EVERYDAY ELECTRONICS

JULY 1992

INCORPORATING ELECTRONICS MONTHLY

£1.60

32 PAGE GREENWELD Summer Catalogue Supplement

HOSEPIPE CONTROLLER

ELECTRONIC CRICKET

CLASS "A" HEADPHONE AMPLIFIER

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

GOT A CARAVAN OR BOAT?

NEW 80 PAGE FULL COLOUR LEISURE CATALOGUE

2,500 NEW LINES FREE WITH ORDER ON REQUEST

OR SEND £1.00

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

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

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

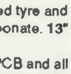
COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

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

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

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

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R.



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

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

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

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 5 tapes New low price £8.00 ref 8P161

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

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

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

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

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

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

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

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

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

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

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

ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system £25.00 ref B25P1 additional detectors £11.00 ref B11P1

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

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

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

BSB SATELLITE SYSTEMS

BRAND NEW

REMOTE CONTROL

£49.00 REF F49P1

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

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

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

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

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

MIRACOM WS4000 MODEMS

V21/23

AT COMAND SET

AUTODIAL/AUTOANSWER

FULL SOFTWARE CONTROL

TONE AND PULSE DIALLING

£29

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

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

STRIP BOARD CUTTING TOOL £2.00 ref 2P352R.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

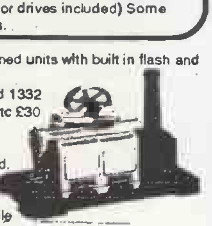
BUGGING TAPE RECORDER
Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R

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

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

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

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



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

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

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

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

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

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

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

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

VIDEO TAPES E180 FIFTY TAPES FOR £70.00 REF F70P1

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

IN SUSSEX? CALL IN AND SEE US!

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE
WITH ORDER PLUS £3.00 POST PLUS VAT.
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
NEXT DAY DELIVERY £6.00
FAX 0273 23077

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 21 No. 7 JULY 1992

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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

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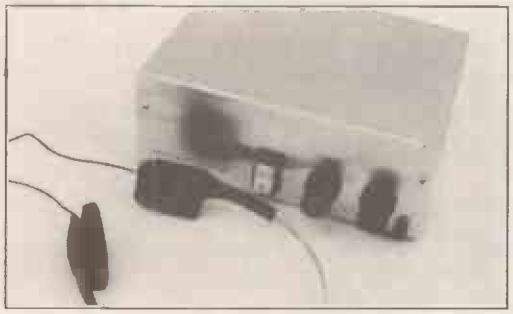
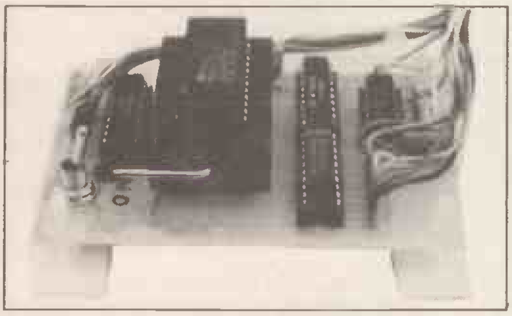
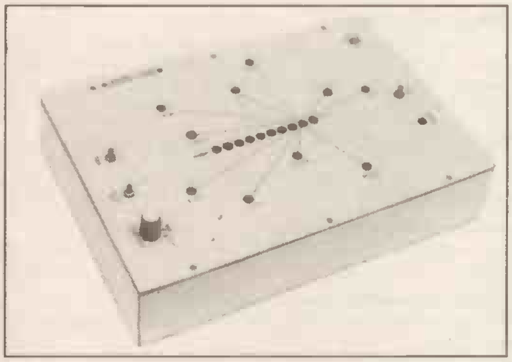
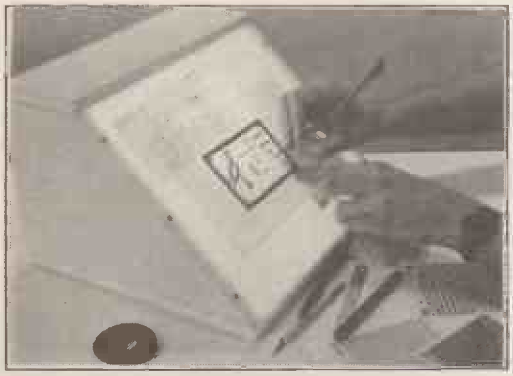
ISSN 0262 3617

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









Our August '92 issue will be published on Friday, 3 July 1992. See page 403 for details.

Projects

Series

Features

SURVEILLANCE

PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all of our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

UTX Ultra-miniature Room Transmitter
Smallest room transmitter kit in the word! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range £16.45

MTX Micro-miniature Room Transmitter
Best-selling micro-miniature Room Transmitter Just 17mm x 17mm including mic. 3-12V operation. 1000m range £13.45

STX High-performance Room Transmitter
Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range £15.45

VT500 High-power Room Transmitter
Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range £16.45

VXT Voice Activated Transmitter
Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range... £19.45

HVX400 Mains Powered Room Transmitter
Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range £19.45

SCRX Subcarrier Scrambled Room Transmitter
Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range £22.95

SCLX Subcarrier Telephone Transmitter
Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range £23.95

SCDM Subcarrier Decoder Unit for SCRX
Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation £22.95

ATR2 Micro Size Telephone Recording Interface
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line £13.45

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dil switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.

Complete System (2 kits)	£50.95
Individual Transmitter DLTX	£19.95
Individual Receiver DLRX	£37.95

MBX-1 Hi-Fi Micro Broadcaster
Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range £20.95

UTLX Ultra-miniature Telephone Transmitter
Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range £15.95

TLX700 Micro-miniature Telephone Transmitter
Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range £13.45

STLX High-performance Telephone Transmitter
High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm. 1500m range £16.45

TKX900 Signalling/Tracking Transmitter
Transmits a continous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation £22.95

CD400 Pocket Bug Detector/Locator
LED and piezo bleeper pulse slowly, rate of pulse and pitch of tome increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation £30.95

CD600 Professional Bug Detector/Locator
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation £50.95

QTX180 Crystal Controlled Room Transmitter
Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catlogue). Size 20mm x 67mm. 9V operation. 1000m range £40.95

QLX180 Crystal Cointrolled Telephone Transmitter
As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range £40.95

QSX180 Line Powered Crystal Controlled Phone Transmitter
As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m £35.95

QRX180 Crystal Controlled FM Receiver
For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Outpt to headphones. 60mm x 75mm. 9V operation £60.95

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft and add £5.00 per order for shipment. Credit card orders welcomed on 0827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

SUMA DESIGNS

DEPT. EE
THE WORKSHOPS, 95 MAIN ROAD,
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WARWICKSHIRE CV9 2LE

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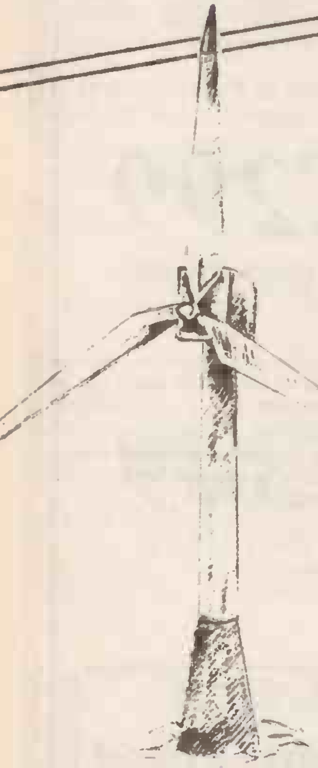


ALTERNATIVE ENERGY

What is the future for Alternative Energy?

Next month we start a short series about renewable energy. In part one we shall take an overview of the topic and look in some detail at the direct use of solar power. In the following months we shall examine some particular examples of renewable energy which have the potential for large-scale exploitation in the U.K. We will also examine at first hand the technology used in the design, construction and operation of modern wind turbines used to generate electricity.

SOLAR-POWERED LIGHTING UNIT

In line with our Alternative Energy series we show you how to build a unit that will provide "free" lighting for a shed, boat or caravan. There is also a simple version of the circuit that can act as a trickle-charger for a car-type battery.

GAS ALARM

A mains or 12V powered unit that will detect the build up of fuel gas plus many other types of inflammable gas and vapour. It will also detect many types of smoke.

SUB WOOFER

Most modern hi fi speaker systems are incapable of delivering good solid bass below about 50Hz. This single speaker unit is designed to add to an existing hi fi setup to provide a dramatic improvement in bass reproduction.

EVERYDAY ELECTRONICS

AUGUST ISSUE ON SALE FRIDAY 3RD JULY 1992

Special Offer!

Exclusive to Everyday Electronics

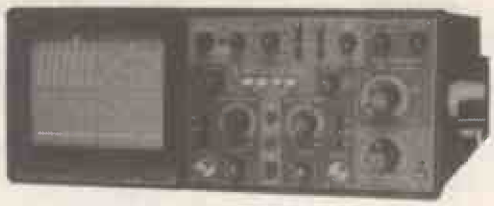
SSI 2120
Dual Trace Oscilloscope

- → DC - 20MHz
- → 1mV sensitivity
- → 0.5μS - 0.2S/div. timebase
- → Versatile trigger
- → TV, ALT, DC/LF
- → X-Y mode

£299
(Save £61.39)

SSI 2220
Dual Trace Oscilloscope
As SSI 2120 - *PLUS*

- → Dual Timebase with Sweep Mode (Ideal for Pulse Waveforms)
- → Component Tester



£349
(Save £70.48)

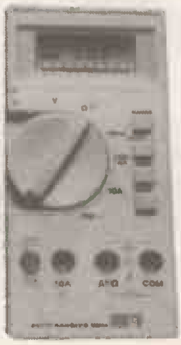
DT 3900
DMM

- → 3 1/2 digit
- → Large LCD with indicators
- → Fully protected
- → Diode and HFE
- → Continuity

£29
(Save £12.13)

DT870
DMM

- → Auto/manual
- → 3 1/2 digit & Bargraph
- → Memory features
- → Continuity



£43
(Save £14.58)

Also available :

BS110 *£13.50*
Passive scope probes (x1/x10)

TL900 *£5.50*
Scope test leads

DMMs supplied with battery and test leads

All Prices are Inclusive of Post/Packing and VAT at 17.5%

Please allow 28 days for delivery

Offer closes September 30th 1992, while stocks last.

Post this Order Form with your remittance to:

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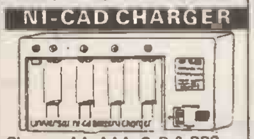

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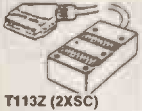

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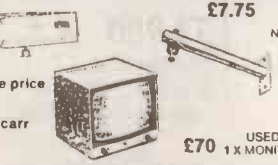

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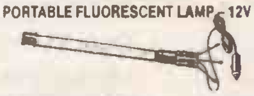

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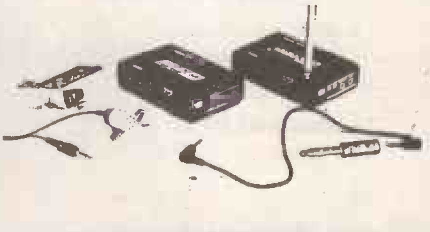

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Signal to noise ratio ....> 80dB
Frequency response 20-20000Hz
Input sensitivity.........10mV-3V adjustable
Input impedance ....Low level input 20kΩ
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Power.........14.4V dc 15A
Dims ....240 x 120 x 50mm

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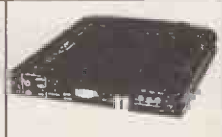

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Input sensitivity.....100mV-3V adjustable
Input impedance ..High level input 100Ω
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Output impedance.........4Ω
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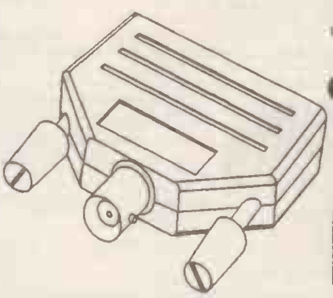

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Do you tapes lack treble?. A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new!. Standard inductances and mountings make fitting easy on nearly all machines (Sony are special, see below) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see!. All our heads are suitable for use with any Dolby system and are normally available ex stock. We also stock a wide range of special heads for home construction and Industrial users.

HM120 Standard Mono R/P Head	£3.51
HC15 Standard Quality Stereo R/P Head	£2.49
HC66 High Quality Stereo R/P Head. Permalloy	£7.98
HS16 Sendust Alloy Stereo Head	£21.49
HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!	£8.30
HQ551 4-Track RECORD & Play Permalloy Head for auto-reverse car players or quadraphonic recording	£14.90
H524 Standard Erase Head	£1.90
H561 Hi Field Erase Head for METAL Tapes	£3.49
HRP373 Downstream Monitor Stereo Combination Head	£47.90

Many other SPECIAL cassette Heads in stock, see our LIST.

REEL TO REEL HEADS

999R 2/4 Record/Play 110mH. Suits Stuart Tape Circuits	£13.64
998E 2/4 Erase Head 1mH. Universal Mount. Suits Stuart	£11.98

TAPE RECORDER CARE PRODUCTS

HART TC1 TEST CASSETTE Our famous triple purpose test cassette. Sets tape azimuth, VU level and tape speed	£5.36
DEM1 Mains Powered Tape Head Demagnetizer, prevents noise on playback due to residual head magnetisation	£4.48
DEM115 Electronic, Cassette Type, demagnetizer	£8.91

COMPUTER CORNER

The following are a selection of our new range of VERY competitively priced, High Quality, computer systems. Due to our long experience of importing we have the necessary contacts in the Far East to buy at very advantageous prices and can pass the savings on to you. All hard disc machines ordered with DOS are fully formatted and ready to use.

HART MODEL AT-286/16WP COMPUTER

Fully fledged AT286 machine, cheap enough to use as the fastest wordprocessor in the west! Only a few years ago the AT-286 machine was the fastest standard office computer known. Now we can offer the superfast 16MHz version (earlier ones were only 10 or 12MHz) at such an incredibly low price that it can be used in any office or home. Not only that but ours comes with ultrafast memory so that the machine can run in 'zero wait state'.

Advanced features are:– Full 1MB of memory (Expandable to 4MB), 102 key UK keyboard, compact desktop case, 1.2MB 5¼" High Density Disk Drive and interface card for extra drive, Graphics/Printer Card, built in Hard Disk Interface.

HART AT-286/16WP	ONLY £277.25
14" FST Hercules monitor, Amber	£83
14" Paper White Hercules Monitor. (Both have T/S Base)	£86
Trust Writer W/P Software uses Wordstar commands.	£19.50

40MB AT-286/16UG Hard Disk Computer

Specification as above but with 45MB 25ms hard disk, VGA Colour Graphics Card with 512K RAM, parallel printer port, 2 serial ports, 1 game port.	£523.50

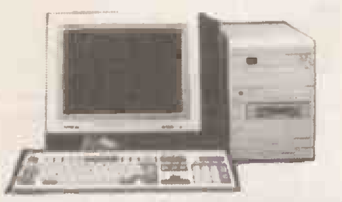
14" VGA Mono Monitor, Amber £86.70 Paper White £89

HART 40MB AT-386/16SX EL

Entry level 386 machine for demanding applications at moderate cost. Spec as our AT286/16WP with 1MB Dram memory, Mini Tower case, 45MB 25ms hard disk drive, VGA Colour Graphics Card with 256K RAM

40MB AT-386/16SX EL is.	ONLY £634.30 (Ex Vat)

HART 52MB AT-386/20SX UG



Luxury version of the above with higher processor speed and amazing 9 millisecond access time hard disk. 2MB SIMM RAM, Compact Tower Case, VGA 1024 x 768 card with 512K RAM, upgradeable to 1MB of Video memory.

40MB AT-386/20SX UG	ONLY £853.10

OPTIONAL EXTRAS

HART Computers can be 'custom made' to fit your personal requirements, at NO extra cost!. Simply select the options you require. If replacing any item in the standard specification for that model then deduct the cost of the part not needed.

SOFTWARE

MS-DOS 5 Latest Release. Full version. 3.5" or 5.25"	£59
DR DOS 6	£77
Microsoft Windows Latest Version 3.1	£67

MONITORS

SM1421 AM TU Hercules Mono with FST Tube and Stand, Amber	£83
SM1421 PW TU As Above but Paper White Screen	£86
SM1416A VGA Mono Monitor c/w tilt and swivel stand. Amber	£86.70
SM1416W As Above; Paper white	£89
SM1485-00 Super VGA Multisync Colour Monitor, ·28" dot pitch, 50MHz Bandwidth, up to 1024 x 768, c/w stand	£235

KEYBOARDS

K261 102 Key Enhanced UK Layout, Tactile Click, AT/XT Switchable with dual slope feet.(Standard Keyboard supplied with systems)	£31
K108 Similar to above, single slope feet, Alps switches	£36
KB6153A As above but with heavy metal base	£44

I/O and GRAPHIC CARDS

AT Super I/O Card 2 x FDD, 1xIDE, 2 Serial, 1 Parallel, 1 Game Ports	£21.20
Hercules Mono Graphic & Printer card	£11.70
16-Bit VGA Card, 256K	£46.50
Trident 8900 VGA Card, 512K	£67.30
Trident 8900 VGA Card with 1Mb	£86.90

DISK DRIVES

5.25" 1.2Mb Floppy Disk Drive	£49
3.5" 1.44Mb Floppy Disk Drive	£45
Adapter to fit 3.5" drive in 5.25" slot, c/w power adapter	£9
45MB 25ms Hard Disk Drive	£165
52MB Quantum Hard Disk. Lightning Fast 9ms Access time	£261

CASES

WE 611P Desktop Case, Flip Top, 200W PSU	£56.40
WE727P Mini Tower Case, 200W PSU	£84.70
108MP Mini Tower Case, Compact Style	£89
CT107 Midi Tower Case	£108

MOTHERBOARDS

AT-286/16 0K.RAM	£89
AT-386-16SX 0K.RAM	£195
AT-386-20SX 0K.RAM	£245

PLEASE NOTE THAT ALL ITEMS IN THIS SECTION ARE PRICED EX VAT.

Send or 'phone for your copy of our List (50p) of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.

Ordering is easy. Just write, telephone or fax your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned or faxed order with your credit card number will get your order on its way to you THAT DAY.

Please add part cost of carriage and insurance as follows:–INLAND Orders up to £20 - £1.50 **Orders over £20 - £3.50 Express Courier, next working day. £10 (For safety all computer parts are only sent by courier) OVERSEAS – Please see the ordering information with our lists.**

MANUFACTURERS OF QUALITY AUDIO KITS AND COMPUTERS

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AUDIO KIT PRICES are VAT INCLUSIVE. COMPUTER PRICES EXCLUDE VAT

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Fax: 0283 46

VERSATILE BBC INTERFACE

A comprehensive interface which allows the BBC Model B computer to be connected safely to a wide range of input and output devices. Two leads connect the interface to the User port and Printer port. Up to 16 outputs (all via single pole change-over relay contacts) and 8 inputs. All inputs are fully protected. LED indication is provided on all lines. Requires an independent 12V supply

Full Kit Ref: 844 £51.95

STEPPING MOTOR DRIVER/INTERFACE

EE Jan '92
A single board, stand alone, stepping motor driver with built-in oscillator for variable low speed, high speed, and acceleration control. Suitable for all Magenta's four-phase unipolar motors and most others – up to 35V and 1·5A per phase. Half step, Full step and Wave-drive modes – switch selectable. LED mimic display and connector for computer port.
Kit includes MD35 motor

Kit Ref: 843 £29.95
Or Built £44.95

Supplying Electronics for Education, Robotics, Music, Computing and much, much more

CATALOGUE AVAILABLE PRICE £1.00 INC. P&P

All prices include VAT at 17·5%
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9-2 Saturday
Official orders welcome

Add £2 p&p to all orders

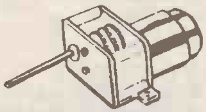
HAMEG HM 203-7 OSCILLOSCOPE

High quality reliable instrument made in W. Germany. Outstanding performance. Full two year parts and labour warranty. 20MHz-2 channels 1mV sensitivity. Easy to operate and high performance

(Cheques must be cleared) £338 + £59.15 VAT

Next day Delivery £10.00

D.C. MOTOR GEARBOXES



Ideal for Robots and Buggies. A miniature plastic reduction gearbox coupled with a 1·5-4·5 Volt mini motor. Variable gearbox reduction ratios are obtained by fitting from 1 to 6 gearwheels (supplied). Two types available:

Small Unit Type MGS £4.08
Speed range 3-2200 rpm. Size: 37 x 43 x 25mm
Large Unit Type MGL £4.65
Speed range 2-1150 rpm. Size: 57 x 43 x 29mm

STEPPING MOTORS

A range of top quality stepping motors suitable for driving a wide range of mechanisms under computer control using simple interfacing techniques.

ID36 Permanent Magnet Motor £16.86
48 steps per rev
MD200 Hybrid Motor £17.10
200 steps per rev
MD35¼ Permament Magnet Motor £12.98
48 steps per rev.
MD38 Permanent Magnet Motor £9.15
48 steps per rev.

EVERYDAY ELECTRONICS KIT PROJECTS

ALL KITS HERE HAVE BEEN FEATURED IN EE AND ARE SUPPLIED WITH MAGAZINE ARTICLE REPRINTS. SEPARATE REPRINTS ALSO AVAILABLE PRICE 80p EACH INCLUSIVE P&P. KITS INCLUDE CASES, PCB's HARDWARE AND ALL COMPONENTS (UNLESS STATED OTHERWISE) CASES ARE NOT DRILLED OR LABELS SUPPLIED UNLESS STATED.

Ref		Price
844	VERSATILE B8C INTERFACE Mar 92	£51.95
843	STEPPING MOTOR DRIVER/INTERFACE Jan 92 or built	£29.95 £44.95
842	PORTABLE ULTRASONIC PEsT SCARER. Aug '91	£22.56
841	DIGITAL LCD THERMOSTAT May 91 with punched and printed case	£29.95
840	DIGITAL COMBINATION LOCK Mar 91 with drilled case	£19.86
839	ANALOGIC TEST PROBE Jan 91 (no case)	£13.23
838	MICROCONTROLLER LIGHT SEQUENCER Dec 90. With drilled and labelled case	£57.17
835	SUPERHET BROADCAST RECEIVER Mar 90 With drilled panels and dial	£17.16
834	QUICK CAP TESTER Feb 90	£10.39
833	EE 4 CHANNEL LIGHT CHASER Jan 90	£32.13
815	EE TREASURE HUNTER Aug 89	Full Kit £45.95
814	BAT DETECTOR June 89	£21.44
812	ULTRASONIC PET SCARER May 89	£14.81
800	SPECTRUM EPROM PROGRAMMER Dec 88	£30.60
796	SEASHELL SYNTHESISER Nov 88	£28.55
790	EPROM ERASER Oct 88	£28.51
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£56.82
744	VIDEO CONTROLLER Oct 87	£33.29
740	ACOUSTIC PROBE Nov 87	£20.01
739	ACCENTED BEAT METRONOME Nov 87	£23.94
734	AUTOMATIC PORCH LIGHT Oct 87	£19.62
730	BURST-FIRE MAINS CONTROLLER Sep 87	£15.50
728	PERSONAL STEREO AMP Sep 87	£16.34
724	SUPER SOUND ADAPTOR Aug 87	£43.86
722	FERMOSTAT July 87	£13.88
719	BUCCANEER I.B. METAL DETECTOR July 87	£30.22
718	3-BAND 1.6-30MHz RADIO Aug 87	£30.30
715	MINI DISCO LIGHTS June 87	£14.39
707	EQUALIZER (IONISER) May 87	£17.75

Ref		Price
700	ACTIVE I/R BURGLAR ALARM Mar 87	£40.74
584	SPECTRUM SPEECH SYNTH (no case) Feb 87	£23.90
581	VIDEO GUARD Feb 87	£9.59
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544	TILT ALARM July 86	£8.94
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528	PA AMPLIFIER May 86	£30.60
523	STEREO REVERB Apr 86	£30.21
513	B8C MIDI INTERFACE Mar 86	£31.93
512	MAINS TESTER & FUSE FINDER Mar 86	£10.07
497	MUSICAL DOOR BELL Jan 86	£21.41
493	DIGITAL CAPACITANCE METER Dec 85	£49.95
481	SOLDERING IRON CONTROLLER Oct 85	£6.25
464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85 1D35 STEPPER MOTOR EXTRA OPTIONAL POWER SUPPLY PARTS	£9.60 £9.15 £5.86
461	CONTINUITY TESTER July 85	£7.08
455	ELECTRONIC DOORBELL June 85	£8.63
444	INSULATION TESTER Apr 85	£22.37
392	B8C MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£40.82
387	MAINS CABLE DETECTOR Oct 84	£6.31
386	DRILL SPEED CONTROLLER Oct 84	£9.91
362	VARICAP AM RADIO May 84	£15.02
337	BIOLOGICAL AMPLIFIER Jan 84	£27.59
263	BUZZ OFF Mar 83	£6.49
242	INTERCOM no case July 82	£6.50
240	EGG TIMER June 82	£7.85
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106	WIERD SOUND EFFECTS GEN Mar 78	£8.94
101	ELECTRONIC DICE Mar 77	£7.15

EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. ideal for beginners. No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects – including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

Adventures with Electronics £6.25
Component Pack (less book) £22.83

FUN WITH ELECTRONICS

From the USBORNE Pocket Scientist series – an enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners – children and adults. Only basic tools are needed. 64 full colour pages cover all aspects – soldering – fault finding – components (identification and how they work). Also full details of how to build 6 projects – burglar alarm, radio, games, etc. Requires soldering – 4 pages clearly show you how. The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

Fun with Electronics Book £2.95
Component pack (less book) £17.93

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time. Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, MW Radio, Fuzz unit, etc.

30 Solderless Breadboard Projects (Book 1) £2.95
Component Pack £27.74

INSULATION TESTER

EE APRIL 85

A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

£22.37

KIT REF 444

PET SCARER

EE MAY 89

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V–12V or via Mains Adaptor).

KIT REF 812

Mains Adaptor £2.02

£14.81

DIGITAL LCD THERMOSTAT

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

EE AUG 87

Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718

£30.30

DIGITAL COMBINATION LOCK

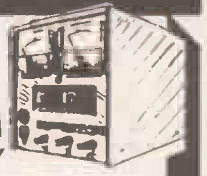
EE MAR '91

Digital combination lock with a 12 key keypad. 4 digit code operates 250V-16A SPCO relay. A special anti-tamper circuit allows the relay to be mounted remotely from the keypad without any loss of security. Can be operated in many modes (latching/unlatching, manual/automatic setting, continuous/momentary output, etc.). Article describes operation as Vehicle Immobilising security system. Low current drain. *Kit includes drilled case.*

KIT REF 840

£19.86

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

£56.82

KIT REF 769

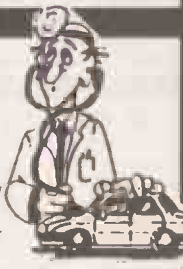
PORTABLE ULTRASONIC PEsT SCARER

EE AUG '91

A powerful 23kHz Ultrasonic generator in a compact hand-held case. A MOSFET output drives a weatherproof transducer at up to 300V peak to peak via a special tuned transformer. Sweeping frequency output requires no setting up or alignment. Kit includes all components, PCB, transducer and case.

KIT REF 842

£22.56



ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740

£20.01

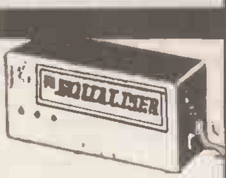
4 CHANNEL LIGHT CHASER

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 Ioniser 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

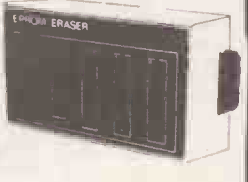
MICROCONTROLLER LIGHT SEQUENCER

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.

£57.17

KIT REF 83B



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.

£17.16

KIT REF 835

ESR ELECTRONIC COMPONENTS

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74LS10	£0.14
74LS107	£0.23
74LS109	£0.21
74LS11	£0.17
74LS112	£0.21
74LS113	£0.21
74LS114	£0.21
74LS12	£0.14
74LS122	£0.31
74LS123	£0.31
74LS125	£0.21
74LS126	£0.21
74LS13	£0.14
74LS132	£0.21
74LS133	£0.18
74LS136	£0.16
74LS138	£0.24
74LS139	£0.25
74LS14	£0.18
74LS145	£0.56
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74LS148	£0.70
74LS15	£0.14
74LS151	£0.25
74LS153	£0.25
74LS154	£0.70
74LS155	£0.25
74LS156	£0.25
74LS157	£0.25
74LS158	£0.25
74LS160	£0.32
74LS161	£0.32
74LS162	£0.32
74LS163	£0.32
74LS164	£0.26
74LS165	£0.48
74LS170	£0.30
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.25
74LS191	£0.24
74LS192	£0.24
74LS193	£0.24
74LS195	£0.24
74LS196	£0.24
74LS197	£0.24
74LS20	£0.16
74LS21	£0.14
74LS22	£0.14
74LS221	£0.36
74LS240	£0.32
74LS241	£0.32
74LS242	£0.32
74LS243	£0.32
74LS244	£0.32
74LS245	£0.33
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS26	£0.14
74LS266	£0.14
74LS27	£0.14
74LS273	£0.32
74LS279	£0.25
74LS30	£0.14
74LS32	£0.14
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS37	£0.14
74LS373	£0.32
74LS374	£0.32
74LS375	£0.34
74LS377	£0.32
74LS378	£0.62
74LS38	£0.14
74LS390	£0.25
74LS393	£0.24
74LS395	£0.26
74LS399	£0.62
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74LS42	£0.25
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74LS74	£0.19
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ENAMELLED COPPER WIRE

All 2oz Reels

14 SWG	£0.63
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22 SWG	£0.76
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26 SWG	£0.89
28 SWG	£0.91
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32 SWG	£0.93
34 SWG	£0.99
36 SWG	£1.04
38 SWG	£1.10
40 SWG	£1.22

4000 Series

4000	£0.17
4001	£0.17
4002	£0.17
4006	£0.32
4007	£0.17
4008	£0.31
4009	£0.19
4010	£0.23
4011	£0.16
4012	£0.16
4013	£0.17
4014	£0.30
4015	£0.31
4016	£0.18
4017	£0.25
4018	£0.27
4019	£0.19
4020	£0.31
4021	£0.31
4022	£0.32
4023	£0.16
4024	£0.21
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4028	£0.22
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4031	£0.70
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4040	£0.29
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4042	£0.22
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4047	£0.25
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4053	£0.25
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4063	£0.29
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4067	£1.91
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4077	£0.17
4081	£0.14
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4085	£0.28
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1.0	–	–	£0.05	£0.06	£0.15
2.2	–	–	£0.05	£0.06	£0.18
4.7	–	–	£0.05	£0.08	£0.30
10	£0.05	£0.05	£0.06	£0.08	£0.48
22	£0.05	£0.05	£0.09	–	–
47	£0.06	£0.06	£0.11	–	–
100	£0.06	£0.09	£0.11	–	–
220	£0.09	£0.12	£0.31	–	–
470	£0.15	£0.19	£0.57	–	–
1000	£0.22	£0.29	–	–	–
2200	£0.37	£0.57	–	–	–
4700	–	£1.11	–	–	–

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1.0	–	–	£0.10	£0.10	£0.19
2.2	–	–	£0.10	£0.10	£0.22
4.7	–	£0.09	£0.10	£0.10	£0.34
10	–	£0.12	£0.12	£0.12	£0.48
22	–	£0.09	£0.13	£0.17	£1.06
47	£0.10	£0.11	£0.16	£0.20	£1.33
100	£0.10	£0.13	£0.21	–	£2.46
220	£0.13	£0.18	£0.42	–	–
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1000	£0.33	£0.40	£1.05	–	–
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VOL. 21 No. 7 JULY '92

THE MODERN AMATEUR ELECTRONICS MANUAL

I am sure a large number of our readers will have been aware of the advertising and inserts for *The Modern Amateur Electronics Manual*, previously available from WEKA Publishing, and advertised extensively in a wide range of hobbyist and technical media. The title has been widely purchased by hobbyists, student, trainees, colleges, training departments and a very wide range of retail and industrial organisations over the past four years.

Earlier this year WEKA decided to close down its UK publishing operation and a number of titles, appealing to a broad spectrum of business and hobby readers, were put up for sale. I am pleased to tell you that Wimborne Publishing – the publishers of *Everyday Electronics* – have purchased *The Modern Amateur Electronics Manual* and will continue to market this product and produce bi-monthly updates for it in the way that WEKA previously did.

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The same editorial team will continue to produce the updates/supplements and we will endeavour to keep up the high standard WEKA have achieved and add a few new ideas of our own. One change that we have already started to introduce is to shorten the title of the publication to *The Modern Electronics Manual*. While the manual is undoubtedly of great benefit to hobbyists it has also established a very firm base in education, training and in the general electronics industry, we therefore feel the word *Amateur* in the title is inappropriate and will in future drop it.

If you are receiving the manual and updates you will have already heard from us, if not why not investigate this excellent product. You will find an advertisement for the manual on pages 456 and 457.

Mike Kenward

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Constructional Project

CLASS-A HEADPHONE AMPLIFIER

PAUL HENDERSON

Get the very best results from your hi-fi when using headphones with this inexpensive class-A amplifier

ANY AUDIOPHILE knows the frustration of wanting to enjoy his/her favourite music when the rest of the household is intent on watching the "box". Or alternatively someone is asleep and cannot be disturbed.

In these circumstances the project described here comes into it's own. Although simple, the circuit is capable of giving far higher fidelity than many standard power amplifiers on the market and substantially better than would be obtained from the headphone socket of a standard power amp. Used with a CD player and/or tuner and tape deck a very high quality system can be assembled at reasonably low cost.

DESIGN CONCEPT

Before describing the circuit in detail it will be as well to review the basic design concepts and explain just how this level of performance can be obtained. Most standard stereo power amplifiers operate in class-B.

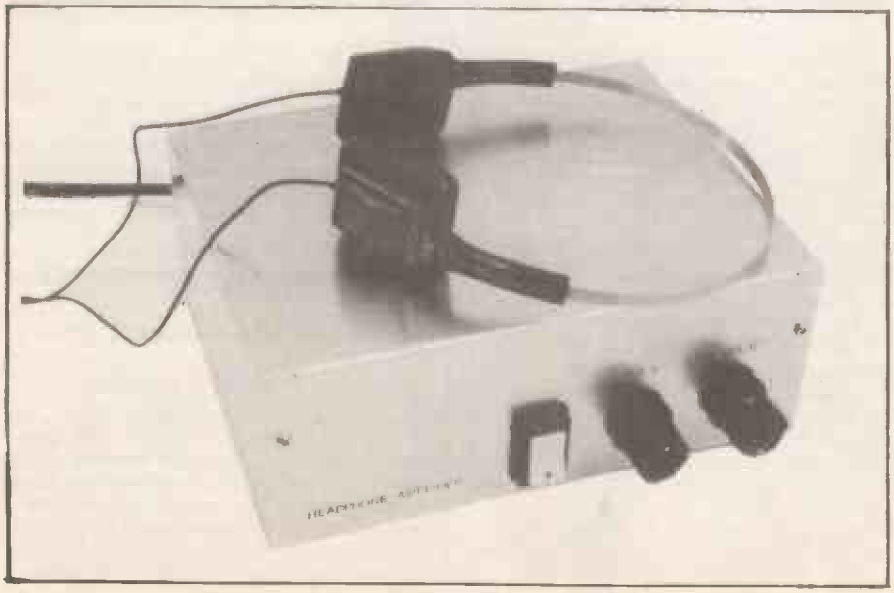
What this means is that the output stage consists of two halves. One half handles negative going output signals whilst the other handles positive. Using this method the idling current can be limited to very low values whilst maintaining the large voltage and current swings required to drive a loudspeaker.

Unfortunately, these amps suffer from a form of distortion known as "crossover distortion" which occurs at and near the zero crossings of the output signal. Crossover distortion is actually due to the fact that the two halves of the circuit are not perfectly matched. The distortion generated is worst at the kind of levels needed for headphone listening.

Another problem associated with headphone sockets on main amplifiers is that a series resistance is inserted between the phones and the output stage to reduce signal levels. This is not as innoculous as it first sounds.

Speakers and headphones are designed to work from a zero impedance source. Feeding either through a series resistance results in a loss of control on the moving diaphragm by the amplifier, usually resulting in a peak in the bass response with a rapid "roll-off" below the frequency of the peak.

To produce an amplifier to drive headphones successfully and to obtain the maximum performance which they are capable of requires that both these problems must be addressed.



To design any piece of audio equipment successfully the first stage is to define exactly what it is that you require and determine the circuit from this information. A decade ago most stereo headphones were 8 ohm units, now most quality units employ Mylar film diaphragms and are usually rated 32 ohm impedance.

Visiting several hi-fi shops , most units, including the 8 ohm types have a sensitivity of between 87db and 96db/mW. Almost universally the maximum power input is limited to 100mW/channel. Of the ten pairs of headphones tested with this amplifier most were delivering truly deafening levels with 10mW input.

CLASS-A

Along with output power the amplifier also requires the usual low distortion levels, low noise and wide frequency response expected for a piece of hi-fi gear. To avoid crossover distortion the output stage must be operated in class-A.

To understand what this means consider the normal small signal class-A transistor stage. To ensure maximum signal swing the collector will be biased at half the available line voltage. The current consumption of the stage will be fixed by the load resistance to which the collector is connected. In a power amplifier the load would normally be a 8 ohm loudspeaker.

Although the maths is beyond the scope of this article it can be shown that the output stage would need to consume twice as much power as delivered to the load. Hence a 50W class-A amp would need to dissipate 100W continuously to operate properly. As you may well imagine this would mean huge heatsinks and power transformers. Such amplifiers are made but you could buy a reasonable family car for the same price.

HEADPHONES

Going back to headphones, to provide 10mW of pure class-A into a pair of 32 ohm 'phones requires a voltage swing of 560mV r.m.s. and a current consumption of 25mA. This can easily be obtained with small signal transistors in the output stage. In fact the maximum output of the amplifier is just over 100mW and the "cans" (headphones) will begin to distort long before the amplifier does with high level inputs.

The output stage is only half the story however. We need to drive this properly. Several circuits were tried and the final choice was made in favour of an op.amp driver with it's output stage biased into class-A. The Class-A Headphone Amplifier

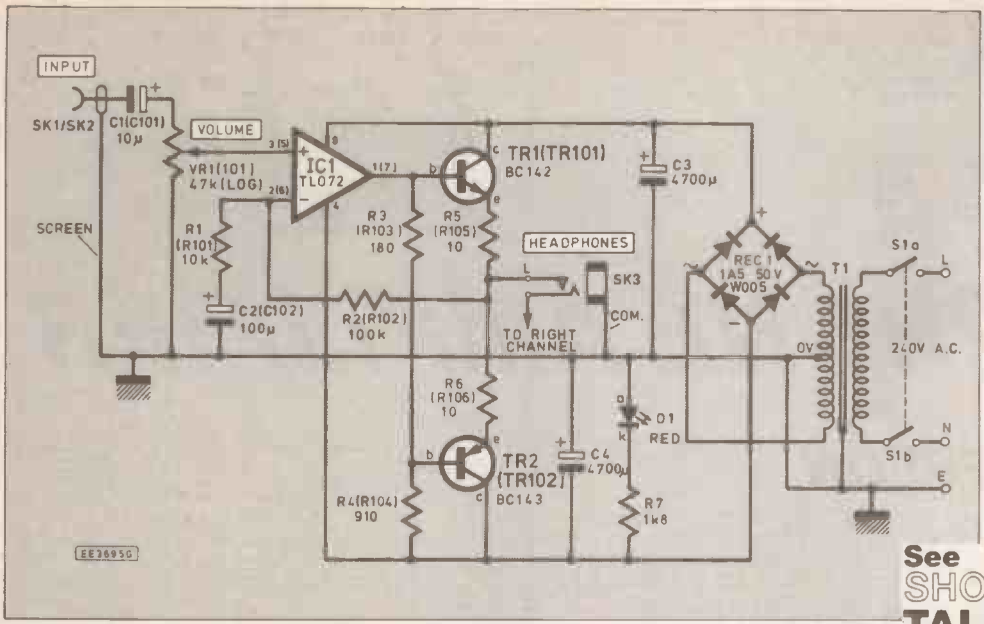


Fig. 1. Complete circuit diagram of the Class-A Headphone Amplifier.

described here has been measured for THD (total harmonic distortion) and bandwidth etc. The results were as follows:

THD: <0·005 per cent at 1kHz
Frequency Response: 2·5Hz-100kHz −3db
Signal-to-Noise Ratio: −90db
Max. Output: 120mW/32 ohm

CIRCUIT DESCRIPTION

One channel (left) of the Class-A Headphone Amplifier and common power supply components is shown in the circuit diagram Fig. 1. Components for the right channel have one hundred added to the component numbering, i.e. R101, TR101, C102 and so on.

Essentially the amplifier is a boosted op.amp designed with both the op.amp and output stage biased into class-A. To allow direct coupling a dual rail power supply is used.

Starting from the beginning. Input signals are first coupled to the volume control VR1 via the d.c. blocking capacitor C1. This latter component has a relatively large value and sets the −3db point in the bass region. The use of the value specified sets this at 2Hz.

For most sources the capacitor could probably be removed as any reasonable signal will not have any d.c. impressed upon it. However, it's certainly better to be safe than sorry especially as one of the symptoms of a d.c. offset at the input would be a similar offset at the output.

At best this will increase current consumption in the output stage producing unwanted hum at the output. At worst the headphones could be damaged.

The volume control VR1 also sets the input impedance of the amplifier at 47kilohms (47k). Since IC1 is a j.f.e.t. input device with an input impedance of about 10-12 megohms.

There are a large number of op.-amps on the market which purport to be ideal for audio applications. Most of these have been used at one time or another but still the TL072 op.amp seems to combine the best characteristics at a reasonable price. The device is low noise, has a slew rate of 13V/µSec and a high current sink/source capability.

All these features make for an excellent package. Nevertheless these devices are rarely run under optimum operating conditions.

For example the output stage of the op.amp operates with a current of a couple of milliamps and can only work in class-AB into loads of less than 10k or so. This problem can be circumvented by using a dodge from American audiophiles who bias the output stage into class-A by the simple expedient of connecting a resistor, of appropriate value, from the output to the nagative supply rail. This forces the upper transistor to source current and thus biases it into class-A.

We are using the op.amp IC1 here as a non inverting amplifier feeding the input signals from the slider (moving contact) of VR1 to the non inverting input (+). Resistors R3 and R4 perform two functions. Firstly, as just described, they force the op.amp into class-A operation and secondly they provide bias for the output stage consisting of transistors TR1 and TR2.

The complementary transistors TR1 and TR2 operate in the emitter follower mode. This provides a relatively high input impedance looking into their bases and a low output impedance at the emitters.

OUTPUT STAGE

Resistors R5 and R6 are vitally important in this design. As they are in series with the emitters of TR1 and TR2 they provide local negative feedback, linearising the operation of the output stage.

Just as importantly the voltage drop across these resistors, in conjunction with the voltage drop across resistor R3 set the output stage into class-A operation. Overall negative feedback is taken from the junction of resistors R5/R6 to IC1's inverting input (pin 2), via resistor R2.

The voltage gain of the amplifier is set by the ratio of resistor R2 to R1 at 11 times. Capacitor C2 is included to reduce the gain at d.c. to unity whilst appearing as a short circuit to a.c. signals.

The output from the amplifier is fed directly to the headphones which are returned to the 0V rail. Power indication is provided by l.e.d. D1 in series with resistor R7 which limits the l.e.d.s current to a suitable value.

Having described the amplifier circuit attention can be turned to the power supply.

COMPONENTS

Resistors

R1, R101	10k (2 off)
R2, R102	100k (2 off)
R3, R103	180 (2 off)
R4, R104	910 (2 off)
R5, R105, R6, R106	10 (4 off)
R7	1k8

All 0·2W 1% crbon film

Potentiometers

VR1, VR100	47k rotary carbon, log. (2 off)

Capacitors

C1, C101	10µ axial elect., 16V (2 off)
C2, C102	100µ radial elect., 25V (2 off)
C3, C4	4700 radial elect., 16V (2 off)

See SHOP TALK Page

Semiconductors

D1	5mm Red l.e.d.
TR1, TR101	BC142 *npn* silicon medium power transistor (2 off)
TR2, TR102	BC143 *pnp* silicon medium power transistor (2 off)
IC1	TL072 dual low noise op.amp
REC1	1A 100V bridge rectifier

Miscellaneous

SK1/SK2	Dual phono socket
SK3	Stereo jack socket, with matching plug
S1	DPST mains on/off switch
T1	Mains transformer: 240V a.c. primary; 0V-6V, 0V-6V 1A secondaries

Stripboard 0·1in. matrix, size 19 strips × 34 holes; aluminium case, size 152mm × 102mm × 51mm; 8-pin d.i.l. socket; audio screened cable, single-core; mains 3-core cable; strain relief clamp; plastic knobs (2 off); connecting wire; solder tag; solder etc.

Note: Components with one hundred numbers added are for the right channel.

Approx cost guidance only **£18.50**

The mains transformer T1 has dual 6V a.c. secondaries which are connected in series to provide 12V a.c. to the bridge rectifier REC1. After rectification the raw d.c. is smoothed by the electrolytic capacitors C3 and C4. Transformer T1, of course, steps down the mains voltage which is connected to it's primary winding. Finally S1 provides an on/off switching function.

CONSTRUCTION

The prototype model was built in a small aluminium case, dimensions 152mm by 102mm by 51mm. This being sufficiently large to accommodate the circuit board, mains transformer, sockets, switch and volume controls. Initially, an ABS plastic case of similar dimensions was tried. However when using this the circuit was prone to electrostatic hum pickup. The result was a low level annoying buzz in the phones.

The screening provided by the aluminium case eliminates this problem. I

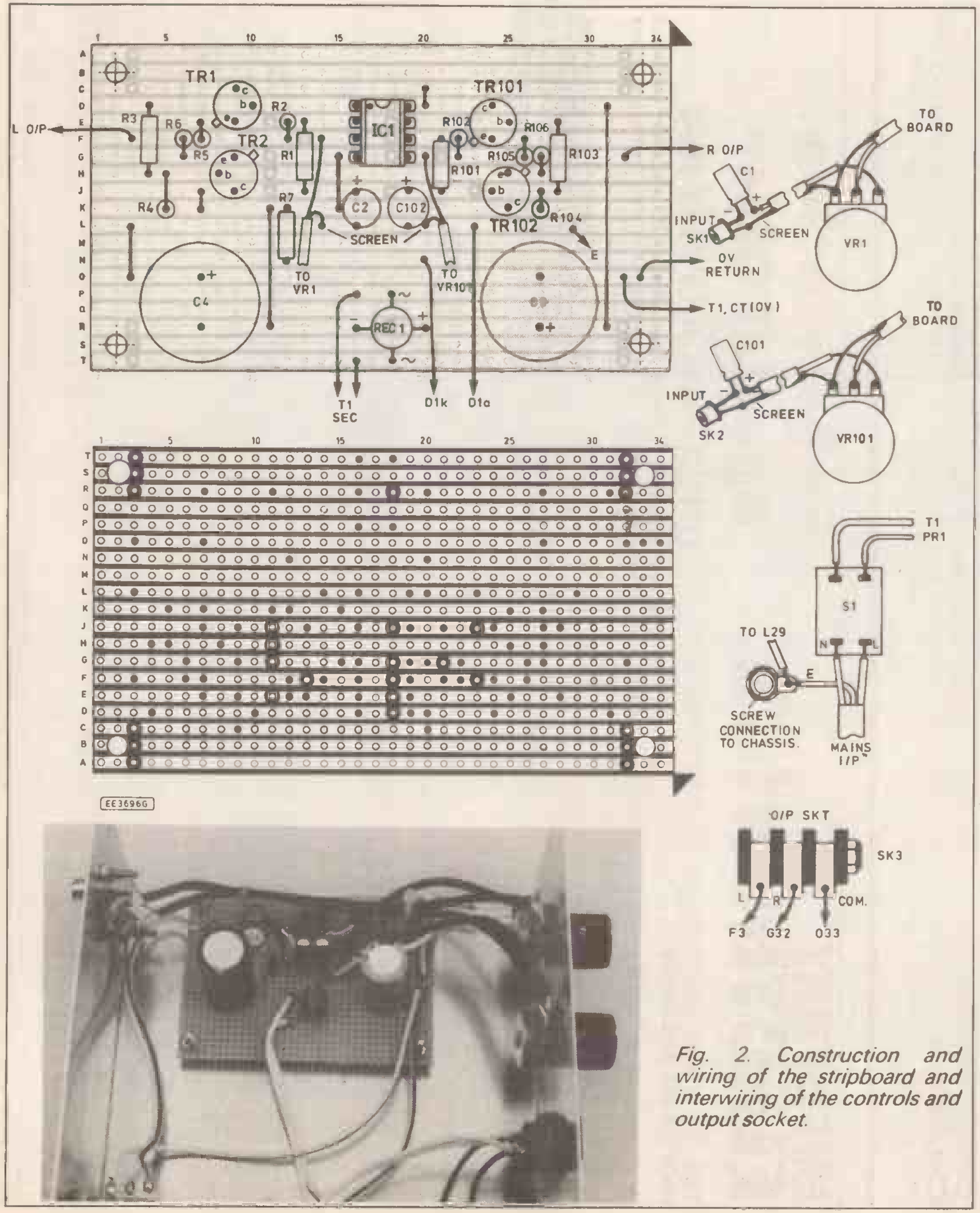


Fig. 2. Construction and wiring of the stripboard and interwiring of the controls and output socket.

