EVERYDAY ELECTRONICS

858

APRIL 1991

INCORPORATING ELECTRONICS MONTHLY

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GREENWELD CATALOGUE INSIDE
32 PAGE SPRING SUPPLEMENT

ELECTRONIC CAT FLAP

TRAIN CONTROLLER

ELECTRONIC DICE

GUITAR TREMOLO UNIT

9 770262 361003 04

The No.1 Magazine for Electronics & Computer Projects

REAL POWER AMPLIFIER For your car, it has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe existing car stereo, so needs no pre-amp. Works into speakers ref 30P7 described below. A real bargain at only £57.00 Order ref 57P1.

REAL 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 30P7.

PERSONAL STEREOS Customer returns but complete with a pair of stereo headphones very good value at £3.00 ref 3P83. We also have customer returned units with a built in FM radio at £6.00 ref 6P34

2KV 500 WATT TRANSFORMERS. Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93

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. £6.00 ref 6P18

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42

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. £25.00 ref 25P24.
Pack of two PAR38 bulbs for above unit £12.00 ref 12P43

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 15P39 Suitable mains adaptor £5.00 ref 5P191

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £18.00 ref 18P10

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 30P12

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 15P42

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £34.00 ref 34P1

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.

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. £25.00 ref 25P21.

LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.

NICAD BATTERYS. Brand new top quality. 4 x AA's £4.00 ref 4P44. 2 x C's £4.00 ref 4P73, 4 x D's £9.00 ref 9P12, 1 x PP3 £6.00 ref 6P35

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104. Bumper pack of 1,000 ties £14.00

BUILD AN IBM COMPATIBLE PC !

AT 12 meg turbo 286 mother board.	£115.00	pc1
1 meg memory for above board.	£55.00	pc2
4 meg memory for above board.	£214.00	pc3
AT keyboard	£49.00	pc4
AT power supply and pc case (complete)	£115.00	pc5
AT controller card with 2 x serial, 1 x parallel Floppy and hard controller + mono Display driver.	£74.00	pc6
1.2 meg 3 1/2" disc drive	£74.00	pc7
1.44 meg 5 1/4" drive.	£66.00	pc8
Amber monitor 12".	£99.00	pc9
40 meg hard disc.	£270.00	pc10
100 meg hard disc.	£595.00	pc11

minimum system consisting of mother board, 1 meg of memory case, power supply, 1.44 meg floppy, interfaces, and monitor is £525.00 inc VAT (single drive mono 286) pc12
£795.00 inc VAT (40 meg + floppy + mono 286) pc13

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158

TV SOUND DECODER. Nicely cased unit, mains powered 8 channel will drive a small speaker directly or could be fed into HI FI etc. Our price £12.00 ref 12P22

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39.

SINCLAIR C5 MOTORS. 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22.
As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and innertube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21.

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 17P3.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3.

MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also avaliable is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.

10 MEMORY PUSH BUTTON TELEPHONES. These are 'customer returns' so they may need slight attention. BT approved. £6.00 each ref 6P16 or 2 for £10.00 ref 10P77.

12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £8.00 each ref 8P26.
acorn data recorder ALF503. Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly instructions £10.00 ref 10P81.

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

SWITCHED MODE POWER SUPPLY (Boshert) +5 at 15A, +12 at 3A, -12 at 2A, +24 at 2A. 220 or 110v input. Brand new £20.00 ref 20P30.

SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.

600 WATT HEATERS. Ideal for air or liquid, will not corrode, lasts for years, coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.

TIME AND TEMPERATURE MODULE. A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.
Remote temperature probe for above unit £3.00 ref 3P60.

GEARBOX KITS. Ideal for models etc. Contains 18 gears (2 of each size) 4x50mm axies and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.

ELECTRONIC TICKET MACHINES. These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.

JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174.

QUALITY PANEL METERS. 50uA movement with 3 different scales that can be brought into view with a lever! £3.00 each ref 3P81.

CAR IONIZER KIT. Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.

METAL DETECTOR. Fun light weight device for buried treasure! 33" long with tune and fine tune controls. £10.00 ref 10P101.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.

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 100 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.

VERO EASI WIRE PROTOTYPING SYSTEM. Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.

MICROWAVE TURNTABLE MOTORS. Complete with weight sensing electronics that would have varied the cooking time. Ideal for window displays etc. £5.00 ref 5P165.

STC SWITCHED MODE POWER SUPPLY. 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £12.00 ref 12P27.

CAMERA FLASH UNITS. Require a 3v DC supply to flash. £2.00 each ref 2P38 or 6 for £10.00 ref 10P101 (ideal multi-flash photography).

TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels. BT approved. £12.00 ref 12P23 (please state telephone no req'd).

25 WATT STEREO AMPLIFIER ic. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).

MINATURE DOT MATRIX PRINTER assembly 24 column 5v (similar to RS type). £10.00 each ref 10P92.

LINEAR POWER SUPPLY. Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.

MAINS FANS. Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.

MINI RADIO MODULE. Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26.

SURFACE MOUNT KIT. Makes a high gain snooping amplifier on a PCB less than an an inch square!. £7.00 ref 7P15.

SURFACE MOUNT SOLDER. In easy to use tube. Ideal for above project £12.00 ref 12P18.

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.

FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88. Pack of 10 51/4" DSDD £5.00 ref 5P168.

SONIC CONTROLLED MOTOR. One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.

FRESNEL MAGNIFYING LENS. 83 x 52mm £1.00 ref BD827.
lcd display. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.

TRANSMITTER AND RECEIVER. These units were designed for nurse call systems and transmit any one of 16 different codes. The transmitter is cased and designed to hang round the neck. £12.00 a pair ref 12P26.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.

100M REEL OF WHITE BELL WIRE. figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.

ULTRASONIC LIGHT. This battery operated unit is ideal for the shed etc as it detects movement and turns a light on for a preset time (light included). Could be used as a sensor in an alarm system. £14.00 each ref 14P8.

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. £4.00 each ref 4P82.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.

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 6P36.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.

HI-FI SPEAKER. Full range 131 mm diameter 8 ohm 60 watt 63-20 khz excellent reproduction. £12.00 ref 12P33.

ASTEC SWITCHED MODE POWER SUPPLY. 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.

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 5P167.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135

POWERFUL SOLAR CELL 1AMP .45 VOLT! only £5.00 ref 5P192 (other sizes available in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.

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

12 " HIGH RESOLUTION MONITOR. AMBER SCREEN BEAUTIFULLY CASED NEEDS 12V AT 1A TTL INPUT (SEP SYNCS). £22.00 REF 22P2.

RADIO CONTROLLED CAR. Sigle channel R/c buggy with forward reverse and turn controls, off road tyres and suspension. £12.00 ref 12P40.

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.

SUPER FAST NICAD CHARGER. Charges 4 AA nicad's in less than 2 hours! Plugs into standard 13A socket. Complete with 4 AA nicad batteries £16.00 ref 16P8.

ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.

TOP QUALITY MICROPHONE. Unidirectional electret condenser mic 600 ohm sensitivity 16-18khz built in chime complete with magnetic microphone stand and mic clip. £12.00 ref 12P42.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.

QUICK FIX MAINS CONNECTOR. Ideal for the fast connection of mains equipment. Neon indicator and colour coded connectors. £7.00 ref 7P18.

COPPER CLAD STRIP BOARD. 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.

TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.

TOROIDAL TRANSFORMER. 24v 5A encapsulated 4" dia £5.00 ref 5P34.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT DEPT EE

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EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
ABC

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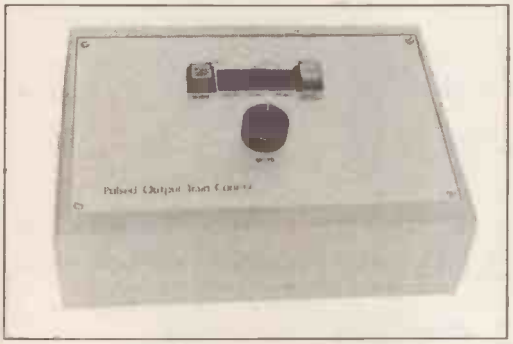
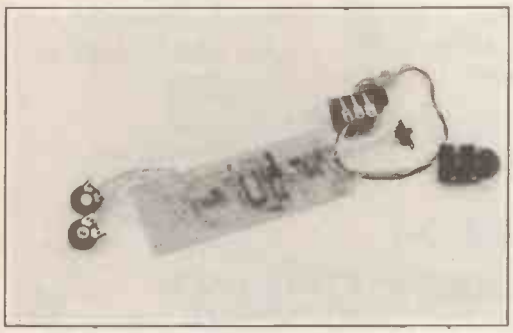
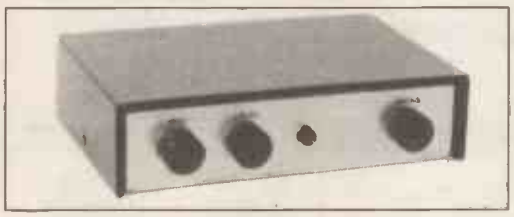
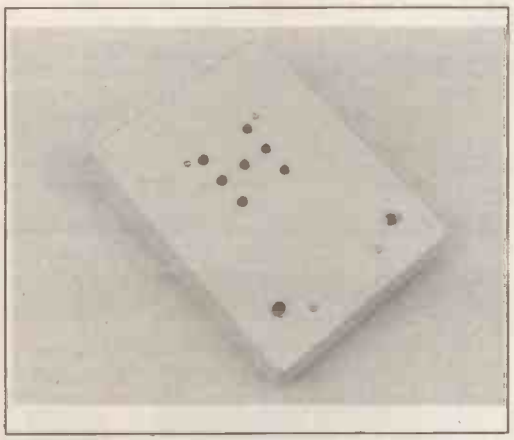
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .









Projects

Series

Features

FREE WITH THIS ISSUE

GREENWELD SPRING CATALOGUE SUPPLEMENT between pages 248 & 249

Our May '91 issue will be published on Friday, 5 April 1991. See page 219 for details.

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C-15W IRON	£8.37
CS-17W IRON	£8.48
XS-25W IRON	£8.59
XS-KIT 25W	£11.98
CS-KIT 17W	£11.87
C-KIT 15W	£11.98

ALL BITS FOR IRONS – £1.75
ELEMENTS £4.10 STANDS £3.24

NI-CAD RECHARGEABLE BATTERIES

	PRICE 1+	EACH 10+
AAA	£1.50	£1.30
AA	95p	85p
C	£1.95	£1.80
D	£2.00	£1.85
PP3	£3.90	£3.75

DESOLDERING PUMP

£2.99 ORDER CODE TOOL/DESOL SPARE TIP 75P

STAR BUY

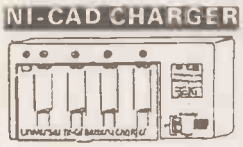
MARCO KITS

Ceramic 50V (125)	£3.99
Electrolytics Red (100)	£8.50
Fuse 20mm Q.B. (80)	£4.75
Fuse 20mm A.S. (80)	£8.50
Pre-set Pots Horiz. (120)	£7.75
Pre-set Pots Vert (120)	£7.75

RESISTORS

0.25W Popular (1000)	£6.99
0.25W 5 off (305)	£3.75
0.25W 10 off (610)	£5.10
0.5W Popular (1000)	£10.75
0.5W 5 off (365)	£5.40
0.5W 10 off (730)	£8.75
1W 5 off (365)	£15.25
2W 5 off (365)	£25.00
Zener Diodes 5 off (55)	£3.99

NI-CAD CHARGER



Charges AA, AAA, C, D & PP3 Ni-Cads 240V AC **£4.99**

APRIL SPECIAL OFFERS

FARNELL 'G' SERIES HURRY, LIMITED QUANTITY, DONT MISS OUT...

The Farnell 'G' Series power supplies use a switching technique to provide stabilised dc from ac inputs. This permits the production of compact, lightweight and high efficiency units which will operate from all nominal international mains supplies. A front panel switch provides a choice of 220 to 240 volts or 115 to 120 volts with tolerances of –20% to +10% of nominal. Once the required input is set, a cover over the switch prevents accidental selection of the wrong input.
A useful range of output voltage is provided and may be varied by screwdriver adjustment of a front panel potentiometer. Full output current is available at any setting of the potentiometer. Output presence is indicated by a front panel LED. With the exception of the 30 watt range the output voltage may be programmed by an externally connected resistor or remotely inhibited. Provision is made for remote sensing of the voltage at the load to compensate for voltage drop across the load connecting leads.

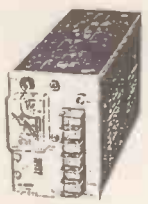
Mostly still in Farnell boxes and unused. Two types available. Info from current Farnell catalogue as follows:

G125S 60 WATTS
(Nominal Output 12V at 5A)
INPUT: 115-120V
220-240V

VARIABLE OUTPUT:
8-12.6V at 5 Amps
DIMS: 88 x 60 x 165mm

Current Price: £189.75!
ORDER CODE: SO/431

OUR PRICE: £75.00



SWITCH MODE POWER SUPPLY
Made by Farnell UK
350 Watts Model N350/F4184

A fully enclosed unit made to the highest standard.

320 x 190 x 75mm

+ 5V at 11A
– 5V at 3A
+ 24V at 7A

240V Input. Outputs are clearly marked.
Original price over £200 each
BARGAIN PRICE!
ORDER CODE: SO/430

PRICE: £15.00 1+
PRICE: £12.50 10+

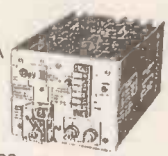
G12-20A 240 Watts
Nominal output 12V at 20A
INPUT: 115-120V
220-240V

VARIABLE OUTPUT:
8-12.6V at 20 Amps

DIMS: 88 x 160 x 194mm

Current Price: £368.00!
ORDER CODE: SO/432

OUR PRICE: £150.00



SOLDER 18 & 22 SWG -500gm REEL

	1+	10+
18swg	£4.95	£4.70
22 swg	£4.99	£4.75

Remember: Our prices INCLUDE VAT!

HEATSHRINK PACK

Approx 10 lengths odd assorted sizes from 1.6mm to 12.7mm. Lengths 12"

PRICE £1.00 ea

LATEST 1991 CATALOGUE

★ Velleman Kit Catalogue
★ Free pre-paid envelope
★ Many new lines
★ Pages of special offers
★ Free gifts

£1.50

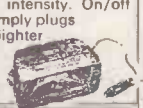
12V TWIN FLUORESCENT LAMP 12" DOUBLE TUBES

ONLY £5.99

DIMENSIONS: 368 X 67 X 43MM

QUARTZ HALOGEN SPOT-LIGHT

Hand-held or hanging, 12ft Curly cable, 5 times normal headlamp intensity. On/off switch. Simply plugs into cigar lighter socket



£5.99

RAYCHEM MINIATURE CO-AX

75 Ohm Type: 7528A1317-9(100). Very high quality, 28awg, stranded 7/0.127mm. Dia: 2.6mm. Colour White. Reel length 100 mtrs
Current price £92 per reel
ORDER CODE: SO/446

PRICE: £45 (per reel)

CLAIRTRONIC TRANSFORMER

TYPE: 9441
PCB Mounting 5.5VA
Input: 0-240V
Output: 0-12V at 250mA
0-12V at 250mA
Dimensions: 44 x 37 x 32mm
Resin encapsulated. High quality
ORDER CODE: SO/447

	1+	5+
PRICE:	£2.50	£2.00

★★★ VALVES ★★★

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PASSIVE INFRA-RED REPEATER

This unit is for use with external PIR detectors that turn on mains lighting. If the light cannot be seen from the house, the occupier has no way of knowing that the PIR unit has triggered. Such information could be useful since it could signal the presence of an intruder and may be worth investigating. The project is an add-on circuit which signals the user with a high-pitched tone when the PIR unit triggers – an l.e.d. on the front panel also lights.

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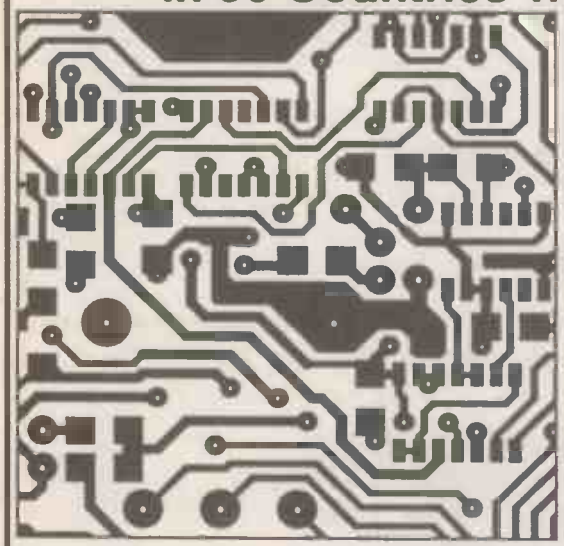

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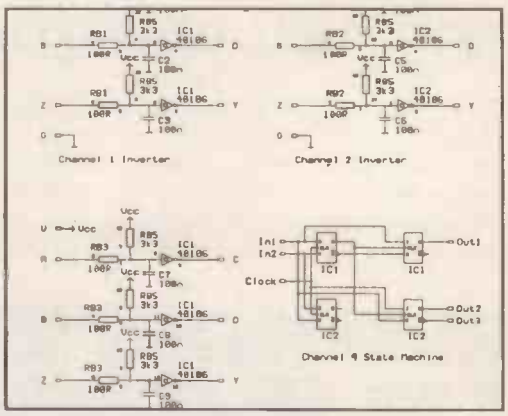

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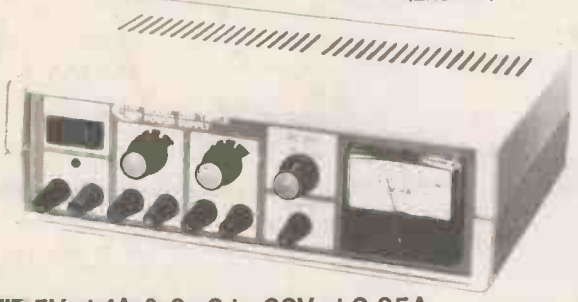

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electronize CAR ALARMS

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- ☆ 2 Operates on all doors and tailgate - no switches needed.
- ☆ 3 Automatically armed 1 minute after leaving vehicle.
- ☆ 4 10 second entry delay with audible warning.
- ☆ 5 Sounds horn intermittently for 1 minute - then re-arms.
- ☆ 6 Easy fitting - only 3 wires to connect - no holes to drill.
- ☆ 7 Compact design can be hidden below dashboard.
- ☆ 8 All solid state Power MOSFET output - no relays.
- ☆ 9 Adjustable sensitivity.

MICRO-PRESSURE ALARM £21.75 SELF BUILD KIT £15.75

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KIT REF 529

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EE NOV '87

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EE Jan '90

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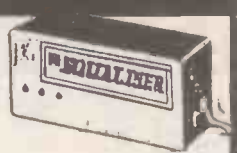
KIT REF 833

£31.45

EE EQUALISER



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A mains powered loniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

KIT REF 707

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MICROCONTROLLER LIGHT SEQUENCER

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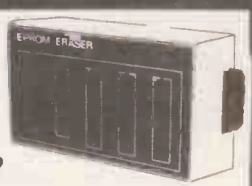


EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790

£27.90

LIGHT RIDERS

EE OCT '86

Three projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	£15.25
KIT REF 560 DISCO LIGHTS	£21.93
KIT REF 561 LAPEL BADGE	£11.40

EE TREASURE HUNTER

EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815

Headphones

£41.95

£1.99

SUPERHET BROADCAST RECEIVER

EE MAR '90

At last, an easy to build SUPERHET A.M. radio kit . Covers Long and medium Wave bands. built in loudspeaker with 1 watt output. Excellent sensitivity and selectivity provided by ceramic I.F. filter. Simple alignment and tuning without special equipment. Kit available less case, or with pre-cut and drilled transparent plastic panels and dial for a striking see-through effect.

KIT REF 835

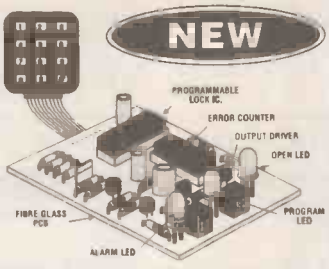
£16.79

TK FOR KITS

GUARD DOG KIT

One of the best burglar deterrents is a guard dog and this kit provides the barking without the bite! Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks. Includes mains supply and horn speaker.
XK125 **£21.95**

PROGRAMMABLE ELECTRONIC LOCK KIT



Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4–digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes; keyboard, alarm buzzer, high quality PCB and all electronic components. Supply 5–15V DC. Will drive our Latch Mechanism (701 150 @ £18.98) or relay directly.
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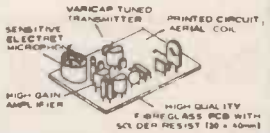

Only 45x25x15mm, including built–in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** **£6.35**

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DL8000K 8–way sequencer kit with built–in opto–isolated sound to light input. Only requires a box and control knob to complete **£39.95**
DL1000K 4–way chaser features bi–directional sequence and dimming 1kW per channel ..**£23.95**
DLA/1 (for DZ1000K)
Optional op-to input allowing audio beat/light response.....**95p**
DL3000K 3–channel sound to light kit, zero voltage switching, automatic level control and built–in mic. 1kW per channel **£19.55**
XK139 Uni-directional chaser. Zero switching and built-in audio input.....**£12.95**

POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.
XK124 STROBOSCOPE KIT. **£17.25**

SIMPLE KITS FOR BEGINNERS

Especially aimed at the beginner. Have fun with your project even after you have built it and also learn a little from building it. These kits include high quality solder resist printed circuit boards, all electronic components (including speaker where used) and full construction instructions with circuit description.

SK1 DOOR CHIME plays a tune when activated by a pushbutton **£4.50**

SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command **£4.50**

SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire–engine siren and machine gun **£4.50**

XK118 TEN EXCITING PROJECTS FOR BEGINNERS this kit contains a solderless breadboard, components and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section component identification and function is included, enabling the beginner to build the circuits with confidence **£17.25**

NEW

REMOTE CONTROL DIMMER KIT

Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).
XK132.....**£19.95**

IR TRANSMITTER KIT

Designed for use with the **XK132** and comes complete with a pre-drilled box. A PP3 9 volt battery is required.
MK 6.....**£4.95**

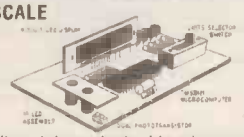
XK136 TOUCH DIMMER KIT.....**£12.95**

VERSATILE REMOTE CONTROL SYSTEM

These kits can switch up to 16 pieces of equipment on and off or control 16 functions depending on the keyboard selected for the MK18 transmitter. MK12 receiver has 16 logic outputs and operates from 12 to 24V d.c. or 240V a.c. via the transformer supplied. The MK18 requires a 9V battery and keyboard. Great for controlling lights, TVs, garage doors etc.

MK12 IR Receiver.....**£19.55**
MK18 Transmitter.....**£8.95**
MK 9 4-way Keyboard.....**£2.75**
MK10 16-way Keyboard.....**£7.95**
601 **133 Box for transmitter** **£2.95**

ELECTRONIC WEIGHING SCALE



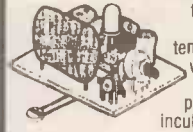
Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.
ES1 **£8.25**

VOICE RECORD/ PLAYBACK KIT

This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daugher's £8 doll to an £80 taking doll!!

Size ..... 76 x 60 x 15mm
Message time ..... 1–5 secs normal speed, 2–10 secs slow speed
XK129 **£25.95**

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Maximum load 3kW (240V AC). Temperature range up to 60°C. Size 50x40x25mm. **XK140**.....**£8.95**

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BAD WEATHER – GOOD WORK

It is interesting to note how much the weather affects our hobby, last summer our p.c.b. and book sales dropped off quite heavily during the long hot spell – remember it? As I write most of the country has been covered in a blanket of snow for over a week and sales of p.c.b.s, books, back numbers and binders are all booming. Provided the post can get through our hobby is just right for the long cold dark nights at home. Your components are pushed through you door by the friendly postman in the morning so you can start planning construction later.

SOLDERING ON

Even if the power fails, with snow bringing down the electricity cables, you can always use our *Battery to Mains Inverter* (published last month) to keep on soldering, it will even keep you warm while you work by supplying the central heating pump and timer. Of course many of our projects are designed to help with the effects of winter and next month we are publishing a *Digital Thermostat*, which should help to keep the fuel bills down, and a *Passive Infra-Red Repeater*, designed to let you know if any IR sensors around your home have been triggered. Both of these projects are designed to work all year round but they are probably at their most useful during the winter months.

SUMMER TIME

When the summer comes (hopefully soon) there are also projects for that time. We have plans for a fisherman's Bite Alarm, a Pedometer and a few items aimed at the camper/caravanner. So keep reading, with five projects a month plus all the regular series and features there should be plenty to interest you in every issue.

Mike Kenward

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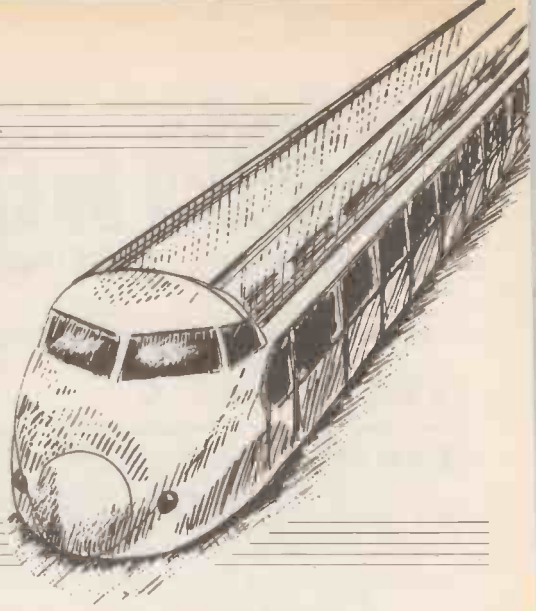
Constructional Project

MODEL TRAIN CONTROLLER



CHRIS BOWES

A modern pulse control unit that simulates operation of older resistance type controllers.

THE PROJECT to be described here features a Model Train Controller using standard pulse control techniques. It has been designed so that the manner of operation is the same as that found in the older, resistance type train controllers.

In this type of controller rotating a "speed" control knob anti-clockwise about the mid-point causes the train to run *backwards*, with speed increasing in proportion to the angle by which the control knob is rotated from it's mid-point. When the control is rotated in a clockwise direction the train proceeds in a *forward* direction, again with the speed increasing as the knob is rotated further from the centre point.

OPTICAL SWITCH

In order to achieve this somewhat unusual control law with a standard rotary potentiometer it has been necessary to incorporate some interesting features into the project. The major problem to be overcome in achieving this action has been how to make the pulse control circuit operate so that the pulses are so shaped that more power is available when the potentiometer is at either the extreme ends of its rotation.

This has been achieved by using two 11F1 integrated circuits as remotely controlled variable resistors. The 11F1 is an opto-isolator i.c. consisting of a infra-red emitting diode and a silicon photo-detector. The detector is electrically isolated from the input and performs like an isolated f.e.t. and is designed to control low level a.c. (50mV r.m.s.) and d.c. analogue signals – ideal as a remote variable resistor.

CIRCUIT DESCRIPTION

The full circuit diagram for the Model Train Controller is shown in Fig. 1. The circuit is best described by dividing it into a number of small sub systems.

POWER SUPPLY

The power supply, used to drive the train controller and associated ancillary outlets, is a conventional bridge rectifier circuit (D1-D4). Mains power from the mains inlet cable is switched on and off by S1 and supplied to the transformer, T1, via fuse FS1. This is a 100mA, anti-surge, fuse which should protect the system in the event of problems arising within the circuit.

The transformer has a 240V primary winding and a 12V secondary winding providing 12 volts a.c. which is made available, via fuse FS2, at the output socket SK1. The 12V a.c. is also fed to the input of the rectifier bridge diodes (D1-D4) which rectify the alternating current to produce direct current which is smoothed by the smoothing capacitor, C1.

This produces the 16V d.c. which is required by the remainder of the circuit. A 16V d.c. outlet (SK2) is connected, via fuse FS3, across the power supply rails to provide an auxiliary d.c. outlet.

Lamp LP1 is a 12 volt bulb which is mounted inside switch S1 to indicate that the unit is live. Resistor R1 is used as a dropping resistor to reduce the 16V available across the power supply lines to the 12V required to drive the lamp.

SPEED CONTROL CIRCUIT

The unusual law required to control the speed of the train is obtained by wiring the two *ends* (outer tags) of the linear track of a variable potentiometer (resistor), VR1a, together and connecting this point and the wiper into a potential divider circuit in conjunction with resistor R2. The effect of this is to produce an output voltage from the potential divider which is at its lowest when VR1a is in the mid position and at its highest when VR1a is at either end of its rotation.

This control voltage is fed, via resistor R6, into the non-inverting input (pin 3) of IC1a which is one quarter of a LM324 quad operational amplifier. A reference voltage, determined by the values of resistors R3 and R4 and the setting of preset potentiometer VR2, is fed via resistor R5 to the inverting input of the same operational amplifier. A feedback resistor R7 sets the amplification of IC1a so that the circuit amplifies the difference between the two voltages present between the inverting and non-inverting inputs of IC1a by a factor of 5.6.

The output of IC1a is fed via resistor R10 to the inverting input of IC1b which is a similar op. amp contained within the same i.c. package. A set voltage, obtained from R8, preset VR3 and R9 is also fed via R11 to the non-inverting input of this op amp. A feedback resistor R12 is connected from the output of IC1b to it's inverting input, to set the gain of this amplifier to unity.

The effect of this arrangement is to produce a voltage at the output of IC1b which rises, as the output voltage from IC1a rises. This circuit therefore produces two voltages, one of which is made to rise and one of which is made to fall as VR1a is adjusted.

PULSE SHAPING CIRCUIT

The two complementary voltages produced at the output of IC1a and IC1b are fed, via guard resistors R13 and R14, to the inputs of IC2 and IC3. These are f.e.t. optical isolators which work as optically isolated variable resistors so that as the voltage fed into them increases the value of the effective resistance between pins 6 and 4 of the i.c. decreases.

These remotely controlled "variable resistors" are wired in a modified version of a 555 timer Astable circuit utilising IC4. Resistor R15 acts as a guard to ensure that there is always a minimum value of 100k between the positive power supply line and pin 7 of IC4. This both ensures that there is always at least a very small part of the output waveform from IC4 which is positive going and also prevents damage occurring to the integrated circuit.

Resistor R16 is included to ensure there is always a minimum resistance between pin 7 and pin 6. The steering diode D5 acts to alter the switching characteristics of the charge/discharge cycle of IC4 into capacitor C2. The effect of this component is to modify the mark/space ratio of the output waveform produced at pin 3 of IC4.

The action of this circuit is such that when the output voltage from the wiper of VR1a is "high" the output waveform from IC4 is predominantly "on". As the control spindle of VR1a is rotated towards the mid position, the output voltage from the wiper of VR1a falls and the output waveform of IC4 gradually alters to predominantly "off". Capacitor C3 is included in the circuit to set the voltage at pin 5 (the control voltage input) of IC4 to the optimum value required by the circuit.

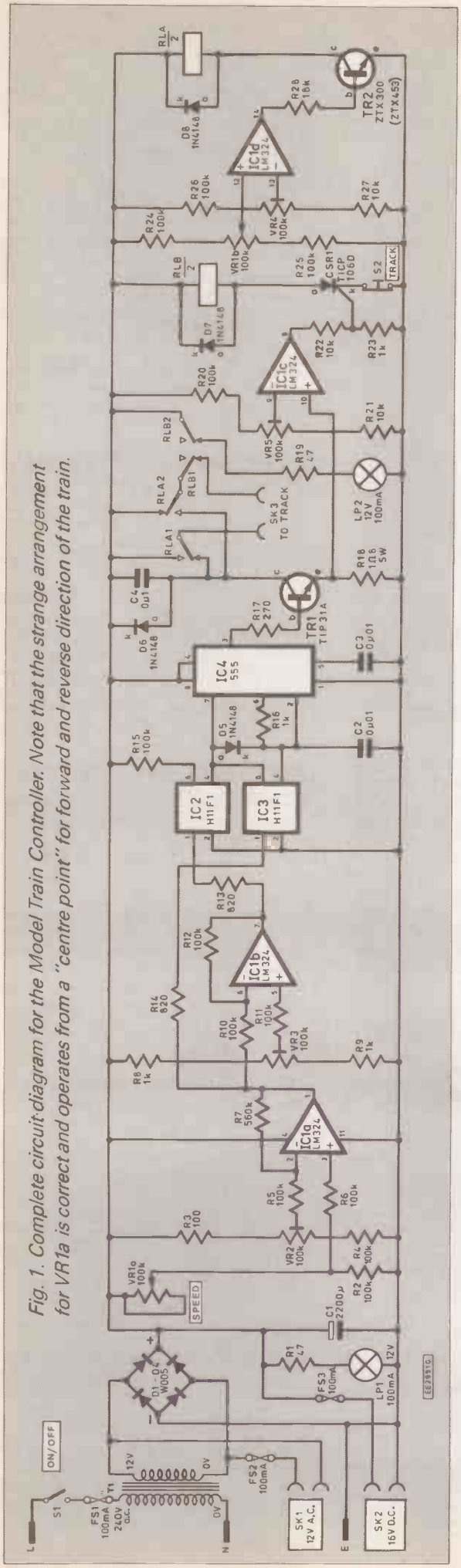
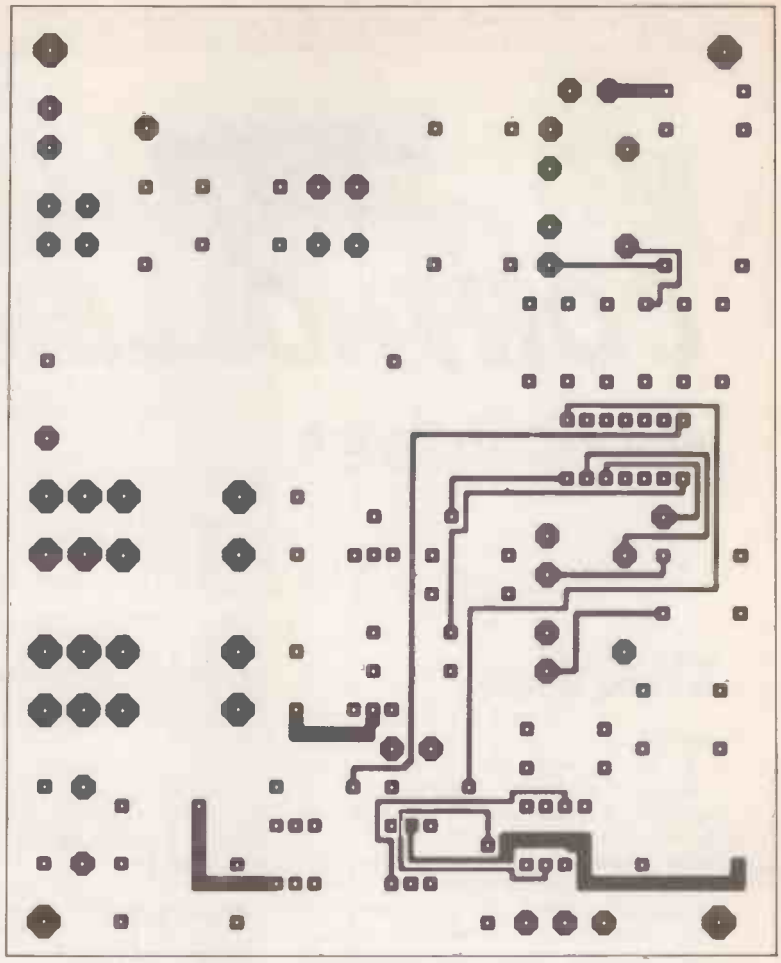


Fig. 1. Complete circuit diagram for the Model Train Controller. Note that the strange arrangement for VR1a is correct and operates from a "centre point" for forward and reverse direction of the train.



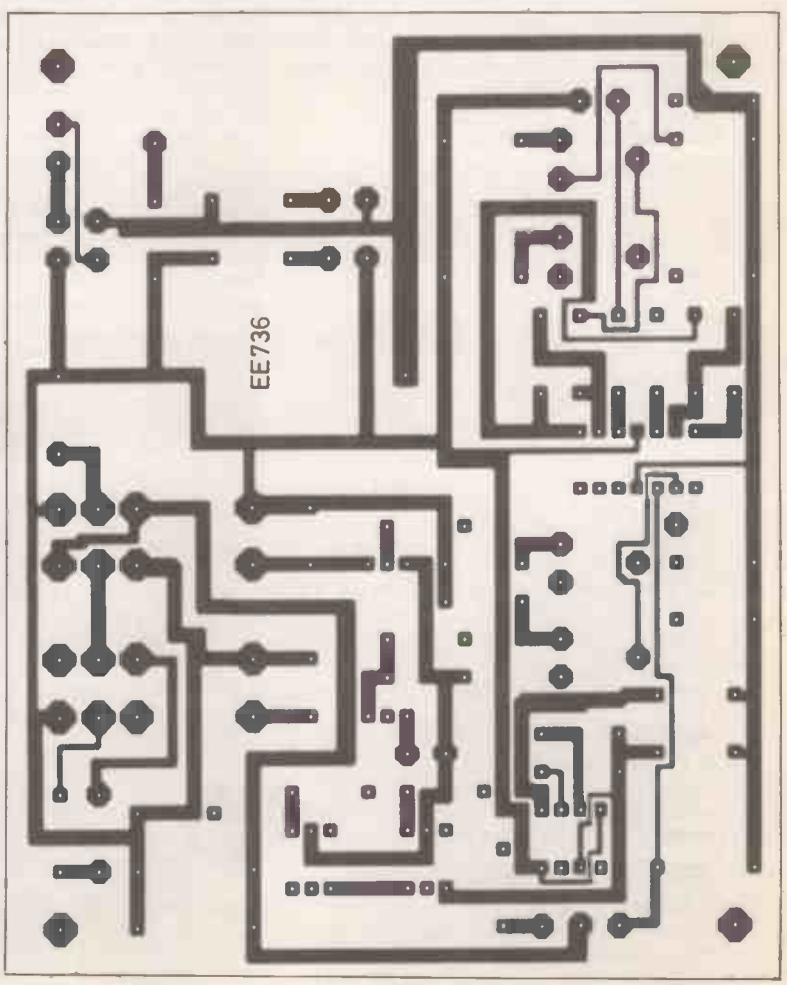
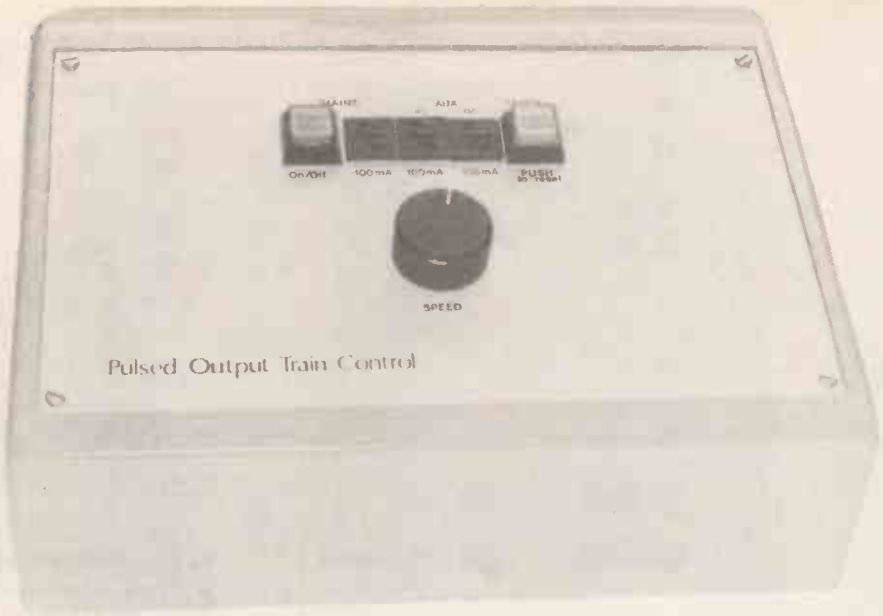


Fig. 2. Full size top and bottom copper foil master patterns.



OUTPUT AMPLIFIER

The output from IC4 is not sufficiently powerful to be able to drive the motor of an electric train directly. The output waveform from pin 3 of IC4 is therefore fed, via R17, to the base of TR1 which is a TIP31A power transistor.

This is wired to the train track through the relay contacts of RLA and RLB so that the operating current for the locomotive motor in effect becomes the collector load of the transistor. Diode D6 and capacitor C4 are smoothing components wired into the circuit so as to smooth out the spikes and back e.m.f. that can be generated by some model train motors and which could upset the components in the circuit.

REVERSING CIRCUIT

For the direction movement of the train to be reversed it is necessary to reverse the polarity of the current supplied by the pulse shaping circuit to the track output socket SK3. This facility is achieved by means of the relay contacts RLA which are wired so as to reverse the polarity to the track when RLA is energised.

Relay RLA is controlled by the output from IC1d. In this case the operational amplifier is connected as a comparator and detects the position of the dual control VR1. VR1b is used as a potential divider, with resistors R24 and R25 being incorporated to limit the maximum and minimum swing about the mid-point of the circuit.

The output from the divider network is fed to the non-inverting input of IC1d. A similar arrangement consisting of resistors R26, R27 and preset VR4 is used to set the reference voltage at the inverting input of IC1d.

When the position of VR1 is such that the output voltage from the wiper of VR1b is less than the reference voltage set by VR4 then the output from the comparator is 0V and the relay RLA is not energised. When the output voltage from VR1b exceeds the reference voltage set by VR4 then the output voltage from IC1d swings rapidly to the power supply voltage.

This output voltage is fed, through resistor R28, to the base of transistor TR2 which amplifies the current from IC1d, causing a current to flow through the coil of RLA. This energises the relay and causes the contacts to change over, thus reversing the flow of current through the locomotive motor.

Diode D8 is connected with reversed polarity across RLA coil to dissipate any back e.m.f. generated when the magnetic field in the coil collapses when it is de-energised.

SHORT CIRCUIT CUT-OUT

In order to protect the system, should the output to SK3 become short circuited, (usually caused by derailment of the engine or another carriage) an overload detecting circuit has been incorporated into the transistor output circuit.

As the load drawn by the train motor increases so the voltage drop across R18 increases causing the voltage present at the non-inverting input (pin 10) to IC1c to increase. The potential divider circuit comprising of resistors R20, R21 and preset VR5 is used to set a reference voltage at the inverting input (pin 9) of IC1c.

When the voltage present at the inverting input (which occurs when an excess current is drawn through the output of the pulse shaping circuit) the output voltage of IC1c swings from 0V to the power supply voltage. This output voltage is then fed, via the potential divider resistors R22 and R23, to the gate of the thyristor CSR1.

When the supply voltage is present at the output of IC1c this causes the thyristor to trigger and allows a current to flow through the coil of relay RLB. The thyristor remains conducting, even when the gate triggering voltage has been removed, until the load passing through it is completely disconnected. This is achieved by operating the push-to-break switch S2.

Diode D7 is included across RLB relay coil to dissipate any back e.m.f. generated when the relay is de-energised in exactly the same way as diode D8.

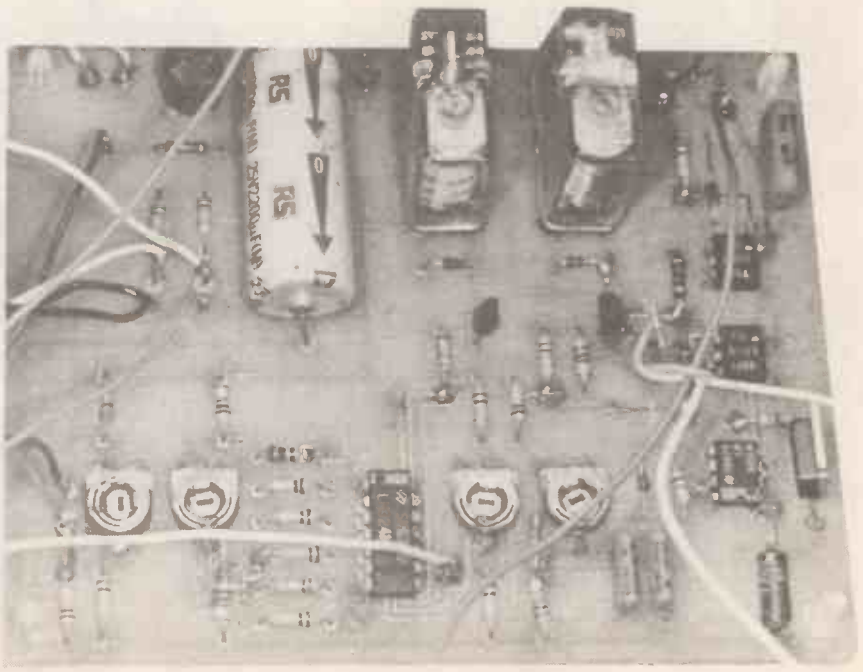
CONSTRUCTION

The Model Train Controller is built on a double-sided printed circuit board. The full size copper foil master patterns and the component layout are shown in Fig. 2 and Fig. 3. This board is available from the EE PCB Service, code EE736.

Commence construction by assembling the components on the circuit board. You will find that it is easier to perform this task if the components are inserted in ascending order of size. All the components of a particular size should be soldered into position before going onto a larger size. Care should be taken to ensure that the polarity sensitive components are mounted on the board the correct way round.

In the prototype, all of the i.c.s are used for connecting signals between the top and bottom layers of the p.c.b. and should be soldered in place along with the other components. If using this method, take care to ensure that they are inserted into the board the correct way round and that a good soldered joint is made on both the top and bottom connection, of the appropriate pins, on the p.c.b.

For the less experienced constructor, and to avoid possible heat damage to the i.c.s,



COMPONENTS

See SHOP TALK Page

Resistors

R1, R19	47 (2 off)
R2, R4-R6, R10-R12 R15, R20, R24-R26	100k (12 off)
R3	100
R7	560k
R8, R9, R16, R23	1k (4 off)
R13, R14	820 (2 off)
R17	270
R18	1Ω8 5 Watt
R21, R22, R27	10k (3 off)
R28	18k

All ¼W 5% carbon, except R18

Potentiometers

VR1	100k dual (stereo) rotary, lin.
VR2-VR5	100k skeleton horiz. preset, lin. (4 off)

Capacitors

C1	2200µ axial elect., 25V
C2, C3	0µ01 metallised polyester film
C4	0µ1 metallised polyester film

Semiconductors

D1-D4	W005 1A bridge rectifier
D5-D8	1N4148 signal diode (4 off)
CSR1	TICP106D 400V 2A thyristor
TR1	TIP31A *npn* power transistor
TR2	ZTX300 (or ZTX453) *npn* low-power transistor
IC1	LM324 quad op.amp
IC2, IC3	H11F1 bilateral analogue f.e.t. opto-isolator (2 off)
IC4	555 bipolar timer

Miscellaneous

S1	On/Off mains push switch, with 12V illuminated square cap
S2	Push switch, normal closed contacts, with 12V illuminated square cap
LP1, LP2	12V 100mA "wedge" bulb to suit S1 and S2 (2 off)
FS1-FS3	100mA anti-surge fuse and panel mounting fuseholder (3 off)
SK1	Yellow screw terminal post (or colour to choice) for "Aux A.C. Out" (2 off)
SK2, SK3	Screw terminal post, red and black (2 off each)
RLA, RLB	12V 205 ohm coil relay, with 5A double-pole changeover contacts (2 off)
T1	Mains transformer, 240V a.c. primary; 12V 1A secondary

Double-sided printed circuit board, available from the *EE PCB Service*, code EE736; ABS plastic "desk console", case with sloping aluminium front panel; control knob for VR1; 3-core mains cable; multi-coloured connecting wire; solder pins; solder etc.

Approx cost guidance only

£45 *plus case*

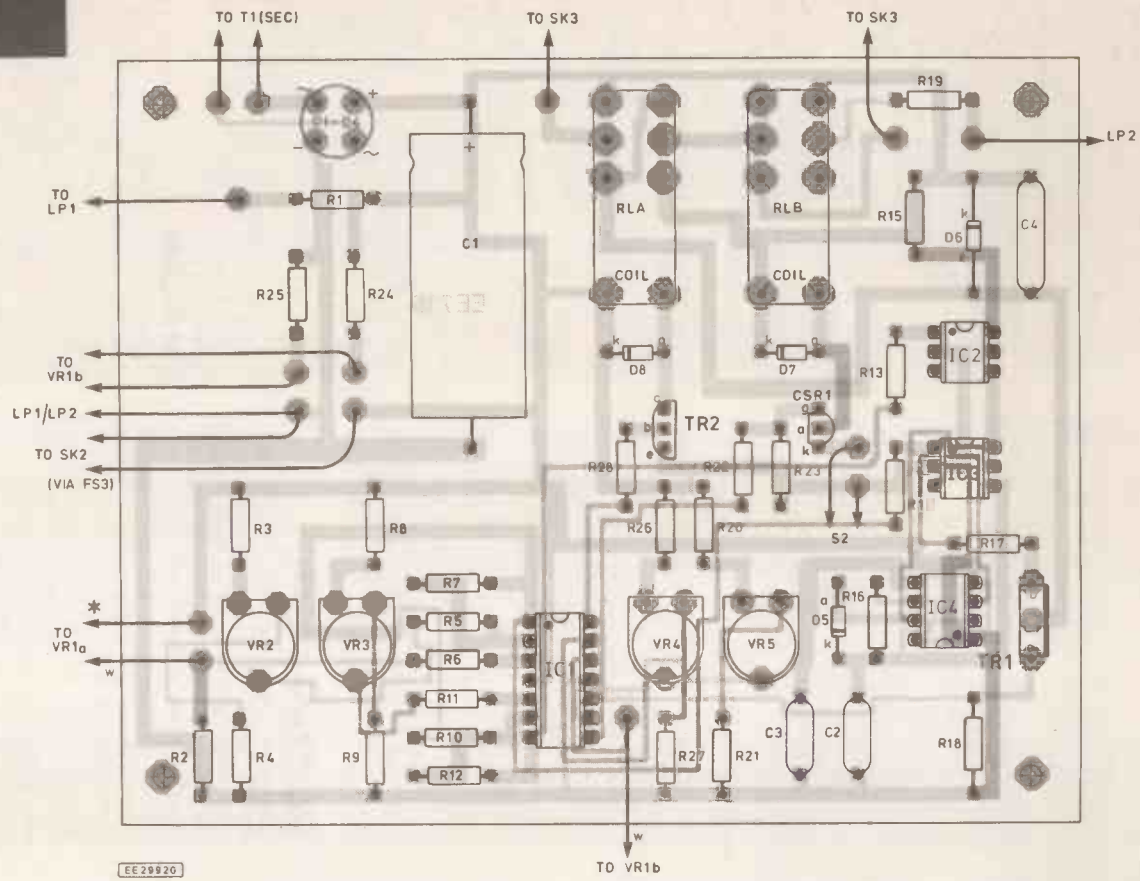
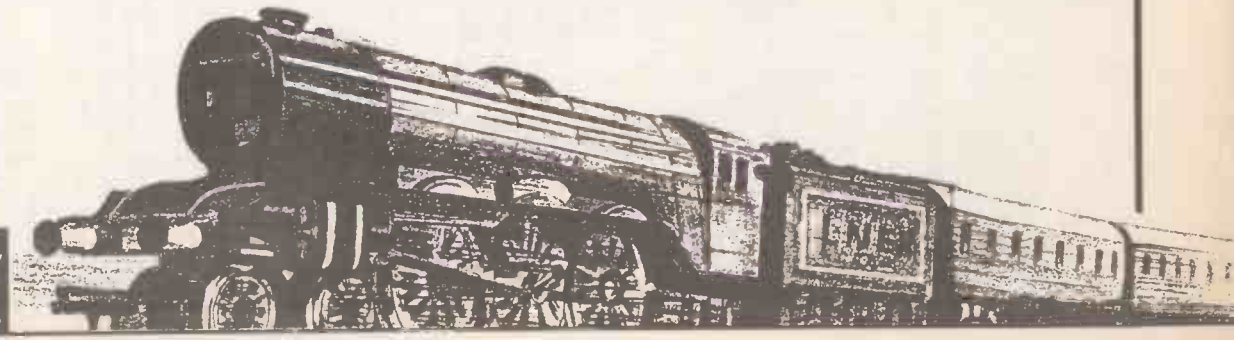


Fig. 3. Printed circuit board component layout. The two different tints refer to the copper tracks on both sides of the board. The lead to VR1a marked with an asterisk is connected to both of the outer tags and the lead marked with a "w" goes to the centre (wiper) tag.



Rear view of the case showing the three groups of output sockets/terminals.

it might be wise to use low-profile d.i.l. sockets for this function – you can apply the soldering iron to the socket pins much longer without causing any damage.

TESTING AND CALIBRATION

Once all the components have been mounted on the board it should be carefully checked for broken tracks, solder blobs and incorrectly placed components before attempting to insert the i.c.s and test the unit. The i.c.s should then be carefully inserted into the correct sockets, taking care to ensure that they are the correct way round.

The circuit can now be tested by connecting it to the mains and checking that the functions described in the "Circuit Description" actually occur as described. ***Extreme care must be taken when working near those parts of the circuit which are connected to the mains voltage.***

CASE

Appropriate holes should be made in the case to accommodate the case mounted components and the case lettered. If rub-down lettering is used this should be protected with several layers of clear varnish which must be allowed to thoroughly dry before any attempt is made to install the case mounted components.

The p.c.b. is best not wired up to the case mounted components until all the non-board components have been mounted and the p.c.b. and mains transformer have been installed in the case. The connections between the p.c.b. and the case mounted components are best made with flexible wires, cut to a size which allows the board to remain connected to the control panel and other case mounted components when it is removed for any fault finding.

There are a number of connections to be made and the use of as many colours of wire as are available will reduce the risk of confusion at this stage. The ends must be prepared by tinning before the cable is inserted into the appropriate holes on the board and then soldered into place.

SETTING UP

Preset controls have been incorporated into the design, at all critical stages, to allow for the tolerances of the components used. These must be adjusted in order to obtain optimum performance.

Before connecting the controller output to the railway track, the operation of relay RLA at the mid-point of the rotation of the "Speed" control VR1 should be set. This is achieved by connecting the controller to a suitable power source, switching it on and setting VR1 to the mid-point. Preset VR4 should then be adjusted so that RLA just operates when the wiper of VR1 is rotated anti-clockwise from the centre, and de-energises when VR1 is operated clockwise from the mid-point.

In order to adjust presets VR2 and VR3 it is necessary to connect the train control to a suitable source of mains voltage, to connect the output from the track output socket (SK3) to a suitable section of railway track and to place a locomotive on the track. If an oscilloscope is available it should also be connected across the outputs of SK3 and the waveform monitored.

Rotate VR1(a) spindle to a "maximum" position (i.e. fully clockwise or fully anti-clockwise) and adjust presets VR2 and VR3 until the train runs at maximum speed. VR1(a) should then be slowly turned to the mid-way position and the performance of the train (and the output waveform if an oscilloscope is connected) monitored.

Ideally the train should slow down smoothly coming to a halt just before the mid-point adjustment of VR1 is reached. If necessary this process should be repeated with VR2 and VR3 in a number of different positions until the optimum position for both is found.

Preset VR5 controls the overload protection circuit cut-off point. Initially the control can be set by measuring the voltage between the 0V "line" and the wiper of VR5.

The position of the wiper should be adjusted until the output voltage of VR5 is approximately 0.5 volts. It will then be necessary to test the system under load by connecting the controller to the track and running a locomotive, under load, along the track ensuring that under normal running conditions the cut out relay RLB does not operate.

