EVERYDAY ELECTRONICS

FEBRUARY 1992

INCORPORATING ELECTRONICS MONTHLY

£1.60

FREE INSIDE BULL ELECTRICAL 40 PAGE CATALOGUE

PROGRAMMABLE TIMER

TIMES FROM MICROSECONDS TO HOURS

SPINNING HEART

A VALENTINE PROJECT FOR YOUR LOVED ONE

TELESOUND

PLAY YOUR PERSONAL HI-FI THROUGH A TV

02

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

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

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter Ideal to work with the amplifier described above Price per pair £30 00 Order ref 30P7R

2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc 250v AC input £10 00 ref 10P93R

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 6P18R

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC Five metre length £7 00 ref 7P29R

12V SOLAR CELL. 200mA output ideal for trickle charging etc 300 mm square Our price £15 00 ref 15P42R

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50° range with a 90 deg coverage Manual override facility Complete with wall brackets, bulb holders etc Brand new and guaranteed £25 00 ref 25P24R Pack of two PAR38 bulbs for above unit £12 00 ref 12P43R

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel) 12v DC op £15 00 ref 15P39R Suitable mains adaptor £5 00 ref 5P191R

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven) £26 00 ref 26P2R

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres Units measure 22x52x155mm Complete with cases £30 00 ref 30P12R

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

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery Complete with shoulder strap and mains lead **NOW ONLY £19.00!! REF 19P14R.**

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones Cased £5 00 ref 5P179R

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 25P21R

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200' Our price £8 00 a pair ref 8P50R

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

NICAD BATTERIES. Brand new top quality 4 x AA's £4 00 ref 4P44R 2 x C's £4 00 ref 4P73R, 4 x D's £9 00 ref 9P12R, 1 x PP3 £6 00 ref 6P35R

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book Latest edition £20 00 ref 20P32R

CABLE TIES. 142mm x 3 2mm white nylon pack of 100 £3 00 ref 3P104R Bumper pack of 1,000 bes £14 00 ref 14P6R

1992 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 gerger counter £39 00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil Transmits to any FM radio 9v battery req'd £5 00 ref 5P158R

FM BUG Built and tested superior 9v operation £14 00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video 12v DC £8 00 ref 8P39R

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft New £20 00 ref 20P22R

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40 00 ref 40P8R

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube Wheels are black, spoked one piece poly carbonate 13" wheel £6 00 ref 6P20R, 16" wheel £6 00 ref 6P21R

ELECTRONIC SPEED CONTROL KIT for c5 motor PCB and all components to build a speed controller (0-95% of speed) Uses pulse width modulation £17 00 ref 17P3R

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours Brand new and cased £6 00 ref 6P3R

12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc £5 00 ref 5P206

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others Includes mains adapter, leads and book £15 00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company Pack of 10 tapes £20 00 ref 20P20R

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

6V 10AH LEAD ACID sealed battery by yuasa ex equipment but in excellent condition now only 2 for £10 00 ref 10P95R

12 TO 220V INVERTER KITS As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts Basic kit £12 00 ref 12P17R Larger transformer £12 00 ref 12P41R

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc Complete with tools, wire and reusable board Our price £6 00 ref 6P33R

MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc £5 00 ref 5P165R

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 £6 00 ref 6P59R

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

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

25 WATT STEREO AMPLIFIER c STK043 With the addition of a handful of components you can build a 25 watt amplifier £4 00 ref 4P69R (Circuit dia included)

LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A Short circuit protected £12 00 ref 12P21R

MINI RADIO MODULE Only 2" square with ferrite aerial and tuner Superhet Req's PP3 battery £1 00 ref BD716R

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

FRESNEL MAGNIFYING LENS 83 x 52mm £1 00 ref BD827R

ALARM TRANSMITTERS. No data available but nicely made complex transmitters 9v operation £4 00 each ref 4P81R

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads Holds up to 5 batteries at once New and cased, mains operated £6 00 ref 6P36R

COLOUR MONITORS

AMSTRAD CTM644

RGB INPUT

£75.00 REF A75P1

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film £5 00 ref 5P170R

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2 00 ref 2P286R

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2 00 ref 2P287R

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3 00 ref 3P92R

LED PACK 50 red leds, 50 green leds and 50 yellow leds all 5mm £8 00 ref 8P52R

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse 2 gears plus turbo Working headlights £22 00 ref 22P6R

MIRACOM WS4000 MODEMS

V21/23

AT COMAND SET

AUTODIAL/AUTOANSWER

FULL SOFTWARE CONTROL

TONE AND PULSE DIALLING

£29

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins) Complete with daylight sensor Unit also functions as a dimmer switch! 200 watt max Not suitable for flourescents £14 00 ref 14P10R

CUSTOMER RETURNED 2 channel full function radio controlled cars only £8 00 ref 8P200R

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

240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40 00 ref 40P200R

300 WATT RMS MONO AMP KIT £55.00 Psu required ref 55P200

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels £16 00 ref 16P200

ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc £18 00 ref 18P200

MODEMS FOR THREE POUNDS!! Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3 00 ref 3P145R

TELEPHONE HANDSETS Bargain pack of 10 brand new handsets with mic and speaker only £3 00 ref 3P146R

BARGAIN STRIPPERS Computer keyboards Loads of switches and components excellent value at £1 00 ref CD40R

PC POWER SUPPLIES These units are new but need attention complete with case, fan IEC input plug disc drive and mother board fly leads Our price is £5 00 (less than the fan alone would cost!) ref 5P208R

HIGH VOLTAGE CAPACITORS A pack of 20 500PF 10KV capacitors ideal for ionizers TV repairs and high voltage experiments etc Price is £2 00 ref 2P376R

DATA RECORDERS Customer returned mains battery units built in mic ideal for Computer or general purpose audio use Price is £4 00 ref 4P100R

SPECTRUM JOYSTICK INTERFACE Plugs into 48K Spectrum to provide a standard Atari type joystick port Our price £4 00 ref 4P101R

ATARI JOYSTICKS Ok for use with the above interface, our price £4 00 ref 4P102R

BENCH POWER SUPPLIES Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply Fused and short circuit protected For sale at less than the cost of the case! Our price is £4 00 ref 4P103R

SPEAKER WIRE Brown twin core insulated cable 100 feet for £2 00 REF 2P79R

MAINS FANS Brand new 5" x 3" complete with mounting plate quite powerfull and quite Our price £1 00 ref CD41R

DISC DRIVES Customer returned units mixed capacities (up to 1 44M) We have not sorted these so you just get the next one on the shelf. Price is only £7 00 ref 7P1R (worth it even as a stripper)

HEX KEYBOARDS Brand new units approx 5" x 3" only £1 00 each ref CD42R

PROJECT BOX 51/2" x 31/2" x 1" black ABS with screw on lid £1 00 ref CD43R

SCART TO SCART LEADS Bargain price leads at 2 for £3 00 ref 3P147R

SCART TO D TYPE LEADS Standard Scart on one end, Hi density D type on the other Pack of ten leads only £7 00 ref 7P2R

OZONE FRIENDLY LATEX 250ml bottle of liquid rubber sets in 2 hours Ideal for mounting PCB's fixing wires etc £2 00 each ref 2P379R

QUICK SHOTS Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2 00 ref 2P380R

VIEWDATA SYSTEMS Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased Our price is only £20 00 ref 20P1R

3 INCH DISCS Ideal for Amstrad PCW and Spectrum +3 machines pack of 10 discs is £12 00 ref 12P1R

AC STEPDOWN CONVERTOR Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin Amercan output socket (suitable for resistive loads only) our price £2 00 ref 2P381R

SPECTRUM +3 LIGHT GUN PACK complete with software and instructions £8 00 ref 8P58R

CURLY CABLE Extends from 6" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1 00 each ref CD44R

COMPUTER JOYSTICK BARGAIN Pack of 2 joysticks only £2 00 ref 2P382R

MINI MONO AMPLIFIER PACK 4 amplifiers for £2 00! 3 watt units 9-12v operation ideal for experiments etc £2 00 ref 2P383R

BUGGING TAPE RECORDER Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said Price is £20 00 ref 20P3R

IEC MAINS LEADS Complete with 13A plug our price is only £3 00 for TWO! ref 3P148R

COMPUTER SOFTWARE BARGAIN 10 cassettes with games for commodore 64, Spectrum etc Our bargain price one pound! ref CD44R

NEW SOLAR ENERGY KIT Contains 8 solar cells, motor, tools, fan etc plus educational booklet Ideal for the budding enthusiast! Price is £12 00 ref 12P2R

FUSE PACK NO 1 Fifty fuses 1 1/4" long (glass) quick blow 10 popular values £2.00 ref 2P384R

FUSE PACK NO 2 Fifty fuses 20mm long (glass) quick blow 10 popular values £2 00 ref 2P385R

POTENTIOMETER PACK NO 1 30 pots for £3 00! Ideal for projects etc Ref CD45R

286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included)

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

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

TALKING CLOCK LCD display, alarm, battery operated Clock will announce the time at the push of a button and when the alarm is due The alarm is switchable from voice to a cock crowing!£14 00 ref 14P200 R

HANDHELD TONE DIALLERS Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones Ideal for the remote control of answer machines £5 00 ref 5P209R

COMMODORE 64 MICRODRIVE SYSTEM Complete cased brand new drives with disc and software 10 times faster than tape machines works with any Commodore 64 setup The orginal price for these was £49 00 but we can offer them to you at only £25 00! Ref 25P1R

USED SCART PLUGS Packof 10 plugs suitable for making up leads only £5 00 ref 5P209R

C CELL SOLAR CHARGER Same style as our 4 x AA charger but holds 2 C cells Fully cased with flip top lid Our price £6 00 Ref 6P79R

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £2.50 POST PLUS VAT.

PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

NEXT DAY DELIVERY £8.00

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SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
ABC

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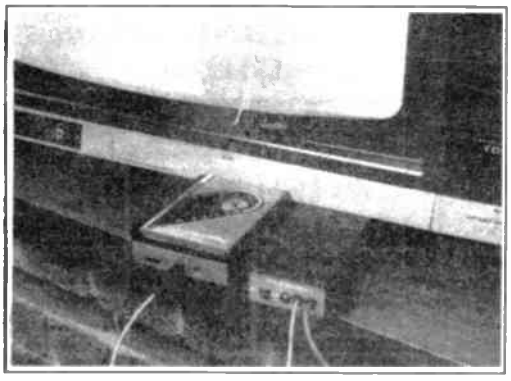
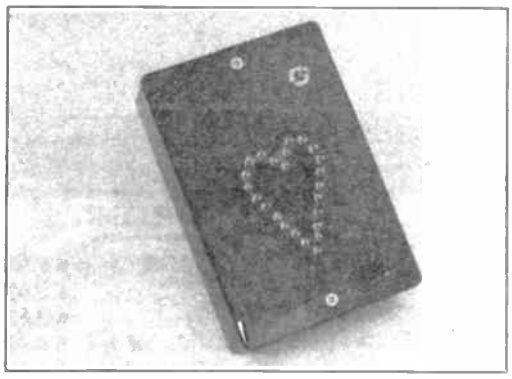
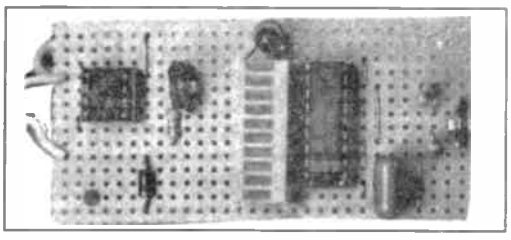
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







Projects

Series

Features

Our March '92 issue will be published on Friday, 7 February 1992. See page 75 for details.

HARD DISC DRIVES

20 Mb (IDE - CONNER)	£ 79
20 Mb (MFM)	£ 79
40 Mb (IDE)	£ 140
100 Mb (IDE - CONNER)	£235
MOUNTING KIT	£ 9
MOUNTING KIT (RAILS ONLY)	£ 5

HARDCARDS

20 Mb AT	£105
■ 20 Mb XT	£125
40 Mb AT	£170
■ 40 Mb XT	£185
100 Mb AT	£265
■ 100 Mb XT	£285

■ IDEAL FOR 1512 / 1640 COMPUTERS

FLOPPY DISC DRIVES

3½" 1.44M	INTERNAL - GREY	£ 40
3½" 1.44M	INTERNAL - BLACK	£ 35
3½" 720K	INTERNAL - GREY	£ 33
3½" 720K	EXTERNAL - GREY	£ 26
5¼" 360K	INTERNAL - GREY	£ 24
5¼" 360K	INTERNAL - BLACK	£ 24
5¼" 1.2M	INTERNAL - GREY	£ 45

MONITORS

TILT & SWIVEL BASES ON ALL MONITORS

14" SVGA+ / XVGA COLOUR	£ 235
0.28" DOT PITCH - 1024 x 768	
14" VGA COLOUR	£185
14" VGA PAPER WHITE	£ 89
12" VGA PAPER WHITE	£ 75

GRAPHIC CARDS

CGA CARD	COMPOSITE & TTL	£ 12
VGA CARD	8 OR 16 BIT - 256K	£ 43
SVGA CARD	16BIT - 512K	£ 60
SVGA CARD	16BIT - 1M	£ 72

COMPUTER CASES

WITH 200W P.S.U AND L.E.D.DISPLAY

FLIP-TOP	WITH 3 BAYS	£ 60
DESKTOP	WITH 4 BAYS	£ 80
MINI TOWER	WITH 5 BAYS	£ 70
MIDI TOWER	WITH 5 BAYS	£ 95
FULL TOWER	WITH 6 BAYS	£ 107

LET HOBBYKIT QUOTE FOR YOUR COMPUTER SYSTEM

D O S SYSTEMS

MS DOS 5.0	£ 62
DR DOS 6.0	£ 65

CONTROLLER CARDS

IDE - AT 16BIT-2HDD/2FDD	£ 17
IDE - AT 16BIT-2HDD/2FDD/2S/1P/1G	£ 26
IDE - 8 BIT XT	£ 29
■ IDE - 8 BIT-SLAVE / 1ST OR 2ND HDD	£ 39
IDE - AS ABOVE 16 BIT WORKS WITH MFM	£ 45
XT - MFM - 8 BIT - 2 HDD ONLY	£ 38
AT RLL - 2 x HDD	£ 25
AT MFM - 2 x HDD / 2 x FDD	£ 44
AT RLL - 2 x HDD / 2 x FDD	£ 40
FDD - 2 x FDD - XT/AT - ALL FORMATS	£ 27
FDD - 4 x FDD - XT/AT - ALL FORMATS	£ 39
I/O CARD - 2S / 1P / 1G	£ 16

■ IDEAL FOR 1512 / 1640 COMPUTERS

MOTHERBOARDS

★ COMPLETE WITH 1 Mb MEMORY ★

286 - 16	L/S 21 MHz	£ 105
286 - 20	L/S 25 MHz	£ 125
386SX - 25	L/S 31 MHz	£ 225
386SX - 25	WITH 32K CACHE	£ 298
386DX - 33	WITH 64K CACHE	£ 407
486DX - 33	WITH 64K CACHE	£ 786

OTHER 386 / 486 MOTHERBOARDS - PLEASE CALL

SPECIAL OFFER

286 - 16 SYSTEM

● FEATURES INCLUDE ●

- 286-16 (L/S 21MHZ)
- 1 Mb ON BOARD MEMORY
- 20 Mb HARD DISC IDE
- 3½" 1.44M FLOPPY
- HDD / FDD CONTROLLER
- 2S / 1P / 1G
- GRAPHICS CARD VGA = 256K SVGA = 512K
- KEYBOARD (102 KEYS)
- MINI TOWER CASE
- CHOICE OF MONITOR

12" VGA PAPER WHITE	£ 460
14" VGA PAPER WHITE	£ 495
14" VGA COLOUR	£ 585
14" SVGA+/ XVGA COLOUR	£ 640

HOBBYKIT

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☎ 081 - 205 7485

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CAPITOL WAY, LONDON, NW9 0EQ
FAX NUMBER : 081 - 205 0603

M O D E M S

INTERNAL MODEM - V22 BIS - 2400 BPS
AUTO DIAL / REDIAL / ANSWER - FULL DUPLEX
TONE & PULSE DIAL - BT & BABT APPROVED
SUPPLIED WITH EAZILINK COMMS PACKAGE
MC2400 - INTERNAL £ 65

EXTERNAL MODEM - V22 BIS - 2400 BPS
AUTO DIAL / REDIAL / ANSWER - FULL DUPLEX
HAYES COMPATIBLE - TONE & PULSE DIAL
COM 1 / 4 SELECTABLE - AUTO DIAGNOSTICS
STATUS LED's - MAINS ADAPTER
SUPPLIED WITH EAZILINK COMMS PACKAGE
LC8824 - EXTERNAL £ 95

KEYBOARD / MICE

AT 102 KEY - UK - IBM CLICK	£24
MOUSE - 3 BUTTON / MAT / ADAPTOR	£15

60 MEG TAPE STREAMER

DC600 - 5¼" TRAY

PRICE : £ 190

●● ALL PRICES INCLUDE V A T ●●

ACCESSORIES

5¼" ADAPTOR KIT FOR 3½" FDD	£ 8.00
5¼" TRAY FOR 3½" FDD	£ 5.50
POWER LEAD FOR 3½" FDD	£ 3.00
IDC PIN TO EDGE CONNECTOR PCB	£ 4.00
SHORT F D D CONTROLLER CABLE 2'	£ 4.00
LONG F D D CONTROLLER CABLE 4'	£ 7.00
POWER SPLITTER	£ 4.50
HARD DRIVE CABLES (MFM/RLL)	£ 6.00
IDE HARD DRIVE CABLE (2 DRIVES)	£ 6.00
KEYBOARD EXTENSION CABLE	£ 3.00
4 MB RAM EXPANSION BOARD (0 RAM)	£62.00

FDD EXTERNAL CASES

METAL GREY CASE SUITABLE FOR EXTERNAL MOUNTING OF FLOPPY DISC DRIVES, HARD DISC DRIVES, TAPE STREAMERS, CD ROMS ETC

5¼" CASE ONLY	£ 8
5¼" CASE + LEADS FOR F D D	£ 17
3½" CASE ONLY	£ 8
3½" CASE + LEADS FOR F D D	£ 20

3 STATION NETWORK SYSTEM

ALL PARTS FOR 3 STATIONS SUPPLIED - DRIVER SOFTWARE AND DATA. USES TWISTED PAIR CABLE - EXPANDABLE - 1Mb TRANSFER RATE - EASY INSTALLATION. £ 57

PLEASE ADD £ 3.00 TO ALL ORDERS TO COVER POSTAGE

GET YOU THROUGH WINTER ISSUE

Special

EMERGENCY PLUGLIGHT

The pluglight operates in much the same manner as emergency lights in public places, coming on automatically in the event of a power failure. It has the advantage over such emergency lights of being portable so it will double as a hand lamp if required.
In the normal standy mode the internal batteries are charged continuously. In the event of a power failure or when used as a hand lamp the internal batteries will last for half an hour, or longer at reduced output.

FREE INSIDE

MARCO TRADING SPRING '92 CATALOGUE

CYCLE LIGHT BACK-UP

Anyone who regularly rides a bicycle at night will know that cycle lamp batteries are a very expensive way of obtaining energy. One way of reducing costs is to use a dynamo lighting set but here the brightness of the lights is speed dependent. Unfortunately the lights go off or dim at times when you need to be most conspicuous – when stopped at a junction, for example, and this can be extremely dangerous. This circuit is a hybrid design which uses a dynamo to provide power while the output is sufficient but switches over to battery operation when it falls below a certain level.

ECONOMY SEVEN TIMER

Anyone who uses Economy Seven power for night storage heaters will know electricity is cheaper when purchased in this way. This timer allows you to use other appliances at night – the dishwasher or washing machine for instance. So if you use Economy Seven you can increase your saving.

AUTO GARAGE LIGHT

A very useful device for the car owner. A garage light control unit which uses the car headlamps to illuminate the garage's electric light for a timed period. No more fumbling in a dark garage! A daytime override is included.

NEXT MONTH

1992 CATALOGUE + 48 PAGE BARGAIN LIST - OUT NOW!

NEW THIS MONTH

Z5200 Spirit burner 93mm dia × 48mm high complete with 70mm disk.
Price ..... £2.50 100+ 1.25

Z5201 Level indicator for LPG tanks.
Price ..... **Only £1.00** 100+ 0.50

TRANSFORMERS

Z5206 Mains transformer with 16V 3A secondary - ideal as charger or model control. **Only £3.00** 100+ 2.00

Z5202 Torroidal, mains in, 14-7.5-0-7.5-14V secondary @ 1.25A **£2.95**

Z5233	17V 1A	£1.50
Z5234	14V 0.5A	£1.00
Z5236	21V 0.5A	£1.50
Z5212	21V 1A	£1.50
Z5213	14V 1.5A	£1.50
Z5214	11V 0.5A	£1.00
Z5215	15V 0.25A	75p

SPECTRUM PSU'S

Z5219	UK700, 9V 0.7A	£2.50
Z5220	EURO1200, 9V 1.2A	£3.00
Z5221	EURO1400, 9V 1.4A	£3.50
Z5222	Psion PSU 10.4V 175mA, plug-in type	£2.00
Z5223	Psion printer PSU 10.4V 600mA	
Price		£3.00
Z5224	Jupiter Ace plug-in PSU 9V 0.8A	
Price		£3.20

NICAD/LITHIUM OFFERS

Z2349 Nicad Battery Pack. Brand new, intended for use in Zonephones, comprising 4 × ½A size cells each rated 1.2V 0.45Ah, size 16.1mm dia × 28mm. DP £9.92.
Our price .... **£2.00** 100+ 1.00 1k+ 0.70

Z4150 Pack of 8 AA Nicads in tough plastic case 56 × 63 × 33mm.
Price ..... **Only £1.60** 100+ 0.80

Z2450 AA Lithium 3.6V PC mntg.
Price ..... **£2.00** 100+ 1.20

Z2451 ½AA Lithium 3.6V PC mntg.
Price ..... **£1.75** 100+ 1.05

HIGH VALUE CAPACITORS

Code	Value	Volts	Size	Price
Z4343	2200	40	45 × 26	60p
Z4419	3300	25	50 × 26	40p
Z5147	4700	100	105 × 51	£3.00
Z4345	10,000	40	56 × 41	£2.50
Z5146	10,000	100	105 × 64	£4.00
Z4346	15,000	25	56 × 41	£2.50

TIMER SWITCH

Z5174 Superb geared mains motor 1 rev per 12 hrs with cam operated switches - 2 c/o rated 16A 250V. Size 60 × 54 × 43mm. **Only£3.00** 100+1.50

LOW COST SOUND CHIPS

UM34811A Melody generator.
Price ..... £1.20 100+ 0.75

UM3562 3 gun sound generator.
Price ..... 75p 100+ 0.38

UM66 3 christmas carols 75p 100+ 0.38
All supplied with a typical circuit.

BRIDGE RECT CLEARANCE

Z2347 4A 200V in line.
Prices ..... 6/£1 100+ 0.09 1k+0.06

PC KEYBOARDS

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K642 Simple kit utilising our Z660 power supply to give a 10 watt variable outpt from 4-20V, fully stabilised. Only needs 2 components added! Input must be at least 3V above max required output. Circuit features overload/short circuit protection and thermal cut-out. Input 7-25V DC, 1.5A; Output 4-20V DC variable 10 watts max; Size 50 × 50 × 21mm.
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VIEWDATA TERMINAL

Z8963 Tandata Modem as used with home banking system. Case 300 × 180 × 75/40mm with 75 key keyboard. Inside, UM1286 UHF modulator, Nicad, modem, lots of chips incl 2114 and 2732. Used but working **£12.95**
Z8964 Later model, brand new and boxed **£16.95**

OPTO BARGAINS

Z2171 24 character × 2 lines LCD by Optrex. High quality display with 192 character ROM, easily interfaced with either 4 or 8 bit uP's. Supplied with data. Characters are 5 × 7 dot arrays with separate cursor. Module size 118 × 35mm. DP around £30.00.
Our price **£10.00**

Z2172 40 character × 1 line LCD by Optrex (Japan). Double height display with 192 character ROM; other characters can be displayed by generation in RAM, easily interfaced with either 4 or 8 bit uP's. Supplied with data. Characters are 5 × 12 dot arrays measuring 3.2 × 10mm. Module size 220 × 40mm. DP over £50.00.
Our price **£15.00**

Z5096 16 character × 1 line. Very similar to our Z1814 but slightly larger character 6.3 × 3.15 (8 × 5 dots). Type LCDM16166 by Refac. Supplied with data. Uses Hitachi HD44780A00 chip (supplied). **£8.00**

Z4148 LCD as Z4115 but 6 digit, 50 pins. Trade price £10.86.
Price **£3.00**

Z5119 Communications LCD. This large (140 × 40mm) display (made for Marconi) has 110 pins and shows a variety of symbols and power levels used in radio communication, includes a bargraph display. No further info and only limited appeal, hence the very low price.
Price ..... **Just £2.00**

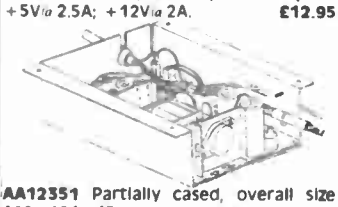
Z4115 8 digit 12.7mm high LCD and holder. These are 14 segment devices allowing alphanumeric display. Normally costing over £15.00 we are offering these for just **£4.50**

Z1637 LCD Display - direct drive 3½ digit with 'Lo-Batt'. 12.7mm high digits. Op voltage 4-12 RMS @ 32Hz type. Consumes only 25µA with all segments on. Trade price £7.97 each. Supplied with data, but no edge connector.
Prices ..... **£1.00** 25+ 0.65 100+ 0.50

Z2163 4 Digit multiplexed LCD, 50 × 30mm probably for an electronic balance-symbols include balance pens, 5 stage bar graph, lb's and kg's etc. Digit height 12mm. Self adhesive pad on back. 13 pin PCB connector.
Price **£2.00**

SWITCH MODE POWER SUPPLIES

Z8921 Apricot PSU - beautiful unit 160 × 110 × 55mm with IEC switched mode inlet. Made by Astec. Model BM43024. 120/240V input. Outputs: +5V @ 2.5A; +12V @ 2A. **£12.95**



AA12351 Partially cased, overall size 160 × 104 × 45mm. Input and outputs are on flying leads, all colour coded. There is also an additional IEC socket to extend mains to another unit.
Input 115/230V, 50/60Hz
Outputs ..... +5V 5A, +12V 0.15A
Total Wattage 50W
Price ..... **£6.95** 25+ 5.43 100+ 4.53

Conversion Kit
K725 This kit converts the AA12531 PSU into a much more versatile supply, giving +5V @ 2.5A; +12V @ 2A; -12V @ 0.1A; -5V @ 0.55A.
Complete kit of parts and full instructions.
Price **£3.50**

BM41012 Astec, totally enclosed steel cased unit 175 × 136 × 65mm, with switched and fused IEC mains inlet. PCB 160 × 80mm with output pins and connector.
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

Z8923 Intelligence SM060 80 watt unit 180 × 110 × 57mm. 120/240V input, and unusually 4 outputs: (Max rating per output quoted - total load must not exceed 80W): +5V @ 6A; +12V @ 2A; +25V @ 3A; -12V @ 500mA.
Price **£22.95**

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K5102 Transistors - a dozen different types including BCF29/30 BCW 29/71/72/81 etc. **Pack of 100 £3.00**

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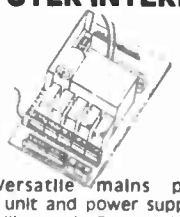
Z8939 Two tone brown case contains PCB 192 × 195mm with easily removed UHF modulator made by Labgear (Sound and Vision); video pre-amp; stabilised power supply and all the decoding circuitry (9 transistors and TBA673 chip). On the front of the case is a cable/off air switch and 5 push buttons (5 channels and on/off mains switch). There are 4 cables coming from the rear. The case can easily be utilised for other purposes - the dark brown inserts on the front are both easily removable, if required. Please note the low price we are asking in no way reflects their true worth - they're taking up a lot of space, so we need to shift them quickly!! Supplied with circuit diagram.
Price ..... **£6.95** 100+ 3.50 1k+ 2.50

COMPUTER INTERFACE



Z8957 Versatile mains powered switching unit and power supply, ideal for controlling up to 5 separate circuits via BBC user port. Supplied with 6 program listings and full instructions. Can also be used with PC - details included. Relay contacts are SPCO rated 10A. There's also 2 auxiliary DC outputs, 12V @ 1.5A and 5V @ 1A. **£14.95**

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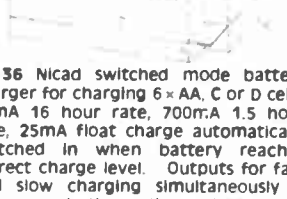

Z5136 Nicad switched mode battery charger for charging 6 × AA, C or D cells. 70mA 16 hour rate, 700mA 1.5 hour rate, 25mA float charge automatically switched in when battery reaches correct charge level. Outputs for fast and slow charging simultaneously if necessary, both on timers to prevent over charging. **£12.95**

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KIT REF 444 £22.37

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EE MAY 89

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KIT REF 812

Mains Adaptor £2.02

£14.81

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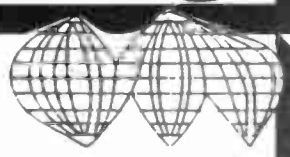
EE MAY '91

A versatile thermostat with LCD read out MIN. MAX temperature recording, clock and individually settable upper and lower switching points. Covers -10 to 110 degrees Celsius, accurate to within 0.1 degrees Submersible probe on 3 meter lead. Kit includes punched and printed case. Save on energy bills by improved control of your hot water system. Also ideal for greenhouse soil temperature and aquarium control. Complete kit includes thermostat and probe, mains power supply and relay output. PCB's and punched and printed case

KIT REF 841 £29.95



3 BAND SHORT WAVE RADIO

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EE MAR '91

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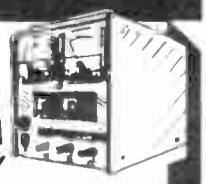
KIT REF 840 £19.86



MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

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PORTABLE ULTRASONIC PEsT SCARER

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EE NOV '87

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KIT REF 740 £20.01

4 CHANNEL LIGHT CHASER

EE Jan '90

A 1000W per channel chaser with zero volt switching, hard drive, inductive load capability, mic sound sensor and sophisticated 'beat' detector. Chase steps to music or auto when quiet. Variable speed and mic. sens. LED mimic on front panel. Switchable for 3 or 4 channels. P552 output. Ideal for rope lights, pin spots, disco and display lighting.

KIT REF 833 £32.13

EE EQUALISER

EE MAY '87

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 £17.75

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EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences.. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features. Complete kit includes case, PCBs, all components and hardware.

KIT REF 838 £57.17

EPROM ERASER

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 £28.51

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	£15.58
KIT REF 560 DISCO LIGHTS	£22.41
KIT REF 561 LAPEL BADGE	£11.65

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

Including headphones £45.95

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 £17.16

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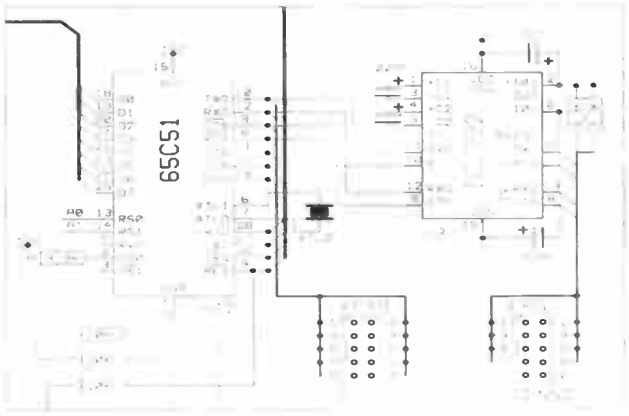
BoardMaker 1 is a powerful software tool which provides a convenient and professional method of drawing your schematics and designing your printed circuit boards, in one remarkably easy to use package. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC- based systems.

BoardMaker 1 is exceptionally easy to use - its sensible user interface allows you to use the cursor keys, mouse or direct keyboard commands to start designing a PCB or schematic within about half an hour of opening the box.



Produce clear, professional schematics for inclusion in your technical documentation.

HIGHLIGHTS

Hardware:

- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

Capabilities :

- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
- Maximum board or schematic size - 17 x 17 inches.
- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
- User definable symbol and macro library facilities including a symbol library editor.
- Graphical library browse facility.
- Design rule checking (DRC)- checks the clearances between items on the board.
- Real-time DRC display - when placing tracks you can see a continuous graphical display of the design rules set.
- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
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Output drivers :

- Dot matrix printer
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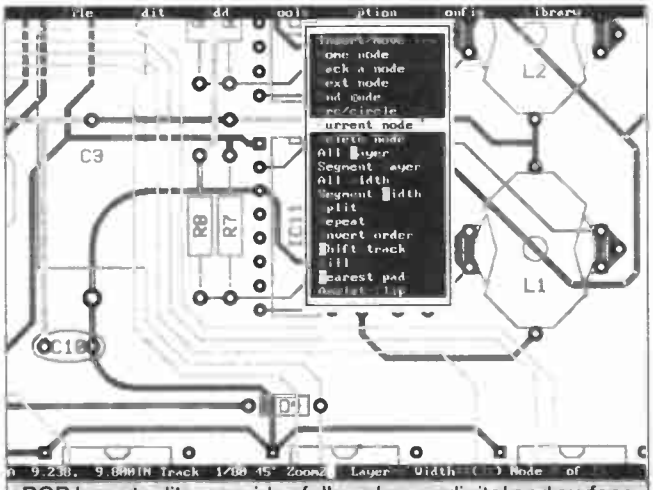
- Photoplot (Gerber) output.
- NC (ASCII Excellon) drill output.

All trade marks acknowledged



PCB layout editor provides full analogue, digital and surface mount support - ground and power planes (hatched or solid)- 45 degree, arced and any angle tracks.

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REMOTE

A number of readers have recently requested projects for wireless remote door bells/baby alarms, etc. While these items can now be purchased and used legally in the UK it is not easy for the hobbyist to build them and use them legally. Basically the position is this:

There is now a category of low power radio devices that are exempt from licensing, virtually all of them do however require type approval before they can be used. To quote the Radiocommunications Agency (an Executive Agency of the Department of Trade and Industry).

"The use or installation of non-type approved devices is an offence under Section 1 of the Wireless Telegraphy Act 1949. It is also an offence to possess such a device with intent to use it, contrary to Section 1 of the 1949 Act. The maximum penalty for each of these offences is £2,000 fine and/or six months imprisonment, where the offence is tried summarily or an unlimited fine and/or two years imprisonment, where the offence is tried on indictment. In each instance, the Courts may also order forfeiture of any equipment used in the commission of the offence."

The only items that do not require type approval are metal detectors and model control equipment, and these must work within certain specifications.

APPROVAL

In short it is not possible to build any low power radio project (other than a metal detector or model control unit) and use it in the UK without getting type approval. (Licenced amateur radio enthusiasts can, of course, build and use transmitting equipment on the various specified amateur bands, they have to pass the Radio Amateurs Examination before they can do this).

Items like radio microphones, radio car alarms, induction communications systems, etc. must all be type approved, this requires the submission of a representative production unit to one of the approved test houses. After satisfactory completion of type testing, provided the Radio Communications Agency accepts the report, a Type Approval Certificate is issued. Of course all this requires the manufacturer to pay the required fees and to confirm that the item under test is representative of a production unit.

Mike Kenward

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We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self addressed envelope and international reply coupons.**

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

COMPONENT SUPPLIES

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

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

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

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TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

TELESOUND

GARY CALLAND

"Hey Presto!" You can play your favourite tapes through the TV sound system. Simply plug into your Personal Stereo and the aerial socket of the TV set.

FOR those people who have to travel away from home and have to stay in hotels, a personal stereo can be a great companion. Hours travelling on the train, boat or plane can seem to fly by with a little help from a favourite D.J. or a recently bought cassette. Again, in the hotel room a personal stereo can be invaluable; most hotel rooms come complete with a television, but few have a tuneable radio and even fewer have a cassette player.

There is one slight problem though; sometimes a personal stereo can be a bit too personal. Listening on headphones is fine on a train, boat or plane, but listening whilst in the hotel room's shower for example soon results in soggy earpads and a broken wet plastic box! Also, strangulation is common whilst using headphones in bed; the headphone cable gripping tighter and tighter with every toss and turn of an evening snooze or a morning doze.

TELESOUND

The obvious solution to this problem, of course, is to obtain an amplifier and plug the personal stereo into it. Then, the amplifiers loudspeaker dispenses with the need for headphones altogether. However, amplifier power supplies are heavy and loudspeakers are bulky so you may as well carry around a proper radio-cassette player in the first place!

But how do you get a large radio-cassette player into your back pocket? They're not easily transportable really!!

So the problem still remains. Also, it seems silly to provide an amplifier and loudspeaker when one already exists in the hotel room – in the form of a Television set. The trick is how to get to it without the use of a soldering iron.!

The solution to all these problems is of course the Telesound; a small black box which plugs into your personal stereo and also into the aerial socket of the television set. All that has to be done is to tune in the television, turn up the volume, press play on the personal stereo and away you go. Problem solved!

HOW IT WORKS

The heart of the Telesound is a UHF Modulator. This accepts video and audio signals and modulates them onto a u.h.f. carrier. This carrier signal is similar in form to the transmitted signals received by the TV aerial and it is processed by the TV in the same way.

The TV's electronics can demodulate the carrier to reproduce the original audio and video signals: the audio signals are simply amplified and fed to the loudspeaker while the video signals are used to generate a picture on the TV's screen. (UHF Modulators are commonly used in home computers where they convert data from the computer into a form a TV can use.)

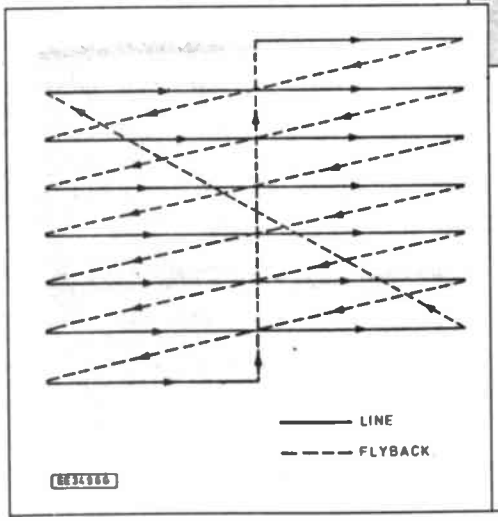


Fig. 1. Showing simplified interlaced scanning on a TV screen.

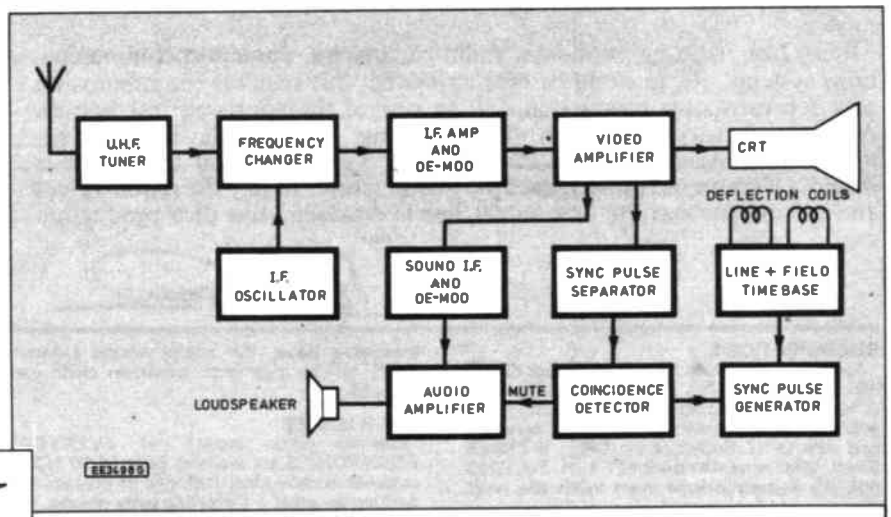


Fig. 3. Block diagram of a monochrome TV receiver.

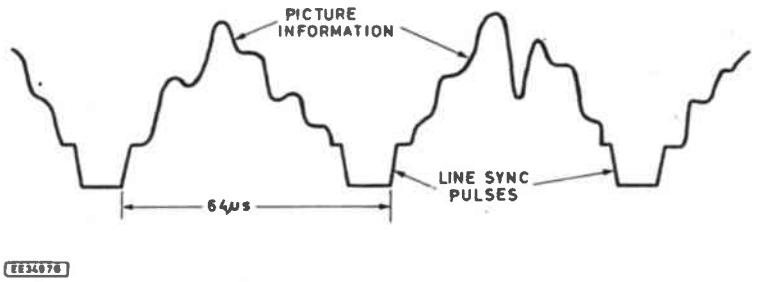


Fig. 2. Typical signal waveform received by the television set.

The Telesound directly feeds the audio output signal from the Personal Stereo, which usually goes to the headphones, to the audio pin of the UHF Modulator. It just so happens that the audio output range from a personal stereo matches the audio input range of the modulator very well.

This unit is not quite as simple as that though. Most colour television sets also require some video signal component to the modulated carrier as well as the audio component in order to operate correctly. Nearly all modern colour television sets have a facility that mutes the sound when no picture information is present.(This feature is omitted from small black and white portables).

The Telesound fools the TV's electronics by providing a crude video signal similar to but not as complex as proper picture information. This crude signal also doubles as an aid to tuning the TV into the Telesounds frequency, since it generates a simple picture on the TV screen when tuned correctly.

TELEVISION PICTURE GENERATION

A TV picture is produced by an electron beam scanning a number of lines over the screen, increasing or decreasing in intensity to produce light or dark areas. In the UK, 625 lines are used.

Ideally, one complete picture should be produced every 1/50 of a second in order to give the impression of continuous uniform pictures. However, this would require a lot of signal capacity, and so to reduce bandwidth, interlaced scanning is employed.

With interlaced scanning, the whole picture area is covered by 312.5 lines. This is a frame and occupies 1/50 of a second. The remaing 312.5 lines cover the screen, filling the space between those in the first frame during another 1/50 of a second. Hence a localised area changes every 1/50 of a second, enough to fool the eye, but the complete picture area is updated only every 1/25 of a second. See Fig 1.

The TV receiver circuits are adjusted for approximately the same scanning speed as that of the TV camera. At the end of each line, a line synchronising pulse occurs and triggers the receivers line-scan and fly-back circuit. Sync pulses are therefore produced at a rate of 15.625kHz.

At the end of the frame, a series of pulses trigger the frame-scanning circuit, returning the electron beam to the beginning of its travel over the picture area. Fig 2 shows a typical signal waveform.

TELEVISION RECEIVER

The simplified block diagram of a typical black and white TV receiver is shown in Fig. 3. The tuner selects the appropriate channel and i.f. frequency conversion takes place in the frequency changer. The weak i.f. signal is amplified and demodulated into video and sound information which is fed to the video amplifier.

The video amplifier output waveform consists of picture information which controls the intensity of the electron beam, and line and field synchronising pulses which are used to trigger the timebase generator. Sound information is also carried. This signal is fed to a sound detector and also to a sync pulse separator.

The separated sync pulses are then compared in the coincidence detector with the line flyback pulse, generated by the line timebase generator. If valid picture information is present, i.e., line sync pulses of the correct frequency and phase are present, then the mute output from the coincidence detector to the audio amplifier is disabled, otherwise the loudspeaker is silent.

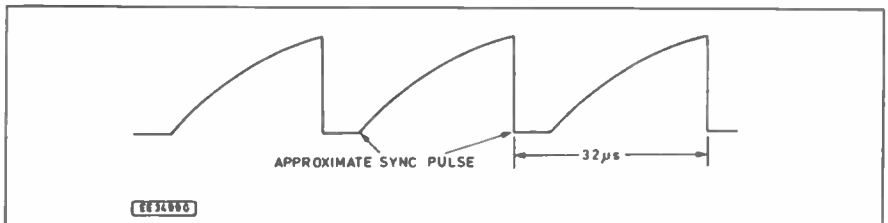


Fig. 4. Waveform produced by Telesound and presented to the TV.