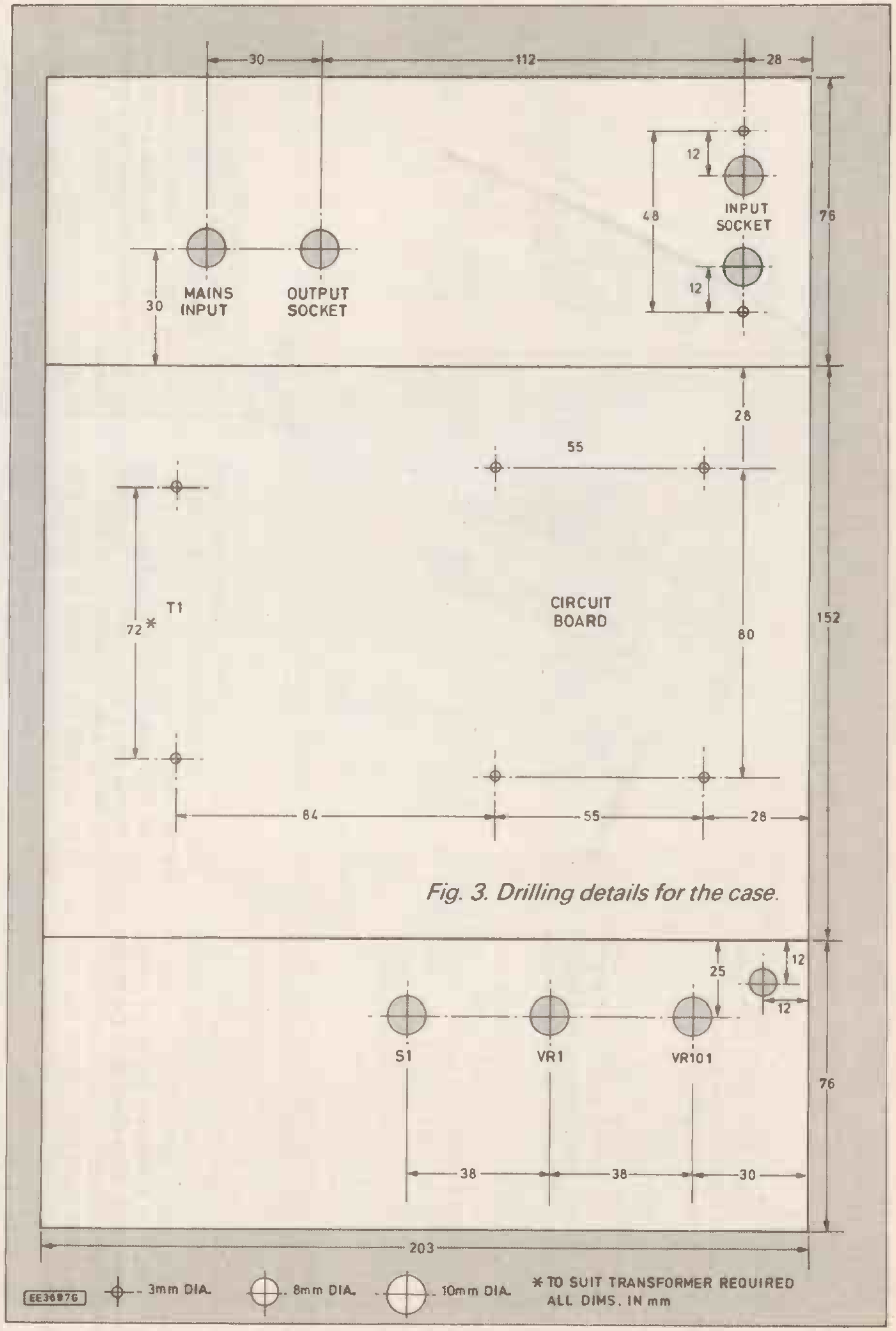


Fig. 3. Drilling details for the case.

mention this for those who might want to use the circuit in other applications. For optimum results a screened box is required with the case connected to 0V and earth.

Most of the components are mounted on a piece of 0·1in. matrix stripboard, size 19 strips by 34 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 2.

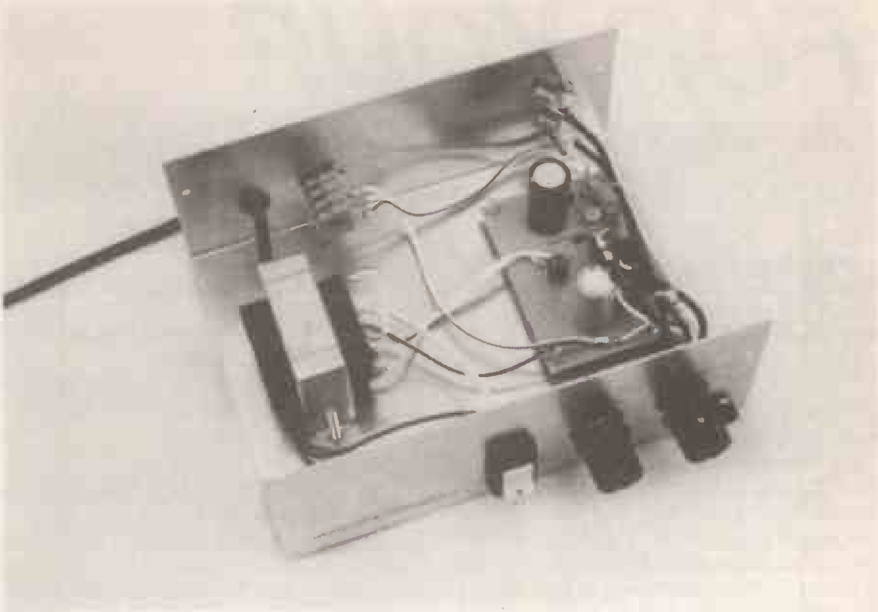
Commence construction of the circuit board by inserting the i.c. and use this as a reference point for the rest of the components. It is probably best to use an i.c. socket and only insert the i.c. on completion of construction and after a final wiring check.

Some people recommend soldering resistors first then capacitors and finally semiconductors. However, it's easier if you solder the smallest parts first and work upward in size; the smaller parts are much more difficult to keep in the board prior to soldering if the board has to be balanced on larger components.

Whatever method you decide to use to wire the board remember to ensure that all polarity conscious components are correctly orientated. Failure to do so can be expensive.

When you have completed the circuit board check it to ensure that there are no dry joints or unwanted blobs of solder bridging tracks. Also check that the breaks in the tracks are made in the correct places.

Now solder the flying leads to the board in the positions shown leaving these at least 300mm long to facilitate easy interconnection. Put the board to one side and start the mechanical work.



CASE

The drilling detail for the aluminium case is shown in Fig. 3. As you can see it's quite simple due to the fact that only the controls, input/output sockets, transformer and board mounting holes are required. The main point to note here is that the mains entry hole needs to be fitted with a 10mm cable clamping grommet.

The case can be finished to taste. The final model was sprayed matt black with car touch up paint. For a neat finish use white rubdown lettering for the legends. These can be protected by a final coat of clear varnish. Small tins of this are available from model shops. Of course, this needs to be undertaken before the parts are attached to the case.

Final construction consists of fitting the various parts to the box and terminating the flying leads to their various destinations. Mount the board on small spacers, say 0·25in above the case. At a pinch the spacers can be substituted for four appropriately sized nuts.

Having finished the job and checked that your work is satisfactory the unit can be tested. Provided the instructions have been followed the project will now be functional.

No setting up is required. All that remains is to wish you good listening! ☐

FOR YOUR ENTERTAINMENT

by Barry Fox

Organised

I was recently put into an awkward position.

Several years ago I wrote some pieces about the Psion Orgainiser, telling how I had devoted man months to trying to learn to use the tiny alpha-numeric keyboard. I got a call from the Chairman of a company, asking if I would be willing to spend some more time – on learning to use a completely new keyboard used by the then-new British system called Microwriter.

I wasn't too keen but said I would. There was then silence for a few years. When the product finally went onto the market, as the Agenda, I was sent a sample which was unusable. There was then more silence, and I was later told that the Microwriter company had been improving the Agenda system.

So I tried again, talking with Microwriter's press office. I was promised a new version Agenda, which never arrived. When I queried this I learned that Microwriter no longer employed a press officer. The job was being done by the Marketing Manager. I spoke with the MM who had never heard of me, never read anything I had written and never heard anything I've said on radio, e.g. to callers on advice line phone-ins.

I was however sent an Agenda, on loan and with the very clear proviso that if I wanted to keep it I would have to pay for it.

In the meantime several companies, inclusing Psion, have launched similar product with Qwerty keyboards so there is less incentive for anyone to learn completely new fingering.

The proviso about having to buy to keep is perfectly reasonable. But it is also a very real disincentive to spending time on learning to microwrite and transferring large quantities of address data from my Psion 128K packs. If I worked hard and cracked the Agenda system, I would end up either having to spend a lot of money to continue, or seeing the time and work wasted.

The value to a company of an experienced press officer is being able to distinguish between journalists who are looking for free samples and those who are serious about their work. I cannot afford the time to try everything and often refuse review loans, both of hardware and software.

When I ask for something it is because I think it is worth trying but in this case the very clear proviso about needing to buy was a strong pyschological deterrent to investing the time and effort needed to learn yet another keyboard technique and language.

Microwriter now have their Agenda back. And this is all I can write about it.

Hang-On!

Do treat stories of LCD hang-on-the-wall TV screens with a pinch of salt.

Sharp-is world leader in LCD technology. The size and price of Sharp's range of pocket LCD TVs confirm what a nonsense it is to predict large panel screens to hang on the wall are "just around the corner".

The largest LCD screen currently available in the UK is now Sharp's 5·6 portable TV (shown below). It costs £900. This has 170,000 pixels (each a triad of red, green and blue coloured cells). An 8·6in. monitor screen (without a TV tuner) costs around £2000 in Japan. Hitachi charges £1300 for a combined VHS playback recorder and 5in. LCD.

Can you imagine how much it would cost to extrapolate from these screen sizes to a wall-sized panel?

In The Picture

Mitsubishi's new video recorders have a feature called "Twin Intelligent Picture". The idea is to tune the record and playback parameters of the machine to the tape being used.

This approach with Intelligent HQ has already been pioneered by Akai. When a tape is put in the VCR, it automatically switches to record a test signal for a few seconds, then rewinds, replays and tweaks the recording parameters to optimize picture quality.

Akai has been reducing the test time, but Mitsubishi's TIP system drops it to just 1·5 seconds by taking advantage of the fact that the video head drum has four heads. While two record the test signal, the other two play it back.

Video Phone

British Telecom has been demonstrating a video phone which BT says will sell for £800 a pair. These will plug into a normal telephone line socket and show one still colour picture every ten seconds. Quite why anyone should want this feature remains unexplained.

How well it works is anybody's guess, too, because BT has been showing the trade a non-working prototype, with a hole where the 3in. colour LCD should be. The only two working models were at the "Ideal Home Exhibition", and there they were working only from signals generated by a personal computer.

Photo CD

Kodak has recently demonstrated Photo CD. The quality of thermal prints available from Photo CD are good, but the price is likely to be high.

The printer handles only 11 x 8·5in. and 11 x 11in. size prints. The thermal paper materials alone cost £2.75 to the trade. Kodak's printer will not handle postcard size prints – surely a curious ommission.

Users of PCs and workstations can access images from Kodak Photo CDs using any CD-ROM XA input device, or one of the new Photo CD compatible CD-ROM drives. CD-ROM XA technology was jointly developed by Microsoft, Philips and Sony as an industry standard to integrate audio and images into computing applications. Because of its compatibility with this standard, it is claimed that Photo CD can be used with virtually any type of computer adhering to common industry standards.

Kodak Photo CD system.

MAILTECH

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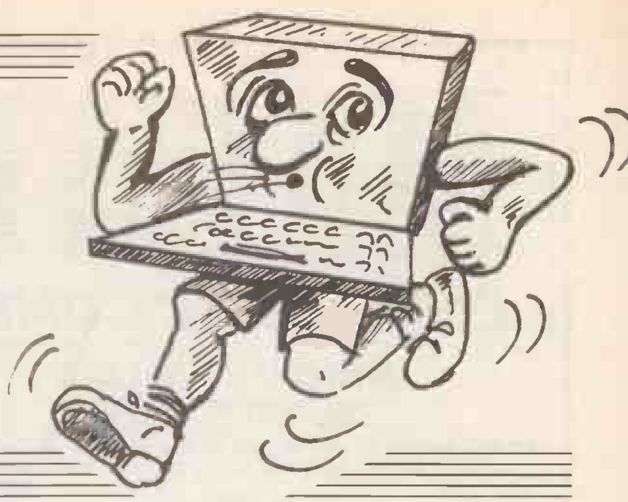


JOHN BECKER

This speedy interface could save you many hours of system development time.

IT'S MOST satisfying to suddenly recognise an easier way of doing something you've been doing the hard way for ages! Such was the case regarding my addiction to designing microprocessor controlled circuits. The obvious dawned when a method of speeding the development time was spotted.

Those familiar with writing software for microprocessor controlled systems will know that a lot of development goes into the process. Much of the software debugging can initially be done on a computer. Eventually, though, the program has to be tested in-circuit.

This first requires the code to be downloaded from the computer out to a dedicated programming unit and transferred into an EPROM or EEPROM, which is then removed and placed into the module under test. Frequently, further development is required, and many improved software versions have to be repeatedly downloaded.

My own system required the use of two programs which had to be loaded independently. One controlled the code assembling and debugging operation, the other controlled the E(E)PROM programmer. After downloading the umpteenth version of one program, loading and reloading assembling and EEPROMming software, I chanced to query the need for using the EEPROM programmer.

All it was doing was essentially the same operation as that performed by the computer when it copied data from one location to another. Why not use a battery-backed SRAM (static random access memory) in place of the EEPROM, plugging it directly onto the computer bus and treating it as any other RAM in the system?

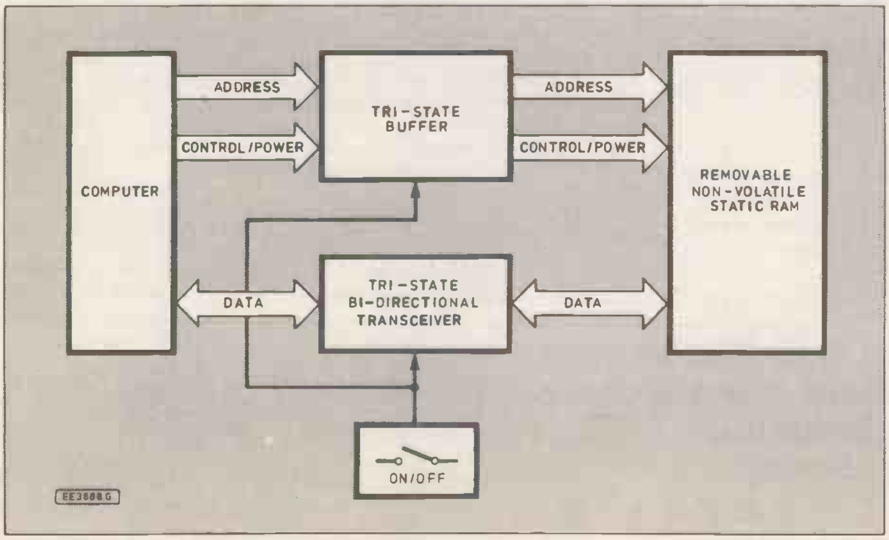
Having its own independent power supply built in, this type of SRAM can be removed from circuit without data being lost. It's ideal for prototyping work.

QUICK PROM

The interface circuit described here illustrates the way the technique was put into use. It was designed for use with a computer having a spare ROM (or RAM) location and for which read/write control is performed by a single line producing a 1µs write pulse. It is *not* suitable for computers which have *separate* read and write control lines, such as IBM-compatibles. Fig.1 and Fig.2 show the unit's block and circuit diagrams.

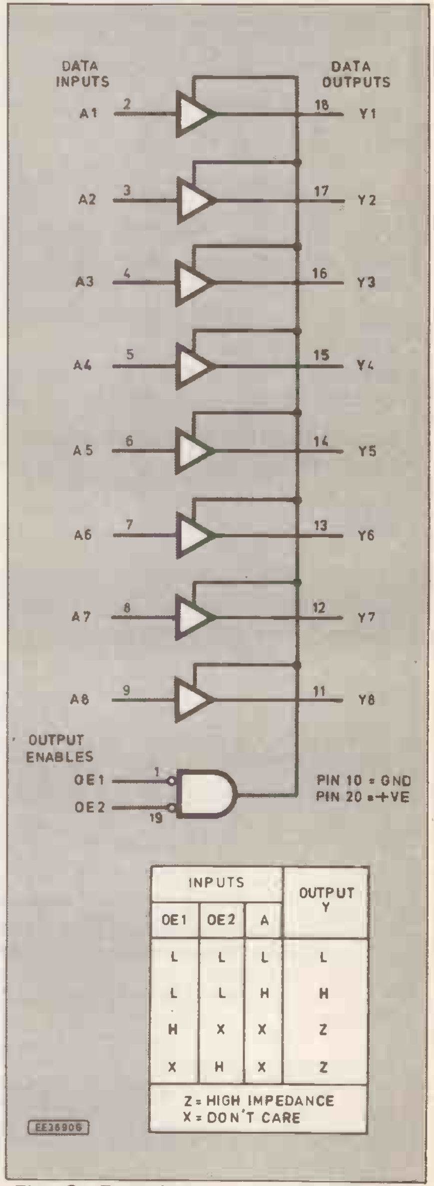
The computer bus directly offers the address, data and control lines required to program an SRAM. What is not allowed for, though, is the need to isolate all the chip's pins (except ground) from the computer lines before extracting it. Failure to do so is likely to result in erroneous data being written into the chip during removal from its socket. Essentially, then, the circuit here is simply an isolator.

Fig. 1. Block diagram for the Quick Prom.



CIRCUIT DESCRIPTION

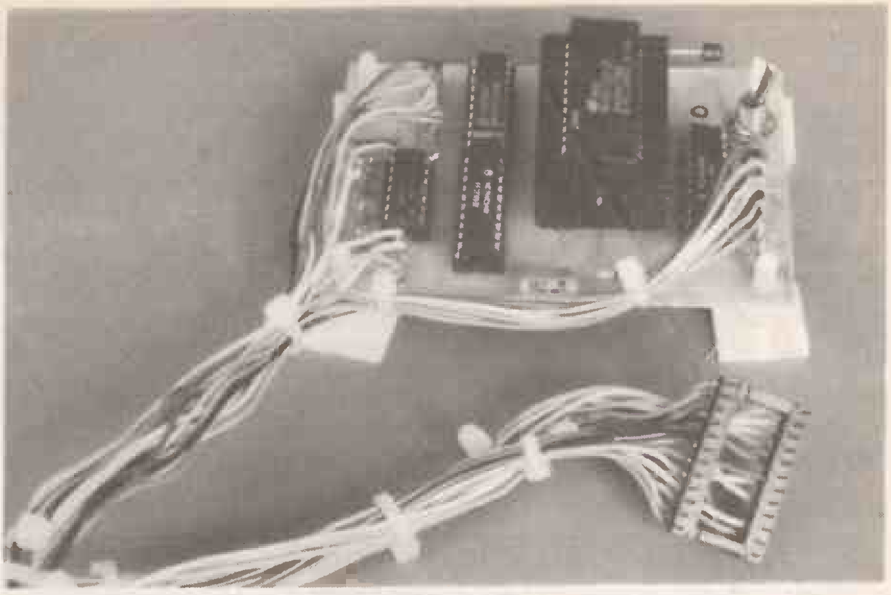
In the full circuit diagram, Fig.2 the SRAM is IC4, an MK48Z02 2048 × 8-bit device with built-in Lithium battery. Its eight data input/output lines are buffered



INPUTS			OUTPUT Y
OE1	OE2	A	
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

Z = HIGH IMPEDANCE
X = DON'T CARE

Fig. 3. Functional logic diagram and truth table for the 74C541.



from the computer's data input/output lines by IC5. This chip is an octal tristate non-inverting bus transceiver type 74HC245. It has three modes of operation controlled by its pins 1 and 19.

Pin 1 controls the data direction, a high logic level setting the direction from side A to side B. A low logic level reverses the direction.

Data is only transferred from one side to the other when the output enable control pin 19 is set low. When this pin is held high, the output pins are set into a high impedance state, behaving as though they are, in effect, switched off.

The SRAM IC4 has 11 address lines, the first eight of which, A0-A7, are isolated by IC2. This chip is an octal tri-state non-inverting buffer type 74HC541 whose outputs are put into a high impedance state when either pin $\overline{OE1}$ or pin $\overline{OE2}$ is set high. When both pins are low, data on the chip's A1-A8 inputs is transferred to the Y1 to Y8 outputs. Fig.3 shows the logic diagram and truth table for the 74HC541.

Another 74HC541 (IC3) isolates IC4's A8-A10 address lines, as well its positive power line and the $\overline{WE}$, $\overline{OE}$ and $\overline{CE}$ control lines. Each output pin of a 74HC541 can sink or source a current of 35mA, provided that the chip's total power dissipation does not exceed 750mW. As the SRAM can draw about 70mA when fully active, power is supplied to it via *two* lines of IC3, along paths A7/Y7 and A8/Y8.

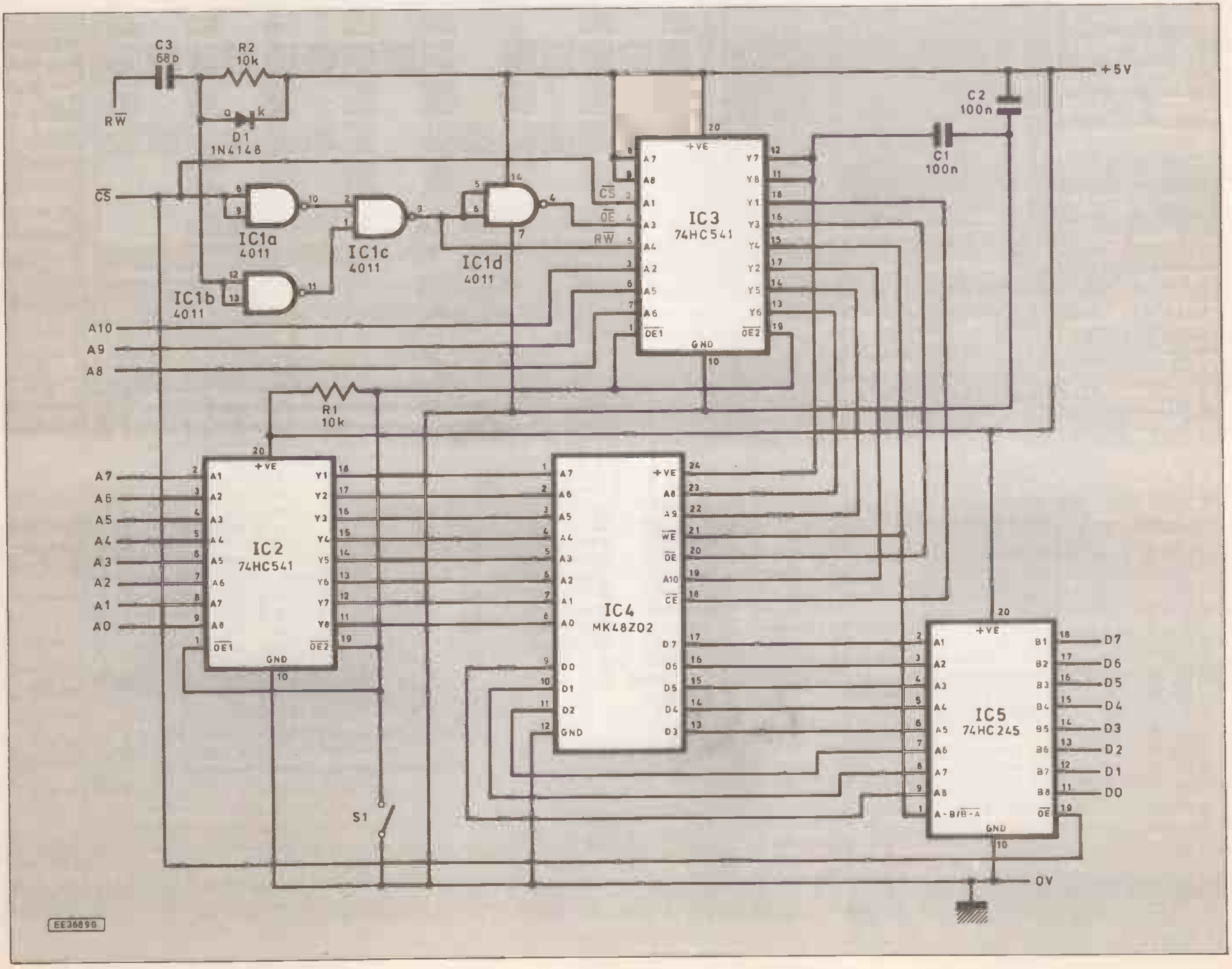
The output enable pins (1 and 19) of IC2 and IC3 are controlled by switch S1. When the switch is open the pins are held at +5V via R1 – allowing the SRAM to be removed, whereas when it is closed the pins are switched direct to ground – (0V) switching the SRAM into circuit.

The output enable pin of IC5 is controlled by the chip select line ($\overline{CS}$) of the computer. This line, via IC3 A1/Y1, also controls the SRAM's $\overline{CE}$ (chip enable) line at pin 18. In conjunction with the computer's read/write line (R$\overline{W}$), $\overline{CS}$ also controls the SRAM's read/write and output enable lines, $\overline{WE}$ and $\overline{OE}$.

The chip select ($\overline{CS}$) is inverted by IC1a which sets the logic on one input of the NAND gate IC1c. The other input to IC1c is controlled by the R$\overline{W}$ line generating a negative-going pulse across C3/R2 which is then inverted by IC1b. Only when both inputs to IC1c are high simultaneously will its output go low.

The output from IC1c is passed via IC3 A4/Y4 to control line $\overline{WE}$ (read/write) of the SRAM (IC4), it is also inverted by IC1d to control line $\overline{OE}$ (output enable) of the SRAM via IC3 A3/Y3. When writing to the SRAM, the computer's $\overline{CS}$ and RW

Fig. 2. Complete circuit diagram for the Quick Prom interface.



lines must both be low. When reading from the SRAM, $\overline{CS}$ must again be low, but $R\overline{W}$ must be high.

For some computers it may be possible to omit capacitor C3, resistor R2 and diode D1, taking the $R\overline{W}$ line direct to IC1b. This will depend on the synchronisation of the $R\overline{W}$ toggling relative to the data and address line timings.

The ending of the $R\overline{W}$ pulse must occur before the address and data lines change their states otherwise data intended for one address may erroneously be written into the previous address as well. The values of C3 and R2 were chosen to shorten the 1µs $R\overline{W}$ pulse generated by the computer's 1MHz system clock to about 0.5µs.

The unit is powered direct from the computer's 5V power line, which must be capable of supplying at least 80mA.

ASSEMBLY

The Quick Prom is built on a single-sided printed circuit board (p.c.b.) and the component layout and full size copper foil master pattern is shown in Fig. 4. This board is available from the *EE PCB Service*, code EE799.

Ordinary dual-in-line (d.i.l.) sockets should be used for all i.c.s except for IC4 for which a "Zero Insertion Force" (ZIF) socket should be used. Connections between the p.c.b. and computer may be via ribbon cable or individual wires drawn together into a neat harness secured with cable ties. About one metre of cabling should be sufficient.

As constant access is needed to the board, it is probably better not to put it in a box. The switch S1 is mounted directly on the board, consequently the height of the p.c.b. supports must allow clearance for its body.

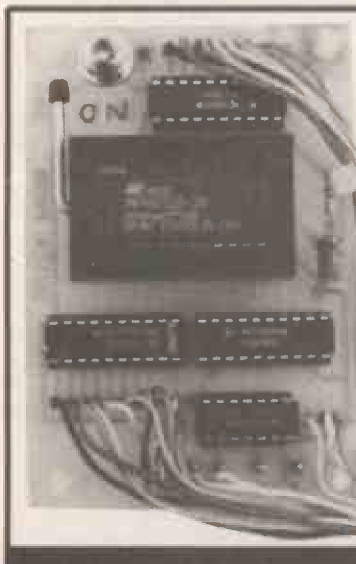
The computer with which the original unit is used has an unused 24-pin ROM socket providing all the necessary pinouts except for the $R\overline{W}$ line. Consequently, all the unit's leads except for $R\overline{W}$ were soldered to the upper side of a separate 24-pin socket which was then plugged into the ROM location.

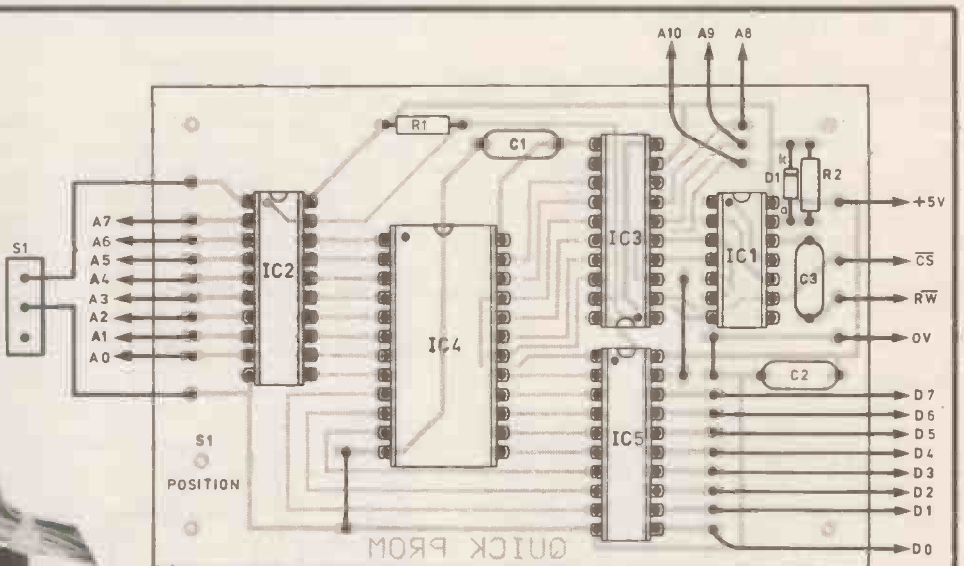
The $R\overline{W}$ lead was connected to the computer's $R\overline{W}$ line on its expansion plug. This plug could not readily be used for all the connections since a dedicated $\overline{CS}$ line is not available on it, whereas $\overline{CS}$ on the ROM location is dedicated to that specific address block.

IN USE

If your computer does not have a suitable spare socket, consult the computer manual and consider whether it is practical to temporarily remove a RAM or ROM (more likely a RAM) to allow the unit to be plugged in. Check the pinouts before wiring the 24-pin connector.

Once the unit is plugged in, the computer does not need to be switched off each time the SRAM is inserted or removed since switch S1 controls all the necessary isolation. When copying data into the SRAM,





COMPONENTS

Resistors

R1, R2	10k 0·25W 5% carbon (2 off)

See SHOP TALK Page

Capacitors

C1, C2	100n polyester (2 off)
C3	68p polystyrene

Semiconductors

D1	1N4148 signal diode
IC1	4011 quad 2-input NAND gate
IC2, IC3	74HC541 octal buffer (2 off)
IC4	MK48Z02 Lithium battery-backed SRAM
IC5	74HC245 octal bus transceiver

Miscellaneous

S1	s.p.s.t. min. toggle

Printed circuit board available from *EE PCB Service*, code EE799; 14-pin d.i.l. socket; 20-pin d.i.l. socket (3 off); 24-pin d.i.l. socket; 24-pin ZIF (zero-insertion-force) socket; multi-coloured connecting wire or ribbon cable (23x1 metre); nylon stand-off p.c.b. supports (4 off); cable ties, if individual wires used; solder pins; solder etc.

Approx cost guidance only **£27**

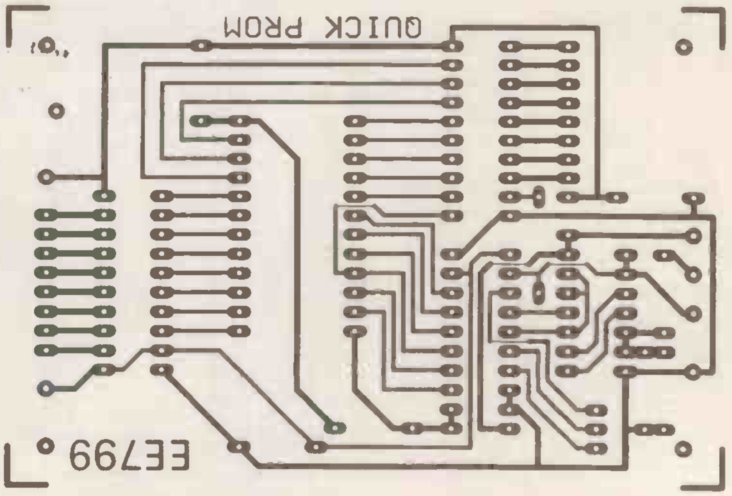
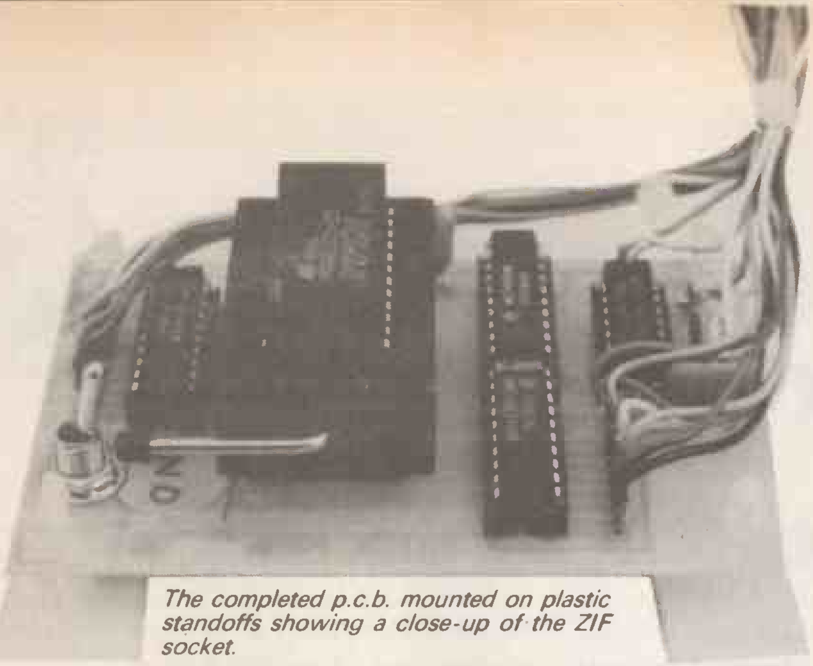


Fig. 4. Printed circuit board component layout and full size copper foil master pattern. IC4 is mounted in a ZIF socket the rest are inserted in standard d.i.l. sockets. The completed board is shown top left.



The completed p.c.b. mounted on plastic standoffs showing a close-up of the ZIF socket.

switch off S1, insert the SRAM, switch on S1 (taking the $\overline{OE}$ pins to 0V), run the copy routine, switch off S1 and remove the SRAM, after which it is ready for use in the circuit you are developing.

The copying procedure will depend on what facilities you have on the computer. Some machine-code assemblers or monitors have a facility for high-speed copying of memory data from one location to another. In this case, machine code is written in the normal way and then transferred under the monitor to the unit by copying the code to the chosen ROM or RAM location.

For example, I might assemble code into RAM block $2000-$27FF and then copy it to the unit plugged in at location $9000. (Using a Supermon mini-assembler, for example, the copy (transfer) command is simply "T 2000 27FF 9000" and the process takes a mere fraction of a second.) Note that it would be inadvisable to assemble the code directly into the location at which the unit is plugged since data could be lost if a mistake is made when relocating the SRAM. It is better to assemble code at another computer memory location, save to disk, and then copy to the unit.

Copying can be done via a Basic program, albeit at a much slower rate. In the following example, the code and unit locations are the same as those above but expressed in decimal.

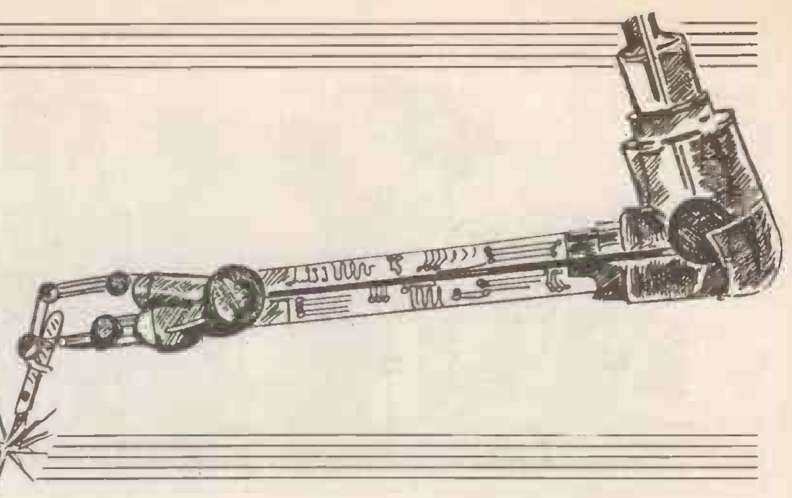
```
100 REM QUICK-PROM COPY
110 M=8192:REM $2000
120 S=36864:REM $9000
130 FOR A=0 TO 2047:REM SRAM MAX CAPACITY
140 P=PEEK (M+A):REM GET MEMORY DATA
150 POKE S+A,P:REM COPY DATA
160 C=PEEK (S+A):REM READ SRAM
170 IF C< >P THEN PRINT "ERROR AT ";S+A;P;C
180 REM LINE 170 VERIFIES DATA COPY
190 NEXT A
200 PRINT "RECHECKING"
210 FOR A=0 TO 2047
220 C=PEEK(S+A)
230 P=PEEK(M+A)
240 IF C< >P THEN PRINT "ERROR AT ";S+A;P;C
250 NEXT A
260 PRINT "FINISHED":STOP
```

If copying errors have occurred (unlikely, but possible), the software can be written to allow for the recopying of just single bytes or short blocks from within the main memory block. It is not necessary to copy all 2048 bytes.

When system development has been completed and you are happy with the machine code, it should then be down-loaded from the computer into an E(E)PROM in the normal way via a suitable programmer. Although it might appear that this unit could be used to copy into EEPROMS, this proved impractical with my own computer because it is not capable of providing the longer write pulses necessary (typically about 10mS). ☐

Regular Clinic

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Welcome once again to Circuit Surgery, our regular clinic for readers' problems. This month has brought in another bumper crop of mail and, in an attempt to deal with as many of your queries as possible, I have tried to include quite a few topics this month. Hopefully, there is something for everyone.

Our July Surgery provides information on how to detect the state of a contact breaker in a magneto, the circuit of an experimental pulse comparator, and a simple a.m. radio tuner. We also revisit Mark Stuart's popular *Variable Bench Power Supply* and offer a timely warning concerning the purchase of electrolytic capacitors. For good measure we have some advice on the selection of analogue to digital converter (ADC) chips and a listing of popular logic gates by their function.

Synchronising engine speed

W. Roberts writes from Jersey to ask for some help in the design of a circuit which will allow him to adjust the timing of engines fitted to a light aircraft:

"This instrument is a project which I would very much like to build and utilize. All light aircraft maintenance workshops would most certainly have one for synchronizing and timing port and starboard magnetos on piston engines. Classic motor cycle restorers and others used to the time consuming "cigarette paper technique" for determining opening time would undoubtedly benefit from the ease and accuracy of timing magnetos afforded by this method."

For the benefit of readers who may not know how a magneto operates, Fig. 1 shows the basic principle of this device. The important thing to note is that this form of HT generator does not require the services of a d.c. supply in order to generate the HT voltage required by the engine's igntion system.

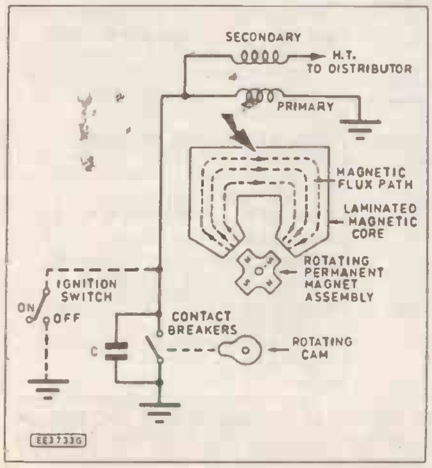


Fig. 1 Basic magneto arrangement (note that the transformer windings are wound on the laminated steel core)

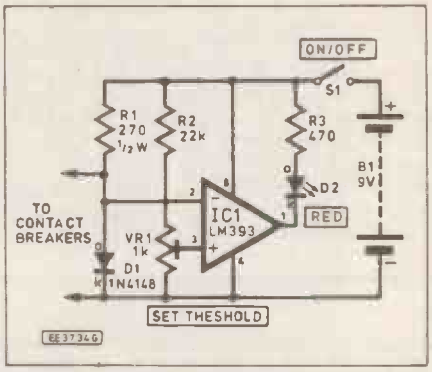


Fig. 2 Simple instrument for sensing the state of the contact breakers

The current in the primary winding is induced by the rotating magnet. As this current reaches a peak value, the contact breaker mechanism (which is driven by a rotating cam) opens and interrupts the primary current. This results in a sudden collapse in flux which, in turn, produces a very high value of induced e.m.f. across the secondary winding.

Mr Roberts quotes typical values of capacitor and primary coil resistance of 2·2μF and 0·7 ohm respectively. Clearly, detecting the opening and closing of the points under static conditions will be somewhat problematic since most ohmmeters will just not be able to detect such a small change in resistance.

The circuit shown in Fig. 2 (based on a comparator) will, however, detect changes in resistance of less than 0·1 ohm. The circuit requires a 9V d.c. supply (50mA maximum) and operates an l.e.d. which will provide a visual indication whenever the contact breakers are open. The threshold sensitivity of the instrument is adjusted by means of VR1. In order to set this for optimum sensitivity, a one ohm resistor should be connected across the probes and the control is adjusted until the l.e.d. *just* becomes illuminated. The resistor can now be removed and the instrument will be ready for use. If necessary, the circuit of Fig. 2 can be duplicated to permit simultaneous adjustment of both engines on a twin engined aircraft.

Finally, the pulse comparator arrangement shown in Fig. 3 has been provided as "food for thought". This circuit should be capable of adaptation for use in synchronizing the speed of two engines

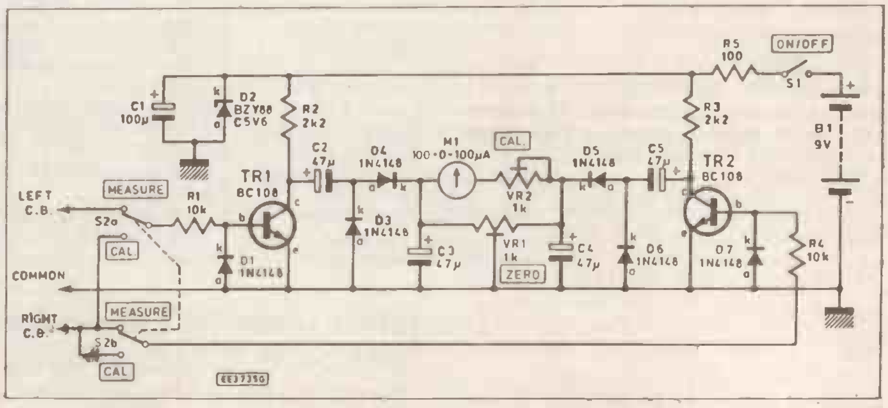


Fig. 3 Circuit of the experimental pulse comparator

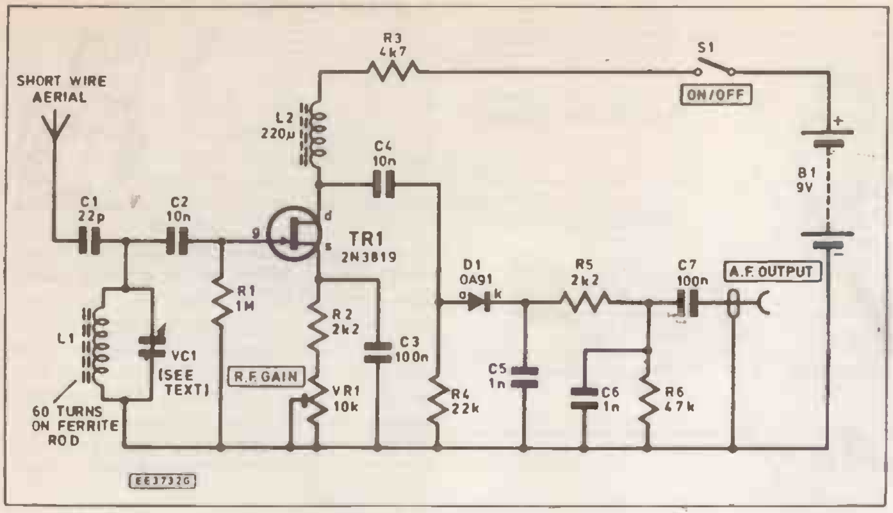


Fig. 4 Circuit of the simple a.m. tuner

when the engines are actually running. It should be noted that the circuit assumes that both contact breakers interrupt the current for an identical proportion of the cycle. The circuit has been "bench tested" and, with the values quoted, it was found quite possible to detect synchronism of two pulse trains to within two per cent.

Simple a.m. tuner

Many of today's audio systems are fitted with tuners which only receive f.m. signals. This can be something of a problem when the user wishes to receive one (or more) a.m. stations on the medium or long-wave band! For such occasions, and provided that only local station reception is required, a simple single-stage a.m. tuner can suffice. Fig. 4 shows the circuit of such an arrangement.

The tuned circuit L1/VC1 comprises an inductor wound on a conventional ferrite rod and a variable capacitor (having a maximum value of between 200pF and 500pF) both of which can be removed from a discarded radio. TR1 (a field-effect device) provides a small amount of r.f. gain and its high input impedance is ideal for directly matching the input tuned circuit. The r.f. gain is made variable by means of VR1. This control is adjusted to produce a satisfactory value of gain coupled with a sufficiently "sharp" degree of selectivity in order to eliminate strong a.m. signals which may be present on adjacent frequencies.

A short length of aerial wire (not more than about three metres) may be necessary in order to receive signals at the high frequency end of the medium waveband. In some cases, it may also be necessary to experiment with the inductor (L1) for optimum results.

The output of the a.m. tuner may be taken to the "auxilliary" input of almost any hi-fi audio amplifier. This input will usually exhibit an input impedance of about 50 kilohms. This will usually have sufficient sensitivity to provide ample volume from the 20 to 100mV output signal obtained from the a.m. tuner.

Versatile Power Supply

Mark Stuart's *Variable Bench Power Supply* was featured in the February 1988 issue of *Everyday Electronics*. This circuit provides a d.c. output fully variable over the range 0V to 24V at up to 2·5A. The design was somewhat unusual in that it used a power MOSFET rather than the usual 2N3055 (or similar) series-pass transistor. Mark's circuit also employed a quad operational amplifier (LM324) and offered separate output voltage and current limit controls.

Mr R. Bolton writes from Pendlebury with a a query concerning this popular constructional project:

"All voltages are OK and the voltmeter works however the ammeter and op-amp output all read zero. There is only 2·6mV across R13 (0Ω1) which gives 0.104V at pin-14 which should be 10V varying to 0V as the pot is rotated.

The power supply is a "must" for my benchwork but I am stuck. Perhaps a breakdown of the circuit would be an answer to my problem."

Well, Mr Bolton, I am not really certain that you DO have a problem! One piece of useful information which you have not given me is what happens when you place a load on the power supply. I assume that the readings you have quoted are under "no-load" conditions. If this is the case, they are not far from what should be expected!

Try placing the unit under load (a current of a few hundred mA would be useful) and see if the voltage drop across R13 increases. Then adjust the current limit control (VR1) and check that the output voltage falls to zero when the limiting value has been reached.

If the voltage dropped across R13 does not increase and the ammeter (ME1) still fails to produce an indication, then you DO have a fault! If there IS a voltage drop across R13 (but no indication on the ammeter) it would be worth replacing IC1 (the LM324) with another device. Failure of IC1b would certainly give rise to the conditions which you describe.

Finally, it is worth pointing out that the voltage at pin-14 does not behave in quite the way in which you suggest. This voltage is simply an amplified version of that which is dropped across R13. It will not normally be affected by the setting of the current limit control (VR1) *unless* the circuit has begun to "current limit".

If any other reader has had any problems with Mark Stuart's *Variable Bench Power Supply* (or can throw any other light on this subject) please drop me a line! Incidentally kits for this design are available from Magenta Electronics Ltd who advertise in EE.

Analogue to digital conversion

Matt Manktelow writes from Co. Antrim, Northern Ireland, to ask if I can suggest a suitable chip for use in an analogue to digital converter. Matt has asked particularly for a device which can be interfaced with a computer so I have searched through my data library in order to find a short-list of suitable devices.

All of the devices listed are "microcompter bus compatible". This means that their outputs can be connected directly to a microprocessor data bus without having to resort to the use of a parallel interface device. In order to avoid an unwanted conflict of data on the bus, the ADC output must only be enabled when it is actually being addressed by the microprocessor. To ensure that this is the case, additional address decoding logic will be required.

The ADC will be allocated an address within the system I/O or memory map (depending upon the microprocessor type involved). Assuming that the system is based on a common 8-bit Z80 microprocessor, the ADC should be allocated a unique I/O address (chosen so as to avoid conflict with other I/O devices which may be present). Reading the data from the ADC is then a relatively simple matter of executing a port input instruction (this has the form IN A,(port) where port is the address of the ADC. In a practical system, the "data available" output of the ADC chip is used to generate an interrupt request (via the active-low IRQ line).

ADC Chips

Number of channels (note 1)	Resolution (bits) (note 2)	Device type number	Package	Special features
1	10	AD573	20-pin d.i.l.	
1	8	AD7575	18-pin d.i.l.	High speed
1	12	AD7578	24-pin d.i.l.	
8	8	AD7581	28-pin d.i.l.	
1	12	AD7672	24-pin d.i.l.	High speed
1	8	ADC0804	20-pin d.i.l.	
4	8	ADC0844	20-pin d.i.l.	
1	12	ADC511	24-pin d.i.l.	Low power
1	8	ZN427E	18-pin d.i.l.	
1	8	ZN439E	22-pin d.i.l.	
1	8	ZN448E	18-pin d.i.l.	
1	8	ZN502E	20-pin d.i.l.	