When a short circuit is placed across the track RLB should operate and the light (LP2) inside switch S2 should come on and relay RLB should then remain energised until push-switch S2 is operated.

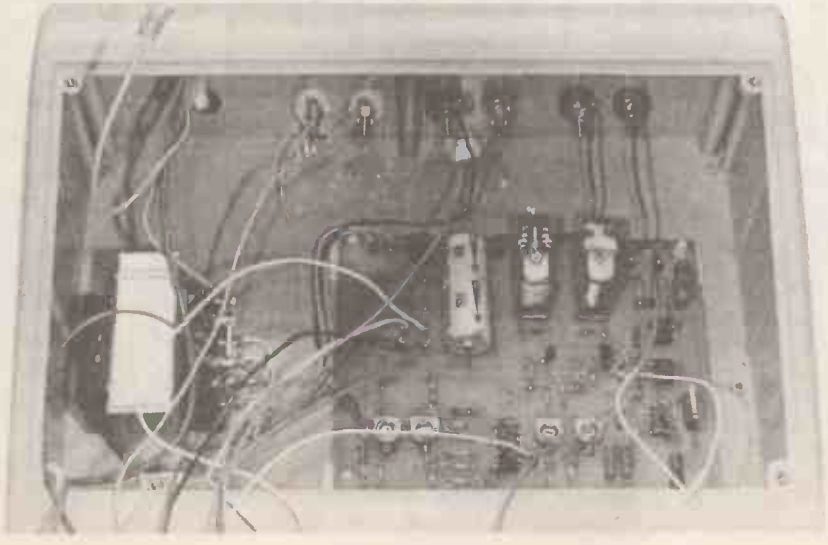
IN USE

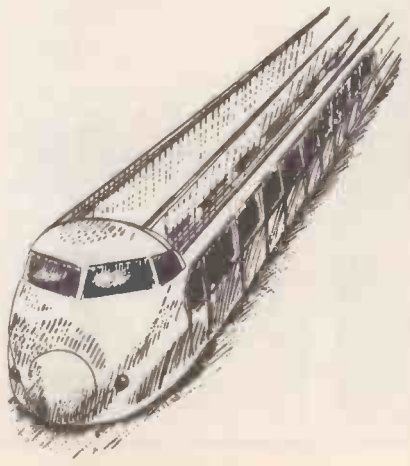
When the controller is connected to a suitable mains supply and switch S1 operated it's internal lamp (LP1) should illuminate to show that the unit is "live". The fixed voltage connections from the output sockets SK1 (16 volts d.c.) and SK2 (12 volts a.c.) are for use by ancillary equipment

The track connections are made to SK3 via any switching required by the model railway layout. The speed of the train is then controlled by turning the Speed control VR1(a) clockwise or anti-clockwise about the mid-point as required.

In the event of a short circuit occurring on the output then relay RLB should operate, illuminating the light in S2 and disconnecting power to the track. Once the obstruction has been removed the circuit may be re-set by operating S2 in which case the light inside it will go out. □

Layout of components inside the case showing the mains transformer T1 mounted to one side. The mains Earth lead should be bolted under one of T1 fixing lugs. The metal front panel must also be "earthed".





FOR YOUR ENTERTAINMENT

by Barry Fox

Speechless

I recently got my first opportunity to try out a CT2 cordless telephone, both at home and on public Telepoints. It's ironical that I only got this opportunity a year after the three services (Feranti's *Zonephone*, Mercury's *Callpoint* and British Telecom's *Phonepoint*) were launched. I say it's ironical because I was writing about CT2 years before most of the people now involved in trying to sell these services had even heard of CT2.

Anyway, I did finally get to try the very neat and tidy Shaye handset and home base station used by BT and Mercury. Now that the package price has almost halved, to around £250 (including rechargeable batteries and charger) this makes a very attractive cordless phone system for home or business use.

Speech quality is good. And because CT2 is an all-digital system, there is no risk of others in the vicinity either accidentally or deliberately eavesdropping on calls or making free calls on someone else's base station.

Remember that the CT1 analogue systems currently on sale all operate on frequencies at the end of the medium waveband and are easily overheard. And not all the CT1 systems have security codes to prevent people with matching handsets stealing calls on other subscribers' home or office base stations – by standing outside in the street and dialling.

Telepoints

For several years prior to the CT2 launch I was writing with enthusiasm about the Telepoint concept. This would let anyone with a CT2 handset make calls from public base stations or "telepoints", with charges billed on their home phone number. I still think this was a great idea in theory. But in practice the CT2 operators have blown their chance.

The three systems are incompatible. You need to subscribe to the Mercury service and have a Shaye handset to make a call at a Callpoint; you have to subscribe to the BT service and have a Shaye handset to make a call at a Phonepoint; you have to have a Ferranti handset and subscribe to the Creditphone service to make a call at a Zonephone.

When the fourth service comes on-stream in 1991, from the BYPS consortium of Philips, Shell and Barclays, you will need a BYPS handset. This uses the Common Air Interface standard which eventually all the operators will have to use. You will also need to subscribe to the BYPS Rabbit service.

What all this means is that by the time you have found the right Telepoint, you have passed several public phone boxes. And making calls from a phone box with coin or card is far easier and cheaper.

You pay around £20 to sign onto the Telepoint service and around £10 a month service charge whether you use it or not. Then you pay up to 20p per minute to make a call inside the UK, and over £1.50 per minute outside the UK.

The only way to know whether you are in range of a Telepoint, is to keep on trying your handset. Even if there is a notice you don't know whether the public base station is upstairs at a tube station, or down on the platform or out in the street. If reception is poor you don't know whether to walk one way, the other, up or down, to get closer to the base station and improve reception.

When the signal is strong, you have to find somewhere quiet to make the call. I found the quietest place was often in a public phone box where I could have made the same call with a coin or card for a fraction of the price.

All the signs are that Telepoint is a dead duck, and will go down in history as the first telecommunications venture (other than *Prestel*) to prove a commercial disaster. The operators have only themselves to blame for splitting the standard, thereby burdening themselves with the cost of duplicating base stations many times over.

Already some sites are fitted with three different base stations, one for each service. When CAI system comes in there will be four service options, with the Callpoint, Phonepoint and Zonephone base stations also obliged to cater for both new CAI and old proprietary handsets. It's INSANE.

All this insanity puts up the capital cost of offering a service and hikes the cost of using the service to a level which makes it wholly uncompetitive with fixed line pay phones.

My tip is this. Forget about Telepoint. But now the price is coming down, buy a CT2 base station and handset for home or office use. If one day Telepoint services see sense and combine to offer common billing, you can always sign on.

Standards Shoot-Out

The scene is now set for a stand-up, shoot-out standards battle between the two rival and incompatible interactive CD formats, CDI (from Philips, Panasonic, Sony, Motorola etc) and CDTV (from Commodore). Commodore was planning to launch CDTV at the Las Vegas Consumer Electronics Show, but Philips is still talking about late 1991 for a domestic launch of CDI in the US and Japan, and 1992 for the European launch.

The MPEG committee (Moving Picture Expert Group of the International Standards Organisation), which is trying to set a world standard for putting an hour of digitally encoded Full Motion Video (FMV) on a 5in. disc, will not reach a final decision until this Spring. So it is clear that there will be no FMV chips ready for either the Commodore or Philips launches this year. This may not matter too much. CDI looks more and more like becoming a vehicle for souped-up video games. It is not in Philips' interest to use CDI as a vehicle for feature films, because this would undermine the latest in a long line of analogue video disc re-launches.

As Philips is always at pains to point out, the picture quality available from FMV CDI may be good, but it is (so far, at least) outstripped by analogue Laser Disc. And the CD quality digital sound on a LD far outstrips (so far) the compressed sound on an FMV CDI disc.

There are two unanswered questions. Will the public pay CDI and CDTV player prices of well over £500, and more likely £700, for a games machine? And what will happen if people buy CDI or CDTV players without FMV – can they be upgraded?

I will report more fully on Commodore's plans for CDTV next month. Philips will not make any binding statements on CDI until later this year, but it already looks as if the first generation of CDI players will have a socket on the rear to take a plug-in cartridge which adds the FMV feature. And hopefully by the time CDI is launched in Europe, the FMV chips will be built-in.

Uncharitable

The US trade is banking on a promise of free cartridge upgrades. Otherwise they will find it very hard to sell first generation players.

Here I have to throw in a word of uncharitable caution. Although a free upgrade may be promised I'll bet that when it comes to the crunch, there will be some fitting or handling charge that means it's not actually fee after all.

Witness what happened in late 1988 when Philips finally launched CD Video with the new generation of video discs which had only digital sound, and thus would not play on old LaserVision players which cope only with analogue sound. Philips had been talking grandly about keeping faith with owners of LV players, but offering generous trade-in deals on new CDV players.

When the crunch came, the trade-in offer on old LV players turned out to be £50 off the price of a £500 CDV Combi player. This is the kind of discount dealers give anyway, without any need for trade-ins.

Constructional Project

HUMIDITY TESTER

E. BARROW

Do you suffer with chapped hands and lips? Do your indoor and greenhouse plants wilt from too much heating or sag from too much moisture in the air? Does your home suffer from condensation? If so! You need to build this simple tester.

IN THE home humidity is associated with bathrooms and steamy kitchens and was usually measured intuitively by condensation and peeling wallpaper. On the other side of the coin low humidity is associated with hot air blowers and dry chapped lips and hands.

The cures for high humidity usually involves improving circulation, and in the case of low humidity, hanging water containers on your radiators. To pin point the problem guess work can be used but for a better job you can invest in a humidity tester.

The main problem with measuring humidity is finding a suitable sensor. In the past obscure methods like using the lengthening of horse hair in damp conditions were used, and the effect was amplified by levers and cogs to give useful readings. In this circuit a piece of blotting paper impregnated with a slightly deliquescent substance (i.e. a substance which absorbs moisture from the atmosphere is used).

The principle is simple enough, as the surrounding air becomes more humid the substance will absorb more water and so the resistance of the strip will decrease. This relationship is exploited and the resulting signal used to feed a bargraph display driver i.c.

THEORY

Most people must have remembered opening up a blocked salt cellar to find a sodden mass of crystals inside. The scientific amongst you might have noted that this occurs during damp weather.

This is due to the small amount of sodium or potassium iodide added for health reasons. This substance is deliquescent and so when left exposed to the atmosphere it leeches water from it. On wet days this water is sometimes enough to cake the salt.

The mixture used in the blotting paper is similar and can be made with two common widely available substances, salt (sodium chloride) and saltpeter (potassium nitrate). To make a sensor, you pour boiling water, about 50ml, on a mixture of salt and saltpeter (about 50/50 by volume and about 10g in total) and mix well.

Now then soak your blotting paper in this solution and leave to dry in an airing cupboard. When it is fairly dry cut a strip about 3 inches long to use as your sensor.

For the inquisitive we should explain what happened when you mixed the two salts in the hot water, some of the Potassium Nitrate swapped partners with the Sodium Chloride to form some Potassium Chloride and some Sodium Nitrate. Now out of these two Sodium Nitrate is deliquescent and so will mirror the humidity of the air with corresponding degrees of wetness.

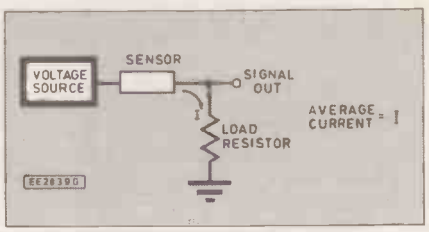


Fig. 1. using a d.c. source can cause electrolysis problems.

To convert this varing dampness into an electric signal we use an a.c. signal generated by a simple relaxation oscillator. The sensor is used as a branch in a voltage divider fed by this a.c. source.

If a d.c. signal is used this will cause the connectors to corrode and the salt on the blotting paper to decompose. This is due to electrolysis caused by the resulting current flow. However if a.c. is used, by definition the average current is zero and so no electrolysis takes place. Both arrangements are shown in Fig. 1 and Fig. 2.

The returned a.c. signal is rectified and conditioned so it is within a suitable range for use in the bargraph display driver. A schematic block diagram of the circuit is shown in Fig. 3.

HOW IT WORKS

The complete circuit diagram for the Humidity Tester is shown in Fig. 4. The l.e.ds, which make up the display, are the recangular types.

Op.amp. IC1a (Fig. 4) is configured as a relaxation oscillator with a frequency of about 2kHz. This signal is passed through capacitor C2, to remove any d.c. components which, as mentioned earlier, might cause problems.

A simple voltage divider is made out of the sensor (R4) and R5 or R6 depending on what range is selected by S1. This is done to allow different degrees of sensitivity to be measured on the display.

Thus with high humidity the sensor resistance will be low and the signal output will be high. Conversely if the humidity is low then the signal output will be low.

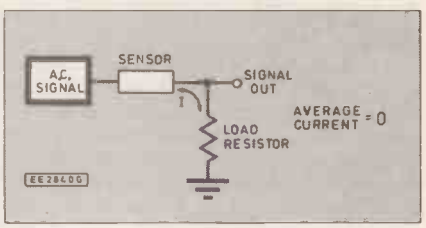
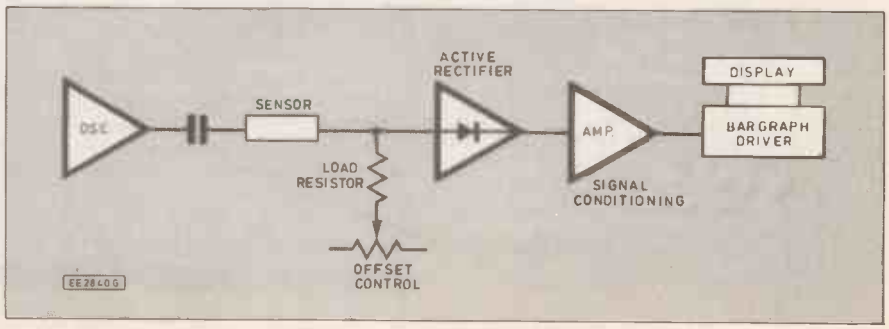


Fig. 2. Using an a.c. signal can solve the problems of electrolysis.

An offset voltage is provided by preset VR1, whose position sets the minimum humidity measurable on the display at that time. The preset VR2, sets the position of the lowest measurable humidity of VR1, more about this in "Setting Up".

Fig. 3. Block diagram for the Humidity Tester.



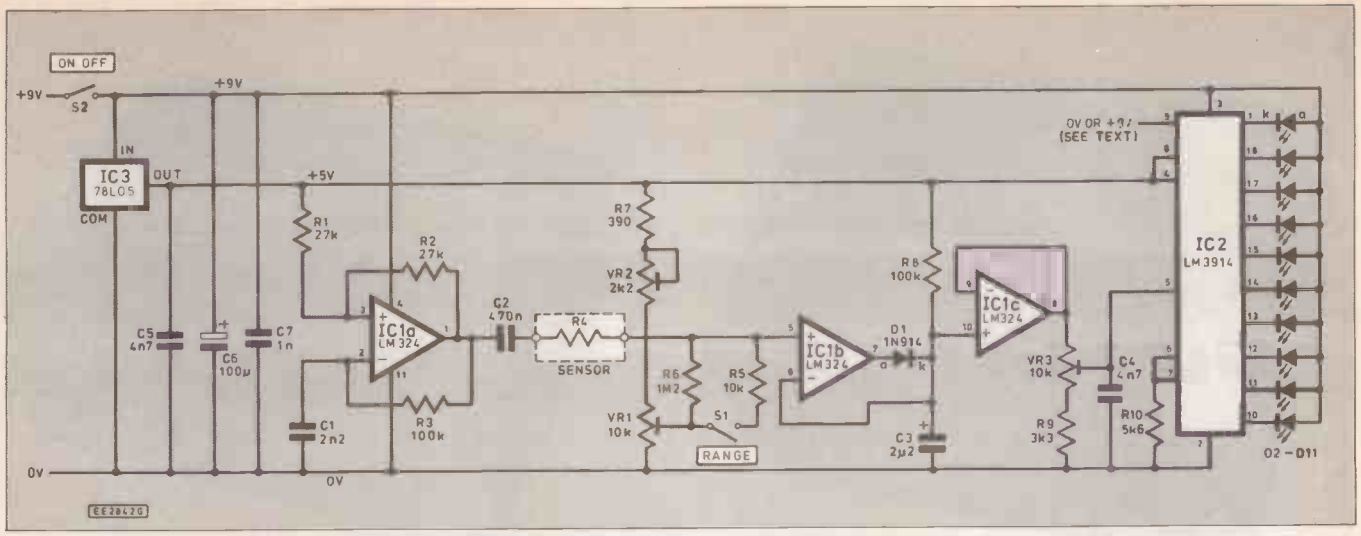


Fig. 4. Full circuit diagram for the Humidity Tester. The sensor R4 is made up from impregnated blotting paper (see text).

The bargraph display is built around the widely used LM3914. On the p.c.b. two options are available for the user, either dot or bargraph mode, this is achieved by tying pin nine high (Bar mode) or low (Dot mode), more of this in "Construction".

Dot mode has the advantage of consuming a lot less current while Bar mode might be more aesthetically pleasing. A point to note here is that resistor R10's value sets the average l.e.d. current, here it is set to give about 10mA per l.e.d. In this circuit the total voltage range covered by the bargraph driver is 1.25 volts.

The power supply can be run from a single PP3 battery. The regulator IC3, is used to generate a pseudo ground plane by which other signals are measured. Also this provides the op-amps with their needed split supplies as their outputs cannot swing to ground.

CONSTRUCTION

All the components, except sensor R4 and switches, are mounted on a single printed circuit board. The component layout and full size copper foil master pattern are shown in Fig. 5. This board is available from the *EE PCB Service*, code EE716.

Before embarking on getting your hands dirty you must first decide what type of display mode you want. If you prefer a bargraph then solder the "Dot or Bar" link wire into place, but note that this mode draws a lot more current than the dot mode as it illuminates more l.e.d.s. So it will not be suitable for continuous battery use espe-

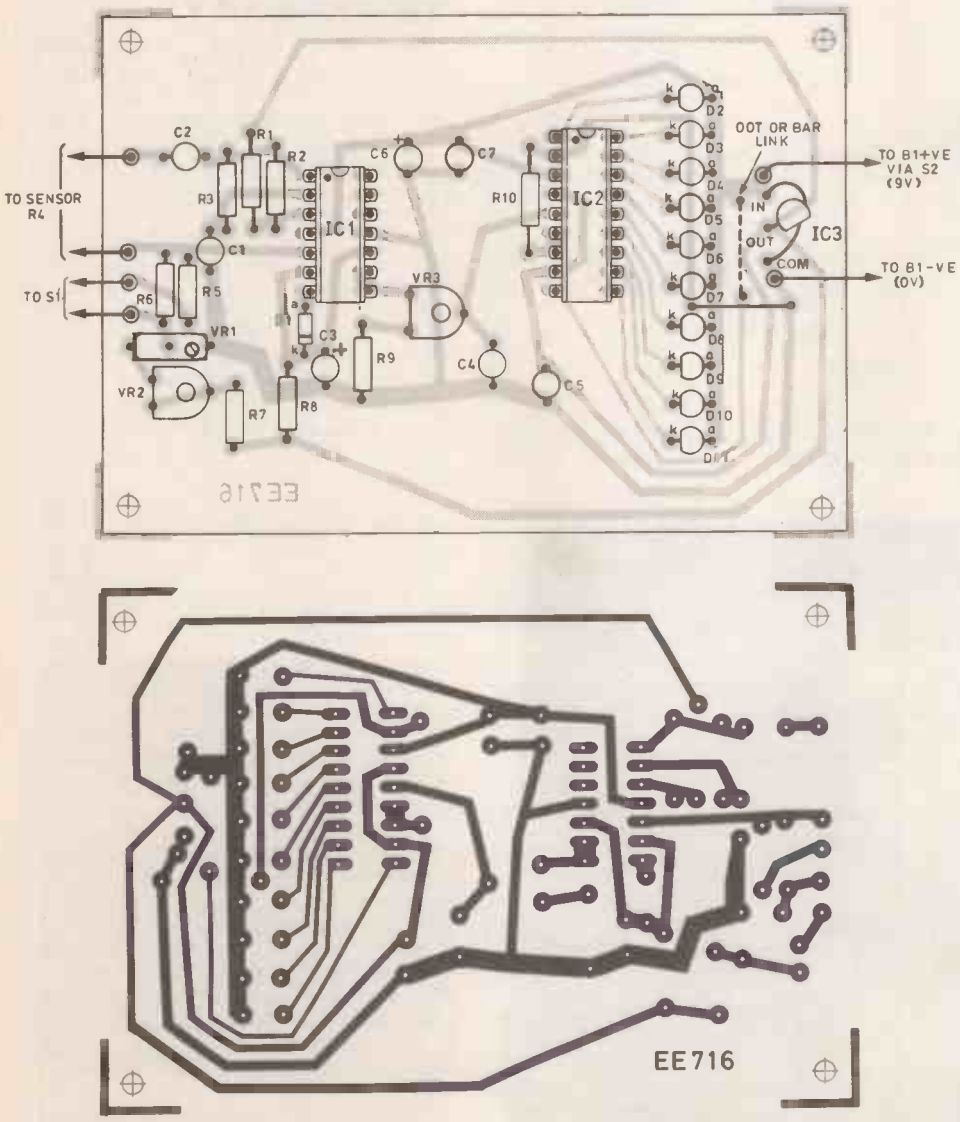


Fig. 5. Printed circuit board component layout and full size copper track master pattern

COMPONENTS

Resistors

R1, R2	27k (2 off)	
R3, R8	100k (2 off)	
R4	sensor (see text)	
R5	10k	
R6	1M2	
R7	390	
R9	3k3	
R10	5k6	

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	10k 20-turn cermet preset
VR2	2k2 skeleton preset horiz.
VR3	10k skeleton preset horiz.

Capacitors

C1	2n2 polyester
C2	470n polyester
C3	2µ2 tantalum
C4, C5	4n7 polyester (2 off)
C6	100µ radial elect. 12V
C7	1n ceramic

Semiconductors

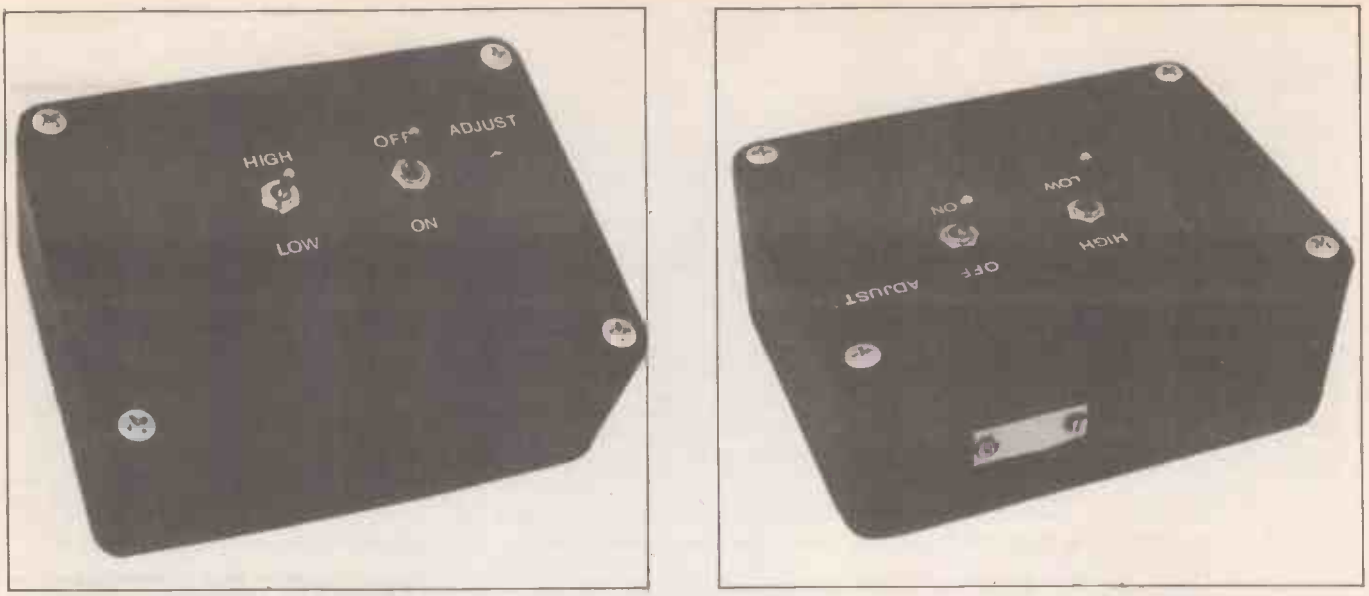
D1	1N914 signal diode
D2-D11	rectangular l.e.d.s – colour as required (10 off)
IC1	LM324 quad op-amp.
IC2	LM3914 bargraph driver
IC3	78L05 5V 100mA regulator

Miscellaneous

S1, S2 s.p.s.t. miniature toggle switch (2 off)

PP3 battery and connecting clip; connecting wire; case to suit, minimum size 100 x 70 x 30mm; p.c.b. available from the *EE PCB Service*, order code EE716.

Approx cost guidance only **£16**



The completed unit above shows the small hole drilled in the lid to allow adjustment of the 20-turn preset. The mounting of the sensor "pad" on one side of the case can be seen top right. Also shown is a filter strip which covers the l.e.d. cutout.

cially in high humidity settings when more l.e.d.s are illuminated.

The dot mode is more economical on battery power only drawing an average of 15mA continuously. This mode is selected by leaving pin 9 on IC2 floating.

All low level components such as resistors and diodes along with link wires should be soldered in first then i.c. sockets, capacitors and presets. When soldering the capacitors and regulator in place be sure to keep their leads short so they do not get in the way when mounting the p.c.b. near the front of the case.

Finally mount VR1 and the l.e.d.s, but make sure you cut the leads of the l.e.d.s so that both them and preset VR1 are of similar length and so accessible via the front panel. On the prototype version the 20-turn preset used needed lengthening by soldering extra wire on to the leads. After connecting the switches and power supply this leaves only the sensor to be connected.

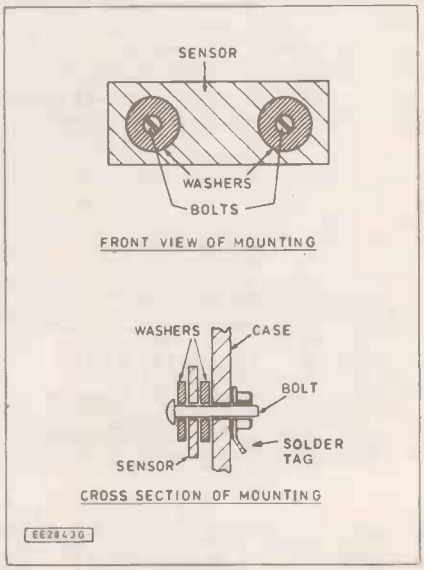
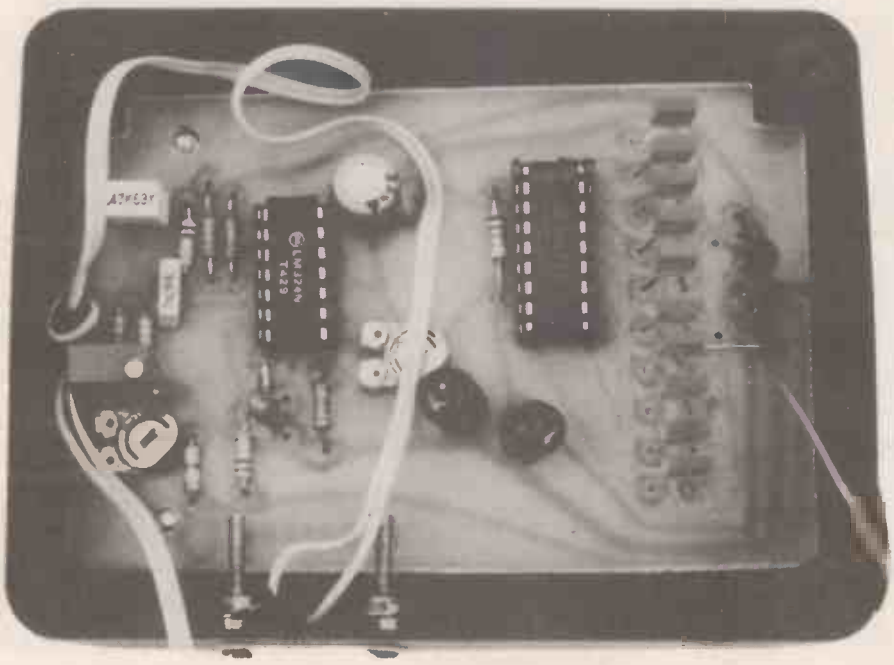


Fig. 6. Suggested method of mounting the sensor on the side of the case and (below) the completed p.c.b. mounted inside the case. The rectangular l.e.d.s should align with a cutout in the case lid.



On the prototype the sensor (R4) was mounted using two stainless steel bolts and washers. The set-up of this is shown in Fig.6, this gives good stable contacts.

SETTING UP AND TESTING

To set the unit up first, as always, switch on the power, then check that the output of IC1a is oscillating at around 2kHz. This can be done with an oscilloscope or a series resistor and a pair of headphones.

Connect the sensor and adjust VR1 so the output of IC1c is around five volts. Next breath on the sensor heavily, the output of IC1c should rise and so should the indication on the l.e.d. display. If all is well here then proceed.

To calibrate the unit you need a sample of air which has a low humidity so you can set VR2. This can be achieved by placing the sensor directly in the path of the air coming out of an air blow heater or hair dryer and allowing the sensor time to settle. This air is very low in water content and so can be used as a reference.

Set VR1 to the zero position (i.e. fully anti-clockwise) and adjust VR2 so the output of IC1c is equal to five volts (i.e. the output of the regulator IC3). An accurate way of doing this is to connect a resistor in series to an ammeter from the output of IC1c to the five volt supply and adjust VR2 so no current flows, as the current falls the series resistor can be gradually reduced to zero to get greater accuracy. Be careful when using little or no resistance especially on a 50µA range as any large movements of VR2 may be accompanied with the bill for a new meter.

Next comes setting the maximum humidity. To generate the correct atmosphere either a steamy kitchen or bathroom may be used. Alternatively a small one may be created by putting a bowl of boiling water in a cardboard box with the unit, covering it and leaving them a while to settle. Then set S1 to the minimum sensitivity range position and adjust VR3 so the top l.e.d. is lit, this has set the maximum readable on the full range setting.

The unit is now ready for use and will provide an instant indication of humidity from virtually 0 per cent to 100 per cent. □

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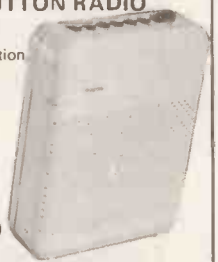

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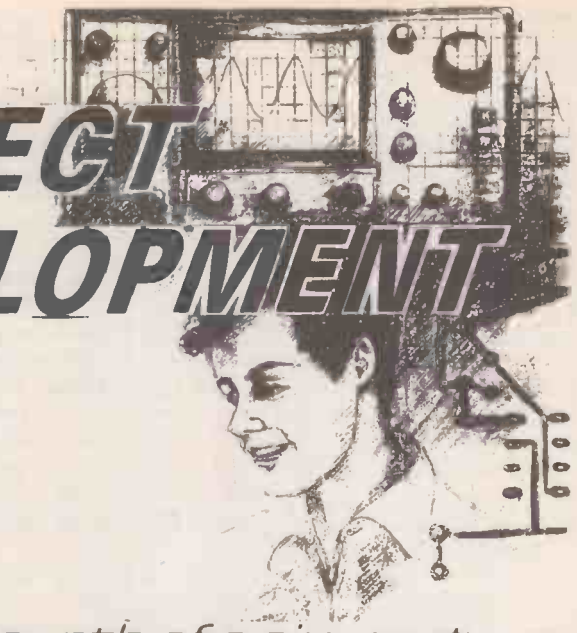


In this, the fourth of a six-part series, a GCSE assessor looks at the planning needed before soldering-up your circuit.

WHEN your circuit is working correctly on the breadboard, you will need to see if it meets the specification. Make a quick check on each point – this will do for now. In this way, you will be able to make any minor alterations as necessary. It is too late to make really drastic changes so if the circuit fails to live up to its promises, you will just have to make the most of it. You will not lose much credit – you may not even lose any. More will be said on this point next month.

You are now almost ready to produce your project in its final form. This means that it will end up as a (preferably) soldered-up circuit panel mounted in a box rather than just on a breadboard as it is at present. If the circuit were to be handed in for moderation in temporary form, less credit would be obtained and the standard of layout would still need to be as high as with other forms of construction.

Wire-wrapping and similar techniques are acceptable but, on the whole, soldering is the preferred method and is really expected. Check with the exam regulations if you are short of time and wish to submit the project in breadboard form. Some boards will award reasonable credit for this but others definitely need a permanent circuit.

Do not be too hasty in starting the soldering-up process. There is much more to it than simply attaching a handful of components to a circuit panel. Planning is needed and your diary should continue to show all development work as it has done up to now.

Planning

First decide what form of circuit panel you are going to use. There are several options. I have known some students make a circuit panel by hammering panel pins into a piece of plywood and soldering the components to these. This is a valid method and I have seen some good examples of work done in this way. On the whole, though, it is a poor technique. Not only does the finished circuit look crude but the soldering is rarely up to standard. Also, it is only suitable for relatively simple circuits.

In practice, most candidates use either stripboard or an etched printed circuit panel made from copper-clad board. Some schools have computer-aided p.c.b. design software and there is no reason why you should not use this. These schools often have proper etching facilities to enable a near professional-quality board to be made. Although producing a p.c.b. in this way may be very satisfying, don't think that it will necessarily gain more credit.

If the equipment you are using is semi-professional, you will be expected to produce a board to match. If you use a simpler form of construction, you will gain credit for your resourcefulness and the standard need not be so high. Any valid method can gain maximum marks if used carefully.

P.C.B. or stripboard

If you have made p.c.b.'s before, perhaps for other mini-projects, you will have experienced most of the pitfalls in this type of work. It might then be a good idea to use an etched p.c.b. for this project.

If you have never etched a p.c.b. before, I think it would be unwise to start now. The snag is that mistakes cannot be easily rectified afterwards and you could end up with a circuit which works on the breadboard but fails to do so on the p.c.b.

On the whole, stripboard is probably the best choice. Most stripboard has a hole spacing of 0.1 inch (2.5mm); Fig. 1. The copper strips are then very close together. Students who have not had much soldering experience sometimes find that solder tends to bridge adjacent copper tracks and cause short-circuits. If so, consider using stripboard having a pitch of 0.15 inch.

This type used to be more popular than it is today but is not freely available like the smaller matrix variety. R.S. Components (or Electromail) supply it, however, and your school may very well have an existing account with this company.

Layout

Having made a decision on the type of circuit panel to use, you must spend some time planning it in detail. A scale drawing should be made in your diary. If using stripboard, your plan will probably resemble your breadboard layout. Fig. 2 and Fig. 3 shows a version of the Elderly Person's Alarm circuit and one possible stripboard layout. This is not the only possible design – there could be better ones – but it is one which any reasonably-able student could devise and it would work.

Note that in all but the simplest circuit, some track breaks and inter-strip link wires are needed. Aim for a neat layout. Keep an eye on the sizes and lead spacing of components – some suppliers' catalogues are very specific about sizes of components and these can be helpful when planning.

Have a piece of scrap stripboard handy so that you can check the positioning of components. Remember that resistors and certain capacitors may be mounted flat against the board or perpendicular to it with one of the leads bent over as shown in Fig. 4.

Perhaps you have been using physically large components in your breadboard design because these are robust. When making your final circuit you may decide to choose smaller ones for example, 0.25W resistors in place of 0.5W ones (subject to the lower power rating being appropriate for the job). You may also decide on capacitors having a lower working voltage (again, so long as this is sufficient). Even so, the assessor will not deny you full marks just because components are not physically ideal for the job.

In a school-based environment, compromises are acceptable and minimum size is not as important as it would be in industry. Allow a little extra space in your circuit panel for the unexpected. Think also about leaving clearance for multitester probes – you may need to make some checks on the finished circuit panel and need room to work.

Mounting the board

An important thing to plan is the eventual method of securing the circuit panel into the box. Thinking about this now will save a lot of trouble later. Many students leave this detail until the last minute and have even been known to leave the circuit panel lying loose in the box. You may get by with adhesive fixing pads but the assessor will not like it because he or she needs to remove the panel to inspect the soldered joints on the underside.

Some students have used Blu-Tak or even Plasticine to secure their circuit panel

– again, most unsatisfactory. There are really only two ways of doing the job properly. One is to use the slots provided in most commercial plastic boxes. This is a good method but requires careful planning not only of the circuit panel but also of the layout of other components so that the right size of box is selected. You then use an appropriate piece of stripboard to fit the slots even though it may be a little larger than it needs to be. Some students find that there are too many imponderables here.

An alternative is to drill holes in the circuit panel so that it may be secured to the base of the box using small fixings. This method is more versatile because the size of the case is less important. Make sure that the positions of the fixing holes are really thought out and do not break tracks in important positions. It is a good idea to cut the stripboad wider than the circuit actually requires to accommodate the fixing holes (see Fig. 3).

metal and gives a very good appearance. Mains-operated projects always need a metal – probably aluminium – box and must be earthed.

Remember the battery – what size is to be used and how is it going to be secured? As with the circuit panel, the battery must not be left loose in the box – a small bracket or a battery drawer will be needed.

You can make your own case or use a box such as a lunchbox. If you have a used plastic box, make sure it is of an appropriate size. If you acknowledge the fact that it is a recycled box, the assessor will not worry too much if it is a bit too big for the purpose. On the other hand, a box which is clearly much too big will receive less credit. It is also important that the box is not too small so that there is an excessive crowding of components causing possible short-circuits.

The LEAG are more particular about the box than other examinations boards. Some

circuit if all the components are not yet to hand. This is because you can easily be caught out with a component size or lead spacing. Sometimes the component supplied may differ in detail to the one ordered.

It is usually false economy and a waste of precious time to shop around too much for components. You could end up paying excessive postage and packing charges. Sometimes resistors cost a little more from one supplier and capacitors a little less. Some suppliers are more expensive but offer a comprehensive stock and a "by return" service. Remember that some companies quote costs less VAT so you need to add 15% to reach the true price.

Try to "club together" to make up a large order if this is possible – you may even be able to avoid postage charges completely. Some companies give a discount when buying several of the same components. Suppliers will usually advise

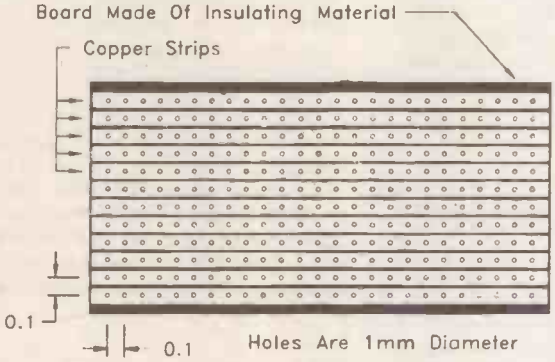


Fig. 1. Stripboard has 1mm holes drilled on a 0.1in. (2.54mm) matrix, plus copper strips along the underside.

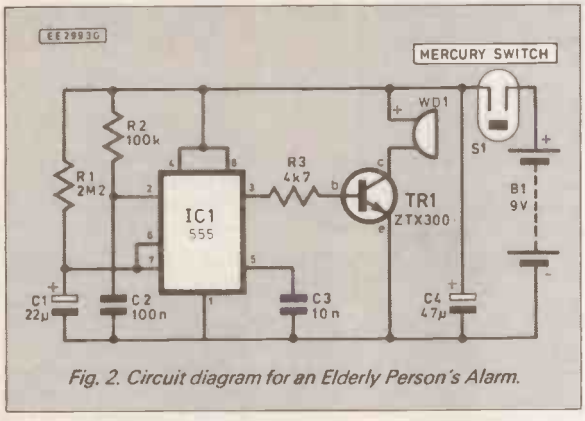


Fig. 2. Circuit diagram for an Elderly Person's Alarm.

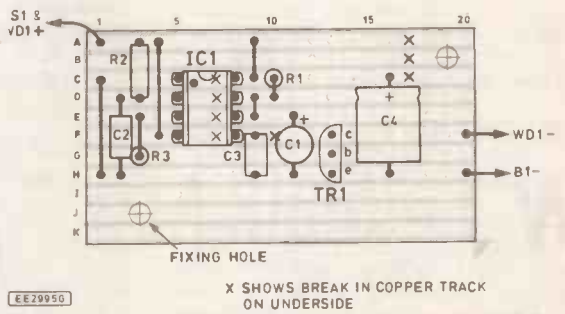


Fig. 3. Stripboard component layout.

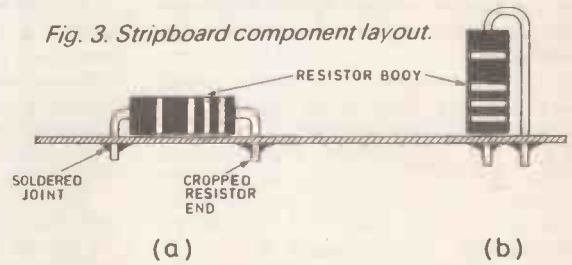


Fig. 4. Component mounting. (a) resistor mounted flat on board. (b) resistor mounted perpendicular to board.

Plan out how the completed circuit panel will be connected to the off-board components such as switches, indicator lights and potentiometers. Draw a diagram to show how this is to be done.

The case

Perhaps your school will have some old boxes from previous projects which can be used for planning. If not, you can make *temporary* ones using cardboard. Make them the correct size as specified in suppliers' catalogues. It is amazing how many sizes of boxes are available if you look in several catalogues.

You will need to make a choice soon as to whether to use a plastic or an aluminium box. Plastic is easier to cut and drill than

boards do not actually insist on a box at all but then the controls – switches and potentiometers – need to be mounted on the circuit panel. In practice, a box is really expected and most students do not feel that the job is finished without one.

Ordering components

Sooner or later, you will probably need to place an order for components with a specialist supplier. Note that local shops are often unsatisfactory because they carry only a limited stock. Mail order companies generally keep a comprehensive stock and one of the larger ones will supply all your needs. You may be fortunate in having one of their retail outlets locally.

Take care when starting to build the

availability of a particular item over the telephone.

If you can persuade a credit card holder to make the order and quote his or her number over the telephone, the goods will often be despatched that day. Remember that the parcel will be delivered to the cardholder's address and this can sometimes be a disadvantage.

Sometimes the school will allow you to use components from stock and pay back later – this is a good plan but, of course, they may not hold in stock everything you need. Sometimes you can use the components free providing you remove the major ones and give them back after moderation – this is a bit soul-destroying and most candidates like to pay for their components so that they can keep their project afterwards.

That's all for this month. Next time, we shall look at soldering technique, the construction of the circuit panel and the work needed in preparing the box. We shall also look at the mounting of off-board components and the evaluation process.

ACTUALLY DOING IT!

by Robert Penfold

USUALLY in electronics, if you should happen to fit something the wrong way around it is unlikely to have particularly dire consequences. The circuit will probably not function properly, if at all, until the mistake is corrected, but it is rare for any damage to result. There are exceptions though, and I recently experienced a fairly spectacular exception when developing some very high power audio amplifier designs for a book.

PUFF OF SMOKE

The circuits were powered from a supply unit which gave something like plus and minus 50 volts at up to about 5A from each rail. Having liberally plastered the manuscript with dire warnings about checking and double checking everything before switching on and trying any of the designs, I suppose I should have had the good sense to heed my own advice!

In fact I failed to do this, and about two seconds after switching on the power to one design there was a loud bang and a puff of smoke. After switching off the power as fast as possible, an investigation soon revealed that the problem was simply due to an exploding electrolytic capacitor.

As is fairly typical in these cases, there was little of the component left! It consisted basically of two wires, a thin film of something sticky (presumably the electrolyte) deposited on the circuit board, and some smoke.

It could be that the component had simply failed, but it is more likely that I accidentally connected it with the wrong polarity. In some cases this type of thing will not lead to a major problem, due to the low voltages and currents present in most modern circuits. In fact most electrolytic capacitors will function quite happily if they are subjected to only a very small reverse voltage.

Getting 50 volts round the wrong way is a different matter though, especially with a supply that can provide very high currents. A high reverse voltage causes the component's insulation to break down, a high current then flows, the interior of the component rapidly heats up, and finally there is a bang and the proverbial "puff of smoke".

The moral of the story is to always take due care when fitting electrolytic capacitors, especially those that fit directly across the supply rails of a project. There seems to be a true lack of standardisation of polarity marking on radial electrolytic capacitors, and you need to be especially careful with these.

In the main, they used to have both "+" and "−" markings to show the polarity of the leadout wires. These days it is more common to have only the negative lead marked, usually via large markings on the body of the component.

However, I have a number of radial electrolytics in the spares box which have the positive lead indicated in this way. It would seem to be advisable to look carefully at the markings rather than jumping to conclusions.

BATTERY DANGERS

It is perhaps worth mentioning that extra care is always advisable when dealing with any low impedance power source. A large mains power supply unit is an obvious source of potentially destructive currents, but there are others.

Battery projects tend to be thought of as being very safe, which they are in many ways. Unless there is some form of voltage step-up circuit, there is no question of a noticeable electric shock being obtained from a project that is powered from a battery having a potential of about 12V or less.

High currents are a different matter, and they are available from certain types of battery. Ordinary zinc-carbon "dry" batteries cannot supply very high currents, but the same is not true of accumulators (including car batteries), NiCad rechargeable cells, and many of the "alkaline" and other "high power" batteries.

These all need to be treated with due respect, and can produce high enough short circuit currents to burn fine gauges of wire. Actually, car batteries and high capacity NiCad types, seem well able to burn through fairly heavy gauges of wire. If you look at an assortment of batteries you will almost certainly find some that have warning messages about the high currents they can deliver.

It might seem to be a funny idea to put a fuse in the supply line of a small battery operated project, but with NiCad and "high power" batteries being used more and more in electronic projects, perhaps this will have to become a standard part of small project construction. Many modern batteries are certainly capable of starting fires and exploding the odd capacitor or semiconductor.

The other warning you will find on many batteries is not to leave the batteries in equipment that will not be used for some time. Modern batteries seem less prone to leaking than those of some years ago, and this problem is not as great as it once was.

However, modern batteries can (and do) leak if left long enough, and the chemicals in some of them seem to be more potent than ever. I have seen large holes burned in plastic cases by leaking batteries, and circuit boards reduced to a sticky mess.

Store batteries separate from projects. Store them where you can keep an eye on them, and where no harm will result if they should start to leak.

CMOS CURRENTS

In the early days of transistor projects it was essential to take great care with the polarity of the battery. Back then the transistors were constructed from *germanium*, whereas these days practically all semiconductors are built from slices of *silicon*.

One of the advantages of silicon transistors is that they are not usually damaged at all if fed with a supply of the wrong polarity. This contrasts with the old germanium devices, where momentarily getting the supply wrong could "blow" every transistor in the circuit. Bearing in mind that transistors in those days cost the equivalent of about £5 each in today's money, this was no joke!

Do not get lulled into a false sense of security by the hardiness of modern components. Although they are generally very tolerant of a reversed supply, it can still cause damage. In particular, great care needs to be exercised when using CMOS logic integrated circuits, and some other MOS integrated circuits.

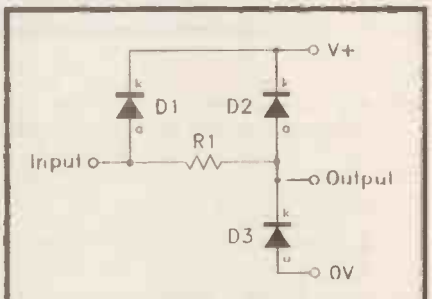


Fig. 1. The CMOS static protection circuit used at most inputs.

Apparently each input is normally protected by a circuit of the type shown in Fig. 1, or something close to this. The diodes are reverse biased and will pass only minute leakage currents.

However, if the supply is connected with the wrong polarity the diodes become forward biased, and place what is a virtual short circuit across the supply lines. Although the logic circuits may not be damaged directly by the reversed supply, they can be damaged by the heavy current that flows.

In my experience of this problem it seems to be the heat which is generated that causes the problem. If the supply is removed fairly quickly, the CMOS devices will be hot but still operational.

Leave the supply connected with the wrong polarity for any length of time and the CMOS integrated circuits may all be destroyed by over-heating. There is even a danger of them exploding with a loud "crack" sound (which is a risk with any over-heating semiconductor).

The static sensitivity of CMOS integrated circuits is a subject which gets endless publicity, but their intolerance of reversed supply lines is one which

seems to get little coverage. The occasional reader's letter complaining of over-heating CMOS devices would suggest that it is far from an unknown problem.

Remember that if you should accidentally fit a d.i.l. integrated circuit into its holder round the wrong way, in most cases this will result in it being fed with a reversed supply. So in future take extra care when fitting CMOS integrated circuits onto a circuit board.

L.E.D. TIP

In a recent *Actually Doing It* article I mentioned the problems associated with getting light emitting diodes (l.e.d.s) connected the right way round. As most readers will probably be aware, unlike light bulbs, l.e.d.s will only operate if they are fed with a signal of the right polarity. Unfortunately, many l.e.d.s do not seem to have any clear method of showing which leadout is the cathode ("k" or "+"), and which is the anode ("a" or "–").

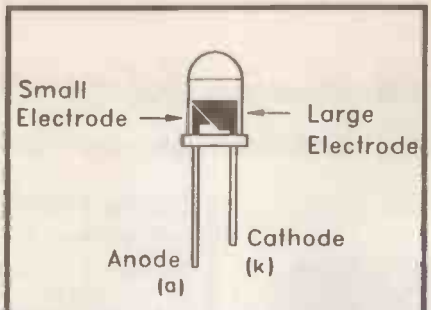


Fig. 2. A simple method of determining the polarities of l.e.d.s.

I am indebted to *Mr. J. Hewes* from Bekenham in Kent for this method of judging the polarity. I cannot guarantee that it will always give the right result, although on trying it out with several dozen l.e.d.s of different types it worked infallibly. Apparently it has never let Mr. Hewes down yet either, so it is probably 100 per cent reliable.

In order to determine which leadout is which you must first look at the interior construction of the l.e.d. This should reveal something along the lines of Fig. 2.

The exact shape of the electrodes vary somewhat, but you have what is basically a small electrode nearer the base of the component, and a bigger one above it which is usually (more or less) triangular in shape. This larger, triangular electrode is the one which connects to the cathode (k) lead.

The only l.e.d.s where I found this method to be of no help was with some that were moulded into fancy panel holders. The problem was simply that there was no way of looking sideways-on into these l.e.d.s. However, it was usable with all the other l.e.d.s I have, including infra-red, ultra-bright types, etc.

SHOP TALK

with David Barrington

Model Train Controller

There are one or two items that may cause readers concern when shopping for components to build the *Model Train Controller*. This applies particularly to the semiconductor devices.

We have only been able to find one source of supply for the special f.e.t. opto-isolator chip type H11F1. This is currently listed by **Electromail** *(☎ 0536 204555)*, stock code 650-790.

The thyristor type TICP106D is housed in a T092 plastic package and was also purchased from the same company, code 638-469. The more common C106D version can be used here, but it is housed in a T0202 "metal tab" package and the connections should be carefully checked when installing on the p.c.b.

The relays used in the prototype were purchased from Electromail and are listed as 5A DPCO type 2. This relay (stock code 349-658) has a coil resistance of 205 ohm and is claimed to operate from 10.9V up to 19.5V.

The special power illuminated switches, from the same source, come very expensive at over £7 each and it might work out cheaper to use *seperate* rocker or pushbutton switches and lamps. These should be available generally and not alter the finished appearance of the unit too much.

The double-sided printed circuit board is obtainable from the EE PCB Service, code EE736 (see page 276).

Humidity Tester

The miniature printed circuit multi-turn potentiometer used in the *Humidity Tester* appears to be available in 18 to 22-turn versions and should not cause any purchasing problems. Either type can be used in this circuit. The rest of the components, including the bargraph driver i.c., all seem to be popular "shelf" items.

The saltpeter used to impregnate the sensor pad was obtained from Boots but it should be available from any good chemist shop. The blotting paper for the sensor pad is sold by most major stationary/newsagents stores.

The printed circuit board for the Humidity Tester is available from the *EE PCB Service*, code EE716 (see page 276).

Electronic Cat Flap

Most of the components called for in the list for the *Electronic Cat Flap* are fairly standard items and most advertisers should be able to offer suitable parts to complete construction.

A suitable miniature coil former for the "collar key" can usually be found listed in catalogues under inductor sections, these are normally used for radio r.f. and i.f. coils. If you do experience any difficulties in locating a source they can be purchased form **Maplin** and **Cirkit**.

It is most important that the specified CA3140E op. amp be used in this circuit as other op. amps, such as the 741 and TL081, have been found not to operate properly in this application.

For the safety of all users, a metal case must be used and it is essential that it is "earthed" to the house mains Earth lead. The case used in the model is one of the vinyl-covered aluminium boxes from Maplin, order code LH38R (WB3 Vinyl).

The above company also supplied the relay and is listed as an Ultra Miniature Relay, code YX94C (Ult Min Rlay SPDT). This relay has a coil resistance of 400 ohms.

The unit should work with any 12V relay that has a coil resistance of 180 ohm and above. The ratings will, of course, need to be able to handle the demands of the "flap" controller unit. Most miniature p.c.b. mounting relays will fit on the 0.1in maxtrix stripboard, but the pin layout is most likely to be different and will mean a slight redesign of the board layout.

Three Transitor Tremolo

We do not expect any component buying problems to be encountered by constructors of the Three Transistor Tremolo. Some areas may be short on the ORP12 light dependent resistor, but a quick phone-round should soon locate a source.

PIP Robot Add-On Module

The f.e.t. transistor, type BST70A, used in the PIP Add-On Module seems to be in very short supply and we have only found it listed by **Farnell** *(☎ 0532 636311)*. We understand from the designer that alternative device would be ZVN 3306A or VN0808M. These devices have NOT been tried in the module.

Suitable low voltage, miniature motors are listed or stocked by quite a few of our advertisers, who should also be able to supply suitable relays.

Teach-In '91

We cannot forsee any component buying problem for both the *Electronic Die*, this month's *Teach-In '91* project or the *Digital Counter*, the *Design Your Own Circuits* demonstration module.

Battery To Mains Inverter

In last month's project for a *Battery-To-Mains* Invertor the annotations on the secondary winding of transformer T2 seem to have caused confusion for some readers.

This transformer has two 12V secondary windings which are wired in series to give the required 24V output. Unfortanately, although the circuit shows the two-windings in series it should have been marked 12V, 0V, 12V.

The details for winding your own transformer (T1) from a kit, given in last month's *Shoptalk*, are for a 7.5V-0V-7.5V version. The comment about a 9V transformer applied to a shop purchased ready-wound unit.

ELV

Technik für Kenner - Made in Germany

We deliver from stock - The fastest way to order is a fax !

ULTRASONIC CAR ALARM

This system is specially designed to protect your car and its contents against potential thiefs. Low current consumption and high noise immunity are just two of its distinguishing features.

Complete kit including case
44.367BKL ..... £ 30.40

In addition the system has a voltage sensing device i.e. the alarm is also triggered if appliances are switched on by an unauthorised person (e.g. the interior lighting when the door is opened).

