B.

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12/24V DC SOLENOID. The construction of this is such that it will push or pull as the plunger is a combined rod and piston. With 24V this is terrifically powerful but is still quite good at 12V and, of course, it can be operated by any intermediate voltage. Price £1, Order Ref. 877.

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100W MAINS TRANSFORMERS normal primaries 20-0-20 at 2.5A or 30V at 3.5A, **£4**, Order Ref. 4P24. 40V at 2.5A, £4, Order Ref. 4P59. 50V at 2A, **£4**, Order Ref. 4P60.

PHILIPS 9" HIGH RESOLUTION MONITOR black & white in metal frame for easy mounting, brand new still in maker's packing, offered at less than price of tube alone, only £15, Order Ref. 15P1.

16 CHARACTER 2-LINE DISPLAY screen size 85mm x 36mm, Alpha-numeric LCD dot matrix module with integral micro processor made by Epson, their Ref. 16027AR, £8, Order Ref. 8P48.

INSULATION TESTER WITH MULTIMETER internally generates voltages which enables you to read insulation directly in megohms. The multimeter has four ranges, AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. These instruments are ex British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50 each, yours for only £7.50, with leads, carrying case £2 extra, Order Ref. 7.5P/4.

MAINS 230V FAN best make "PAPST" 4½" square, metal blades, £8, Order Ref. 8P8.

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

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SOLAR CHARGER holds 4 AA nicads and recharges these in 8 hours, in very neat plastic case, £6, Order Ref. 6P3.

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FIELD TELEPHONES just right for building sites, rallies, horse shows, etc., just join two by twin wire and you have two way calling and talking and you can join into regular phone lines if you want to. Ex British Telecom in very good condition, powered by batteries (not included) complete with shoulder slung carrying case, £9.50, Order Ref. 9.5P/2.

MAINS ISOLATION TRANSFORMER stops you getting "to earth" shocks. 230V in and 230V out. 150watt upright mounting, £7.50, Order Ref. 7.5P/5 and a 250W version is **£10**, Order Ref. 10P79.

MINI MONO AMP on PCB. Size 4" x 2" with front panel holding volume control and with spare hole for switch or tone control. Output is 4 watt into 4 ohm speaker using 12V or 1 watt into 8 ohm using 9V. Brand new and perfect, only £1 each, Order Ref. 495.

ATARI 65XE at 65K this is quite powerful, so suitable for home or business, unused and in perfect order but less PSU, only **£19.50**, Order Ref. 19.5P/5B.

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

PROJECT BOX size approx 8" x 4" x 4½" metal, sprayed grey, louvred ends for ventilation otherwise undrilled. Made for GPO so best quality, only £3 each, Order Ref. 3P74.

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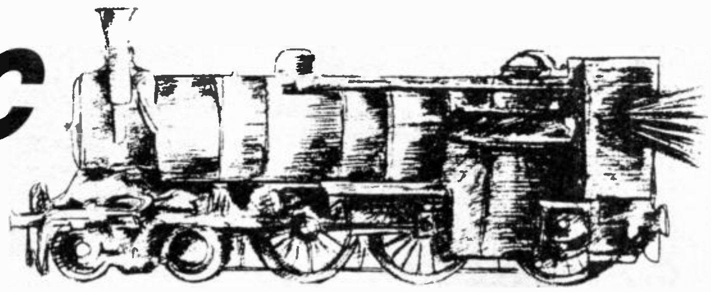
ELECTRONIC FIRE



J. HEWES

Realistically mimics the glowing embers and flickering flames of a real fire – without the risk! Ideal for the model maker.

Constructors of model scenery, such as on model railways, often like to include special features to add interest to the scene. A popular feature is a building on fire, complete with fire engines rushing to the rescue.

The fire is quite difficult to represent; a simple red and yellow glow or a light steadily flashing are not at all convincing. This Electronic Fire circuit is the answer because it realistically mimics the glowing embers and flickering flames of a real fire. Other uses for the circuit include a coal fire for a dolls' house and the firebox of a model steam locomotive.

CIRCUIT DESCRIPTION

The full circuit diagram for the Electronic Fire is shown in Fig. 1. The circuit consists of two 555 astables which produce pulses at slightly different frequencies. These pulses have mark-to-space ratios of about three; this means that they are "high" (on) for three times as long as they are "low" (off).

Two red l.e.d.s (D1, D2) are driven directly by these pulses to represent the red *glow* at the heart of a fire with only a slight flicker. Both red l.e.d.s share the same series resistor (R4) to reduce the number of wires to the l.e.d.s, and to give each l.e.d. a little extra flicker as the other turns on and off.

Two yellow l.e.d.s (D3, D4) which represent the *flames* are connected *between* the astable outputs so that they flicker in a realistically irregular manner due to the differing frequencies of the astables. A yellow l.e.d. will light when one astable is high and the other is low, but not when both are low or both are high. The series resistor (R3) for the yellow l.e.d.s is a lower value than normal to give a bright flash, but the l.e.d.s will not come to any harm because the flashes are very brief.

The frequency of the first astable (IC1) is determined by resistors R1 and R2 and capacitor C1. The values used give a frequency of 8·1Hz. Resistors R5, R6 and capacitor C4 determine the frequency of the second astable (IC2) and this is 6·7 Hz.

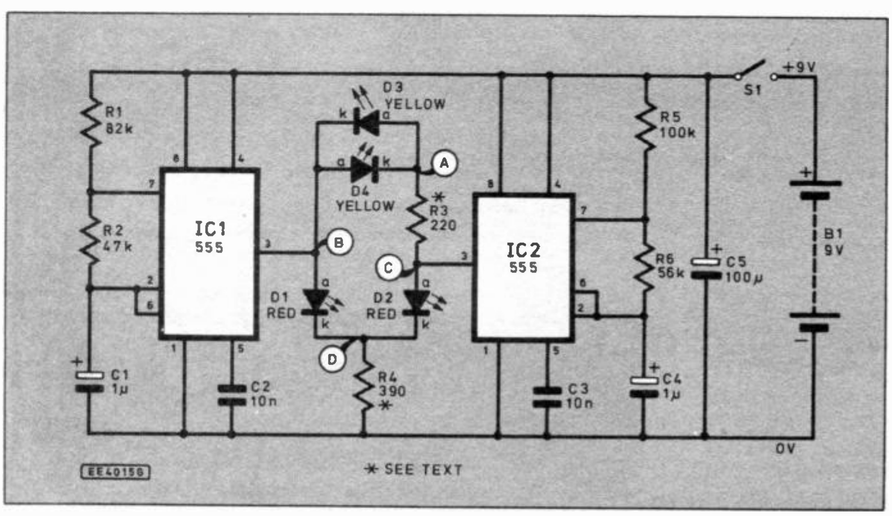
Constructors may like to experiment with slightly different values for these components so the formulae for frequency and mark-to-space ratio as follows:

First Astable (IC1):

$$\text{Frequency} = \frac{1.4}{(R1 + 2R2) \times C1}$$

$$\text{Mark/space ratio} = \frac{R1 + R2}{R2}$$

Fig. 1. Complete circuit diagram for the Electronic Fire.