Note 1: The "number of channels" specifies the number of analogue inputs that may be connected to the ADC chip. Where more than one channel is provided for, the device in question will incorporate some form of analogue multiplexer.

Note 2: The basic resolution of an ADC chip is dependent upon the number of bits used to represent the analogue input. The greater the number of bits, the smaller the change in analogue input level that can be detected by the device.

Basic logic functions

Matt Mantelow has also asked me to list some of the more common logic gates according to their function. So, here goes:

Logical AND function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS08	
4	2	74LS09	Open collector
3	3	74LS11	
3	3	74LS15	
2	4	74LS21	

Logical OR function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS32	
3	3	4075	
4	2	74LS136	

Logical EXOR (exclusive-OR) function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS86	
4	2	74LS136	
4	2	74LS386	

Logical NAND function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS00	
4	2	74LS01	Open-collector
4	2	74LS03	Open-collector
3	3	74LS10	
3	3	74LS12	
2	4	74LS13	Schmitt input
4	4	74LS20	
4	4	74LS22	Open-collector
4	2	74LS26	High-voltage
1	8	74LS30	
4	2	74LS37	Buffer
4	2	74LS38	Open-collector
2	4	74LS40	Buffer
4	2	74LS132	Schmitt input
1	13	74LS133	

Logical NOR function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS02	
2	4	74LS25	Strobe
3	3	74LS27	
4	2	74LS28	Buffer
4	2	74LS33	Buffer
4	2	74LS266	Exclusive
2	4	4002	
1	8	4078	

The foregoing lists are not exhaustive but should cover the vast majority of eventualities. The 'LS series of TTL devices is available from a great many component suppliers but I have listed a few useful CMOS devices as well.

Caveat emptor

"Next time you purchase electrolytic capacitors, take a careful look at the markings!". This is the timely advice offered by ***Colin Pickwick.*** He recently purchased some capacitors (from a well established supplier) only to find (on close examination) that the marked working voltage was well below the advertised value.

It would appear that either the values had been substituted by the supplier (without warning) or the capacitors had been mistaken for components having an identical capacitance value but with a much reduced voltage rating. In some cases this would not matter too much, however there could very well be serious implications of operating a component at a potential which is appreciably greater than its rated voltage.

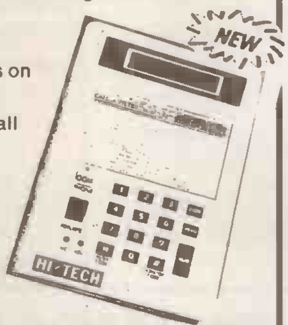
Readers will doubtless already be well aware that the voltage ratings quoted for electrolytic capacitors are really quite important. As an example, a capacitor rated at 16V will invariably not operate safely in a circuit which specifies a component rated at 35V. The moral to this little story must therefore be that it is always worth checking that the components you receive from a supplier are the ones that you actually ordered!

Next month: In next month's Surgery we shall be describing an improved low-battery warning indicator and have a computer program for designing 555 timer circuits.

DROP ME A LINE

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

Note: If you have a specific query on an EE project see the information under *Readers Enquiries* on the Editorial page and write to the Editorial Offices at the address shown at the top of that page.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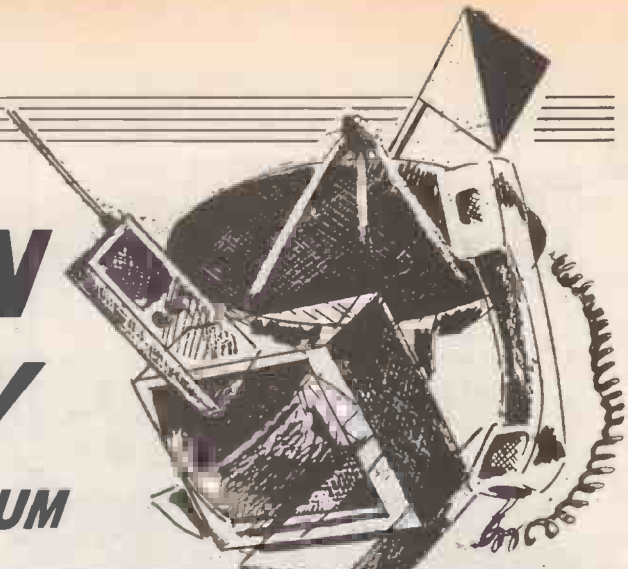


INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 9

THIS is the ninth in a 12-part series concerning Information Technology, Logic Systems and related matters in and around the Science National Curriculum. We shall devote the whole of this month to *bistable-based* circuits.

HAPPY FAMILIES

The bistable is a circuit which is stable in either of two states – hence its name. It is a member of the *multivibrator* family the other two of which are the *monostable* and the *astable*. Readers who have been following this series will remember that the latter pair were met in Part 5 (March, 1992 issue). It will now be useful to describe all three using mechanical models since this shows where the bistable fits into the complete picture.

Imagine we have a swinging pendulum (a piece of string with a weight on the end) – see Fig. 1a. We could think of the extremes of its swing to be called states A and B. We can see that the pendulum is not stable in either of these states. No sooner has it reached A than it reverses and goes to B, returns to A and so on. This is a mechanical *astable*.

Now imagine we lift a marble above the table (Fig. 1b) we can call the raised-up position state A and table level, state B. Here, the object is only stable when it is on the table. If it is raised and released it will fall from state A to state B and remain there. This is a mechanical *monostable* – it is stable in only one state.

Now think of a two-section piece of egg box and a marble (Fig. 1c). We could place the marble in one hole (state A) and it would remain there indefinitely. We could equally well have placed it in the other hole (state B) and it would similarly remain there. It appears that the marble is stable in *either* of the two states. This is a mechanical *bistable*.

Although it helps to illustrate the multivibrator family in this way, here we are really concerned with the *electronic* version.

FLIP-FLOPS

Today, bistables used in practical circuits almost invariably take the form of *integrated circuits*. However, bistables based on individual transistors are sometimes used and valves were used for the purpose many years ago. The bistable has some important uses in information handling, some of which are to make a circuit *latch*, to make *binary counters* and *frequency dividers* also to *store* data – that is, to provide *computer memory*.

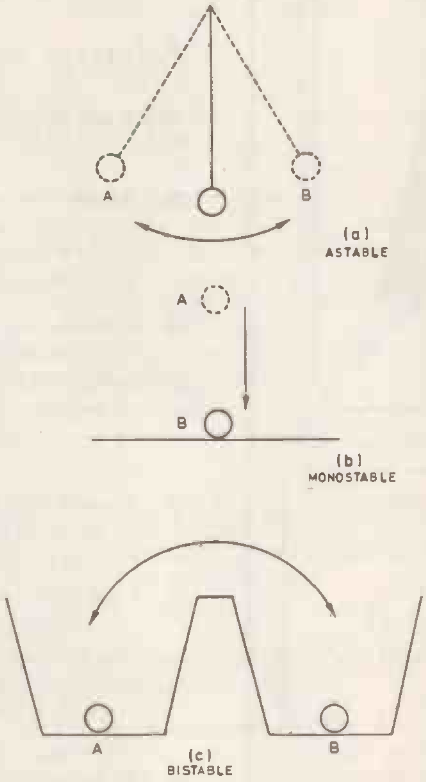


Fig. 1. Mechanical models of the multivibrator family.

Readers who have not been following the series are advised to read Part 6 (April, 1992 issue). This gives certain background information about logic gates which form the basis of bistables.

The bistable is often called a "flip-flop" because you can "flip" it into one state or "flop" it into the other. The simplest electronic flip-flop is a form of *Set-Reset* (S-R) bistable consisting of the pair of cross-coupled NOT gates shown in Fig. 2. This circuit has two outputs (one to represent each state) called Q and $\overline{Q}$ (pronounced Q bar).

The significance of these names is that Q and $\overline{Q}$ normally have opposite logic states – that is, if one of them is Logic 0, the other will be Logic 1. In the mechanical analogy, this is like saying that when the marble is in state A (Logic 1) it is *not* in state B (Logic 0). The bistable has two inputs – one called Set (S) and the other Reset (R). These are used to change the output states as required. Fig. 3 shows the symbol for an S-R bistable.

HOW IT WORKS

In theory, an S-R bistable could be built from the arrangement of NOT gates shown in Fig. 2. However, this is not a practical circuit and, although simple, would be difficult to control. It is best not to built it at all but to *imagine* how it would work. Consider the instant when the supply (not shown) is connected. The output states of both gates would be 0 (because nothing has happened yet).

Now consider Gate A. Since its output ($\overline{Q}$) is 0 the input to gate B (R) will also be 0 because they are connected together. A NOT gate inverts the logic state of the input so the output of Gate B (Q) will become 1 and this makes the input of gate A (S), 1 also. The output of Gate A will therefore remain 0. The existing states of the outputs, $Q=1$, $\overline{Q}=0$, are therefore

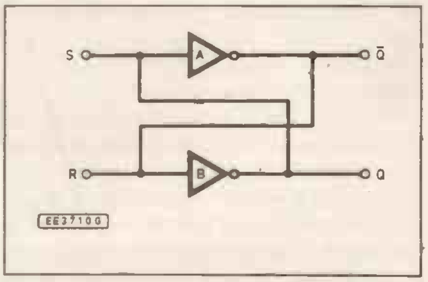


Fig. 2. NOT gate bistable.

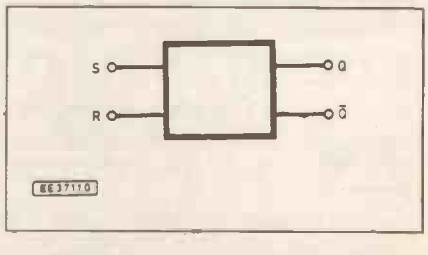


Fig. 3. Symbol for S-R bistable.

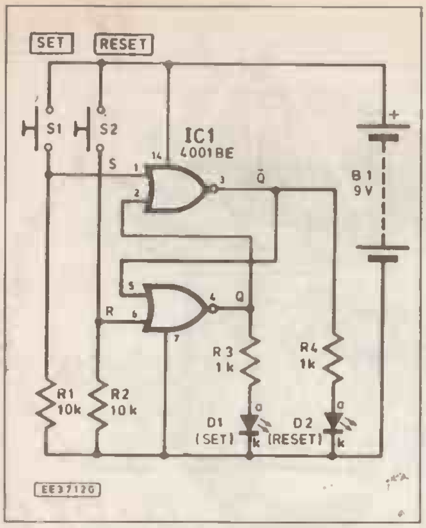


Fig. 4. Practical S-R bistable.

maintained – that is, the bistable is *stable*. This is called the *Set* condition.

We must, however, consider what would have happened if the 0 state at Gate B output (Q) had given Gate A an output of 1 first. This state would have been fed to Gate B input whose output would therefore be 0. This condition, $Q = 0$, $\bar{Q} = 1$, would be equally stable and is called the *Reset* condition. It appears, therefore, that whether $Q = 1$ and $\bar{Q} = 0$ or $Q = 0$ and $\bar{Q} = 1$, depends on which gate processes the information presented to its input first – there is a *race* between the two gates.

Since no two gates are identical, one will always do this first. The bistable will therefore power-up in either the *Set* or *Reset* condition. Such racing is not good because it introduces an unpredictable element and is avoided in real systems.

Suppose on switching on, the bistable is *Set* ($Q = 1$, $\bar{Q} = 0$). By making $R = 1$, Q will be forced to become 0 and $\bar{Q}$, 1 – the outputs will change states i.e. it is *Reset*. If S is now made 1, the outputs will revert to their *Set* conditions.

A PRACTICAL S-R BISTABLE

To be useful, a bistable needs to have more sophisticated access to its inputs. With the NOT gate bistable, the inputs are connected *direct* to outputs. This means that in controlling the inputs, the outputs can be short-circuited.

A practical S-R bistable circuit which does not suffer from the problem mentioned above is shown in Fig. 4. This consists of a pair of cross-coupled NOR gates. Switches, S1 and S2 respectively are used to set and reset the device and l.e.d's, D1 and D2 indicate the logic state of the outputs, Q and $\bar{Q}$ – when *lit* the state is 1, when *off*, it is 0.

As a basis for this month's experiments, the simplest approach is to use a modular kit (for example, the Unilab Alpha Kit). Alternatively, circuits may be built using basic components on a Plugblock (prototype board) – layouts are given in all cases.

Note that a description of the Plugblock and its use in circuit-building was given in Part 5 (March, 1992 issue).

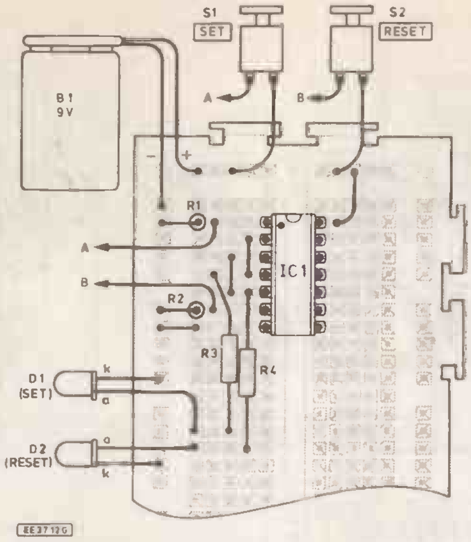


Fig. 5. Practical S-R bistable construction.

The component "shopping lists" assume the use of the Plugblock and a few short pieces of single-strand connecting wire to be used as link wires. A PP3 or other 9V battery and a suitable connector are also needed.

Remember, if you have been building circuits from previous parts of the series, check your stock of components before ordering new ones. Special *low-current* l.e.d's are available from several suppliers and it is worthwhile using them. Ordinary l.e.d's may be used but they will not be as bright.

To build the practical bistable you will need the following:

IC1	4001BE quad. NOR gate
R1, R2	10k resistors (2 off)
R3, R4	1k resistors (2 off)
D1, D2	5mm low-current red l.e.d.s (2 off)
S1, S2	light-duty push-to-make switches (2 off)

Following the Plugblock layout (Fig. 5). Note that two of the four NOR gates contained within the 4001 chip are used. Resistors, R1 and R2 are "pull-down" resistors which keep the inputs at logic 0 (negative battery voltage) when switches S1 and S2 are released. This prevents possible false operation.

The l.e.d's must be connected the correct way round or they will not work – the shorter lead denotes the cathode (k) end. When complete, connect the battery and note that one output assumes a Logic 1 state and the other, a 0. You should find that you can change the output states by pressing the appropriate *set* or *reset* switch.

The S-R bistable operates as follows. When the battery is connected, all inputs and outputs first assume Logic 0. Since a NOR gate will produce a Logic 1 output when both inputs are at Logic 0, it follows that the race condition occurs. There will be a competition between the two gates to process this information and one output will take on a Logic 1 state before the other. This will be applied to the input of the other gate making its output 0. The bistable will now be in a stable condition.

Suppose it is output Q which assumes the 1 state and output $\bar{Q}$ is 0, that is, the bistable is *set*. A Logic 1 pulse applied to the Reset input now changes the output states to $Q = 0$, $\bar{Q} = 1$. This is because Logic 1 applied to the Reset input will make Q Logic 0 (a NOR gate produces a Logic 1 output only if *both* inputs are Logic 0). This then feeds the input of the other gate making this Logic 0 too. The corresponding output, $\bar{Q}$, will then assume Logic 1. It will then remain like this until the circuit is Set by making $S = 1$ whereupon Q will become 1 and $\bar{Q}$, 0.

Unlike the NOT gate bistable, the Set and Reset inputs are not directly coupled to outputs so there is no chance of short-circuits occurring. The best way to summarise the action of the S-R bistable is by using a truth table:

S	R	Q	$\bar{Q}$	Notes
0	0	1	0	Initial conditions
		or 0	1	– unpredictable
1	0	1	0	Set pulse applied
0	0	1	0	Set pulse removed – no change state
0	1	0	1	Reset pulse applied – outputs change state
0	0	0	1	Reset pulse removed – no change to outputs

The table above resembles the truth table for a gate but, although the circuit is made from gates, it is not itself a gate. In a gate, the output is always the same for any given set of input conditions. Here, the outputs depend on the states they had previously that is, $Q = 1$, $\bar{Q} = 0$ if S was 1 previously and $Q = 0$ and $\bar{Q} = 1$ if R was 1 previously. This being so, we could say that the bistable has *remembered* what the input states were – it has *memory* whereas a simple gate has not. This is very important because it is the basis of *computer memory*.

BURGLAR ALARM

The S-R bistable may be used to illustrate a burglar alarm. When an intruder opens a door or window and operates a switch, a Logic 1 pulse is given to the *set* input. Output Q then assumes Logic 1 (equivalent to being a battery positive voltage). This operates a transistor or a relay (see Part 6: April, 1992 issue) and switches on a siren or bell. Nothing the burglar can do will silence the alarm since once the bistable has *set*, it will remain like that until *reset*. For security, the reset switch is situated in a secret place and may be key-operated.

Build a model of the burglar alarm (Fig. 6 and Plugblock layout Fig. 7). Assume the bistable is *set* by pressing the TRIGGER switch, S1, Q becomes 1 and current passes to the base of transistor, TR1, via resistor R3 and operates buzzer, WD1. S2 may subsequently reset the bistable and cancel operation. The l.e.d, D1, operates when $\bar{Q} = 1$ (i.e. when *reset*) and indicates the standby (READY) state.

Note that buzzer, WD1, is polarity-sensitive and must be connected the cor-

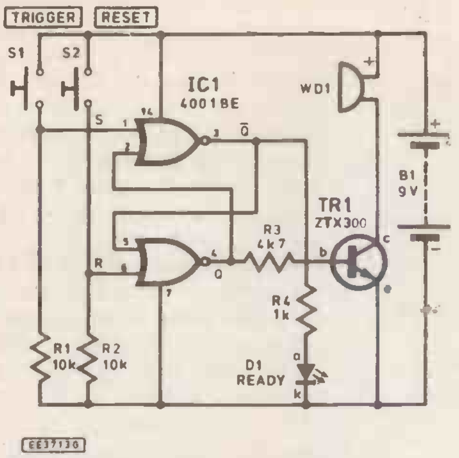


Fig. 6. Demonstration burglar alarm.

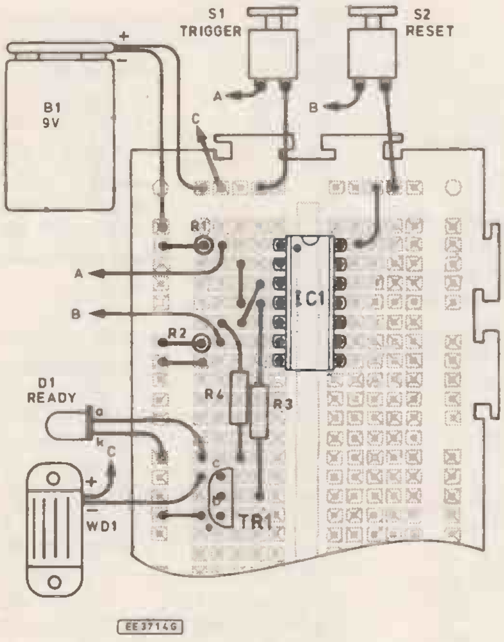


Fig. 7. Burglar alarm Pluglock layout.

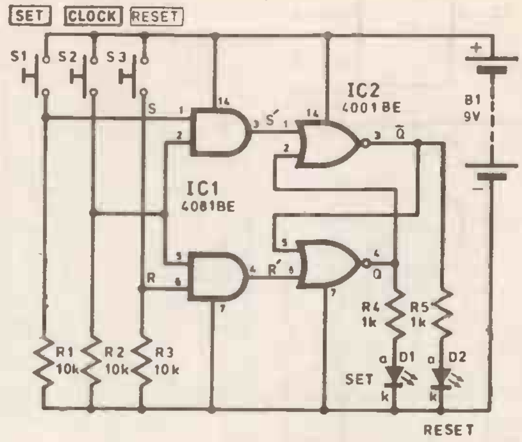


Fig. 8. Clocked S-R bistable.

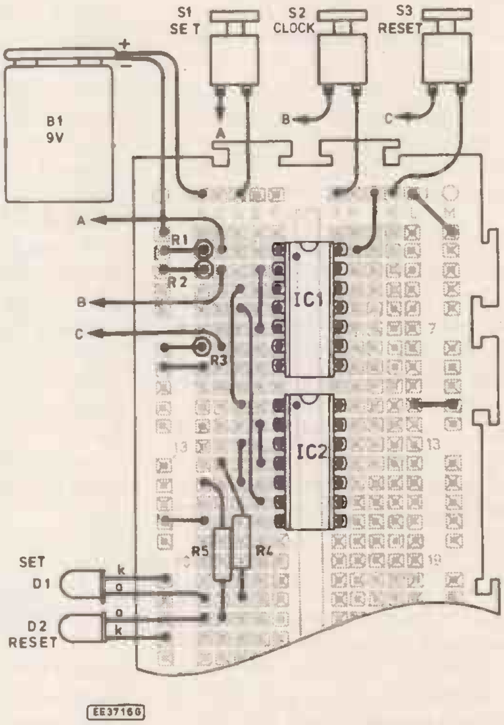


Fig. 9. Clocked S-R bistable layout.

rect way round in the circuit or it will not work – the *red* wire is the positive one. Note also the orientation of transistor TR1. When the battery is first connected, the buzzer may sound if Q happens to be left high (i.e. *set*) due to the race condition mentioned earlier.

In addition to the components used previously, you will need the following:

R3	4k7 resistor.
TR1	Transistor ZTX300 *npn* silicon.

Solid-state buzzer –6V operation.

CLOCKED S-R BISTABLE

It is sometimes useful to allow the Set or Reset condition to take effect only when a pulse is applied to a third input called the *Clock* (Ck). This allows input conditions to be set up in advance.

The circuit for a clocked S-R bistable is shown in Fig. 8. This consists of an S-R bistable with inputs S' and R', controlled by the outputs of a pair of AND gates. Only when a Logic 1 pulse is applied to Ck (clock input) is it possible for data applied to the S and R inputs to be allowed through to the bistable proper and take effect. This is because an AND gate needs *both* inputs to be Logic 1 for the output to be Logic 1. The clocked S-R bistable can be build using the Plugblock layout shown in Fig. 9.

In addition to the components used previously, you will need the following

IC1	4081BE quad. AND gate
S1	Light-duty push-to-make switch
R1	10k resistor

Push-button switch, S2, applies clock pulses. When the battery is connected, the initial output states are unpredictable due to the race condition. Pressing the Set or Reset button should have no effect. Now, *keeping the appropriate Set or Reset switch pressed*, apply a clock pulse. The bistable will set or reset – try it a few times.

THE D-TYPE BISTABLE

The D-type is a special variety of clocked bistable with several uses in electronics. Its symbol, and a practical circuit to illustrate how it works, are shown in Fig. 10. The D-type bistable has two inputs – one called Data (D) and the other, Clock (Ck).

The D-type bistable operates as follows. When *data* – that is, a 1 or a 0 – is applied to the D input, nothing happens. However, when a clock pulse is applied to Ck, output Q assumes the same state as D and output $\overline{Q}$ the opposite one. For example, if we put a logic state of 1 on the D input and give a Logic 1 pulse to Ck, Q will become 1 and $\overline{Q}$, 0. If we subsequently put a 0 on the D input then apply a clock pulse. Q and $\overline{Q}$ will change states i.e. Q = 0 and $\overline{Q}$ = 1.

The clock pulses have no effect if the data applied to D has not changed. The action of the D-type bistable should be compared with the simple clocked S-R bistable.

Operation of the D-type bistable may be illustrated using the circuit shown in

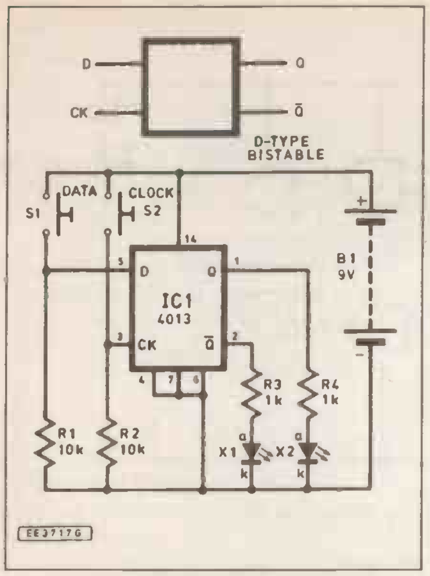


Fig. 10. D-type bistable symbol and a practical circuit.

Fig. 10. Note that the 4013 chip contains two separate D-type bistables but here we are using only one of them. In addition to previously-used components you will need:

IC1 4013 dual D-type bistable

Switch S1 supplies the *data* – when pressed, D = 1 when released D = 0 (due to the effect of pull-down resistor, R1). A clock pulse is given by pressing switch, S2. Light-emitting diodes, X1 and X2 indicate the logic states of Q̄ and Q respectively. **Note that from now on in this series, l.e.d's are denoted by X1 and X2 instead of D1 and D2 to avoid possible confusion later with the data inputs D1, D2 etc.**

Following the plugblock layout shown in Fig. 11. The connections between pins 4 and 6 and the battery negative line keep the unused inputs which exist on the 4013 at Logic 0 and prevent false operation. Connect the battery. The outputs, Q and Q̄, should have opposite states that is one l.e.d. will be on and the other one off. Say Q = 0. Make D = 1 by pressing S1 and, *keeping it pressed*, apply a clock pulse. The data will transfer from D to Q i.e. Q = 1, Q̄ = 0 (X2 on, X1 off). This is how it will remain until fresh data is applied and a further clock pulse given.

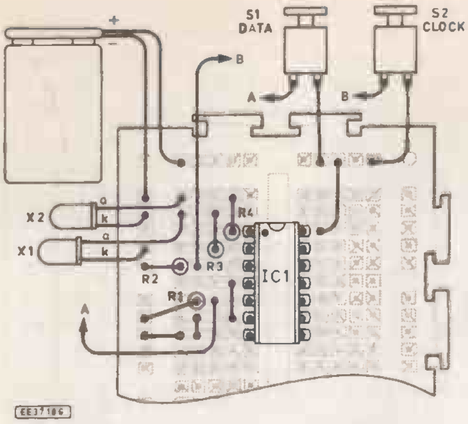


Fig. 11. D-type bistable construction.

If S1 is left unpressed then D = 0 and when a clock pulse is given, this will be transferred to Q (X2 off, X1 on). Check that clock pulses have an effect only when the data applied to the D-input is *new*. In this way, a single D-type bistable can remember one binary digit – or 0 or a 1. It could therefore be called a *1-bit data latch*.

THE 2-BIT DATA LATCH

A data latch remembers binary numbers and this is often useful in IT systems. Some basic information about Binary Arithmetic was given in Part 7 (May, 1992 issue). It is now helpful to consider a 2-bit number since this shows the general principle of operation. Although a 1- or 2-bit latch is not in itself very useful any larger number may be accommodated by having more flip-flops – one for each bit. The 4013 i.c. contains two independent bistables so a 2-bit latch may be made using only one chip.

The circuit for the 2-bit data latch is shown in Fig. 12 and the Plugblock layout in Fig. 13. No additional components are needed to build this circuit. If a 2-bit number is set up on Data inputs D1 and D2 using switches S2 and S3, this number can be "remembered" by giving a momentary clock pulse using S1. Note that the clock input is common to both bistables.

After building the 2-bit data latch, connect the battery and check operation by setting up a binary number such as 10. Remember, for Logic 0 the appropriate switch is left unpressed. Now *keeping the data switch or switches pressed*, apply a clock pulse. The data transfers to the Q outputs and the flip-flops latch; l.e.d's, X1 (for Q1) and X2 (for Q2) then display the number. Fresh data may be supplied and a further clock pulse given. Try all possible 2-bit numbers – 00, 01, 10 and 11.

TOGGLING A BISTABLE

It often happens that we wish to change the status of the bistable outputs with successive clock pulses. That is, on the first clock pulse Q = 1, Q̄ = 0 on the second Q = 0, Q̄ = 1 and so on. This action is called *toggling*. It is easy to achieve with a D-type bistable by connecting the Q̄ output to the D input (see Fig. 14). Think the operation through before actually building the circuit.

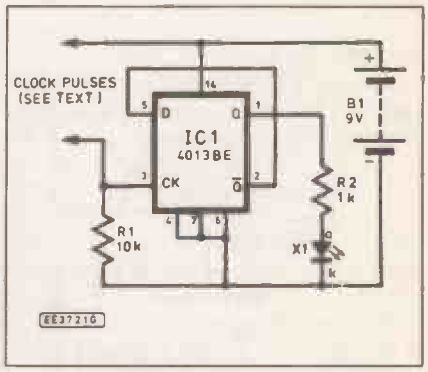


Fig. 14. Toggling a bistable.

Consider the situation where D = 1 and a clock pulse is applied. Q will become logic 1 i.e. Q = 1 and Q̄ = 0. Since Q̄ is connected to D, D now becomes 0. On the next clock pulse this is transferred to Q i.e. Q = 0 and Q̄ = 1. This state of 1 is again transferred to the D input i.e. D = 1. On the next clock pulse this 1 will be transferred to Q so Q = 1 and Q̄ = 0. This sequence of events repeats indefinitely.

Note that the number of times Q changes state is one half the number of times the clock is pulsed. We have therefore *divided the number of clock pulses by 2* – that is, we have made a frequency

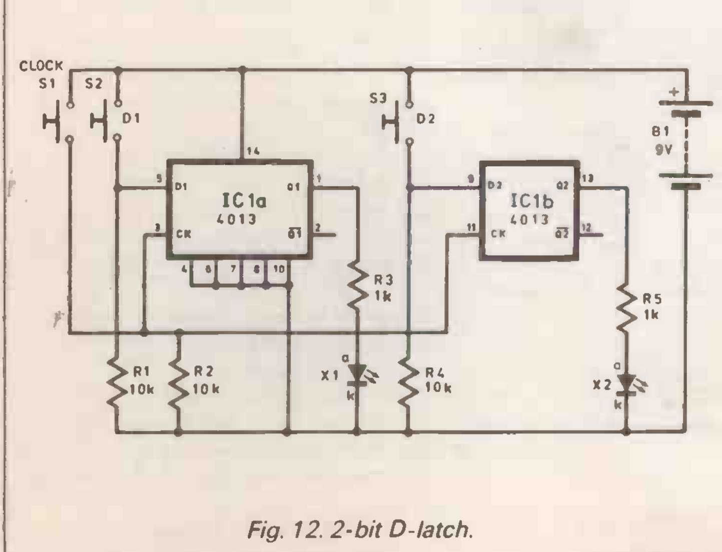


Fig. 12. 2-bit D-latch.

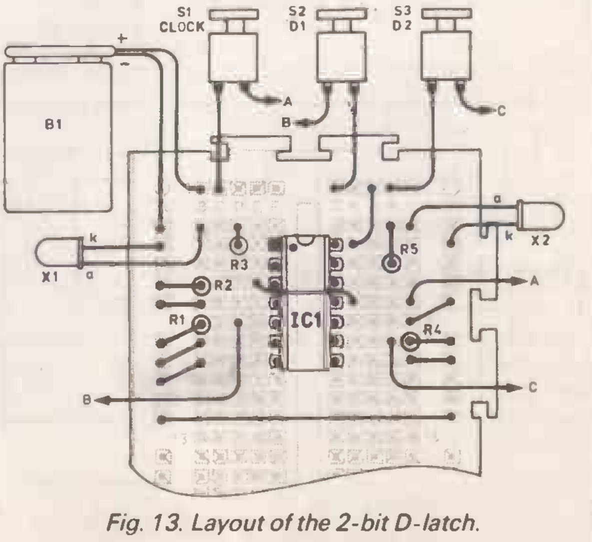


Fig. 13. Layout of the 2-bit D-latch.

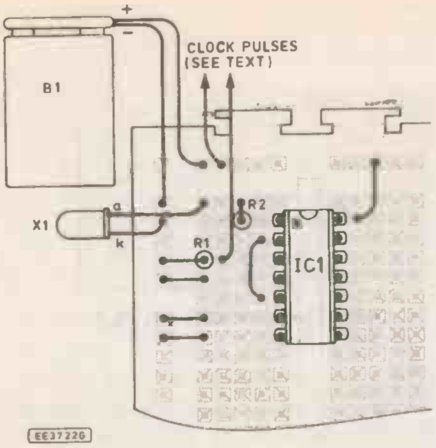


Fig. 15. Construction of the toggling circuit.

divider. This will be examined in more detail presently.

COMING CLEAN

Toggling a bistable may be investigated using the Plugblock layout shown in Fig. 15. No additional components are required.

The main problem with using this circuit is providing the clock pulses. An ordinary push-button switch usually produces several pulses instead of one. This is because the contacts *bounce* as they touch. In view of the great speed at which the bistable can operate, it would toggle on each bounce and the results would be unpredictable. To overcome this, a *debounced* switch is needed.

If a modular kit is being used, then a debounced switch will be provided or "built in" so there should be no problem. In practice, for simple experimental work an ordinary switch may give reasonable results. Sharp and deliberate pressing of the switch helps. It is worth remembering that luck often comes to the aid of the experimenter. Sometimes the switch contacts happen to bounce an even number of times, say 2 or 4, and this achieves the same result as having no bounce at all!

In real systems, a *monostable* is used to provide the clock pulses. An ordinary push-button switch triggers the monostable whose output goes from Logic 0 to 1. This, in turn, provides the clock pulse for the bistable. While it is in the triggered state further pulses due to switch bounce have no effect.

An unconventional method of producing reasonably bounce-free switching may be carried out using a small amount of water in an egg-cup. The clock pulse input wire leading to battery positive is dipped permanently in the water. The wire leading to pin 3 is then dipped in to give a pulse. With practice, this works well. For some reason, a pulse is given as the wire enters and another as it leaves! If using this method, it is necessary to use a higher value of resistor R1 (100k works well).

THE BINARY COUNTER

A binary counter displays the number of pulses fed into it. It consists of a series of interconnected D-type flip-flops each connected in toggle mode (see Fig. 16). Each $\overline{Q}$ output activates the clock for the next one in line. One bistable is needed for each bit – thus, a 4-bit counter (able to count up to 1111 or 15 in decimal) could be made using 4 flip-flops (or 2 off 4013's).

For ease of construction it is helpful to make a 2-bit counter – that is, one able to count up to 11 (3 in decimal). Again, not very useful in itself but by adding further stages any number may be counted. Fig. 17 shows the Plugblock layout. No additional components are needed to build this circuit. Note that clean clock pulses are once again needed and the water-dipping method described earlier works fairly well.

Refer to Fig. 16; l.e.d's X1 and X2 count units and two's respectively. Imagine an initial state where D1 and D2 = 1 with Q1 = 0 and $\overline{Q1}$ = 1 – X1 is therefore *off*. Similarly for the second stage, D2 = 1 with Q2 = 0 and $\overline{Q2}$ = 1 – X2 is also off so the count is 0 0. On the first clock pulse, the logic state on D1 (1) is transferred to Q1 (X1 lights) and $\overline{Q1}$ = 0. This makes D1 = 0 also.

In the absence of a clock pulse to CK2, nothing yet happens at the second flip-flop and X2 remains off. Thus the count is 0 1. On the second clock pulse, data is transferred from D1 (0) to Q1 so Q1 = 0 (X1 goes off) and $\overline{Q1}$ = 1. This makes D1 = 1 and a clock pulse is also given to CK2. The data is transferred from D2 (1) to Q2 – X2 lights and $\overline{Q2}$ = 0. This makes D2 = 0 also. The count is therefore 1 0. On the next pulse, data is transferred from D1 (1) to Q1 so Q1 = 1 and X1 lights. The count is therefore 1 1. On a further pulse the cycle would begin again and repeat continuously.

If the above sequence is written down we can see that the device is counting in binary:

Clock pulse	Twos (X2)	Units (X1)		Decimal Equivalent
0 (start)	0	0	=	0
1	0	1	=	1
2	1	0	=	2
3	1	1	=	3

If it is re-written (without the decimal equivalent) but this time extended through a few complete cycles something else emerges:

Clock pulse	X2	X1
0 (start)	0	0
1	0	1
2	1	0
3	1	1
4	0	0
5	0	1
6	1	0
7	1	1
8	0	0
9	0	1
10	1	0
11	1	1
12	0	0

– and so on. Inspection shows that whereas the clock has pulsed 12 times, X1 has pulsed on 6 times and X2 only 3. Thus, we have extended the idea of *frequency division* mentioned earlier. Division by two can be carried out any number of times by using more bistables.

This idea is used in an electronic clock or watch to produce the 1 second pulses for the display. It is easy to produce accurate pulses at very high speed yet it is 1 second pulses which are needed. To solve the problem, pulses are produced at a precise rate of 32,768 per second (32.768kHz) by means of a *crystal controlled oscillator*. This is divided by a string of 15 flip-flops. The first one divides by two to produce 16,384Hz. The next div-

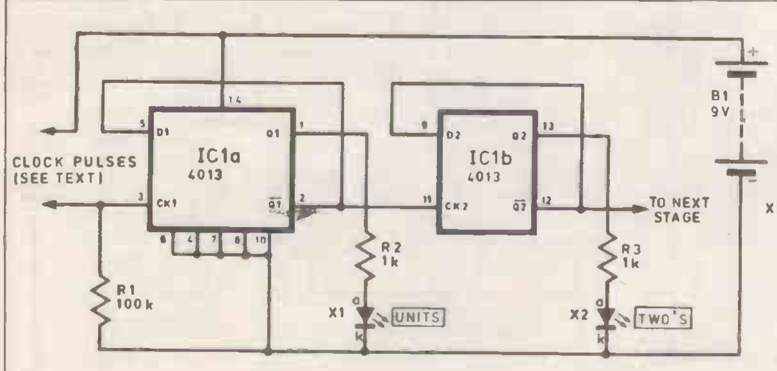


Fig. 16. 2-bit binary counter.

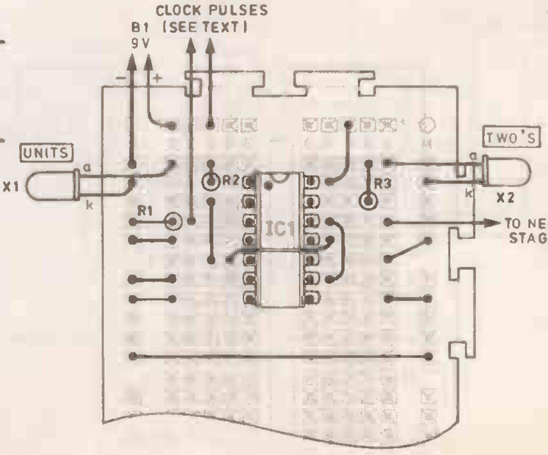
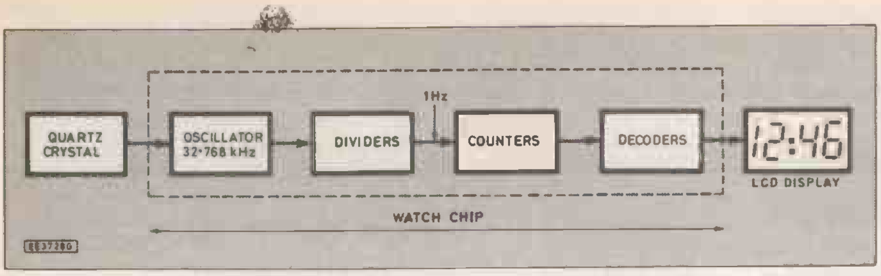


Fig. 17. (right) 2-bit binary counter construction.



The working parts of a digital watch.

ides by two again to give 18,192Hz and so on. After successive divisions, the output of the 15th bistable is 1Hz (check this with a calculator). Of course, if you take the back off a watch you won't find 15 individual flip-flops inside. These are built in a single "dedicated" integrated circuit.

THE SHIFT REGISTER

A shift register is another multi-stage D-type flip-flop circuit with each Q output connected to the following D input. The following explanation is for a 4-bit serial shift register. Suppose all four Q outputs are initially at logic 0. When data is fed into input, D1 and a clock pulse given, the data moves along one place.

	Q1	Q2	Q3	Q4
Initial state:	0	0	0	0
If a 1 is fed into D1 the display will be:	1	0	0	0
with a 0 fed in:	0	1	0	0
then a 1:	1	0	1	0
then another 1:	1	1	0	1
and so on.				

Suppose we wish to send binary data along a telephone line. This is commonly done where information needs to be transferred from one computer to another as in banking or for the operation of a fax machine. Since only one bit at a time can be sent, we could not send the 8-bit binary number:

1 0 1 1 1 0 1 0

all at once unless we had eight separate telephone lines and this would be obviously impractical. Instead, we work *sequentially*. First, the number is set up in a shift register and when the system is ready, it is clocked repeatedly. The digits move along one step at a time and eventually arrive at the end of the chain,

whereupon they are fed along the line. Some computer printers – so called, *serial* printers – receive their information from the host computer sequentially.

The circuit of a 2-bit shift register is shown in Fig. 18. Suppose a Logic 1 state is applied to D1 by pressing S1 (DATA IN). On the arrival of a clock pulse, this will be transferred to Q1 so X1 lights. This also supplies the data for D2. However, nothing more will happen, until a further clock pulse is given whereupon this logic 1 state will be transferred to Q2. Meanwhile more data can be input to D1. It can be seen that digits move (shift) 1 place to the right with each clock pulse. Eventually, data is lost as it "falls off" the end.

The 2-bit shift register may be constructed using the Plugblock layout shown in Fig. 19. No additional components are needed. It is necessary to apply "clean" pulses to the clock input, Ck1, to avoid the effects of contact bounce. It may otherwise be difficult to trace through the action of each pulse. This may be done using the water-dipping method described previously.

Switch S1 sets the input data – pressing it gives Logic 1 and leaving it released, Logic 0. After building the circuit, connect the battery. Apply clock pulses and check that the data shifts along as it should.

	COLUMN 1	COLUMN 2	COLUMN 3
ROW 1	FLIP FLOP 1	FLIP FLOP 2	FLIP FLOP 3
ROW 2	FLIP FLOP 4	FLIP FLOP 5	FLIP FLOP 6
ROW 3	FLIP FLOP 7	FLIP FLOP 8	FLIP FLOP 9

Fig. 20. Random access memory illustration.

A 2-bit shift register may not be very useful but by adding further identical stages, any size number may be accommodated.

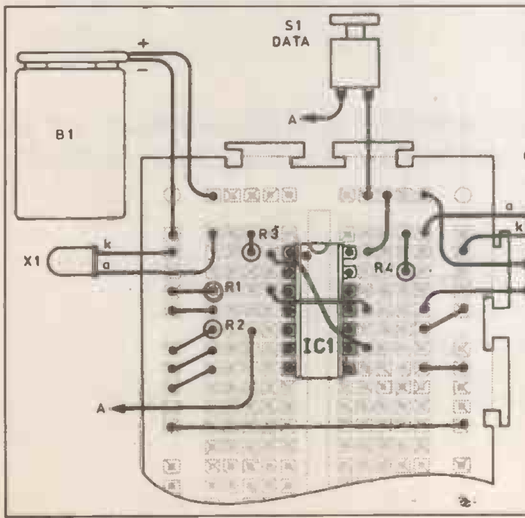
RANDOM ACCESS MEMORY

Bistables form the basis of computer memory. We have seen that a single flip-flop can remember one binary digit. With sufficient flip-flops we can remember as many bits as we choose. With modern technology many thousands of bistables can be formed on one silicon chip. The memory device called *Random Access Memory (RAM)* enables data to be *written* (placed) into memory cells and *read* (retrieved) from them again. The principle of operation is shown in Fig. 20.

For simplicity there are only 9 flip-flops in a 3 × 3 array. Each flip-flop can be accessed by referring to its row and column. This gives a unique position called its *address*. For example, we could call the second flip-flop in the top row "Row 1 column 2". By referring to the address, we select any flip-flop we choose.

This is what is meant by the rather confusing term *random access*. It is like having a large array of small drawers containing electronic components. If someone wanted a diode you could say "go to the third row, fourth column along". This is the unique address of the diode drawer. A modern RAM i.c. can access a given address and retrieve or place data in a matter of 100 nanoseconds (100 thousand millionths – 0·0000001 – of a second) or less.

That's all for this month. Next time we shall look at the use of IT devices to monitor and control experiments.



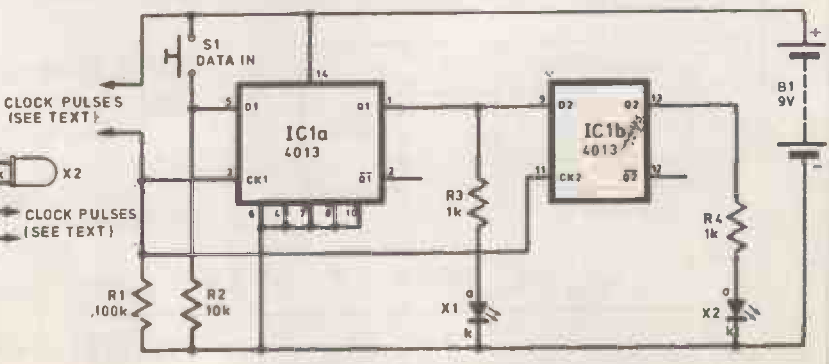


Fig. 18. 2-bit shift register.

Fig. 19. (left) 2-bit shift register construction.

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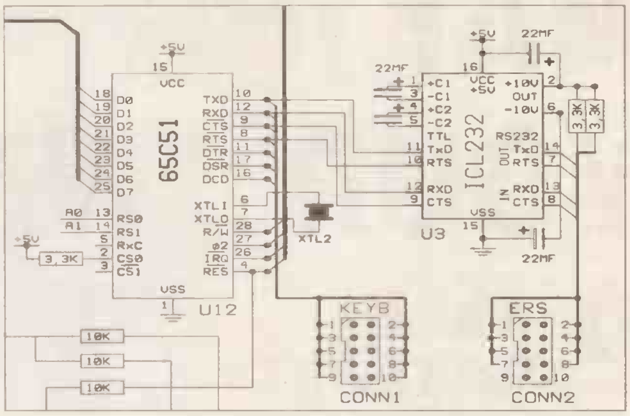

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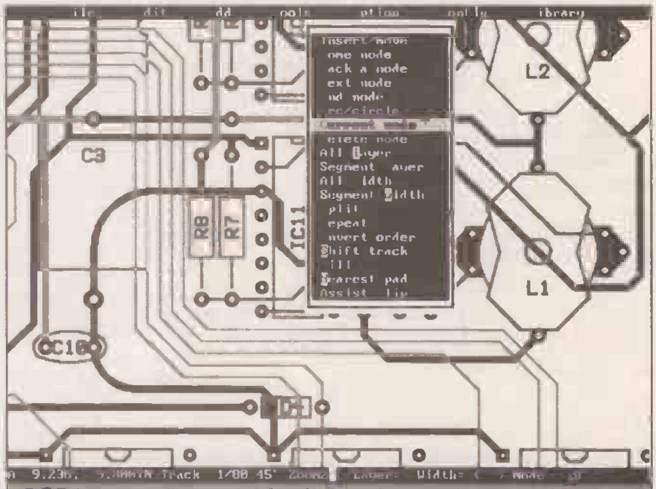

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It's easy if you have the right chemistry

Part Three: Originating your own artwork

THIS part suggests some ways of designing your own printed circuit board artwork, which will appeal especially to those who have invested in the necessary equipment to fabricate boards with the ultra-violet method.

As we said earlier, one benefit of using the UV technique is that all artwork can be retained for future use, perhaps being modified if necessary. Identical boards can also be produced this way in small batch quantities using the same artwork.

Rather than lay an etch-resist pattern directly onto the copper foil of a board, it is much more convenient to prepare artwork on a polyester film where the opaque transfers and crepe paper decals can be altered at will. Utilising existing artwork – such as that given in a project – simply involves tracing the copper track layout onto the film, using the methods described last month. But you might want to create your own track pattern from a circuit diagram, or perhaps convert a stripboard layout to a printed circuit board (p.c.b.).

Guidelines

This month's feature suggests ways of designing your own artwork, and will be of interest to those who do not have the benefit of a computer-aided p.c.b. routing system. Before drafting the artwork, it is worth considering the following aspects of the circuit you are assembling:

1. The physical features of the components used in the circuit. Some parts like transformers may be relatively large or heavy, or might have unusual terminals or mounting requirements.
2. The operating characteristics of both the individual components and the circuit itself – voltages, currents and operating frequencies etc. High voltages and currents (either localised or "global," throughout the circuit) need to be taken into account when deciding the copper track widths and distances from neighbouring tracks.
3. The available space in the cabinet or box housing the p.c.b., which determines the overall size of the board.
4. The need to take various flying leads to or from the board (for indicators, switches, sockets etc.).
5. Any components which become hot in normal operation, e.g. power transistors/heatsinks or resistors. This controls the proximity of any adjacent parts which might be affected by excess heat.
6. The method by which the board is going to be mounted into the enclosure.

In the absence of any other guidelines it is best to start the design of the artwork by defining the above factors, perhaps listing them out for reference.

Neat and Tidy

As far as the size of the board is concerned, one of the enjoyable challenges of designing your own board may actually be to make the p.c.b. as compact and neat as possible, and with practice you will soon become skilled in routing the copper track layout accordingly to limit the size of the card.

Where the size of the board is not critical, it is often preferable to draft the p.c.b. artwork allowing yourself plenty of design space if necessary, and then finalise the board size afterwards before selecting a suitably-sized housing for it from supplier's catalogues (if indeed you are using a box at all). Obviously one has to bear in mind the general sizes (and cost!) of boxes that are available, and not make the p.c.b. impractically large!