DIGITAL PROFESSIONAL ECHO 1000

(Elektor Electronics June 89)

This low cost echo unit is certain to impress music lovers - amateur and professional - everywhere. Excellent specification and top performance make the EU 1000 a winner and despite meeting professional requirements the unit will not make too big a hole in your pocket.
Working on the delta modulation principle on a digital base, delay times up to one second are possible at full bandwidth and large signal to noise ratio.

Complete kit
44.255BKL ..... £ 99.50

Ready assembled module
44.255F ..... £ 134.50

Specification

Input sensitivity:
Input 1 : 2 mV
Input 2 : 200 mV
Dealy Time:
variable from 60 ms to 1 s
Bandwidth :
100 Hz to 12 kHz

Additional features:
- inputs mixable
- single and multiple echo
- adjustable delay level
- switchable vibrator
- switch-controlled noise suppression

PC Radio (Elektor Electronics Febuary 1990)

This FM radio consists of an insertion card for IBM PC-XTs, ATs and compatibles and is available as a kit or a ready-built and aligned unit. The radio has an on-board AF power amplifier for driving a loudspeaker or a headphone set, and is powered by the computer. A menu-driven program is supplied to control the radio settings.

Complete kit
44.544BKL ..... £ 82.75

Ready assembled module
44.544F ..... £ 137.30

VM 1000 Video-Modulator

(Elektor Electronics March 90)

Many inexpensive or older TV sets lack a SCART or other composite video input, and can only be connected to a video recorder or other equipment via an RF modulator. The modulator operates at a UHF TV channel between 30 and 40. Use is made of a single-chip RF modulator that couples low cost to excellent sound and picture quality.

Complete kit
44.546BKL ..... £ 36.90

RFK 7000 RGB-CVBS Converter

(Elektor Electronics October 89)

Nearly all computers supply as an output signal for colour monitors RGB signals. With the help of the RFK 7000 it is possible to record this signals with a videorecorder or to give them onto a colour TV (This is only possible, if the computer delivers a vertical sync. of 50 Hz and a horizontal sync. of 15.625 Hz).
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.525BKL ..... £ 66.50

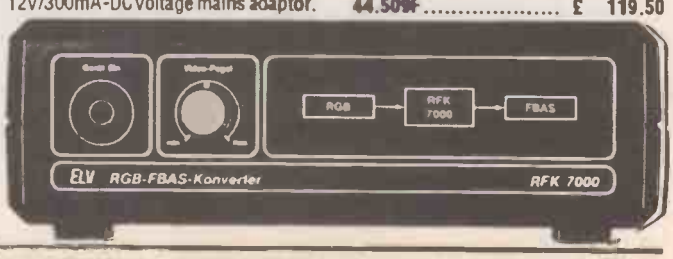
Ready assembled module
44.525F ..... £ 119.50

FRK 7000 CVBS-RGB Converter

With the help of the FRK 7000 e.g. it is possible to use a cheap clour monitor with RGB input on a video recorder.
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.509BKL ..... £ 66.50

Ready assembled module
44.509F ..... £ 119.50



Ordering and payment:

- **all prices excluding V.A.T.** (french customers add 18.6%T.V.A.)
- send Euro-cheque, Bank Draft or Visa card number with order. Please add £ 3.00 for p & p (up to 2 kg total weight)
- postage charged at cost at higher weight Air/Surface
- we deliver worldwide except USA and Canada
- dealer inquiries welcome

ELV France - B.P. 40 - F-57480 SIERCK-LES-BAINS - France - Tel.: (33) 82.83.72.13 - Fax: (33) 82.83.81.80

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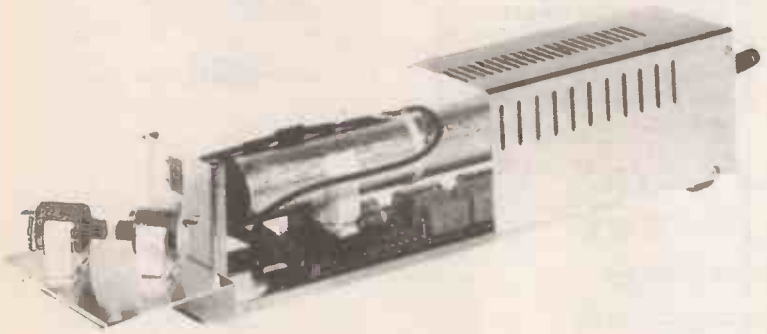
LPS 8000 / LC 7000 Low Cost Show Laser

(Electronics The Maplin Magazine Dec 88 + Feb-Mar 90)



An almost infinite number of circular patterns can be projected onto a wall or ceiling with this super laser show equipment.
The complete project includes a laser tube and accompanying power supply, housed in a metal case, and a laser controller, LC 7000. The laser controller drives the accompanying deflection unit, fixed onto the laser power supply case, which produces the numerous configurations.
Naturally the laser tube, together with the power supply, can produce beams without the laser controller and the controller can be used with other, similar lasers.

LPS 8000 Laser Power Supply, complete kit
Version 240 Volts AC
44.428BKL220 ..... £ 86.90
Version 220 Volts AC
44.428BKL240 ..... £ 86.90

LC 7000 Laser Controller, complete kit
Version 12 Volts DC
44.427BKL ..... £ 60.80

H-N Laser Tube 2 mW
44.428LR ..... £ 60.80

LPS 8000 Laser Power Supply, ready assembled module
Version 240 Volts AC
44.428F240 ..... £ 156.50
Version 220 Volts AC
44.428F220 ..... £ 156.50

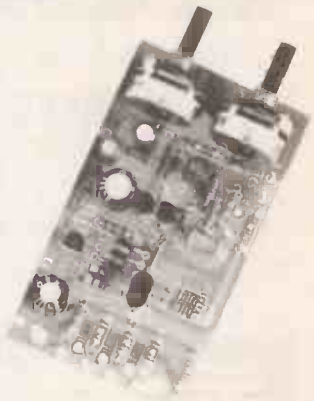
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F ..... £ 104.30

Laser Motor-Mirror Set, complete kit
44.506M ..... £ 22.95

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

Losses can easily occur when copying video tapes resulting in a distinct reduction in quality. By using this video recording amplifier, with no less than four (!) outputs, the modulation range is enlarged and the contrast range of the copy increases.
Two level controllers for edge definition (contour) and amplification (contrast range) allow individual and precise adaptation.

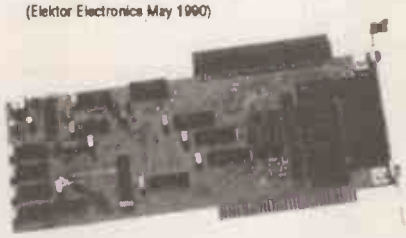


Complete Kit
(including Box, PCB and all parts
44.324BKL ..... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

This card was developed for assistance in the field of service, development and test. The card is used as a bus-extension to reach the measurement points very easy. It is also possible to change cards without having a "hanging computer".



Complete kit
44.517BKL ..... £ 77.95

Ready assembled module
44.517F ..... £ 137.95

TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

This automatical telephone answering unit uses a 256-kbit voice recording circuit to store and replay your spoken message of uo to 15 seconds. Noteworthy features are that it is available as a complete kit, providesd a battery back-up facility and does not require alignment. No provision is made, however, to record incoming calls.

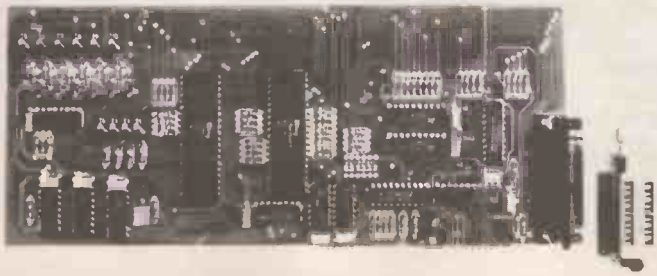
Complete kit
44.433BKL ..... £ 45.65

Ready assembled module
44.433F ..... £ 87.25

IC TESTER for IBM-PC-XT/AT

(Electronics The Maplin Magazine Jun-Jul 89 +
Elektor Electronics December 89)

With the ELV IC tester logic function tests can be carried out on nearly all CMOS and TTL standard components, accommodated in DIL packages up to 20 pin. The tester is designed as an insertion card for IBM-PC-XT/AT and compatibles. A small ZIF test socket PCB is connected via a flat band cable. Over 500 standard components can be tested using the accompanying comprehensive test software.



Complete Kit including Textool socket, connectors, sockets, Flat band cable, PCB, Software
44.474BKL ..... £ 60.85

Ready Assembled Module
4.474F ..... £ 113.00

Software, single
44.474SW ..... £ 17.85

ELV France - B.P. 40 - F-57480 SIERCK-LES-BAINS - France - Tel.: (33) 82.83.72.13 - Fax: (33) 82.83.81.80

Constructional Project

ELECTRONIC CAT FLAP

ROBERT PENFOLD

Why feed all the neighbourhood cats when you can give your cat the "key to the door" and make them feel like the Cats Wiskers!!

THIS NOVEL electronic lock design was produced in response to readers' requests for a circuit that could be used as the basis of an electronic cat flap.

Cats are quite intelligent creatures, but the average "moggy" is presumably not going to be able to use any normal form of key or learn to operate a combination lock! What is needed is something that can be fixed to the cat's collar, and which will act as a "key" to automatically open the lock if the cat simply stands in the correct place.

In this case the "key" is a small coil and capacitor connected to operate as a parallel tuned circuit. This tuned circuit is detected by a simple oscillator based circuit which uses the same principle as a grid dip oscillator (or its modern equivalent, the gate dip oscillator).

It has to be admitted that this design has not been tried in earnest (i.e. with the assistance of a feline friend), but the coil will certainly operate the lock at a range of up to about 100 millimetres to 150 millimetres. This should be adequate for the present application.

In my experience cats are fairly quick to latch onto anything that gets them their own way. If nothing else, the unit represents an unusual and interesting form of proximity switch for use in general security applications.

OPERATING PRINCIPLE

As already pointed out, the unit exploits the same phenomenon that permits grid/gate dip oscillators to function. In one of these instruments there is an *L-C* oscillator which has its tuning coil mounted outside the case.

If this coil is placed close to a tuned circuit operating at (or very close to) the oscillator's operating frequency, this tuned circuit tends to absorb a large amount of signal from the oscillator. This dampens the oscillations, giving reduced currents in the circuit that can be detected by a meter connected at a suitable place in the unit. If the two tuned circuits are in very close proximity, oscillation might even be dampened to the point where it ceases.

A grid or gate dip oscillator is normally tunable over wide limits, with interchangeable coils giving several tuning ranges. The basic idea is that its coil should be placed near the tuned circuit under investigation, and the tuning control should be adjusted until a "dip" from the meter is obtained.

The operating frequency of the tuned circuit under test can then be read off the tuning scale of the dip oscillator. This enables tuned circuits to be checked without making any connections to the circuit being checked, or even having the device in question switched on. This is especially useful when checking radio transmitters.

In the present application this system has the advantage that it enables a suitably equipped cat to be detected, but practically nothing else will activate the unit. An important factor is that the "key" is purely passive, which enables it to be quite small and light, with no need to periodically replace batteries.

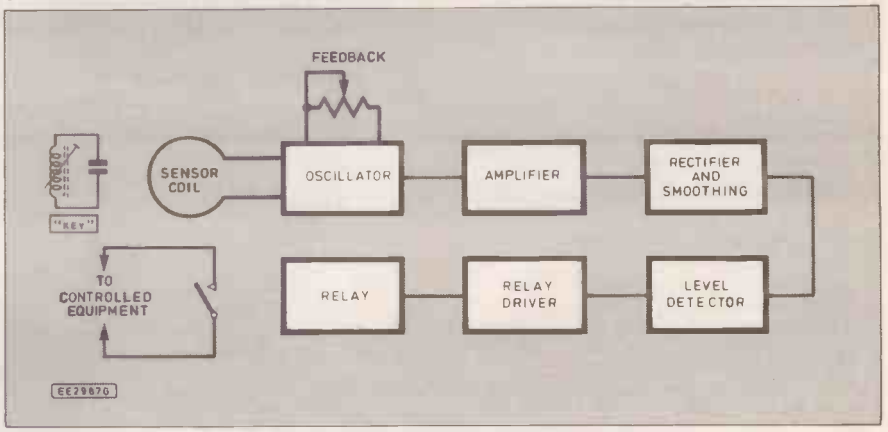


Fig. 1. Block diagram for the Electronic Cat Flap.

HOW IT WORKS

The block diagram of Fig. 1 shows the general arrangement used in the Electronic Cat Flap. The oscillator stage has a feedback control which is adjusted to the point where the circuit is just gently oscillating. This ensures that the slight damping of the oscillations caused by the presence of the "key" has a significant affect on the level of oscillation.

As the oscillator only oscillates gently it has a fairly low output level. Consequently, its output must be boosted by an amplifier in order to provide an adequate level to drive the subsequent circuits.

The first of these circuits is a rectifier and smoothing circuit. This provides a positive d.c. output voltage that is roughly proportional to the a.c. output voltage of the oscillator. Therefore, this voltage drops when the key is placed near the sensor coil. This method was found to give better results than trying to directly monitor small voltage or current changes in the oscillator circuit.

A level detector circuit monitors the output potential from the rectifier and smoothing circuit. If the output voltage of the smoothing circuit falls below a preset threshold level, the output of the detector activates the relay via a simple driver circuit. The relay contacts are used to control the "cat flap" solenoid in the electronic bolt mechanism, or whatever device the system is used to control.

Obviously the level detector is adjusted so that the normal output level from the smoothing circuit holds the unit in the *off* state. If the "key" is placed near the sensor coil, the drop in voltage from the smoothing circuit results in the relay being activated.

CIRCUIT OPERATION

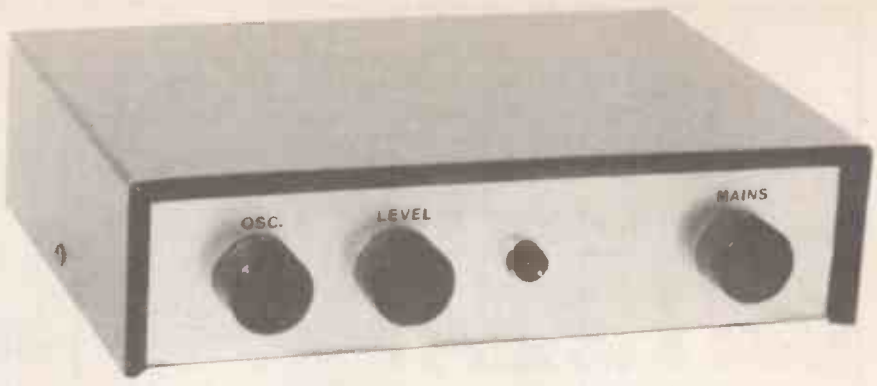
The circuit has been kept reasonably simple, as can be seen from the full circuit diagram shown in Fig. 2. The oscillator is based on TR1, which is a junction gate field effect device (j.f.e.t.) used in the source follower mode). This provides less than unity voltage gain, but there is a voltage step-up through the tuned circuit which ensures that there is sufficient feedback to sustain oscillation under standby conditions.

The tuned circuit for the oscillation consists of coil L1 plus the series capacitance of capacitors C2 and C3. The latter provide a capacitive centre-tap on the tuned circuit, and it is by coupling the feedback to this that the required voltage step-up is obtained.

The feedback is via resistor R1 and potentiometer VR1, with VR1 enabling the amount of feedback to be accurately controlled. L1 is a large air-cored coil (which gives greater operating range than a small ferrite cored type).

The "key" is formed by coil L2 and capacitor C6. L2 is a small coil having an adjustable ferrite core. This core enables the resonant frequency of this tuned circuit to be set up to accurately match the operating frequency of the tuned circuit in the main unit.

Transistor TR2 amplifies the output of the oscillator, and this is a common emitter stage. The gain of TR2 is far higher than is needed in this application. Accordingly, resistor R3 is used to introduce some negative feedback that reduces the voltage gain of this stage to about 20dB (ten times).



that can be generated when the highly inductive relay coil is turned off. D3 is simply a panel l.e.d. which lights up when the unit is activated. This is particularly useful when initially setting up and testing the unit.

POWER SUPPLY

A reasonably well smoothed and regulated 12 volt supply is required. This is provided by a simple stabilised mains power supply unit based on monolithic voltage regulator IC2. A small (100 milliamp) regulator is suitable as the current consumption of the circuit should never be more than about 70 milliamps, and with most relays will be little more than half this figure.

The voltage regulator is preceded by a conventional full wave rectifier circuit of the push-pull type, with smoothing provided by electrolytic capacitor C10.

Transformer T1 provides the voltage step-down and isolation from the mains supply.

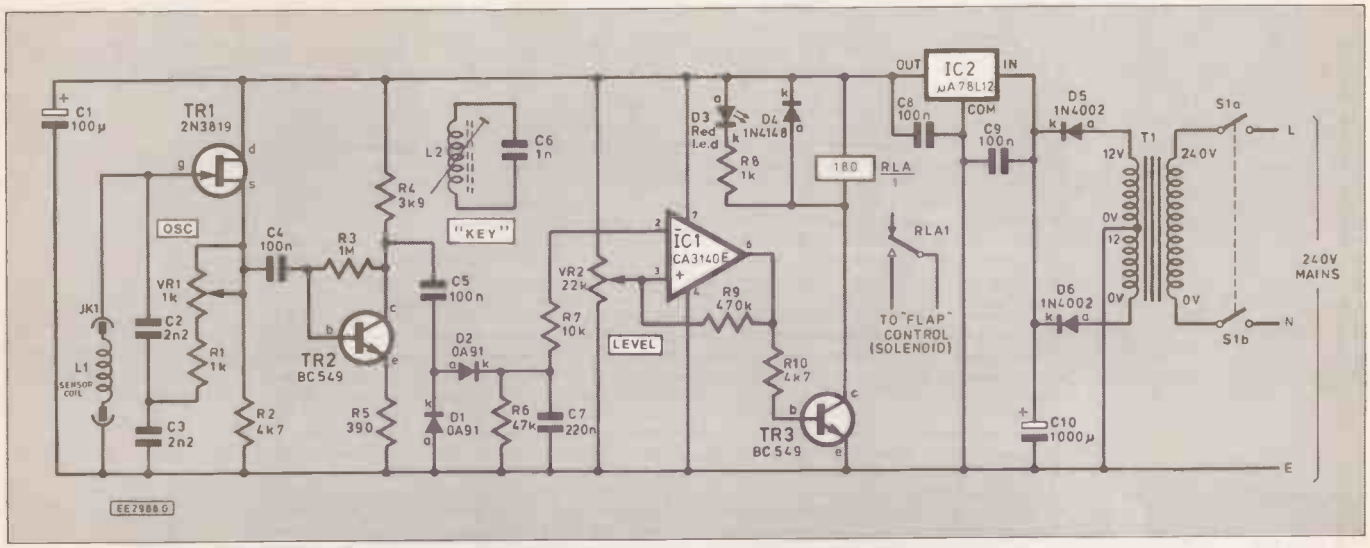


Fig. 2. Complete circuit diagram for the Electronic Cat Flap. The "key" is made up of coil L2 and capacitor C6.

The rectifier and smoothing circuit is a simple twin diode type based on D1 and D2, with smoothing provided by capacitor C7. IC1 is an operational amplifier which acts as the level detector. It is used as a voltage comparator, with a small amount of positive feedback provided by resistor R9. This introduces a small amount of hysteresis (a slight reluctance to switch from one output state to the other) which helps to avoid relay "jitter".

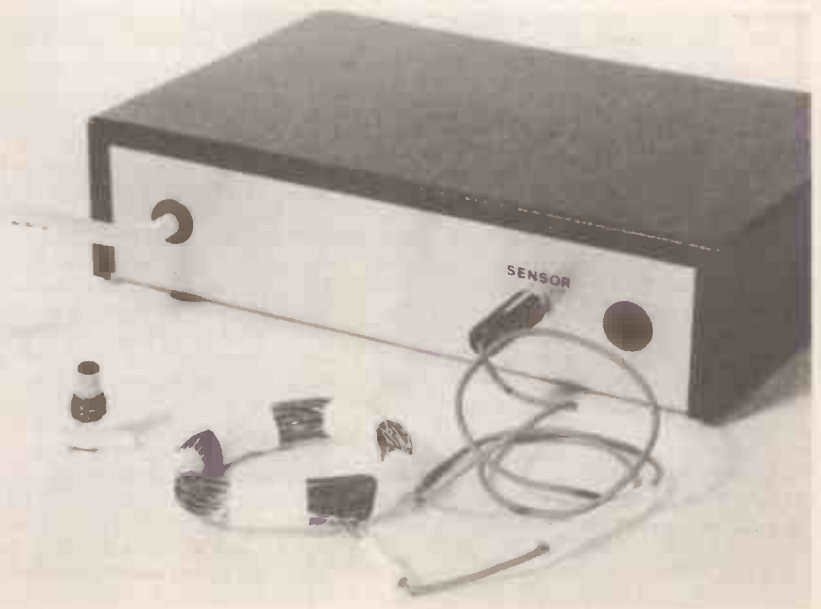
Potentiometer VR2 controls the voltage at the non-inverting input of IC1, and must be set so that under quiescent conditions this voltage is lower than the one at the inverting input. This gives a low output state, with the output going high when the unit is activated and the voltage from the smoothing circuit falls to a lower level.

RELAY DRIVER

Transistor TR3 is a simple common emitter switch which functions as the relay driver. This is normally switched off, and the relay coil only receives minute leakage currents. TR3 is switched on by the base current it receives via resistor R10 when the output of IC1 goes high, and it then activates the relay coil.

Diode D4 is the usual protection diode which suppresses the high reverse voltage

Rear view of the completed unit showing the sensor coil and "key".



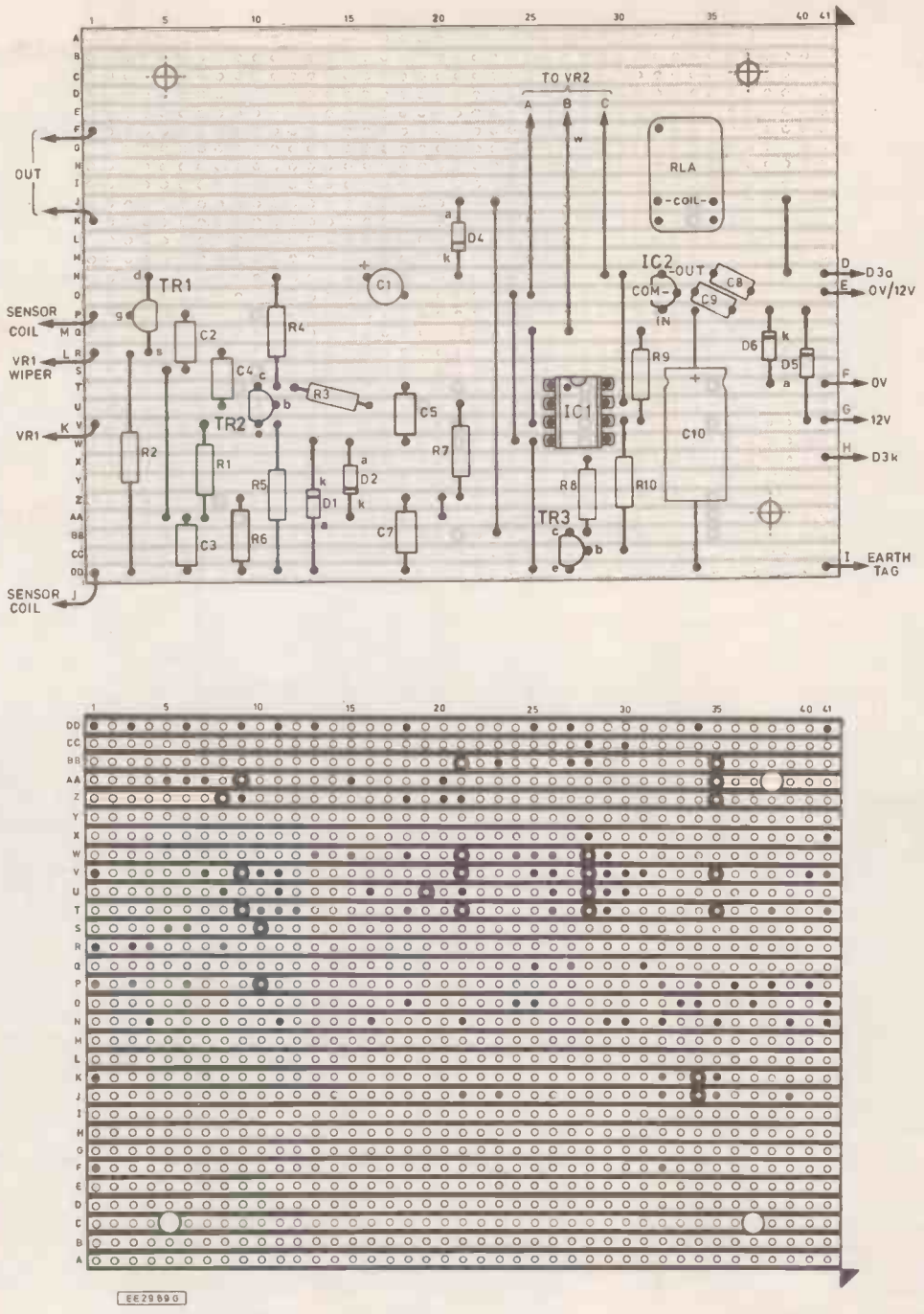


Fig. 3. Stripboard component layout and details of breaks required in the underside copper tracks. The larger capital letters against the leads from the board refer to the connection points on the off-board components, see Fig. 4.

CONSTRUCTION

Details of the stripboard component layout and breaks required in the copper tracks are shown in Fig. 3. This layout is based on a board having 30 copper strips by 41 holes.

This is not a standard size in which the board is sold, and it must be cut from a larger panel using a hacksaw. With 0.1in. pitch board it is not practical to cut between rows of holes – you must cut along rows of holes. This leaves rather ragged edges, but these are easily filed to a smooth, neat finish.

The three board mounting holes can be 3.3mm in diameter if M3 or 6BA mounting bolts are to be used. If you intend to use plastic stand-offs, the size of these holes must be chosen to suit the particular stand-offs you will be using. Be careful when cutting, drilling, or filing stripboard as it can be slightly brittle, and can shatter if it is not treated with reasonable care.

Next the breaks in the copper strips are made. Either the special tool can be used, or a hand-held twist drill bit of about five millimetres in diameter will do the job quite well. Either way, make sure the strips are properly severed, but do not cut any deeper into the board than is really necessary.

Fit solder pins to the board at the points where connections to off-board components will eventually be made. Then add the link wires which are made from 22s.w.g. tinned copper wire. These should be kept quite taut or covered with p.v.c. sleeving so that there is no risk of them short circuiting to anything.

To complete the board the various components are soldered in place. Start with the resistors and capacitors, and finish by fitting the semiconductors and relay.

Be careful to fit the electrolytic capacitors and the semiconductors the right way round. IC1 is a static sensitive device which requires the usual handling precautions. This basically means fitting it in a holder, but not actually fitting it in place until the unit is finished in all other respects.

Handle this component as little as possible, and keep it clear of any obvious sources of static electricity. Note that IC1 must be of the specified type as most other operational amplifiers (741C, TL081, etc) will not operate properly in this circuit.

Diodes D1 and D2 are also vulnerable to damage, but not due to static charges. These are germanium diodes which are more vulnerable to heat damage than are the more familiar silicon devices.

Consequently, extra care should be taken when fitting diodes D1 and D2, it is advisable to fit them last of all. It should not

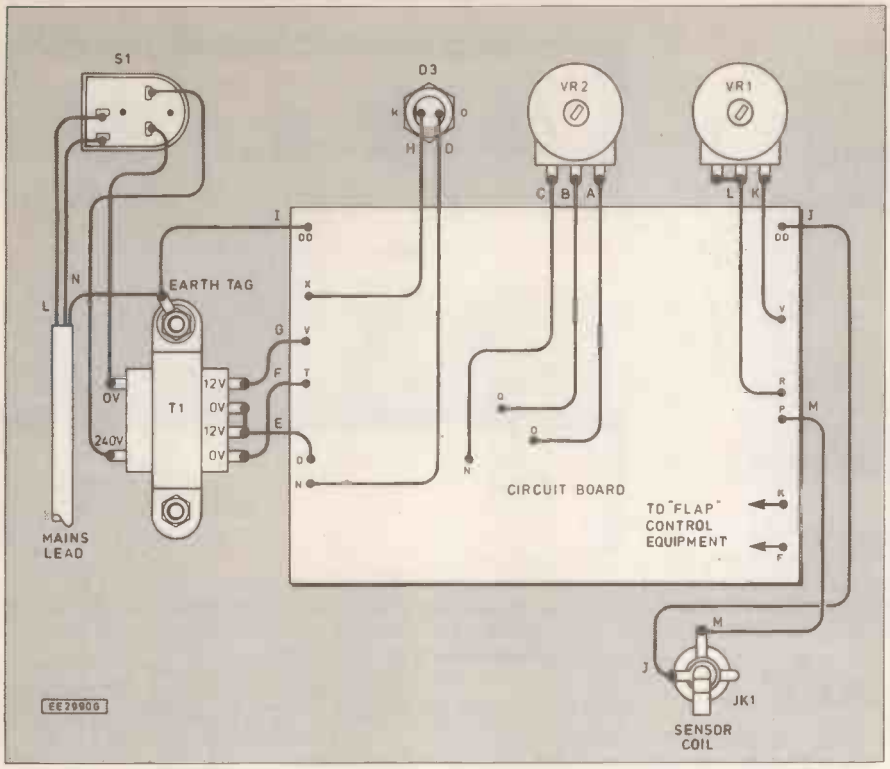
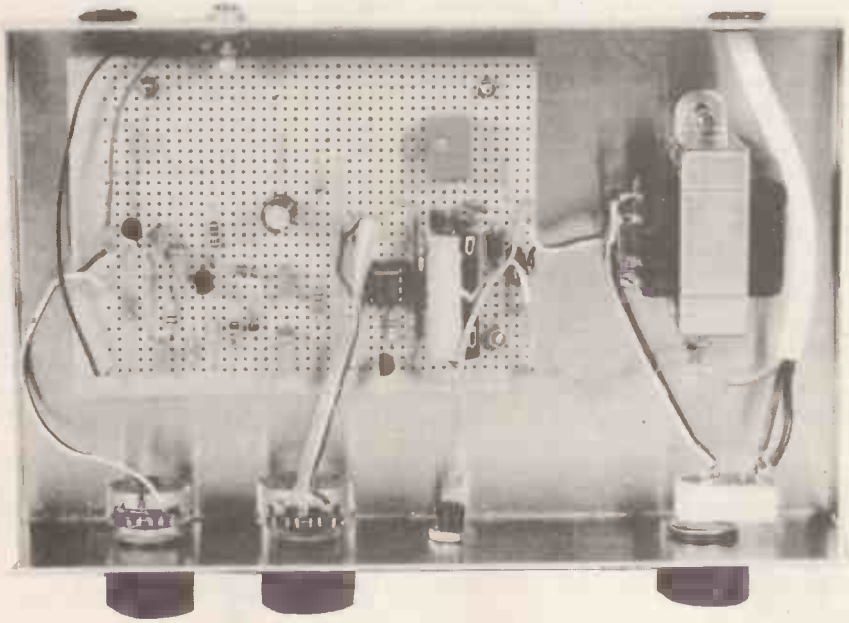


Fig. 4. Interwiring from the circuit board to all off-board components.



Positioning and interwiring of components inside the metal case.

COMPONENTS

Resistors

R1, R8	1k (2 off)
R2, R10	4k7 (2 off)
R3	1M
R4	3k9
R5	390
R6	47k
R7	10k
R9	470k

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	1k rotary carbon, lin.
VR2	22k rotary carbon, lin.

Capacitors

C1	100µ radial elect. 16V
C2, C3	2n2 polyester (2 off)
C4, C5	100n polyester (2 off)
C6	1n polyester
C7	220n polyester
C8, C9	100n ceramic (2 off)
C10	1000µ axial elect. 25V

Semiconductors

D1, D2	OA91 germanium signal diode (2 off)
D3	Red panel l.e.d.
D4	1N4148 silicon signal diode
D5, D6	1N4002 100V 1A rectifier (2 off)
TR1	2N3819 *n*-channel j.f.e.t.
TR2, TR3	BC549 *npn* silicon (2 off)
IC1	CA3140E MOSFET op.amp
IC2	µA78L12 100mA 12V regulator

Miscellaneous

L1, L2	See text
T1	Mains primary, 12-0-12V (or twin 12 volt) secondary rated at 200mA or more
S1	Rotary mains switch
RLA	Relay, 12 volt coil (with a resistance of 180 ohm or more), contacts as required
JK1	Chassis mounting 3.5mm jack socket

Stripboard, 0.1in. matrix, 41 holes by 30 strips; control knob (3 off); metal instrument case, about 203mm x 127mm x 51mm; 24s.w.g. enamelled copper wire for L1; 36s.w.g. enamelled copper wire and 6mm dia. coil former with dust core for L2; 8-pin d.i.l. i.c. holder; solder pins; mains lead and plug; connecting wire; solder, etc.

Approx cost guidance only **£22**

be necessary to use a heatshunt on each lead when soldering it in place, provided each joint is completed reasonably quickly.

RELAY

If the specified relay RLA is used it will fit onto the board just like any of the other components. This relay has a changeover contact that can handle currents of up to 2A (resistive) or 1A (inductive) at voltages of up to 24V d.c. or 120V a.c.

The method of connection to the board shown in Fig. 2 ignores one of the relay contact tags, and uses the other two as a simple on/off switch that is normally in the off state. This is presumably what will be required in most applications.

The unit should work perfectly well using any 12V relay that has a coil resistance of about 180 ohms or more, plus suitable contact ratings for whatever device the unit will control. Virtually any modern miniature type should fit onto the 0.1in. matrix stripboard without any difficulty, but the pin layout is likely to be completely different, necessitating a slight redesign of the relevant section of the component panel. If a large relay is utilized it will probably be necessary to mount it off-board on a suitable mounting bracket, and to then hard wire it to the component panel.

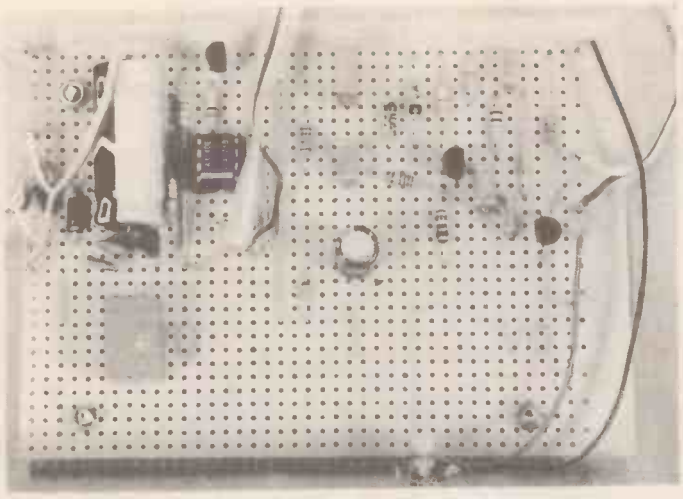
CASE

An instrument case of aluminium or aluminium and steel construction makes a good housing for this project. For safety reasons I would strongly urge the use of a metal case "earthed" to the mains Earth lead.

Also for safety reasons, the case should be a type having a screw fitting lid or cover, and not some form of clip-on type. The case for the prototype has approximate outside dimensions of 303mm by 127mm by 51mm, and this comfortably accommodates all the parts.

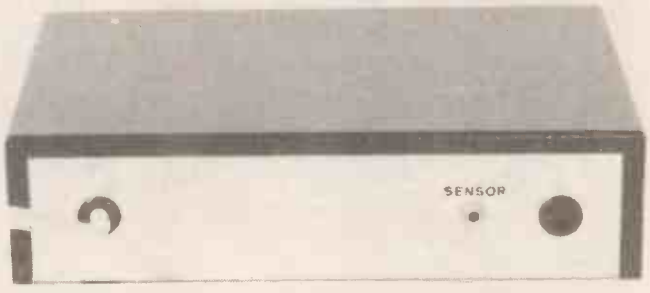
The exact layout of components inside the case is not particularly critical, but it is advisable to keep the mains transformer T1 and on/off switch S1 well towards one side of the unit, and reasonably well separated from the rest of the circuit. Mount the component panel using stand-offs or spacers that keep the underside of the board well clear of the metal casing. The stand-offs or spacers should be at least six millimetres long.

Drill holes in the rear panel for the mains lead and the lead which goes to the controlled equipment. These should both be fitted with p.v.c. grommets to protect the cables.



Layout of components on the finished stripboard. If a different relay is used it may necessitate modicications to the board layout to accomodate any variations in the relay pinouts. It is most important to house the board in a metal case and for it to be "earthed" to the mains Earth lead through the solder tag beneath the mains transformer fixing bolt.

Front panel lettering and controls.



Rear view of the completed unit showing the mains lead, sensor coil jack socket and the grommetted hole for the equipment (solenoid bolt) control leads.

A hole for the lead to the sensor coil can also be made in the rear panel, or the coil can be connected to the main unit via a 3.5mm jack socket. The coil must then be fitted with a short *screened* lead terminated in a 3.5mm jack plug.

Whichever method of connection is adopted, the screened connecting lead should be no more than about 0.5 metres long. A longer lead could damp the oscillator to the point where oscillation cannot be obtained at any setting of VR1.

All the point-to-point wiring is shown in Fig. 4 (in conjunction with Fig. 3). This is quite straightforward, but with a project that connects to the mains supply it is as well to proceed very carefully, double checking all the wiring for errors. Be especially careful with the wiring to S1, T1, and the relay RLA.

SENSOR COIL

The optimum size for the sensor coil L1 seems to be about 50mm or so in diameter. It should consist of 60 turns of about 24s.w.g. enamelled copper wire wound on a temporary coil former of about 50 to 55 millimetres in diameter.

You may need to improvise a little in order to find a suitable former. I found that a jar of a well known brand of mustard or some small fizzy drinks bottles were just about the right size.

Leave short leadout wires so that the coil can be connected to the lead from the main unit. Do not worry about making the winding very neat, and do not bother to wind it very tight (which will simply make it difficult to remove from the former).

Once the coil L1 has been removed from the temporary coil former, some bands of insulation tape can be used to hold the windings together and make it reasonably stable. Some tape or sleeving can be used over the connections to the leadout wires to ensure that they do not short circuit together.

The coil will presumably be situated out of doors in most applications of the unit, and it will therefore need to be protected against the elements. This is probably best achieved by fitting it in a weatherproof *plastic* case. Note that the unit cannot function properly if the coil if fitted in a metal case, or even one that is made from plastic but has a metal front panel.

KEY

The coil for the "key" is wound on a 6mm or ¼in. diameter coil former fitted with a dust iron core. It consists of 150 turns of about 36s.w.g. to 40s.w.g. enamelled copper wire.

The winding does not need to be terribly neat, but as with any inductor, keep all the turns going in the same direction. Winding the turns quite tightly helps to give the finished inductor stability and helps to hold the winding together, but it will still be necessary to use some adhesive in order to hold everything in place really well.

Capacitor C6 must be mounted on the coil holder and wired to the winding. A little ingenuity must be used here, but one simple method is to glue the capacitor to the base section of the coil former, and then use its leadout wires as tags to which the winding can be connected. A printed circuit mounting capacitor with short but rigid leadout wires is best if this method is adopted.

Ideally the finished "key" should be given a protective coating of something like polyester resin, so that the thin wire of the coil is rendered much less vulnerable to breaking. At this stage, do not do anything that will prevent the core from being adjusted.

ADJUSTMENT

With potentiometer VR1 adjusted fully counter clockwise it should be possible to switch the relay RLA and panel l.e.d. D3 on and off by adjusting VR2. There should be a jitter-free switch-over point with VR1 somewhere near to a middle setting. Adjust VR2 so that the relay is switched on, and then back off VR2 just far enough to switch the relay off again.

If the "key" is now placed close to the sensor coil the relay should be switched on again, although at this stage the two may need to be very close together indeed in order to "open" the lock. Note that the range is greatest with the two coils parallel to one another, and is very limited with them perpendicular to one another.

By adjusting the core of L2 the range of the unit can be much improved, and a little trial and error should soon have the system operating reliably over a range of about 100 millimetres or so. Use some glue to fix the core of L2 at the optimum setting.

The oscillator can be made to oscillate less strongly by adjusting VR1 in a clockwise direction. Readjustment of VR2 in a counter clockwise direction will then switch off the relay again, and improved range should be obtained.

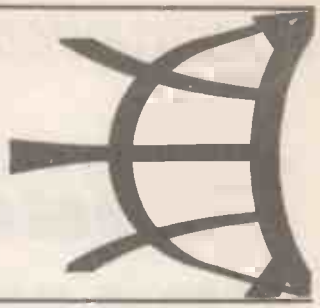
However, if VR1 is adjusted too far, oscillation will cease and the unit will not function. With VR1 adjusted to the point where oscillation is just maintained, and VR2 carefully adjusted so that the relay is just switched off under standby conditions, it will probably be possible to obtain an operating range of over 200 millimetres.

It is probably best not to have either VR1 or VR2 very close to the settings that give maximum operating range. Any slight drift in the circuit's operating conditions could easily result in it being rendered inoperative. Also, with everything critically adjusted there is a risk of problems with relay jitter, or the relay tending to latch in the on state.

With both controls backed off slightly from the settings that give optimum range the unit should still give a usable range of about 100 to 150 millimetres, together with good reliability □

REPORTING AMATEUR RADIO

Tony Smith G4FAI



MORSE BICENTENNIAL

Samuel F. B. Morse, inventor of the Morse telegraph and its associated code was born on 27th April 1791. On and around 27th April 1991, many specially arranged amateur radio activities will celebrate this important anniversary, which is of great significance not only to amateur radio but to the telecommunications industry as well.

Both professional and amateur radio operators used Morse code for the very first radio transmissions, and amateurs used the code for their pioneering transmissions in the 1920's which proved that global communication was possible on the shortwaves. It was the original Morse telegraph, however, which first led to worldwide message transmission, using overhead wires or undersea cables, long before the advent of radio.

Morse was a well-known artist turned inventor. In 1832, he conceived the idea of an electro-magnetic circuit which would transmit intelligence over long distances by means of interrupted electrical currents corresponding to a pre-arranged code. In 1843, he persuaded Congress to allocate $30,000, to test his invention on a 40-mile line to be constructed along the railway from Washington to Baltimore. This line opened on 24th May 1844, with the sending of the apposite phrase "What Hath God Wrought!", and within a year private companies came into being with plans to run Morse lines to all parts of America.

WIRELESS

In the years that followed, Morse's invention was improved in many ways and served virtually every aspect of human activity, business, industry, railways, newspapers, military, etc, plus the needs of ordinary people who wished to send urgent messages of any kind. When Marconi invented wireless, 50 years later, his purpose was simply to eliminate the restrictive wires which connected existing Morse telegraph stations. When wireless proved capable of sending messages over great distances it was adapted for use in ships at sea, providing one of the most valuable, and dramatic, aspects of Morse telegraphy.

Eventually, all ships over a certain size had to carry one or more radio operators ("Sparks"), and in time of danger thousands of lives were saved thanks to the S.O.S. signals put out in Morse code by these operators, who sometimes lost their own lives in the process. Space does not permit detailed reference to the many applications of wireless telegraphy on land, sea and air, although honourable mention should perhaps be made of its significant role in clandestine/intelligence operations during WW2.

LAST USER

Today, maritime Morse is being phased out. Soon, ships at sea will be equipped with hi-tech satellite communications equipment, and "Sparks" will be no more. Professional Morse can still be heard on the shortwave radio bands, but in the not too distant future amateur radio may be the last user of this unique mode.

The decline in the use of maritime Morse is directly linked to economic considerations. There is no reflection on the efficiency of radio telegraphy (CW), it is simply that more cost-effective communication systems have dispensed with the need to have specially trained radio operators. Anyone can operate the new equipment!

However, amateur radio does not function under commercial considerations and CW still represents the most effective means of communication in difficult conditions, thanks to its efficient use of radio spectrum, i.e., narrow bandwidth used, its ability to use simple low cost transmitters and receivers (as well as the latest state-of-the-art rigs if required), its internationally recognised system of code abbreviations which overcome language limitations, and its ability to communicate over weak and fading signal paths.

DISPUTE

Within the hobby, however, there is dispute about the Morse code. At present there is an international requirement for amateur operators to pass a Morse test before they can operate on frequencies below 30MHz. Because professional CW is on the way out, there is a proposition that the need for amateurs to know Morse, to avoid interference with essential services, is no longer necessary. If newcomers didn't have to learn the code, the argument goes, more would be attracted to the hobby.

Going a step further, it is suggested that if commercial users are giving up Morse it must be obsolete, that there is little if any future for it in amateur radio in the face of the new high-technology modes, and that frequencies allocated for CW operations should therefore be given up to the new modes.

Thousands of amateur operators around the world who still use Morse do not, of course, agree with this argument! While enjoying the practical advantages of CW, they still find satisfaction and pleasure in using those personal skills and abilities which the new technology sets out to eliminate.

SPARKS' STORY

Ray Redwood, a British born ex-Sparks now resident in the USA, has written a fascinating book, "QTC (I have a message for you)", which sets out "to tell the Sparks saga to the general public before this extraordinary and important figure fades from the marine scene forever." Intriguing personal reminiscences are combined with accounts of the early development of wireless at sea and some of the great maritime rescue stories where the Sparks played a vital and often heroic role.

Copies of this unique 376 page book can be obtained by sending payment to Barclays Bank, 12 High Street, Great Dunmow, Essex, quoting Capital Advantage Account 0074-2597, at the same time writing to the publisher, Sequoia Press TX, 2502 Cockburn Drive, Austin, Texas 78745, USA, advising that payment has been sent to Barclays. Prices are Hardback, Surface £10, Airmail £15. Paperback, Surface £7, Airmail £10.

ORIGINAL MORSE TELEGRAPH

Landline Morse telegraphy survived for many years after the invention of wireless. The Post Office began to phase it out in 1931, the Armed Services used it until well after WW2, and the railways used it in some places until the early 1970's. America, the land of its origin, had it until the 1960's using American Morse, Samuel Morse's original code from 1844, which is different to the international code of today. There is dispute about who actually devised the American code, but that's for another time!

Samuel Morse's story is told in some detail in a special issue of *Morsum Magnificat*, the quarterly journal for Morse enthusiasts. Authoritative articles describe the great man himself; how his invention was conceived, and brought to reality; and the development of the code form its 1832 version, which used numbers linked with a code dictionary, through various alphabetical codes, until the fore-runner of today's International Morse code came into use in Germany in 1852.

The special Morse bicentennial issue of this magazine, Spring 1991, can be obtained from *Morsum Magnificat*, 8A Corfe View Road, Corfe Mullen, Wimborne, Dorset BH21 3LZ, price £2.00, incl. postage. Cheques should be payable to "G.C. Arnold Partners".

1	•	6	•–
2	••	7	••–
3	•••	8	•••–
4	••••	9	••••–
5	•••••	0	•••••–

Fig. 1. Samuel Morse's original code of 1832. A special dictionary was used to convert words to numbers. At the receiving end, the numbers were converted back to the original words by means of another dictionary.

Constructional Project

THREE TRANSISTOR TREMOLO UNIT

M. G. ARGENT

Bring back the sounds of the Sixties with this low-cost effects unit.

MANY musical instruments, particularly electric guitars and keyboards, can benefit from electronic effects such as a Tremolo Unit. The name "tremolo" refers to regular volume modulation of the musical signal.

There have been several types of tremolo circuits published over the years and some have been quite elaborate, but this project uses only three transistors plus resistors and capacitors. No integrated circuits are used at all!

The performance is good and there is no "Tremolo Thump" fed to the main amplifier as sometimes happens even with more elaborate designs.

CIRCUIT DESCRIPTION

The circuit diagram for the Three Transistor Tremolo Unit is shown in Fig 1 and consists of a transistor amplifier TR1, a low frequency oscillator TR2 and an l.e.d. driver TR3.

The amplified signal at the collector of transistor TR1 is attenuated by resistors R5 and R6 when switch S1 is in the Normal position, or by R5 and R7 when the switch is in the Tremolo position.

The light dependent resistor (l.d.r.) R7 is a particular type of resistor because its value varies according to the amount of light shining on it.

When the l.d.r. is in darkness it has a very high resistance and conversely, when there is light present its resistance is low. This feature is used to good advantage in the Tremolo Unit by varying the amount of light falling on R7 by the use of a flashing l.e.d. D1.

Transistor TR2 is connected as a low frequency phase-shift oscillator with a good sinewave output, the frequency being dependent on R9, R10, C6 and C7, C8, R12/VR1. Varying potentiometer VR1 alters the frequency and is used as the Speed control.

The output of this oscillator is fed to transistor TR3, which drives l.e.d. D1. Potentiometer VR2 adjusts the amount of drive to D1. Using a sinewave gives a better quality tremolo effect than the chopping style of a squarewave.

The l.e.d. and R7 are optically coupled – that is facing each other – so that the resistance of R7 is varied in sympathy with the oscillator frequency. This causes the modulated attenuation of amplifer TR1, giving the required tremolo effect.

CONSTRUCTION

All components except switch S1, the input/output sockets, and potentiometers VR1, VR2 are mounted on a piece of stripboard consisting of 12 strips by 35 holes in length. The component layout and details of breaks required in the underside copper tracks are shown in Fig. 2.

The layout has been designed so that there are only nine hole cuts and these are all in a row to make it easier. Note that R7 and D1 are facing each other, to provide good optical coupling.

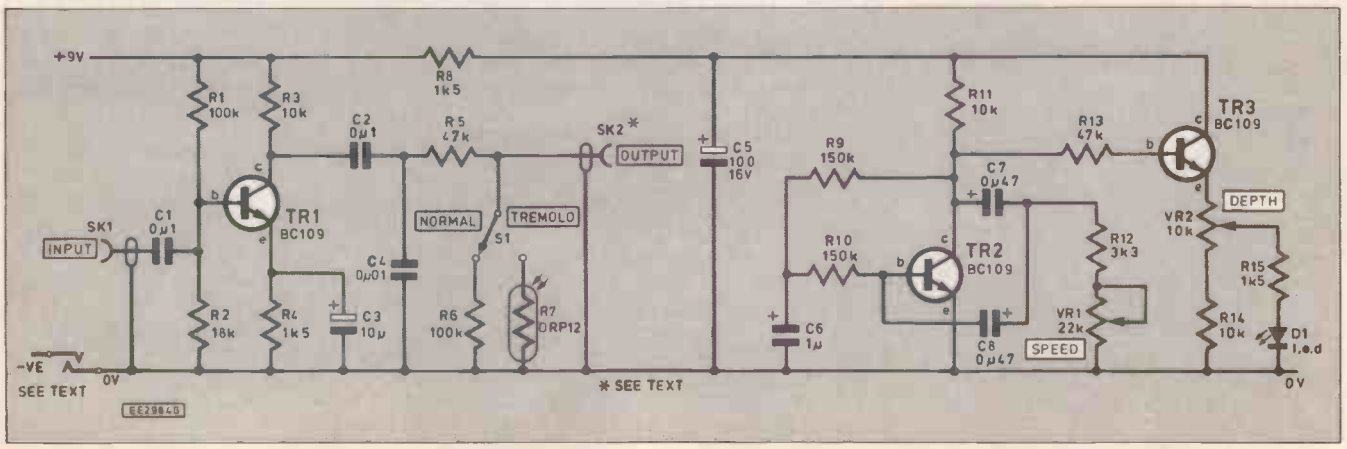
The interconnections to the sockets SK1, SK2, selection switch S1 and the Speed and Depth controls are shown in Fig. 3. The output socket SK2 is a stereo version, but not for stereo use. The extra contact is used to provide a switching facility for the battery.

When a mono plug is inserted, its shaft shorts out the first two contacts to 0V and switches the battery on. So long as the output jack is inserted, the Tremolo Unit will be powered up.

TESTING

When the whole unit is wired and checked thoroughly for any errors, insert a jack plug into SK2 to power up. The l.e.d. should flash on and off depending upon the setting of VR1 and VR2. The speed of the flash will alter as VR1 is moved and the brightness will vary according to VR2 setting.

Fig. 1. Complete circuit diagram for the Three Transistor Tremolo Unit. Note that the "Output" jack socket SK2 is a stereo type and two of the contacts are used as the battery negative supply switch. The mono jack plug shaft, when inserted, shorts the two contacts together; switching on the unit.



COMPONENTS

Resistors

R1, R6	100k (2 off)
R2	18k
R3, R11, R14	10k (3 off)
R4, R8, R15	1k5 (3 off)
R5, R13	47k (2 off)
R9, R10	150k (2 off)
R12	3k3
R7	ORP12 light dependent resistor

All ¼W 5% carbon except R7.

See SHOP TALK Page

Potentiometers

VR1	22k min. rotary, lin.
VR2	10k min. rotary, lin.

Capacitors

C1, C2	0µ1 polyester (C280) (2 off)
C3	10µ radial elect. 16V
C4	0µ01 polyester (C280)
C5	100µ axial elect. 16V
C6	1µ tantalum
C7, C8	0µ47 tantalum (2 off)

Semiconductors

D1	Red l.e.d. (5mm)
TR1, TR2, TR3	BC109 *npn* silicon or similar (3 off)

Miscellaneous

S1	single-pole changeover slide switch
SK1	mono jack socket
SK2	stereo jack socket, see text

Stripboard, 0.1in. matrix 12 strips x 35 holes; metal box; 9V battery and battery clip (PP3); control knobs (2 off); connecting wire; solder pins; solder, etc.

Approx cost guidance only **£8** *excl. case*

For the circuit to function as a Tremolo Unit, no outside light must be allowed to shine on R7. For testing purposes simply cover the board with a cloth, this will be sufficient.