The waveform produced by the Telesound is shown in Fig 4. It is simple, but enough to fool the TV's coincidence detector into disabling the mute function; the waveform's troughs approximate to sync pulses. A frequency of 31.25kHz, double the usual sync pulse frequency, is used as this produces better results.

CIRCUIT DESCRIPTION

The full circuit diagram for the Telesound unit is shown in Fig. 5. The u.h.f. modulator requires +5V and this is provided by the regulator IC1. Resistor R1 and l.e.d. D1 provide power on indication.

The audio output from the Personal Stereo is fed directly to the audio pin (B) of the modulator module. Resistor R3 sets the modulators fine tune carrier frequency.

Video information is provided by the unijunction relaxation oscillator formed by TR1 and emitter follower TR2. The voltage at the emitter of the unijunction TR1 rises as capacitor C3 charges via resistor R2 and preset VR1 until its trigger voltage is reached. TR1 then conducts, discharging C3 rapidly. The cycle then starts again.

The charge/discharge voltage across capacitor C3 is buffered by emitter follower TR2 and fed to the video pin (D) on the modulator. Frequency can be altered by adjustment of preset VR1 and amplitude adjusted by preset VR2.

The low value resistors R4 and R5 have been included to "mix" the two channels from the personal stereo headphone output socket. A twin-core screened lead from R4/R5 is terminated with a stereo jack plug.

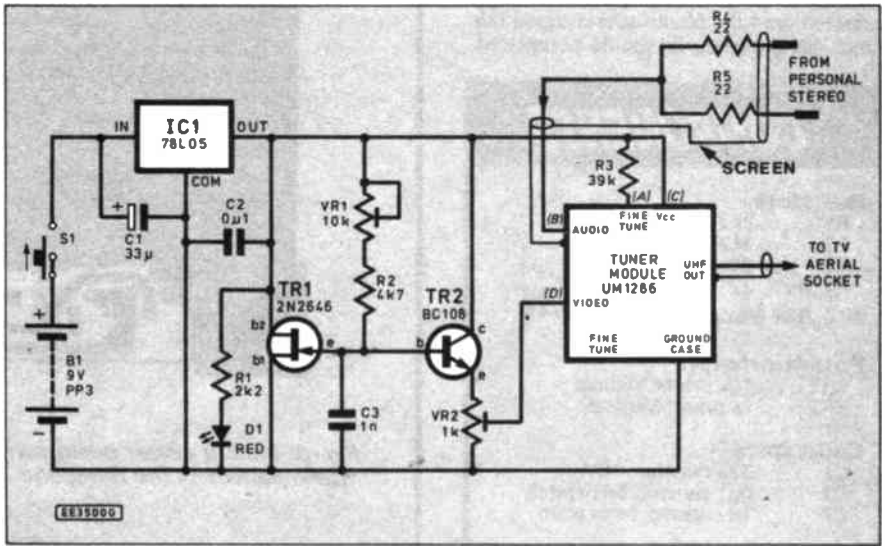


Fig. 5. Complete circuit diagram for the Telesound unit.

CONSTRUCTION

The Telesound unit is built on a small single-sided printed circuit board (p.c.b.) and the component layout and full size copper foil master pattern is shown in Fig. 6. This board is available from the *EE PCB Service*, code EE784.

The relatively few components are all fitted onto the p.c.b. Holes for the modulator's mounting tabs should be drilled first before any components are mounted. Note, the rear tab should be removed since this prevents the battery compartment lid from sliding into position when the unit is complete.

No particular order of component insertion is strictly necessary but orientation of components should follow that of Fig 6. Remember to bend in slightly and solder to the p.c.b. ground plane the modulators mounting tabs.

The specified case used to house the circuit board comes complete with a PP3 battery compartment, p.c.b. fixing holes and a removable front panel. See Fig. 7 for front panel drilling details.

The audio screened lead from the Personal Stereo is simply soldered directly onto the p.c.b. via a grommet in the front panel. However, the TV coaxial cable has to be soldered into the u.h.f. modulator.

The outer "screening" braid is soldered onto the phono socket outer, while the inner cable enters the u.h.f. modulator via the phono socket. The modulator's lid is removable, and the inner cable is carefully soldered onto the phono socket signal tab. Once completed the lid should be replaced.

COMPONENTS

Resistors

R1	2k2
R2	4k7
R3	39k
R4, R5	22

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	10k preset, vertical
VR2	1k preset, vertical

Capacitors

C1	33µ tantalum 16V
C2	0µ1 ceramic, 5mm pitch
C3	1n ceramic, 5mm pitch

Semiconductors

D1	5mm red low current l.e.d.
TR1	2N2646 unijunction transistor
TR2	BC108 *npn* transistor or similar
IC1	78L05 +5V 100mA voltage regulator
Mod.1	UM1286 UHF Modulator

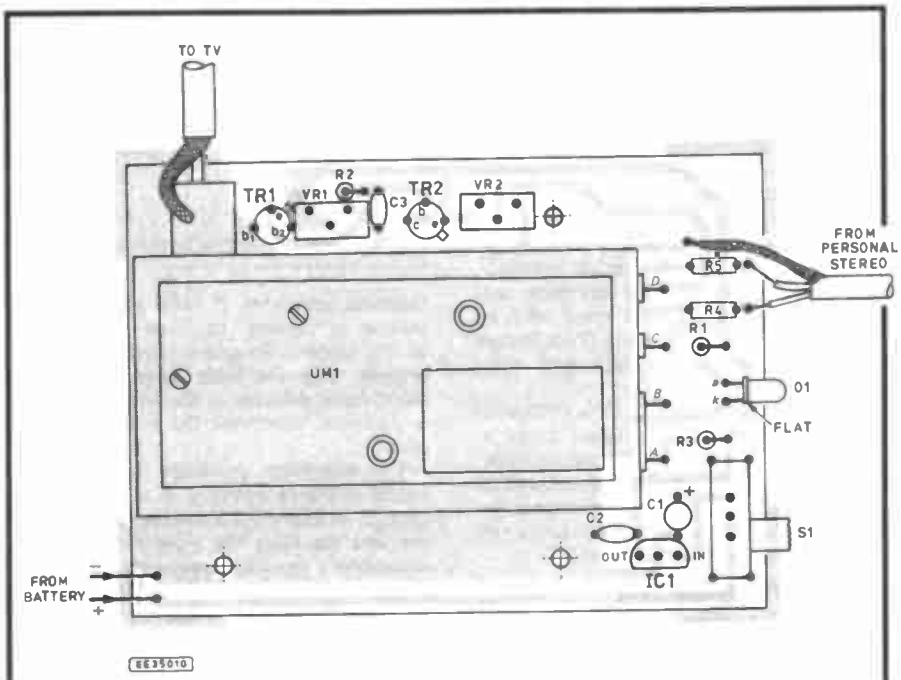
Miscellaneous

S2	Single pole, right-angled, p.c.b. mounting slide switch

Case, remote control box size 119mm x 67mm x 37.5mm; 3.5mm stereo jack plug; TV aerial socket; single-core screened audio cable; single-core coaxial TV cable; small rubber grommets (2 off); PP3 battery clip, with leads; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE784.

Approx cost guidance only **£25**



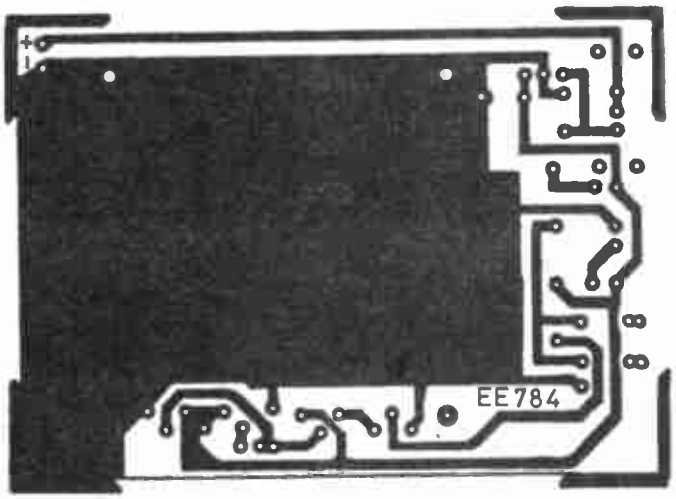
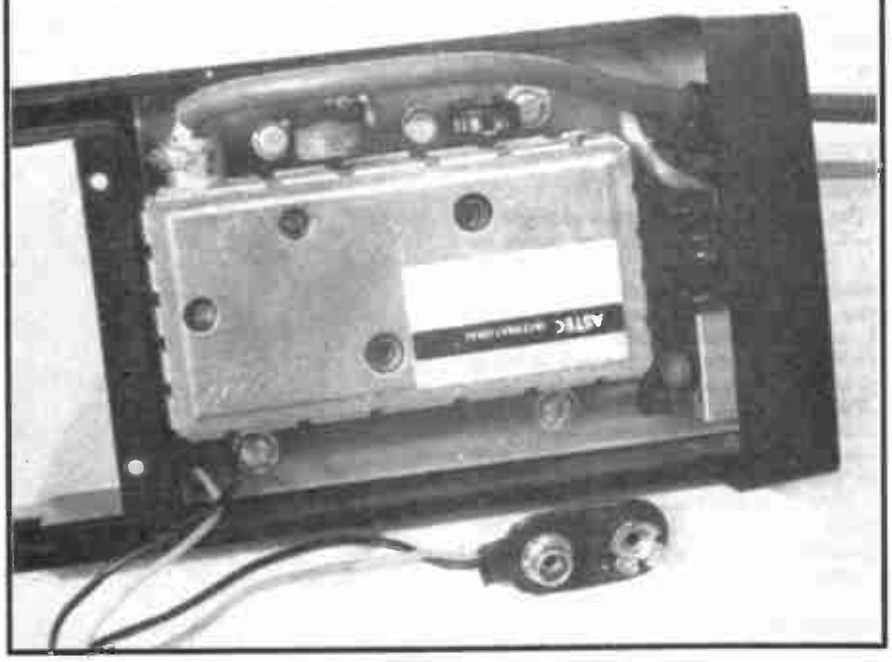


Fig. 6. Printed circuit board component layout and full size copper foil master pattern for the Telesound.



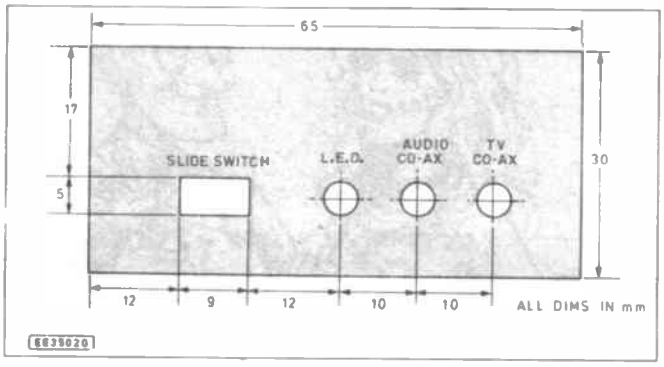


Fig. 7. Case front panel details.

The completed p.c.b., after battery supply cable connection, is fixed to the case via three self-tapping screws into the recesses provided. Cable ties are used around both cables to prevent cable strain damaging the soldered connections.

SETTING-UP AND USE

To set up the Telesound unit it is plugged into the aerial socket of the TV, which should be tuned to channel 36. Then VR2 is set to mid-way position and preset VR1 adjusted until the screen changes from noise to that of Fig 8.

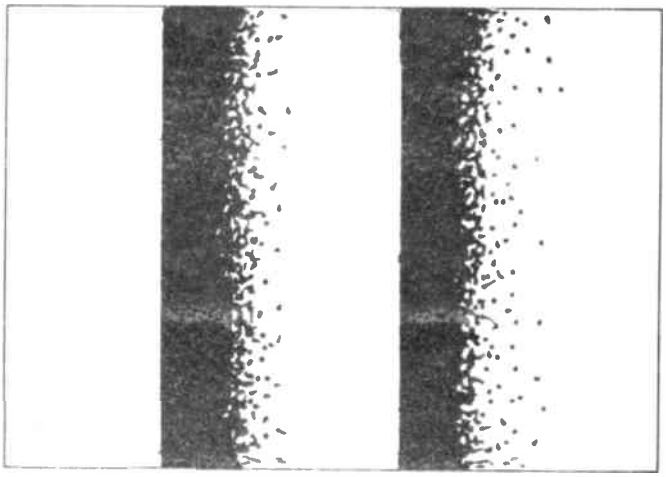


Fig. 8. Screen image when unit is correctly tuned.

Adjust VR2 to the optimum position. This is best done by trying the unit in two or three different TV's. Once this is done, acceptable sound quality should be heard once "play" has been pressed on the Personal Stereo.

Not only can cassettes be played, but the unit should not affect normal personal stereo radio reception. However, the lead from the personal stereo to the Telesound should be quite long since this is also used as the radio aerial.

The current drain from the PP3 battery powering the Telesound is quite small and so the battery should well outlast those of its Personal Stereo companion. □

Constructional Project

THE SPECTRA-LITE

CHRIS WALKER

Add a touch of colour to your day! A novel colour-changing lapel badge or brooch.

ONE OF the most awkward questions that a constructional electronics enthusiast can be asked is, "What is your hobby?"

What do you answer?

"Electronics," is a vague title which does not describe the constructional aspect; the hobby of an arcade game player could be described as 'Electronics'. How about, "I build and modify electronic devices based on constructional articles in monthly journals or from kits of parts ... ," yawn, yawn!

When being introduced to strangers, we are often labelled as 'The Electronics Boffin', or 'The Whiz-Kid'. The author was once described as a "freelance inventor" – Yuk!

RIGHT SPECTRUM

What we need is a simple artefact which sums-up our fascinating hobby without further enhancement, and which leaves the opposition intrigued and speechless.

The Spectra-Lite is a very discreet lapel badge or brooch which slowly, smoothly and subtly changes in colour between red, orange, yellow and green. In the same way that a member of a national club or institution would wear a buttonhole badge to announce his membership to others, you can wear the Spectra-Lite as an exhibition of your electronic creativity.

Unlike some similar electronic jewellery, this badge was designed to be discreet and smart, not blatant and vulgar. Nevertheless, it does tend to make the wearer the focus of attention in a crowd and it works wonders for destroying someone's drift in the middle of a face-to-face conversation!

BADGE

The badge itself is made from a tri-colour light emitting diode. These devices actually contain two l.e.d. chips, one green and one red, in a single milky-white package. By illuminating each chip to different extents, the l.e.d. can be made to light up any colour in the spectrum from red to green.

These l.e.d.'s are available in 5mm round and 10mm round packages and also in a rectangular version. The prototype badge is actually formed from two rectangular devices mounted side-by-side. This produces a 5mm square light-emitter which protrudes neatly through the button-hole on a jacket lapel.

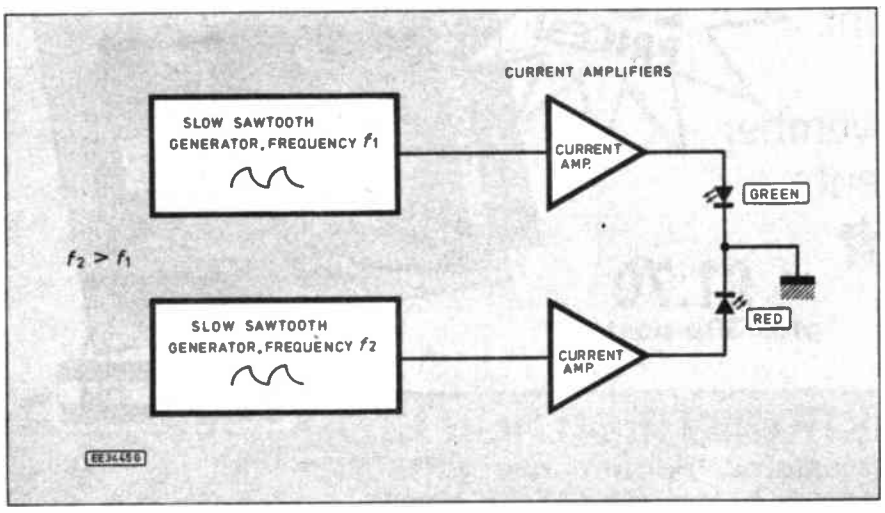
Feel free to use the other shaped tri-colour l.e.d.'s to create other badge designs if you wish.

HOW IT WORKS

A sawtooth waveform generator is used to slowly increase the intensity of the green part of the l.e.d. up to is maximum brightness, see Fig. 1. The intensity is then slowly reduced until the l.e.d. is off. This cycle is repeated with a period of about one minute.

The red l.e.d. receives current from another sawtooth generator and it undergoes a similar but slightly faster cycle with a period of about 50 seconds. The result is that the overall l.e.d. appears to very slowly change colour as the two sawtooth waves move into phase and out of phase with each other.

Fig. 1. Block diagram for the Spectra-Lite Lapel Badge.



CIRCUIT DESCRIPTION

A glance at the circuit diagram in Fig. 2 will reveal that the complete circuit for Spectra-Lite is built from two almost identical sections.

Before we go any further, it should be noticed that a "split rail" power supply of +4.5V and −4.5V is obtained from a single 9V battery, B1. The 0V line is to be found at the centre of the potential divider formed by resistors R1 and R2. All voltages in the following text are measured with respect to the 0V line.

Operational amplifier IC1a together with resistors R3 to R5 and capacitors C1 and C2 form an astable multivibrator, a circuit in which the output of the op. amp (pin 1 of IC1) oscillates between about +4.5V and −4.5V with a cycle period (in seconds) given by the formula:

$$T = 2.7 \times R3 \times (C1 + C2)$$

R3 in MΩ
C1, C2 in μF

To understand how the multivibrator works, imagine that the output (V_1) is saturated high at about 4V (the outputs of the LM324 cannot quite reach the positive supply voltage). The voltage at the junction of R4 and R5 will be:

$$4 \times \frac{100}{(100 + 68)} = 2.4V$$

and this voltage is presented to the non-inverting input (pin 3) of IC1a. Call this voltage V_+.

Current will flow from the output of the op.amp through resistor R3, and this will start to charge up the capacitors C1 and C2 so that the voltage across the capacitors increases exponentially, see Fig. 3. This voltage (V_-) is presented to the inverting input (pin 2) of IC1a. Incidentally, two 1μF capacitors are used because they fit more conveniently on the circuit board than one, larger 2.2μF capacitor.

Op.amp. IC1a behaves as a voltage comparator and it's output will stay high until the capacitors have charged so that V_-

just exceeds V_+. At this point, V_{OUT} will saturate low, right down to −4.5V and V_+ will now be at a value of :

$$-4{\cdot}5 \times \frac{100}{(100 + 68)} = -2.7V$$

The capacitors C1 and C2 will begin to charge with the opposite polarity and, therefore, V_- will decrease exponentially. When V_- falls just below V_+, V_{OUT} will once again go to +4V and the whole cycle starts over again.

CURRENT BUFFER

The multivibrator circuit is often used to provide a square wave signal at the output of the op.amp but, in this application, the sawtooth waveform across the capacitors is taken to the non-inverting input of another op.amp, IC1b, wired as a voltage-follower. The input impedance of an op.amp is very high, so the charge/discharge rate of the capacitors is unaffected by this connection.

A voltage-follower has a voltage gain of one, so the output at pin 7 follows the same sawtooth waveforms as that across capacitors C1 and C2. However, the output impedance of the op.amp is quite low and pin 7 can easily supply the current necessary to light the two Green l.e.d.'s D1a and D2a.

Another multivibrator and voltage-follower is formed by IC1d and IC1c which drive the red l.e.d.'s D1b and D2b. However, since resistor R6 has a lower resistance than R3, this oscillator cycles slightly faster than the "green" one.

Current consumption goes up and down like a yo-yo as the l.e.d.'s turn on and off. With both l.e.d.'s off the circuit consumes about 5mA. When fully illuminated this rises to about 45mA. An alkaline PP3 battery should give about 20 hours of service, enough to last through the longest of social engagements!

CONSTRUCTION

Most of the control circuit and the battery is housed inside a small plastic Verobox (or similar) measuring 72mm x 49mm x 25mm. It is a bit of a squeeze fitting everything in, but you do require a compact unit which can be hidden in a pocket somewhere on your person. Three thin wires link the control box to the badge.

Apart from the on/off switch, tricolour l.e.d.'s and the limit resistors, all components are mounted on a small piece of stripboard size 8 strips x 27 holes. The topside component layout and details of the breaks required in the underside copper strips is shown in Fig. 4.

If using the specified plastic case, prepare the stripboard by cutting it to size and removing the corners to allow for the corner pillars in the case. Before mounting any components, make sure the board will

COMPONENTS

Resistors

R1, R2	4k7 (2 off)
R3	10M
R4, R7	68k (2 off)
R5, R8	100k (2 off)
R6	8M2
R9 to R12	330 ohms (4 off)

All 0.6W 1% metal film

See SHOP TALK Page

Capacitors

C1 to C4	1µ metallised polyester film (4 off)

Semiconductors

D1, D2	tri-colour rectangular light emitting diode (2 off)
IC1	LM324 quad op-amp

Miscellaneous

S1	single pole miniature slide switch
B1	PP3 9V battery

Stripboard 0.1in. matrix, size 8 strips by 27 holes; plain matrix board 30mm x 45mm; plastic case, size 72mm x 49mm x 25mm; 14-pin d.i.l. socket; battery clip; thin insulated connecting wire; nylon ties; solder etc.

Approx cost guidance only **£6.50**

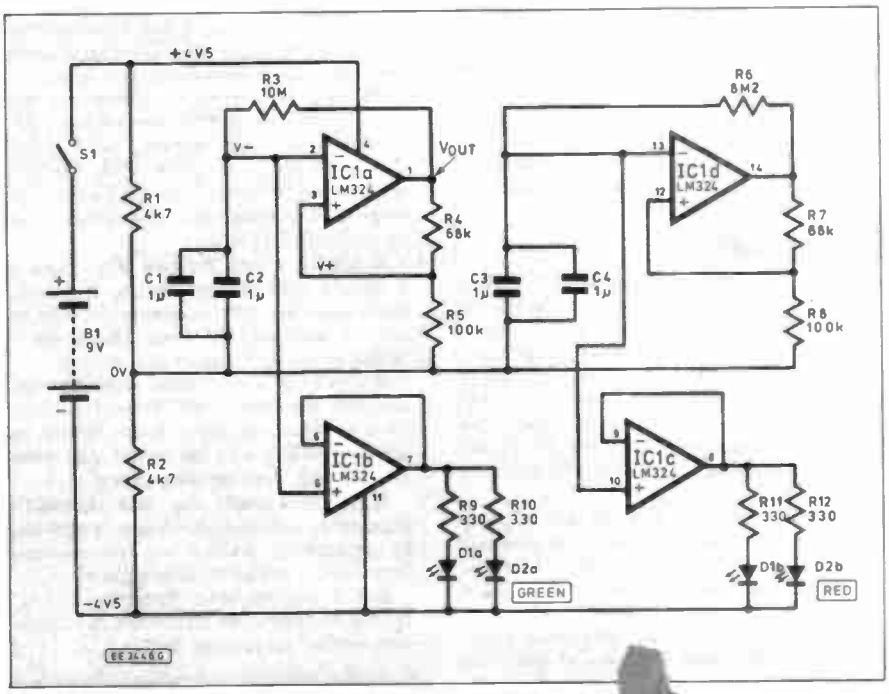


Fig. 2. Complete circuit diagram for the Spectra-Lite. Diodes D1 and D2 are tri-colour rectangular l.e.d.s.

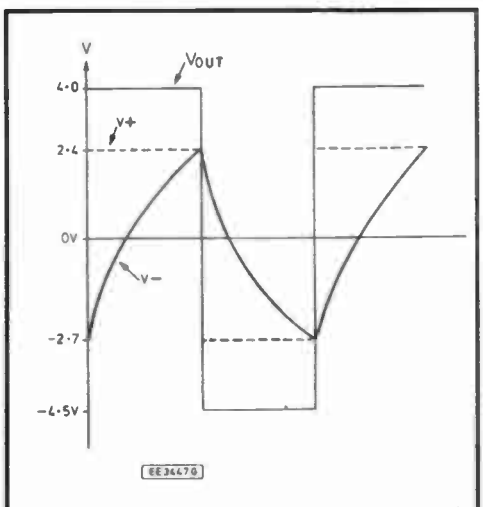
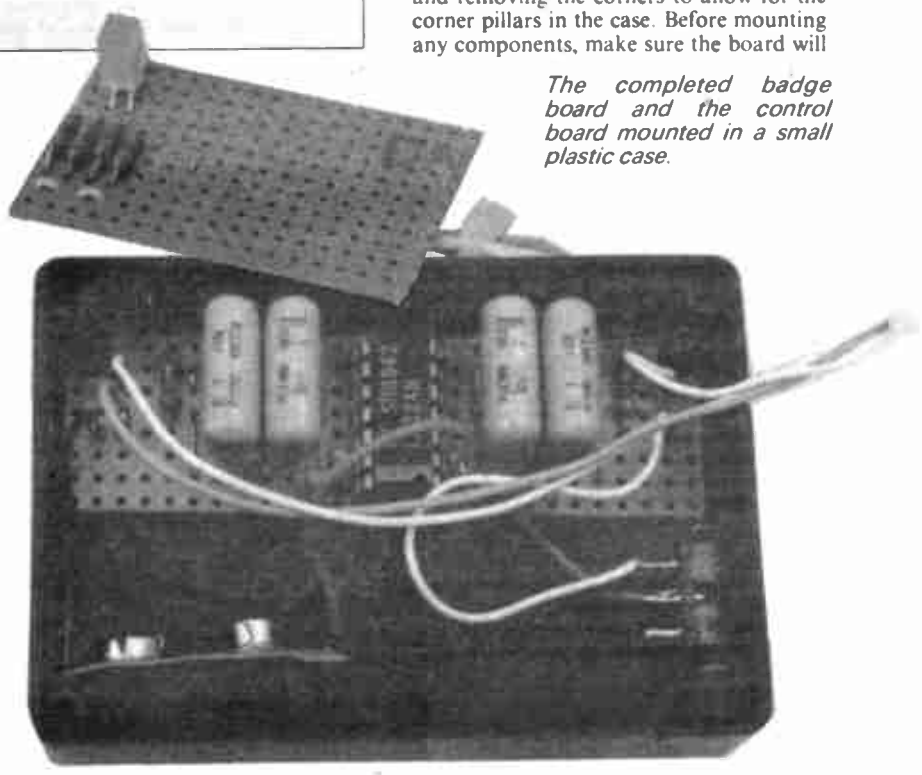


Fig. 3. Voltage variations in the astable multivibrator. Refer to Fig. 2 and text.



The completed badge board and the control board mounted in a small plastic case.

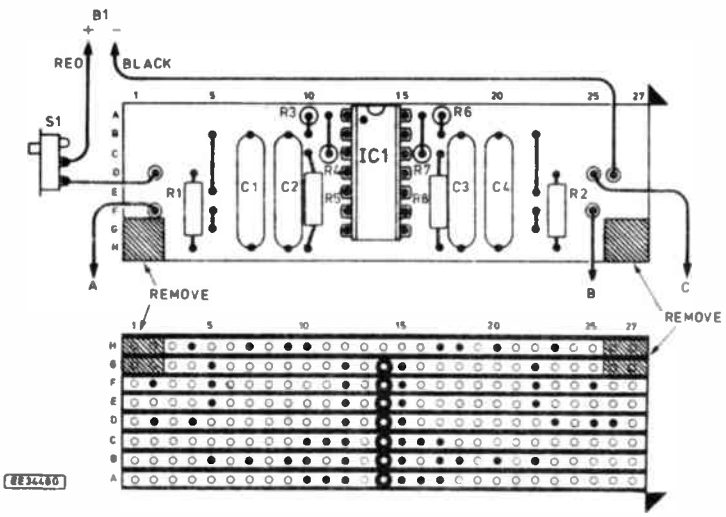


Fig. 4. Control circuit stripboard component layout and details of breaks required in the underside copper tracks.

fit in the case along with the battery; file down the board if necessary.

Make the seven breaks in the cooper strips as shown. Either use a track-cutting tool for this purpose or use a 9/64" twist drill held in the fingers.

Assembling the components on the stripboard is straightforward and should not be beyond the abilities of most beginners. However, the high components density calls for a small soldering iron bit and a steady hand. It is also a good idea to hold the board steady in a vice or clamp whilst working on it.

Start by soldering a 14-pin d.i.l. socket in place to take IC1, but do not insert the i.c. at this stage. Then solder in the resistors R1 to R8 making sure that you place the correct values in the appropriate places; refer to the component list. Notice that resistors R9 to R12 are located on the Badge circuit board.

Now insert the capacitors and then the four wire links. Small pieces of single-core tinned copper wire is best for these links. Cut three light-duty insulated flexible wires to a length suitable to run from the control box to the badge and solder these wires to the stripboard.

Cut mounting holes in the box for the on/off switch S1 and also a small exit hole for the wires to the badge. Complete the wiring between the battery clip, switch and circuit board according to Fig. 4.

Finally, insert IC1 into it's socket, ensuring that the device is correctly orientated. This i.c. is not sensitive to static electricity and may be handled without fear!

It is beneficial to now brush the copper side of the stripboard with methylated spirits to remove finger grease from between the tracks which, if allowed to remain, could reduce the effective resistance of R3 and R6 which would increase the oscillator frequency.

BADGE

The prototype badge was built on a small piece of *plain* matrix board as detailed in Fig. 5. It is not worth buying a large piece of plain board especially for this job, any thin, stiff insulating material (plastic, stiff card etc.) will suffice. If such material is used, then small diameter holes should be drilled for the component leads at the relevant positions.

Mount the two l.e.d.'s D1 and D2, and the four resistors R9 to R12, on one side of the board. On the reverse side, bend the leads flat against the board to secure the components in place.

The side faces of the two rectangular l.e.d.'s can be glued together so that they appear as a single unit. It does not really matter which way around the l.e.d.'s are inserted on the board as long as they are both positioned the same way so that green is connected to green and red to red.

Solder the component leads together as shown in the diagram. The l.e.d.'s, like most semiconductors, can be damaged by excess heat whilst soldering so be as brief as possible with the iron.

Attach the three leads from the Control Box to the Badge. To prevent the wires straining on the soldered joints they should be threaded through the holes in the board as described in Fig. 5. The wire labelled *A* in Fig. 5 goes to connection *A* in Fig. 4, *B* to *B*, etc.

Finally, the leads can be neatly fastened together with nylon cable ties, or something similar.

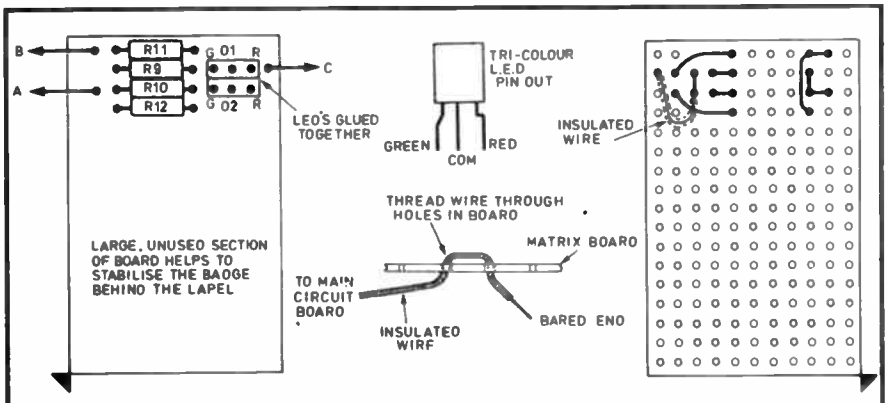


Fig. 5. Layout and wiring of the plain matrix "badge" board together with l.e.d. pinout details and suggested method of anchoring the flying leads.

TESTING

Attach a battery and switch S1 ON. The l.e.d.'s should immediately light and start to change colour. Check that both red and green lights cycle through the complete intensity range from off to full brightness.

If neither l.e.d. lights then switch off and carefully check your construction. By far the majority of circuit faults boil down to constructional error; wrongly placed components or bad soldering leading to dry joints and/or solder blobs bridging across adjacent copper tracks.

If you are convinced that your construction is impeccable then try the following tests which may help to locate a fault.

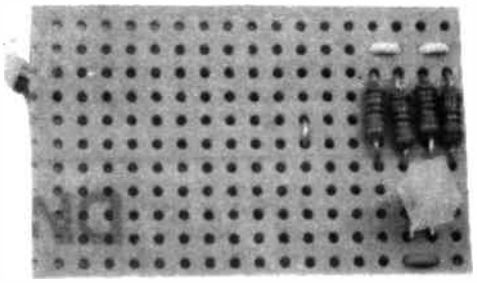
Remove IC1 from its socket and then, with power applied to the circuit, use a piece of wire to link between pin 4 and pin 7 of the empty i.c. socket. This effectively applies +4.5V directly to the badge board and, as a consequence, the green l.e.d.'s should light brightly.

Similarly, a link between pin 4 and pin 8 should light the red l.e.d.'s. If either of these tests fail then (assuming that the battery is not dead) the fault may lie on the badge board or its associated wiring.

If the l.e.d.'s pass these tests then it is possible that the LM324 i.c. has failed. This is especially likely if the device was wrongly inserted in its socket and power was applied. Try renewing the i.c.

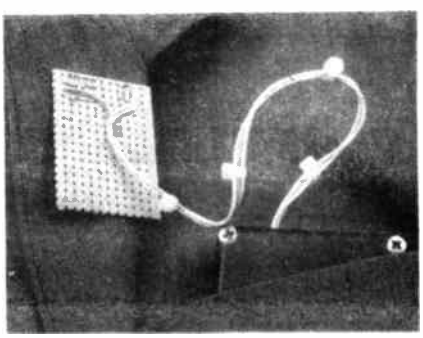
It is very unlikely that new resistors or capacitors will be faulty but it is very easy to accidentally confuse two resistor values and insert them in the wrong places.

Enjoy wearing your 'Spectra-Lite'. It is bound to raise a few eyebrows as it adds a touch of colour to your day! □



Badge component layout.

Spectra-Lite hidden behind lapel and in breast pocket



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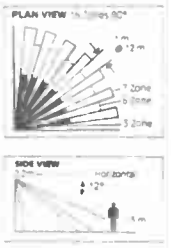

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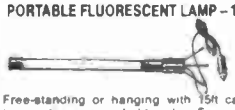

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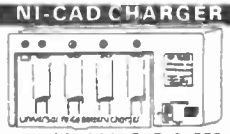

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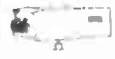

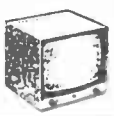

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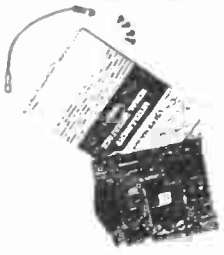


INTERFACE

Robert Penfold

FROM PC analogue to digital converters we now move on to conversion in the opposite direction. While analogue to digital converters seem to be mainly microprocessor bus compatible, digital to analogue converters do not.

Many of these devices must be interfaced to the computer via a latching output port, and the two digital to analogue converter circuits featured in this month's article certainly fall into this category. Both devices are 8-bit types, and can for example, be driven from one port of an 8255A that has been configured as an output type. Digital input and output ports for PCs have been covered in previous *Interface* articles, and this aspect of things will not be considered further here.

ZN426E

One of the best 8-bit digital to analogue converters, but also one of the most simple to use, is the Ferranti ZN426E. This could reasonably be regarded as a complementary device to the ZN448E featured in the previous two articles.

In common with the ZN448E, it has a built-in 2.55 volt reference generator which gives the device a resolution of 10 millivolts. The output voltage is equal to the digital input value divided by one hundred, or multiplying the digital value by ten gives an answer in millivolts.

The circuit diagram for a simple Digital to Analogue Converter (DAC) based on the ZN426E is shown in Fig.1. The PC expansion bus can provide the required supply potentials of +5V, +12V, and −12V. The terminals marked D0 to D7 are the data inputs, and as explained previously, these must be fed from a latching output port, not direct from the PC's data bus.

This circuit utilizes the internal 2.55 volt reference generator of the ZN426E. There are separate reference input and output terminals at pin 5 and pin 6 respectively, and it is possible to use an external reference voltage source if desired.

However, the internal reference generator is a very high quality type which is highly accurate and stable, with excellent temperature compensation. In practice it is unlikely to be worthwhile using an external reference voltage. R1 and C1 are the load resistor and decoupling capacitor for the reference voltage generator.

VOLTAGE GAIN

The basic 0V to 2.55V output voltage range of the ZN426E will normally need to be modified somewhat by an attenuator, or (more probably) an amplifier. It is advisable to include a buffer amplifier even if the output voltage range of the device is suitable for your requirements.

In this circuit IC2 acts as a simple non-inverting amplifier which has a voltage gain of two times. This gives an output voltage range of 0V to 5.1V, but this is easily altered by changing the value of resistor R2.

The voltage gain of the circuit is equal to (R2 + R3) divided by R3. The value of resistor R2 for a given voltage gain is therefore 10k multiplied by one less than the required voltage gain.

For instance, a 0V to 10V output range would require a voltage gain of about four times. Multiplying 10k by one less than this gives an answer of 30k. Bear in mind that the +12 volt supply rail means that the maximum output voltage from the circuit is limited to about 11 volts.

If the output voltage range must be set very accurately, then R2 must be replaced by a preset resistor, or a preset and a fixed resistor in series, so that the maximum output voltage can trimmed to exactly the desired figure. Incidentally, I used a CA3140E for IC2 simply because this device happened to be to hand. The circuit should work just as well using a uA741C, LF351N, TIL081CP, etc.

With digital to analogue converters there is no need for any handshaking. You output a series of values to the circuit which are rapidly converted to corresponding voltages.

With a powerful PC though, it is probably possible to output values at a higher rate than the ZN426E can handle. There should be no difficulty with around 500,000 values per second, or even a million per second if IC2 is a fairly fast type such as a CA3140E of LF351N. If there is a risk of values being sent at a higher rate, a software routine must be used to slow things down slightly.

DIFFERENTIAL DAC

The circuit diagram for a Differential Digital to Analogue Converter based on the DAC0801 is shown in Fig. 2. This is very different to the ZN426E as it is

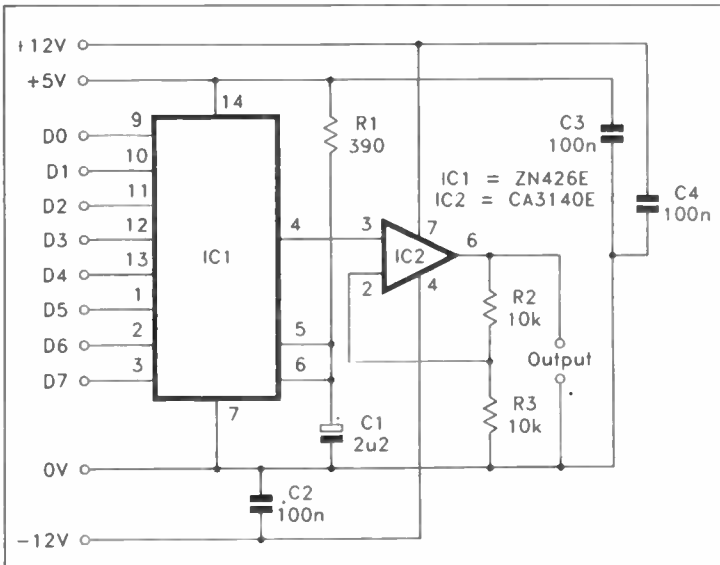


Fig. 1. The ZN426E D/A Converter circuit diagram. Note that D0 to D7 must be fed from latching outputs, not the PC data bus.

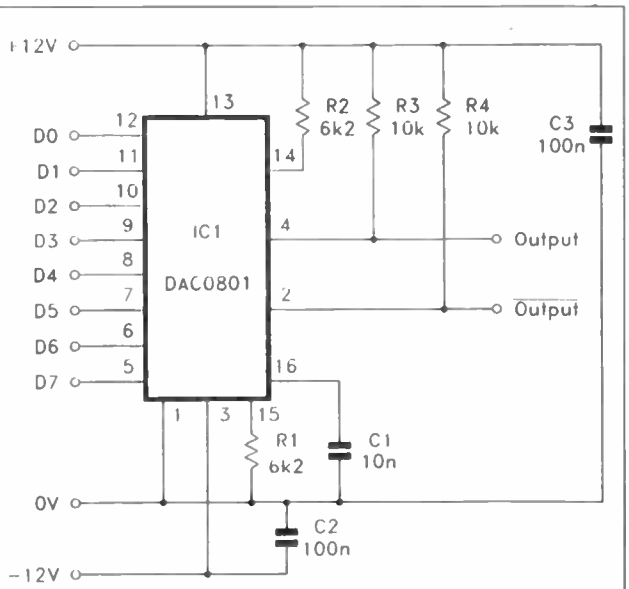


Fig. 2. A differential DAC based on the DAC0801 converter.

Speed Tests

If you make a major upgrade to your PC such as adding a new hard disk, or you build your own PC from the basic "building blocks" that are sold by numerous companies these days, how do you know that everything is working at full speed?

I recently upgraded from two 286 based PCs to two 386 based types by buying two cheap basic units, and then adding hard disks, extra memory, etc. obtained at low prices from other sources. The two finished PCs clearly worked and were quite fast, but were they as fast as they should be?

Fortunately there are a number of speed test programs available which will show up problems such as hard disks with slow access times, slow memory performance, etc. Commercial utility programs such as PC Tools have useful system analyser routines which will measure various aspects of performance, and show the relative speed of the test PC against some IBM models. In the case of such things as hard disk access times and data transfer rates, you actually get times in milliseconds, and transfer rates in kilobytes per second.

The set of tests devised by the American *PC Magazine* must be one of the most gruelling you can use on you PC. These are designed to test such things as various aspects of VGA compatibility, processor performance, memory read/write speed, and extended memory read/write speed. If something is not set up correctly, or is simply performing below par, then these tests will normally reveal the problem.

The PC Magazine *"Lab Benchmark Tests"* are available from some shareware suppliers, and are worth trying on your PC, if you dare. My two PCs performed very creditably, although on some memory speed tests they seemed to be slightly slower than expected.

If you look inside several far eastern PC clones of the same basic type, but having motherboards from different manufacturers, you often find that the motherboards all look remarkably similar. Modern PCs are based on LSI chip sets which replace the rows and rows of TTL chips on the early PCs.

Apparently the manufacturers of these chip sets produce printed circuit board designs on which the LSI chips are guaranteed to work. These designs can be used by companies that buy the chips, and to keep down costs most manufacturers use the "off the shelf" designs rather than developing their own. Thus, six boards from six different manufacturers, if they are based on the same chip set, may all be to the same design!

Strangely, in speed tests such boards do not always produce the same results. Whether this is due to genuine differences in the performance of the board, or quirks in some test routines, I really do not know. There are components in the system other than the processor and LSI chips, and I suppose that these might have some effect on certain aspects of performance.

The PC Magazine speed test program is available from *PDSL, Winscombe House, Dept EE, Beacon Road, Crowborough, Sussex, TN6 1UL (☎ 0892 663298).* It is on one disk and the catalogue number is 2425. It may well be available from other shareware suppliers, but under a different disk number.

primarily intended for differential operation.

In other words, there are two outputs which are at about the 0V supply potential with an input value of 64. Higher values take the negative output more positive and the positive output more negative. Lower values have the opposite effect.

This may seem to be the wrong way round, and it would seem to be more logical to have higher values take the positive output more positive. However, this is a current rather than voltage oriented device.

The output that the manufacturers refer to as the negative one (pin 2) has reduced output current with increased input values. This reduced current gives a lower voltage across the load resistor (R4), and increased output voltage. Similarly, increased current at the other output (pin 4) gives a higher voltage across load resistor R3, and reduced output voltage.

