EVERYDAY ELECTRONICS

858

SEPTEMBER 1992

INCORPORATING ELECTRONICS MONTHLY

£1.60

ULTRASONIC TAPE MEASURE

WASHER BOTTLE MONITOR

QUICK TEST

SOUND OPERATED NIGHT LIGHT

ALTERNATIVE ENERGY – 2
Wind Power

9 770262 361027 09

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

AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD). £179 (PPC1512DD). £179 (PPC1640SD). £209 (PPC1640DD). MODEMS £30 EXTRA.NO MANUALS OR PSU.

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7R.

2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. Now only £4.00 ref 4P157

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.

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

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

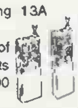
PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

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

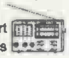
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £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 NOW ONLY £19.00!! REF 19P14R.



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. £19.00 ref 19P30

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R

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

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32R.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104R. Bumper pack of 1,000 ties £14.00 ref 14P6R

GOT A CARAVAN OR BOAT?

NEW 80 PAGE FULL COLOUR LEISURE CATALOGUE

2,500 NEW LINES FREE WITH ORDER ON REQUEST

OR SEND £1.00

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

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.

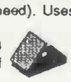
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.

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

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20R, 16" wheel £6.00 ref 6P21R.

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.

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



12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.

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 5 tapes New low price £8.00 ref 8P161

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 15 w 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

HIGH RESOLUTION 12" AMBER MONITOR 12v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2R

VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4R

25 WATT STEREO AMPLIFIERc. 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.

ALARM TRANSMITTERS. No data avaliable but nicely made complex radio transmitters 9v operation. £4.00 each ref 4P81R.

12V 19A TRANSFORMER. Ex equipment but otherwise ok. Our price £20.00

GX4000 COMPUTERS. Customer returned games machines complete with plug in game, joysticks and power supply. Retail price is almost £100. Ours is £12.00 ref B12P1

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 £25.00 ref B25P1 additional detectors £11.00 ref B11P1

IBM XT KEYBOARDS. Brand new 86 key keyboards £5.00 ref 5P612

IBM AT KEYBOARDS Brand new 86 key keyboards £15.00 ref 15P612

386 MOTHER BOARDS. Customer returned units without a cpu fitted. £22.00 ref A22P1

BSB SATELLITE SYSTEMS

BRAND NEW

REMOTE CONTROL

£49.00 REF F49P1

286 MOTHER BOARDS. Brand new but customer returns so may need attention. Complete with technical manual £20.00 ref A20P2

286 MOTHER BOARDS. Brand new and tested complete with technical manual. £49.00 ref A49P1

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.

CAPACITOR PACK ...

MIRACOM WS4000 MODEMS

V21/23

AT COMAND SET

AUTODIAL/AUTOANSWER

FULL SOFTWARE CONTROL

TONE AND PULSE DIALLING

£29

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R.

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.

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91R

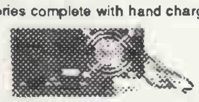
4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365R

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366R

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57R. Atari ST conversion kit £2.00 ref 2P362R.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205R

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200R



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 flyleads. £15.00 ref F15P4

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200

ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200

MODEMS FOR THREE POUNDS!! Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3.00 ref 3P145R

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

BARGAIN STRIPPERS Computer keyboards. Loads of switches and components excellent value at £1.00 ref CD40R

DATA RECORDERS Customer returned mains battery units built in mic ideal for Computer or general purpose audio use. Price is £4.00 ref 4P100R

SPECTRUM JOYSTICK INTERFACE Plugs into 48K Spectrum to provide a standard Atari type joystick port. Our price £4.00 ref 4P101R

ATARI JOYSTICKS Ok for use with the above interface, our price £4.00 ref 4P102R

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 insulated cable 100 feet for £2.00 REF 2P79R

MAINS FANS Brand new 5" x 3" complete with mounting plate quite powerfull and quite. Our price £1.00 ref CD41R

DISC DRIVES Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P1R (worth it even as a stripper)

HEX KEYBOARDS Brand new units approx 5" x 3" only £1.00 each ref CD42R

PROJECT BOX 51/2" x 31/2" x 1" black ABS with screw on lid. £1.00 ref CD43R

SCART TO SCART LEADS Bargain price leads at 2 for £3.00 ref 3P147R

SCART TO D TYPE LEADS Standard Scart on one end, Hi density D type 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

QUICK SHOTS Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2.00 ref 2P380R

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

AC STEPDOWN CONVERTOR Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R

SPECTRUM +2 LIGHT GUN PACK complete with software and instructions £8.00 ref 8P58R/2

CURLY CABLE Extends from 8" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1.00 each ref CD44R

COMPUTER JOYSTICK BARGAIN Pack of 2 joysticks only £2.00 ref 2P382R

BUGGING TAPE RECORDER Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R

IEC MAINS LEADS Complete with 13A plug our price is only £3.00 for TWO! ref 3P148R

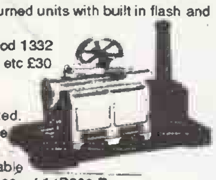
NEW SOLAR ENERGY KIT Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

286 AT PC

286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) Some metal work req'd phone for details.

35MM CAMERAS Customer returned units with built in flash and 28mm lens 2 for £8.00 ref 8P200

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

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

ATARI 2600 GAMES COMPUTER Brand new with joystick and 32 game cartridge (plugs into TV) £29.00 ref F29P1 also some with 1 game at £19.00 ref F19P2.

BEER PUMPS Mains operated with fluid detector and electronic timer standard connections. Ex equipment. £18.00 ref F18P1

90 WATT MAINS MOTORS Ex equipment but ok (as fitted to above pump) Good general pupose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt 4R 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.

VIDEO TAPES E180 FIFTY TAPES FOR £70.00 REF F70P1

360K 5 1/4" Brand new drives white front. £20.00 Ref F20P1

IN SUSSEX? CALL IN AND SEE US!

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

NEXT DAY DELIVERY £8.00

FAX 0273 23077

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

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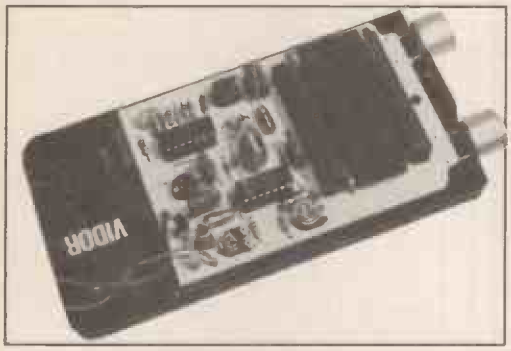
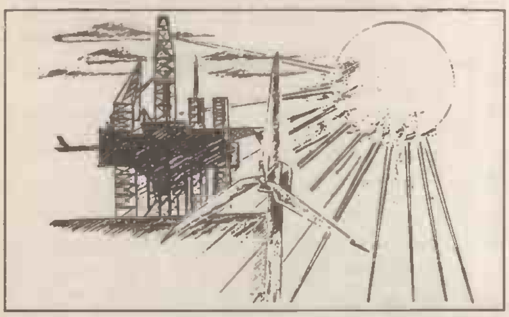
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





Our October '92 issue will be published on Friday, 4 September 1992. See page 547 for details.

Projects

Series

Features

2 x 220 watt MOSFET AMPLIFIER

A top-of-the-range performer that will satisfy the most demanding audio enthusiast. If you're looking for an amplifier to power your subwoofer, the **SPARKOMATIC** is all you'll need! Highly sophisticated MOS-FET technology dramatically extends frequency response, separate input sensitivity controls, built-in protection circuitry for overheat and short circuit with l.e.d. indication, output power: 2 x 220 watt maximum and 2 x 110 watt at 0.1% THD, Bridged 440 watt mono maximum and 220 watt mono at 0.5% THD.

£168.50 plus £3.50 p&p

100 watt x 4 CLASS A AMPLIFIER FOR CARS

Delivers 4 x 100 watt into 4 woofers or with the aid of its built in active cross over delivers 200 watt of Bass via sub-woofer output and 2 x 100 watt, full range into 2 speakers; thus giving you all the power you require to make even traffic jams a positive pleasure. SPECIFICATION 4 x 100W (4Ω), 2 x 200W Bridged, THD .08%, S/N RATIO: 7 90db, RESPONSE 10Hz-50kHz, LOW PASS FILTER SWITCHED 75Hz 150Hz, INPUT 4 x PHONO 100-3 Volts, INPUT x 4 HIGH LEVEL 20kΩ, SIZE 240mm x 50mm x 400mm.

£118.50 postage £4.50

80 watt CAR POWER AMPLIFIER

The AMP 7000 produces high power at low distortion. The amplifier accommodates low level, high level and high power radio speaker inputs. The response is linear and extends beyond the capability of all music sources. This compact unit mounts easily and its quick connect terminals accept RCA or straight wire input terminals. Power rating 2 x 40 watt per channel. MMP 2 x 20 watt at 10%. THD response 20Hz-20kHz. Size 160mm x 130mm x 45mm.

£32.95 plus £3.50 p&p

11 BAND COMPONENT GRAPHIC EQUALIZER FOR CARS

This neat unit connects between the line output of your car stereo and your power amplifiers so that you are able to adjust the sound as in a studio compensating for soft furnishing and sound reflections from glass, also it has a subwoofer output to drive a separate amplifier for that extra deep bass sound. FEATURES: 2 channel inputs 4 channel outputs via phono sockets, CD input via 3.5mm jack 11 band graphic. SPECIFICATION RANGE 20Hz-60kHz THD 0.05%, S/N RATIO 85dB. EQ FREQUENCIES 60Hz, 120Hz, 250Hz, 380Hz, 500Hz, 750Hz, 1kHz, 2kHz, 4kHz, 8kHz, 16kHz (boost cut of ±12dB) SIZE 178mm x 25mm x 140mm.

£32.70 postage £1.80

EMINENCE 4Ω PROFESSIONAL USA MADE IN CAR CHASSIS SPEAKERS

All units are fitted with big magents "Nomex" Voice coils NOT ALUMINIUM, "Nomex" is very light and can stand extremely high temperatures, this mixture makes for high efficiency and long lasting quality of sound.

V6 6½" 200W Max	Range 50Hz-3kHz £34.40
V6 8" 300W Max	Range 45Hz-3kHz £39.35
V10 10" 400W Max	Range 33Hz-4kHz £44.45
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.

Postage £3.85per speaker.

Build your own Bazooka sub woofer tube to suit Eminence car speakers. 10mm thick fibre supplied with grille and clamp terminals finished in black vinyl.

Eminence U10, Size 270mm x 700mm **£25.95** £3.50 p&p

Eminence U12 Size 320mm x 710mm **£29.95** £3.50 p&p

RTVC

MAIL ORDER BARGAIN PACKS

No.	Qty. per pack	Description	Price
MO20	1	30W dome tweeter by *Eagle/Japan Made* size 90mm x 66mm	£1
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	£4.95 + £2.50 p&p
MO23A	1pr	40 watt Car Speakers made for Roadstar of Switzerland. Fitted with dual polypropylene cone and foam rubber surround. Big 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 JBL 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
MO28	1	15000μF 40V d.c. can type 23A electrolytic size 113mm x 50mm	£1
MO29	1	33000μF 16V 27A can type electrolytic size 113mm x 50mm	£1
MO30	20	Assorted Variable trimmers	£1
MO31	4	Tuning capacitors 2-gang dielectric type	£1
MO32	2	10k + 10k wirewound precision potentiometer	£1
MO33	8	Rotary potentiometers	£1
MO34	5	100k multiturn Varicap type tuning potentiometer with knob size 45mm x 5mm	£1
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
MO51	2	AM/FM tuner head modules'. *Made by Mullard*	£1
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	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
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	Bridge rectifiers 1amp 24Volt	£1
MO61	10	OC44 transistors. Remove paint from top and it becomes a photo electric cell (ORP12)	£1
MO62	30	Low signal transistors *npn* and *pnp* type	£1
MO63	6	14 watt output transistors. Three complimentary pairs in T066 case (replacement for AD161 +162)	£1
MO64	5	5 watt Audio i.c. No. TBA800	£1
MO65	5	Motor Speed Control i.c.	£1
MO66	1	Digital DVM Meter i.c. *Made by Plessey,* with diagram	£1
MO67	4	7-Segment 0.3in l.e.d. display (red)	£1
MO68	1	Tape Deck i.c., with record replay switching. No. LM1818, with diagram	£1
MO69	2	Ferrite Rod. High grade with LW, SW & MW coils, size 140mm x 10mm	£1
MO70	1	Moving coil dynamic, handheld, ball microphone. *Ross Electronics* customers returns (*no warrantee*)	£1
MO71A	1	Analogue Multimeter. *Ross Electronics* customers returns (*no warrantee*)	£3.90 + 90p p&p
MO72	1	WW II EX WD headphone, A BIT OF NOSTALGIA, low impedance	£3.50 + £1.20 p&p
MO73	1	Koss Stereo Headphones on ear. Lightweight design, vari-fitting ear-cups with contour cushions, 36in. cord. 3.5mm + 6.35mm Jack plug adaptor	£3.50 + £1 p&p
MO74	2	Tone dialling keypad, use services that require DTMF tone signals for a rotary dial pulse phone, size 90mm x 55mm 12mm	£11.00 + 70p p&p
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
MO78	1	TV Aerial Amplifier housed in a neat plastic box, coax input and output sockets. Mains operated. Double the output signal of your aerial	£6.50 + £1.50 p&p
MO79	1	Rechargeable fluorescent lantern, twin 9W switchable tubes, flashing beacon and search lamp. Built-in lead acid battery and mains charger. Gives equivalent light output of 60W lamp. Size 24mm x 8mm x 17cm, weight 1.6kg	£22.95 + £2.65 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	£8.95 + £1 p&p
MO83 ★	1	Video Sender. With this handy unit you can transmit output of your home video, wideo camcorder or satelite equipment over the air to a receiving television within a range of 100ft. Simply connect the video and audio output of your equipment into this unit, and a 10-13.8V d.c. power supply – extra £3.75	£11.75 + £2 p&p
MO84	1	Multiband radio. Listen to air traffic control, aircraft, radar, public utilities VHF 54-176MHz + CB 1-80 with built in squelch control	£17.95 + £2 p&p
MO85	2	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	£23.00 + £3.65 p&p
MO86	1	(As above)	£15.00 + £2.80 p&p
MO87	1	Amplifier Kit 30 + 30 Watt. An easy to build amplifier with a good specification. All components mount on single p.c.b. punched and back-printed for ease, case ready drilled finished in black vynil with matching scale and knobs. Inputs for: CD/AUX tape 1; tape II; tuner and MC phono. Controls: bass; treble; volume; balance; mode and power switch. Featured project in *Everyday Electronics,* April 1989 issue; reprint with kit	£40.00 + £3.65 p&p

All items prefixed with MO number **MAIL ORDER** only or can only be collected by prior appointment from address below. Where p&p not stated please add £3.65 per order for postage and carton charge.

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2 Watt transmitter kit, supplied with fibre glass pcb, all components, diagrams, ready for you to build. 12-24V d.c. **£8.50 + £0.70** pp

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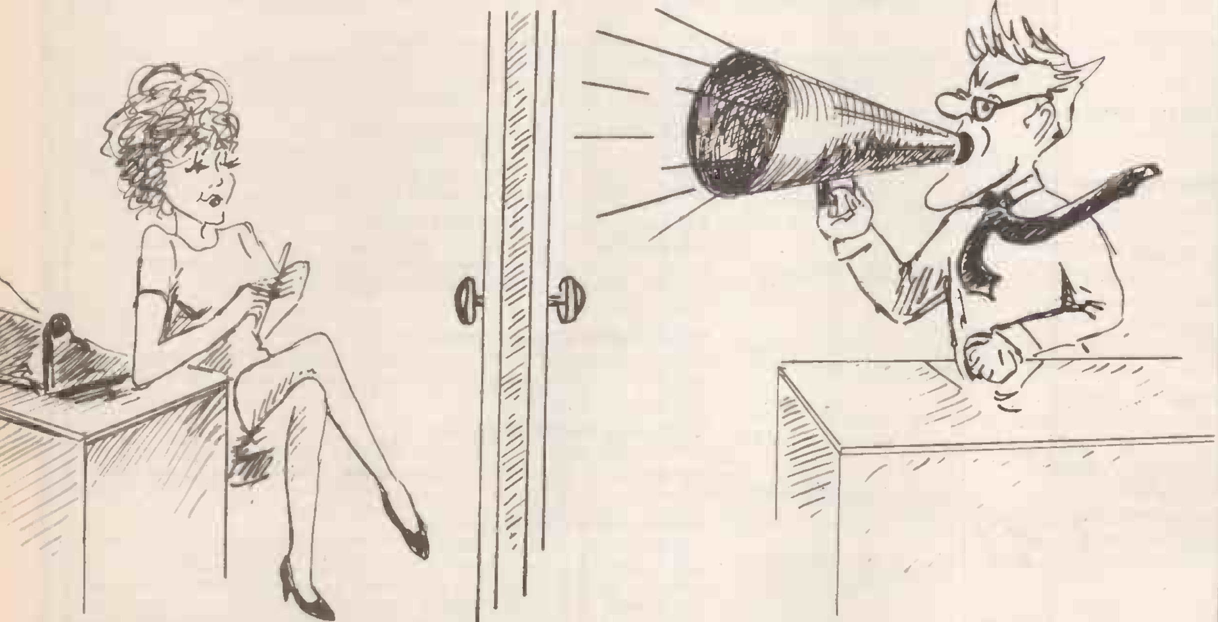
Versatile Intercom

A single "master" design which can be linked to as many similar stations as required. The audio quality is particularly good and a "conferencing" set up is possible.



Lights-on warning

If you have ever suffered a flat battery because "someone" left the car lights on then this unit could be invaluable. Of course some modern cars are fitted with such devices, but not all. This design has the added advantage of an anti-theft facility which could deter the casual thief.

Wide range Capacitance Meter

Unlike most inexpensive capacitance meters this design gives a range of capacitance values from about 2pF up to 5000μF in two distinct sections; from 2pF to 1μF on a low range and from 0.5μF to 5000μF on a high range; further, the stray capacitances are "tuned out" within the system so that there is no theoretical lower limit to the measurement range. An additional feature, very useful when checking electrolytics particularly, is a qualitative measure of leakage current with an applied potential of about 9V.

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OCTOBER ISSUE ON SALE FRIDAY, 4th SEPTEMBER 1992

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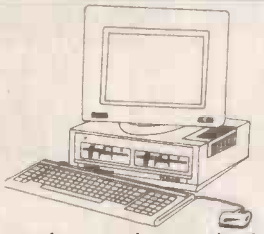

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Value Pack £49.95

Z9109 New and boxed games machine based on the popular C64 computer - you get the console, power supply, TV lead, Cheetah joystick and 4 game cartridge - Flimbo's quest, Fiendish Freddy, Klax and International Soccer.

VHF/UHF TV RECEIVER/CONVERTER

Z8991 Amstrad MP3 computer modulator/converter.

A complete, fully tuneable VHF/UHF TV receiver with RGB and composite video out, and sound on the internal speaker. For use with the Amstrad CTM644-2 monitor specifically, or can be used with any colour/mono home computer monitors that have a 15.625kHz line frequency. Grey case 330x250x50mm Controls: contrast, colour, tuning, volume and band select (VHF-L, VHF-H, UHF) RGB output on 6 pin DIN skt, and composite video. Intended for European market - needs 2 ceramic filters changing. Parts and instructions supplied. Needs stabilized 12V DC, either from monitor or seperate power supply (our AL12, £8.14 is ideal)

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Z8999 Model CT1 - in plastic case that sits under monitor. MW/LW/FM receiver with 3" speaker, + digital clock with alarm and snooze facilities.

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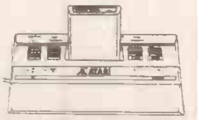
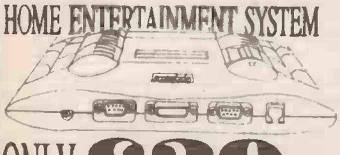


AMSTRAD GX4000 HOME ENTERTAINMENT SYSTEM



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- *2 Control Paddles
- *TV lead
- *Burnin' Rubber Cartridge
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Inputs for 2 paddles, analogue joysticks, light gun/pen etc. Outputs: UHF, RGB on 8 pin DIN skt, SCART skt, stereo sound 3.5mm skt. Uses 168 pin dedicated chip, Z80A CPU, AY-3-8912 sound chip, UM1234 UHF modulator

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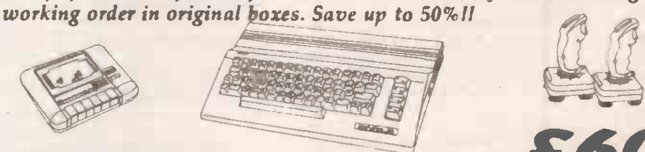

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Z5405 High quality heavy duty all metal construction stereo cassette player mechanism, probably intended for continuous background music. This is a lovely bit of kit - starts playing as soon as a cassette is inserted. Has fast forward, rewind and eject keys. It's bi-directional, and the sensing circuit automatically reverses the tape at the end. Has a Canon motor and works off 12V DC. Great value at £4.95.

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Z5406D High efficiency step down power regulator module by SGS. This is a GSR400 type, as listed by Farnell at £41.11 each. Output is 7V @ 4A from a DC input of 10-46V. Possible uses include battery charger, or put two together and use 24V lorry battery to power car equipment. Our special price - just £5.75 each.

Z5409 Eurocard size - 160x100mm by Protek. 115/230V input. Outputs: +5V @ 3A; +12V @ 2A; -12V @ 0.25A Price £8.95

UHF TUNER

Z2648 UHF TV tuner - at least, the front end. Fagor SUF743 has a co-ax socket inlet into the screened case 65x50x20mm. Inside the PCB has some surface mount bits + BF966S, BF970 and BF199 transistors and a few coils. Giveaway Price 2 for £1.00

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4 x IN-FLEX SWITCHES with neon on/off lights, saves leaving things switched on. Order Ref. 7.
2 x 6V 1A MAINS TRANSFORMERS upright mounting with fixing clamps. Order Ref. 9.
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2 x CASES 2½ x 2¼ x 1¾ with 13A pins. Order Ref. 565.
4 x LUMINOUS ROCKER SWITCHES 10A mains. Order Ref. 793.
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ARTWORK LIGHT BOX similar to that described in the August issue but not sloping. Complete kit includes wooden box, semi-opaque fibreglass panel and double 'D' fluorescent tube with its control gear. Price only £10 but, if not calling, please add £4 as very special packing is required. Order Ref. 10P75.
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ULTRA THIN DRILLS Actually 0.3mm. To buy these regular costs a fortune. However, these are packed in half dozens and the price to you is £1 per pack, Order Ref. 797B.
YOU CAN STAND ON IT! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools. Internal size approx. 10½" x 4½" x 6" high. These are complete with snap closure lip and shoulder-length carrying strap. Taken from used equipment but in good condition, price £2, Order Ref. 2P283B.
BUILD YOUR OWN NIGHT LIGHT, battery charger or any other gadget that you want to enclose in a plastic case and be able to plug into a 13A socket. We have two cases, one 3½" x 2¼" x 1¾" deep, £1 each, Order Ref. 845. The other one is 2½" x 2¼" x 1¾" deep, 2 for £1, Order Ref. 565.
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POWER SUPPLY WITH EXTRAS mains input is fused and filtered and the 12V dc output is voltage regulated. Intended for high class equipment, this is mounted on a PCB and, also mounted on the board but easily removed, are 2 12V relays and a Piezo sounder. £3, Order Ref. 3P80B.
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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 enable 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.
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AMSTRAD POWER UNIT 13.5V at 1.9A encased and with leads and output plug, normal mains input £6, Order Ref. 6P23.
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10W ISOLATION TRANSFORMER if you want to isolate some small piece of equipment from earth this may be what you are looking for. You can use it either with a tapped input or a tapped output. It's upright mounting and well insulated. Price £1, Order Ref. 821.
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BUILDING YOUR OWN PSU, battery charger, night light, or any other gadget that you want to enclose in a plastic case and be able to plug into a 13A socket? We have two cases, one 3½ x 2¼ x 1¾" deep, £1 each, Order Ref. 845. The other one is 2½ x 2¼ x 1¾" deep, 2 for £1, Order Ref. 565.
500V BRIDGE MEGGER developed for GPO technicians the Ohmeter 18B is the modern equivalent of the bridge megger. 9V battery operated, it incorporates a 500V generator for insulation testing and a null balance bridge for very accurate resistance measurement. Ex B.T. in quite good condition with data & tested. Yours for a fraction of original cost, £45, Order Ref. 45P2.
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15W 8 OHM 8" SPEAKER & 3" TWEETER made for a discontinued high quality music centre, gives real hi-fi, and only £4 per pair, Order Ref. 4P57.
FREE POWER! Can be yours if you use our solar cells – sturdily made modules with new system bubble magnifiers to concentrate the light and so eliminate the need for actual sunshine – they work just as well in bright light. Voltage output is .45 – you join in series to get desired voltage – and in parallel for more amps.

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Module B gives 400mA	Price £2	Order Ref. 2P199
Module D gives 700mA	Price £3	Order Ref. 3P42
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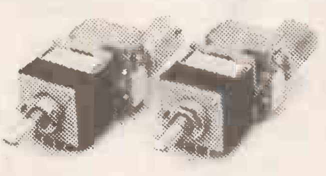

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ELEVATED EGO

Our contributor Steve Knight has made an interesting point in the last paragraph of a letter to us (see *Everyday Readout* in this issue). In a delicate manner he is voicing what many of us have experienced over the years.

I remember when EE first started back in 1971 (yes we are 21 years old this year, but more of that in a few months time), I was working for the magazine at that time and found a number of people looked down their noses at a hobbyist magazine aimed mainly at students and beginners. Thankfully the attitude and the standing of EE in these people's eyes has changed for the better over the years and we are proud that many highly qualified engineers are pleased to write for us and impart some of their knowledge to our readers.

For those that still worry about their egos, perhaps they should remember how they started the learning process some years back. Surely your social standing is enhanced by imparting knowledge rather than reduced by it?

FOR THE SAKE OF IT

On a totally different subject, this time one touched upon in our *Information Technology* series, I have often rejected projects for EE because they "use a sledge hammer to crack a nut", though this is not always the case. Let me explain: What point is there in building an elaborate piece of electronics to tell you something which can be easily indicated by other simple and inexpensive means.

I once saw an interesting device to tell a car owner when he had reversed his car to just the right point inside his garage – some form of infra-red beam? or possibly an ultrasonic range finder? No, simply a rubber ball suspended on string from the garage roof, when the ball touched the rear window the car was in the correct position. The device is cheap, easy to install and fool proof – unless the string breaks. What I am trying to say in a roundabout way is to look at all the possible solutions.

To go back to my first statement, we have on occasions published projects which are more complicated than necessary because they illustrate the use of various electronic systems and are therefore educational. We also publish various projects which could be purchased for less as commercial items but, after all, part of the enjoyment of our hobby comes from building it for yourself and therefore cost is not always the final decider.

Mike Kenward

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

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

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

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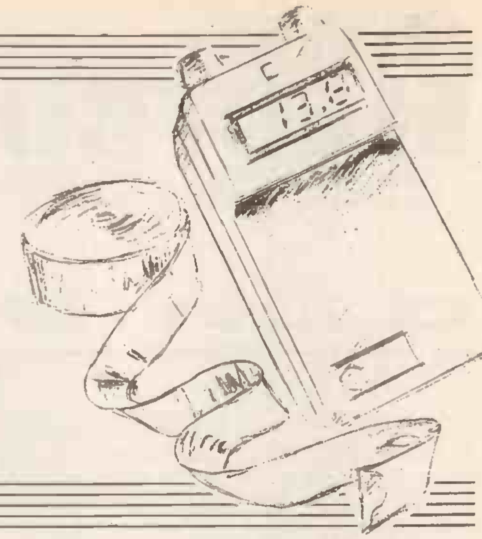
Constructional Project

LCD ULTRASONIC TAPE MEASURE



JOHN BECKER

An ultrasonic measure that probes parts other tapes cannot reach.

UP, DOWN or sideways, distances of up to nine metres or 30 feet can be easily measured and displayed by this pocket-sized unit. Using twin ultrasonic transducers, a decoding counter and a 3½ digit liquid crystal display (LCD), accuracies to within one decimal place are obtainable.

An unusual feature is the foreground masking circuit which enables weak distant echoes to be more readily detected.

TIMING CIRCUIT

The block diagram of the complete concept for the LCD Ultrasonic Tape Measure is shown in Fig. 1. Essentially the unit consists of a timer which is started at the moment an ultrasonic signal is transmitted and stopped when an echo signal is received back.

The echo-return time is digitally stored in a register whose contents are shown on an LCD. After the time has been stored, the counter is reset and the sequence repeated. The LCD shows only the stored time and is unaffected when the counter is reset.

In the main circuit diagram Fig. 2, IC3 is a combined counter and LCD driver. Its full pinouts and those of the LCD are shown in Fig. 3. IC3's internal clock which controls the LCD segments and backplane is also used as the trigger for resetting the counter and starting the transmission sequence. Its rate is set by capacitor C3 to approximately 4Hz.

The oscillator, whose pulses are counted by IC3 during the transmission/echo return period, is formed around the Schmitt inverter IC1f and has its clock rate set by capacitor C5, resistor R6 and preset potentiomenter VR3. The rate is determined by the speed of sound through air and whether the readout is to be in feet or metres.

Sound travels at about 331·4 metres per second (through dry air at 0°C and 1013·25 millibars atmospheric pressure). Consequently, for a metric readout with an accuracy of 0·1 metres, the oscillator should run at 1657Hz (331·4 x 10 / 2). For imperial measurements (feet) the oscillator rate is increased by 3·28 to 5435Hz.

However, precise frequency measurement of the oscillator is not necessary since preset VR3 can be set by comparison of the readout against a known distance. It is not practical in a simple unit to adjust the clock rate to compensate for changes in air temperature and density, nor would it have any significance in this short-range application.

Counter resetting occurs when IC3 pin 33 is taken low and is controlled by the backplane clock inverted by IC1d. The same phase stops the count oscillator by taking its input pin 5 low via diode D7, ensuring that the oscillator always starts at the same point in its output phase. If the oscillator were simply allowed to run freely, pulse count totals for a given distance could differ erratically, by about two pulses.

At the end of the reset pulse, IC3 counts the pulses from IC1f but does not show the result on the LCD until the Store input pin 34 is taken low when an echo pulse is detected. An echo pulse causes the output of IC2c to go high, allowing capcitor C12 to charge via diode D6 and resistor R4.

When C12 has charged sufficiently, the output of IC1e is triggered from high to low, generating a negative-going pulse across capacitor C9 and resistor R3, causing IC3 to transfer the current count value to its internal register and the LCD. Simultaneously, the output of IC1e also takes IC3's Inhibit pin 31 low so stopping the counter.

Diode D4 prevents the occurrence of a secondary store pulse when IC1e pin 8 reverts to high. As will be seen, an additional circuit terminating in diode D5 prevents IC3 from responding to premature pulses from IC2c.

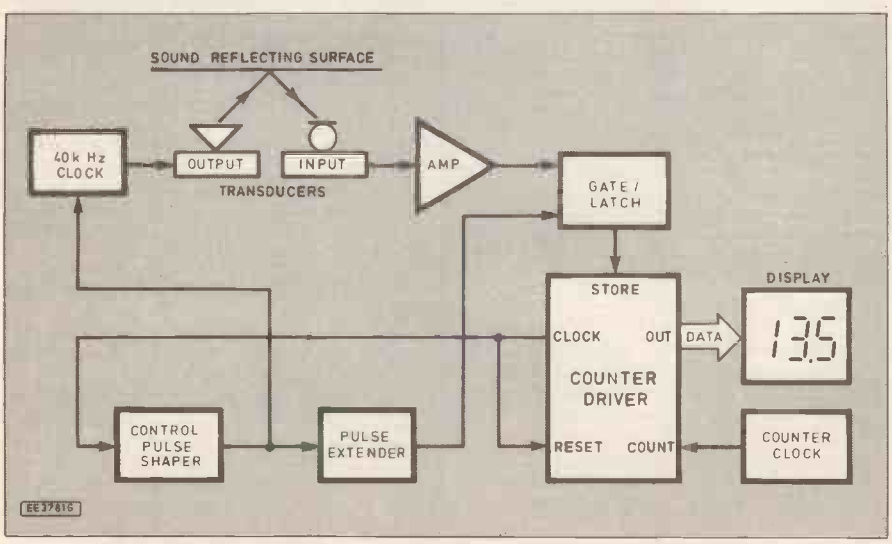
TRANSMITTER

The 40kHz transmission frequency is generated by the circuit consisting of Schmitt trigger IC1a, capacitor C1, resistor R1 and preset VR1, the latter fine tuning the oscillator. IC1b inverts the clock phase and the Transmitter TX1 is driven in push-pull mode by both IC1a and IC1b.

Transmission is pulsed at a rate and duration controlled by the LCD backplane clock and the circuit around IC1c. The squarewave output from IC3 pin 5 is differentiated by C2 and R2 to create short negative-going pulses on input pin 13 of the Schmitt inverter IC1c. Diode D2 coupled to the positive line prevents pulses from being generated by the positive-going clock phase.