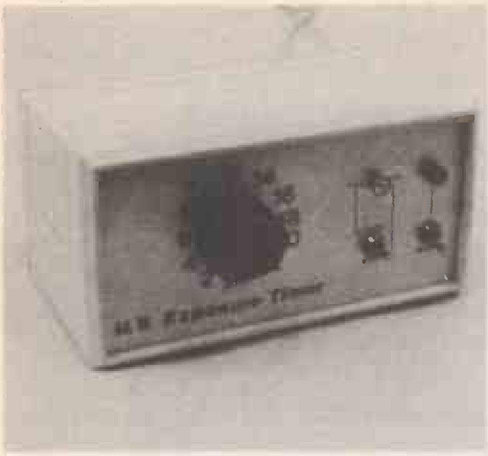
The designer can thus either simply design the copper track layout first, and then make the board the correct size to accommodate it, or alternatively define the size of the board to start with and then try to make the copper track pattern fit it. The latter option may take some skill (and patience), especially with more complicated circuits.

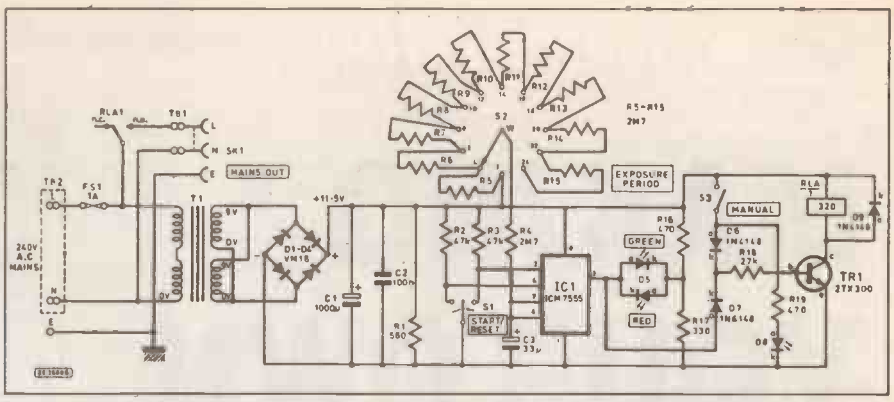
Your initial design brief might also allow for the fact that many plastic boxes (for example) incorporate mounting bushes in their bases so that the p.c.b. can be retained with either self-tapping or machine set screws. No other mounting hardware is generally required in these instances, and the design of the p.c.b. could include the mounting hardware fixing centres, so these would be designed into the artwork to begin with.

Components

Having defined the size of the board the next stage is to consider the circuit and the components themselves, before getting down to the job of designing the copper track pattern itself.

Let's consider an actual design example which will demonstrate the principles of drafting a p.c.b. master artwork from a circuit diagram. A useful accompanying project, *UV Exposure Timer* is described elsewhere in this issue, so the circuit description and constructional details are given in that article. Once the circuit has been designed and finalised, we can





The circuit diagram of the UV Exposure Timer which is used here to demonstrate the approach taken in designing your own p.c.b. A photograph of the completed project is also shown.

specify the basic p.c.b. design in accordance with the above criteria.

It is a very good idea to employ p.c.b.-mounted parts wherever feasible. Often it is possible to build the mains side of the circuit directly on the p.c.b. to reduce any mains interwiring – this makes the project assembly quicker, neater and safer. So when planning the board for the *UV Exposure Timer* we could utilise a p.c.b. transformer (T1) along with the fuseholder FS1 (see article). Both components will fit directly on to the board without any necessary extra hardware being required. The relay too can be a board-mounted type to simplify assembly even more.

Hot Lines

The circuit employs mains and low voltages. In this design the low-voltage side is straightforward though certain circuits (like power amplifiers or heavy duty power supplies) might need extra design considerations to maintain stability and performance. These aspects relate to more advanced designs and will not be discussed further here.

Radio frequency (r.f.) circuits can also have their own quirks, especially when one considers that two adjacent copper tracks can act as an air-spaced capacitor! Alternatively a double-sided board may have an inherent capacitive characteristic when you consider that copper tracks on both sides of the board, separated by the board itself, may give rise to a dielectric effect.

This can unintentionally cause "stray capacitance" around the p.c.b. which could affect the performance of the circuit. Apart from planning the layout carefully, one might also use very thin copper tracks wherever possible to reduce the capacitive effect of the conductors on the circuit. You might see this on an oscilloscope board, for example, where the C.R.O. can operate at very high frequencies (10MHz or more): steps are taken by designers to ensure that the design of the copper tracks does not affect accuracy or performance.

Mains Voltage

In our *UV Exposure Timer* example, a major factor to bear in mind is that a.c. mains voltage is present on the board and is also switched through a relay. It is best to try and group all mains-voltage components into one area rather than disperse them around the board. Also, the tracks which carry mains voltage *must* be of adequate thickness to carry the peak current safely. The rest of the circuit is at a low voltage and the design of the p.c.b. tracks in that area should be straightforward.

Having pondered the operating characteristics of the circuit, the next criterion in our list relates to the space available in the housing used to accommodate the finished board. In fact, the author opted to select the (plastic) box first and design the p.c.b. to fit it and so the dimensions of the board were finalised at 110mm × 68mm. The plastic box used (see parts list) is also high enough to accept the highest component on the p.c.b., namely the mains transformer.

Also we need to consider the flying leads which we wish to take from the board and hook up to external switches, indicators etc. Two sets of mains-voltage flying leads will be utilised – live (L) and neutral (N) mains input, and also live and neutral mains output to the outlet socket. The safest way to connect mains leads to the board is via p.c.b-mounting screw terminal blocks, so two two-way terminals will be required.

All other flying leads for the switches and indicators are at low voltage and these can be soldered directly to the p.c.b. More elaborate designs might use pin headers and sockets so that flying leads can be plugged into the board, making it easy to disconnect them to remove the board for servicing or repair.

None of the components in this design get unduly hot during operation, so we do not need to worry about leaving ample space for a heatsink.

The final specification for our board relates to the mounting hardware for the board. The plastic box chosen does not have any mounting bushes moulded in the base, so the board will be mounted firmly with nylon screws, nuts and stand-off pillars. We need to remember to incorporate mounting holes in the p.c.b., therefore.

Light Work

Having outlined the main p.c.b. design parameters let's now look at the process of preparing the artwork itself.

This is best drafted onto polyester film, which is translucent and tear-resistant. Other media which could be used included transparent acetate film (such as overhead projector film) but some types are liable to rip very easily, destroying the artwork with it!

The job of drawing up the artwork is made considerably easier by using a light-box, especially when dealing with more complex designs involving integrated circuits. Light-boxes have a translucent surface and are illuminated from inside with fluorescent tubes. Using a light box enables you to superimpose electronic component arrangements onto copper track layout artwork so that you can design the p.c.b. on paper and see the copper tracks underneath through the component layout.

Thus, with a light-box, you can juggle both the component layout and the copper track design around, and see one side of the board in relation to the other. A light-box also obviously illuminates the work while you draft it and makes the artwork easier to see!

It is relatively simple to make a fluorescent light box from readily-available materials (e.g. Conti Board and Perspex) and the author designs all his artwork on the light console which will be described next month. The design utilises a Thorn "2D" compact fluorescent tube which fits a standard bayonet (BC) light socket and requires no external starting or control gear. The box also has a sloping front making it easier to use when sat at a desk.

Starting Grid

Many components such as transformers, relays and integrated circuits have their terminals arranged on a regular grid, and generally – but not always – a 0·1in. matrix "pitch" (distance between the lines on the grid) is employed. It is obviously necessary to make sure that the holes drilled in our p.c.b. have a pitch which matches the terminals of the components if the parts are to fit the board properly.

It is possible to buy an accurate 0·1in. pitch grid printed like graph paper onto polyester film, which helps to gauge distances between terminals when designing the artwork. (The grid is often included in packs of plain polyester drafting film). It is best to tape this grid using Scotch Magic Tape to the light box to enable the designer to accurately align components onto a 0.1in pitch.

The next step is to try and determine the best arrangement of the components on the board, and it often helps if at least the major parts (large transformers, relays etc.) are to hand so that the designer can visualise the arrangement of the components. Using a pencil and paper, draw out an approximate actual size layout of the components to get an idea of how the parts can best fit together.

You will probably need to change the layout around as the artwork evolves. Bear in mind the specification we drew up earlier, so that hot components are not too close to other parts, mains-voltage parts are all grouped together where possible, etc.

Board Room

At this stage the author uses the light box to see through the paper, and by turning over the paper it is possible to draw in with pencil on the reverse, a rough copper track layout which will link up the components in accordance with the circuit diagram. If a copper track cannot be routed because it is blocked by existing copper tracks, use jumper link wires to bridge over the obstruction.

When the paper is viewed on the light box, a see-through view is obtained so that it is possible to see the rough copper track layout, like an X-Ray, in relation to the components.

There are no hard and fast rules regarding the best way of drafting out a rough layout, and you may wish to use tracing paper for both the parts arrangement and the copper track layout. View them in alignment with each other to realise the overall artwork design. Whichever method you adopt, the use of a light box will certainly make the job a lot easier.

Eventually, after some trial and error (a lot, on complex boards!) you will have a rough draft of how the parts are to be arranged on the p.c.b. and also how the copper track pattern is to be designed. The next stage is to translate this into actual artwork, ready for exposure using the ultra-violet system.

Place a fresh piece of polyester drafting film, cut to a suitable size and leaving a generous margin, over the 0·1in. pitch grid on the light box, and tape it down with Scotch Magic Tape. Ensure the film is completely flat against the light box.

Using your rough pencil copy as a guide, commence the

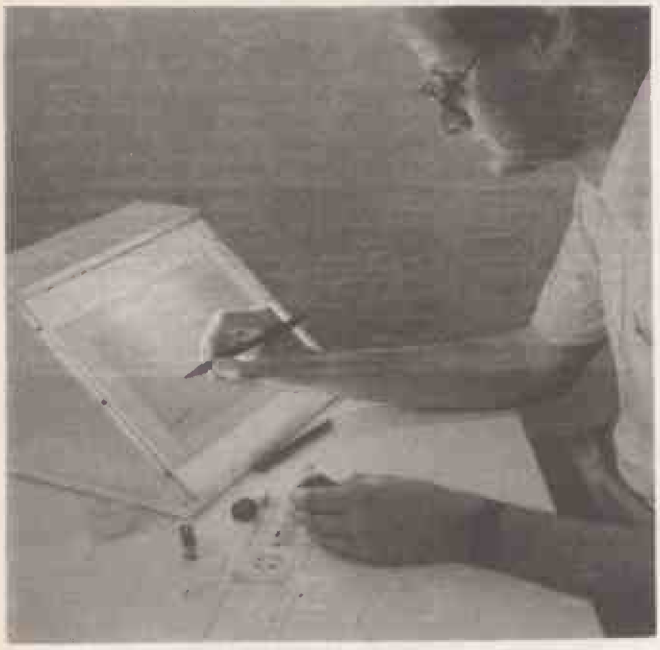


Photo 1. Designing your own artwork starts by drafting a rough component layout diagram, referring to the circuit diagram and manufacturer's data as required. Here, the EE Light Box (next month) is being used, which proves invaluable in the following stages.

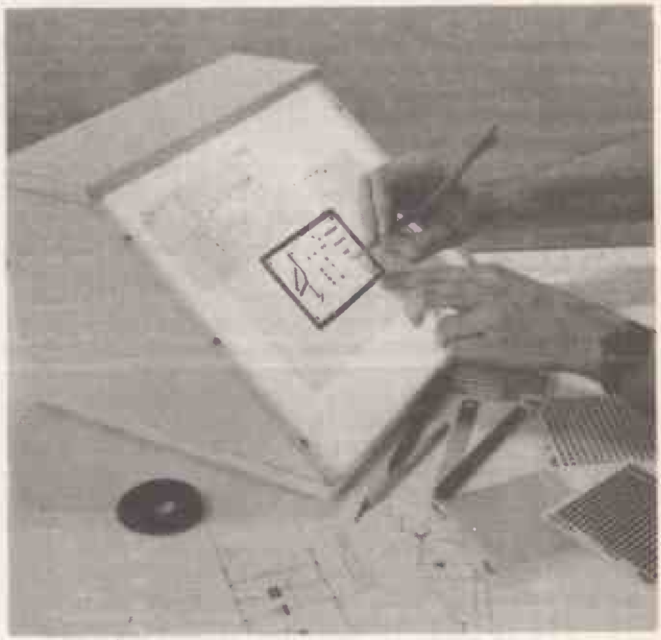


Photo 2. Starting to prepare the master artwork using Alfac rub-down transfers. Also on the Light Box is the author's rough draft – the proposed copper track layout shows through the paper so that an "X-Ray" view of the rough version is seen.

Photo 3. The completed artwork on the light box–the precision 0·1in. matrix grid is also visible. This view is actually equivalent to seeing the copper track pattern "through" the board from the component side.

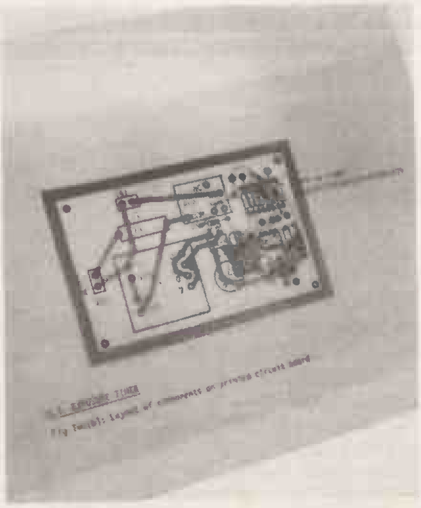


Photo 4. The artwork with the finalised component layout superimposed on it. This stage can be used for double-checking your copper track design for errors or omissions.

Photo 5. The artwork is turned over and clearly labelled "Copper Track View Side" – this is your first sight of the actual copper foil pattern which will be etched into your p.c.b.!

preparation of the artwork by placing down the mounting pads of the components, using either crepe tape circles or rub-down dry transfers of appropriate diameter. Use the same technique as described earlier (May '92 issue – Supplement) in the "Direct Etch" method of p.c.b. production.

Large circles (roughly 3·6mm outside diameter (o/d) or more) are best for mains components and terminals. For general purpose pads 2.4mm o/d are quite adequate and again special shapes are available for integrated circuit pin-outs which are already conveniently laid out on the correct 0·1in. pitch. Lay down all pads on the intersections of the 0·1in. matrix so that they match the pinouts of the various components used.

Trim the pads if necessary with a scalpel to prevent them touching any neighbouring pads or tracks. You will see that several large pads have been trimmed for this reason on our working example layout for the *UV Exposure Timer*.

Some components are manufactured on a metric grid, often showing up in data as a distance of 5·00mm between pins. An equivalent part in a true imperial pitch of 0·1in. would be shown as 5·08mm distance in catalogues. The two parts are not always interchangeable: the small difference of 0·08mm can give rise to a cumulative error which could mean that a metric pitch part will not necessarily fit a 0·1in. pitch p.c.b., and vice versa.

Where a metric pitch part is used (certain mains transformers, for instance), the 0·1in. grid taped to the light box will have to be ignored if the metric component is to fit the board correctly.

Making Tracks

Next, start to interlink the pads with either crepe tape or dry transfer lines, using the relevant thicknesses as necessary. Looking at the artwork for the *UV Exposure Timer*, it will be seen that all mains parts are at one end of the board, with 240V connections via screw terminals for safety.

The mains-voltage tracks need to be of adequate thickness. As a rule of thumb, the author designs these mains-voltage tracks in 2·5mm wide section (which is good for up to 5 Amps at 250V in 1oz. copper foil), and separates them by a distance of 1·5mm to 2mm minimum where possible. Extreme care is needed not to space the tracks so closely together that any high voltages flash over between tracks can occur.

The primary and secondary windings of the transformer have been interlinked as shown in the circuit diagram, such that the twin 120V primary windings are in series, making the transformer suitable for domestic 240V mains operation. The two secondary windings are in PARALLEL (both 0V terminals joined together, and both 9V pins similarly linked.)

It is absolutely vital that the transformer is wired correctly to avoid any unpleasant occurrences! Double check with supplier's data and look at the part itself to confirm the pinouts. There appears to be no standard pinouts for p.c.b. mounting transformers and different manufacturers each have their own style.

Likewise double check the bridge rectifier connections and the smoothing capacitor C1 for polarity, as there is no standard arrangement. Reversed polarities here could prove dangerous. Again, supplier's catalogues will be of help when determining distances and pinouts.

It is often a good idea to make the positive and negative power supply conductors as thick as possible to avoid any noise or ripple being induced on the power supply lines when thin conductors could create an unwanted electrical resistance. One may also need to consider high switch-on surges amongst other factors, the effects of which will be reduced by keeping the power supply tracks as thick as practicable. It is not critical in this design, where supply requirements are not very demanding, but it is not a bad habit to use wide (say 2.5mm) track for main power conductors, even though they are at low current.

The rest of the copper track layout is really a matter of translating one's rough pencil sketches onto the polyester film using more opaque transfers. The rest of the *UV Exposure Timer* artwork is quite straightforward and uses 1·00mm or 0·8mm wide lines for most of the low-voltage component interconnections. You can be as elaborate as you like and you will doubtless develop your own style.

Retouching

The ultra-violet process method will reproduce any flaws in the artwork, so it is necessary to ensure that there are no breaks in the conductor lines etc. Any faults can be touched up using more transfers laid on top.

Any pads or tracks which are laid down in error can often be removed by laying some sticky tape over the offending area, and pulling away sharply. The transfers will often come away with the adhesive tape. Alternatively, the transfers can be scraped away with a scalpel.

It will be seen on the example artwork that there are several relatively large areas of copper. These can be drafted by outlining the area with tape or transfer lines, and then painting in the central area with matt black enamel paint; or, fill in the middle by laying down wide transfer lines, slightly overlapping each other and cut to shape with a scalpel.

It must be borne in mind that more copper equates to more adhesive holding the copper foil onto the glass fibre panel. Extremely thin tracks and very small pads are not able to withstand much heat when soldering and may lift off. (Tips were given in Part Two about repairing the board under these circumstances). By laying down larger areas of copper track, you will not only make the copper foil pattern better able to adhere to the board, but you will speed up the etching time also.

Component View

When eventually the artwork has been drafted, you will finish up with a "see-through" view of the copper track pattern, as seen through the board from the component side. The next thing to do whilst it is still taped to the light box is to draw up a component layout diagram, actual size. Lay a piece of paper over the artwork and draw on the actual positions of the components, showing the locations of all pinouts and terminals clearly.

Also label the components on your drawing as per your circuit diagram and retain for future reference. At this stage, you will have drawn both the copper track layout and have separately superimposed the component layout onto it: you can now *double* check your work thoroughly.

Look especially for incorrect or reversed connections to integrated circuits, transistors etc. A mistake spotted now can be rectified on the polyester film, but once you have committed your design to the board, it could be difficult or impossible to effect any corrections. Check carefully!

On the Right Side

Now remove the artwork from the light box and *turn it over*. You will now be looking at the actual design which is to be etched into the copper foil.

It is strongly recommended that you put an adhesive label on this side of the artwork in the margins and mark it with the title of the project, date etc. and very clearly mark words to the effect of "*this side copper track view/this side to UV light*" or similar. You can, incidentally, also add rub-down lettering such as the name of the board in the layout, on this side of the artwork and it will appear (the right way round!) on the copper foil layout of your board.

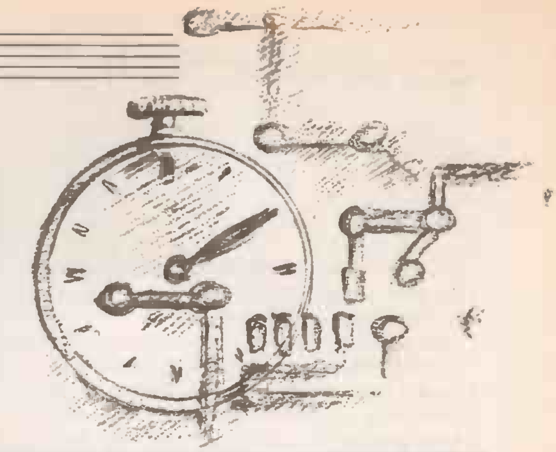
You are now only interested in the labelled side of the artwork, i.e. the side on which you did NOT apply any layout transfers. This view represents the *actual* foil pattern layout and is the side which will be placed down against the UV light source. The sensitised board – which is cut to size to fit the artwork – will be placed on top of it. The board can then be exposed and processed as normal using the techniques described in previous months.

When you have finished with the artwork, it can be stored in a stiff envelope or a file, along with the component layout diagram, so that it can be modified or re-used at a later date. Take care when handling the artwork as the rub-down dry transfers of the artwork are liable to be damaged by scratching.

Designing your own printed circuit board from scratch and then fabricating it from just a plain board can be a very rewarding experience. This series has shown the constructor the various techniques for both originating artwork and producing your printed circuit boards at home. The reader will certainly benefit from experimenting to develop his own preferred methods – have fun!

Next Month: The construction of a simple Artwork Light-Box will round off this short series.

Constructional Project



UV EXPOSURE TIMER

ALAN WINSTANLEY

You will only obtain consistent results if your "light sensitive" p.c.b. receives the right exposure. Covers a time period of 2 to 24 minutes in two minute steps.

When producing printed circuit boards (p.c.b.s) with the more advanced ultra-violet processing system, it is necessary to expose a sensitised board to a UV light source through the artwork positive.

Exposing the board for too long a period will rarely cause any damage, but troublesome problems can be caused by *under-exposure*, when the UV sensitive coating will not have thoroughly reacted to the UV light. This will only become apparent when you try to develop the board, because it will be impossible to remove all of the unwanted resist coating. The surface of the etch-resist ink might wash off in the developer but a layer of ink can still be left on the board, because the UV light has not had enough time to penetrate all the way through the resist.

Under these circumstances, all you can do is to try to re-align the board on the artwork and expose it for a further period, but you may well have to scrap that attempt and start again with a freshly-coated board. Further information is given in the *"Making Your Own Printed Circuit Boards"* series.

MAKING TIME

In order to obtain consistent results, it is best to expose the board for a timed period, though only the more expensive UV Light Boxes have a built-in timer.

The UV Exposure Timer described here enables the constructor to operate an ordinary UV Light Unit for a predetermined period (from 2 to 24 minutes, in two-minute steps) and will then automatically turn off. You can use this time to prepare the developer, etchant etc., or carry out any other tasks.

Using the timer also means that you can experiment to optimise the exposure times with different makes of sensitised boards and not worry about under- or over-exposure. You will certainly need to experiment with exposure periods if you are coating your own boards with a UV sensitive aerosol lacquer.

CIRCUIT DESCRIPTION

The full circuit diagram for the UV Exposure Timer is given in Fig. 1 and is seen to be based around a simple 555 timer chip IC1, wired as a monostable. The time period is determined by the resistor network R5 to R15 which are switched through S2.

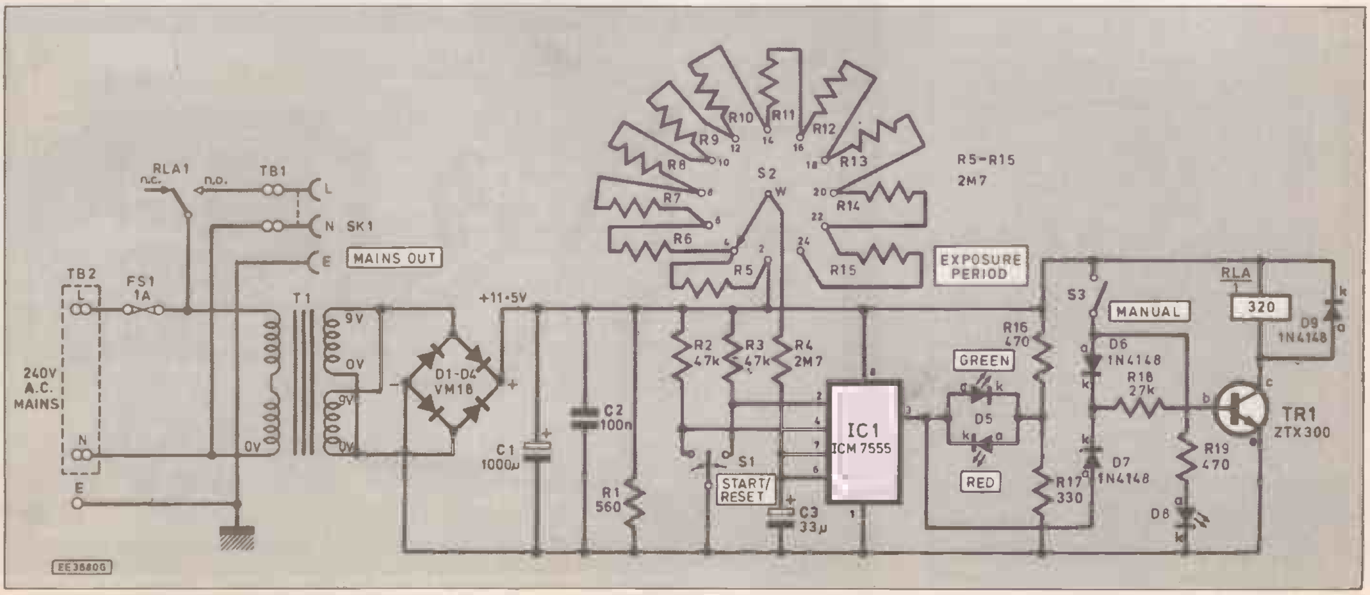
Rotating the switch S2 increments the monostable period by almost exactly two minutes, as measured on the prototype. The unit generates delays of between 2 and 24 minutes, which should cover every eventuality.

Since the 555 timer IC1 can be both triggered and reset by grounding pins 2 and 4 respectively, these functions have been combined into one control S1, a single-pole biased centre-off toggle. When IC1 is enabled, the output at pin 3 goes high, the l.e.d. D5 glows green and changes back to red when the period is up.

The 555 also drives a mains relay RLA through the transistor buffer TR1. The relay contacts RLA1 switch on the UV Exposure Light Unit, which is connected to the Timer via the miniature mains socket SK1. It is possible to manually operate the UV "Light Box" by operating switch S3, which completes the circuit to the relay coil and also illuminates D8.

The whole circuit is driven by a simple mains power supply and associated components. The circuit is fused, along with the mains load connected to SK1, by a 1A quick-blow fuse FS1.

Fig. 1. Complete circuit diagram for the UV Exposure Timer. A Light-Box is connected to the timer via the "Mains Out" socket SK1.



CONSTRUCTION

In order to simplify construction, nearly all parts are mounted on a single-sided glassfibre printed circuit board, measuring 110mm x 68mm. This board can be purchased from the *EE PCB Service* code EE792), but you might want to make it yourself! The actual design of the p.c.b. artwork is discussed in Part 3 of *"Making Your Own Printed Circuit Boards"* and may be of interest to the constructor.

The 1:1 (full size) artwork positive of the underside copper foil master pattern and topside component layout is shown in Fig. 2. It can be seen that all the mains parts, except socket SK1, are mounted on the board which greatly simplifies the interwiring, also making the unit that much more reliable.

Both the mains transformer and the relay MUST possess pinouts which match the p.c.b., and only the specified components (see *Shoptalk*) should be used in this respect. Other parts may not fit the p.c.b. artwork given, though the constructor making his own board can easily adapt the artwork to accept any components which he has available, provided that the electrical characteristics match those specified.

COMPONENTS

Resistors

R1	560 ½W
R2, R3	47k (2 off)
R4 to R15	2M7 (12 off)
R16	470
R17	330
R18	27k
R19	470

All 0.25W 5% carbon film except R1.

See SHOP TALK Page

Capacitors

C1	1000μ radial elect. 25V
C2	100n polyester
C3	33μ radial elect. 16V

Semiconductors

D1-D4	VM18 100V 0.9A d.i.l. style bridge rectifier
D5	5mm bi-colour l.e.d.
D6, D7	1N4148 signal diode (2 off)
D8	5mm red l.e.d.
D9	1N4148 signal diode
TR1	ZTX300 *npn* silicon
IC1	NE555V or ICM7555 timer i.c.

Miscellaneous

T1	p.c.b. mounting transformer, twin 120V primaries, 0V-9V, 0V-9V secondaries 6VA total
RLA	min. mains relay s.p.c.o. 3A a.c., 320 ohm 12V coil
FS1	20mm p.c.b. mounting fuseholder with 1A quick blow fuse
S1	s.p.c.o. miniature toggle switch biased both ways to centre off
S2	Single-pole 12-way rotary switch
S3	s.p.s.t. min. toggle switch
SK1	Euro-style miniature panel mounting mains safety socket

Case, Vero Apollo S3 beige, size 155mm x 79mm x 91mm; mains rated, p.c.b. mounting, 2-way screw terminal block (2 off); 8-pin d.i.l. socket; l.e.d. lens clip, one each-transparent and red; 6A 3-core mains cable; cable retention gland; 6A connecting wire; single-core connecting wire; p.c.b. mounting hardware; pointer knob; solder etc.

Printed circuit board available from *EE PCB Service*, code EE792.

Approx cost guidance only **£20** *excluding case*

CASE AND INTERWIRING

The p.c.b. was designed to fit an instrument box measuring 155mm x 79mm x 91mm which has a clip-together plastic top and bottom with drop-in aluminium front and rear panels. The board is secured to the base section with M3 mounting hardware.

The front panel carries the switches, and the timing resistors are soldered directly to the tags of the rotary switch S2 as shown in Fig. 3. The two light-

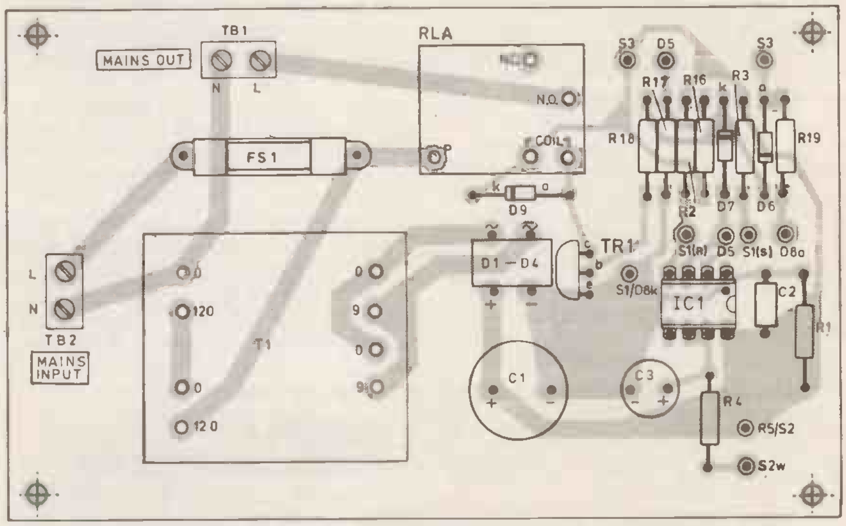
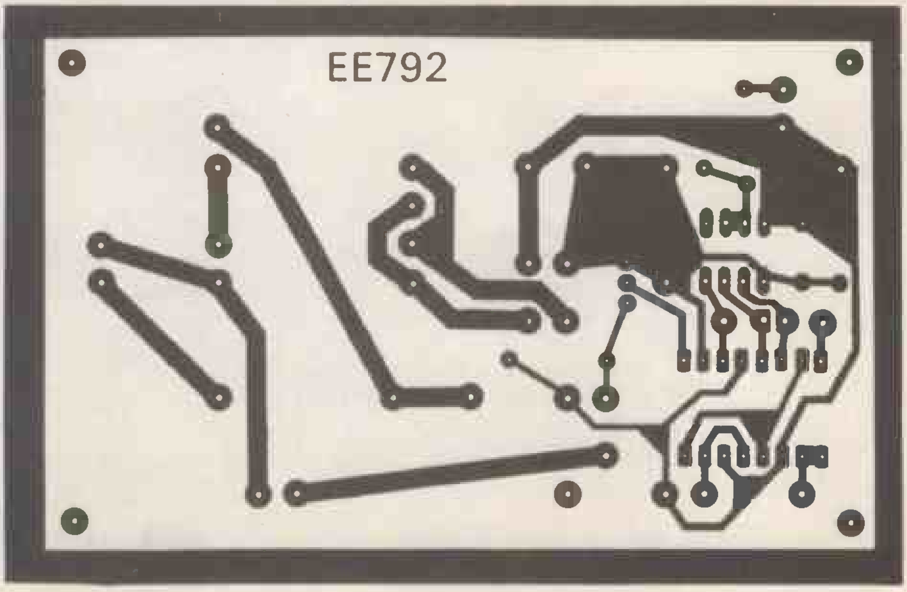


Fig. 2. Printed circuit board component layout and full size copper foil master pattern.



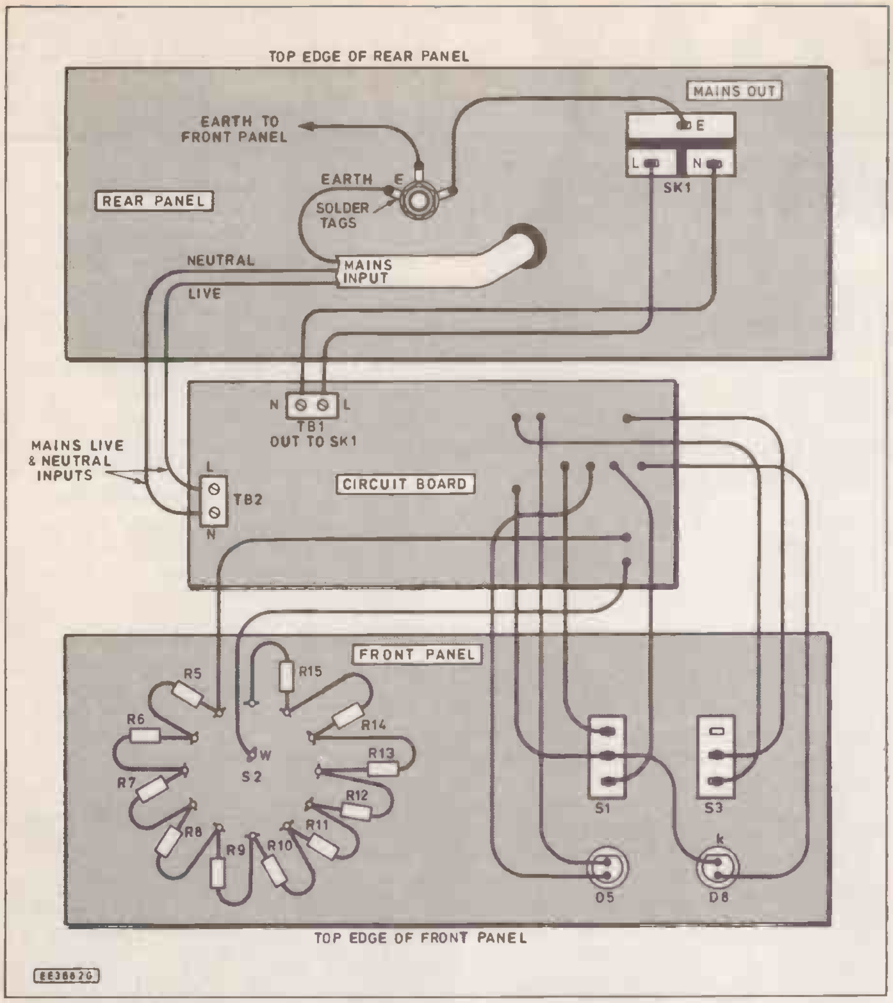
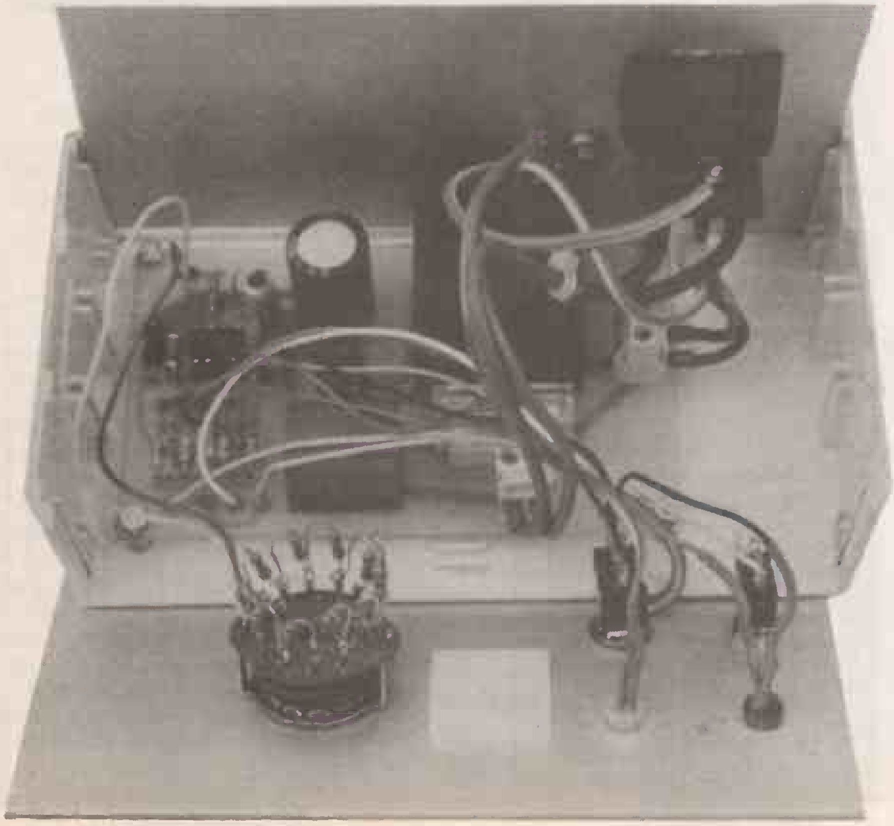


Fig. 3. Interwiring from the circuit board to the front and rear panels. The Earth lead from the rear panel solder tag to the front panel can be "earthed" under either switch S1 or S3 mounting washer. The completed unit showing layout of components inside the case is shown below. Where the mains leads are soldered to the output socket SK1 the solder joints and tags should be covered with plastic sleeving.



emitting diodes D5 and D8 require either mounting bushes or lens-clips. The bicolour l.e.d. can utilise a transparent lens-clip to good effect. You may wish to embellish the controls with rub-down lettering followed by a coat of spray-on protective lacquer as usual.

The interwiring is generally straightforward and is completed with general purpose hook-up wire. Six amp three-core mains flex is used for the mains input which connects straight to the p.c.b. You can, if you wish, for added safety wire an illuminated, double-pole, mains rocker or rotary switch between terminal block TB2 and the mains lead. The switch can be mounted on the front panel and will show when the unit is powered-up. The front and rear metal panels MUST be soundly Earthed as shown. A series of solder-tags is connected together with a countersunk mounting screw on the rear panel. The screws used for p.c.b. mounting must be nylon as they pass through the plastic case.

The mains output socket SK1 is a Euro-style snap-in type which is fitted into a suitable cutout on the rear panel. The mains inlet cable must be secured to prevent it from pulling out, and a cable gland or "P" clip can be used as normal.

TESTING

When all construction has been completed in accordance with the diagrams, check all interwiring etc. carefully, set the rotary switch to "2 Minutes" and then power up the unit. The bicolour l.e.d. D5 should glow red ("Reset" mode) and operating switch S1 to "Start" should change D5 to green and the relay should be heard to click in.

After the selected delay the relay will click out and the bi-colour l.e.d. D5 will revert to red. Finally, check that the "Reset" S1 and "Manual" S3 functions operate and the unit is then ready for use. The UV Light Unit is connected to the Timer with a miniature 3-pin plug to match SK1.

MAINS SUPPRESSION

The author's UV Light Unit contains two fluorescent tubes along with the usual control gear. It was occasionally found in practice that the timer would re-trigger when the light tubes were switched off when the timer timed-out, presumably caused by a switch-off "spike" on the supply.

The result is that the relay RLA is heard to click at the end of the timing period, but the timer re-starts as it is caused to re-commence timing for a further period.

This problem was entirely eliminated by adding a suitable R/C suppressor between the Light Unit and the Timer. A standard delta-capacitor type device was used which has a built-in inductor and bleeder resistor (Roxburgh suppressor type SDC051, rated 250V 5A).

In fact, since there was no room within the timer box to add the filter, a separate plug-in suppressor unit was built, which has the output wired to a miniature plug to mate with SK1: the unit has a 13A flush mounting socket into which the UV Light Unit is plugged. It is very simple therefore to plug the suppressor in-line.

Readers can determine whether or not any extra suppression is required with some simple usage tests, as it may not be necessary to go to the added expense of incorporating any spike suppressors, depending on the characteristics of the light unit used. □

EVERYDAY NEWS

BUGGING THE TRUCK

Satellite communications are getting more versatile. And growing: BT's big ground station at Goonhilly Downs in Cornwall is just one of a number. A terminal in London's Docklands now carries 41 TV channels to Europe.

The early analogue systems are giving way to more powerful digital ones. These can cater for the smaller user. The range of services already includes automatic telephones for commerical passenger aircraft. Under a new development contract BT will extend this Skyphone service to include fax, probably next year. Such developments are aided by the possibility of using small omnidirectional aerials compatible with airframe structures. Another likely development will be a global paging system.

Costs fallen

The concept of the *Inmarsat* marine communications facility, designed for commercial ship use, has now been extended to embrace smaller vessels such as yachts. The necessary aerials are a fraction of the original size and costs have fallen too. But why stop at aircraft and shipping? Land vehicles could also benefit from satcom links.

A promising type of customer is the trucking fleet operator. Satcoms based on modern digital satellites like *C-Sat* could provide affordable data links. Even a one-way (headquarters to driver) link could deliver money-saving changes of schedule to the driver. A two-way link could be revolutionary. By also fitting the truck with a receiver for the GPS global position-finding system its whereabouts could be monitored automatically at base, with an accuracy of 100 metres. BT is currently carrying out a survey of customers' needs.

In the USA a truck system has already performed a feat comparable with the arrest, in the earlier days of radio, of the murderer Dr. Crippen in an Atlantic liner as the result of a Morse message. A hijacked truck's progress was mapped. When it stopped in a remote area police pounced and arrested the robbers as they off-loaded the cargo.

Future hijackers may be smart enough to disable the satcom link but simply knowing where and when it happens could be a useful clue. Less exciting but profitable uses could be re-direction of the driver to alternative delivery points and early warnings of temperature rise in refrigerated cargoes.

Efficient use of *C-Sat* is ensured by a message store-and-forward system. When the satellite is busy messages queue up and are sent out at a steady rate. Delays are unlikely to exceed a few minutes while capacity is maximised. By using low data rates (600 bits/sec) the mobile aerial can be compact and omnidirectional.

The huge dishes at the BT ground stations don't seem to change much over the years. But the technology behind them does. The front end receiving amplifiers were once elaborate parametric or maser types which were cooled to very low temperatures (to reduce noise) by elaborate cryogenic refrigeration systems. Now they are simple GAs-f.e.t.s, equipped with compact Peltier coolers which reduce temperature to the required 80-100°K.

London Teleport reaching 20 million people in Europe.

Low Profile Transformer

A new range of encapsulated low profile mains transformers are now available from Cirkit. These high quality, p.c.b. mounting transformers are ideal for applications where space is at a premium, the 6VA size, for example, is only 44 x 52 x 22mm. Independent primary windings allow 120 or 240V 50/60Hz operation, together with independent secondaries which may be connected for series, parallel or centre tap operation, giving a wide choice of voltage/current combinations. Wound on twin double section bobbins to provide maximum isolation – 4kV – between windings and near toroidal characteristics.

Cirkit Distribution Ltd., Dept EE, Park Lane, Broxbourne, Hertfordshire EN10 7NQ. Tel. 0992 441306, Fax. 0992 464457.

SHARP APPLES

One of Japan's leading electronics companies, Sharp Corporation, has announced a long-term agreement with Apple Computer Inc. of America for the development, manufacture and distribution of the next generation personal information equipment.

Apple Computer, Inc. in the States is claimed to be the world leading computer manufacturer and, in January 1992, they advocated a prospect and development for "PDA (Personal Digital Assistant)" information devices of a new category which would bridge a gap between the current personal computers and consumers electronics.

Sharp is claimed to be leading the world in the area of development and production of individual/home information tools and plans development and exploitation of "the next-generation of products based on their 'Personal Information Tool' initiative which advocates considering communication among people and copossession of information going beyond the conventional personal idea and creating a new life culture." – Their words not ours!

FM BREAKTHROUGH

A new method of decoding narrow band f.m. signals has recently been announced by Ampsys Ltd., a small spin off company of Paisley College. This patented technique removes the spikes (or spurs) from the radio signal just as the link is breaking down and also provides inaudible squelching. These two effects, it is claimed, greatly reduce listener fatigue especially over sustained periods. Other advantages include a 25 per cent increase in usable range for any f.m. PMR and/or a reduction of fifty per cent transmitted power for the same reception range.

A further improvement is that co-channel interference is reduced and two f.m. channels on the same centre frequency can now be decoded without mutual destruction. The circuitry is currently under evaluation by a number of multinationals. The new decoder uses an amplitude locked loop in combination with a phase locked loop to achieve this breakthrough.

Speak Up

Three flight cased loudspeakers made by IBL are now available in the UK via B.K. Electronics. The full range are; 12" 100 Watts rms; 12" 200 Watts r.m.s. and 15" 200 Watts r.m.s. All models are fitted with wide dispersion horns and include grilles, factory-fitted to the die-cast aluminium loudspeaker chassis. These models are priced respectively at £159.00, £175.00 and £229.00 per pair, including V.A.T. Delivery, via a specialist carrier, is charged at £12.50. ***B.K. Electronics*** *are at Dept Ee, Units 1 and 5 Comet Way, Southend-On-sea, Essex. SS2 6TR. Telephone: 0702 527572 Facsimile: 0702 420243.*

NEW FACE OF C&G

City and Guild's *Information Technology (7261)* scheme, first launched in 1985, now boasts 55 modules in subjects ranging from Coding and Programming in 'C', Program Design Tehniques and Data Processing, through Microcomputer Business Applications, Computer-aided Graphics and Desktop Publishing, to Digital Electronics, Analogue Circuits and Fault Diagnosis and Microcomputer Systems Installation and Maintenance.

Many of the modules have been extensively revised and updated, and further development and revision work on other modules is continuing.

New diplomas and certificates, made up of particular groupings of *7261* modules, are now available as listed below. These groupings have TEED (the Employment Department's Training, Enterprise and Education Directorate) approval as VQs, and are accepted as being equivalent to NVQs at levels 1, 2 and 3.

Certificate, Diploma, Advanced Diploma in:

- Information Technology
- Wordprocessing
- Programming
- Business and Office Technology
- Data Processing and Information Systems.

C&G tell us that named diplomas and certificates in other subject areas will be considered in due course. Let us hope that the various electronics related subjects will be among them.

WEATHER EYE

A new range of weather monitors that enable everyone to keep an eye on prevailing conditions is now available from Davis Instruments. Shown below is the Weather Wizard II, it can measure inside and outside temperature, high and low temperature, wind direction, wind speed and wind chil and has a recording facility, alarms plus time and date. An optional extra is a rainfall monitor.

The basic unit costs £229.95 and a computer link is available plus various cables and adaptors for car/boat use etc. For further information contact ICS Electronics Ltd, Dept EE, Unit V, Rudford Industrial Estate, Ford, Arundel, West Sussex BN18 0BD. Tel 0903 731101. Fax 0903 731105.

Dry Cell Recharger

Our *Dry Cell Recharger* project back in the September '91 issue stirred up plenty of interest amongst readers and the national press. Quite a few readers have asked if such an item is available commercially and we are pleased to report that a unit is being pilot marketed by Coltronics Systems. Their Dry Cell Recharger will charge AA, C, D, and PP3 batteries. It will recharge Ni Cad, Zinc-Chloride and Alkaline cells. During one complete charge cycle of 96 hours the charger consumes approximately 1½p worth of electricity, so it is not expensive to run.

The act of charging any battery causes a chemical reaction inside the cell, restoring battery voltage and capacity, with excess energy being dissipated as heat. Overheating degrades battery electrolyte, and rechargeable types are designed to cope with this to a large extent, but dry cells are not.

Any attempt to charge dry cells with conventional battery chargers causes severe electrolyte degradation, eventually shorting out the cell completely and leading to a very rapid heat build up inside the cell. Consequently, dry cell manufacturers, quite rightly, put warnings on their products as such abuse can lead to the cell rupturing and electrolyte leakage.

The Coltronics charger avoids these problems, employing state-of-the-art electronics to carefully control and profile the charging current to eliminate heat build up and minimise electrolyte degradation.

We should say that this is a more sophisticated design than the simple unit we published and is available by mail order for an inclusive price of £39.95. This price includes adapters, which incorporate dedicated circuitry, for the four sizes of battery.

Coltronics Systems Ltd., are at Dept EE, 47 Hardwick Industrial Estate, Bury St. Edmunds, Suffolk, IP33 2QH. Tel. 0284 755600, Fax. 0284 753299.

NEW VIDEOS

ON ELECTRONICS

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

The first three videos available are:

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

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

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

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

To order see our Direct Book Service "Ordering Details" – the postage for tapes is the same as for our range of books and you can order tapes and books at the same time and pay only one lot of postage.

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

Constructional Project

ELECTRONIC CRICKET GAME

Steve Knight

Come rain or shine, you are sure of a perfect pitch with this enthralling game – No "Rain stopped play" signs here!

OVER the years there have been a great number of electronic games concocted for the hobbyist, including one or two cricket games. The author has felt that these latter efforts have not in some way brought out the real flavour of the game in the sense that the play does not take place on a real pitch, surrounded by players who get in the way of run-making and occasionally do their stuff by bowling the batsman out or sending him back to the pavilion by some other means.