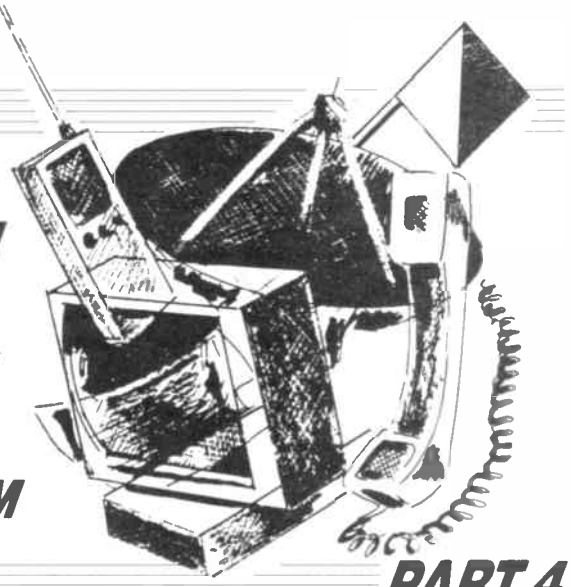
Resistors R1 and R2 provide bias currents to the reference inputs of IC1. Using the specified reference and load resistor values an output voltage swing of about 12V peak-to-peak is obtained at each output, or some 24V peak-to-peak between the two outputs.

Using fixed resistors for the load resistances the outputs will not be precisely balanced, and an output of 0V will not be obtained with an input value of 64. Where precision operation is needed, resistors R3 and R4 must be replaced with preset resistors (potentiometers) so that the circuit can be trimmed for optimum accuracy.

A compensation capacitor C1 is needed in order to prevent instability in the operational amplifier at the reference inputs. Unusually, this circuit does not require a +5V supply. However, provided pin one is connected to the 0V rail, the digital inputs will operate properly with standard TTL input levels.

Next month we will look at some circuits which use the ZN426E and DAC0801 in some practical applications, such as controlling small d.c. motors.

Special Series



INFORMATION TECHNOLOGY AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 4

THIS is the fourth article in a 12-part series concerning Information Technology and related matters in the Science National Curriculum. Certain background information was given in Part 1 (November issue) and readers who have not been following the series are advised to read this first.

The first part of this month's work has a particular emphasis on computers. After that, we shall look at the range of microelectronic devices found in everyday life. We shall begin next month with some experiments using microelectronics.

COMPUTERS PAST AND PRESENT

As we saw last month, certain machines which may be regarded as computers were developed by Charles Babbage in the early part of the 19th century. So important was his work that he is often remembered as the *father of computing*. For many years, development of what we would call *information technology* today took the form of bigger and faster mechanical calculators made possible with advances in accurate machine tool technology.

A mechanical device using punched cards was invented in the late 19th century to process American census information. This could be regarded as the first *data processing* machine.

It soon became clear that there were limits in terms of speed and reliability to what could be done using mechanical devices and people began to think about using *electrical* techniques instead. It had been known for a long time that all mathematics can be carried out using only two numbers – 0 and 1 (the *binary system*) instead of the usual ten digits 0 to 9. No further details will be given here but more will be said about binary arithmetic in a later article.

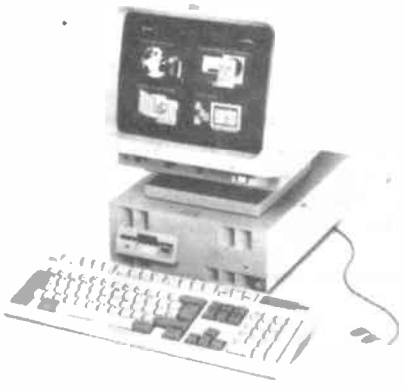
By switching a current *on* to represent 1 and *off* to represent 0 and by manipulating these states, arithmetic can be performed. Such switching could be done mechanically and the first electrical (rather than electronic) computers did just that.

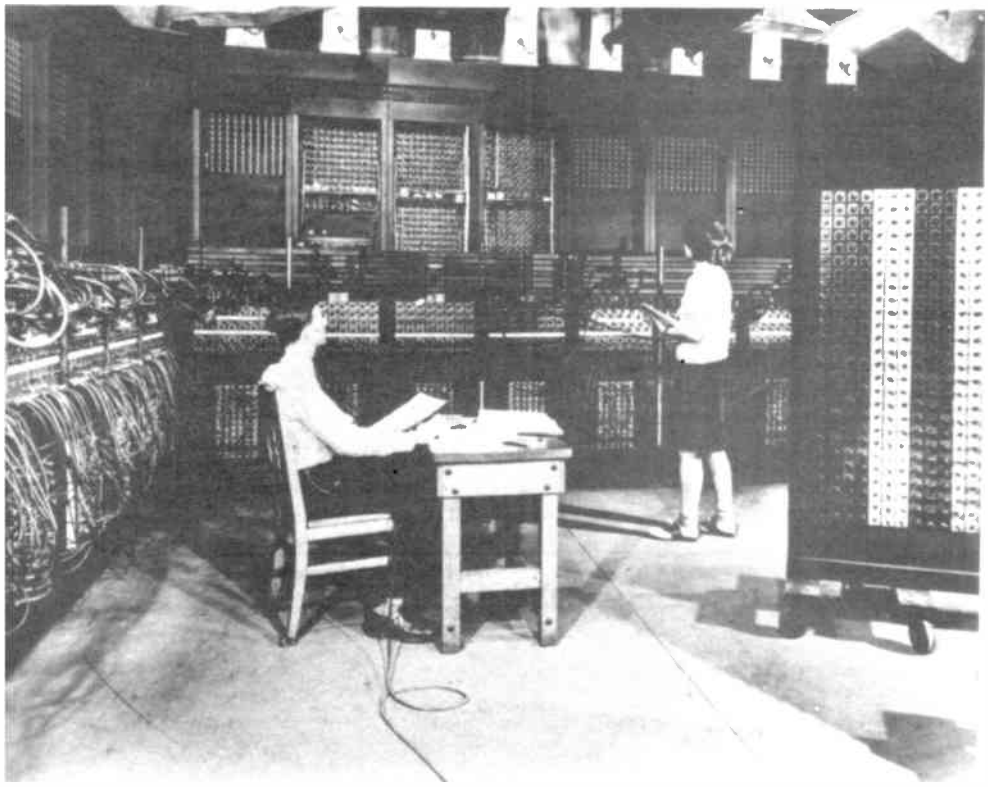
ELECTRONIC COMPUTERS

With the invention of the triode valve by Lee de Forest (see last month's article), switching could be carried out *electronically* at a much faster rate than mechanical devices could achieve. The photograph shows the first electronic computer called *ENIAC* (Electronic Numeric Integrator and Calculator) built in the 1940's – in this 18,000 valves were used as the switching elements to perform calculations.

Although a great improvement on earlier mechanical devices, valves proved to be expensive, unreliable, and very wasteful in terms of power and space. ENIAC filled a large room and needed 200kW of power – this is the same power as is needed for 200 single-bar electric fires!

Electronic computers were developed for use in the Second World War because they could unravel enemy secret codes – one of these was called *Colossus*. Computers using valves are called "first generation" com-





The IBM PS/1 personal computer, compare this with ENIAC (left).

(Left) ENIAC 1946. The Electronic Numeric Integrator and Calculator was designed by J. P. Eckert and J. W. Mauchly of the Moore School of Electrical Engineering of the University of Pennsylvania. Completed in 1946, it contained 18,000 valves and 1,500 relays. It was designed to calculate firing tables for the US Army's artillery, and could calculate a trajectory in half a minute, compared with 20 hours for a human calculation.

(Photo courtesy of IBM)

puters and you will now only see them in museums.

Compare ENIAC with a modern school or home microcomputer. The micro is cheaper, faster, smaller, much less power-hungry and very much more reliable. It is also much more *powerful* – that is, able to do far more complex calculations.

PROGRAMS

We think of a computer as a device which works from a set of instructions called a *program*. This is why Babbage's machines were true *computers* rather than simply *calculators*. In a modern computer the program may be changed and this, together with the sheer power to process information, makes it the most versatile machine that man has yet devised.

To give instructions to the computer, we need to write the program first (or use one which has already been written). In the future, a computer will probably be able to follow instructions spoken in everyday English. However, a school computer needs a program to be typed on the keyboard in a "language" which it understands. The program may then be used directly or stored and used later when required.

There are several computer languages such as *COBOL, FORTRAN, Pascal,* etc. but for everyday purposes, many people use *BASIC* (Beginners All-purpose Symbolic Instruction Code). In BASIC, English words such as *PRINT, SAVE, LOAD* and *RUN* are used and this makes the program easy to understand. Some simple examples of BASIC programming appear later in this article.

SPEED

Recent advances have increased the speed of computers enormously – that is, the speed needed to process information. For a simple calculation, this is so fast that even an old-fashioned computer will seem to do it instantaneously. However, when long and laborious chains of calculations are needed the speed of the computer becomes noticeable. Try to show children a sorting program to put into order the test marks of 100 children or more. Compare this type of activity with the speed of a child doing the same operation.

A computer needs a *memory* – called Random Access (RAM) – in which to place the information it is working on temporarily. However, electrical power is needed to keep this working so if the computer is switched off, or the power supply fails, the contents of the RAM will disappear – the memory is said to be *volatile*.

It is therefore vital to be able to save important information in some more permanent way so that it is not lost. This is often done by connecting an external cassette recorder or a disc drive. This is also useful because ready-made programs can be bought on a cassette or disc. Storing information in this way uses the same principle as sound recording on tape (see last month's article). Show children either tape or disc storage. If possible, the two may be compared.

Tape has the advantage of using an inexpensive cassette recorder. However, loading the information is very slow and rather unreliable. A disc drive uses a magnetic disc – this is more expensive but it is reliable. Also, access time to a particular piece of information is very fast because the whole surface of the disc can be scanned very quickly unlike a cassette which has to wind through. Programs written on disc or cassette are referred to as *software* – the *hardware* is the computer itself.

Programs written on disc or tape may be altered to suit the purpose – although with complex ones this may demand considerable skill. However, it often happens that the program, once written, will never need to be changed. it may then be written in ROM (Read Only Memory). This is a purely electrical medium having no moving parts. It will thus be ready for instant use when the computer is switched on. The memory in a spelling checker is of this type – the words are all stored in ROM.

The Oxford Dictionary is now stored in a computer database. This is just a means of storing bulk information on a disc or other means, being able to retrieve it quickly and, if possible, update it as required.

The computer can locate information in a database even when you are not completely sure what you are looking for. For example, a crime might be committed and a witness might remember a few odd numbers and letters from the number plate of a car. If the car was also known to be a red Metro, the computer could list all its possible owners. Of course, the less information that is known, the more possibilities of ownership there will be.

MEMORY EXPERIMENT

Try the following using a BBC computer with a disc drive. Put some numbers in the memory and process them using a simple program. This is a BASIC program and needs line numbering. The first line is usually called No. 10 and, if there were more than one line, would go up in steps of 10. Note that *PRINTING* here just means displaying something on the screen. *RUN* instructs the computer to carry out the program. The ">" sign is called the *prompt* and signifies that the computer is ready to receive an instruction. (RETURN) means that the return key is pressed before proceeding.

> 10 PRINT 2 + 3
(RETURN)
> RUN
5
>

The answer 5 comes up on the screen. Now do the same but before typing **RUN**, switch off the computer for a few seconds then switch it on again. When **RUN** is typed in, nothing happens because the RAM contents have been erased. However, the information could have been saved on disc then retrieved like this:

> 10 PRINT 2 + 3
(RETURN)
> SAVE "TRIVIAL"

SAVE instructs the computer to put the program onto a disc and give it the *filename* "Trivial" – note the inverted commas. The disc drive makes a whirring sound and a red light comes on. After a short while it goes off and the program is saved. Switch off the computer, then on again so that the memory is erased. Now type:

> LOAD "TRIVIAL"
(RETURN)
> RUN
5
>

The answer 5 appears once again. This illustrates that the contents of the memory have been saved on the disc and later retrieved. Obviously this program was not really worth saving but the same process could be used for long and complex calculations. Also, you could go back to it months, or even years later.

You can make the computer give a list (catalogue) of all the items on a disc (called *files*) by typing *CAT). This is useful if you have forgotten a filename.

ROM, RAM AND CPU

The computer RAM may be thought of as a large array of trays. Each tray has an address (which is a number) so that the computer can keep track of where it puts information. This may be likened to a house address which enables the postman to put information in the correct letter box. We don't usually know what the actual address is – it is usually sufficient to let the computer decide where to put the information.

The Central Processing Unit (CPU) is the "brain" of the computer. This manages everything and does the actual calculations. It takes numbers out of RAM (it is said to *read* from memory) and put numbers in (it *writes* into memory). The result may be put into other memory locations and these may be used again for further calculations. It can do these things in a fraction of a millionth of a second!

Here is a BASIC program which illustrates how memory locations are used to enable the CPU to do a calculation. The computer looks at the program and deals with each instruction in line order. Note that certain simplifications and short-cuts could be made to this program. However, it is more easily understood as it stands. Also, it will work on other computers.

> 10 LET A = 2
(RETURN)
> 20 LET B = 3
(RETURN)
> 30 LET C = A + B
(RETURN)
> 40 PRINT C
(RETURN)
> RUN
5
>

Explanation

Line 10: A memory location is called "A" and the number 2 is written into it.

Line 20: A memory location is called "B" and the number 3 is written into it.

Line 30: The contents of locations A and B are read and added together. The result, 5, is written into a further location called "C".

Line 40: The contents of memory location "C" are printed on the screen – that is, the number 5.

COMPUTER SIMULATION EXPERIMENT

This experiment illustrates how the above program works. A child acts as the CPU and obeys the program in line order.

You will need a few small trays laid out in a row to represent the computer memory. The program above is written on a large sheet of paper. A child, representing the CPU, looks at line 10, sticks a label on a tray calling it "A", writes the number "2" on a piece of paper and places it in the tray. He or she now looks at line 20 and does similarly – the tray is labelled "B" and a piece of paper with "3" written on it is place inside.

Line 30 is now looked at and a new tray is labelled "C". The contents of trays A and B are now added together and the result, "5", written in tray C. Line 40 is an instruction to print the contents of tray C. This is done by writing it on a piece of paper and showing it to the class.

The calculations can be made more difficult and may use more trays. The results may then be checked using a calculator. The children should realize that (a) the computer does not make mistakes (b) it works much faster than a human (c) the trays are not real but *electronic* – they hold electrical signals which represent the numbers and (d) the computer has many thousands – perhaps even millions – of such "trays". In this way, the computer can do very complex calculations accurately and quickly.

STORING TEXT

If the numbers put into RAM represent letters of the alphabet then the computer appears to be dealing with *words*. This is how word-processors work.

To give an idea of how the computer can use words, the following can be used. This BASIC program with no line numbering gives instant printing of the text. However, it is not very useful.

> PRINT "The cat sat on the mat"
(RETURN)
The cat sat on the mat
>

Note the inverted commas around the text to be printed. This is a signal to the computer that *text* is expected, rather than numbers. The inverted commas are not printed. If you do not want immediate printing when you press RETURN, you can use this program with line numbering. It will then only print the text when you type **RUN**:

> 10 PRINT "The cat sat on the mat"
(RETURN)
> 20 PRINT "The dog sat on the log"
(RETURN)
> 30 PRINT "The fish was in the dish"
> RUN

The above method needs a lot of line-numbering and typing of **PRINT**. This is very time-consuming and inconvenient and there are better ways of doing it.

The text would be lost if you switched off the computer. To avoid this, you could store the data on a disc – in this case, in a file called "CAT".

> 10 PRINT "The cat sat on the mat"
(RETURN)
> SAVE "CAT"

To retrieve it you type:

> LOAD "CAT"
(RETURN)
> RUN
The cat sat on the mat
>

In this program, the computer seems to be dealing with words but, in reality, it is just using numbers as it always does. These programs may seem trivial but the computer is doing a lot of work to execute them. Every letter of the alphabet, lower and upper case, every punctuation mark, etc. is given a *code* – a number – which is unique to it. This is usually the ASCII (pronounced Askey) code which stands for American Standard Code for Information Interchange invented in 1963. It is obviously useful for different makes of computer to use the same code.

In the ASCII code, for example, capital "P" is given the number 80 but lower case "p" is given the code 112. An exclamation mark is coded 33 and so on. The computer looks at each letter in a piece of text and turns it into the ASCII code. It can then put these numbers into RAM, retrieve them and convert them back to letters to be displayed on the screen.

In the BBC computer, you can find the ASCII code for any letter, number, punctuation mark, etc. by typing:

> PRINT ASC "a"
97
> PRINT ASC "A"
65
> PRINT ASC "!"
33
>

The foregoing programs store and retrieve small amounts of text in a simple manner and this may be sufficient for children. The problem is, the text cannot be manipulated easily. For more serious work, they should use word-processing software if this is available. In this way they will appreciate that blocks of text may be written, modified as required, stored on a disc, retrieved at a future time, printed on paper, etc.

They will get much more benefit out of a word processor if they use it for a real purpose rather than simply as an exercise. Too much dwelling on the various facilities available is a waste of time. Once they know the fundamentals they will pick the rest up as they go along. Let them use the word processor to do written work providing, of course, a printer is available.

Desk-top publishing is also useful and enables a child to appreciate how a modern newspaper is produced. Art packages and educational games with graphics and sound illustrate the storage and retrieval capability of a computer with things other than numbers and text.

THE MICROELECTRONIC WORLD

This section is about *microelectronics* – children should know a little about some of the microelectronic devices they meet in everyday life. It will be helpful to illustrate what is meant by the term microelectronics. If we were to take the back off an old valve radio dating from, perhaps, the 1940's we would see inside a mass of components all connected together with dozens of soldered wires.

Failure of one of these connections or components would prevent the radio from working properly. Furthermore, any fault might be difficult to find and it would be time-consuming and expensive to repair. The radio would have been expensive to buy in the first place because of the amount of work needed to hand-build it. Other pieces of electronic equipment such as record players, televisions and computers were built in the same way.

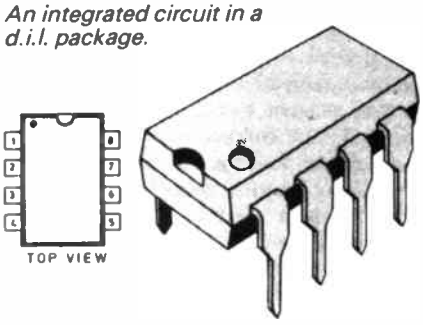
If we now looked at more recent pieces of equipment, dating perhaps from the 1960's, we would see that much of the wiring has been preformed on one or more *printed circuit panels*. The components are mounted on top of the panel, connections pass through holes and are soldered to the ready-made copper tracks underneath. These tracks replace all the individual wires.

Thousands of such panels could be produced very quickly and cheaply and the amount of work needed by an operator to connect them up was greatly reduced. Also, the device would be far less likely to fail on account of the more reliable wiring. At that time, transistors were gradually replacing valves and the device as a whole was becoming smaller. However, the circuit was still built using separate (so-called *discrete*) components.

INTEGRATED CIRCUITS

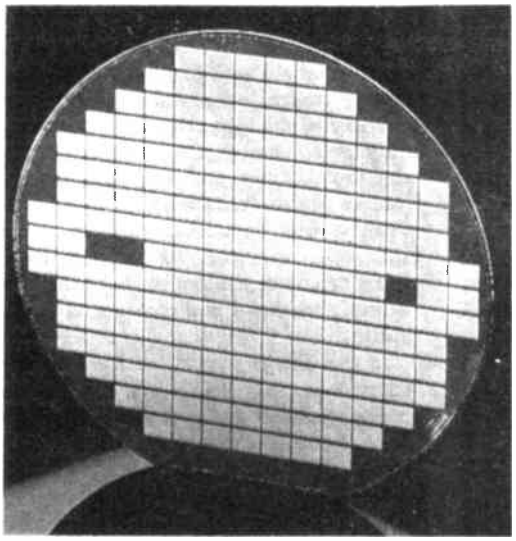
The next logical step was to build the components themselves in packages called *integrated circuits* (see photographs) so that many components were pre-connected. Since i.c's could be mass produced, they would be much less costly than the individual components they replaced. Furthermore, they would be much smaller and very reliable. The basis for an i.c. is a slice of silicon about 2mm square – the so-called *silicon chip* or *microchip*. Transistors and certain other (but not all) components can be formed on this single slice.

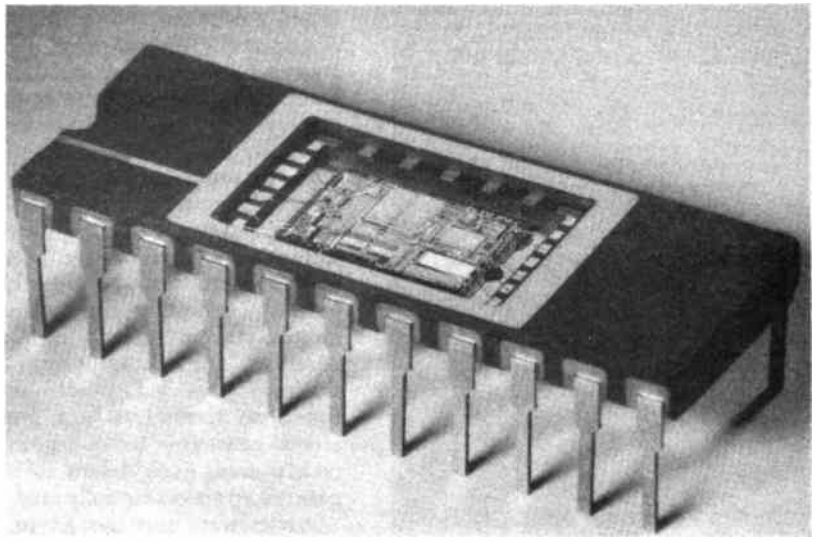
An integrated circuit in a d.i.l. package.



It is important to realize that the components are actually *made* on the chip together with all the necessary connections – there is no internal "wiring up" done after manufacture. This would be impossible due to the small size.

In manufacture, several hundred identical i.c's are formed, using photographic tech-





The chips are made on a disc of silicon then cut up and mounted in their package. The photographs show a disc with chips on and a package holding a chip. Fine wires connect the chip to the "legs" of the d.i.l. package.

niques, on a single large wafer of silicon. Each i.c. is tested and the faulty ones thrown away – many fail under test (perhaps as many as 70%) because there is a lot to go wrong in the process.

The wafer is cut up into individual chips and each is enclosed in a plastic case. This is called a dual in-line package (d.i.l) and a typical small one may have 8 or 14 pins. The chip is connected to these pins using gold wire then encapsulated permanently.

Once an i.c. is tested and found to be working properly, it is most unlikely that it will ever fail in service unless mistreated.

SCALE OF INTEGRATION

The earliest i.c's of the 1950's contained just a few components – up to 10 – but as time passed, the maximum number increased dramatically. In the 1970's this amounted to a doubling each year and the rapid increase continues to this day. Now it is possible to form somewhere around one million transistors on one silicon chip – although for higher numbers of components the chip is larger.

We talk about the *scale of integration* – small scale (SSI), medium scale (MSI), large scale (LSI), very large scale integration (VLSI) and super large scale integration (SLSI).

Approx. transistors per chip	
SSI	about 10
MSI	up to 500
LSI	up to 20,000
VLSI	up to 100,000
SLSI	More than 100,000

Computers built using transistors instead of valves in the 1960's are called *second generation computers*. Computers using early integrated circuits are called *third generation* computers. Present-day school, home and business computers are of the *fourth generation* kind. These use an enormously complex integrated circuit called a microprocessor.

The microprocessor provides three things on one clip. Firstly, the *arithmetic logic unit* (ALU) which attends to all the calculation and logic decisions of the computer. Secondly, *registers* which are a type of temporary memory used by the ALU and, thirdly, the *control circuits* which organize the working of the ALU in such operations as when to read and write data to and from RAM.

The microprocessor needs RAM chips connected externally using link wires called *buses*. Obviously a computer also needs an input device such as a *keyboard* and an output device such as a *screen* (VDU), *printer*, etc. Without these, humans and computers cannot communicate with one another!

WORKING WITH I.C.s

Working with integrated circuits (i.c.s) rather than using separate components is called "microelectronics". Microelectronics does little which could not have been done many years ago. Just about everything we can do now could have been done with first generation technology but such devices would have been very much larger, less reliable, extremely power-hungry, slow to operate and much more expensive.

ENIAC weighed about 30 tonnes and cost one million dollars to build yet it was a midget compared with a present day home or school computer. Imagine how large, heavy, costly and unreliable a home micro using first generation technology would be!

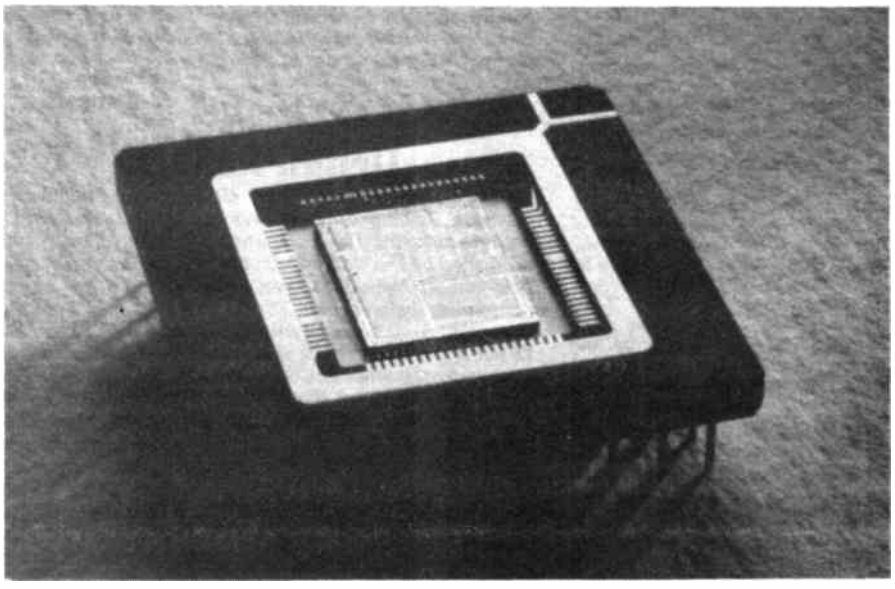
If a microchip ever fails (this is extremely unlikely) it is impossible to repair but this is of no concern. It is so cheap that it is simply replaced and this involves hardly any labour cost.

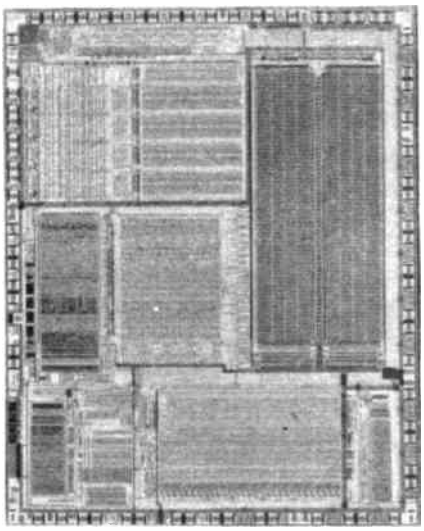
A study of microelectronics does not need an understanding of how an i.c. works. It is only necessary to know what the chips do and to learn the rules about connecting them together to make a useful system.

In some areas the change has been slow because the old technology is well understood and industry is geared up to using it. It needs huge capital investment to set up production of new technology equipment. Some of the electrical parts of a car are an example of "behind the times" technology.

Microelectronics revolutionized the 1960's and increasingly so the 70's and 80's. With ever-increasing numbers of components being integrated we shall have to see what the late 90's bring. Perhaps the most exciting development is the *transputer* (see photograph). This may typically have 250,000 transistors on a

The Inmos transputer, this photograph is approximately twice the actual size.





The circuit on the chip of the transputer. This is actually about 7mm across.

7mm square silicon chip (as many as 1,000,000 devices on one chip is possible).

Not only this, transputers will link with other transputers to make computers so powerful that they will be able to make complex decisions and be able to recognize ordinary spoken words. (Edinburgh University has a computer using 1,000 transputers). They will be consulted as experts in, say, medical fields. Computers based on the transputer are called *fifth generation* computers.

The foregoing may suggest that the more components that are formed on a silicon chip, the better. For some purposes, this may be true. However, for many everyday purposes, small or medium-scale integration is all that is necessary. The new technology has not displaced the old. Note also that transistors themselves – a product of second generation technology – are still widely used. Even valves (of the first generation) are occasionally used.

A microwave oven uses a type of valve – a magnetron – to generate the high frequency radio waves called microwaves. Valves are also used in some high-powered radio transmission equipment. Even the picture tube on a domestic T.V. set is a type of valve.

CHIPS EVERYWHERE!

There are so many things in everyday life which use microelectronics that it is difficult to know where to begin. In the home we have calculators, televisions – perhaps with teletext and infra-red remote control – cameras, video games, memory telephones, telephone answering machines, "quartz" clocks and watches, electronic diaries and spelling checkers, foreign phrase translators, currency converters, video camcorders, burglar alarms and audio equipment to mention just a few. Even some modern sewing machines, washing machines and toasters have i.c.s inside.

In the outside world we have cellular telephones, cash dispensers, car washes, coffee machines and petrol pumps. Shops have electronic checkouts and cash registers. The armed services operate a bewildering array of microelectronic devices. Aircraft are also host to a large number of systems using them. Industry abounds with automatic control systems.

Next month we shall build some circuits using an integrated circuit. We shall then discuss how environmental changes may be detected and measured.

EVERYDAY NEWS

Video Technophobia

Ease of use and ease of programming remain key issues with the majority of video recorder users according to the Ferguson annual Electronics Market Report *'91. Despite the increased ownership of VCRs in this country, with UK household penetration now standing at 73 per cent, a startling proportion of users still experience real difficulty in programming their home video.*

It is claimed that 28 per cent off all adults find programming their VCR ardous, and this proportion rises to even higher percentages in the case of female users (35 per cent) or those over 45 years of age (50 per cent).

"Programme complex and inflexible", "too many buttons" *and* "remote controls too complicated" *are just some of users criticisms. Perhaps the introduction of Startext – see last month – and the "easy-to-use" '92 models are the answer.*

High Speed Law

Police officers are required to drive at high speed whether in response to emergency calls or in pursuit of the ever growing "joyrider" or villain. High speed training on public highways is very dangerous, an obvious risk to the public, and out of the question.

The Scottish Police Training College have commissioned the National Computing Centre to develop a new, or adapt the award winning Vistrain, interactive video simulator to train police drivers in emergency response driving. The need for this type of training is highlighted by the fact that in Scotland alone last year there were some 1800 accidents involving police drivers.

The short term aim is to produce a system to demonstrate that it is possible to provide effective training at a reasonable cost. The long term aim is the take-up of the system by the police forces of the UK and its extension to the training of drivers in the fire and ambulance services.

The project, costing more than £100,000, is being funded by the Scottish Police College and the Employment Dept. It is hoped to attract further collaborators to extend the scope and features of the simulator.

★ ★ ★ ★ ★ ★

Granada Computer Services have made 300 UK employees redundant. The cuts mainly affect administrative staff and means the closure of offices in Birmingham, Bristol and Wapping.

★ ★ ★ ★ ★ ★

Multitone Electronics, which has traditionally designed the mechanics of its radio paging products and produced prototypes manually, has just started using a computer-aided design and manufacturing (CAD/CAM) system supplied by Matra Datavision (UK)

Valued at £116,000, the order includes hardware, software, support and training at Multitone's Basingstoke premises and at Matra UK's Coventry headquarters.

★ ★ ★ ★ ★ ★

★ ★ ★ ★ ★ ★

After the skirmishes of the last two or three years, the dust has settled and it has finally happened. A decision has been made and the new UK telephone numbering plan will come into being on Easter Sunday, 3 April 1994. So don't say you haven't been warned.

★ ★ ★ ★ ★ ★

UNIMPRESSED

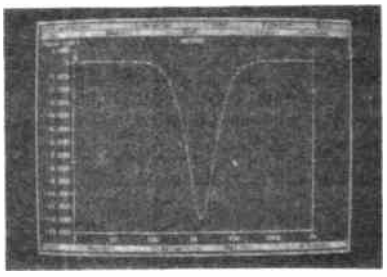
A new report claims that Government initiatives to promote training and improve standards are failing to impress industry. The Computer/IT Training Survey 1991, published by the National Computing Centre and Training Information Network, reveals that only 15 per cent of companies believe that TECS (Training and Enterprise Councils) have a useful role to play in helping meet their IT training requirements, with a third of organisations not even knowing what TECS are, or what their role is.

It is also reported that there is a clear indication that employers do not see legislation and binding contracts as a way of correcting the problems of skills shortages we experienced during the last decade. About 90 per cent of employers would not wish to operate under training levy schemes which forced a commitment to train, nor were employers supportive of training contracts with their employees, where only 20 per cent saw a useful role for these.

ANALYSIS

It is claimed that with the aid of Number One System's new Analyser III software program, circuit designs can be tested and proved before a single component is soldered in position. This saves time and money and, in many cases, it is claimed that the breadboarding stage can be eliminated completely, allowing prototypes to be built directly on the p.c.b.

This latest program is ideal for the analysis of filters, amplifiers, crossover networks, wideband amplifiers, aerial matching networks, i.f. amplifiers and linear i.c.s. It has a claimed frequency range extending from 0.001Hz to tens of Gigahertz; displaying the frequency response of a circuit, not only in terms of gain but also including input and output impedances, phase response and group delay.

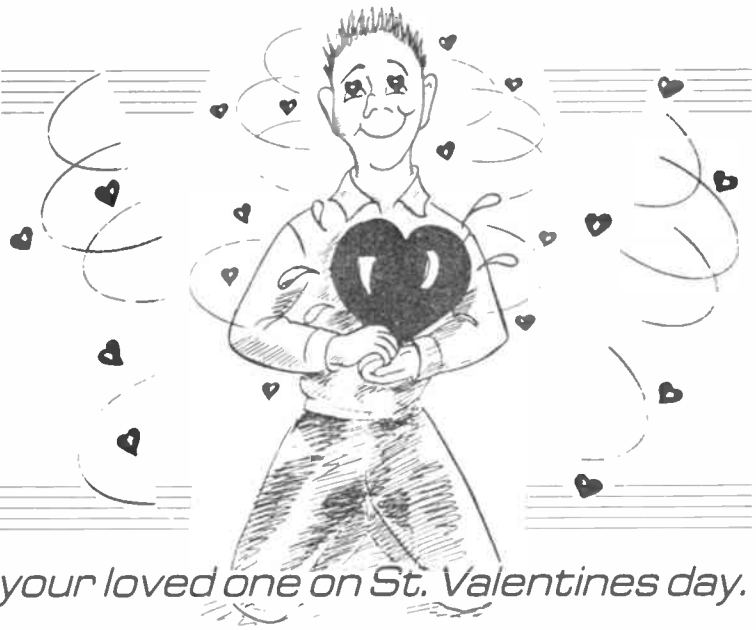


It features full "component library" facilities, including the ability to create user-defined models and presents its output as a high-resolution graph plot, which can be outputted on either a dot-matrix or laser printer. In keeping with their philosophy of making CAD affordable, Analyser III is priced at £195 plus VAT, complete with manual, example circuit files and telephone support back-up.

For further information contact: **Number One Systems Ltd., Dept EE, Harding Way, Somersham Road, St Ives, Huntingdon, Cambs, PE17 4WR. ☎0480 61778).**

Constructional Project

SPINNING HEART



RAFE ALDRIDGE

A novelty circuit to impress your loved one on St. Valentines day.

ST VALENTINES day will soon be upon us and novelties to tell your sweetheart how you feel are often expensive. Here is a clever little circuit that is bound to get the message over and impress the one you love on the 14th of February.

The spinning heart consists of 24 red l.e.d.s arranged in the shape of a love heart. When switched on three evenly spaced l.e.d.s light up, these then go out and the adjacent l.e.d.s light and so on. This produces a spinning effect and looks very effective. Potentiometer, VR1, allows the speed of the effect to be altered from very slow to fast enough for the heart to look almost completely lit up.

CIRCUIT DESCRIPTION

The full circuit diagram for the Spinning Heart is shown in Fig. 1. It is a relatively simple circuit consisting of three main parts. The first part of the circuit is an astable multivibrator built around IC1, a NE555 timer. VR1, R1, R2 and C1 form the timing components with VR1 providing a means of changing the output frequency from 1Hz to 1kHz.

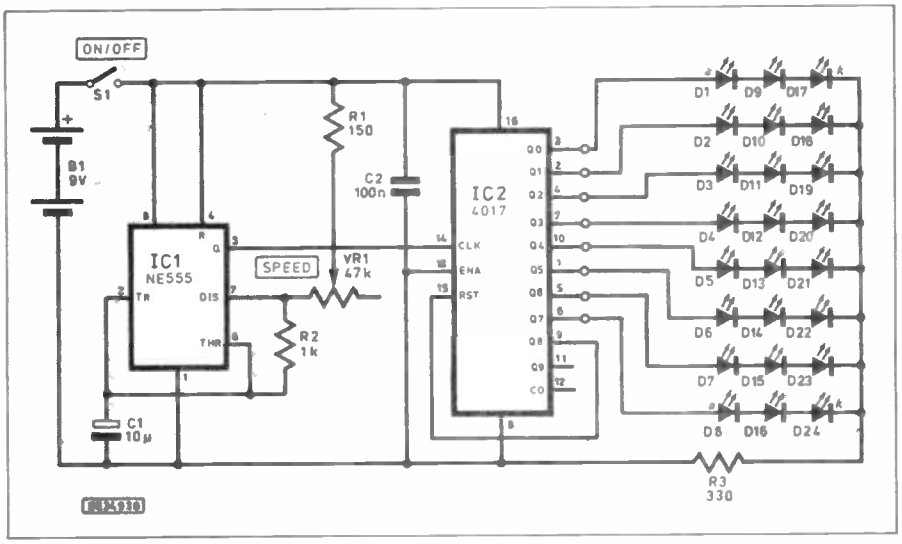


Fig. 1. Circuit diagram of the Spinning Heart.

The reason for R1s existence is that IC1 will not operate properly with a very low value of resistance between the positive line and pin 7. So R1 provides an acceptable resistance between positive and pin 7 even if VR1 is wound right down.

The astable feeds pulses into the decade counter, IC2. This selects which set of l.e.d.s will come on. The counter has output number 8 (pin 9) connected to its reset pin (pin 15). This means that when the last set of l.e.d.s go out the counter resets, and the first set of l.e.d.s is the next to light, hence the continuation of the sequence. Resistor R3 is included to limit the current flow through the l.e.d.s and ensure that no damage occurs to them or the i.c.

CONSTRUCTION

Before construction commences there are a few things to decide upon. Due to the large variety of l.e.d.s on the market I have left the size completely up to the constructor. In the prototype 5mm l.e.d.s were used which made a nice size heart. However, there is no reason why 8mm or 10mm l.e.d.s cannot be used to make a larger display. Alternatively 3mm l.e.d.s could be used and the display turned into a brooch. Assembly of the circuit is done on a piece

COMPONENTS

Resistors

R1	150
R2	1k
R3	330

All 0.6W 5% carbon

See SHOP TALK Page

Potentiometer

VR1	47k rotary carbon, linear

Capacitors

C1	10µ radial elec. 16V
C2	100n polyester

Semiconductors

IC1	NE555 timer
IC2	4017BE decade counter
D1 to D24	Red l.e.d. (24 off) (see text)

Miscellaneous

S1 S.P.S.T. toggle switch

Stripboard 12 rows x 27 holes, 8-pin d.i.l. socket; 16-pin d.i.l. socket; l.e.d. clips (24 off); battery clip; plastic case (see text); 9-way ribbon cable, knob, solder, etc.

Approx cost guidance only **£8**

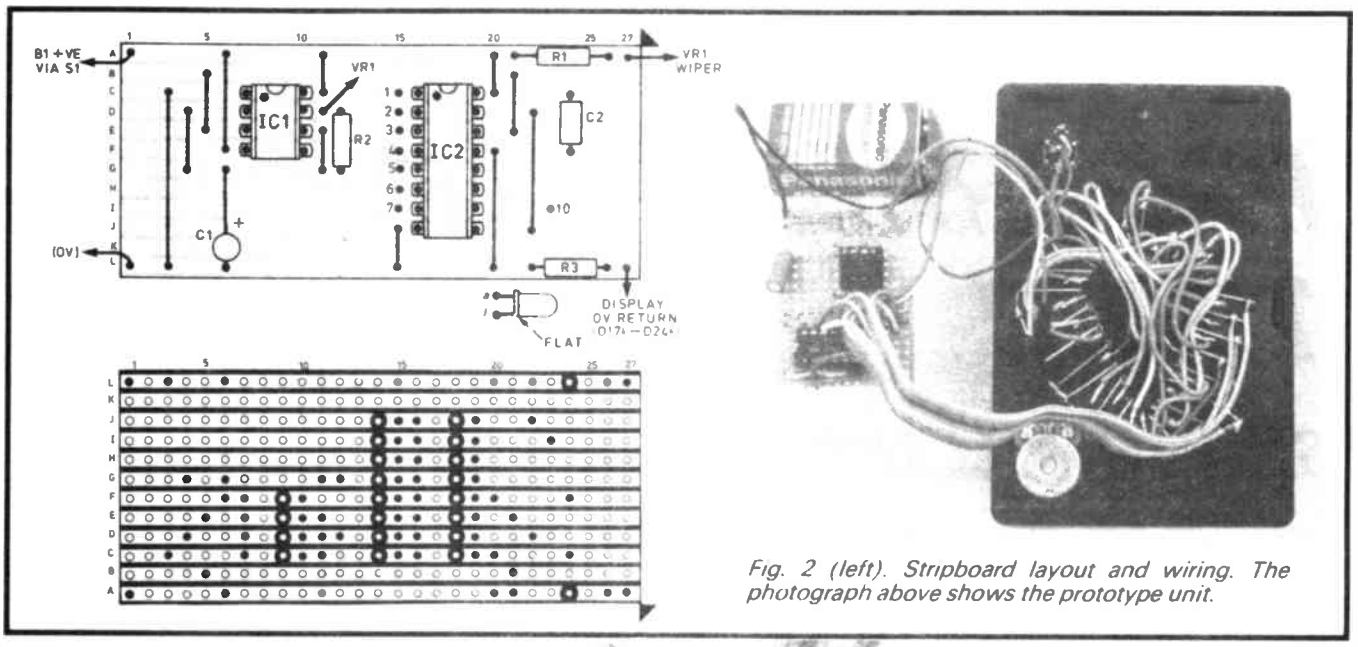


Fig. 2 (left). Stripboard layout and wiring. The photograph above shows the prototype unit.

of stripboard and full wiring details are shown in Fig. 2. Start by cutting the board to size and making the cuts in the copper tracks. Once this has been done construction is simple.

Sockets should be used for both i.c.s especially if a lower power version of the NE555 is to be used, and these should be fitted first. Then insert all the wire links followed by the resistors and capacitors. Note that capacitor C1 must be connected the right way round. Then solder all of the off board connections (pins 1 to 7 and 10), using a 9-way ribbon cable for the display.

DISPLAY

On the prototype the display was built into the top of the case using the dimensions of the heart as shown in Fig. 3. There is a lot of scope for the constructors own ideas to be implemented here.

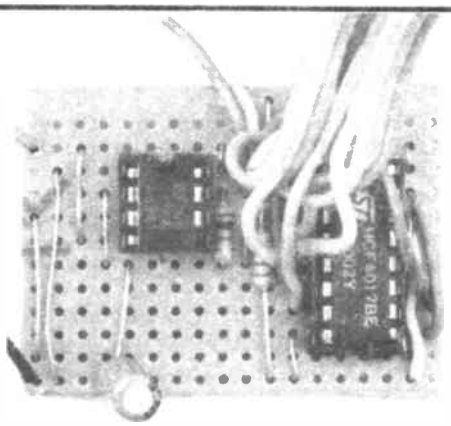
Once the display is built great care must be taken to connect the l.e.d.s up in the correct order and with the correct orientation. It was found best in the prototype to wire up the l.e.d.s in sets, e.g. wire up D1, D9, D17 first. Emphasis must be put on the care taken in this stage as it can be very difficult to trace errors and correct them later. Follow the circuit diagram and make sure the l.e.d.s are the correct way round.

It could be worth a look round for "bargain packs" of l.e.d.s. Some suppliers are selling packs of 25+ l.e.d.s for a lot less than what it would cost to buy them "individually".

After checking the display wiring and ensuring that there are no solder splashes between tracks, the circuit can be tested. Insert both i.c.s ensuring correct orientation. Connect a 9V battery to the circuit and switch on.

If nothing happens then switch off immediately and recheck all wiring. If this is okay then connect a l.e.d. in series with a 1k resistor between pin 3 of IC1 and 0V. Set VR1 to 47k the l.e.d. should flash showing that the problem lies with the counter, otherwise the problem is due to the astable.