In the absence of a clock pulse, IC1c's output pulls the input to IC1a low via diode D1, thus stopping the 40kHz oscillator. The oscillator functions normally when IC1c pin 12 is pulsed high, transmitting its signal via TX1 for the duration of the pulse, typically for around 0.8 milliseconds.

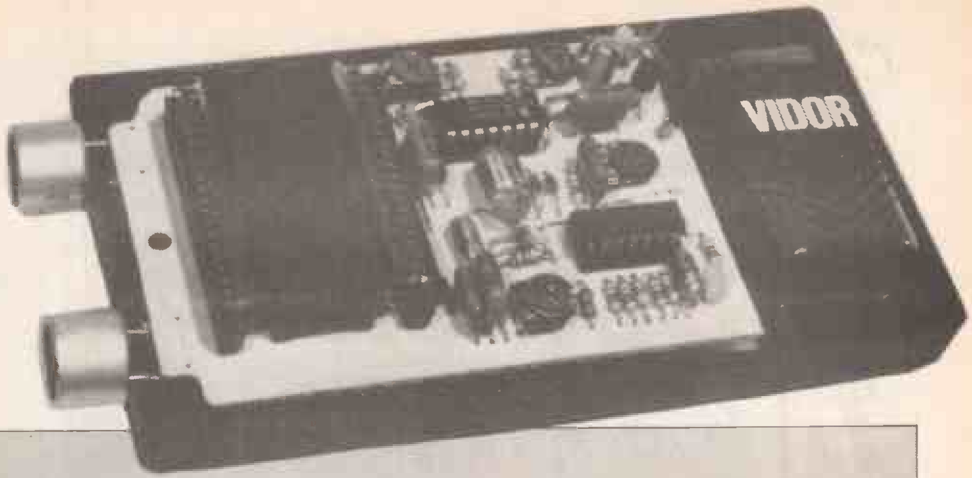
Fig. 1. Block diagram for the LCD Ultrasonic Tape Measure.



RECEIVER

Objects in the path of the transmitted pulse train reflect the signal back to the Receiver RX1. The signal is amplified by IC2a and IC2b, which have gains of about 100 and 47 respectively, and passed to comparator IC2c.

Preset VR4 in series with resistors R13 and R14 controls the comparator's sensitivity, setting the reference level so that the output is triggered from low to high even when low amplitude echo signals are received. As previously discussed, the comparator's output pulses cause the counter to update the LCD display.



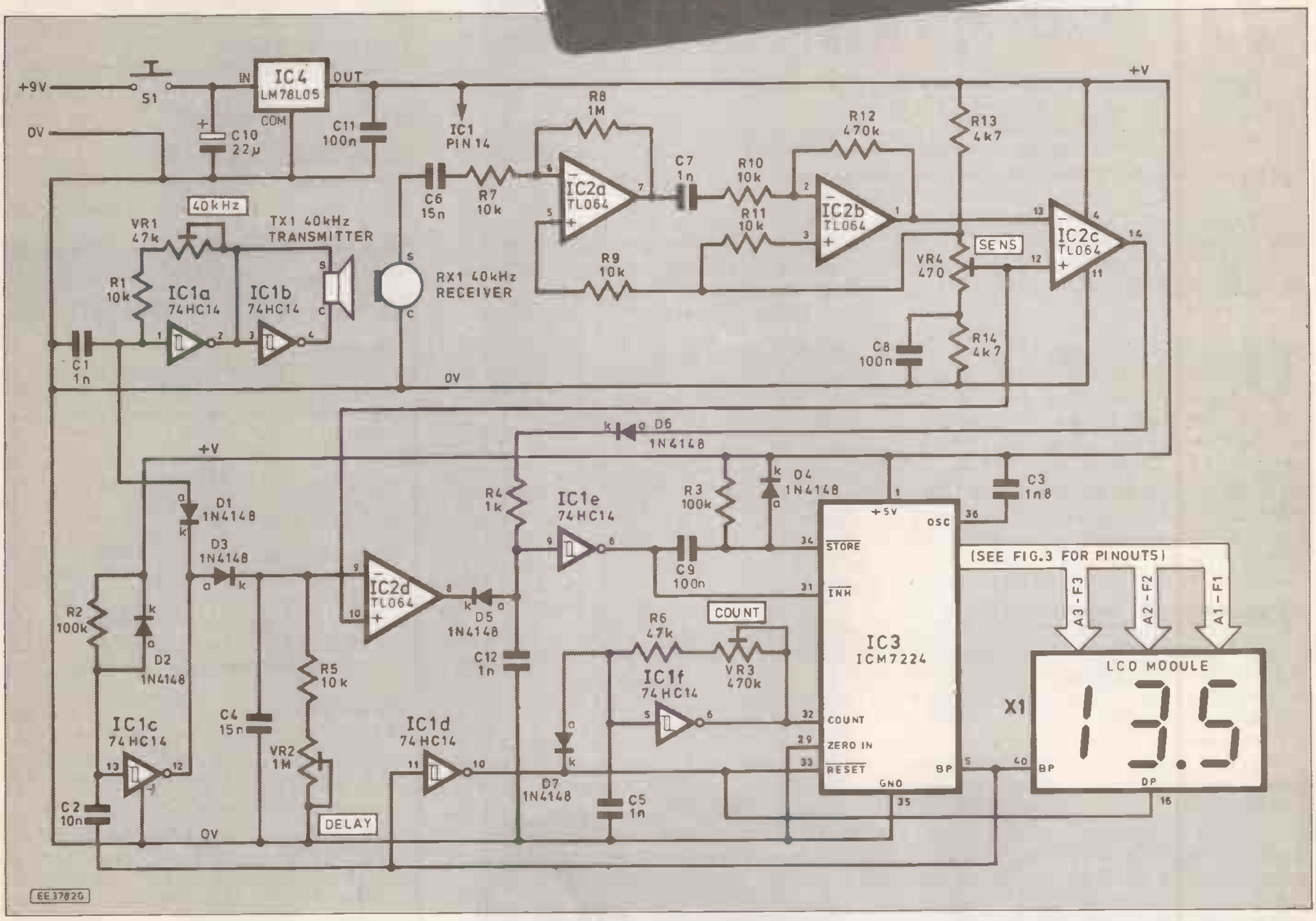


Fig. 2 (above). The main circuit diagram for the LCD Ultrasonic Tape Measure. Details of the counter circuit IC3 connections to the display can be seen in Fig. 3.

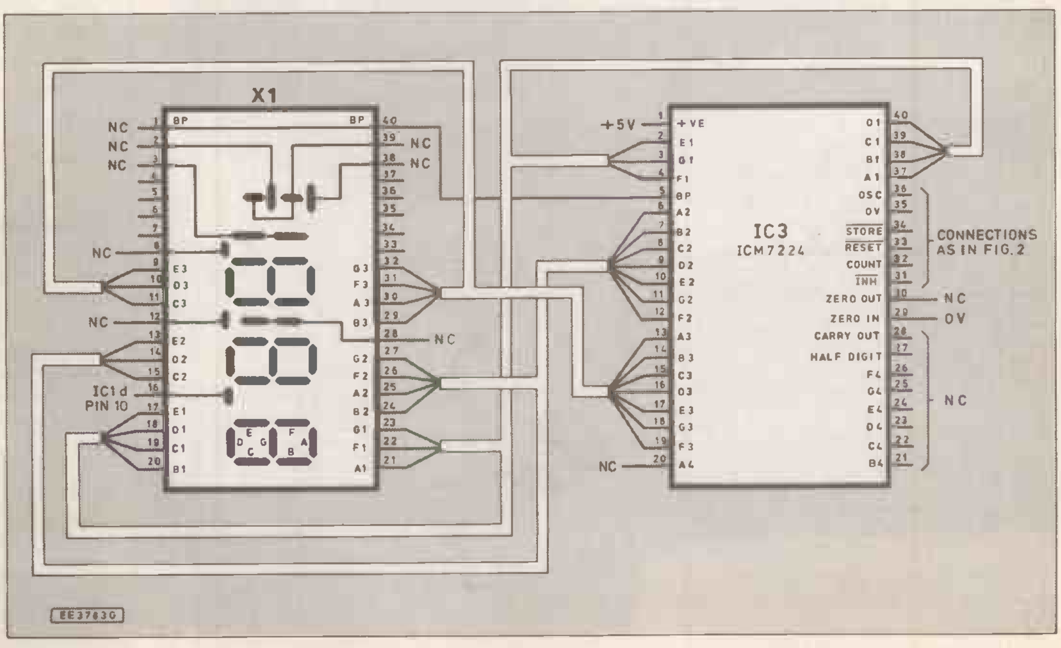


Fig. 3 (right). Details of the interconnections between the LCD display and the counter IC3.

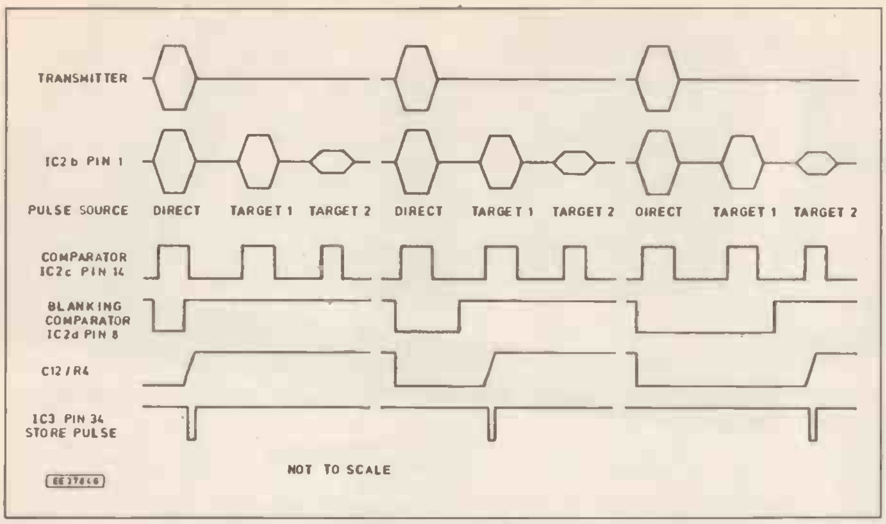


Fig. 4. Foreground blanking principle. How different echo-blanking periods, controlled by IC2d, affect counter-store triggering.

The amplifier circuit (IC2a, IC2b) has a very high gain and is naturally prone to undesirably picking-up signals while they are being transmitted by TX1. If this situation were to be left uncorrected, the counter would be triggered prematurely, resulting in incorrect display values.

An inhibitory circuit, based around IC2d, has been included to stop the counter from responding to the transmission output. It also allows the unit to be set to ignore echo signals received from nearby targets, so giving it a range more distant than commonly found with ultrasonic measurers. Fig. 4 shows the principle.

When IC1c pin 12 goes high during transmission, it also causes a positive level to be sent via diode D3 to input pin 9 of the comparator IC2d, simultaneously charging capacitor C4. The comparator's reference level on pin 10 is the same as that supplied by preset VR4 to IC2c.

For the duration that the voltage on IC2d pin 9 is above the reference level, IC2d pin 8 will be held low which, via diode D5, prevents trigger pulses from IC2c being allowed to affect IC1e. Consequently, IC3's store input cannot be triggered during transmission.

Capacitor C4, resistor R5 and preset VR2 have been included to extend the inhibition period beyond the transmission length. When IC1c pin 12 goes low at the end of transmission, C4 begins to discharge via R5 at a rate set by VR2. Only when the charge on C4 has fallen below IC2d's reference level will IC2d pin 8 go high, thus allowing IC1e to respond to any echo pulses from IC2c.

Components R4, C12 and D6 serve a double purpose. They prevent IC1e from responding to brief transient signals from IC2c, noise for example, and secondly they prevent IC1e from reacting to multiple-echo signals. On receipt of the first major echo signal after IC2d pin 8 has reverted high, capacitor C12 charges up and remains so until discharged via D5 at the start of the next transmission cycle.

Occasionally, there can be situations when no single echo signal is powerful enough to trigger IC1e, but in which several very small echoes cause C12 to additively charge above the necessary level. This can sometimes result in the display being updated even though no primary target has been detected.

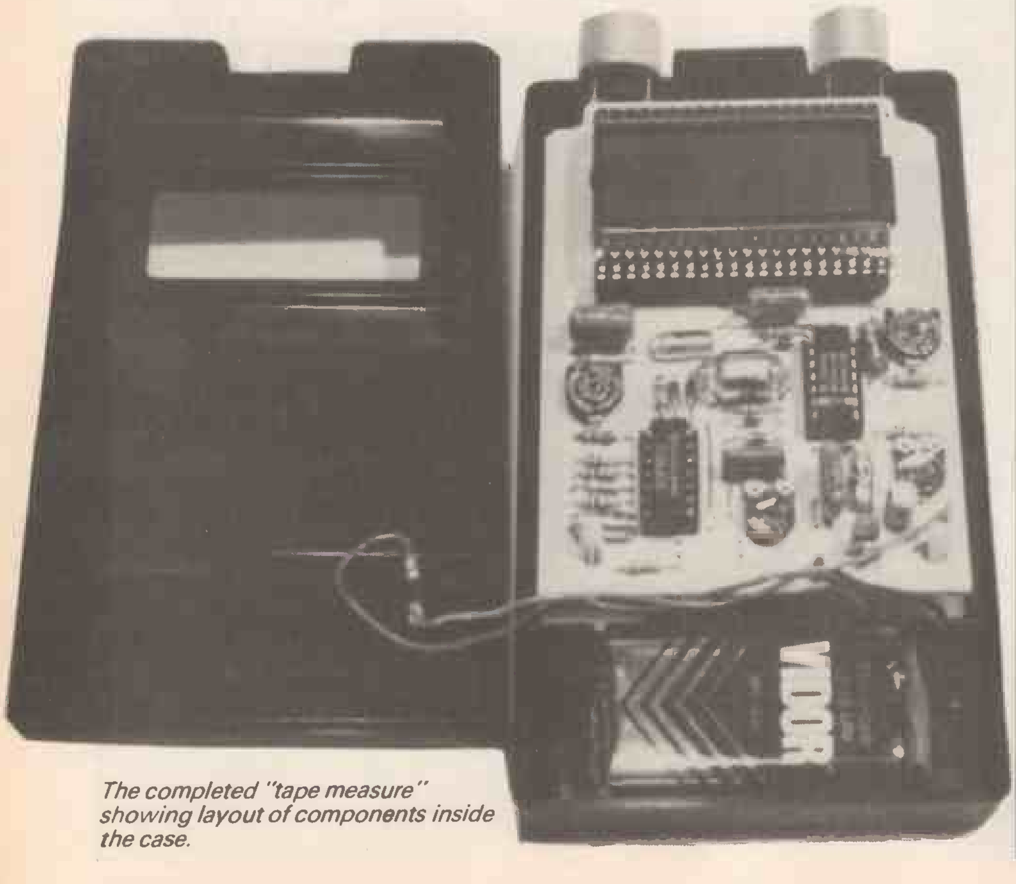
POWER SUPPLY

A PP3 nine volt battery is the unit's power source and is switched on by the push-button switch S1. IC4 regulates the 9V down to 5V to suit the limits of IC1 and IC3.

The current drawn is only about 6.5mA. A rechargeable Nicad battery may be used instead of a disposable PP3.

ASSEMBLY

Printed circuit board topside component layout and full size underside copper foil



The completed "tape measure" showing layout of components inside the case.

COMPONENTS

Resistors

R1, R5, R7, R9 to R11	10k (6 off)
R2, R3	100k (2 off)
R4	1k
R6	47k
R12	470k
R13, R14	4k7 (2 off)

All 0.25W 5% carbon film or better

See SHOP TALK Page

Potentiometers

VR1	47k
VR2	1M
VR3	470k
VR4	470

All min. skeleton preset, horizontal

Capacitors

C1, C5, C7, C12	1n polystyrene (4 off)
C2	10n polystyrene or polyester
C3	1n8 polystyrene
C4, C6	15n polyester (2 off)
C8, C9, C11	100n polyester (3 off)
C10	22µ elect.16V

Semiconductors

D1 to D7	1N4148 signal diode (7 off)
IC1	74HC14 Hex Schmitt trigger inverter
IC2	TL064C quad low-power op.amp.
IC3	ICM7224IPL 4½-digit counter
IC4	78L05 +5V 100mA voltage regulator

Miscellaneous

X1	3½ digit LCD display
S1	Single-pole push-to-make, release-to-break switch
TX1	40kHz transmitter } pair
RX1	40kHz receiver } pair

Handheld, calculator style, plastic case (with 50mm x 20mm window cutout), size approx. 148mm x 60mm x 36mm; 14-pin d.i.l. socket (2 off); 40-pin d.i.l. socket (3 off – see text); PP3 9V battery and battery connector; self-adhesive p.c.b. supports (2 off); single-core link wire; solder etc.

Printed circuit board available from *EE PCB Service*, code EE802.

Approx cost guidance only **£30**

master pattern details are given in Fig.5. This board is available from the *EE PCB Service*, code EE802.

A fine tipped soldering iron and thin solder (22s.w.g.) are recommended for the finely tracked areas. Dual-in-line (d.i.l.) sockets should be used for all the i.c.s. and the LCD.

The board has been designed so that the LCD display is mounted above IC3 but d.i.l. sockets to suit the LCD's pin spacing and height requirements seem to be unavailable. Consequently, two normal 40-pin sockets need to be cut lengthwise in half. Two of the strips are soldered into the board at the LCD position after which the second layer is plugged into the first to hold the LCD above IC3.

Solder in other components in order of link wires, resistors and diodes, preset potentiometers and then capacitors and the voltage regulator IC4. Pay particular attention to the polarities of the i.c.s, diodes and the electrolytic capacitor C10.

The 40kHz transducers are normally sold in pairs and marked accordingly as transmitter and receiver. Although ultrasonic transducers can often be used for the opposite purpose to that intended, in this application their correct function should be adhered to.

The transmitter transducer has a lower impedance than the receiver, allowing more power to be generated across it. It is also more sensitive to the correct setting of the transmission frequency as shown in the graphs of Fig. 6.

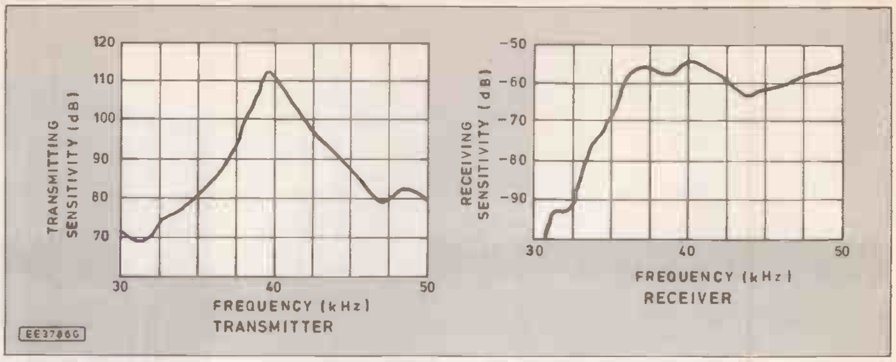


Fig. 6. Transmitter and receiver frequency response curves for typical 40kHz ultrasonic transducers.

On the rear of the transducers are two wire connections, one directly connected to the body, the other connected via an insulated entry point. It is preferable (though not absolutely vital) that the connections are made as indicated by the C (chassis) and S (signal) notations in Fig. 5. The transducer wires are soldered directly to the tracks on the rear of the p.c.b., allowing sufficient length for the bodies of the transducers to be outside the case as seen in the photographs.

Make sure that the transducers are correctly aligned with respect to each other. Small slots should be cut in the end of the case to allow the wires to pass through. When drilling the switch hole in the lid of the case ensure that clearance is allowed for the insertion of the battery.

CHECKING OUT

Before switching on, check all the soldered joints with a close-up magnifying glass, ensuring that there are no shorts between adjacent copper tracks. When power is first applied, immediately check with a multimeter that +5V is present at the output of the voltage regulator IC4. A voltage significantly higher than this will most likely indicate that IC4 is incorrectly inserted.

A much lower voltage could indicate excessive current being drawn, possibly because of an overlooked track short, or a polarity-conscious component inserted the wrong way round. In either instance, switch off immediately and recheck the assembly.

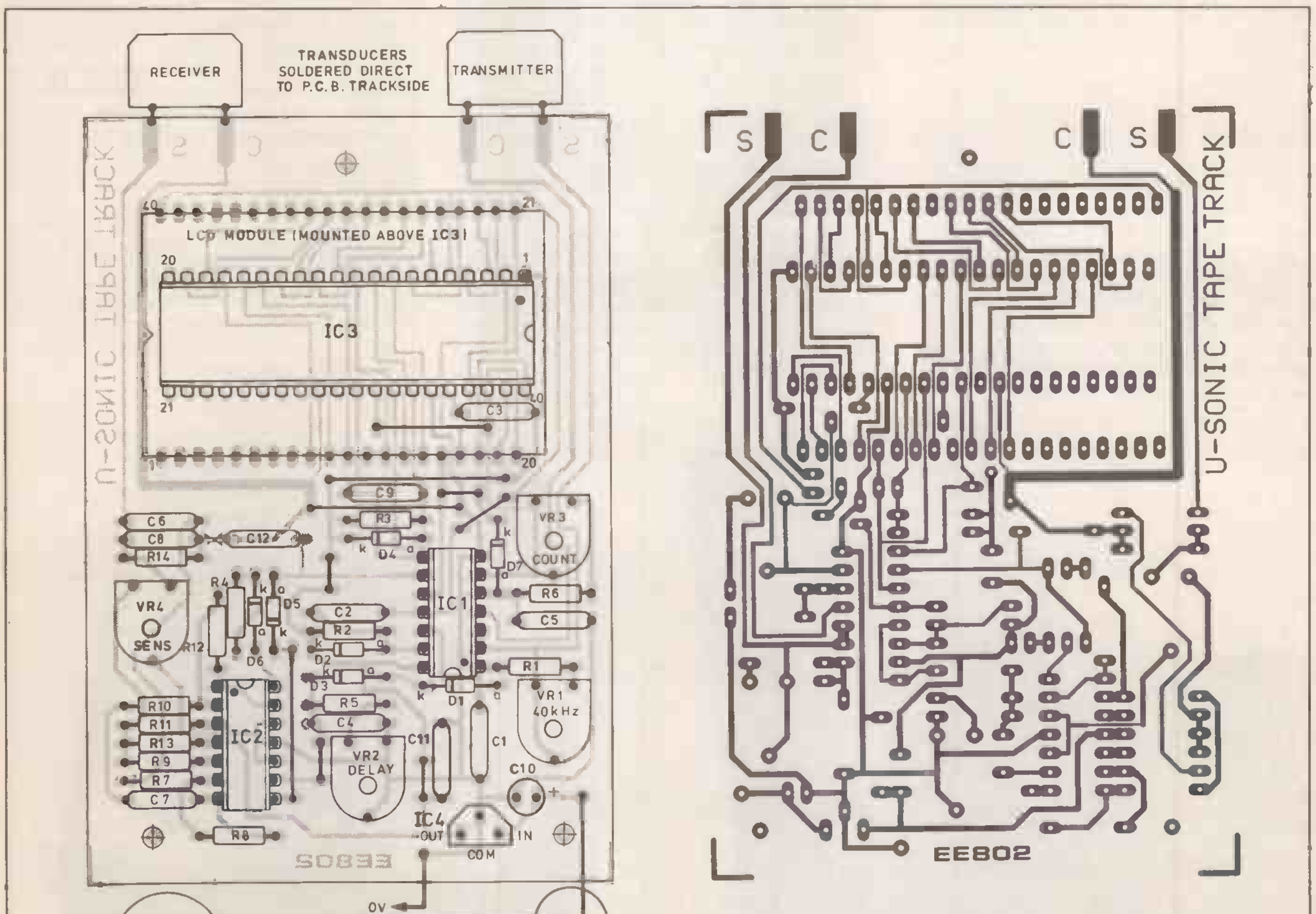


Fig. 5. Printed circuit board component layout and full size copper foil master pattern. Note that the "isolated" pin S (see base view) of the transducers must connect to the identical points on the p.c.b.

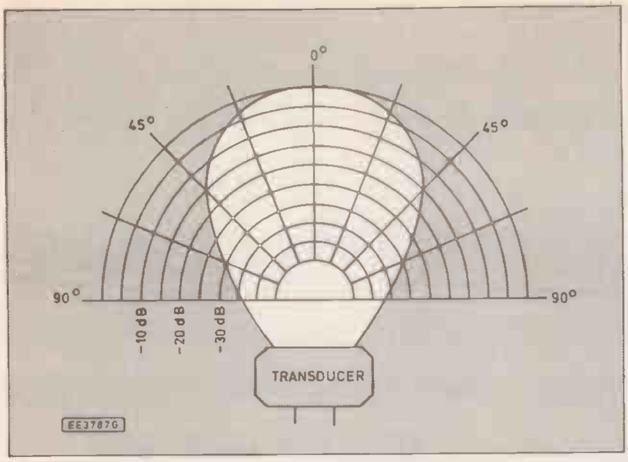
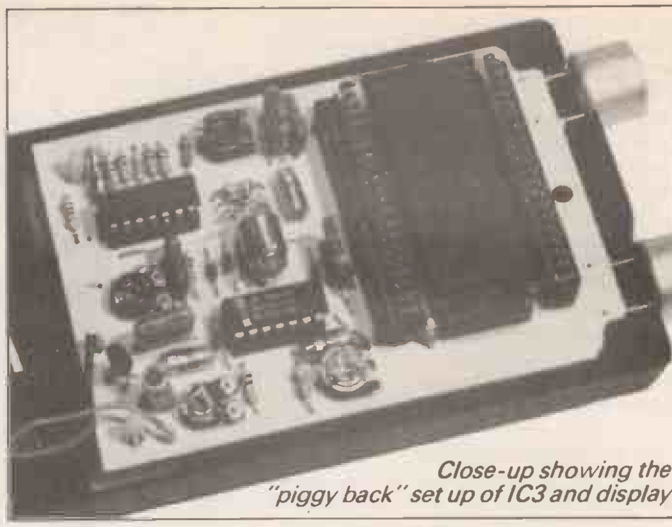


Fig. 7. Typical 40kHz transducer radiation response zones and powers.



Close-up showing the "piggy back" set up of IC3 and display

Once satisfied with the power supply, setting-up is made easier if the push switch S1 is temporarily bypassed by connecting a short wire across its terminals. Alignment can be done without test equipment by watching the LCD readout while making adjustments to the preset potentiometers. However, if you wish to monitor the circuit, the following are the easiest points to observe:

Set preset VR2 to minimum resistance and the other presets midway. With a multimeter or oscilloscope ('scope) monitor pin one or pin 40 of the LCD, both of which are backplane (BP) clock connections. Check that the pin voltage is changing up and down somewhere between 0V and 5V. The scope should confirm that the swing is fully 0V to 5V and at a rate of about 4Hz.

Meters, because they respond more slowly, will only give a general indication that there is a reasonable swing occurring at a slow rate. In this instance, an analogue meter is better than a digital one. Check that a similar rate and amplitude of swing occurs at IC1 pin 10 and IC2 pin 8.

Only a scope can confirm that the transmission and count oscillators are being pulsed so assume that they are functioning correctly and check the echo detector circuit. Point the unit towards a good sound-reflecting surface about two metres (six feet) away and monitor IC2 pin 14.

Adjust preset VR4 until the meter shows a maximum reading of about 4V. This should confirm that signals are being received but that the comparator is being tripped too readily. Reduce the setting of VR4 until the meter shows a reading of about 0·8V. A scope will confirm that echo signals are being processed, causing IC2 pin 14 to be pulsed high on their detection.

It should now be apparent that IC3 is counting, storing and being reset. Next check that the receiver is responding to echo signals and not to the actual transmission signal.

Point the unit towards large hard objects at varying distances and verify that the LCD readout responds to the changes. If necessary, increase VR2's resistance to lengthen the period within which IC3 should not respond to echoes. Progressively move the unit further away from a single target and very carefully adjust preset VR4 to give the comparator maximum sensitivity to distant echoes.

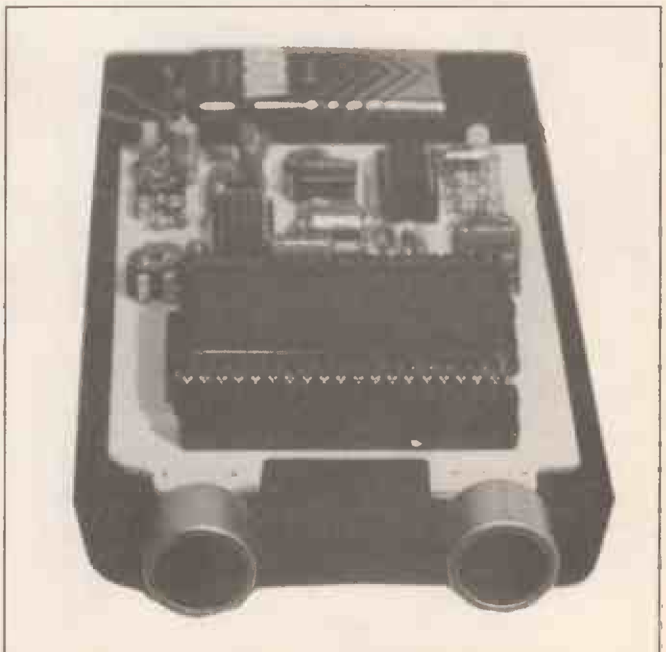
If the transmission oscillator has not been tuned on a scope, try adjusting preset VR1 as well as VR4 to extend the range. Experiment also with various settings of VR2 to extend or shorten the blanking period. As the oscillator is not temperature compensated, in practice its frequency may drift slightly, affecting the maximum distance detectable.

Now place the unit in a fixed position facing a target at close to the maximum detection distance. With an ordinary measuring tape, measure the exact distance between the transducers and the target. Remove objects from any place which might fall within the transmission zone. The typical radiation pattern for a 40kHz transducer is shown in Fig. 7. Keeping the unit stationary, adjust preset VR3 until the LCD shows the exact distance of the target to the nearest decimal point, either in metres or feet as preferred.

IN USE

It will be found that a compromise setting of VR2 must eventually be decided upon to give maximum distance detection while still allowing reasonably nearby objects to be registered. In the test model, the minimum response distance was set to about 1·1 metres (3·5ft), allowing a maximum target distance of about 9·1 metres (30ft). The latter, incidentally, has also been achieved in the open air, aiming the unit across the garden at glass patio doors.

When using the unit make sure that other objects in the vicinity of the transmission zone do not cause false readings. Also be aware that in some surroundings multiple echoes generated by one transmission pulse could be picked up during the reception period of the next pulse. □



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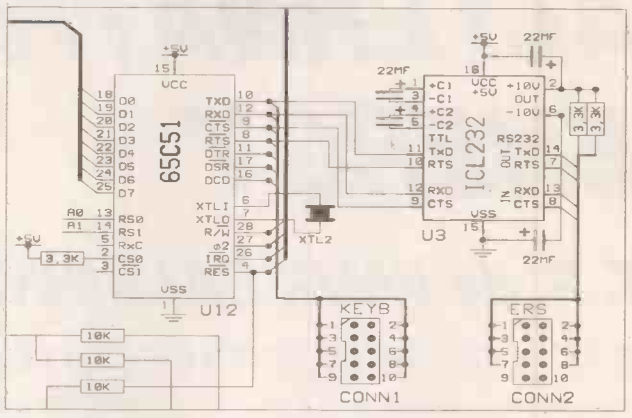

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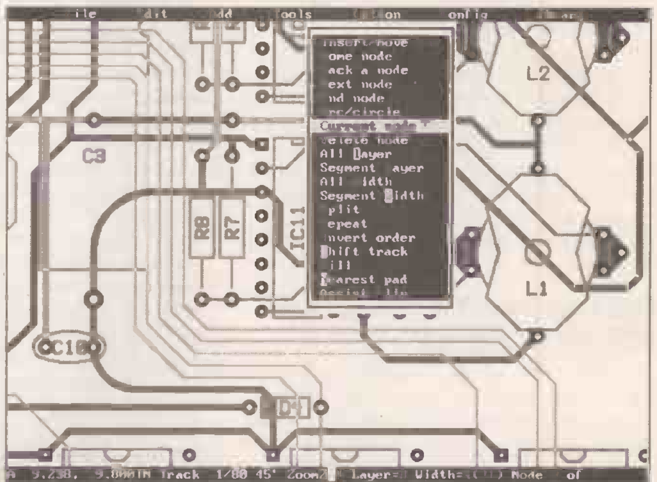

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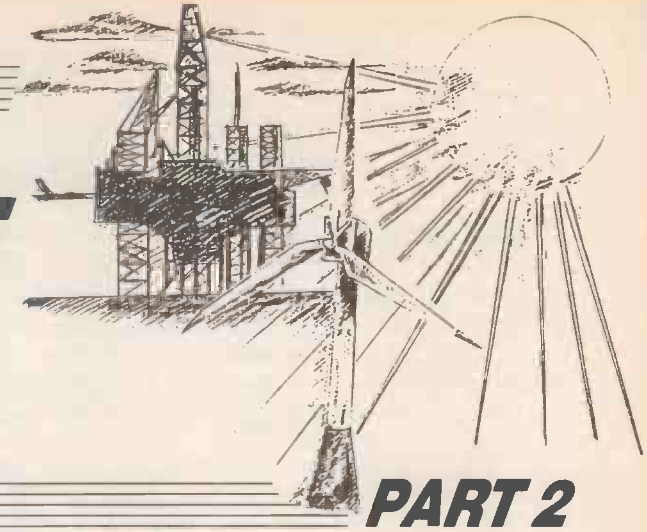


ALTERNATIVE ENERGY

T. R. de VAUX BALBIRNIE PART 2

Is the answer blowing in the wind?