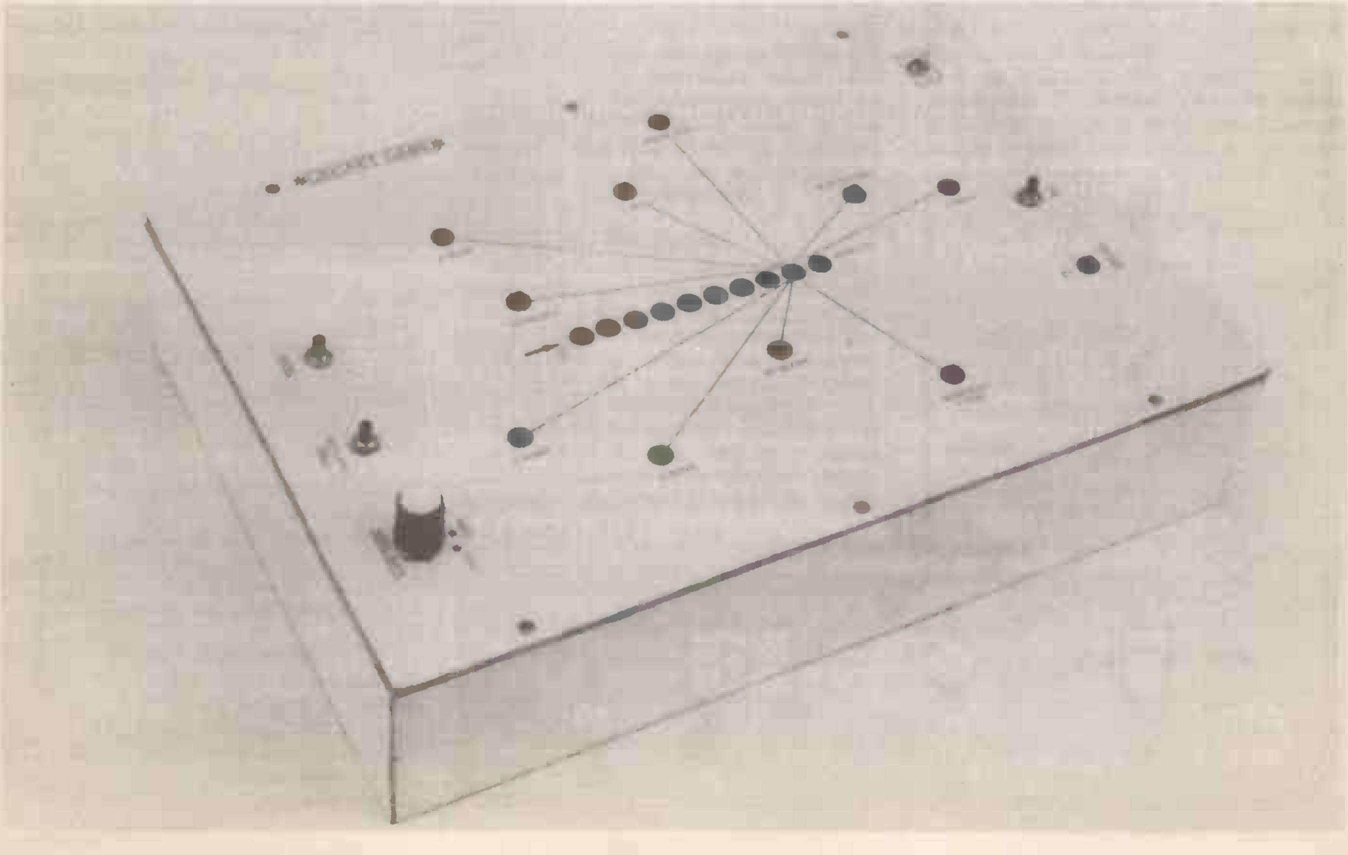
This present offering is a portable game, suitable for two or more players, and is guaranteed to be in action whatever the weather or the time of year. It is played on a "field" measuring 300mm by 230mm (12in. by 9in.), though this can be enlarged, or reduced, to suit your own particular liking.

The field has a pitch which shows the path from bowler to batsman, and there are, of course, a range of bowling speeds, "slow", "medium" and "fast", to test the batsman's reaction. If he happens to take his eye off the ball, he is very likely to be bowled, and if he hits the ball it may go to any point on the ground where the possibilities of making runs, being caught or surviving an appeal to the umpire are all on the cards. However, to the system and its construction, with more about playing the game later on.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Electronic Cricket Game is given in Fig. 1. All the components for this excepting the three control buttons S2, S3 and S4, the bowling rate switch S1 and the twenty-one l.e.d.s, are assembled on a single p.c.b. measuring 133mm by 100mm (5¼in. by 4in.). Current consumption is about 35mA using a 6V battery, though a simple power unit may be added so that the mains supply can be used.

Integrated circuit IC1 is a 7555 chip, which is a CMOS form of the familiar 555 timer (though a 555 may be used at the cost of an increased current consumption), operating as a clock generator. The pulse repetition frequency is selected by the three position switch S1 and this switch provides the three bowling rates (style).



MAKE A BIG HIT WITH YOUR FELLOW PLAYERS

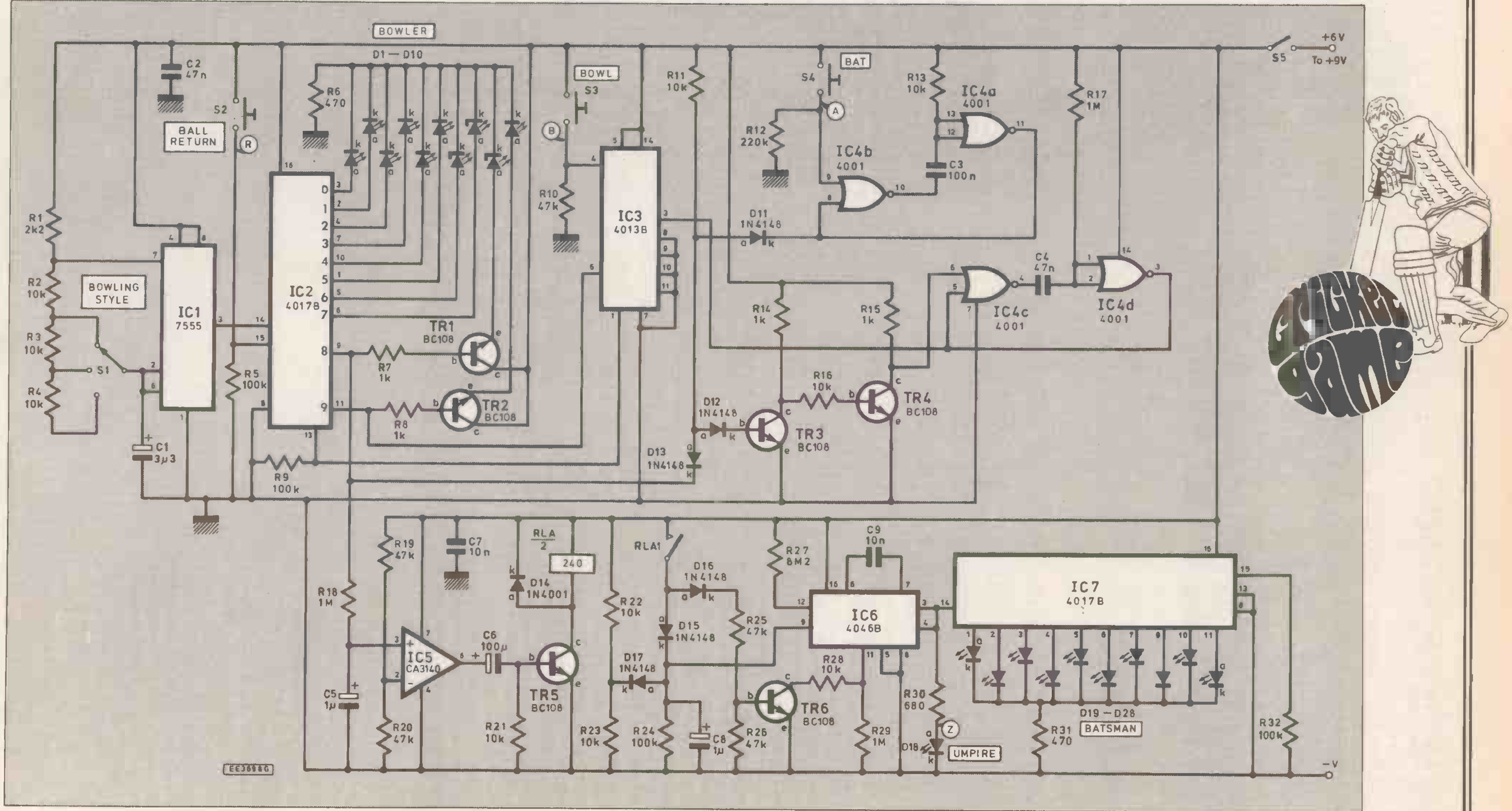


Fig. 1. Complete circuit diagram for the Electronic Cricket Game. All components except D1 to D10 and D18 to D28 inclusive, resistors R6 and R31 and switches S1 to S4 are mounted on the p.c.b. Circled letters refer to outgoing points.

BOWLING

With the component values specified, around switch S1, these rates are approximately 8, 12 and 20 pulses per second and these seem about right for the game as the author has played it. Individual constructors can easily adjust the rates to suit their own fancy.

The pulse output from the timer IC1 pin 3 is fed to pin 14 of IC2, a 4017B 5-stage decade "twisted-ring" counter, then to the output pins of IC2 which are connected to a sequence of l.e.d.s (D1 to D10 inclusive) which we might call the "Wicket Sequence". Only one of these ten l.e.d.s is on at a time, the position changing to the following l.e.d. with each successive input pulse. A running light is therefore obtained from l.e.d.s D1 to D10 at a frequency determined by the setting of switch S1.

If this running light is to emulate the movement of a ball along a pitch, from the bowler's end represented by D1 to the wicket represented by D10, the l.e.d.s must light in the correct order and necessarily stop on reaching D10, in spite of the fact that the clock pulses are continually applied. This is accomplished by allowing the run from D1 to D10 to occur while pin 13 of IC2, the clock enable pin, is held low by way of resistor R9. This pin is switched high by the Q output of a D-type flip-flop, IC3, when D10 lights and passes a high input to the reset, pin 6, of IC3.

The ball is reset to the bowler's end when necessary by the action of pushbutton switch S2; this switch is consequently labelled Ball Return. The ball then waits at the bowler's end of the pitch until the reset button switch, S3, on pin 4 of IC3 is operated; taking pin 4 high then resets the flip-flop and pin 13 of IC2 goes low, enabling the clock again to run the wicket sequence from D1 to D10. Push switch S3 is appropriately labelled Bowl.

BATTING

Now l.e.d. D10 is the "wicket" and if the "ball" reaches this, the batsman in action at the time, is deemed to have been bowled. To try to prevent this fate befalling him, "batsman" must halt the light sequence at l.e.d. D9 which is the batting position.

He can do this by pressing push switch S4 (the Batting switch) at the precise moment that the ball reaches the "bat" position (l.e.d. D9). Pressing S4 before or after this moment, or holding it down all the time, will have no effect on allowing the ball to pass the bat and scatter the stumps!

The circuit performs this function by feeding the output at the Bat position (pin 9 on IC2) to one of the inputs, via diode D13, of a discrete coincidence gate made up from transistors TR3 and TR4. The other input to this gate derives from pressing the Bat switch S4 which feeds a high signal via the anti-bounce switch comprising IC4a, IC4b and diode D11.

Only when these two inputs are *simultaneously* high does an output appear at the collector of TR4. This output is in turn fed to a monostable made up from NAND gates IC4c, IC4d which is turned on for a period of a few milliseconds determined by the values of resistor R17 and capacitor C4. The negative-going edge of this output enables IC3 by way of pin 3 and the Q output at pin 6 goes low, locking the Bat position in the wicket sequence.

Any failure to press the Bat switch while the Bat diode D9 is momentarily lit results in a low output from transistor TR4 and the ball moves on to the wicket l.e.d. where it stays to let the batsman know he has been bowled out. This high at pin 11 of IC2 sets IC3 and changes the Q output, so locking l.e.d. D10 firmly on "out".

Reset switch S2 returns the ball to the bowler's end when required as already explained and D10 is then extinguished. The following ball can then be played by pressing the Bowl switch S3. This completes the description of the upper part of the circuit diagram.

SCORING SEQUENCE

The "scoring" or run making part of the circuit includes IC5, IC6, and IC7 and transistors TR5 and TR6. Its function is to randomly send the ball (provided it has been correctly "hit" by the resident batsman) to some part of the field where it may (or may not) score runs or, unhappily, be caught by a fielder or perhaps a loud "Howzat?" may be asked of the umpire.

When the ball has been successfully played, l.e.d. D9 is lit and this high signal remains on. Let us look first of all at that part of the circuit associated with TR6, IC6 and IC7. In the same way as the wicket sequence of l.e.d.s was operated by IC2, so the scoring sequence of ten l.e.d.s (D19 to D28) is similarly controlled by IC7, another 4017B decade counter.

The ten l.e.d.s concerned here are placed at various positions in the "field", each representing a number of runs or a no-score, plus a couple which may lead to a catch or an appeal for lbw. Our object is to illuminate one of these l.e.d.s in a random manner directly a correct hit has been made by the batsman at the crease.

What is used is a run-down clock generator of the kind often found in electronic dice games. This clock runs the sequence of l.e.d.s at a very rapid rate for a fraction of a second and then halts the process very quickly to leave just one of the indicators illuminated. This l.e.d. then tells the batsman his score – or his fate!

The control of IC7 is made by IC6, a 4046B phase locked loop i.c. which houses a voltage controlled oscillator (VCO) as part of its circuitry. The frequency at which this oscillator works is controlled by the voltage on pin 9, the resistance between pin 11 and "ground (0V)" and the value of capacitor C9 wired between pin 6 and pin 7. A square wave output appears at pin 4. With the values used, the frequency is several kilohertz but is in no way critical for this present purpose.

When relay RLA contacts are closed (this is a relay operating as a switch – but more about this later), transistor TR6 is switched on by way of diode D16 and potential divider chain resistors R25, R26, and connects pin 11 of IC6 to ground through resistor R28. This causes the VCO to oscillate at a relatively high frequency so that an unpredictable number of pulses are fed to the input of IC7 all the time the relay contacts remain closed.

When the relay contacts open, transistor TR6 switches off and the oscillation then depends only upon the small charge remaining on capacitor C8 and the value of resistor R29. The presence of resistor R24 ensures that the osciallation falls very quickly to zero, hence the input to IC7 vanishes and only one of the scoring sequence of l.e.d.s remains on.

GOOD SHOT

Now if the output of pin 9 of IC2 is used directly to trigger the VCO, then the scoring sequence will be set into action even if pin 9 is passed in the normal wicket sequence. This is not wanted so there has to be a circuit arrangement which does not respond to a short pulse from the batting l.e.d. but acts only if this l.e.d. remains on for a longer period, that is, when the batsman has correctly intercepted the ball.

This action takes place by way of a simple op.amp comparator, IC5, and transistor TR5. The inverting input to IC5, pin 2, is held at half the supply voltage by the divider chain resistor R19, R20. The output from pin 9 of IC2 feeds to IC5 non-inverting input (pin 3) by way of resistor R18 and capacitor C5.

This integrating combination has a long time-constant and for a momentary pulse output from IC2 does not allow the voltage across capacitor C5 to rise much above ground. The voltage on pin 3 of IC5 stays. therefore, below that on pin 2 and the output at pin 6 remains low.

For a sustained output from IC2 however, capacitor C5 is enabled to charge up to a level exceeding that on pin 2 of the op.amp and the output switches high, so

The "Pitch" slid back to reveal the battery clamped in one corner of the case

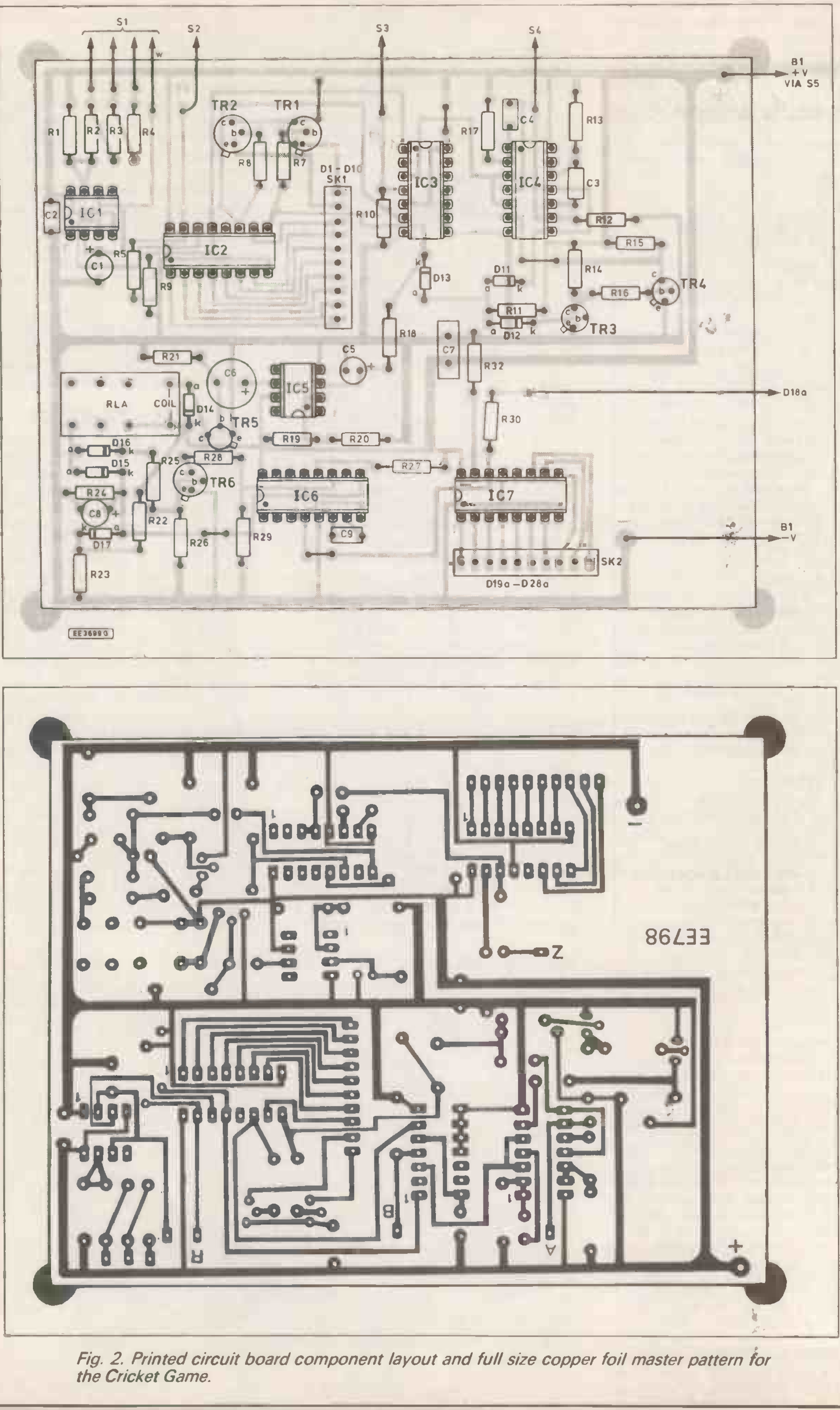
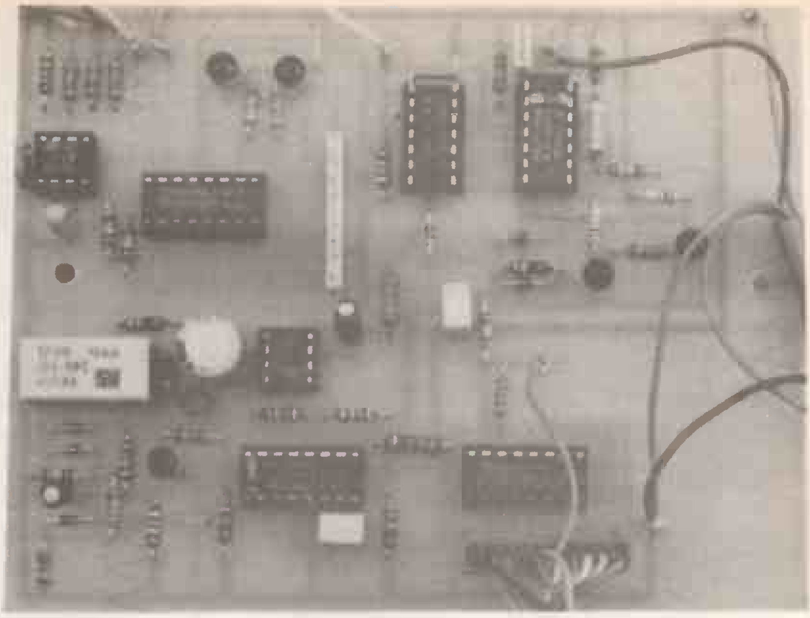


Fig. 2. Printed circuit board component layout and full size copper foil master pattern for the Cricket Game.

(Right) Completed prototype printed circuit board. The transistors here have been replaced with BC108 types.

(Bottom right) Pitch layout on the completed board.



COMPONENTS

Resistors

R1	2k2
R2, R3, R4, R11, R13, R16, R21, R22, R23, R28	10k (10 off)
R5, R9, R24, R32	100k (4 off)
R6, R31	470 (2 off)
R10, R19, R20, R25, R26	47k (5 off)
R12	220k
R7, R8, R14, R15	1k (4 off)
R17, R18, R29	1M (3 off)
R27	8M2
R30	680

Capacitors

C1	3µ3 tantalum bead, 35V
C2, C4	47n min. polycarbonate or poly layer (2 off)
C3	100n min. polycarbonate or poly layer
C5, C8	1µ min. radial elect. (2 off)
C6	100µ radial elect., 35V
C7, C9	10n min. polycarbonate (2 off)

Semiconductors

D1-D10, D18-D28	5mm high efficiency l.e.d.s (8 yellow, 5 red, 8 green)
D11, D12, D13, D15, D16, D17	1N4148 signal diode (6 off)
D14	1N4001 1A 50V rect. diode
TR1-TR4, TR5, TR6	BC108 *npn* transistor (6 off)
IC1	ICM7555 CMOS timer or NE555 timer
IC2, IC7	4017B decade timer (2 off)
IC3	4013B dual D-type flip-flop
IC4	4001 quad 2-input NOR gate
IC5	CA3140 MOSFET op.amp
IC6	4046B phased locked loop

Switches

S1	4-pole 3-way min. rotary, Lorlin
S2, S3, S4	Miniature pushbutton, normally open
S5	Miniature s.p. on-off

Miscellaneous

RLA	6V 240 ohm coil d.i.l. relay, with d.p.c.o. contacts (only one set used).

Printed circuit board available from *EE PCB Service*, code EE798; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (3 off); 5mm l.e.d. mounting clips (21 off); 14-way tag strip; two pieces of hardboard or plywood (3mm) to required size; two 10-way header pin strips and connectors (if used – see text); 13mm (½in.) brass gimp pins (24 off – see text); connecting wire; solder etc.

Approx cost guidance only **£25**

turning transitor TR5 on and operating the relay which closes RLA1 contacts. This closure is only momentary because of the differentiating action of the coupling components capacitor C6 and resistor R21, and the rest of the circuit is then activated in the way already explained.

The use of relay at this point may seem a bit odd as the switching could be electronically activated, but the use of a mechanical relay introduces a small but desirable time variation (as well as possible bounce!) in the duration of the relays closure and so helps in enhancing the random operation of IC6 during the short time that the VCO is producing its high frequency output.

Only the function of diode D18 remains to be mentioned. This l.e.d. is the game's "Umpire" and gives a verdict for or against the batsman.

The output of IC6 may, when the VCO oscillations cease, settle randomly in either the "high" or "low" state. In the former case D18 will be lit and in the latter case it will be extinguished. If the D18 l.e.d. is lit, the appeal is allowed. We will return to this point when the actual method of play is discussed.

CONSTRUCTION

There are essentially three parts in the construction of the game: first, the assembly of the printed circuit board (p.c.b.) which is quite straightforward; secondly, the assembly of the wicket and fielding l.e.d.s on to the board which can be a piece of thin plywood or hardboard sheet, an assembly which is a bit fiddly but not insurmountable; thirdly, the fabrication of a very simple box which holds the finished job in a nice compact manner.

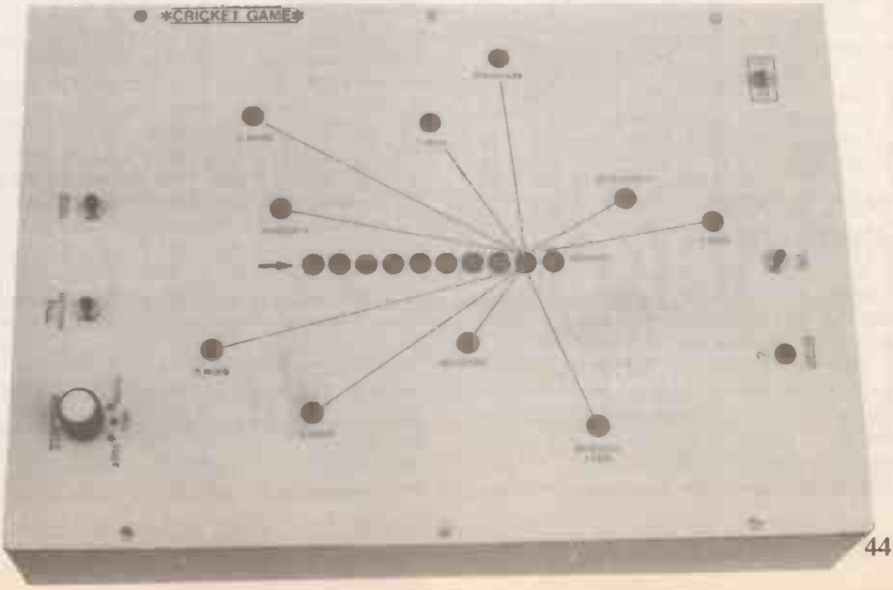
The component layout and full size copper foil pattern of the printed circuit board is shown in Fig. 2. This board is available from the *EE PCB Service*, code EE798.

There should be no problems in assembling this board provided all the usual precautions about soldering and the orientation of polarized components are observed. The integrated circuits are best mounted in low-profile holders, otherwise there is little to comment on.

On the prototype the l.e.d. outputs from IC2 and IC7 terminate on 10-way header strips; this is done purely for convenience in the later interconnections stage and you can, if you wish, simply connect ordinary outgoing wires or ribbon cable at these points for later connection to the various l.e.d.s. Different coloured wires are essential to avoid confusion. Solder pins are fitted to the other output points, that is, the various switch connections and the output to the "Umpire" l.e.d. D18.

PITCH

Turning now to the actual pitch, the layout of the prototype is shown in Fig. 3. This was made on a piece of 3mm hardboard measuring 300mm by 230mm (12in. by 9in.) although you can adjust these measurements to suit yourself; nothing else is affected by this.



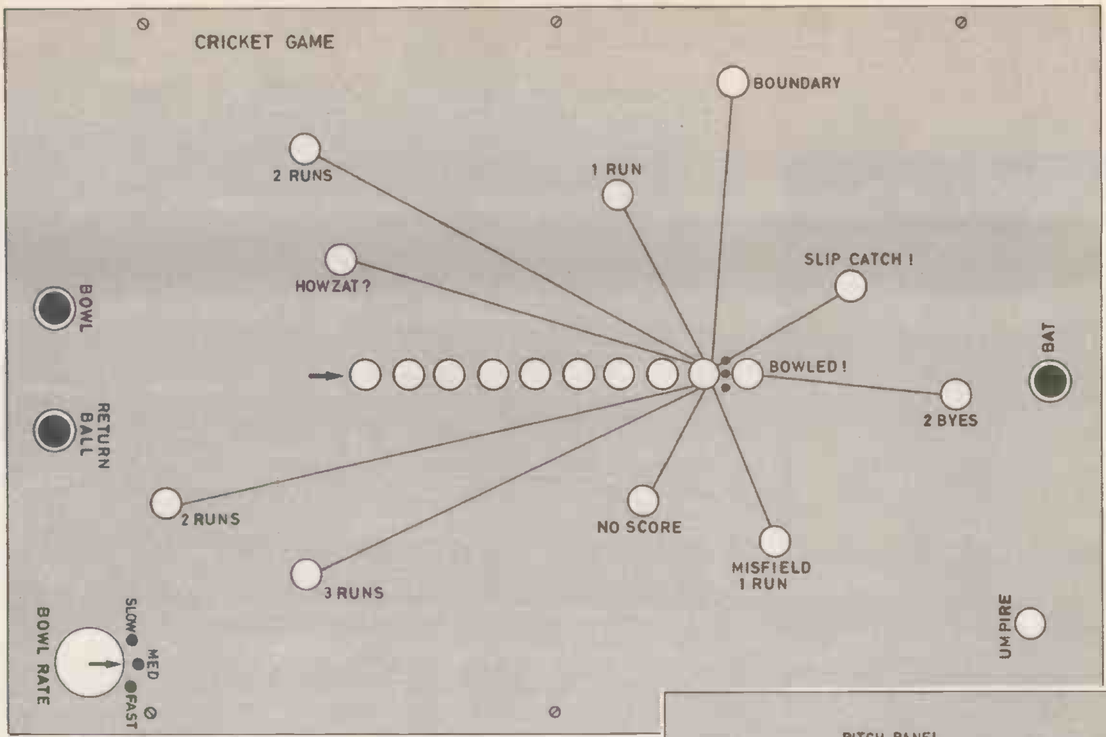


Fig. 3. Suggested field layout. The "wicket" l.e.d.s are spaced 10mm apart.

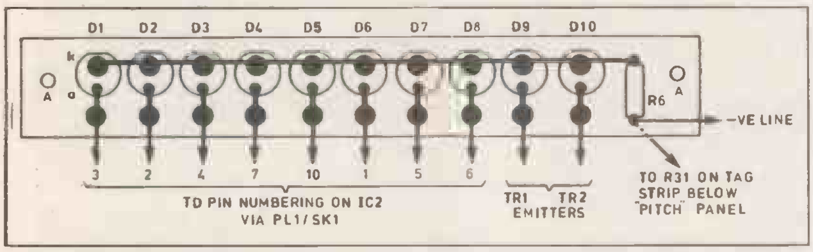


Fig. 4. Using a small board to wire the wicket l.e.d.s. This board could be made from stripboard.

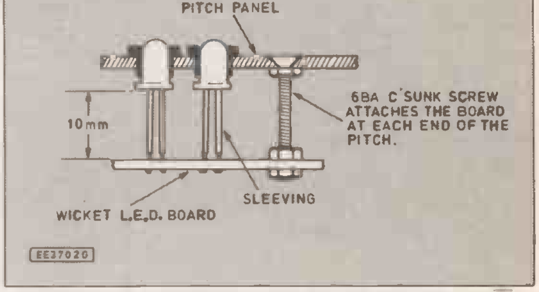


Fig. 5. How the l.e.d.s are mounted on the subsidiary "wicket" board and fixed to the pitch panel.

The l.e.d. holes are all drilled 6mm (¼in.) diameter as are the specified pushbutton switch holes. The bowling rate switch S1 needs a 9mm (3/8in.) hole and there are six fixing holes along the longer edges to take ordinary wood screws when the "ground" is later attached to a simple case. Two 6BA countersunk clearance holes are also required at each end of the wicket to support a small auxiliary p.c.b. which carries the ten l.e.d.s associated with the wicket sequence.

Additionally, two pins are driven into the hardboard on each side of the "fielders" l.e.d.s, but we return to these points in a short while. In the layout of the fielding positions you can, of course, do your own thing; a piece of 3mm ply, may be substituted for the hardboard and the various fielding points (and the scores or penalties associated with them) can be moved around to please yourself. The central "pitch" should not, however, be altered in any way.

WICKET SEQUENCE

The board which holds the wicket sequence l.e.d.s is shown in Fig. 4. The l.e.d. spacing is 10mm and the panel drilling must, of course, be identical with this.

The ten l.e.d.s are fitted to the board as Fig.5 illustrates, making sure that the cathodes (k), usually indicated by a flat on the l.e.d. casing, go to the common wire which connects to one side of resistor R6. The other side of R6 has a wire attached which should be taken to the common (–V) foil track on the main board.

The use of sleeving on the l.e.d. wires ensures that they are all at the same *height* above the board: Also make sure that they are in line when viewed along the *length* of the sequence.

Preferably use yellow l.e.d.s for pitch positions D1 to D8, with a green for the batsman's position (D9) and red for the wicket (D10). Fig. 5 also shows how the board is fitted to the panel – but don't do this just yet.

FIELDER'S SEQUENCE

Wiring up the fielder's l.e.d.s is a bit fiddly because these have to be hard wired and it is necessary to provide some sort of anchorage at each of the indicator positions. The method used (and you may well think of a better one!) is to drive two brass gimp or panel pins into the panel on each side of each of the l.e.d.s such that the l.e.d. wires can be looped around (no tightness here) and be soldered to the pins rather as Fig. 6 shows. *Don't* use steel pins as there is then a possible soldering problem without acid fluxes, though brassed or coppered style pins can be employed.

A simple wiring harness can then be made up to bring the eleven anode (a) points (including D18 here) and the common cathode (k) wire to a tag strip, twelve connections in all. Wires from this tag strip then go down to the main p.c.b. The photograph shows the completed underside of the pitch panel.

COMPLETING THE ASSEMBLY

Before mounting and wiring up the panel l.e.d.s, a bit of preparation is needed if the finished job is going to look neat and presentable. The two 6BA screws for the "wicket" l.e.d.s and the gimp pins for the anchorage of the others must be fitted and the surface blemishes left by these levelled off with a filler and smoothed with fine sandpaper, before anything else is done.

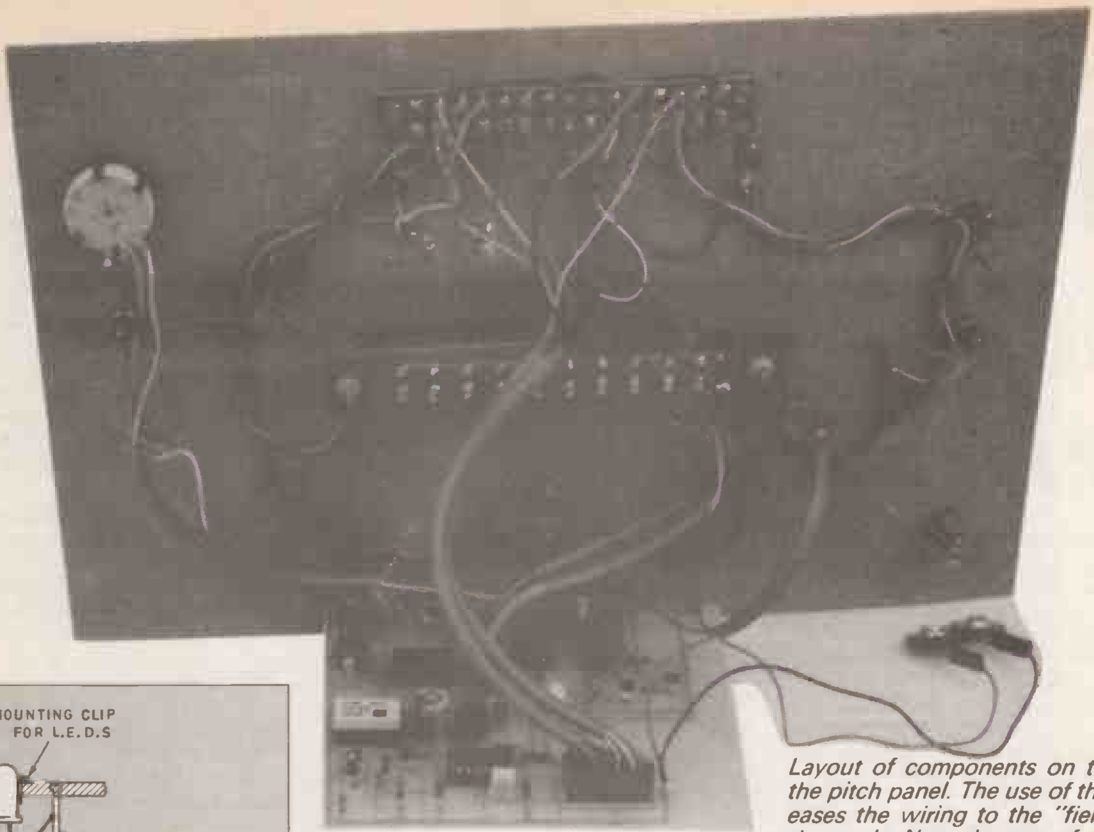
A coat to paint is now required to simulate the field. A light green is best and matt emulsion or undercoat, preferably rolled on, is ideal. Alternately, a piece of light green paper might be glued over the hardboard.

Whatever you use, all the legends should next be added using rub-down lettering, after which the l.e.d.s and the switches can be mounted. Use green l.e.d.s for the scoring positions and red for the "out" positions and Howzat?

To tidy up the l.e.d. holes, use panel bushes which fit into the 6mm (¼in.) holes already drilled and the l.e.d.s themselves then snap into these.

To make up a box, get a piece of hardboard the same size as the panel for the box bottom. Screw to this as the sides of the box four pieces of wood of thickness about 9mm (3/8in.) to give a depth of about 51mm (2in.).

The main p.c.b. along with a suitable



Layout of components on the rear of the pitch panel. The use of the tag strip eases the wiring to the "fielders" and the p.c.b. Note the use of the header connections on the p.c.b.

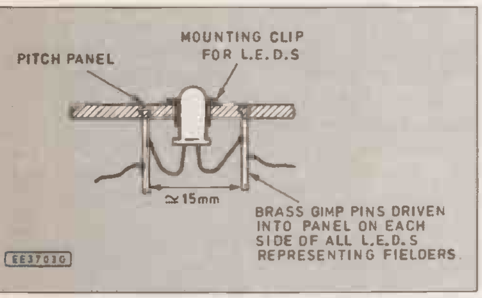


Fig. 6. How the "fielders" are mounted and wired on the pitch panel.

battery (or a simple mains unit if you wish) are fixed to the base, and the interconnections between the field panel and the p.c.b. can then be made. Prop the panel against one side of the box to do this; don't make the leads so short that there is a strain on any connection. You want to be able at any time to get into the box, perhaps to change the battery, and you want to be able to flip the lid (the field) back as though it was on a hinge in order to do this.

Apart from the "Howzat/Umpire" l.e.d. (D18) which connects to resistor R30 on the board, the other fielding l.e.d. anodes can go to any of the output pins of IC7, the whole sequence being random anyway, unlike the wicket sequence which must be wired to the outputs of IC2 in the correct order. In this it is essential to note that the diode numbers (apart from D2 and pin 2) do NOT coincide with the pin numbers on IC2.

The correct sequence is shown in Fig. 1 and *must* be followed, i.e. D1 to pin 3; D2 to pin 2; D3 to pin 4, and so on to D9 to emitter (e) of TR1; D10 to emitter of TR2. The common lead returns through resistor R6 to the negative line. Unless you get this order right, you are going to bowl some amazing googlies!

PLAYING THE GAME

The bowler's end of the field has three control points: two pusbutton switches marked Bowl and Return Ball respectively, and the Bowling Rate selector switch. At the batsman's end there is one pushbutton switch marked Bat and the Umpire l.e.d.

When the game is initially switched on a number of the field l.e.d.s may light up, but by pressing the Return Ball button the bowler positions the ball at his own end of the pitch. At this point one of the field l.e.d.s will be lit but this is ignored. The game is now ready to play.

The bowler starts things off by pressing the Bowl button; the "ball" will then move down the pitch at a rate selected by the Bowling rate switch. When the ball reaches the batsman's position (l.e.d. D9) the batsman must simultaneously press the Bat button to halt the ball on this l.e.d.; this constitutes a hit and the field display will then indicate his score or his penalty.

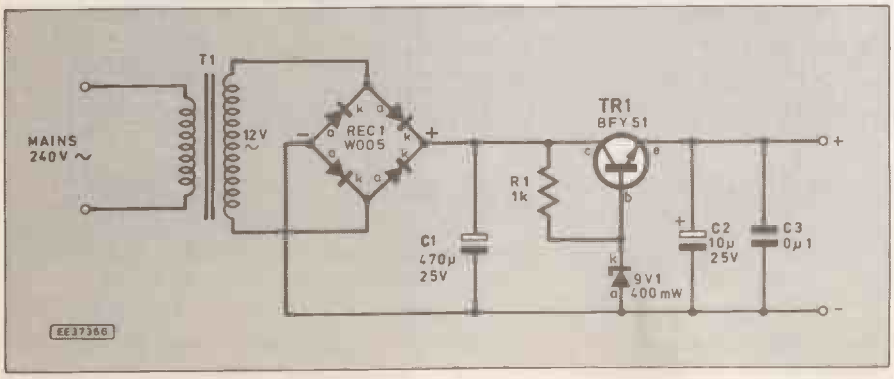
If the ball is missed by the batsman, the wicket will be hit and the tenth l.e.d. will light. The batsman is then dismissed. The bowler returns the ball to his own end and prepares for the next delivery.

The fielding scores are self explanatory but if the Howzat l.e.d. lights, reference must be made to the "Umpire" which is the l.e.d. next to the batsman's button. If this l.e.d. is lit, the batsman is adjudged out lbw; if the l.e.d. is not lit, the verdict is not out.

It is suggested (though you can make your own rules) that each "side" (even if there are only two players) play through ten wickets each (or to an agreed score), recording each score along with any extras and how out. The bowling rate for each batsman should start off at Slow for the first "over" of six balls, then go to Medium for the next over, and Fast for the third over; this sequence then repeating if the same batsman is still at the crease. For the enthusiast, a second innings might be played to determine the outcome, with a side following on if it fails to come within an agreed number of runs of its opponents score.

Clearly, any reasonable number of players can have a go at this game, taking it in turns to bat and bowl. An individual scorer might be useful where an odd number of people are concerned.

Fig. 7. Suggested mains power supply. The transistor should have a clip-on heatsink.



SUPPLIES

A brief note about power supplies might not be out of place here. The unit will run quite satisfactorily on a 6V battery supply, though this should be made up of four U2 size cells, in preference to the small single 6V batteries. You may, if you wish, use a 9V supply, but this does increase the current consumption and is not so economic.

A simple mains unit is the best bet if you are going too play the game a lot, or indoors, and a suitable circuit is shown in Fig. 7. This can be easily assembled on a suitable board or piece of stripboard and will provide an output of about 8V.

Good batting! □

ACTUALLY DOING IT!

by Robert Penfold

SOME time ago the topic of mains power supplies was covered in an *Actually Doing It* article, but it is worthwhile covering broadly the same ground again here. It is a subject which seems to provide a small but steady flow of readers' letters.

Mains transformers seem to be the main cause of problems, and I suppose that when building power supplies you do sometimes have to connect the transformer in an apparently illogical manner. However, if you look at things in the right way it is all quite logical and straightforward.

DANGERS

Before proceeding further the usual warnings about working with the mains supply have to be given. For anyone building their first few projects the best advice is to avoid any mains powered project. Choose battery powered projects as these enable you to make mistakes without any drastic consequences. If you make an error in a project powered from a PP3 size 9 volt battery, about the worst that will happen is that one or two semiconductors will be destroyed. It is quite possible that no damage at all will result, and there is probably no risk at all of any personal injury.

If you make a mistake when building a mains powered project there is almost certain to be some damage, even if it is only something minor such as a blown fuse and a damaged switch. A serious error could easily result in every semiconductor in the project being destroyed, possibly in spectacular fashion. At worst you would get a severe electric shock, *which could prove fatal.*

When dealing with the mains supply you should proceed with the same care you would exercise if your life depended on it, because it does!

Here are some do's and don'ts:

Never work on any project that is connected to the mains supply. It is not enough to switch off at the mains supply or at the project's on/off switch. The device *must be unplugged* from the mains socket.

If you are not sure about the right way to connect something in a mains power supply circuit, do not resort to trial and error. This could cause expensive damage and could be extremely dangerous.

Youngsters should not construct mains powered projects unless they are supervised at all times by a suitably experienced adult.

Mains powered projects should always be housed in cases that have a screw fitting lid. Do not use types having clip-on lids, slide-in panels, etc. It should not be possible to get at the dangerous mains wiring without using a screwdriver or other tool.

Any exposed metal must be reliably earthed to the mains Earth lead. The normal way of ensuring this is to use a case of all-metal construction which is connected to the mains earth lead. Any screws etc. fitted on the case will then be earthed via the case.

Even if you normally do not bother too much about checking the wiring before trying out a new project, always at least *double-check the mains wiring on any mains powered projects.*

TRANSFORMATIONS

A mains power supply should always include a mains transformer. With modern circuits that run on low voltages the mains transformer provides two functions. One of these is simply to reduce the 240 volt mains supply down to the much lower voltage required by the circuit.

The second, and no less important function, is to provide safety isolation. There is no direct connection between the mains input to the primary winding and the low voltage output from the secondary winding of a mains transformer. This ensures that anyone touching any wiring on the output side of the mains transformer will not be in contact with the mains wiring, and that (providing the secondary is a low voltage winding) they cannot receive a severe electric shock. In fact, provided the secondary potential is only around 30 volts or less, you cannot get a noticeable shock from the secondary circuitry.

Of course, the wiring on the primary side of the transformer connects to the mains supply, and is potentially lethal. Also any transformer with a high voltage secondary winding (of the type used to power most valve circuits) is potentially lethal. Due care must be taken to ensure that none of the primary wiring comes into electrical contact with the wiring on the secondary side of the transformer.

SECONDARY EDUCATION

Many modern mains transformers are designed to be versatile, but this versatility can (and does) cause a certain amount of confusion. It is now quite common for mains transformers to have two secondary windings that are identical. These can be connected in three basic ways.

Suppose that a transformer has two 6 volt 250 milliamp secondary windings. These could actually be used as two separate windings driving separate supply circuits, but it would be very unusual for a transformer to be used in this way.

SERIES

A more likely method of connection is with the two secondary windings connected in series, as shown in Fig.1(a). This effectively adds the two 6 volt windings to give a combined output potential of 12 volts. The current rating of the combined secondaries is the same as when they are used separately, 250 milliamps in this example.

Note that this method of series connection will not work properly if you link two 0 volt or two 6 volt terminals. This will wire the windings in series, but their phasing will be such that the output of one winding will cancel out the output from the other. The result is no output whatever.

The second method of connection is much the same as the series one just described, but the interconnection between the two secondaries is utilized, as shown in Fig.1(b). This effectively gives a 6-0-6 volt transformer having a current rating of 250 milliamps. A transformer of this type is needed with a power supply that has push-pull full-wave rectification (the type that uses only two rectifiers).

It seems that this is the method of connection that causes the most confusion, and the correct way of connecting the secondary windings is not really the obvious one. The obvious way of handling things is to connect together the two 0 volt terminals in order to give the central 0 volt output. The two 6 volt terminals would then provide the two 6 volt outputs.

Although this may seem to be the

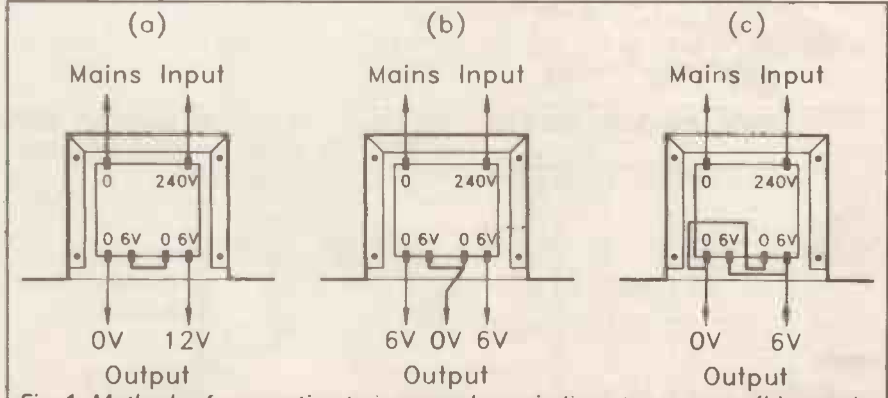


Fig. 1. Methods of connecting twin secondary windings (a) in series (b) pseudo-centre tap (c) parallel.

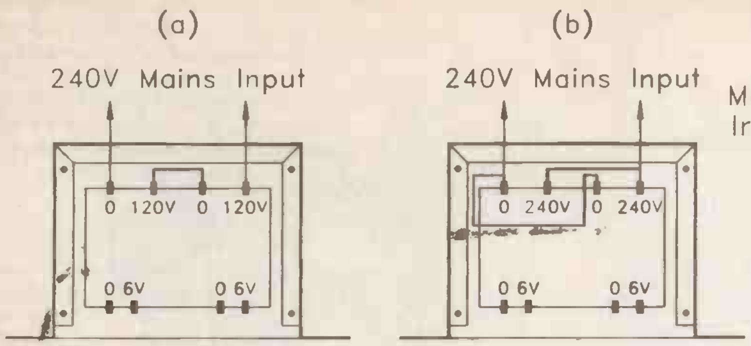


Fig. 2. (left). (a) Wiring two 120V primaries in series for 240V mains operation. (b) Twin 240V primaries are used in parallel.

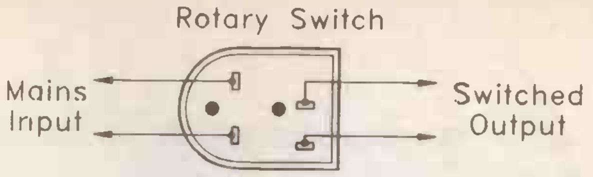


Fig. 3. The correct connections for a rotary mains switch.

logical method of connection, it will definitely not provide the desired result. The two 6 volt outputs will be in-phase, whereas it is out-of-phase signals that are required.

This would effectively reduce the power supply to a simple half wave rectified type. The practical result would be substantially reduced maximum output current, and a lot of ripple on the d.c. output. This would almost certainly prevent the main circuit from working properly. The connection method shown here gives the correct anti-phase outputs, and a suitable alternative to a true centre tapped secondary winding.

PARALLEL

The third method is to connect the two windings in parallel, as shown in Fig.1(c). It has to be stressed that this method of connection is only acceptable if the mains transformer is a type which has accurately matched secondary windings which are intended for use in this way. If the retailers catalogue or other literature does not specifically state that a mains transformer is suitable for this parallel operation, it should be assumed that it is unsuitable for use in this manner.

With parallel operation the output voltage is equal to the voltage rating of one winding, or 6 volts in this case. However, the current rating is the sum of the individual current ratings, or 500 milliamps in this case.