Second Astable (IC2):

$$\text{Frequency} = \frac{1.4}{(R5 + 2R6) \times C4}$$

$$\text{Mark/space ratio} = \frac{R5 + R6}{R6}$$

Experienced constructors will realise that the circuit could have been designed with a 556 dual timer i.c. in place of the two 555s. However, there is little, or no, saving in cost and there is a lot to be said for standardising on the very popular 555.

The 555 i.c. is used in such a wide variety of circuits that most electronics constructors are likely to have a number in stock. If you haven't, order some extras with the parts for this project as they are bound to be needed sooner or later.

DISPLAY

The l.e.d.s are mounted off the printed circuit board (p.c.b.) on a small piece of stripboard making them easy to position in a small model or similar confined space.

COMPONENTS

Resistors

R1	82k
R2	47k
R3	220 (for 9V, see text)
R4	390 (for 9V, see text)
R5	100k
R6	56k

All 0·25W 5% carbon film

Capacitors

C1, C4	1μ radial elect., 63V (2 off)
C2, C3	10n metallised polyester (2 off)
C5	100μ axial elect., 25V

Semiconductors

D1, D2	red light emitting diode
D3, D4	yellow light emitting diode (D1-D4 should be chosen to suit application, see text)
IC1, IC2	NE555 timer (2 off)

Miscellaneous

S1 Single-pole on/off switch

Plastic case to suit application; display stripboard (at least 5 tracks x 7 holes); 8-pin d.i.l. socket (2 off); 9V battery or other supply (see text); battery clip; stranded connecting wire; solder etc.

Printed circuit board available from the *EPE PCB Service*, code EPE 820.

Approx cost guidance only **£9**

The size and type of l.e.d. used should be chosen to suit the application.

For many purposes standard 5mm l.e.d.s are fine, but if small size is important miniature (e.g. 3mm) l.e.d.s could be used. High intensity l.e.d.s are best if you want to throw a bright reflection off a wall inside a model building.

The l.e.d. resistor values are given for 9V operation, if you want to use a 12V or 15V supply use the following values:

For 12V: R4 = 560 ohms, R3 = 330 ohms.

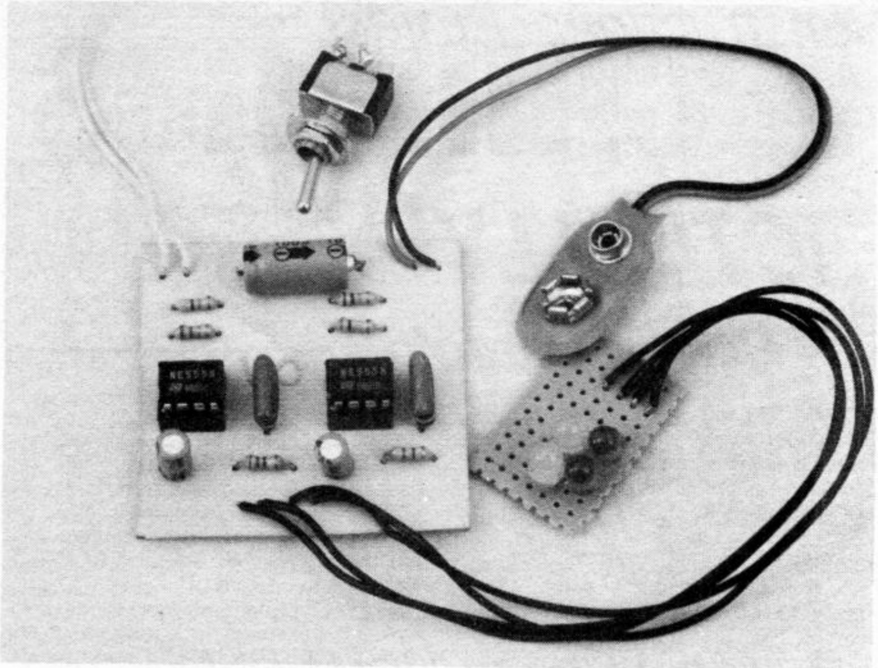
For 15V: R4 = 680 ohms, R3 = 390 ohms.

CONSTRUCTION

The component layout and full size copper track pattern for the printed circuit board is shown in Fig. 2. The board is available from the *EPE PCB Service*, code EPE 820.

The components may be added to the board in any convenient order, except IC1 and IC2 which should not be inserted in their sockets until all other soldering is completed. Take care to insert the electrolytic capacitors C1, C4 and C5 the correct way round. The four leads (*A, B, C, D*) from the circuit board to the l.e.d. panel should be made long enough to suit your intended application.

The arrangement of the "fire" l.e.d.s on the small piece of stripboard is shown in Fig. 3. Take care to insert the l.e.d.s the correct way round; Fig. 4 shows how to identify the anode (a) and cathode (k).



All l.e.d.s can be damaged by excess heat when soldering but this is not normally a problem with standard (5mm) l.e.d.s if you are able to solder quickly. However, minature l.e.d.s are easily damaged and even experienced constructors should use a heatsink (such as crocodile clip) clipped to the lead between the l.e.d. body and the joint being soldered.

Before connecting a battery and switching on, inspect your soldering to ensure there are no bridges of solder between copper tracks/pads. Check again the orientation of C1, C4, C5, IC1, IC2 and the l.e.d.s. □