LAST month we looked in general terms at the problems of providing the world's energy needs into the 21st century. This month we shall look in detail at the problems associated with fossil fuels and go on to examine one established alternative energy technology – wind power.

For many years the world has relied heavily on fossil fuels (coal, oil and natural gas) and more recently on uranium (for nuclear power generation) to supply almost all its energy needs. In Britain today, most electricity is generated by using coal. This is burned in furnaces to provide heat, boil water, raise high-pressure steam and turn the blades of turbines. These operate generators which make electricity to be sent out on the National Grid.

HERE TODAY NONE TOMORROW

In the past, steam engines were used *directly* to provide the power for industry. Today, the internal combustion engine has replaced the old-fashioned steam engine to provide inexpensive road and rail transport and the jet engine has revolutionised air travel. All these devices use fossil fuels. The technology is well-developed, safe, relatively simple and inexpensive.

Our dependence on fossil fuels began in 1698 when Thomas Savery made the first practical steam engine. Its purpose was to pump water out of mines. In 1711, Thomas Newcomen, an English blacksmith, developed the design and by the mid-18th century, James Watt had improved it to the point where it could be used directly for many large-scale manufacturing processes such as weaving and printing.

Steam power was to seed the Industrial Revolution and turn Britain from a mainly agricultural country into a major manufacturer of cheap goods to be traded throughout the world. Man had for the first time found a reliable way of doing his work without using beasts of burdon, his own muscle power, the waterwheel or the windmill.

Steam reigned supreme and there seemed to be a never-ending supply of cheap fuel to keep the wheels of industry turning. No one was concerned about environmental issues such as clean air so no care was taken to seek ways of burning the fuel efficiently. The combustion process therefore caused much dirt and smoke to be poured into the atmosphere.

Health problems were rife together with problems of crumbling buildings, black stonework, filthy rain and thick black fog. This continued until recent times. So bad was the problem that a London *smog* (Smoke and fog) killed 4,000 bronchitis sufferers in 1952.

NUCLEAR PROMISE

The nuclear power station at Clader Hall opened in 1956 with a power output of 200MW (a small amount by today's standards). This brought the promise of cheap power without the pollution caused by coal. The new technology was eagerly pursued as a source of heat for raising steam which could then operate conventional turbines and generators to make electricity. However, nuclear power brought its own problems – disposal of nuclear waste and the possibility of some catastrophic accident such as that which happened recently at Chernobyl.

Coal began to enjoy confidence once again as the *safe* fuel and with coal reserves in Britain possibly good for a further 200-300 years, its future seemed assured. The Clean Air Acts of 1956 and 1968 forced more efficient combustion methods and the use of devices such as *electrostatic precipitators* (see Fig. 1) to remove almost all the flue ash and black smoke from the chimney stack emissions. A typical power station produces approximately 30 tonnes of ash per hour which would otherwise go into the atmosphere.

NOT KING COAL

More recently, opinion has turned against coal and the other fossil fuels once again for there is now known to be a far more serious problem associated with their use. Although the *visible* material has been cleaned out of the flue gases, its purity is an illusion. In burning fossil fuels, millions of tonnes of *carbon dioxide* are discharged into the atmosphere each year. Carbon dioxide (CO_2) is a *greenhouse gas* and although it allows the sun's rays to pass through the atmosphere to the earth quite easily, its effect is to prevent them from travelling back again so readily.

When the solar energy falls on to the earth about 30 per cent is reflected back into space. If this is prevented from happening to some extent, the heat energy will be trapped rather like a greenhouse where sheets of glass serve the same purpose (Fig. 2). Carbon dioxide is produced because coal consists of impure carbon and when this

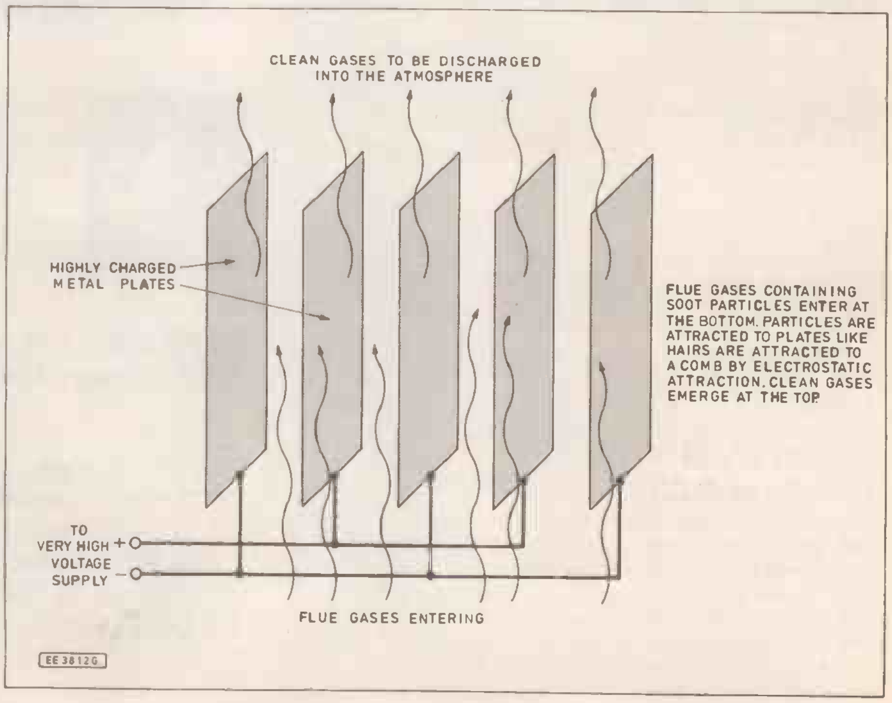


Fig. 1. Method of operation of electrostatic precipitators.

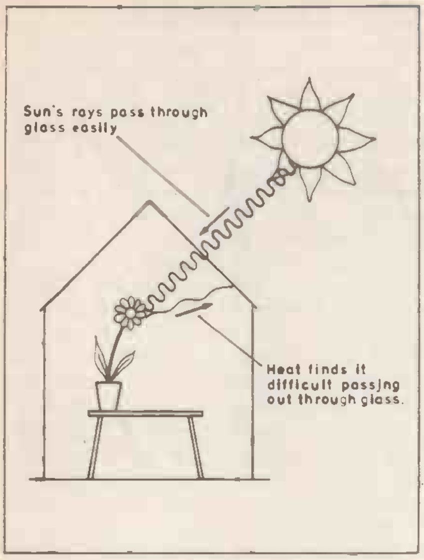


Fig. 2. The greenhouse effect.

burns in the oxygen of the air, carbon dioxide is formed. This is a fundamental chemical process and cannot be prevented by any known means.

If we wish to continue burning fossil fuels, we simply have to put up with it. Each kilowatt-hour of electricity (the energy required to operate, for example, a single-bar electric fire for one hour) generated using coal produces approximately one kilogramme of carbon dioxide.

GREENHOUSE GAS

Electricity generation in conventional (that is, non-nuclear) power stations is responsible for one-third of the total carbon dioxide released by burning fossil fuels. Taking into account that generated by transport burning petrol and diesel fuel (both of which are derived from oil), also for central heating systems and so on, more than *five billion tonnes* of carbon dioxide annually are discharged worldwide into the atmosphere (in 1950 it was less than two billion tonnes). Whereas 100 years ago, there were less than 300ppm (parts per million) of carbon dioxide in the atmosphere, now there are some 350ppm – an increase of over 16 per cent.

The factor which is not yet fully understood is how much carbon dioxide will eventually dissolve in the oceans and therefore be effectively removed from the equation. There are widely differing estimates of this. Cutting down the forests and clearing the land of green plants compounds the problem because it reduces *photosynthesis* – the natural process by which carbon dioxide is turned into starch by the chlorophyll in green leaves accompanied by the re-release of oxygen.

GETTING YOUR OWN BACK

It is sometimes argued that when we burn coal, we are just getting back the carbon dioxide which was taken up by the trees in the first place i.e. during photosynthesis. This is true but the problem is one of *scale*. It took millions of years for the enormous number of trees to grow to give us coal so the carbon dioxide was taken up over a long period of time. However, we are burning coal at a rate far exceeding the time taken for the trees to grow – some 3,000 million tonnes per year worldwide – so carbon dioxide is being returned to the atmosphere at a correspondingly enormous rate.

One possible consequence of the greenhouse effect is *global warming*. One hundred years ago, the average world temperature was approximately 14.5 degrees. Today, it has risen by about one degree. However, with the increasing use of fossil fuels some scientists believe that it could produce a rise of some four degrees over the next 50 years or so. This may sound very little but if it were allowed to happen, it would probably be the fastest change in the world's climate for several million years.

At first sight, a small rise in temperature seems attractive, especially in Britain where a few degrees more in summer and winter could make the climate more agreeable. However, this reasoning misses the point that global warming would cause a general raising of the level of the oceans – that is, increasing *sea level*. This could happen for two reasons. Firstly, warm water occupies a larger volume than cold water – that is, it *expands*. Also, a higher world temperature would melt some of the polar ice caps where vast reserves of water are stored quite harmlessly at the moment.

Again, this may not seem to be of much consequence but we must remember that there are large areas of the world's surface which are only marginally above sea level and these would be flooded. Holding the water back over such large areas would itself need prohibitive amounts of energy.

Scientist make widely differing estimates of the scale of the problem but it could be a fairly profound one. A small increase could put much of East Anglia below water, for example.

It is interesting to look at carbon dioxide emissions due to the various technologies used for electricity generation (see Table 1). This will give an idea of their contribution to the greenhouse effect. Note that these figures take account of *all* sources of emission from extraction of the fuel itself (if necessary) and during construction of the plant as well as actual operation.

TABLE 1

Method	CO_2 – tonnes per thousand-million kWh
Coal	751-964
Natural gas	484
Geothermal (hot rocks)	57
Hydroelectric	5-10
Nuclear	8
Wind	7
Solar cells	5

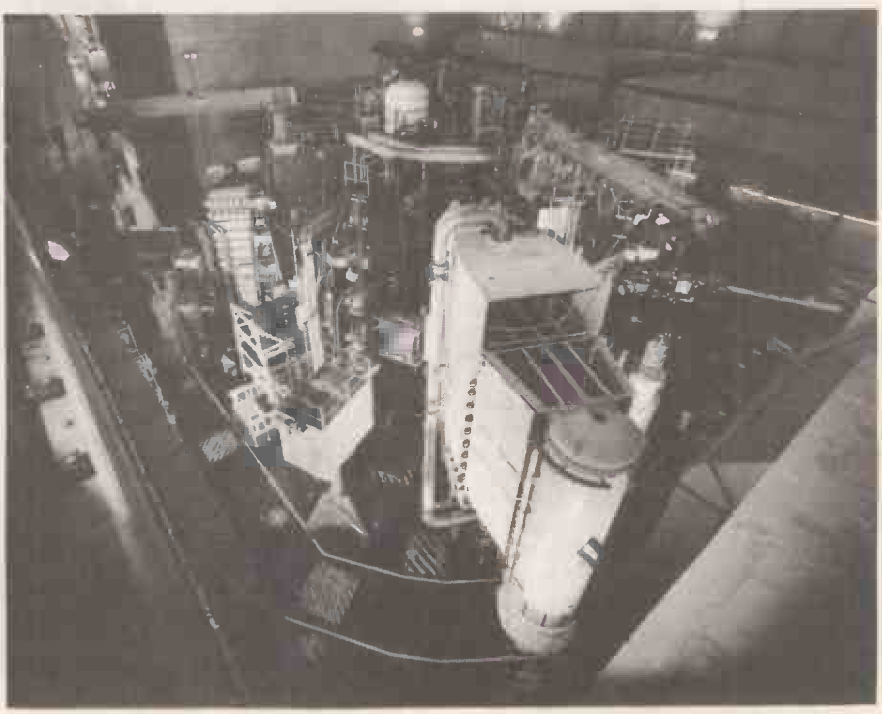
As well as carbon dioxide, burning coal produces other unpleasant pollutants chief of which are the gases *sulphur dioxide* and *nitrogen dioxide*. When these are dissolved in water, acids are formed and these cause problems of *acid rain*. Scandinavia sees the effect on its trees of acid rain produced by our sulphur dioxide carried over on the prevailing wind. At some cost, these gases can be removed – although a reduction of 90 per cent would involve an increase of 5 per cent in the cost of electricity. Recognising that there is a problem, Britain is committed to reducing sulphur dioxide emissions by three-fifths by the year 2004.

ENERGY EFFICIENCY

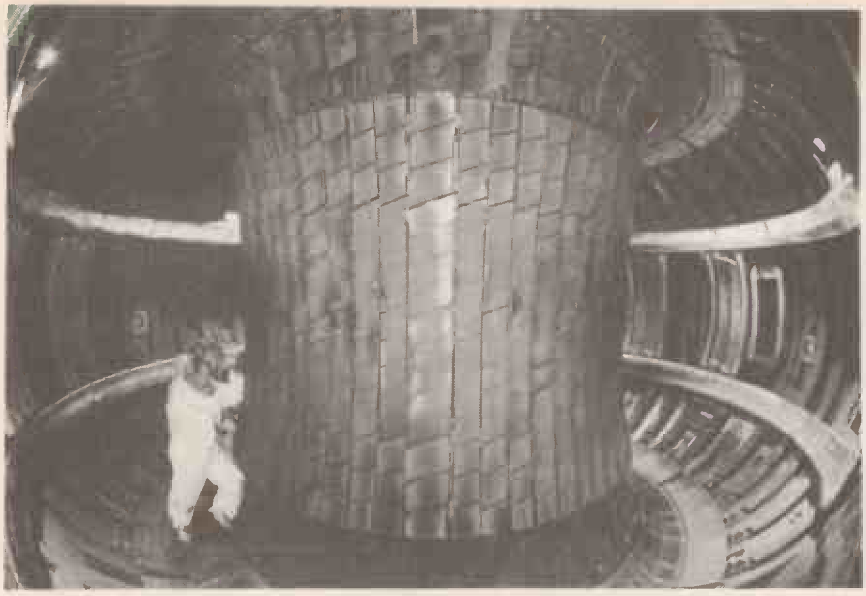
No one disputes that fossil fuels will be used for many years to come. Friends of the Earth acknowledge that they cannot be phased out abruptly. However, most scientists agree that fossil fuels will need to be used in moderation and with much more respect in the future.

Less coal would be needed if we worked towards greater energy efficiency in the home, in commerce and in industry. Ideas such as better household insulation, more efficient transport and lower space heating temperatures would help but there is obviously a limit to what can be achieved. Another parallel approach is to seek alternative ways of providing energy without the need to release greenhouse gases.

Nuclear fission – that is, nuclear power as used at the moment supplies 16 per cent of



A general view of the JET vessel designed to develop nuclear fusion.



Inside the JET vessel.

Britain's electricity. Increasingly this contribution is a possible way forward. Belgium and Sweden generate 50 per cent of their electricity and France 66 per cent of it in this way. However, there are continued concerns about its safety. Also, taking into account *true* costs rather than apparent ones (for example, the energy needed to build the plant in the first place, the true cost of disposal of waste and clearing up the site when the life of the reactor is over) actually means that nuclear power could be an expensive way of generating electricity compared with other technologies.

NUCLEAR FUSION

A piece of recent news is the reported achievement of controlled *nuclear fusion*. The idea is to *fuse* hydrogen atoms together to make helium. This releases an enormous amount of energy and is, in fact, how the sun works. Up until the present time, the only way of achieving nuclear fusion was in a hydrogen bomb – i.e. all the energy released in an uncontrolled burst. Now, scientists working on the JET (Joint European Torus) project in Oxford – an experiment funded and operated by a group of European countries – are said to have achieved controlled and prolonged nuclear fusion.

Unlike nuclear *fission*, fusion is *clean* – that is, almost totally non-polluting. Also, it uses only water as its raw material. Since there is practically an unlimited supply of this, nuclear fusion may be regarded as renewable energy technology. Although nuclear fusion does not work by using the sun's energy, it could rival all other direct and indirect solar energy production methods in the long term. However, there are many unknowns.

The technology to build a nuclear fusion power plant is still a long way off – perhaps 50 years or more – so it leaves ample scope to develop other forms of alternative energy for the short and medium term.

THE CONTENDERS

Last month we saw that *direct* use of solar power for large-scale electricity generation is something of a long-shot – especially in Britain. A more likely way forward is to use natural phenomena which have turned the sun's energy into a form more easily reached by cheap and well-known technology.

Short-term contenders in the alternative energy stakes are hydroelectric power (the energy of falling water), burning landfill gas and solid waste, wave power, biomass (burning crops as fuel), geothermal energy (using hot underground rocks), wind power and tidal energy. These are described as *renewable energy sources*. By this we mean they are *everlasting* – they do not rely on burning the *fossil fuels* which, apart from the problems mentioned previously, will eventually run out.

It is unlikely that only one alternative energy method will be the answer. All methods must be looked at in economic terms as well as considering possible detrimental effects on the environment. A tidal barrage at the Severn could contribute the equivalent of two large conventional power stations but there could be a profound effect on wildlife in the area. It could kill thousands of birds and destroy the habitat of many more.

Let us now look in detail at *wind energy* as an example of a well-developed renewable energy source.

WIND ENERGY

Wind energy has been used for thousands of years – to carry ships around the world and, of course, in the form of the familiar *windmill* for grinding corn and pumping water. There is some evidence for windmills having been used in the Middle East around 2000 B.C. Corn-grinding windmills certainly existed in Persia (Iran) in the 7th century A.D. while in the late 11th century the windmill appeared in England.

During the 12th century the Dutch, Germans, Danes and others developed the design of windmills to a form similar to that which was in general use in Britain until relatively recently. In Holland, during the 19th century, there were over 1000 large corn-grinding windmills. The chief problem with these has always been that the wind is not always reliable in terms of strength or direction. Also, in a gale the windmill could be easily damaged.

More recently developed windmills have been used for driving small electrical generators. These can charge batteries which may then operate lighting or power emergency radio equipment. These are still important uses today. Small wind turbines (between one and three metres in diameter) produce between 50W and several kilowatts depending on the wind speed. These have been useful for providing small-scale power in remote regions. However, it is only recently that large commercial wind turbines have been produced relatively cheaply and which are capable of producing a significant amount of electrical power.

Now, under the *non-fossil fuel obligation*, the government requires electricity boards to buy electricity generated by non-conventional means. With such access to the national Grid possible, advantage has been taken by several commercial organisations in the UK. Thus, a company can generate electricity for its own use, sell excess capacity on to the National Grid and purchase from the grid when, for example, there is insufficient wind to meet the demand.

A wider and more serious view has been taken by countries which have traditionally relied more on the wind than ourselves – Denmark, Holland and Belgium. France has little wish to use wind power

A traditional windmill at Alford, Lincolnshire. (John Howard/Science Photo Library)

North of Scotland Hydro Electricity Board's 3MW wind turbine at Burgar Hill, Orkney. At 45 metres tall it is one of the largest turbines in the world. It has variable pitch tips and rotates at 34 r.p.m. (Michael Marten/Science Photo Library).

since, as mentioned previously, this country has a well developed large-scale nuclear energy programme. Germany, Spain, Portugal, Greece, Italy and the UK all have operational wind-energy projects.

The largest wind generator constructed in the UK and one of the largest in the world is the Wind Energy Group's 60m diameter LS-1 with a generating capacity of 3MW. This was installed on Orkney in 1987 and serves about 2000 people. The larger wind turbines, however, turn out to be much too expensive for general use and smaller ones producing somewhere between 250kW and 500kW and having a diameter of up to 40m, are becoming the norm. Since a large coal-fired power station can generate in excess of 1000MW, it would need 400 of the 250kW wind generators to produce the same amount of power.

DOWN ON THE FARM

One strategy is to group turbines together in *wind farms*. These may then extract the diffuse wind energy over a large area. There must be sufficient space left between the units if they are to have their own wind supply and operate effectively. This can mean very large areas of land being used. In practice this involves leaving about 300m between units.

Taking into account the access roads which are needed for repair and maintenance, for the equivalent power output of a 2000MW large coal-burning power station, an actual area of $7km^2$ – or around 2000 acres – would be needed for the turbines themselves. However, these would be spread over a total area of $500km^2$ (i.e. providing 4MW per km^2) so over 98 per cent of the land could still be farmed in the traditional way.

Large wind farms are operational in the United States – in California, 18,000 wind turbines of approximately 80kW each, are providing a total power output of 1400MW. These have provided European researchers with much valuable information.

Colin Moynihan, then Minister for Energy, re-iterated the Government's support for alternative energy in September, 1990 – "It is very important to place emphasis on the renewables". Privatisation of the generating and distribution industry has provided a whole new dimension and under the *non-fossil fuel obligation*, progress has been maintained.

Under a non-fossil fuel contract, a medium sized wind turbine costing £1000 per kW would break even with a 15 per cent rate of return on investment with an average wind speed of 7.5m/s. This is not particularly high and Britain has $500km^2$ of useable land with a mean windspeed greater than this. Given that turbines would be erected to provide 4MW per km^2, Britain has an economic capability to generate 2,000MW or the output of one large conventional power station.

A further idea is to use *off-shore* wind generators and the Swedes and Danes are undertaking this type of research at the moment. In Britain, a prototype off-shore wind turbine is planned to be sited 5km from the Norfolk coast in the next few years. One advantage of putting the turbines off-shore, apart from placing them *out of sight, out of mind* is that wind speeds are generally higher and therefore each turbine produces more power. The disadvantage is the much greater construction and maintenance costs also the extra cost of the transmission cables. For this and other reasons, the official view is that off-shore wind farms are something of a long shot at the moment.

A BEAUTIFUL SIGHT

People who think that wind farms scattered around the countryside would look ugly and spoil the landscape, would be pleasantly surprised to see one. It is, of course, acknowledged that *beauty is in the eye of the beholder*. Modern wind turbines can be quite beautiful with their large sails moving slowly and gracefully. It is not generally known that the speed of rotation of the blades is typically only 40 revolutions per minute.

Others people worry about the possible noise from a wind farm. Again, such worries seem to be largely unfounded. There is, of course, some noise generated by the blades and also some mechanical noise from the generator and transmission itself. However, because the units are spread over a large land area, the noise at any given place is small.

Another objection – that of possibly endangering wildlife – seems, once again, to be groundless. There are few reported cases from the RSPB or any other body, of birds or other animals being harmed by rotating sails or driven away by the noise. There have been far more accidents to wildlife due to conventional sources of power.

The wind turbines are quick to install – they can be erected on site in 24 hours and be producing electricity the following day. Since construction is relatively quiet anyway, wildlife is not seriously disrupted. It is also found that, when construction is complete, any wildlife which has been frightened away usually returns.

POWER UP

Following a decision made in March 1988 to proceed with wind farm construction in Britain, the new generating companies, Powergen and National Power have taken this up and are each developing a wind farm at the time of writing. Each will comprise 25 medium-sized turbines, so each site will provide about 8MW of power – sufficient to serve 10,000 people.

We should remember that the production of a wind turbine plant itself uses energy – mostly fossil fuel energy – both for manufacturing and for transport of material. However, it can be shown that this energy is recovered after about one year of operation. After that, totally clean energy is supplied throughout the working life of the machine which is taken to be nominally 20 years but it is likely to turn out to be much more.

It is important when making cost comparisons that we treat like with like. The energy itself may be free but there are costs involved in extracting it. When *true* costs are compared, wind power is no more expensive than fossil fuel energy at today's prices and is considerably cheaper than nuclear power.

If we include hidden charges such as health costs caused by pollution, attending to oil spillages and so on, wind power turns out to be cheaper still. Furthermore, as the

Wind farm producing electricity at Altamont, California.
Peter Menzel/Science Photo Library).

technology is developed, wind energy costs are likely to fall by some 20 to 30 per cent in the short term.

With fossil fuel costs rising steadily, wind power is likely to prove ever more attractive in the future. Wind turbines need little maintenance and are very reliable. There is therefore little time wasted while the machinery is stripped down for repair.

CONTRIBUTION

It would be fanciful to imagine that onshore and off-shore wind turbines will supply a large proportion of the electrical energy needs of the UK although this would be possible – Denmark and Britain (in Scotland) have some of the best climates in Europe for utilising wind power. It is more realistic to set targets so that wind and other forms of alternative energy, gradually increase their total contribution and reduce our reliance on fossil fuels and uranium.

If a reduction of 20 per cent in the use of conventional energy sources were to be made, the actual cash saving would amount to some £7Bn a year and this does not take into account hidden savings and benefits to the environment which cannot be quantified. Table 2 shows the *technical* potential (rather than the economic viability) of various alternative energy sources for the UK as a percentage of total demand. If all these were exploited to their maximum, we could generate more than twice as much electricity than is actually required.

The European Community could easily meet at least 10 per cent of its total electricity demand (in 1990 this was 1,000,000MW) using alternative energy sources by 2030 – and this would be only 20 per cent of what could be reasonably achieved. One relatively painless strategy would be to increase the present 500MW contribution to 4,000MW by 2000, 115,00MW by 2005, 250,000MW by 2010 and 100,000MW by 2030.

TABLE 2

Technology	Potential % for UK
Wind energy – onshore	45
Wind energy – off-shore	50
Tidal	20
Geothermal	78
Wave	18
Hydroelectric	1
Landfill gas	2

Of the countries in the EC, Denmark, Holland, Germany, Italy, Greece and Spain have declared goals. Table 3 shows the July 1991 contributions of wind energy (installed capacity), in MW, in various EC countries. It can be seen that Denmark leads the way by a large margin. Worldwide, about 2000MW of wind power are currently installed – most of it in California.

TABLE 3

Country	Installed Capacity MW
Denmark	360
Holland	55
Germany	55
Spain	15
UK	10
Greece	5
Italy	5
Belgium	2
Portugal	3

Denmark's wind energy programme is remarkable. At present two per cent of her total electrical needs are generated in this way with a planned goal to generate 10 per cent of total demand by the end of the century. This country was the first to plan an installation programme of modern wind turbines in the late 1970's and since then has increased her total capacity by about 5MW per month. More recently, Germany and Holland have begun to make similar significant contributions.

Next month, we shall take a trip across the North Sea to Denmark to visit the Vestas (Danish Wind Technology) factory where a range of medium-sized turbines are designed and made to be sold all over the world including Britain. These are designed to be a cost-effective means of generating electricity for local use of for placing the output on to a national distribution system.

While in Denmark we shall also look at a wind farm to judge for ourselves the environmental effect of such an installation and see if there is anything for the British to learn. We shall look at an animal shelter in Cambridgeshire making use of wind power and at an innovative project in the North-East of England where wind power will make a significant contribution to the electricity needs of a new hospital.

SHOP TALK

with David Barrington

LCD Ultrasonic Tape Measure

We have a small problem with the supply of the transducers for the *LCD Ultrasonic Tape Measure*. Most of our component advertisers seem to stock ultrasonic transducers, but not all sell them as transmitter/receiver pairs.

The same transducer can often be used for both transmitter and receiver application, but in this circuit they should only be used as indicated. The specified transmitter has a lower impedance (200Ω) than the receiver (70k) and better power handling figures.

The ones used in the model are designated T40-16, R40-16 and are obtainable from **Maplin** (code HY12N) and sold as pairs. Also, the latest listing from **ESR Components** (☎ *091 251 4363*) includes an offer for ultrasonic transmitter and receiver transducers. No impedance details are given, they may work in this circuit but it is emphasized they have not been tried in the model.

The 3½ digit LDC display and calculator style case should be readily avaiable and the ICM7224IPL 4½ digit counter i.c. is listed by Maplin, code FP62S.

The single-sided printed circuit board is available from the *EE PCB Service*, code EE802 (see page 603).

Model Railway Automatic Signal

Most of the components required to build the *Model Railway Automatic Signal* are standard items and should not cause any purchasing problems.

The reed switches, used to trigger the red and green lights, should be the miniature glass-encapsulated, single-pole make type. The required bar magnet may come together with the switch or have to be purchased separately.

The train signalling lights tower used in the model is the Hornby code R406 type. This should be available from any good railway modelling shop.

The choice of "rocker" switch will depend on the size of plastic case used. Due to the small amount of space available in the prototype, a miniature round type was used. Whichever case is chosen, check that the switch contacts cannot short on the circuit board.

Quicktest

The particular case called for in the *Quicktest* project appears to be untraceable and cannot be found listed in our components catalogues. However, a similar, although slightly larger, case is available from **Magenta Electronics** for the sum of £2.39 plus £2 p&p.

This case also has a battery compartment, but the battery is sited across the width of the case as against "top to bottom" in the model. You could, of course, use a different type of case altogether.

Using a larger case does mean that there will be no need to make the small cutouts in the sides of the circuit board to allow it to fit in the case.

The triangular touch pads in the model were ordered from Maplin, code HY01B. Alternative arrangements, such as a 6BA countersunk bolt with a large washer as the "touch pad", could be tried, but it may work out just as expensive as the pads.

Judging from the model, the "test" switch appears to be either a miniature (press-to-make release-to-break) modular switch, without accessories, or a non-locking keyboard type. Once again, the main criterion here is to ensure that the switch contacts do not foul or short on the circuit board when the case is closed up.

The small printed circuit board for the Quicktest is available from the *EE PCB Service*, code EE803. See page 603.

Washer Bottle Monitor

The special fluid level i.c. type LM1830 called for in the *Washer Bottle Monitor* is currently being listed by **Maplin**, code YY99H. It may be carried by other suppliers but does not appear in current listings.

The Scotchlok connectors may be purchased from most good motorist spares discount shops or spares counters. If the unit is to be installed in the engine area, the box and terminal block connections must be waterproofed. One of the bathroom silicone sealers may do the job here – not sure about the possible effects of heat though.

Finally, remember that it is essential that the monitor is connected to the right supply polarities as the i.c. could be destroyed if not. Most vehicles today operate a negative "earth" (common) system.

Sound-Operated Nightlight

Some readers may experience local difficulties in obtaining the MEL12 phototransistor for the *Sound-Operated Nightlight* project. This device is a photo-Darlington and is currently stocked by Maplin (code HQ61R) and **Cricklewood Electronics** (MEL12).

The 12V solar panel used in the prototype model was purchased from **Robert Keyes (GW41ED), Dept EE, 4 Glanmor Crescent, Newport, Gwent, NP9 8AX.** Solar panels are stocked by many of our advertisers and **Bull Electrical** (☎ *0273 203500*) are offering one (15P42R) at a reasonable price.

Interface – Bar Code

This month's *Interface* article gives details of a barcode interface circuit using a photo-reflective infra-red sensor i.c.

The article mentions RS and Maplin as stockists of this device. However, we have been unable to locate it in the current Electromail (RS) catalogue. The Maplin code for this device is: UK81C (Sen. OPB706B).

EVERYDAY READOUT

REVERBERATIONS

Dear Ed.,

Could you possibly help me with a query on the *CCD Reverb Unit* project featured in the June 1992 edition of *Everyday Electronics*?

The main chip used in this circuit, the MN3011 3328 stage BBD, is shown connected to a single nine volt battery. Maplin stock this chip and the specification is detailed on page 426 of their 1992 catalogue, this shows the chip to run at –15V nominal. I enclose a photocopy of part of a "datafile" which states the operating voltages to be MIN –14V, MAX –16V.

I have built several projects designed by the contributor for this article and have always been pleased with the results but as this chip is relatively expensive I would like to know why he's running it so far out of spec?

Rod Hall
London N8 8RP

NEGATIVE VIBES

Dear Ed.,

In your June 1992 edition of *Everyday Electronics* you supplied a circuit for a *CCD Reverberation Unit*. The circuit included a MN3011 BBD 3328 stage i.c.

The d.c. supply to this i.c. in your circuit diagram shows that pin one is $+V_{DD}$ and pin three –Ve. However, the Maplin catalogue shows these pins as pin 1 –Ve and Pin 3 $+V_{DD}$.

Could you please confirm which of these is correct. It is essential that reverse connections are avoided particularly on this i.c., as it is quite an expensive item as you quote in your article.

A. E. Woods
Baginton

*Taking the letter from Mr Woods first, I think he is probably confused by the fact that the NM3011 is a **PMOS** chip, and as such it is designed to operate in a positive earth circuit. Hence pin 1 ("ground") goes to the positive supply, and pin 3 goes to the negative supply.*

It is, of course, possible to use the MN3011 in a negative earth circuit (as in my design). The only real problem in doing this is that the circuit is sensitive to "hum" on the supply lines. If it is powered from a mains power supply unit, this must have a suitably low noise output.

Turning to the letter from Mr Hall, my original (and provisional) data for the MN3011 gave a rather wider supply voltage range than the one currently quoted in the Maplin and RS data. Anyway, I have tried several of these chips on nine volt supplies and they all seem to work fine.