To keep outside noise down, as for all audio amplifiers, the board should be mounted in a metal box. □

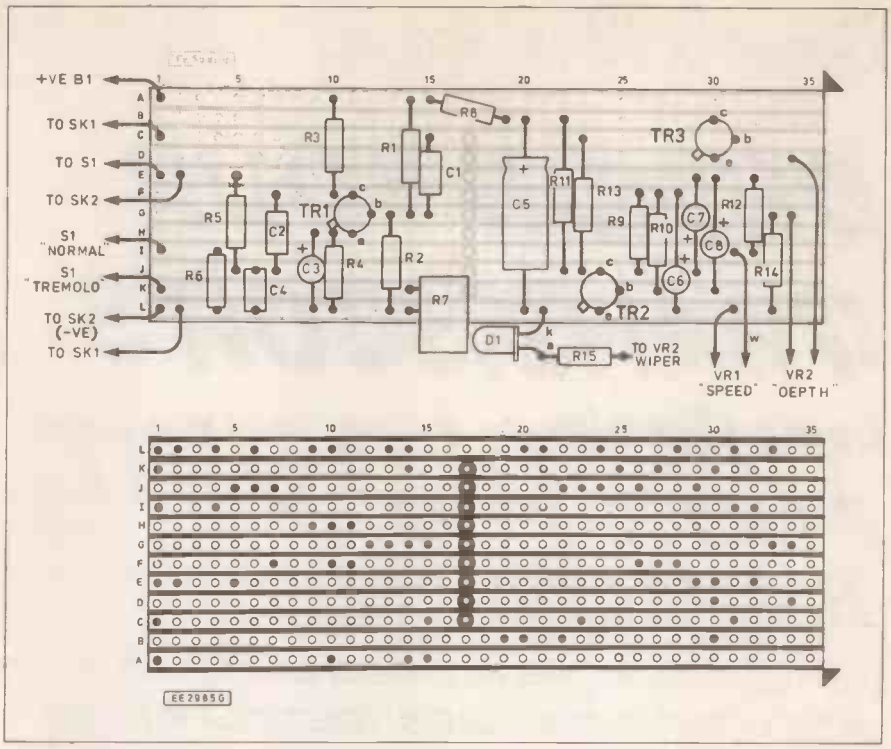


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

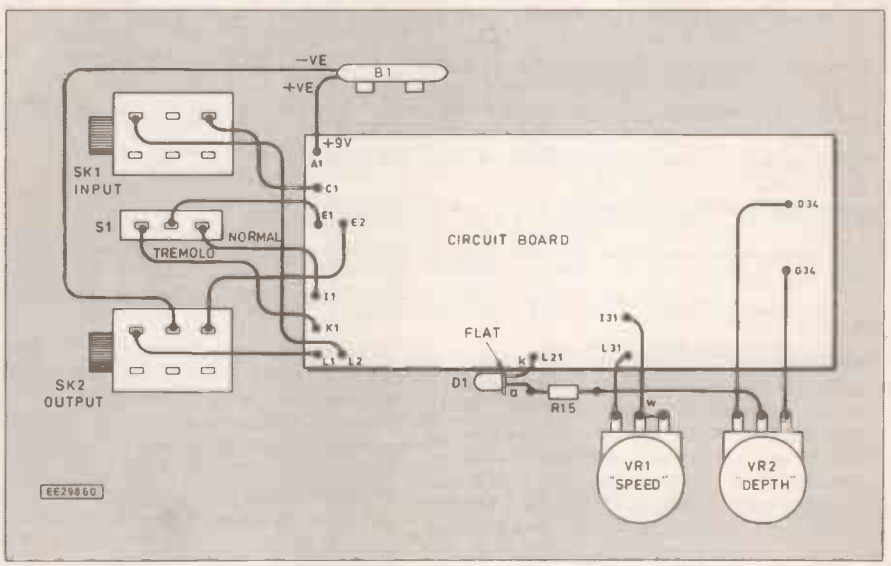
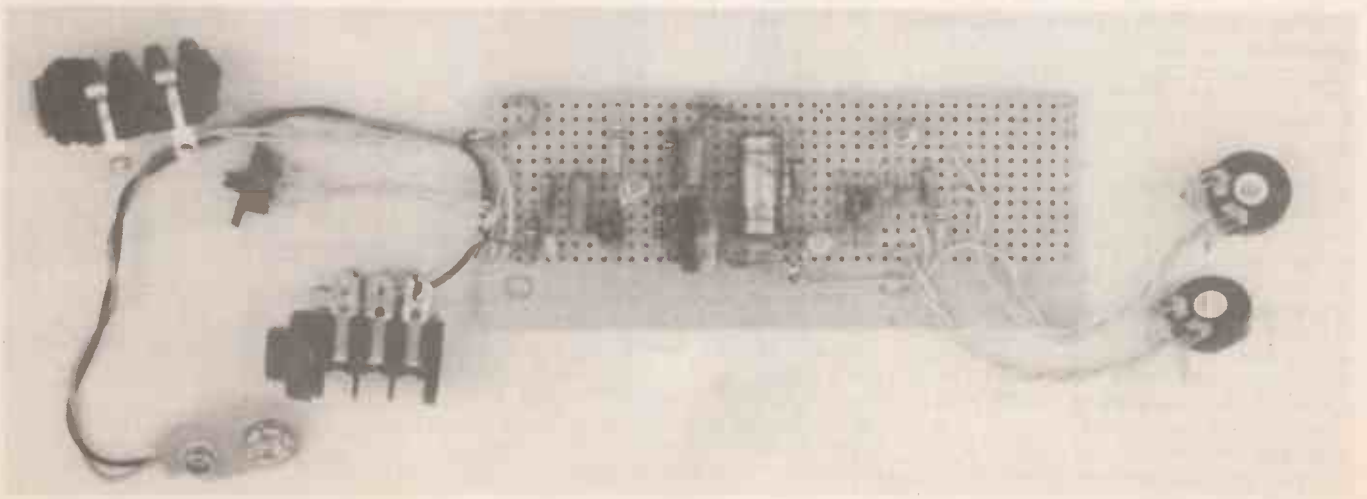
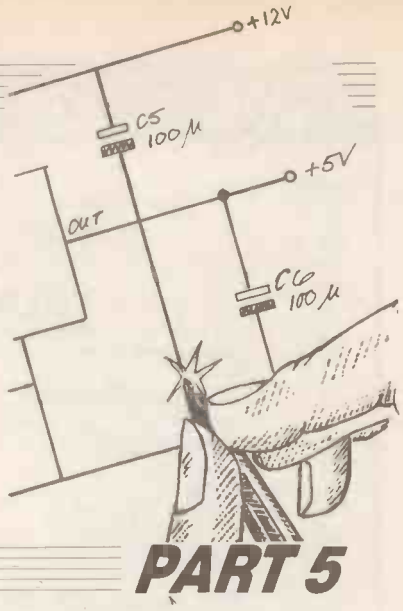


Fig. 3. Interwiring to all off-board components. The soldered connections at each end of resistor R15 should be covered with insulation tape.





DESIGN YOUR OWN CIRCUITS

Logic Circuits

MIKE TOOLEY BA

PART 5

This ten part series aims to dispell some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits. This fifth part deals with logic circuits. Our design problem is based on an intruder alarm whilst our companion project deals with the construction of an Electronic Die.

Introduction

The first four parts of our series have dealt with circuits which can essentially be categorised as "linear". The currents and voltages in such circuits can change continuously within limits dictated by operational parameters (such as the power supply voltage). This month we shall be introducing a range of circuits which operate on discrete, rather than continuous voltage levels. These circuits are "digital" and the prime movers within them are referred to as "logic gates".

In order to help put this into a practical context right from the outset, consider the need for a circuit which can detect and respond to a "majority vote" situation. Let's assume that we have a panel of three experts to whom a series of problems are put. Each expert has at his or her fingertips a switch which operates when the expert in question wishes to make a "yes" response or is simply left alone to indicate a "no" response. We will further assume that we wish to operate a buzzer when any two, or all three, of our panel of experts simultaneously responds with a "yes".

Clearly this is a digital rather than an analogue situation. The panel members can each only provide one of two possible responses (we shall disallow a "maybe"!). The switches that represents these two responses can therefore only assume one of two possible states; open and closed.

At this stage we might wish to consider how many possible outcomes there are when our panel is presented with a problem. To preserve anonymity, let's call our three experts A, B and C. The eight possible outcomes can be represented in the table shown below:

Expert			Buzzer
A	B	C	sounds?
no	no	no	no
no	no	yes	no
no	yes	no	no
no	yes	yes	yes
yes	no	no	no
yes	no	yes	yes
yes	yes	no	yes
yes	yes	yes	yes

This "truth table" shows that there are four possible ways of reaching a majority "yes" vote (in which case the buzzer should sound) and four ways of obtaining an overall "no" vote (in which case the buzzer should remain silent).

At this stage, it is worth mentioning that we could show our truth table in a slightly different way. The "yes" and "no" entries could simply be represented by 1's and 0's, respectively. A 1 would indicate that the corresponding switch was operated (i.e. depressed by the expert) or, in the case of the buzzer, that power is applied and the buzzer is sounding. The truth table would then be as follows:

Expert			Buzzer
A	B	C	sounds?
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Now let's turn to the problem of providing a circuit which will perform according to the truth table!

We shall assume that the switches we have are of the push-to-break variety. Hence a "no" vote would result from a closed switch (short-circuit) whilst a "yes" vote would be produced by an open switch (open-circuit). If two switches are connected together as shown in Fig. 5.1, only if both switches are both open (i.e. registering a "yes" vote) will the output voltage of the circuit be "high". If either (or both) of the switches is closed (in response to a "no" vote), the output voltage will be "low".

Having combined three pairs of inputs in this way, we can simply connect them together in a three-transistor wired-OR configuration, as shown in Fig. 5.2. Any one of the transistors forced into saturated conduction will cause the full supply voltage to appear across the buzzer which will then sound.

Fig. 5.2 is an effective solution to our problem, however consider an application in which several different outputs are a

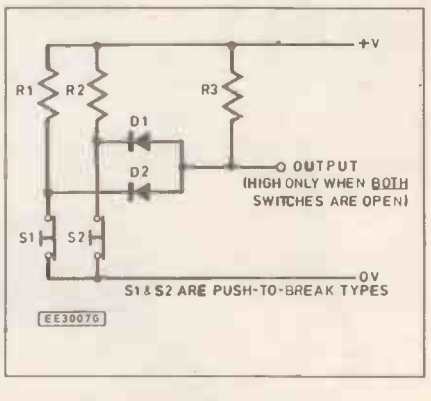


Fig. 5.1 Simple switch logic

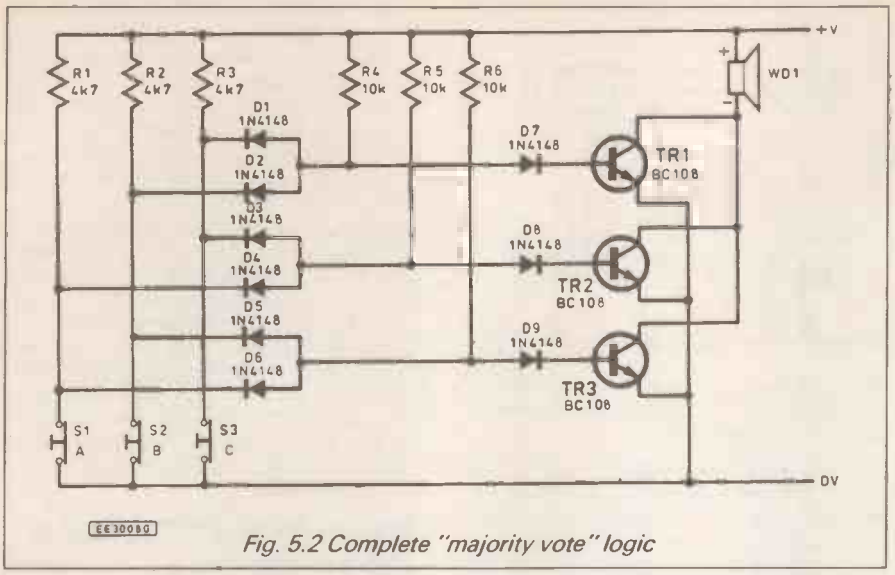


Fig. 5.2 Complete "majority vote" logic

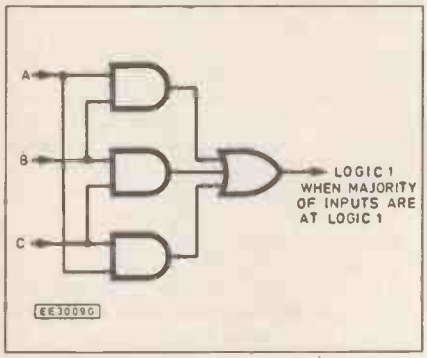


Fig. 5.3 "Majority vote" arrangement based on logic gates

function of a large number of inputs. Furthermore, in many practical digital circuits the signals present may be changing at a fast rate. Simple circuits based on diodes, resistors and transistors will just not operate fast enough in high-frequency switching applications.

Fortunately, digital logic is so widely used that all of the most common (and some not so very common!) logical functions are provided in a conveniently packaged integrated circuit form. Using such circuits, we can reduce the discrete component solution of Fig. 5.2 to something like that shown in Fig. 5.3!

Logic gates

The basic building blocks of digital circuits are integrated circuit logic gates. The British Standard (BS) and American Standard (MIL/ANSI) symbols for the basic logic gates are shown in Fig. 5.4. The MIL/ANSI standards have overwhelming support in the UK and very few manufacturers currently adhere to the recommended British Standard.

For those who may be newcomers to digital circuits and in order to distinguish clearly between the action of each of the basic types of logic gate we shall briefly examine each type:

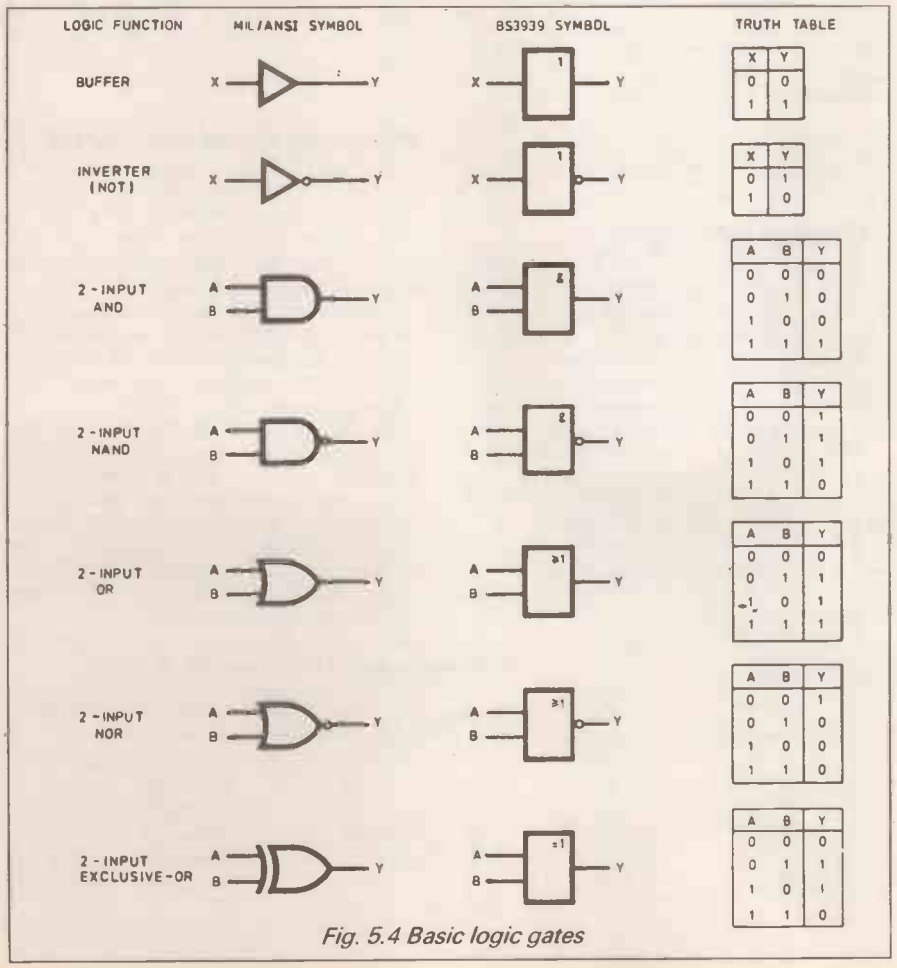


Fig. 5.4 Basic logic gates

Buffers

Buffers have no effect on the logical state of a digital signal (i.e. a logic 1 input results in a logic 1 output whilst a logic 0 input results in a logic 0 output) and are merely used to provide extra current drive at the output. They can also be used to regularise the logic levels present at an interface.

Inverters

Inverters are used to complement the logical state (i.e. a logic 1 input results in a logic 0 output and vice versa). Inverters also provide extra current drive and, like buffers, are sometimes used in interfacing applications.

AND gates

AND gates will only produce a logic 1 output when all inputs are simultaneously at logic 1. Any other input combination results in a logic 0 output.

NAND gates

NAND gates will only produce a logic 0 output when all inputs are simultaneously at logic 1. Any other input combination will produce a logic 1 output. A NAND gate, therefore, is nothing more than an AND gate with its output inverted! The circle shown at the output denotes this inversion.

OR gates

OR gates will produce a logic 1 output whenever any one, or more, inputs are at logic 1. Putting this another way, an OR gate will only produce a logic 0 output whenever all of its inputs are simultaneously at logic 0.

NOR gates

NOR gates will only produce a logic 1 output when all inputs are simultaneously at logic 0. Any other input combination will produce a logic 0 output. A NOR gate, therefore, is nothing more than an OR gate with its output inverted. A circle is again used to indicate inversion.

Exclusive-OR gates

Exclusive-OR gates will produce a logic 1 output whenever either one of input is at logic 1 and the other is at logic 0. Exclusive-OR gates produce a logic 0 output whenever both inputs have the same logical state (i.e. when both are at logic 0 or both are at logic 1).

With the exception of buffers and inverters (which each have only one input and one output) and exclusive-OR gates (which have only two inputs) all of the other gates are commonly available with multiple inputs (i.e. 2, 3, 4 etc).

Question 1: A four-input AND gate is to be made from a number of two-input AND gates. Devise a suitable arrangement.

Question 2: A four-input OR gate is to be made from a number of two-input OR gates. Devise a suitable arrangement.

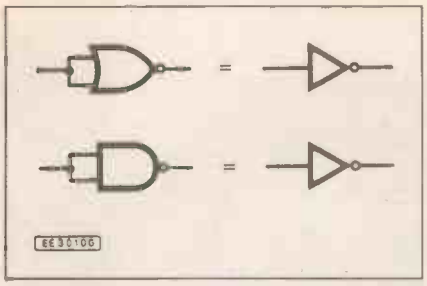


Fig. 5.5 Using standard NOR and NAND gates as inverters

Having arrived at a particular logic arrangement, it is often necessary to:

(a) minimise the number of logic gates present and

(b) re-design the arrangement using a limited number of available logic gates (e.g. all in terms of two-input NAND).

By using these two approaches, the designer can reduce the number of integrated circuit packages required, reducing the overall cost and also making savings associated with the p.c.b. (size and complexity of layout). One often used dodge is that of connecting a multi-input NOR or NAND as an inverter, as shown in Fig. 5.5. Furthermore, if the output of an AND or OR gate is complemented (by adding an inverter), its logical function will change to NAND or NOR, respectively. Similarly, the output of a NAND or NOR gate can be inverted to produce an AND or OR function. It is also possible to replace AND and OR gates by combinations of either NAND or NOR hence it is possible to realise any desired logic gate arrangement using, for example, only two-input NAND gates!

Question 3: Show how a two-input AND gate can be made from two two-input NAND gates.

Question 4: Show how a two-input OR gate can be made from two two-input NOR gates.

Question 5: Show how a two-input AND gate can be made from a number of two-input NOR gates.

Question 6: Show how a two-input OR gate can be made from a number of two-input NAND gates.

Logic families

The basic logic gates are commonly available in two basic families, CMOS (complementary metal oxide semiconductor) and TTL (transistor transistor logic) according to the technology employed in their manufacture. Within the two families there are a number of sub-families (such as LS-TTL and B-series CMOS) which have their own particular generic characteristics.

It is important to note that, whilst CMOS and TTL devices generally satisfy the same range of basic logic functions (AND, OR, NOR, etc), their operational characteristics are vastly different in a number of very important respects. For this reason, designers need to be aware of the practical limitations of both types of device and the situations in which one type of device is preferred to the other.

Tables 1 and 2 summarise the principal TTL and CMOS devices currently available (note that most, but by no means all of these devices are available in other forms, such as LS-TTL, CMOS B- series, etc).

Logic levels

The logic levels (0 and 1) are represented by a range of voltages which depends upon

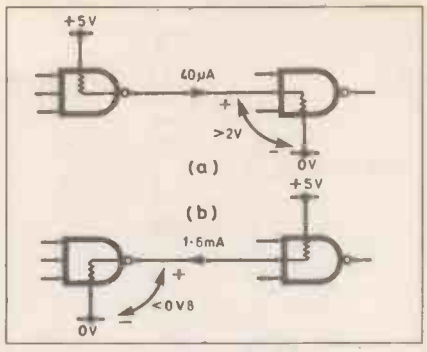


Fig. 5.6 Logic interconnection based on standard TTL device; high-state and low-state conditions

the logic family employed. The logic levels for CMOS differ markedly from those associated with TTL. In particular, CMOS logic levels are relative to the supply voltage (V_{DD}) which can vary from around 3V to 15V! The logic levels in TTL circuits, on the other hand, are reasonably standard (typically 0.2V for logic 0 and 4V for logic 1).

The range of voltages which exist between the *highest* permissible voltage which can be used to represent logic 0 and the *lowest* permissible voltage which can be used to represent logic 1 is declared "indeterminate" since we cannot reliably predict the logical state which they will represent. These voltages are, in effect, forbidden and we should take positive steps to ensure that they do not arise (other than when switching rapidly from one logical state to another).

The following logic levels should normally be assumed in the design of logic circuits:

	CMOS	TTL
Logic 1	more than 2.3 V_{DD}	more than 2V
Logic 0	less than 1.3 V_{DD}	less than 0.8V
Indeterminate	between 1.3 V_{DD} and 2.3 V_{DD}	between 0.8V and 2V

(Note: V_{DD} is the positive supply associated with CMOS devices)

Noise margin

In many "real world" applications noise can be a very real problem. In digital systems, noise can result in ambiguity in the logic levels present and may cause undesirable effects such as spurious counts, false triggering, and multiple switching. The designer must, therefore, take into account the noise immunity of his or her circuits. Since it is sensible to plan for "worst- case" situations, it is wise to take the most pessimistic viewpoint when considering noise in electronic circuits.

The ability of a logic device to reject noise is measured in terms of its "noise margin". Noise margin is defined as the difference between:

(i) the minimum values of high state output and input voltage and

(ii) the maximum values of low state output and input voltage.

The noise margin for standard 7400 series TTL is usually 400mV whilst that for CMOS varies according to the supply voltage and is normally equivalent to $1/3V_{DD}$.

It is worth putting this statement into context. Assume, for a moment, that a CMOS device is operating from a 5V d.c. supply rail (as would be essential for its TTL counterpart). The noise margin would amount to 1.67V, equivalent to *four times* that of a TTL device!). If the same device were to be operating from a 12V d.c. rail (quite permissible for CMOS), its noise margin would amount to a massive 4V. This factor makes CMOS the obvious choice for use in a really noisy environment!

Standard TTL load

When designing logic circuits, it is important to be aware of the relative magnitude of the currents and voltages at the interface between gates. The interconnection of two standard TTL devices is shown in Fig. 5..6.

When the first gate is providing a high state (logic 1) output, the voltage present at the node should be greater than 2V and the current flowing (from the output of the first gate into the input of the second) will typically be of the order of 40µA, or so.

When the first gate is providing a low state (logic 0) output, on the other hand, the voltage present at the node should be less than 0.8V whilst the direction of current flow is *reversed* (i.e. flowing from the input of the second gate into the output of the first gate). The magnitude of this "sink" current is very much greater than the "source" current in the previous state (typically 1.6mA).

This explains why interconnections between certain types of logic family sometimes fail (there is insufficient sink current to reduce the voltage at the node in question to a value which represents logic 0).

Fan-in and fan-out

The **fan-in** of a TTL logic circuit is a measure of the loading effect of its inputs in comparison with a standard TTL gate. A TTL device with a fan-in of two will have inputs which are each equivalent to two standard TTL input loads.

The **fan-out** of a logic gate is a measure of its ability to drive further inputs. A TTL device with a fan-out of two will be capable of driving two standard TTL input loads. Clearly, at any node in a digital logic circuits, the fan-out of the driving stage must always be greater than, or equal to, the total fan-in of the following stages. This is an important point, particularly when designing complex logic circuits in which a very large number of inputs must be driven by one, or more, output. The following table provides some indication of the limits which must not be exceeded:

Driving device	Maximum number of inputs that may be driven				
	74	74LS	74S	74HS	CMOS
74	10	40	8	unlimited	unlimited
74 buffers	30	60	24	unlimited	unlimited
74LS	5	20	4	unlimited	unlimited
74LS buffers	15	60	12	unlimited	unlimited
74HC	2	10	2	unlimited	unlimited
74HC buffers	4	15	4	unlimited	unlimited
CMOS	–	1	–	50	50

TABLE 1: TTL LOGIC GATE SUMMARY

Device	Function	Package
7400	Quad 2-input NAND	14-pin DIL
7401	Quad 2-input open-collector NAND	14-pin DIL
7403	Quad 2-input NAND	14-pin DIL
7404	Hex inverter	14-pin DIL
7405	Hex open-collector inverter	14-pin DIL
7406	Hex open-collector high-voltage inverter	14-pin DIL
7407	Hex open-collector high-voltage inverter	14-pin DIL
7408	Quad 2-input AND	14-pin DIL
7409	Quad 2-input open-collector AND	14-pin DIL
7410	Triple 3-input NAND	14-pin DIL
7411	Triple 3-input AND	14-pin DIL
7412	Triple 3-input open-collector NAND	14-pin DIL
7413	Dual 4-input Schmitt NAND	14-pin DIL
7414	Hex Schmitt inverter	14-pin DIL
7415	Triple 3-input open-collector AND	14-pin DIL
7416	Hex open-collector high-voltage inverter	14-pin DIL
7417	Hex open-collector high-voltage buffer	14-pin DIL
7418	Dual 4-input NAND	14-pin DIL
7421	Dual 4-input AND	14-pin DIL
7422	Dual 4-input open-collector NAND	14-pin DIL
7423	Dual 4-input NOR with strobe	16-pin DIL
7425	Dual 4-input NOR with strobe	14-pin DIL
7426	Quad 2-input open-collector NAND	14-pin DIL
7427	Triple 3-input NOR	14-pin DIL
7428	Quad 2-input buffered output NOR	14-pin DIL
7430	Single 8-input NAND	14-pin DIL
7432	Quad 2-input OR	14-pin DIL
7433	Quad 2-input open-collector NOR	14-pin DIL
7437	Quad 2-input NAND	14-pin DIL
7438	Quad 2-input open-collector NAND	14-pin DIL
7440	Dual 4-input NAND	14-pin DIL
7470	Single J-K bistable with preset and clear	14-pin DIL
7472	Single J-K bistable with preset and clear	14-pin DIL
7473	Dual J-K bistable with clear	14-pin DIL
7474	Dual D-type bistable with preset and clear	14-pin DIL
7475	Quad D-type bistable latch	16-pin DIL
7476	Dual J-K bistable with preset and clear	16-pin DIL
7478	Dual J-K bistable with preset and clear	14-pin DIL
7486	Quad 2-input Exclusive-OR	14-pin DIL
7490	Divide-by-two and divide-by-five	14-pin DIL
7491	8-bit serial-in, serial-out shift register	14-pin DIL
7492	Divide-by-two and divide-by-six counter	14-pin DIL
7493	Divide-by-two and divide-by-eight counter	14-pin DIL
7494	4-bit dual asynchronous presettable shift register	16-pin DIL
7495	4-bit shift-left or shift-right shift register	14-pin DIL
7496	5-bit asynchronous presetable shift register	16-pin DIL
74100	Dual 8-bit bistable latch	24-pin DIL
74104	Single J-K bistable with preset and clear	14-pin DIL
74105	Single J-K bistable with preset and clear	14-pin DIL
74107	Dual J-K bistable with clear	14-pin DIL
74109	Dual J-K bistable with preset and clear	16-pin DIL
74110	Single J-K bistable with preset and clear	14-pin DIL
74111	Dual J-K bistable with preset and clear	16-pin DIL
74112	Dual J-K bistable with preset and clear	16-pin DIL
74113	Dual J-K bistable with preset	14-pin DIL
74114	Dual J-K bistable with preset and clear	14-pin DIL
74121	Single monostable	14-pin DIL
74122	Single retriggerable monostable with clear	14-pin DIL
74123	Dual retriggerable monostable with clear	16-pin DIL
74124	Dual voltage controlled oscillator	16-pin DIL
74132	Quad 2-input Schmitt NAND	14-pin DIL
74133	Single 13-input NAND	16-pin DIL
74134	Single 12-input tri-state NAND	16-pin DIL
74135	Quad 2-input Exclusive-OR	16-pin DIL
74136	Quad 2-input Exclusive-OR	14-pin DIL
74137	Single 3-to-8-line decoder	16-pin DIL
74138	Single 3-to-8-line decoder	16-pin DIL
74139	Dual 2-to-4-line decoder	16-pin DIL
74174	Hex D-type bistable with clear	16-pin DIL
74175	Quad D-type bistable	16-pin DIL
74176	Single presetable decade counter	14-pin DIL
74177	Single presetable binary counter	14-pin DIL
74178	Single 4-bit universal shift register	14-pin DIL
74179	Single 4-bit universal shift register	16-pin DIL
74240	Octal tri-state Schmitt bus driver	20-pin DIL
74241	Octal tri-state Schmitt bus driver	20-pin DIL
74242	Quad tri-state inverting Schmitt bus transceiver	14-pin DIL
74243	Quad tri-state Schmitt bus transceiver	14-pin DIL
74244	Octal tri-state Schmitt bus driver	20-pin DIL
74245	Octal tri-state Schmitt bus transceiver	20-pin DIL
74260	Dual 5-input NOR	14-pin DIL
74266	Quad 2-input open-collector Exclusive-OR	14-pin DIL
74365	Hex tri-state bus driver	16-pin DIL
74366	Hex tri-state inverting bus driver	16-pin DIL
74367	Hex tri-state bus driver	16-pin DIL
74368	Hex tri-state inverting bus driver	16-pin DIL
74640	Octal tri-state Schmitt inverting bus transceiver	20-pin DIL
74641	Octal open-collector Schmitt bus transceiver	20-pin DIL
74642	Octal open-collector Sc. inverting bus transceiver	20-pin DIL
74645	Octal tri-state Schmitt bus transceiver	20-pin DIL

TABLE 2: CMOS LOGIC GATE SUMMARY

Device	Function	Package
4000	Dual 3-input NOR plus inverter	14-pin DIL
4001	Quad 2-input NOR	14-pin DIL
4002	Dual 4-input NOR	14-pin DIL
4006	18-bit shift register	14-pin DIL
4007	Dual CMOS transistors plus inverter	14-pin DIL
4008	4-bit full-adder	16-pin DIL
4009	Hex inverter (replace with 4049)	16-pin DIL
4010	Hex buffer (replace with 4050)	16-pin DIL
4011	Quad 2-input NAND	14-pin DIL
4012	Dual 4-input NAND	14-pin DIL
4013	Dual D-type bistable	14-pin DIL
4014	8-bit parallel-in, serial-out shift register	16-pin DIL
4015	Dual 4-stage serial-in, parallel-out shift register	16-pin DIL
4016	Quad bilateral CMOS analogue switch	14-pin DIL
4017	Decade synchronous counter	16-pin DIL
4018	Programmable walking ring counter	16-pin DIL
4019	Quad 2-input AND/OR data selector	16-pin DIL
4020	14-stage ripple binary counter	16-pin DIL
4021	8-stage parallel-in, serial-out shift register	16-pin DIL
4022	Octal synchronous counter	16-pin DIL
4023	Triple 3-input NAND	14-pin DIL
4024	7-bit binary ripple counter	14-pin DIL
4025	Triple 3-input NOR	14-pin DIL
4026	Decade counter and seven segment decoder	16-pin DIL
4027	Dual JK bistable	16-pin DIL
4028	1-of-10 decoder	16-pin DIL
4029	Decade or hexadecimal synchronous up-down Counter	16-pin DIL
4030	Quad exclusive-OR (replace with 4077)	14-pin DIL
4032	Triple adder	16-pin DIL
4033	Octal counter and seven segment decoder	16-pin DIL
4034	8-bit bidirectional shift register	24-pin DIL
4035	4-bit parallel-in, parallel-out shift register	16-pin DIL
4038	Triple adder	16-pin DIL
4040	12-bit binary ripple counter	16-pin DIL
4041	Quad inverting/non-inverting buffer	14-pin DIL
4042	Quad bistable latch	16-pin DIL
4043	Quad RS bistable (NOR logic)	16-pin DIL
4044	Quad RS bistable (NAND logic)	16-pin DIL
4045	21-bit binary counter	16-pin DIL
4046	Phase-locked loop	16-pin DIL
4047	Single monostable	14-pin DIL
4048	Single 8-input multi-function gate	16-pin DIL
4049	Hex inverter	16-pin DIL
4050	Hex buffer	16-pin DIL
4051	1-of-8 analogue multiplexer	16-pin DIL
4052	Dual 1-of-4 analogue multiplexer	16-pin DIL
4053	Triple 1-of-2 analogue multiplexer	16-pin DIL
4054	Decoder/driver	16-pin DIL
4056	Decoder, driver	16-pin DIL
4060	14-stage binary ripple counter with oscillator	16-pin DIL
4066	Quad analogue switch	14-pin DIL
4067	1-of-16 analogue switch	24-pin DIL
4068	Single 8-input NAND	14-pin DIL
4069	Hex inverter	14-pin DIL
4070	Quad exclusive-OR	14-pin DIL
4071	Quad 2-input OR	14-pin DIL
4072	Dual 4-input OR	14-pin DIL
4073	Triple 3-input AND	14-pin DIL
4075	Triple 3-input OR	14-pin DIL
4076	4-stage tri-state shift register	16-pin DIL
4077	Quad two-input exclusive-OR	14-pin DIL
4078	Single 8-input NOR	14-pin DIL
4081	Quad 2-input AND	14-pin DIL
4082	Dual 4-input AND	14-pin DIL
4086	Dual 2-input AND/OR/invert	14-pin DIL
4089	Binary rate multiplier	16-pin DIL
4093	Quad 2-input Schmitt NAND	14-pin DIL
4096	Single JK bistable	14-pin DIL
4097	Dual 1-of-8 multiplexer/demultiplexer	24-pin DIL
4098	Monostable	16-pin DIL
4099	Latch	16-pin DIL
40103	8-bit binary synchronous down counter	16-pin DIL
40105	4-bit x 16 word FIFO register	16-pin DIL
40106	Hex Schmitt inverter	14-pin DIL
40107	Dual 2-input NAND	14-pin DIL
40109	Level shifter	16-pin DIL
40110	Counter/latch/ display driver	16-pin DIL
40160	Asynchronous decade counter with clear	16-pin DIL
40161	Asynchronous 4-bit binary counter with clear	16-pin DIL
40162	Synchronous decade counter with clear	16-pin DIL
40163	Synchronous 4-bit binary counter with clear	16-pin DIL
40174	Hex D-type bistable	16-pin DIL

Supply voltages and power consumption

Most TTL and CMOS logic systems are designed to operate from a single supply voltage rail of nominally 5V. With TTL devices, it is important for this voltage to be very closely regulated. Typical TTL i.c. specifications call for regulation of better than ±5% (i.e. the supply voltage should not fall outside the range 4.75V to 5.25V).

It is very important to note that, if the supply voltage used with TTL devices (other than that used with the collector load of an open-collector device) ever exceeds approximately 7V, the devices are liable to self destruct very quickly!

CMOS logic offers greater tolerance of supply rail variations and operates from a wider range of supply voltages (typically 3V to 15V) than TTL. Coupled with minimal current demand, this makes CMOS an obvious choice of logic family for use with battery operated (portable) equipment.

TTL devices require considerably more supply current than their CMOS equivalents. A typical TTL logic gate requires a supply current of around 8mA; approximately 1000 times that of its CMOS counterpart when operating at a typical switching speed of 10kHz. It is important to note that, whilst the power consumption of a CMOS gate is minimal under quiescent conditions, the power consumption increases with switching speed. In some circumstances and at high switching rates (e.g. several MHz) the power consumption of a CMOS device may approach (or even exceed) that of a comparable LS-TTL device.

Propagation delay and switching speed

When operating at reduced supply voltages (particularly in the case of CMOS devices) it is important to note that the propagation delay (i.e. the time taken for a change of state to appear at the output in response to a change at the input) will be significantly increased. In order to maintain performance at high switching speeds, it is important to use a relatively high value of supply voltage. Unbuffered CMOS devices exhibit smaller propagation delay at the expense of slightly reduced noise margin when compared with their buffered counterparts.

CMOS devices generally operate at somewhat lower switching speeds than the equivalent TTL or LS-TTL logic. TTL devices can generally operate satisfactorily at up to 16MHz, and some devices will switch quite happily at rates in excess of 35MHz. CMOS devices, on the other hand, should not be relied upon to operate at much above 10MHz unless special precautions are taken.

Static precautions

All CMOS devices are now fitted with input static protection diodes but these should not be relied upon and appropriate static precautions should *always* be adopted when handling such devices. Typical precautions involve use of anti-static packaging, anti-static (grounded) bench mats, grounded/low voltage soldering equipment, etc. Under no circumstances should CMOS devices ever be connected or disconnected from an item of equipment which has power applied (even though it may be switched "off").

Comparison of major logic families

The following table summarises some of the more important characteristics of four of the most popular logic families:

Characteristic	Logic family			
Technology	**Standard TTL**	**Low power Schottky TTL**	**High-speed CMOS TTL**	**Buffered CMOS**
Series	**74**	**74LS**	**74HC**	**40BE**
Maximum supply voltage	5.25V	5.25V	5.5V	18V
Minimum supply voltage	4.75V	4.75V	4.5V	3V
Static power dissipation (mW per gate at 100kHz)	10	2	negligible	negligible
Dynamic power dissipation (mW per gate at 100kHz)	10	2	0.2	0.1
Typical propagation delay (ns)	10	10	10	105
Maximum clock frequency (MHz)	35	40	40	12
Speed-power product (pJ at 100kHz)	100	20	1.2	11
Minimum output current (mA at $V_O = 0.4V$)	16	8	4	1.6
Max. fan-out (LS loads)	40	20	10	4
Maximum input current (mA at $V_I = 0.4V$)	–1.6	–0.4	±0.001	-0.001

Unused inputs

Erstwhile circuit designers often ask about what should be done with unused inputs on a logic device. Inputs left "floating" can be problematic and, whereas TTL inputs invariably float high (i.e. they assume a logic 1 condition), this phenomenum should not be relied upon. Floating inputs on CMOS devices can be even more unpredictable, taking high, low, or indeterminate states and even drifting between these states from time to time!

It is thus essential to take steps to define the state of any unused input. This can be taken low or high by respectively hard-wiring to 0V (to produce a logic 0 input) or connecting a "pull-up" resistor to V_{CC} (in order to produce a logic 1 input). The pull-up resistor can consist of a 1k or 2k resistor. Note that hard-wiring to V_{CC} is *not* a good idea as it can render the device more prone to failure due to spikes carried on the supply rail (these should not, of course, be present if the power supply rail has been designed correctly!).

When several inputs need to be pulled-up, one resistor can cater for up to 20 unused standard gate inputs. Note, however, that it may be undesirable to adopt a common pull-up arrangement due to constraints which will become clear when one attempts to produce a p.c.b. layout. For this reason, I generally only use one pull-up resistor for every 2 to 4 inputs (usually on the same chip).

Both CMOS and TTL logic require low-impedance supplies which are adequately decoupled. Supply borne noise (due to transient spikes) can usually be eliminated by placing capacitors of 100n and 10µ at strategic points distributed around a p.c.b. layout.

As a general rule, one disc or plate capacitor (of between 10n and 100n suitably rated) should be fitted for every two to four devices whilst an electrolytic capacitor (of between 4µ7 and 47µ suitably rated) should be fitted for every eight to ten devices. Buffers (both inverting and non-inverting) and line-drivers will normally require additional (individual) decoupling.

Monostables

Provided the input states of one of the basic types of logic gate remain static, the output state will also remain static. There are, however, a number of applications in which a momentary pulse (i.e. a 0-1-0 or 1-0-1 transition) is required rather than a permanent change of logical state. A device which fulfils this function is said to have only one stable state and is consequently known as a monostable.

The action of a monostable is quite simple; its output is initially at logic 0 until a level or "edge" arrives at its trigger input. This level change can be from 0 to 1 (positive edge trigger) or 1 to 0 (negative edge trigger) depending upon the particular monostable device or configuration.

Immediately the trigger is received, the output of the monostable changes state to logic 1. Then, after a time interval determined by external C-R timing components, the output reverts to logic 0. The monostable then awaits the arrival of the next trigger.

Monostables are available in a variety of forms and, whereas it is possible to make a simple form of monostable from individual logic gates and a few discrete components, the use of purpose-designed integrated circuit monostables (such as the 74121 or its dual counterpart the 74221) is much to be preferred.

The 74121 is a TTL monostable (see Fig. 5.7) in which triggering occurs at a particular input threshold voltage level. The device can be triggered by either positive or negative edges depending upon the configuration employed. The chip has complementary outputs (labelled Q and $\overline{Q}$) and requires only two timing components (one resistor and one capacitor).

The internal arrangement of the 74121 is depicted in Fig. 5.7. Control inputs A1, A2, and B are used to determine the trigger mode and may be connected in any one of the following three ways:

(a) A1 and A2 connected to logic 0. The monostable will then trigger on a negative edge applied to B.

(b) A1 and B connected to logic 1. The

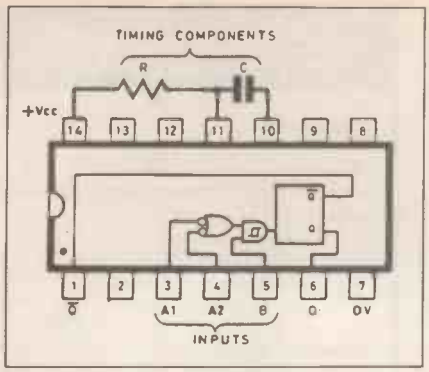


Fig. 5.7 Internal arrangement of the 74121 monostable

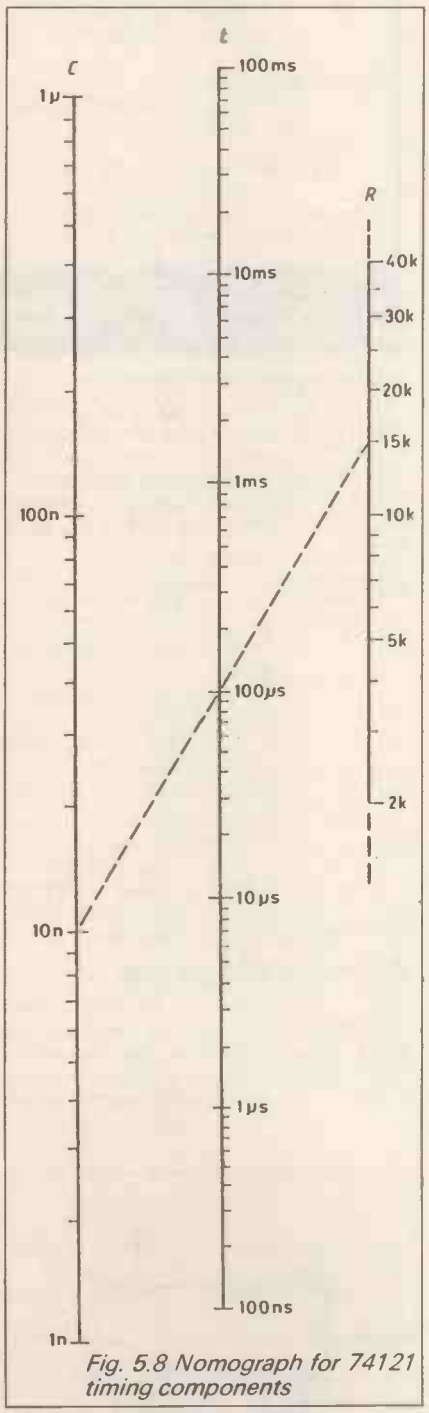


Fig. 5.8 Nomograph for 74121 timing components

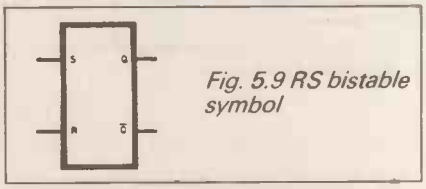


Fig. 5.9 RS bistable symbol

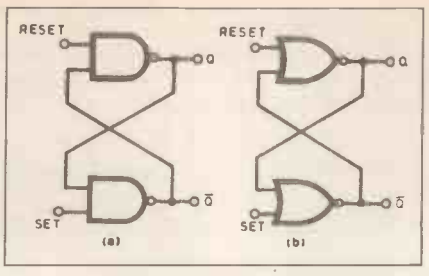


Fig. 5.10(a) RS bistable using cross-coupled NAND gates. (b) RS bistable using cross-coupled NOR gates

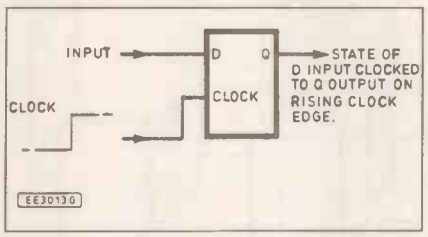


Fig. 5.12 One-bit "data latch"

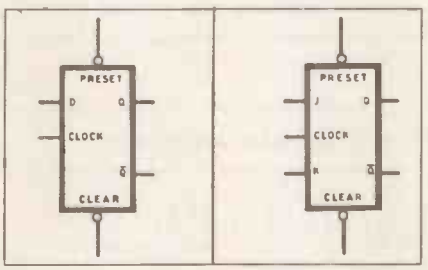


Fig. 5.11 D-type bistable symbol

Fig. 5.13 JK bistable symbol

monostable will then trigger on a negative edge applied to A2.

(c) A2 and B connected to logic 1. The monostable will then trigger on a negative edge applied to A1.

It should be noted that, unlike some other monostable types, the 74121 is *not* re-triggerable during its monostable timing period. This simply means that, once a timing period has been started no further trigger pulse will be recognised. Furthermore, in normal use, a recovery time equal in length to the monostable pulse should be allowed before attempting to re-trigger the device.

A typical application for a monostable device is in stretching a pulse of very short duration. A 74121 is an ideal device to perform this function; it can be triggered by a very short duration pulse and will continue with its fixed duration timing period long after the input signal has reverted to its original state. The only requirement is that, to ensure reliable triggering, the input pulse should have a width of at least 50ns.

For a 74121, the values of external timing resistor should normally lie in the range 1.5kilohm to 47kilohm. The minimum recommended value of external capacitor is 10p whereas the maximum value of capacitor is only limited by the leakage current of the capacitor employed. In practice this means that, if necessary, values of several hundred µF can be used. This all leads to a monostable circuit which can provide a very much wider range of monostable periods than the simple circuits based on inverters described earlier. Typical values of 74121 monostable period for various capacitor values can be determined from the nomograph shown in Fig. 5.8.

Bistables

Whilst a monostable device can be useful in a number of applications (such as pulse stretching) the device cannot "remember" a logic state indefinitely; eventually, at the end of the monostable period, the output will revert to whatever it was previously. Clearly there is a requirement for a logic device which will retain a change of state for an indefinite period. Such a device is known as a "bistable" and it has a latching action; retaining the state into which it is triggered until it is reset or until the power is removed.

Various forms of bistable are in common use and each type has its own particular advantages and disadvantages. We shall examine each of the most common types in turn:

RS bistables

The simplest form of bistable is known as an RS (standing for reset and set) bistable. The general symbol for an RS bistable is shown in Fig. 5.9. Such devices can be built using using nothing more than conventional NAND or NOR gates, as shown in Fig. 5.10(a) and Fig. 5.10(b) respectively. Each of these arrangements have two inputs (labelled SET and RESET) and two complementary outputs (labelled Q and $\overline{Q}$). A logic 1 applied to the SET input will cause the Q output to become (or remain at) logic 1 whilst a logic 1 applied to the RESET input will cause the Q output to become (or remain at) logic 0. In either case, the bistable will remain in its set or reset state until an input is applied in such a sense as to change the state.

Simple NAND and NOR gate bistable arrangements suffer from a problem as it is not possible to predict the output state which results from the simultaneous application of a logic 1 to both the SET and RESET inputs and thus the designer must take steps to ensure that this disallowed state never arises.

NAND and NOR gate bistables should thus be used for only the simplest of applications (such as the switch de-bounce circuit shown in Fig. 5.20). In practice a variety of integrated circuit bistables are available which are both more flexible and predictable in their operation.

D-type bistables

The D-type bistable (see Fig. 5.11) has two principal inputs; D (standing variously for data or delay) and CLOCK. The data input (logic 0 or logic 1) is clocked into the bistable such that the output state only changes when the clock changes state. Operation is thus said to be synchronous. Additional subsidiary inputs (which are invariably "active low") are provided which can be used to directly set or reset the bistable. These are usually called PRESET (PR) and CLEAR (CLR).

The illustration in Fig. 5.12 shows how a D-type bistable can be used as a simple one-bit "data latch". The Q output changes state to logic 1 on a rising clock edge (the Q output remains unaffected by a falling clock edge). It should be noted that, whereas most common D-type bistables (e.g. 7474, 74174, 74175) are all clocked on the rising edge of the clock waveform, this rule does not generally apply to JK bistables which invariably complete their clocking on a falling clock edge!

JK bistables

JK bistables (see Fig. 5.13) have two clocked inputs (J and K), two direct inputs

J	K	Q_n+1	Comment
0	0	Q_n	No change
0	1	0	Output cleared
1	0	1	Output set
1	1	$\overline{Q}_n$	Output changes state

Preset	Clear	Q
0	0	Indeterminate
0	1	1
1	0	0
1	1	Enables clocked operation

Fig. 5.14 Truth tables for a JK bistable: (a) for the J and K inputs (b) for the PRESET and CLEAR INPUTS

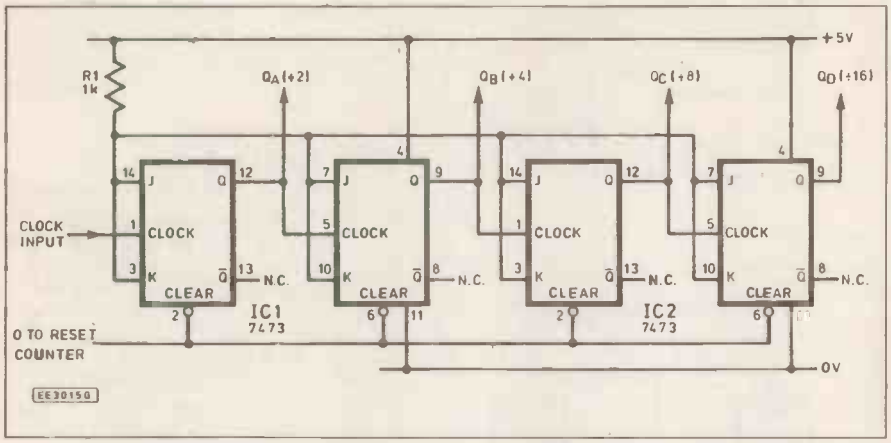


Fig. 5.15 Binary counter (divide-by-16) based on JK bistables

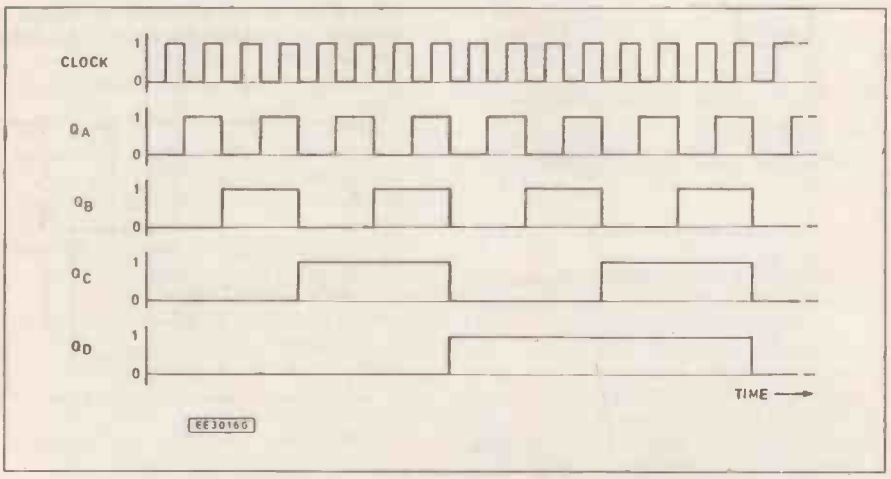


Fig. 5.16 Timing diagram for the circuit of Fig. 5.15

(PRESET and CLEAR), a clock input, and two outputs (Q and $\overline{Q}$). As with the RS bistable, the two outputs are complementary (i.e. when one is 0 the other is 1, and vice versa). Similarly, the PRESET and CLEAR inputs are invariably both active low (i.e. a 0 on the PRESET input will set the Q output to 1 whereas a 0 on the CLEAR input will set the Q output to 0). The truth tables for a JK bistable are shown in Fig. 5.14.

Binary counters

The JK bistable is an extremely useful device and it can be configured to operate as a binary divider by simply tyeing the J and K inputs to logic 1 (via a pull-up resistor) and feeding the Q output of one stage to the clock input of the next. Fig. 5.15 shows a typical four-stage binary counter which can be realised using two 7473 or 74LS73 devices.

A common "active-low" CLEAR signal is used to reset the counter. If this line is momentarily taken low, all of the Q outputs will revert to logic 0 before counting recommences. Fig. 5.16 shows how the four Q outputs vary with time (note that the frequency of the final output, Q_D, is one-sixteenth that of the clock input).

Decade counters

Frequently decade rather than natural binary counters are required and specialised logic devices are available which can perform this function. One such device is the 7490 (or 74LS90) as shown in Fig. 5.17. This chip comprises a divide-by-two followed by a divide-by-five section and extra inputs are provided to reset the count to zero or set the count to nine. The output frequency of the signal at Q_3 (pin-11) is exactly one tenth of that at the input.

Digital counter module

The circuit of Fig. 5.18 shows how a 7490 decade counter (IC1), 7475 quad data latch (IC2), and 7447 seven-segment decoder/driver (IC3) can be used to form a complete decade counter module. The output of the module is displayed using a common-anode seven-segment l.e.d. If desired, identical modules can be used together (pin-11 of IC1 on one module connected to pin-14 of IC1 on the next module) to provide a multi-digit display.

A p.c.b. layout for this circuit is shown in Fig. 5.19. Connections to PL1 are as follows:

Pin number	Function
1	Clock input (standard TTL levels)
2	Reset 0 input (taken high to reset the stage to 0)
3	Reset 9 input (taken high to set the output to 9)
4	Latch (taken low to freeze the display)
5	Ground/0V

To enable normal counting, the input signal should be applied between pins 1 and 5 of PL1 with LK1 and LK2 fitted.

Switch inputs

Readers who may be tempted to drive the input of a counter (such as our digital counter module) directly from a switch/pull-up resistor combination may be puzzled by the erratic display that will

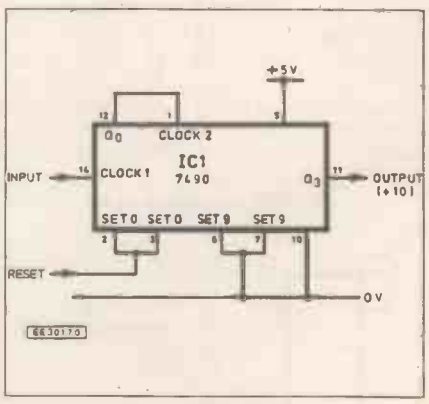


Fig. 5.17 7490/74LS90 decade counter

COMPONENTS

Resistors
R1, R2, R3 2k2 (3 off)
R4-R10 270 (7 off)
All fixed resistors are 0.25W 5% carbon types.

Capacitors
C1 100µ radial elect. 16V
C2 100n polyester

See SHOP TALK Page

Semiconductors
IC1 7490
IC2 7475
IC3 7447
IC4 Common anode seven segment display

Miscellaneous
PL1 5-way straight PCB header (0.1inch pitch)
LK1, LK2, LK3 P.C.B. jumpers (0.1inch pitch)
Printed circuit board available from the *EE PCB Service*, order code EE738.