If any of the l.e.d.s do not light then check orientation of all the l.e.d.s in that set and the wiring to them. Make sure that every set is connected to an output from the counter and the cathode (k) end of each set is connected to R3.



The prototype stripboard

There is not really anything that can go wrong with this circuit so it should work if all components are inserted and wired correctly.

CASE

As this project is likely to be a present, care should be taken with the case as this is what the person will see. The size of the case depends on the size of l.e.d.s used. The prototype was build in a case of dimensions 114mm × 76mm × 38mm which provides a "roomy" top enabling a neater presentation to be achieved.

The on off switch was mounted at the top of the case with room left next to it for a "sweet nothing", such as "I love you, Catherine", to be written. The display took up most of the case with VR1 mounted in the bottom right hand corner.

A guide to the size of the love heart is shown in Fig. 3 This is the design used in the prototype and is for 5mm l.e.d.s. The lid of the case was covered in masking tape and the design copied on. The masking tape helps prevent the drill bit slipping and damaging the finish. The l.e.d.s fit inside this outline.

Either drill two holes 2.5mm apart so that the l.e.d.s legs fit through and their package butts up to the line and repeat this for the 25 l.e.d.s as in the prototype. Alternatively, you can use l.e.d. clips and mount the l.e.d.s flush with the top of the case. Slight alteration will be needed to make up the design but this should be quite simple.

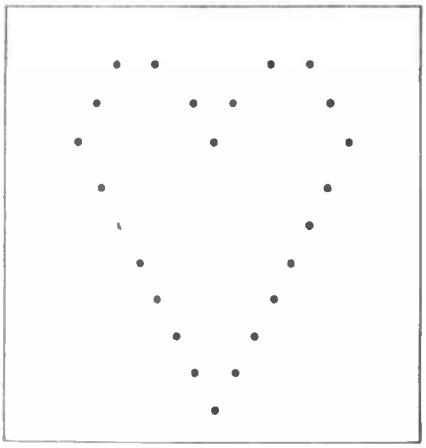
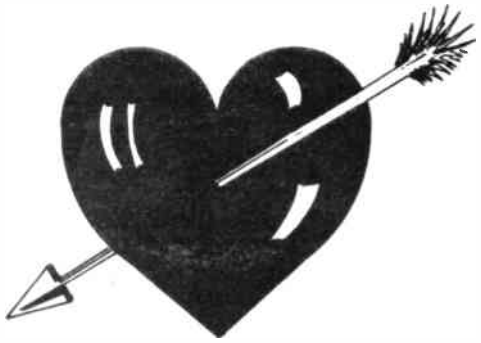


Fig. 3. Layout of the l.e.d.s to form the heart shape (full size).

The circuit can of course be used to power other display configurations for various "applications". There is no reason why any "shape" of l.e.d.s should not be arranged and make up as a badge, as part of a hat, in car display or even for a mini disco etc.

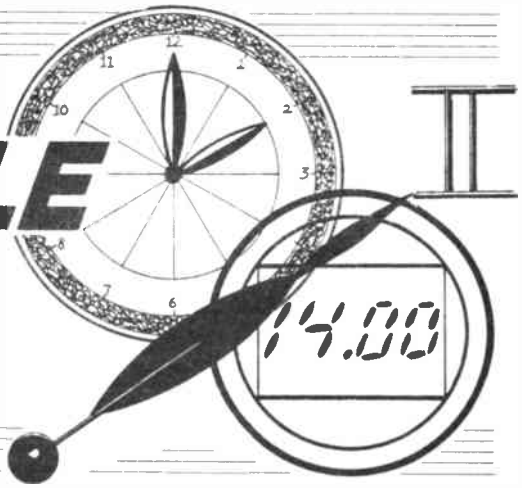
IN USE

There is not really much to say on the use of the circuit. Use VR1 to obtain different "effects". It has been found that looking at the display in the dark and out of focus, weird effects start to appear. Hope your loved one likes it! □



Constructional Project

PROGRAMMABLE TIMER



STEVEN HOLLAND

A simple, easy to construct unit that will give time periods from microseconds to hours. The timer has unlimited use such as: TV sleep timer; alarm bell duration timer; lamp flasher; process or cooking timer etc.

THIS PROJECT is a timer with an unlimited amount of uses, it is based on one *RC* network and can have delays from microseconds to hours. One advantage is that the time delays are programmable by using a single dual in-line package (d.i.l.) switch. Using d.i.l. switches provides different delay methods such as switch-on delays, switch-off delays, one-shot or dual delay modes.

The heart of the circuit is a LS7210 programmable digital delay timer i.c. It has an internal oscillator with an alternate external clock input facility.

All inputs are CMOS, PMOS and TTL compatible. The pinout layout and functions is shown in Fig. 1. The block diagram for the Programmable Timer is shown in Fig. 2.

CIRCUIT DESCRIPTION

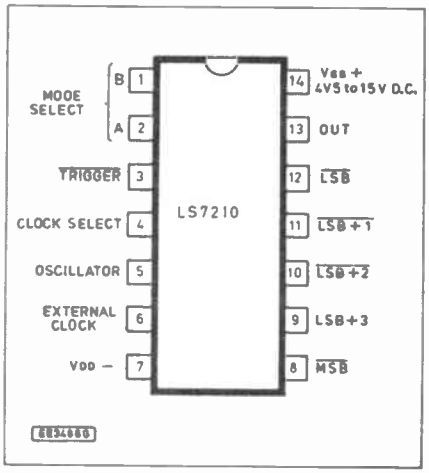
The complete circuit diagram for the Programmable Timer is shown in Fig. 3. The power supply circuit is shown in the top left.

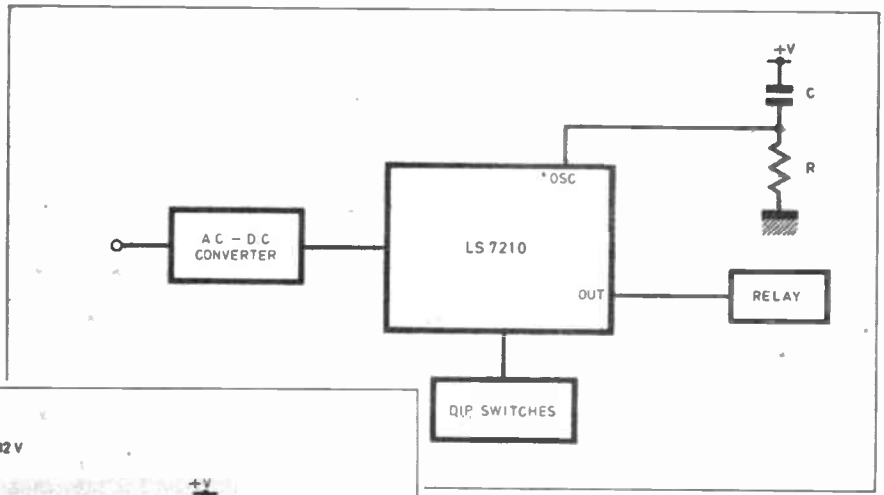
The delays are formed by IC1 the LS7210 CMOS timer, which is a specially designed integrated circuit for digital delays. There are five binary weighted inputs which control the delays from one period to one period times 31. There are also four modes in which the unit will operate.

There is no need for resistors on the input pins as they have internal pull-up resistors. The input switch S9 supplies a negative edge to trigger IC1.

The output from pin 13 is connected to transistor TR1 via resistor R1. The output from the transistor can then be used to activate a relay.

The bridge rectifier REC 1 converts a.c. voltage to a d.c. voltage and the ripple content of the rectifier output is smoothed by capacitor C1. The supply voltage is then regulated by IC2 to 12V and capacitor C2 smooths it against any spikes or "glitches" on the line.





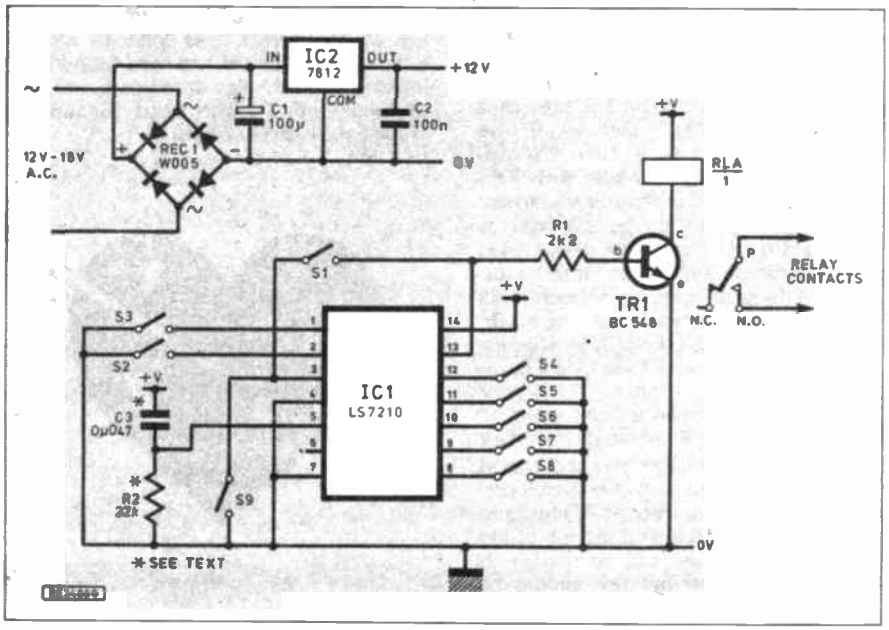


Fig. 1 (top). Pinout functions for the LS7210 programmable digital delay i.c.

Fig. 2 (above). Timer block diagram.

Fig. 3 (left). Full circuit diagram for the Programmable Timer.

Switch S1 on the programming switch bank S1-S8 selects the output from pin 13 to be fed back to the trigger input, pin 3, in order to operate in the dual mode. The four modes are:

Delayed Switch-On

Delayed Switch-Off

Dual Delay

One-Shot

Delayed switch-on:– When the trigger is logic 0 and the time period has elapsed the output goes high ("1").

COMPONENTS

See SHOP TALK Page

Resistors

R1	2k2
R2	See Text (22k)

All 0.25W 5% carbon

Capacitors

C1	100μ radial elect., 25V
C2	100n ceramic
C3	See Text (0μ047 ceramic)

Semiconductors

TR1	BC548 *npn* silicon transistor
IC1	LS7210 programmable digital delay
IC2	7812 12V voltage regulator
REC 1	W005 1A 50V bridge rectifier

Miscellaneous

S1-S8 8-way d.i.l. switch
S9 Pushbutton or toggle switch
Mains transformer, 15V secondary; 12V relay, contacts rated to suit application; 14-pin d.i.l. socket; 16-pin d.i.l. socket; connecting wire; solder etc.
Printed circuit board available from the *EE PCB Service*, code EE785.

Approx cost guidance only **£17**

Delayed switch-off:– When logic 0 is pulsed to the trigger the output is high until the time period has elapsed.

Dual delay:– This setting toggles the output at the rate set by the timer.

One-shot:– When the trigger pin is low, the output is high for the set period and returns to low and waits for another trigger pulse.

One of the four modes mentioned above can be set by "programming" the d.i.l. switches. (See Fig. 1 and Fig. 3).

Control		Mode
A	B	
1	1	Dual delay
1	0	Delayed Switch-off
0	1	Delayed Switch-on
0	0	One-shot

The *RC* network, made up of resistor R2 and capacitor C3, at pin 5 of IC1 sets the internal oscillator rate. The choice of values for R2 and C3 will, of course, depend on final application. Some typical uses are given later and include specific values for R2/C3.

TIMING CHART

The equation for the delay period is:

$$\frac{(1 + 1023 \times n)}{f}$$

e.g. $1 + 1023 \times 1 = 1024$

where $f = 3.17$kHz and $n = 1$ $1024 \div 3.17$

delay = 323 microseconds

n can be any number between 1 and 31.

If n = 3 delay is 969μS

Example: C2 = 330nF R2 = 2k2
Oscillator frequency 1.2kHz

n = 1 Delay Period 853.3μS
n = 7 Delay Period 5973.3μS

CONSTRUCTION

Construction of this project is very simple and it is built on a small printed circuit board. All the components, except the "start" switch S9, mains transformer and relay, are mounted on the p.c.b.

The printed circuit board component layout and full size copper foil master pattern for the timer is given in Fig. 4. This board is available from the *EE PCB Service*, code EE785.

Commence construction by soldering in the two link wires and the two d.i.l. sockets. One for the d.i.l. switch (16-pin) and the other (14-pin) for IC1. As IC1 is a CMOS device, the usual handling precautions should be taken and the i.c. only

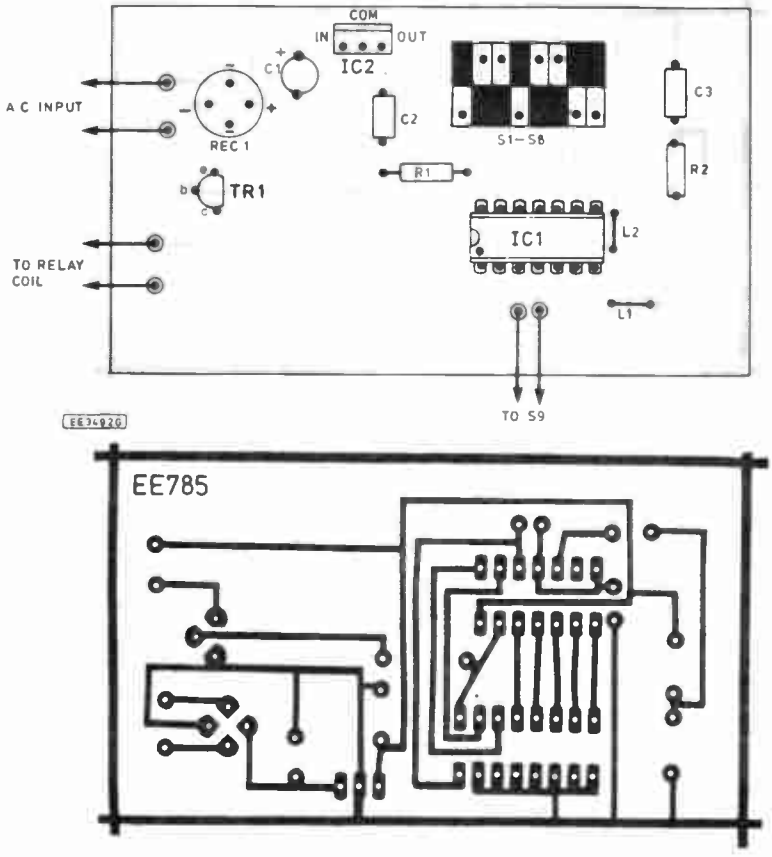
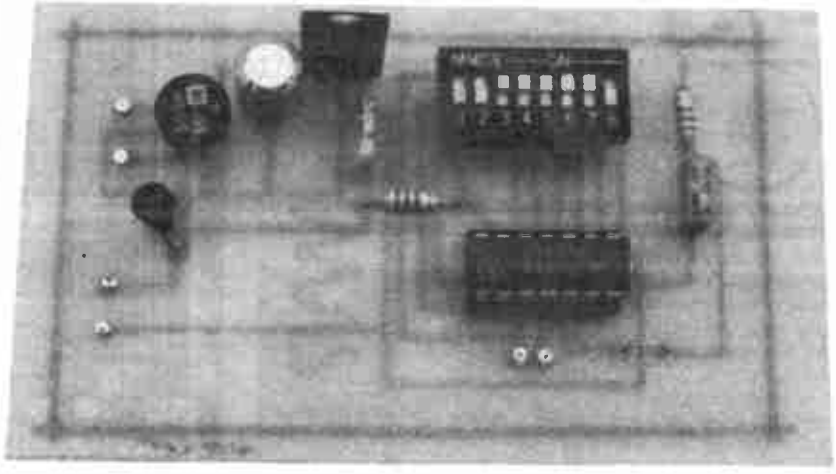


Fig. 4. Printed circuit board component layout and full size copper foil master pattern. The completed Programmable Timer board can be seen below.



inserted on the board after completion of the wiring.

Next solder in the transistor and bridge rectifier taking careful note of the polarity as this is most important. Having selected the desired values for resistors R2 and capacitor C3, solder the remaining components in position.

Finally, check the board for any wiring errors and inspect the underside for "dry joints" or solder blobs bridging across copper tracks. Complete the wiring to all off-board components and double-check for any errors. When all is O.K. IC1 can be inserted on the board together with the d.i.l. switch (S1-S8).

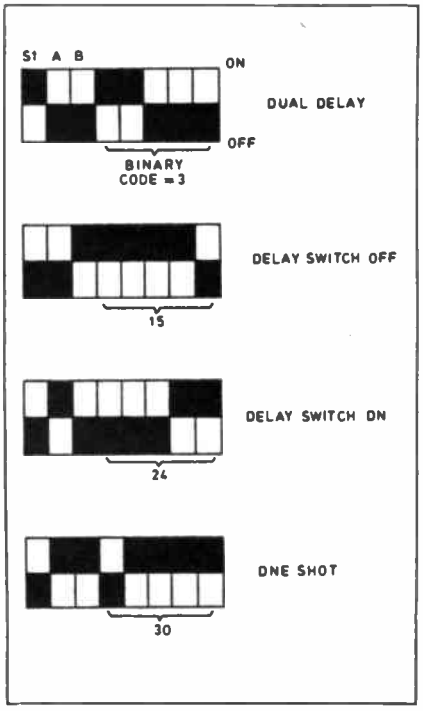


Fig. 5. Testing and setting up modes. All the binary inputs are active low, so be aware of this.

TESTING

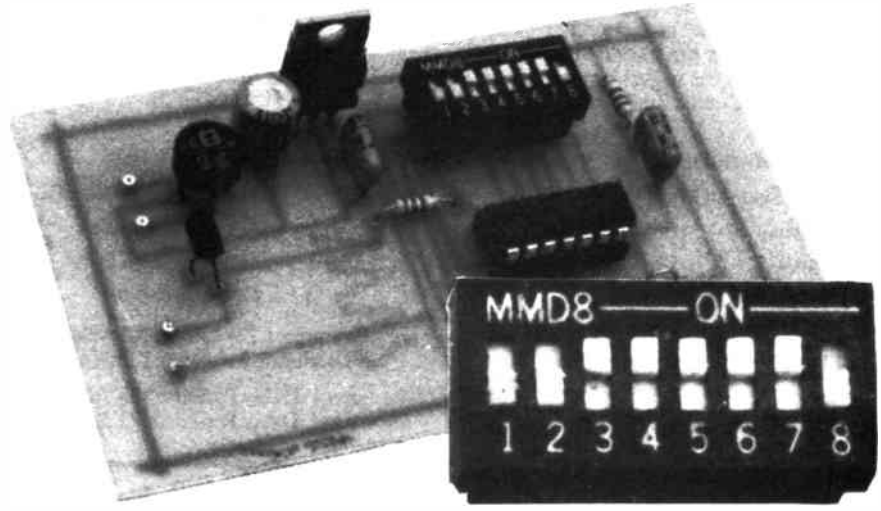
To test the unit apply the low a.c. voltage output from the transformer secondary to the power supply input pins on the p.c.b. The voltage can be between 13 and 20 volts, so a wide range of transformers can be used.

Set the d.i.l. switches to the mode and time required (see Fig. 5) and start the chosen sequence by operating switch S9 and checking that the unit functions as instructed. The "trigger" or "start" switch S9 can be any type to suit your needs but remember if using the *delayed switch-on* mode a "normally closed" switch should be used, whereas the other two modes simply require a normally open switch. S9 is not required when using *dual delay* mode and should be omitted.

APPLICATIONS

There are many situations in which the Programmable Timer could be used: From sleep timers to light controllers, computer watchdogs to soldering iron auto shut-off. In fact, almost any item that could prove to be too dangerous to leave on or where you wish to save on electricity.

Some of these applications are shown in the following schematic diagrams together with a very brief explanation. Also included are the values for the *R/C* network components R2 and C3.



TV Sleep Timer

The arrangement shown in Fig. 6 is used to switch a TV set off after a set time. The period is two minutes so it can be set to a maximum of 62 minutes by the d.i.l switches.

Due to the presence of mains voltage extreme care must be exercised when building and operating this circuit.

Resistor R2 should be 22 kilohms (22k) and capacitor C3 4µ7.

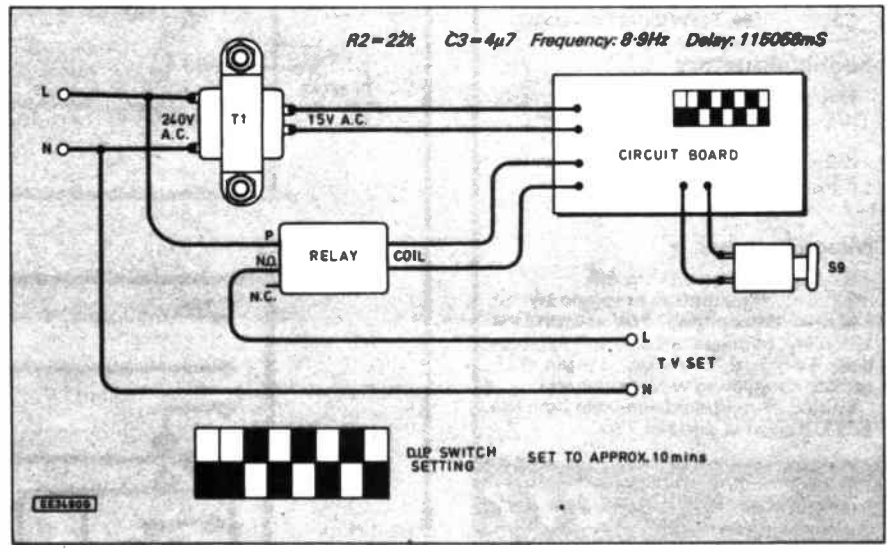


Fig. 6. Set-up for a Sleep Timer for a TV Set.

Bell Duration Timer

Auto shut-off for an alarm bell can be timed with this module in the One-Shot mode, see Fig. 7. When the trigger is low then the output goes high for the set period then returns low, even with the input still at 0V. The time can be adjusted anywhere from 1 to 31 minutes. Resistor R2 can be 10k and capacitor C3 4µ7.

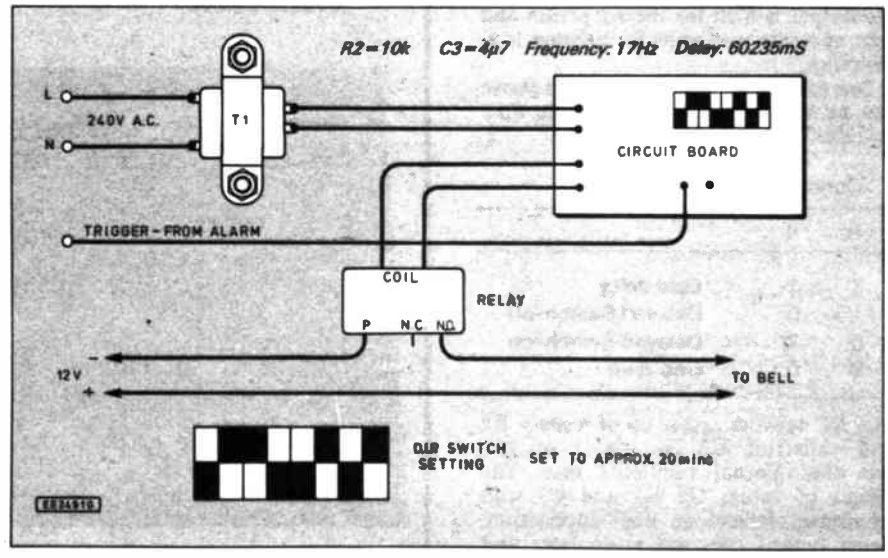


Fig. 7. Using the "one-shot" mode for a Bell Duration Timer.

Flashing Lights

The delay can be set to oscillate the output at a given rate. This can then operate a relay which in turn can switch on a light or alternate the relay contacts to form alternating lights, see Fig. 8.

Resistor R2 is 22k and capacitor C3 0μ047.

IN USE

Once an application has been found for the Programmable Timer board and when it is installed, the use of the project is very simple.

If it is used as a TV Sleep Timer (Delay Switch-Off) then a simple press of S9 will switch on the TV and after the set period the TV will switch off and stay off until you switch it on again. This is ideal for use at night if you fall asleep, or for children who tend to leave things switched on.

The TV could be replaced by a soldering iron. This will extend the life of the iron and the bit by ensuring it is not left on. □

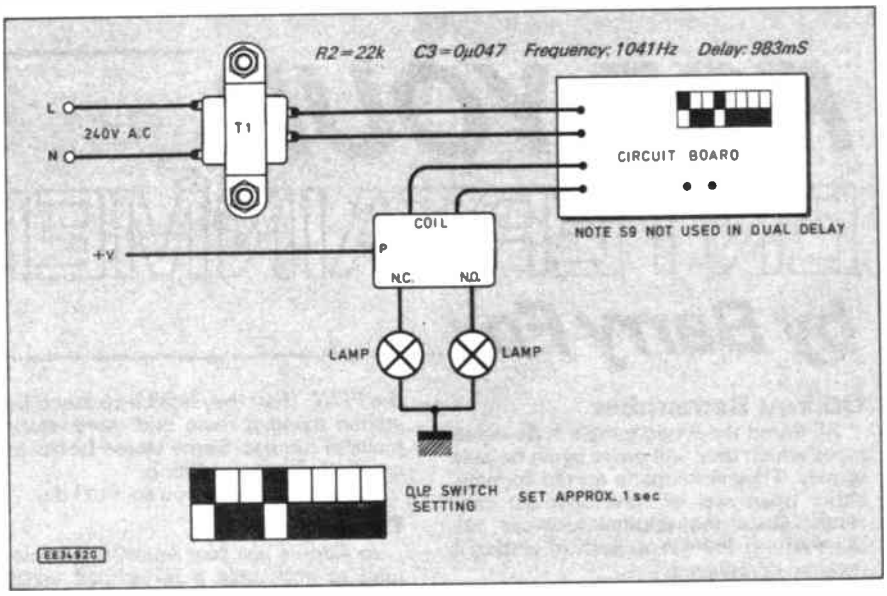


Fig. 8. Set-up for using the timer to create "Flashing Lights".

SHOP TALK

with David Barrington

Telesound

Some readers may have difficulty in obtaining the Astec u.h.f. modulator, called for in the *Telesound* project, from their local supplier. The UM1286 modulator in currently listed by **Cirkit** (☎ *0992 444111*) code 40-01286 and **Maplin**, code BK66W (UM1286 Mod.).

The small "remote control" box, with battery compartment, should the available from most of our components advertisers. The one used in the model was purchased from **Maplin**, code LH90X.

The single-sided printed circuit board for the *Telesound* is available from the *EE PCB Service*, code EE784.

Spectra-Lite

All components for the *Spectra-Lite* are standard off-the-shelf items and should be available from most of our components advertisers. The rectangular shape tri-colour l.e.d.s are not quite so common but the 5mm and 10mm round types are just as effective.

Why hide the circuit board? Even though the board is so small, it could easily take the l.e.d.s and form part of the "lapel badge"!

Spinning Heart

We do not expect constructors to experience any problems when shopping for parts for the *Spinning Heart*.

When ordering the l.e.d.s for the display, it is certainly worth "sounding out" the retailer for a bulk discount. Some advertisers, such as **Greenweld**, **Bull Electrical** and **Marco Trading**, are often making special offers on components and already make up l.e.d. packs of 25 plus l.e.d.s from time to time.

To add to the fascination of your Valentine message you could always build the *Auto Melody Maker* project in the same case.

Programmable Timer

The only component likely to cause concern to builders of the *Programmable Timer* is the LS7210 programmable digital delay chip. This i.c. was, until recently, stocked by **Tandy** stores but has since been discontinued.

Searching around for another source for this i.c. has, to date, only revealed two suppliers. The LS7210 is being stocked by **Magenta** (☎ *0283 65435*) and **Viewcom Electronics** (☎ *081 471 9338*).

The 8-way d.i.l. switch is now carried by most of our advertisers and should not cause any purchasing problems. The timer printed circuit board is available from the *EE PCB Service*, code EE785.

Charge State Monitor

The only listing we have been able to find for the ICL8211 micropower voltage detector called for in the *Charge State Monitor* is from **Maplin** (code YH43W) and **Electromail** (☎ *0536 204555*), stock no. 283-249.

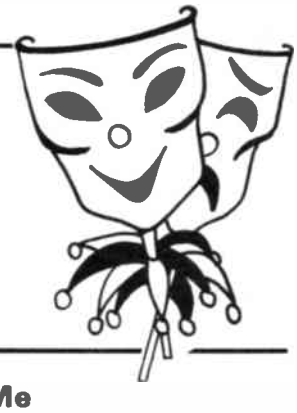
The rest of the components for this project, including the 10-segment bargraph display, seem to be standard items and should be readily available.

Auto Melody Maker

The melody i.c. UM66, used in the *Auto Melody Maker*, is available in four versions with melodies ranging from a medley of Carols to Elvis's Love Me Tender. This device is fairly popular and stocked by a number of our advertisers.

When placing your order for parts, make sure your supplier understands that you must have the BC184L. Other types without the letter L have different leadout arrangements and the pins will have to be bent to fit the circuit board.

FOR YOUR ENTERTAINMENT



by Barry Fox

Do You Remember

All round the world people have video tapes which they will never again be able to play. They were made on old formats, either open reel or now-obsolete cassettes. Once the original recorder has gone wrong, there is no hope of getting it repaired or replaced.

In the electronics industry just a few years is a lifetime. Who even remembers the Sony half inch and Akai quarter inch open reel video formats, the Panasonic cartridge, the Philips one hour N1500 and two hour N1700, Grundig's SVR four hour modification of the N1500 or the Technicolor/Funai quarter inch cassette for early portables.

Many people still have large libraries of Beta tapes. Some people will have cassettes made on Philips' ill-fated V2000 machines. But try buying a replacement Beta machine, or V2000 recorder. The best you can hope for is that someone has one in a cupboard under the stairs and they are only too pleased to sell it. Eventually all the cupboards will be bare.

The same thing has happened with computer formats. Ten years ago they were popping up like mushrooms. Many disappeared as fast as mushrooms, too. As with early video recorders, there is virtually no chance of getting these old machines repaired or replaced. This means that any text or data stored on disc or tape in those formats is as securely trapped as papers in a vault with no key.

Listed for Transfer

The only hope is to transfer the data as ASCII code, by serial cable connected to an IBM compatible PC or Apple MAC. If you have been thinking about doing this but not yet got round to it, do it now.

When your obsolete computer goes wrong, you will have lost all your data. The only hope will be to find a transfer service which can still read the old tapes or disks. But they may well charge you an arm and a leg for getting the data onto modern format discs.

If you are still using an obsolete video recorder, don't procrastinate over transferring worthwhile recordings onto VHS by hard-wire video dub. If there is one thing you can be sure of, it is that one day your old machine will stop working.

For the last six years, when friends asked me what computer to buy, I warned them off the Amstrad PCW range. There was nothing wrong with the computers or their price or performance, I stressed. It was just that the PCW range was incompatible with anything else. When the range is discontinued or changed, I warned those who asked for advice, you will have difficulty getting data off your discs.

More often than not my friends said they were not interested in storing data on discs. They went ahead and bought the PCW. Then they liked it so much they started using it more and more, storing material on disc. Some stored books and articles for later up-dating.

I hate to say I told you so, but I did.

Incompatible

In August last year Amstrad was planning to announce a re-vamped version of the PCW. On the face of things it was a much better machine, at the same low price of under 500 pounds. But the re-vamp creates basic incompatibility between old and new PCWs.

When Amstrad launched the Personal Computer Wordprocessor, the PCW 8256, in August 1985, it was bundled with a printer and unashamedly positioned as an electronic replacement for the typewriter. To keep the price below 400 pounds, Amstrad used the CP/M operating system instead of MS-DOS which IBM made a de facto standard with its PC, and provided no serial connection port. Users must buy an adaptor for the printer port if they want to connect their PCW to a telephone line modem or other computer.

Amstrad's biggest cost saving came from the master stroke of adopting a non-standard floppy disc drive. Instead of using the 9cm (3.5in.) disc developed in 1980 by Sony and subsequently made an industry standard by Hewlett Packard, Apple and IBM, Amstrad chose the 7.5cm (3in.) format developed in 1981 by Hitachi, Maxell and Matsushita.

By 1985 the small disc format had already failed commercially and Matsushita had stocks to sell off at very low prices. When the PCW caught on Matsushita agreed to supply 7.5cm discs and drives on a rolling three month contract. The PCW range has grown but Amstrad has stuck with the non-standard disc drive.

Now Amstrad has switched to the 9cm disc. A company spokesman said in August that 7.5cm disc and drive stocks had dried up. The company had already stopped making PCW word processors with 7.5cm drives. The last stocks were already in the hands of wholesalers and retailers. When these are gone there will be no more. Anyone wanting a PCW will have to buy one with a 9cms drive.

The most obvious problem is that people with 7.5cm machines will find it increasingly difficult to get blank discs. The less obvious and much more serious problem is that data stored on old discs cannot be retrieved on new machines.

Although the CP/M operating system and Locoscript software remains the same, old PCW discs will not work on new machines because they are of physically different size. When old machines fail and are replaced with a new model, their owners may have up to six years of work locked onto discs which will not run on their new machine.

Search Me

Amstrad says it does not see the switch as a practical problem, because the company never saw the PCW as more than a tool for printing text onto paper. Authors and researchers who have spent the last six years saving work which they hoped one day to update may well think differently. How will they retrieve their data? "Search me?" was an Amstrad spokesman's first reaction.

It is clear that computer buffs saw the PCW as a cheap machine with a lot of potential, and they have exploited it. These buffs will have no difficulty juggling and shunting data.

One told how "simple" it was to use a serial interface and write a program (PIP %1 = AUX: [e] etc) to transfer data. This is like telling someone who bought a mechanical typewriter to dismantle the spring and lever mechanism.

Others report that Locomotive Software produce a PC version of the PCW Locoscript word processing software. But you still have to get the data from the PCW to the PC via the PCW's serial/parallel interface. I am assured that the necessary software and leads are "easly available". This will be of little practical use to the man or woman who just bought the PCW as an electronic typewriter.

I am assured that some manufacturers produce.add-on 9cm drives for the PCW and that a company called Timatic, in Hampshire, sell a 7.5 cm drive for a PC. Uniform is a program which lets the PC read, write and format 7.5cm PCW compatible discs (among other types). Advantage in Cheltenham produce a version of file transfer software Kermit which works with the PCW, for use with the PCW interface and null-modem cable.

Third Party

Please do not write to me for further advice on these products or solutions. I am not a PCW user, and merely pass them on as a service. My point was, and remains, that the reason why the PCW sold so well was that it was aimed at people who wanted to use it as a typewriter, and then found themselves collecting discs of data.

These people do not want to know about add-on drives, Kermit and null-modems. But they will be willing to pay a fair fee for transfer.

Nick Hewer, Amstrad's PR man, predicts that a third party industry for transferring data will spring up. "But Amstrad won't get involved" he confirms.

As one correspondent puts it: "There must be many computer enthusiasts who would do the transfers for a small sum to help them finance their hobby".

I expect to see adverts start appearing along these lines very soon.

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ACTUALLY DOING IT!

by Robert Penfold

IN DECEMBER'S *Actually Doing It* article we looked at simple methods of making printed circuit boards. This month we will consider a more up-market approach. I could not recommend this system for someone making a start on printed circuit construction.

The methods described in December provide a more realistic introduction to the subject. However, these simple methods can be difficult to apply to large or intricate boards, and you may soon out-grow them. The more sophisticated methods of production described here can cope with practically any printed circuit boards.

POSITIVE APPROACH

The up-market solutions to producing printed circuit boards rely on the use of photo-sensitive copper laminate board. This is basically just ordinary copper laminate board which has been coated with a special etch resist. This resist is sensitive to ultra-violet light, but is not greatly affected by ordinary indoor lighting. Nevertheless, the board should be stored in a cool dark place, with the peel-off opaque covering in place.

When you actually come to use the board, the brief exposure to daylight that it will receive will definitely not "fog" it. The only point to watch is that you do not leave the board in direct sunlight for any length of time. Sunlight contains significant amounts of ultra-violet light, and this could conceivably "fog" the photo-resist.

The board is developed in caustic soda or one of the special developers that are available, and the exposed areas of resist dissolve away. The board is then etched in ferric chloride in the usual way. This means that the exposed areas of board have the copper etched away, and the unexposed areas retain the copper coating. Before development the board must therefore be exposed to ultra-violet light through an actual size photographic positive carrying the printed circuit pattern.

Clearly the first step in producing a board using this photographic method is to produce the photographic positive. This can be done using a large format camera plus a suitable lens etc., but this is not really a very practical approach for most amateur p.c.b. builders.

At one time there was a kit available which permitted a sort of contact print to be made from a p.c.b. design in a book or magazine. Also, there were one or two companies offering materials for this sort of thing. On checking through a few current electronics catalogues I failed to find anything along these lines. I may have overlooked something, but this method does not seem to be a practical proposition at present.

PHOTOCOPIER

Probably the only simple method that is likely to work well is to use a good quality photocopier. For this method to be practical the copier must be able to produce a reasonably accurate life-size copy, and it must also be able to copy onto some sort of transparent or translucent medium.

It does not matter too much what sort of translucent medium you use, as any normal form of transparent or translucent paper/film seems to transmit ultra-violet light well enough to ensure good results in this application. Transparent acetate film, translucent polyester drafting film, or even tracing paper will work well enough.

It is just a matter of using whatever material of this type that is compatible with the copier. This method has to be regarded as the best one, since it is very fast, cheap, and with a suitable copier should also be very accurate.

With a copier that will not operate properly with any form of transparent or translucent medium, there is apparently an alternative which involves first making a copy onto ordinary copier paper. This is then treated using a special spray which makes the paper translucent, but leaves the areas covered with toner reasonably opaque.

This method can even be used to directly convert the p.c.b. track diagram from a book or magazine into a photographic positive. The only problem here is that there must be no printing on the reverse side of the diagram, as this would obviously show through and appear on the finished p.c.b.

This method seems to be a good one, but the special sprays seem to be very difficult to obtain. I cannot comment on how well or otherwise this method works, as I have yet to try.

GETTING IT TAPED

The slow but sure method is to produce the positive by hand, using the p.c.b. drafting materials that are available from some of the larger electronic component retailers. They are also available from some of the larger suppliers of art and drafting materials. The design is produced on translucent drafting film. I would not recommend using tracing paper. This is much cheaper than drafting film, but is not really tough enough for use with p.c.b. drafting materials.

If you make a mistake and remove a track or pad, you may well find that this results in tracing paper becoming damaged. Drafting films are made from tough plastic materials that can easily withstand a lot of corrections and alterations to the drawing.

Step number one is to fix the piece of drafting film securely in place over the drawing you are going to copy. This can be done using double-sided adhesive tape, masking tape, etc. The drawing is then traced using your preferred method.

The old-fashioned method is to use a pen and ink. If you are reasonably skilful you can achieve quite good results this way using a proper technical pen, a good quality ink, etc.

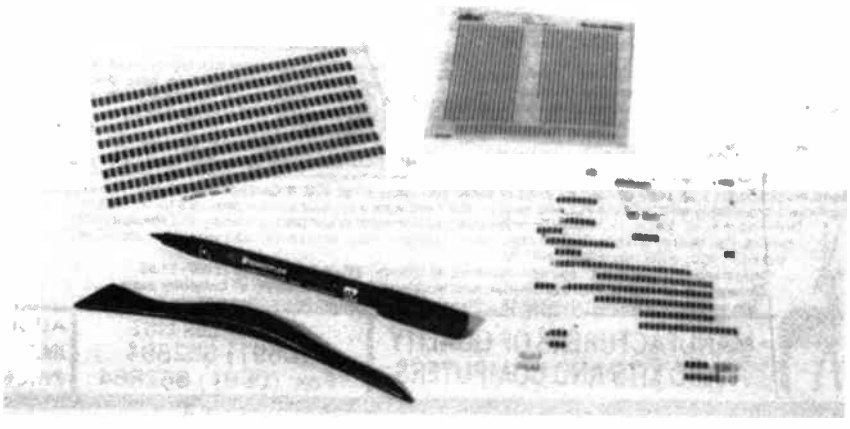
Using something like a fibre-tipped pen freehand will almost certainly result in some rather scrappy looking results. Also, the ink may not be sufficiently opaque to give good results in this application.

The more popular method these days is to use rub-on transfers, crepe tapes, etc. Using the rub-on transfers is an easy method that can provide very good results. This is very much like producing the design direct onto the board using transfers, as described in last month's *Actually Doing It*. In fact it is rather easier, as you are working over the original diagram, rather than over a rough guide marked on copper laminate board.

There is a slight problem with rub-on transfers in that they tend to rub-off relatively easily. If you use this method you therefore need to treat the finished drawing carefully.

A tougher final result can be produced using crepe tapes plus transfers which are printed onto a transparent self-adhesive backing material. Pads are sometimes in the form of thin self-adhesive plastic pads on rolls of backing paper. These are usually somewhat tougher than the type

Three types of etch resist transfers, etch resist pen and rub-down spatula.



which is printed onto a transparent plastic film, and are the type I would recommend.

Apart from pads of various sizes, these transfers include d.i.l. clusters, edge connectors, "D" connector clusters, etc. They are usually arranged so that half the backing paper can be removed, making it easy to manoeuvre each transfer precisely into position. It is then semi stuck down, the second piece of backing paper is removed, and finally it is carefully pressed firmly in place.

With the smaller pads it is usually easier if they are completely removed from the backing paper, and then placed onto the end of something like a small screwdriver. They can then be easily moved into place, and semi stuck down. With the screwdriver carefully pulled clear so as not to displace each pad, it can then be fully pressed into place.

TAPES

Once all the pads are in position, the crepe tapes are used to add the tracks. These tapes are available in a wide range of widths. Because they are made from a crepe material they can be taken through gentle curves without any difficulty. This is one respect in which they are more versatile than rub-on track transfers.

In use the tape is first positioned on a pad, making sure that it overlaps it slightly. However, be careful not to block the holes in the middle of pads. Next the tape is laid down over the required route, pressing it firmly down onto the drafting film as things progress.

When the destination pad is reached, a very sharp modelling knife or a scalpel is used to trim the tape to length. Again, it should slightly overlap the pad.

Be careful not to create cracks in the artwork by cutting right through the pad as well. Just cut deep enough to sever the tape, angling the blade inwards under the end of track. If you should cut slightly too deep, this will help to disguise the cut in the pad.

Although the tapes can be taken through gentle curves, they cannot be taken through sharp corners. The corners must be produced by cutting the tape, and then starting again at right angles to the original track. Use plenty of overlap at the corners.

Remember to add corner markings to the drawing. Special corner marker transfers are available, but some short pieces of "track" will do the job just as well.

EXPOSURE

Once you have a suitable photographic positive, the next step is to cut a piece of photo-resist board to the appropriate size. I am assuming here that you will use ready made photo-resist board, rather than trying to coat an ordinary copper laminate board with one of the photo-resists that are available.

It is probably cheaper to take the do-it- yourself route, but I must admit that I have not often obtained good results in this way. Getting these resists to flow into a nice even layer on a copper surface is harder than you might think. Initially at any rate, I would recommend that you use ready coated boards.

In order to expose the board you need an ultra-violet light box; these are available from some of the larger component retailers, and designs for do-it-yourself light boxes appear in the electronics press from time to time (e.g. *UV Exposure Unit*, EE Oct '91). It is actually possible to use direct sunlight to provide the exposure. The problem with this method is that the amount of ultra-violet in sunlight seems to vary considerably, depending on the time of day, time of year, and clarity of the air.

I have tried experimentally making some exposures using sunlight on a couple of occasions, but in both cases failed to get anything approaching consistent results. The wastage using sunlight would probably be very high, making it an impractical proposition.

SUN LAMP

A method that I have found to be quite usable is to use a sun-ray lamp as the ultra-violet source. Provided you are always careful to use exactly the same setup, with the distance from the lamp to the board/positive carefully measured and adjusted, this can give results that are as consistent as those from a light box.