The performance of the chip is reduced in certain respects, and in particular the maximum signal level that can be handled is subsequently reduced. However, performance is still perfectly adequate in this respect.

For optimum results the circuit can be powered from two 9V batteries wired in series. A 15V monolithic voltage regulator should be used to reduce the nominal 18V supply to the required 15V (the raw 18V output could destroy the MN3011).

Robert Penfold

WELL PREPARED

Dear Ed.,

Thanks again for a very well prepared magazine. I derive great interest and enjoyment from it.

You might remember I wrote some time ago concerning the scarcity of components here. I followed your suggestion and ordered from three British companies, all of which gave me courteous and prompt service.

I was wary of ordering direct, since I have been defrauded no less than three times ordering from the United States. I have contacted the Los Angeles Police Department, who informed me that fraud by mail was "*under the jurisdiction of the postal authorities.*"

I contacted the postal authorities, who said that "isolated complaints" such as mine would not support civil or criminal action, but that a *pattern* of fraud had first to be established!

Evidently they don't maintain the same standards of civilization out there.

Now for two things about the magazine....

You have published a good number of circuits in the past using moving-coil *meters*. Examples are a capacitance meter and a frequency counter.

Many of us use *digital multimeters*, and would gladly plug these circuits into them to save the extra expense of a moving-coil meter. The circuits, however, are often not compatible with the digital multimeter ranges!

Would it be possible to bear this in mind in future, and to offer alternative values for components so as to plug into a digital multimeter?

Also, recently, you had some fascinating circuits based on CMOS 4017 decade counters, I immediately saw possibilities for experimentation – but the articles concerned didn't go into any detail regarding the chip's operation. I had to look elsewhere.

Just a paragraph or two would be very instructive when describing the use of such chips. Just enough to give us the ability to tinker a little ourselves.

Nothing to say . . .

Incidentally, I enjoyed your editorial some time back in which you had nothing to say. *(Nov. '91 for anyone desperate to read it – Ed.)*

There was a similar case involving, I think, the *New York Times*. The editor had writer's block, and so printed the 10 Commandments. One man demanded the cancellation of his subscription, because the editor had become too personal!

I write an editorial myself every month, and I find that people *listen* to what I say. It truly does influence some people's lives. I have no doubt that the same is true of your editorial.

Your colleague over at *ETI*, in his editorials, seems to have a mission to change the world. He appears to view electronics as being intrinsically beneficial to our world – whereas, of course, their benefit or lack of it is wholly dependent upon the people who use them.

Rev. Thomas O. Scarborough
South Africa

Thank you for the suggestions (and encouraging comments) we will keep them in mind when preparing future articles. – Ed.

MAKES SENSE

Dear Ed.,

I was interested in Mr H. F. Howard's letter in the August '92 issue of EE, not just because I received a mention in that letter but because he raises a number of points about the problems any prospective designer faces when he gets into print.

Now while it is quite true that I do not use a piece of gear such as the *Low Cost Capacitance Meter* which I described in the September 1991 issue for my own experimentation, my students at the local college do, and they are encouraged, given the design, to make their own suggestions about possible improvements and adaptations when making the equipment for their own personal use. So I think it has to be with constructors who make up the many projects described every month in EE.

The designer cannot satisfy everybody, and (apart from the absolute beginner) it shouldn't be impossible to say, for instance, that such and such a box would suit me better than the one described, or these terminals, knobs or what have you, would look more pleasing to me than those suggested by the designer. We are, after all, as Mr Howard is, only talking about the trimmings, not the design itself, which would require a lot more technical expertise.

So I believe Mr Howard speaks good sense and may his organisation continue to help the beginner in the way he advocates. For my own part, I should add that I always keep the practical problems that a constructor might face with his limited space and resources, right to the fore whenever I adapt a design for possible publication.

Professional designers and researchers (and I have been in those businesses for many years) are, I agree, not very often down to earth in their relationship with the user (and the repairer) of their equipment, but then, as we know, there are some people who think that coming down from their own particular Parnassus of learning, might somehow diminish their own elevated egos.

Steve Knight
Market Harborough

Constructional Project

SOUND OPERATED NIGHTLIGHT

ELEANOR MAITLAND

Take away that fear of darkness from the child's room at night. Reassure your child with this sound activated, battery/solar powered nightlight.

FEAR of darkness is common in young children. This project is a sound-activated lamp which glows brightly upon receiving a loud sound (for example a child's initial cry) and slowly dims when the sound ceases.

The prototype has been successfully used for over a year in a two-year-old child's room, giving reassurance regarding the child's surrounding when he occasionally wakes during the night.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Sound Operated Nightlight is shown in Fig. 1. Sound is picked up by the crystal microphone MIC1 and fed into a direct coupled two-transistor amplifier TR1/TR2 via a d.c. blocking capacitor C1 and the "Sensitivity" potentiometer VR1.

Bias for TR1 is supplied via R1, TR2 and R3. Stabilisation is ensured by this configuration since excessive conduction by TR1 leads to a reduction in TR2's bias current resulting in less bias for TR1 (negative feedback). Capacitor C4 decouples R4 to allow some gain over TR1 and TR2, and C2 is used to prevent the amplifier oscillating at radio frequencies.

The amplified sound output appears at the collector of TR2 and is passed through the d.c.-blocking capacitor C3. Negative transitions are clamped to the ground rail via diode D1 and positive transitions pass through D2 and are accumulated in capacitor C5. The voltage on C5 is then used to drive the lamp (LP1) via R6, TR4 and TR5.

DAYLIGHT CUTOUT

To enable the unit to be left on during daytime (more on this shortly), a quiescent mode is introduced by the inclusion of resistor R5 and TR3. These components provide a low resistance path to ground for any charge attempting to accumulate on C5 during daylight.

Bear in mind that the lamp and phototransistor TR3 should be isolated as much as possible since ANY source of light falling on TR3 will cause it to conduct. This would rapidly remove the charge on capacitor C5 which provides the bias for TR4 and in turn TR5.

The LES lampholder used here did not leak light back into the case, but other lamp holders may. In this case a small amount of black adhesive over the back of the photo-transistor TR3 may block this light-path (you could put the tape over the lamp holder, but with plenty of use the heat generated by the lamp may cause the tape to lose adhesion and possibly fall off).

POWER SUPPLY

Resistor R7 and capacitor C6 provide a better stabilised supply for the amplifier circuit and help to isolate sudden load changes (the lamp turning on or off) from affecting the amplifier.

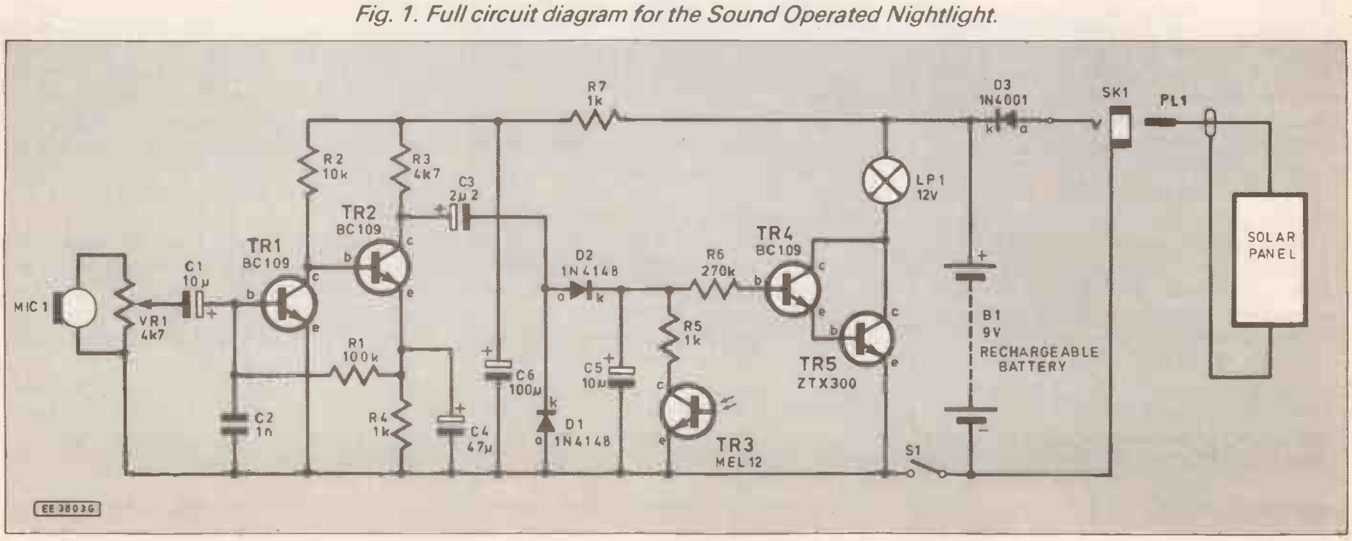
The power source caused an amount of consternation since this project is intended for a small child's room. A mains supply would of course provide all the necessary power, at the cost of the latent danger within 240 volt mains (note that the often-quoted mains approximation of 240 volts is the root mean square (r.m.s.) value – the peak voltage is actually 340 volts).

An alternative to mains power is a battery. Though the lifetime of any battery depends on the usage of equipment connected to such a battery, its against my Scottish tardiness to use a disposable battery in such an often-used device.

A rechargeable battery would be an acceptable compromise solution since it will be relatively safe and also economical. The disadvantage is that it will require periodic charging (depending on use, of course).

This is where the solar panel comes in. Although Britain is not noted for its

Fig. 1. Full circuit diagram for the Sound Operated Nightlight.



sunshine (and Scotland is worse), cloudy daylight should provide enough power to trickle-charge a rechargeable battery. This is not to imply that the battery will never require conventional charging, but it should postpone such events.

Solar panels are not everlasting power sources, and the technical data I received with my panel states that there will be a natural variation of output between otherwise identical panels. My panel gave 21 volts open-circuit in afternoon sunlight, and 0·7 volts at 80 milliamps under short-circuit conditions. On a cloudy day the figures were 15 volts open-circuit and 0·1 volts at two milliamps short-circuit. In-circuit, the charging current into the battery was 44mA during evening sunshine (7·15pm).

CONSTRUCTION

Start construction with a rectangle of 17 strips of 0·1in. matrix stripboard, each continuous copper strip being 23 holes long. There are seven breaks to be made in the stripboard, as shown in Fig. 2.

Begin by inserting the single wire link and then insert the components in an approximate left-to-right fashion as shown. Note that four of the resistors and a single diode are mounted vertically, and also observe the polarity of the tantalum and electrolytic capacitors.

Off-board connections are required for the microphone, light-dependent transistor TR3, the lamp, the battery and the solar panel.

COMPONENTS

Resistors

R1	100k
R2	10k
R3	4k7
R4,R5,R7	1k (3 off)
R6	270k

See SHOP TALK Page

Potentiometer

VR1	4k7 skeleton preset, horiz.

Capacitors

C1,C5	10µ tantalum 16V (2 off)
C2	1n ceramic
C3	2µ2 tantalum 35V
C4	47µ tantalum 16V
C6	100µ radial elect. 16V

Semiconductors

TR1, TR2, TR4	BC109C *npn* transistor (3 off)
TR3	MEL12 phototransistor
TR5	ZTX300 *npn* transistor
D1,D2	1N4148 signal diode (2 off)
D3	1N4001 1A 50V rec.

Miscellaneous

S1	s.p.s.t. toggle switch
MIC1	Crystal microphone
B1	9V PP3 rechargeable battery
LP1	12V LES bulb and lampholder
SK1/PL1	2.5mm jack plug and socket

Metal or plastic case approx 155 x 105 x 52mm; 5mm l.e.d. grommet; Velcro sticky pad (to secure battery); case feet; stripboard, size 17 strips by 23 holes; fixings; spacer for stripboard; connecting wire etc.

Solar panel: 300mm x 150mm (approx) 12V panel

Approx cost guidance only **£17** *excl Batt*

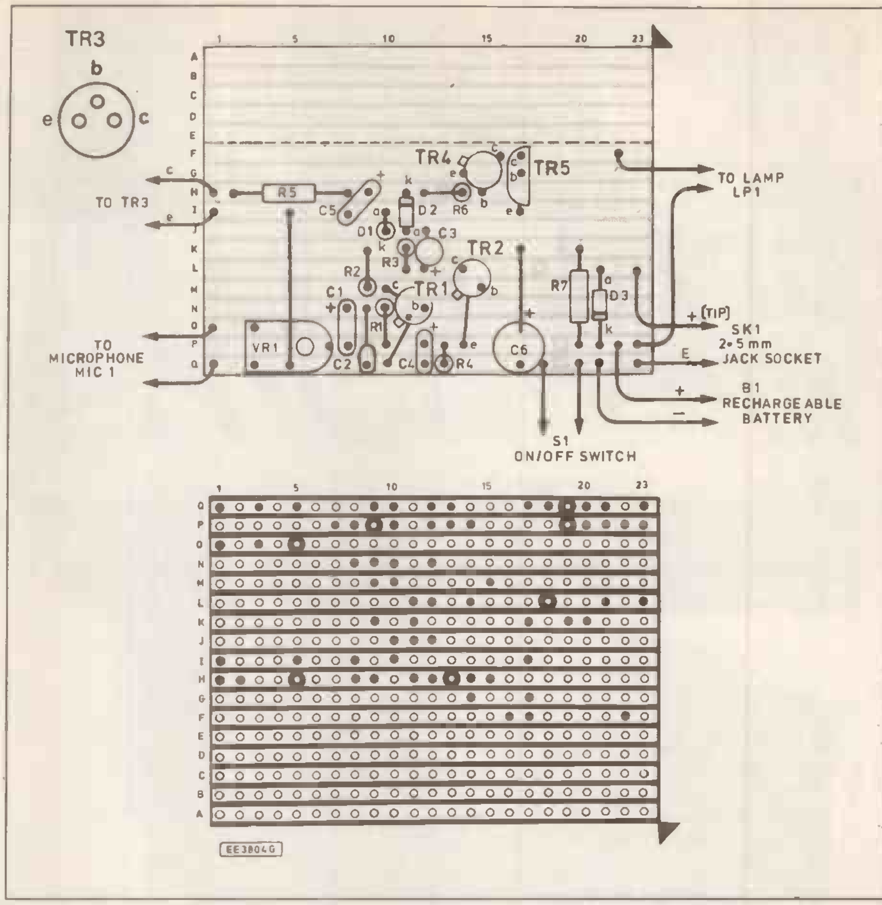


Fig. 2. Stripboard component layout and details of underside breaks required in the copper strips.

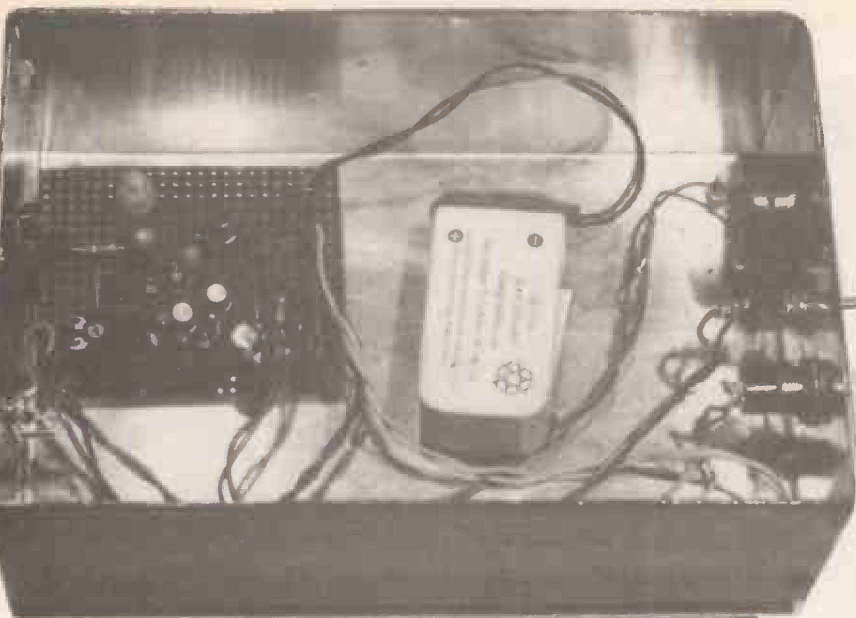
The case used for this project was one salvaged out of the components box, but its saving grace is that it can accommodate a large disposable PP9 battery should you prefer to use one of these. Do NOT use the solar panel in conjunction with a disposable battery.

The circuit board was attached to the case with two nylon bolts such that TR3's leads could be used instead of soldering extension leads to them. Conveniently, TR3's diameter fits snugly into a 5mm l.e.d. grommet.

Attaching the solar panel via a plug and socket proved extremely convenient when the user went to stay elsewhere overnight – the solar panel stayed put and the device went with the child.

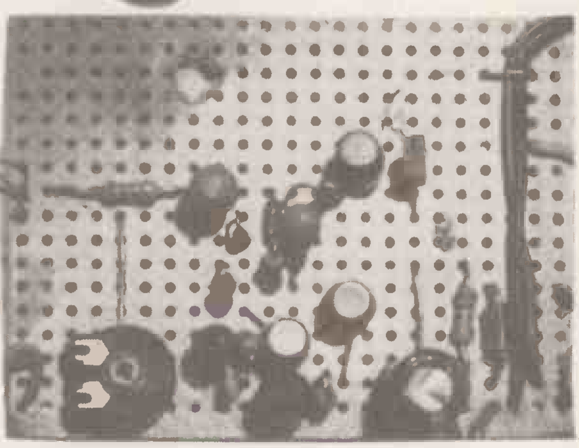
An ON/OFF switch was added due to the user's bedroom being frequently used as a (noisy) playroom. This was connected such that it switched the battery to the circuit, leaving the solar panel permanently connected to the battery.

Addition of switch S1 puts an onus on remembering to switch on the circuit when required, but this was merely included in the bedtime routine of the child.



(top) Layout of components inside the metal case. The battery is held in place by a Velcro pad.

(left) The photo-transistor and solar panel jack socket are mounted one end of the case and the microphone and lamp the other.



(right) Completed circuit board. The phototransistor is mounted directly on the board and carefully bent at right-angles to align with the hole in one side of the case.

The completed Nightlight with solar cell panel.

CASE

The prototype case is arranged as shown in the photographs with the microphone and lamp at one end and the light-dependent transistor TR3 and solar panel jack socket at the opposite end. The microphone was glued in place, though this may still prove to be an ideal receptacle for inquisitive fingers!

Layout of the components within the case is open to rearrangement, but a couple of points should be noted. The light-dependent transistor TR3 should be isolated from the lamp LP1 as much as possible. Attaching leads to TR3 may prove fiddly.

Since the case used was metal, no screening problems were envisaged so plain twisted-pair wires were used for connecting the microphone.

INSTALLATION

Every location for this project will be different, but the following advice may prove helpful. The solar panel should be exposed to the maximum amount of daylight, tempering this with what will not cause angst from the household-owners!

Remember too that the intended users will more often than not have inquisitive fingers, inexperience of fragile items and an almost magnetic attraction to trip over any otherwise-tidy cable. Tucked behind an opened curtain close to the window pane might be ideal, but also consider condensation.

ILLUMINATING

It was found that an EVEN illumination of ALL of the solar panel was fundamental – standing the panel close to a window such that the bottom 1cm was masked by the window frame reduced the output dramatically.

Experimentation with the panel is, if you will pardon the pun, illuminating! Short the panel output via a multimeter on a 100mA range and orientate the panel to see the output difference (make sure that your experimentations do not coincide with a cloud covering or revealing the sun). Remember though that the panel's output is as a SUPPLEMENT of power, not a SOURCE, hence outputs of a few milliamps are not to be sneered at.

MAIN UNIT

Siting the main unit is less troublesome. Any location close to the head of the cot or bed should be adequate. Keep in mind those inquisitive fingers nonetheless, and be aware of any cable runs to the solar panel. Preset VR1 should be initially set fully anti-clockwise for maximum sensitivity.

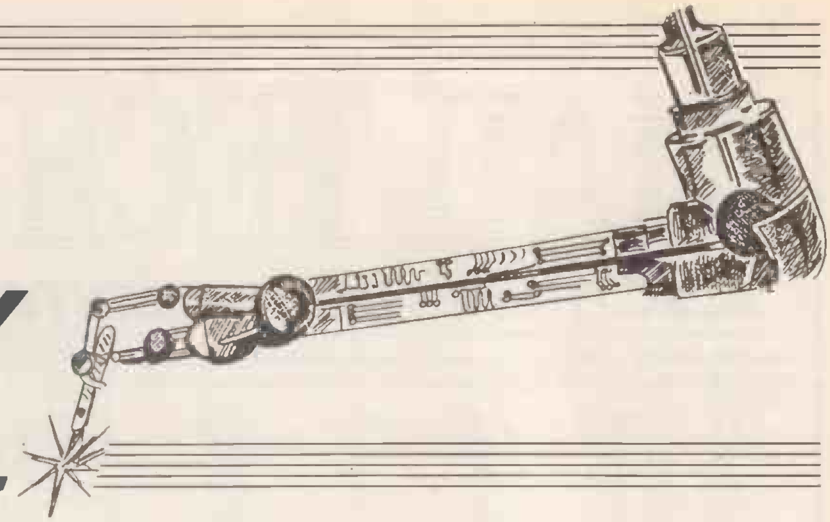
Should the unit trigger too frequently, reduce the sensistivity. A multimeter in series with the lamp may prove helpful in showing significant currents flowing through the lamp that are unable to light the lamp ("significant" in terms of battery discharge).

On the prototype, this component was "set and forget" for this application. It may be prudent to install a panel-mounting potentiometer if you consider that frequent sensitivity alteration will be necessary.

ALTERATIONS

You might want to add a constant-current limiter for the charging current from the solar panel. Reference to the *Solar Powered Lighting Unit* published last month will help. □

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Welcome again to *Circuit Surgery*, our regular clinic for readers' problems. This month we shall be attempting to unravel the mystery of the SCART connector before moving on to provide details of an l.e.d. bargraph display which can act as low-cost alternative to the use of a conventional moving coil meter.

The SCART connector

The SCART (or Peritel) connector seems to have become firmly established as a means of interconnecting a wide range of audio-visual equipment. *Ron White* from Tyne and Wear has asked me to provide some suggestions as to how the SCART socket can provide audio for his Hi-Fi system. Ron writes:

"I would like to take the audio from my VCR and connect it to my Hi-Fi system in order to produce a cassette tape of the soundtrack of some of my family videos. The tape deck has two phono inputs and the VCR has a SCART/Euroconnector as well as a BNC connector for video. Can you tell me which of the connections I should use?"

The SCART connector provides access to a variety of video, audio and data signals present in modern TV receivers and video recorders. The SCART interface conforms to a European Standard (it is also described in British Standard BS6552) and was designed to provide a reasonably universal interface to permit interconnection of TV equipment, video recorders, camcorders, satellite decoders, video disc players and home computers. It is therefore not surprising that so many video and TV manufacturers are starting to include this interface as a standard feature in their products.

The pin connections for a standard SCART connector are shown in Fig. 1. The signals present on the connector (not all of which may actually be present) are summarised in the table opposite.

Readers should note that there are two separate left and right channel audio inputs (pins 2 and 6) as well as two separate left and right audio outputs (pins 1 and 3). The audio signal at each audio output is normally in the range 100mV to 200mV peak-peak and this will be perfectly adequate for direct connection to the "auxiliary" or "tuner" inputs on almost any cassette recorder.

Fortunately, male SCART connectors are relatively inexpensive and can be purchased from a number of suppliers including Maplin (stock code FJ41U) and RS/Electromail (stock code 474-697). In order to avoid problems with hum

SCART CONNECTIONS

Pin Number	Designation	Notes
1	Audio output (right)	Impedance: < 1kilohm Level: 200-500mV
2	Audio input (right)	Impedance: > 10kilohm Level: 200-500mV
3	Audio output (left)	Impedance: < 1kilohm Level: 200-500mV
4	Audio ground	Earth signal return common to all audio channels
5	Blue video ground	Earth return for the blue video signal
6	Audio input (left)	Impedance: < 10kilohm Level: 200-500mV
7	Blue video	Impedance: 75 ohm Level: 700mV
8	Function switching	Low (0V to +2V) = TV High (+9V to +12V) = External
9	Green video ground	Earth return for the green video signal
10	Data 2	Communication data
11	Green video	Impedance: 75 ohm Level: 700mV
12	Data 1	Communication data
13	Red video ground	Earth return for the red video signal
14	Data ground	Common earth return for both data signals
15	Red video	Impedance: 75 ohm Level: 700mV
16	Video blanking	Impedance: 75 ohm Level: 0V to 0·4V 1V to 3V (blanked)
17	Video ground	
18	Blanking ground	
19	Composite video output or Synchronising output	Impedance: 75 ohm Level: 1V pk-pk Impedance: 75 ohm Level: 0·3V pk-pk
20	Composite video or Synchronising output	Impedance: 75 ohm Level: 1V pk-pk Impedance: 75 ohm Level: 0·3V pk-pk
21	Ground	Outer shield

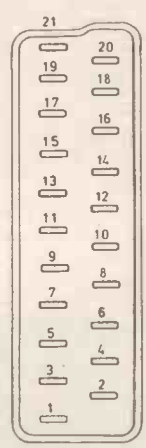


Fig. 1. Pin connections for the SCART connector

and noise, the connecting cable should use screened audio leads. Finally, the left and right channel signals should be "summed" by connecting them together via two 47k resistors when it is necessary to make recordings on a mono cassette recorder.

Bargraph display

Allan Ayre has written from Hull with an interesting enquiry concerning a replacement for a conventional moving-coil meter. Allan writes:

"I wish to make up some 'simple to use' pH meters for use with my secondary school pupils. The probes are available and I think a suitable circuit would be one such as that shown in "Electronic Science Projects" by Own Bishop.

The problem is in the display device to be used; moving coil meters are expensive, large and not very rugged. I would much prefer to use a simple l.e.d. display and help would be much appreciated in the circuitry involved in replacing the 100µA meter with a bargraph display or an alphanumeric display to indicate whole number values of pH."

I must admit that Mr Ayre's request provides a real challenge to my miserly instincts! Not having purchased a moving coil meter for several years, I thought I would take a look in the latest Maplin catalogue to see just how much they do cost. Prices seem to range from about £8 upwards though Maplin do offer a very reasonable quantity discount for 10 or more meters purchased at the same time.

An LM3914 (linear bargraph display driver), on the other hand, costs a mere £3 and this clearly has to be the solution to Mr Ayre's problem. Bearing in mind his remarks, I set myself a cost limit of £7 for a complete bargraph module, smug in the knowledge that an l.e.d. display would be very much more reliable and less bulky than any moving coil meter!

The LM3914 will sequentially illuminate one of ten l.e.d.s when a varying d.c. voltage is applied to its input (pin-5) or will provide a bar display in which all l.e.d.s below and including the corresponding input will become illuminated.

The brightness of the l.e.d. display can be very easily adjusted using just one resistor in order to set the l.e.d. current in the range 2mA to 30mA (normally a current of about 10mA per l.e.d. will suffice). Furthermore, the LM3914 can be readily cascaded in order to provide a stacked display (in multiples of ten). The LM3914 will operate successfully with supply voltages in the range 3V to 18V.

The l.e.d. display can comprise either 10 individual l.e.d.s soldered to the matrix board or a 10-segment d.i.l. bargraph array. An even better solution is the use of a panel-mounting 10-segment l.e.d. bar array which is available from Maplin (stock code YH76H). This module comprises ten matched rectangular red l.e.d.s mounted on a printed circuit board (p.c.b.) measuring approximately 68mm x 14mm and it is ideal for mounting direct on the front panel of a small instrument case.

The final circuit of the bargraph display module based on an LM3914 is shown in Fig. 2. The field effect transistor (f.e.t.) TR1 provides a high input impedance together with an input which is "ground-referenced" (i.e. one side is taken to 0V). IC1 provides voltage gain (adjustable by means of VR2) whilst TR2 provides a regulated +5V supply for the common anode bargraph display.

The bargraph display can be configured for either dot or bar mode by means of link wire LK1. The display is first zeroed by preset VR1 (so that none of the l.e.d.s are illuminated when the input is temporarily disconnected) and then VR2 is adjusted for the desired full-scale deflection.

It is important to note that the circuit shown in Fig. 2 essentially functions as a voltmeter which provides a full-scale indication with an input of 100mV, or less. Hence, to replace a 100µA meter it will normally be necessary to connect a one kilohm resistor across the input terminals in order to simulate the meter resistance.

Next Month: In next month's *Surgery* we shall be looking at fuse selection (sorry that we did not have room for it this month) and revisting the 555 timer software described last month.

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	10k
R2	1M
R3	1k
R4	3k3
R5	1k
R6	220
R7	470
R8	1k
R9	3k3
R10	2k2
R11	1k
R12	1k

All 0.25W 5% carbon film

Potentiometers

VR1	4k7 miniature skeleton preset
VR2	100k miniature skeleton preset

Capacitors

C1	10µ radial elect. 16V
C2	10µ radial elect. 16V
C3	10µ radial elect. 16V

Semiconductors

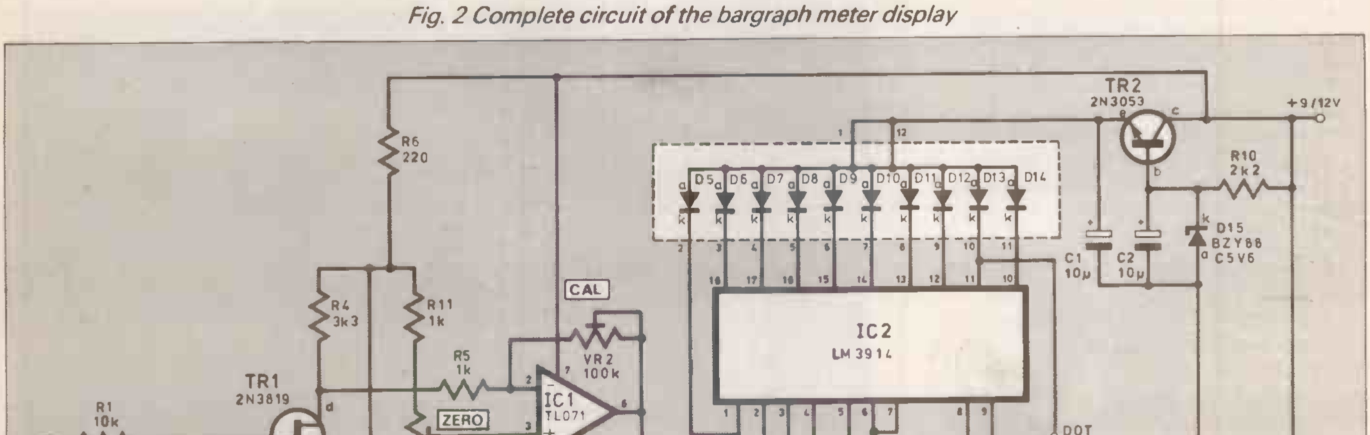
D1	1N4148 signal diode
D2	1N4148 signal diode
D3	BZY88 C6V8 500mW 6·8V Zener
D4	BZY88 C2V7 500mW 2·7V Zener
D5-D14	10-segment l.e.d. bar array (Maplin YH76H)
D15	BZY88 C5V6 500mW 5·6V Zener
TR1	2N3819 *n*-channel f.e.t.
TR2	2N3053 med. power *npn* transistor
IC1	TL071 (or TL081) op.amp.
IC2	LM3914 display driver

Miscellaneous

Stripboard, 0·1in matrix, measuring approx. 40mm x 60mm; Terminal pins; connecting wire, solder etc.

Approx cost guidance only **£7**

Fig. 2 Complete circuit of the bargraph meter display



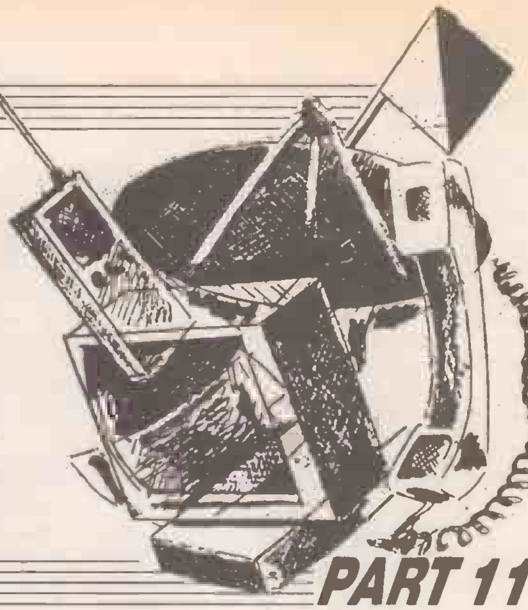
Special Series

INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 11



THIS is the eleventh in a 12-part series concerning Information Technology, problem-solving, feedback in electronic systems and related matters in and around the Science National Curriculum.

This month's work is in two parts. Firstly, we shall look at *problem-solving* using electronic devices. After that, we shall examine the effects of *feedback* in control systems and amplifiers.

PROBLEMS . . . PROBLEMS

Students need to design solutions to problems and here we cannot look at every possible type of problem nor would we wish to. A better way forward is to examine the general nature of a problem and show students the thought processes needed to solve it.