Approx cost guidance only **£7**

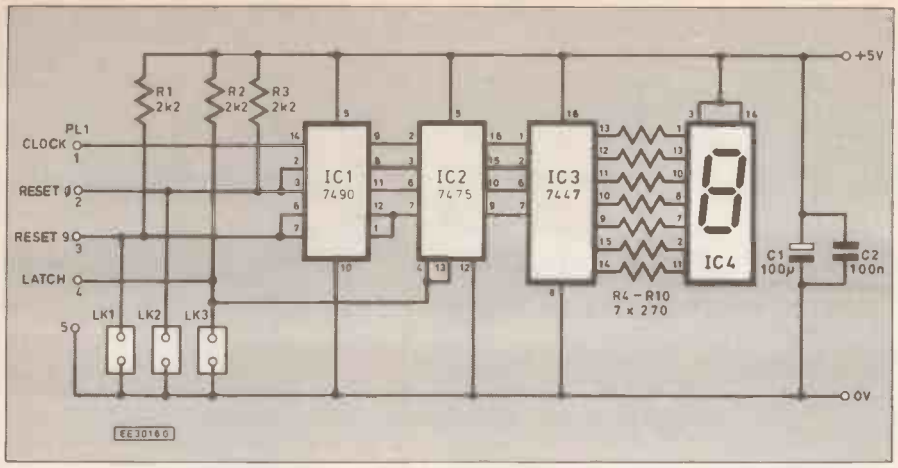
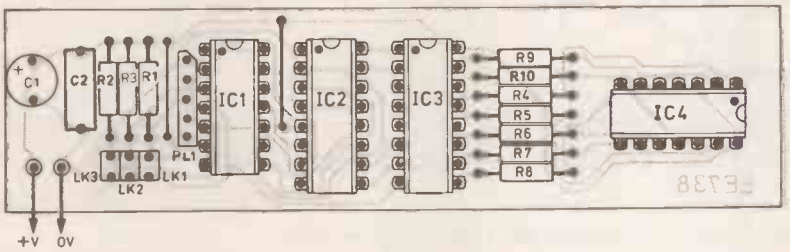


Fig. 5.18 Complete circuit diagram for the digital counter module



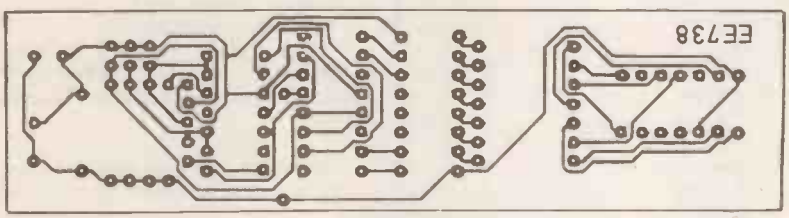


Fig. 5.19 P.C.B. track and component layout for the digital counter module

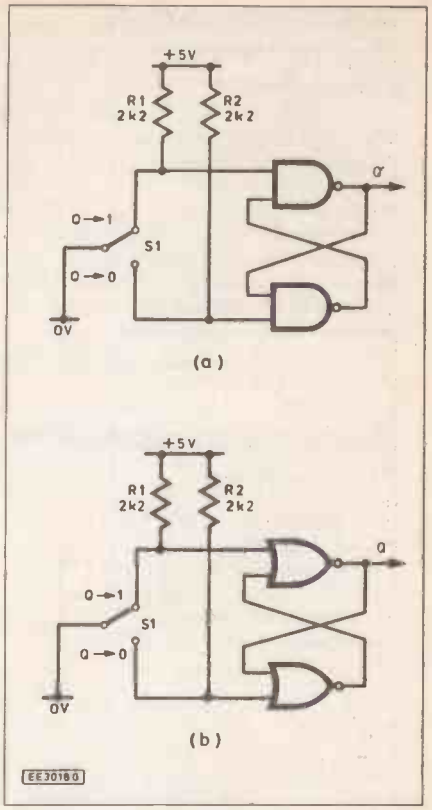


Fig. 5.20 Switch debounce circuits: (a) based on NAND gates (b) based on NOR gates

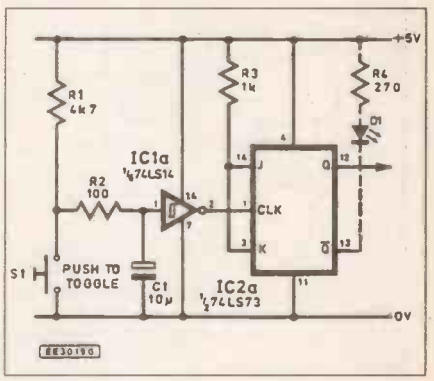


Fig. 5.21 Circuit to provide a latching toggle action from a conventional push-button switch

almost certainly result. The reason for this is simply that few mechanical switches provide a "clean" switching action. In fact, the contacts are liable to bounce, causing a momentary series of pulses rather than a single,clean logic state transition.

This problem can be overcome using a bistable switch debouncing circuit based on a simple bistable arrangement like those shown in Fig. 5.20. Alternatively, if a latching action is required from a simple push-button (without changeover contacts) the circuit of Fig. 5.21 may be used. This circuit can also provide a visual indication of its current state by means of the l.e.d. connected to the $\overline{Q}$ output (pin-13).

Design Problem

This month's design problem (as with all of the design problems presented in this series) is designed for readers who would welcome the opportunity of tackling a little "homework". The exercise may be tackled purely "on paper" or may be used as the basis of a complete constructional project.

This month's problem arises from the need for a means of detecting the presence of an unauthorised person attempting to gain access to a room or building.

Counter module specification

Supply voltage:	+5V ± 10%
Supply current:	90mA max.
Maximum count frequency:	10MHz min.
Input:	Standard TTL levels
Control:	Reset 0, Reset 9, and display latch

An intruder alarm is to be designed according to the following target specification:

Door sensors:
Number of sensors: 2
Sensor type: *Microswitch (open when door opens)*

Window sensors:
Number of sensors: 2
Sensor types: *Aluminium foil strip (breaks when window broken)*

Alarm:
Type of transducer: *Siren (requires 12V d.c. at 2A)*

Control switch:
Type of switch: *Keyswitch (with one set of change-over contacts)*

Power supply: *12V lead-acid battery*

Design a suitable alarm circuit based on the above specification. Include in your circuit a "test" button so that the user can check that the siren is operational.

Answer to last month's design problem:

A signal injector is to be designed according to the following target specification:
Fundamental output frequency: *1kHz ± 10%*
Output voltage: *1V pk-pk*
Power supply: *9V (PP3)*

Design a suitable signal injector circuit suitable for mounting in a hand-held instrument case and based on low-cost, low-tolerance discrete components.

One solution to last month's design problem is shown in Fig. 5.22.

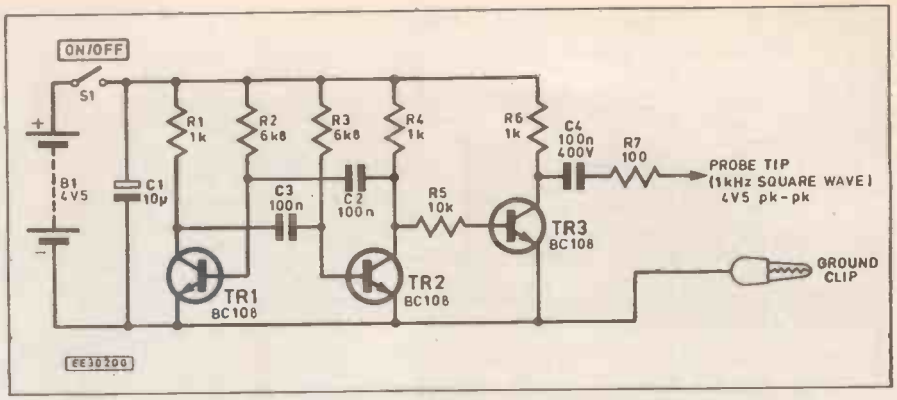


Fig. 5.22 Answer to last month's Design Problem

Answers to questions in Part Five

Question 1: see Fig. 5.23
Question 2: see Fig. 5.24
Question 3: see Fig. 5.25
Question 4: see Fig. 5.26
Question 5: see Fig. 5.27
Question 6: see Fig. 5.28

Next month: Next month's instalment deals with timers. Our design problem involves a Darkroom Timer whilst our accompanying constructional project features a pulse generator.

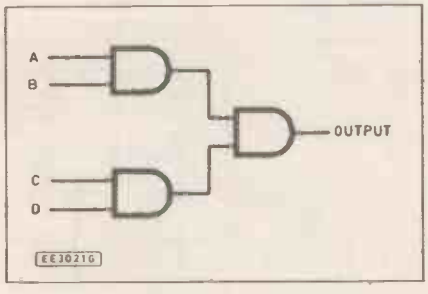


Fig. 5.23 Solution to Question 1

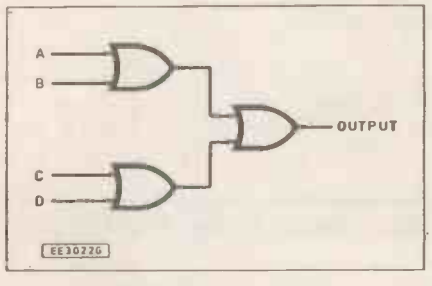


Fig. 5.24 Solution to Question 2

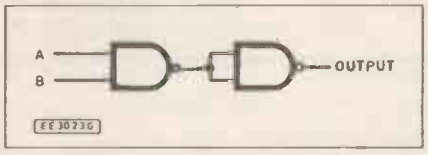


Fig. 5.25 Solution to Question 3

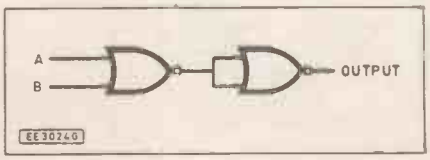


Fig. 5.26 Solution to Question 4

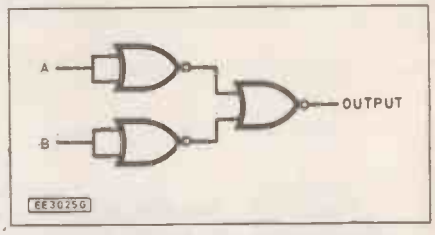


Fig. 5.27 Solution to Question 5

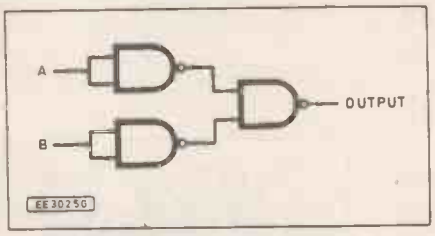
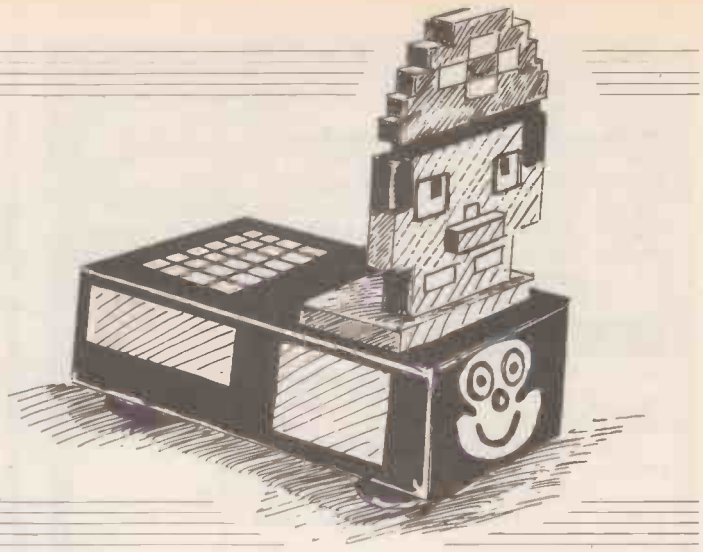


Fig. 5.28 Solution to Question 6

Cumulative index to modules

Title	Part	Function/specification
Dual output power supply module	1	Dual ±5V, ±12V or ±15V regulated power supply rated at 1A max. output
723 variable power supply module	1	Single variable output of +2V to +37V at up to 5A max. Output voltage and current limit are set by means of preset controls.
L200 variable power supply module	1	Single variable output of +2.7V to +35V at up to 2A max. Inutput voltage and current limit are set by means of variable controls.
General purpose transistor amplifier module	2	Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.
General purpose operational amplifier module	2	Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between ±5V and ±15V at 10mA nominal.
High-quality power amplifier module	3	Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between ±12V and ±20V at up to 2A.
TBA820 i.c. amplifier	3	Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between +5V and +15V.
Sine wave oscillator	4	Low distortion sine wave oscillator capable of providing outputs over the range 50Hz to 50kHz. Frequency and amplitude adjustable. Requires +12V to +15V supply at 10mA (nominal).
8038 waveform generator	4	Provides sine, square and triangle outputs adjustable the range 0.01Hz to 20kHz. Requires ±9V supply at 10mA.
Digital counter module	5	Single stage decade counter with seven-segment l.e.d. display. Standard TTL input levels. Requires +5V supply at 90mA.

PIP ROBOT REVIEW



ALAN PICKARD

A FIRST impression of the PIP educational robot vehicle, which has actually been around for over twelve months, is that it is just another turtle suitable for primary schoolchildren. This review will attempt to describe the robot as not only a well engineered and robust product, in ready made form, but also as having potential for the electronics hobbyist and schoolteachers (and older pupils) involved in electronics hardware.

Operation

The PIP is a completely self-contained, microprocessor controlled, programmable robot vehicle. It requires no cable connection to an external computer, having a built in sealed lead acid battery with "intelligent" charging circuitry which deals with attempts to overcharge or completely discharge its battery.

It is housed in an extremely tough black plastic case, rather like a medium sized shoe box (14.5cm × 21.5cm × 6.5cm). Its 24 position keyboard occupies the front half of the top of the unit leaving the rear half and sides available for the addition of "add-ons", such as Lego base boards (very strong double-sided adhesive tape provided) or even additional electronic hardware. The vehicle is designed to enable children to customise or even personalise PIP as shown in the photograph.

The robot vehicle is supplied with battery charger unit and (× 10) modifier plug which enables PIP to move in 10 centimetre steps and in 10 degree steps per keyed digit. A simple magnetic pencil lead holder is also included to allow PIP to leave a trail.

An instruction manual, song book and application notes are also provided, all of which enable the user or teacher to demonstrate quickly the facilities of the robot. The manufacturers, **Swallow Systems** claim that the user interface can be mastered in twenty minutes!

Keyboard Operation

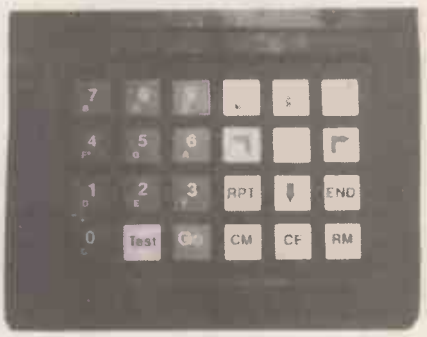
The PIP mobile is designed for use by children as young as four and up to the age of 12. Its keyboard is easy and straightforward to use with no shift or control keys.

Although it could be said to replace the earlier BIG-TRAK, which used a single chip computer device, the PIP is a much more robust and advanced system with emphasis given to toughness, accuracy of operation and reliability in use. Unlike BIG TRAK, PIP has a rechargeable battery which does not need to be removed for charging.

There are 14 commands available on the keyboard and the numbers 0-9. The numbers are additionally labelled as musical notes and recognised as such if preceded by the musical note symbol key. Ten notes are available covering just over one octave as per a recorder instrument.

The command keys enable forward and reverse movement in centimetre steps and left or right turns in single degree steps. A "flash" key turns on the l.e.d. on the top of the case a chosen number of times and a "pause" key inserts tenths of seconds into programs.

Clear Memory and Clear Entry keys operate as on calculators and RPT (repeat) and END enables repetitive operations which can be nested up to three levels. GO runs the user program and TEST provides a useful test and demonstration of the unit following a square path. Sounds and tunes are generated by inputting tone sequences with or without pauses.



Keyboard Layout

Technical Specification

The chassis assembly of the vehicle comprises the base of the case which has mounted in it two quality stepper motors (48 steps per revolution) fixed in 1.6mm galvanised steel chassis. The motors drive two substantial nylon wheels via rubber belts which are effectively the tyres. The wheels are not only grooved to accept the belt, but have an internal convex profile to prevent the belt from climbing out of or off the wheels.

The vehicle has a single control board with a special purpose microprocessor (6303XP) which is a 64-pin device with on chip input and output ports (1 × input port and 2 input or output ports which also provide serial I/O lines). Input to the system is via the keyboard and output devices are the motors and l.e.d.s.

A 7-pin DIN socket at the front of the case enables a cable to be connected to the BBC Micro serial port such that the program steps entered into PIP's memory may be transferred to the BBC for storage on disk or tape. The same socket is used for the battery charger and also as a means of outputting to a simple output device to be switched on or off by PIP.

Memory comprises an 8K EPROM (8K or 16K socket) and on chip RAM for storage of user programs. The robot's operating system is written in Forth and then compiled before loading into EPROM.

The control board also houses the charging circuit which provides constant voltage, current limited charging for the sealed lead acid battery (12V). A loudspeaker is included (1.5in.) and the unipolar stepper motor drive circuit is achieved via four f.e.t.s.

Molex connectors are used throughout and the fibreglass p.c.b. is through plated, double-sided solder resist. The keyboard is a 24-key (6 × 4) matrix, non-tactile membrane construction giving long life and protection from sharp objects. A keyboard mask can also be employed, providing a subset of the keys for "beginners".

Charging

A charging l.e.d. and On/Off switch also occupy the front of the unit. The switch button is positioned to avoid damage to the actual switch if say, the unit is dropped.

The red l.e.d. is off when the unit is in a fully charged state. The unit does not turn off automatically but it emits a "grumble" every four minutes when no keys are used.

Robustness

The motor assembly is sprung giving the unit some crude but highly effective suspension. A favourite demonstration of its designer, Duncan Louttit, is to stand on top of the vehicle and then show it to be still operational (with load removed!).

Stability is achieved by the use of four heavy duty plastic supports which are no less effective than a roller ball support for a unit of this weight. They also protect

the motor/chassis assembly from extreme stress (e.g. axle bending) when standing on it as the chassis assembly moves towards the interior of the unit, whilst the load weight is taken by the supports and case.

All units are subjected to a fairly exhaustive test after assembly and also some pretests on the mains charger, including safety checks. The robot is tested on a test surface with the "master" EPROM fitted.

Tests include a left turn through 720 degrees followed by a right turn through 720 degrees, after which positional error is measured. The measured error is then converted into a constant which is entered into the appropriate memory location of the PIP EPROM.

When the EPROM is fitted the unit is tested again with a full test routine consisting of a 15 step program with the unit on its back. Throughout the process the unit is also on charge. All units are charged for six hours before despatch and final measurements are carried out on the charging system.

Potential

The PIP mobile is clearly aimed at the educational market and its robust construction, accuracy and reliability is reflected in its price. It costs £195 + VAT, but a 15% discount applies if you pay cash or cheque with order. Postage and packing is £5 + VAT. It can also be hired at the rate of £8 + VAT per week (plus carriage) and if a purchase follows, the rental cost is deducted from the purchase price.

At over £200, PIP is rather expensive for anyone wishing to adapt it or extend its basic facilities. There are no plans to provide PIP as a kit, but Swallow Systems can supply a case, motor/drive assembly, minus the lead acid battery (for £65 + VAT).

The PIP robot vehicle has been sold to schools throughout the UK and also in Eire, Australia and Canada. Application notes have been generated as a result of use in schools and are an indication that this product will be around for some time.

As someone with a particular interest in the building of small robot vehicles, I find the size, shape and basic design appealing. Many hobbyists and perhaps particularly EE readers may be interested in building a simple robot vehicle, but are put off by the mechanical aspects of motor/drive and wheel combinations. For some reason component suppliers have never considered it worthwhile to put together any form of basic "buggy" kit.

Whilst it is not feasible to buy a PIP and modify or even remove its control circuitry for one with your own design requirements, it may be very realistic to consider a chassis such as that used by PIP.

Pip is available from: Swallow Systems, 32 High Street, High Wycombe, Bucks HP11 2AQ
0494 813471

Its full price (with VAT and carriage) is £230. A 15% discount is available to anyone paying (cash or cheque) with their order (total price is then £196.36). Delivery is 8 to 10 weeks at the time of writing.

Rentals are available and Swallow Systems can supply separately a motor/wheel chassis minus battery (£74.75 including VAT and carriage).

PIP is also distributed by:
Fernleaf Educational Software Limited.
Fernleaf House, 31 Old Road West, Gravesend, Kent DA11 0LH
0474 359037

Connection to BBC Micro

The creator of PIP has also produced a serial lead (7-pin DIN to IDC (User Port) cable) which with the appropriate software on disk can transfer PIP programs to and from the BBC Micro (see Fig. 1).

Another "add-on" is a simple control circuit, again utilising the universal 7-pin DIN socket. Swallow Systems do not intend to market this device but it is included here for those constructors to build, whether they are school teachers or older pupils who have access to a PIP. Fig. 2 shows how this is achieved.

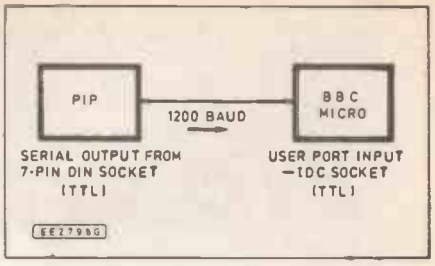


Fig. 1. Connection to BBC Micro for program storage.

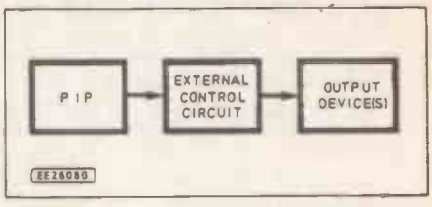


Fig. 2. Controlling an external device from PIP.

External Control Circuit

THE Add-On Control Module circuit diagram Fig. 3 shows how the serial output signal from PIP can be used to activate a device such as a motor. The prototype was used to turn on a tiny motor which was fixed to the vehicle end, opposite the keyboard.

A simple "propeller", actually made from a piece of stripboard gave clear indication of motor operation. The motor is separately powered by rechargeable AA size batteries.

The control command from the PIP is achieved by the use of the "Flash" key. In other words, the key in addition to turning on and off the green l.e.d. on the top of the case also outputs a 2-channel code (i.e. 1 (01 in binary) for ON, 2 (10) for OFF.

A program example written in "PIP" is as follows:

RPT,3,↑,10,0̋,1,↓,10,0̋,2,END

This can be explained in detail as:

KEY	PIP Action	Control Circuit Action
RPT	repeat this program	
3	three times	
↑	forward	
10	10cm	
0̋	flash green LED	MOTOR ON (01)
1	once	
↓	reverse	
10	10cm	
0̋	flash green LED	MOTOR OFF (10)
2	twice	
END	of program (3 loops)	

This program causes the robot to go forward, flash its l.e.d. once and turn on the control motor. The robot then reverses and the l.e.d. goes off as does the motor. In addition, the two l.e.d.s mounted on the control p.c.b. indicate the appropriate binary combination used, i.e. l.e.d. 1 = ON, l.e.d. 2 = OFF (for motor on) and l.e.d. 1 = OFF, l.e.d. 2 = ON (for motor off), where l.e.d. 1 and l.e.d. 2 represent the least significant and most significant bits respectively.

This simple control function provides a quite spectacular demonstration of a robot on the move whilst controlling an external device (motor) and also producing a binary display of the control circuit's output state. Although simple enough, the observer is expected to assimilate movement of the vehicle including change of direction, the switching on of a motor (the prototype had the home made propellor attached) and two indicator sources.

The spectacle of a roving "propeller driven" robot providing some motor noise and l.e.d.s flashing around the vehicle body cannot fail to inspire educational and electronics enthusiasts alike (not to mention young children!). It may be aimed directly at the school environment, but it has definite if unintentional potential as a mini robotic experimental vehicle, particularly if its top and side surfaces are used to attach other circuit boards.

Circuit Description

Operation of the flash key followed by the number 1 or 2 results in two bytes being outputted from the PIP serial port. The bytes are the ASCII bit pattern for "1" or "2", i.e. 31H or 32H. Serial data is thus transferred from the PIP at 1200 baud and each bit of data is fed into the 8-bit shift register IC3 (see Fig. 3).

The +5V supply (regulated) is derived from the PIP control p.c.b. with resistor R1 limiting surge current at switch on. A 555 timer, IC1 acts as a monostable for one character time (adjusted via VR1) and IC2 is an astable for 1 bit time (adjusted via VR2). Each timer is the CMOS type as is the shift register. C1 is a supply line decoupling capacitor.

This circuit utilises only 2 of 8 possible outputs (pins 3-6, 10-13) of IC3, but the flash function could be used to produce a predetermined bit pattern to activate up to eight output devices. Obviously the circuit in Fig. 1 would have to be multipled.

A simple truth table illustrates the control circuit operation:

FLASH NO.	ASCII CODE	2-BIT BINARY	ACTION
2	31H	01	MOTOR ON
2	32H	10	RELAY ON
3	33H	11	BOTH ON

Output Driver

The Output Driver circuit diagram shown in Fig. 4 is required for each channel or device used. In this example two of these are needed.

The input of f.e.t. transistor TR1 is 0/5V CMOS for OFF/ON. When TR1 is on, resistance across Source and Drain is three ohms. The test motor takes about 0.5A. Two diodes D1 and D2 act as blocking diodes to protect the control p.c.b. from motor supply transients.

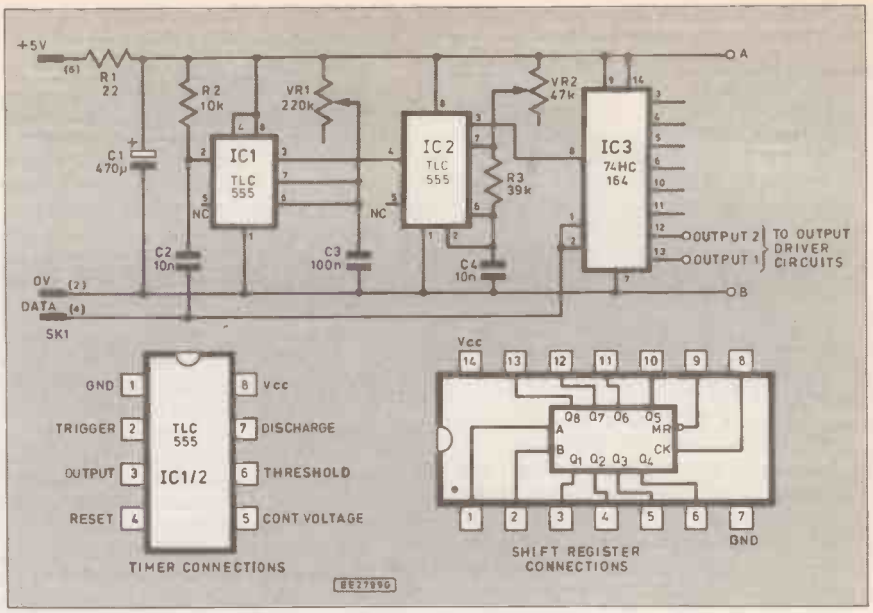
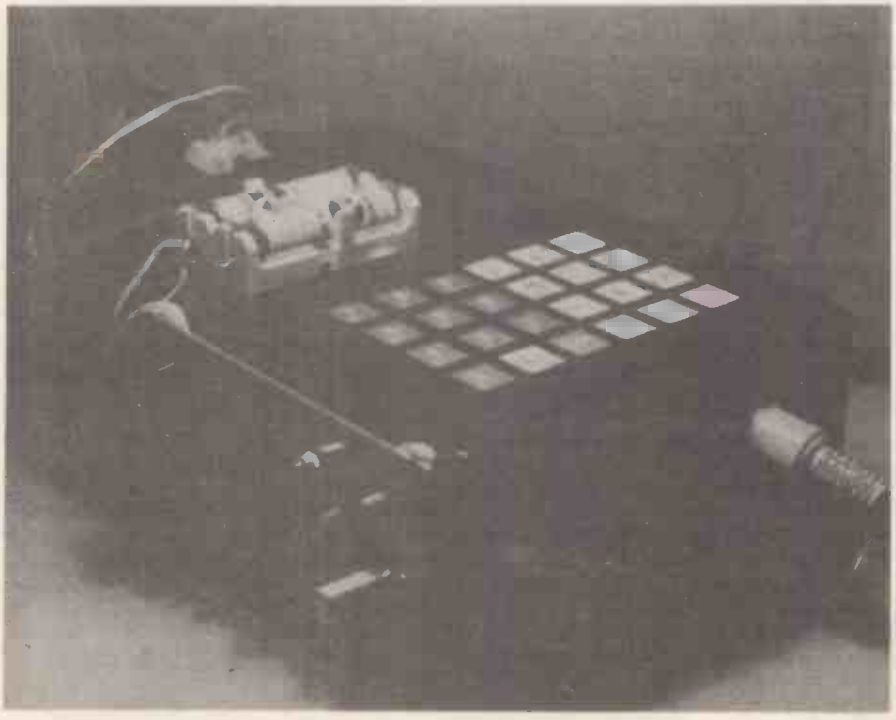


Fig. 3. Control circuit diagram and i.c. pinout details.

Construction

The combined external "add-on" control circuit and 2-channel output driver is built on a single piece of 0.1in matrix stripboard, size 15 strips x 34 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 5.



COMPONENTS

Resistors

R1	22
R2	10k
R3	39k
R4, R5	200 (2 off)

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	220k min. skeleton carbon preset, horiz.
VR2	47k min. skeleton carbon preset, horiz.

Capacitors

C1	470µ radial elect. 16V
C2, C4	10n polyester layer (2 off)
C3	100n polyester layer

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3, D4	1N4001 1A 50V rec. diode (2 off)
D5, D6	Red 5mm l.e.d. (2 off)
TR1, TR2	BST70A *n*-channel MOSFET
IC1, IC2	TLC 555CP Lin. CMOS timer (2 off)
IC3	74HC164N 8-bit shift register

Miscellaneous

X1, X2 motor, relay etc. to suit

Stripboard, 15 strips x 34 holes; connectors; battery holder; 2 x AA rechargeable batteries; wire; links; i.c. sockets, 14-pin, 8-pin (2 off) 7-pin DIN plug; 3-way p.c.b. screw terminal block (2 off); solder pins; solder etc.

Approx cost guidance only **£12** *plus Batts*

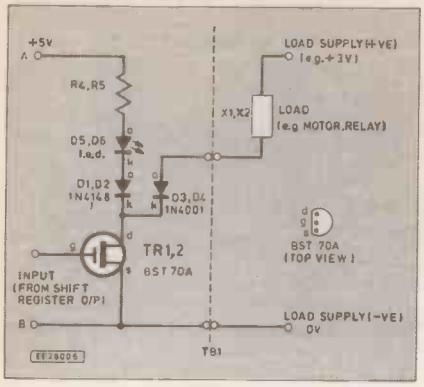


Fig. 4. Output driver circuit diagram. Two are required for the add-on control module.

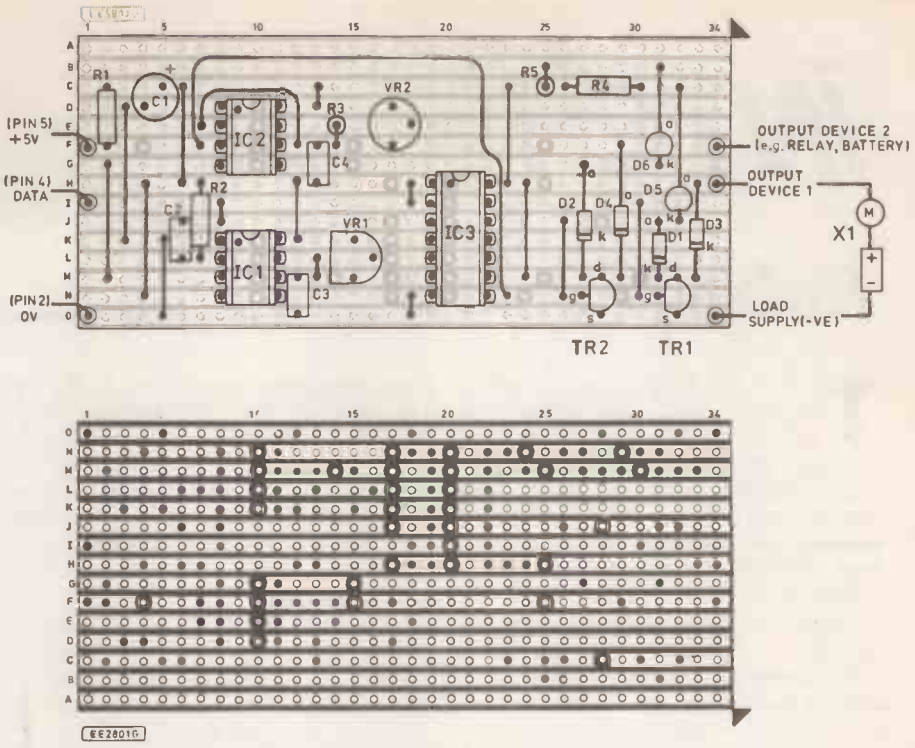


Fig. 5. Stripboard component layout and details of breaks required in the underside copper tracks.

The output driver stage would need to be extended (repeated per channel) if the constructor wished to add further channels, up to a maximum of eight.

A 7-pin DIN plug is wired to the input of the circuit and outputs are connected to the load and its supply. Output 2 is shown connected to the test motor and its batteries.

Constructors may find it useful fitting an on/off switch to the load supply, enabling a "panic button" operation to be executed in the event of unforseen revolutions when testing the circuit! All connections should be checked before switch on, including track cuts and links. Blue tack or its equivalent is very useful for mounting the board and output devices on the vehicle.

Demonstration Program

The following program is suitable for demonstrating all the facilities of PIP, including the operation of its external control board.

```
RPT 2  (↰45, ↑10, ↺10, ↓10, ↱45) END
RPT 3  (♪A) END
RPT 3  (↑10, 01, ↓10, 02) END
RPT 2  (5555 7766 5766 5555) END
       01, ↰720, ↺10, ↱720, 02
```

The penultimate "line" of this program requires the insertion of the musical note symbol before each number, but is omitted here to aid clarity.

The program demonstrates movement, sound, control, "singing" and lastly performs an encore!

Conclusion

The only minor criticisms I have are that it might be useful to incorporate an "ON" l.e.d. although I suspect it is not fitted so as to enable PIP to be programmed to lie in a dormant state and then suddenly be activated by use of the pause instruction. For example the program steps: RPT 99, 0 999, END would delay a particular operation sequence by 99+99.9 seconds=2 hours and 45 minutes, depending on the accuracy of the 1/10 seconds in PIP. By using sequences of these repeat loops it should be possible to program it to act as a timer or even to perform a mechanical function well over twenty four hours later!

Another feature I would like to see is a collision detection facility as this could usefully deal with operational errors and provide some childish amusement. Although the charging system is fairly foolproof and robust, it is possible for the motors to almost grind to a standstill before the charge light turns on.

Other minor difficulties occur when inputting programs. Although CE (Clear Entry) deals with errors it is not possible to step through a program or verify it. This is, of course,, a penalty of overall ease of use and keeps down the unit's price. Another useful feature might be the inclusion of additional test routines and maybe an (infinite) loop command, but I imagine that has been omitted to lengthen PIP's lifetime!

These points are comments rather than criticisms and as far as I am aware, PIP appears to be one of the best and most useful vehicles on the market, not least because it has been carefully engineered to a standard, rather than down to a price. It is fully guaranteed for 12 months and its simplicity, robustness and reliability lend its use to experimental work. □

INTERFACE

Robert Penfold

THE rise in the popularity of public domain ("PD") and shareware software over the past few years has been little short of amazing. The increase in the number of programs available in both categories has been no less spectacular. The number of shareware programs in particular, has increased vastly.

Both types of software are now available for most of the popular computers in substantial numbers, but the IBM PCs (and compatibles) probably have the greatest number and the widest range of shareware/PD programs available.

Techno-Shareware

In order to appreciate the range of subjects covered you need to obtain one of the larger PD/shareware catalogues for the PCs. Some suppliers of this type of software concentrate on popular programs, and do not stock the more unusual programs. Probably the largest range of PD/shareware software for the PCs is available from "The Public Domain Software Library". Despite its name, both types of software are supplied by this source, and well over two thousand disks are available!

There are quite a number of programs for the radio and electronics enthusiast included in the range. The radio software is not something that we will consider here, but there are the usual log book programs, some sophisticated satellite orbit prediction software, plus programs to compute aerial dimensions, resonant frequencies, etc. If you are interested in radio it could be worthwhile trying out some of these programs.

There are other programs of interest to the radio and electronics enthusiast, including printed circuit design, linear circuit simulation, digital circuit simulation, and drawing programs for producing circuit diagrams etc. As one would expect, there is not a vast range of software in such specialised categories, but there are some interesting and useful programs available.

PC p.c.bs

Probably the most interesting of the two or three printed circuit design programs available is "PC-Route" (disk No.2034). This does not require a particularly advanced PC, and seems to run quite happily on a single drive system with a CGA display. It does seem to require the full 640K of RAM though.

In common with the other software mentioned here, it is an extremely complex program. I have not given this program (or the others mentioned here) a thorough try-out, and there is insufficient space available to describe them in great detail. I can give you a basic run-down on what they can do. Remember that it only costs about £3-00 per disk to try out these programs, so you are not risking a great deal if you obtain a few programs to try out for yourself.

The approach taken by PC-Route is much the same as the one adopted by many up-marked p.c.b. CAD programs. You first design a library of component symbols, with each symbol having a number assigned to each pin/leadout. The circuit is entered into the program using the netlist method. A netlist is basically just a list of the interconnections.

If a track must connect the pins of five components together, then the five components are entered into the netlist, complete with the appropriate pin number for each component. This process is repeated for each set of interconnections, until the complete circuit has been entered.

Next the board size is specified (up to 12 inches x 8 inches), and the components are placed in position. You then have the board at the "rats-nest" stage, which simply means that the tracks run straight from point A to point B, probably crossing over half a dozen tracks in the process. You can route the tracks manually, but the program includes an automatic routing facility. This can handle single or double sided boards, and is quite efficient.

Only the most sophisticated (and expensive) of auto-routers will provide 100 per cent routing of boards, and this one is certainly not in that category. However, it does not normally leave you too many tracks to route manually. It is better than most of the other low cost auto-routers I have encountered, many of which are of little practical value.

Printout

Having completed the board design, it can then be printed on a "PC Printer", and Epson 24 pin dot-matrix type, or an H.P. Laserjet II/Deskjet printer. Alternatively it can be written to a file which can be read into AutoCAD, and from there printed or plotted on a wide range of output devices. At least it can if you have access to the extremely expensive (£2,500 plus VAT) AutoCAD program!

This program is certainly worth trying out, but I am not entirely convinced that it can handle complex boards comfortably. Like many shareware programs, it is very sophisticated in some ways (the auto-router for example), but is quite crude in others. The quality of the screen graphics for instance, in no way compares to those produced by the lower cost commercial p.c.b. design programs.

The way the program operates, with the board design being broken down into a number of logical steps, is the standard method used for commercial p.c.b. production. This would make the program an attractive proposition for educational use, or for those who would like to know more about current p.c.b. design techniques.

Note that although it will run on quite basic PC hardware, in common with any program of this type, it runs at a much more usable speed on a fast PC. With a registration fee of $65-00 (about £35-00 to £40-00) "PC-Route" costs much less than any commercial p.c.b. design program for PCs.

Circuit Modelling

There are several shareware/PD programs available which provide linear or digital circuit simulation. There is a British one called "ACIRAN" (disk No.1908) which I have mentioned in previous articles in *Everyday Electronics*. Consequently, I will not discuss it in detail here, but it is one of the better programs of this type; its graphics are particularly good.

The basic idea is to provide simulations of a linear circuit so that the performance can be assessed without actually building the circuit. This has a number of advantages, such as savings in time, the ease with which modifications can be made and assessed, and avoiding the purchase of masses of very expensive test equipment.

Most of these programs are very accurate indeed, but you always have to bear in mind that the circuit layout can significantly affect the performance of linear circuits. A circuit analyser tells you what the program will do if it is built on a well designed circuit board.

Pspice

The industry standard circuit analysis software is "Pspice", which is an excellent but quite expensive set of programs. A cut-down PD version has been made available though, and this is on disks 1954A and 1954B. This version is unable to handle the mega-circuits that the full version can digest without difficulty, but it can still handle "up to about ten transistors". It is not supplied with the full library of component models, but a useful range are included.

The ability to calculate distortion has not

been included, but frequency response, phase response, d.c. operating conditions, etc. can all be plotted. It is an extremely complex program which gives a more detailed analysis than any other program of this type that I have encountered.

The "Pspice" program only provides numeric data, and it has no built-in graphics capability. However, a program called "Probe" is included on one of the disks, and this can process the output of "Pspice" to produce some simple graphs. Note though, that "Probe" will only run if the computer is fitted with a maths co-processor. "Pspice" does not require a co-processor, but it will run much faster if one is fitted.

Friendly

A common grumble about circuit simulation programs is that they are not very user-friendly when the circuit is being entered. "Pspice" overcomes this problem by processing text files which contain the circuit description. This means that the circuit description can be produced on any word processor or text editor that can generate a standard ASCII file, and can easily be edited if mistakes or alterations to the circuit are made.

The circuit description is in the form of a netlist, much like that used in "PC-Route". The only major difference is that with a p.c.b. design program each component is paired with a symbol, which is a simple physical description of the component. With a circuit analysis program each component is paired with a mathematical model of its electrical characteristics. This model is quite straightforward for passive components, but is detailed and complex for active components. Fortunately, the component models supplied are adequate for most purposes.

"Pspice", even in this cut down educational version, is a formidable piece of software. Like any program of this complexity, it takes a while to fully master it. Also, you need to have a certain amount of technical knowledge in order to understand the terminology involved. It is well worthwhile giving it a try-out though, and making a little effort to learn how to use it.

Try entering the circuits of some *Everyday Electronics* projects and see if you can make a few modifications to improve their performance! Bear in mind that this software is PD and not shareware. It only costs a few pounds for the two disks, and there is no registration fee if you decide to go on using it. It must be one of the best software bargains currently on offer.

Ecap

Mention should be made of another linear analysis program called "Ecap" (disk No.2075). This program is an all-in-one type which seems to be less than 64K long. It only provides plots of phase and frequency response, but in many cases these are all that will be required. It has built-in graphics capability, and will operate using any normal PC graphics display. Although it is less sophisticated than "Pspice", it is more straightforward to use, and possibly represents an easier starting point if you are trying out this type of software for the first time. It is a shareware program with a registration fee of $69-00.

Digital Simulation

For the digital enthusiast there is a program called "Lsystem" on disk No.2117, which seems to be quite powerful even in the slightly cut-down shareware version (you get the real thing if you register your copy). This program requires at least a two disk system with 640K of RAM and one of the standard graphics displays.

It is similar to "Pspice" in the way it operates, with the circuit first being described by preparing a text file using a word processor or text editor. This file is then fed to the first of three programs. The first one compiles the data into a form that the second one can use to produce the simulation. The third program provides a waveform display.

Unlike some logic simulation programs, "Lsystem" is not restricted to circuits containing a few simple gates, which your brain could probably simulate just as well. It can handle large circuits using simple and more complex logic devices. I must admit to being more at home with linear circuits than digital types, and this probably accounts for my difficulty in getting to grips with this program.

If you are into digital electronics, then this program should be well worth a try. If not, you may never get to the stage where you fully understand what it is doing!

Drawing The Line

Electronics involves the production of numerous drawings, such as circuit diagrams and block diagrams. There are quite a few shareware/PD drawing programs for PCs, but many of these are not well suited to electronics use. The complexity of most electronic diagrams requires a vector based program, and not a pixel based type where you are severely limited by the screen resolution. In other words, you require a proper CAD program and not a paint type.

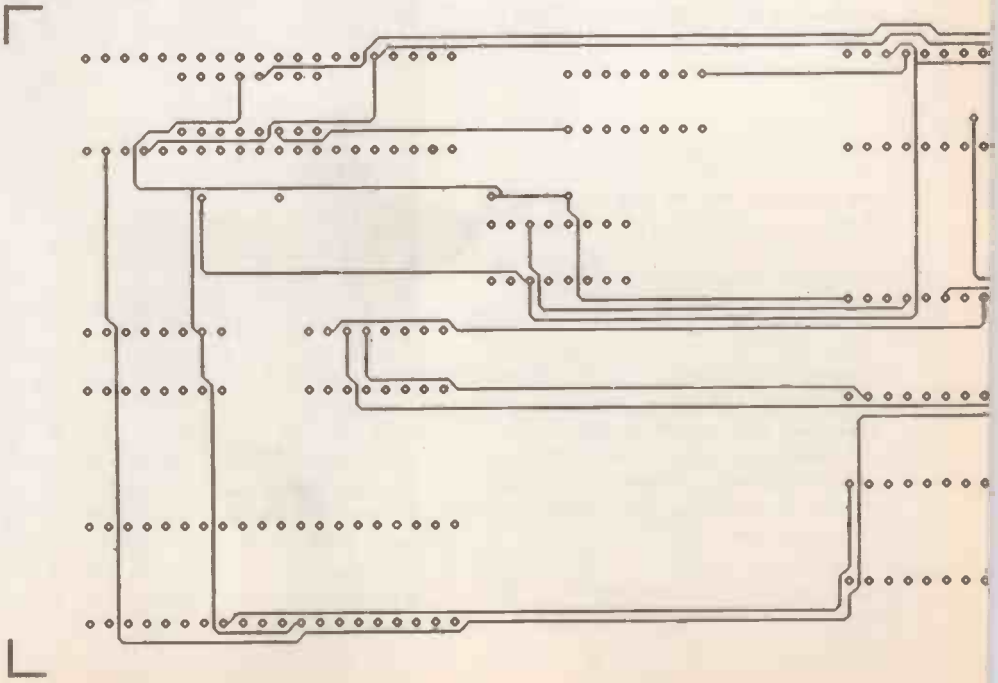
Programs of this type and of a usable quality have been noticeably absent from the shareware catalogues until quite recently. However, there are now at least three programs that are worthy of investigation, and these are "PC-Draft-CAD" (disk No.2081), and "PC Draft Choice" (disk No.1832), and T-Square (disk Nos.2093A to 2093D). These are all powerful drawing programs which can easily handle quite complex circuit diagrams etc., and permit modifications to be easily made. They compare quite well with the cheaper commercial CAD programs, but are somewhat cheaper if you should decide to use one and register with the author.

One problem with drawing software is that it can be quite time consuming to learn to use it effectively. Apart from all the commands that have to be learned, a mental leap has to be made. Drawing using a pencil and paper is something we do without having to think about it too much. Initially, drawing on the screen of a monitor and then printing out the results is a totally alien way of doing things. An advantage of shareware in this context is that if you cannot get to grips with the program, at least you will not have wasted much money on it.

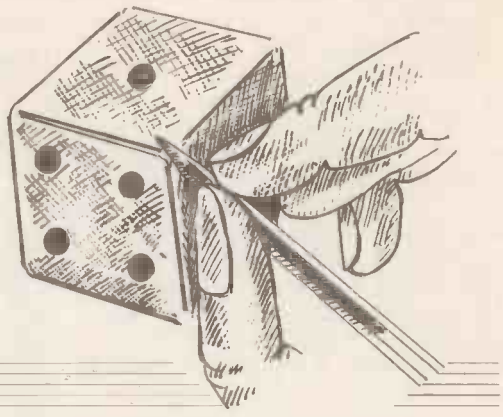
I have only been able to mention some of the electronics related shareware/PD programs that are available for PCs. If you have a PC, I would certainly recommend that you get one of the larger PD/shareware catalogues and study the radio, graphics, and electronics sections carefully. There are more technical programs listed than you might expect.

Note that all the programs listed here are available from **The PDSL, Winscombe House, Beacon Road, Crowborough, Sussex, TN6 1UL** (☎0892 663298). Some of the programs are available from other sources, but under different catalogue numbers.

"PC route" example printout showing some auto-routed tracks. Unusually for an auto-router 45 degree track sections are included.



ELECTRONIC DIE



MIKE TOOLEY BA

This companion fifth project to our Design Your Own Circuits series shows how logic circuits can be used in a simple application which will be well known to readers. As with all of the practical constructional projects in this series, a number of modifications are suggested so that the more intrepid constructor can customise the unit to his or her own particular requirements.

BOARD games invariably rely on the use of a die to produce an element of random chance. Few of us will not have experienced the frustration of searching for such an item before being able to get started with a game (they always tend to find their way into the most improbable of locations!). Furthermore, we have doubtless all had the "pleasure" of repeatedly scrabbling on the floor for the dice thrown by an over-enthusiastic child.

Our Electronic Die provides a modern solution to this problem which is truly random, impossible to cheat with, and not quite so easy to lose!

Bearing in mind that our Electronic Die is to replace a low-cost item, cost has been foremost in the design of this project. The final result can be built for an outlay of less than £10 (excluding case and batteries) even when purchasing components on a "one-off" basis. The design is based on four i.c.s; three low-power Schottky TTL logic gates and a CMOS programmable counter.

CIRCUIT DESCRIPTION

The block schematic of the electronic die is shown in Fig. 1. The circuit has been divided into four functional blocks; a clock generator (which may be gated on and off), a counter (divide-by-6), decoding logic, and seven l.e.d.s arranged in the same manner as the spots on the face of a die.

The complete circuit of the electronic die is shown in Fig. 2. IC1, a quad two-input NAND gate provides a square wave clock signal (pin-11). The clock signal is gated on and off by means of IC1a, the output of which (pin 3) goes high (enabling the oscillator) whenever S1 is pressed. When S1 is released, the output of IC1a goes low and the oscillator is disabled. Feedback within the oscillator arrangement (IC1b to IC1d) is provided by means of C2 and R2 which also determine the frequency of operation (approx. 2kHz).

Component IC2 is a synchronous divide-by-ten counter which may be programmed as a divide-by-n counter by means of a reset input (pin-15). When pin-15 is taken high (as the count reaches 7), the counter resets to zero, thereafter, counting recommences. IC3 and IC4 provide a decoding arrangement which enable the appropriate l.e.d.s whenever the relevant outputs are taken low.

DECODING LOGIC

In order to assist the would-be digital designer, it is worth examining the decoding logic in some detail. The decoding logic is required to respond to each of the six possible input states (present on output lines 1 to 6 provided by IC2) and generate the requisite logic states on the four output lines which operate the l.e.d.s, see Figs. 3 and 4.

At this stage, it is important to note that, although we have a total of seven l.e.d.s (each representing a single spot on the face of the die), we have reduced the number of output lines in Fig. 3 to just four. This reduction is made possible because we are able to arrange six of the l.e.d.s in pairs. These pairs will always be illuminated at the same time, the only l.e.d. which is addressed on an individual basis is that which appears in the centre of the die. The reduction in the number of lines help to reduce the complexity of the decoding circuit.

Having ascertained the inputs (1 to 6) and outputs (D1, D2 and D3, D4 and D5, D6 and D7) we can produce a truth table which defines the function of the logic, as shown in Fig. 5. The next stage is that of designing a logic gate arrangement which

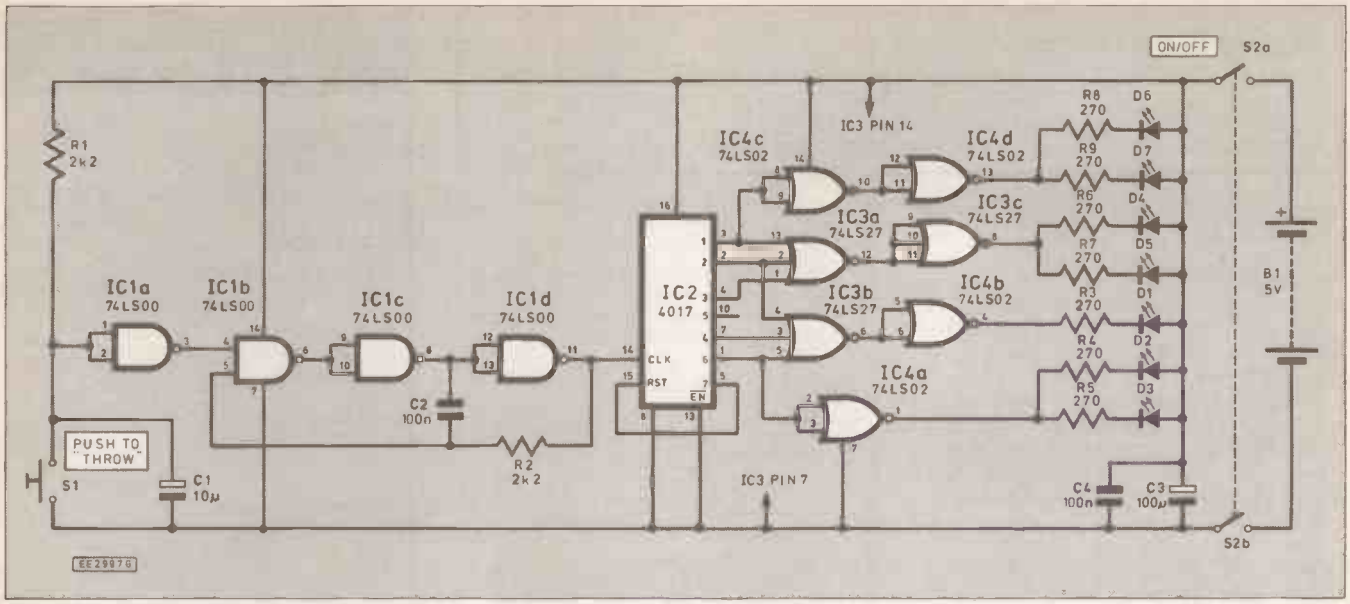


Fig. 1 (below) Block diagram of the Electronic Die

Fig. 2 (above) Complete circuit of the Electronic Die

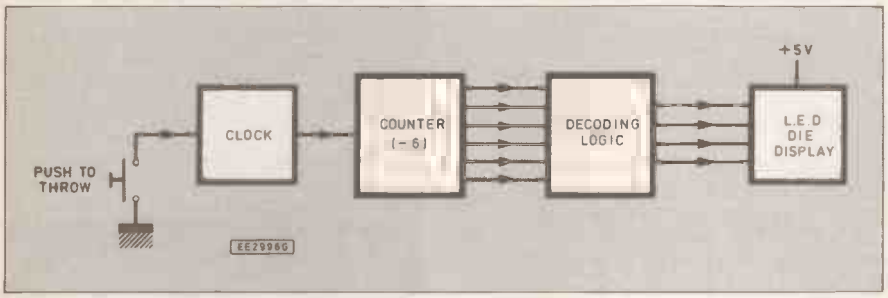
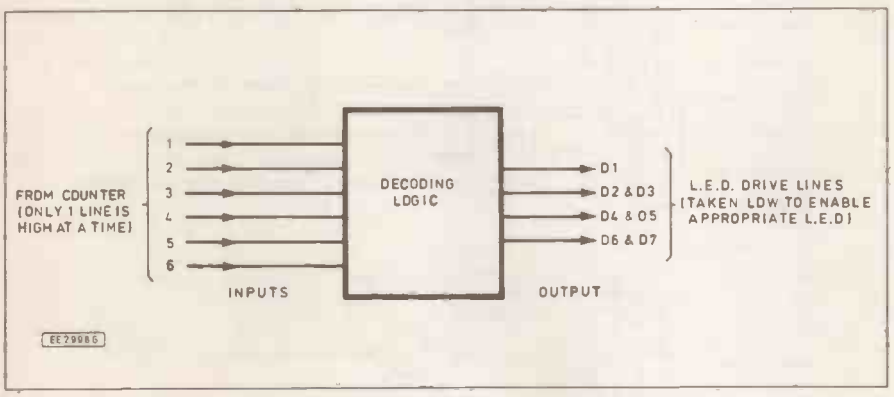


Fig. 3 (below) Decoding logic



TRUTH TABLE

Inputs						Outputs			
1	2	3	4	5	6	D1	D2 & D3	D4 & D5	D6 & D7
1	0	0	0	0	0	0	1	1	1
0	1	0	0	0	0	1	1	1	0
0	0	1	0	0	0	0	1	1	0
0	0	0	1	0	0	1	1	0	0
0	0	0	0	1	0	0	1	0	0
0	0	0	0	0	1	1	0	0	0

Fig. 5 Truth table for the decoding logic

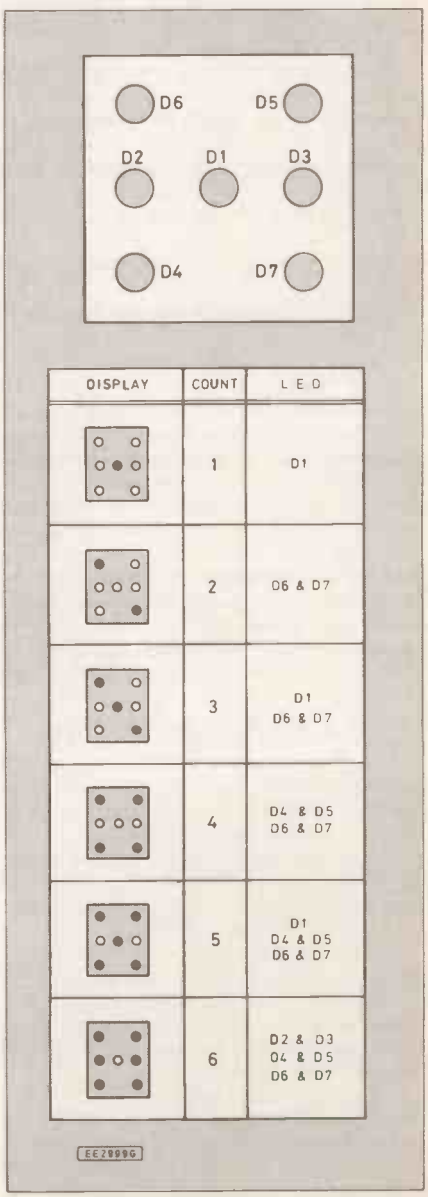


Fig. 4 L.E.D. layout.