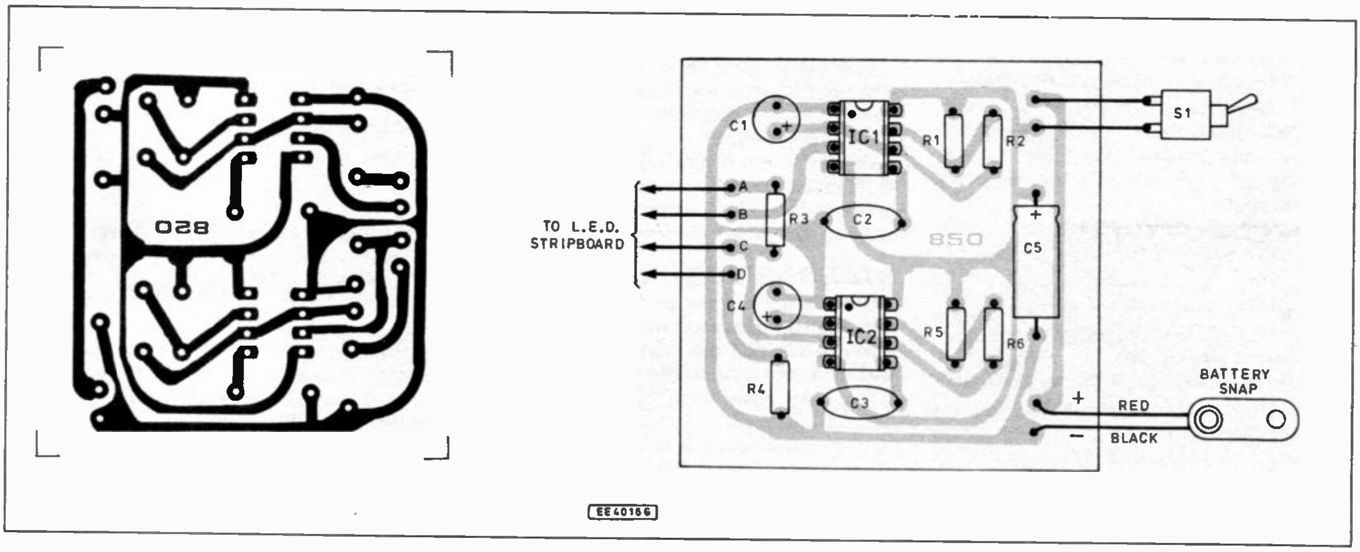


Fig. 2. Printed circuit board component layout and full size copper foil master pattern.

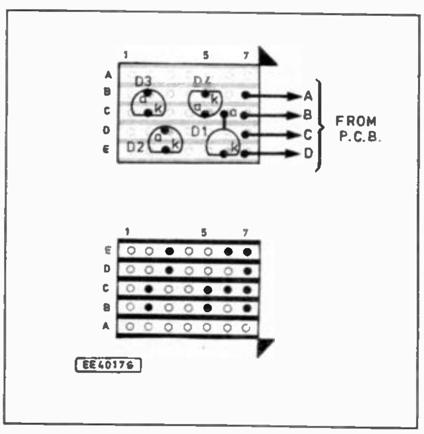


Fig. 3. Stripboard l.e.d. display layout. There are no breaks in the underside copper tracks.

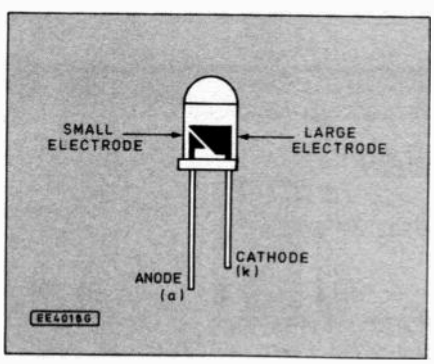
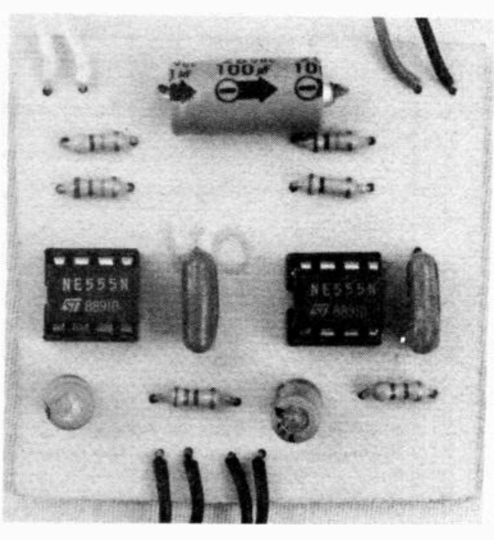


Fig. 4. Identifying the anode (a) and cathode (k) leads of the l.e.d. The cathode lead can also be identified by a flat on the body next to the lead.



Techniques
ACTUALLY DOING IT!
by Robert Penfold

SOCKETS and switches must be two of the most simple types of electronic components, and are perhaps the most simple of all. In general they are both very straightforward to use, but there are some potential problems for beginners. In this month's *Techniques* article we will take a look at some of the more awkward aspects of sockets and switches.

Using most types of socket is very straightforward indeed, but jack sockets can be rather confusing. This is due to the fact that they often have built-in switches, but many applications do not actually utilize these switches. Consequently, there may be one or more unused tags.

Unused tags on any component, or even something like unused pins on integrated circuits, seem to worry many project builders. It is worth making the point that many projects have component tags or pins that are left unused. In some cases (mainly with integrated circuits) some of the tags or pins are dummies which do not connect to anything internally.

When integrated circuits first started to appear in projects for home constructors it was not unusual to get letters pointing out that certain pins did not connect to anything, and enquiring "where they should go". In most cases the pins were simply unused, and the diagrams in the article were correct.

ALL RIGHT JACK

The 3·5 millimetre jack sockets are popular for use in electronic projects, and have been for many years. They were originally used as earphone sockets for transistor radios, cassette recorders, etc., but these days they are used in a wide variety of equipment.

Most component retailers sell inexpensive 3·5 millimetre jack sockets of the open construction type. In other words, sockets which do not have a case, and where the "works" are visible.

These sockets tend to give a few problems as they are two-way sockets, but they have three tags. The reason for the extra tag is that these sockets incorporate a break contact. In their original earphone socket application this was used to automatically switch out the loudspeaker when the earphone was plugged in.

The break contact is still required for this purpose in some projects, but in most cases it is not required. Fig.1(a) shows the correct method of connection when a switched 3·5mm jack socket is used for its intended purpose. Fig.1(b) shows the correct method of connection when the built-in switch is not required.

STANDARD CONNECTIONS

Standard (¼ inch or 6·35 millimetre) jack sockets are used in various types of audio gear, but are particularly popular for use in electronic music equipment. The open style sockets have no switch contacts, and should present no problems.

The plastic cased variety invariably seem to have some switch contacts, and this usually means two break contacts (one on the earth tag and one on the signal tag). Like the built-in switches of 3·5mm sockets, these contacts are often left unused, but are sometimes used to provide automatic muting of an internal loudspeaker.

I am not entirely sure about the reason for twin contacts being fitted, since it is only necessary to break the connection in one lead in order to mute the internal loudspeaker. Possibly things are arranged this way to make the wiring-up easier. Anyway, Fig.2(a) shows how to connect one of these sockets if the switch contacts are to be utilized, while Fig.2(b) shows the correct method of connection if automatic loudspeaker muting is not required.

It is perhaps worth mentioning that many builders of electronic music gadgets always use plastic cased jack sockets, and avoid the open type like the plague. The cased jack sockets are generally known as "insulated" sockets, because the plastic bodies insulate the tags from what is usually a metal front panel.

With the open variety the earth tag connects to the mounting bush internally. It therefore connects to the metal front panel as well. Apparently the insulated sockets give fewer problems with "hum" loops, and stray pickup of mains "hum", etc. If a components list specifies insulated jack sockets, then it would not be a good idea to use the open type.

REVERSED

Bear in mind that if you reverse the connections to a jack socket (or virtually any two-way socket) it is unlikely that the project will function properly. Swapping the two connections to an open socket will often result in the input or output of the project being short circuited.