Suppose we have some books which we use every day. At the moment they are kept in a cardboard box on the bedroom floor. We may consider using a bookshelf. Think – do we have a problem and, if so, how are we going to go about solving it? Sometimes things are best left as they are. Here are some of the considerations on which we could base our plan.

Is the cardboard box adequate – do we need to do anything?
If so, is a bookshelf the best solution?
If so, where should it be placed?
How strong does it need to be?
What should it be made of?
How long, wide and thick should it be?
What type of brackets should be used?

When considering a problem, the students should be encouraged to think along the following lines:

Is there a problem – should things be left as they are?
Assuming there is a problem – am I absolutely clear what it is?
Am I sure that the first solution thought of is the best one? Do I need to explore alternative ideas before being sure which solution is best?
Can I make use of existing material?
Is the chosen solution cost-effective?

The answer to the second question seems obvious but it is surprising how confused people can be over the nature of the problem. In the bookshelf example above, are we clear whether the priority is to tidy up the bedroom floor or whether to make the books more accessible? We may end up doing both but we must then be clear about our priorities because this may affect the final solution.

ELECTRONIC PROBLEM SOLVING

The foregoing will be found helpful in solving all problems. However, here we are more concerned with problem-solving using *electronic systems*. Suppose we wish to make an alarm which will tell us if the garden shed has been broken into. Assuming there is a problem, we must first of all be clear what it is. We then need to draw up the specification for a suitable device so that we know what we are aiming for.

Is there a problem?
If so, is an *electronic* solution best? – would a lock do?
If electronics is used, can I buy something ready-made more cheaply?
If not, am I capable of developing a solution?
If so, shall I design it from scratch or can I modify a circuit taken from a book or magazine?
Can I find several ideas which fulfil the specification then choose the best one? How may alternatives do I need to try in detail?
Do I have the expertise and practical knowledge to make it?
What type of power supply shall I use?
Do I have the necessary safety knowledge if a mains supply is to be used?
What form of construction shall I use?
Can I make use of scrap or existing components?

It is interesting to note that an electronic solution is not always best. A *mechanical* system may be cheaper, smaller more reliable and, perhaps, more versatile. Furthermore, a mechanical system does not need a power supply. It is important to explore *all* possibilities before deciding which is the best solution.

Often people immediately go for an *electronic* solution because "modern methods are best" when there may well be a better way. In the above situation, why not consider using a simple lock? It may be that the alarm gives a better chance of catching the culprit. If this is

The Singer XL-10 Professional microprocessor controlled sewing machine.

not a consideration then a lock would probably be better.

Assuming we choose an electronic design and then go on to make and test the alarm, we should then do an evaluation. We do this by asking ourself these questions:

Does the device fulfil its purpose as well as I had hoped?

Does it need to be modified so that it does?

After any modifications, a further evaluation would be needed. This may be followed by further cycles of modifications and evaluations until a satisfactory result is obtained.

PLANNED THINKING

In everyday life, we go through this reasoning without writing any of it down, or even being fully aware of what we are doing. However, in this type of work, it is important for students to write down their plans. A special planning sheet could be designed which will direct them to thinking about the problem in a logical way.

Students who are doing a technology or electronics project, perhaps for GCSE, should already have this way of thought firmly established. Those studying traditional sciences – physics, chemistry and biology may need a little help.

DEVELOPMENT WORK

For development work, an excellent approach is to use a modular kit such as the Unilab Alpha Kit. This form of construction is useful because the circuits work reliably and are easily modified. Where time is limited or where there is no need for students to learn conventional construction work, modular kits are probably the best way forward.

A further advantage is that, providing a few simple rules are followed, the individual modules are fairly indestructible so the students can use their imagination freely without having to worry too much about ruining components. When the circuit has been developed to satisfaction, a permanent – probably soldered – version can be made.

Note that in this sort of exercise it is not essential to understand *how* each module works. It is only necessary to understand what it *does*. This is called the *systems approach*. The systems approach may not give the most efficient solution (i.e. the most elegant circuit or minimum component count) but it will give highly effective ones.

Consider a microprocessor used to control, say, a washing machine or a sewing machine. The microprocessor is, theoretically, far too sophisticated a device to perform such a mundane function. On the other hand, microprocessors are cheap because they are manufactured in large numbers, they are highly reliable and small.

Making a circuit using the minimum number of components may take many hours of work to design. It may turn out to be less reliable and possibly larger than the microprocessor-based version. Also, it would be incapable of being re-programmed in the future. Thus, the design using a microprocessor often turns out to be the best way of doing the job.

A SPECIMEN PROBLEM

Suppose we have a freezer in the garage. Sometimes it is switched off by mistake. Sometimes someone does not close the lid or door properly. This causes the temperature inside the cabinet to rise. The problem is that we need to monitor the freezer and signal a fault so that action may be taken before the food inside is ruined.

Are we clear about the nature of the problem? Do we need a device which will detect a rise in temperature or could we simply use a door switch to operate a buzzer? Clearly, a door switch would not help if the freezer was switched off at the socket.

Could we devise a circuit which would signal the user if the mains was switched off, *or* the lid was left open? Probably, but it would be easier to detect the rise in temperature. Also, such a circuit would provide a signal if the temperature were to rise for some other reason such as failure of the compressor. Thus, it would be a more *versatile* design. Also, if we bought a new freezer, the circuit could be instantly transferred to it.

BASIC RESEARCH

We should first do some measurements using a thermometer to see what rise of temperature needs to be detected. If the temperature in the freezer cabinet is normally −18 degrees C, we may decide that the alarm should operate at, say, −15 degrees C. If it is set too finely, the alarm will sound when the lid is opened in the normal course of removing food.

We must decide what type of warning should be given – a flashing light? A buzzer? Where should the warning be given? The kitchen? Living room? We could do some tests with lamps and buzzers in various places to find the best site. Would a pulse-tone buzzer provide better warning? We then need to ask ourselves:

Am I sure that an electronic solution is best?

Can I buy something which will do the job more cheaply?

Am I capable of designing the system?

Can I use or modify an existing design?

For development work, we need to decide whether to use ready-made modules or to build a circuit using separate components on a Plugblock (this means of construction has been used in previous parts of the series and specific information was given in Part 5 (March, 1992 issue).

Whichever mode of construction is decided upon, we need an input sensor which responds to changes in temperature – probably a thermistor. We also need an output transducer to provide the warning – possibly a buzzer. We need a processing circuit to operate the output transducer at the correct temperature. A NOT gate may be used here but its output is insufficient to operate the buzzer direct. We therefore need a *transistor output* stage.

Students should be encouraged to look at books and magazines to find circuits which, perhaps, with some modifications will fulfil the purpose. This approach makes good sense but it is often viewed by the students as cheating.

CIRCUIT

The circuit shown in Fig. 1 together with the Plugblock layout (Fig. 2), could be used. Readers who have been following the series will remember that such a circuit was used in Part 7 (May, 1992 issue) to control a motor. Note that this is a basic circuit and would need further development before it could be used in the real situation. However, it is good enough to allow some tests to be made. The following is a list of components needed but you may well find that most of them are part of your kit so check before ordering.

Vero Plugblock
R1 1M fixed resistor or 1M potentiometer – see text
R2 Bead thermistor – resistance at 0°C 500k approximately
R3 3k3 resistor
IC1 4011BE NAND gate

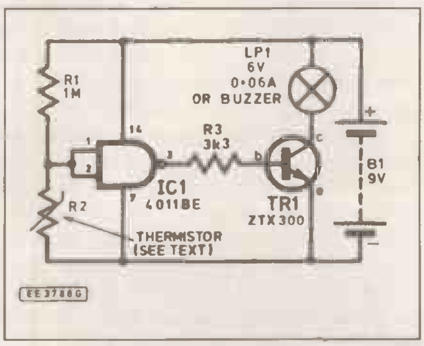
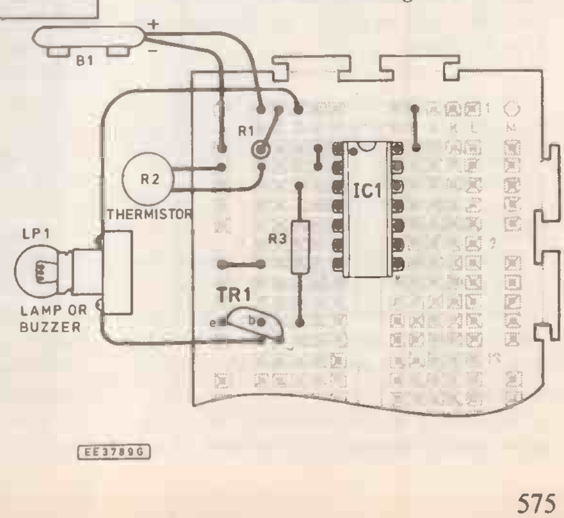


Fig. 1 (above). A specimen problem – freezer alarm.

Fig. 2 (right). Freezer alarm Plugblock layout.



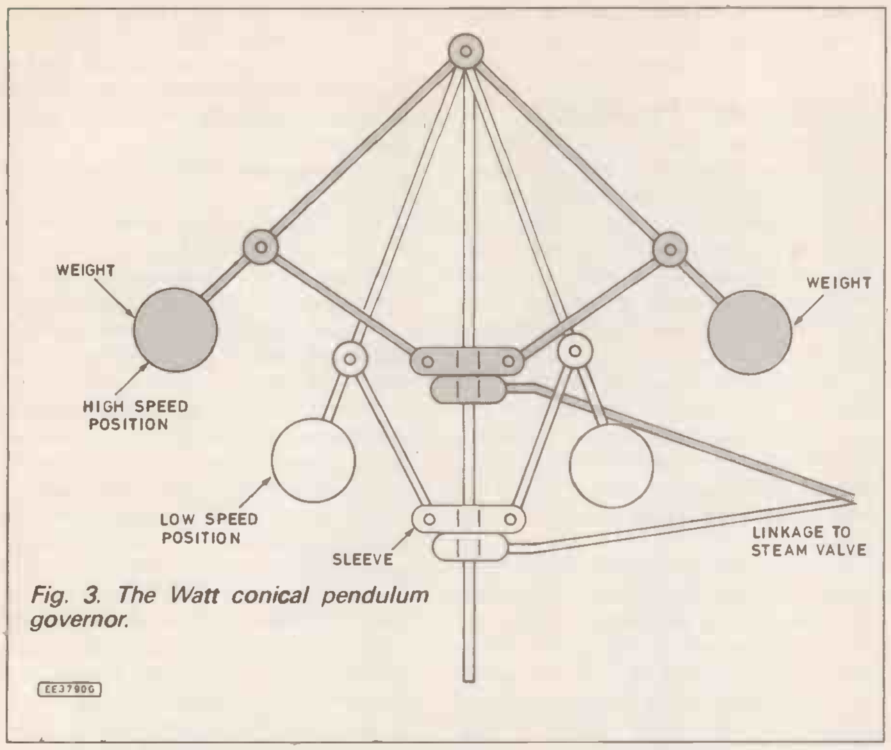


Fig. 3. The Watt conical pendulum governor.

TR1 ZTX300 *n.p.n.* transistor
WD1 6V 0.06A bulb in holder or 6V solid state buzzer
B1 9V PP3 battery and connector

Note that the NOT gate is formed by connecting together the two inputs of the NAND gate. R2 is a *thermistor*. As its temperature *rises* a falling voltage will be applied to the NOT gate input. There is no need to go into details of exactly why this happens here – it involves a potential divider and this topic will be found in a standard electronics text book.

The NOT gate interprets any voltage less than half supply voltage as logic 0 and anything over this figure as a 1. As the thermistor warms up, therefore, the input will change from Logic 1 to Logic 0 so the output will suddenly switch from 0 to 1. This turns on transistor, TR1 and hence the bulb or buzzer in its collector circuit.

By using a variable resistor, VR1, in R1 position rather than a fixed value, the switching temperature may be varied between wide limits. If the circuit needs to work in the opposite sense – that is, to switch *on* when the temperature *falls* rather than *rises*, this may be done by swapping around R1 and R2. This could be useful for, perhaps, an ice warning device for a car.

We now come to the second part of this month's work. This is concerned with *feedback* and the effects this has on electronic systems.

FEEDBACK

Students should be able to recognise the effects of feedback in a system – electronic or otherwise. To understand the meaning of feedback, it is helpful to look at some examples of *non-electronic* feedback first.

Suppose you are travelling in a foreign country and doing your best to ask your way in the local language. If the listener frowns and shakes his head it is clear to you that he does not understand what you are trying to say. You then modify your speech. The listener then smiles and nods and you know he understands. You then continue until he frowns again. When he responds with directions, you may do the same thing back. This is an example of human feedback. There is clearly an interaction between the two people and each modifies his or her behaviour according to the response of the other.

POSITIVE FEEDBACK

If a man kicks a dog, the dog is likely to growl and snarl. If the man kicks the dog harder, the dog will respond with more barking and biting. This may annoy the man, who kicks even more, and this annoys the dog so it bites harder.

Here, there is a type of interaction between dog and man called *positive feedback*. We could say that positive feedback occurs when a *cause* (kicking) produces an *effect* (snarling and biting) which increases the cause (more kicking) and the effect (more biting) and so on until some limit is reached (the man cannot kick any more and the dog can't bite any harder).

Postive feedback causes *lack of control*. Note the *loop* which is a characteristic of feedback systems – in this case from dog to man, back to dog and so on. Many arguments are in the form of positive feedback where a gentle insult ends up in a fight.

There is another type of feedback called *negative* feedback. Unlike positive feedback, this *reduces* the cause and therefore has a calming effect. For example, when a baby cries, the parent picks it up and makes soothing noises. This, hopefully, causes the baby to cry less so the parent becomes quieter and so on. Note that there is a loop here too – baby (input) to parent (output) and back to baby. This type of human interaction can be used to soothe arguments and bring the situation under control again.

MECHANICAL FEEDBACK

A very good example of a *mechanical* negative feedback system is the centrifugal governor used in an old steam engine – the Watt conical pendulum governor (see Fig. 3). This was invented by James Watt to solve the problem evident in earlier engines where the shaft turned more slowly as the load was increased.

To overcome this, the rotation of the shaft caused ball weights on umbrella-like arms to fly outwards. This caused the sleeve to rise on a central rod and this, in turn, was linked through a rod to the steam control valve. This was made to partially close and reduce the flow of steam so slowing the engine down.

If the load was increased so that the shaft slowed down, the weights would move inwards a little, the sleeve would slide down and the control valve would open and admit more steam so speeding the engine up. In this way, the engine maintained a steady speed for a wide variation in load.

An electrical/acoustic example of positive feedback with which everyone is familiar is *acoustic feedback*. This is apparent in a badly adjusted PA (public address) system where someone is speaking or singing into a microphone. If the volume control on the amplifier is turned up too high, excessive sound from the loudspeakers re-enters the microphone.

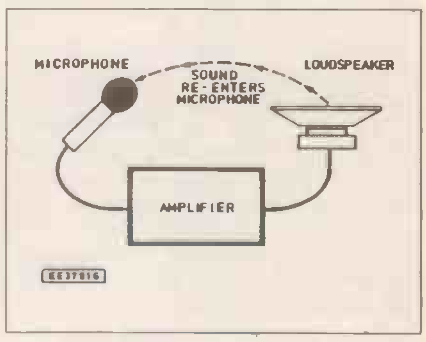


Fig. 4. Positive feedback in a PA system

This is subsequently amplified and re-appears at the loudspeakers even louder. This is picked up by the microphone again and so on making a feedback loop – see Fig. 4. This usually makes itself known by a loud howling noise. It is *positive* feedback because it increases the cause and results in loss of control and instability. Obviously there is a limit when the howl is as loud as the equipment permits.

THERMAL RUNAWAY

Another example of positive feedback sometimes met in electronics is *thermal runaway*. This can occur with transistors and other semiconductor components. Here, the current causes the device to become warm. This reduces its resistance which allows more current to flow. This causes the material to become even hotter and so on. Either the device is eventually destroyed or the temperature cannot rise any further i.e. heat is given to the surroundings as quickly as it is being supplied.

Early transistors used *germanium* as the semiconductor material rather than silicon as is the trend today. Germanium transistors were very susceptible to destruction by thermal runaway. Today, with modern silicon transistors, the temperature can rise considerably and they are much less likely to be ruined.

Modern components often survive the most appalling abuse by students. A circuit can be protected against the effects of thermal runaway by certain modifications but we shall not go into such detail here.

To summarize, the characteristic of both types of feedback – both positive and negative – is a *loop*. Positive feedback leads to instability and tends to make a system go out of control. Negative feedback has a calming influence – it reduces the cause hence reduces the effect and so on.

BIOLOGICAL FEEDBACK

Suppose we have a factory in which fragile objects of different shapes and sizes are being made. We use a robot arm to pick each one up and move it to another place. Left to itself, the arm is likely to squeeze some objects too tightly and break them, or not squeeze hard enough and allow them to slip and fall.

A human operator would pick them up and feel the force given by the hand and finger muscles. He or she would regulate the amount of force being applied so that the object was just gripped sufficiently to prevent slipping – a form of *biological feedback*. If it were felt to slip, the grip would be tightened a little. Of course, all this is done subconsciously.

The robot arm would need to be given a similar sense of touch. This may be done by using pressure pads and, perhaps, movement sensors. The pads change their electrical resistance when they are squeezed. When the degree of grip is sufficient, the resistance of the pads will reach a certain figure and this will signal the motor adjusting the grip to stop turning. If the grip relaxed for any reason, the motor would turn and increase it a little. If the object was felt to be slipping, the movement sensors would increase the grip until no more movement was felt. This is a negative feedback system.

When we were discussing the home-made telephone system (see Part 8 in this series) what amounted to negative feedback was mentioned but this term was not used at the time. When we make a telephone call, we can hear ourselves speak through the earpiece as well as the person we are talking to. If we speak too loudly, we respond by talking more quietly and vice-versa. This is another example of *biological negative feedback*.

Brain rhythms can be detected, amplified, and fed back via the eyes in the form of flashing lights or by the ears in the form of rhythmic sounds. The brain rhythms can then be modified and so on. This technique is said to produce a state of relaxation if correctly used.

ELECTRONIC FEEDBACK

Many electronic systems use feedback. Suppose we need light of constant brightness for, say, some photographic or industrial process. Fig. 5 shows a battery-powered circuit which shows the principle. This circuit can be built using the Plugblock layout in Fig. 6. The following is a list of components required. However, readers who have been following the series will find most of the electronic components in their kit already so they should check this point before ordering more.

	Vero Plugblock.
R1	ORP12 light-dependent resistor
R2	220
VR1	47k standard potentiometer
TR1	ZTX300 *npn* transistor
LP1	6V 0.06A MES lamp and lampholder
B1	9V PP3 battery and connector

The light-dependent resistor, R1, connected in series with variable resistor, VR1, provides a certain voltage between point X and the negative supply line. This voltage rises as the amount of light shining on R1 falls. At a certain level, and with a certain adjustment to VR1, there will be sufficient voltage appearing between point X and the negative supply rail to turn the transistor on. Collector current then begins to flow through the lamp, LP1 so lighting it. If the light from LP1 falls on R1, an *optical feedback loop* is formed. The resistance of R1 falls and with it TR1 base voltage. This reduces the collector current and so the lamp then becomes dimmer.

Suppose the light was obscured by holding something in front of it. The LDR now receives less light, its resistance rises and with it TR1 base voltage. More collector current flows and the lamp becomes brighter. The lamp therefore tries to keep R1 evenly illuminated.

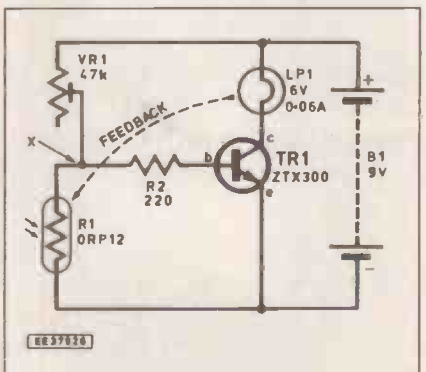


Fig. 5 (above). Optical feedback.

It is best to do this experiment in a dark place so that the only light falling on R1 is from LP1. Place R1 close to the lamp so that the light shines directly on to it. Connect the battery and adjust VR1 so that the lamp is at about half brightness. Now move a piece of thin cardboard between the lamp and the LDR. It will be seen that the lamp becomes brighter as more of the light is obscured.

Of course there is a limit to how far the lamp can do this because it has a certain maximum brightness. This experiment is not very useful in itself but illustrates how the principle of negative feedback may be used in an industrial or commercial situation.

AMPLIFIER FEEDBACK

High-quality amplifiers used for reproducing music in hi-fi systems use plenty of negative feedback. This reduces the degree of amplification but has the beneficial effects of making the amplifier stable (unlikely to oscillate due to stray positive feedback loops – see oscillators below) and also improves the *bandwidth* – that is, the range of frequencies in the sound which it can amplify equally (a perfect amplifier would amplify all frequencies equally but this can never be realized in practice).

The loss of amplifying power is easily made up by using extra stages – e.g. transistors. This is acceptable since electronic components are relatively inexpensive. Amplifier design is a large topic and has only been touched upon here.

OSCILLATORS

An oscillator is a type of amplifier where positive feedback is applied. This causes oscillation and a regular train of waves are produced at the output. This may be desirable or not depending on the use to which the device is put. It is obviously undesirable in an audio

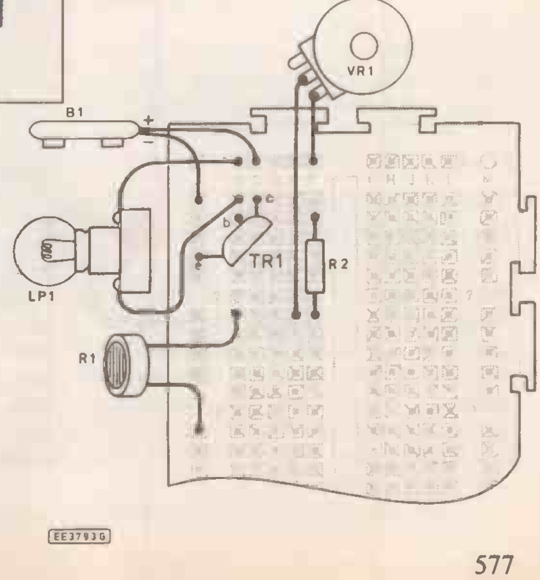


Fig. 6 (right). Layout for the optical feedback circuit shown above.

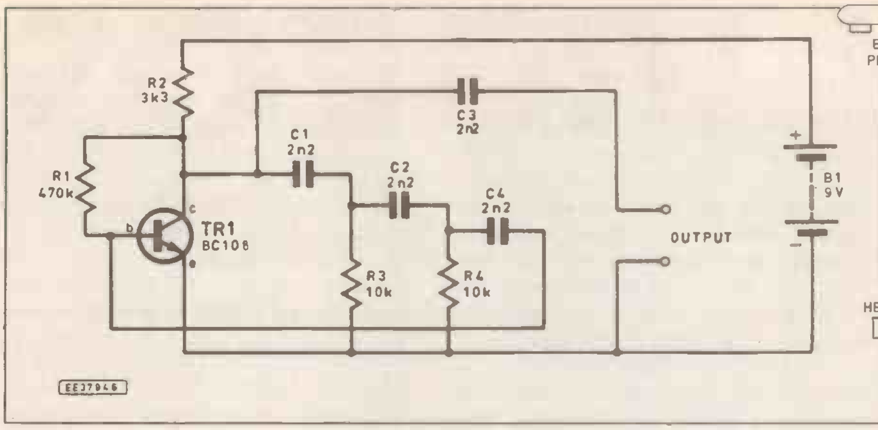
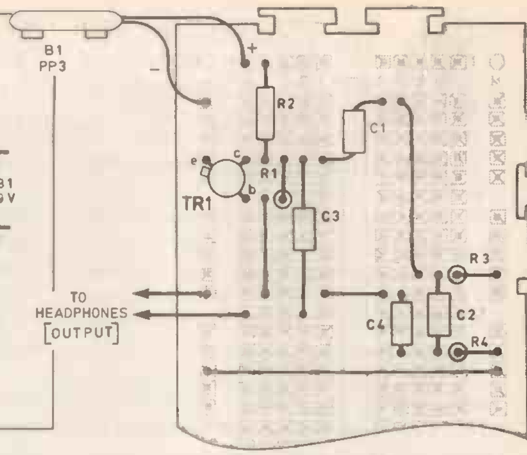


Fig. 7. A phase-shift oscillator.



amplifier and, as mentioned previously, steps will be taken to make sure that it cannot happen accidentally by applying negative feedback. However, if oscillation occurs rapidly enough and is fed to an aerial – i.e. a piece of wire – *radio waves* are emitted – and we have a radio transmitter. *Note that it would be illegal to make a radio transmitter in this way.* Slow oscillations when fed to a loudspeaker or earpiece produce sound waves and this could form the basis of a musical instrument.

The circuit shown in Fig. 7 is one such audio oscillator called a *phase-shift oscillator.* It is basically a transistor amplifier but some of the output (from the collector) is fed to the input (the base) via the network containing capacitors, C1 C2 and C4. This arrangement together with resistors R3 and R4 ensures that the feedback is *positive* – we shall not explain in detail exactly how this arises here.

A suitable Plugblock layout is shown in Fig. 8. You will need the following components. If you have been following the series, some of the components will already be part of your kit so check before ordering.

	Vero Plugblock
R1	470k
R2	3k3
R3, R4	10k – 2 off
C1, C2, C3, C4	2n2 – 4 off
TR1	BC108 *npn* silicon transistor
B1	9V PP3 battery and battery connector. Personal stereo headphones

After construction, connect a pair of stereo "Walkman" headphones with the output connected either to one channel or to both channels connected together in parallel. A musical tone should be heard.

THE ASTABLE MULTIVIBRATOR

The astable multivibrator (Fig. 9) is a type of oscillator circuit based on two transistors (here, separate transistors are used but they could be part of an integrated circuit). Feedback between the transistors ensures that when one of them is off the other is on. The circuit then oscillates between the two states as long as a supply is connected.

Specific information about the astable circuit and other members of the multivibrator family was given in Part 9 of this series (July, 1992 issue). The circuit for an astable multivibrator is shown in Fig. 9 and a Plugblock layout of an experimental version in Fig. 10. You will need the following components.

	Vero Plugblock
R1, R2	10k – 2 off
C1, C2	100µ – 2 off
TR1, TR2	ZTX300 *npn* silicon transistors – 2 off
LP1, LP2	6V 0.06A lamps in lampholders – 2 off
B1	9V PP3 battery and battery connector

Note how capacitors, C1 and C2 apply the feedback from the collector (output) of one transistor to the base (input) of the other. After construction, connect the battery and observe the lamps. They will flash in turn. With the values of C1 and C2 specified (100µ). they should flash at approximately one second intervals.

A full-scale version could be used for motorway or level crossing lights. By using a single bulb with a resistor in place of the other one, beacons – perhaps to attract attention at sea could be made. A flashing light is much more effective at attracting attention than a steady glow.

THE SERVOMECHANISM

Suppose we wish to steer a model car. A small motor could turn the steering mechanism when a control lever on a hand-held box is moved to the left or right. We need the motor to stop when the wheels reach an angle which depends on the position of the control. To do this we require a *servomechanism* (often

Fig. 8. Phase-shift oscillator Plugblock layout.

simply called a *servo*) and it works by using the principle of negative feedback.

As the wheels of the car swivel to give a turning effect, the spindle of a potentiometer is rotated and this feeds a voltage back to the control circuit. The value of this voltage depends on the position of the wheels. The hand control turns another potentiometer and this feeds another voltage to the control circuit.

The difference between these two voltages gives an *error signal* and this causes the motor to turn. When the voltages are equal – that is, there is no error signal – the motor stops. Thus, the wheels mimic the position of the control lever. Servomechanisms are widely used in industry in such fields as robotics and medical electronics.

That's all for this month. Next month is the final article in the series and we shall take the opportunity to tie up some loose ends.

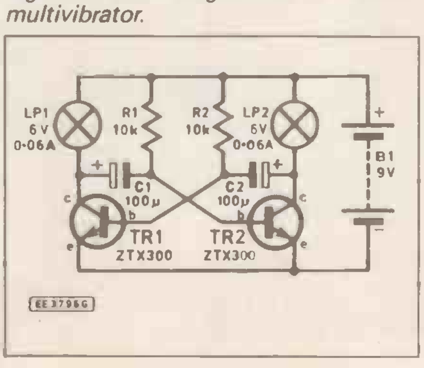


Fig. 9. Circuit diagram of an astable multivibrator.

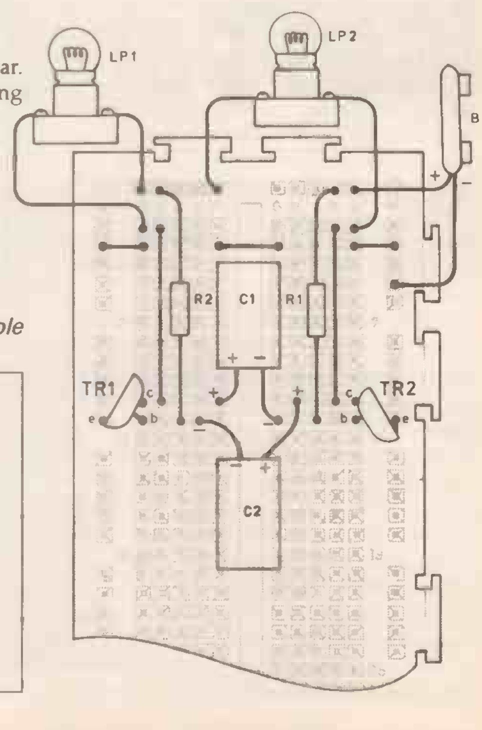


Fig. 10. Plugblock layout for the astable multivibrator.

NEW VIDEOS ON ELECTRONICS

Everyday 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.

The first three videos available are:

1. *Electronics And You – Part 1:* D.C. Series and parallel circuits and the use of a digital multimeter. Running time approx. 53 mins.
   Order code VT201 — **£29.95** inc. VAT

2. *Part 2:* A.C. Coils, capacitors, transformers and other a.c. devices. Running time approx 71 mins.
   Order code VT202 — **£29.95** inc. VAT

3. *Part 3:* Semiconductors. Basic semiconductor theory plus fifteen different semiconductor devices explained. Running time approx. 47 mins.
   Order code VT203 — **£29.95** inc. VAT

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.

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.

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

Constructional Project

WASHER BOTTLE MONITOR

ALAN WINSTANLEY

When the water runs out you are breaking the law. Avoid any problems with this unit. Uses a special fluid detector chip to warn when the reservoir needs topping up.

THIS VERY useful device will certainly appeal to the motorist who often has to travel long distances, perhaps on business. As may drivers will know, having to cope with congested motorways and city traffic can be exasperating enough, and in dirty road conditions the last thing you really need is an empty washer bottle to hinder your progress even more.

Regular checking under the bonnet will help to avoid this situation, of course, but it is still not difficult to empty the washer fluid bottle under adverse conditions. As for the business driver, he is more likely to be worrying about his urgent appointments rather than the remaining capacity of the washer bottle!

Furthermore, hatchback and estate cars often have two screen washers these days, for the front and rear screens, and possibly headlight pressure washers also. It is quite common to have one reservoir serving both screen washer pumps, the theory being that the driver simply has to maintain one water bottle instead of two. Sometimes the bottle is so large that you virtually forget that it is there – until you run out of water!

On the other hand, the bottle may not necessarily be large enough to cater for cleaning both front and rear screens in dirty conditions, and it is then quite possible to empty a full bottle within a day. In actual fact, it is illegal to drive a car which does not have a windscreen washing and wiping system which allows the driver adequate forward vision.

Some high-specification cars incorporate a warning device which alerts the driver when the washer fluid is running low. This enables the driver to economise on washer fluid in the meantime until he is able to re-fill it at, say, a filling station.

CIRCUIT DESCRIPTION

The author's first attempt at a *Washer Fluid Monitor* was published in Everyday Electronics, August 1984 and the unit to be described here is an improved, maintenance-free version which is easy to construct and install. The full circuit diagram for the Washer Bottle Monitor appears in Fig. 1.

As can be seen, there is a low component count since most of the work is performed by IC1, an LM1830 fluid level detector chip. The circuit operates directly from a 12V d.c. supply which is connected to IC1 pin 14 and pin 11 through TB1/1 (+12V d.c.) and TB1/4 (0V) of a 4-way terminal block, R1 being a dropping resistor to protect the i.c. against transient spikes.

The main function of IC1 is to generate an alternating signal which can be passed between two probes dipped into the fluid being monitored. An a.c. signal overcomes any problems that arise through electrolytic action if a direct current is used. The original fluid monitor did suffer from erosion of the probes through this electrolytic breakdown, with the result that the probes eventually weakened and broke.

The internal oscillator frequency of IC1 is determined by an external capacitor C2, and in this design the frequency of operation is about 6·6kHz as measured on the prototype. The output of the oscillator is taken from IC1 pin 13, via an internal 13k resistor, which then compares this reference resistance with that of the probes which dip into the washer fluid. The probes are connected through C1 which is a blocking capacitor, so there is no direct current flowing through the liquid, which greatly reduces the electrolytic action.