To use this method you will need a sheet of glass or transparent plastic. The positive is taped to the glass, with the side that carries the pads and tracks against the glass. The board is then taped in place over this, aligning it accurately with the corner markers.

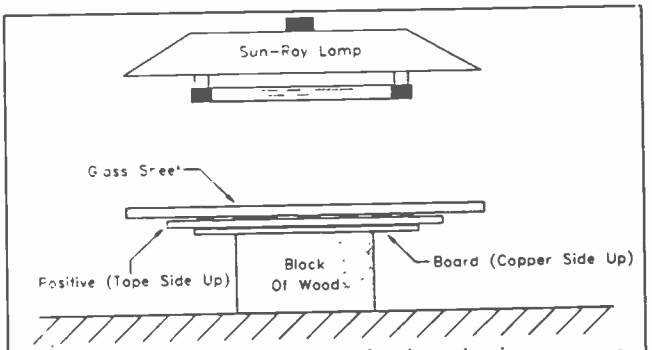


Fig. 1. A simple set-up for exposing board using a sun-ray lamp as the UV source.

If you place this assembly on a block of wood, some old books, or whatever, glass side uppermost, the weight of the glass should press the positive flat against the board. The lamp must be positioned where it will give the board a strong dose of ultra-violet, or the exposure time will be impractically long. Fig. 1 shows the general setup to use. *Heed the lamp manufacturers warnings about exposure to ultra-violet light, particularly the warnings regarding damage to eyesight.*

A proper light box will include a sheet of glass above the ultra-violet tubes. The positive and piece of photo-sensitive board are taped onto this in the manner described previously. There should be a foam pad in the lid of the box which will press everything firmly together when the lid is closed.

The optimum exposure time depends on the strength of the ultra-violet light, and the particular photo-resist used on the board. There is no alternative to making a few test exposures on some scraps of board to determine the time interval that gives the best results.

It is likely that a fairly wide range of times will give acceptable results. If so, experience would suggest that the best one to use is one near to the lowest time that will give acceptable results. For a powerful light-box this could be as little as a couple of minutes, or with a sun-ray lamp something more like 20 minutes could be required.

DEVELOPMENT

Caustic soda solution is often used as the developer for photo-resist. This chemical lives up to its name, and has to be regarded as slightly dangerous. In the weak solutions used for development it is safer than when it is in solid form. The strength of the solution needed depends on the particular resist used, and the retailers catalogue, or an information sheet provided with the board/photo-resist, should give details of this.

These days there are alternative developers available, and I would recommend using one of these. They usually come in the form of sachets of crystals, together with instructions that detail the right amount of water to dissolve them in.

In terms of results they are probably not a great deal better than caustic soda. On the other hand they are based on chemicals that are safer (although it is probably still better not to get the developer on your skin). Another advantage of these developers is that they can be used over and over again.

In order to obtain long life from the developer it should be stored in an air-tight bottle, and in a cool dark place. Caustic soda deteriorates rapidly after use, which means that it must be used once and then thrown away. Although caustic soda is relatively cheap, to develop a single board from time to time can use up a large amount of chemical.

Photographic dishes are a good choice for developing boards. Use enough developer to comfortably cover the board, and agitate the developer to aid even development.

Modern photo-resists seem to be very good, and the board should develop crisply over a period of about two or three minutes. Sometimes the final film of resist can be a bit reluctant to disperse, but very gently swabbing the board with a piece of paper towel soaked in water or developer should remove it.

ETCHING

Once the resist has fully developed, remove the board from the developer and rinse it thoroughly. Use plastic tongs when manipulating the board, or wear plastic gloves to protect your hands. I usually etch the board immediately, rather than letting it dry first.

There is a potential advantage in letting the resist dry, as this allows it to harden if there was some softening in the developer. On the other hand, letting the board dry tends to result in some slight surface corrosion on the copper, which hinders the etching process.

I find this second problem more serious than any softening of the resist, which is why I etch the board immediately. From the etching stage onwards the board is processed in the usual way.

Constructional Project

CHARGE STATE MONITOR

T. R. de VAUX BALBIRNIE

A narrow-scale, bargraph readout, voltmeter for checking car batteries. Includes l.e.d. "under-range" indicator.

THIS PROJECT is a voltmeter but instead of the traditional pointer on a scale it uses an l.e.d. bargraph to display the readings. The range covered is 9.5V to 14V approximately in 0.5V steps. In addition, a separate l.e.d. indicator gives an "under-range" warning.

The circuit was designed for checking the charge state of car-type batteries used as portable power supplies for caravans and boats. However, it could be used for other similar purposes requiring a narrow-scale voltmeter.

The nominal voltage of a car battery is 12V but this varies with the charge state. When freshly charged it may exceed 14V but when almost discharged it will fall to less than 10.5V under load.

Batteries gradually lose their charge when left idle and can be ruined if left in a discharged state. Periodic checking is therefore advisable. Note that the under-range l.e.d. comes on when the voltage falls below 10V approximately and even an almost "flat" battery will light it because the current requirement is very low – 14mA approximately.

For car, caravan and boat supplies, the Charge State Monitor will normally be left connected to the battery. No power is consumed except while pressing a push-to-test switch.

DISPLAYS

The bargraph display and under-range l.e.d. show through holes in the lid (see photograph). In the prototype unit, the bargraph display was green with a red l.e.d. providing under-range indication. Some readers may prefer to use a red display and, perhaps, a *flashing* l.e.d.

For setting-up purposes, it is best to have a voltmeter (or multi-tester) available. If using this method, you will also need a power supply unit (or you could use the car battery itself). This should cover the range 0V–15V. It is, however, possible to adjust the circuit by trial and error. Details for this method will be given later.

CIRCUIT DESCRIPTION

The complete circuit for the Charge State Monitor is shown in Fig. 1. IC1 is a bargraph driver i.c. and IC2 the actual l.e.d. display.

The driver IC1 is a complex device containing a high impedance buffer, a reference voltage source and a set of voltage comparators. IC2 simply contains ten l.e.d's in the shape of short horizontal bars. The separate section comprising IC3, R3, VR2 and l.e.d. D2, is concerned with under-voltage indication and will be explained later.

Bargraph driver IC1 accepts a positive input at pin 5 and its outputs, pins 1 and 18 to 10 go "low" in turn as the voltage increases so allowing current to "sink" through the appropriate l.e.d. In unmodified form, the voltage at pin 5 would need to be within the range 0.125V (where one bar would light) to 1.25V (where all ten bars would light).

OPERATING VOLTAGE

These operating voltages would obviously be unsuitable for the present purpose. Zener diode, D1, fixed resistor, R1, and preset potentiometer VR1, however, modify the operating voltage levels in the following way.

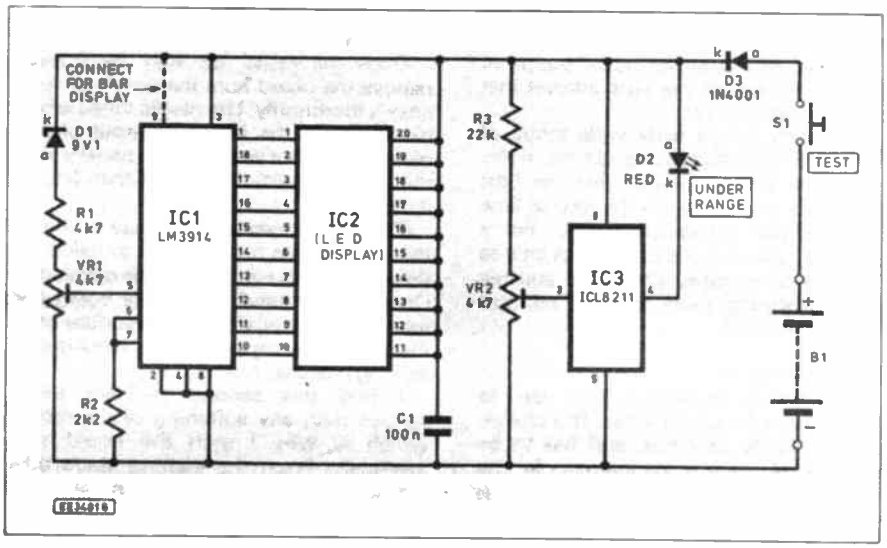
With 10V approximately applied to the input and with VR1 sliding contact adjusted to approximately mid-track position, the 9.1V Zener diode, D1, just conducts (0.7V being dropped across input diode, D3). With 9.1V appearing across D1, very little voltage will appear between the zero volt line and VR1 sliding contact. This voltage when applied to IC1 pin 5 will therefore be insufficient to light the first segment of the display.

When a slightly higher voltage is applied to the input, a residual voltage will appear between the zero volt (earth) line and VR1 sliding contact and at a certain point will be sufficient to light the first bar – that is, IC1 pin 1 goes low. With higher input voltages, each voltage threshold inbuilt in IC1 is exceeded and pins 18, 17, 16 and so on go low in sequence so lighting successive bars, pins 1, 2, 3, 4 and so on in IC2.

The exact level at which the last bar will light is determined by the setting of preset potentiometer, VR1, and this will be adjusted at the setting-up stage for correct operation. Resistor R2 sets the l.e.d. segment current to the correct working level. Because this is done automatically by IC1, the separate l.e.d. bars in IC2 do not require current-limiting series resistors as would normally be the case.

Diode, D3 guards against possible damage due to reverse polarity. Thus, if the input leads were connected to the battery the wrong way round, D3 would be reverse-biased and fail to conduct. S1 is the push-to-test switch. Capacitor, C1 cures possible instability problems caused by stray pick-up by the connecting leads.

Fig. 1. Complete circuit diagram for the Charge State Monitor.



As described, the display is used in *dot* mode – that is, only one segment is on at one time. Some readers will wish to use *bar* mode – that is, bars lighting and remaining on to give a thermometer-like display. This involves connecting IC1 pin 9 to supply positive (shown dotted in Fig. 1).

RANGE INDICATION

Under-range indication is provided by a separate section of the circuit centred on voltage detector integrated circuit, IC3. This contains an on-chip voltage reference of 1.15V and a comparator.

When the voltage applied to the threshold input, pin 3, falls below the internal reference voltage, the output, pin 4, goes low. This is then able to "sink" current from the supply positive line through l.e.d., D2 (Under Range). Internal circuitry within IC3 limits the output current to 7mA. This means that, although D2 will not appear particularly bright, no external series resistor is required to limit its operating current.

Preset potentiometer, VR2, in conjunction with fixed resistor, R3, selects a fraction of the input voltage and applies it to IC3 pin 3. R3 limits the range of adjustment provided by VR2 from 0V to 2V approximately.

Preset VR2 will normally be adjusted to provide an input of 1.15V (equal to the reference voltage) at the point where the first bar of the l.e.d. display is just unable to light. This will be done at the setting-up stage. Since the under-range indicator circuit is completely independent of the bargraph display, this section could be omitted if desired.

CONSTRUCTION

The circuit panel component layout and details of breaks in copper strips for the Charge State Monitor is shown in Fig. 2. Note the display common anode busbar.

The circuit consists of a piece of 0.1in. matrix stripboard, size 14 strips × 30 holes. Cut the material to size, drill the two mounting holes, make the breaks in the copper tracks and connect all link wires.

Use a piece of single strand connecting wire, with the insulation removed, for the busbar on the copper strip side of the circuit panel. Solder this to interconnect all strips *A*–*K* on the right-hand side of IC2. This forms the common anode connection for the 10 l.e.d's and saves soldering a lot of individual link wires. Even so, there are still rather a lot of link wires so check carefully that the job is complete and all soldered joints are sound.

Solder the on-board components into position. Cut diode D2 leads to a length of 15mm – this component is easily damaged by heat from the soldering iron so it would be a wise precaution to use a heat shunt. This just means gripping the end wires with a pair of pliers between its body and the circuit panel. This will prevent excessive heat from reaching the l.e.d. If bar rather than dot mode is required, connect IC1 pin 9 to supply positive – the necessary link wire is shown as a dotted line in Fig. 2.

Complete construction of the board by connecting a 5cm piece of light-duty red stranded wire to strip *E* 30 and a piece of similar black wire of suitable length to strip *K* 30 as indicated. Insert the integrated circuits into their sockets.

The bargraph display IC2 carries a product code along the anode end – this will be placed to the right of the circuit panel. If this component is inserted in its holder the wrong way round it will not work. Bend l.e.d. D2 legs so that the body lines up with the centre of IC2.

CASE

Prepare the case by drilling holes in the base to align with the fixing holes in the circuit panel. Drill a hole in the side for the battery connecting wires to pass through.

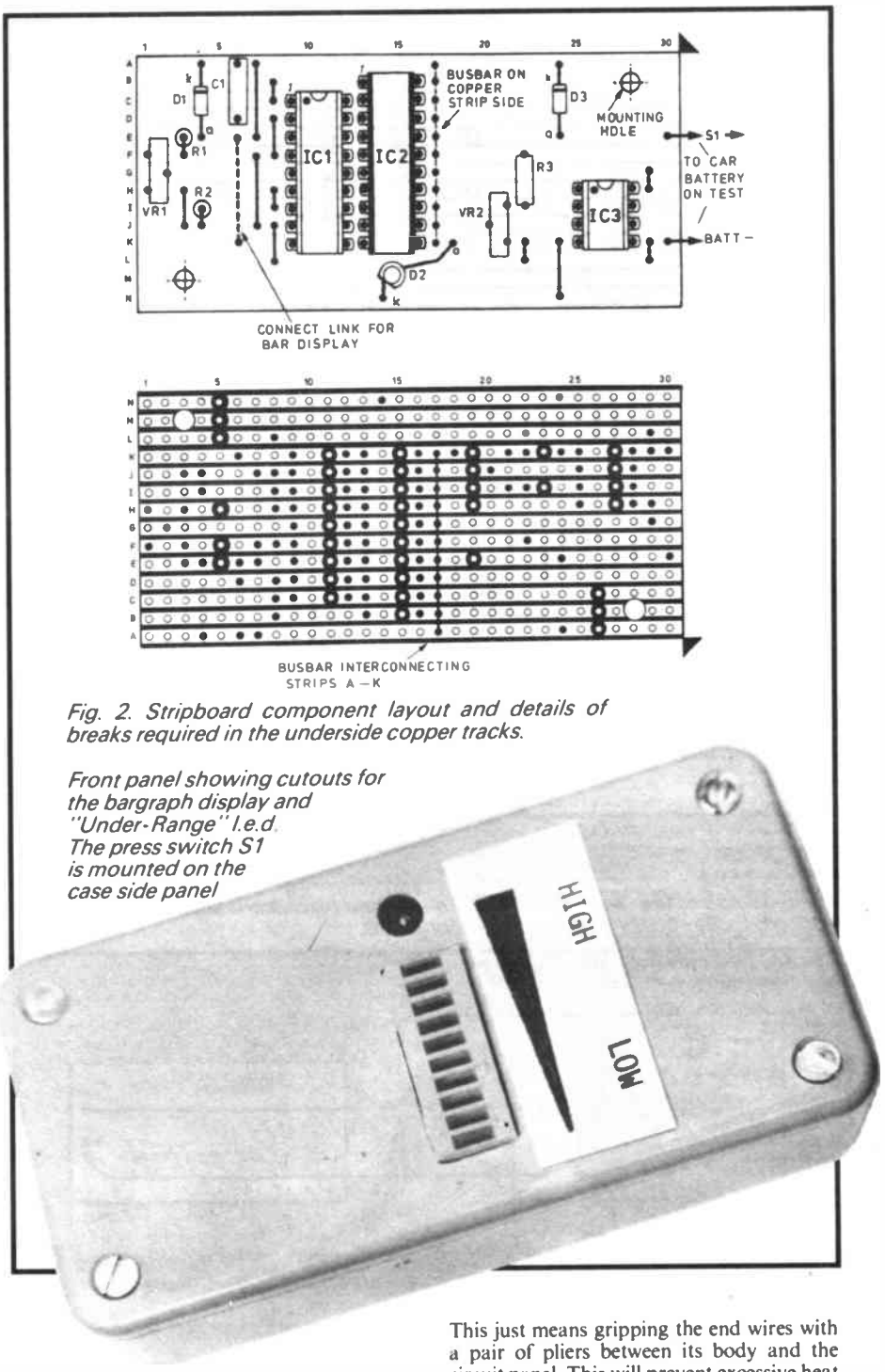


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

Front panel showing cutouts for the bargraph display and "Under-Range" l.e.d. The press switch S1 is mounted on the case side panel

COMPONENTS

Resistors

R1	4k7
R2	2k2
R3	22k

All 0.25W 10% carbon.

See SHOP TALK Page

Potentiometers

VR1, VR2 4k7 miniature vertical preset (2 off)

Capacitor

C1 100n ceramic

Semiconductors

D1	BZY88 9V1 Zener diode
D2	5mm Red l.e.d. (or flashing l.e.d. – see text)
D3	1N4001 50V 1A rec. diode
IC1	LM3914 bargraph driver
IC2	10-segment bargraph display
IC3	ICL 8211 voltage detector.

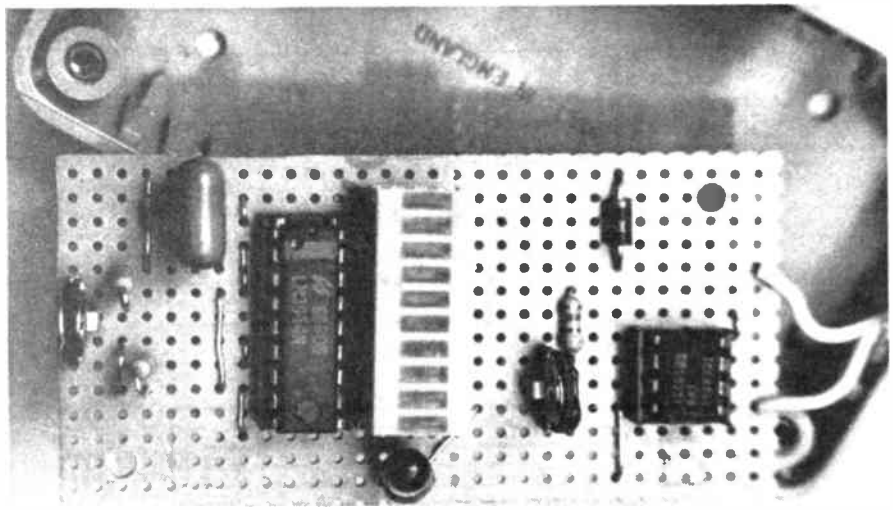
Miscellaneous

S1 Miniature push-to-make switch

Stripboard 0.1in. matrix, size 14 strips x 30 holes; plastic box, size 96mm x 46mm x 21mm (internal); 20-pin d.i.l. socket; 18-pin d.i.l. socket; 8-pin d.i.l. socket; light-duty stranded connecting wire; crocodile clips (2 off); solder etc.

Components for setting-up if required – see text.

Approx cost guidance only **£14**



Layout of components on the completed circuit board. Note that the l.e.d. is positioned centrally below the bargraph.

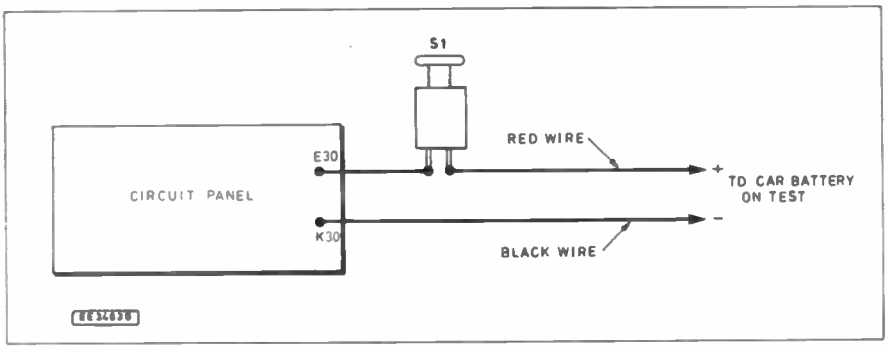


Fig. 3. Wiring to the "test" switch S1. The red and black leads should be terminated with crocodile clips or other suitable connectors.

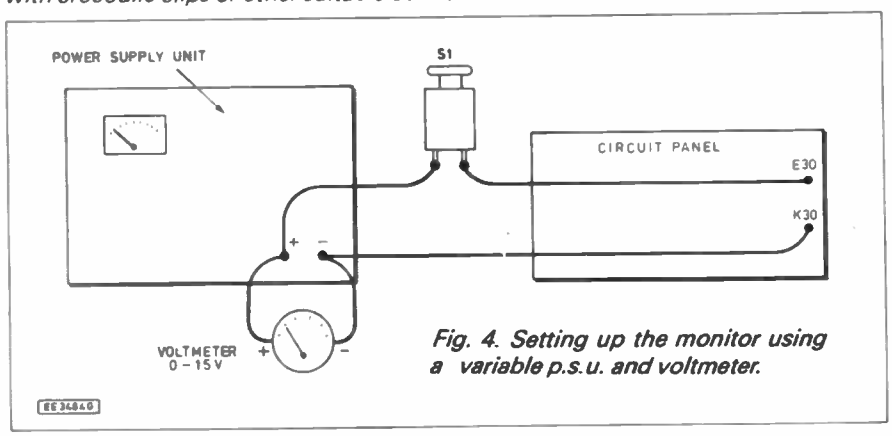


Fig. 4. Setting up the monitor using a variable p.s.u. and voltmeter.

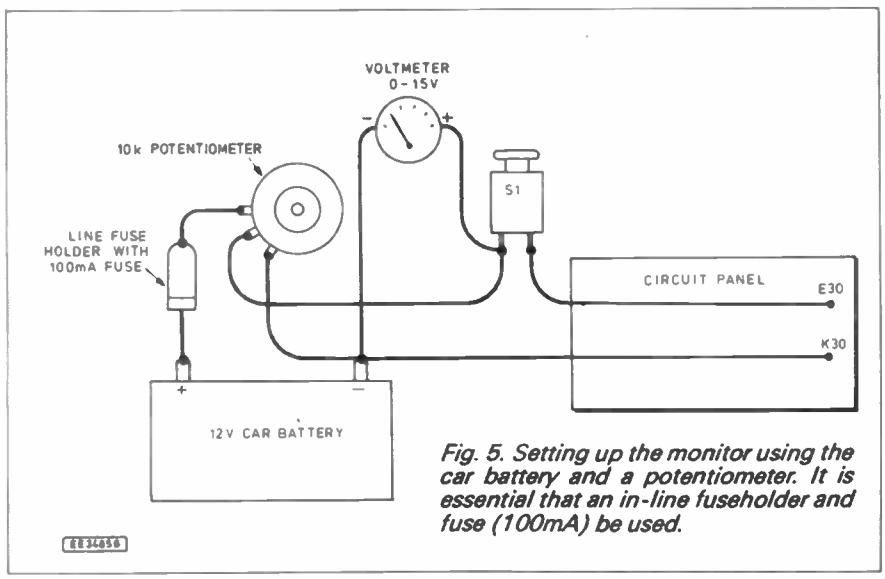


Fig. 5. Setting up the monitor using the car battery and a potentiometer. It is essential that an in-line fuseholder and fuse (100mA) be used.

Measure the positions of IC2 and D2 and cut corresponding holes in the lid. Drill a hole in the side for the push-button Test switch. Attach the circuit panel to the base with plastic spacers on the bolt shanks so that IC2 and D2 are level with the face of the box or as desired. Refer to Fig. 3 and complete the wiring.

Knot together or attach a strain relief bush to the input wires inside the box and pass the free ends through the hole in the side. Fit crocodile clips or other connectors as required to the free ends. Leave VR1 and VR2 adjusted to approximately mid-track position.

SETTING-UP PROCEDURE

The best way to set up this circuit is to use a variable voltage power supply unit covering the range 0V–15V. Alternatively, the car battery itself could be used. *Note that wherever a car battery is used, it is essential to include a line fuseholder in the positive battery lead – short-circuits could have a disastrous effect otherwise.* A 100mA fuse would be a suitable value to use.

A good quality voltmeter is also needed. Do not rely on the voltage as given by a meter on the power supply unit itself unless you know that it is accurate.

Refer to Fig. 4 and connect the p.s.u. and voltmeter to the Charge State Monitor as shown, observing the polarity, red wire to positive and black to negative. If incorrectly connected the circuit will not work.

Increase the output voltage of the p.s.u. gradually to 14V. From approximately 10V upwards, l.e.d. bars should light in turn.

Adjust preset VR1 so that the last one just illuminates at 13.5V to 14V. Check that the first one comes on at 9.5V to 10V. VR1 should be adjusted for the best compromise between high and low points. Adjust preset VR2 so that the under-range l.e.d. D2 lights below 10V or as required.

If no segments light at all, check the orientation of IC2. If one or two segments fail to light, suspect the appropriate connections at the busbar on the underside of the circuit panel.

If a satisfactory low point voltage (the voltage at which the first bar comes on) cannot be obtained, use a different Zener diode. For a lower operating voltage, it should be reduced and vice-versa.

If using the car battery itself as a power supply, this should first be fully charged. Use the circuit shown in Fig. 5 and follow the procedure for the mains-operated power supply – the rotary potentiometer adjusts the input voltage to the circuit.

As an alternative, adjustment may be carried out by trial. To do this, connect the unit to the fully charged car battery. Adjust VR1 so that all IC2 segments are just on. Put the battery into service and test occasionally as the voltage fails and segments go off one by one.

When the battery is beginning to fail, the first segment should go off. VR2 should then be adjusted so that the "under-range" l.e.d. operates. A reliable low point is obtained only when the battery is under a load of 3A approximately – this may be obtained by switching on a few lights.

If desired, a scale marked off in volts could be attached to the front panel or the display may be marked simply "HIGH" and "LOW" as in the prototype (see photograph). Your battery should never let you down with the Charge State Monitor. □

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Take the ribbon itself, which is usually referred to as the base. Many materials have been used over the years since tape recording was first invented. Among them have been acetate, p.v.c., and even paper. I still have a recording I made on an early reel-to-reel kraft paper tape.

NO GIMMICK

There was also wire, in fact originally, steel wire was the preferred medium, and magnetic tape was just an inferior and unpromising dead-end gimmick. Wire recorders were produced, but the reels of wire were expensive and inconvenient. They could not be spliced and edited, and if turns slipped off the reel they made a dreadful tangle.

There was also the ever present possibility of rust. So although tape seemed an also-ran, the greater ease in handling and using, plus developments and improvements in tape manufacture made it the eventual winner.

In spite of its name, Polytethylene glycolterephthalate is now almost universally used, because it has superior physical qualities to most other materials and is of moderate cost. It stretches slightly under stress and recovers later, a very useful characteristic for recording tape.

It is more commonly known as polyester, which is just as well. Some other materials such as polymide are better, but are more costly and not available in the prodigious quantities needed by the recording tape industry.

The thickness of the tape varies according to application. For open-reel recorders it is 35µm. Compact cassettes use much thinner tape, from 12µm for C60's, 7.5µm for C90's, down to 6µm for C120s. For the C90 and especially the C120 cassette, the tape is very thin and needs special treatment to strengthen it to withstand the stresses imparted by repeated playings. This is done by *tensilising*.

Normally, the tape is stretched equally in both directions when extruded, and it is then said to be *balanced*. When tape is tensilised, it is stretched more in one direction than the other, and this increases its longitudinal strength at the expense of the transverse. There are few if any stresses across the width of the tape, so strength is imparted in the direction it is needed.

IN THE ROUGH

Another factor is ***roughness***. Surface unevenness produces an image through the coating, so an uneven coating surface is offered to the head. This produces three effects: increased noise; drop-outs (the momentary reduction or cessation of signal level); and increased head wear.

However, while the tape could be given an optically smooth surface, this too has its drawbacks. A major one is the exclusion of air from between adjacent layers which could result in distortion of the tape during manufacture, difficulties in spooling, and possible tape tangles.

To avoid these, a *controlled roughness* is introduced by suitable additives to the polyester mix. The size of the particles must be within fine limits, if they are too small they have little effect, but if too large they produce unevenness problems. An alternative is to put a coating on the back which has the prescribed roughness and which also can be made anti-static. At one time you could always tell which was the business side of a tape, because the oxide coating made it dull or matt, while the back was always shiny. This is no longer so; with modern tapes the oxide side is equally as shiny or may even be more so than the back.

Another method of achieving the desired roughness is to extrude the tape material between a pair of rollers, one of which is smooth and the other rough. Thus the back is made rough while the front is smooth. The accurate slitting of the tape from rolls which are 1.2m (5ft) wide is another task calling for great precision to get the width exactly right with no curling of the edges.

Well, it can be seen so far, that much precision and high technology is required, and we have only considered the base! What then of the coating?

Make up of a BASF C90 cassette.

COATINGS

It may be thought that the coating, being of iron oxide, is little more than finely ground particles of rust, but here again things are not as simple as they seem. There are many iron compounds, and not all of them are magnetic; it is only those in which the magnetic fields resulting from the variously orbiting electrons do not completely cancel. Those that are usable have a cubic atomic lattice structure.

There are three possible iron compounds! simple low *oxide of iron* FeO; the high oxide Fe_2O_3, called *ferric oxide*; and the intermediate Fe_3O_4, termed *ferrous oxide* and commonly known as **magnetite**. Magnetite has a lattice structure consisting of 24 iron atoms and 32 oxygen atoms, but it is chemically unstable, being halfway between the simple oxide and the ferric oxide. It can thus easily absorb more

oxygen from the atmosphere and so prove an unreliable tape coating.

The Fe_2O_3 ferric oxide has the highest oxide content, but having five atoms cannot form a cubic lattice. It can though be prepared in hybrid form by further oxidizing magnetite. It then forms a lattice of 32 oxygen atoms and an average of 10 iron atoms.

As you cannot have two-thirds of an atom, the result forms itself into a superlattice in which some groups have 10 and others 11 iron atoms. The result is a systematic structure that is stable. It is termed *gamma ferric oxide* to distinguish it from the ordinary or alpha ferric oxide.

DOPANTS

Although the lattice of gamma ferric oxide is stable, it has vacancies. This is fortuitous because it means that small amounts of foreign atoms can be introduced to fill the holes and if the right substance is chosen, thereby considerably enhance the magnetic properties. One such is cobalt which can increase the coercivity from around 300 to nearly 1,000 oersteds according to the amount added.

Early efforts in doping tape with cobalt were not too successful because of the uneven distribution throughout the lattice. This produced regions of uneven magnetism, and also problems from signal print-through between adjacent layers of tape on the spool.

This has been largely overcome by the use of what are known as *epitaxial* oxides. Instead of the dopant being applied to the ferric compound before it is formed into particles and thereby permeating the whole structure of the particle, albeit unevenly, it is diffused into the surface of each particle after it is formed. Thus the outer layer of the particle is doped while the core remains pure ferric oxide. This seems to do the trick.

PARTICLE SHAPE

The particles in early tape coatings were of all shapes and sizes which was one of the reasons for what is today considered their high noise level. As we saw in an earlier article, the predominant field across the head gap is longitudinal, that is in the direction of tape travel.

A higher *coercivity* can be obtained by making the particles long and thin, like tiny bar magnets lined up along the tape, rather than a round or granular shape. The question is, how can it be done? At least two methods are employed.

In the first, the compound starts as ordinary *iron oxide*, FeO, which is initially hydrated to make FeOOH. This is done by an aeration process during which seeds of the compound are grown. These turn out to be *acicular* or needle-shaped which is almost the ideal.

The length is controlled by the seeding time and ranges from 0.1μm to 0.5μm which is around the wavelength of visible light. After the particles have formed, the compound is dehydrated to produce magnetite, and then oxidized to form gamma ferric oxide.

The second method starts with *alpha ferric oxide*. It is subjected to what is known as the hydrothermal process. This was originally developed to produce *chromium dioxide* for chrome tape but has more recently been applied to ferric oxide with considerable success.

It consists of heating the ferric oxide under a pressure of several hundred atmospheres. The result is the production of *ellipsoid particles*, that is ones shaped like a lengthened rugby ball. These have been found to be even better magnetically than the needle shape.

OTHER COATINGS

At one time it seemed that chromium dioxide was set to oust ferric coated tape at the upper end of the market. It was prepared by the hydrothermal process which produced uniform particles of ideal shape from CrO_2, which has a tetragonal lattice.

Some six grams of CrO_2 are needed for a C90 cassette. The basic material is actually only slightly superior to ferric oxide, but the big advantage lay in the uniform particle size and optimum shape. This resulted in among other things, better high-frequency response. Now that the same process is applied to ferric tape, the difference has diminished, and cobalt doping of ferric particles has reduced it further.

Chrome tape had a bad reputation for head wear, although the makers asserted that this was unjustified. Even so it seems to have virtually died out, as its frequency response and overall characteristics have been matched by improvements of ferric tape.

The use of *pure iron*, without any oxide, would appear to be the obvious and the ultimate tape material. This is virtually back to the wire recorder without the handling problems. It has problems of its own though, the main one being that the small particles required, oxidize easily and quickly, often as soon as they are exposed to air, sometimes with explosive force!

ON YOUR METAL

The remedy is to cover each particle with a protective coating, but other metal magnetic particles could be used, such as cobalt, chromium, nickel and their alloys. Although introduced with a flourish and a blaze of publicity a few years ago, metal does not seem to have caught on for audio tapes. As is the case with chrome, ferric tapes have been developed to such a high standard, that little difference can be detected with ordinary playing equipment.

Metal is really better suited for other applications which require what is termed a *thin-film coating*, instead of the application of individual particles. It can be deposited directly on to the base without the use of a binder thereby achieving 100 per cent concentration.

Films can be produced that are from 0.1μm to 0.3μm thick. These are ideal for recording very short wavelengths that would quickly self-demagentize in thick coatings. They are thus ideal for video and digital audio applications.

Three methods can be used for making a metal thin-film coating: *electroplating; evaporation;* and *ionic sputtering*. With electroplating, a primer coating and small amounts of phosphorous are first deposited so that the metal coating has a grainy structure which emulates the particle make-up of the normal coating. Evaporation is achieved by passing the tape over boiling metal, and ionic sputtering by bombardment of a metal cathode by the positive ions of an inert gas.

Each has its advantages and snags. Electroplating is slow, and so not very practical. Sputtering is also slow, energy inefficient and wastes a lot material.

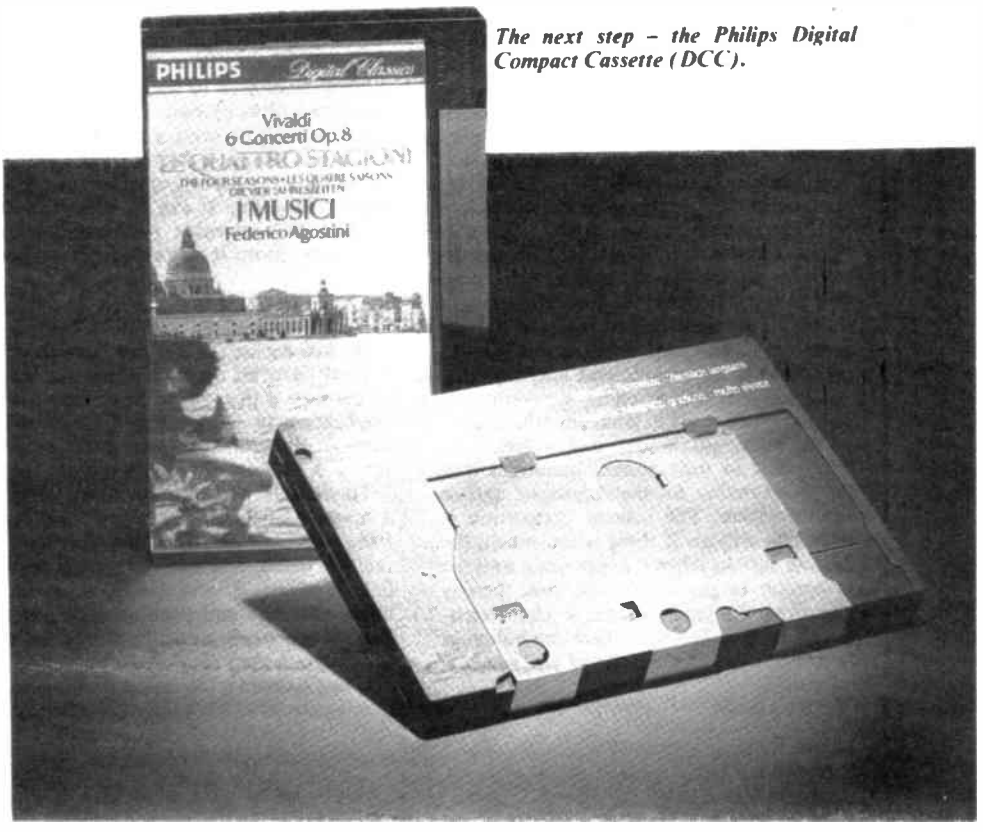
However, the high temperatures required for evaporation can melt the tape. The temperature required can be reduced by evaporating in a high vacuum, but even then is around 2,000°C. To avoid tape destruction, the coating must be deposited by several very fast passes, so building it up in layers.

PREPARING THE COATING

Back now to the coating of the ferric tape. The particles are supplied according to specification to the tape manufacturer, by a manufacturing chemical firm. Being magnetic, they arrive in clumps and must be broken apart before they can be applied to the tape as a coating.

Now this presents a problem. A hard bashing would most likely break up the particles so spoiling their shape and reducing their size which was so carefully made to the optimum. The result of this would be that they would magnetize too easily, and so be prone to print-through.

At one time the process was performed by a ball mill which consisted of a slowly revolving cylinder containing steel balls.



The next step – the Philips Digital Compact Cassette (DCC).

The results were uncertain, with some particles being broken apart but others not being touched at all. So tape performance tended to be variable.

Nowadays the breaking apart is done by a **bead mill**. The aggregate passes in a continual stream in one end of the mill and out of the other. Inside are a large number of small glass beads up to one millimetre in diameter which whirl turbulently around.

As the aggretate leaves the first mill, the beads are removed by filtering, and the material passes in turn through other mills having successively smaller beads. There are thus a large number of contacts between beads and particles so that all are affected, but the small and decreasing size of the beads ensure that as the clumps are reduced in size, the applied force is also reduced so minimising breaking up of the particles.

BINDING AGENT

Something is obviously needed to secure the particles to the base. A vital quality is that the *binder* must really do its job, oxide shedding means loss of performance and frequent head cleaning. So binders are chosen that are a combination of polymeric resins that have a strong adhesion to the base film.

The qualities of toughness and flexibility are also essential, yet these are opposites, so a combination of brittle and elastic resins is selected to afford a suitable compromise between the two. Other additives are included to improve flexibility, reduce static, add controlled roughness, and give lubrication. The binder must be in fluid form, so all these are dissolved into a suitable solvent which must be capable of dissolving all of them.

It can be seen from this that even the production of the binding agent is no small task, but one requiring much expertise to get it right. There is certainly a lot of binder in the finished product, it accounts for some 60 per cent of the coating against 40 per cent of the ferric particles.

However, the picture is not yet complete. The resins which make up most of the binder are organic by nature, while the ferric particles are inorganic. While the binder has an excellent adhesion to the polyester base it is not so keen on sticking to the particles. What is needed is an interface or what is termed a *wetting agent*.

WETTING AGENT

A further function of the wetting agent is to expel all air from between the particles, and encourage the full ingress of the solvent in all cracks and crannies. The wetting agents used are partly organic, consisting of long chains of atoms having carbon at one end that combines readily with the organic resins, and having atoms at the other that have a strong affinity for ferric oxide.

Every particle is coated with the wetting agent to a thickness of just one molecule, each having its organic end sticking, outward like the spikes on a "conker-case". They are then ready to latch onto the binder.

The additives, binder and solvent are introduced in their correct quantities into the bead mills, as the aggregate passes through them. The solvent proportion is especially critical. If there is too much, the coating shrinks when it evaporates, and the dispersion of particles is too thin thereby impairing the tape's magnetic characteristics. If there is too little there are adhesion problems, and filtering out of the beads is difficult.

TIGHT SQUEEZE

The base film comes in rolls 1.2m (5ft) wide, and 3,000m (10,000ft) long which is just under two miles! This is enough for 10,500 C90 cassettes. There are two principal ways of applying the coating: the *reverse roll* and *gravure* methods.

With the reverse roll system, the mix is first applied via an applicator roller, then a contra-rotating metering roller carries off the excess. This roller is spaced exactly the required thickness of the coating away from the film. A blade held against its surface finally removes the surplus.

In the case of the gravure method, the applicator roller has grooves etched in it which have exactly the capacity to hold the required amount of mix. After the mix is fed to the roller, the surplus on the surface is wiped off leaving only that in the grooves.

A slightly compressible pressure roller presses the film against an applicator roller thereby extracting the material from the grooves. This leaves a groove pattern on the film which must be smoothed out to give an even surface. Either mechanical smoothing by another roller, or magnetic smoothing is employed.

With the reverse roll method, the concentricity of the roller must be extremely accurate, the slightest error will produce cyclic variations of coating thickness. The gravure method is not quite as critical as the amount of coating is fixed by the grooves. However, coating thickness, which varies with different sized cassettes, can be changed with the reverse roll by simply changing the height of the roller over the film, but because the amount is fixed with the gravure method, no change in thickness is possible.

The spacing of the metering roller above the film is microscopic and is really a marvel of precision considering the width of the roller and the film passing under it. This can be seen from the thicknesses of the coatings which it produces. For open-reel tape the thickness is 10μm, for a C60 it is 6μm, for a C90, it is 5μm, and with a C120, it is 3.5μm.

It is interesting to note the proportion of base to coating thicknesses in each of these sizes. The base thickness of the C60 is 12μm, so with a coating of 6μm we have a total thickness of 18μm of which the coating is a third. In the case of the C90, the base is 7.5μm, and the coating 5μm, giving a total thickness of 12.5μm, the coating being two-fifths of that.

For the C120, with a base of 6μm, the coating is 3.5μm, so the total is only 9.5μm, to which the proportion of coating is just under two-fifths. It can be seen then that coating is a sizeable proportion of the thickness, more than perhaps is generally realised.

ORIENTEERING

We saw earlier that the needle or ellipsoid shaped particles must lie along the length of the tape if they are to be effective. After application in the binder, they are all in random directions, so they must be lined up.

To do this, the film is passed through a magnetic field before the coating dries, then when it does, the particles are correctly aligned. The strength of the applied field is critical. If too strong, the particles move violently and produce a rough surface; if too weak, not all are affected and many retain their random orientation.

If this happens, the tape exhibits what is called the *velour effect*, which produces a different magnetic performance in one direction than the other. So recordings made in the forward pass are either weaker or stronger, and with possibly a different frequency response, than those made on the return pass.

DRYING OUT

Next, the coating must be dried. As with most of the other processes, this is not as straightforward as it sounds. The drying must be gradual so as not to create voids in the coating surface and so must be carefully controlled.

It is carried out in a heated drying tunnel from which air and the solvent vapour is extracted. The temperature and air flow must be precisely regulated to achieve the required rate of drying.

The problem is that in transporting the sheet down the tunnel, the tacky surface could easily be marred by physical contact with the transporting medium or tunnel walls. To overcome this, the film is floated along on jets of air. Jets above and below keep the material centred throughout its passage. To add to the difficulties, the air/vapour mixture that is drawn off is *highly explosive!*

CALENDERING

After drying, the coated film is passed between sets of calendering rollers at high pressure. One of each pair is hard and is heated, while the other is slightly compressible. The temperature varies between 80°C to 120°C depending on the exact composition of the binder. The pressures exerted are around 2,300kg per cm width.

At least four functions are performed by calendering. The first is compaction of the coating. This ensures that the magnetic material is as dense as possible, and any small cavities filled. The second function is polishing. This is done by making the compressible roller accelerate and de-accelerate as it runs over the point of contact, thereby giving a rubbing action as the film passes over the hard roller.

The third task performed is the squeezing of lubricants and other additives up to the surface where they are needed. Fourthly and finally, the binder is partly cured by cross linking of the resin molecules to give a hard wearing surface.

Curing and crosslinking is not completed by calendering. It continues and progresses with time in an exponential manner. It is thus never completely cured.

However, it must be quite hard and at an advanced stage before the film can be cut up into individual tape widths. The rolls are therefore stored in a warm environment for some days or even weeks before they are taken to the cutting department. An alternative, is instant curing by means of electronic stream bombardment, but this requires different resins in the binder, and there are also other practical snags.