Reversed connections to an insulated socket is less serious, but you may find that it causes a problem such as large amounts of "hum" and general noise on the output of an audio device. It could even cause a short circuit across a signal path via a circuitous route. Always check the connections to sockets before switching on a newly completed project, especially if the project includes a power amplifier stage (which could be damaged by incorrect wiring).

INS AND OUTS

Most simple on/off switches are easy to fathom, but double-pole types sometimes have tag arrangements which make the correct "ins and outs" something less than obvious. The two main candidates for problems are a popular style of rotary on/off switch, and the integral switches of rotary potentiometers. Fig.3 shows the correct method of connection for these.

The switches are double-pole types because they are intended for on/off switching of the mains supply. It is normal to switch both the live (L) and neutral (N) mains leads.

Beginners who wish to live long enough to become experienced constructors should restrict themselves to battery powered projects! With. battery power it is normal for only the positive

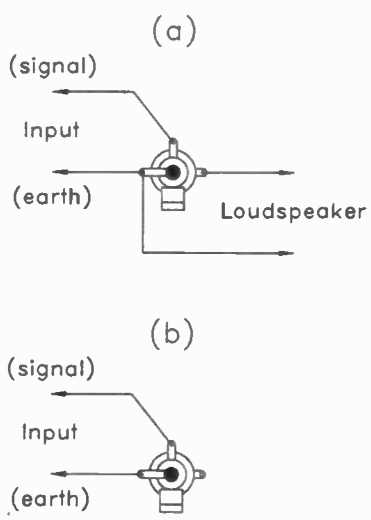


Fig. 1a. Utilizing the break contact of a 3·5mm jack socket, and (b) the connections when the built-in switch is not required.

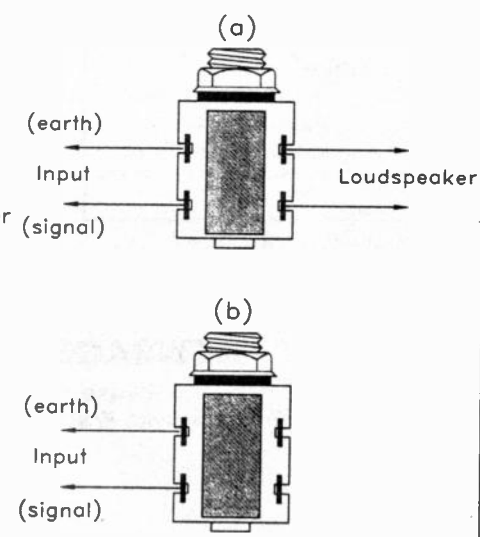


Fig.2a. Utilizing the twin break contacts of a standard (insulated) jack socket, and (b) the connections used if the switches are not needed.

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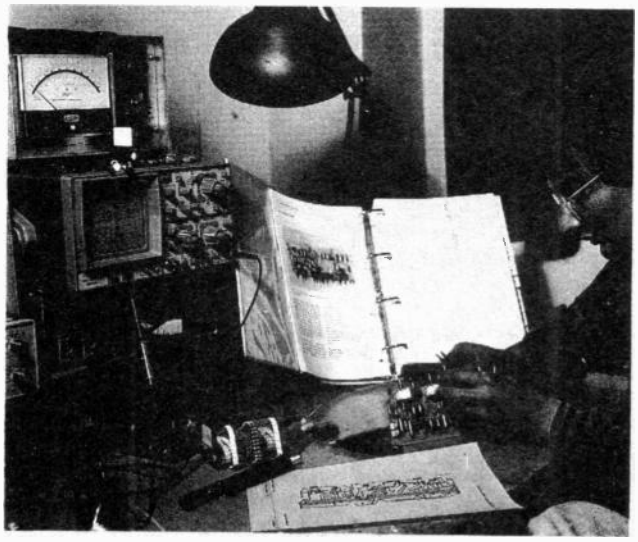

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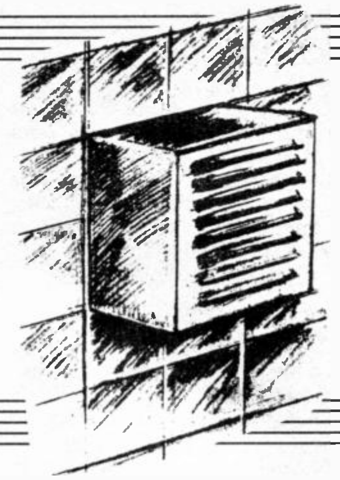
Constructional Project



VENTILATION FAN TIMER

BART S. TREPAK

A "delayed off" mains timer module for fans and other appliances.

DURING some rebuilding work recently, it was decided to take the opportunity to change the layout of a flat to make better use of the available space. As a result the WC and bathroom were moved to a position with no outside wall necessitating the installation of an extractor fan mounted in the ceiling and ducted to the outside. This was not a great problem and a suitable fan was duly purchased from a local DIY store and installed.

When the building work was finished, the Council Building Inspector came to approve the work and decided that the fan should have been specified as one fitted with a 15 minute timer which would keep the fan running for this period after the room had been vacated. Returning to the DIY store, it was found that such fans were indeed available but the cost was nearly double that of an identical fan without the timer.

The original which would now have to be discarded had cost nearly £20 so that the final "combined" cost of a fan with a timer would now be well over £50! This sort of pricing structure may be all right for a builder who will only add it to the customers bill anyway, but knowing the price of electronic components, I was not going to pay another £30 for a triac and a 555 timer.

HEAD WORK

The major "design work" was done in my head on the way back from the store (which gives some indication of how complex the device is) resulting in the block diagram shown Fig. 1, and the details (circuit diagram) filled in later. A 15 minute timer triggered by the light switch using reasonable values of capacitors and resistors is just about within the realms of possibility without resorting to fancy digital timers with oscillators and dividers, so the 555 timer approach was tried.

While this would certainly work, it was felt that the timing should start from the instant that the light was turned off rather than when it was first turned on. Also, the fan should switch on as soon as the light was switched on.

The problem therefore boiled down to detecting when the light was turned on and charging a capacitor and while keeping it charged, triggering a triac to switch on the fan. When the light was turned off, the capacitor would be allowed to discharge and eventually the triac would switch off.

Ideally the whole circuit would fit into the space in the fan housing which contained the terminal block connector so the use of a transformer in the power supply was ruled out.

TRIACS

Before describing the circuit diagram it may be beneficial to some readers to explain some of the relevant characteristics of triacs. Triacs are semiconductor switches similar to CSRs (thyristors) but designed to operate on a.c. supplies.

This means that not only can they conduct in both directions, but they can also be triggered into conduction by a positive or negative gate current. Since the gate current can be of either polarity, four modes of operation exist namely positive main terminal or load current with positive or negative gate current and negative load current with positive or negative gate current.