Specifications

Output:	1 to 6 (at random) based on conventional die display format
Supply voltage:	5V nominal (4 x AA-size rechargeable nickel cadmium cells)
Supply current:	16mA to 55mA (40mA typical)
Battery life:	Typically 10 hours of intermittent use

will satisfy each of the output functions in turn. Various methods can be used for this (including Boolean algebra and Karnaugh mapping) however it is well worth inspecting the truth table first in order to see whether any "short cuts" are possible. We shall take each output column in turn:

(a) D1 output.

A logic 1 appears in this column whenever input lines 2 or 4 or 6 are at logic 1. Hence the logic function which we require is that which would be produced by a simple three-input OR gate (see Fig. 6(a)).

(b) D2 and D3 output.

This column is the logical opposite of the column for input 6. We can produce this function by means of a single inverter, as shown in Fig. 6(b).

(c) D4 and D5 output.

A logic 1 appears in this column whenever input lines 1 or 2 or 3 are at logic 1. Hence the logic function which we require is that which would be produced by a simple three-input OR gate (see Fig. 6(c)).

(d) D6 and D7 output.

This column is *identical* to that of input column 1. In theory, we can simply connect column 1 to the output however, since the inputs of the decoding logic are driven by a CMOS device, we need to provide some buffering in order to obtain enough current to successfully operate the l.e.d. Fig. 6(d) shows how this is achieved.

The individual logic gate arrangements required to satisfy requirements (a) to (d) can now be assembled together in order to form the basis of our decoding logic. Unfortunately, we arrive at a somewhat mixed bag of logic devices; two three-input OR gates, a single inverter and a single buffer, as shown in Fig. 7(a). In order to minimise the number of integrated circuits required (at the expense of increasing the total number of logic gates present), we shall base our decoding logic purely on a mixture of two-input and three-input NOR gates. We can then achieve the arrangement which we require using only two devices (a 74LS27 triple three-input NOR gate and a 74LS02 quad two-input NOR gate, as shown in Fig. 8). Fig. 7(b) shows the final arrangement of the decoding logic.

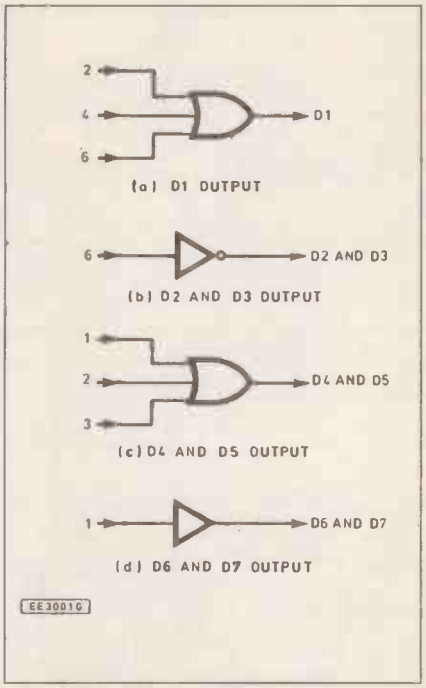


Fig. 6 Logic gate arrangements to satisfy Fig. 5; (a) D1 output; (b) D2 and D3 output; (c) D4 and D5 output; (d) D6 and D7 output.

COMPONENTS

See SHOP TALK Page

Resistors

R1,R2	2k2
R3 to R9	270 (7 off)

All resistors are 0.25W 5%

Capacitors

C1	10µ radial elect. 16V
C2, C4	100n polyester (2 off)
C3	100µ radial elect. 16V

Semiconductors

D1 to D7	Red 0.2inch l.e.d. (7 off)
IC1	74LS00
IC2	4017B
IC3	74LS27
IC4	74LS02

Miscellaneous

S1	Normally-open miniature push-button switch
S2	DPDT miniature toggle switch

ABS enclosure (to suit individual constructor's preference) min. dimensions 160 x 70 x 30mm approx. (see text); printed circuit board available from the *EE PCB Service* Order Code EE737; Plastic p.c.b. fixing pillars with self-tapping No. 6 fixing screws (4 off); snap-fit battery connector; battery holder (for 4 AA-size batteries); rechargeable cells (four AA-size size); 14-pin low-profile d.i.l. sockets (3 off); 16-pin low-profile d.i.l. socket; push-fit 0.040 inch terminal pins (4 off); connecting wire.

Approx cost guidance only **£10** *excluding case*

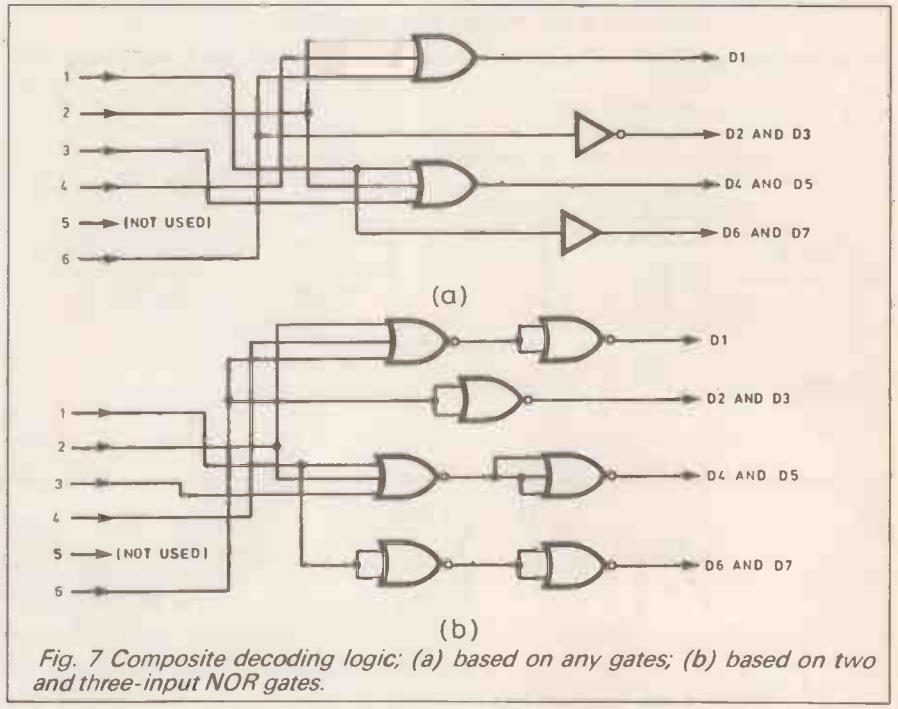


Fig. 7 Composite decoding logic; (a) based on any gates; (b) based on two and three-input NOR gates.

CONSTRUCTION

Construction of the Electronic Die is very straightforward. With the exception of the push-button and on/off switches, all of the components are assembled on a single-sided printed circuit board measuring approximately 120 x 60mm. The copper foil and component layout of the printed circuit board is shown in Fig. 9.

Components should be assembled on the printed circuit board in the following sequence; d.i.l. sockets, terminal pins, resistors, capacitors, and l.e.d. (the leads to the seven l.e.d.s should be left at full length and should preferably be sleeved).

As with all of our projects, it is vitally important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as the electrolytic capacitors, l.e.d.s and the four integrated circuits) it is absolutely essential to ensure that each component is correctly orientated.

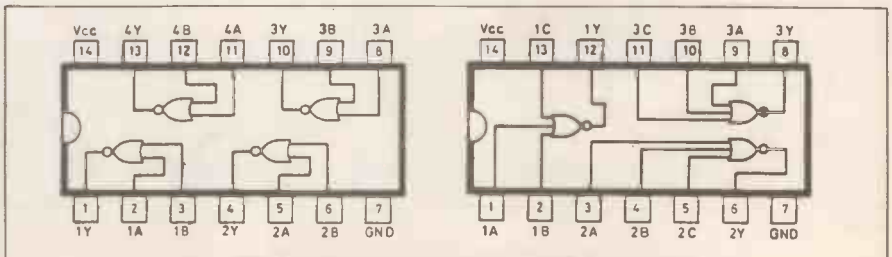
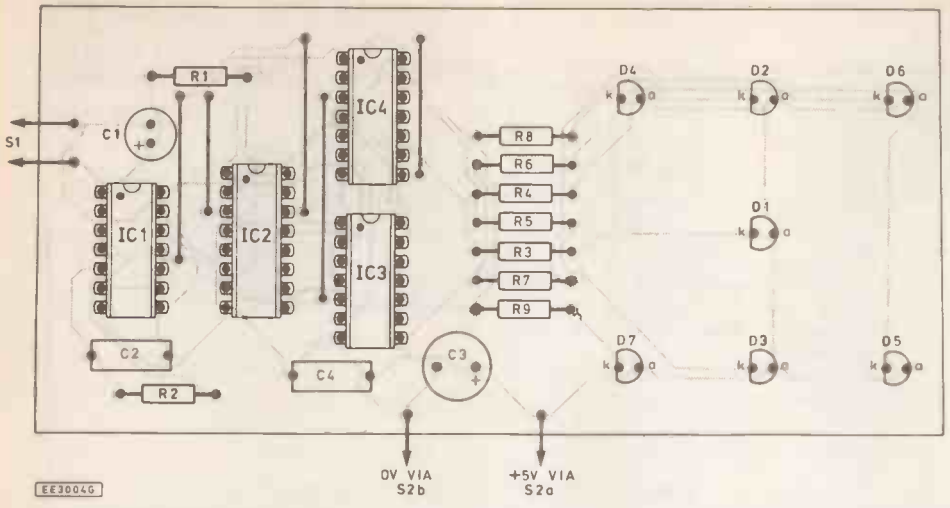


Fig. 8 Internal connections for IC3 and IC4



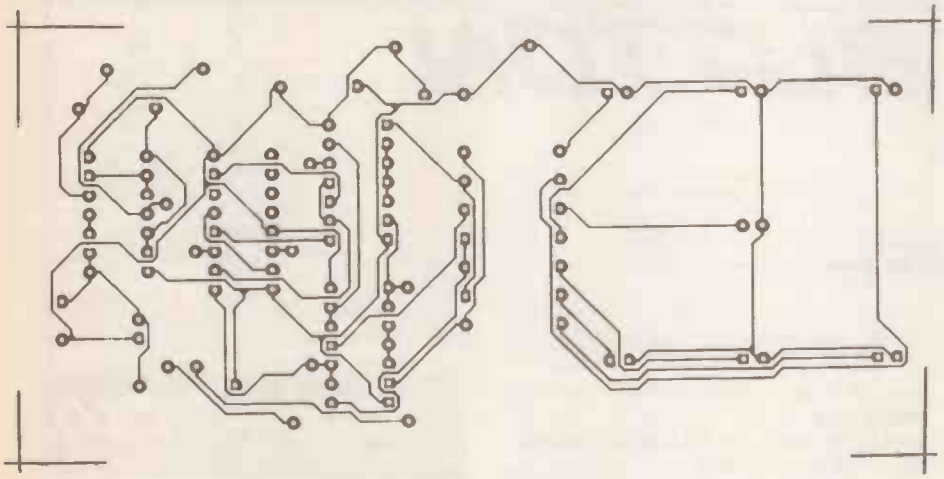
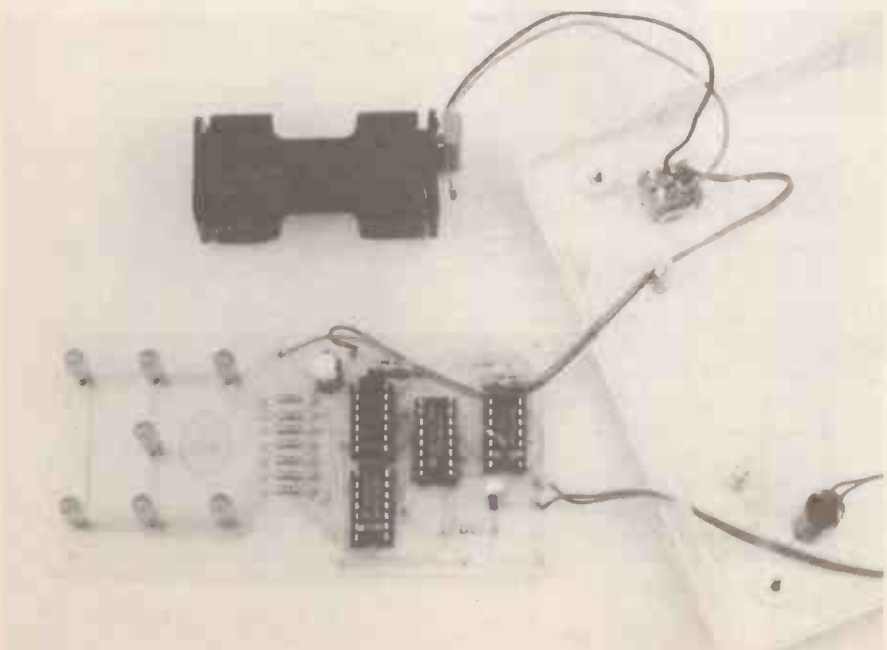


Fig. 9 P.C.B. component and copper foil layout

When construction of the printed circuit board has been completed (and before inserting the integrated circuits into their respective sockets) it is well worth carrying out a careful visual check of both the upper and lower sides of the board. The upper (component) side of the printed circuit board should be examined to ensure that the components have been correctly located.

The lower (copper track) side of the board should be checked to ensure that there are no dry joints or solder bridges between adjacent tracks. This simple precaution will only take a few minutes to carry out but can be instrumental in preventing much heartache at a later stage!

When assembly of the printed circuit board has been completed, the four integrated circuit, IC1 to IC4, should be inserted into their respective 14-pin and 16-pin sockets (taking care to observe the correct orientation in each case). The CMOS device, IC2, should be handled carefully, observing anti-static precautions.



ENCLOSURE

The Electronic Die can be housed in almost any small ABS enclosure which is of sufficient size to acommodate the printed circuit board, battery and switches (the unit can look particularly attractive in a small sloping front enclosure).

The upward facing part of the enclósure should be drilled to accommodate the seven l.e.d.s (it is worth marking this out carefully before drilling) and the two switches. The p.c.b. should be mounted behind the front panel by means of four snap-fit p.c.b. mounting pillars. Connections to the printed circuit board are made using the four terminal pins.

TESTING

Before testing the Electronic Die, it is important to carefully check the wiring of the p.c.b. and the two front panel mounted switches. A 5V supply (consisting of four AA-size nickel cadmium rechargeable cells) should be connected to the unit and a milliammeter inserted to measure the supply current in the positive supply rails.

Switch the unit "on" and measure the supply current. This should be in the range 16mA to 55mA, depending upon the number of l.e.d.s which are currently illuminated. If the supply current is not within this range or if all of the l.e.d.s are illuminated or extinguished, disconnect the supply and carefully check the wiring and p.c.b..

Now depress the push-button "throw" switch. All seven of the l.e.d.s should become illuminated at about half their normal brightness (in fact, they are flashing on and off at a very fast rate). Release the switch, and the electronic die should "freeze" with a 1 to 6 display. If this is not the case, check the p.c.b. around IC1 and IC2 (the clock and counter stages). If an oscilloscope is available, check that the signal at pin-14 of IC2 is a pulse waveform with a frequency of approximately 2kHz and an amplitude of at least 2.6V.

MODIFICATIONS

Several useful modifications may be made to enhance the performance of the Electronic Die. The suggestions made here are provided as "food for thought" and should make a starting point for further development. Constructors are invited to report their own modifications to be incorporated in the Readers' Feedback which will appear in the final part of our Design series.

Dry battery operation

Rechargeable batteries are highly recommended for use in the Electronic Die however, some constructors may wish to keep the component cost to an absolute minimum by using conventional dry batteries. In such a case, it will be essential to reduce

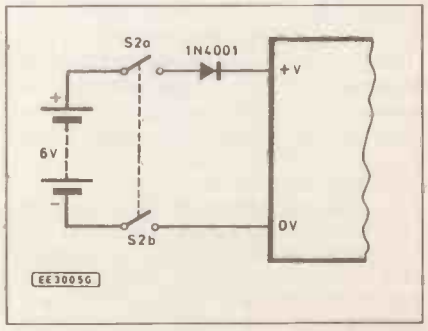


Fig. 10 Modification for operation from dry batteries.

the supply voltage to an acceptable value (four fresh dry batteries connected in series will produce a supply voltage in excess of 6V!).

The necessary reduction in supply voltage can be achieved simply by connecting a silicon diode in series with the supply, as shown in Fig. 10. The resulting supply voltage will be approximately 5.3V max. falling to about 4.5V at the end of the normal working life of the four cells.

Mains operation

The Electronic Die can be very easily adapted for mains operation. A suitable mains supply is the Dual Output Power Supply module which appeared in Part One of the series. The module should be fitted with a single positive 5V regulator (7805) and the negative output can simply be ignored. Fig. 11 shows the necessary circuit modifications.

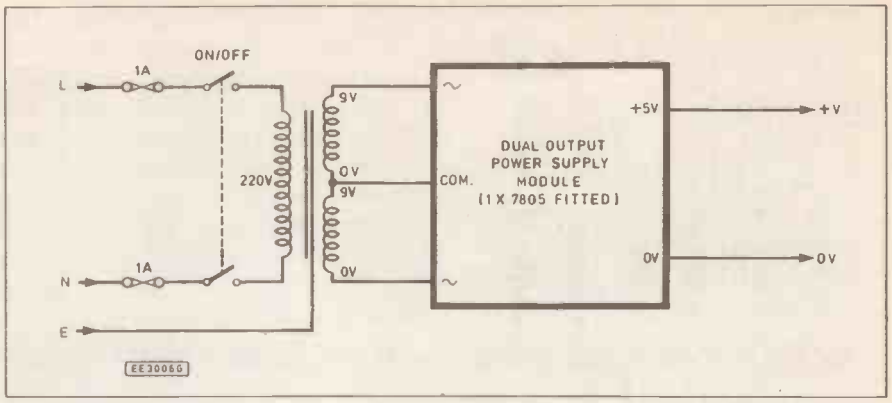


Fig. 11. Modification for mains operation

BLACK BUTTON BLUES

By Tony Hopwood

RADIOS and TV's have always been hostage to fashion. In the early days of radio, when the "C" in Beeb meant good company, the "wireless" was highly technical – usually a polished wooden box with a matt black front panel covered with knobs and switches, plus another box for the power pack and separate horn loudspeaker – all on a table or tidied into a mock Jacobean cupboard.

Many sets were fitted with doors to make them inscrutable and reassured those nervous of letting a device into the living room which could drag the wicked world into the family circle.

Full Frontal

In these full frontal days, the radio is still a box covered with knobs and switches but has lost its doors. It's also cloned a whole sinister stack of extra boxes all festooned with tiny knobs and switches – and all in Henry Ford's favourite colour – black.

For some reason, domestic electronics have gone black and computers a sort of biscuit colour. Megabucks have been spent across the globe to ensure that a mix 'n match CD player from Holland won't clash with an amplifier from Japan, and tuner from Taiwan. All very fine, but how do the humans who are supposed to use and enjoy this technological cornucopia fare?

Rather badly. Digital electronics is no respecter of those who are all fingers and thumbs, and from whom the years may have stolen 20/20 vision and added more than 625 lines to the frame.

Funny Instructions

Take the common-or-garden TV and video recorder. The instructions which accompany most of these technological miracles are vague, badly written and funny.

Apart from an assumption that the average user is fully computer literate and can divine the crucial details omitted in the interests of economy, they contain some wonderful statements of the obvious to make up for those omitted from the instructions. . . .

"Do not locate this television receiver where the cord will be abused by persons walking on it"

"Do not place your television on an unstable cart . . ." Wonderful. Come back Steptoe – at least the old telly on your cart had knobs on it. Which brings me back to black.

Remote Dog

These days everything has sprouted an infra red remote control. Some earlier remote controls worked on ultrasonics. I remember some friends rented a video recorder with one, and kept the service contract warm by continuously complaining that the recorder switched channels or stopped for no apparent reason . . . naturally each time the machine was taken back to the workshop it behaved perfectly.

One day one of the children noticed that the VCR changed channels when the dog shook itself, jangling its chain collar – mystery solved. The VCR was fixed by giving the dog a leather collar!

Today's remote controls are no longer pet sensitive, but are no less frustrating.

Take the controller. Naturally its black. Trouble is you have to peer at it to see which end to point at the set because some genius made it a clean rectangular box unrelieved with any tactile clues to stop you programming your stomach. Most of the buttons are black too, which makes it difficult to use in an average living room when the lights are turned down for comfortable viewing.

Eyesight Test

Setting up a TV or video recorder is a free eyesight test. The essential controls are hidden in a black hole behind a black fascia. When you have sussed out how to get at them, you will find the control buttons reduced to black pimples with tiny letters so that all but the keenest sighted must grovel on the floor with a torch to peer into the recess to see which button to press next.

Why all the buttons have to be black when they are concealed is a mystery to me. I don't think they are made from recycled plastic – that usually turns out accountant grey.

Until the designers get away from their black obsession we're all in for a long dose of the "black button blues" – that is unless someone is brave enough to offer me a tasty consumer electronics design consultancy!

The IGRANIC Neutrosonic De Luxe Radio Gramophone.

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The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full details are given on the last book page.

For another selection of books see next month's issue.

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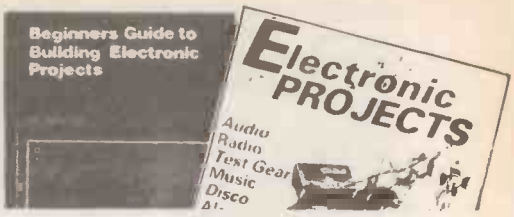

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BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.

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Ian R. Sinclair
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Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.
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Book 2 *112 pages* **Order code BP131** **£2.75**

SENSORS AND TRANSDUCERS
Keith Brindley
There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the Ideal, and only then can a totally satisfactory decision be made to use one in particular.
176 pages **Order code NE17** £12.95

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.
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50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components—the light-emitting diode (LED). Also includes circuits for the 707 common anode display
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BOOK 2 50 more l.e.d. circuits **Order code BP87** **£1.95**

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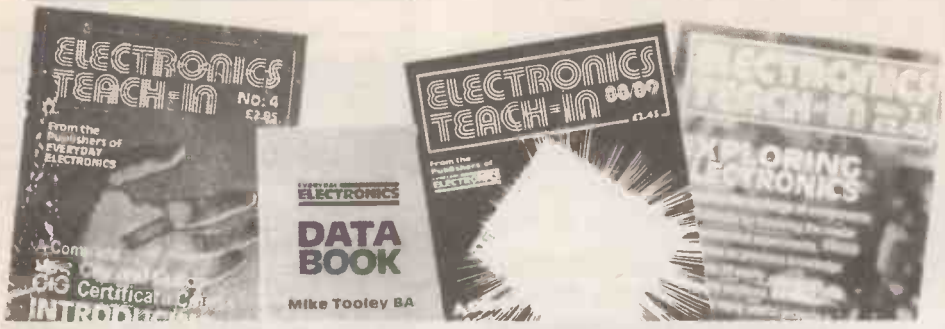
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.
80 pages **Order Code BP92** **£1.75**

TEACH-IN, THEORY, AND REFERENCE



ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book
112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS NEW
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Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?

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Owen Bishop
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Mike Tooley BA (published by *Everyday Electronics*)
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E. A. Parr
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ELECTRONICS – A "MADE SIMPLE" BOOK
G. H. Olsen
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EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
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It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!
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ELECTRONIC HOBBYISTS HANDBOOK
R.A. Penfold
Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.
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G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
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Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
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COMPUTING

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Michael Tooley
An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This first edition covers a vast range of subjects at a practical level, with the necessary explanatory text. The data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit.
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UNDERSTANDING PC SPECIFICATIONS NEW
R. A. Penfold
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range form simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM: RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!
104 pages **Order code BP282** **£3.95**

COMPUTERS AND MUSIC — AN INTRODUCTION
R.A. Penfold
Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone. Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.
174 pages **Order code PC107** **£7.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.

The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
64 pages **Order code BP232** **£2.95**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.
144 pages **Order code BP152** **£2.75**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.
144 pages **Order code BP119** **£2.50**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., C.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.
192 pages **Order Code BP112** **£3.50**

AUDIO & MUSIC

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
148 pages **Order Code BP256** **£2.95**

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages **Order code PC101** **£6.95**

DATA & COMPONENT IDENTIFICATION

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
Chart **Order code BP7** **£0.95**

TESTING & TEST GEAR

TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller
Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.
Chart **Order code BP70** **£0.95**

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold
This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits. Plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.
104 pages **Order code BP267** **£3.50**

RADIO, TV, SATELLITE

AN INTRODUCTION TO AMATEUR RADIO
I.D. Poole
Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.
This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.
150 pages **Order code BP257** **£3.50**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:
Listening to Short Wave Radio; ITU Country Codes; Worldwide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts In English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.
320 pages **Order code BP255** **£4.95**

AERIAL PROJECTS
R. A. Penfold
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.
Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
96 pages **Order code BP105** **£2.50**

NEW

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold
Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.
The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver; Contains everything you need to know in order to get started in this absorbing hobby.
88 pages **Order code BP275** **£3.95**

AN INTRODUCTION TO SATELLITE TELEVISION
F.A. Wilson
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
There is also plenty for the DIY enthuslast with practical advice on choosing and installing the most problematic part of the system—the dish antenna.
104 pages **Order Code BP195** **£5.95**

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmissions assessment are included, finally a short chapter on optical transmission.
256 pages **Order Code BP89** **£2.95**

AN INTRODUCTION TO VHF/UHF FOR RADIO AMATEURS
I. D. Poole
This book covers the essentials required to gain the most from using the VHF and UHF bands. As such it will be of use to both the newcomer and more experienced operator alike.
Topics included in this book include propagation, descriptions of the bands with outlines of the bandplans and channels, aerials, receivers, transmitters and a special chapter on scanners. In addition to this repeater and mobile operation are included as well as DXing and data modes together with a section on packet radio.
102 pages **Order Code BP281** **£3.50**

NEW

AN INTRODUCTION TO AMATEUR COMMUNICATIONS SATELLITES
A. Pickard
Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies. Even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.
There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.
This book describes several currently available systems, their connection to an appropriate computer and how they can be operated with suitable software.
102 pages **Order code BP290** **£3.95**

COMPUTERS AND MUSIC

— see computer section

MORE BOOKS NEXT MONTH

PCB SERVICE

Printed circuit boards for certain 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 overseas airmail. 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).**

We do occasionally have older boards in stock – please enquire.

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. Boards can only be supplied on a payment with order basis.

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BBC Sideways RAM/ROM	NOV'87	585	£4.10
Multi-Chan Remote Light Dim	JUN'88		
Relay/Decoder		601	£4.86
Dimmer Board		602	£3.07
Power Supply		603	£3.00
Video Wiper	JUL'88	612	£6.75
Tea Tune	AUG'88	609	£3.00
Time Switch		614	£4.84
Suntan Timer		610	£3.07
Car Alarm		615	£3.12
Breaking Glass Alarm	SEP'88	617	£4.27
EPROM Eraser	OCT'88	620	£4.07
Doorbell Delay	NOV'88	616	£3.56
Infra-Red Object Counter Trans	£9.28	622	£4.61
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Display	set	624	£3.05
Seashell Sea Synthesiser		625	£4.84
Downbeat Metronome	DEC'88	629	£4.84
EPROM Programmer *(On Spec)*		630	£8.29
Phasor		631	£5.64
Monkey/Hunter Game	JAN'89	634	£3.36
Continuity Tester	FEB'89	619	£2.67
Sound-to-Light Interface	MAR'89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
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4-Channel Auto-Fade Interface		642	£6.80
Pet Scarer	MAY'89	644	£3.00
Electron A/D Interface		645	£4.84
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Electronic Spirit Level	AUG'89	649	£3.85
Distance Recorder		651	£5.23
Treasure Hunter		652	£3.73
Xenon Beacon	SEP'89	650	£4.13
Probe Pocket Treasure Finder		653	£4.12
Power Supplies – Fixed Voltage		654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	64	£3.85
Power Supplies – 25V 700mA		656	£4.35
30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Power Supplies – 1.5V-25V 2A		663	£4.78
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Four-Channel Light Chaser		667	£6.70
Quick Cap Tester	FEB'90	668	£3.92
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Anemometer – Freq./Volt Board		670	£3.94
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Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR'90		
Display Driver		672 & 678	£4.22
Display and Sensor		671	£4.47

PROJECT TITLE		Order Code	Cost
Fermostat Mk2	MAR'90	677	£4.28
Superhet Broadcast Receiver-	cont'd		
Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR'90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser	MAY'90	689	£4.68
Quizmaster		690	£4.74
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control			
Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
Encoder Board B		695	£4.78
The Tester		696	£4.15
Mains Appliance Remote Control	AUG'90		
Mains ON/OFF Decoder		697	£4.55
(5 or more 697's ordered *together* £3.25 each)			
Simple Metronome		698	£3.94
Hand Tally	SEP'90		
Main Board (double-sided)			
Display		699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control			
Temperature Controller (p.c.b. only)		702	£5.20
Ghost Walker	OCT'90	703	£4.32
Frequency Meter		704	£5.25
Freq. Meter/Tachometer	NOV'90	705	£3.98
EE Musketeer (TV/Video/Audio)		706	£5.78
Colour Changing Christmas Lights	DEC'90	707	£4.39
Microcontroller Light Sequencer		708/709	£10.90
Versatile Bench Power Supply Unit		710	£4.24
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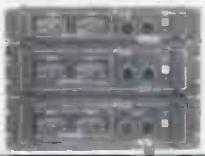

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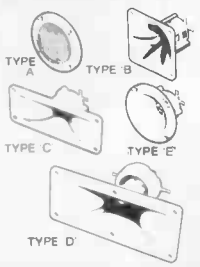

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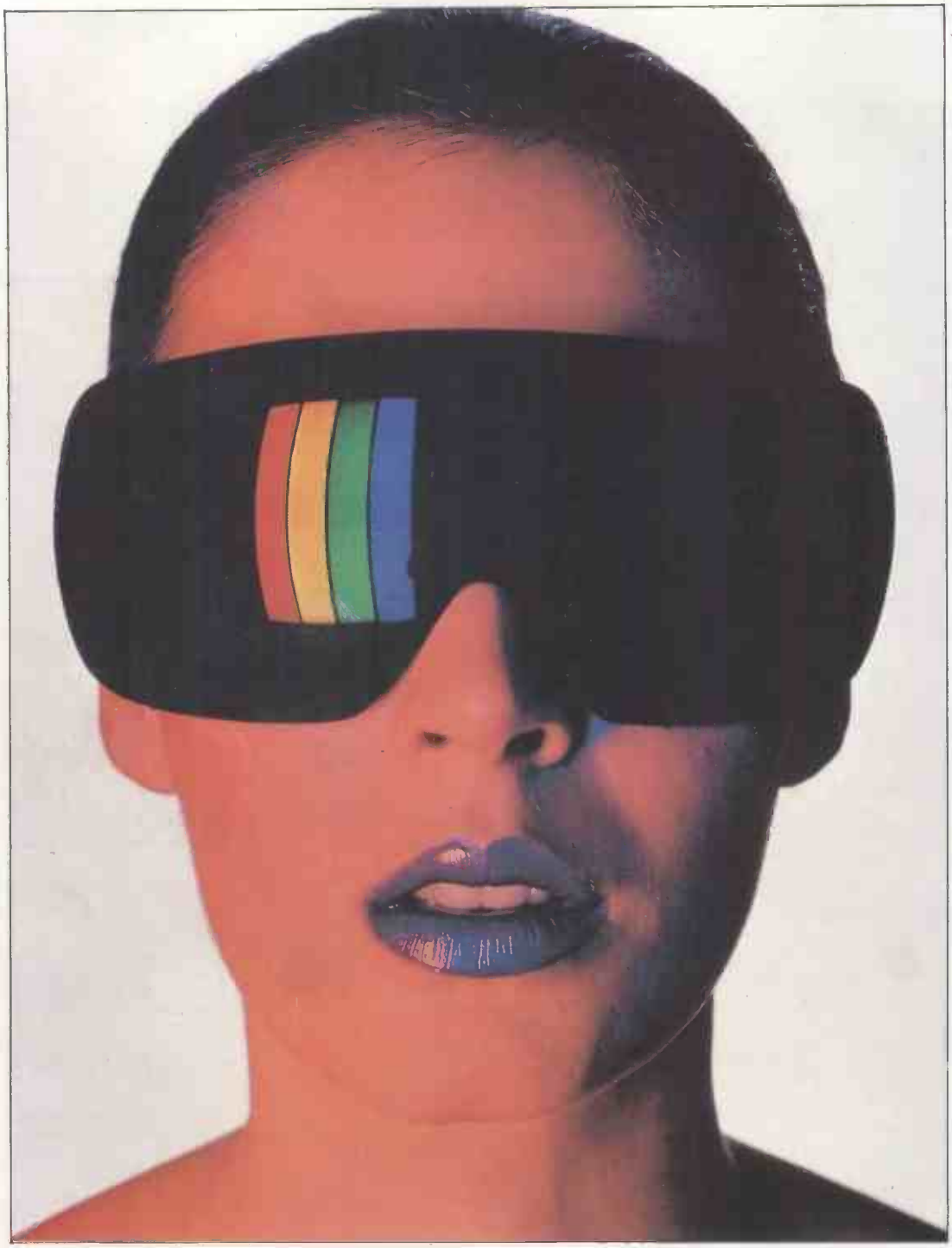
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85×85mm. **Price £3.99 + 50p P&P.**

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features 5 Inputs** with individual faders providing a useful combination of the following:—
3 Turntables (Mag). 3 Mics. 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360×280×90mm. Supply 220-240v.
Price £134.99 — £4.00 P&P

B. K. ELECTRONICS Dept EE

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL: 0702-527572 FAX: 0702-420243



NICAM...

...set your sights on a better sound!

Experience a new sensation. An experience that opens up a whole new spectrum of sound.

Put yourself on stage at the Albert Hall, surrounded by a great orchestra. Imagine the sound you will hear, every nuance, every note; or travel up the Nile with an intrepid explorer, a journey not only full of breathtaking beauty and colour, but rich in the sounds of another continent; or capture the hidden gasps of 100,000 hardened fans at Wembly for the F.A. Cup Final, when the ball skims the crossbar with the last kick of the match; follow with your ears as well as your eyes, dodging the bullets, as your favourite hero battles out of yet another tight corner, it's just like being in a cinema!

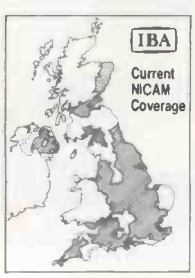
Nicam hi-fi stereo will turn your living-room into a living room of sound! You don't settle for second best with television picture quality, why settle for second best in television sound quality? Nicam sound is the new high quality digital stereo sound system, pioneered by BBC, ITV and TV/video manufacturers. In fact so good is Nicam it is comparable to the superb sound reproduction of the compact disc, when played through your existing hi-fi arrangement. If your television hasn't got a built-in Nicam decoder, you will need the Maplin Nicam Tuner System. Ultimately almost all of your favourite programmes will be broadcast in superb hi-fi quality stereo-sound. Without a Maplin Nicam Tuner you won't be able to capture every sound to its full.

Nicam hi-fi stereo. Catch your breath, open your eyes, and pin back your ears! It's what your hi-fi system was made for . . . It's what your ears are made for!

DIGITAL STEREO TV SOUND FROM YOUR HI-FI

The complete kit contains all the components required to build the unit. However you will also need: a power supply, 12V at 600mA regulated e.g. YZ21X at £8.95; a co-ax Y adaptor e.g. FS23A at £1.20; a co-ax lead to connect to your TV or video; RW36P 2m long at £1.28, JW39N 5m long at £1.98, or JW40T 10m long at £2.95; a phono lead to connect to your hi-fi e.g. RW50E at 98p or a SCART/Peritel lead JW36P at £4.95. An infra-red remote control kit is also available LP20W at £29.95.

Complete kit LP19V only £139.95 incl. VAT + £1 mail-order handling charge.



Maplin ELECTRONICS

CREDIT CARD HOTLINE

0702 554161

For a friendly welcome and the very best of service why not visit our shops in Birmingham, Brighton, Bristol, Leeds, London (Edgware and Hammersmith), Manchester, Newcastle-upon-Tyne, Nottingham, Reading, Southampton and Southend-on-Sea.

Subject to availability. Prices subject to change.

Digital stereo sound companion for your TV set.

GREENWELD

ELECTRONIC COMPONENTS

1991 SPRING SUPPLEMENT

FREE WITH THIS ISSUE OF **EVERYDAY ELECTRONICS**

FREE WITH EVERY ORDER!!★

This useful craft knife!

PLUS **FREE** WITH ORDERS OVER £100★

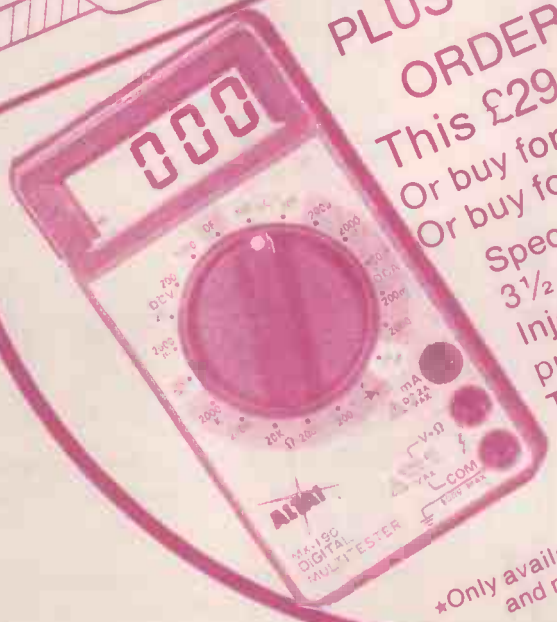
This £29.95 Digital multimeter

Or buy for just £5 with orders over £50

Or buy for just £10 with orders over £20

Spec: Model MX190 - 19 ranges - 3½ digit 12mm - LCD Display - Signal Injector Function - Diode test - Fuse protection - Auto polarity & zero - Test leads with 4mm plugs. Battery & instructions included. Size 126 × 70 × 24mm.

★Only available with orders from this catalogue and must include the voucher below affixed to the order form.



Free Craft knife ☐

Multimeter:

Orders over £100 - Free ☐

Orders over £50 - £5 ☐

Orders over £20 - £10 ☐

TEL: (0703) 236363 FAX: (0703) 236307

Welcome to our Spring Supplement.

I do hope you find lots of interest within its 32 pages - we've featured some top selling lines from our 1991 catalogue and added a great many new products. A number of books are shown on page 7 and an expanded range of telephone accessories on page 9.

Our Bargain List goods starting on page 13 feature many exciting products at prices way below those you'd normally expect pay. See pages 24-25 for some exceptionally low prices on power supplies, both switch mode and conventional. On page 23 is a large selection of new packs; pages 26 & 27 show seven segment LEDs from 10p each and mains indicators from just 6p!

I look forward to receiving your order soon.

Peter Green

Peter Green
Managing Director

CONTENTS

ORDERING INFORMATION

VAT is included in all 1 off prices in this catalogue, except for books which are ZERO rated; when using quantity prices, add 15% VAT. We accept cheques (but please, to avoid prohibitive bank charges, not less than £3,00; stamps are quite acceptable for small amounts), P.O's, Money orders, Cash, including foreign currency bank notes, book tokens, Access and Visa. We also accept Official Orders from Schools, Colleges, ITeCs and other Government funded sources. Monthly account facilities are available to Companies and trade customers. Ask for details. Write your order on the form in this catalogue (or use an Official Order Form). In the UK add £2.00 part postage costs to all orders and send it to:

Greenweld Electronics Ltd
27 Park Road
Southampton
SO1 3TB
United Kingdom

Most orders are despatched within a day or two, but some may be delayed because of temporary non-availabilty of goods.

HOW TO CONTACT US:

By Post: Use the address above
By Phone: (0703) 236363
(Ansaphone out of business hours)
By Fax: (0703) 236307
By Telex: 3762848 (COMPUSERVE) To: 100014,1463
By EMail: Compuserve 100014,1463

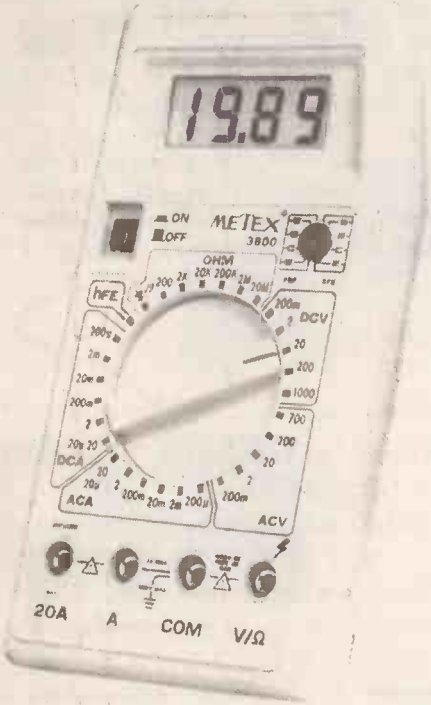
We are happy to despatch orders to anywhere in the world. The most convenient way to order is by Fax, and the best way to pay is by credit card. Our International Telefax number is +44 703 236307, although you may of course telephone us on +44 703 236363, or write to us. Overseas orders are exempt from VAT, and 13% should be deducted from prices shown, except books, which are zero rated. A guide to postage charges is shown below:

Weight	Europe Surface	Europe Air	Rest of World Surface	Rest of World Air
250g	£2.10	£2.10	£2.10	£5.00
500g	£3.10	£3.10	£3.10	£7.50
1kg	£4.68	£4.68	£4.70	£9.50
2kg	£7.00	£7.00	£8.20	£13.50
5kg	£12.20	£16.70	£12.40	£25.50
10kg	£16.20	£24.70	£19.40	£45.50

RETURNS: In order to offer a better service on returns, it is essential to follow the following instructions:

If for any reason it is necessary to return your goods to us, a returns number must be quoted. Ring, or write explaining why you wish to return goods and you will be given a number. No responsibility can be accepted for goods returned without this number.

OUR TOP SELLING METEX MULTITESTERS



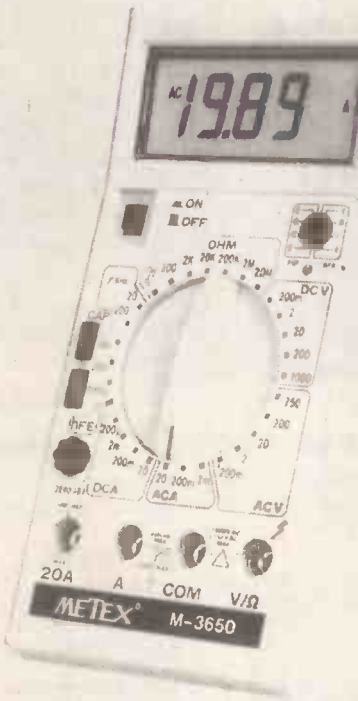
Y122F **10MΩ** **M3800**

- ★ 3½ digit 12mm LCD display
- ★ 32 ranges including **20A ac/dc**
- ★ Transistor test
- ★ Diode test
- ★ Rugged yellow case
- ★ Test leads with shrouded 4mm plugs
- ★ Carrying case
- ★ Fuse protection
- ★ Automatic polarity and zero

Battery and instruction manual included.

AC volts	0-200m-2-20-200-700Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.5%
AC current	0-20μ-200μ-2m-20m-200m-2A-20Aac ±1%
DC current	0-20μ-200μ-2m-20m-200m-2A-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Transistor hFE	0-1000 PNP/NPN
Dims	172 x 88 x 36mm

Price **£37.00** 5+ 26.67



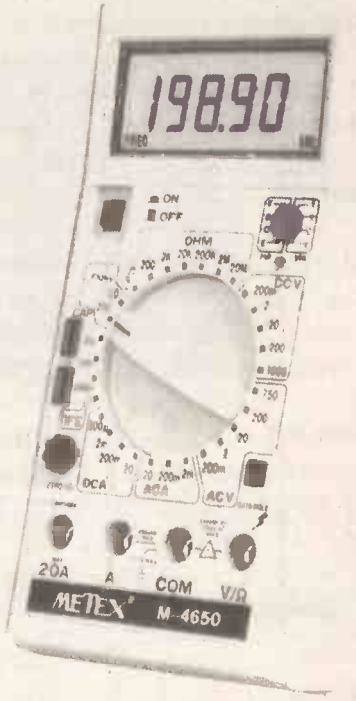
Y123HC **10MΩ** **M3650**

- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including **20A ac/dc**
- ★ **Frequency** counter
- ★ Capacitance test with zero adjust
- ★ Continuity test with LED indicator and buzzer
- ★ Transistor and diode test
- ★ **Built and tested to IEC348**

Fully shrouded test leads, battery, instruction manual and carrying case included.

AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-2m-200m-20Aac ±1.8%
DC current	0-200μ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Capacitance	0-20p-200n-20μF ±2.0%
Frequency	0-20k-200kHz ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

Price **£62.00** 5+ 42.48



Y123HD **10MΩ** **M4650**

- ★ 4½ digit 15mm LCD display
- ★ 30 ranges including **20A ac/dc**
- ★ **Frequency** counter
- ★ **Capacitance** ranges with zero adjust
- ★ Transistor and diode test
- ★ Continuity test with LED and buzzer
- ★ **Data hold** switch
- ★ **Built and tested to IEC348**

Fully shrouded test leads, battery, carrying case and instruction manual included.

AC volts	0-200m-2-20-200-750Vac ±0.5%
DC volts	0-200m-2-20-200-1000Vdc ±0.05%
AC current	0-2m-200m-20Aac ±1.0%
DC current	0-200μ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.15%
Capacitance	0-20p-200n-20μF ±2.0%
Frequency	0-20k-200kHz ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

Price **£94.00** 5+ 63.52

A full range of Analogue & Digital Multitesters from £7.95 is shown in our main catalogue. See page 30 for details.

ALL 1-OFF PRICES INCLUDE VAT - QUANTITY PRICES DO NOT

Wireless microphone systems available as a complete kit or in seperate parts. All operate on the standard frequencies allocated to wireless microphones systems (173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz and 175.0MHz).
Please note that unless specific frequencies are requested, orders will be supplied with random frequencies from current stock.

£169.95 PROFESSIONAL WIRELESS MIC SYSTEM WMS202

A complete wireless microphone system comprising a G201 receiver with matching G202 microphone, windshield, 1.4m patch lead for connection of receiver to amp/mixer and one pair of racking brackets for the receiver. All packed in a tough vinyl case.

Receiver

Receiving frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Receiving system	Single super heterodyne conversion FM detector
Intermediate frequency	10.7MHz
Antenna impedance	75Ω
RF sensitivity	0.7μV
S/N ratio	Better than 90dB
Squelch threshold	Adjustable from 10dBμV to 40dBμV
Image and spurious rejection	At least —80dB
De-emphasis	75μS
Audio output level	250mV at 600Ω
Audio harmonic distortion	Less than 0.5%
Power	240Vac 50Hz/12Vdc
Dims	190 x 54 x 200mm

Transmitter:

Receiving frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Frequency stability	0.005%
Modulation system	Crystal controlled FM
Harmonic and spurious output power	Less than —45dB below carrier level
Pre-emphasis	75μS
Max frequency deviation	±50kHz
Frequency response	70Hz - 12000Hz
Distortion	Less than 0.5%
S/N ratio	Better than 87dB
Ambient temperature range	0°C - 40°C
Operating voltage range	3.8V to 4.5Vdc

£95.00 SIGNAL RECEIVER RC300

Professional wireless microphone receiver for use with G202, G203 and G204 transmitters. Single super heterodyne system for dependable operation. 2-channel, 5-LED indicators for carrier and output signal levels. Output gain and signal squelch controls.

Power .... 240Vac 50Hz or 12Vdc via external adaptor (not supplied)

Receiver specification same as G200 (WMS202)

£75.00 WIRELESS MIC HT300

Professional wireless mic. Shock proofed high quality dynamic insert. Crystal controlled direct FM transmission for stable oscillation frequency under changing temperature and battery voltage conditions. Low battery and mic on indicators on base.

Power ..... 3 x AA batteries (not included)

Receiver specification same as G200 (WMS202)

TIE CLIP MIC

£60.00 PT300

Tie clip wireless mic. High quality electret insert connected to transmitter pack by 1.6m lightweight screened lead. Lightweight transmitter pack (125g with batteries) with belt clip and on/off switch.

Power ..... 3 x AA batteries (not included).

Transmitter specification same as G200 (WMS202)

GUITAR TRANSMITTER

£58.00 GT300

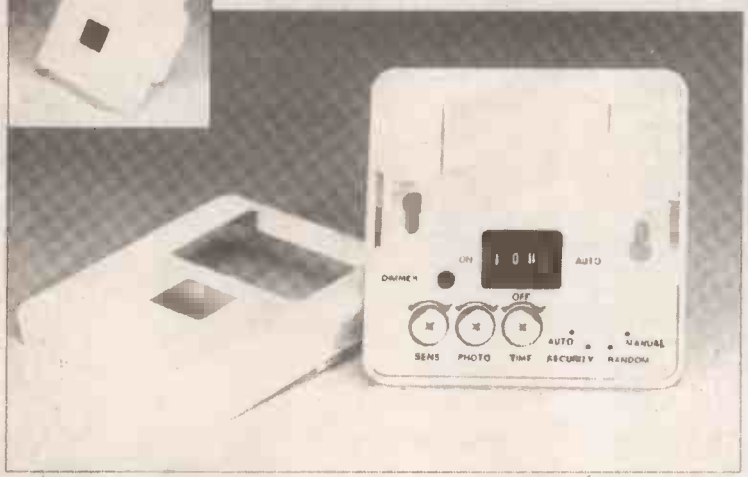
Professional wireless guitar transmitter. Guitar connected to transmitter pack via a 1.4m double screened noiseless lead, with 6.35mm plug. Lightweight transmitter pack (125g with batteries) with on/off switch and belt clip.

Power ..... 3 x AA batteries (not included).

Transmitter specification same as G200 (WMS202)

TEL: (0703) 236363 FAX: (0703) 236307

P.I.R. AUTOMATIC LIGHT SWITCH F602 (PIR1000)



- Automatically switches light on when you enter the room, and off when you leave.
- Flashes the lights on and off rapidly when an intruder is detected.
- Switches the lights on and off at random periods while you are out or on holiday.
- Also acts as a conventional light switch.

The PIR1000 is an automatic, hands-free light switch. It turns the light on automatically when you enter the room by detecting your body heat and comparing it against the background temperature. When you leave the room the light will gradually dim over twelve seconds and finally switch off. This avoids any potential hazard from the room suddenly being plunged into darkness. In addition to its main function as an automatic light switch the PIR 1000 offers: manual override, in which it will perform like any ordinary light switch; security function in which it will act as an alarm, flashing the light on and off and auto function which will act as a burglar deterrent, switching the light on and off at random times for random periods, simulating occupancy of the house. The PIR1000 offers convenience, safety, energy savings and security in one package.

Price **£27.95**
5+ 21.24

XENON STROBE L118A (LE127)

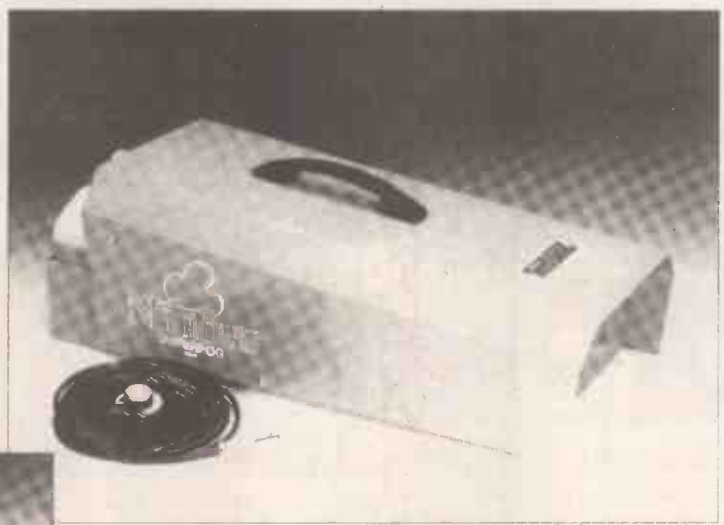
Low profile, fully sealed weatherproof flasher containing a high intensity long life xenon tube. Reverse polarity protected. Typically used on alarm boxes as a visual backup. Blue lens. Two bolt fixing.

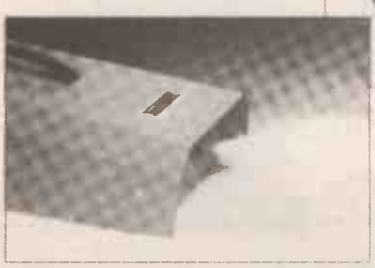
Power output.....1W
Voltage.....12Vdc
Curreny.....150mA
Flash rate.....120/min
Dims.....70 (dia0 x 64mm
Fixings.....2 x M5 screws on 56cm centres

Price £7.95 10+ 4.62

SMOKE MACHINE G002A (NSM2)

The Nimbus Superfog is a high quality, powerful smoke machine using an industrial quality pump and heater. Smoke generation is remotely controlled by an electronic handset connected by two-core cable to the smoke machine. The fluid tank is removable for clean filling.