CUTTING PANCAKES

The problems in cutting up a 1.2m wide thin film tape nearly two miles long into strips only 4mm wide can be well imagined. Two rotary cutters are used for each cut, one above and the other beneath the film. These enmesh, penetrating the film from both sides.

The cutters bear slightly sideways against each other like a pair of scissors, in a shearing action. The film is kept taught as it is pulled past the cutters by a slipping clutch

arrangement similar to that used for the take-up spool in a recorder.

Individual tapes are wound on to large *pancakes* as they are called. From these, measured lengths are later wound off, fitted with leaders, and assembled on to a cassette hub.

Then, with pressure pad, shield, rollers and liner, it is fitted to the cassette shell. Although special tools and jigs are employed, cassette assembly is still largely carried out by human operatives.

FUTURE IMPROVEMENTS

With almost the full frequency range recoradable at what, at one time, would have been considered the very slow speed of one inch per second, and noise reduced to a level that is often below that of the playback equipment, there seems that little further improvement is possible with analogue tape systems. Hence the trend toward digital recording.

There is a system though that could offer considerable improvement over the existing method. As described in Part Two of this series, the magnetic field balloons out sideways from the head gap so that the lines of force are mainly longitudinal along the tape. There are though perpendicular regions where the field leaves and enters the head poles on either side of the gap. The lagging perpendicular field tends to erase the shorter wavelengths already recorded, as they pass.

Another defect of the existing system is that it produces a chain of magnetic zones that have like poles end-to-end. This tends to produce self-demagnetization.

A solution to these problems would be to direct the magnetic field through the tape from front to back so that it was virtually wholly perpendicular. The magnetic zones would in effect be standing on end. Thus no zones would be end-to-end, and there would be no erasure from the lagging pole field.

It would mean that the magnetic particles would have to be standing on end too, but as present particle length is nor more than 0.5μm and the coating thickness of a C90 is 5.0μm, they could be easily accommodated embedded on end in the coating.

In fact, much longer particles could be used, so improving the coercivity of the tape, and giving a greater packing density of particles to binder. The required orientation could be achieved during manufacture by changing the orientation of the applied field from longitudinal to perpendicular.

The big snag is in its use. The tape would have to pass through the head gap which would have to take the form of an open-ended slit. The tape would be introduced into the slit which would have to be very narrow.

Also the pole pieces would have to be very thin in order to concentrate the field into a narrow portion of tape and thus record short wavelengths. To protect them, the poles could be surrounded by non-magnetic material.

It could be possible to expand the slit for loading the tape and close it during playing and recording. It can be seen that the mechanical problems, though not impossible to solve, would make a more complex arrangement necessary.

The idea is by no means new, but the mechanical considerations have so far kept it from being used. The high standard reached by modern tape has certainly reduced its attractiveness. However, in the quest for ideas to make existing equipment obsolete and so boost flagging sales, it is not impossible that some manufacturer in the future will latch on to it and produce a super analogue recorder to rival the digital units.

In the next article we will examine the jargon used to describe tape and the types of tape currently available.

Constructional Project

AUTO MELODY MAKER

MAX HORSEY

Low-cost tune player with a host of possible applications such as, "polite" warning alarm, musical "door mat" or games timer.

THE PROJECT is based on an i.c. type UM66 available for around 60 pence. In fact four (possibly more later) i.c.s are available depending upon which melody or group of melodies is required. At present the types available are:

Type 1: Jingle Bells/Santa Claus/ We Wish you a Merry Christmas

Type 2: Happy Birthday

Type 3: Wedding March

Type 4: Love Me Tender, Love Me True

Possible applications include a polite warning device which plays the melody when a door is opened or a pressure mat switch is stepped on. Alternatively, when linked to a timer the circuit will provide a more musical signal than a simple buzz or bleep.

The project enables the melody to be played through a loudspeaker at the press of a switch, without the need for the switch to be held on. At the end of the melody cycle the circuit switches back to its standby mode.

The melody i.c. is pre-programmed to play through its cycle once and then stop until the power supply is switched off. However, for maximum triggering flexibility a latching circuit is included. The circuit may be permanently connected to a battery, since the current consumption during stand-by is negligible.

PRINCIPLE OF OPERATION

The trigger switch may be a "normally closed" or "normally open" type. The latter is shown in Fig. 1 and Fig. 2, but a normally closed switch may be fitted by changing the position of resistor R1 as described later.

When one of the inputs to the OR gate is made "high" (logic 1), its output goes high, causing IC2 to start playing through its melody cycle. The audio signal produced is amplified before being fed to the loudspeaker.

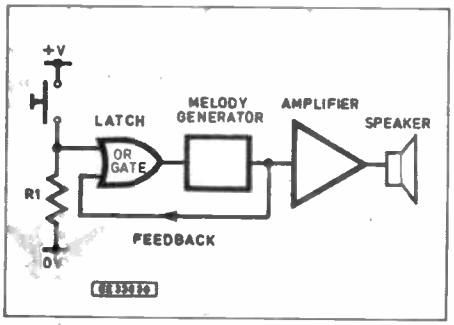


Fig. 1. Auto Melody maker block diagram using a normally "open" push switch.

Part of the audio signal is rectified (i.e. changed into d.c.) and fed back to the other input of the OR gate. This ensures that the output of the OR gate stays high even if the trigger switch is released.

CIRCUIT DESCRIPTION

The full circuit diagram for the Auto Melody Maker is shown in Fig. 2. The melody i.c. requires about 3V, and a 74HC series i.c. was therefore chosen to provide the OR gate, since this series works down to 2V. A 74HC02 i.c. was selected, since it is cheap and readily available.

The 74HC02 contains four NOR gates. When two such NOR gates are connected together as shown in Fig. 2, the effect is equivalent to an OR gate. The inputs to the unused NOR gates MUST be connected to 0V.

When power is applied to the circuit, pin 3 is held at 0V due to resistor R2, and pin 2 is at 0V due to the open contacts of S1. This keeps IC2 switched off.

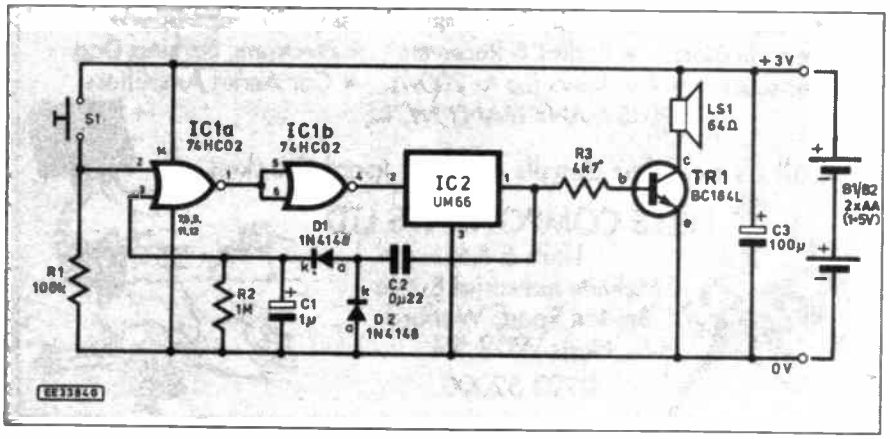
When switch S1 is pressed to complete the circuit to the i.c., input pin 2 goes "high" (logic 1), causing output pin 4 to go "high". This turns on IC2, which begins its melody.

Part of the audio signal is fed via capacitor C2 to diode D1. Diodes D1 and D2 form a voltage doubling circuit, the result being that the alternating audio signal flowing via C2 is converted into a d.c. supply which charges capacitor C1.

The voltage on C1 is sufficient to maintain pin 3 of IC1 at logic 1, and hence the circuit remains latched on. When the melody cycle is complete, resistor R2 discharges C1, and the circuit reverts to its standby mode

Transistor TR1 amplifies the audio signal, and drives loudspeaker LS1. Capacitor C3 decouples the circuit to maintain a steady d.c. voltage level.

Fig. 2. Complete circuit diagram for the Auto Melody Maker.



CONSTRUCTION

The circuit is constructed on a piece of stripboard with at least 10 tracks by 30 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 3. In practice, a larger piece will enable mounting holes to be drilled. Begin by marking out the board, and making the eleven breaks as shown.

The socket for IC1 may now be soldered into place, followed by the wire links. The melody chip, IC2 looks like a transistor, and may be directly soldered to the stripboard.

However, a transistor socket is recommended to allow the different types of i.c. to be tried. Some care must be exercised in

mounting the transistor socket to ensure that the i.c. makes the correct connections.

The other components may now be fitted ensuring that the diodes, capacitors C1, C3 and the transistor are the correct way round. Finally solder in the leads for the pushswitch, loudspeaker and two-cell battery holder.

The i.c.s may now be fitted. IC1 is a CMOS type and must be handled with care. First Earth yourself in case you are charged with static electricity, then place IC1 carefully into its socket, ensuring that the notch or tiny hole is at the top. If IC2 has not been soldered directly to the board it may be inserted into the socket taking care to fit it the correct way round.

NORMALLY CLOSED SWITCH

The circuit may be easily modified to allow the use of a "normally closed" switch (see Fig. 4), for example a reed switch and magnet fitted to a door or window. Switch S1 and resistor R1 are simply interchanged. This causes pin 2 of IC1 to be low (0V) when the switch is closed. When the switch opens, resistor R1 ensures that pin 2 changes state to logic 1 (high).

On the stripboard, the ends of resistor R1 must be soldered to points *A4* and *C4* on the board. The resistor will not lie down in the space available and should be mounted vertically, with one wire bent around the body. The switch S1 must be connected to points *C1* and *H1*.

TESTING

Connect the batteries and press the switch S1. If the circuit fails to work, disconnect the supply in case a short circuit exists which might damage the project or run down the batteries. If all is well, the project should run through its melody cycle, then stop automatically.

COMPONENTS

See SHOP TALK Page

Resistors

R1	100k
R2	1M
R3	4k7

All 0.25W 5% carbon

Capacitors

C1	1µ radial elect. 10V
C2	0µ22 polyester
C3	100µ axial elect. 10V

Semiconductors

D1, D2	1N4148 signal diode (2 off)
TR1	BC184L *npn* silicon transistor
IC1	74HC02 quad 2-input NOR gate
IC2	UM66 (select type number according to melody – see text)

Miscellaneous

LS1	Loudspeaker 64 ohms
S1	Min. push-to-make or push-to-break switch (see text)

Stripboard, 0.1 in matrix size 10 strips x 30 holes; 14-pin i.c. socket, 3-lead TO18 transistor socket; plastic case, size 102mm x 76mm x 38mm; two AA size batteries and holder; connecting leads; wire; p.c.b. supports; solder etc.

Approx cost guidance only **£6.50**

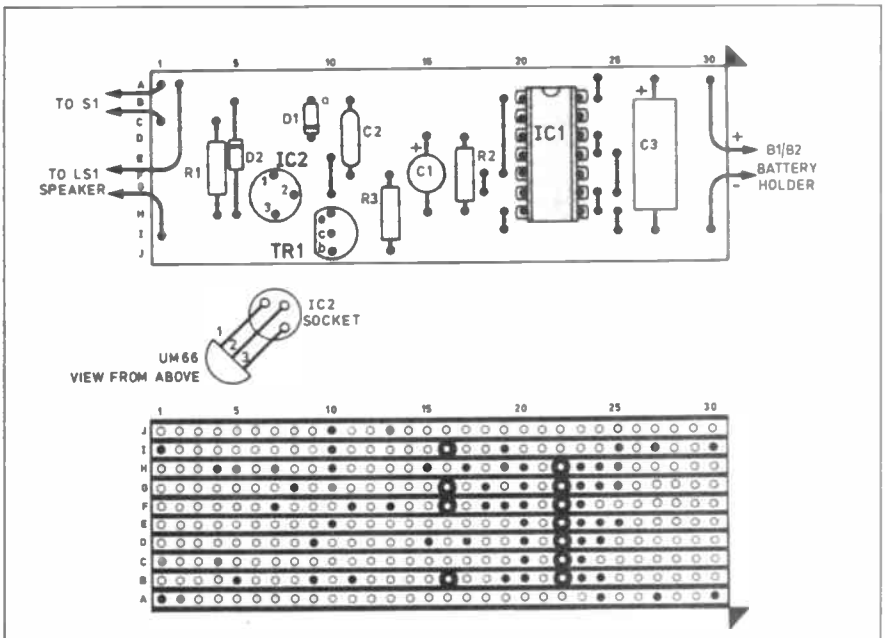


Fig. 3. Stripboard component layout, melody i.c. pinning arrangement and details of breaks required in the underside copper tracks.

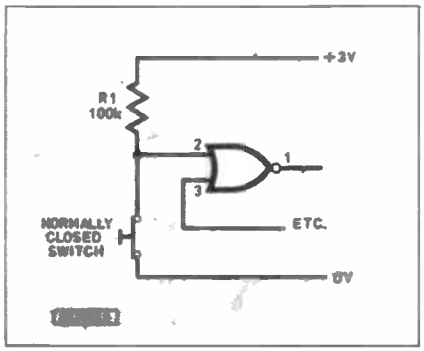


Fig. 4. Modifying the circuit to take a normally "closed" switch.

FAULT FINDING

If a fault does exist, first check that no pairs of tracks have been bridged with solder, and that the breaks have been made cleanly, not leaving fragments of copper across the breaks. Also check the positions of the components relative to the diagram and each other, not forgetting that all except the resistors and C2 must be fitted the correct way round.

If a voltmeter or multimeter (set to "volts") is available, re-connect the batteries and check the voltage across pin 14 and pin 7 of IC1. It should be about 3V. If the meter reads less than 2V, and new batteries were used, disconnect again, and continue to check for short-circuits.

Assuming the voltage was correct, fasten the negative side of the voltmeter to negative (0V), and use the positive side as a probe. Touch the probe against pin 2 of IC1. The reading should be 0V.

Press and hold down switch S1. The reading should rise to about 3V. Repeat this test at pin 4. The results should be about the same except that the circuit should latch without holding down S1.

Repeat the same test with the probe touching pin 2 of IC2. Again the results should be the same. Check that pin 3 of IC2 is at 0V throughout this test.

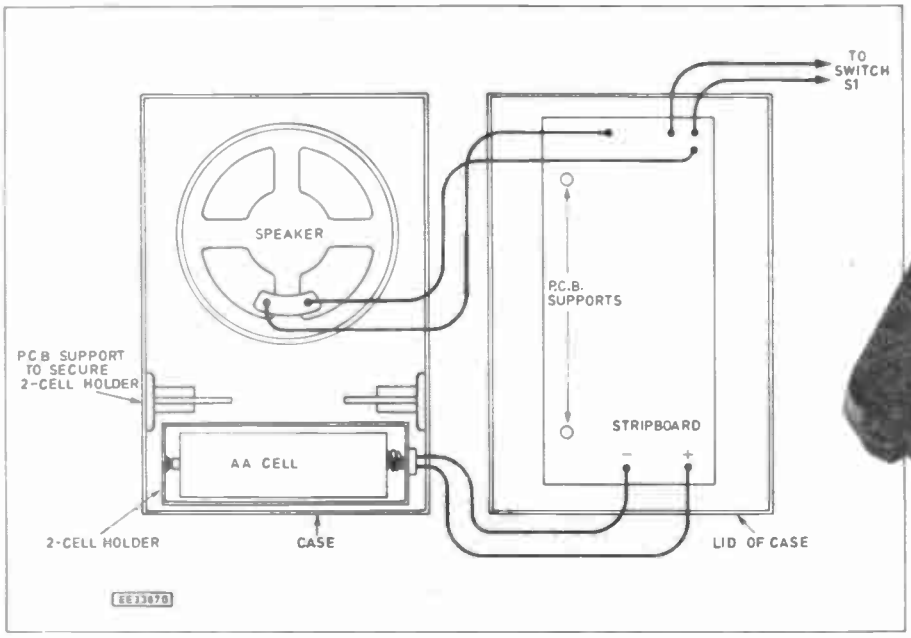


Fig. 5. Layout of components inside the case and interwiring from the circuit board to all off-board components.

When the probe is touched against pin 1 of IC2 the reading should fluctuate at between 1V and 2V when a tune is played, returning to 0V on standby. The voltage at the base of transistor TR1 should be 0V when the circuit is on standby, but rise to a d.c. average of about 0.4V when a tune is played.

If the circuit fails to latch on, or plays continuously, check the reading on pin 3 of IC1. It should be about 0V during standby, and rise to between 2V and 3V when playing. Failure in this area means carefully checking the feedback components R1, C1, C2, D1, and D2.

CASE

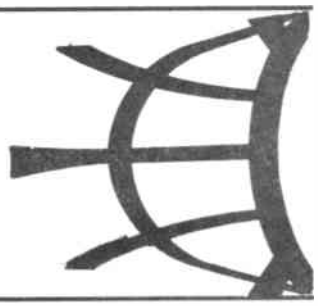
Any case may be employed which can house the circuit's batteries and loudspeaker. The prototype was housed in a black plastic case measuring about 102mm by 76mm by 38mm.

The loudspeaker may be mounted in the body of the case, together with the two-cell battery holder which is fastened by means of two p.c.b. self-adhesive supports. Drill some small holes for the sound from the loudspeaker, and a hole for the wires leading to switch S1. The circuit board may be fastened to the lid of the case using self-adhesive p.c.b. supports.

OTHER USES

The Auto Melody Maker could be adapted for use in games or quizzes as a reward for a correct answer or a win. It can also be used as an instrument of mild torture, since few people can stand more than a few musical cycles before becoming violent!

REPORTING AMATEUR RADIO



Tony Smith G4FAI

NEW LICENSING ARRANGEMENTS

From 1st April 1992 all new amateur and CB licences will be issued by SSL (Subscription Services Ltd), a wholly owned subsidiary company of the Post Office, and existing licensees will receive reminders direct from this company. For amateurs this simply means that the existing centralised licensing service at present run by Post Office Counters Ltd will be provided by a new organisation. What is new is that CBers will also have to obtain their licences centrally.

This change was foreshadowed in the Radiocommunications Agency's annual report for 1990/91 mentioned last month. The report indicated that the present system of over-the-counter issues from post offices could no longer be sustained in the face of decreasing CB licence numbers which, as at March 1991, had fallen to 69,803, a drop in one year alone of just over 10,000.

PHONE PATCHING AT SEA

In many countries phone patching is permitted, linking amateur radio transmissions into the public telephone system. This practice comes into its own when used as a public service for military personnel (as in the Gulf war) or for expeditions far from home.

An example of the latter is recalled in an article in *The Canadian Amateur* magazine, October 1991, by Bill Sullivan VO1AI. In 1989, at the age of 57, he signed on as Radio Officer for four month's temporary employment on the Canadian MV *Lady Franklin*. This was on charter to Australia to transport personnel and cargo from Hobart to Antarctic bases, and to bring back expeditioners returning from the Antarctic.

During the voyage, in which only one other vessel was seen in ten weeks, he operated an amateur radio station in addition to his official duties. His main purpose was to keep in contact with home via other Canadian amateurs but in the process he also kept normal amateur activity going, working several thousand amateurs in 100 different countries.

CANADA DIRECT

He says in his article "The vessel had never before had a Radio Officer who was a ham, and the crew were amazed and delighted. Being half way around the world from home, my cabin became a popular 'hang-out'. Collectively we could not adequately express our thanks to the many VEs (Canadian stations) and others who passed traffic, provided phone patches, relayed the hockey scores, provided us with news from home and helped keep a clear frequency."

It was an interesting voyage in terms of amateur operation. He originally planned to keep in touch with home via Australian amateurs, who have regular third party nets linking in to North America, but found it easier to work Canada direct from the Antarctic. "Dxpeditions" usually work from one location for perhaps a couple of weeks. Bill Sullivan's operation was different. He sailed 27,000 nautical miles in 10 weeks, operated in 17 times zones and met Neptune several times crossing the Antarctic Circle and the Equator.

He's back at his land-based job as a Radio Communications Instructor now but if the opportunity occurred again, he says, he would not need much encouragement to pack his bags, and his trusty TS430 amateur transceiver, to head south once again!

AUTOMATIC TUNER

Traditional antenna tuning units (ATUs) used by amateurs usually consist of one or two tuning capacitors, and a tapped/switched coil or roller inductor which after manual adjustment provide a "match" between antenna and transmitter, hopefully ensuring maximum possible transfer of radiating power to the antenna. Such units are relatively easy to construct and are popular homebrew projects.

A new concept is the *automatic* tuner, an example of which is the Smartuner from SGC Inc. using computerised operation to match virtually any antenna with any rig. It tunes itself on a transmitted signal; it matches random length antennas, from 2.5 to 27 metres long, over the frequency range 1.8 to 30MHz; it memorises previous tuning by means of 500 memories; it tunes an unknown antenna in two seconds, and a known antenna in milliseconds. All it needs is a 12V supply and a good earth to provide all band operation matching the antenna to the rig in a faster time than it takes to change bands on a transceiver and tune to a new frequency.

The basic design is in fact a traditional "pi match", comprising two tuning capacitors and a coil. Instead of manual controls, however, it has 26 relays, controlled by microprocessor, to select specific values from 64 input and 32 output capacitance combinations, plus 256 inductance combinations, resulting in half a million possible permutations to provide the correct "match".

If it wasn't for the cost, nearly $600 in the US, this unit could be the answer to many amateurs' prayers. Installing suitable antennas for multiband operation, often with limited space or local restrictions, can be the most difficult part of setting up an amateur station.

It will almost certainly be less efficient than an antenna purpose built for a specific band, but even the best antenna tuner can only be a compromise when operated with a random length of wire. Reports so far, however, suggest that the Smartuner does make all the difference between getting contacts and not getting contacts with what might otherwise be an unsuitable antenna for all band operation.

IN MEMORIAM

Over the years one particular radio frequency, 500kHz, or 500kc/s as it used to be known, has had a special meaning for Radio Officers at sea, in the air, or in coastal radio stations. This is the wireless telegraphy distress and calling frequency which in its heyday was a constant cacophony of Morse signals, falling silent for three minutes twice an hour, at a quarter past and a quarter to the hour. This "silence period" was intended to give a faint SOS or other emergency call a better chance to be heard and acted on.

This time-honoured system, which saved many thousands of lives, is being replaced in the 1990s by the Global Maritime Distress and Safety System (GMDSS), and the dedicated Radio Officer at his Morse key will then be obsolete. The change is already taking place and one early effect has been the closing down of many famous coast stations around the world and a reduction of the distress watch on 500kHz.

Radio amateur Bruce Morris, GW4XXF, himself an ex-ship's Radio Officer, has been collecting tape recordings of the last transmissions from coast stations or ship callsigns signing off from 500kHz for the very last time. He has now produced a compilation on cassette of some of these recordings including potted histories of each station.

This historic record includes farewell signals from British stations GLV, GIL, GKZ, GNI; PCH in Holland, and EJM in Ireland. The commentary is excellent, and some of the final signals are very moving. It would have been very easy for this one-time vital service to "slip away" into the ether unnoticed. Fortunately Bruce Morris has taken it on himself to ensure that an appropriate record remains for posterity.

His cassette, *500kHz. The End Is Nigh*, can be obtained from him at 62 Gerllan, Tywyn, Gwynedd, LL36 9DE, price £5 including p&p. He is still adding to his collection and would be delighted to hear from anyone who has famous coast stations or ship callsigns on tape, "or anything that gives the feel of that constant babble of Morse code on 500 from anywhere in the world."

DIRECT BOOK SERVICE

The books listed have been selected by Everyday Electronics editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue.

Special Everyday Electronics Books

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 PROJECTS – BOOK 1
Published by *Everyday Electronics* in association with Magenta Electronics.
Contains twenty of the best projects from previous issues of EE each backed with a kit of components The projects are Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator
128 pages (A4 size) Order code EPT **£2.45**

ELECTRONICS TEACH-IN No.5 GUIDE TO BUILDING ELECTRONIC PROJECTS NEW
Published by EVERYDAY ELECTRONICS
Due to the demand from students, teachers and hobbyists we have put together a range of articles from past issues of *Everyday Electronics* that will assist those involved with the construction of electronic projects
The book contains the complete *Project Development for GCSE* series
Contents: Features – First Steps in Project Building, Building with Vero, Project Development for GCSE, Getting your Project Working, Guide to Printed Circuit Boards, Choosing and Using Test Equipment – The Multimeter, The Oscilloscope, P S U s, Logic Probes, Digital Frequency Meters, Signal Generators, etc; **Data** – Circuit Symbols, Component Codes, Resistors, Identifying Components, Capacitors, Actually Doing It – Understanding the Circuit Diagram, Component Codes, Mounting circuit boards and controls, Understanding Capacitors, **Projects** – Lie Detector, Personal Stereo Amplifier, Digital Experimentsr's Unit, Quizmaster, Siren Effects Unit, UV Exposure Unit, Low-cost Capacitance Meter, Personal Radio
88 pages (A4 size) Order code TI5 **£2.95**

ELECTRONICS TEACH-IN 88/89 – INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303) The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc The course is ideal for the newcomer to the subject
80 pages (A4 size) Order code TI-88/89 **£2.45**

EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but also deals with a wide range of practical electronic applications.
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!
256 pages Order code DATA **£8.95**

ELECTRONICS TEACH-IN No. 3 – EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with
Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections
88 pages (A4 size) Order code TI3 **£2.45**

Computers and Computing

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 written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first" Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
64 pages Order code BP232 **£2.96**

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 6800 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc , in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
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., DC.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer
192 pages Order code BP112 **£3.95**

NEWNES COMPUTER ENGINEER'S POCKETBOOK (Second Edition)
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 data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit
205 pages (hard cover) Order code NE01 **£10.95**

UNDERSTANDING PC SPECIFICATIONS
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 from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money
This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc), Maths co-processors, Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM: RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times), Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!
104 pages Order code BP282 **£3.95**

Audio and Music

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**

PREAMPLIFIER AND FILTER CIRCUITS NEW
R. A. Penfold
This book provides circuits and background information for a range of preamplifiers, plus tone controls, filters, mixers, etc. The use of modern low noise operational amplifiers and a specialist high performance audio preamplifier i.c. results in circuits that have excellent performance, but which are still quite simple. All the circuits featured can be built at quite low cost (just a few pounds in most cases).

The preamplifier circuits featured include:- Microphone preamplifiers (low impendance, high impedance, and crystal). Magnetic cartridge pick-up preamplifiers with R I A A equalisation. Crystal/ceramic pick-up preamplifier. Guitar pick-up preamplifier. Tape head preamplifier (for use with compact cassette systems).

Other circuits include:- Audio limiter to prevent overloading of power amplifiers. Passive tone controls. Active tone controls. PA filters (highpass and lowpass). Scratch and rumble filters. Loudness filter. Audio mixers. Volume and balance controls.

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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**

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**

ACOUSTIC FEEDBACK – HOW TO AVOID IT NEW
Feedback is the bane of all public address systems. While feedback cannot be completely eliminated, many things can be done to reduce it to a level at which it is no longer a problem.

Much of the trouble is often the hall itself, not the equipment, but there is a simple and practical way of greatly improving acoustics. Some microphones are prone to feedback while others are not. Certain loudspeaker systems are much better than others, and the way the units are positioned can produce or reduce feedback. All these matters are fully explored as well as electronic aids such as equalizers, frequency-shifters and notch filters.

The special requirements of live group concerts are considered, and also the related problem of instability that is sometimes encountered with large set-ups. We even take a look at some unsuccessful attempts to cure feedback so as to save readers wasted time and effort duplicating them.

Also included is the circuit and layout of an inexpensive but highly successful twin-notch filter, and how to operate it.

92 pages Order code BP310 **£3.95**

COMPUTERS AND MUSIC. See Computers section

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**

Theory and Reference

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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NEWNES ELECTRONICS POCKET BOOK
E. A. Parr
Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op amp, applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.

315 pages (hard cover) Order code NE02 **£10.95**

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Owen Bishop
This book describes over 60 modular electronic circuits – how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control.

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FROM ATOMS TO AMPERES
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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?

Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.

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PRACTICAL DIGITAL ELECTRONICS HANDBOOK
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 pulser; verstaile 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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ELECTRONICS – A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics Teach-In* Book and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.

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Project Building

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R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

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R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

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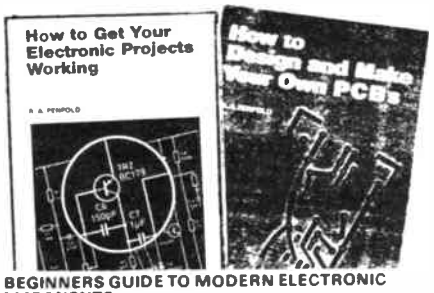

A BEGINNERS GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold
The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages Order code BP285 **£3.95**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also include examples in the form of simple projects.

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O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.

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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.

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Testing and 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, *viz* – 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**

Circuits and Design

PRACTICAL ELECTRONIC BUILDING BLOCKS – BOOK 1

PRACTICAL ELECTRONIC BUILDING BLOCKS – BOOK 2
R. A. Penfold
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators – sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers – simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous–noise generators, rectifiers, comparators and triggers, etc.

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 controller amplifiers. Filters – high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous – i.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* Order code BP117 **£1.95**
BOOK 2 *112 pages* Order code BP118 **£1.95**

MODERN OPTO DEVICE PROJECTS
R. A. Penfold
In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electrical devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.

While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.

104 pages Order code BP194 **£2.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston
One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.

124 pages Order code NE11 **£12.95**

DIGITAL LOGIC GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages Order code PC106 **£8.95**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kit and a wide range of mechanical components available. The 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.

92 pages Order code BP179 **£2.95**

ELECTRONIC POWER SUPPLY HANDBOOK
Ian R. Sinclair
This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

136 pages Order code PC108 **£7.95**

HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages Order code BP88 **£2.95**

MICRO INTERFACING CIRCUITS – BOOK 1
MICRO INTERFACING CIRCUITS – BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer; Book 2 deals primarily with circuits for practical applications.

BOOK 1 *112 pages* Order code BP130 **£2.75**
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.

179 pages Order code NE17 **£14.95**

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

64 pages Order code BP42 **£1.95**

BOOK 2 50 more l.e.d. circuits Order code BP87 **£1.95**

Radio, TV, Satellite

AN INTRODUCTION TO AMATEUR RADIO
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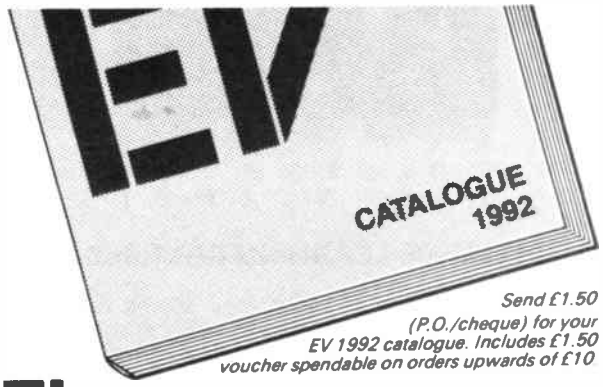

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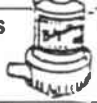

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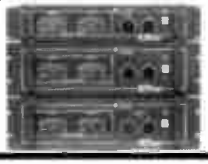

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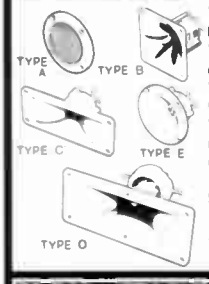

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SPECIALIST CARRIER DEL. £12.50 PER PAIR

IN-CAR STEREO BOOSTER AMPS

PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono
ALL POWERS INTO 4 OHMS
Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D.s (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control for very fast rise and decay times. Tough moulded plastic case, with acrylic tinted front. Size 84 x 27 x 45mm.
PRICE £8.70 + 50p P&P

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LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (50p STAMPED) FOR COMPLETE LIST.

P - From McKenzie Professional Series
S - From McKenzie Studio Series

McKENZIE:- INSTRUMENTS, P.A., DISCO, ETC

ALL McKENZIE UNITS 8 OHMS IMPEDANCE

8" 100 WATT **P** C8-100GP GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 80Hz, FREQ. RESP. TO 7KHz, SENS 96dB. PRICE £31.45 + £2.00 P&P

10" 100WATT **S** C10-100GP GUITAR, VOICE, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 72Hz, FREQ. RESP. TO 6KHz, SENS97dB. PRICE £38.89 + £2.50 P&P

10" 200WATT **S** C10-200GP GUITAR, KEYB'D, DISCO, EXCELLENT HIGH POWER MID.
RES. FREQ. 69Hz, FREQ. RESP. TO 5KHz, SENS 97dB. PRICE £53.21 + £2.50 P&P

12" 100WATT **P** C12-100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO.
RES.FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 98dB. PRICE £40.35 + £3.50 P&P

12" 100WATT **P** C12-100TC (TWIN CONE) HIGH POWER, WIDE RESPONSE, P.A., VOICE, DISCO.
RES. FREQ 45Hz, FREQ. RESP. TO 12KHz, SENS 97dB. PRICE £41.39 + £3.50 P&P

12" 200WATT **S** C12-200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 45Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £71.91 + £3.50 P&P

12" 300WATT **S** C12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARDS, DISCO ETC.
RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 100dB. PRICE £95.66 + £3.50 P&P

15" 100WATT **P** C15-100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 98dB. PRICE £ 59.05 + £4.00 P&P

15" 200WATT **P** C15-200BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 3KHz, SENS 98dB. PRICE £80.57 + £4.00 P&P

15" 250WATT **S** C15-250BS VERY HIGH POWER BASS.
RES. FREQ. 39Hz, FREQ. RESP. TO 4KHz, SENS 99dB. PRICE £90.23 + £4.50 P&P

15" 400WATT **S** C15-400BS VERY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 4 KHz, SENS 100dB. PRICE £105.46 + £4.50 P&P

18" 500WATT **S** C18-500BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 27Hz, FREQ. RESP. TO 2KHz, SENS. 98dB. PRICE £174.97 + £5.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)
BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8" 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P

10" 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P

10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P

12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P

6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P

8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P

10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

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PRICE £8.90 + £1.00 P&P

PHOTO: 3W FM TRANSMITTER

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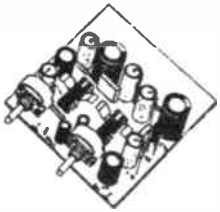
ARE SUBJECT TO VAT

CALLERS WELCOME MON - SAT

Accoustic Water Detector Kit

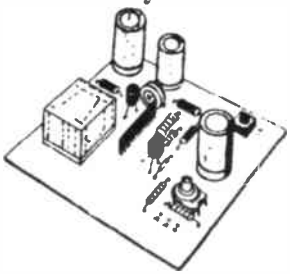


Raises a loud alarm on contact with water. Ideal for broken pipes overflowing washing machines, bath tubs etc. Sensor can be connected by a longer cable up to 100m away. Power supply 9v battery. £5.00 Ref 5P212

Electronic Accupuncture kit.

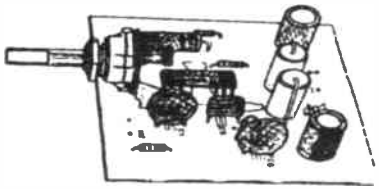
This kit operates in accordance with the electronic accupuncture method. Complete with instructions. migrane, poor circulation, backache etc! 3-12v operation. £7.00 ref 7P36

Universal Alarm System Kit.



Reliable alarm system for 9 - 12v operation. Max 20 alarm contacts may be connected. Adjustable starting and alarm time delay of a few seconds, alarm time approx 30-60 sec. includes reset button. £14.00 ref 14P15.

Hi Fi Amplifier kits.



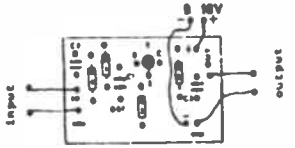
Two types available.
No1 is a stereo amplifier with a 2 x 8 watt output. £14.00 Ref 14P16.

No 2 is a 10 watt mono. £9.00 ref 9P19

Antenna Amplifier kit.

Wide band antenna amplifier approx 0.15-350mhz, 9 -18v Gain approx 5-20 db (VHF approx 10db) Ideal for improving reception of radios and TV sets. (Up to 150mhz). £5.00 Ref 5P213.

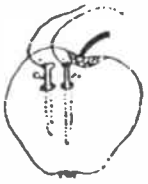
Antenna Amplifier Kit No 2.



Wide band antenna amplifier approx 30-850 mhz. 12-18v operation. In and out impedance 60R. Max gain 20db. Ideal for use in the UHF and VHF bands. £8.00 ref 8P54.

Apple Powered Radio

Small medium wave radio. The operating voltage is generated by two special electrodes inserted in an apple. £7.00 Ref 7P37.



DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
AERIALS			
102mm x 6mm ferrite rods for aerials etc.	4	£1.00	BD445
Slab ferrite aerials with Long and Medium wave coils.	2	£1.00	BD61
5" ferrite rods with Long and Medium wave coils.	2	£1.00	BD185
Telescopic aerials suitable for radios etc. chrome. 630mm	2	£1.00	BD255
ALARMS			
6" underdome alarm bell. 24v operation.	1	£8.00	8P2
Piezo sounder 3-30v operation 90db output. 25 x 4mm.	1	£1.00	BD647
Piezo siren 12v DC 150mA 100db cased with bracket.	1	£7.00	7P26
Minature electronic buzzer 22x16x15mm. 6v 25mA 82db.	1	£1.00	CD22
Minature electronic buzzer 22x16x15mm. 9v 25mA 82db.	1	£1.00	CD23
Minature electronic buzzer 22x16x15mm. 12v 25mA 82db	1	£1.00	CD24
Electronic siren waterproof horn 200x115x234mm 120 db output 6 -12v 2A.	1	£24.00	24P7
Star wars horn.12v klaxon shaped siren.	1	£4.00	4P43
AMPLIFIERS			
Stereo 2 x 2 watt amplifier with v/c+ data sheet.	1	£2.00	2P51
TV amplifier 1 way mains, cased 7db gain.	1	£9.00	9P14
TV amplifier 2 way mains, cased 14db gain.	1	£12.00	12P45
TV amplifier 8 way mains, cased 21 db gain.	1	£27.00	27P1
2W record player amplifier with volume control.	1	£1.00	BD351
Unilex 4W Mullard ref EP9000.	1	£2.00	2P11
Unilex streo preamp Mullard ref EP9001.	1	£1.00	BD216
1W amplifier Mullard ref 1172. 9v.	1	£1.00	BD114
150w stereo power amp 12v 20-20KHZ. Cased.	1	£57.00	57P1
7 channel graphic equalizer plus 60w power amp. 12v.	1	£25.00	25P14
BASES			
11 pin moulded bases for valves or relays. chassis mnt.	4	£1.00	BD93
BATTERY CHARGERS			
Transformer type Nicad charger, mains op.	2	£1.00	BD385
Nicad charger 5.2v output at .7vA.	1	£2.00	2P153
Universal nicad charger takes AA,D,C and PP3,s.	1	£6.00	6P36
BATTERIES AND BATTERY HOLDERS			
Nicad battery PCB mount 25x25x15mm 3.6v 100maH.	1	£2.00	2P340
4aH D size nicad cell.	6	£10.00	10P47
Battery holder for 6 D cells.	1	£1.00	BD286
Battery holder for 2 D cells.	2	£1.00	BD287
PP3 battery connectors with leads.	5	£1.00	BD759
Lithium battery 3v. 24mm x 2mm PCB mount.	2	£1.00	BD558
AA nicad rechargeable battery.	4	£4.00	4P44
AAA nicad rechargeable battery. (ex equipment).	10	£4.00	4P92
C size nicad battery.	2	£4.00	4P73
D size nicad battery.	4	£9.00	9P12
PP3 size 9v nicad battery.	1	£6.00	6P35

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Pack of 10 mixed watch and calculator button cells.	1	£1.00	CD210
Universal charger to take all above batteries.	1	£6.00	6P36
YUASHA 6 volt 10 AH sealed lead acid. Rechargeable.	2	£10.00	10P95
Lithium battery 9 volt 33 x 13mm.	1	£2.00	2P290
BOOKS			
25 simple amateur band aerials.	1	£1.95	BP125
Practical digital electronics.	1	£6.95	CF2
Electronic power supply handbook.	1	£7.95	CF3
The worlds broadcasting stations. LW,SW,MW,FM,TV.	1	£12.95	CF4
25 indoor and window aerials.	1	£1.75	BP136
30 solderless breadboard projects book 1.	1	£2.95	BP107
30 solderless breadboard projects book 2.	1	£2.25	BP113
50 FET projects.	1	£2.95	BP39
50 circuits using 7400 series ic's.	1	£2.50	BP58
50 circuits using germanium & silicon diodes.	1	£1.50	BP278
50 projects using relays scr's and triacs.	1	£2.95	BP37
50 simple LED projects book 2.	1	£1.95	BP87
A concise advanced users guide to MS-DOS.	1	£2.95	BP264
A concise introduction to D-BASE.	1	£3.95	BP263
A concise introduction to GEM.	1	£2.95	BP230
A concise introduction to MS-DOS.	1	£2.95	BP232
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An introduction to BASIC 2 on the Amstrad PC.	1	£5.95	BP199
An introduction to amateur radio.	1	£3.50	BP257
An introduction to loudspeaker enclosure design.	1	£2.95	BP256
An introduction to satellite television.	1	£5.95	BP195
An introduction to Amstrad PC's.	1	£5.95	BP197
An introduction to Z80 machine code.	1	£2.75	BP152
Audio amplifier construction.	1	£2.95	BP122
Audio projects.	1	£2.50	BP90
Coil design and construction manual.	1	£2.50	BP160
Computer hobbyists hand book.	1	£5.95	BP251
Computer music projects.	1	£2.95	BP173
Digital audio projects.	1	£2.95	BP245

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Electronic circuits for model railways.	1	£2.95	BP180
Electronic circuits for robots.	1	£2.95	BP179
Electronic hobbyists handbook.	1	£4.95	BP233
Electronic projects for cars and boats.	1	£1.95	BP94
Electronic science projects.	1	£2.95	BP104
Electronic security projects.	1	£2.50	BP56
Crystal set construction.	1	£1.75	BP92
Electronic calculations and formulae.	1	£4.95	BP144
How to design and make your own PCB's.	1	£2.50	BP121
How to design electronic projects.	1	£2.25	BP127
How to get your electronic projects working.	1	£2.50	BP110
How to identify unmarked IC's.	1	£0.95	BP101
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International transistor equivalents.	1	£3.50	BP85
An introduction to UNIX.	1	£2.95	BP259
Midi projects.	1	£2.95	BP184
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Advanced power supply projects.	1	£2.95	BP192
Popular electronic circuits book1.	1	£2.95	BP80
Popular electronic circuits book2.	1	£2.95	BP98
Power supply projects.	1	£2.50	BP76
Projects in opto electronics.	1	£1.95	BP45
Upgrading and repairing PC's and compatables.	1	£4.95	BP271
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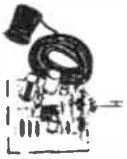
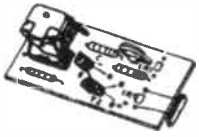
Telephone Amplifier Kit.
Suitable for monitoring telephone s with pickup coil (supplied)
8R speaker and 9V supply required.
£8.00 Ref 8P159



Thermal Switch Kit.
Turns a device on or off at a pre fixed temperature ideal ice warning, fire, extractor fan, heating etc.
-30 to +150 deg C. 5A relay output.
£9.00 Ref 9P24



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Emits high powered ultrasonic sound adjustable from 8000-25000hz
Complete with transducer. 9v battery required.
£6.00 Ref 6P86.

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Stroboscope kit with U shaped tube. Adjustable speed 1-10hz.
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Screen pattern generator for connection to aerial socket of TV
Choice of different patterns available.
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Twilight Switch.
Turns a light on automatically at twilight and off at day break.
Adjustable sensitivity. max 250 watt 240v ac.
£9.00 Ref 9P25

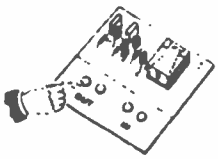
Warship Siren Kit.
Decks clear for action siren
3-15 watt output
6-12v operation. 8R speaker req'd.
£9.00 Ref 9P21.

Star Wars Siren Kit.
3-15 watt output
12v 1.5A supply
8-32R speaker req'd.
£9.00 Ref 9P23.

Robot Voice Kit.