Having twin and matched secondary windings clearly makes a mains transformer very versatile, but it also means that you have to be rather more careful when wiring it up. Make sure that you do not get a link-wire in the wrong place so that it short circuits a secondary winding. This could easily result in the transformer being ruined. Also be careful not to use series connection where parallel connection is required. This would give double the required output voltage which could easily cause damage to the power supply components and beyond. Other errors are unlikely to cause any damage – the supply will simply not function correctly.

PRIMARY EDUCATION

Provided a mains transformer has a single primary winding there should be no difficulty in wiring up this section of the supply. Unfortunately, a substantial proportion of modern mains transformers have either twin primary windings, or a tapped winding. The latter is the easier to deal with. If the transformer is suitable for operation on the 240 volt UK mains supply it should have terminals marked "0V" and "240V", and these are the two terminals to which the mains input should be connected. The other tags are left unconnected.

Some mains transformers seem to have twin 120 volt windings, and this is presumably to permit them to operate on continental 120 volt supplies or the 240 volt UK supply. For operation with the latter the two windings *must* be wired in series (Fig.2(a)).

From time to time I have encountered mains transformers which have twin 240 volt primary windings. I have never been able to ascertain just why such an arrangement should exist, since there would seem to be no 480 volt mains supplies. Series connection of the windings would therefore seem to be something that would never be used in practice. The only suggestion that I can offer is that this system enables mains transformers of various ratings to be put together from a limited number of standard sub-assemblies. This would presumably help to keep down production costs.

Anyway, if you should encounter one of these transformers, the primary windings are connected in parallel, as shown in Fig.2(b). Note that the same basic method of connection is used for transformers which have twin 120 volt primary windings when they are used with continental 120 volt mains supplies.

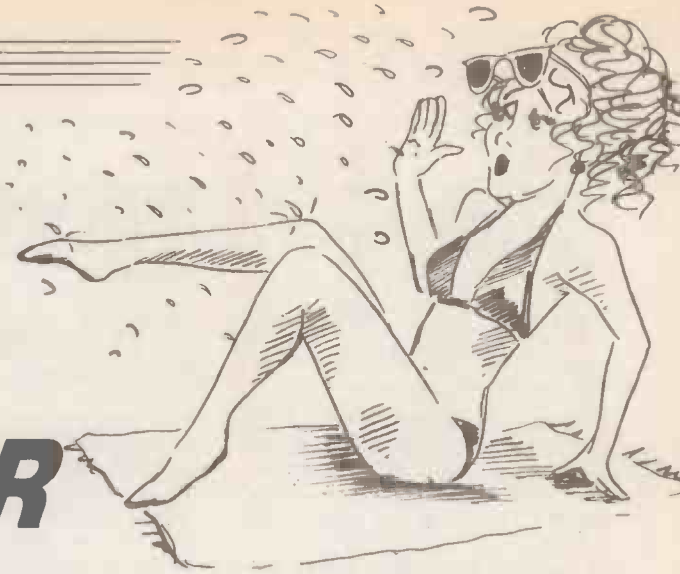
ROTARY SWITCH

It is essential to get the on/off switch of a mains power supply connected correctly. If you should get it wrong, you will probably find that switching on has the effect of short circuiting the mains supply through the on/off switch! The fuse in the mains plug (which should be a 2 or 3 amp type for most projects) should "blow" and prevent any serious problems. The on/off switch might not survive the experience though.

With most switches the correct method of connection is fairly obvious, but if in doubt it is always a good idea to check any switch with a continuity tester before making any connections to it. A few checks will soon show which tags (if any) connect together at each position of the switch.

The switches I find the most awkward to deal with are the mains rotary on/off switches that are supplied by several of the main electronic component retailers. Checks with a continuity tester have invariably revealed that I was about to connect the switch incorrectly. Fig.3 shows the correct method of connection for this type of switch.

Constructional Project



GARDEN HOSEPIPE CONTROLLER

T. R. de VAUX-BALBIRNIE

No need for your prize plants or garden produce to feel neglected while you take your annual holiday.

THIS mains-pressure hosepipe controller is designed to keep your garden watered while you are away from home. This does it by operating a sprinkler for a preset time each day. A control on the front panel adjusts the operating time between limits of less than one second and four minutes approximately.

However, these timings could be easily altered if required. It would also be a simple matter to alter the "daily" timing to a period of more or less than one day. A reset button may be used to cancel operation and a further pushbutton switch used to trigger the unit at any time.

Readers should realize that this device does not provide precise "daily" timings and that these will drift with ambient temperature. Under reasonably constant temperature conditions, the prototype unit provided a time period of 24 hours within two to three minutes.

When the temperature changes, the timing period will vary by up to two minutes per degree approximately. Readers requiring precision timings, perhaps for other purposes, should use an alternative circuit. Further details about the effect of temperature on time periods are given towards the end of the article.

WATER SUPPLY

The device which controls the supply of water to the sprinkler is a 12V d.c. solenoid valve. The specified valve will operate at mains water pressure and has standard ½in. b.s.p. threaded male ends.

Connectors may be obtained from a local plumber's merchant or DIY store to enable it to be fitted to a standard threaded water tap at one end and the hosepipe itself on the other. It is essential to use proper secure fittings especially if the unit is to be left unattended.

Although for safety the main unit must be situated indoors, the hosepipe and solenoid valve will probably be outside but so sited that catastrophic failure of the circuit or a sticking solenoid valve would not cause problems with flooding. The wire connecting the main unit to the solenoid valve may be of a light-duty twin type of any reasonable length.

The Garden Hosepipe Controller is mains-powered so needs a supply socket available nearby. *It must NOT be connected permanently to the mains.* Under standby conditions, the circuit requires 20mA approximately and while operating the solenoid valve, 200mA. Thus, the cost of powering the circuit is negligible.

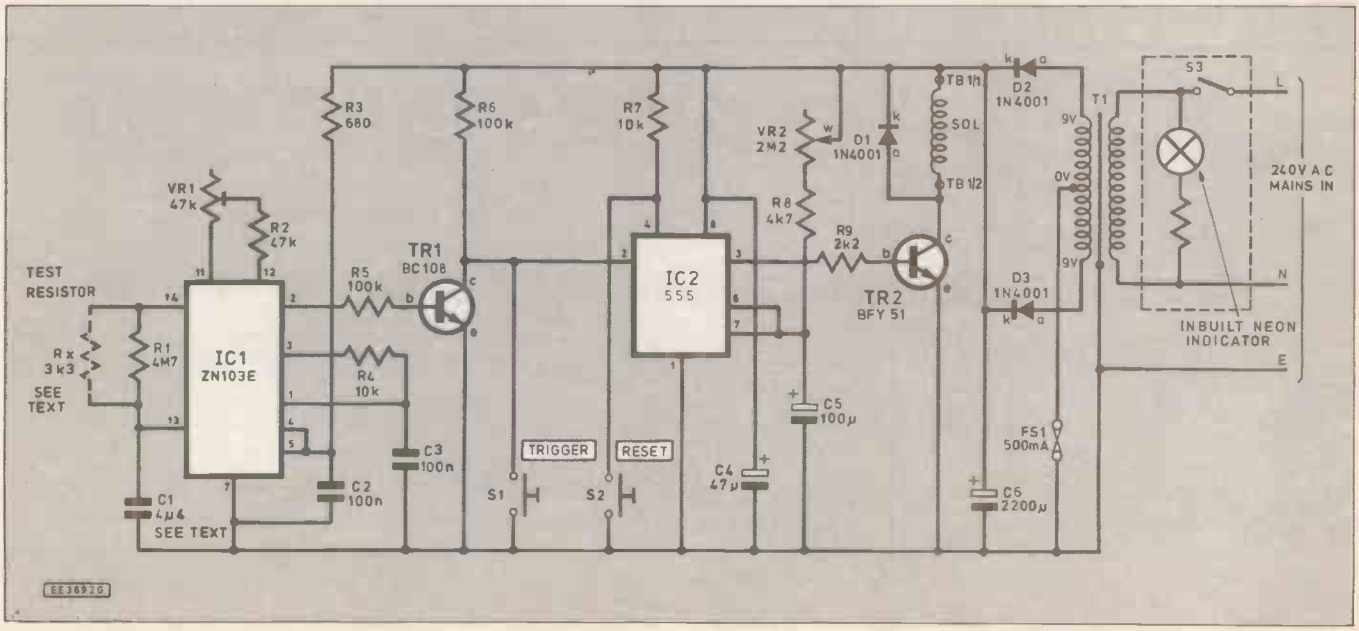
CIRCUIT DESCRIPTION

The full circuit diagram for the Garden Hosepipe Controller is shown in Fig. 1. IC1 is a precision timer integrated circuit. This is a sophisticated device which operates in the following way.

With a power supply established, timing capacitor C1 charges through fixed resistor R1. The time (nominally 21 seconds) taken for the voltage to reach a predetermined level is recorded by an on-chip 12-stage binary counter. C1 now discharges and repeats the cycle.

When 4095 such charge/discharge cycles have been counted the two outputs, pin 2

Fig. 1. Complete circuit diagram for the Garden Hosepipe Controller.



and pin 3, change state – pin 2 going from low to high and pin 3 from high to low. With the values of C1 and R1 specified, the time taken to do this is nominally 24 hours. Preset potentiometer VR1, in conjunction with fixed resistor R2 connected between IC1 pins 11 and 12, provide an adjustment which will be used to trim the timing period for best accuracy at the end of construction.

When IC1 pin 2 goes high at the end of the timing period, current flows into transistor TR1 base (b) through current limiting resistor, R5. This turns TR1 on and its collector (c) goes low. This low state is transferred to pin 2 (trigger input) of the 555 timer IC2.

TIMING

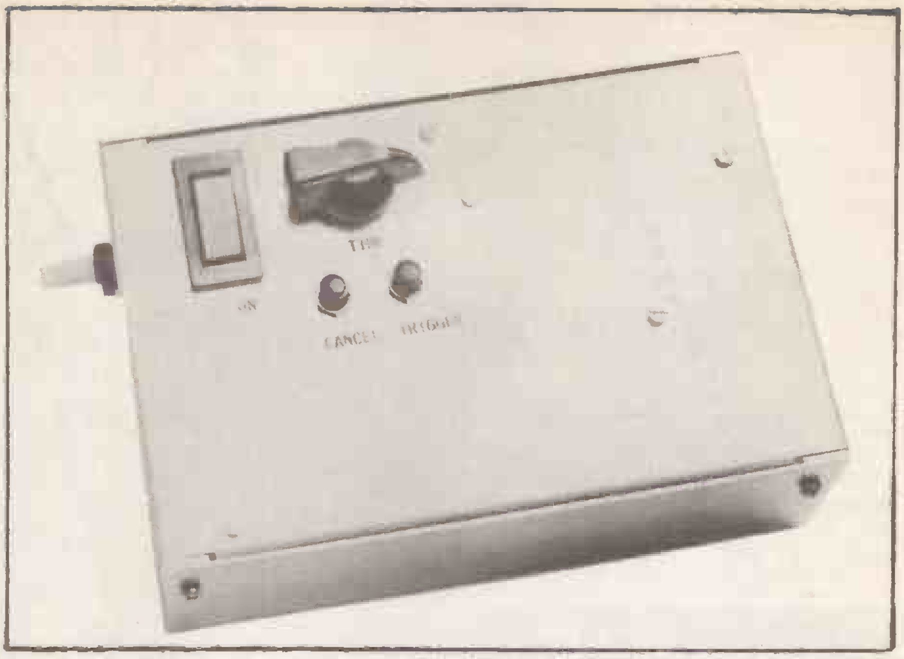
The Timer IC2 is connected as a monostable – that is, once triggered in this way the output, pin 3, goes high for a certain time then reverts to low. Between operations, IC1 pin 2 is low and transistor TR1 is off. IC2 pin 2 is then held high through resistor R6 and this prevents triggering.

The time period of IC2, during which the solenoid valve will be operating, depends on the adjustment of potentiometer VR2 in conjunction with fixed resistor R8 and capacitor C5. With VR2 providing minimum resistance the time period is less than one second but at maximum resistance, it is four minutes approximately.

Normally IC2 reset input, pin 4, is kept high through resistor R7 and this prevents resetting. However, pushbutton switch S2 (Reset) may be used to make it low and this cancels the operation immediately.

A further push-to-make switch, S1 (Trigger), may be used to initiate IC2 timing and operate the solenoid valve at any time. This it does by making IC2 trigger input, pin 2, low.

Note that the monostable timing capacitor, C5, is of the electrolytic type. This will not provide great accuracy but is thought to be quite satisfactory for the present purpose. For a longer operating time it could be increased in value.



At the end of IC1 ("daily") timing cycle, the low state of pin 3 is applied to pin 1 (the trigger input) through resistor R4 – this retriggers the i.c. and initiates a further timing cycle. This process will repeat indefinitely until the supply is switched off.

SOLENOID VALVE

The output of IC2, pin 3, is incapable of supplying sufficient current to operate the solenoid valve SOL directly so, for this purpose, transistor TR2 is used as a simple current amplifier. When IC2 output, pin 3, goes high (positive supply voltage) current flows through resistor R9 into TR2 base and turns it on. Collector current now flows through the solenoid coil. This produces a magnetic field which pulls an iron armature and actuates the water valve.

Diode, D1, connected in parallel with the solenoid coil bypasses the reverse high-voltage pulse which occurs when the current switches off and the magnetic field collapses. Without this, semiconductor components in the circuit could be destroyed.

POWER SUPPLY

Power for the circuit is obtained from a conventional arrangement of mains transformer, T1, on-board rectifier diodes, D2 and D3 and smoothing capacitor, C6. The fuse, FS1, in T1 secondary circuit, provides protection in case of component failure or short-circuit.

No voltage regulator is required for IC1 since this is provided on the chip in con-

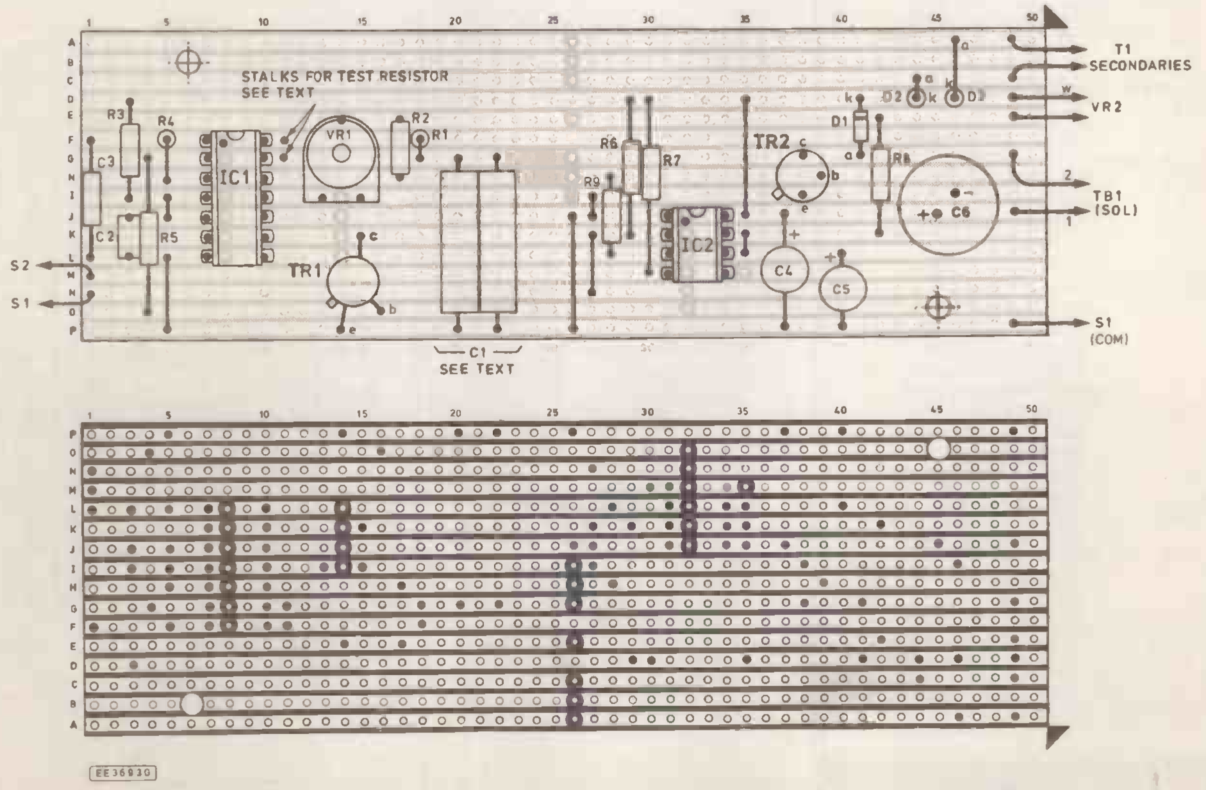


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

junction with resistor R3. Voltage regulation is not required for IC2 either because its timing is largely independent of the supply voltage. In any case, the exact value of the time period – that is, the time during which the hose operates – is not thought to be particularly critical.

Mains transformer T1 must have a generous current rating. This ensures cool and stable operation during continuous operation.

It also makes sure that the extra load of the solenoid valve does not cause problems due to sudden voltage drops. Do not use a transformer having an output rated at less than 500mA.

CONSTRUCTION

Safety Note: In constructing the Garden Hosepipe Controller, mains connections need to be made. Anyone who is not certain of being able to make a safe job must consult a qualified electrician.

In particular, the unit must be built in an Earthed aluminium box and plugged into an adjacent supply using a plug fitted with a 2A fuse. If a fused plug is not used, a separate 1A or 2A mains-type fuse must be fitted in the transformer primary circuit.

COMPONENTS

Resistors

R1	4M7
R2	47k
R3	680
R4, R7	10k (2 off)
R5, R6	100k (2 off)
R8	4k7
R9	2k2
Rx	3k3 test resistor – see text

See SHOP TALK Page

All 0·25W carbon film

Potentiometers

VR1	47k sub-minature preset horizontal
VR2	2M2 rotary carbon, linear

Capacitors

C1	2µ2 polyester (2 off) or single 4µ7 – see text
C2, C3	100n ceramic (2 off)
C4	47µ radial elect. 16V
C5	100µ radial elect. 16V
C6	2200µ radial elect. 16V

Semiconductors

D1, D2, D3	1N4001 50V 1A rectifier diodes (3 off)
TR1	BC108 *npn* silicon
TR2	BFY51 *npn* silicon
IC1	ZN1034E timer
IC2	555 timer

Miscellaneous

T1	Mains transformer with 240V primary and 9V-0-9V secondary (or two 9V secondaries) rated at 500mA minimum
S1, S2	Min. press-to-make, release-to-break push switch (2 off)
S3	Mains rocker switch with neon indicator
FS1	500mA 20mm fuse and chassis fuseholder
SOL	Mains-pressure water solenoid valve – 12V d.c. operation

Stripboard 0·1in. matrix, size 16 strips x 50 holes; aluminium box, size 152mm x 102mm x 51mm; two-way terminal block; 8-pin d.i.l. socket; 14-pin d.i.l. socket; stand-off insulators (2 off); connecting wire; solder tags; solder etc.

Approx cost guidance only **£26**

Construction is based on a circuit panel made from a piece of 0·1in. matrix stripboard, size 16 strips × 50 holes. This carries most of the components. Topside component layout, details of underside track breaks and inter-strip links needed are shown in Fig. 2.

Drill the two fixing holes and mount all on-board components taking care over the polarity of diodes D2 to D3 and of electrolytic capacitors C4, C5 and C6.

In the case of the polyester capacitor C1, the specified value (4·4µF – 4·7µF) is higher than many suppliers stock. However, ample space has been left on the circuit panel for two 2·2µF polyester capacitors to be connected in parallel (see photograph). Additional capacitors could also be used to increase the time period.

Note the two short "stalks" or terminal posts to which test resistor *Rx* is connected temporarily – these consist of 10mm pieces of clipped-off resistor ends. The timing period of IC1 is shortened to approximately one minute by *Rx* and simplifies the testing and adjustment procedure.

Solder 10cm pieces of light-duty stranded connecting wire to copper strips *D*, *E*, *G*, *J* and *P* along the right-hand side of the circuit panel and to strips *M* and *N* on the left as indicated.

CASE AND INTERWIRING

In the prototype unit, all internal components were mounted on the base section of the case. This method imposes least strain on the interconnecting wires. It also means that the unit is easily attached to the wall if required.

Prepare the case by drilling holes for transformer T1 mounting, for switches S1, S2 and S3, potentiometer VR2, fuseholder FS1 and terminal block, TB1. Drill holes also to align with the mounting holes already drilled in the circuit board.

Make holes for the solenoid valve output wire and for the mains input wire. Make sure these holes are large enough to accommodate the strain relief bushes to be fitted later.

Solder T1 secondary output wires to strips *A* and *C* on the board then, referring to Fig. 3, mount all internal components and complete the wiring (see photograph). Note the solder tag at one of the T1 fixing lugs. This will be used to Earth the transformer core and is an essential safety requirement – *do not use a makeshift method.* Note also that one of switch S1 terminals is a meeting point for several "earth" wires – make sure these are secure.

Mount the circuit board on 5mm long plastic stand-off insulators to keep the copper strips and soldered connections clear of the metalwork. Place a piece of cardboard between the circuit board and the box if necessary.

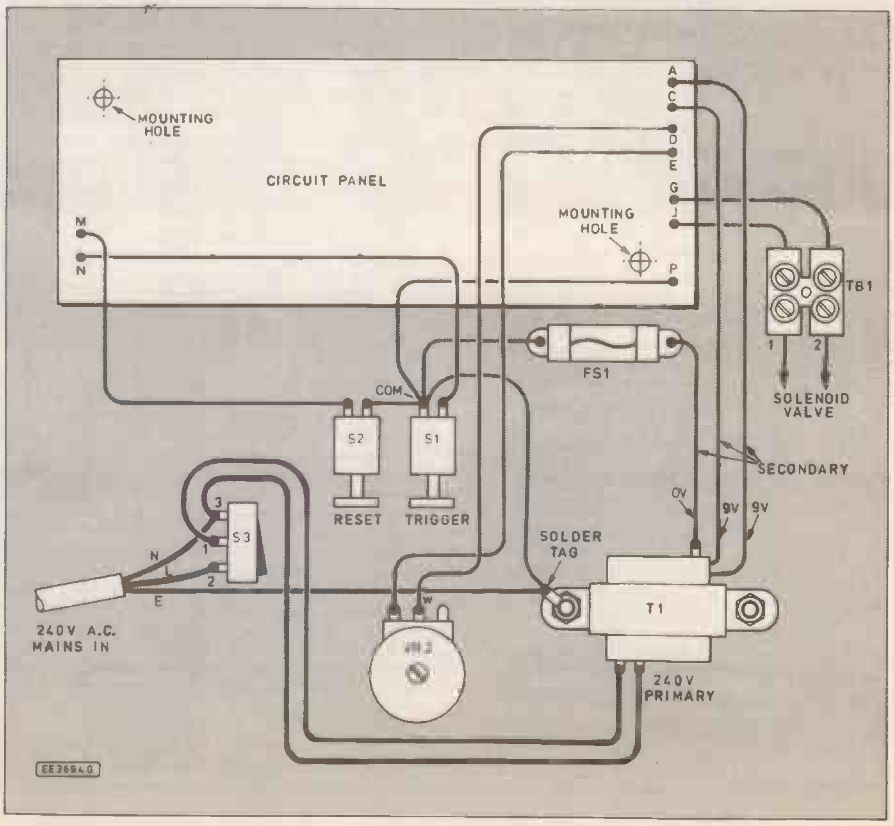
Insert the fuse into its holder. Fit VR2 control knob and adjust both VR1 and VR2 sliding contacts fully anti-clockwise (to provide minimum timings).

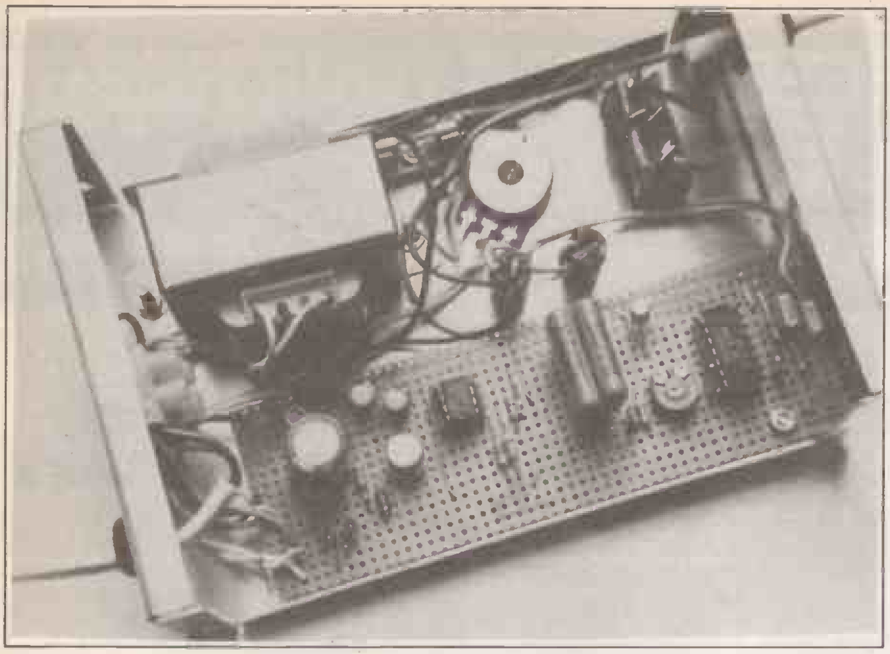
Make and fit the mains lead. This consists of a suitable length of 3-core mains-type wire of 3A rating minimum. Fit this through the hole drilled for the purpose using a strain relief bush – this will prevent it dislodging from On/Off switch S3 in service.

Connect the Live and Neutral wires to switch S3 – hook the wires through the holes and solder securely. Use a similar hooked connection to attach the Earth wire and the wire leading from S1 to the solder tag. These wires must be secure – especially the mains Earth one.

Prepare the solenoid valve connecting wire. This may consist of any light duty twin type such as bell wire. However, if the unit is to be sited some considerable distance from the water supply, it may need to be

Fig. 3. Interwiring from the circuit board to off-board components.





The complete circuit board mounted inside the metal case. The metal case must be "Earthed" through the mains lead, see Fig. 3.

thicker to prevent excessive voltage drop – loudspeaker wire, for example. Tests will reveal if this is necessary since on test the solenoid valve will operate sluggishly or not at all.

Fit one end of the wire with spade receptable connectors to fit those on the solenoid valve. Secure the other end using a strain relief bush and connect to TB1/1 and TB1/2 (polarity unimportant).

TESTING AND ADJUSTMENT

There are exposed mains connections at switch S3 inside the case. For safety reasons therefore, the box must be assembled whenever the unit is plugged in. Adjustments to VR1 are made in small steps with the lid replaced each time.

For testing, it will be found convenient to connect a small 12V bulb (2·2W rating) to the output wires in place of the solenoid valve. Plug the unit into the mains and switch on. It usually self-triggers and the lamp will light for one second or so. After one minute approximately, the lamp should light again and the process repeat indefinitely.

If the lamp remains on for a longer time it is possible that the incorrect outer (track) connection to the rotary potentiometer VR2 has been used. Check by rotating the control knob fully clockwise. If the circuit now behaves correctly, connect the wire leading from strip *E* on the circuit panel to the other outer tag of VR2.

You will save time later by adjusting VR1 sliding contact clockwise in very small steps so that an operating time of one minute (within one second or two) is obtained. *Rx* may then be removed. IC1 time period will now be approximately one day.

Over a trial period, adjust preset VR1 slightly to provide a timing of 24 hours or as required. If the correct timing cannot be obtained even with VR1 at an extreme of its travel, resistor R2 will need to be increased to increase the timing and vice-versa.

By triggering the unit manually, rotary control VR2 could be calibrated and a scale of operating time in seconds marked out on the front panel. This was not thought worthwhile in the prototype.

EFFECT OF TEMPERATURE

This circuit is not designed to produce precise daily timings and maximum repeat accuracy will only be obtained if the temperature of the unit is kept reasonably constant. If the unit is situated in a centrally heated room where the temperature is thermostatically controlled, accuracy of a minute or two per day may be expected. IC1 itself introduces a daily timing error of up to 800ppm (parts per million) per degree – the timing falling with a rise in temperature.

Capacitor C1, also introduces a temperature effect – using the specified polyester type this is typically 200ppm per degree. This is a positive coefficient – that is, capacitance rises with a rise in temperature. This is useful since it offsets the effect of IC1 itself to some extent.

Resistors R1, R2 and preset VR1 also introduce a small temperature effect. The final effect of temperature on timing error may be expected to be in the region of 1000ppm per degree maximum which corresponds to approximately 1½ minutes per degree in the finished circuit.

IN USE

Attach the unit to the wall if required. Remove the test lamp. Fit the solenoid valve to the water tap – note the arrow on the body which indicates the direction of water flow.

Low voltage mains-pressure water solenoid valve.

Connect the hosepipe. Attach the output wires. Turn the tap on and check for leaks.

Switch on the mains and if the unit does not self-trigger, press switch S1. The solenoid valve should operate and water issue from the hosepipe for a time set by control VR2.

If rain can reach the solenoid valve, remember to provide some protection to the terminals so that corrosion and consequently poor contact cannot occur. The Hosepipe Controller may now be put into service. Note that it is normal for the case to become slightly warm.

Remember to have a neighbour on call so that the unit may be switched off should a hosepipe ban be imposed by the local water authority. Remember also, that a licence may be required to use this type of device since it is not handheld – if in doubt, consult your local water company. ☐

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INTERFACE

Robert Penfold

THE subject of bar codes is one which seems to crop up in reader's letters from time to time. Judging from letters I have received, and some I have seen published in various magazines, there seems to be a few misconceptions about the precise way in which bar codes operate. Before proceeding further it would perhaps be as well to dispel one or two myths.

Code Cracking

Many people seem to think that bar codes carry a lot of information. For example, if you read the contents of a bar code on a can of baked beans, the common belief is that you would get something along the lines of "Heinz Baked Beans, 225g, 38p". This seems reasonable, because reading the bar code into a supermarket checkout system would result in this sort of information being displayed, and printed on the receipt.

In reality matters are not as simple as this, and a do-it-yourself system that will provide a similar function is not a very practical proposition. The problem is that the bar code only provides detailed information in an indirect fashion, and it is not readable straight from the code. If you look at a bar code it will normally be accompanied by a long number (usually eight or thirteen digits long). There is a bar code plus thirteen digit number on the front of this copy of *Everyday Electronics*.

When a bar code is read, all that is fed into the computer system is this same number. Thus, if the bar code becomes damaged and cannot be read, the number can be typed into the system by hand. This quite often has to be done at supermarket checkouts, as many readers will no doubt have noticed.

Look-up

So how is the detailed information extracted from the multi-digit code number? It is apparently done in quite a crude fashion, using a look-up table. There are actually large telephone directory style books which contain details of standard bar codes. Using one of these you can look up the code number on a can of beans, magazine, or whatever, and the relevant entry will give the string of text for that particular code.

Using a bar code reader and a suitable computer system greatly speeds things up of course, and the books of codes are presumably only needed for reference and checking purposes. The basic method for extracting the detailed information is much the same though. The code number is read into the computer, and then the text string for that number is read from the computer's data base. Without this massive data base, all you read in from the bar code is a meaningless number.

This is a good way of doing things in that it enables what is effectively a limitless number of different codes to be used, with as little or as much data as desired being attached to each code. The data associated with each code number can be as small as a price such as "38p", or 100,000 words of text. The upper limit on the amount of data is set by the database that has to handle it all, rather than by the bar code system.

The system is less satisfactory in that you can only extract meaningful information from a bar code if you have a computer equipped with a suitable decoding system and database. This makes it rather impractical to implement a home produced system that can read bar codes from everyday products and provide the appropriate string of text. Reading bar codes into the system is a practical proposition, but the database side of things is not.

Being realistic about it, a bar code system that would directly provide text strings is not a very practical proposition. Even a simple price such as "38p" would require three seven bit ASCII codes, or some 24 bits in total. Adding a product description would require hundreds more bits to be included. Bar codes hundreds of bars in length are not usable in most practical situations. The look-up system may be an inconvenient one, but it is perfectly usable.

DIY Bar Codes

While reading commercial bar codes and displaying the relevant information is not a very practical proposition for the home user, this is not to say that do-it-yourself bar codes are totally impractical. It is quite possible to use your own system of bar codes if you can come up with a suitable application. Bar codes are not restricted to supermarket stock style applications. One of the more imaginative commercial applications is in certain Canon EOS cameras which have an optional bar code reader and a book of pictures. Each picture is, of course, accompanied by a bar code.

The basic idea is that you look through the book until you find a picture that is of the type you are going to take, and you then read the accompanying bar code into the camera. Its programmed exposure system then sets the most suitable shutter speed and aperture under the prevailing circumstances. If you are taking some sort of action shots for instance, the camera will set fast shutter speeds (to freeze the action) and use wide apertures if the light level is indifferent.

Such a feature is clearly a waste of time if you are a reasonably expert photographer (and there is no bar code reader input on the professional EOS models), but it helps the non-expert to get good results. Another use of bar codes is in security applications, and there must be many other novel uses for them.

Software

There are programs available for some computers that will print out various sizes and types of bar code. There is at least one set of shareware bar code generator programs available for the IBM PCs, and you should find this set listed in any of the larger PC shareware catalogues (but note that the output is only suitable for Epson 9-pin and true Epson 9-pin compatible printers). Reading the bar codes is more difficult, since this type of software only seems to be sold as part of a complete bar code reader and software package.

The do-it-yourself bar code user therefore has to write his or her own reader software. Of course, you do not have to do things one of the standard ways if a system is only for your own use, and compatibility with someone else's bar code system is not needed. Indeed, it is probably more practical not to do things the standard way as this avoids what is likely to be severe over-kill for do-it-yourself applications.

Implementing a practical bar code system is slightly more difficult than you might think, as anyone who saw one of the early commercial systems in operation will no doubt have realised. Quite a high percentage of bar codes could only be read in after several attempts, and a not insignificant percentage simply would not read in at all. Modern readers are very much better, but they use some expensive technology which goes beyond the scope of do-it-yourself projects. However, it is possible to obtain quite good results from simple systems.

Practical Matters

It is not too difficult to devise a simple but practical bar code system, but there are a few important factors to bear in mind. One of these is that there will inevitably be widely differing reading speeds. Each user will wave the "pen" over the bar code at a different speed, and there may well be significant variations each time the same person uses the system. The way around this problem is to use a relative rather than an absolute approach to reading the bars.

A binary number can easily be coded into the bars by using narrow bands for 0s and wide bands for 1s (or vice versa).

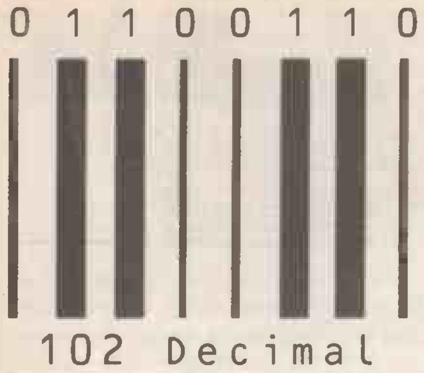

Fig. 1.

Fig.1 shows how an eight bit binary number can be bar coded using this system. Reading the bars on the basis of narrow bars being below a certain read time, and wide bars being above it, will not work very well. Anyone "waving" the reader slightly too fast or too slow will produce all 0s or all 1s.

A better method is to measure the time taken for the full code to be read in. This is then divided by an apposite amount to produce the threshold time that is used to distinguish between the 1s and 0s. The threshold time is therefore automatically raised or lowered to compensate for the reader being swept to slowly or too quickly.

Although this may at first seem to be an absolute method of reading the bar widths, it is actually reading the widths of the bars relative to the total width of the bar code. This gives much better reliability than a truly absolute method.

Implementing a system of this type in hardware is far from straightforward, but it is easily implemented in computer software. It will give good reliability in general, but it will not cope with variations in sweep speed while a code is being read. It should be possible to detect and compensate for this using "intelligent" software routines, but this would seriously complicate the software.

It is better if this problem can be avoided by having the operators work the system properly. It is really not too difficult to wave the reader at a reasonably constant speed while it is over the bar code.

Refinements

It is possible to add a couple of useful refinements to the basic system if desired. One possibility is to have start and finish codes. The idea of this is to enable the system to detect whether or not the bar code has been read the right way round, or in reverse. If a reversed code is detected, the system can automatically invert it to produce the right result.

Another useful refinement is to add error checking. This type of thing is usually implemented using some form of checksum system. The basic idea is to have one or more extra digits in the code. When the main code is mathematically processed in some way, this gives an answer equal to the additional number. If when the main code is read in it becomes scrambled, this will prevent the right checksum value from being obtained, even if only one binary digit has been affected. This can be detected using a software routine which would alert the user to the fact that the code had not been read correctly. A fresh attempt can then be made.

Resolution

Using a relative system of bar code decoding means that, for once, size really is not important. In theory, you can scale the bar code up as large as you like, or make it as small as necessary. Provided the relative widths of the bars are unaltered, the code can be read properly. In practice matters are not as simple as this, and there is the resolution of the reader to be taken into account.

The widths of the lines on commercial bar codes are mostly quite small. There are actually exceptions to this, and bar codes on warehouse containers are usually "Jumbo" sized. This is so that they are easy to find on the large boxes. Obviously it is not practical to have large bar codes on small products such as tins of peas. This results in some bar codes that have very narrow bands.

If you make some measurements on the bar code on the front of this magazine you will find that the wide bars are actually less than one millimetre wide. The narrow bars are only a fraction of a millimetre wide. To read in such a small bar code successfully requires a very high degree of resolution. In fact it requires special sensors that are difficult to obtain, and quite expensive.

For the do-it-yourself bar code user it is best to settle for a narrow bar that is at least one millimetre thick. This still enables reasonably compact bar codes to be used, but keeps the reading process easy enough for inexpensive sensors to be used successfully.

Next month some practical bar code hardware and software will be described.

SHOP TALK

with David Barrington

Garden Hosepipe Controller

All components required to build the *Garden Hosepipe Controller* are standard items except the 12V d.c. operation mains pressure solenoid valve.

The water valve used in the prototype model was purchased through **Electromail** (☎ *0536 204555*), order code 342-023. It is quite possible a local plumbing supplies shop may stock a suitable solenoid valve. They will also be able to supply the coupling connectors.

A couple of points to remember: A metal case must be used and be soundly "earthed" to the mains earth lead. The mains transformer used must have a generous current rating and ***must not*** be less than specified. Make sure you site the water solenoid in a position which, should there be a breakdown, any possibility of flooding will not do any damage.

Finally, the unit must not be *permanently* connected to the mains power supply. Also, please comply with any hosepipe ban imposed by the local water company.

UV Exposure Timer

It is best to use only the specified mains transformer and relay when constructing the *UV Exposure Timer.* This will ensure that these components fit on the p.c.b.

The ones used in the model were purchased from **Farnell Electronic Components** (☎ *0532 636311*), code 149-975 (Mains Tran.) and from **Maplin**, code YX97F (Ult-Min. 10A Mains Rly).

A suitable Euro-style safety plug and socket would be from the Bulgin range. This range is stocked by most of our component advertisers.

The case was obtained from **Verospeed** (☎ *0703 644555*) and is from their Apollo 3 range, code 75-39242A. The printed circuit board is available from the *EE PCB Service,* code EE797 (see page 467).

Cricket Game

The only component that can be classed as special amongst the items required to build the *Cricket Game* is the relay. The rest of the parts are standard "off-the-shelf" lines.

Once again the use of the specified relay is because it must sit directly on the printed circuit board and connect to the correct copper solder pads on the underside of the board. The relay was obtained from **Electromail** (☎ *0536 204555*), order code 350-557.

Other relays can, of course, be used provided they have identical pinout configurations and electrical characteristics. The relay could also be mounted separately inside the case and "hard wired", using insulated leads, to the circuit board.

If contemplating building the suggested mains power supply, a suitable transformer would be a 3VA type, either single 12V or two times 6V secondaries. Any similar p.s.u. can be used as long as it is capable of an output voltage of between 7·5V and 9V at 100mA. The specified transistor should have a clip-on type heatsink.

The Cricket Game printed circuit board is available from the *EE PCB Service,* code EE798 (see page 467).

Quick Prom

The zero insertion force (ZIF) socket called for in the *Quick Prom* should be widely available and prices range from about £6 to £7.

The MK48Z02B-25 static RAM (SRAM), with integral lithium battery, is not such a common device and may not be available locally. However, a complete kit, (£27 all inclusive), including the SRAM, is available from **Becker Systems, Dept EE, 8 Finucane Drive, Orpington, Kent, BR5 4ED.**

The printed circuit board for the Quick Prom is available from the *EE PCB Service,* code EE799.

Class-A Headphone Amplifier

We cannot foresee any component buying problems ahead for constructors wishing to build the *Class-A Headphone Amplifier.* When ordering parts remember its important to specify "log" type potentiometers.

BARGAINS GALORE

SUPER MULTIMETER Ex British Telecom, this is a 19-range 20k o.p.v. top grade instrument, covers AC & DC voltages, current and resistance, very good condition, fully working and complete with leads **£9.50**, leather carrying case **£2** extra (batteries not included but readily available).

MULTI-CORE CABLES all with 8A 230V cores so suitable for disco and other special lighting effects. With earthable woven screen and thick pvc outer. 3 core, **30p** per metre, 16 core, **50p** per metre, 18 core, **80p** per metre, 25 core, **£1** metre and 36 core, **£1.50** per metre.

VOLTABLOCK an infinitely variable unit gives any voltage from 0-230 a.c. at ½A. Obviously an invaluable piece of equipment which should be in every workshop and probably would be except that the usual price for this is **£35** plus VAT. Now is your chance to buy one, brand new, at **£15** including VAT, Order Ref. 15P42B.

ULTRA THIN DRILLS Actually 0.3mm. To buy these regular costs a fortune. However, these are packed in half dozens and the price to you is **£1** per pack, Order Ref. 797B.

YOU CAN STAND ON IT! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools. Internal size approx. 10½" x 4½" x 6" high. These are complete with snap closure lip and shoulder-length carrying strap. Taken from used equipment but in good condition, price **£2**, Order Ref. 2P283B.

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POWER SUPPLY WITH EXTRAS mains input is fused and filtered and the 12V dc output is voltage regulated. Intended for high class equipment, this is mounted on a PCB and, also mounted on the board but easily removed, are 2 12V relays and a Piezo sounder. **£3**, Order Ref. 3P80B.

5V 2.5A POWER SUPPLY UNIT £5, Order Ref. 5P186.

12V 1.9 AMP-HOUR a sealed lead-acid battery, charged ready for use **£5.50**, Order Ref. 5.5P/1.

100W MAINS TRANSFORMER normal primary 20-0-20 at 2.5A. 40V at 2.5A, **£4**, Order Ref. 4P59. 50 V at 2A, **£4**, Order Ref. 4P60. Or, instead of 20-0-20, this same transformer will deliver 30V at 3.5A.

PHILIPS 9" HIGH RESOLUTION MONITOR black & white in metal frame for easy mounting, brand new still in maker's packing, offered at less than price of tube alone, only **£15**, Order Ref. 15P1.

16 CHARACTER 2-LINE DISPLAY screen size 85mm x 36mm, Alpha-numeric LCD dot matrix module with integral micro processor made by Epson, their Ref. 16027AR, **£8**, Order Ref. 8P48.

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1/3 HP 12V MOTOR – THE FAMOUS SINCLAIR C5 brand new, **£15**, Order Ref. 15P8.

SOLAR CHARGER holds 4 AA nicads and recharges these in 8 hours, in very neat plastic case, **£6**, Order Ref. 6P3.

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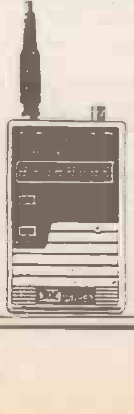
AIR SPACED TRIMMER CAPS 2-20 pf ideal for precision tuning UHF circuits, 4 for **£1**, Order Ref. 818B.

FIELD TELEPHONES just right for building sites, rallies, horse shows, etc., just join two by twin wire and you have two way calling and talking and you can join into regular phone lines if you want to. Ex British Telecom in very good condition, powered by batteries (not included) complete with shoulder slung carrying case, **£9.50**, Order Ref. 9.5P/2.

MAINS ISOLATION TRANSFORMER stops you getting "to earth" shocks. 230V in and 230V out. 150watt upright mounting, **£7.50**, Order Ref. 7.5P/5 and a 250W version is **£10**, Order Ref. 10P79.



DIGITAL FREQUENCY METER. This is a hand-held instrument with an LCD display allowing 8 digits of frequency to be read, has internal nicad batteries, and a power supply which will recharge the batteries. Ideal for field and service work as well as general and industrial applications. Has high and low BNC inputs and a plug-in antenna which enables remote tests. It covers a very wide range of frequencies: switch position 'A' covers 10Hz to 20MHz and switch position 'B' covers 20MHz to 1200MHz. Price **£99**, but it compares very favourably with instruments selling at over £500 by our competitors. Order Ref. 99P2.

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with orders this month one year's subscription to our bi-monthly newsletter. You will be the first to hear of our new lines!

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A £60 UNIT FOR LESS THAN £10 – switch mode power supply with outputs +12V at 4A, +5V at 16A and −12V at ½A. Enclosed in plated steel case, brand new, offered at a special price of **£9.50** until July 31st, Order Ref. 9.5P1.

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AMSTRAD POWER UNIT 13.5V at 1.9A encased and with leads and output plug, normal mains input **£6**, Order Ref. 6P23.

AMSTRAD 3.5 FLOPPY DRIVE brand new and cased, **£35**, Order Ref. 35P4.

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DOWN TO EARTH

George Hylton

Distortion happens when output is not strictly proportional to input. In an audio amplifier, the kind of distortion which causes severe problems is harmonic distortion. A "pure" signal in the form of a perfect sine-wave contains only one frequency, the fundamental and no multiples of it (harmonics).

If the sine wave is distorted, harmonics are generated. This leads to a simple way of stating the amount of distortion: as the ratio of harmonics to fundamental.

Harmonic distortion is usually expressed as a percentage. Total harmonic distortion is sometimes expressed as the sum of all the harmonic power expressed as a percentage of the fundamental power.

In very bad cases this leads to the curious result that the distortion is more than 100 per cent. A more reasonable figure is given by comparing distortion with total power; i.e. with fundamental plus distortion.

Distortion Factor

In practice total harmonic distortion is not easy to measure, especially when small. One thing that blurs the picture is noise. All amplifiers generate noise. If the level of distortion is very low it is difficult to separate distortion from noise.

This has led to an alternative way of stating amplifier performance: compare the distortion plus noise with the total output. This gives a "distortion factor":
Distortion Factor = (Distortion plus noise)/(Fundamental + distortion + noise). Again this is usually expressed as a percentage.

For moderate levels of distortion (such as five per cent) the distortion factor is virtually the same as total harmonic distortion. For very low distortion the distortion factor is higher because noise becomes comparable with harmonics.

Measurement Systems

There are several ways of measuring distortion. A common scheme is shown in Fig. 1. The amplifier (or the circuit) under test is driven by a sine-wave system of great purity (i.e. virtually no harmonic content). The input is adjusted to set the output to some standard level (such as the rated output power). A sharp filter giving infinite attenuation of the fundamental is connected. This allows harmonics and noise to pass freely. With switch S1 in position 1 the distortion-plus-noise is measured. In position 2 the total output is measured.

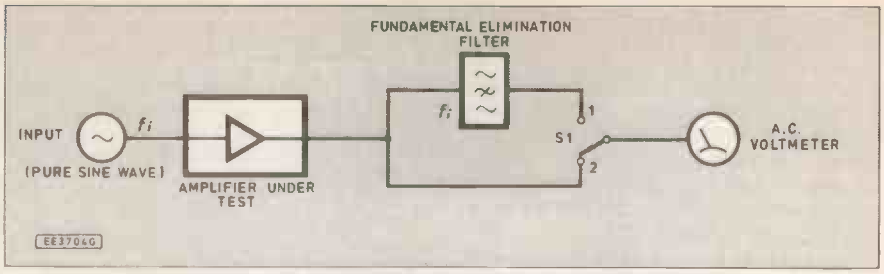


Fig. 1. Distortion factor measurement setup.

Comparing the measurements gives the distortion. Strictly speaking, the voltmeter should give true r.m.s. measurement. The distortion is really proportional to power rather than voltage. Sometimes the distortion is given as a decibel figure: if the distortion voltage is one thousandth of the fundamental voltage the distortion is −60dB, i.e. 60dB down on the fundamental.

Fundamental Filter

Eliminating the fundamental is not easy. A distortion of 0.1 per cent means that the harmonic power is 60dB down. A filter which attenuates the fundamental by 60dB still allows as much fundamental to get through as distortion, giving an exaggerated distortion figure. Modern amplifiers may have distortion levels as low as 80dB below fundamental, or even lower. Filters of exceptionally good performance are needed. However, they need only eliminate one single frequency. This eases the problem, because a number of circuits exist which give a complete null at one frequency.

The Twin-T network of Fig. 2 gives zero output at the frequency where the reactance of *C* is equal to the resistance *R*, but attenuates the lower harmonics to some extent. For good results the tolerance of the components must be very tight. More sharply tuned is the Bridged-T trap (Fig. 3), which eliminates signals at the resonant LC frequency when *R* is correctly adjusted.

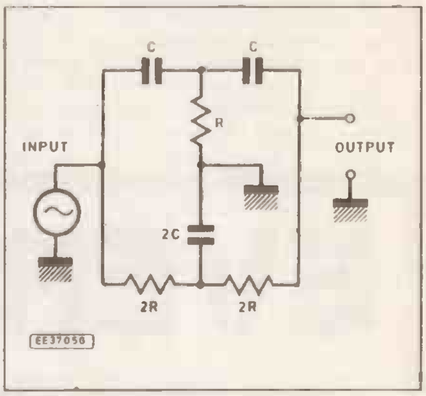


Fig. 2. Twin-T network.