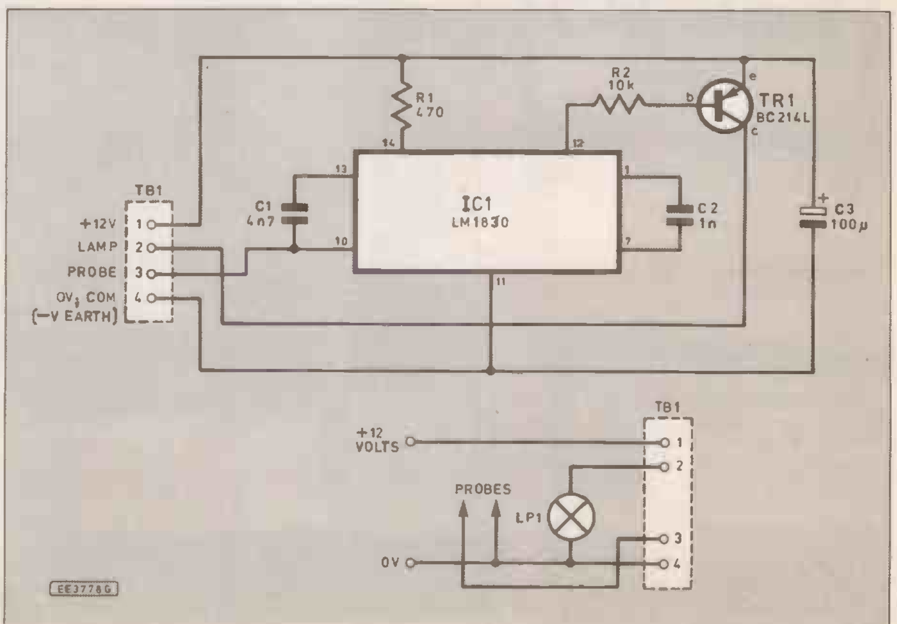
Thus IC1 generates an alternating signal out of pin 13, through the d.c. blocking capacitor C1 and then through the probes (TB1/3 and TB1/4). Pin 10 of IC1 is the detector input and if the water level drops below the probes, the probe resistance will then exceed the internal 13k reference resistor at pin 13.

This change in resistance is detected by IC1 which, in this "alarm" state, generates an output signal at pin 12. This is actually an open-collector output which will drop to nearly 0V when activated by a drop in fluid level.

The output will sink up to 20mA and would drive an l.e.d. directly but, it was decided to use a filament lamp (LP1) for the alarm indicator which is mounted on the dashboard. The lamp is driven through a transistor buffer TR1 and is connected through TB1/2 of the terminal block.

Note that the output (pin 12) actually oscillates at the same frequency as the a.c.

Fig. 1. Complete circuit diagram for the Washer Bottle Monitor.



signal generator: it is not a simple high/low output, although the bulb will appear to be continuously alight. It could be utilised, for example, to drive a loudspeaker directly and give an audible warning tone.

CONSTRUCTION

The Washer Bottle Monitor is constructed on 0·1in. matrix stripboard, size 9 strips x 24 holes. The topside component layout and details of breaks required in the underside copper track is shown in Fig. 2.

Commence construction by drilling two 6BA (or M3) clearance holes in the stripboard to accommodate the mounting hardware, then make all the breaks in the copper track using a spot face cutter. If the proper tool is not available then a handheld twist drill bit can often be used as an improvisation.

The components and link wires can now be located in accordance with Fig. 2. The constructor may prefer to protect IC1 by using a 14-pin dual-in-line socket, but the device does not require any particular anti-static precautions.

Note expecially the orientation of the transistor leads and the chip itself, together with the polarity of electrolytic capacitor C3. The two link wires should be inserted in position first as one of them runs below C3.

After assembling the circuit board, check carefully to ensure that all breaks have been made effectively in the copper strips, and that there are no wisps of solder shorting adjacent tracks. This chip can be damaged by accidental shorting of neighbouring pins and because the device is not too cheap it is worth making an extra effort to check the soldering before powering up.

CASE AND INSTALLATION

The completed prototype unit was built into a small plastic box measuring 72mm x 47mm x 25mm, with the 4-way terminal block being mounted on the outside surface

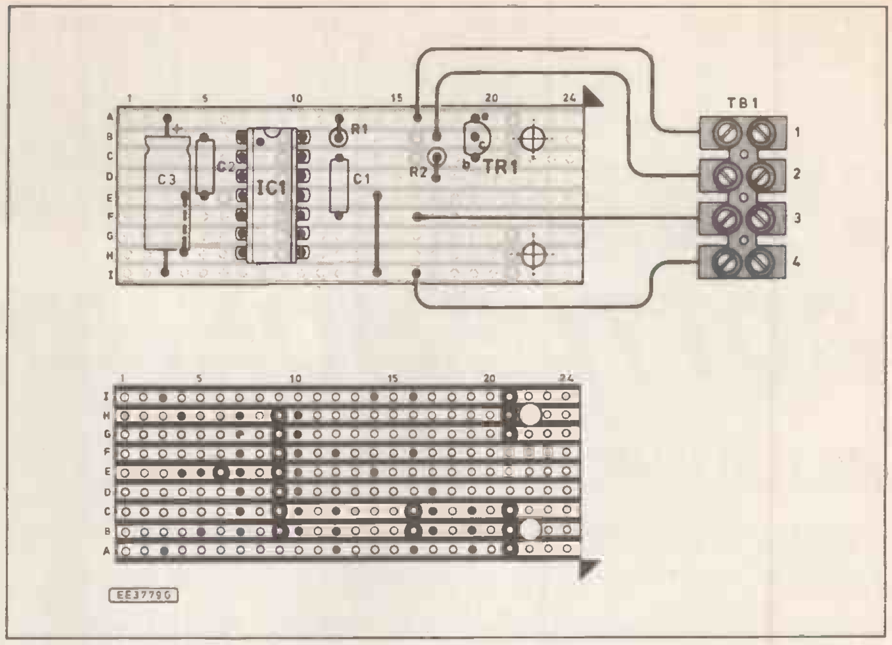
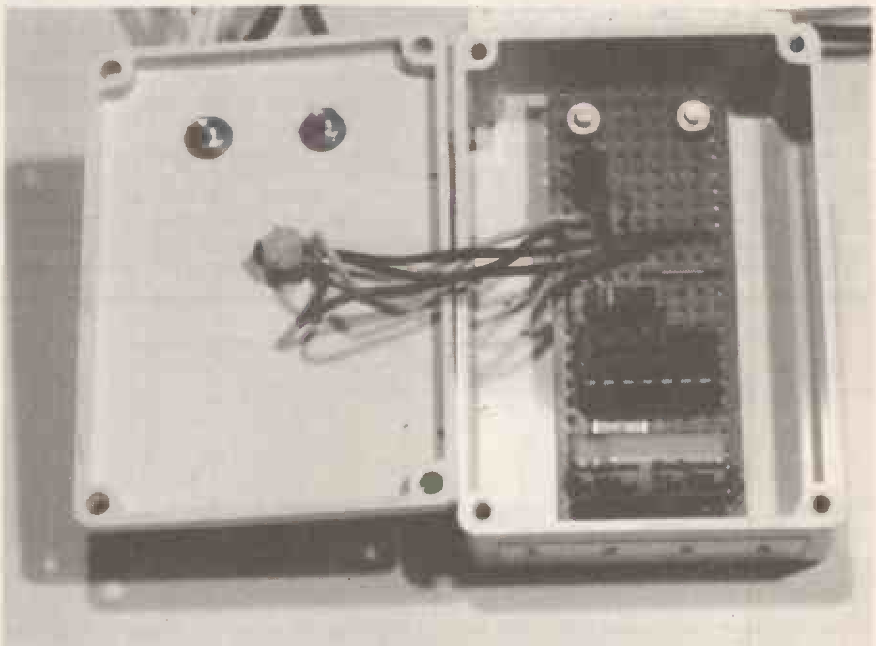


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.



COMPONENTS

Resistors
R1 470
R2 10k
Both 0·25W 5% carbon film

See SHOP TALK Page

Capacitors
C1 4n7 polyester
C2 1n polyester
C3 100µ axial elect., 25V

Semiconductors
IC1 LM1830 fluid level detector
TR1 BC214L *pnp* silicon transistor

Miscellaneous
LP1 12V to 14V 40mA panel mounting filament indicator lamp
TB1 4-way screw terminal block

Stripboard 0·1in. matrix, size 9 strips x 24 holes; plastic box, size 72mm x 47mm x 25mm; 14-pin d.i.l. socket; material for probes (e.g. twin-core wire); mounting hardware; interconnecting wire; Scotchlok connectors; solder etc.

Approx cost guidance only **£7**

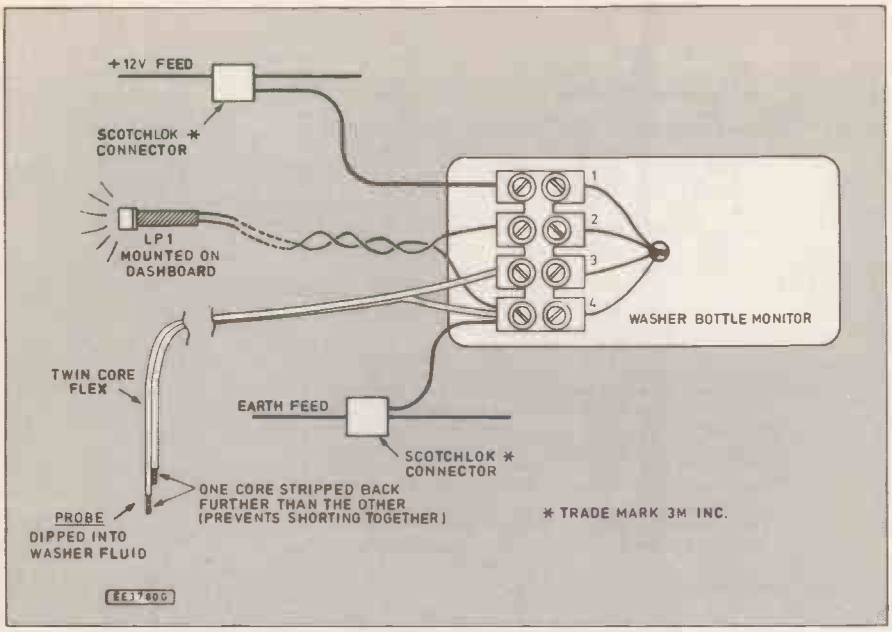


Fig. 3. Interwiring and installation details for the liquid level monitor.

and connected to the component board inside by passing the four connecting wires through a hole in the lid.

Installation is quite straightforward, see Fig. 3. The 12V d.c. supply can be obtained from any ignition-controlled accessory – perhaps the radio – but the prototype was actually wired into the front windscreen electric washer pump supply as this was readily accessible in the engine bay.

Some cars such as the Vauxhall Nova/Cavalier and Renault 5 have a single bottle with two pumps attached – one for the front screen and the other for the rear wash/wipe. You can determine which is the front windscreen washer pump by tracing the washer jet piping, so that you can tap into the right supply.

POLARITY

It is essential that the unit is correctly polarised as the i.c. may be damaged by a reverse voltage. A voltmeter will soon determine the polarity of the 12V feed to the washer pump, and Scotchlok connectors may be employed to splice into the supply.

Wiring into the pump motor feed does mean however that the warning bulb will only be illuminated when the washer pump is activated, but this has not proved to be a handicap in practice.

The prototype unit was fixed under the bonnet near the washer bottle, and the probes simply consisted of a piece of twin-core zip wire with one core stripped back further than the other (to prevent shorting to each other) with about 15mm of copper bare. The wires were pushed through a tight hole in the top of the washer bottle so that they were about 25mm (1 in.) from the bottom of the bottle. This method may be especially suitable for those cars which have a refillable bag for a reservoir instead of a plastic bottle (e.g. Fiat Uno).

If the constructor installs the unit in the engine bay, as opposed to under the dashboard, then all that is required is to route two wires through a convenient grommet in the bulkhead to the dashboard-mounting filament lamp, ensuring that *all* joints are *fully insulated* and that the wires will not chafe on metal edges.

TEST RUN

With installation complete, test the unit by firstly keeping the probes out of water, and the lamp should light up when the electrical supply to the Washer Bottle Monitor is activated. Inserting the probes into the washer bottle at the desired depth should extinguish the bulb, in which case the device is ready for service. □

PLEASE TAKE NOTE

Dual Metronome (August 1992)

Page 496, Fig. 6. During the processing of the artwork, the underside link wire connections were shifted, in error, to the left by one pad.

The corrected layout is shown in the diagram opposite. We appologise for any inconvenience caused.

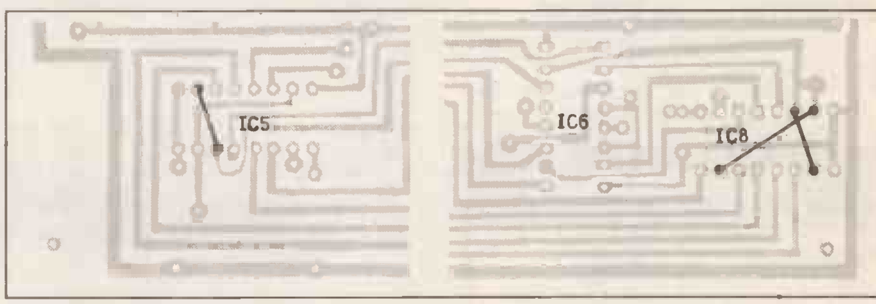


Fig. 6. Details of the underside link wires. These should be insulated leads.

EVERYDAY NEWS

EURO-LINK FOR STUDENTS

Schools go live across Europe

THE new government minister responsible for space in the UK, Mr Edward Leigh MP, presided over the launching of an innovative European schools satellite video conference link when he visited the Portsmouth site of Matra Marconi last month (June '92). The Parliamentary Under Secretary of State for Technology, was making his first visit to a UK space company since his recent appointment.

The project, part of British Industry in Space Year, is planned to give children and teachers from local schools the opportunity to talk directly to their European counterparts via live video conference links through the European Space Agency (ESA) *Olympus* satellite.

After declaring the first of the school satellite conferences open, pupils from Purbrook Park School, Portsmouth carried out a telecoference with French and British schools local to the MMS Toulouse and BAe Stevenage sites. Schools in Holland, Austria, Italy and Canada will eventually join the scheme.

As well as learning about the advanced satellite technology behind the system, the pupils have prepared projects ranging from geography and languages to "live" drama for transmission and discussion, with other European schools on the link.

The System

In addition to the custom-designed conferencing studio, the system uses a Matra Marconi Space (MMS) designed and built ground station, called TDS-6, which occupies only a small area. The ground station communicates with other locations via the *Olympus* satellite, part of which was also manufactured in Portsmouth.

The Metra Marconi TDS-6 satellite ground station.

A feature of the system is that three sites may be connected simultaneously, with all parties able to speak normally without the need for microphone switching common to other systems. This has been made possible using technology developed under a joint cooperation with ESA on the agency's DICE programme (Direct Intersite Conferencing Experiment).

The Portsmouth studio is connected to the TDS-6 ground station by fibre optic cable and is equipped with three colour monitors, two cameras and sound system for audio-visual transmissions. There is also a graphics terminal to allow transmission of pictures, diagrams and written text.

VOLUNTEERS WANTED

VOLUNTEERS with some technical training who live in, or around, the London area are urgently needed by the Royal National Institute for the Blind to help with the maintenance of its popular and priceless *Talking Book Service.*

This service enables about 70,000 blind and partially sighted people to enjoy the pleasures of reading. It is a library of over nine thousand books on cassettes which can be played on special playback machines.

The special playback machines, which are loaned from RNIB, have to be maintained and repaired and it is here that volunteers are needed. Nearly 3,500 people in London use RNIB's Talking Book Service. Many of them are frail and elderly. Indeed 230 users are aged over a 100 years old. All are reliant on their playback machine working properly.

The Institute would welcome any volunteers who have some technical training in the fields of electrical or electronic engineering and would be prepared to spend one or two evenings a month maintaining or repairing the machines. Each helper will be sent circuit diagrams and full technical details, and technical back-up will always be available by telephone.

Anyone interested in volunteering should contact David Finlay-Maxwell, Honourary Recruiting Organiser of RNIB Talking Book Servicing Volunteers, Prospect House, Prospect Street, Huddersfield HD1 2NU. Tel Day 0484 450982, Evenings 0484 604546

Radio Course

THE City of Westminster College (formerly Paddington College), will be running a *Radio Amateurs Examination* (RAE) evening course commencing early September 1992 (for May 1993 examination). Both class A and class B licenses will be catered for (i.e. A Morse course will run concurrently). Additionally, an 'Advanced Morse' course is hoped to be conducted, taking candidates upto 22/25w.p.m. with an insight to professional/marine procedures etc.

Professional college lecturers will conduct the courses. Prospective candidates should contact the college Science and Technology Dept, Ann James, Tel: 071 723 8826 for enrollment details etc.

Display for UK

CLAIMED to be one of the leading manufacturers of l.e.d. based electronic information displays, Data Display of Ireland has formed a subsidiary company in the UK. The new company will be based in Newcastle-upon-Tyne and will provide sales, marketing and technical support to all existing and future UK customers.

Exporting to over 20 countries worldwide, Data sees the establishment of its UK operation as a major step towards providing a strong technical backup to its UK customer base.

ACTUALLY DOING IT!

by Robert Penfold

CONTINUING with our look at semiconductor leadouts and pinouts, we now turn our attention to integrated circuits. The first point to bear in mind when dealing with integrated circuit pinout diagrams is that they are almost invariably ***top*** views. This is the opposite to the convention for transistors which, as explained last month, are always shown as base or *underside* views in leadout diagrams.

You have to be a bit careful when dealing with integrated circuit diagrams as there are occasional exceptions to the rule. When dealing with the usual d.i.l. (dual in-line) devices there should be no problem. A few integrated circuits, such as small voltage regulators and some sensor devices, are contained in ordinary TO92 transistor style encapsulations, or something similar.

Presumably due to their transistor-like appearance, the leadout diagrams for some of these components are shown as transistor style base views. Where this is the case, there should be some "fine print" somewhere on the diagram to point out that the views are base types. In fact most leadout diagrams for these components include a label or caption which states whether they are base or top views.

ORIENTEERING

When fitting a d.i.l. integrated circuit onto a circuit board it is essential to get the orientation of the device correct. I (and many others) recommend the use of holders for all d.i.l. integrated circuits, and many beginners question the need for this.

On the face of it, I suppose there is no obvious reason for using a holder for a device that is not sensitive to static charges. In some cases the holder will cost nearly as much as the integrated circuit that will be plugged into it.

However, there are two problems with connecting a d.i.l. integrated circuit direct to a circuit board. One is simply that there tends to be a build-up of heat in the device as each pin is soldered in place. Particularly with devices that have 16 or more pins, you can easily end up with an overheated integrated circuit if you are a bit slow at completing each joint.

This is something that can be avoided by letting the device cool-off after every two or three joints have been completed. It is also something that can be avoided by efficient soldering, which is a skill that comes with practice.

WAY OUT

The main problem is that, sooner or later, everyone manages to fit an integrated circuit with the wrong orientation. If the device is fitted in a holder there is no difficulty in removing it and plugging it back in again the right way round.

There are special tools available for removing integrated circuits, and these are usually in the form of out-size tweezers with hooked ends. The latter go under the ends of the integrated circuits, which can then be extracted with a steady pull on the tweezers.

In most cases integrated circuits can be prised from their holders using the blade of a very small screwdriver. This is used to lift one end of the component, and then the other. Repeat this procedure a few times until the integrated circuit has been wiggled high enough for it to be easily removed by hand.

If you start tugging away hard at an integrated circuit which is still deep in the holder you will almost certainly end up severely buckling the pins, some of which may well bury themselves in one of your fingers. You may then find that no matter how carefully you straighten the pins, they tend to snap off.

If any minor bending of integrated circuit pins should ever occur, in most cases they can be carefully pushed back into place without any of them breaking off. However, prevention is better than cure, and it is best to take due care to avoid bent or buckled pins.

If a d.i.l. integrated circuit should be accidentally soldered to the board the wrong way round, removing it could be very difficult indeed. The more pins it has, the more difficult it will be to remove it. Even with the aid of desoldering equipment it can be very difficult to get every pin properly freed from the board.

Unless the integrated circuit is an expensive one, it is often best to simply cut through each pin using wire clippers, remove the "body", and then remove the remaining pieces of pin one-by-one. This avoids the risk of damaging the board, which is the likely outcome if you persist in desoldering an awkward device.

PIN NUMBERS

There are three ways in which a d.i.l. integrated circuit can be marked to show which end is which. Most devices seem to have only one or two of these, as in the examples shown in Fig.1, but you may encounter some "belt and braces" devices which have all three.

Most d.i.l. integrated circuits have a small circular indentation in the top surface of the body, close to pin one. Most also have the small "U" shaped – or rectangular notch in the pin one end of the body. Unfortunately, there are often other indentations in the plastic encapsulation, and these are presumably just moulding marks or faults.

Rather unhelpfully, there is sometimes a "U" or semi-circular shaped indentation in the wrong end of the case. This is larger and shallower than the proper notch, but it makes it easy to get the

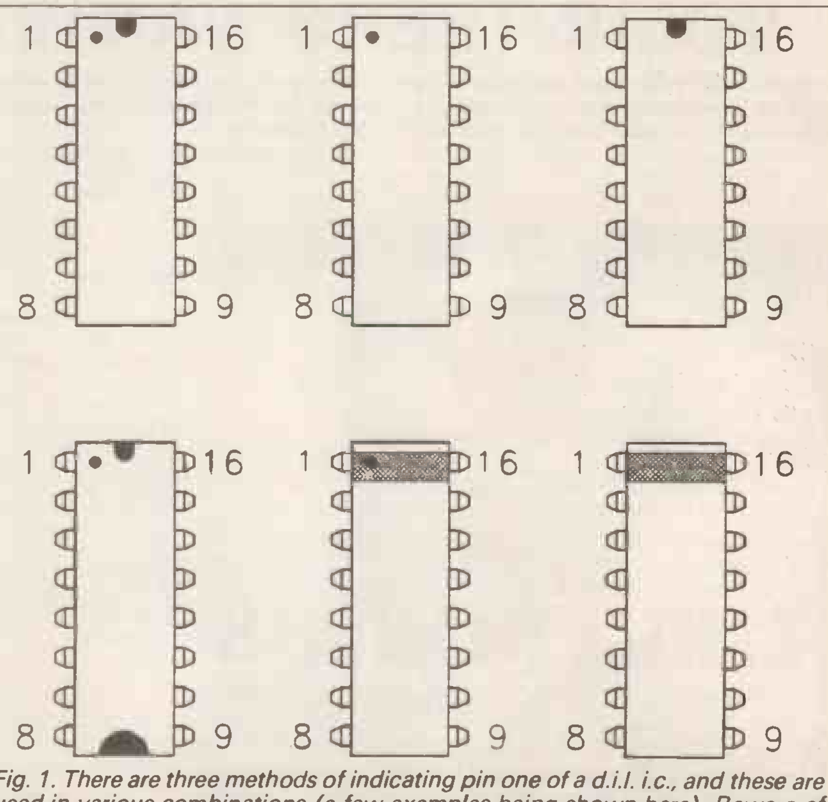


Fig. 1. There are three methods of indicating pin one of a d.i.l. i.c., and these are used in various combinations (a few examples being shown here). Beware of confusing moulding marks, as in one of these examples.

device fitted the wrong way round if you are not paying due attention.

The third method is to have a band marked across pin one end of the case. This used to be a rare method of doing things, that was mainly used on microprocessors and their peripheral chips.

However, these days it seems to be increasingly common, and is used a good deal on both logic and linear devices. It does have the advantage of being very clear and unambiguous, which is not always true of the other two methods.

WHICH ENCAPSULATION?

It is worth mentioning that many integrated circuits are available in more than one encapsulation. Most of the popular chips are now available in miniature encapsulations. These are for use with the "surface-mount" method of construction.

You are unlikely to find these devices listed in catalogues for the project builder, but you might encounter cheap surplus surface-mount devices. Note that these are only about half the size of normal d.i.l. integrated circuits, and will not fit into component layouts intended for normal 2.54mm (0·1in.) pin spacing.

The popular µA741C operational amplifier, plus some other operational amplifiers, have been produced in 8-pin d.i.l., 14-pin d.i.l., and TO5 versions. The TO5 encapsulation is a metal type with leadout wires and case styles which look rather like large transistors having eight leadout wires.

The pinout/leadout details for the three versions of the µA741C and similar devices is shown in Fig.2. Why the 14-pin d.i.l. version was ever produced is a mystery, and it can be seen from Fig.2 that this is much the same as the 8-pin d.i.l. version, but with three pairs of pins to which there are no internal connections. The 14-pin versions seem to be quite rare these days, but there are still some of these components in circulation.

If you wish to build an old project which has a circuit board designed for 14-pin d.i.l. operational amplifiers, obviously an 8-pin type should fit into the layout without any difficulty. The same is not true if you should obtain some 14-pin devices and wish to use them in a layout designed to take 8-pin versions. There being no space on the board to accommodate the longer case of the 14-pin devices.

Although integrated circuits having TO5 style cases were quite common a few years ago, they are also quite rare these days. You may still encounter the popular CA3130 and CA3140 devices in this case style. The TO5 versions have an "*A*" or "*S*" suffix whereas the 8-pin d.i.l. version has an "*E*" suffix.

The TO5 cased devices may at first sight appear to be totally incompatible with the other versions, but there is no difficulty in arranging the leadout wires into the 8-pin d.i.l. configuration. In fact some TO5 cased devices have their leadout wires preformed into this layout. You can even plug one of these components into an 8-pin d.i.l. holder.

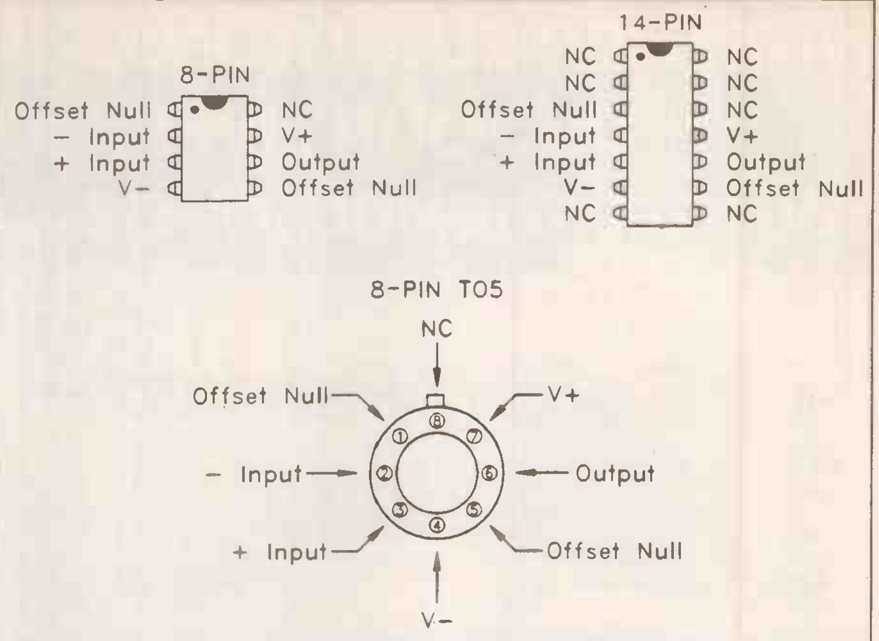


Fig. 2. The µA741C and several other operational amplifiers are available with different encapsulations. There is a degree of compatibility between the three types.

Consequently, there is no difficulty in using a TO5 version in a layout designed to take an 8- or 14-pin d.i.l. version. Things are less certain the other way round, but an 8-pin d.i.l. version might be usable in place of a TO5 type.

POWER I.C.s

Integrated circuits which have to dissipate more than about one watt do not have ordinary d.i.l. encapsulations. They have cases that can be bolted to heatsinks (which are simply metal cooling fins). Some have a case which looks rather like a plastic power transistor, but with five or more leadout wires. Despite their transistor-like casings, these are usually shown as *top* views in leadout diagrams.

Another popular style of case for power integrated circuits is a form of s.i.l. (single in-line) encapsulation. This is rather like an outsize d.i.l. case, but with one row of pins replaced by a metal fin. The fin is ready-drilled with one or two holes so that it can be bolted to a heatsink. These are again shown as top views in pinout diagrams, and some have the "dimple" next to pin one.

TRIACS, ETC.

Triacs and thyristors have transistor type encapsulations. In leadout diagrams they therefore tend to be treated in the same way, and are normally shown as base views.

Two of the leadouts of a triac are marked "MT1" and "MT2" in the base diagrams, and these abbreviations tend to cause a certain amount of puzzlement. The "MT" simply stands for "mains terminal". This is reasonably apt, as these devices are mainly used in mains power control circuits.

It is important to realise that these two terminals are NOT interchangeable, and that they must be connected the right way round. Incidentally, the third terminal of a triac is called the "gate".

The three terminals of a thyristor are called the "gate", "anode", and "cathode", or just "g", "a", and "k" on leadout diagrams. These components are also known as s.c.r.s (silicon controlled rectifiers).

Triac and thyristor are not different names for the same thing. Triacs are used in a.c. control circuits, and thyristors are used in d.c. control circuits. If a triac of equivalent ratings is used in place of a thyristor it will almost certainly work perfectly in the circuit. A thyristor cannot be used in place of a triac though.

Diacs are two terminal components which look like diodes or small rectifiers, and may appear to have a method of polarity marking. However, these components are probably unique amongst semiconductor devices in that they can be fitted either way round.

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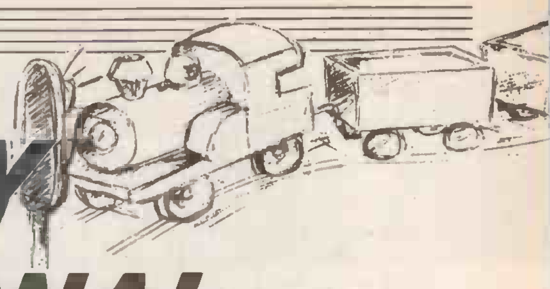


MODEL RAILWAY AUTOMATIC SIGNAL

STUART DANDO

Why not let the train take control? You will get a "Green-for-Go" and be on the right track.

RECENTLY my son received a present of a colour light signal for his model train set. I was very disappointed, when the present was opened, to find that the signal required a switch to make it function properly. The switch, that could be purchased for the lights, was only a simple manual two-way type to make the signal change from green to red and back to green again.

A more attractive system would be to make use of the train itself to operate the signal automatically, rather than manually switching the signal backwards and forwards every few minutes.

The main problem was how to operate a switch with a moving train. After careful consideration of the alternatives, it was decided that two reed switches fixed in the middle of the track and operated by a small magnet fixed to the bottom of the train was the best system to use.

When the train passed over the first reed switch the signal would turn from "green" to "red". At another point in the track the train would pass over the second reed switch and change the signal back to "green".

CIRCUIT DESCRIPTION

The circuit is built around a bistable multivibrator made up from two NAND gates – see Fig. 1. It has two inputs, Set (S) and Reset (R), and two outputs Q and $\overline{Q}$ of which $\overline{Q}$ is normally the inverse of Q.

The truth table for a NAND gate is shown in the Table 1. This shows that the output can only be "high" if one of the inputs is "low". In order to make Q high we must make S low and to make $\overline{Q}$ high we need to make R low.

One drawback of CMOS devices is their relatively low output current capability. This is limited to several milliamps. This is more than adequate to drive small loads such as l.e.d. indicators which could be used to construct a simple signal.

The complete circuit for the Model Railway Automatic Signal is shown in Fig. 2. The colour light signal which had been purchased required more than a few milliamps so the output was used to provide a base current for transistors TR1 or TR2. These are BC109 *npn* silicon transistors which can handle loads up to 100mA.

The pinout details for the 4011 i.c. are shown in Fig. 3. This is a CMOS device and only two of the NAND gates are required in the circuit. The unused inputs of the i.c. (pins 8, 9, 12 & 13) are all connected to the 0V line.

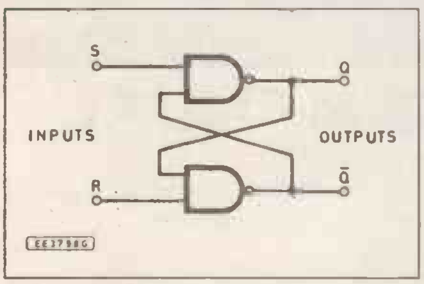


Fig. 1. A bistable multivibrator made from two NAND gates.

NAND		
INPUTS		OUTPUT
0	0	1
0	1	1
1	0	1
1	1	0

EE3799G

Table 1. Truth table for a NAND gate.