Modulates human voice with an adjustable frequency to produce different voice effects. Voice requires amplification afterwards. ie tape reorder etc. 9-12v supply.
£8.00 Ref 8P56.

Touch Switch Kit.
If th sensors are touched by a finger or nose etc relay will be operated and can operate equipment as required. 9-12v supply.
£7.00 Ref 7P42



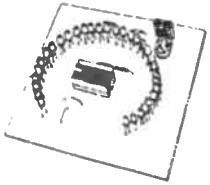
Kojak Siren Kit.
Very loud siren 12v
8-32R speaker req'd.
£9.00 Ref 9P22.

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
50 simple LED projects book 1.	1	£1.95	BP42
BBC basic on PC's.	1	£3.95	BP243
An introduction to radio DXing.	1	£1.95	BP91
How to use op amps.	1	£2.95	BP88
Simple shortwave broadcast aerials.	1	£1.95	BP132
Basic and Pascal in parallel.	1	£1.50	BP126
Essential theory for electronic hobbyists.	1	£2.50	BP228
Solid state short wave receivers for beginners.	1	£2.95	BP222
Practical introduction to digital IC's.	1	£2.50	BP225
Popular electronic projects.	1	£2.50	BP49
How to build advanced short wave receivers.	1	£2.95	BP226
An introduction to Basic programming.	1	£1.95	BP86
Electronic music projects.	1	£2.50	BP74
Basic and Fortran in Parallel.	1	£1.95	BP137
Accoustic Feedback and how to avoid it.	1	£3.95	BP310
More advanced electronic music projects.	1	£2.95	BP174
How to get your computer programs running.	1	£2.50	BP169
Learning to program in C.	1	£4.95	BP258
From Atoms to Amperes.	1	£3.50	BP254
Programming in Fortran 77.	1	£4.95	BP250
Electronic synthesiser construction.	1	£2.95	BP185
An introduction to computer communications.	1	£2.95	BP177
BBC basic 86 on PC's.	1	£2.95	BP244
Power selector guide.	1	£4.95	BP235
An introduction to Antenna theory.	1	£2.95	BP198
Test equipment construction.	1	£2.95	BP248
More advanced power supply projects.	1	£2.95	BP265
A concise introduction to Smartware II.	1	£4.95	BP283
Beginners guide to building projects.	1	£1.95	BP227
How to build more advanced shortwave receivers.	1	£2.95	BP226
International radio stations guide.	1	£5.95	BP255
Basic and Logo in parallel.	1	£2.95	BP196
TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE.	1	£20.00	20P32
BOXES AND CASES			
Black ABS project box 165mm x 119mm x 75mm.	1	£3.00	3P49
Metal box 8" x4" x4" louvred ends, ideal psu.	1	£3.00	3P75
Metal box 8" x4" x1", slightly sloping.	1	£1.00	BD209
PLastic box with screw on lid 216mm x 130mm x 85mm	1	£4.00	4P7
Plastic box with screw on lid 220mm x 159mm x 64mm	1	£4.00	4P8
4"x2"x2" project boxes with slot in top.	2	£1.00	BD780
ABS project box 90x50x25mm black.	1	£1.00	CD25
ABS project box 110x56x20mm black.	1	£1.00	CD26B
ABS project box 100x75x40mm black.	1	£1.00	CD27A

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
ABS project box 150x100x55mm black.	1	£2.00	2P341
ABS project boxs with anodised aluminium top panels.			
90 x 45 x 30mm.	1	£2.00	2P410
125 x 70 x 40mm	1	£3.00	3P410
220 x 135 x 75mm	1	£5.00	5P510
Aluminium 2 piece cases covered in protective film.			
55 x 40 x 25mm	1	£1.00	CD410
105 x 125 x 35mm	1	£3.00	3P411
155 x 105 x 45mm	1	£4.00	4P152
175 x 125 x 45mm	1	£5.00	5P211
BURGLAR ALARMS			
Car alarm system complete with ultrasonic detector 110db siren, engine immobilizer, battery backup, remote control.	1	£75.00	75P6
Add on central locking kit for above system.	1	£10.00	10P150
Internal PIR alarm sensor 12v, covers whole room.	1	£15.00	15P49
Domestic alarm panel keypad entry 2 zone. New.	1	£18.00	18P13
Alarm sirens 9-12v loud, low power consumption.	1	£4.00	4P93
Smoke alarm ionization type.	1	£5.00	5P206
CABLE TIES			
75mm x 2.4mm nylon white cable ties.	100	£1.00	BD868
75mm x 2.4mm nylon white cable ties (1,000 pack).	1	£5.00	5P181
142mm x 3.2mm nylon white cable ties.	100	£3.00	3P104
142mm x 3.2mm nylon white cable ties (1,000 pack).	1	£14.00	14P6
385mm x 5mm nylon white cable ties.	100	£10.00	10P97
Cable tie bases 21 x 21mm self adhesive.	100	£5.00	5P182
Cable tie bases 28 x 28mm self adhesive.	100	£5.00	7P25
Cable tie gun. Tensions then cuts tie. Good value.	1	£6.00	6P38
Spiral cable wrap for 6 -50mm bundles (10 m length).	1	£2.00	2P329
Spiral cable wrap for 12-70mm bundles (10 m length).	1	£4.00	4P74
CAPACITOR BARGAIN PACKS			
Mixed pack of non electrolytic capacitors.	100	£3.00	3P412
Mixed pack of electrolytic capacitors.	40	£2.00	2P287
Mixed pack of ceramic capacitors.	100	£4.00	4P153
CAPACITORS AC WORKING			
Capacitor 8uf 440v AC 97 x 45mm.	1	£1.00	BD632
Capacitor 1uf 440v AC 48 x 38mm.	2	£1.00	BD633
Capacitor 15uf 440v AC 120 x 75 x50mm.	1	£2.00	2P201
Capacitor 2uf 440v AC 70 x 35mm.	1	£2.00	2P164
Capacitor 12uf 660v AC 150 x 90 x 45mm.	1	£2.00	2P163
Capacitor 2.5uf 440v AC 73 x 30mm.	1	£2.00	2P176
CAPACITORS ELECTROLYTIC			
Capacitor 4,700uf 25v axial.	4	£1.00	BD613
Capacitor 32uf + 32uf 350v.	2	£1.00	BD608
Capacitor 10uf 25v radial.	20	£1.00	CD26A

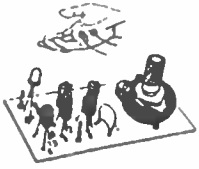
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Capacitor 22uf 25v radial.	20	£1.00	CD27C
Capacitor 47uf 25v radial.	15	£1.00	CD28A
Capacitor 100uf 25v radial.	12	£1.00	CD29A
Capacitor 220uf 25v radial.	10	£1.00	CD30A
Capacitor 470uf 25v radial.	6	£1.00	CD31A
Capacitor 1000uf 25v radial.	5	£1.00	CD32A
Capacitor 2200uf 25v radial.	4	£1.00	BD856
Capacitor 2200uf 6.3v 5.8A can type.	1	£1.00	BD644
CAPACITORS EHT			
Capacitor 220pf 8kv ceramic.	4	£1.00	BD440
Capacitor 100pf 8kv ceramic.	5	£1.00	BD442
Capacitor 68pf 8kv ceramic.	10	£1.00	BD443
Capacitor 2.5nf 10kv 35 x 15mm.	2	£1.00	BD522
Capacitor .265uf 1.5kv metal case. 110 x55 65mm	1	£1.00	BD362
Capacitor 500pf 10KV ceramic.	20	£2.00	
CAPACITORS VARIABLE			
Air spaced 2 gang 1/4" spindle 365pf.	2	£1.00	BD36
Solid di-electric AM & FM sections. Two gang.	2	£1.00	BD37
Minature twin tuning condensor 150pf 1/4" sindle.	1	£2.00	2P237
Transmitter tuning condensor 160pf (ex-equip).	1	£1.00	BD424
Trimmer capacitor 3-40pf Mullard.	1	£1.00	BD656
CONTACTORS			
Heavy duty 24v DC operation 4 pole 25A 95x60x70mm.	1	£1.00	BD68
Heavy duty mains operation 4 pole 25A 90x75x90mm.	1	£5.00	5P64
COUNTERS			
Tape deck counter 3 digit. resettable. flywheel/belt op.	2	£1.00	BD26
7 digit 24v counter panel mount.	1	£2.00	2P267
Resettable 3 digit. mains operated 45x70x60mm.	1	£2.00	2P26
6 digit counter 12v DC operation.	1	£2.00	2P342
CRYSTALS			
1000 KHZ crystal	1	£1.00	BD866
5242.880 HZ	1	£1.00	BD867
8 mhz 12 x 5mm.	1	£1.00	BD937
CONNECTORS			
3.5mm mono jack sockets. Chassis mount.	8	£1.00	BD697
Chassis mount BNC socket. (4 hole fixing).	2	£1.00	BD851
Bulgin 3 pin line socket 1 1/2" diameter.	2	£1.00	BD715
9 way D type male solder. Gold plated.	3	£1.00	BD941
9 way D type female solder. Gold plated.	3	£1.00	BD942
Plastic hood for 9 way connector.	3	£1.00	BD943
15 way D type male solder. Gold plated.	2	£1.00	BD944
15 way D type female solder. Gold plated.	2	£1.00	BD945
Plastic hood for 15 way connector	2	£1.00	BD947
25 way D type male solder. Gold plated.	3	£2.00	2P306

LED VU Meter Kit.



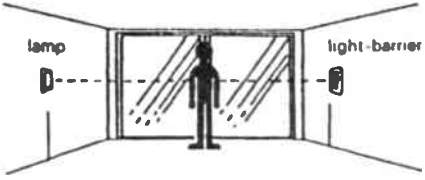
30 LED voltage display fully adjustable. Ideal as meter amp output etc. £15.00 Ref 15P58.

Lie Detector Kit.



Monitors changes of skin resistance which change during lies, fear etc. 4.5v. £6.00 Ref 6P57.

Light Barrier Kit.

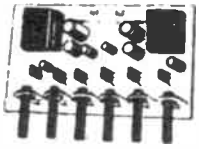


A lght barrier which causes an LDR to operate a relay. Light source required (i.e torch). 5A relay contact output. 12v operation. £9.00 Ref 9P20.

Single Channel Sound To Light Kit.

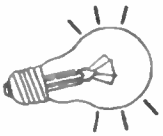
Illuminates light bulbs to rhythm of music. Ideal for paties etc. Max 240v 1000 watt. £6.00 Ref 6P84.

Six Channel Sound To Light Kit.



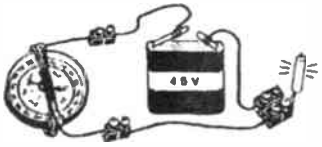
Each channel is adjustable max 500 watt per channel 240v AC high sensitivity. £17.00 Ref 17P6.

Light Swelling Kit.



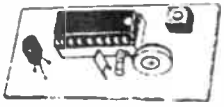
240v light bulbs (max 200w) are gradually dimmed and illuminated at regular intervals (approx every 2 secs) Ideal displays, discos etc. £11.00 Ref 11P11.

Little Electrotechnician Kit.



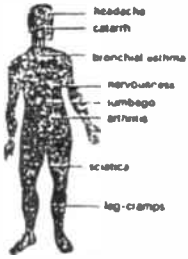
Educational kit for beginners comprising 7 different circuits. 4.5v batt required. £8.00 Ref 8P156.

12 Melodies Generator Kit.



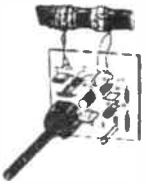
Plays 12 different tunes at the touch of a button. 3v. 8R speaker required. £11.00 Ref 11P12.

Mesmeric Instrument Kit.



Magnetic field instrument is said to have curing effect on certain ailments! £8.00 Ref 8P157.

Metal Detector Kit.



Uses mini ferrite aerial to detect metal in walls etc 6cm range led output. 9v. £5.00 Ref 5P199

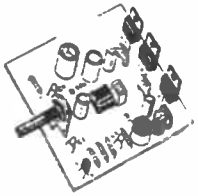
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
25 way D type female solder. Gold plated.	3	£2.00	2P307
Plastic hood for 25 way connector.	3	£2.00	2P308
XLR 3 pin inline metal plug. Latching.	1	£2.00	2P354
XLR 3 pin inline metal socket. Latching.	1	£2.00	2P355
XLR 3 pin chassis mount metal socket. Latching.	1	£2.00	2P356
XLR 3 pin chassis mount metal plug. Latching.	1	£2.00	2P357
1 1/4" mono plastic jack plug.	3	£1.00	CD200
1 1/4" stereo plastic jack plug.	2	£1.00	CD201
1 /14" chassis mount mono switched socket.	2	£1.00	CD202
1 1/4" chassis mount stereo switched socket.	2	£1.00	CD203
Bulgin 8 pin mains plug 6A.	1	£4.00	4P83
Bulgin 8 pin chassis socket 6A.	1	£2.00	2P358
Scotch lock connectors (for car wiring etc up to 3.5mm)	100	£6.00	6P55
Centronics 36 way cable plug (inc cover).	1	£1.00	BD948
4 mm banana plug. red.	4	£1.00	BD953
4 mm banana plug. black.	4	£1.00	BD954
4 mm banana socket red	4	£1.00	BD955
4 mm banana socket. black.	4	£1.00	BD956
Crocodile clips (pack of 10 red and 10 black).	1	£2.00	2P309
BNC 50 ohm plug.	3	£2.00	2P310
BNC 75 ohm plug.	3	£2.00	2P311A
SCART plug.	1	£1.00	BD957
CO-AX plug (TV type).	5	£1.00	BD958
CO-AX socket (TV type).	2	£1.00	BD959
2.5 mm jack plug. (Mono).	5	£1.00	BD960
3.5 mm jack plug. (Stereo).	3	£1.00	BD961
CONNECTOR AND TERMINAL STRIPS			
12 way 3A connector strip. One side screw terminals the other side is solder terminals.	5	£1.00	BD451
12 pole 25A poly connector strip. Screw type.	2	£1.00	BD159
12 way 5A connector strip.	4	£1.00	BD158
3 way connectors plug in type.	4	£1.00	BD160
CLOCKS			
Flip over digital clock no case.	1	£3.00	3P139
Electric cooker clock mains operated, no case.	1	£1.00	BD211
COILS AND FORMERS			
Subminature I/F transformers (all the same type).	100	£1.00	BD360
465KC I/F transformers 1/2" x 11/2" high.	4	£1.00	BD40
COMPONENT MOUNTINGS			
50 tag component mounting strip.	2	£1.00	BD168
COMPUTER BITS			
2 way RS232 DATA swich (3 female D25). Cased.	1	£14.00	14P7
2 way Centronics data switch (3 Centronics fem) cased.	1	£18.00	18P9
Spectrum sound box with amplifier etc.	1	£4.00	4P53

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
1200/75 internal PC modems, data but no software.	1	£9.00	
BBC joystick with 2 fire buttons.	1	£2.00	2P360
Quickshot joycard VII for Atari and Commodore.	1	£3.00	3P85
Computer mice (single button).	1	£8.00	8P57
3 1/2" customer returned drives. No data.	1	£7.00	7P35
Commodore 64 data drive system.	1	£25.00	25P27
Dial up modems no data or info. Cased.	1	£3.00	3P1E
Customer returned portable computers.	1	£75.00	75P1E
Atari joysticks.	1	£4.00	4P6E
Tandata viewdata system.	1	£20.00	20P40
Spectrum joystick interface.	1	£4.00	4P5E
Monitor converter converts RGB monitor into TV.	1	£25.00	A25P2
Chinnon cased disc drive with leads 3 1/2" 360K	1	£40.00	40P1
Acorn data recorder ALF503 with psu and leads.	1	£15.00	15P43
Coverter to change bbc joystick port to Atari type.	1	£2.00	2P261
Computer terminals s/hand. mixed makes.	1	£15.00	15P33
Keyboard made for OPD Computer.	1	£3.00	3P27
Commodore 64 games pack (5 different).	1	£3.00	3P97
Spectrum 48K games pack (5 different).	1	£3.00	3P96
PC power supply 150W switch on back. Cased.	1	£15.00	15P54
PC power supply 200 W switch on back. Cased.	1	£20.00	20P41
Amstrad CTM644 colour monitor (RGB).	1	£75.00	75P7
Amstrad 464 computer with GT65 monitor and software.	1	£89.00	89P3
Spectrum +3 light gun and software pack.	1	£8.00	8P1E
Spectrum +2 lightgun and software pack.	1	£8.00	8P150
VGA mono paper white 12" mains monitors.	1	£45.00	45P150
Amber hi res 12" Hercules/TTL 12v 1.5A monitor.	1	£22.00	22P26
DELAY SWITCHES			
Mains motor driven switch 20 secs on or off after push of button.	1	£3.00	3P138
DIODES			
OA91 germanium signal diode.	10	£1.00	BD976
IN4148 signal diode.	30	£1.00	BD977
IN4001 50v 1A	25	£1.00	BD971
IN4002 100v 1A	25	£1.00	BD972
IN4006 800v 1A	20	£1.00	BD973
IN5401 100v 3A	10	£1.00	BD974
IN5408 1000v 3A	8	£1.00	BD975
DISPLAYS			
16 character 2 line display. Epsom with data.	1	£10.00	10P50
Vaccuum flourescent displays. 4 letters or digits.	2	£1.00	BD614
7 segment displays common cathode .5".	4	£1.00	BD466
.3" 7 segment LED display. Common cathode.	4	£3.00	3P117
.3" 7 segment LED display. Common anode.	4	£3.00	3P118

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
.5" 7 segment LED display. Common cathode.	4	£3.00	3P119
.5" 7 segment LED display. Common anode.	4	£3.00	3P120
.56" 7 segment LED display. Common cathode.	4	£3.00	3P121
.56" 7 segment LED display. Common anode.	4	£3.00	3P122
Clock display 1/2" figures.	1	£1.00	BD329
16 character 1 line display no data.	1	£6.00	6P32
LCD display 4 digit with connection data.	1	£3.00	3P77
ELECTRICAL ACCESSORIES			
13A switched double socket. White. New.	1	£4.00	4P75
13A switched single socket. White. New.	1	£2.00	2P343
Single gang light switch. White. New.	1	£1.00	CD27
Two gang light switch. White. New.	1	£2.00	2P344
Ceiling rose. White. New	1	£1.00	CD28
Pendant lampholder. White. New.	2	£1.00	CD29
Pendant lampholder with switch. White. New.	1	£1.00	CD30
Batten lampholder. White. New.	1	£1.00	CD31
Battened lampholder angled. White. New.	1	£1.00	CD32
Junction box 15A. White. New.	1	£1.00	CD33
Junction box 30A. White. New.	2	£3.00	3P115
Dimmer switch 630 watt. White. New.	1	£4.00	4P77
Dimmer switch 630 watt brushed aluminium. New.	1	£5.00	5P185
White flush light switches. Standard fixing.	2	£1.00	BD5
Double pole 20A switch on standard plate with neon.	1	£1.00	BD531
Double pole 20A mains brown surface mount switch.	2	£1.00	BD190
White shallow pattress for switches etc.	10	£1.00	BD338
30A rotary switch surface mounting with pointer knob.	1	£2.00	2P122
MK splitter 45A switch 3 x 15A fuses.	1	£5.00	5P100
Switched spur in meta box.	1	£1.00	BD589
Inflex push switch for table lamp etc.	3	£1.00	BD562
Pull switch ceiling mount with cord and tassle. white.	1	£1.00	BD528
13A swiched socket and spur on double plate. Brown.	1	£1.00	BD249
13A fused spur and socket on double plate. White.	1	£1.00	BD302
13A ring main spur boxes.	5	£1.00	BD2
Cable clips 2.5mm flat with hardened nails.	50	£1.00	BD577
5A 3 pin flush sockets. Brown.	6	£1.00	BD193
Shaver adaptors for 13A sockets.	2	£1.00	BD617
13A adaptors to take 2 13A plugs.	3	£2.00	2P187
13A plugs with sleeved pins. white.	10	£5.00	5P195
EMERGENCY LIGHTING (3 HRS)			
3 watt 6" flourescent. cased.	1	£30.00	30P3
FANS AND BLOWERS			
4 1/2" x 41/2" Muffin type fan 115v (ex-computer).	1	£3.00	3P36
Snail type. 6"x4" 240v 270mA. silent and powerful.	1	£5.00	5P166
41/2" x 41/2" Muffin type fan 230v (ex-computer).	1	£5.00	5P40

Metronome Kit.
An ajustable electronic metronome with a signature between 30 and 300 beats per min.
Loud speaker output. 4.5-6v supply.
£7.00 Ref 7P40.

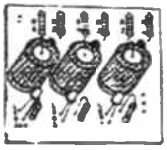
12v 3 Channel Sound To Light Kit
Kit will drive 3 x 12v halogen bulbs (max 100w each). Heatsinks and bulbs required 12vAC operation.
£12.00 Ref 12P57



Microhone Preamp Kit.
Impedance load variable from 4R to 100kR.
Input voltage 2-40mV
Output max 1.8v
20-40khz. 6-20v operation.
£6.00 Ref6P85.

Mini Moving Light Kit.
Moving light with 3 very small bulbs.
Adjustable speed
9-12v ideal for models, brooches etc.
£5.00 Ref 5P216

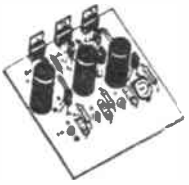
Mini Traffic Light Kit.
3 small LED's are illuminated one after the other.
4.5-6v operation.
£5.00 Ref 5P200



Morse Code Practice Kit.
Sound generator with touch switch and loud speaker. 3-9v £8.00 Ref 8P158

Moving Rope Light Kit.
Complete kit to build a rope light 6.5m long. Gives running light effect.
Requires 12v 2.5A. £25.00 Ref 25P28

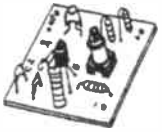
Moving Light Kit.
Adjustable speed uses 6-24v bulbs max 3A (3 chan).
£12.00 Ref 12P54



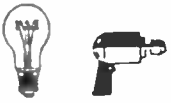
10 Channel Moving Light.

Drives 10 500watt 240v bulbs.
Speed adjustable.
£30.00 Ref 30P11.

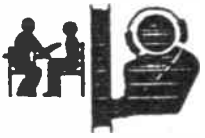
MW Testing Transmitter.
Close range test oscillator.
Not to be used for transmitting.
£5.00 Ref 5P217



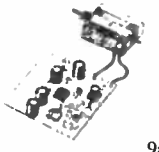
Power Controller Kit.
Regulates bulbs, drills stoves, soldering irons etc. Max 1300 watt.
£12.00 Ref 12P55



Spy Stethoscope Kit.
Using an earpiece allows you to listen through thin walls, doors windows etc.
£15.00 Ref 15P59.



SW CB Receiver Kit.
Short wave receiver for CB etc (6-30mhz)
4.5-6v. £15.00 Ref 15P60.



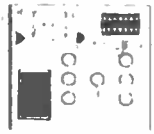
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
3 3/4" square Papst fan 110v.	1	£5.00	5P53
3 1/4" square 12v brushless fan. 120mA PAPST.	1	£12.00	12P12
85mm square 240v fans.	1	£9.00	9P10
5" Woods extractor fan (ex-equipment) 230v.	1	£5.00	5P41
5" alumimium fan blades to fit 1/4" shaft.	2	£1.00	BD86
Mains motor to suit above blades.	1	£1.00	BD88
18" long tangential blower with motor at 1 end. 230v.	1	£10.00	10P89
14" blower with motor in the middle. 230v.	1	£10.00	10P90
12v DC fan made by Papst 3 1/2" square.	1	£10.00	10P33
Mains operated centrifugal blower 5" x 1 1/2" output.	1	£5.00	5P99
4 1/2" x 4 1/2" Axial fan. Papst 230v.	1	£6.00	6P6
Plastic fan blades approx 3" across.	2	£1.00	BD638
4 1/2" x 4 1/2" brushless fan 12v.	1	£5.00	5P196
6 1/2" powerful fan 240v 210 cu ft min	1	£10.00	10P67
FEET			
38mm square self adhesive feet.	8	£1.00	BD726
20mm square self adhesive feet.	8	£1.00	BD891
12.5mm square self adhesive feet.	12	£1.00	BD892
FERRITE POTS ETC			
1" diameter for chokes etc.	20	£1.00	BD363
Ferrite core 56mm x 18mm E shaped.	4	£1.00	BD156
FLUORESCENT LIGHTING			
12" 8 watt fluorescent tube.	1	£1.00	BD314
Philips W tube 30 watt.	1	£1.00	BD336
Starter for 40-80 watt tube.	4	£1.00	BD92
Starter holders. Standard type.	4	£1.00	BD407
Terry clip for 1 1/2" tube.	5	£1.00	BD406
12v cased flourescent light with on/off switch. 8w.	1	£8.00	8P48
DISC DRIVES AND DISCS			
3 1/2" 720K drive by NEC.	1	£60.00	60P2
3" disc for Amstrad etc.	1	£3.00	3P24
3 1/2" disc.	2	£2.00	2P185
5 1/4" disc drives 720K brand new.	1	£35.00	35P5
5 1/4" ex equipment 360K drive .(condition unknown).	1	£18.00	18P5
5 1/4" discs unbranded but good quality.	10	£5.00	5P168
3 1/2" discs unbranded but good quality.	15	£10.00	10P88
Disc box holds 100 5 1/4" discs. Lockable.	1	£11.00	11P5
Disc box holds 40 3 1/2" discs or CDs. lockable.	1	£9.00	9P4
FUSES AND FUSEHOLDERS			
20mm quick blow 250mA.	12	£1.00	BD983
20mm quick blow 500mA	12	£1.00	BD984
20mm quick blow 1A.	12	£1.00	BD985
20mm quick blow 2A.	12	£1.00	BD986
20mm quick blow 4A.	12	£1.00	BD987

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
1" plug top fuse 2A.	10	£1.00	BD993
1" plug top fuse 3A.	10	£1.00	BD994
1" plug top fuse 5A.	10	£1.00	BD995
1" plug top fuse 13A.	10	£1.00	BD996
20mm chassis mount fuseholders.	20	£1.00	BD543
Panel mount fuseholder 20mm..	4	£1.00	BD618
1 1/4" fuse holder. Panel mount.	5	£1.00	BD752
Fuse pack no 1. 50 1 1/4" fuses (10 diff values).	50	£2.00	2P384R
Fuse pack no 2. 50 20mm fuses (10 diff values).	50	£2.00	2P385R
GEARS			
Gearbox kit contains 18 gears, 4 axles and 12v motor.	1	£3.00	3P93
GOOSENECKS			
Chrome finshed 8" long with standard fittings.	1	£2.00	2P345
Chrome finished 12" long with standard fittings.	1	£3.00	3P116
Chrome finished 21" long standard fittings.	1	£4.00	4P76
Goose neck base plate. 3 hole fixing.	1	£2.00	2P346
HEATSHRINK SLEEVING			
1.6mm dia shrinking to .8mm. 1.2 metre length.	1	£1.00	BD997
2.4mm dia shrinking to 1.2mm. 1.2 metre length.	1	£1.00	BD998
3.2mm dia shrinking to 1.6mm 1.2 metre length.	1	£1.00	BD999
4.8mm dia shrinking to 2.4mm. 1.2 metre length.	1	£2.00	2P331
6.4mm dia shrinking to 3.2mm. 1.2 metre length.	1	£2.00	2P332
9.5mm dia shrinking to 4.7mm 1.2 metre length.	1	£2.00	2P333
12.7mm dia shrinking to 6.4mm 1.2 metre length.	1	£2.00	2P334
HEATSINKS			
TO220 bolt on heatsink 21 deg C/W.	5	£1.00	CD1
TO5 push on heatsink 50 deg C/W.	4	£1.00	CD3
HEATING			
1.2kw min tangential blow heater 70X45mm element.	1	£6.00	6P54
600 watt coil heaters air or liquid. 4"x3" 10 year life.	1	£3.00	3P78
Time and temp module. Displays either in C or F. 1.5v	1	£9.00	9P5
Additional sensor for above unit on long lead.	1	£3.00	3P60
2.5kw tangential blow heater 195x45mm element.	1	£5.00	5P62
3kw tangential blow heater 300x40mm element.	1	£8.00	8P24
750 watt standard pencil element 220mm long.	2	£1.00	BD377
1000 watt standard pencil element 232mm long.	2	£1.00	BD376
80 watt brass encased elements for fridges etc.	2	£1.00	BD8
15m heating wire, waterproof. Ideal for pipes etc. Mains.	1	£5.00	5P109
Quick cuppa 12v immersion heater. Cigar lighter plug.	1	£3.00	3P92
HEADPHONES AND INSERTS			
Stereo headphones 8 ohm 1/4" plug.	1	£2.00	2P254
Stereo walkman type headphones.	1	£3.00	3P51
Inner ear stereo headphones.	1	£3.00	3P56

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Dynamic fullsize stereo h/phones 20-20KHZ 32R imp.	1	£8.00	8P33
Inline headphone volume control with 5m lead.	1	£1.00	BD717
IC SOCKETS			
8 way IC socket.	10	£1.00	BD773
14 way IC socket.	7	£1.00	BD774
16 way ICsocket.	7	£1.00	BD775
18 way IC socket.	5	£1.00	BD776
20 way IC socket.	5	£1.00	BD777
28 way IC socket.	4	£1.00	BD779
40 way IC socket.	4	£1.00	BD780
INDICATORS AND BULBS			
12v lilliput bulbs.	5	£1.00	BD177
1.5v 300mA MES bulb.	8	£1.00	CD10
2.5v 200mA MES bulb.	8	£1.00	CD11
3.5v 300mA MES bulb.	8	£1.00	CD12
6.0v 60mA MES bulb.	8	£1.00	CD13
12.0v 200mA MES bulb.	8	£1.00	CD14
24v MES bulbs 80mA 2 watt.	10	£1.00	BD694
Amber indicators with neons 240v. Oblong.	3	£1.00	BD179
Amber neon idicators round 240v.	6	£1.00	BD180
LED holders 3mm	4	£1.00	CD33B
LED holders 5mm.	4	£1.00	BD518
LED 5mm red.	15	£1.00	BD893
LED 5mm red. (1,000 pack).	1	£44.00	44P1
LED 5mm green.	12	£1.00	BD894
LED 5mm green. (1,000 pack).	1	£54.00	54P1
LED 5mm yellow.	10	£1.00	CD5
LED 5mm yellow. (1,000 pack).	1	£64.00	64P1
LED 3mm red.	15	£1.00	CD4
LED 3mm red. (1,000 pack).	1	£44.00	44P2
LED 3mm green.	10	£1.00	CD6
LED 3mm green. (1,000 pack).	1	£54.00	54P2
LED 3mm yellow.	10	£1.00	CD7
LED 3mm yellow (1,000 pack).	1	£64.00	64P2
FLASHING LED 5mm red 9-12v DC 3HZ.	4	£2.00	2P335
FLASHING LED 5mm green 9-12v DC 3HZ.	4	£2.00	2P336
FLASHING LED 8mm red 9-12v DC 3HZ.	2	£2.00	2P337
FLASHING LED 8mm green 9-12v DC 3HZ.	2	£2.00	2P338
High power INFRA-RED source 12mW 1.7v 5mm.	3	£1.00	CD8
High power INFRA-RED sensor 5mm.	1	£1.00	CD9
MES bulb holders. Batten type	4	£1.00	BD895
3 colour LED.	2	£1.00	BD611
INFRA RED SENSORS ETC			
IR 5 metre beam 22-26v DC 250mA switching.	1	£25.00	25P15

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
INSULATORS AND CABLE GRIPS			
PVC grommets for 3/8" cable.	100	£1.00	BD181
Cable grips for up to 3/8" cable.	10	£1.00	BD431
KEY BOARDS			
84 key keyboards uncased with control PCB.	1	£3.00	3P89
LOUDSPEAKERS AND GRILLS			
Set of 3 speaker grills 140mm, 70mm and28mm. Black.	1	£1.00	BD737
Flush mounting speaker grill for 8" speaker.	1	£2.00	2P281
Tweeter on chrome mounting plate.	1	£3.00	3P68
7" x 5" 8 ohm speaker with built in tweeter. 5 watt.	2	£3.00	3P69
8" round 8 ohm 60 watt full range speaker. Ali coil.	1	£12.00	12P14
5" diameter full range speaker 30 watt+HF cone 8R.	1	£8.00	8P49
3" diameter full range speaker 20 watt+HF cone. 8R.	1	£5.00	5P183
Pair of 70w per channel 3 way car speakers.	1	£28.00	28P1
Pair of 100w per channel 3 way car speakers.	1	£30.00	30P7
6" x 9" 8 ohm 15 watt speaker.	1	£3.00	3P76
6" x 4" 16 ohm 5 watt rating.	2	£1.00	BD243
6 1/2" 4 ohm speaker 10 watt rating.	1	£1.00	BD137
2 1/4" 60 ohm speaker.	2	£1.00	BD453
2 1/4" 8 ohm speaker.	2	£1.00	BD454
6" x 4" 15 ohm speaker 10 watt rating.	1	£2.00	2P167
3" 4 ohm tweeter.	1	£1.00	BD433
40 watt 3 way crossover.	1	£1.00	BD23
25 watt cross over for woofer and tweeter.	2	£1.00	BD22
110 db horn/speaker.	1	£4.00	4P60
Personal mini speaker. Plugs straight into cassette.	1	£4.00	4P50
TV speakers 3 watt 8 ohm 70 x 55m.	2	£3.00	3P108
TV speakers 5 watt 4 ohm 55 x 125mm.	2	£3.00	3P109
Loud speaker wall mounting brackets. (pair).	1	£5.00	5P152
5"x 3" 16 ohm speaker 5 watt.	2	£1.00	BD725
Mylar waterproof cone speaker 3 1/4" sq 35R 2 watt.	1	£1.00	BD903
20 watt 4 ohm 6 1/2" dia with built in tweeter.	1	£5.00	5P205
KNOBS ETC			
Solid aluminium 1 1/8" dia. Grub screw fixing on 1/4" sft.	2	£1.00	BD720
LASERS			
Philips 2mw Helium Neon laser. 260x37mm.	1	£40.00	40P10
Mains ABS cased power supply kit for laser.	1	£20.00	20P33
Plastic case with PSU kit big enough to hold tube as well.	1	£22.00	22P3
Boxed and built laser.	1	£75.00	75P4
MAGNETS			
Flat magnet 1" x 1/2" x 1/8".	6	£1.00	BD897
Very powerful magnet. 25x13x6mm u shape.	2	£1.00	BD642
Powerful electro magnets 6v 1x50mm sq and 1 20mm sq.	2	£2.00	2P371

Electronic Dice Kit.



After touching a button the digital dice displays random numbers between 1 and 6. 4.5v. £9.00 Ref 9P13.

Diode Receiver MW & SW Kit.

Good educational kit that doesnt require batteries. £8.00 Ref 8P154.

Electronic Dog Bark Kit.

Generates a dog barking sound. suitable for a 8R speaker.9-12v operation. £16.00 Ref 16P10.

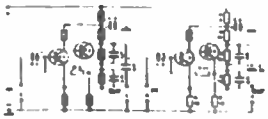
Visual Door Bell Kit.

A lamp up to 12v .5A connected to this kit will flash for up to 20 secs Ideal for deaf people or noisy rooms etc. £10.00 Ref 10P152.

Electrifying Apparatus Kit.

Generates a weak adjustable high tension of approx 80-300v from a 9v battery. Ideal for catching worms etc Max current 50-250mA £7.00 ref 7P30.

Stereo Pre-amp Equalizer Kit.



For record players with magnetic pickup. 12-24v supply req'd. £6.00 Ref 6P82.

Electronic Mains Filter Kit.

Highly effective anti interference device fits into the mains supply to your computer, tv, video etc. 750 watt max. 110-240v AC. £10.00 Ref 10P153.

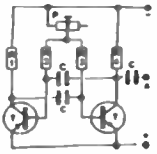
Lamp Flasher Kit.

6-24v bulb can be flashed very brightly for adjustable period. Max 1A. £5.00 Ref 5P214.

Fog Horn Kit.

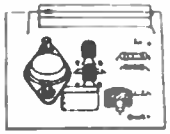
Generates a deep noisy sound similar to a ships fog horn. 4.5-12v. 5 watt max output. 8R speaker req'd. £6.00 Ref 6P56.

Frequency Generator Kit.



Adjustable frequency approx 1-50khz 6-12v. Short circuit proof capacitive output. Rectangular waveform output. VHF harmonics. £4.00 Ref 4P154.

Electronic Fuse Kit.



An Electronic fuse suitable for 5-30v DC only at up to 3A. Cuts off supply when overloaded. Reset by turning supply off and on again. £6.00 Ref 6P83.

Gas Sensor Kit.

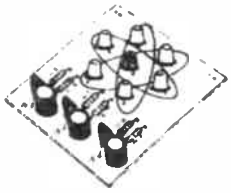
Detects alchohol propane,benzine, carbon monoxide, ideal for fire and smoke alarm. £20.00 Ref 20P43

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
MICROPHONES AND STANDS			
Dynamic handheld mic with stand. Cassette type.	1	£1.00	BD305
Hand held dynamic mic with on/off switch.	1	£1.00	BD711
FET electret capacitor mic capsule 1.5v 500 ohm.	1	£1.00	BD646
MICROSWITCHES			
V3 size 15A 250v c/o button operated. Push on tags.	3	£1.00	BD341
V3 size 10A 250v c/o button operated. Push on tags.	4	£1.00	BD340
V3 size 10A 250 c/o lever operated. Push on tags.	3	£1.00	BD342
Extra thin 1 1/4" x 7/8" x 1/4" 10A contacts.	4	£1.00	BD403
Subminature microswitches. Assorted.	5	£1.00	BD313
MISCELLANEOUS			
Musical sounder for cards.	1	£1.00	BD328
Good quality AM/FM mains/batt radio.	1	£10.00	10P133
Cabinet locking mechanism with 2 keys.	1	£1.00	BD55
Personal stereo innards. Tape mech and head.	1	£1.00	BD763
Motor start/stop switch, skeleton type with trip.	2	£1.00	BD254
CB coverter converts car radio into AM CB radio.	1	£4.00	4P48
Through panel cable grips. Adjustable size.	10	£1.00	BD431
Therocouple for measuring internal heat.	1	£2.00	2P137
Clear lacquer in an aerosol can.	1	£1.00	BD660
2764 eprom BBC compatable.	1	£3.00	3P48
Ceramic insulating beads. Fit 20 swg wire.	100	£1.00	BD690
MONITORS			
9" monitor, black and white. Uncased.	1	£20.00	20P26
Metal case for 9" monitor.	1	£12.00	12P3
Kit to convert comp video into separate H sync, Vsync.	1	£8.00	8P39
AC MOTORS			
1 1/2" stack double ended very powerful motor.	1	£2.00	2P55
3" square shaded pole motor 24v AC.	1	£2.00	2P266
240v AC 25 watt 3000 rpm motor 6"x4"x3".	1	£4.00	4P54
3" square shaded pole motor. 240v AC.	1	£2.00	2P265
Mains shaded pole motor 7/8" stack.	1	£1.00	BD85
Precision motor for disc or tape.	1	£2.00	2P12
MOTORS WITH GEARBOXES			
2 rpm mains motor 2w (suitable mirror ball etc).	1	£2.00	2P17
500 watt mains motor and 3 speed control.	1	£5.00	5P193
5 rpm 60 watt motor with gearbox. Powerful. 125x60x45.	1	£5.00	5P54
16 rpm mains 2 watt motor with gearbox. 50mm dia x30.	1	£1.00	BD91
150 rpm mains 60 watt motor with gearbox. 60x80x90mm	1	£2.00	2P38A
5 rpm Crouzet type motor 240v.	1	£4.00	4P63
60 rpm 60 watt mains motor.	1	£5.00	5P173
MOTORS DC			
1/10th HP 12v motor 1/4" spindle. 75x65mm.	1	£4.00	4P22

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
1/8th HP 12v motor 75x75mm spindle 25x8mm.	1	£6.00	6P1
1/3rd HP 12v motor (Sinclair C5). 180x100mm 3300 rpm	1	£20.00	20P22
C5 motor complete with 4 : 1 reduction box.	1	£40.00	40P8
Electronic speed controller kit for C5 motor or equiv.	1	£17.00	17P3
Model motor 1.5v-9v (speed is voltage dependent).	1	£1.00	BD540
3v cassette motor. Very low current.	1	£1.00	BD681
MOTORS STEPPER			
Stepper motor 7.5 deg step 10-14v 27 ohm 70x40mm	1	£5.00	5P81
MOTORS 1-12V			
Model aircraft motors. Spin to start. 12x20mm.	10	£1.00	BD134
Low current motor for working with solar cells.	1	£1.00	BD681
NOISE FILTERS			
Chassis mounting noise filter. 45x30x16mm.	1	£2.00	2P225
IEC filtered chassis socket.	1	£3.00	3P50
OPTO			
Sub-min light dependent resistor.	2	£1.00	BD19
Camera flash units. Contains Xenon tube etc 3v op.	1	£2.00	2P38B
Slotted opto interupted switch	1	£1.00	BD545
Light dependent resistor ORP12.	1	£1.00	BD619
PANEL METERS			
0-40v panel meter 80 x 70mm.	1	£6.00	6P24
0-80v panel meter 80 x 70mm.	1	£6.00	6P26
0-160v panel meter 80 x 70mm.	1	£6.00	6P27
0-200v panel meter 80 x 70mm.	1	£6.00	6P28
0-10A panel meter 80 x 70mm.	1	£6.00	6P29
0-5A panel meter 80 x 70mm.	1	£6.00	6P30
45-55 HZ frequency indicator.	1	£15.00	15P19
200uA panel meter 4 3/4" x 2 1/2".	1	£10.00	10P24
1mA panel meter 6" x 3 1/2".	1	£10.00	10P41
0-100uA panel meter. Scale separate.	1	£4.00	4P32
100-0-100uA panel meter. Scale separate.	1	£4.00	4P67
1mA panel meter. Scale separate.	1	£4.00	4P68
VU meter 1 1/2" square.	2	£1.00	BD366
PANEL METERS 60 X 45MM			
0-50mA 2K3 internal resistance.	1	£6.00	6P39
0-100mA 1K2 internal resistance.	1	£6.00	6P40
0-500mA 360R internal resistance.	1	£6.00	6P41
0-1mA 100R internal resistance.	1	£6.00	6P42
0-10mA 60R internal resistance.	1	£6.00	6P43
0-100mA 0.6R internal resistance.	1	£6.00	6P44
0-1A	1	£6.00	6P45
0-25v DC 25K internal resistance.	1	£6.00	6P46
0-30v DC 30K internal resistance	1	£6.00	6P47
PCB PRODUCTION EQUIPMENT			

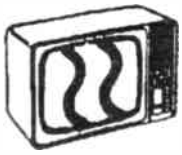
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
PHOTO ETCH PCB (UV sensitive)			
100 x 160mm single sided.	1	£3.00	3P133
203 x 144mm single sided.	1	£4.00	4P78
100x 160mm double sided.	1	£4.00	4P79
203 x 144mm double sided.	1	£5.00	5P189
Ferric chloride etchant (makes 1 litre).	1	£3.00	3P134
Developer crystals (makes 1 litre).	1	£2.00	2P348
Polypropylene trays. 325 x 225 x 50mm.	1	£2.00	2P349
Brass wire brush.	1	£1.00	BD837
Transfer starter pack 12 different sheets.	1	£10.00	10P100
POTS-VARIABLE RESISTORS			
Mini volume controls. 1/4" shaft. Assorted valus.	10	£1.00	BD109
Slider pots. Various values.	10	£1.00	BD110
10 turn 100 ohm 3w 1/4" shaft.	1	£1.00	BD291
50ohm 3w wirewound.	4	£1.00	BD73
8 ohm 25 w 1/4" shaft.	2	£1.00	BD69
1000 ohm 25w 1/4" shaft.	2	£1.00	BD70
Minature pot 1/4" shaft 50K.	4	£1.00	BD781
Minature pot 1/4" shaft 200K.	4	£1.00	BD782
Stereo gang pot 1/4" shaft 50K.	3	£1.00	BD784
POWER SUPPLIES			
Astec PSU 5v at 5A, 12v at 2A, -12v at 1A 4"x5".	1	£10.00	10P126
Astec PSU 5v at 4A, 12v at 2A, -12v at 1A 4" x 5".	1	£10.00	10P127
Customer returned switched mode PSU's for repair.	1	£2.00	2P292
Switched mode PSUs ex-equipment +5, +12 & -12v.	1	£8.00	8P36
In car PSU 12v in 3,4.5,6,7.5,9,12v 800mA out, Cig plug	1	£5.00	5P167
24v with sep channels for stereo use. Max 20 watt.	1	£2.00	2P4
4.5 100mA PSU in case with lead.	1	£1.00	BD104
6v 700mA PSU in case.	1	£1.00	BD899
8-12v variable PSU.	1	£2.00	2P3
12v 200mA PSU in case for 13A socket.	1	£2.00	2P114
9v 350mA AC PSU in case for 13A socket.	1	£1.00	BD566
13.8v DC 5A regulated cased PSU for CB etc.	1	£22.00	22P7
13.8v DC 3A regulated cased PSU for CB etc.	1	£17.00	17P4
3/4.5/6/7.5/9/12v DC 750mA non regulated plug in PSU.	1	£5.00	5P197
24v PSU chassis with all components.	1	£2.00	2P150
9v AC 100mA in case with lead.	1	£1.00	BD733
15v 500ma DC power supply.	1	£2.00	2P289
PRESSURE SWITCHES			
Brass pressure switch set for 8psi but adjustable to 15psi.	1	£2.00	2P92
Switch with 3 different operating pressures. Can be mouth operated. 85x30mm.	1	£1.00	BD67
PROJECTS AND KITS			
Camera 35mm with built in flash. (customer returns).	2	£8.00	8P151

Atomium Kit.