In practice it is found that the triac is most sensitive i.e. requires least gate current, when the load current and gate current are in phase (positive load current with positive gate current and negative load current with negative gate current) and is only slightly less sensitive when the load current is positive and the gate current negative. The sensitivity in the last mode however is much lower for most triacs unless they are specially selected so this mode (negative load current with positive gate current) is to be avoided. This is done simply by arranging for a negative supply for the circuit so that the gate current is always negative, which explains the somewhat "upside down" appearance of the circuit diagram.

A characteristic which the triac shares with the CSR is that of latching current. This is simply the main terminal or load current which must be flowing through the device after it has been triggered to ensure that it remains conducting when the gate drive is removed and is usually of the order of a few tens of milliamps for small triacs.

This is not normally a problem with resistive loads, even on a sinusoidal supply where the load current builds up quite rapidly to the required value and the triac remains conducting until the current falls to zero at the end of the half cycle. Problems can however arise with low power loads where the peak current may only be a few tens of milliamps anyway, or inductive loads where the current builds up relatively slowly.

The load that we want to switch (the fan motor) falls into this category being both low power and inductive. Fortunately, a triac will conduct and switch currents lower than its latching current provided that the gate current is maintained throughout the required conduction period and this is what is done in the present circuit. The penalty is a higher supply current and triac gate dissipation but these are not of major concern here.

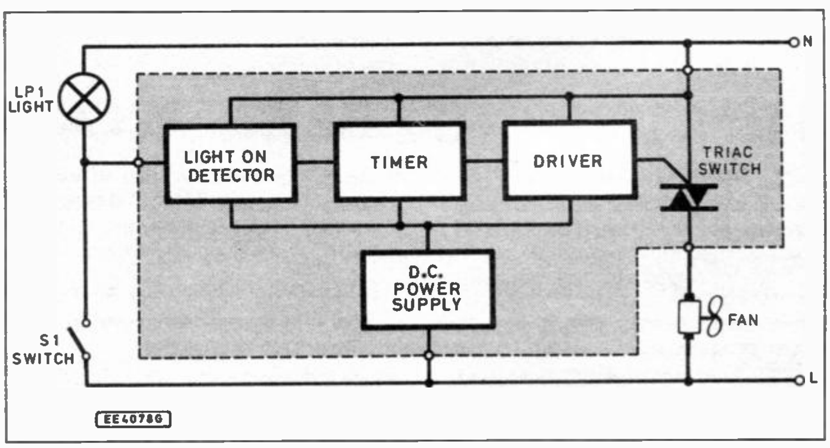


Fig. 1. Block diagram for the Ventilation Fan Timer

CIRCUIT DESCRIPTION

The final circuit diagram for the Ventilation Fan Timer is shown in Fig. 2 and does not use a 555 timer at all but an even cheaper i.c., namely a CMOS 4093 which is a quad Schmitt trigger NAND gate. This provides a more convenient way of sensing if the light is switched on or off as well as providing the timing and triac drive circuits.

The d.c. power supply to the circuit is provided by capacitor C3 and diodes D1 and D2. C3 drops the mains voltage and works like a mains dropper resistor except that it does not dissipate any heat and this voltage is limited to 12V by the Zener diode D1.

Diode D2 rectifies this voltage which is smoothed by the electrolytic capacitor C2 to produce a d.c. voltage which is slightly less than 12V. This voltage is not well stabilised and drops to about 5V when the triac is triggered but this is of no consequence here.

LIGHT STATUS

Sensing the status of the light is accomplished using gate IC1a and resistors R1 and R2. When the light is off, switch S1 is open, the voltage across the lamp LP1 is zero and the input of IC1a remains high and its output low.

As soon as S1 is closed, the a.c. mains voltage is applied to the lamp and to the input of gate IC1a, via the potential divider R1 and R2. The values are chosen to ensure that the applied voltage is about 15V a.c. and this is clipped by the internal input protection diodes of gate IC1a to the supply voltage of the chip.

The output of IC1a therefore switches between low and high as the mains waveform goes positive and then negative, causing capacitor C1 to be charged each time the output goes high. C1 maintains a logic high level at the inputs to gates IC1b, IC1c and IC1d even though the output of IC1a is switching because of the action of diode D3 which prevents C1 from discharging.

The outputs of the three gates (IC1b, c, d) are therefore switched to the negative supply rail and trigger the triac, via resistor R4, causing the fan to switch on. The triac is a sensitive gate device requiring only about 5mA to trigger which is well within the output current capability of the three paralleled gates.

This situation is maintained for as long as the light remains on causing the fan to operate for as long as the WC is occupied. When the light is switched off, capacitor C1 is no longer kept charged, via the diode D3, and begins to discharge through resistor R3 and preset VR1.

Eventually the voltage on C1 falls below the logic threshold of IC1b, IC1c and IC1d causing their outputs to switch to a logic high and the triac and fan to switch off. The length of time which this takes depends on the value of C1 and the combined resistance of R3 and VR1. With the values suggested this gives a time of about 10 to 20 minutes depending on the setting of preset VR1.

DELAY TIME

Unlike most timer circuits which rely on charging a capacitor through a resistor, this timer discharges the capacitor through a resistor. This has the advantage that any leakage currents in diode D3, the inputs to gates IC1b, IC1c and IC1d or indeed within C1 will only serve to shorten the delay rather than prevent the triac from switching off once the timer has been activated. Thus there is not the limit on the value of R3/VR1 which there would be if say a 555 timer i.c. had been used.

A time delay of 30 minutes was easily obtained simply by replacing R3 by a 4·7 megohms resistor. Longer time delays are possible by increasing R3 to 10 megohms or more and increasing electrolytic capacitor C1 to 1000µF.

But unless the time period required is, as in this application, not too critical, such long time delays require the patience of a saint to adjust. It is then far better to use a timer such as the ZN1034 where only the time base oscillator frequency needs to be adjusted and the actual time delay is obtained by frequency division.

Purists may object to the fact that in the case of the fan, the mains Neutral (N) connection is switched and not the Live (L) as is standard practice, and it is therefore not safe as the fan is always at mains potential even when it is switched off. While this may be true, a triac cannot be regarded as a "safe" switch from the point of view of isolation as the leakage current through the device can certainly be high enough to light a neon and probably give a nasty shock if touched inadvertently.

In any event, the circuit should be mounted in such a position that the user would not be able to gain access to the motor connections without the use of a screwdriver and would presumably in this eventuality *switch the mains off* at the consumer unit *before* attempting any repairs or adjustments. If it is required to switch the Live motor connection then this may be accomplished at the expense of a slightly lower triac gate drive by utilising one of the three gates and adding a few components as shown in Fig. 3.