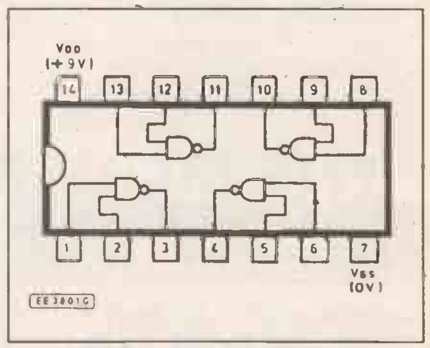
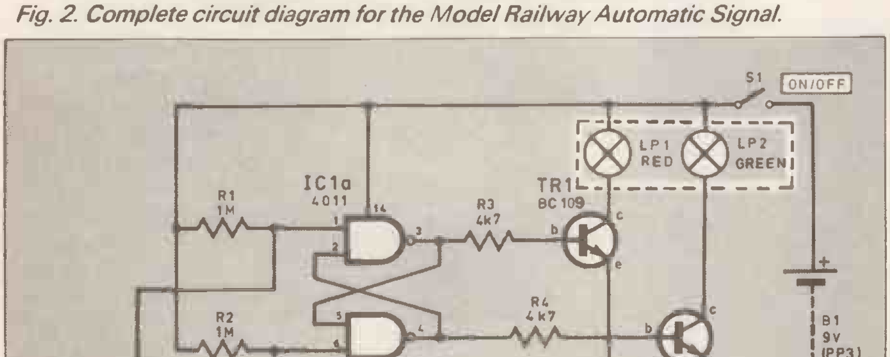


Fig. 3. Pinout details for the 4011 quad 2-input NAND gate i.c.

Fig. 2. Complete circuit diagram for the Model Railway Automatic Signal.



CONSTRUCTION

Most of the components are mounted on a piece of 0·1in. matrix stripboard, size 15 strips by 15 holes. The complete stripboard component layout and the details of the breaks required in the underside copper tracks are shown in Fig. 4.

It is important to make only six breaks in the tracks between the i.c. pins. No break is required between pins 7 and 8.

The 14-pin d.i.l. socket was positioned first and then the short pieces of link

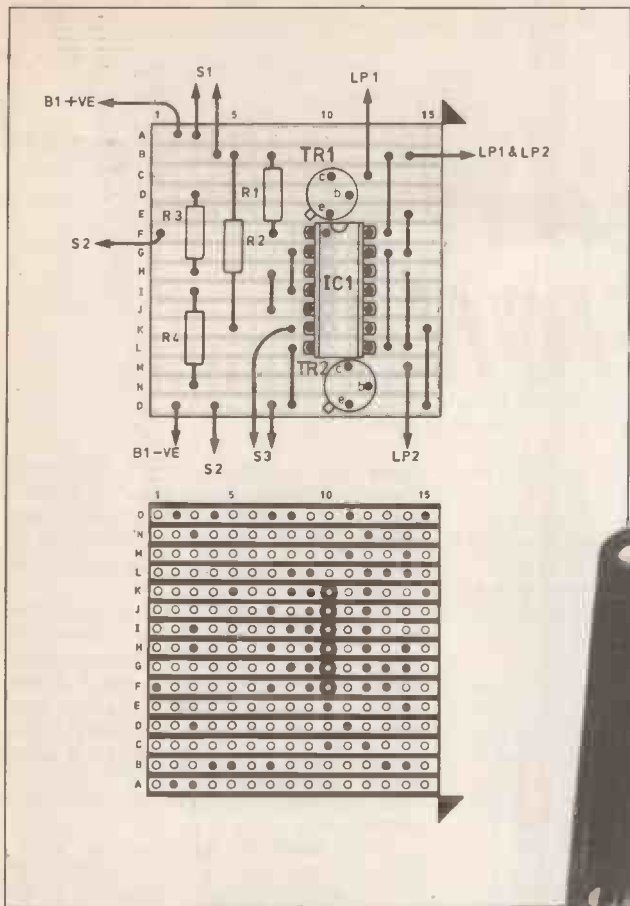
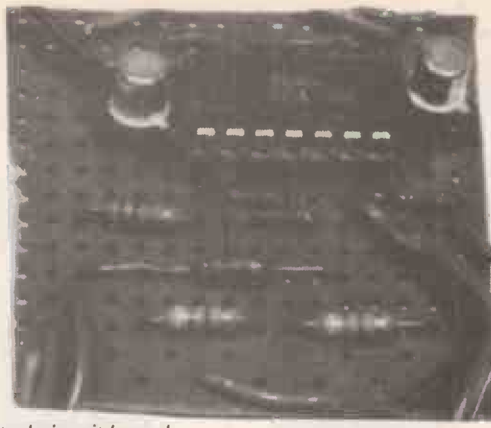


Fig. 4. Stripboard component layout and details of breaks required in the underside copper tracks.



The completed circuit board (above) and the layout of components inside its case (below).

wires. These were followed by the resistors and finally the two transistors, TR1 and TR2.

The circuit board is place into an ABS box of internal dimensions 76mm x 58mm x 38·5mm. Two small holes at opposite sides of the box allow the leads to be connected to the colour light signal "tower" and the two reed switches.

An on/off switch is inserted in the top of the box and when all of the connections have been made the i.c. and PP3 battery are fitted into place. The stripboard and battery are held in place inside the box with a small piece of polystyrene.

TESTING

There appeared to be no problems when the circuit was tested with a small magnet placed above the reed switches. The circuit functioned properly when the reed switches were placed in the centre of the track and a small magnet was fixed under a clockwork train with Blu-tack adhesive "putty".

When an electric train was used the positions of the reed switches had to be altered several times to avoid false triggering of the line signal. □

COMPONENTS

Resistors
R1, R2 1M (2 off)
R3, R4 4k7 (2 off)
All 0·25W
5% carbon film

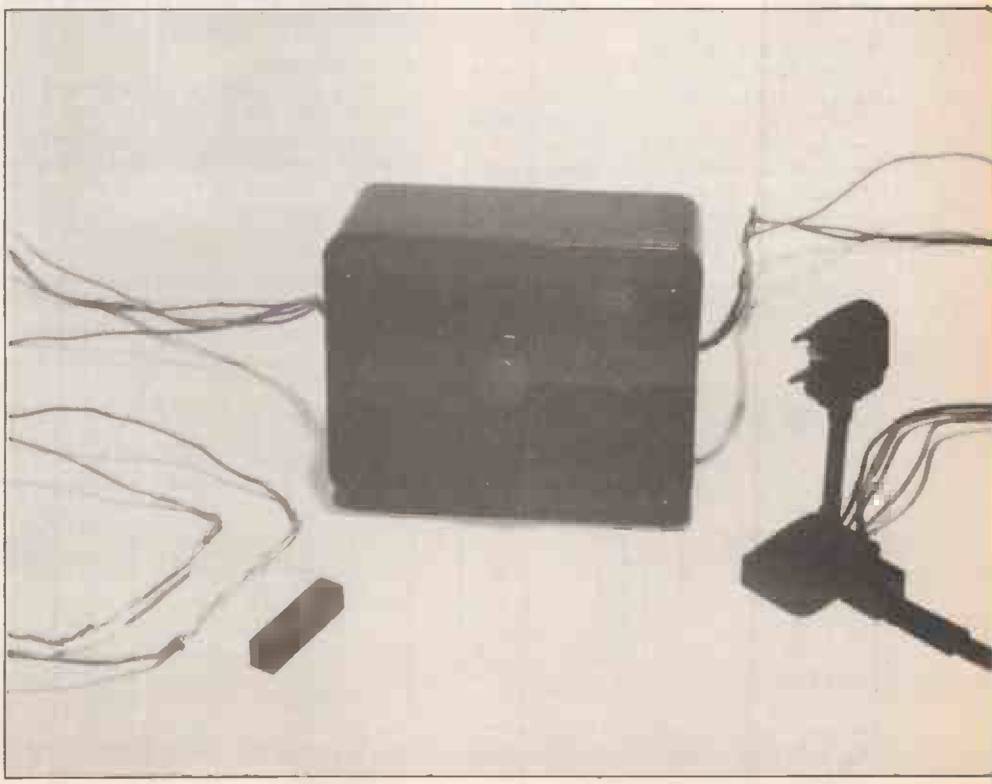
See SHOP TALK Page

Semiconductors
TR1, TR2 BC109 *npn* silicon transistor (2 off)
IC1 4011 CMOS quad 2-input NAND gate

Miscellaneous
S1 S.P.S.T. rocker switch
S2, S3 Reed switch (miniature) (2 off)
LP1, LP2 Colour Light Signal (Hornby Railways code R406)

Plastic case (ABS), internal size 76mm x 58mm x 38·5mm; stripboard, 0·1in. matrix, size 15 strips x 15 holes; 14-pin d.i.l. socket; miniature magnet; PP3 battery and clip; connecting wire; solder etc.

Approx cost guidance only **£15** *exc batt.*



DOWN TO EARTH

George Hylton

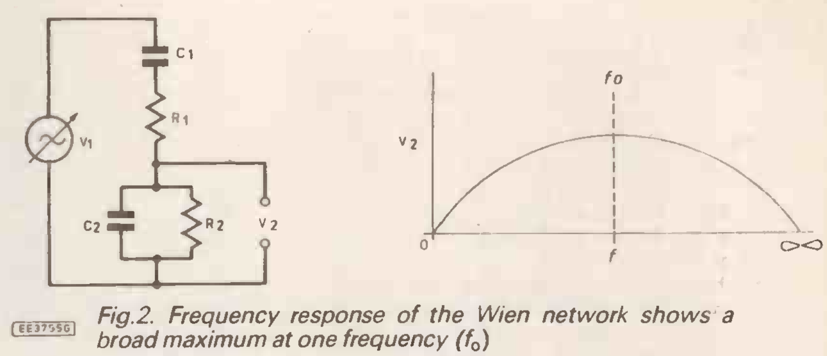


Fig.2. Frequency response of the Wien network shows a broad maximum at one frequency (f_o)

The Wien Network

In electronics, some circuits crop up again and again. They are "building bricks" from which many different applications can be constructed.

One circuit of this kind is the combination of resistance and capacitances of Fig.1a. This is a venerable network, which predates electronics. Its originator was a German professor of physics called Wien (pronounced Vee-un with the stress on the "Vee").

The Wien network has two arms: the upper, series arm has a capacitance and a resistance. The lower, parallel arm also has a capacitance and a resistance. In most practical applications the capacitances are equal and so are the resistances. It's convenient, when drawing diagrams, to put a box labelled S for the series arm and one labelled P for the parallel arm.

Frequency Bridge

Professor Wien used his network in conjunction with two resistive arms (Fig. 1b A and B) to form a bridge. This bridge has the peculiarity that it is balanced at only one frequency. With equal R's and C's, balance is obtained when A = 2B. The balance frequency is then the frequency at which the reactance of C is equal to R.

This behaviour of the Wien network is easily understood without doing any maths. In Fig.2, the network is shown as a voltage divider driven by an a.c. signal of variable frequency. At the low-frequency end C1 is a complete block to d.c. and a high impedance to low-frequency a.c. The output is therefore low. At infinitely high frequency C1 offers no impedance at all, and current can flow freely.

However, C2 is also a virtual short circuit to very high frequencies so V_2, the voltage across it, is again zero. These two effects (attenuation of l.f. by C1 and of h.f. by C2) offset one another at intermediate frequencies, so there is some output. The upshot is that as the frequency is raised from zero V_2 at first increases rapidly then, as the shunting effect of C2 becomes more significant, more and more slowly. In the end, after reaching a maximum, V_2 falls off and plunges to zero at h.f.

Phase Shift

Mathematical analysis gives an important result which is not obvious (to me, at least) just from inspecting Fig. 2. At the frequency of maximum response (often misleadingly called f_o) there is no phase shift: V_2 is in phase with V_1. At lower frequencies there is a phase lead, at higher, a lag. With equal R's and C's ($R1 = R2 = R$; $C1 = C2 = C$) f_o is given by the formula: $f_o = 1/(2\pi RC)$. Under these conditions $V_2 = V_1/3$.

Oscillations

In the pre-electronic age, the main use of the Wien bridge (Fig.1b) was as a means of measuring frequency. When the S and P arms and the resistive arms were adjusted to give zero output across the floating terminals of the bridge the frequency could be calculated from the values of R1, R2, C1 and C2. This may seem a tedious way of measuring frequency, but remember that in those days there were no digital counters. Moreover, it was a relatively small step, once electronics had arrived in the shape of the radio valve, to adapt the circuit so as to make the S and P arms determine the frequency of an oscillator.

In present-day terms, the oscillator can be depicted as Fig.3. An operational amplifier is connected so that its output drives a Wien bridge. Its input is the bridge's "floating" output. As we have seen, this is zero at f_o. If, however, the bridge is slightly unbalanced by making the "2R" upper resistance arm too high then the circuit oscillates at a frequency close to f_o.

Fine adjustment of unbalance is obtained by using a balance potentiometer whose resistance is a small fraction of the total. In Fig.2 the balance pot has one-fifth the resistance of R. By connecting a fixed resistance of R/10 across its lower part balance is obtained with the slider of R/5 at the half-resistance point.

Decade Oscillators

The Wien bridge oscillator is very convenient for generating low frequencies. The frequency-varying component is just a two-gang pot. If low frequencies were generated by a tuneable LC oscillator enormous inductors and variable capacitors would be needed.

There is something else about the Wien bridge oscillator which makes it convenient. This is the ability to set the frequency in small precise steps. The frequency formula $f_o = 1/(2\pi RC)$, if carefully inspected, shows that when C is fixed and R varied the frequency is proportional not to R, but to 1/R. If R is not a single resistance but two in parallel (Ra and Rb), familiar Ohm's Law arithmetic says that $1/R = 1/Ra + 1/Rb$.

In the oscillator, 1/Ra gives one frequency, say 1000Hz. If 1/Rb gives 100Hz then the frequency for Ra and Rb

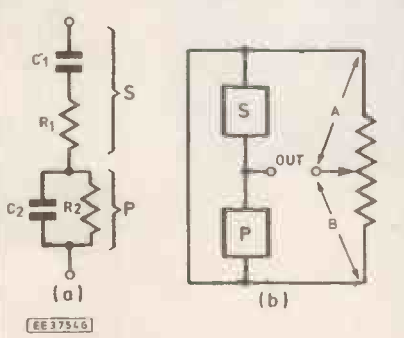


Fig.1(a) The Wien network (b) Wien Bridge.

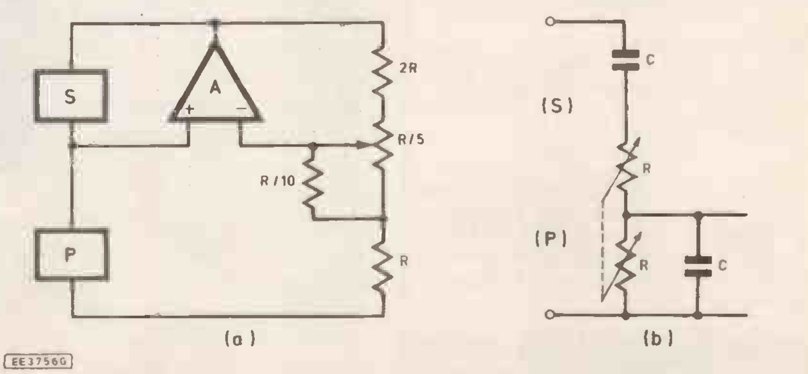


Fig.3. (a) In the "Wien Bridge" oscillator the reactive bridge arms S and P determine f_o frequency (b) Practical tuning network with variable R.

in parallel is 1100Hz. If a choice of Rb's is provided, selectable by a multi-position switch, then the frequency can be made to change in steps such as 1000, 1100, 1200, 1300Hz and so on. In practical terms this gives rise to a famous test oscillator, the Muirhead-Wigan decade oscillator, which covered the audio range in 1:10 frequency decades, each resolvable into small fixed steps.

Amplitude Stabilization

Once an oscillator gets going the amplitude of oscillation builds up and up until something stops it. The mechanism which usually puts the brakes on is overloading of the amplifier part, causing the peaks of the oscillation waves to be clipped or crushed. This is distortion, and in audio test oscillators (the common use of the Wien type) distortion must be minimised.

Some reduction in distortion is obtainable by taking the output across the P arm (i.e. as V_2 in Fig.2). Here, the frequency-selective property of the network discriminates against harmonics. Unfortunately, it doesn't discriminate well: the tuning is too broad. Also, the output voltage is only one third of the amplifier output.

The standard solution is to substitute

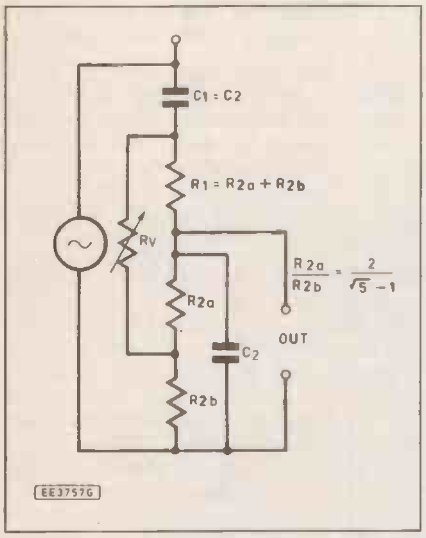


Fig.4. Wien network modified for single element control.

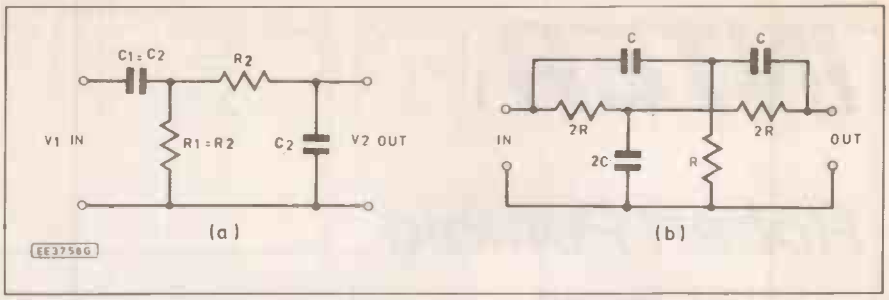


Fig. 5. Wien network equivalents which avoid floating terminals. (a) Cascade (b) Twin-T.

a thermistor for the "2R" element in Fig.3. As amplitude increases, the current warms the thermistor. If it is a negative-temperature-coefficient (N.T.C.) thermistor "2R" then falls. This pulls the bridge closer to the balanced condition and output is prevented from increasing. With careful design, the overload point is never reached and the amplitude stays close to some mean value.

Amplitude Bounce

There are snags. One is that to be able to respond quickly the thermistor must be very small. This means using a subminiature bead type. They are expensive.

Another is that the oscillator can get itself into a state in which the amplitude does not stabilize, but fluctuates either continuously or in a transient fashion. This "hunting" or "amplitude bounce" becomes more troublesome as the amplifier is made more linear. So the oscillator with the lowest distortion is likely to have the worst bounce.

Resistance Tracking

Bounce is found to be stimulated by operating the tuning control. The reason lies in the impossibility of obtaining perfect tracking between the two parts of the two-gang tuning resistance (R1 and R2 in Fig.2). If R1 at one setting is higher than R2 then output falls, and vice versa. As the tuning is changed, minor inequalities of R1 and R2 crop up, causing minor changes of amplitude which encourage bounce.

Since no twin-gang variable resistance can have perfect tracking designers have been at pains to invent circuits in which a single variable resistance somehow has the effect of changing R1 and R2 equally. Since there is no tracking problem with a single variable resistance, amplitude changes are minimized (theoretically, eliminated).

One arrangement, a product of the same Wigan as the designer of the Muirhead-Wigan oscillator, is shown in Fig.4. The variable R_V straddles the Wien network from the top of R1 (now a fixed resistance) to a tap on R2. The arrangement works well, but two facts reduce its utility. First, the correct tapping point on R2 depends on the ratio of C1 to C2. These are nominally equal, but tolerances produce a difference. In a multi-range oscillator where the ranges are set by switching capacitances the tap on R2 must be preset for each range.

The second inconvenient fact is that the circuit as shown, with equal C's, gives a practical tuning range not much in excess of 2 to 1. Rather a lot of ranges are then needed to cover, say, 10Hz to 100kHz.

More complex single-control circuits do rather better and ranges with variation of $\sqrt{10}$ to 1 are possible. This gives coverages such as 10Hz to 32Hz, 32 to 100, 100 to 320 etc.

Alternative Networks

Wien network equivalents, which have similar frequency response are shown here. Fig.5a gives the same performance as Fig.2, while Fig.5b is the equivalent of the complete bridge (Fig.1b) and gives zero output at f_0.

The Twin-T (Fig.5b) is much used in fixed-tuned "notch filters" to give zero response at one frequency, such as the mains frequency in hum-reducing circuits. It has the advantage that there are no "floating" output terminals.

INTERFACE

Robert Penfold

THIS MONTH, amongst other things, we continue with the barcode interface. The Maplin or RS miniature infra-red reflective sensor can be used in an extremely simple barcode interface, but I did not obtain very good results using such a circuit. If the infra-red l.e.d. is fed with a current of around 40 milliamps, and the photo-transistor is used as a common emitter switch having a load resistor of a few kilohms, there will be an output of sorts if the sensor is run across a suitable barcode.

There are a some major problems with such a setup though. One of these is that the output signal does not switch very fast, and it could give problems if fed to some logic inputs.

The lack of switching speed is mainly due to the fact that photo-transistors are not particularly fast devices. The output does not switch particularly cleanly either.

The output signal may not be strong enough to drive some logic inputs properly anyway. The main problem though, is that the width of the output pulses seems to be much the same for thin bars and thick ones!

Active Sensor Circuit

Results seem to be vastly better if an active circuit is used, with some amplification and signal conditioning being utilized to provide a "clean" output signal that properly reflects the bar widths. The final circuit adopted is shown in Fig. 1.

Resistor R1 is the current limiter resistor for the l.e.d. section of the sensor IC1. This sets the l.e.d. current at approximately 13 milliamps. This is high enough to give a reasonably strong infra-red signal, and there seems to be no real advantage in using a current which is close to the 50 milliamp maximum continuous rating of the l.e.d.

The only exception to this might be if the barcode is printed on something that is not particularly reflective (e.g. some low quality papers). It might then be advantageous to reduce R1 to 82 ohms.

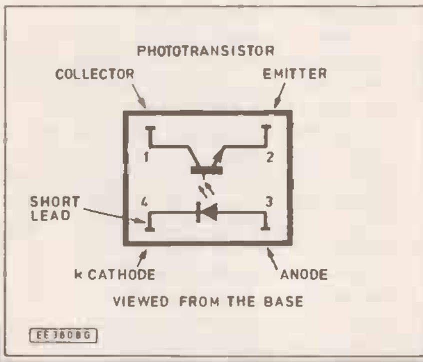
102 Decimal

Example of the type of barcode generated.

Incidentally, I would only recommend printing the barcodes on white paper. Tinted papers could well give problems with a lack of contrast.

The photo-transistor, within IC1, is operated in the emitter follower mode, and it drives a discrete common emitter switching stage based on transistor TR1. This arrangement gives a relatively fast switching speed and good sensitivity.

The sensitivity can be adjusted via VR1, and this enables the sensitivity to be set at a level which provides two distinctly different pulse widths from the wide and narrow code bars. Maximum resistance through VR1 gives maximum sensitivity.



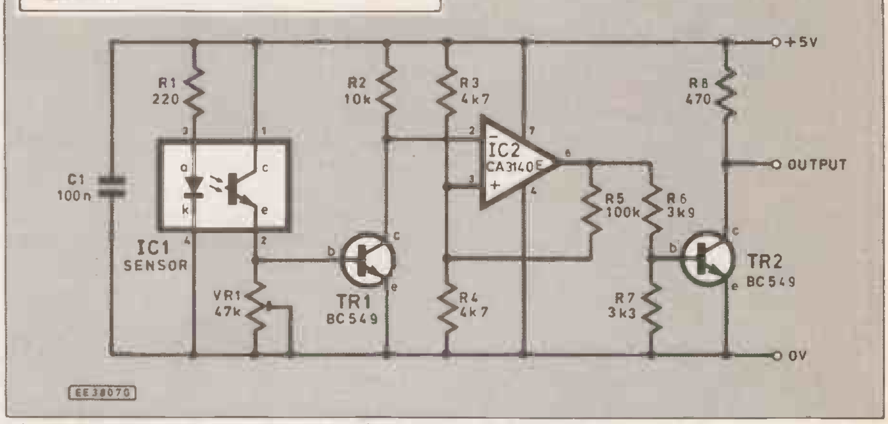


Fig. 1. The barcode interface circuit diagram. Pin connections for the sensor IC1 are shown inset above.

One Logic to Another

The output from TR1 might contain some spurious signals on transitions from one logic level to the other, and its output impedance is too high to drive most logic inputs properly. Therefore IC2 is used as a trigger circuit having a moderate amount of hysteresis provided by resistor R5. Provided the bar code is printed reasonably crisply this should give a good quality and glitch-free output signal.

The output of IC2 (pin 6) will drive some logic inputs properly, but will not "sink" enough current to drive some inputs satisfactorily. Transistor TR2 is therefore used as a common emitter switching stage which provides an output signal that will drive any normal logic input successfully.

Under stand-by conditions (i.e. with the sensor IC1 aimed at the white background of a barcode) the output from the interface is at logic 0. It was found that the best way to provide VR1 with a suitable setting was to first accurately position the sensor over a narrow bar. By adjusting VR1 it should be possible to set the output at logic 0 or logic 1. Good results should be obtained if VR1 is set just slightly on the logic 1 side of VR1's switch-over point.

Through The Window

Remember that the sensor can only operate properly if it is held *slightly clear* of the barcode. The RS data gives the optimum sensing distance as just 1.2 millimetres, but the barcode printer program produces bar codes that are chunky enough to permit some margin of error here.

Also bear in mind that the sensor will only work properly if the rectangular "windows" (which can be clearly seen if you look at the end of the sensor) are more or less parallel to the bars in the code. If you get the sensor so that these "windows" are at right angles to the bars the system will not function properly at all.

Ideally the circuit should be tested by displaying the output signal on an oscilloscope. A simple alternative is to monitor the output using a crystal earphone. A series of "clicks", or a deep "buzzing" sound should be heard as the sensor is swept across a barcode.

Next month: We will look at interfacing the barcode reader to a PC, and some software will be provided.

Quickroute

There are now several public domain and shareware printed circuit design programs for PCs, one or two of which have been reviewed in previous *Interface* articles. While these programs are quite clever in some respects, overall they tend to leave me feeling that it would be quicker and more reliable to draw-up the designs using traditional drafting methods!

The latest PC shareware printed circuit design program to appear is called "Quickroute". The version distributed as shareware is almost the same as the version you get for a £30 registration fee. The main difference is that the registered version is equipped with additional printer and plotter drivers. These extra drivers are for HP Laserjets, Epson 24-pin printers, and HP plotters. The shareware distribution version only has drivers for Epson and IBM 9-pin printers.

The registered version is capable of driving a wide range of output devices, since many printers and plotters are compatible with the supported Epson, IBM, and HP devices. The Laserjet output is suitable for use with HP Deskjet and similar inkjet printers incidentally. Unusually for this type of software, I had no difficulty in getting the program to work with a variety of output devices.

You do not need expensive hardware to run this program. The minimum requirement is an 8088 based machine with 512k of memory and a C.G.A. display.

Screen redrawing is quite fast, but a more powerful PC is still preferable, as is the higher resolution provided by a V.G.A. display. A Microsoft compatible mouse is also more than a little helpful, since the program makes extensive use of pop-down menus, icons, etc.

There is insufficient space available here for a detailed description of the program to be provided, and a general overview will have to suffice. The user interface is very professional, and is almost totally graphic oriented. Using the program is very much like using one of the sophisticated Windows based graphics programs.

On The Screen

On the right hand side of the screen there are icons, and these are mainly used for selecting the objects (tracks, pads, symbols, etc.) which are to be placed onto the board. There are exceptions in the arrowhead icons which are used for panning around the screen, and the eraser icon which is used for deleting objects one-by-one. The question mark icon brings up a large window in the middle of the screen which provides easy selection of track widths, pad styles and sizes, integrated circuit symbols, etc.

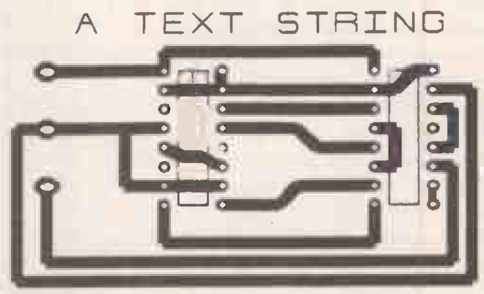
At the top of the screen there is a menu bar which gives access to six pop-down menus. The menus provide facilities such as loading and saving, editing functions, setting up the cursor and screen grids, layer selection, etc.

Most programs currently use the left hand mouse button for just about everything, with the other button or buttons being largely ignored. In Quickroute the left button is used for control via the icons, and the right hand button is used for the pop-down menus. This takes a certain amount of getting used to, which is not helped by a slight reluctance for the menus to pop down.

This program is certainly very sophisticated in many respects. It can print at virtually any scale, there is a simple auto-router, custom as well as preset zoom levels are available, and as already pointed out, the user interface is a very modern graphical type.

Quickroute does have is limitations though. These mainly centre around the editing of designs. The main advantage of using a computer for this type of design work is the ease with which alterations and corrections can be made to a design.

Unfortunately, it does not provide editing functions to rival the low cost commercial equivalents. There are some useful block operations available (mirror, copy, rotate, move, and delete), but it is easy to get it wrong with this type of thing, and there is no "Undo" facility. Even just deleting one or two objects can sometimes be awkward and time consuming.



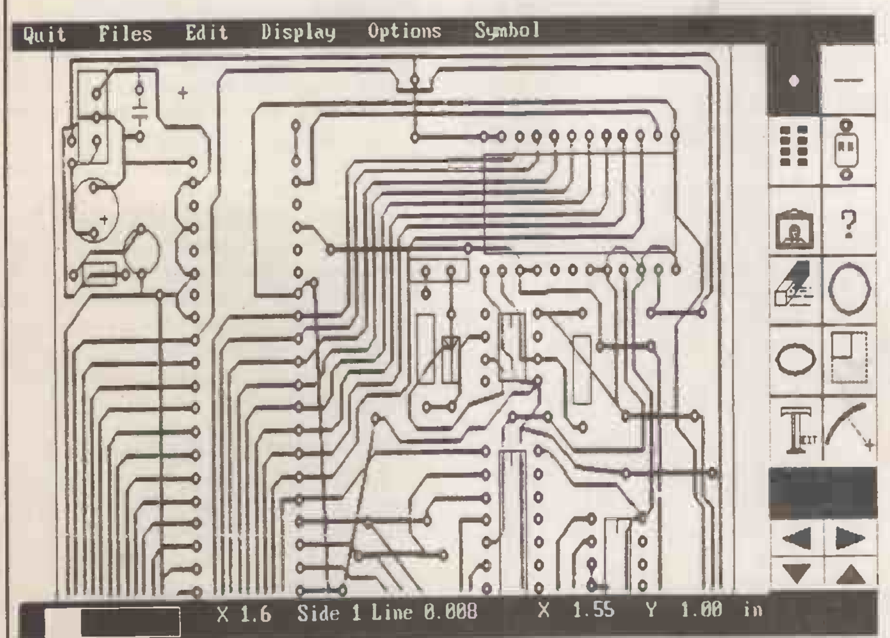
An example of a 1:1 output from Quickroute. Produced using an Epson EPL4100 laser at full 300d.p.i. resolution.

Although the program is very modern and sophisticated in some respects, the editing facilities are rather out of date. Another and more minor problem is that with some output devices the quality of the hard copy is not quite as good as that provided by most other graphics programs.

It is certainly possible to design quite complex printed circuit boards using Quickroute, and to then produce hard copy which can be used in the production of the boards. You need to proceed rather more cautiously than with most of the commercial competition though.

Despite my reservations, it has to be said that "Quickroute" offers exceptional value for money, and is certainly worthy of consideration if you are in the market for this type of software. Remember that it is shareware, and that it costs very little to try out the program. If you have a PC and are interested in electronics, then this is a program that you should give a try, even if it is only for the fun of it.

Quickroute is produced by *Powerware, Dept EE, 14 Ley Lane, Marple Bridge, Stockport, SK6 5DD*. The shareware version is available from *The P.D.S.L., Dept EE, Winscombe House, Beacon Road, Crowborough, Sussex, TN6 1UL* (☎ *0892 663298)*. It is disk No.2937. It should be available from most other large shareware libraries, but it will have a different catalogue number.



Screen dump with the demo p.c. design loaded. Note the icons on the right, and the menu bar at the top of the screen.

FOR YOUR ENTERTAINMENT

by Barry Fox

PC Compatibility Joke

Out here in the real world there is a quaint old custom. When we buy something we expect to be able to use it, without first negotiating an obstacle course that soaks up time like a sponge, saps business profits and creates good grounds for divorce. The Japanese consumer electronics industry recognised this simple truth long ago, and has grown rich on that recognition.

The Western computer industry, which has grown rich over the last fifteen years on the promise of personal computing, is riding for a fall because it has never had any truck with such quaintness. If you buy into the joke world of IBM PC "compatibility", then getting hardware A, to work with peripheral B, and software C, merits rejoicing.

It is the eighth wonder of the world that the PC industry has grown so far and so fast with such appalling contempt for its customers. When the bubble bursts, the market will shake out in favour of those few hardware and software companies which care, just a little, for their paying customers. With MS-DOS on most of the world's 70 million PCs, and thereby causing more misery than any other single piece of software, justice dictates that Microsoft faces the longest drop.