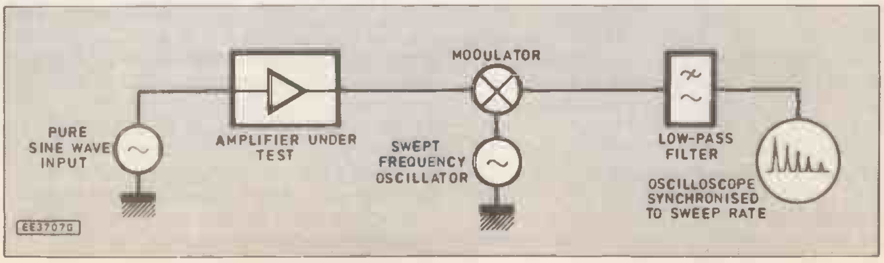
Spectrum Analysis

An alternative way of examining harmonic distortion is to display the total spectrum of frequencies on an oscilloscope (Fig. 4). Incoming harmonics applied to the modulator give an output pulse when the sweep frequency coincides with the harmonic frequency.

If the oscilloscope timebase is synchronised to the frequency-sweep control waveform the display shows successive harmonics as blips. The height of a blip shows the intensity of the harmonic.

The system is much used for radio-frequency investigations but in principle is applicable at audio frequencies too. The sweep rate must be very low and an ordinary scope cannot then give a steady display.

Fig. 4. Spectrum analysis.



Intermodulation

A consequence of some forms of harmonic distortion is that a strong signal modulates a weak one. In spectral terms this means that new frequencies are generated, the main ones being the sum of the strong and weak frequencies and their difference. Thus a strong 400Hz signal and a weak 1000Hz one intermodulate to yield 600Hz and 1400Hz. Since these frequencies are not present at the input they are distortion products.

It is arguable that intermodulation gives a better indication of audio quality than total harmonic distortion, since its use of simultaneous signals on different

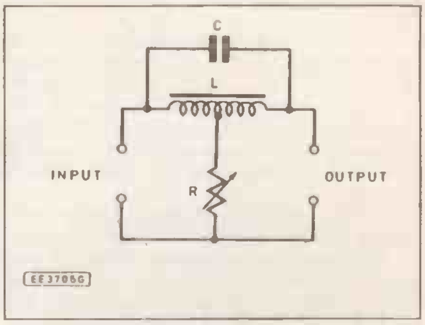


Fig. 3. Bridged-T trap.

frequencies mimics speech and music to some extent.

A particularly simple technique for intermodulation measurement has been evolved by telephone engineers. In a wide-band multichannel carrier telephone link the presence of many different speech signals can be simulated quite closely by white noise, which is an equal mixture of all frequencies.

To test such a wide-band network (Fig. 5), the output of a white noise generator is passed through a notch filter which cuts a slot in the spectrum at a narrow band of frequencies around f_s. Thus the signal applied to the system contains all possible frequencies except f_s. Intermodulation in the system causes spurious signals (distortion) at f_s to appear. These are selected by a sharp filter tuned to f_s and their amplitude measured to indicate the severity of the distortion.

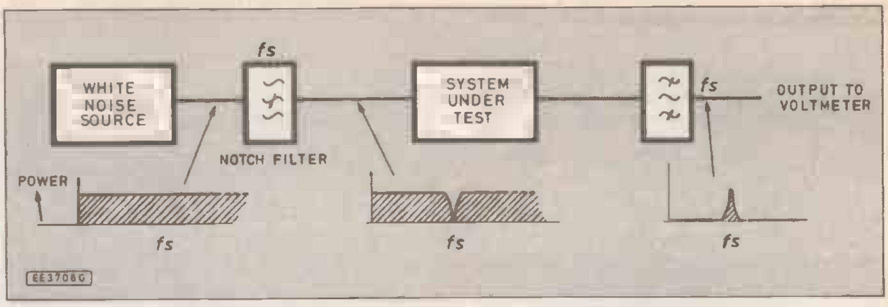


Fig. 5. Intermodulation measurement by "noise in slot" method.

White noise is not a good simulator of music, which contains more energy at low frequencies than at high ones. If white noise is passed through a spectrum-shaping filter which applies the right degree of top cut the resulting "pink noise" is more like real audio signals.

EVERYDAY READOUT

CONSIDERABLE RELIEF

Dear Ed.,

When I last wrote to you in January I mentioned that I hoped to be relieved of the secretarial duties of the B.A.E.C. by another member who had volunteered to take these over. At the beginning of this week I visited Jeremy Hind, the member in question, to finalise the arrangement. He already has about three quarters of the membership on his computer database of members' electronic expertise, so the amount of extra work will not be too great, but it will be a considerable relief to me. I shall continue as chairman for the present, and shall continue to edit the newsletter. I should be grateful if you would amend the small advertisement for the B.A.E.C. at the next time of insertion so that the last part reads: "For details, write to the Secretary, Mr. J.S. Hind, 7 Carlyle Road, West Bridgford, Nottingham NG2 7NS."

Some of the other magazines have carried small ads for a club calling itself "Electronics UK", based in Lancing. I wrote as chairman of the B.A.E.C., asking for details, but have had no reply. The National Components Club seems to have folded up – I haven't seen any of their adverts recently.

I am pleased that you have started publishing readers' letters. Your correspondent Mr. Pike wrote to me before writing to you about his diesel tacho. I get a few letters of this sort from people who think the advert for the B.A.E.C. in your classified section, which says it "exists to help electronics enthusiasts", is a general invitation to all and sundry to send their problems to me. I do help if I can, but I also point out to them that the help is to members of the club (and I send them details and a membership application form – but this rarely has any effect; I don't even get an acknowledgment as a rule).

Your editorial pat on the back was well justified. I always find much of interest in each issue as it reaches me and if I do criticise from time to time, this is meant to be constructive and helpful. The number of enquiries I get from distant countries is ample evidence of EEs wide circulation, and some of them are not a little odd or amusing. I respond to them all, but in many cases that it the last I hear from the senders. Perhaps they expect to get the club services free of charge.

H.F. Howard
Chairman B.A.E.C.

This is part of a lengthy letter from Herbert we hope to publish more of it next month.

PULSED MOTOR PROBLEMS

Dear Ed.,

Robert Penfold's advocacy of pulsed controllers for model railways in the April issue should perhaps have contained a motor health warning! Pulsed controllers arouse considerable controversy in specialised model-railway publications, with sad stories of smoking armatures and demagnetised magnets said to sometimes follow their use, as well as complaints of excessive hum from some motors at the drive frequency. I believe the present main warning is that they should not be used with "can-motors", and the May issue of *Continental Modeller* reviewing a German-made locomotive quotes the accompanying leaflet as saying that it is powered by a "Faulhaber" motor which must not be used with "pulse power units".

My own experience when devising a controller for use with computer control is that if low-enough frequencies are employed the motors respond like "stepper-motors" advancing a small amount for each pulse. Unfortunately, with a mixed fleet of locomotives, the optimum frequencies vary between about 12 and 30Hz, and I have compromised on 18Hz. Readers might like to experiment with a shunting locomotive – reliable progress seems possible at scale speeds as low as 2mph on *clean* track. Mindful of pulse control warnings I employ increasing pulse width at 16V up to about 15 per cent mark-space ratio and then further increase speed by raising the "space" voltage so that the top-speed waveform is 10V d.c. with the 16V 16 per cent pulses superimposed.

This works satisfactorily for me, and I find that charging the capacitor carrying the control voltage from a constant-current source over about 15sec. gives visually acceptable acceleration. For stopping I use a track reed switch to trigger an initial slowing to about 20mph using a C-R discharge of the capacitor to the lower voltage over about 6sec., with a second reed then triggering a discharge to a control-voltage rather below the zero-speed value over about 3sec. These decelerations look reasonably realistic to me, and consistent stopping positions are obtained to within a few cms.

A gimmick I employ with this pulse system is that train-detector circuits are referenced to 13V so that l.e.d.s on the track-diagram show an 18Hz flicker for moving trains and are steady for stationary ones.

T. B. Owen
Aberystwyth

COMPUTER UPSET

Dear Ed.,

Not long after moving house just recently I began to experience intermittent malfunctions with my home computer. These machine errors happened two or three times a day, I put it down to mechanical damage whilst moving.

I myself, not having much knowledge of computer electronics called for the services of a professional Computer Engineer, after explaining the symptoms he gave the PC a thorough check, he then informed me no fault could be found but suggested that as the problem was intermittent and the PC was somewhat old, it could be susceptible to noise not conducted but radiated at some external source, Radio Frequency Interference (R.F.I.). This sometimes occurs in certain environments and when asked how this could be rectified he said it was not viable to work on a computer of that age and to invest in a new one.

Do older machines suffer from R.F.I.? Have you or any other readers experienced problems caused by R.F.I. in computer or microprocessor controlled equipment? What are the potential sources of R.F.I. and how do you overcome them? Are there any good books on the subject, I have searched several good bookshops but to no avail 'Please help'.

J. Conners
Cambridge

It sounds more like r.f.i. or spikes on the mains, often caused by inductive loads switching on an off, rather than a radiated r.f.i. problem. We would suggest you try a mains filter before getting involved with trying to eliminate radiated r.f.i. Perhaps other readers will have had similar experiences?

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R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages Order code BP239 **£2.95**

MORE ADVANCED USES OF THE MULTIMETER
R. A. Penfold

This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extended the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.

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THE ILLUSTRATED DICTIONARY OF ELECTRONICS – 4th EDITION
Rufus P. Turner and Stan Gibilisco

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ELECTRONIC CIRCUITS HANDBOOK

Michael Tooley BA

This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

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R. M. Marston

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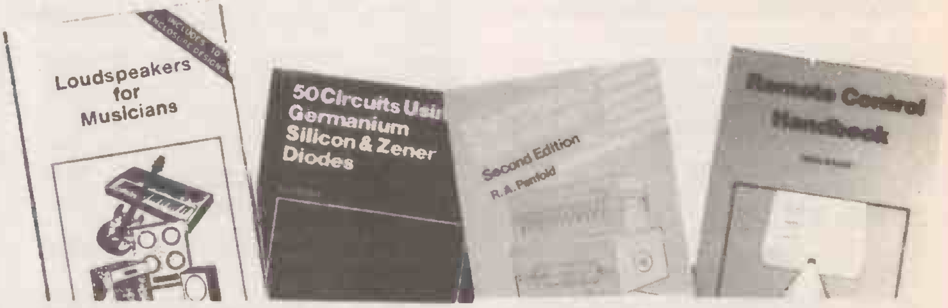

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R. A. Penfold

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Waveform generator circuits may be built using transistors, op-amps, standard digital ICs, or dedicated waveform or "function" generator ICs

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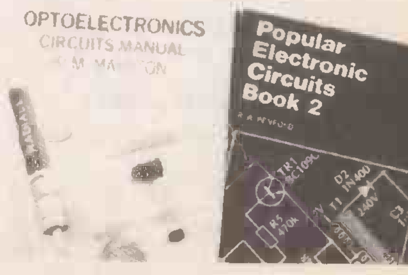

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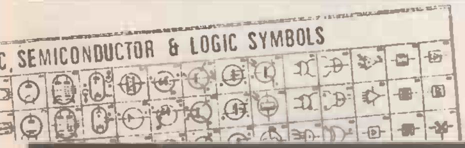

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We now supply *all* the books published by Bernard Banani (Publishing) Ltd. We have always supplied a selected list of Babani books and you will find many of them described on the previous pages or in next months issue of *Everyday Electronics* (the books with a BP prefix to the order code are Babani books).

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SEE PREVIOUS PAGE FOR FULL ORDERING DETAILS

PCB SERVICE

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

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

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

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Monomixer	571	£4.75
Noise Gate SEP'87	577	£4.41
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Suntan Timer	610	£3.07
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Biofeedback Signal Generator	JAN '90	666	£4.08
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Weather Stn: Anemom. – Freq./Volt Board		670	£3.94
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System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
Weather Stn: Display Driver	MAR 90	672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver/Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR '90	[illegible]1	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
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Amstrad Speech Synthesiser	MAY '90	689	£4.68
80 Metre Direct Conversion Radio	JUN '90	691	£4.95
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(5 or more 697's ordered *together* £3.25 each)			
Simple Metronome		698	£3.94
Hand Tally: Main Bd and Display Bd	SEP '90	699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
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Temperature Controller (p.c.b. only)		702	£5.20
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LM723 Module		713	£4.21
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Gingernut 80m Receiver	FEB '91		
R.F. section (726), Voltage Regulator (727)		726/7/8	£3.06
Audio Amplifier (728)			per board
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– Power/Relay Board		741	£3.76
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PROJECT TITLE		Order Code	Cost
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Modular Disco Lights – Simple Chaser		745	£5.00
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Automatic Light Control – PSU Board		747	£4.88
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Teach-In '91 Part 7 – R.F. Amplifier Module		750	£4.23
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Ultrasonic Proximity Meter			
Display Unit (753) & Sensor Unit (754)		753/754	£7.06
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Teach-In '91 Part 8 – Solid State Switch Module		757	£4.24
Mod. Disco Lights – Pattern Gen	AUG '91	760	£6.79
Teach-In '91 Part 8 – Light Sensitive Switch		761	£4.74
Opto-Link (Teach-In '91 Project 9) – Transmitter		762	£4.85
Receiver		763	£4.88
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Modular Disco Lights – Dimmer Interface		765	£8.17
Mod. Disco Lights	OCT 91		
VU Sound Module (Double-sided)		767	£8.68
UV Exposure Unit		768	£4.63
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Supersweep (Double-sided)		772	£8.26
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BLOCK CAPITALS PLEASE

REPORTING AMATEUR RADIO

Tony Smith G4FAI

RSGB OPEN HOUSE

The Radio Society of Great Britain threw open its doors on Saturday 11th April to show-off to members its newly re-vamped headquarters at Potters Bar, Herts. Previously, visitors to HQ, including myself, had commented on the rather unwelcoming aspect of the reception/enquiries area and the feeling of being kept at bay from "their" society.

Now everything is changed. A light spacious reception and shop area with friendly staff draws visitors right inside the building. Close at hand is a small but interesting museum with radio equipment, home-made and commercial, dating from earlier days of amateur radio. Adjacent to this is a well-equipped radio station, callsign GB3RS, which licensed members can operate by arrangement.

Visitors were taken round the headquarters' accommodation, including the editorial offices of the Society's journal, *Radio Communication*, which nowadays is produced by the latest "new technology" processes. To put members "in the picture" about just what goes on at Potters Bar the tour extended to the membership department, the various offices and even the accounts department.

Of great interest was the QSL bureau which is the service used most frequently by most members. Here, thousands of QSL cards pour in each week for sorting and onward transmission in bulk to other bureaux at home and abroad, for eventual delivery to individual amateurs in confirmation of radio contacts made. Down in the basement, what is effectively a small warehouse holds and dispatches all RSGB publications and other radio books purchased by mail order, with the income earned providing a useful supplement to the Society's funds.

SERVICES PROVIDED

Like most of the visitors, I was impressed and reassured by what I saw. When one is a member of any society from a distance it is easy to get a wrong impression about what goes on at headquarters. There have been rumblings in recent years about the need for a more open Society but recent changes, typified by this open day, augur well for the future.

Apart from paid staff at headquarters, around 800 volunteers provide specialist services for members such as QSL sub-bureaux, an audio-visual library, organisation of operating awards and contests, technical advice, advice and help on interference problems, propagation predictions, exhibitions and conventions, help in obtaining planning permission for antennas, news bulletins, slow Morse training broadcasts, Morse tests for licences, provision of radio beacons and repeaters, Novice training courses and much more.

The greatest benefit in having a national society, however, arises from the fact that although amateur radio is a hobby it is governed by national and international regulations which define not only the radio communication modes which can be used, and the nature of the communications allowed, but also the frequencies allocated to amateurs.

DEFENDING FREQUENCIES

These frequencies are under constant threat as commercial and broadcast radio services seek to expand, and an absolutely essential link is maintained by the RSGB with the DTI's Radiocommunications Agency, Britain's radio licensing authority. This ensures that the needs of amateur radio are taken into account whenever frequency allocations or licensing conditions are discussed by the authorities at either national or international level.

Without a national society to maintain such a link it is doubtful if amateur radio could survive in today's cut-throat world of radio communication where a single frequency in commercial terms is estimated to be worth millions of pounds. The strange thing is that not all amateur operators seem to understand this and only about half the country's licensed amateurs are members of the RSGB. The other half, presumably, just haven't thought about the implications or are content to let the others do whatever is necessary on their behalf!

Membership of the Society is open to anyone interested in amateur radio, whether licensed or unlicensed. Further information can be obtained from RSGB, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE.

YOUTH IN ACTION

Denby Dale Amateur Radio Society's annual "Youth in Action" weekend will be held on 14 to 16th August. This ambitious presentation of amateur radio to young people involves inviting Novice trainees, Scouts, Guides and ATC members to take part in amateur radio related activities arranged over the whole weekend plus some social activities.

These events take place in a field at Crosland Moor, conveniently located for radio purposes at 1000 feet a.s.l., where caravans, tents and marquees are installed for the weekend, including special event amateur radio station, GB2YIA.

Last year's activities included explanatory talks, simple construction projects, radio fox hunting, Morse instruction, radio operating with contacts as far away as Australia, USA and Japan, including opportunities for attendees to chat to the overseas operators, and experiments with a kite antenna. Additionally, there was an evening barbecue entertained by a local pop group.

It appears that "a good time was had by all" and I am told by Tony Galvin, G0DDB, that planning for this year's event is proceeding well. "The idea is to keep everything fairly simple and let the young people actually make a useful piece of equipment, e.g. a crystal set. We also have ideas for a Morse exercise which should be quite fun."

RADIO BYGONES

There seems to be a lot of interest nowadays in the radio of the past. Apart from pure nostalgia, perhaps this is because in the "old days" it was fairly easy to look at a faulty circuit, identify components used for specific functions, replace them and get the set going again whether it was commercially or home-made. This can still be done, old components can still be obtained and it is often possible to restore 50/60 year old, or even older, wireless sets to their former glory.

I was reminded of the techniques of early home-construction by a piece in *Radio Bygones*, a magazine devoted to the radio art of the past. An article in the February/March 1992 issue describes the technique of "breadboarding" where all components are assembled and screwed down on a thick board and connected up with stiff wire laid out in straight lines around the board. Large diameter coils, glowing valves, brass fittings, large meters mounted in ebonite front panels, all evoke the atmosphere of the past and the article suggests ways of re-creating your own authentic or individual masterpiece – or maybe just a glorious Spiders' Nest!

Edited by Geoff Arnold, G3GSR, *Radio Bygones* is a high quality authoritative publication which covers all aspects of early wireless, transmitting and receiving – professional, amateur and domestic, with superb colour photographs helping to bring the whole subject to life.

Examples of recent articles show the range of subjects covered. "Wireless on RMS Queen Mary" provided an in-depth survey of the design and installation of the equipment on this famous liner. A photo-feature illustrated a collection of domestic receivers from the 1950s-60s located at the Bampton Museum of Communication and Domestic and Local History in Devon. Other, self-explanatory, titles included "Birth and Growth of Pye Radio Ltd", "From Cat's Whisker to Integrated Circuit", "Starting a (vintage radio) Collection", "The Vintage Years of Amateur Wireless" and "Saved by Radio – Evolution in Air-Sea Rescue radio transmitters".

For anyone interested in the history of radio, or collecting those beautiful radios of yesteryear, this wide-ranging magazine is a "must". Obtainable by mail only from Radio Bygones, 9 Wetherby Close, Broadstone, Dorset BH18 8JB, the annual subscription, for 6 issues, is £17. A sample copy can be obtained at a special price of £2.50 if you mention EE when writing.

APPROVED 418MHz UHF RADIO SWITCHING

A high quality ready to use radio control system consisting of a small UHF key fob transmitter with digital encoder and a UHF receiver housed in a custom made case with digital decoder and open collector transistor output. The codes of each transmitter and receiver are factory set, (can be changed by user). Available as a single or dual channel system. The transmitters are DTI approved to MPT 1340. Applications include: Vehicle Security, Door Access Systems, Remote Controlled Lighting, Garage Door Opener, Security Devices, etc.

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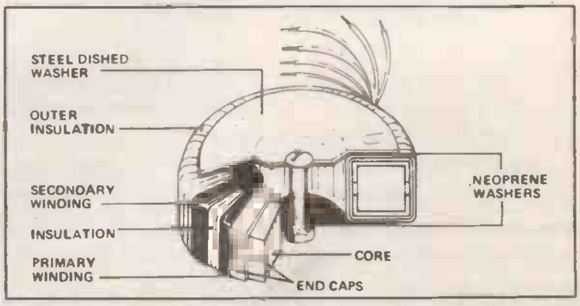

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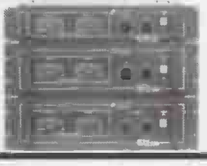

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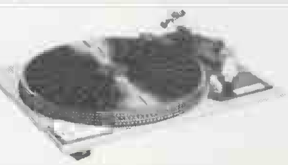

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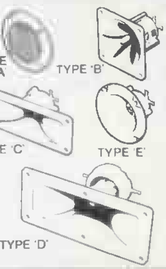

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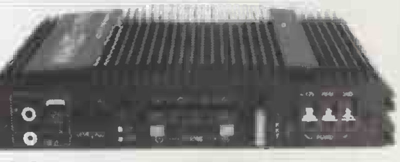

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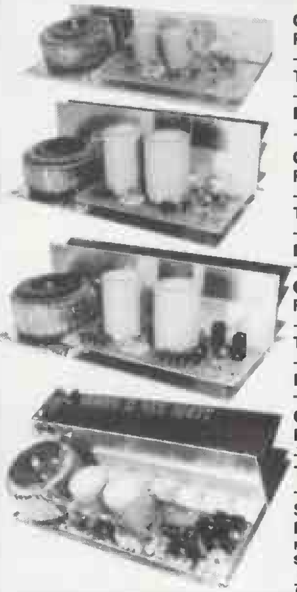

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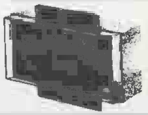

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RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. **PRICE £42.12 + £3.50 P&P**

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**

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

PHOTO: 3W FM TRANSMITTER

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA,
ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243

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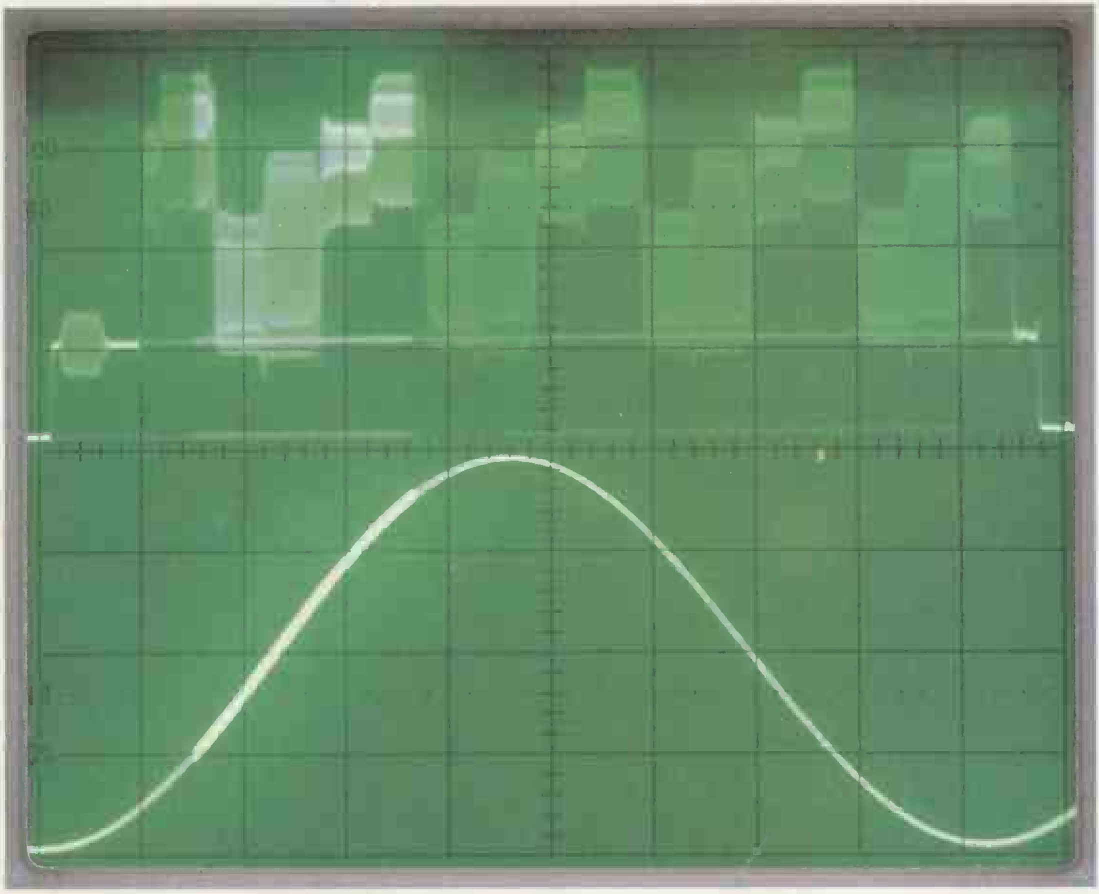
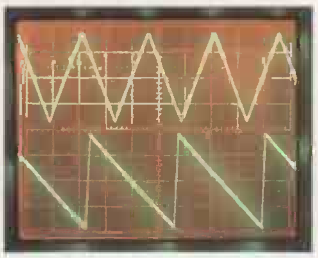


Let's talk waveforms...

...AND THE BEST IN OSCILLOSCOPES.

Our new range of precision laboratory oscilloscopes offer not only the best features, but also prices. From the sophisticated 20MHz 7025 to the delayed sweep 40MHz 7046, advanced design and high quality combine to bring you features such as; 1mV/div sensitivity, advanced 6-inch CRT with percentage markers and internal graticule, eliminating parallax error and ensuring a highly accurate display. X-Y mode allows Lissajous patterns to be produced and phase shifts measured.



The 7025 has all the capabilities required of a general purpose oscilloscope and will accept signals from DC to at least 20MHz with a high degree of accuracy. The 20MHz 7026 incorporates a delayed sweep time base, which can be used to magnify a portion of the waveform, and makes accurate time interval measurements and the study of short duration events possible. The sophisticated 40MHz 7045 includes a 40ns delay line to help show very short duration events in their entirety. A delayed sweep oscilloscope of advanced design and high quality is found in the shape of the 40MHz delayed sweep 7046, having an increased magnification along with a 40MHz bandwidth and capable of displaying complex signals with precision and accuracy.

Full details of our oscilloscopes and all other test equipment can be found in the 1992 Maplin catalogue, available from **WHSMITH** *or Maplin shops nationwide £2.75 or by post £2.95. Mail Order to: P.O. Box 3, Rayleigh, Essex, SS6 8LR. Credit Card Hotline, 0702 554161 or visit your local store.*

/// Maplin ELECTRONICS

GL29G [H] 20MHz scope 7025...£299.95. GL30H [H] 20MHz scope 7026 ...£349.95. GL31J [H] 40MHz scope 7045...£449.95. GL33L [H] 40MHz scope 7046...£499.95 (illustrated).

All items subject to availability. Handling charge £1. [H] Indicates carriage charge of £5.30. All prices inclusive of VAT.

Visit our stores at: **BIRMINGHAM;** Sutton New Road, Erdington. **BRIGHTON;** 65 London Road. **BRISTOL;** 302 Gloucester Road. **CARDIFF;** 29 City Road. **CHATHAM;** 2 Luton Road. **GLASGOW;** 264-266 Great Western Road. **LEEDS;** Carpet World Building, 3 Regent Street. **LEICESTER;** Office World Building, Burton Street. **LONDON;** 146-148 Burnt Oak Broadway, Edgware. 120-122 King Street, Hammersmith. **MANCHESTER;** 8 Oxford Road. **NEWCASTLE-UPON-TYNE;** Unit 4, Allison Court, The Metro Centre, Gateshead. **NOTTINGHAM;** 86-88 Lower Parliament Street. **READING;** 129-131 Oxford Road. **SHEFFIELD;** 413 Langsett Road, Hillsborough. **SOUTHAMPTON;** 46-48 Bevois Valley Road. **SOUTHEND-ON-SEA;** 282-284 London Road, Westcliff. Plus new stores in **COVENTRY** and **SOUTH LONDON** opening soon. Ring 0702 552911 for further details.

GREENWELD

Super sensational Summer Sale

The BIG One

Sunny Bargains for everyone!!

*This is the **BIG** one - no other electronic mail order component company in the UK has a **SALE** like this!! **BIGGER DISCOUNTS, BETTER DEALS, MORE STOCK.** We have **MILLIONS** of components to dispose of; **MASSES** of surplus boards, units and power supplies to sell; **MIND-BOGGLING AMOUNTS** of top quality gear to almost give away!! If you use electronic components and equipment, tools, hardware etc, there's bound to be something for **YOU** in these 32 pages! Don't miss out - stocks move fast at these low prices, so place your order **TODAY** by phone, fax, post or in person!*

There are only 3 special conditions if you order from these pages:

1) The **MINIMUM GOODS VALUE IS £12.00** (although this can include goods from any of our lists or catalogues).
2) **POST & PACKING CHARGE IS £3.00**
3) Free gifts and reduced price offers from previous catalogues and supplements are not available with sale goods.

Regrettably, we cannot accept orders for **Sale Goods** that do not meet these requirements.

GREENWELD ELECTRONICS LTD 27 PARK ROAD, SOUTHAMPTON, SO1 3TB
TEL: (0703) 236363 FAX: (0703) 236307

BATTERY BONANZA!!!

Z4150 Ex mobile radio battery. 56 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.25V 600mA

Price **£3.00**

SALE PRICE £1.60

Z4149 As above but 84 × 66 × 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.25V 900mA.

Price **£4.50**

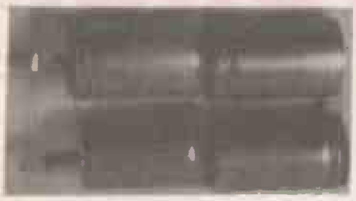
SALE PRICE £1.75

Z4216 Much sought after 4.8V 150mA batteries with PCB mounting tags on 25mm pitch. Battery size 25 × 16 dia. Ideal for paralleling. Some corrosion.

Prices reduced to .... **50p each** 25 + 0.35 100 + 0.25

SALE PRICE 5/ £1.00

NICAD BATTERY PACKS



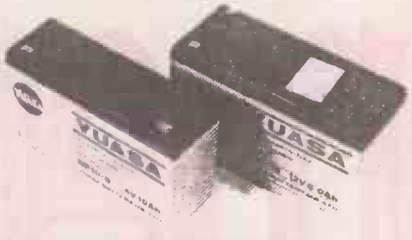
Z2349 Nicad battery packs. Brand new, intended for use in zonephones comprising 4 × ½A size cells each rated 1.2V 0.45Ah, size 16.1mm dia × 28mm in a plastic housing easily removed. Solder tag connections. DP £9.92.

Our price . £2.00 100 + 1.00 1k + 0.70

SALE PRICE £1.00

Z2539 PCB mntg 2.4V 100mA Ni-cads. These have a distributor price of 1.90 – but you can have one for £1.00; 25+ 0.60; 100+ 0.40

SALE PRICE 2 FOR £1



Sealed Lead Acid Batteries

YUASA NP6-12. 12V 6Ah sealed lead acid battery. These have been regularly trickle charged whilst in store. Size 150 × 95 × 65mm. List price £28.00

Order Code **Z8918**

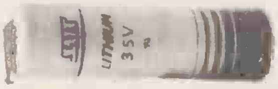
Prices .... **£14.95** 10 + 11.20

SALE PRICE £8.00

Z8977 12V 12A sealed lead acid battery by Yuasa. These are brand new and have and have a DP of 45.80.

Our Price £20.00

SALE PRICE £15.00



Z2452 Lithium battery – inorganic type by Tadiran, type TL5104. AA size, 3.6V PC tabs. Date code 06/88 **£1.70**

SALE PRICE £1.00

Z2453 As above, but type SL360, date code 4/87. **£1.50**

SALE PRICE 80P

Z2450 Tadiran AA size battery 3.6V PC mounting. Date code 6/89. DP on these is 5.17. Our price **£2.00** 25+ 1.50 100+ 1.20

SALE PRICE £1.00

Z2451 Tadiran 0.5AA size battery, 3.6V PC mntg. Date code 8/86. DP 4.58 Our price **£1.75**

SALE PRICE £1.00

Regular Nicads

Rechargeable Nicads

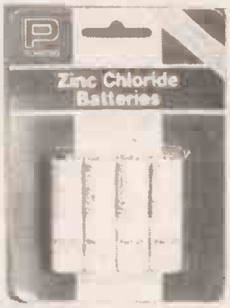
Code	Type	Rating	1+	25+	100+
X131	AAA	180mA/H	**£1.20**	0.85	0.68
X132	AA	500mA/H	**99p**	0.72	0.58
X133	C	1.2A/H	**£2.20**	1.76	1.41
X134	D	1.2A/H	**£2.30**	1.82	1.46
X135	PP3	110mA/H	**£3.95**	3.26	3.10

SALE PRICE 10% off

Regular Dry Cells

A range of batteries from Hi-Tech featuring long life and reliability at a competitive price.

Code	Type	1+	20+	100+
X111	AA/RG/HP7	**29p**	0.15	0.12
X112	C/R14/HP11	**50p**	0.26	0.21
X113	D/R20/HP2	**58p**	0.30	0.24
X114	PP3/6F22	**99p**	0.52	0.42
X115	1289/3R12	**99p**	0.52	0.42
X116	PJ996/4R25	**£2.57**	1.34	1.07



Low cost dry cells

2 popular sizes of battery on a card of 4 at very attractive prices.

X107

Price per pack of 4 .... **69p** 10+ 0.46 100+ 0.31

X109

Price per pack of 4 .... **76p** 10+ 0.51 100+ 0.34

Alkaline Batteries for heavy duty use

Code	Type	1+	20+	100+
X121	AA/ MN1500/ LR6	68p	0.39	0.30
X122	AAA/ MN2400/ LR03	68p	0.39	0.30
X123	PP3/ MN9100/ R6	£2.74	1.69	1.30

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT

MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

KRAZY KEYBOARD KLEARANCE!!!

Z8848 Keyboard by Cherry. Room for 104 keys, all normal keys (65) fitted. Chips on board: LS373 × 2, LS374, LM3086 × 2. LS138 × 3, 555, LS08, 6805. Size 442 × 175mm.

SALE PRICE £5.00

Z8852D Keyboard. Superb brand new high quality keyboard with LCD displaying 1 line of 10 characters and a further line with various symbols. 100 keys, inc seperate numeric keypad. Chips on board are 2x74HC05, 80C48. LCD + driver chip are easily removed. **Amazing low price – only £10.00**

SALE PRICE £5.00

Z8863 Keyboard. High quality unit made by Micro Switch. 69 pale grey and blue keys. 6 red 5mm LED's, 15 various LS chips.and socketed D8048 by Intel. Output via 7 way plug and there's a 4 way edge connector too. Keyboard frame is 317 × 128mm. PCB on which it's mounted is 285 × 170mm.

SALE PRICE £6.00

Z5026 Membrane keypad. Essentially a PCB 365 × 92mm. Used as a front panel. 30 keys connected to a 16 pin plug. Cut outs for 2 displays (80 × 22mm) and 10 lamps/LED's (13 × 8mm).

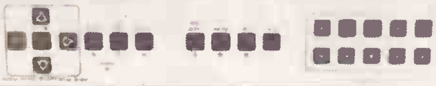
Price **£2.00**

SALE PRICE £1.00

Z4363 Membrane keyboard 225 × 84mm with 11 keys - 1-9 & 2 others. Output (common bus) on 12 way ribbon cable. Could be cut down to 95 × 70mm if only 1-9 needed.

Price .... **60p** 100 + 0.30

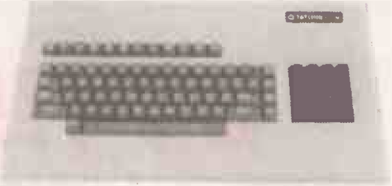
SALE PRICE 30P



Z4364 Computagraph Colorwriter panel 352 × 67 × 12mm. Ally frame supports a membrane keyboard which has 22keys. On the rear of the panel are 6 yellow submin LED's, a 3mm red LED and 2 × 19W edge conns.

Price **£1.00**

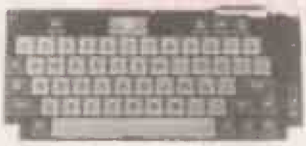
SALE PRICE 50P



Z8842 Tatung VT4100 keyboard. Cased 85 key units with separate numeric keypad. With circuit. Has 2 or 3 broken key tops. 450 × 65 × 125mm.

Price **£9.95**

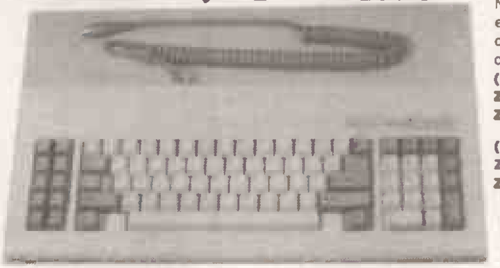
SALE PRICE £5.00



Z8882 Keyboard from Liberator Computer. 278 × 124mm. 62 keys. Some of these have been used. Output to 20 way connector.

Price **£5.00**

SALE PRICE £2.50



Z8980 PC/AT Keyboard Standard 84 key, brand new in original packaging offered at a fraction of their original cost! Top quality, made by Alps, they have an excellent touch. Nicely contoured case, Caps Lock, Num Lock, and Scroll Lock LED's, and curly lead with 5 pin DIN plug. **Our Price £19.95**

SALE PRICE £12.00

Z1797 Membrane keyboard 155 × 113mm with 80 × 22m aperture for display from case Z4245. 22 keys. Output to 11 way flexible connector. Self adhesive.

Price .... **Only £1.00**

SALE PRICE 50P

Z8981 89 key keyboard intended for the Torch computer – this was the all singing, all dancing upmarket BBC based business machine. 10 function keys. 6 core curly cord. Uses 8749, 8251 and other chips. Made by Alps – amazing value at £9.95

SALE PRICE £5.00

Neat keypads in various styles by ORCOM, both with encoded and matrix outputs. All PCB's have room for coder chip (74C922) to be fitted. All feature 0-9 keys and other characters as shown. Output via 20 pin plug. Data supplied.

(a) No chip fitted:

Z5107 3 × 4 (★ #) **£2.00**
Z5108 4 × 4 (A-F) **£2.50**

(b) 74C922 fitted:

Z5110 3 × 4 (★ #) **£2.50**
Z5111 4 × 4 (A-F) **£3.00**

ALL ½ PRICE

Z4116 24 way (8×3) membrane keypad. Large (200×90mm) area – these were originally used as a teaching aid. Overlay template and pinout supplied.

.... **Now only £2.00**

SALE PRICE £1.00

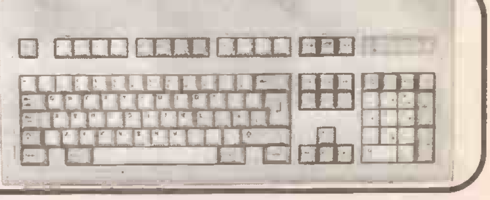
PC KEYBOARDS

After the Russian keyboards featured in Bargain List 74, we've now purchased some French (sacre bleu!) and German (Donner und Blitzen!) varieties. Slightly different character set to UK models.

Brand new in original packaging. High quality, made by Intelligent, switchable AT/ XT offered at a knockout price:

Z8954 French **£20.00**
Z8955 German **£20.00**

SALE PRICE £12.00



BULK LED's

Now! Standard LED's at prices from less than 2p each! This parcel was supposed to contain a variety of shapes and colours for our LED packs - but there are too many standard red ones to mix in, hence this too good to miss offer!!

Code	Colour	Size	Shape	Manf'r/Type	Lead length	£1 pack	100+	1k+
Z2090	Red	5mm	○std	QTMV5752	28.5	15	0.032	0.025
Z2091	Red	5mm	□std	Liton LTL9223A	29.5	12	0.038	0.030
Z2094	Red	3mm	○min	MLR327	17	18	0.030	0.022
Z2098	Red	7 × 2.55	Rect	Senior elecSE6511D	32	12	0.038	0.030
Z2095	Red	5mm	Rect*	Phillips HR44DL	26	12	0.038	0.030
Z2096	Clear(IR)	4.5 × 1.5	Rect	Honeywell 8406	20	8	0.060	0.040
Z2097	Red	5 × 2	Rect	GIMV57123	29	12	0.038	0.030

* Square with rounded corners

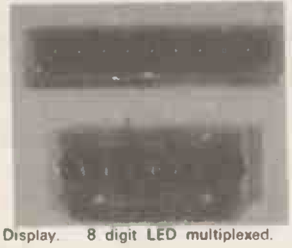
10k + mix of any of the above	**0.02**
100k + mix	**0.016**
Total available 250k +	

AMAZING VALUE !!!

TRICOLOUR LED BARGAIN

F166T Chrome holder needs 10mm hole. LED has 3 leads – common, red and green, when used together produce yellow. These normally sell for around 80p each – Our special offer price 4 for £1.00; 100+ 0.12; 1000+ 0.09

SALE PRICE 8 FOR £1.00



Z415 Display. 8 digit LED multiplexed. With data. 31 × 16mm.
Price 80p

SALE PRICE 2 FOR £1

Z416 Display. 9 digit LED multiplexed. With data. 42 × 10mm.
Price 90p

SALE PRICE 2 FOR £1

Z2434 Dual 7 seg LED , type TDDR5250 by TFK. Red common anode 13mm digit height. DP 1.14. Our special low price (we have 10000 to clear) 2 for £1.00; 100+ 0.25; 1k+0.18

SALE PRICE 4 FOR £1

Z2435 Single 7 seg LED 10mm high digit. Type LN514RK. Common cathode. 4 for £1.00; 100+ 0.15; 1k+ 0.10

SALE PRICE 8 FOR £1

Z2362 MS463M 0.6" common cathode 4 digit multiplexed display on PCB 70x30 with 15 way connector. Intended for digital clock use. Supplied with pin out. **ONLY £1.50**

LED Displays

0.3in (7.62mm) Display Height

H - 19.05
W- 10.16
D - 5.4

Pin spacing 2.54
Row spacing 7.62

(a) 0.3" (7.62mm) display height; luminous intensity 0.6mCd @ 10mA

Code	7/+1	DP	CC/CA	1+	25+	100+
Z1937	7 seg	LH	CA	**31p**	0.20	0.16
Z1938	7 seg	RH	CA	**31p**	0.20	0.16
Z1939	7 seg	RH	CC	**31p**	0.20	0.16
Z1940	+1	LH	CA	**20p**	0.13	0.10

0.5in (12.88mm) Display Height

H - 19.0
W - 12.7
D - 8.0

Pin spacing 2.54

H - 19.05
W - 25.0
D - 8.0

Row spacing 15.24

(b) 0.5" (12.88mm) display height; luminous intensity 0.8mCd @ 10mA

Code	7/+1	DP	CC/CA	1+	25+	100+
Z1943	+1	RH	CA	**23p**	0.15	0.12
Z1944	+1	RH	CC	**23p**	0.15	0.12

0.8in (20.32mm) Display Height

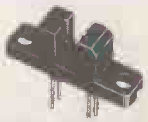
H - 27.7
W- 19.9
D - 8.38

Pin spacing 2.54
Row spacing 15.24

(c) 0.8" (20.32mm) display height; luminous intensity 0.8mCd @ 10mA

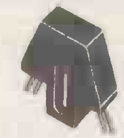
Code	7/+1	DP	CC/CA	1+	25+	100+
Z1948	7 seg	RH	CC	**47p**	0.30	0.24
Z1949	7 seg	LH	CA	**47p**	0.30	0.24
Z1950	7 seg	LH	CC	**47p**	0.30	0.24

ALL 50% OFF..!!

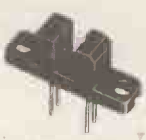


Z2122 Vactel Type VTL 10DI - IR emitter and detector can be removed from the plastic housing if required. An extremely cheap version of TIL100/TIL38!
Pack of 5 .... **£1.00** 100+ 0.10 1k+ 0.07

SALE PRICE 8 FOR £1



Z1499 Opto slotted switch on small (25×26mm) panel Type P850 .... **75p**
Z1500 Opto reflective switch type OPB6076 with 3pin connector **75p**
PS4005 Opto slotted switch **£1.00**

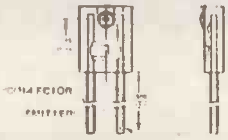


Z1743 TIL143 Opto slotted switch. These have cropped leads and some are ex-equip, but are all working.
Price .... **Pack of 3/ £1.00**

SALE PRICE 8 FOR £1

Z1847 4 Phototransitor SDP8405 with data.
Price £1.00

SALE PRICE 2 PACKS £1



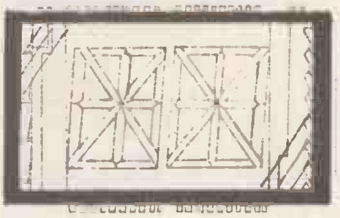
Z1846 2 pairs of infra red emitter/ receiver SDP8406/ 8506 by Honeywell with comprehensive data.
Price £1.00

SALE PRICE 2 PACKS £1

OPTO DISPLAYS

Z1731 NEC Vacuum Fluorescent Display FIP8BII. 8 digit multiplexed output 10mm high. Heater voltage 2V, grid/ anode voltage 24V. (Use Z4248 transformer to power).
Price **£3.00**

SALE PRICE £1.00



Z5118 Giant 30mm fluorescent 2 character green star burst display, 88 × 49 × 8mm. Futaba type 2-JY-O2Z. Needs 3V and 10-18V. Data supplied. **Only £2.00**

SALE PRICE £1.00

OPTO OPPORTUNITIES

Z5352D Densitron alphanumeric LCD module 40x1 character type H2572HT. Farnell's price 29.28 – Superdeal price £9.95

SALE PRICE £6.00

Z5351D Giant graphic module LCD – Hitachi LM213XB. 256x64 pixels, display area 150x43mm with built in controller chip. Farnell's price 69.84 – Our special low price £25.00

SALE PRICE £15.00

Z2543 Epson 4 digit LCD with 13mm high digits. 40 pin package. **Only £2.00 each**

SALE PRICE £1.50

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. **Just £2.00**

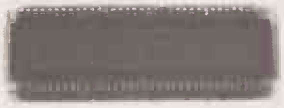
SALE PRICE £1.00

LCD MODULE

Z5096 16 character × 1 line. Very similar to our Z1814 but slightly larger character -6.3x3.15 (8 × 5 dots). Type LCDM16166 by Relac. Supplied with data. Uses Hitachi HD44780AOO chip.

Price £8.00

SALE PRICE £5.00

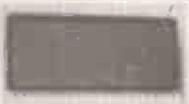


Z4115 8 digit 12.7mm high LCD and holder. These are 14 segment devices allowing alphanumeric display. Normally costing over £15.00 we are offering these for just **£4.50**

SALE PRICE £2.00

Z4148 LCD as Z4115, but 6 digit 7 seg. 50 pins DP 10.86. **Our low price £3.00**

SALE PRICE £1.50



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

SALE PRICE 50P

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. **£2.00**

SALE PRICE £1.50

Z2172 40 character × 1 line LCD by Optrex (Japan). High quality double height display with 192 character ROM; other characters can be displayed by generation in RAM. Other features include cursor with control, blink character, scroll display, read and write display data, single +5V supply, data and power inputs by one 16 pin 0.05" SIL socket, pin outs standard and compatible with other Optrex displays, contrast control, easily interfaced with either 4 or 8 bit uP's. Supplied complete with data. Dimensions: Characters are 5 × 12 dot arrays measuring 3.2 × 10mm

Display size 170 × 17.5mm

Module size 220 × 40mm

DP over £50.00 **Our Price £15.00**

SALE PRICE £7.50

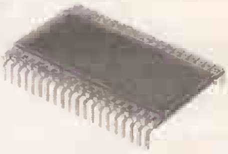
Z2498 Toshiba TLC501 LCD. 24 x 2 line display with standard connexions (supplied). V. similar to our Z2171 £9.95

SALE PRICE £6.50

Z4372 Epson LCD module EA-Y40040AT. 40 × 4 character format. Viewing area 156 × 34mm. Full alphanumeric 96 character set contained in the module's own memory. 5V supply. With comprehensive data. List price over £200.

Our special price **£40.00**

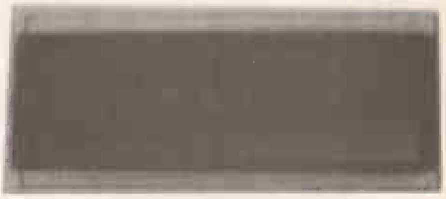
SALE PRICE £25.00



Z2119 4 digit LCD 12.5mm high with low battery and clock symbol. Complete with edge connector.

Price .... **£1.60** 25+ 0.95 100+ 0.65

SALE PRICE 75P



Z2432 LCD 8 digit 10mm high. Single sided 36 way edge connector. **Only £2.00** 100+ 1.00 1k+ 0.80

SALE PRICE £1.00

GIANT DISPLAY

Z5328D Giant graphic dot matrix LCD by Citizen, model G6201. These measure 290x118mm and have a display area of 230x76mm. Resolution 640x200 dots (128k) with backlighting. DP is around £300. Our special low price, complete with 12 pages of data is **£49.95** (Data only, £1)

SALE PRICE £30.00

Uniqard Development Boards

E1S, E2S & E1D series are circultry development boards for memory (both dynamic and static. RAM and ROM) and also for combined CPU-memory function.

EPB series have backplane and motherboard uses (both 3U and 6U) and the smaller lengths are also used for extender cards. A range of profiles with and without mounting flanges and extra busbars are available. Used as high density memory development boards they only require a small amount of extra wiring.