Heat up time.....6 minutes
Fluid flow.....1.5 cc/min @ max.
Max. continuous output.....30 seconds
Reheat time after max. output..1.5 mins approx.
Smoke generation.....0-max. infinitely variable
Power.....240Vac 1.1kW
Dims.....480 x 240 x 170mm

Price £250

SMOKE MACHINE FLUID G002AA (5LF)

5 litre bottle of smoke generating fluid for use with smoke machines. Particularly recommended for use with the Nimbus smoke machine (G002A). Non-toxic. Medium persistance.

Price £17.50

HEADSHELL G050Z (HS1)

Universal cartridge headshell. Replacement headshell for G050 (DLP1) and G053 (DLP3)

Price £1.95 50+ 0.95

POWER SUPPLY

A plug-in power supply conforming in all respects to the relevant paragraphs of BS415. Plugs directly into 13A socket. Output via 1.8m lead to 4-way spider plug and PP3 battery clip. Polarity reverse switch. Thermal fuse overload protection.

Input voltage.....240Vac 50Hz
Output voltage.....3, 4.5, 6, 7.5, 9, 12Vdc
Output current.....300mA
Stability.....40%
Ripple.....1V
Dims.....74 x 52 x 55mm

P007M (ALA89)

~~£4.95~~

£3.50
50+ 2.24+VAT

WARNING: This unit is not stabilized. Its maximum rating is 300mA, and if less current is drawn there is a corresponding voltage rise. At less than 150mA this rise could be

TEL: (0703) 236363 FAX: (0703) 236307

PROFESSIONAL DISCO TURNTABLE

High quality, belt driven, fully manual, disco turntable. Fast start and stop from push button switch. Electronically controlled 33/45rpm with pitch control and strobe. Well balanced tone arm with anti-skate control. Built-in record cue light. Complete with leads and 7" single adaptor.

Wow and flutter	Less than 0.15- wrms
Turntable platter	309mm dia. aluminium
Speed	31/3 rpm and 45 rpm
Tone arm	Statically balanced
Power supply	240V 5060Hz
Power consumption	5.0W
Dims	419 (W) x 115 (H) x 335 (D) mmm
Net weight	10kgs

G050 (DLP1)

~~£130.00~~

£120.00
4+ 95.00 +VAT

STEREO VIDEO MIC

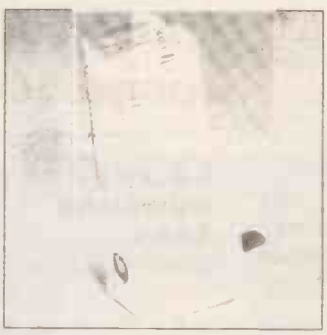
High quality stereo electret condenser video microphone. Satin black anodised aluminium body. Supplied with short lead fitted with 3.5mm stereo plugs for use on video camera, and 3m lead fitted with 3.5mm stereo plug and two 3.5mm mono plugs for remote use. Extras include two 3.5mm to 6.35mm mono adaptors, windshield and mic holder. Packed in a strong vinyl case.

Type	Stereo uni-directional electret cond.
Impedance	600Ω
Response	50 - 18000Hz
Sensitivity	-65dB ±3dB @ 1kHz
Dia	22mm
Length	197mm

G164 (EM800)

~~£22.95~~

£14.95
10+ 9.90+VAT



NIGHT LIGHT F318D (NL505)

Plug-in night light with built-in photo sensor which will switch the light on at dusk and off at dawn. Illumination is by a commonly used 7W Eddison screw bulb contained safely behind a fresnel lens. Plugs directly into a 13A socket. Power: 240Vac 7W max.

Price £3.95 20+ 2.61

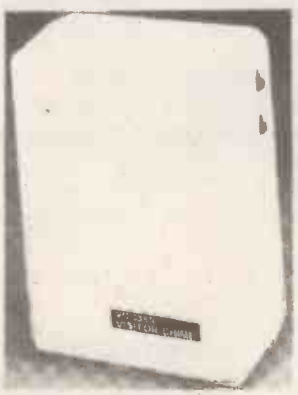
GREENWELD ELECTRONIC COMPONENTS

UHF/VHF/FM ANTENNA with built-in amplifier T143A (UKEU670S)

The EU670S antenna has many useful features, not least of which is the dual voltage input which allows it to be used in the home or whilst camping, picnicing, boating, etc. The antenna dish can be rotated left or right to pick up the best signal which can then be boosted using the built-in amplifier and gain control. The EU670S antenna may be used as an amplifier for an external (roof) aerial. LED indicators indicate which aerial is in use (red = integral antenna, green = external antenna). As the amplifier gain is increased, the amplifier will automatically switch from external to integral aerial.

Gain	20dB VHF, 30dB UHF
Gain control	0-30dB
Max. output level	100dBμV
Power	220/240Vac or 12Vdc

Price £17.95 5+ 10.91



DOOR ANNUNCIATOR T072 (VC338N)

Self-contained door annunciator (requires no external switches, contacts, reflectors, etc.) Loud two-tone chime sounds when the beam is broken. Requires two D batteries (not included). Portable or wall mounted. Dims: 115 x 80 x 60mm

Price £4.95 20+ 2.75

12Vdc CAR FAN B047 (SC711)

A 12Vdc oscillating car fan with a large suction cup for attaching the fan to the dashboard. Fully adjustable for tilt and angle. Supplied with a 1.7m lead fitted with a cigar lighter plug.

Price £8.95 10+ 5.29

A full range of products can be found in our catalogue - see page 30 for details.

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Babani Electronics Radio & Computer Books

Please note the following changes to books listed in the 1991 catalogue: BP130 now £2.75; BP273 title is 'Practical Electronic Sensors'; BP275 title is 'Shortwave Superhet Receiver Construction, price £2.95; BP283 now £4.95.

The following titles are all due to published later this year; we will send any ordered by you on publication.

A CONCISE INTRODUCTION TO MICROSOFT WORKS BP294
£4.95 N Kantaris & P R M Oliver
If you are a PC user and would like to get to grips with Microsoft Works, then this book will teach you how to do just that in the shortest and most effective way.
0 85934 239 51991198 × 130mm160pp

A CONCISE INTRODUCTION TO WORD FOR WINDOWS BP295
£4.95 N Kantaris
Similar in concept to the above book but this time dealing with the word processing package Word for Windows, which is fully WYS/WYG and mouse controlled.
0 85934 240 9 1991918 × 130mm 128pp

A CONCISE INTRODUCTION TO Q & A BP296
£4.85 N Kantaris
Again similar in concept to the above but this time dealing with the integrated word processor/database package Q & A which also provides an 'Intelligent Assistant'.
0 85934 241 7 1991198 × 130mm128pp

A further 200+ titles are shown in our main catalogue. For details of this 132 page publication see page 30.

LOUDSPEAKERS FOR MUSICIANS BP297
£3.95 V Capel
Contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals.
It gives tips on constructing cabinets, wiring up, available fittings, finishing and how to connect multi-speaker arrays etc.
Ten enclosure designs with plans and comments are given in the last chapter.
0 85934 242 5 1991 178 × 111mm 160pp

CONCISE INTRODUCTION TO THE MACINTOSH SYSTEM AND FINDER BP298
£3.95 J Glenwright
If you have one of the popular Macintosh range of computers, this book is designed to help you get the most from it. Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms.
All Macintosh computers are covered including the new'Classic' range.
0 85934 243 3 1991 198 × 130mm 112pp

PRACTICAL ELECTRONIC FILTERS BP299
£3.95 O Bishop
Contains a number of designs of varying complexity, application and type of electronic filters, also covers some of the necessary theory in an unmathematical way as possible.
0 85934 244 1 1991 178 × 111mm 144pp

SETTING UP AN AMATEUR RADIO STATION BP300
£3.95 I Poole
Just as the title describes, all you need to know to go about setting up an efficient 'Ham' shack.
0 85934 245 X 1991 178 × 11mm 128pp

ANTENNAS FOR VHF AND UHF BP301
£3.95 I Poole
The theory and practise of making VHF and UHF aerials, and contains many practical designs.
0 85934 246 8 1991 178 × 111mm 128pp

New Series of Electronic Pocket Guides

6 books to be published over the next few months; the first is available now.

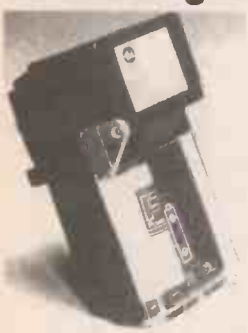
BP501 TTL Pocket Guide Vol 1
Lists all commonly used TTL components describing their structure, operation and typical application. Covers 7400-74200. Size 187 × 106mm 286 pages.
Price £11.95

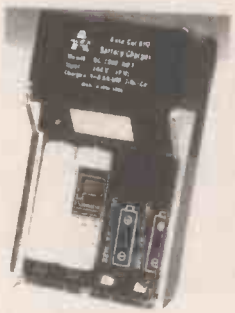
TEL: (0703) 236363 FAX: (0703) 236307

Ni-Cad Batteries . . .

Code	Type	Rating	1+	25+	100+
X131	AAA	180mA/H	£1.20	0.85	0.68
X132	AA	500mA/H	99p	0.72	0.58
X133	C	1.2A/H	£2.20	1.76	1.41
X134	D	1.2A/H	£2.30	1.82	1.46
X135	PP3	110mA/H	£3.95	3.26	3.10

and charger for them.



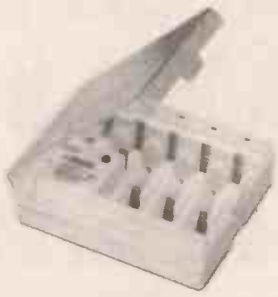


A124 Compact plug in charger for up to 4 AA type Nicad batteries. Unit plugs directly into 13A socket and can charge 2 or 4 penlight cells simultaneously. Separate LED indicators show when charging point is working. Tough black plastic case with transparent lid. Built-in thermal fuse for extra protection.

Input voltage 240Vac 50Hz
Charging current ..... 4 × 45mA
Charging time ..... 10-16 hours
Charges ..... 4 × AA batteries
Dims ..... 108 × 64 × 51mm
Price ..... **£4.95** 10+ 3.18 25+ 2.55

A125 Fastcharger. Compact plug-in charger for up to 4 AA type Nicad batteries. High charging current cuts charging time from 15 hours to approximately 3 hours. AUTO CUT-OFF switches charger off automatically when batteries are fully charged. Touch sensitive reset plate. Tough plastic case with sleeved pins.

Input voltage 240Vac 50Hz
Charging current 150mA
Charging time ..... 2-3 hours
Charges ..... 4 × AA batteries
Dims ..... 107 × 65 × 53mm
Price ..... **£5.95** 10+ 4.94 25+ 3.95



A123 This neat and attractive charger will charge 4 different sizes of battery: RX6, RX14, RX20 and RX22 either singly or in any combination. The charge time is 7-8 hours for RX6 batteries or 14-16 hours for other sizes. This attractive produce incorporates a test facility to check whether or not a battery needs charging. The CX 600 is supplied in a single display box.

Price ..... **£6.95** 10+ 4.12 25+ 3.30

CX2000 This large and versatile battery charger will recharge the complete range of domestic rechargeable batteries. It will charge up 8 1.2V batteries, and/or up to 3 RX22 batteries, in various combinations simultaneously. It is designed to complete the recharge in 14-16 hours.

The CX2000 incorporates reverse polarity protection and LED charging indicators. A battery tester is provided to check whether a battery needs charging or not. Stylishly designed in an attractive white, it is simple and easy to operate and is supplied in an eyecatching display box.

Price ..... **£18.95** 5+ 15.39 25+ 13.11

NEW CAMCORDER BATTERIES. Top quality Uniross rechargeable Nicad and sealed lead acid camcorder batteries for all popular models.

VP66 6V 1700mAh Ni-Cd

£27.00

REPLACEMENT FOR:-

FISHER	FVC901
FUJI	F610
NIKON	VN9000
PENTAX	PVC840, PVC840E
RICOH	R610, R630
SANYO	VMD3, VMD5
SONY	CCDV88, CCDV90, CCDV95, CCDF330, CCDF335, CCDF340, SP5
TAMRON	CX7

VP752 9.6V 1500mAh Ni-Cd

£30.00

REPLACEMENT FOR:-

AKAI	PVC8
FERGUSON	3V50, 3C03
J.V.C.	GRC2, GRC7
MITSUBISHI	HSC20
NORDMENDE	CV2102, CV2201
PHILIPS	VKR6830
SHARP	VLC73HA, VCC50
TELEFUNKEN	VM2895, 1890
TOSHIBA	SK60P

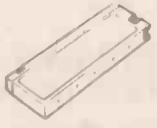
VP962 9.6V 1000mAh Ni-Cd

£30.00

REPLACEMENT FOR:-

BAUER BOSCH	VCC606AF, VCC616AF, VCC656AF
FERGUSON	FC05, FC06, FC07, FC08, FC15
J.V.C.	GRC9, GRC11, GRC30, GRC45, GRC60, GRS77E
MINOLTA	C50
NORMENDE	2201, RP3000
PHILIPS	VKR6835, VKR6841
PANASONIC	VMC6, VMC10, MS50
TELEFUNKEN	VM2895, VM2892, VM4000, VM4100
TOSHIBA	A1420BK

VP30 12V 2300mAh Sealed lead



£31.00

REPLACEMENT FOR:-

BAUER BOSCH	VCC526, VCC550
CANON	VR30
OLYMPUS	VR104
PANASONIC	NVM7B, M5, MS1, NV180, TC30CTV
PHILIPS	VKR6820, VKR6851

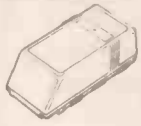
VP22H 6V 1700mAh Ni-Cd

£27.50

REPLACEMENT FOR:-

FISHER	FVCP801
FUJI	P300AF, P600AF
PIONEER	VEM8
SANYO	VMD1, VM8, VCR88
SONY	CCDM8E, V8, V8AF, V7, V30 V50, V100, V200, M10, EVC8, MPKM8
VIVITAR	MAGIC 8

VP522 12V 1500mAh Ni-Cd



£40.00

REPLACEMENT FOR:-

HITACHI	VM200, VM500, VM600
LOEWE OPTA	CC90
MITSUBISHI	HSF10
PENTAX	PV11

VP520 12V 1500mAh Ni-Cd

£45.00

REPLACEMENT FOR:-

HITACHI	VMC30, VMC40
MITSUBISHI	HFC30

TEL: (0703) 236363 FAX: (0703) 236307

COMMTEL
TELEPHONE ACCESSORIES

APPROVED for connection to telecommunication systems specified in the instructions for use subject to the conditions set out in them.

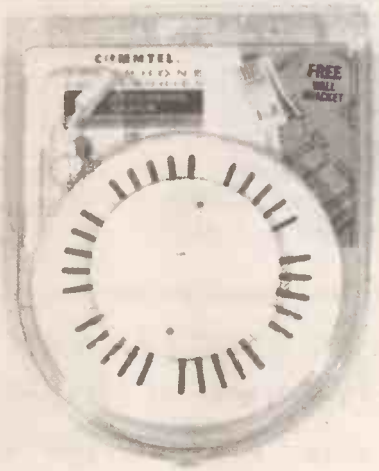
The COMMTEL range of BT approved telephone accessories are manufactured using the finest quality materials for reliability. Each of the accessories is individually bubble packed, ready for display.

P200 (C5009)
3 metre
Extension Lead
£1.98 50+1.33

P201 (C5010)
5 metre
Extension Lead
£2.32 50+1.55

P202 (C5014)
5 metre
Curly Extension Lead
£3.80 30+2.55

P203 (C5011)
10 metre
Extension Lead
£3.32 50+2.22



P204 (C5000)
15 metre
Extension Cable Reel
£7.98 10+5.35

P205 (C5003)
15 metre
Extension Kit
£6.40 20+4.15

P210 (C5006)
Double Adaptor
£1.66 50+1.11

P211 (C5016)
Bell Ringer
£5.95 20+3.95

P212 (C5017)
Compact Socket
£1.36 40+0.91

P213 (C5018)
Telephone Plug Kit
£1.38 40+0.92

TEL: (0703) 236363 FAX: (0703) 236307

Scart Leads

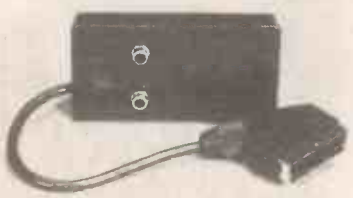
P295 SCART plug to 6 phono plugs 1.5m long795p

P294 Scart Plug to Scart Plug. All circuits connected. 1.5m long.
Price £4.95
P293 As above but 5m long.
Price £8.95

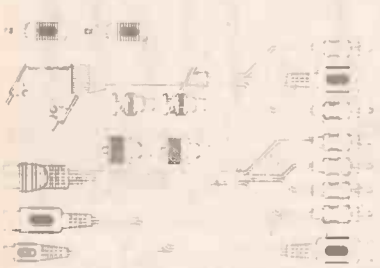
P292 Scart Plug to Scart Socket (Extension lead). All circuits connected. 3m long.
Price £6.95

T113Z Scart Adaptor. Scart plug to 2 scart sockets. For coupling together 3 pieces of audio/ video equipment with scart sockets.
Prices £14.95

T113W Scart Adaptor. Scart plug to 5 scart sockets. For coupling together 3 or more pieces of audio and video equipment with scart sockets.
Price £17.95



T113Y Audio Breakout Box. A scart adaptor to tap off the audio signal from TV or video and feed it into hi-fi systems. Scart plug to scart socket adaptor with audio out via 2 × phono sockets with audio/ video sound change-over switch.
Price £9.50



T113S SCART lead kit consisting of:
1 lead scart plug to 5-pin DIN plug and 2x phono plugs. 1.5m
1 lead 6-pin DIN plug to 5-pin DIN socket and phono socket. 0.2m
2 phono socket to BNC plug adaptors
2 phono socket to PL259 plug adaptors
2 phono socket to 3.5mm plug adaptors..... 895p

Switching Units

X441 3-way stereo sound and video switching box for selecting between three audio/ video inputs to a single audio/ video output. All black slimline case with chrome soft touch switches. Supplied with a 1.5m, 3 phono plugs to 3 phono plugs connecting lead. Packed on an attractive blister card.
Prices ..... £14.95 5+ 9.45

X425 8-way amplifier to supply 8 TV's from one antenna. White plastic box with aluminium panel. On/off switch with neon.
Band width 40MHz-860MHz
Gain ..... 3dB per cahnnel. Total 21dB
Impedance 75Ω
Max. output 80mV (38dBmV)
(signal/cross modulation=46dB)
Noise 6dB
Isolation between outputs ..... 40dB min.
Power 240Vac 50Hz
Dims ..... 250×100×60mm
Prices ..... £27.95 3+ 18.00

WIRELESS MICROPHONE

G210 2-part wireless microphone system designed for use with video cameras. The hand-held microphone has a high/ low power switch to select the transmission range (up to 200ft). The receiver has a video camera mounting shoe, volume control and integral output lead to 3.5mm mono plug. The system allows for greater flexibility with the microphone than can be achieved with a conventional microphone. Complete with vinyl carrying case.
Prices ..... £34.95 3+ 26.50

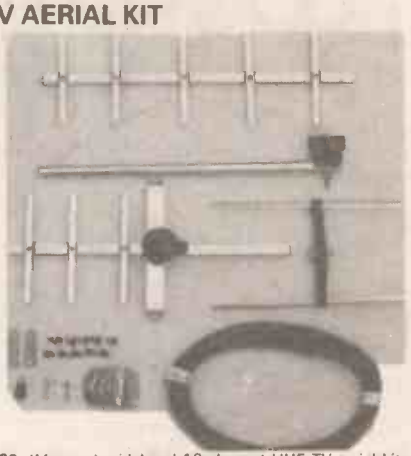
VIDEO MIXERS

MX350 3-channel portable stereo video sound mixer. Inputs from camera audio, stereo microphone and music source. Output to video recorder controlled by master volume. Earphone monitor socket. Powered by internal battery or external power supply. Supplied complete with 4 connecting leads and a 6.35mm stereo adaptor.
Prices ..... £29.95 3+ 22.58

MX300 This versatile mixer is an essential part of editing videotapes. It allows inputs from camcorder or second video recorder (phono), cassette recorder or other music source (phono), and 2 microphones (3.5mm). The original soundtrack can be monitored and there is a master output (phono) ot the VCR. Power can be a PP3 battery or an external 9V source. Smartly styled in a sloping front case with a matt black finish. The overal dimensions are
Price ..... £24.95 5+ 18.90

T128C A stereo sound and picture enhancer designed to improve picture and sound quality when recording from tape to tape or from camera to tape. Audio and video gain controls and picture stabilizer. Input and outputs via phono sockets. Requires an external 12Vdc 100mA power supply.
Audio frequency range 100Hz-1kHz
Video frequency range 0.5MHz-5MHz
Audio gain ..... 15dB min
Video gain ..... 4dB min 8dB nor
Audio gain adjust ..... 20dB min
Video gain adjust ..... 20dB min
Prices ..... £23.95 5+ 15.40

TV AERIAL KIT



X422 'Mercury' wideband 10 element UHF TV aerial kit - universal wall or loft mounting - suitable for colour or black and white. Contains 10m low coax cable, fixing clips, coax plug, bracket and fixings, aerial in 3 sections.
Prices ..... £9.50 5+ 7.12

VHS Video Tape

E180 Top quality blank 3hr VHS video tape. Manufactured under licence of Victor Company of Japan. Each packed in attractive cardboard sleeve and cellophane wrapped. Super grade 'A' quality.
Prices ..... £2.50 10+ 1.80 40+ 1.50 200+ 1.35

TEL: (0703) 236363 FAX: (0703) 236307

GLUE GUN OFFER

A hot melt glue gun suitable for home and industry. Electronically controlled heating element which melts the longstick of solid glue when inserted into the back of the gun. A smooth flow of adhesive is controlled by the trigger feed. Suitable for a wide range of materials including most metals, PVC, concrete & asbestos.

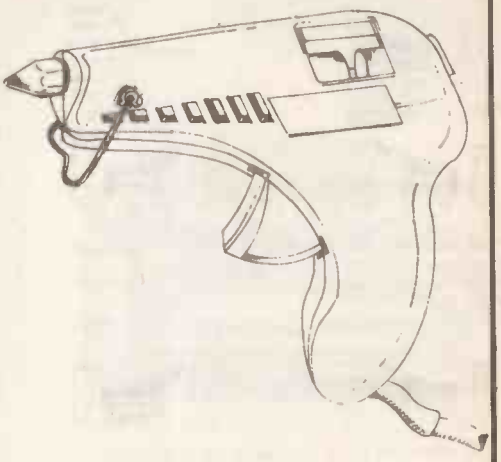
Supplied with a FREE stick of glue!

Normally retails around £9.95

OUR SPECIAL OFFER PRICE £4.95

Order Code Z8892

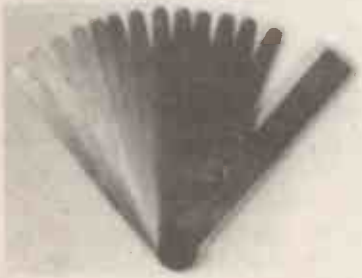
87-0405 Pack of 10 glue sticks £1.00



NEW TOOLS AND ACCESSORIES

A further selection of low cost tools offering excellent value for money.

T201 3 piece scissor set. Ok, so they're not the same quality as the surgical tools on an earlier list, but they're perfectly adequate for most jobs. 100mm, 150mm and 175mm long. All 3 pairs for **£1.99**

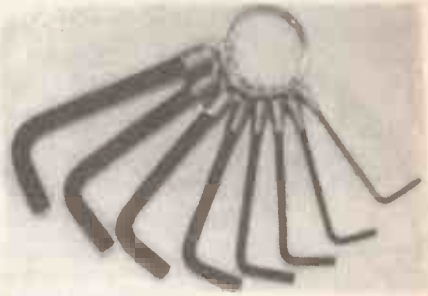


T206 Feeler gauge set. German made, 13 blades from 0.05-1mm. **Price** **£1.75**

T202 6 piece screwdriver set with thru-shafts allowing them to be hit without the handle shattering. 4 straight blade 150, 175, 245 and 270mm long; 2 pozidrive 150 & 195mm long. Green handles. Great value **£3.95**

T215 Heavy duty tool roll with 12 pockets **£2.95**

T214 Small 4oz pin hammer 240mm long **£1.25**



T209 10 piece hex key set - metric, 1.5-10mm, all on a keyring **£1.95**

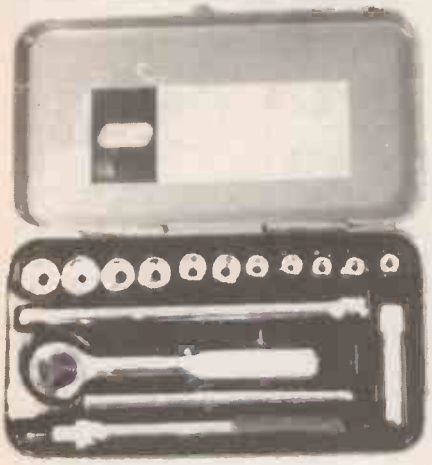
T210 8 piece hex key set - metric, 1.5-6mm, all on a keyring **£1.50**

T207 25 piece hex key set. Plastic wallet contains both metric 1.5-10mm and imperial 1/16" to 3/8". Extra long heavy duty set **£3.95**

T203 7 piece screwdriver set with wooden handles. 4 flat black, 3 pozidrive. Good selection of blade widths and lengths from 130-210mm **£3.75**

T204 11 piece screwdriver set with wooden handles. This is a much larger set, containing instruments from 125mm long to a massive 470mm long! 8 straight and 3 pozi blades **£5.95**

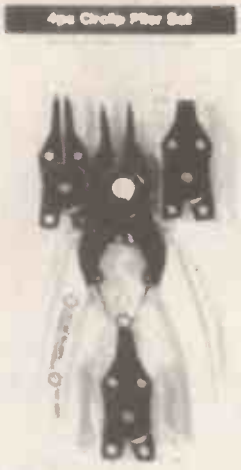
TEL: (0703) 236363 FAX: (0703) 236307



T211 17 piece ¼" drive socket set 4-12mm. 11 sockets, reversible ratchet handle, cross bar, flexible handle, 2 extra bars. All enclose in handy metal case **£4.95**

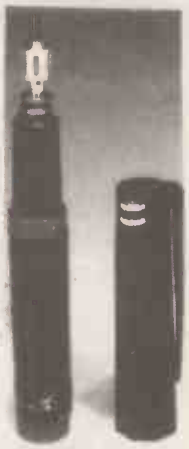
T205 'Grafter' 100 piece tool set - 9 piece ¼" drive sockets; 6 piece ⅜" drive sockets; handle, ratchet bar and adaptor; 5 piece double ended spanner set; 8" pliers; 6" eyelet pliers and 25 eyelets; 7 piece hex key set; 6" combination pliers; crimping tool and 29 crimp terminals; tape measure; 6 piece spark plug gauge; 2 reels insulation tape; 3 piece screwdriver set. All this for just ..... **£29.95!!**

T212 12 piece wood carving tool set, containing a good variety of shaped blades **£3.50**



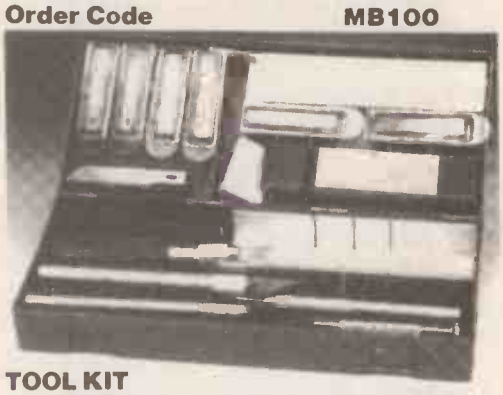
T213 Circlip pliers with 4 detachable heads for internal and external use. 2 × 180°, 90°, and 45°. Effective range 10-50mm. Indispensable tool. **£6.95**

T208 13 piece drill set in handy plastic case with drill stand moulded into back **£4.75**



GAS SOLDERING IRON
S1752 Butane powered catalytic soldering iron with cap containing the starting flint. A fully portable soldering iron, re-fillable from standard butane lighter fuel canister.
Price ..... **£13.95** 10+ 8.71

GAS SOLDERING IRON KIT
S1751 Butane powered catalytic soldering iron kit comprising: gas tank and regulator, catalytic soldering iron tip, catalytic hot knife tip, heat blower tip, blow torch, 3 auxilliary cold tools, sponge, cap with flint and carrying case. A fully portable hot tool kit. Re-fillable from standard butane lighter fuel canisters.
Price ..... **£29.95** 5+ 22.71
Order Code **MB100**



TOOL KIT
N2688A A model making 30 piece tool kit, containing: 3 knife handles (light, medium and heavy duty); fine blade handsaw; sanding block; mitre block; scriber; tweezers; miniature screwdriver; 24 knife blades. All contained within a compact plastic case.
Price ..... **£11.95** 10+ 7.50

MAGNIFIER GLASS
CTK104 2.5 (65mm) hand held magnifier glass. Bright steel frame with plastic handle. 2 × magnification.
Price ..... **£1.99** 20+ 1.31

CO-AXIAL CABLE STRIPPER
5395 Easy to use co-axial cable stripper. ABS plastic body contains two sets of blades set at one end for stripping the outer sheath, and at the other to strip down to the inner core. Cutting depth is controlled by hand pressure.
Price ..... **£1.95** 50+ 1.08

TEL: (0703) 236363 FAX: (0703) 236307

Just purchased, a very mixed parcel from Marconi. Many of the items are in small quantities only, but listed below are a few bits and pieces we've sorted out so far:

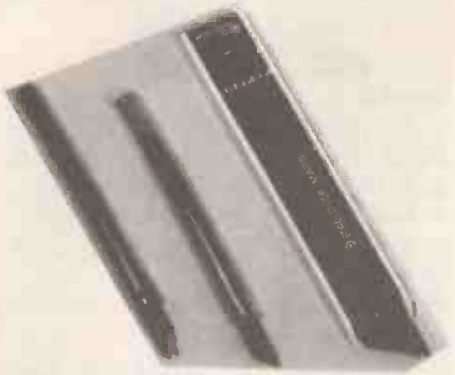
(a) Stationery products - mostly as used in plotters.

Pentel Rolling Writers. These fine point cartridges are essentially complete pens without an outer casing, so can be used as they are. Current price is around 60p. Now look at our prices! (State 2nd choice)
Z23199 Black
Z23201 Blue
Z23200 Red
Z23202 Green (only a few)
Prices (any mix) ..... **30p each**
24+ 0.20 96+ 0.15

Staedtler/Mars Plot pen refills (only in small quantity, so give 2nd/3rd choice).
Z2035 Green
Z2036 Black
Z2037 Red
Z2038 Blue
Price ... **All 30p each, any quantity**

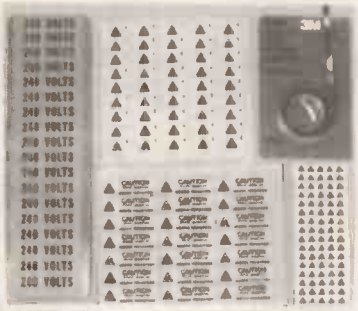
Z2039 Staedtler/Mars Plot tungsten carbide screw-in nib. Size PL3.
Our price **£2.00**

Drawing ink Staedtler/Mars 23ml plastic bottles in 4 colours. Normally £1.87
Z23183 Black
Z23184 Red
Z23185 Blue (few only)
Z23186 Green
Prices (any mix) ..... **£1.00 ea**
10+0.70



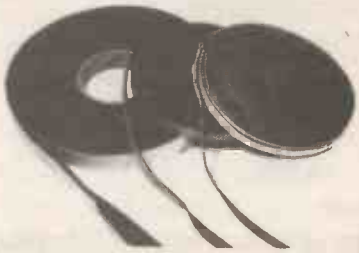
Z01268 Staedtler/Mars lumochrom leads. Pack of 12 in dispenser. Blue 2mm. Fits all standard lead holders.
Prices ..... **30p** 10+ 0.20 50+ 0.15
Z01158 Tube of 12×2H leads 2mm dia.
Prices ..... **25p** 10+ 0.17 50+ 0.12
Z01159 Tube of 12 Green leads 2mm dia.
Prices ..... **30p** 10+ 0.20 50+ 0.15

(b) Sticky things! (tape/glue/labels)
Z5001 Bulk pack of Araldite 1500 GB twin pack yellow epoxy encapsulant. Bag is divided by clip which when withdrawn enables resins and hardener to mix. Contents can then be squeezed out of bag as required.
Price **£3.00**



Z01155 Orange label 57×12.5mm with 240 VOLTS printed in bold black.
Price for Card of 18 ..... **£1.00**
Z23221 Antistatic adhesive labels. Sheet of 45 18×12mm. Black print on yellow background.
Price **£1.00**
Z23222 As above, but includes wording 'Caution static sensitive. Observe precautions.' Sheet of 21 45×13mm.
Price **£1.00**

Z01152 Scotch sensing markers for magnetic computer tape, 1/8" wide; 1" long tabs. 250 on a reel.
Price **£1.50**
Z2033 Self adhesive reusable vinyl triangles. Pack of 480 3/16".
Price **50p**



3 types of adhesive backed foam strip.
Z04001 12mm wide 2mm thick. Roll of 10m.
Price **£2.00**
Z03763 8mm wide 2mm thick. Roll of 10m.
Price **£1.50**
Z29007 25mm wide 4mm thick. Roll of 10m.
Price **£2.50**

Z5002 3M, or similar masking tape. 25mm wide×50m long. Normally all at over £2.
Our price **£1.50**
Z23162 Reel of white 25mm wide×66m long adhesive tape printed with colour coding of wires for 13A plugs. Repeats every 75mm.
Price **£1.50**

GREENWELD
GIFT VOUCHERS
Available in any value of £'s from £1 upwards, supplied with a card and envelope. Makes an ideal present for electronics enthusiasts!!

Z2034 13mm×10m Black Group 9 telex. Heavy duty nylon ribbon.
Price **50p**
Z23154 Nylon 6.2mm wide Teleprint KSR 430 ribbon. Ref N465.
Price **£1.00**

TEL: (0703) 236363 FAX: (0703) 236307

Connectors
D Type

Z2001 50 way 'D' IDC plug
Price **£4.00**
Z2002 50 way 'D' IDC socket
Price **£4.50**
Z2003 37 way 'D' cover, plastic
Price **80p**

Z2005 25 way 'D' PC right angle mounting plug.
Price **50p**
Z2006 25 way 'D' PC right angle mounting socket.
Price **60p**

Z03341 IDC 15 way D plug. Special low price on quantities: Our catalogue price is £2.72, but we've rather a lot at the moment!
Clearing at ..... **2 for £1.00**
25+ 0.35 100+ 0.25
Z03340 IDC 15 way D socket.
Price ..... **70p each**
25+ 0.42 100+ 0.32

Z1970 9 pin D plug, right angle PCB mounting by Souriau. Gold plated pins ..... **3 for £1.00** 100 0.20

Z2004 24 way centronics style (IEEE 488) socket by 3M. IDC. List £5.81.
Price **£2.00**

BNC/SMC etc

BNC connectors
Z2020 RS456-194 right angle plug 75R, cable mounting.
Price **£2.50**

Z2022 PCB mounting socket, 50R by Belling Lee.
Price **£1.00**

Z2021 Verospeed 25-26567 right angle PCB mounting socket.
Price **£2.50**

Z2040 BNC Bulkhead Socket 50R Vero 252-50071. Their price £4.44.
Our price **£2.00**

Z2023 SMC screw coupling elbow plug by Greenpar.
Price **£2.00**
Z2024 SMA screw coupling PC mounting right angle PCB socket. Verospeed 252-36746. List price £6.66.
Price **£2.00**

Z1987 75R Sealectro miniature RF connector type 50-107-0000. List price £3+
Our price **£1.00**

DIN41612

DIN41612 Connectors
Z2015 96 way right angle PC mounting plug.
Our price **£1.00**
Z2016 96 way socket (matches above).
Our price **£1.50**
Z2017 64 way right angle (AC) PC mounting plug.
Our price **90p**

Z1982 DIN41612 mini ½ B socket, 32 (2 × 16) way RS470-774. Their price £2.97.
Our price ..... **£1** 100+ 0.35

IC SOCKETS

Standard profile, high quality by Vero, Amphenol, etc. Available as listed in the following table, all at remarkably low prices:
All gold plated:

Z1681	16pin	**10/90p**
Z1685	24pin	**10/£1.55**
Z1688	40pin	**10/£2.20**

Z1554 Turned pin 28 pin DIL socket. This is a Jermyn device allowing IC's to be in close contact with PCB. Rows of pins are held on a carrier which is removed after soldering in place. This means that pins could be used individually if required. Jermyn's price £1.02
Our price **30p**
10/£2.50; 100/£18.00

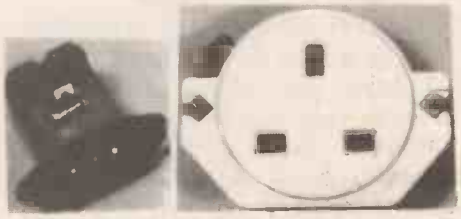
Terminal Blocks/Strips

Z2014 RS424-563 2A shrouded terminal block, 3 way. Their price £2.13.
Our price **£1.00**

Z2019 Heavy duty 12 way terminal block in brown bakelite, Klippon type EKS 12/4. Rated 20A 300V.
Price **£1.50**

Z03367 Barrier strip. Cinch 9 way 15A.
Price ..... **3 for £1.00**

Mains/CEE22



Z2027 Suppressed CEE22 inlet by Shaffner. This is a high current version, rated 10A. Connection by 0.25" tabs at right angles to body. Screw fixing.
Price **£4.00**
Z2028 Panel mounting 13A socket RS489-425. Needs 50mm dia cutout. Their price £3.08.
Our price **£1.50**

Z1844 Vertical chassis mounting IEC plug, solder tags.
Price ..... **3/£1.00**

Z2029 US style mains 3 pin plug.
Price **£1.50**
Z2030 Matching 3 pin socket.
Price **£1.00**
Z2031 Continental style 3 pin plug.
Price **£1.00**

TEL: (0703) 236363 FAX: (0703) 236307

Miscellaneous

Z2007 IDC 14 way DIL plug. Normally £1.00.
Price ..... **3/£1.00** 100+ 0.17
Z2008 IDC 16 way DIL plug. Normally £1.10.
Price ..... **3/£1.00** 100+ 0.18

Z2025 14 way DIN type line sockets with locking sleeve.
Price **£1.00**

Z1897 1mm plugs. Belling & Lee L1944 type in Red, Black, White, Blue, Green and Yellow. 25 of each colour, total 150.
Price for 150..... **£7.50**

PC connectors for 0.1 pitch. Like RS466-882 etc. (Their price shown in brackets).
Z2009 6 way plug (1.02) **40p**
Z2010 6 way socket (1.59) **60p**
Z2011 12 way plug (1.84) **80p**
Z2012 12 way socket (2.82) .. **£1.20**

Z2013 RS470-588 0.156" double sided 18 way edge connector. Their price £2.20.
Our price **£1.00**

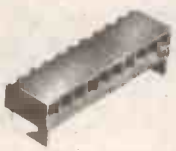
Z1895 Edge connector by Souriau 40 way double sided 0.1 pitch with solder tags. Gold plated for extra reliability. List price of these is over £7.00!
Our low prices **£2.20**
10+ £1.30 100+ £0.70

PCB Terminal Blocks - similar to our range on Page 35. All 5mm pitch.
Z1954 2 way 45° **8 for £1;** 100+0.06
Z1993 10 way 90°.. **2/£1;** 100+ 0.25
Z1956 10 way 45° **2 for £1;** 100+0.25

Z1976 Pack of 500 RS terminal pins 433.860. Double sided for 0.04" holes. Their price £2.59.
Our price **£1.75**

Z2026 Cambion PCB pins. High quality double sided. Needs 1.8mm hole.
Packs of 1000 ..... **£8.50**
(sample free)

Z2018 Pin header 36 way right angle single row. Notched to allow easy subdivision.
Pack of 2 ..... **£1.00** 100+ 0.25



Z4369 90° PCB socket connector 10 way 0.1 pitch. Farnell type 143-156; their price 60p. Made by Molex.
Prices ..... **Pack of 10 £2.00**
100+ 0.14 1k+ 0.09

5 PIN
240° DIN SOCKET
PC Mntg Box of 56
ONLY £2.00
20 boxes £25.00

Crimp Connectors

Supplied to us on reels, we have the following types:
Z1988 3.2mm receptacle, brass.
Pack of 50 ..... **£1.00**
Z1989 5.0mm receptacle, brass.
Pack of 50 ..... **£1.00**
Z1990 ¼" receptacle, tinned.
Pack of 50 ..... **£1.50**
Z1991 ¼" locking receptacle, tinned.
Pack of 50 ..... **£1.50**
Z1992 ¼" blade, copper (for use with above).
Pack of 50 ..... **£1.80**

Mains Leads

Z03068 2 metre mains lead CEE22 socket one end, 3 pin US style plug the other.
Price **£2.30**
Z03209 4 metre mains lead CEE22 socket one end, open the other.
Price **£2.50**
Z4358 Mains lead - 13A plug one end, 3 pin IEC socket the other. Overall length 2m.
Price **£2.30**
Z4249 Mains lead 2m long with shrouded right angle 3 pin IEC plug one end, bare wires the other.
Price **£2.00**
Z03561 RS489-138 mains cable 5m long fitted with right angle CEE22 plug. Their price £4.99.
Our price **£2.50**

Z4309 BT 'breakout' lead. One end has moulded housing with 6 pin BT plug and socket. Other end has 6 pin FCC68 plug (as used on some computers). Overall length 3m
Price **£2.20**

Z1806 We also have bandoliered wire links, 60mm long 24SWG.
Price .....**Pack of 200/£1.00;** 1000/£3.00; reel of 15,000/£25.00

BNC leads. Good quality with colour coded ends 3m long.
Z89903-1 Red
Z89903-2 Blue
Z89903-3 Black
Z89903-4 Green
Prices (any mix) ..... **£3.00 each**
10+ 2.00
Z03779 10 metre long ext'n computer or printer cable. 25 way D plug one end 25 D socket the other.
Price **£10.00**

Z4353 6 way DIN lead; 1.5m lead terminated one end with a 6 pin DIN plug. Bare wires the other end.
Prices ..... **Pack of 4/£1.00**
100/£12,00 1k/£90.00

Cable

Z30154 RS367-410 15 core screened. 100m reel. Their price £66.08
Our price **£30.00**
Z30157 RS367-353 4 core screened. 100m reel. Their price £34.60
Our price **£15.00**
Z30152 RS367-634 20 core screened. 100m reel. Their price £107.15
Our price **£50.00**
Z30257 RS378-189 3 core mains 13A 1.25mm² black. 100m reel. Their price £45.08.
Our price **£30.00**
Z30189 2.5mm² (20A) 3 core mains white sheath. 100m reel. List price £61.00
Our price **£40.00**
Z30210 1.0mm² 32/0.2 10A 3 core mains screened. Black sheath. 50m coils. List price £35.57
Our price **£20.00**
Z30165 1.0mm² 32/0.2 2 core mains screened. Black sheath. 100m coils.
Our price **£10.00**
Z30162 3 core mains 16/0.2 0.5mm 3A. Black sheath. STC 209656H 100m. List price £17.11
Our price **£10.00**
Z30186 6 core 16/0.2 and overall screen STC 00017D 100m. List price £75.03
Our price **£35.00**
Z30185 3 core 16/0.2 and overall screen black STC 00022X. 100m. List price £56.60
Our price **£25.00**
Z30212 RS367-331 screened twin 100m. Their price £47.87
Our price **£22.00**
Z30188 6mm² 84/0.3 black 100m reel. List price £37.56
Our price **£20.00**
Z30239 Woven 7/0.2 blue and orange (20 of each) ribbon cable. 40 way. Just pulling a thread separates all cores. 10m length giving 200m of flex.
Price **£4.00**

Z30158 3 core mains 0.75mm 5A black sheath. 100m reels. List price £23.43.
Our price **£15.00**
Z30156 25 core screened 7/0.2. Black sheath. 1 × 80m coil. List price £87.
Our price **£40.00**
Z30171 Insulated earthing braid
Price **25p/m**
Z30244 Woven twisted ribbon cable red/orange 7/0.2 10 core.
Price **25p/m**
Z30226 RS388-243 URM70 Coax 100m reels. Their price £27.35.
Our price **£12.00**
Z30246 Screened 16 core 7/0.2. Grey sheath. 100ft reels.
Our price **£15.00**
Z30223 10mm² Red 80/0.4. STC 715950. Their price £57.32
Our price **£25.00**

Z27273 Black PVC sleeving 2mm bore. 50m coil.
Price **£2.50**
Z29016 RS399-259 4mm black PVC sleeving. 30m reels. Their price £3.61.
Our price **£1.50**
Z01042 Braided Nylon Lacing tape 1.5mm wide, black. 500yd reel.
Our price **£4.00**

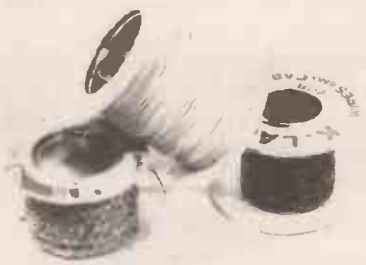
Strain relief bushes for anchoring cable through panels. For cables up to about 5mm dia.
Price ..... **Pack of 25 £1.00**
100+ 0.025 1k+ 0.016
Z5003 Black
Z5004 White
Z07007 long sleeved grommet 45mm long. Hole dia 4mm.
Price ..... **Pack of 40 £1.00**
1k+ 0.01

CABLE TIE SCOOP!

Z4360 Genuine RS cable ties, 543-349 in packs of 100. Size 188mm long × 4.8 wide. Max dia 44mm. White nylon with non-release ratchet lock action. 'RS price' £3.77
Our price **£1.95**
20+ 1.20 100+ 0.90

Cable ties, releasable type. 140mm long × 7.5mm supplied in pack of 100:
Z07007 Black
Z07084 White
Price **£2.00**

Z07069 Cable tie mounting base. Natural nylon colour. Self adhesive with holes for screw fixing if required. 28.5mm sq. List Price £5+
Our price/pack of 100 ..... **£2.00**



GIANT FLEX PACKS!!

Z8901 1km of 7/0.2 flex - 10 × 100m reels, all different colours. Normal price £31.50.
Offer price **£15.00**
Z8902 1km of 16/0.2 flex - 10 × 100m reels, all different colours.
Amazingly low price **£22.00**
Z8903 1km of 1/0.6 solid core wire - 10 × 100m reels, all different colours. Normal price £26.50.
Offer price **£15.00**
Z8904 Extra special offer - Any 100 reels of above 3 types for just **£120**
Z8905 10/0.1 flex 100m reels red/ black/orange/white/purple/blue/ green/ yellow/ brown. Only about 100 reels altogether so give 2nd/ 3rd/4th choice. Normally around £3/reel.
Our price **£1.50**

Z2044 Sub min rotary DIL switch 16 position BCD. List price £2.40.
Our price **£1.00**

Z2040 Do-it-yourself thumbwheel switch - all parts contained in a handy plastic case.
Price **50p**

Z1958 Hamlin SIL reed relay type HE3321CO500. SPCO, 1200R coil. 5V operation. List price on these is over £5!
Our special price **£1.50**

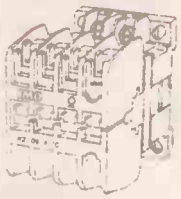
Z218 26.5V sealed relay. 675R DPCO @ 1A. Made by STC 22 × 20 × 10mm.
Price **60p**

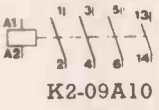
Z2047 Omron time delay relay. Sub min 4 pole c/o type H3Y-4-U5. 110V AC coil. 0.1-5 sec timing range. List price over £25.
Our price **£6.50**
Z2048 IMO Octal relay, 24V DC coil 2 pole c/o 10A contacts. List price over £5.
Our price **£2.50**

Z281 Octal based relay by IMO with 24V ac coil. Type 60.12u DPCO contacts rated 10A **£2.20**

Z2045 Omron LY2 relay 220/240 ac coil, DPCO contacts rated 10A. List price on these is over £5.00.
Our price **£2.50**
Z2046 RS346-924 chassis socket for above. Their price 89p.
Our price **40p**

Z2049 RS348-611 relay miniature low profile flat pack. 24V DC coil, 4 pole c/o contacts. Mounts on 0.1 grid. Their price £5.45.
Our price **£2.00**

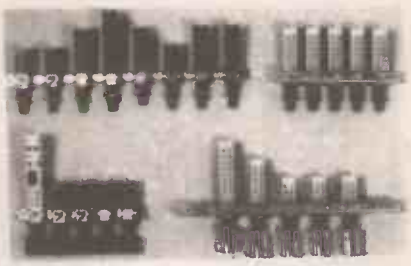




K2-09A10

Z05348 Contactor by IMO. 3 pole mains and 1 pole aux. Can be DIN rail or surface mounted. 240V coil. Rated 9A 415Vac. List price £11+
Our price **£3.50**

Z2041 Proximity switch 39 × 10 × 5mm by Flight Refuelling type RSMO6 A15.
Price **£3.00**
Z2042 Matching encapsulated magnet type RSMO7.
Price **£1.50**
Z2042 Tiny bar magnet - only a few unfortunately. Size 18.5 × 1.6 × 2.4mm. Ideal for operating min reed switches.
Price ..... **4/£1.00**



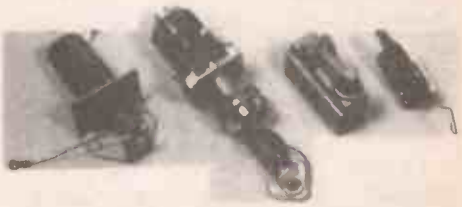
New switchbanks. Although these don't seem to be particularly popular, we thought if they were cheap enough they could be adapted to user's requirements. Total quantity of the 4 types listed is about 2000 - would clear the lot for **£150.00**
Z4365 8 switches, 6 interlocking (4 × 4PCO, 1 × DPCO, 1 × 6PCO); and 2 independent (both DPCO). No knobs.
Price ..... **3 for £1** 100+ 0.15
Z4366 5 interlocking switches (2 × DPCO, 1 × 4PCO, 1 × 6PCO, 1 blank); with shiny chrome round knobs.
Price ..... **3 for £1** 100+ 0.15
Z4367 5 switches, 3 interlocking (2 × DPCO, 1 × mains, DP on/off); 2 independent (both DPCO). Shiny chrome oblong knobs.
Price ..... **3 for £1** 100+0.15

Z4368 5 switches, 4 interlocking (all 4PCO); 1 independent 4PCO. No knobs.
Price ..... **5 for £1.00** 100+ 0.10

Z1984 Sub miniature microswitch, Omron type D2MQ-1. These have a body size of 8 × 6 × 2.6mm.
Price ..... **2/£1** 100+ 0.25
Z355 Ex-equip (BT) μswitches with bracket and button.
Price ..... **3/£1.00**

Z4370 Burgess 20A microswitch. Incorporates 2 switches into one housing 20 × 12.5 × 17.5mm - 1 changeover and 1 break.
Prices ..... **2 for £1** 100+ 0.25

Z4362 Metal bracket with push to make switch (W421).
Pack of 5 for **£1.00**
Z1957 High quality, high current push to make switch by Arcolectric. Rated 250V 1A. Single hole fixing, needs 12mm dia hole. Plunger 7.5mm dia × 10mm long.
Price ..... **2 for £1.00**



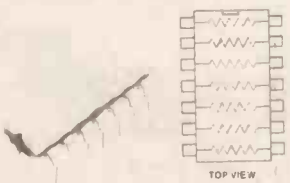
Z1433 12V solenoid by Airpax. Body is 37mm long × 19mm dia. Threaded bush 14mm dia for fixing. Plunger is 8mm dia and has attached a wire link. 3mm movement with supplied bracket attached - probably capable of more.
Price **£1.00**
Z2041 Key operated switch. 4 position, switches a low current single pole wafer and a double pole 2A mains switch. Yale type key can be removed in any position.
Price **£2.50**
Z2050 Heavy duty Burgess microswitch V9LR rated 10A 250V AC. Roller lever. Aluminium body. List price over £5.
Our price **£2.00**
Z1437 Standard size microswitch with wire lever requires only 5 gm pressure to operate.
Price **60p**

Resistors

Low value, close tolerance wirewound resistors:
Z1966 OR5 5W 1%
Price ..... **Pack of 5 £1;** 100+ 0.12
Z1967 OR1 3W 1%
Price ..... **Pack of 5 £1;** 100+ 0.12

DIL Networks

Z1978 SIL Resistor Network. 10 pin package containing 9 × 10k 5% resistors.
Pack of 8 ..... **£1** 100+ 0.06



Z1369 14 pin DIL resistor network 7 × 220R. Piher.
Prices ..... **10/£1.00;** 100/£6.00

Z1980 DIL Resistor Network by Beckman. 16 pin DIL containing 8 × 4k7 1% resistors. Normally around 60p each.
Price ..... **4/£1.00** 100+ 0.10

Z1979 DIL Resistor network by Beckman. 16 pin DIL containing 15 × 10k 1% resistors. Normally around 60p each.
Price ..... **4/£1.00** 100+ 0.10

A number of cermets now available:
(a)Bourns 3296W or similar series (11mm sq multiturn)

Z1971 200R ..... **2/£1** 100+ 0.28
Z1972 5k ..... **2/£1** 100+ 0.28
Z1973 100k ..... **2/£1** 100+ 0.28

(b)Bourns 3006 (¾" multiturn)

Z1974 25k ..... **3/£1** 100+0. 20

(c) Bourns 3362
(single turn 6.35mm sq; in-line leads)

Z1975 20k ..... **3/£1** 100+0. 20

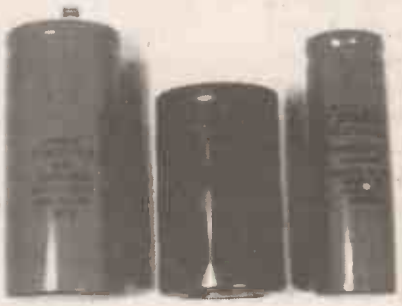
K185 1R ½ watt carbon film resistors, preformed for horizontal mounting ..... **200 for £1.00**

Z1983 VA1040 Thermistor 130R @ 25°C, 2R6 when hot. Normally 90p each.
Pack of 20 ..... **£2.00**

Fuseholders

Z2051 PCB mount (horizontal) 20mm fuseholder with bayonet cap. Max 10A 380V. List price around £1.
Our price ..... **3/£1.00**

Z546 Belling Lee heavy duty fuseholder for 32mm fuses. Includes 3A fuse. Complete with rubber shroud. Screwdriver release. Rated 15A. Ex-equip.
Price ..... **2/£1.00**



Large Electrolytics

3 types available:
Z02122 51,000µF 40V 145mm × 65mm dia by Sprague.
Price **£5.00**
Z02286 33,000µF 40V 40A ripple current by Phillips. 105 × 65mm dia.
Price **£4.00**
Z02287 30,000µF 40V 142mm × 45mm dia by Sprague.
Price **£4.00**

Z02284 DIL multilayer ceramic caps - 2 pin, so can be packed closely together on PCB using standard DIL spacing. Only one value - 0.22µ. List price on these is 98p each.
Our price ..... **Pack of 8/£1**
100+ 0.09 1k+ 0.06

Z1965 Ceramic disc caps .01. Small body, just 6mm dia. Leads preformed to 7.5mm pitch.
Price ..... **40 for £1;** 1k+ 0.004

Z1969 Phillips MKT film caps 0.1µF 5% 100V 10mm pitch **£3/100**

0.1W PRESETS - all Horizontal mounting

Code	Value	MNFR	Type	25	100	1000
Z1575	470R	Piher	Carbon	£1.50	£4.00	£30.00
Z1577	1K	Piher	Carbon	£1.50	£4.00	£30.00
Z1578	1K	Bourn VAO5	Cermet	£4.00	£12.00	£90.00
Z1579	4K7	Bourn VAO5	Cermet	£4.00	£12.00	£90.00
Z1580	4K7	Piher	Carbon	£1.50	£4.00	£30.00
Z1581	10K	Bourn VAO5	Cermet	£4.00	£12.00	£90.00
Z1584	220K	Bourn VAO5	Cermet	£4.00	£12.00	
Z1574	2M7	Piher	Carbon	£1.50	£4.00	£30.00

TEL: (0703) 236363 FAX: (0703) 236307

Bargain Packs of Diodes

CODE	TYPE	DESCRIPTION	PRICE
K450	AA132	100V 10mA Ge point contact	8/£1.00
K451	AA133	130V 10mA Ge point contact	8/£1.00
K452	BA128	75V 50mA Si diode	10/£1.00
K453	BA130	25V 75mA Si diode	10/£1.00
K454	BA147	15V 50mA Si diode	10/£1.00
K455	BA155	150V 100mA Si diode	10/£1.00
K456	BA218	50V 10mA Si switching	10/£1.00
K322	BAX12A	Silicon glass 90V 400mA	20/£1.00
K323	BAX16	Silicon glass 150V 200mA	25/£1.00
K457	BB104	Dual capacitance Si 34-39 pF	3/£1.00
K324	BB121A	VHF/UHF tuning diode	5/£1.00
K325	BB142	VHF/UHF tuning diode	5/£1.00
K326	BB221	Variable capacitance diode 1.8-2.2pF 28V	5/£1.00
K327	BB329	Variable capacitance diode 2.5-3.2pF 28V	4/£1.00
K458	BY196	100V 1.2A fast rect	5/£1.00
K328	BY197	200V 1.2A fast rect	5/£1.00
K459	BY198	400V 1.2A	4/£1.00
K329	BY199	600V 1.2A fast rect	4/£1.00
K460	BY212-750R	800V 1A Si 'tophat' rect	10/£1.00
K330	BY250	Pinnacle. Supplied in a neat clear plastic case	5/£1.00
K461	BY401	1A rect	15/£1.00
K462	BY550-100	100V 5A Si rect	5/£1.00
K463	BYX22-400	400V 1.4A Si 'tophat' rect	10/£1.00
K464	BYX36-300	300V 1A rect	20/£1.00
K331	BYX55-300	Silicon rect 330V 1A	25/£1.00
K465	DK14	80V 120mA Ge diode	8/£1.00
K466	HG5085	Small signal diode	20/£1.00
K332	IN277	Germanium diode 125V 100mA	8/£1.00
K467	IN446	Si	20/£1.00
K468	IN459	175V 3mA Si	20/£1.00
K469	IN627	100V 30mA switching Si diode	20/£1.00
K470	IN643	200V 5mA switching Si diode	20/£1.00
K471	IN916A	75V 10mA switching Si diode	20/£1.00
K333	IN2069	Silicon rect 200V 0.75A	25/£1.00
K472	IN3890	100V 40A rect	2/£1.00
K473	IN4149	75V 10mA Si	20/£1.00
K474	IN4154	25V 30mA Si	20/£1.00
K475	IN4446	75V 10mA Si	20/£1.00
K476	IN4447	75V 20mA Si	20/£1.00
K477	IN4448	75V 5mA Si	20/£1.00
K478	IN4454	75V 10mA Si	20/£1.00
K479	IN4744	15V 1W 10% zener diode	15/£1.00
K480	IN4752	33V 1W 10% zener diode	15/£1.00
K334	IN4821	Silicon rect 500V 1.5A	15/£1.00
K335	IN4933	Fast (150ns) rect 50V 1A plastic	12/£1.00
K481	IN5062	800V 1A Si rect	15/£1.00
K482	IN5257	33V 400mW 20% zener diode	20/£1.00
K483	IS021	Top hat	10/£1.00
K484	IS410	Stud mntg 3A 100V	6/£1.00
K485	IS423	Stud mntg 10A 400V	2/£1.00

Z1985 Dynamic 256K RAM modules SIMM. 8 × 4256-12 with room for 9th chip. Similar to RS types costing £100+.
Our low price - just £10.00 each or buy 40 (10 Meg of memory) for £250.00.