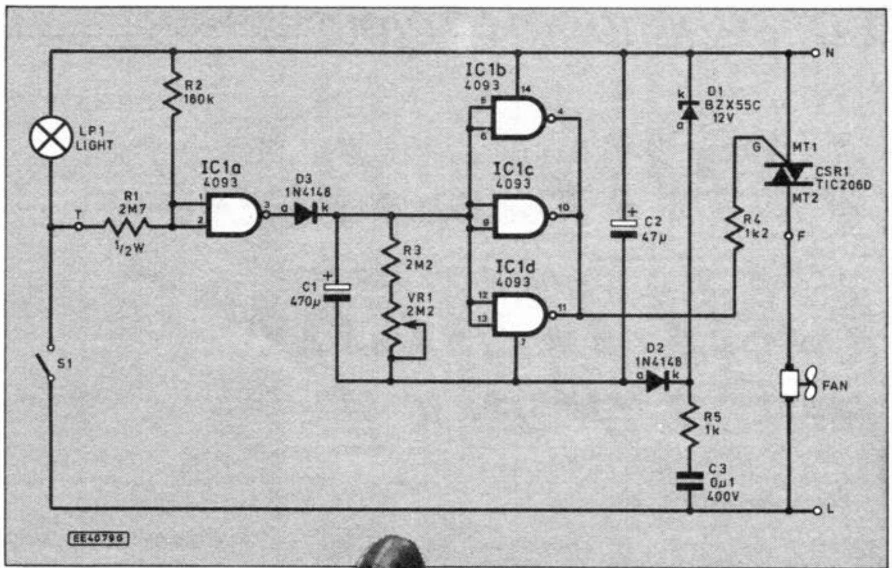
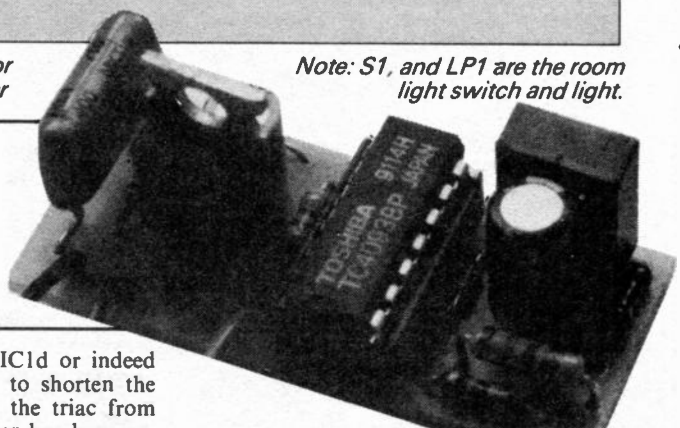


Fig. 2. Circuit diagram for the Ventilation Fan Timer

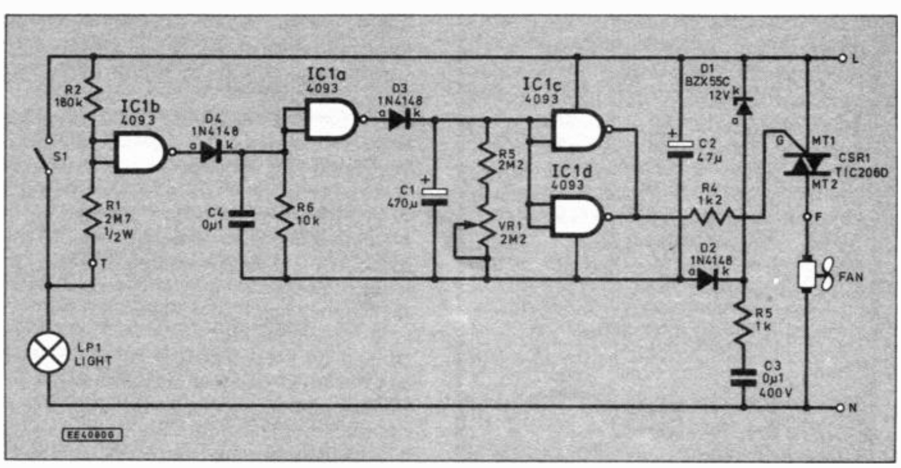
Note: S1, and LP1 are the room light switch and light.

Due to the presence of MAINS voltages, extreme care should be taken during construction, testing and installation of this module. The fan circuit must be fused.



The completed Fan Timer circuit board

Fig. 3. Alternative circuit diagram for switching the live (L) fan motor connection.



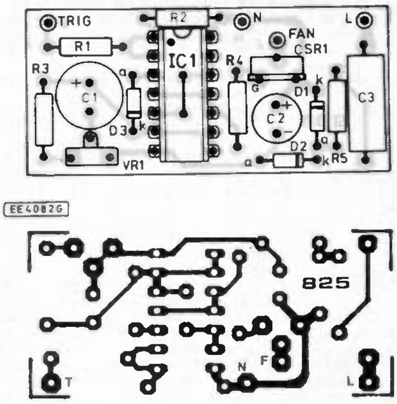


Fig. 4. Printed circuit board component layout and full size copper foil master pattern.

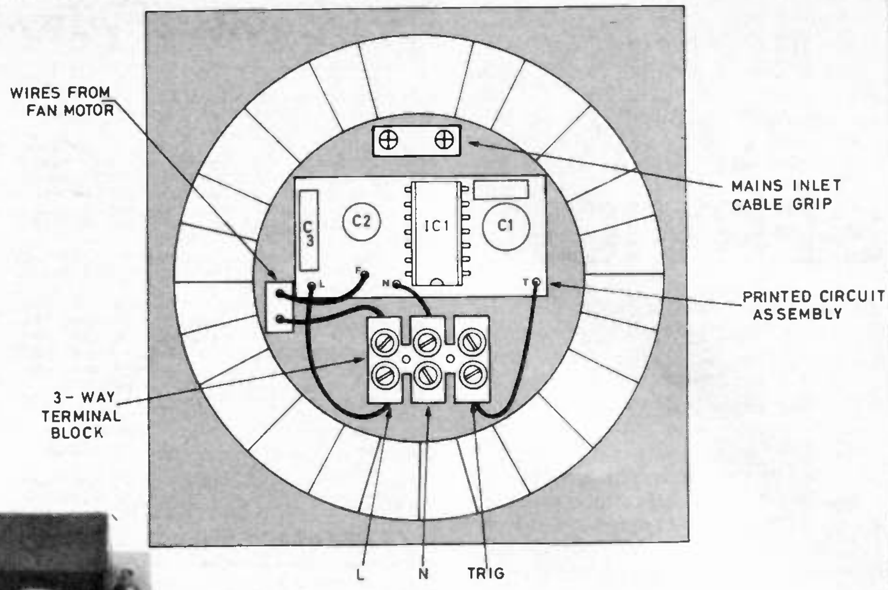
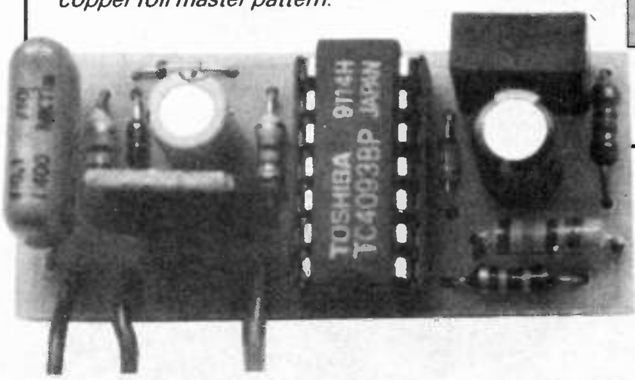


Fig. 5. Installing and wiring the timer module in the fan housing.