Recently, the latest in a long string of glossy magazine puff articles about "billion dollar geek" Bill Gates "at 36 the richest man in America" told how sycophantic Microsoft staff admire his foresight and brilliant perception of intricate detail in software programs.

This puzzles me. Whether or not Mr Gates was actually responsible for MS-DOS (or simply bought the right authoring company at the right time) it is Gates who, along with IBM, condemned some 70 million people round the world using IBM compatible PCs to the absurdity of a file labelling system which limits the identifying description to eight text characters, with some useful markers barred from use. Anyone who actually works in the real world with text files knows how daft this is.

Ten Years to Late

And it was Gates' company, Microsoft, which put out a first version of Windows which was so inadequate that it had to be junked in favour of the later version, or more accurately versions.

Only now, after ten years, has Microsoft written into DOS (the fifth version, no less, and after numerous sub-versions) some of the core features of utility programs, like Norton, which make DOS halfway to usable.

Who, who had any forseight, could have failed to provide utilities like "unerase"and "safe format" in DOS from day one? And, while claiming better memory management, DOS 5 still provides no automated allocation of memory. The long-suffering user must struggle with the manual, and then try juggling all possible permutations.

Gates gave the keynote speech at the Microsoft-sponsored Multimedia and CD-ROM Conference in San Francisco earlier this year. His guruspeak view of the future skated through interactive multimedia, digital video and high definition television, with a muddled string of half-informed non-sequiturs.

Again puzzled, I asked afterwards if I could speak with him briefly. A string of Microsoft minions looked genuinely astonished that some limey hack should have such cheek. Gates, I was told, was far too busy giving interviews about the future to important magazines like Newsweek.

Master Time

Pity. Among other things I wanted to talk to Bill Gates about a complaint I had lodged with the Advertising Standards Authority. I had noticed that London Underground trains were carrying adverts for Windows 3 software placed by Microsoft.

The advert stated that "Two hours thirty minutes (is) the average time a computer user takes from scratch to master Microsoft Windows 3.0 software".

Writing as someone who has suffered the misery of trying to install and master Windows 3.0 from scratch I just could not believe this and asked the ASA to investigate the evidence for this claim.

It would of course be true to say that if someone is presented with a computer system on which Windows has already been installed, if they are prepared to use only the applications software (e.g. wordprocessing programs) for which Windows has been pre-set to use, if they already have a mouse fitted and if they are helped by someone who is already familiar with Windows, they might well learn how to use the basic commands in the time claimed.

But that is not what the advert claimed, nor is it a realistic situation.

Microsoft usually takes care to launch software at glitzy demonstrations which serve up pre-tailored systems for the trade and press to try. This is not a real world situation. In the real world the computer user will have to install the software, learn that some functions can only be performed with a mouse (not with a keyboard), learn how to juggle control settings (e.g. edit PIF files) to suit the application software they use, meet Windows' memory requirements and fine tune settings to avoid crashes, all the time referring to the 640 page manual. Just to read the manual would take far, far longer than Microsoft claims.

I suggested that the ASA should actually try loading and using Windows for themsleves, from scratch with only the manual to help them. They could then judge the validity of the advert.

The ASA wrote and told me that it was investigating and would let me know what was happening. That was in February. At the beginning of June I had still heard nothing. Perhaps they were still trying to get Windows to work.

In the meantime Microsoft has launched yet another version of Windows (Windows 3.1). Users of Windows Ver 3 can upgrade for £45, instead of paying the full price of £99, Microsoft claims increased robustness, improved performance, and greater stability.

Inadequate and Unstable

Turn those claims around and you have an admission from Microsoft that Windows 3 suffered from lack of robustness, inadequate performance and poor stability.

Under the circumstances I should have thought the upgrade from Ver 3 to Ver 3.1 should at least be free, and more fairly come with a £45 cheque to compensate people who bought and

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This I/O Port follows the general approach of the 'INTERFACING to PCs' series in this mag, BUT allows user's prototype control circuitry to be set up and run OUTSIDE the PC.

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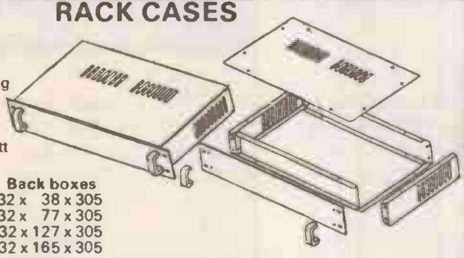

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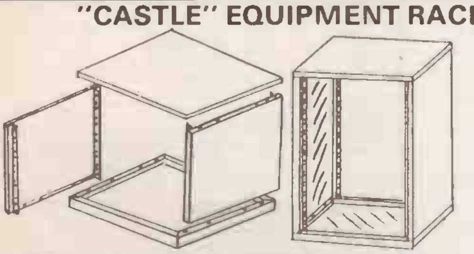

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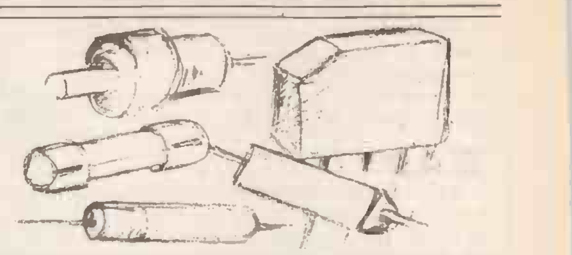


QUICKTEST

MARK DANIELS

A simple, low-cost, hand-held piece of test equipment that will perform continuity tests, without the use of test leads.

TESTING fuses and small components for continuity can be a fiddly business, involving chasing the component around the workbench with a pair of test-prods.

If the suspect part under test happens to be a diode this makes testing doubly difficult, since after managing to get one test result the entire procedure has to be repeated to obtain a reading in the opposite direction to ensure that the part in question is indeed a diode and not a piece of wire or an open circuit in disguise.

With the growth in popularity of S.M.T. (Surface Mount Technology), devices are becoming ever harder to hold onto while testing takes place. An ideal test situation for any small component would involve no test leads at all and would simply require holding the device in one hand and the tester in the other.

The Quicktest described in this article is a very simple to use piece of test equipment that will perform continuity tests on various devices without the use of test leads.

HOW IT WORKS

The complete circuit diagram for the Quicktest is shown in Fig. 1. The circuit is based around two very low cost and popular integrated circuits, namely the 555 timer and the 741 op.amp.

The first of these, IC1, is a multivibrator, which in this circuit is configured as an astable device to give a continuous pulse train at a frequency of approximately 2Hz. Resistors R1 and R2 along with capacitor C2 set the operating frequency of the oscillator. The output of IC1 at pin 3 is connected to a metal touch contact on the outside of the case.

The bi-polar op.amp IC2 is connected in its inverting mode. Its non-inverting (+) input at pin 3 being biassed by resistors R3 and R4 to the mid-point of the supply voltage. When its inverting (−) input at pin 2 is taken above or below this mid-point voltage the output at pin 6 swings almost to the negative or positive supply rail respectively.

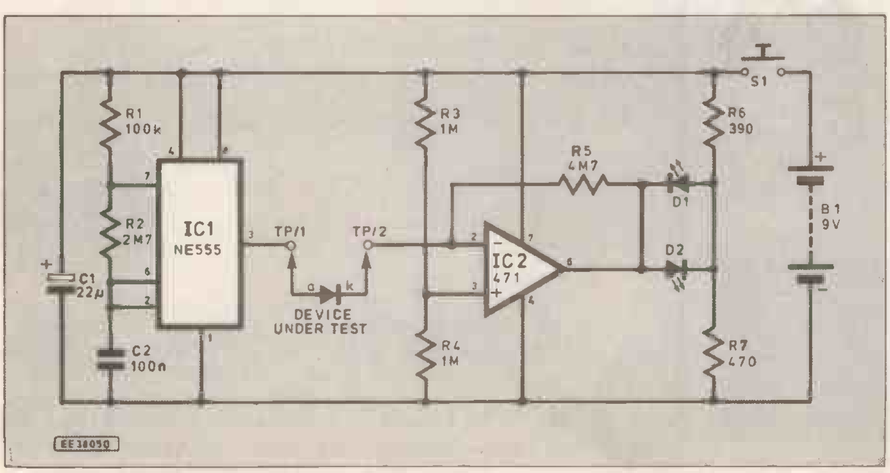
When the output swings positive current flows through l.e.d. D2 and resistor R7 to the negative supply rail causing D2 to illuminate and flash on and off. With the output negative, current will then flow from the positive supply rail through resistor R6 and l.e.d. D1 (and of course to the supply rail through IC2), which will light. It is possible to replace the l.e.d.s with a single bi-colour device – see Fig. 2.

Resistor R5 provides a small degree of negative feedback to stabilise the amplifier. Without this it would oscillate uncontrollably with no input.

If the touch contacts are connected together with a piece of wire (or a human body!) a minute current can then flow from pin 3 of IC1, into pin 2 of IC2 which amplifies both the negative and positive pulses thus turning on l.e.d.s D1 and D2 alternately. If a functional diode is now connected in place of the wire link either the positive or negative pulses will be blocked so IC2 will then only have the negative or the positive pulses present on its input pin. Its output will in this case only be able to swing in one direction, thus only one of the l.e.d.s will be able to flash.

Capacitor C1 is included in this circuit to decouple the noise produced by IC1 and prevent it from affecting the very sensitive amplifier stage.

Fig. 1. Circuit diagram of the Quicktest.



CONSTRUCTION

A small single-sided glass-fibre printed circuit board (p.c.b.) is used to simplify assembly. The copper foil master pattern and component layout for this is shown in Fig. 2. This board is available from the *EE PCB Service*, code EE803.

Fit p.c.b. pins for the three leads which will interconnect off-board components to the board, this will simplify later assembly. Next fit the seven resistors followed by the two capacitors. Note the polarity of the electrolytic capacitor C1.

The two i.c.s may be soldered directly into the board without the use of sockets if the soldering is quick. If you are at all uncertain about soldering them in then do

COMPONENTS

Resistors

R1	100k
R2	2M7
R3, R4	1M 1% metal film (2 off)
R5	4M7
R6	390
R7	470

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

See SHOP TALK Page

Capacitors

C1	22µ radial elect. 10V
C2	100n polyester layer; 5mm pitch

Semiconductors

D1, D2	5mm Red and Green l.e.d. (one of each), or one bi-colour l.e.d.
IC1	555 timer
IC2	747 op.amp

Miscellaneous

S1	Wafer thin, push-to-make p.c.b. mounting switch
B1	9V battery (PP3)

Plastic box with battery compartment, size 125mm x 46mm x 24mm; metal touch contacts (2 off); p.c.b. solder pins (3 off); multistrand connecting wire; 6BA nuts (4 off), washers as required; 6BA solder tag; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE803.

Approx cost guidance only **£12.50**

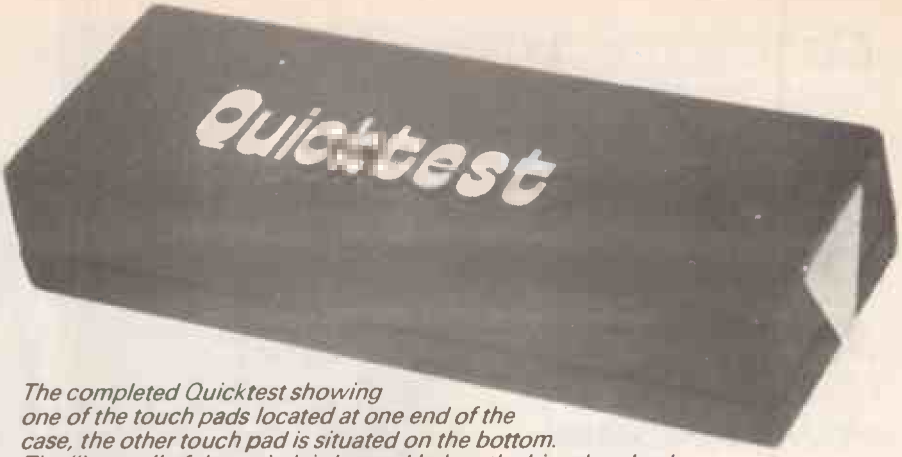
use sockets. The i.c.s are not static sensitive devices, so do not require special handling.

When the board assembly is completed check it thoroughly for dry joints and shorts. Also check component positioning and orientation paying special attention to the i.c.s and capacitor C1.

CASE DETAILS

If the recommended case is used it will be found that the p.c.b. is just the right size to fit in the bottom half of the case in front of the battery compartment. Locate the p.c.b. in the case and using the hole marked "Touch Pad" in Fig. 2 as a guide drill a 3mm hole through the bottom of the case.

If the specified touch pads are used these are secured by a single 6BA nut. In this application packing washers are fitted underneath the mounting nut to pack it to the right height in order that it may make contact with its respective pad on the p.c.b. when fitted.



The completed Quicktest showing one of the touch pads located at one end of the case, the other touch pad is situated on the bottom. The "button" of the switch is located below the bi-colour l.e.d.

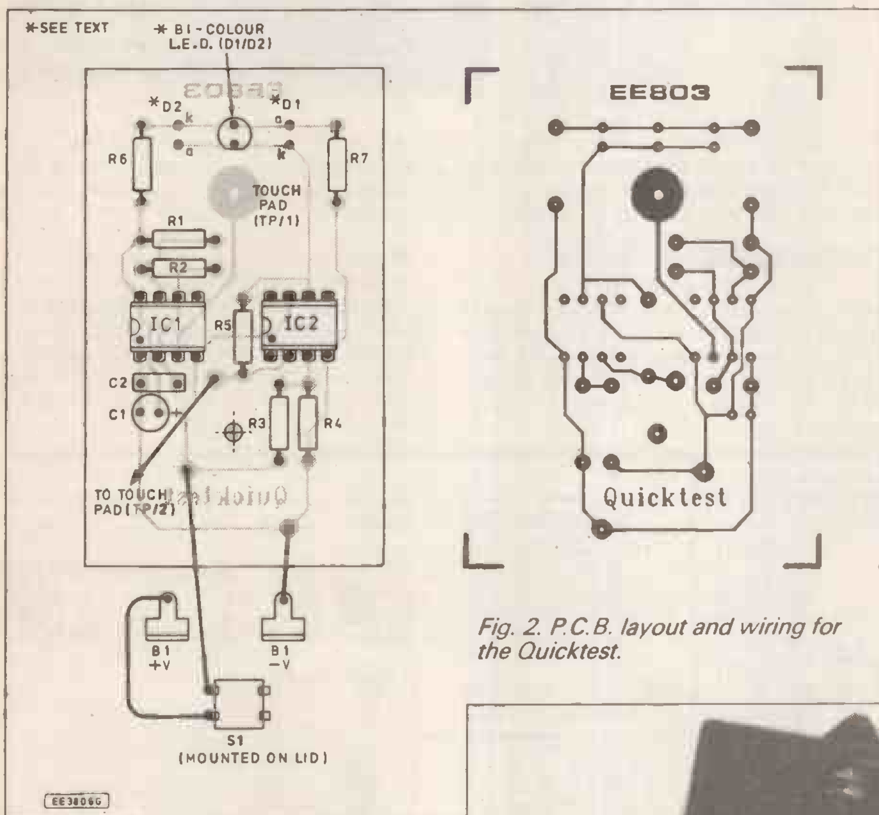


Fig. 2. P.C.B. layout and wiring for the Quicktest.

If you are using the "alternative" bi-colour l.e.d., as used on the prototype model, a single 5mm diameter hole needs to be drilled centrally in the case lid 11mm from the end opposite to the battery compartment. For the two l.e.d. version drill 5mm holes 7·5mm from the centre line, again at 11mm from the end of the case. Now fit the l.e.d.(s) to the board and adjust the height such that when the p.c.b. is fitted in its correct position in the case the l.e.d.(s) locate into their hole(s).

Once the board is completed it may be fitted. A second nut on the touch pad is used to secure the p.c.b. in place and the stud on the touch pad trimmed flush with the nut.

In the front end of the top part of the case a 3mm hole is drilled centrally about 11mm down from the top to mount the second touch pad. The stud on this will also need trimming to clear internal fittings. Fit a solder tag and second nut to this stud to facilitate interconnections.

A wafer thin, p.c.b. mounting, push-to-make switch is used for S1 and after a suitable hole has been cut and countersunk internally the switch should be bonded in place with cyanoacrylate adhesive ('Superglue'). If this method of mounting is to be used great care must be taken to avoid the adhesive penetrating the switch, therefore use only a very small amount.

The final positioning of the p.c.b. in the case and all interwiring is shown in the photograph. The use of p.c.b. pins will now be appreciated at this stage.

Fit the case lid and secure with the single fixing screw. Open the battery compartment lid and insert a PP3 battery, carefully observing polarity since it is possible to insert the battery either way round.

TESTING

For complete testing of the Quicktest all that is required is one diode and one pair of hands.

An initial test is performed by holding the Quicktest in one hand with the forefinger on the button touch pad and the thumb on the switch. Press the switch

and then with the other hand touch the front pad. The l.e.d.s should then start flashing alternately about twice every second each. (A bio-colour l.e.d. will obviously be changing colour in a similar fashion).

To test a diode, hold the device by one lead and touch its other lead to the front touch pad and press the test button. In this test only one l.e.d. will flash indicating that the diode is functional.

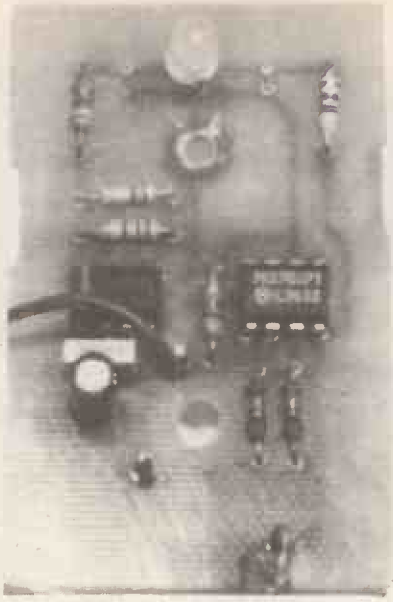
Reversing the polarity of the diode will cause the other l.e.d. to flash. When the anode (a) of the diode under test is touching the front pad l.e.d. D2 should flash and D1 when it is the cathode (k).

FAULT FINDING

There is not really a lot which can go wrong with a circuit as simple as this one. The main causes of problems are incorrect assembly or overheating of the i.c.s when soldering – a case for d.i.l. sockets perhaps? Before jumping to conclusions though, check the battery first!

One problem which did occur during proto-typing involved the l.e.d.s. It would appear that the circuit works a lot better with the bi-colour l.e.d. (or the two separate ones) one way round than the other. This is presumably due to red and green l.e.d.s having different forward volt drops and efficiencies.

If one l.e.d. comes on faintly when the "test button" is pressed but no connections are made via the test pads the value of resistor R5 may need reducing slightly. This should not be made too low as it also affects the sensitivity of the Quicktest.



The completed circuit board showing the layout of components. Note the two cutout slots in the side of the board to ease mounting in the case. The photo on the right shows the wiring to the switch and one of the touch pads. The board mounting bolts also make contact with the other touch pad.

MODIFICATION

If it is desired that the display be continuous for some reason rather than flashing this may be achieved, in appearance, by increasing the operating frequency of the astable multivibrator, IC1, such that it runs so fast that the eye cannot detect the individual flashes.

Reducing the values of resistors R1 to one kilohm and R2 to 10 kilohm will give approximately 700Hz. At this frequency no flicker will be visible. Now when a good fuse (or similar) is tested both l.e.d.s will appear to be lit continuously, or if a bi-colour l.e.d. is used it will appear orange or yellow. □

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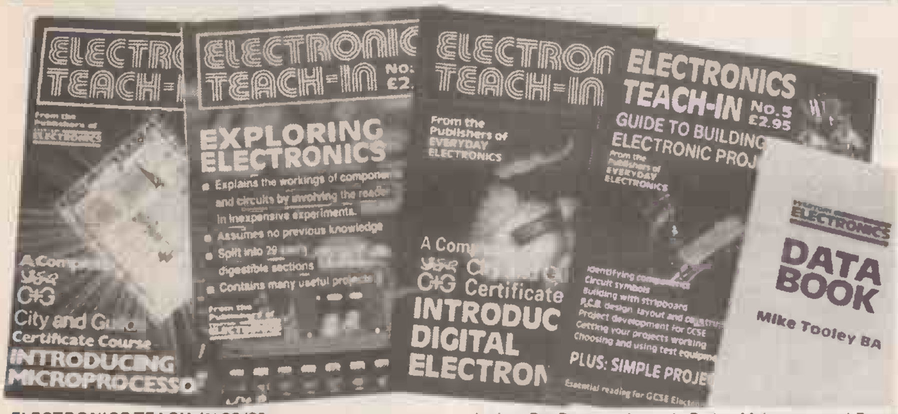

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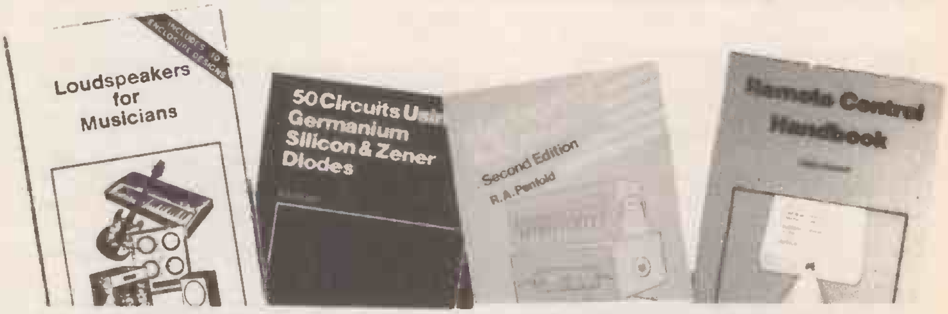

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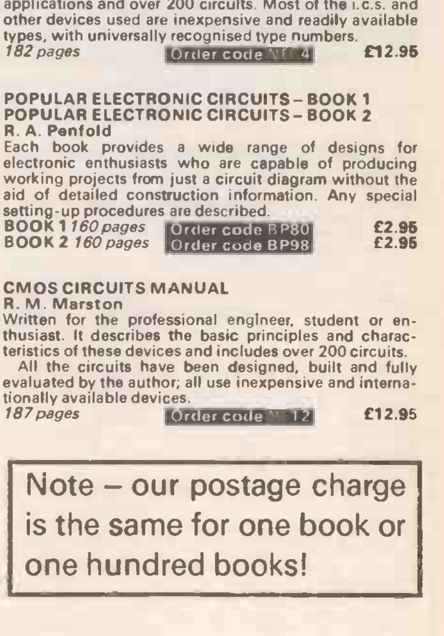

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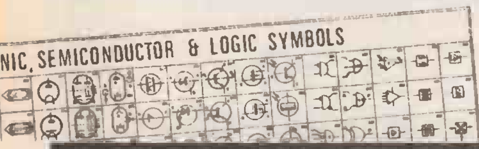

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SEE PREVIOUS PAGE FOR FULL ORDERING DETAILS

PCB SERVICE

Printed circuit boards for certain EE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* (**Payment in £ sterling only**).

NOTE: While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Please check price and availability in the latest issue.

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Mini Disco Light	JUNE'87	(sorry sold out)	
Fermostat	JULY'87	(sorry sold out)	
Monomixer		571	£4.75
Noise Gate	SEP'87	577	£4.41
BBC Sideways RAM/ROM	NOV'87	(sorry sold out)	
Pseudo Echo Unit	DEC'87	(sorry sold out)	
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SOS Alert	MAR'88	(sorry sold out)	
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Weather Stn: Display Driver	MAR'90	672 & 678	£4.22
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Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver/Tuner/Amp		679/680	£4.22
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REPORTING AMATEUR RADIO

Tony Smith G4FAI

METEOR SCATTER

Last month I described how radio amateurs take advantage of seasonal and other phenomena to make v.h.f. operation a most interesting, and at times quite exciting, area of activity. I briefly covered tropospheric ducting, sporadic-E (Es) and auroral propagation.

Even more esoteric than the latter, meteor scatter (MS) uses the intense ionisation trails of meteors entering the earth's atmosphere to reflect or scatter radio signals in short "bursts" lasting from less than a second to several minutes.

Special operating procedures and equipment are required for MS operation, including reasonably high power transmitters with excellent frequency stability, and highly directional antennas. SSB speech can be used, but more often high speed Morse is used with contacts often pre-arranged so that both stations are listening on the same frequency at the same time and on the correct beam heading.

Because of the limited time available, the Morse signals are sent by memory keyers or computers at very high speed and are recorded at the receiving end by recorders with variable speed control. They are replayed at a slower speed but as the slowed-down Morse has a low audio frequency up-converters are used to raise the pitch of the signals.

The ionisation trails occur at an altitude of around 100km, the same height as Es clouds and aurora, and contacts over distances up to 2,000km may be achieved.

MOONBOUNCE

Earth-moon-earth (EME) popularly known as "moonbounce" is another highly specialised amateur activity. Radio signals are beamed at the moon and reflected back to be received both at their point of origin and at points on the earth's surface thousands of miles away. The only requirement for a two-way EME contact is that both stations can see the moon at the same time.

This is not as easy as it sounds, however. Steerable high gain antennas are needed to follow the path of the moon, and high power, around 600 watts, is needed for reasonably consistent results. Additionally, very sensitive receivers are required as only a tiny portion of the transmitted signal is reflected back to the earth's surface after its journey of nearly half a million miles.

Despite the difficulties and uncertainties, hundreds of amateurs around the world operate moonbounce with specially constructed stations, usually with Morse although single sideband speech has been used on occasions.

I began these notes last month with the comment that it is not necessary to know Morse to obtain an amateur "B" v.h.f./u.h.f. transmitting licence and to enjoy most of the activities available on the higher frequencies. This is perfectly true and many licensees enjoy their hobby quite happily without ever bothering to learn the Morse code.

However, as can be seen above, even some v.h.f. activities can benefit from a knowledge of code and other "B" licensees do eventually take the Morse test, not only to obtain access to the international h.f. bands but to enhance their capability on v.h.f. too.

EMC REGULATIONS

The European Community's Directives on electromagnetic compatibility (EMC) due to take effect on 1st January 1992 are now subject to an extended transitional period because the harmonised EMC standards were not ready.

Without going too deeply into definitions, EMC is the term used to describe a product's ability to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance. For example, a vacuum cleaner should not interfere with TV reception, computers should not scramble radio messages, and unwanted radio transmissions should not break through on domestic receiving equipment.

By the end of the transitional period manufacturers, importers and suppliers of radio equipment will be required to ensure that the products they sell in the Community comply with defined EMC protection requirements. This means that in every product the electromagnetic disturbance it generates must not exceed a level allowing radio and telecommunications equipment and other apparatus to operate as intended.

Conversely, each product shall itself have an adequate level of intrinsic immunity to electromagnetic disturbance to enable it to operate as intended. Products complying with the Directive will carry the "CE" mark and non-compliant products will be banned from the market.

IMPACT ON AMATEUR RADIO

The Directive will not apply to radio equipment used by radio amateurs which is not commercially available. If the equipment is commercially available the regulations will apply in the same way as to other products.

It may either be self-certified by manufacturers to harmonised EMC standards or may comply with the EMC Protection Requirements (i.e., be manufactured with specifically approved apparatus and procedures to ensure conformity with the protection requirements). Amateur transmitters, however, will not require the additional EMC type examination certificate, to be issued by the Radiocommunications Agency, which will be obligatory for most other transmitters, including CB.

Exemption from some parts of the regulations will not mean lower standards for amateur equipment, rather the opposite. A licence obtained by examination will still be required to operate an amateur transmitter and the terms of the licence will continue to impose stringent requirements to ensure that the station shall not cause undue interference "to any wireless telegraphy", meaning any other radio-frequency transmissions, with a requirement to close down in certain circumstances when in breach of the regulations.

QRP DX

"Dx" is normally thought of as long distance transmission to countries outside one's own continent. A contact with Rio de Janeiro, 5,700 miles from London, for instance, is pretty good going with, say, a 100 watt transmitter, but what if a low power (QRP) transmitter with only one watt of power covers the same distance?

The American QRP Amateur Radio Club International (*QRP ARCI*), measures the success of its members with a "1000 miles per watt" table calculated by dividing the number of miles covered by the number of watts (r.f. output) used during a contact. Over the distance covered above, the performance of the 100W transmitter equates to 57 miles per watt, while the QRP transmitter of one watt equals an impressive 5,700 miles per watt.

When the power is reduced to microwatts, some startling figures begin to emerge. A contact between the USA and Australia, noted by *QRP ARCI*, with the U.S. transmitter using 0·0021W, resulted in the equivalent of 3,988,810 miles per watt; and a two-way QRP contact in the States, with both stations running six microwatts, equated to 218,333,333 miles per watt!

These sort of achievements require high-gain carefully tuned and aligned antennas, very sensitive receivers, and quite a lot of skill, but they do demonstrate that high power isn't always necessary to achieve remarkable results.

My final example is outside the field of amateur radio, but it very definitely shows what QRP can do! In February, the *Pioneer 10* spacecraft, launched in 1972, was about five billion miles away from Earth and its transmitter, now reduced in power to about 7·8W was still sending signals back to earth. There's no point in being too precise as the craft is continuing on its journey at something like 32,000 mph, but in February the output of its transmitter equated to well over half a billion miles per watt!

To receive these signals NASA Deep Space network stations have 70-metre diameter dish antennas and highly sensitive receivers with circuitry frozen in liquid helium to minimise EMC problems.

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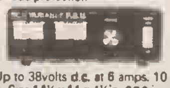

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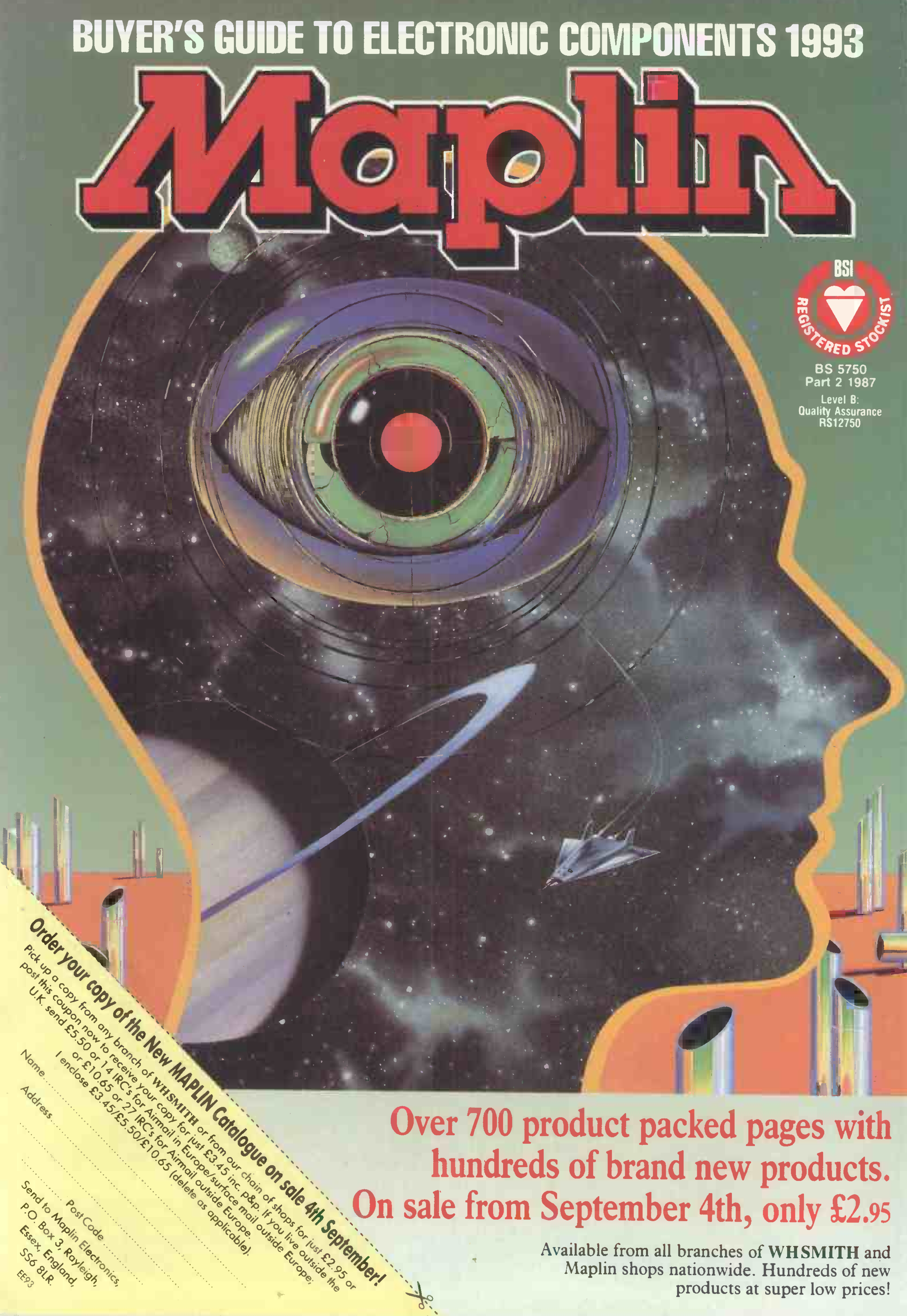
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