Z1986 Xtal, ex-equip 147.50 HC6U case.
Price ..... **2/£1**

Z1436 Reflective optocoupler from sheet feeder type OPB703A, on small PCB with 4 pin plug fitted.
Price **50p**

Z1435 Reflective optocoupler from sheet feeder type OPB711, on small PCB with 4 pin plug fitted.
Price **50p**

Semiconductors

K801 Heavy current stud rectifier - 1R 25G5. Rated 50V 60A. List prices is over £8.
Our special low price **£2.00**

K620 High quality 13 watt amplifier kit. This single chip amp uses the TDA2030 which is capable of providing an output power of up to 21 watts into a 4R load. All components + PCB supplied - just add power & speaker!
Price **£3.95**

Z1959 L4960 voltage regulator - variable +1 to +40V @ 2.5A TO220 package, 7 leads. List price of this SGS device is over £4.00. Supplied with data.
Price **£1.50**

Z1960 BTA08-400B SCR. 8A 400V SCR in TO220 package. Usually 82p.
Clearance price ..... **2 for £1.00**
100+ 0.25

K120 Germanium output transistors similar to AC128/AC176.
Price .....4 pairs £1.00

Z1968 Infra red LED's 5mm - no other data so offered at **6 for £1.00**

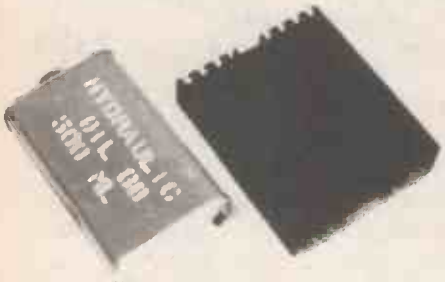
Z4366 Massive bridge rectifier 57 × 57 × 25mm, but only rated 200V 10A. Tag connections.
Price **£1.00**

Tuning Diode
MV1404 - very high capacitance change - for a change in bias from 1-10V, there is a change in capacitance from 10pF-150pF, making this suitable for AM radio broadcasts. RS charge £17.94 each for these - which makes them about 1 2 times as valuable as gold!
Our special price **£6.00**
100+ 3.00

Z1977 Current Regulator Diode, type J505. TO92 case. 2.1-50V spread for constant I. I_F = 1mA Z_D = 1.9M. Normally around £1 each.
Our price ..... **3 for £1**

Z27227 Industrial gas spring - as used for holding open lids on machines etc. This one requires 40 Newton force, has a stroke of 200mm with a 6mm dia plunger. 6mm eye one end, 7.5mm recess the other. Overall length 500mm. List price £30.67
Our special price **£10.00**

Z07076 Dycem 'Grippipad'. Anti-slip mat in blue. Size 350 × 250. Ideal for modelling or in the home to keep crockery, ornaments from moving. List price £8.28
Our price **£4.00**



Z01216 Hydraulic oil 68. 500ml can.
Price **£2.50**
Z02936 Heatsink. Type W. 130 × 150 × 32mm drilled for 2 TO3 transistors. Normally £4.50.
Special price **£2.50**

Z01205 Rocol kilopoise - dampening grease - increases friction. Type 0868G. 50gm tube list price £5.23.
Our price **£2.50**

Z27245 Heavy duty castor - weighs 900gm. Composite material wheel 76mm dia × 29mm on steel ball bearing mounting. Fixing by 12.5mm bolt.
Price **£3.00**

Z1798 Brushed Aluminium sheet 1.2mm thick (18g) 144 × 108mm, drilled with a 4mm hole in each corner and an additional 4mm hole on one side. Film protected. Pack of 5 sheets.
Price **£1.00**

Z4349 Anybody who has been dealing with us for a very long time may remember our 7" tape spools we were selling many years ago. Standard clear plastic spools for ¼" tape individually wrapped.
Prices ..... 3/£1; 20/£5; 100/£18

Transformers

Z9005 0-220-240V primary, secondary 0-8V 1A; 16-0-16V 1A; 28-24-0-24-28V 12A.
Price **£30.00**
Z9006 RS207-144 20VA 12V@ 0.8A twice. Their price £6.59.
Our price **£4.00**
Z9007 RS196-296 6VA 6V@ 0.5A twice. Their price £3.86.
Our price **£2.00**
Z9008 RS196-426 filament. 6.3V@ 1.8A twice. Their price £7.35.
Our price **£4.00**
Z4207 30V @ 1.5A, 6V @ 0.5A. 80 × 65 × 72mm. 4 way fix design. Tags.
Price **£4.60**

Ferrites

Z1367 Pack of 100 ferrite beads 4mm OD, 1mm ID, 5.5mm long. Held together in pairs by few turns of wire.
Price **£1.50**

Z1896 Ferrite rings. These torroids are 26mm OD, 14.5mm ID and stand 15mm high. Material unknown. Made in Hungary. A similar size ring sells for around £1.50.
Our low price ..... **4/£1.00**

Z1961 Ferrite ring, red with a green spot. OD: 7.7mm; ID: 3.1mm; Height: 4.9mm.
Price for pack of 10 ..... **£1.00**

Flash Units

Z4225 Like Z4100, only no relay.
Price **£2.10**

Z4165 Flash unit. Bit more sophisticated than Z488 or Z4100. This one is a 6 transistor circuit that incorporates a light dependent resistor, so that the flash only fires at low light levels. Supplied with full circuit diagram and notes on use.
Price **£2.90**

BYW 20 BRIDGE

25A 50V

To Clear:

10 for £10

Z27111 Rexine covered box with felt lined interior. Overall size 165 × 85 × 45mm.
Price **£1.50**

Z654 6V 6 digit counter by Veeder Root. Size 60 × 48 × 34mm.
Price **£1.50**

Z1771 Transducer, cased PC mounting; 50R impedance; 20mm dia × 14mm high. FC-5mm. Ideal miniature speaker.
Price ..... **3 for £1.00**

Z1964 50mH choke, fairly low current. PC mounting. Adjustable. 13mm dia × 12mm long.
Pack of 3 for **£1.00**

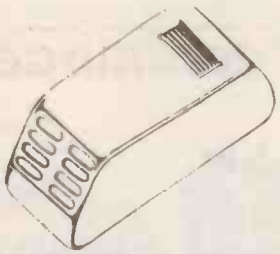
Z1963 8R Earpiece with, unusually, 2 × 4mm plugs.
Price ..... **4 for £1.00**

Z4361 FM aerial - twin feeder 'T' type with 2 pin plug **50p**
25+ 0.30 100+ 0.20

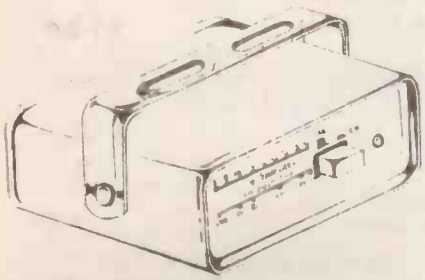
Z1962 Delay line by MCG Electronics Inc. Model SLP-4-100V25.
Price **£1.00**

TEL: (0703) 236363 FAX: (0703) 236307

Z652 We've found a couple of hundred more coin mechs - these units were installed in the cream dispensers we had a year or two ago and were extremely popular. Made by Coin Controls, this unit will accept various size coins by simple adjustment of 4 screws. Incorporates various security features - magnet, bent coin rejector etc. Microswitch rated 5A 240V. Front panel 115 × 64mm. Depth 130mm. Normally £12.
Our price **£4.50**



Z4355 'FireScout' Mk II Burglar Alarm. A grey hammer finish steel case 170 × 71 × 42mm with slots at either end and in the top is contained a metal cased buzzer (similar to our A391), battery clips and a bi-metal strip. Takes 2 × D size cells. Boxed.
Price **£1.50**



Z4347 CB Converter. We had some of these a year or two ago and they went like hot cakes! Its in a neat case 108 × 68 × 44mm with a drilled mounting bracket for installation. By simply connecting the power leads, plugging your car aerial into the converter and feeding the output to your AM radio, you have the facility to tune through channels 1-40. A switch is fitted to the front panel so the unit can be by-passed. Comes complete with boxed with instructions.
Price **£3.00**

Z4354 Computagraph Colorwriter panel 352 × 67 × 12mm. This is from the DS10 Digital Plotter. The ally frame supports a membrane keyboard which has 22 keys. On the rear of the panel are 6 yellow submin LED's, a 3mm red LED and 2 × 19W edge conns. Must be useful for something!!
Price **£1.00**

Z4368 Panel 310 × 90mm with 20 CMOS chips, 3 × MC1488, 2 × MC1489, 6 × C251 opto isolators and a 64 pin chip MB60504.
Price **£3.00**

Z4090 PCB overall 170 × 105mm from sheet feeder. Contains drive circuits for stepper motors - 4 × TIP110, 4 × TIP115, LM3302, 7407 × 2, MPSA × 4, Rs, Cs, Diodes, etc. IDC 34W plug.
Price **£2.00**

Z1438 Control panel from sheet feeder. 90 × 45mm. PCB fitted with 4 illuminated push switches (all with yellow LED), and separate green LED.
Price **£2.00**

Z1434 12V electronic buzzer by Star. 22 × 16 × 14mm.
Price **50p**

Z2032 Warbling siren by Pensee 12V DC. Nice and loud. Size 50mm dia × 46mm high. FC 60mm.
Price **£2.00**

Z22278 Cherry keyboard in dark grey aluminium case. Separate numeric keypad. Output via curly lead to 14 pin DIN socket. Model UB89 370 × 177 × 20mm.
Price **£10.00**

Z4364 Few more Newbrain keyboards have turned up. These are standard QWERTY, but have a few extra characters (Scandinavian). Still the same price **£6.00**

Z4363 Membrane keyboard 225 × 84mm with 11 keys - 1-9 & 2 others. Output (common bus) on 12 way ribbon cable. Could be cut down to 95 × 70mm if only 1-9 needed ..... **60p** 100+ 0.30

SB16 Headphones - just found another box of these popular headphones. Full size lightweight stereo. Black adjustable headband, 32R. 30-12000Hz. 1.8m straight lead with ¼" stereo plug. Still the same price **£2.50**

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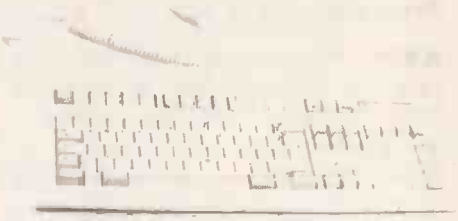
Z9011 Disk Drive. Teac FD-55BR-501-U. 5¼" double sided 40 track. Brand new.
Price **£35.00**

Z9010 Tape Streamer. Tandberg TDC3319. Internal fitting (same size as 5¼" disk drive). Takes DC600 tapes. Unsure of capacity - possibly 60Mb. Does anyone know?
Price **£250.00**

Z22454 Emulex Intelligent Host Adaptor. MSCP Compatible. Panel with lots of expensive chips, plus a very comprehensive 208 page handbook. Must have cost a fortune originally.
Our price **£30.00**
(Handbook only on approval if required; £10 refundable deposit + £2 post).

Z22455 Similar to above: Emulex MTO3 Controller. For interfacing SC51 hosts and controllers to a model TDC3309 0.25" streaming cartridge tape drive. Handbook available as above.
Price **£30.00**



Z22468 Brand new and boxed IBM-MF compatible keyboards by Cherry for PC, XT, AT and PS/2 systems.
Price **£40.00**

Z22297 Disk pack CDC1204 16MB CMD cartridge.
Price **£30.00**

Z9012 Memorex MRX IV ½" computer tape. 600 ft on 175mm dia spool. 6250BPI. In case, in sealed poly bag. List £7.49.
Our price ..... **£3.50** 50+ 2.00

SOFTWARE CLEARANCE
We have a quantity of software on tape for various computers - some in library cases - and are offering it for the value of the tape only. A mix of 20 tapes giving many hours of playing time is yours for just **£3.00**

'SIMON' BOARD CLEARANCE
Mostly with slight board damage. Components believed to be OK, which are:
TMS1000 microprocessor, 75494, 4 MES holders with 2.5V bulbs, SPCO slide switch, 1p 3w slide switch, 4 position slide switch, 0.1 and 100pF caps, PP3 battery clip with long leads. All this on a PCB 127 × 127mm.
Z955 **5 for £1.00**
25/£4.00 100/£12

Motors/Fans

Z4352 Crouzet mains motor with gearbox. Superb precision motor, standard 240V 50Hz operation with reduction gearbox giving an output of 60RPM. Spindle is 4mm dia × 9mm long. Motor 75mm dia × 60mm deep. Gearbox (which can easily be removed if required) is 65 × 50 × 15mm. Similar to RS 322-802 + 332-868. Their price £29.64
Price **£5.00**

Z4089 12V 36R 7.5° stepper motor by Airpax. Size 58mm dia × 24mm. 20 tooth gear wheel 17.5 mm dia fitted to 6mm shaft.
Price **£4.00**

Z5005 Excellent quality instrument fan by Toyo. Model TF92230A 230V AC. 92.2mm² × 25.5mm deep. Silent operation. List around £19.50.
Our price **£6.00**
25+ 4.80 100+ 3.60

Z05054 Stepper motor by Astrosyn. Heavy duty (weighs 1.3kg) 2v, 0R56, 3.6A, 1.8°, 200 step. Size 85mm dia × 63.5mm deep. Shaft 9.5mm dia × 29mm long. List price £59.04.
Our price **£15.00**

Z559 MICROVISION PANELS
Incomplete panels from the famous SINCLAIR MICROVISION. The 135 × 75mm panel is packed with useful components; 9 transistors, multiturn preset, 6 single turn cermets, 22mm dia mylar film speaker, power socket, headphone socket, R's, C's and diodes. Supplied with circuit too! These were £1 each - now reduced to 3 for £1.00
12 for £3 50 for £10
AMAZING VALUE!!!

CLEARANCE OF HEAVY DUTY CABLE
Z8867 This is a fantastic bargain! Extremely heavy duty 3 core cable with rubber insulation, overall dia 14mm. Inside, each core is rubber insulated and colour coded. Each has 40/0.2 conductors. Current rating is 25A. At the low price we are asking, this could be used for jump leads (use P856 clips). Supplied in boxes of 250ft (76 metres). **ONLY £25.00**
Also available by the metre - £1 per metre

HARDWARE PACKS - ALL £1.00 EACH

K631 Cotter pins - 144 piece assortment from 25-60mm **£1.00**
K632 Pk metal screws - 95 piece assortment from 10-40mm, all with screwdriver slot **£1.00**
K633 Wood screw assortment - 95 piece assortment 10-30mm, nos 4-10 **Price** **£1.00**
K634 Washer assortment. 146 pieces of straight and spring washers of varying sizes. **£1.00**
K635 Nuts and bolts/screws assortment. 100 pieces of various sizes, up to ¼"dia **£1.00**
K636 Nail assortment. 7oz of 25-40mm nails **£1.00**
K637 Wall plugs. 115 plugs 5 colours, 5 sizes from 4-8mm. **Price** **£1.00**

NEW HARDWARE PACKS

A recent purchase of fasteners of immense variety from a recently bankrupt local company allows us to offer these exciting packs. (All quantities are approximate, as packs are calculated by weight)

K553 2BA screw mix. Mostly steel, few brass/nylon etc, cheesehead and countersunk, mainly in lengths from 3-38mm. Excellent selection.
Price ..... **100/£2.50**
K552 4BA screw mix. Nearly all steel cheesehead and countersunk from 5-51mm.
Price ..... **200/£2.75**
K551 6BA/8BA screw mix. Again an amazing mixture of lengths from 3-38mm. Nearly all cheesehead and countersunk in steel.
Price ..... **200/£2.40**
K596 Nuts - believed to be all BA sizes - from 2BA to 8BA. Again, mostly steel.
Price ..... **200/£2.40**
K597 Washers - super pack, this - contains a huge variety of plain, crinkly, spring and other washers in sizes from 8BA to 2BA. Includes metric and other types too.
Price ..... **1000/£3.00**

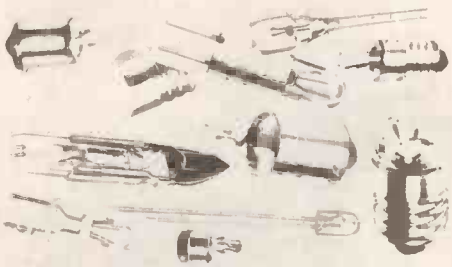
K598 Solder tags. Good variety of sizes from 3-11.5mm ID. Includes some small crimp types. Most are double ended. Great value.
Price ..... **200/£2.20**
K599 Captive, shakeproof and locking nuts in sizes from 2BAto 6BA, mostly alloy.
Price per pack of 100 ..... **£3.20**

K595 Everything that didn't fit into the above packs is in here! Very few small BA sizes - nearly all metric, BSF, Whitworth, DZU, etc. Tremendous variety of heads - cheese, countersunk, pan, hex, allan, round etc, etc. As for size - well, we've seen some as small as 3mm and a few as long as 80mm. There's even some 12.5mm diameter in there! You'll probably also find a few odd clips, washers, nuts, etc in this pack too!
Price/500gm pack **£2.70**

K534 Sleeving Pack - we've now accumulated enough sleeving to offer this very popular pack again. A terrific variety of types, sizes and colours from 1-20mm bore, OD's from 2-24mm. Lengths from 10mm to 76mm. Well over 25 different types, including PVC, rubber, silicone etc.
Price ..... **200/£2.00**

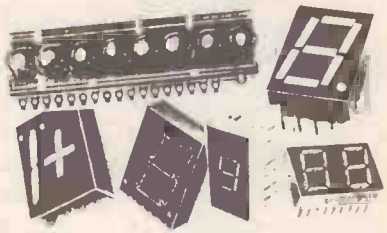
K538 Diode Pack - untested small signal diodes like IN4148 etc at a price never before seen!!
Price/1000 ..... **£2.50**

K537 IC Pack - a mix of linear and logic chips, from 6 to 40 pin. All are new and marked, but some may not be full spec.
Price/100 ..... **£6.75**

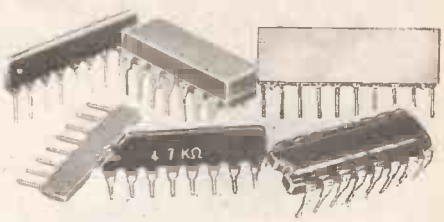


K804 Lamp Pack. A superb quality pack containing a wide variety of small lamps. Many different types - wire ended, bi-pin, slide, MBC, MES LES, TI, wedge, miniflange etc in voltages from 2.5V to 220V. Most are marked with voltage/current.
Pack of 50 ..... **£4.00**

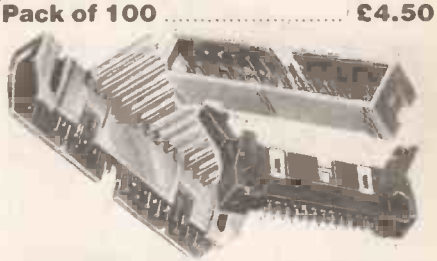
K531 Precision Resistor Pack - High quality, close tolerance R's with an extremely varied selection of values mostly ¼W and ½W tolerances from 0.1% to 2% - ideal for meters, test gear etc.
Prices ..... **250/£3.00;** 1000/£10.00



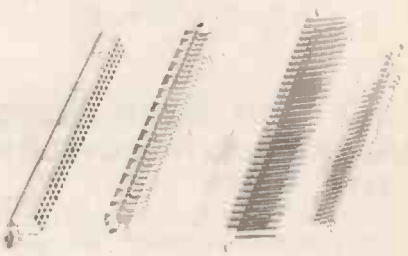
K801 Seven seg LED pack. Big variety of sizes in this pack. May include Red and Green, also overflow/polarity displays, single/double digit, also 7/8/9 digit magnified displays. Sizes from 0.11" to 0.8". 20 pieces for just **£3.95**



K572 Resistor Networks. Both SIL and DIL in here, from 6 to 16 pin. Plenty of popular values like 1k, 4k7 and 10k, and a good sprinkling of many other values.
Pack of 100 ..... **£4.50**



K803 PCB headers pack with/ without ears, straight and right angle from 10-64 way ... **Pack of 20 £5.50**



K802 Pack of DIN41612 connectors. These popular PCB connectors come as 32/64/96 way. Both plugs and sockets, some with pins missing. Normally costing £1-£3 each ..... **Pack of 25 £8.00**

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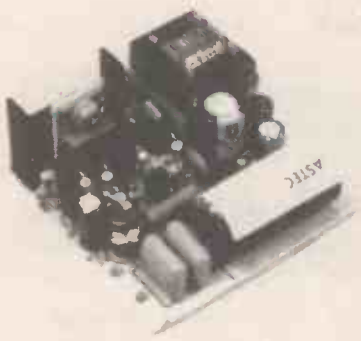
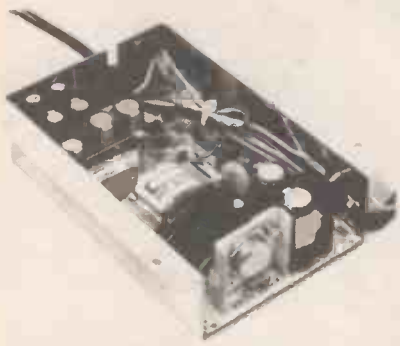
THE POW - POW -



Z660 Astec switched mode PSU type AA7271. This small PCB, just 50 × 50mm will accept 8-24V input and give a stable 5V dc at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at a remarkably low price.
Price **£5.00**



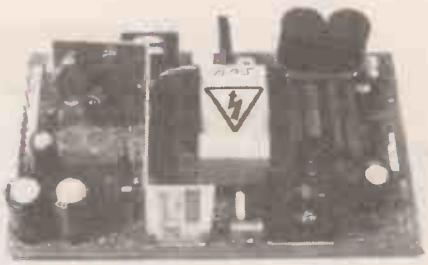
We still have good supplies of yet another Astec model. This one is partially cased, the overall size being 160 × 104 × 45mm. The PCB measures 160 × 100mm. Input and Outputs are on flying leads, all colour coded. There is also an additional IEC socket to extend mains to another unit.

Specification:	
Model Number	**AA12531**
Input	115/230V, 50/60Hz
Outputs	+5V 5A
	+12V 0.15A
Total Wattage	50W

Price ..... **£6.95** 25+ 5.43 100+ 4.53

HAVE YOU PURCHASED AN AA12531 SWITCH MODE PSU?

If so, we have a conversion kit to change the output to the same as the AC8151 **plus** an additional output!! (+5V 2.5A; +12V 2A; -12V 0.1A; and -5V 550mA). The PCB on both these PSU's is identical - by changing a few components and adding a few more, the above outputs can be achieved.
Complete kit of parts + full instructions **(K625)** **£3.50**
Instructions only **(K626)** **£1.00**

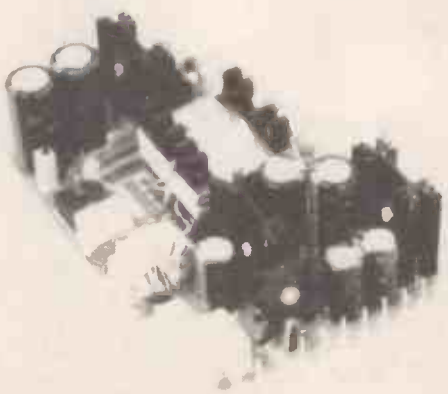


Z4112 Switch mode PSU. 50W unit on 160 × 100mm PCB. Input 105-125, 210-250Vac. Outputs: 24V @1.7A; 12V @0.8A. Ridiculously low price - these cost over £50.00 normally!
Our price **£9.95**

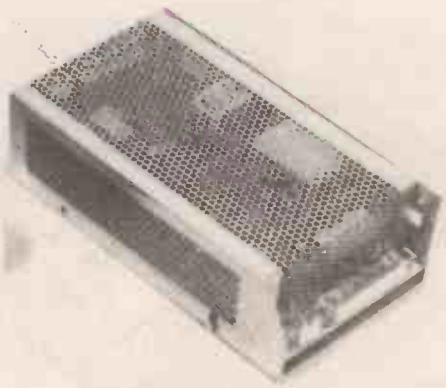
Z8887 Made by STC, this 160 × 100mm panel is attached to an aluminium chassis. 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details, we can offer these at a fraction of their normal cost!
Price ..... **£5.95** 10+ 4.30 100+3.43

Z8888 A larger version of the above, PCB 220 × 100mm and chassis 225 × 102 × 65mm providing a single 5V 10A output. Supplied with connection details.
Price ..... **Only £8.95** 10+ 6.50 100+5.20

Z8890 DC-DC CONVERTER BOARDS. These panels 220 × 195 require 50V DC input for a 5V 19.5A output. Inputs and outputs on DIN41612 connector. These brand new panels made by STZ are now being offered at just:
Price ..... **£7.95** 25+ 5.20 100+ 3.89



Z4168 Europower SMPSU. 65 watt unit on panel 160 × 100 giving +5V@ 6A, +12V@ 2A and -12V@ 1A **£12.95**



We've also discovered a small quantity of an Astec model offered previously. Regrettably we've had to increase the price, but they still represent outstanding value for money. Enclosed in a steel case 203 × 112 × 60mm is a PCB 197 × 106mm. Input and Outputs are via pins on the PCB.

Specification:	
Model Number	**AC9231**
Input	115/230V, 50/60Hz
Outputs	+12V 2.5A
	+5V 6A
	12V 0.5A (+ or −)
	5V 0.5A (+ or −)
Total Wattage	50W

Price .. £17.95 25+ 14.05 100+ 11.70

Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 × 136 × 65mm, which has incorporated in it a switched and fused IEC mains inlet. Inside, the PCB is 160 × 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.

Specification:	
Model Number:	BM41012
Input:	115/230V, 50/60Hz
Outputs:	+5V 3.75A
	+12V 1.5A
	−12V 0.4A
Total Wattage:	65W

Price ... £14.95 25+ 11.70 100+ 9.75

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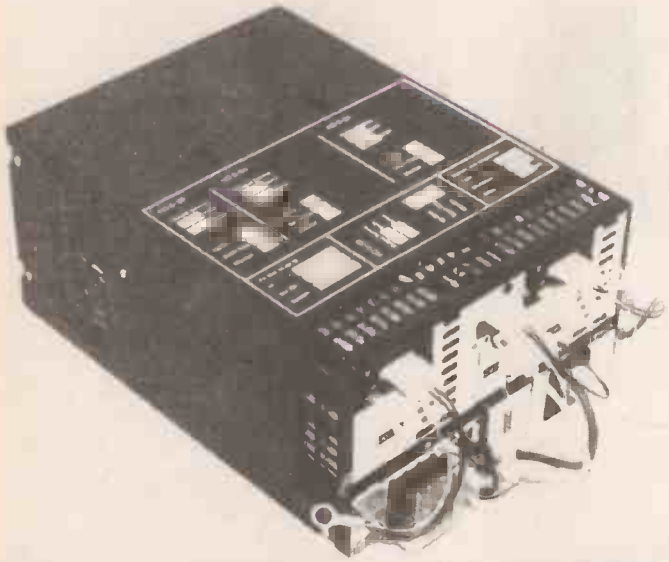
POWER PAGES!



HIGH POWER SWITCH MODE POWER SUPPLY

Z8895 These 1000 watt power supplies by Hi-Flex consist of 4 sub-units housed in a frame 280 × 203 × 103mm. Input range 88-132V or 176-264V. Outputs: 5V@ 60A twice; 5V@ 30A twice.
Each module is wired separately so can be connected in series or parallel. The output from each module can be varied from 2.5-8V by adding an external pot. As a result, this becomes an extremely useful bench supply giving anything from 2.5 to 32V at currents from 30 to 180A! Details are provided showing how this can be achieved, as well as how to wire it up to give 13.8V @ 60A, making this an exceptionally useful unit for checking out high powered car audio equipment. List price of this unit is close on £1000.

Our special low price **£200.00**

Z8802 Battery charger unit. 2 part vacuum formed black plastic case 570 × 210 × 85mm with room for 10 × 2.6AH 6V sealed lead acid batteries. Inside is a neat PSU - RS torroidal transformer 207- 958. 120/240V primary 0-9, 0-9 secondary, each at 10VA. There is a bridge rectifier and smoothing cap. The output is taken to a PCB 510 × 45mm containing 10 identical charging circuits. Each has a TIP31A, 741, IN4002 and couple of Rs, and a 3 pin connector.
Clearing at ..... **£8.00 each**

Z975 PSU - Mains input via 13A built in plug. Output 14V 600mA AC. Case 92 × 57 × 52mm.
Price **£3.50**

Z4212 Mains transformer - 0-110-120-240V primary, secondary 9-0-9V 2A and 20V 2A. Size 100 × 75 × 60mm.
Price **£3.00**

NICAD BATTERIES

These are shown on page 118 of the 1991 catalogue, but few details are given.
Z4150 Ex mobile radio battery. 56 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.25V 600mA
Price **£3.00**
Z4149 As above but 84 × 66 × 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.25V 900mA.
Price **£4.50**

Z4359 'Cylon' sealed lead acid battery. As listed by RS (591-483) at £5.76, 2V 5Ah cell offers longer life and is less susceptible to overcharge abuse. Can be charged from constant voltage or constant current source. Size 72.5 × 46mm dia. Weight 350g.
Price **£3.50**

Z1951 Varta 'Memopac' PCB Nicad 8.4V 100mAh. Although new, these batteries are not in pristine condition, so are offered at way below normal costs. Size 41 × 26 × 14mm.
Price **£1.50**

Z1952 AA Nicads - 2 sleeved end to end. Easily split into 2 if required.
Prices **£1.50**
25+ 1.10; 100+ 0.75

Transformers

Z9001 0-110-115-120, 0-110-115-120 primary, secondary 240V 10A and 6.3V 1A. Use as step up, step down or isolating transformer.
Price **£60.00**
Z9002 Same primary as above, secondary 23V 14.4A 331VA.
Price **£20.00**
Z9009 0-240V primary, secondary 0-11-12-13V 6.3A and 28-24-0- 24-28V 7.2A.
Price **£20.00**
Z9003 0-220-240V primary, secondary 0-22.2-24V 3A & 11.2-0-11.2V 3A.
Price **£12.00**
Z9004 Autotransformer 0-220-225-230-235-240V output, 0-120-240V input. Rated 250VA.
Price **£18.00**

ALL 1-OFF PRICES INCLUDE VAT - QUANTITY PRICES DO NOT

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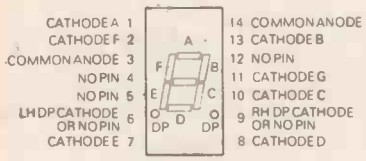
NEW PARCEL OF LED DISPLAYS!
Nice quality single and dual red 7 segment, also polarity/overflow types, too.

0.3in (7.62mm) Display Height

H – 19.05
W – 10.16
D – 5.4

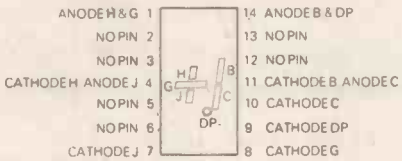
Pin spacing 2.54
Row spacing 7.62



Common anode
RH alt LH DP

Common cathode
RHDP only

PIN CONNECTIONS (TOP VIEW)



Common anode
polarity and overflow
LHDP

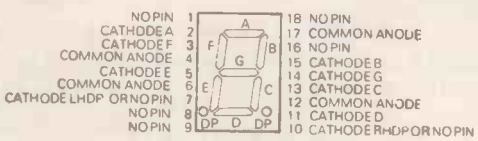
(a) 0.3" (7.62mm) display height; luminous intensity 0.6mCd @ 10mA

Code	Type	7/+1	DP	CC/CA	1+	25+	100+
Z1937	SEA3110	7 seg	LH	CA	31p	0.20	0.16
Z1938	SEA3210	7 seg	RH	CA	31p	0.20	0.16
Z1939	SEC3010	7 seg	RH	CC	31p	0.20	0.16
Z1940	SEA3310	+1	LH	CA	20p	0.13	0.10

0.8in (20.32mm) Display Height

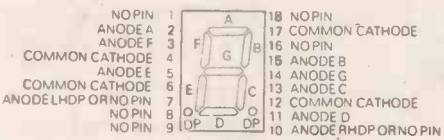
H – 27.7
W – 19.9
D – 8.38

Pin spacing 2.54
Row spacing 15.24



Common anode
RH alt LH DP

PIN CONNECTION (TOP VIEW)



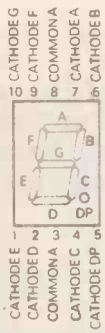
Common cathode
RH alt LH DP

(c) 0.8" (20.32mm) display height; luminous intensity 0.8mCd @ 10mA

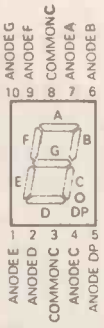
Code	Type	7/+1	DP	CC/CA	1+	25+	100+
Z1947	SEA8010	7 seg	RH	CA	47p	0.30	0.24
Z1948	SEC8010	7 seg	RH	CC	47p	0.30	0.24
Z1949	SEA8110	7 seg	LH	CA	47p	0.30	0.24
Z1950	SEC8110	7 seg	LH	CC	47p	0.30	0.24

0.5in (12.88mm) Display Height

H – 19.0
W – 12.7
D – 8.0

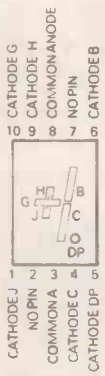


Common anode
RHDP

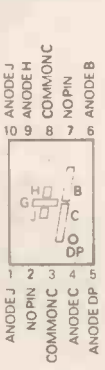


Common cathode
RHDP

PIN CONNECTIONS (TOP VIEW)



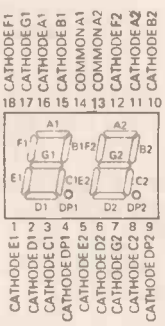
Common anode
RHDP



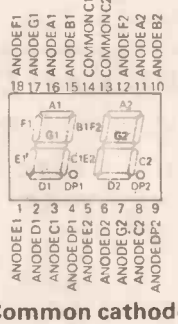
Common cathode
RHDP

H – 19.05
W – 25.0
D – 8.0

Pin spacing 2.54
Row spacing 15.24



Common anode
PIN CONNECTION (TOP VIEW)



Common cathode

(b) 0.5" (12.88mm) display height; luminous intensity 0.8mCd @ 10mA

Code	Type	7/+1	DP	CC/CA	1+	25+	100+
Z1941	SEA5110	7 seg	RH	CA	35p	0.23	0.18
Z1942	SEC5110	7 seg	RH	CC	35p	0.23	0.18
Z1943	SEA5410	+1	RH	CA	23p	0.15	0.12
Z1944	SEC5410	+1	RH	CC	23p	0.15	0.12
Z1945	SEA5210	Dual 7 seg	RH	CA	58p	0.38	0.30
Z1946	SEC5210	Dual 7 seg	RH	CC	58p	0.38	0.30

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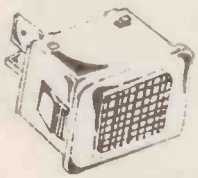
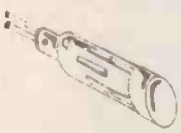
THE INDICATOR COLLECTION

A parcel of IMO Neon indicators and various other lamps has just been delivered and offers the hobbyist a selection of top quality components at rock-bottom prices! Why are they so cheap? They're all for 110/120V! However, that's no problem because with every indicator we supply a suitable resistor for mains operation.

Type A - Panel mounting 33 × 15mm with 0.25" tags. Clip fix, requires 25 × 12.5mm cut-out.
Z1898 Red
Z1899 Green
Z1900 Amber
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06

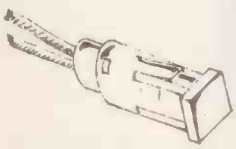


Type B - Panel mounting 36.5 × 26.5mm with 0.25" tags. Clip fix, requires 30 × 22.5mm cut-out.
Z1901 Red
Z1902 Green
Z1903 Amber
Z1904 White
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06

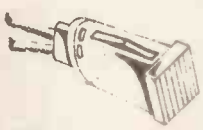


Type C - Small round face 10mm dia. Clip fix, requires 9mm dia hole.
Z1905 Red
Z1906 Green
Z1907 Amber
Z1908 White
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06

Type D - Large round face 13.5mm dia. Clip fix, requires 12.5mm dia hole.
Z1909 Red
Z1910 Green
Z1911 Amber
Z1912 White
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06



Type E - Small square face 10.5mm. Clip fix, requires 9.5mm dia hole.
Z1913 Red
Z1914 Green
Z1915 Amber
Z1916 White
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06



Type F - Large square face 13.5mm. Clip fix, requires 12.5mm dia hole.
Z1917 Red
Z1918 Green
Z1919 Amber
Z1920 White
Price: **(Any mix) 5 for £1**
100+ 0.10 1k+ 0.06

Type G - Small round face 7.5mm dia, threaded body, requires 6.5mm dia hole.
Z1921 Red
Price: **5 for £1; 100+ 0.10; 1k+ 0.06**

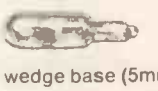
K700 Pack of indicators, types A-G. May include any of those listed above. Great value for money! **20 for £2.50**

Z1928 MES 110V neon indicator **5 for £1.00**

Z1922 MBC 220V neon indicator **5 for £1.00**

Z1923 Slide (PO type) 220V **5 for £1.00**

Z1924 Small slide base 48V 25mA T5.5 **5 for £1.00**
Z1925 Small slide base 24V 20mA T5.5 **5 for £1.00 100/£10**
Z1926 Small slide base 60V 20mA T5.5 **5 for £1.00**



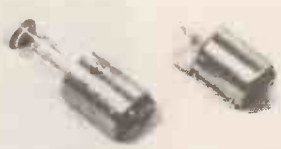
Z1930 Small wedge base (5mm dia) 24V 30mA **8 for £1.00**

Z1929 T3/4 (10mm) wedge base 28V 60mA **5 for £1.00**

Z1927 LES 6.5V 0.15A **6 for £1.00**

Z1931 Sub-midget flanged 12V 30mA T1 **3 for £1.00**

Z1936 GE Lamps No 346 18V 0.04A. Unusual base, so clearing at (per box of 10) **50p**
10 boxes 3.50
50 boxes 12.00



Z1953 SBC mains neon indicator with magnified end lens. Overall size 51 × 15.5mm dia.
Price ..... **3 for £1.00**

Z2043 Lamp, SBC 3A15D base 6V 5W.
Price ..... **25p** Box of 10 £2.00

7-SEG LED CLEARANCE!

As listed on Page 2 of B/L 62 supplement.

Type	Size	CC/CA	DP
4710	0.43"	CA	RH
4710A	0.43"	CA	
4720	0.43"	CA	LH
3719	0.3"	CA	RH
3729	0.3"	CA	LH

ALL THE SAME PRICE: **20p each**
ANY 10 £1.60 100 £10.00

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BULK CLEARANCE SALE

On tidying up one of our stores, we discovered we are overstocked on a number of surplus lines - so we're having a clearout of the following items:

Z4081 CB AERIAL ELIMINATORS. Box of 20 **£8.00**

SB9 DRAGON INTERFACE - case 116 × 62 × 29mm with 2 × 9 pin D Plugs, 2 leads with 5 pin DIN plug. Inside is a PCB with 4 transistors and 20 resistors.
Box of 50 **£20.00**

Z4133 CORGI TELECONTROL. 100 × 60 × 25mm plastic case with 3 switches & 5 core lead.
Box of 50 **£6.00**

Z8827 DIECAST BOX 150 × 80 × 50mm with 25'D' socket and 13 core 2m lead. Inside, 24 off 12V 1W Zeners and fuses.
Box of 20 **£15.00**

Z4224 METER CASES 135 × 120 × 45mm.
Box of 100 **£25.00**

Z024/5 LOW AIR PRESSURE SWITCHES with 16A mains switch. Operate by blowing.
Box of 50 **£15.00**

Z610 ENTERPRISE DEMO TAPE - compact cassette in library case, 4 mins per side.
Box of 100 **£10.00**

Z1395 15mm PANEL MOUNTING FUSEHOLDER - Belling Lee L575.
Bag of 100 **£5.00**

ALL 1-OFF PRICES INCLUDE VAT - QUANTITY PRICES DO NOT

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	Z0000			1991 132 page Catalogue	UK/BFPO O'SEAS	1.50 3.00		

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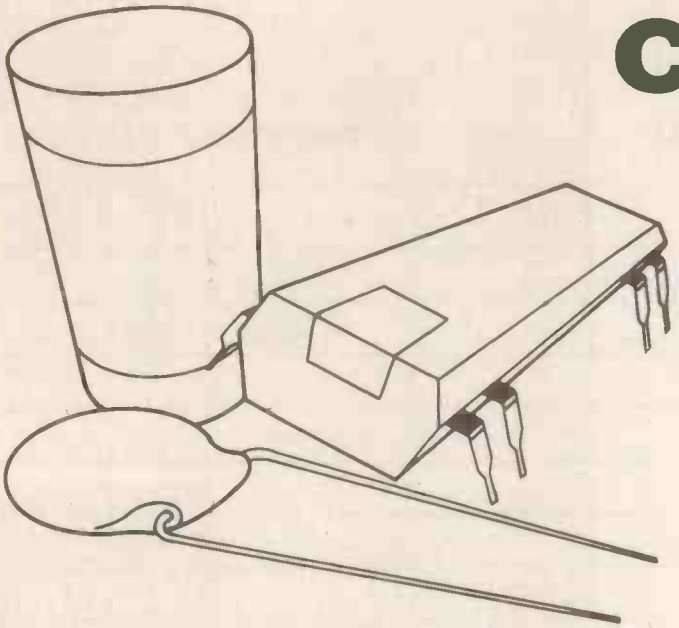

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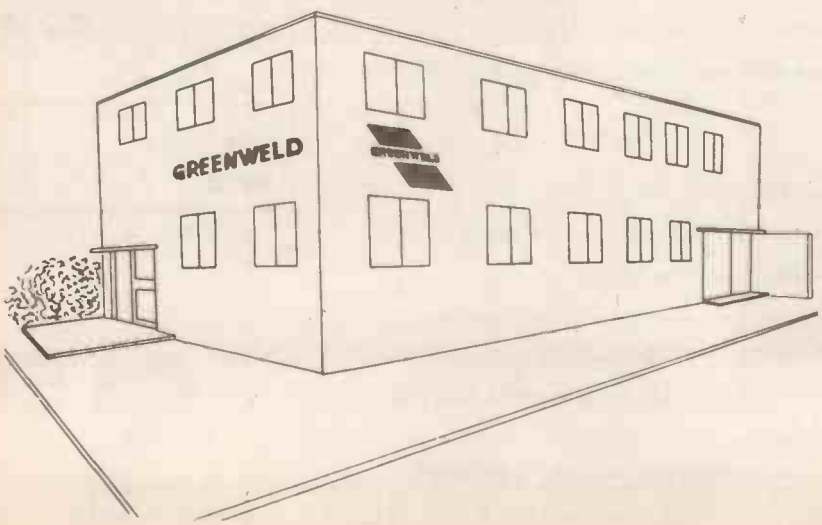

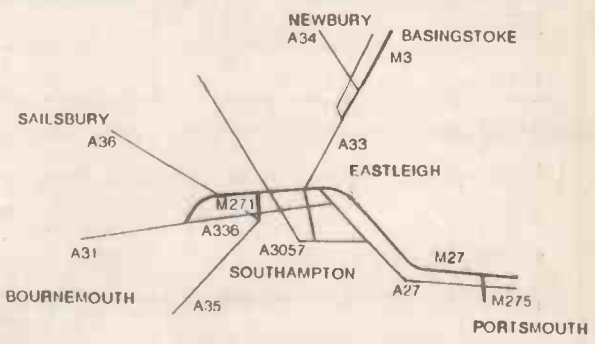

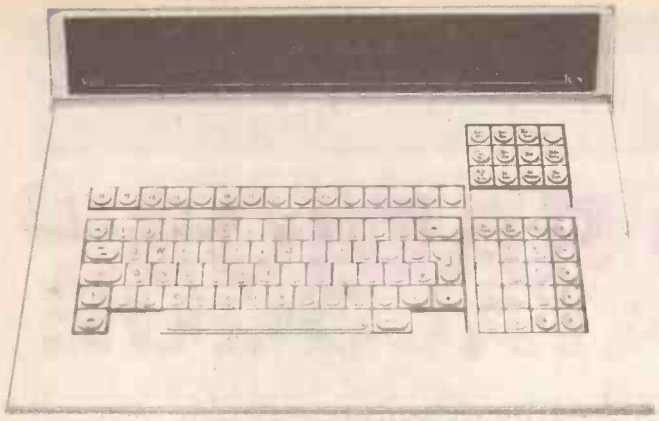

Vistel II TOTAL COMMUNICATION for DEAF PEOPLE

VISTEL II SPECIFICATIONS.

- Dimensions: 34cm x 45cm x 13.7cm
- Weight: 4.5kg
- Full 'QWERTY' keyboard plus 'function' keys for ease of use
- 40 character screen which displays your messages quickly, clearly and quietly
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- Auto-dialling capability for sending messages during cheap rate telephone periods
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- Calculator
- Printer Interface for connection to a printer
- Telecom Gold, or BKU mail box, function key
- Vistel II runs from mains with battery back-up so memory is retained even when Vistel II is turned off
- For connection your only requirements are a power point and a British Telecom jack plug socket

Options:

- Printer

WHY IS VISTEL II DIFFERENT?

Vistel II is a visual telephone plus 'answerphone' which allows everyone to communicate over the telephone network.

VISTEL II IS EASY TO USE.

By simply dialling a number and typing in your message you can be in touch with anyone else with similar equipment — whether they are across the road or at the other end of the country.

VISTEL II THE ANSWERPHONE.

By pressing one clearly marked button you can send or receive typed messages even when you are out. Additionally you can prepare and send a message at a particular preset time (during cheap periods to save you money).

VISTEL II IS UNIQUE.

With Vistel II not only can you talk to other Vistel II users but Vistel I (of which there are over 1,000 already in use by deaf people throughout the U.K.), Telecom Gold, Breakthrough Trust's BKU Mailbox Network, Mailink, the R.N.I.D. telephone exchange or any other computer with a modem.

These units are new and boxed, but because the company who manufactured them has gone bankrupt they are offered without guarantee. There is a comprehensive 143 page instruction manual provided. These units originally sold for over £500.

Our Bargain Basement Price **£150**

If you want to look through the manual first, send £12 (£10 deposit + £2 post); £10 refunded on its return.

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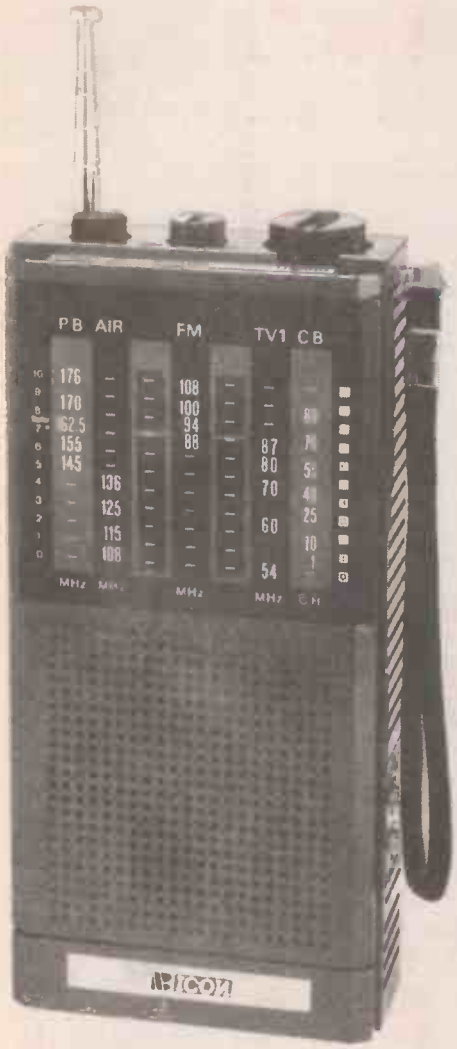
MULTIBAND RADIOS!!



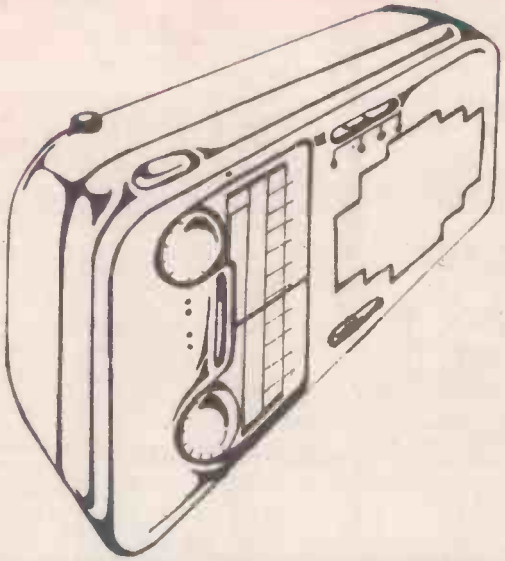
MULTIBAND RADIO

This compact piece of equipment 200 × 95 × 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume, squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

1) CB, channels, 1-80
2) TV1 54-87 MHz & FM 88-108 MHz
3) AIR 108-145 MHz & PB 145-176 MHz.

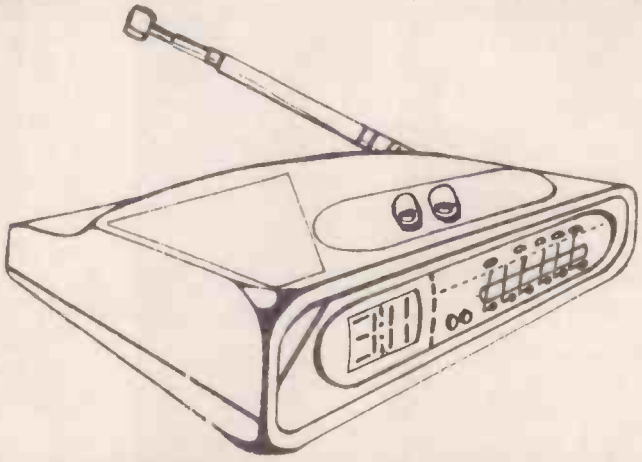
The large 3" full range speaker delivers 280mW of undistorted power. There is an earphone jack and DC adaptor jack. The unit is powered by 4 × AA cells. All this technology for just **£17.95**

Order Code **MB 100**



Z8891 Superb 4 waveband radio by Ross, model RR5. Covers FM 88-108MHz, MW 518-1610kHz, LW 150-275kHz SW 5.7-18.1MHz (16.5-52.6m). Nicely styled case measuring 210 × 145 × 70mm with clear scale markings. telescopic aerial, headphone socket. Volume, tone and tuning controls. ON/OFFswitch/ waveband selector switch and AFC switch. Mains/battery. (Takes 4 × C cells). Originally retailed at £19.95

Our Price **£14.95**



Z4357 Clock Radio by Ross. Extremely neat unit measuring 140 × 80 × 35mm. MW/FM bands, telescopic aerial,stand, carrying pouch and strap. Clock has LCD display and can be used in 12 or 24 hr mode. Alarm. Light. Earphone socket. Takes 2 × AA cells.

Great value at **£13.95**