The completed circuit board ready for installing in the fan unit. Do not forget the link wire under IC1. See Fig. 4.

CONSTRUCTION

Since the unit was built for a specific fan a printed circuit board was produced. This is very small and should therefore fit the majority of extractor fans on the market but there may be some types which will require a different shape board. In these cases it is probably best to build the circuit on a piece of stripboard but it should be remembered that the circuit operates at mains voltage and some parts of the circuit have a high voltage across them.

The printed circuit board (p.c.b.) topside component layout and the full size underside copper foil master pattern is shown in Fig. 4. This board is available from the *EPE PCB Service*, code 825.

Construction should pose few problems even for a relative novice because the small number of components reduce the probability of errors. it must be said however, that it only needs one error to make any circuit inoperative or worse still to destroy it completely.

Care should be taken when fitting diodes and electrolytic capacitors and, of course, the i.c. which is a CMOS device and therefore prone to damage by static electricity. A suitable d.i.l. socket is strongly recommended for this device.

Note that resistor R1 is specified as a ½W device. This is because ¼W resistors may have too low a voltage rating as this device has nearly the full mains voltage applied to it. Similarly, capacitor C3 should have a voltage rating of at least 400V minimum.

The fan that was modified had a two-way terminal block (the "chocolate" block type which normally come in strips of twelve) and this had to be replaced by a three-way type to provide the input trigger connection, the other two connections being Live (L) and Neutral (N). The printed circuit board had wires soldered directly to it to connect it to the terminal block. (See Fig. 5).

Mounting of the p.c.b. will of course depend on the fan that is being modified, but the small size and lack of heavy components make the board easy to mount on the plastic body of the fan using double-sided adhesive pads. If the p.c.b. can be mounted in the fan housing using a *nylon nut and bolt* so much the better. it cannot be dislodged by any vibration from the motor once it is running.

COMPONENTS

See SHOP TALK Page

Resistors

R1	2M7 ½W
R2	180k
R3	2M2
R4	1k2
R5	1k

All 0·25W 5% carbon film, except R1

Potentiometer

VR1	2M2 miniature carbon preset, vertical

Capacitors

C1	470µ radial elect., 16V
C2	47µ radial elect., 16V
C3	0µ1 polyester, 400V a.c.

Semiconductors

D1	BZX55C12V Zener diode
D2, D3	1N4148 signal diode (2 off)
CSR1	TIC206D 4A 400V triac
IC1	4093BP quad 2-input NAND Schmitt trigger

Miscellaneous

Printed circuit board available from *EPE PCB Service*, code 825; 3-way 5A (min) screw terminal block; mains rated connecting leads; p.c.b. solder pins; mains cable grip; solder etc.

Alternative Circuit Fig. 3
(not allowed for on p.c.b. layout)

R6	10k 0·25W carbon film
C4	0·1µ polyester
D4	1N4148 signal diode

Approx cost guidance only **£8.50**

APPLICATIONS

Although designed primarily for use in a ventilator fan, the module has many other applications where the mains needs to be disconnected from an appliance after a preset time. Uses which spring to mind are EPROM Erasers and P.C.B. Exposure Units which usually need to be activated for a few minutes.

Both these devices are available with or without built-in timers but like extractor fans the price charged for the timer versions is often out of all proportion to the cost of the extra electronics. In these cases of course, a push-to-make switch would be used to trigger the unit and no lamp would be fitted.

The retriggerable nature of this device could make it useful for automatically switching off appliances which tend to get left on accidentally, such as the soldering iron or the TV if you are in the habit of falling asleep while watching the "Late Night Movie" (and who can blame you). In this application the time could be set for say 15 to 30 minutes and a push-to-make switch fitted to reset the time interval. This would be pressed every so often while the appliance was in use but in the event of it being left unattended or the user falling asleep (in the case of the TV not the soldering iron!) the timer would time out and switch the mains off.

In these applications care *MUST* be taken to ensure that the *maximum* rating of the triac is not exceeded. With the triac specified, the maximum load current is 3A (750 Watts) but in this case the triac should be mounted on a heatsink. Remember that with this triac the heatsink tab is internally connected to Main Terminal 2 and the heatsink should therefore be fitted inside an insulated ventilated box and not "Earthed".

The use of higher power triacs is not recommended unless the device has been specially selected, as these tend to have lower gate sensitivities (some as high as 50mA to 100mA) which the circuit is unable to provide. □

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This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
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A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., DC.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.
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MAKING MS-DOS WORK FOR YOU
N. Kantanis & P. R. M. Oliver

This book was written with the busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the book has also been designed to be circular, which means that you don't have to start at the beginning and go to the end.
The book explains: How to write customised batch files which allow you to display what you want on your screen, and in the form and order you want it, instead of being forced to use the DOS prompt on a blank screen. How to design and set up a fast interactive and professional looking menu system, so that you or anyone else can run utility applications or commercial software packages easily. How the ANSI.SYS display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters or change their colour. How the Edit screen editor or the Edlin line editor can be used to enter ESCape (ANSI.SYS) commands into simple ASCII files to allow control of both your screen display and your printer. How to control the operation of the two main types of printers in use today, Epson compatible dot matrix and HP compatible laser printers. How to use several useful routines, such as moving and finding files, protecting files from accidental erasure, a simplified backup process, a screen saver, and a disc cataloguing system.
The Debug program and how it can be used to create, see and change the contents of any file, including those of programs written in assembler code. This includes how to find your way around the names and tasks of the CPU registers and the meaning of some simple assembler mnemonics.
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Audio and Music

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V. Capel
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The special requirements of live group concerts are considered, and also the related problem of instability that is sometimes encountered with large set-ups. We even take a look at some unsuccessful attempts to cure feedback so as to save readers wasted time and effort duplicating them.
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R. A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
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V. Capel
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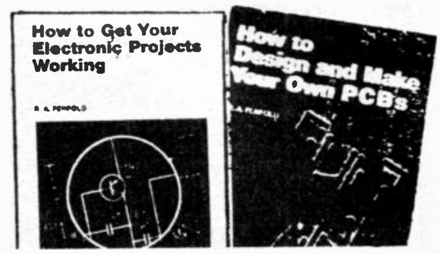

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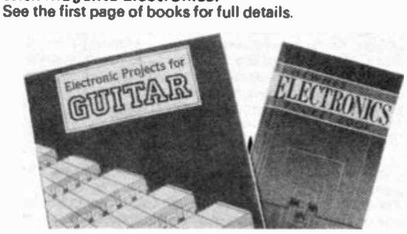

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ISWL TAPESPONDING

Last month I mentioned the International Short Wave League but had insufficient space to mention that, among its varied activities, it has a Tape Section that enables like-minded members to keep in touch with each other. As in amateur radio contacts, controversial topics like politics or religion are avoided, but otherwise virtually anything can be discussed.