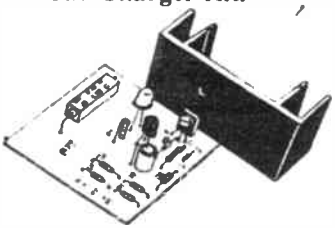
A decorative device which uses six red LED's which optically circle around a green LED. Requires a 9v battery. Ideal for jewellery etc. £7.00 Ref 7P38

Audio Scope Kit.



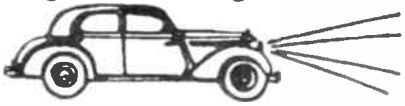
Produces black, vertical bars which move to the rythm of the music similar to oscilloscope patterns. Simple connection to the aerial socket of TV. £10.00 Ref 10P151.

Universal Ni-Cad Charger Kit.



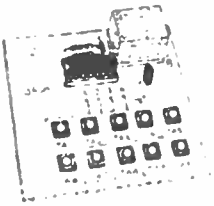
Automatic charger for cells from 1.2 to 15v. The charging current will automatically adjust, to remain constant as the battery charges. Has a selection of seven settings 5-600mA. A transformer 18-20v .6A is req'd. £8.00 Ref 8P152.

Car Lights On Warning Kit.



Produces a noisy 'honk' if you turn off the ignition but leave the lights on. Works off car battery. £8.00 Ref 8P153.

Combination Digital Lock Kit.



After keying in a 4 digit code the relay switches on. The code is independently programmable and can be easily modified. Relay contact 3A, 1 x c/o. Ideal for keyless locks for door, video, computer etc. £15.00 Ref 15P56.

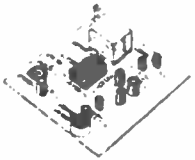
Car Antenna Amplifier Kit.

This amplifier is connected between the antenna and the radio, using co-ax cable 60-75R. Gain max 22db. Frequency range 0.5-150mhz. £6.00 Ref 6P81.

Converter 100mhz - 200mhz Kit.

Extends the range of radios to cover amateur bands, ships, TV stations etc. Simply introduced into aerial cable. £15.00 Ref 15P57.

Sound Operated Switch Kit.



This accoustic circuit turns on a relay, can be triggered by a clap etc. Another clap turns it off. Adjustable sens Ideal for turning on and off lights or equipment. 12v operation. £14.00 ref 14P17.

Diesel Engine Sound Kit.

Generates 7-10 watt sound with adj exhaust, valves and running speed! For 4-8R speakers. £11.00 Ref 11P10

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Surface mount kit. Makes mini micro amp.	1	£7.00	7P15
Surface mount solder.	1	£12.00	12P18
FM bug kit with PCB embedded coil and sub min mic.	1	£5.00	5P158
Stabilized PSU kit 3-30v 2A . Excluding case.	1	£20.00	20P25
30 watt rms mono amp kit with tone cntrls (psu reqd)	1	£10.00	10P131
30 + 30 watt rms stereo amp kit with tone cntrls (psu reqd	1	£20.00	20P38
300 watt rms hi fi power amp mono kit.	1	£55.00	55P1
40 + 40 watt stereo amp kit. (Pre amp and psu required)	1	£18.00	18P14
80 + 80 watt rms stereo amp kit tone controls (psu reqd)	1	£40.00	40P11
Sound operated light . Battery operated, cased.	1	£4.00	4P85
Solar powered wooden helicopter kit.	1	£9.00	9P6
Solar powered wooden aeroplane kit.	1	£9.00	9P7
Solar powered wooden gramophone kit.	1	£9.00	9P8
Electronic dipstick kit (10 different levels).	1	£5.00	5P204
12-220v inverter kit 15 watt.	1	£12.00	12P17
12-220v inverter kit 80 watt.	1	£20.00	20P27
Microwave tester 9v.	1	£6.00	6P1
25 watt stereo amplifier IC plus diagram. STK043.	1	£4.00	4P69
Geiger counter kit 9v operation.	1	£39.00	39P1
Powerful ionizer mains operated kit with case.	1	£18.00	18P2
3 channel sound to light kit 750w /channel with case.	1	£20.00	20P35
Accoustic water detector 9v detects water leaks etc.	1	£5.00	5P212
Electronic accupunture kit with instructions! 9v.	1	£7.00	7P36
Alarm system max 20 contacts, adj start & alarm time 12v	1	£14.00	14P15
Amplifier kit 2x 8W stereo.	1	£14.00	14P16
Amplifier kit 10 watt mono.	1	£9.00	9P19
Antenna amplifier .15-350MHZ, ideal TV, radio etc 9-18v.	1	£5.00	5P213
Apple powered radio kit. Plugs into ordinary apple!	1	£7.00	7P37
LED display ideal for fun jewellery etc. 9v 7 leds.	1	£7.00	7P38
Audio scope produces sound to light display on TV. 12v.	1	£10.00	10P151
Ni cad charger 1.2-15v 5-600mA. 18-20v .6A TX req'd.	1	£8.00	8P152
Car 'lights on' warning kit saves flat battery!	1	£8.00	8P153
Programmable digital lock. 6v 3A relay output. 4 digit.	1	£15.00	15P56
Car antenna amplifier. Fits between aerial and radio.	1	£6.00	6P81
Converter 100MHZ to 200MHZ for radio use!	1	£15.00	15P57
Clap switch on and off. Relay o/p. 12v. adj sensitivity.	1	£14.00	14P17
Diesel engine sound. 3 sound adjustments.	1	£11.00	11P10
Crystal set kit. Educational. No batteries req'd.	1	£8.00	8P154
Visual door bell takes 12v lamp up to 5A. 20 secs on.	1	£10.00	10P152
Stereo pre-amp, equalizer for mag pick up. 12-24v.	1	£6.00	6P82
Electronic mains filter 110v-240v AC 750Watt.	1	£10.00	10P153
Lamp flasher kit 6-12v 1A adjustable frequency.	1	£5.00	5P214
Frequency generator 1-50KHZ 6-12v. ideal test aid.	1	£4.00	4P154
Electronic fuse 5-30v 3A. Resets on power on/off.	1	£6.00	6P83

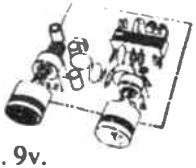
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Gas detector for alchohol, benzol, propane, carbon monoxide (contained in smoke) etc. 12v.	1	£20.00	20P43
Game of skill kit. 9-12v.	1	£5.00	5P215
IC radio SW, MW, LW 220mW 9v.	1	£8.00	8P155
Ice warning kit for cars, fridges, freezers etc. 9-12v.	1	£7.00	7P39
DC speed controller 12-16v 2A. Ideal trains, drills etc.	1	£10.00	10P154
Inductance bridge for metering coils. 9v.	1	£12.00	12P52
Interval switch adjustable ideal for wipers, alarms etc12v.	1	£12.00	12P53
LED light band 14 leds on 1.5m lead light alternately.18v	1	£10.00	10P155
LED voltage display 0-30v adj. ideal VU, batt ind, 12v.	1	£10.00	10P156
LED display superior version with 30 leds in an arc.	1	£15.00	15P58
Light barrier (light source req'd) relay o/p. 12v.	1	£9.00	9P20
Single channel sound to light kit 1000 watt.	1	£6.00	6P84
Six channel sound to light kit. 500 watt per channel.	1	£17.00	17P6
3 channel sound to light for 12v 100w bulbs. 12v AC.	1	£10.00	10P157
Light swell kit . Gradually lights & dims 240v bulb, 2 secs	1	£11.00	11P11
Educational kit, 8yrs+, 7 experiments. batt req'd.	1	£8.00	8P156
12 melody generator 3v. speaker req'd.	1	£11.00	11P12
Mesmeric insrument kit.	1	£8.00	8P157
Metronome 30-300 beats per min. 6v.	1	£7.00	7P40
Microphone preamp 4R-100KR imp. 2-40mV. 6-20v.	1	£6.00	6P85
Mini moving lights (3 lights) 9-12v.	1	£5.00	5P216
Morse code practice kit. 3-9v.	1	£8.00	8P158
Moving light rope kit 6.5m long. 12v.	1	£25.00	25P28
Moving light 3-24v. 3A channel (3 channels).	1	£12.00	12P54
Moving light 10 channels, 500w/chan mains adj speed.	1	£30.00	30P11
MW test transmitter.	1	£5.00	5P217
Mains power controller 1300w ideal drills, motors,lamps.	1	£12.00	12P55
Spy stethoscope for listening through walls etc.	1	£15.00	15P59
SW - CB receiver 6-30Mhz. 6v. Speaker req'd.	1	£15.00	15P60
Telephone amplifier uses pickupcoil (included) 9v.	1	£8.00	8P159
Warship siren up to 15watt o/p. 12v	1	£9.00	9P21
Kojak siren, loud.	1	£9.00	9P22
Star wars siren up to 15 watt.	1	£9.00	9P23
Strobe kit 1 -10Hz adj. 240v.	1	£16.00	16P15
Ultrasonic dog whistle 8k-25khz. 9v.	1	£6.00	6P86
Thermal switch adj from -30 to +150 deg C. Relay o/p.	1	£9.00	9P24
Ships siren 5 watt o/p ok for door bells, alarms etc. 12v.	1	£6.00	6P87
Universal stereo pre-amp 9-30v.	1	£7.00	7P41
Touch switch. On & off contacts. Relay o/p.	1	£7.00	7P42
Tone control, stereo, bass, treble, volume. 9-18v.	1	£15.00	15P61
TV test channel pattern generator (selection) 6v.	1	£10.00	10P158
Twilight switch. On at dusk off at dawn. 250w 240v.	1	£9.00	9P25
5 watt fog horn kit 4.5-12v DC.	1	£6.00	6P56

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Alternate flashing signal for 2 6-12v bulbs. Adjustable.	1	£3.00	3P88B
IC radio kit MW-SW-LW.	1	£8.00	8P53
Shocking kit generates 80-300v from 9v battery.	1	£7.00	7P30
Antenna amplifier kit. 0.15 MHZ - 350MHZ 9 -18v.	1	£5.00	5P198
Lamp flashing circuit (4-12v) 1-3 per sec (kit).	1	£3.00	3P89B
VHF receiver kit. 79-110 9v operation.	1	£10.00	10P122
Lie detector kit. 4.5v battery required.	1	£6.00	6P57
Electronic dice kit.	1	£9.00	9P13
Antenna amplifier kit (wide band) 30-850MHZ 12-18v.	1	£8.00	8P54
Infrared 6m light barrier kit 9-12v.	1	£16.00	16P9
Metal detector kit.	1	£5.00	5P199
2 varicolour LED adjustable flashing kit for badges etc.	1	£4.00	4P84
Electronic dog bark kit!	1	£16.00	16P10
Traffic light kit with LEDS. Suitable for models etc.	1	£5.00	5P200
FM transmitter kit 2 watt output.	1	£8.00	8P55
Robot voice kit. Converts your voice into a robot voice.	1	£8.00	8P56
Parabolic microphone kit 15"dia 200 metre range.	1	£20.00	20P36
Dummy car alarm module.	1	£5.00	5P201
PUMPS			
Drill operated pump. Fits any drill.	1	£3.00	3P140
Washing machine pump. mains.	1	£5.00	5P18
RECTIFIERS			
Bridge rectifier 600v 3A.	1	£1.00	BD546
Rectifier 35A 60v.	1	£2.00	2P179
50v 1.5A Woo5 bridge rectifier.	5	£1.00	CD411
400v 1.5A W004 bridge rectifier.	4	£1.00	CD412
400v 3A KBPC104 bridge rectifier.	3	£1.00	CD413
800v 6A KBPC 608 bridge rectifier.	2	£1.00	CD414
600v 25A KBPC2506 bridge rectifier.	2	£3.00	3P413
RELAYS			
PCB mount relay 5v coil 2 C/O 2A contacts. 26x18x17.	1	£1.00	BD665
Mains operated relay. Single 8A C/O .45x30x32mm	1	£1.00	BD486
Mains operated relay. 4 8A C/O contacts.60x50x30mm	1	£2.00	2P144
3v reed relay kit. 4 coils and 4 reeds.	1	£2.00	2P411
12v water resistant relay.	1	£1.00	BD154
12v sealed relay 2 C/O contacts. 20x10x22m.	1	£1.00	BD311
12v minature relay SPDT 16A 240vAC contacts.	1	£2.00	2P412
12v minature relay 700 ohm coil. 2 C/O contacts.	1	£1.00	BD51
12v minature relay. 4 C/O contacts. 160ohm.	1	£1.00	BD52
12v DC or 24v AC plug in relay. 3 C/O contacts.	2	£1.00	BD50
24v minature relay . 4 C/O 5A contacts. 28x20x32mm.	2	£1.00	BD580
1.5v relay 16 ohm 2 C/O contacts. 23x18x30mm.	1	£1.00	BD512
2v reed relay. Normally closed contacts.30x12x9mm	2	£1.00	BD549
RESISTORS 1/4 WATT 2% METAL FILM			

Game of Skill Kit.

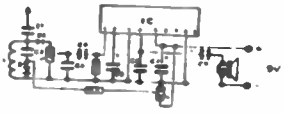
Pass the loop over the wire to prevent the alarm and the light operating. 9-12v.
£5.00 Ref 5P215.

IC VHF Receiver Kit.



High quality receiver uses TDA7000.
Good selectivity
8R 1W speaker required. 9v.
£10.00 Ref 10P122.

IC Radio MW-SW-LW Kit.



Single circuit radio that receives medium, short or long wavebands. 220mW output.
9v. £8.00 Ref 8P155.

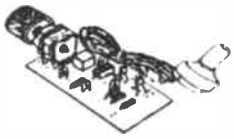
Ice Warning Instrument Kit.

Indicates undesirable temperature changes in fridges, freezers or as frost warning for cars etc.
9-12v supply req'd.
£7.00 Ref 7P39.

Impulse Voltage Control Kit.

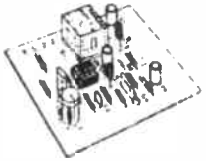
Almost loss free regulation of speed for DC motors providing almost full torque at all speeds.
Ideal for trains,drills toys etc. Max 2A
12-16v.
£10.00 Ref 10P154.

Inductance Bridge Kit.



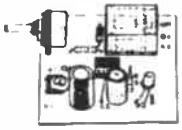
With this kit coils can be easily measured
2 adjustable scales
1-100mH, .1-10H.
9v operation. £12.00 Ref 12P52.

Infra-Red Light Barrier Kit.



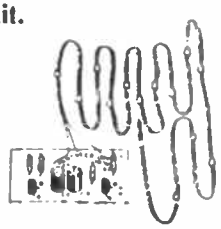
Light Barrier with invisible infra red light beam.
Complete with transmitter and receiver. 6 m range 9-12v . 3A relay contact output. £16.00 Ref 16P9.

Interval Switch (Universal) Kit.



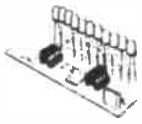
Interval time 1-140sec
Length .2-12sec
7.5-12v operation
5A relay contact o/p
LED inverval indicator. Ideal for wiper controller, lamps, motors, alarms etc. £12.00 Ref 12P53.

LED Light Band Kit.



Decorative 1.5m band of 14 LED's which light up alternatively to give a moving display. 18v.
£10.00 Ref 10P155.

LED Modulation/Voltage Display Kit.



A voltage measuring kit. Displays up to 30v. Ideal for batt indicator, amp o/p speaker peak meter etc.
12v operation.
£10.00 ref 10P156.

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
10 x 50 values (500 resistors in all).	1	£5.00	5P170
10 x 10 values of your choice (1/4watt metal film).	100	£2.00	2P413
HI WATTAGE RESISTOR PACKS			
2.5 watt wire wound resistors.	60	£3.00	3P414
5 watt wire wound resistors.	45	£3.00	3P415
9 watt wire wound resistors.	35	£3.00	3P416
SEMI CONDUCTORS			
LM317T Variable voltage reg 1.5A.	2	£1.00	BD905
NE555 timer chip.	4	£1.00	CD204
NE556 dual timer chip.	3	£1.00	CD205
Bargain pack of 20 different ICs.	1	£1.00	BD906
TIP3055 power transistor.	1	£1.00	BD655
100 watt mosfet pair 2SJ99 and 2SK343.	1	£4.00	4P51
Power mosfet 2SJ77.	1	£2.00	2P285
J111 JFET.	10	£1.00	BD864
SERVISOL SERVICE AIDS			
Switch cleaner 226g aerosol with applicator.	1	£2.00	2P321
Aero clene precision cleaner. Aerosol.	1	£2.00	2P322
Circuit freezer for fault finding. 226g aerosol.	1	£2.00	2P323
Foam cleanser (powerful). 370g aerosol.	1	£2.00	2P324
Silicone grease for waterproofing. 226g aerosol.	1	£2.00	2P325
Anti static spray mist. 150g aerosol	1	£2.00	2P326
Plastic seal. 145g aerosol.	1	£2.00	2P327
Aero duster. 200g aerosol.	1	£2.00	2P328
Quick fix mains connector.	1	£7.00	7P18
Carbon fibre record cleaning brush 1,000,000 fibres.	1	£1.00	BD707
500 ml of precision gear oil with applicator tube.	1	£2.00	2P269
Disc drive head cleaner for 51/4" double sided.	1	£2.00	2P250
Soldering iron stand complete with sponge.	1	£3.00	3P66
Etch resist pen for making PCBs.	1	£1.00	BD699
15 watt mains soldering iron.	1	£3.00	3P65
Antex 15 watt iron with 1mm bit. 250v.	1	£10.00	10P86
1/2kg solder 60/40 multicore resin solder 22swg.	1	£6.00	6P9
Instrument case with handle 5"x4"x2".	1	£1.00	BD742
Portasol gas soldering iron (uses lighter gas) 10-60w.	1	£18.00	18P4
SOLAR CELLS			
Solar battery charger. Takes 4 AA cells.	1	£6.00	6P3
Solar battery charger. Takes 2 C cells.	1	£6.00	6P88
100mm x 60mm 1.87v, 153mA Amorphous silicon cell.	1	£4.00	4P155
70mm x 50mm 3v, 40mA Amorphous silicon cell.	1	£3.00	3P417
150mm x 150mm 7.5v, 108mA Amorphous silicon cell.	1	£8.00	8P160
150mm x 300mm 7.5v, 200mA Amorphous silicon cell.	1	£12.00	12P56
53mm x 25mm 2v, 20mA Amorphous silicon cell.	1	£2.00	2P414
300mm x 300mm 12v 200mA Amorphous silicon cell.	1	£15.00	15P62

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
700mA .45v solar cell. 95x65x7.5mm.	1	£3.00	3P42
400mA .45v solar cell. 75x45x7.5mm.	1	£2.00	2P199
100mA .45 solar cell. 45x26x7.5mm.	1	£1.00	BD631
SOLENOIDS			
Mains solenoid. 38x25x32mm 25mm travel.	1	£1.00	BD300
Mains solenoid. 50x35x38mm 20mm travel	1	£1.00	BD199
12v solenoid with plunger. 30x12x12mm 20mm travel.	1	£1.00	BD232
70v DC solenoid 2 1/2" x 1". Powerful.	1	£2.00	2P271
12v DC solenoid 1 3/4" square. Powerful.	1	£2.00	2P272
SPECIAL LIGHTING EFFECTS			
Motor driven switch 6 or more 10A c/o contacts.	1	£2.00	2P19
Sound to light kit. 750 watts per channel(3). Cased.	1	£20.00	20P35
Mains motor driver flasher 1000 watt.	1	£2.00	2P25
Strobe light, cased, 240v AC adjustable speed.	1	£25.00	25P23
ALSO SEE PROJECTS AND KITS			
STRIP BOARD			
5"x 4" .1 spacing copper clad strip board.	1	£1.00	BD736
17" x 4" .1 spacing copper clad strip board.	1	£4.00	4P62
STRIPPERS			
Component board full of ICs transistors etc.	1	£2.00	2P282
UK cased modems ideal for stripping.	1	£3.00	
SUPPRESSORS			
Mains filter (inductance and capacitance) with leads 13A.	1	£1.00	BD248
Auto noise eliminator inline for car use.	2	£1.00	BD751
Noise suppressor 2A inline mains. Chassis mount.	1	£1.00	BD570
SURVEILLANCE PRODUCTS			
FM bug built inside a 13A mains adapter. The adapter still functions but transmits even the slightest wisper.	1	£26.00	26P2
FM bug kit with embedded coil.	1	£5.00	5P158
Built and tested superior minature FM bug.	1	£14.00	14P3
Built and tested phone bug fits inside phone and is powered by the phone.	1	£20.00	20P28
As above but built into a secondary BT socket.	1	£23.00	23P10
As above but built into a master socket.	1	£24.00	24P5
Handheld built and tested bug detector.	1	£50.00	50P4
Airband receiver.	1	£25.00	25P17
SWITCHES ROTARY			
4 pole 3 way.	3	£1.00	BD870
3 pole 4 way.	3	£1.00	BD871
2 pole 6 way.	3	£1.00	BD872
1 pole 12 way.	3	£1.00	BD873
Rotary mains on/off switch.	2	£1.00	BD456
Ceramic wave change switch 12 pole 3 way. 1/4" shaft.	1	£1.00	BD303
SWITCHES PUSH			

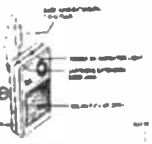
DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Normally on heavy duty metal switches.	4	£1.00	BD176
Oblong push switches 5A 220v AC.	2	£1.00	BD263
Key board style push switch with knob.	8	£1.00	BD201
Panel mount push switch. 5A 250v.	4	£1.00	BD670
Pushon push off mains table lamp switch.	4	£1.00	BD121
Heavy duty illuminated switch 2 pole C/O at 16A.	1	£1.00	BD722
SWITCHES SLIDE			
Slide switch single pole C/O chassis mount.	5	£1.00	BD756
Mini slide switch DPDT 5A.	5	£1.00	BD869
SWITCHES TOGGLE			
Submin toggle sw SPST 8x4x7mm.	2	£1.00	CD415
Submin toggle sw SPDT 8x4x7mm.	4	£2.00	2P415
Submin toggle sw DPDT 8x4x7mm.	3	£2.00	2P416
Minature toggle sw SPST 13x8x9mm.	2	£1.00	CD416
Minature toggle sw SPDT c/off 13x8x9mm.	4	£2.00	2P417
Minature toggle sw DPDT 13x13x9mm.	3	£2.00	2P418
Minature toggle sw DPDP c/off 13x13x9mm.	1	£1.00	CD417
High current toggle sw SPST 10A 30x18x14mm.	2	£3.00	3P418
High current toggle sw DPDT 10A 30x21x20mm.	2	£4.00	4P156
Standard size toggle switch.	2	£1.00	BD605
4 pole cetre off c/o toggle switch. 10A 250v.	1	£1.00	BD343
Sub minature toggle switch 8 x 4 x7mm SPST.	3	£1.00	BD649
SWICHES ROCKER			
Rocker switch panel mount single pole 10A. White.	8	£1.00	BD41
Double pole rocker with built in 3A trip. 240v.	1	£2.00	2P268
Rocker switch 2 pole C/O 10A.	1	£1.00	BD732
Rocker switch SPST centre off. 10A 250v.	5	£1.00	BD43
Rocker switch SPST. 13A.	8	£1.00	BD41
Spring loaded 10A rocker switch. (car window etc).	2	£1.00	BD728
SWITCHES VARIOUS			
30A panel mount toggle switch 250v.	1	£1.00	BD166
Key operated switch good quality Yale.	1	£2.00	2P288
Key operated 3 way good quality switch. Yale type.	1	£2.00	2P370
Glass reed switch.	12	£1.00	BD13
Mercury switch.	1	£1.00	BD269
Humidity swich.	1	£1.00	BD32
Telephone keypad on PCB.	1	£1.00	CD11
Switch pack 10 assorted switches.	1	£2.00	2P372
Thumb wheel switch standard size normal contacts.	1	£1.00	BD590
Double pole on off leaf switch.	40	£1.00	BD350
TAGS AND CONNECTORS			
Push on 1/4" tag connectors.	100	£1.00	BD217
Soldercon terminals (make your own IC sockets).	100	£1.00	BD219

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
TELEPHONE BITS			
100 metre reel of white 6 core cable.	1	£14.00	14P11
500 pack of cable clips for above cable.	1	£2.00	2P99
10 digit switch pad for telephone etc.	1	£1.00	BD200
3 metre phone leads new style plug. Black.	2	£1.00	BD639
3 mtre phone leads new style plug. White.	1	£1.00	BD705
Device to enable any phone to be converted to new plug	1	£2.00	2P249
5 metre new style telephone extension lead.	1	£3.00	3P70
TERMINALS			
Screw down terminal posts. Also take 4mm banana plug.	6	£1.00	BD264
THERMOSTATS			
Wall mounting low voltage thermostat.	1	£1.00	BD115
Panoset. Keeps saucepans at pre set temperature.	1	£1.00	BD252
Oven thermostat with tep calibrated knob.	1	£2.00	2P158
Appliance thermostat. Spindle type adjustment.	2	£1.00	BD582
3 level water thermostats.	4	£1.00	BD537
THERMISTORS			
5mm dia NTC 40R @ 100 deg, 300 @ 25R.	4	£1.00	BD978
5mm dia NTC 80R @ 100 deg, 1K @ 25R.	4	£1.00	BD979
5mm dia NTC 380R @ 100 deg, 5K @ 25R.	4	£1.00	BD980
5mm dia NTC 1K8R @ 100 deg, 30K @ 25R.	4	£1.00	BD981
5mm dia NTC 5K1 @ 100 deg, 100K @ 25R.	4	£1.00	BD982
TIMERS AND TIME SWITCHES			
25A electrical programmer (ex equipment).	1	£3.00	3P106
Microwave control panel with digital clock and relay o/p.	1	£6.00	6P18
10 min clockwork time switch 15A 230v.	1	£1.00	BD579
90 min time switch engraved in mins 15A 230v.	1	£2.00	2P90
2 hour time switch. Clockwork 15A.	1	£2.00	2P89
Smiths time and set switch for heating etc. 15A.	1	£2.00	2P9
100A time switch. 1 on 1 off per 24 hours.	1	£10.00	10P14
Plug in Venner solar dial including case with window.	1	£7.00	7P17
Adaptor kit for above to give 12 on/offs.	1	£3.00	3P105
24 hour time switch. (ex equipment).	1	£1.00	BD45
Mains driven electric clock. (uncased).	1	£1.00	BD211
TOOLS ETC			
Extra thin screw driver.	4	£1.00	BD129
5" electricians pliers.	1	£2.00	2P253
Multimeter 16 ranges .2K OPV with leads.	1	£7.00	7P10
Multimeter 20K OPV 10A AC ample ranges.	1	£15.00	15P30
4BA spanner.	10	£1.00	BD142
Screw drivers.	10	£1.00	BD322
Top pocket screw drivers.	2	£1.00	BD436
7" electricians pliers.	1	£3.00	3P25
6" diagonal side cutters.	1	£2.00	2P161

STEAM ENGINE

Brand new complete steam engine including boiler burner and fuel. Made by Mamod. Our price £30.00 ref 30P124

WHISPER 2000 LISTENING AID



You may have seen these aids advertised in the national press at £8.95. If you haven't its a device that enables you to hear sounds that would otherwise be inaudible. **Our Price Is £5.00 ref 5P179**

STEAM TRACTION ENGINE.

Again made by the famous Mamod company A realistic model of a traditional traction engine again complete with fuel etc. Our price is £58.00 ref 58P124

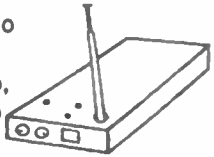
12 BAND COMMUNICATIONS RECEIVER

Cmprehensive receiver covering 7 shortwave bands FM, AM and LW. Tuning eye DX/local switch mains or battery. Complete with shoulder strap & mains lead. **£19.00 ref 19P14**

FM CORDLESS MICROPHONE

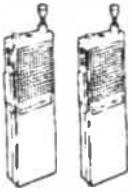
microphone that transmits to an ordinary FM radio. It is battery operated (PP3) and has two transmit power levels. Tuneable from 90-105MHZ max imum range is 500' **£15.00 ref 15P42**

VIDEO SENDER UNIT

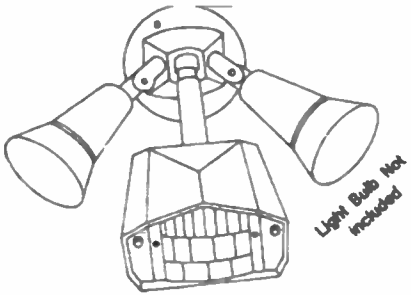


These units are designed to transmit audioand video signals from either a Video, a camera or a computer to a standard TV set. Max range is 100 ft. 12v operation, **Price £15.00 ref 15P39** 12v psu £5.00 ref 5P178.

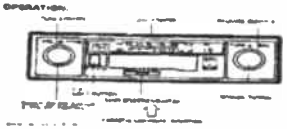
MINATURE RADIO TRANSCEIVERS



A pair of walkie talkies with a range of up to 2 Kilometres. Units measure 22x52x155mm and come complete with cases, aerials and earpieces. Price for the pair is **£30.00 ref 30P12.**



CAR STEREO AND FM RADIO



Low cost car stereo system giving 5 watts per channel. Signal to noise ratio < 45db wow and flutter less than .35%. neg earth. Retail price £49.95, ours..**£19.00** ref 19P30

PASSIVE INFRA RED MOTION SENSOR

Built in day light sensor. Adjustable lights on time (8 sec-15mins) 50' range with a 90 degree coverage. Manual over ride facility. Complete with wall brackets bulb holders etc Brand new and guaranteed **OUR PRICE £19.00 ref 19P29**

BULL ELECTRICAL 0273-203500

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
Set of 6 minature flat blade screwdrivers in case.	1	£2.00	2P311B
Set of 6 minature crosspoint screwdrivers in case.	1	£2.00	2P312
Set of 5 minature nut spinners in case (metric).	1	£2.00	2P313
7" Mole grip style wrench.	1	£3.00	3P114
Minature electronics vice, table mounting. Metal.	1	£5.00	5P180
Minature electronics vice, suction mounting. Plastic.	1	£2.00	2P419
Minature PCB drill 9-16v DC 1.5A. With case.	1	£15.00	15P41
CHROME VANADIUM SCREWDRIVERS			
75 x 3mm flat blade.	1	£1.00	CD15
100 x 3mm flat blade.	1	£1.00	CD16
150 x 5mm flat blade.	1	£1.00	CD17
200 x 5mm flat blade.	1	£1.00	CD18
75mm 0 size pozidrive.	1	£1.00	CD19
75mm 1 size pozidrive.	1	£1.00	CD20
100mm 2 size pozidrive.	1	£1.00	CD21
150mm 3 size pozidrive.	1	£2.00	2P339
TRANSFORMERS COUPLING			
Minature driver transformer 20K to 1K (centre tapped).	1	£1.00	BD653
TRANSFORMERS MAINS			
6v 1A upright mounting.	2	£1.00	BD9
15v 2A upright mounting.	1	£3.00	3P88A
30v 1A upright mounting.	1	£2.00	2P270
9-0-9v .4A PCB mounting.	1	£1.00	BD661
12-0-12v 4.2 V A PCB mounting.	1	£1.00	BD636
20-0-20v 2.5A upright mounting.	1	£4.00	4P24
50v 2A plus 6.3v upright mounting.	1	£3.00	3P10
250-0-250v 60mA plus 6.3v at 5A.	1	£4.00	4P41
20v 1.5A upright mounting.	1	£2.00	2P214
500 watt 2kv microwave transformer.	1	£4.00	4P157
CHASSIS MOUNT TRANSFORMERS			
6-0-6 2A 59x50x54mm 24VA.	1	£5.00	5P184
9-0-9 2A 59x59x50mm 36 VA.	1	£6.00	6P48
12-0-12 2A 68x57x55mm 48VA.	1	£7.00	7P27
20-0-20 2A 78x65x66mm 80VA.	1	£10.00	10P98
30-0-30v 2A 78x65x66mm 120VA.	1	£12.00	12P36
6-0-6v 4A 68x57x54mm 48VA.	1	£7.00	7P28
6-0-6v 8A 78x65x72mm 96VA.	1	£12.00	12P37
9-0-9v 4A 68x57x66mm 72VA.	1	£10.00	10P99
12-0-12v 4A 78x65x70mm 96VA.	1	£12.00	12P38
12-0-12v 8A 96x83x82mm 192VA.	1	£22.00	22P4
0-15 3A 68x58x62mm 45VA.	1	£6.00	6P49
AUTO TRANSFORMERS			
Electronic auto transformer 1KW resistive loads only.	1	£5.00	5P157
100 watt auto transformer.	1	£2.00	2P6

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
TRANSISTORS			
BC108	6	£1.00	BD911
BC109	6	£1.00	BD912
BC182L	12	£1.00	BD921
BC184L	10	£1.00	BD923
BC212L	10	£1.00	BD924
BC238B	10	£1.00	BD927
BC337	10	£1.00	BD928
BFY51	3	£1.00	BD933
BU208	1	£2.00	2P298
MJ2955	2	£2.00	2P299
MJE3055	2	£2.00	2P300
TIP29A	6	£2.00	2P301
TIP30A	6	£2.00	2P302
TIP31C	5	£2.00	2P303
TIP32C	5	£2.00	2P304
ZTX300	5	£1.00	BD934
2N3055	3	£2.00	2P305
TRIACS AND THYRISTORS			
TIC206D 3A 400v triac.	4	£2.00	2P314
TIC226D 8A 400v triac.	3	£2.00	2P315
TIC246D 16A 400v triac.	2	£2.00	2P316
TIC106D 4A 400v thyristor.	5	£2.00	2P317
TIC116D 8A 400v thyristor.	3	£2.00	2P318
TIC126D 12A 400v thyristor.	2	£2.00	2P319
TV BITS			
Flyback EHT unit ITT ref 17ACC79.	1	£2.00	2P111
8kv GEC line output transformers.	1	£2.00	2P262
TV sound receiver box 240v 7 channel.	1	£12.00	12P22
75 ohm low loss co-ax cable.(10 metres).	1	£2.00	2P236
75 ohm low loss co-ax cable (100 metres).	1	£15.00	15P31
UNISELECTORS			
Minature 50v unselector with circuit ideas.	1	£1.00	BD56
VALVES AIR AND FLUID			
24v DC air or water valve. Threaded couplings.	1	£10.00	10P73
Air or gas shut off valve. Temp operated.	1	£1.00	BD153
230v mains operated air valve.	1	£2.00	2P34
230v mains water valve.	1	£1.00	BD370
High pressure mains gas or water valve 1/2" thread.	1	£5.00	5P171
VIDEO TAPES			
Blank 3 hour top quality video tape. (VHS).	1	£2.00	2P420
Blank 3 hour top quality video tapes. (VHS).	5	£8.00	8P161
VOLTAGE REGULATORS			
5v 1A TO220 voltage regulator. 7805	3	£1.00	BD962

DESCRIPTION	PACK QUANTITY	PACK PRICE	ORDER NUMBER
12v 1A TO220 voltage regulator. 7812	3	£1.00	BD963
-5v 1A TO220 voltage regulator. 7905	3	£1.00	BD964
-12v 1A TO220 voltage regulator. 7912	3	£1.00	BD965
5v 2A TO220 voltage regulator. 78S05	2	£1.00	BD966
-12v 2A TO220 voltage regulator 78S12	2	£1.00	BD967
WHEELS			
13" C5 spoked wheel with tyre & tube. Cycle bearing	1	£6.00	6P10
16" C5 spoked wheelwith tyre & tube. 1" centre hole.	1	£6.00	6P11
WIRE AND CABLE			
2 core pvc covered cable 5A . (18 metres).	1	£2.00	2P218
2 core pvc covered cable 8A. (15 metres).	1	£2.00	2P219
3 core pvc covered cable 5A. (15 metres).	1	£2.00	2P189
3 core pvc covered cable 8A. (14 metres).	1	£2.00	2P220
3 core pvc covered cable 10A. (12 metres).	1	£2.00	2P221
IBM printer lead (D25 to Centronics plug). Parallel 2m.	1	£5.00	5P186
IBM printer lead (d25 to Centronics plug). Parallel 3m.	1	£6.00	6P50
RS232 data cable D25 male to D25 male 2Metres long.	1	£5.00	5P187
RS232 data cable D25 female to D25 male. 2M long.	1	£5.00	5P188
Centronics cable. Plug to plug 2 metres long.	1	£6.00	6P51
50 metres of mains cable precut to 2m lengths.	1	£3.00	3P91
24 metres of 4 core screened audio cable 1.2m lengths.	1	£2.00	2P365
RS232 D25 gender changers. Male to male.	1	£3.00	3P124
RS232 D25 gender changers. Female to female.	1	£3.00	3P125
D9 gender changer male to male.	1	£3.00	3P126
D9 gender changer female to female.	1	£3.00	3P127
Centronics gender changer male to male.	1	£6.00	6P52
Centronics gender changer female to female.	1	£6.00	6P53
D9 male to D25 female adaptor. (IBM compatable).	1	£3.00	3P128
D9 female to D25 male adaptor. (IBM compatable).	1	£3.00	3P129
IEC lead fitted with IEC socket. 2 metres.	1	£2.00	2P347
IEC lead fitted with IEC socket and 13A plug. 2M.	1	£3.00	3P130
4 core cable 7 x .2mm grey. (100 metres).	1	£8.00	8P19
Garden tool extension cable 2 core. (20m).	1	£2.00	2P20
2 core screened cable. (10 metres).	1	£1.00	BD122
High voltage flex 14 x .007 heavily insulated. (5m).	1	£1.00	BD207
2.5mm red and black twisted cable 15A 230v. (10m).	1	£2.00	2P168
Extra flexible cable (ideal test leads) 25m reel. Red.	1	£3.00	3P131
Extra flexible cable (ideal test leads) 25m reel. Black.	1	£3.00	3P132
Curly 3 core 13A cable goes from 1' to 9'.	1	£2.00	2P243
RF cable type RG58C/U 50 ohm black 100m reel.	1	£22.00	22P5
RF cable type RG59B/U 75 ohm black 100m reel.	1	£26.00	26P1
RF cable type RG62A/U 93 ohm black 100m reel.	1	£32.00	32P2
3 metres of speaker cable and 2 2 pin din plugs.	1	£1.00	BD724
10 feet of 24 way cable terminating in 2 D25 plugs.	1	£10.00	10P121

COMMODORE 64 DRIVE £25
4 times faster than the original drive and 40 times faster than the data recorder! Complete system with media and software £25.00 ref 25P27. Additional 64K cartridges are £4.00 ref 4P150

VIEWDATA SYSTEM £20
Made by Tandata these units comprise a full qwerty keyboard, 1200/75 modem and plug straight into a TV or monitor. Just plug into BT phone socket and you can access Prestel, Telecom gold, bulitin boards etc. £20.00 ref 20P40

HI RES MONITOR £22.00
Amber 12" screen Hercules compatible, TTL input, white plastic case, H sync, V sync, and video signals req'd. 12v 1.5A DC supply required. £22.00 ref 22P26

12V 19A TRANSFORMERS
Ex equipment but ok complete with very tatty case! £20.00 ref 20P41

MAGNETIC AGITATORS £3
Mains operated motorized units made for stirring liquids etc. Complete with plastic covered magnets, recovery system, extension feet and cable! £3.00 ref 3P257

SINCLAIR C5 MOTOR
Ideal for motorizing push bikes, submarines, boats, small cars, model trains etc. Two types available £20 for standard motor ref 20P22 or £40 for standard motor with 4 to1 reduction gearbox fitted. Ref 40P8. We also have an electronic speed control kit to suit the above motors at £17 ref 17P3

PC MODEM FOR £9.00
Plug in XT/AT modem made by Westinghouse. No data or software so if you buy one you are on your own!! £9.00 ref 9P1J

CASED MODEMS FOR £3.00
Made for UK use (dialup) but again no data or info. Good value even if you strip them! £3.00 ref 3P1E

BENCH POWER SUPPLY £4
Superbly made units cased in attractive steel cases. Give 12v at 2A plus a 6V supply. Built in battery backup circuitry, short circuit protected and fused. Standard IEC inlet. £4.00 ref 4P3E

PC POWER SUPPLIES £5.00
3 types available.
150 watt. New £15 ref 15P54
200 watt. New £20 ref 20P41
Customer returned units (so may need attention) £5.00 ref 5P210

MICROWAVE CONTROLLERS £4.00
Mains powered with digital clock, programmable so can be used to turn something on or off at a preset time. High current relay output. Makes a superb enlarger timer! Our price is £4.00 ref 4P151

286 MOTHER BOARD £49
Brand new boards upgradable to 4 meg on board, 10MHZ, full technical manual, 30x35 cm. Ref 49P11
Also customer returned units available at £20.00 ref 20P42

DISC DRIVES FOR £7
Customer returned units of mixed capacities and sizes. These are sold on a random basis so we are unable to offer a choice of drive. £7.00 ref 7P35

286 PACKAGE £139
We can supply a 286 mother board, 1 meg of memory, keyboard, power supply and full size metalcase for only £139 ref 139P1
Note - The case will have to modified to accept the mother board and power supply, ther are no I/O cards, drives etc supplied with the system but a full mother board technical manual is included.

FAX PAPER BARGAIN £1.50
We have a large quantity of FAX paper made by Cannon. Standard A4 by 50 metre roll. Packed in boxes of 6 at £9.00 ref 9P18. We expect quite a high demand for this so please check availability before ordering.

AMSTRAD 464 COMPUTER £30
We have refurbished 464's complete with GT64(5) green screen monitors and software pack for £89.00 ref 89P3
Customer returned 464's at £30.00 Ref 30P210
Customer returned GT64(5) monitors at £15.00 ref 15P55

MIRACOM WS4000 MODEM £29
We have a large quantiy of Refurbished units complete with leads and power supplies available at only £29.00! The recommended retail for these units is £199!
Specifications
CCITT V21/23 standards
AT command set
Full software control
Microprocessor based
Autodial/Auto answer
Audio call monitoring
Tone and pulse dialling
Non volatile memory
Call progress detection
38mm (H) 182mm (W) 245mm (D)
High impact ABS case.

ONLY £29.00 Ref 29P210

CALL IN AND COLLECT YOUR GOODS. SHOP OPEN MON-SAT 9-5.15 250 PORTLAND ROAD HOVE.

TELEPHONE ORDERS 0273 203500

PRIORITY ORDER FORM

TO BULL ELECTRICAL dept 92
250 PORTLAND ROAD
HOVE SUSSEX
BN3 5QT

USE THIS FORM FOR
ANY ORDER WITH CASH
CHEQUE OR CREDIT CARD

QUANTITY	DESCRIPTION	ORDER NO	COST
		POSTAGE	£3.00
		VAT	
		TOTAL	

FROM ______________________

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CREDIT CARD NO ______________________

EXP DATE

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