Additionally, a news tape goes to all participating members containing a variety of material with contributions from other tapesponders, "from train or bird sounds to the latest Dx news or broadcast station identification, or talks and reminiscences of the old days".

Membership information can be obtained from ISWL HQ, Dept. EPE, 10 Clyde Crescent, Wharton, Winsford, Cheshire, and a sample copy of the League's monthly journal, *Monitor*, costs 60p. Cheques or P.O.'s should be payable to "ISWL" but stamps are acceptable.

NET DIRECTORY

Apart from individual contacts on the amateur bands, "nets" are a popular activity. These are gatherings of radio amateurs on the same frequency, with a "net-control" station in charge calling in participants in turn to make their own contribution to whatever topic is under discussion.

Although popular with many amateurs I actually prefer to listen to nets rather than take part in them. There is limited time available for each participant but listening to the whole can be most interesting. The number and variety of nets is surprising and over 900 are listed in *The World Ham Net Directory*, edited by Mike Witkowski and published in the USA.

Some are restricted to members of particular organisations, and others are open to all. Among many specialised subjects, there are nets for enthusiasts for individual aspects of amateur radio itself, the armed services, police, missionaries, railway enthusiasts, stamp collectors, farmers, Scouts, fire fighters, novices, seafarers and virtually anyone else you can think of!

The directory is in three sections, listing nets by name, by frequency, and by time of operation. It is of value to both licensed amateurs who wish to find other amateurs with similar interests and to shortwave listeners who wish to expand their listening activities. For award hunters or QSL card collectors, it offers the opportunity of adding more Dx stations to their totals.

The World Ham Net Directory is available from Tiare Publications, PO Box 493, Lake Geneva, WI 53147, USA, price US$9.95, plus $3.00 foreign postage (Visa or Mastercard accepted).

NOVICE SUCCESS

The first ever UK Class "A" Novice, has become the first UK Novice to receive the G-QRP Club's Class "A" CW Novice Award. Created to encourage an interest in CW (Morse) operating among beginners, this award is open to any amateur who, during the first twelve months of holding a licence, contacts 50 different stations while using CW. Class "A" is for contacts using up to 5 watts output and for Class "B" any power may be used.

Twelve-year old Keith Goodwin, 2M0ACT, used 3 watts of power (just about enough to light a flashlamp bulb) to make his first fifty contacts. These included seven with USA/Canada, two with Indonesia, and twelve separate countries in all. His father Stuart, GM0CAG, says that Keith is getting a great thrill from the hobby and that many of his contacts have helped him relate to his school geography and French lessons.

Dave Gosling G0NEZ, G-QRP Novice Services Manager, reports that other Club Novices are also achieving high standards of operating ability and has asked all operators to encourage and help them when they hear them on the air.

Membership of the G-QRP Club, which is devoted to low-power operating, is open to both licensed amateurs and shortwave listeners. It has an excellent quarterly journal, *SPRAT*, which includes a column for novices of all ages and is full of projects, often suitable for beginners, for transmitters, receivers, and many station accessories.

A sample copy can be obtained by sending a stamped addressed C5 envelope to the Club Secretary, Rev George Dobbs G3RJV, St. Aidans Vicarage, 498 Manchester Road, Rochdale, OL11 3HE. Tell him you read about the club in G4FAI's column in EPE. I am a long-time member, and like to keep in with the guv'nor!

NUMBERS STATIONS

Shortwave listeners around the world have been puzzled for years by the "numbers stations" which broadcast groups of coded numbers – and nothing else. According to an article by Nils Schiffhauer DK8OK, in *Monitoring Times* last September, although it was widely thought these mysterious transmissions came from behind the Iron Curtain some were, in fact, broadcast by BND, West Germany's CIA, to agents in eastern Europe.

The transmissions could be received on a domestic shortwave receiver and, in the seventies, Grundig's *Ocean Boy* was widely used for this purpose. The strange thing is, even though the country is now re-united, Germany's numbers stations are still on the air as if nothing has happened on the political scene!

SPY NETWORK

The authority responsible for these transmissions is "BFST", the Federal Service for Telecommunications Statistics which, according to Nils, provides telecommunications for the German intelligence services. There are stations all over Germany and he found one near Husum in Schleswig-Holstein, on two sites, bristling with antennas capable of transmitting signals near and far. In his words, "it looked as though some ham operator's dream had come true!"

The numbers broadcasts are by voice, but on this occasion he verified CW (Morse) numbers on 9161kHz, "only ten metres away" from the antenna, with the signal overmodulating his car radio. The callsign was EC3Y.

As a dedicated shortwave listener he then sent what was probably the first ever reception report to a German numbers station – and to the right address, knowing exactly where the transmission came from!

ON-THE-AIR QSL

The answer was short but polite. "On principle" they did not verify reception reports. He hadn't really expected any answer at all so was quite pleased to receive this letter, although a small mystery remained. Inexplicably, this German station was using a Spanish callsign. Nils checked, and discovered that EC3Y was a call for an amateur novice licence in Madrid.

The Deutsche Bundespost was actively cracking down on the illegal use of scanners at the time (subsequently legalised mid-1992) so he wrote to ask them to investigate the apparent illegal use of a foreign callsign by a government agency which he understood was responsible for enforcing international treaties!

Within a week he received a phone call from the PTT informing him that BFST used the callsign EC3Y for transmissions *towards* Spain but would change the call to a legal one that very day. He switched on his receiver to check, and they really had changed the call! Since 20th January, 1992, therefore, the call for the BFST transmissions on 9161kHz has not been EC3Y but DEA47, which complies with the international regulations.

He sent another reception report, and again they declined to verify it. He didn't mind. He thought their change of callsign was one of his best ever QSLs – even though it was only "on-the-air"!

Out of curiosity, I have been tuning 9161kHz from time to time, but have not yet heard DEA47. Nils suggests "Maybe they closed down. Maybe they switched to another (winter?) frequency." If any SWL readers do hear them, please let me know.

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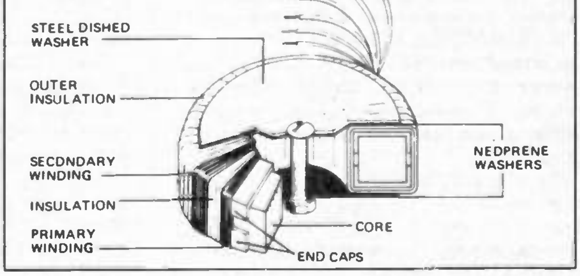

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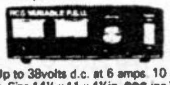

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