Order Code	Type	Size	Price each
129B-PCB-006SF	E1S-00	3U 0.3"	**£12.62**
129B-PCB-007SF	E2S-00	3U 0.6"	**£12.62**
129B-PCB-011SF	EBP-02	Extender 3U-220	**£8.46**
129B-PCB-012SF	EBP-03	Extender 6U-160	**£18.18**
129B-PCB-014SF	EBP-05	Horizontal Mntg 6U-112	**£11.00**

SALE PRICES **75% OFF**

Line Termination Unit

Comes in 2 parts:

Z035 Grey ABS case 197 × 106 × 60mm with lid contains PCB with 2 relays, transformer etc. A 3m lead with 4 pole plug (old type) is fitted one end and a 6 way lead 1m long the other which connects to:

Z036 a PCB 265 × 143mm. This contains 5 × LM348, 4016, 4093 & ZNA2H006E chips + transitors, R's, C's, xtal, etc.

Both for £4, or individually Z035 £3.00; Z036 £1.00

SALE PRICES **Z035 £1.60** **Z036 60p** **Both £2.00**

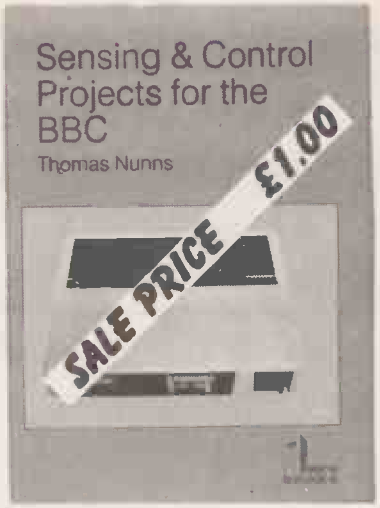
Electronic Organ Kit

EK2 High quality kit by OK. All parts supplied in attractive plastic case which becomes the housing for the finished project. Covers a full octave. £3.34.

SALE PRICE **£2.00**

Z4135 'Stethophone' mini stereo headphones, complete with stereo jack plugs. 8R. Hinged headband.
Price **£1.75**

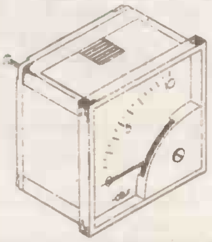
Z348 Optical Shaft Encoder. Made by sharp. Ideal wherever the position or speed of a rotating shaft needs to be know - ie machine tool control, robotics etc. Supplied with comprehensive data sheet. Size of module 46 × 33.5 × 20mm; size of disc 28mm dia. Bush with grub screw will take a 4mm dia shaft. Disc has 96 slots. DP £48.19.
Our Price **£8.50**
Data sheet available separately **30p**



'Go Forth' by Paul Kail
An introduction to Forth Language. It's as easy to use as BASIC, but is much faster. This book is a complete foundation course in Forth programming, and contains a number of complete programs. Originally published at £8.95.
Our Price **£2.00**

SALE PRICE £1.00

10A PANEL METER



Z5335 Very smart panel meter by Hobut, brand new & boxed 72 x 72 mm. Scaled 0 – 10A AC. Moving iron model no D72SD. List 12.51.
Our Price £4.00 100+ 2.50

SALE PRICE £2.50

LANGUAGE CASSETTES

Now our ties with Europe are becoming closer, you'll need to learn a foreign language. Just so happens we've purchased a job lot of language tapes to prepare you for this eventuality - and we don't just stop at the EEC! Expand your horizons - learn Russian too!

These are Normans Language Courses. Each consists of a C90 EMI cassette tape in library case with a 32 page book covering a wide variety of subjects, supplied in a plastic wallet. OK, so its not your Linguaphone course, but very useful - especially at the price we are asking!!

Z5060 Italian **£2.00**
Z5061 German **£2.00**
Z5062 Portuguese **£2.00**
Z5064 Russian **£3.00**

We also have a number of Erotone books - a 32 page 'Listen,Repeat & Learn', and a 48 page 'Phrases & Useful Information for the Traveller'. (No tapes with these.)

Z5065 French (2 books) **£1.00**
Z5066 Spanish (2 books) **£1.00**

Two more audio cassettes arrived with this parcel:

Z2124 'Public Speaking' by Dorian Williams - C90 tape giving some very useful information on the subject. **£2.00**

Z2125 Hans Christian Anderson's Fairy Tales. A C90 cassette with 7 stories on it - inc The Gingerbread Man, Goldilocks, 3 Little Pigs, etc. **£2.00**

ALL HALF PRICE

BBC 'B' SOFTWARE - FINAL CLEARANCE

This has been cluttering up our stores for far too long - (SAE for more information, colour leaflets).

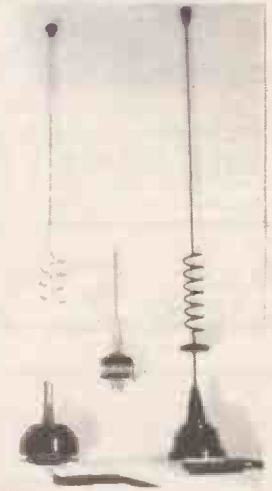
Micro Maestro - Comprises 5¼" disk + computer tape; 16 page handbook; C60 stereo cassette with backing tune of popular tracks like 'Ghostbusters', 'Chariots of Fire', and 'Superman'. **Original Price £17.95.**
Z4333 Concert Pitch **£4.95**
Z4334 B^b **£4.95**

Music Master - Comprises microphone to attach to recorder + processing device; 5¼" disk; 12 page handbook. **Original Price £52.78.**
Z4326 40 track disk **£14.95**
Z4327 80 track disk **£14.95**

Mupados Recorder Tutor - Comprises 5¼" disk; 38 page large format spiral bound handbook; C90 stereo cassette with 52 tunes. **Original Price £30.94**
Z4328 40 track disk **£7.95**
Z4329 Ensemble Pack **£2.95**
Z4330 Duet Pack **£2.95**
Z4239 Recorder tutor Classroom Ensemble Network pack, for use when several micros are being utilised. Includes 2 disks, a cassette and book.
Price **£4.95**

ALL HALF PRICE OR 10 ASSORTED (OUR CHOICE) £10

Cellular Mobile Aerials



A few different types, all new in original packing.

Z5281 Antiference TAP9036 ¼ + ½ wave 3dB. Frq 890–960MHz VSWR 1.5:1. Includes ¾" claw mount with 5m of RG58 cable. Complete with fitting instructions. Only £3.00

SALE PRICE £2.00

Z5282 ZS Electroniques ZS914–09 claw mount with 4m cable and fitting instructions £3.00

SALE PRICE £1.50

Z5283 Jaybeam MU904–ZG/h with 4m of cable attached. £3.00

SALE PRICE £2.00

MODEM MADNESS

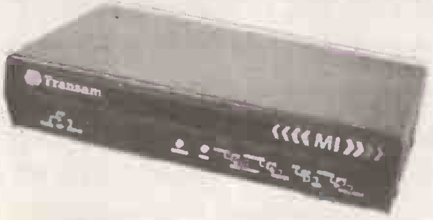
This parcel consists of several hundred brand new BT approved modems - but we are not allowed to say who makes them. They do, however, offer extremely good value for money, as they are being sold for a fraction of their true worth

Z8973D V21/V23 300 or 1200/75 baud modem. New, boxed and complete with power supply and some data. Plugs into std BT skt and RS232 port on any computer. Tone/auto dialling + last number re-dial. Size 205x195x30mm. Front panel has reset button and 5 status LED's. **Only £49.95**

SALE PRICE £20

Z8953 Complete unit with power supply and comprehensive instructions. Designed to add the facilities of error correction, speed buffering, encryption (optional) and a battery backed data store with a printer port to existing modems capable of speeds up to 2400 baud. Easy to use. (Send £5 returnable deposit for user manual for further information). **£20.00**

SALE PRICE £10



Z8974D Transam M1 mobile/mains intelligent modem. New and boxed with mains plug in power supply (9.5V 800mA). Auto dial and answer, V21/V23, buffered terminal interface from 75-9600 baud, password access. Black steel case 230x150x50mm. Rear panel has lead with BT plug, 15 way D skt for radio interface (needs S5/8 - RS232 converter) and 12V input skt. On the front panel there's these switches: ext/batt/off; auto/manual answer; originate/answer; 300/1200; normal/intelligent. Comprehensive 36 page user manual (Photocopy for £1.50). **Our Price £50.00**

SALE PRICE £25

SEMICONDUCTORS

We've got millions - far too many to list here. Everything from diodes to micro-processors - all available on a seperate list, on request

Z8937 One to One 21/23 IAD CCITT V21/23 auto answer modem 300, 1200/75, 75/1200 baud full duplex, 1200 baud half duplex Tx or Rx. Made by Master Systems Ltd.
Complete, new and boxed modem suitable for use with micro computers with RS232C interfaces. Professional quality modem featuring full auto dial, last number redial, selectable baud rates, speed conversion to allow DTE/DCE communications to proceed at an apparent 1200/1200 baud (all functions operated by control characters sent from DTE), auto answer, internal bell or CCITT standards switch, and many other useful facilities. Comes with comprehensive 76 page manual, external power supply and 25 pin Din standard DCE connector. **£75.00**

SALE PRICE £25

Z6123 Modem. Fully functional brand new and boxed. Standard 160 × 100mm Eurocard with DIN41612 connector. Only 300 baud, but at the price we're asking represents superb value for money!! Supplied complete with wiring details - needs ± 12V.

Price .... **Only £14.95**

SALE PRICE £8.95

Dataspectrum

Z6138 Modem serial interface and software package. Plugs directly into spectrum edge connector. Baud rates 1200/ 75,. 75/ 1200, 300/ 300. Allows use of Prestel, Viewtext user-user comms with suitable modem. Includes Prestel telesoftware downloader. Main menu options include: Transmission Format selection, Prestel ID storage, Viewdata mode entry, Teletype mode entry, Frame processor, Mailbox editor, Save. Complete and new with cassette and user guide in plastic case. **Only £7.00**

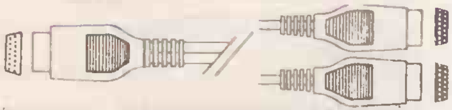
SALE PRICE £4

Databeeb

Z6139 Intelligent comms ROM. Complete comms firmware allowing Prestel, Viewtext, Bulletin Board, Telex, Database, user-user comms with a suitable modem on BBC computer. Allows baud rates of 1200/ 1200, 1200/ 75, 75/ 1200, 300/ 300, 600/ 600. Full fitting instructions and user guide supplied in plastic case. **Only £7.00**

SALE PRICE £4

SPLITTER LEAD



T196A Dual splitter lead (2 x 15 way D kts one end, 1 x 15 way D plug the other) for use with BBC computer. Length 2x0.5m

SALE PRICE 2 FOR £1

Z4132 Firing speed adjuster. Neat device for connecting between joystick and Atari/ Commodore etc computers. Switched pot enables firing speed to be changed. 9 pin 'D' in and out.

Price .... **Only £1.00** 100 + 0.35

SALE PRICE 2 FOR £1

SB9 DRAGON INTERFACE

Interface unit to convert digital input (as obtained from Atari-compatible joysticks) to the correct analogue level for use with such home computers as Dragon, Tandy Colour, Radio Shack, etc. Two separate channels for competitive games. Two 5-pin 240° DIN plugs to compact case with two 9-pin plugs, with internal circuitry and connections for Atari-type joysticks. Black plastic.

Dims:- ....(Body) 116 x 62 x 29mm

SALE PRICE 3 FOR £1

MICROPHONE

G158 Sub-min omni directional electret condenser tie pin microphone with 5.9m lead. Takes 1.35V mercury battery in body of plug. Packed in vinyl case. 600R; FR 50-16000Hz; Sens. -64dB @ 1kHz; dia 8mm; length 18mm £12.95

SALE PRICE £7.50

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT
MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

PACKS - PACKS - PACKS - PACKS

All our packs contain top quality, brand new full spec components (unless otherwise stated) and represent incredible value for money! How do we do it? By purchasing bankrupt stocks and manufacturers surplus. It's too costly to sort and catalogue all these parts, hence these outstanding packs at extraordinarily low prices - so stock up now!!

Please note most packs are calculated by weight: quantities quoted are approximate, but we do try to ensure contents are at least the number specified.

SEMICONDUCTORS

K547 Zener Diodes. Glass and plastic, 250mW to 5W ranging from 3V to 180V. All readily identifiable, with list supplied.

Price .... 100 for £4.95

SALE PRICE £2.75

K709 Bridge Rectifiers. Another superb value pack - could include anything from ½ amp to 35A, 25V to 1000V, plastic and metal.

Price .... 20 for £6.95

SALE PRICE £4.50

K710 SCR's & TRIACS. Big mixture could include all types from TO92 plastic up to DO5 stud mounting with a chance of everything in between! 25V to 1000V, 100mA to tens of amps. Marvellous value.

Price .... 25 for £5.95

SALE PRICE £3.50

K708 Voltage Regulators. This is an excellent pack, made up from a huge variety of the +ve, -ve, fixed and variable regulators from 1.2V to 37V, 100mA to 5A, plastic and metal.

Price .... 25 for £6.95

SALE PRICE £5.00

K517 Transistor pack. 100 assorted full spec. marked plastic devices PNP NPN RF AF. Type numbers include BC114, 117, 172, 182, 183, 198, 239, 251, 214, 255, 320, BF198, 255, 394, 2N3904 etc, etc. Retail cost £16.00+

Special low price £5.95

SALE PRICE £3.50

K575 Plastic Power pack. Mainly TO126 and TO220 transistors, SCRs, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.

Price 50/ £7.95

SALE PRICE £4.50

K576 Mixed pack of TO220 and 4 pin power mosfets with data and pinouts. Types may include: 2N7004/5/6/14, IRF620/710/720/820, IRF9520/9620, VN0300D etc.

Price .... Pack of 25/ £8.00

SALE PRICE £4.50

K577 Surface mount FETs including SM versions of 2N4340/1, 4392, 4857, 5488/9/60/1, also 2N7001/2 etc. Big variety at a low price!

Price .... Pack of 50/ £4.00

SALE PRICE £2.50

K536 74 Series Pack. 'On board' chips for you to desolder - containing many LS and other types. Good mix.

Price 100/ £4.00

SALE PRICE £2.50

K711 74 Logic Pack. All brand new full spec devices from basic gates to complex logic. May include 54 & 64 types as well as 74 in L, LS, S, ALS, H, HC, HCT, etc.

Price for pack of 100 .... £6.50

SALE PRICE £4.50

K537 IC Pack - a mix of linear and logic chips, from 6 to 40 pin. All are new and marked, but some may not be full spec.

Price/ 100 .... £7.50

SALE PRICE £4.50

K560 We've now collected together enough semis to offer this pack again - it was extremely popular a couple of years ago. All types of semiconductor included - diodes, transistors, I.C.'s etc all new full spec and marked. Qty is aproximate depending on the number of power devices included.

Price .... Pack of approx 100 £5.95
300 £12.95
1000 £42.95

CAPACITORS

K544 Mullard Polyester Caps. Cosmetic imperfections, electrically OK. Wide range of values from 0.01 to 0.47µF in 100, 250, 400V working.

Price 200/ £4.75

SALE PRICE £2.50

K546 Polystyrene/ Mica/ Ceramic Caps. Lots of useful small value caps up to about 0.01µF in voltages up to 8kV. Good variety.

Price 100/ £2.75

SALE PRICE £1.75

K528 Electrolytic Pack. Axial and radial some ready cropped for PCB mounting. This pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF. 6V to 100V.

Prices 100/ £4.50

SALE PRICE £2.75

K518 200 Disc Ceramic Caps. Big variety of values and voltages from a few pF to 2.2µF; 3V to 3kV.

Price £2.00

SALE PRICE £1.30

K530 100 Assorted Polyester Caps. All new modern components, radial and axial leads. All value from 0.01 to 1µF at voltages from 63 to 1000!!

Super value at £3.95

SALE PRICE £2.50

K582 Polystyrene Caps. An amazing range of values from a few pF to .01. Tolerances 1-20%. Voltages to 500V.

Price .... Pack of 200/ £4.00

SALE PRICE £2.00

K714 Power Supply Capacitors. All cans, mostly computer grade including popular values like 10,000µ 40V etc. Big mix of values and voltages up to 100V or more and 50,000µF.

Price for box of 25 .... £12.50

SALE PRICE £10.00

K548 Tant bead capacitors A variety of values and voltages.

Price .... Pack of 50 £3.00

K549 Trimmer capacitors. A nice selection of small value caps ranging in value from a few pF to 100pF or more. Various dielectrics.

Price Pack of 20 .... £1.75

RESISTORS

K523 Resistor Pack. 1000 - yes, 1000 mainly ½W 5, 10% & 20% carbon/ carbon film resistors with preformed leads for PCB mounting. Fair range of preferred values.

Prices .... Only £2.95

SALE PRICE £1.50

PACKS - PACKS - PACKS - PACKS

K580 Metal Oxide Resistors,TR4, 0.25W by Electrosil. Wide range of values, mostly 5%, few closer tolerances. Super value for money

Price .... Pack of 200/ £2.00

SALE PRICE £1.20

K531 Precision Resistor Pack - High quality, close tolerance R's with an extremely varied selection of values mostly ¼W and ½W tolerances from 0.1% to 2% - ideal for meters, test gear etc.

Prices 250/ £3.00

SALE PRICE £1.50

K572 Resistor Networks. Both SIL and DIL in here, from 6 to 16 pin. Plenty of popular values like 1k, 4k7 and 10k, and a good sprinkling of many other values.

Pack of 100 .... £4.50

SALE PRICE £2.25

K503 100 Wirewound Resistors. From 1W to 12W, with a good range of values.

Price £3.50

SALE PRICE £2.00

K525 Preset Pack. Big, big variety of types and sizes - sub-min, min and std, MP, slider, multiturn and cermets are all included. Wide range of values from 20R to 5M. 100 assorted.

Prices £6.75

SALE PRICE £3.50

K505 20 Assorted Potentiometers. All types including single, ganged, rotary and slider.

Price £2.30

SALE PRICE £1.20

K827 Cermet trimmers. An excellent range of multiturn miniature cermets from 10R to 2M

Price .... Pack of 50 £7.95

SALE PRICE £4.50

K828 'Lo-ohm' wirewound pack. Values less than 10R are always popular, and this pack contains only resistors between 0R1 and 10R

Price .... Pack of 50 £4.30

SALE PRICE £2.50

K554 Thermistors. A mix of PTC & NTC mostly rod and disc types, but including some VA3102 beads(cat 6.20 each) as well. Great value.

Price .... Pack of 50 £5.00

SALE PRICE £3.00

OPTO

K701 110V Indicators. This pack of neon indicators comprises round and square panel mounting types in red, green, amber and clear.

Price .... Pack of 20 £2.50

SALE PRICE £1.75

K539 LED Pack. Not only round but many shaped LED's in this pack in red, yellow, green, orange and clear. Fantastic mix.

Price 100/ £6.50

SALE PRICE £3.95

K806 LED Pack. Contains only red LED's - round, square, rectangular etc, from 3mm to 7 × 2.5mm.

Price 100/ £5.00

SALE PRICE £3.00

K524 Opto Pack. A variety of single point and 7 segment LED's (incl. dual types) of various colours and sizes, opto isolators numicators, multi digit gas discharge displays, photo transistors, infra red emitters and recievers.

Price .... 25 asstd. £4.50

SALE PRICE £3.00

K801 Seven seg. LED pack. Big variety of sizes in this pack. May include Red and Green, also overflow/ polarity displays, single/ double digit, also 7/ 8/ 9 digit. magnified displays. Sizes from 0.11" to 0.8".

20 pieces for just **£3.95**

SALE PRICE £2.50

K804 Lamp Pack. A superb quality pack containing a wide variety of small lamps. Many different types - wire ended, bi-pin, slide, MBC, MES, LES,TI, wedge, miniflange etc in voltages from 2.5V to 220V. Most are marked with voltage/ current.

Pack of 50 .... £4.00

SALE PRICE £2.50

SWITCHES AND RELAYS

K532 Relay pack. We've now built up enough surplus relays to offer this popular pack once more. Could contain anything from 2V to 250V coils, SP to 6 pole contacts switching up to 10A!

Price .... 20 for £6.95

SALE PRICE £3.95

W4700 Push Button Banks. An assortment of latching and independent switches on banks from 2 to 7 way. DPCO to 6PCO. A total of at least 100 switches.

Prices 100/ £6.50

SALE PRICE £3.50

K587 A selection of toggle switches, mainly from page 122 of our 1990 Catalogue. Includes single pole to 4 pole sub min and min. Pack of 50, £30 at cat prices.

Price £14.95

SALE PRICE £9.95

K520 Switch Pack. 20 different assorted switches - rocker, slide, push, rotary, toggle, micro etc. Amazing value!

Price £2.50

SALE PRICE £1.75

K542 Reed relays. Mostly DIL, single pole & double pole also some changeover, these are manufacturers rejects, but a good proportion work. 5V-50V coils 50 assorted.

Price £3.30

SALE PRICE £1.50

K569 Reed Switch Pack. A selection of about 15 types of reed switch from submin 12mm long to 5A rated 50mm long, mosly form A (make), few form C (changeover).

Pack of 30 .... £3.25

SALE PRICE £2.25

K715 DIP Switch Pack Tremendous selection of DIP switches, mostly from Page 121 of 1991 catalogue. Everything from 1-9 way at an astonishingly low price! Pack of 20 3.25

SALE PRICE £2.00

K592 Pack of 25 miniature rocker and lever switches from page 125 of the 1991 catalogue. **4.00**

K593 Pack of 25 push and slide switches from page 125 of the 1991 catalogue **3.50**

K824 Rocker Switches , both miniature and standard, single and double pole illuminated red/green/amber and plain. Fantastic value.

Price £4.95

SALE PRICE £3.50

K825 As above but also included some illuminated push switches.

Price .... Pack of 20 £2.95

SALE PRICE £1.95

PACKS - PACKS - PACKS - PACKS

PLASTIC/ SLEEVING

K564 PCB Stand-offs. A mixture of 8 different styles and sizes from 4.75 to 12.7mm high
Price **100/ £2.95**
SALE PRICE £2.00

K826 Jumbo pack of plastic stand offs & a few cable clips & bits and pieces 1000 parts.
Price **£9.95**
SALE PRICE £6.00

K533 Silicon Rubber Sleeves. 15mm long, 5.5mm bore, 1mm wall.
Price **100/ 50p**
SALE PRICE 40p

CONNECTORS

K557 Terminal Blocks. In all shapes and sizes, solder and screw from single way to 12 way in many different current ratings.
Price **20/ £2.95**
SALE PRICE £2.25

K803 PCB headers pack with/ without ears, straight and right angle from 10-64 way.
Pack of 20 .... **£5.50**
SALE PRICE £3.00

K802 Pack of DIN41612 connectors. These popular PCB connectors come as 32/ 64/ 96 way. Both plugs and sockets, some with pins missing. Normally costing £1-£3 each.
Pack of 25 .... **£8.00**
SALE PRICE £5.00

K822 'D' Type connector pack. a good assortment of these popular connectors - both plugs and sockets in 9, 15 or 25 way with maybe the odd 39/50 way thrown in for measure.
Price .... **Pack of 30 £8.95**
SALE PRICE £5.95

K836 DIL Socket pack. A super selection of DIL IC sockets from 8 to 64 way, low profile and standard mntg, turned pin, tinned, gold plated, wirewrap and solder terminals.
Price .... **100 for £14.95**
SALE PRICE £9.95

K837 Lead pack. assortment of signal and power leads terminated with a variety of plugs and sockets.
Price .... **25 for £3.95**
SALE PRICE £2.00

K562 Edge connectors. Mostly 0.1 pitch, some 0.15, 0.156 and 0.2 as well. Single/ double sided, tinned/ gold plated, solder/ wirewrap/ PC connections.
Price .... **Pack of 20 £3.95**

K705 PCB Headers. SIL & DIL PC mounting header plugs straight & right angle mostly 0.1"pitch in a variety of ways from 3 - 30.
Price .... **Pack of 100 £6.00**
SALE PRICE £4.00

MOTOR + GEAR PACK

K579 This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc, 16 - 60mm dia + worms and shafts amazing value.
Priec **£7.95**
SALE PRICE £6.95

HARDWARE

K553 2BA screw mix. Mostly steel, few brass/nylon etc, cheesehead, hex, countersunk, slot & pozi, mainly in lengths from 7-63mm. Excellent selection.
Price .... **100/£2.60**
SALE PRICE £2.00

K552 4BA Screws. - Super mix of types, mostly steel, with round, pan, cheese, c/s heads in lengths from 5mm to 50mm. Great value.
Price .... **200 for £2.75**
SALE PRICE £2.00

K811 6BA screws. Nearly all pan head pozi in plated steel. Lengths to 16mm.
Pack of 100 .... **£1.50**
SALE PRICE £1.20

K807 M3 screws. Good selection of sizes including a few brass. Most heads. Lengths to 35mm.
Pack of 100 .... **£1.50**
SALE PRICE £1.20

K808 M4 screws. Huge variety! Pan, c/ s, cheese, set, slot, pozi. From 4-50mm long. All steel, plated, black/ hi-tensile.
Pack of 100 .... **£1.60**
SALE PRICE £1.30

K809 M5 screws. As above.
Pack of 100 .... **£2.00**
SALE PRICE £1.60

K833 M6 Pack. Excellent value - contains screws in various lengths and head. Mostly steel some hi-tensile
Price .... **Pack of 100 £4.50**
SALE PRICE £3.00

K830 M8 screws and bolts. Good assortment from 16 - 90mm long c/s, hex, pozi some hi-tensile. All steel!
Price .... **Pack of 50 £3.80**
SALE PRICE £2.30

K831 M10 Bolts. Mostly high-tensile hex head, lengths from 16-90mm.
Price .... **Pack of 20 £3.20**
SALE PRICE £2.00

K832 M12 Bolts-mostly high-tensile hex head, lenghths from 40-15mm.
Price .... **Pack of 10 £2.40**
SALE PRICE £1.70

K820 Large bolts and set screws. Could weigh as much as 150g each (up to 16mm dia × 90 mm long). Practically all are steel. Many different heads.
Parcel weighing 5kg **£10.00**
SALE PRICE £7.00

K595 Big mix of screws - very few BA, mostly metric, BSF, Whitworth, DZU etc. Tremendous variety of heads - cheese, cs, pan, hex, allan, round etc, etc. As for size, well we've seen some as small as 3mm and a few as long as 80mm. There's even some 12.5mm dia in this pack! You'll probably also find a few odd clips, washers, nuts etc, too. 500gm pack **£2.70**
SALE PRICE £2.00

Z7005 Screw and nut pack ¼" Whit: 25 each of 38mm C/S, 25mm C/S, 63mm (threaded 14mm) hex bolts and 25mm (threaded 14mm) hex bolts + 100 steel nuts.
Price .... **Pack of 200 parts £5.00**
SALE PRICE £3.50

K812 Pack of 100 assorted rivets **£1.80**
SALE PRICE £1.20

K550 Self tapping screws. both pointed (AB) and blunt (B) in an assortment of sizes from 6mm to 32mm long. No4 to No8 hex and Pozi head. Excellent value
Price .... **200 for £1.50**
SALE PRICE £1.25

K596 Assorted nuts, believed to be all BA size from 2BA-8BA. Mostly steel
Price .... **Pack of 200 £2.40**
SALE PRICE £1.90

PACKS - PACKS - PACI

K535 Spring Pack Approx 100 assorted compression, extension and torsion springs up to 22mm diameter and 30mm long.
Price..£1.70
SALE PRICE £1.00

K527 Hardware Pack. This has a large variety of PK (caps) and self tapper screws from 2 × 1½" up to 8 × 1¼"also washers, some BA, metric and Whit. Screws plus other miscellaneous brackets, captive nuts and bits and pieces. 1kg(up to 1000 pieces).
Price...1kg/ £4.00
SALE PRICE £2.50

K599 Captive, shakeproof and locking nuts in sizes from 2BA to 6BA, mostly alloy.
Price per pack of 100 ....£3.20
SALE PRICE £2.00

K821 PC pins - SS & DS, insulated and plain for holes 0.8 - 1.2mm
Price..............................Pack of 200 £1.50
SALE PRICE £1.00

MISCELLANEOUS

K555 Fuses. A marvellous selection of 15, 20, 25 and 32mm fuses both cartridge and wire ended in quickblow and antisurge varieties. May be anything from 32mA to 50A!!
Price 100/ £3.95
SALE PRICE £2.50

K829 Transducers. Piezo, electromagnetic, permanent magnet in assorted sizes from 15mm dia upwards. Lovely mix.
Pack of 25..£3.50

K823 Pack of 10 piezo and electromagnetic transducers, PC mounting and with leads. Various sizes and shapes from 15-30mm dia. Manf'rs include Star and Murata. Supplied with info sheet showing drive circuits etc. **£2.50**

K834 Thermal Fuses.- 104, 109, 121 & 152°C some with cropped leads.
Pack of 20..£2.95
SALE PRICE 2.00

K581 Copper clad board. A selection of single and double sided, mostly fibreglass in useful sizes:
200 sq ins..£3.00
SALE PRICE 2.00

K835 Transformer Pack. All mains primary, secondary range from 6-24V, 0.5 to 2A.
Pack of 25..£18.00
SALE PRICE £10.00

K574 Wire link pack. A wide range of sizes from 3mm to 50mm for use with Breadboards or PCBs. Some are bare, a few are not preformed.
Price per pack of 250 .... £1.00
SALE PRICE 75p

K561 Coils and Chokes. Pot cores, IF cans, open wound coils, chokes, etc from a few µH upwards in a wide variety of sizes and values.
Prices 50/ £2.80
SALE PRICE £2.00

K573 Pack of assorted TOKO RCL coils, mainly in 10 × 10mm screened cans.
Price 100/ £6.00
SALE PRICE £3.00

K541 Printed Circuit Boards. A wide variety of high quality printed circuit boards including audio, RF, digital etc all covered in components - resistors, capacitors, transistors, ICs, LEDs, switches etc, etc. A big pack of 2kg.
Price .... Only £7.00
SALE PRICE £4.00

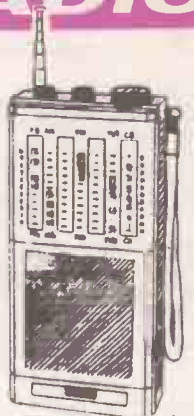
K712 Crystals. Mostly HC60 and HC18U in a wide variety of frequencies from a few hundred kilohertz to many megahertz and the odd crystal oscillator module or two.
Price .... 20 for £4.95
SALE PRICE £4.00

K713 Fuseholders. Panel and chassis mounting from a basic clip to high current enclosed types for 15, 20 and 32mm fuses.
Price for pack of 50 .... £4.00
SALE PRICE £3.00

Power Supply Parcel

K506 This one's an absolute gem! Contains a selection of conventional and switch mode power supplies, including AA12531, Z660, (these 2 alone are worth what we're asking for the entire parcel!) Z5307/ 8 Z5226/7 + lots more! Parcel of 10 originally selling for £40+.
SALE PRICE £15.00

MULTIBAND RADIOS!

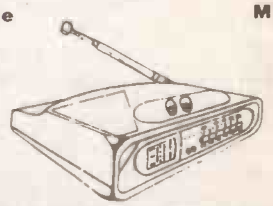


This compact piece of equipment 200 × 95 × 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume, squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

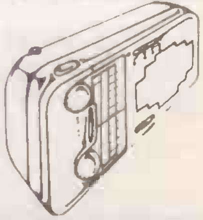
1) CB, channels, 1-80
2) TV1 54-87 MHz & FM 88-108 MHz
3) AIR 108-145 MHz & PB 145-176 MHz.

The large 3" full range speaker delivers 280mW of undistorted power. There is an earphone jack and DC adaptor jack. The unit is powered by 4 × AA cells. All this technology for just **£17.95**

Order Code MB100



Z4357 Clock Radio by Ross. Extremely neat unit measuring 140 × 80 × 35mm. MW/FM bands, telescopic aerial, stand, carrying pouch and strap. Clock has LCD display and can be used in 12 or 24 hr mode. Alarm. Light. Earphone socket. Takes 2 × AA cells.
Great value at £13.95

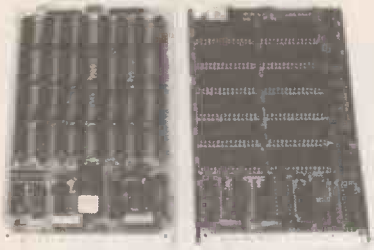


Z8891 Superb 4 waveband radio by Ross, model RR5. Covers FM 88-108MHz, MW 518-1610kHz, LW 150-275kHz SW 5.7-18.1MHz (16.5-52.6m). Nicely styled case measuring 210 × 145 × 70mm with clear scale markings. Telescopic aerial, headphone socket. Volume, tone and tuning controls. ON/ OFF switch/ waveband selector switch and AFC switch. Mains/ battery. (Takes 4 × C cells). Originally retailed at £19.95
Our Price £14.95

PANEL PREPONDERANCE!!!

PANELS

A collection of 4 panels, all Eurosize (160 × 100mm) with 64 way DIN plugs fitted.



Z5089 32 × TC5514AP-3 1k × 4 STATIC RAM, plus few other chips etc.

Price **£3.00**

SALE PRICE £1.50

Z5090 12 × M5M5165P-15L 8k × 8 STATIC RAM, plus few other chips etc.

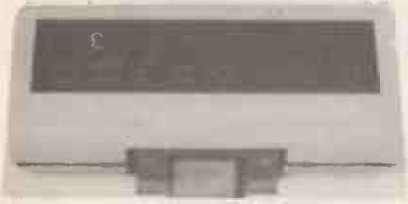
Price **£4.00**

SALE PRICE £2.00

Z5092 8 × HM3-6514-9 (1k × 4?) RAM plus few other chips.

Price **£1.00**

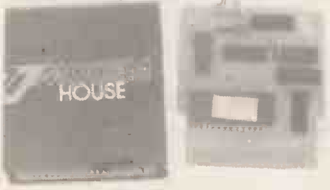
SALE PRICE 50P



Z5093 Till display. Plastic housing 200x95x45mm contains PCB 195 x70mm with 8 7-seg HP LED'S type 5082-7651, red 0.43 CA;, 16 5mm red leds, 8255 programmable interface and other chips etc.

Price **£2.50**

SALE PRICE £1.50



Z030 This add-on connects to the user port of the C64 and gives a serial output to a 5 way domino plug. Believed to be new and working. Components on the panel are 27256, 6502, 02, 174, 4049, 52, 60. Cased.

Price .... **Reduced to £3.95**

Z031 As above, but uncased now only **£2.95**

SALE PRICE £2.00 £1.50

Motor Panels

PCB 92 × 31mm with mercury tilt switch, 2 VTL 10D2 opto slotted switches, length of 11 core cable with socket and stepper motor as described above.

Order Code **Z5046**

Prices .... **£3.50** 100 + 2.20

SALE PRICE £1.95

1W Amplifier - mono

Z914 Audio amp panel 95 × 65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol control. Just connect battery and speaker. Full details supplied.

Prices .... **Only £1.50** 25 + 0.80 100 + 0.60

SALE PRICE 75P

1W Amplifier - Stereo

Z915 Stereo version of above 115 × 65mm, featuring 2 × TBA820M and dual volume control.

Prices reduced to .... **£3.00** 25 + 1.80 100 + 1.20

SALE PRICE £1.50

Z5075 Interesting panel 155 × 80mm crammed with top quality components: SAB80C535 CMOS microcontroller for external RAM in socket (DP £10.95); 27CP128 EPROM in socket; 5 × LM339 + other chips, SIL resistors, DIL switch, IDC plugs and 5 × 24V relays with DPCO contacts

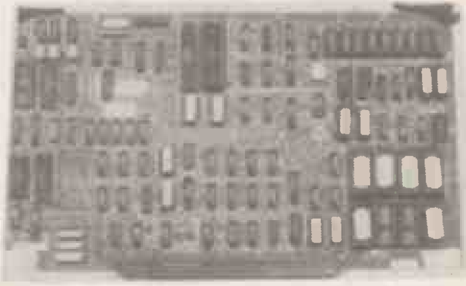
Price **£4.50**

SALE PRICE £2.25

Z4279 Interesting little panel (75mm × 40mm) with 16 position BCD channel switch (24 pins), 2 dual green 7-segment displays: 2 min keyboard switches, and a short A4093. Attached by a short length of ribbon cable is a second panel (same size) with 4518, 4019 and 2 × 5068 chips. Supplied with circuit.

Price .... **Only £2.20**

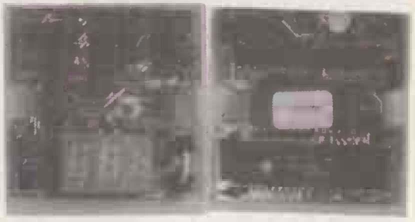
SALE PRICE £1.25



Z4235 Superb panel 340 × 200 packed with high quality parts, giving outstanding value for money! 6809 microprocessor in socket 6840, 6850, 6844 support chips; 6 × 27128-25 EPROMS in sockets; 9 × 8264A-10 RAMs; over 50 other chips, LS, linear etc.

Price .... **Reduced to £15.00**

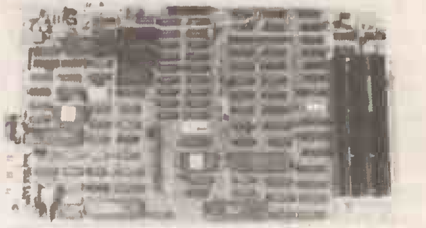
SALE PRICE £7.50



Z5044 Neat display panel comprising 2 boards, each 66 × 63mm held together by 4W, 6W and 18W plugs and sockets. Top panel has 3 × 7 seg 0.3" amber displays MAN4610A in sockets, 2 × HC374, HC368, 3 × BC184 + R's, C's etc. Lower panel has 27C64 in socket, HD63B03, HC138, HC373, R's, C's etc.

Excellent value at **£2.50**

SALE PRICE £1.25

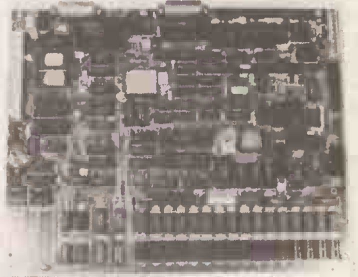


HIGH QUALITY ICL COMPUTER PANELS – 2 types, the first a mother board and the second a panel which plugs into the first.

Z4209 Panel 360×210mm covered in high quality chips: 8085AHC, 8255, 8257, 8251A×2, 8253 -5, 8275, 8202A, 2732, 2716, all in sockets; 18×4116-2 + other mainly LS chips + min switches, LED's, oscillator, large tants, 3×50 way double sided edge connectors. Amazing value at only £16.95

Reduced to **£9.95**

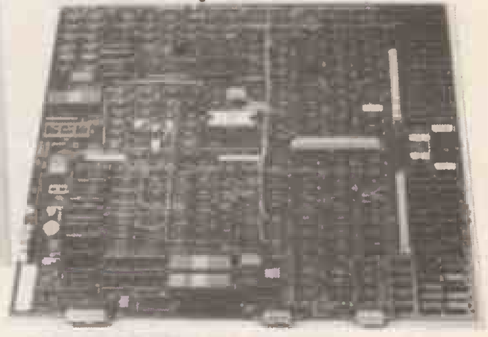
SALE PRICE £5.00



Z4210 Panel 260 × 210 which could plug into the above board. Lots of memory on this one: 36 × 4116-20. Also 8085AC, 8202 and 2716 in sockets + 55 other mainly LS chips, DIL switch, large tants etc.

Reduced to **£5.95**

SALE PRICE £3.00



½MEG MEMORY BOARD

Z8900 Massive panel 460 × 400mm smothered in chips. Could be a complete computer judging by the IC's on the board. Made by Whitechapel Computer Works. Contains at least the following (some panels have extra chips):
64 × 4164-15 RAM's; over 200 74LS, F and other logic chips; 3 × 4016-3, 2 × 8253-5,8251, 2 × 5516, 6 xtals, 3 × 'D' Plugs and sockets, 3 × DIN 64 way socket, + R's, C's etc. Price equivalent to 4164's @ 30p each and rest of chips @ 3p each!

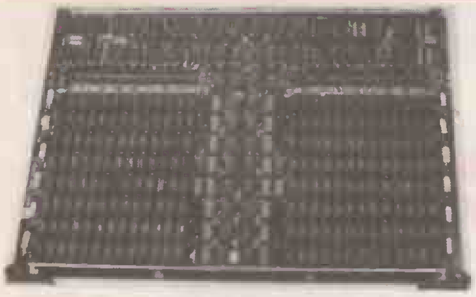
Price **£25.00**

SALE PRICE £15.00

Z1699 Mini inverter - This handy PCB 31 × 23mm uses a 2 transistor circuit to provide a 60V peak ac supply (20V dc @ 1mA) from a 3-7V dc input. Can be used to drive Z1637 LCD or for powering vacuum displays. Originally used in Newbrain computer.

Price **3/ £1.00**

SALE PRICE 6/ £1.00



Z5231 Memory panel, contains 208 4164 64k RAM chips all in sockets. £30.00

SALE PRICE £15.00

Along with the panels Z5231/2 mentioned on page 12 (which are here now) there are a great many packed with hi-tech chips - not just 74LS, but Z80 and other processor chips, EPROM's etc. The boards are 430x320mm and mostly contain over 250 chips, date coded '84. **Order Code Z8967 - clearing at £5 per panel - but to get a good mix, you'll need 2 or 3 boards.**

SALE PRICE £2.00

More GEC Cablevision units - these were the rack mounted distribution panels. 2 types available as below:

Z5204 Diecast housing 252x140x25mm (subscriber module) contains PCB with lots of nice high frequency bits, much of which is containedwithin 2 diecast boxes bolted on to the board. Most of the transistors (there are 17 of them) are BF980, BFR90A/91A BFW92 etc. Single output socket, 2 DIN41612 plugs. **Great value at £4.50**

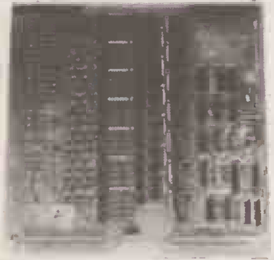
SALE PRICE £2.50

Z5272 PCB 71x64 with SP0256 speech chip , 2 support chips and few other bits and 5 pin DIN plug. 22way edge connecter. These are returns and may be faulty - but they are only 50p each!!

SALE PRICE 4 FOR £1

Z5263 Panel 80x60mm with FPT100A phototransistor, LM324 quad op amp, 24v SPCO heavy duty relay, BC546, diodes, R's and C 's, Smashing little board - only £1.00

SALE PRICE 2 FOR £1

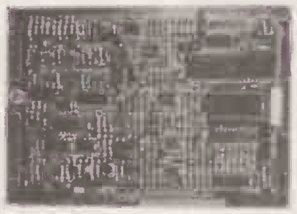


Z5244 Mosfet panel: 56 x VN0808M (DP 1.01 each!) 80V N-channel 1W 2A device in TO237 case + 28 x ILCT6 8 pin opto isolators, also 30+ CMOS, 74SC etc; 26 SIL networks, 56 0.1uF caps and a few other odd bits. **Super value - only £7.50**

SALE PRICE £4.00

Z5271 Some more Currah Microspeech returns, for the Spectrum. No tape or handbook, sold for spare parts only. The 67 x 65 x 18 mm case has a 28w edge socket, phono lead, 3.5 mm jack plug lead and phono socket. Inside is 78MO5 reg, SP0256 speech chip and 2 support chips, trimming cap, transistor etc Only £1.50 each to clear.

SALE PRICE £1.00



Controller Boards

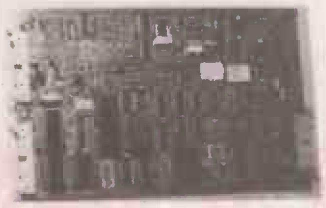
PCB 175 × 122mm containing a wealth of components - 80C39 CPU, 4 × TL066, TL094, CMOS and 74 series chips, 8 × TO126 transistors, 13 TO92 transistors and lots of R's and C's etc - also a 3V lithium battery. 3 connectors on it go to (a) card reader (b) motor panel & (c) display panel which is identical to our Z027 (P111 of Catalogue).

Order Code **Z5047**
Reduced to .... **£2.00** 100+ 1.00

SALE PRICE £1.00

Z5203 Relay panel - some panel, this! 50, yes 50 DPCO 24V DC min relays, Omron type G2V (our type W834) on PCB 230x160mm with 2xDIN41612 64 way plugs. At 1 off prices, this would cost around £100, but you can have a complete panel at just 20p per relay - **that's only £10.00!**

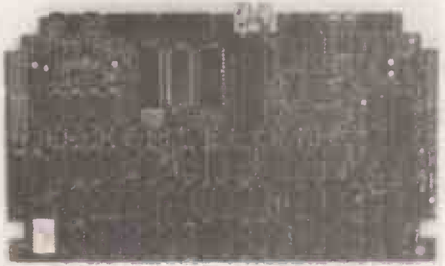
SALE PRICE £5.00



Z5048 Panel 275 × 178mm containing some excellent components: 2 × D8243 I/O expander, 8035 CPU, 8253 timer, 2651 USART all in sockets, 2 × 2111A-4 RAM, 25 mostly CMOS chips, 8 × TO126 transistors, 5 × TO92 transistors, R's, C's etc; 26W IDC plug, 2 × 34W IDC plugs, 2 xtals.

Only **£3.00**

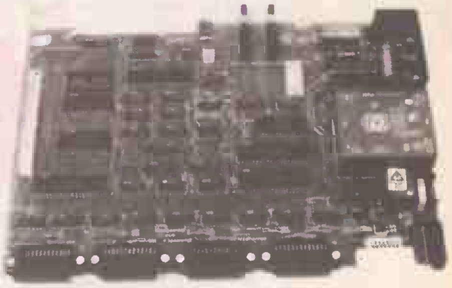
SALE PRICE £1.50



Z672 Newbrain motherboards. Complete but probably faulty .... £

SALE PRICE £2.0

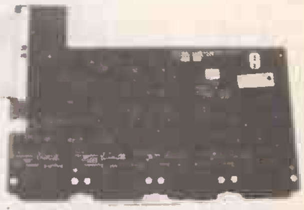
Z674 Newbrain data. Interfaces and connector pin out i/p, o/p, port map, cct diagram + data on CP420C. (This lot replaces cct diag only for 75p) **£2.00**



Z4320 Kilostream Multiplexer Panel 300 × 210mm with 4 × 25 way 'D' sockets, 15W 'D' socket Z84C42 × 3, Z84C30 × 2, CMOS Z80 CPU, 6264 RAM, 30 assorted CMOS/ TTL/ Linear chips and nice power supply comprising a potted transformer with mains input and 0-9V, 0-9V outputs both at 1A, 7812, 7915 and 7805 regs. Also Xtal, 64 way connector, switches etc. Now even better value.

Price .... **Reduced to £4.50**

SALE PRICE £2.25



Z4321 Expander Panel for above. 230 × 170mm with 4 × 25 way 'D' sockets, 2 × Z84C42, Z84C30, 8 × 45406 + 7, 74 chips. Also short length of 64 way ribbon cable with IDC socket. This panel is complete.

Price .... **Reduced to £3.00**

SALE PRICE £1.50

INSTRUMENT CASE

Z8969 Superb heavy duty steel instrument case finished in light grey 426x290x78mm with 4 plastic screw on feet. This was an Isolan repeater for use on a data network, and although the contents have been removed (before being used), the front and back panel remain, the former having 4 oblong red LED's and the latter a fused, suppressed IEC mains inlet, on/off DP rocker switch and 2 x 15 way D sockets joined to 16 way IDC skts with a short length of ribbon cable. Ther's a 60mm circular cut-out for a speaker on one side and mounting pillars in the base. Just look around and see the price this type of high quality case normally costs! - somewhere around the £30-£40 mark - then compare it to our low, low price - **just £9.95**

SALE PRICE £7.50

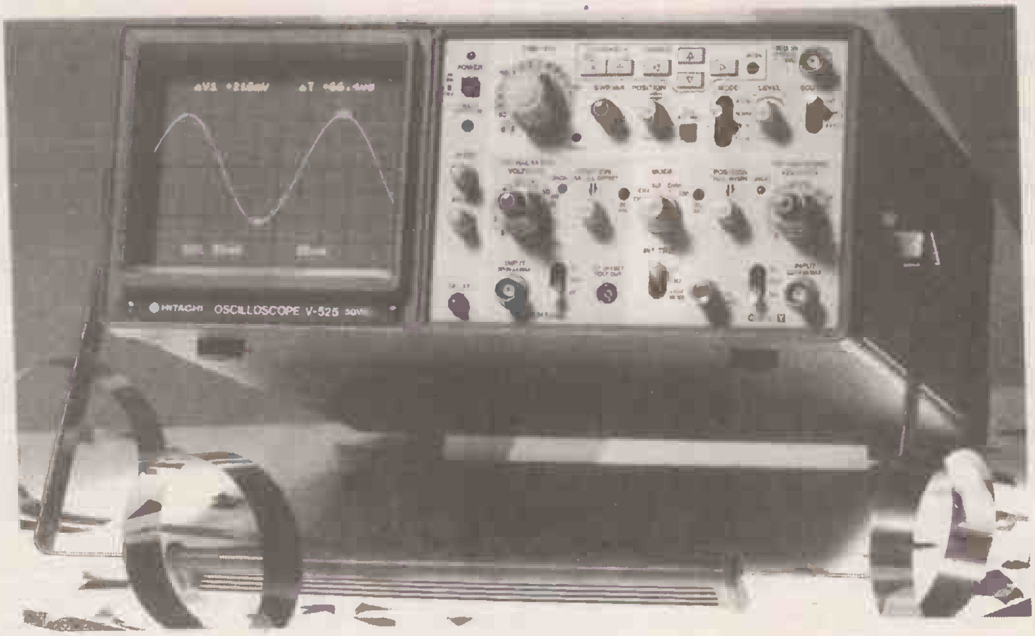
SUMMER SALE CATALOGUE

GREENWELD 27 PARK ROAD, SOUTHAMPTON, SO1 3TB TEL: (0703) 236363 FAX: 236307

EASY-TO-USE

HITACHI

50MHz SCOPES



DC to 50MHz, 2-Channel, DC Offset function, Alternate Magnifier function

V-525	Include CRT Readout & Cursor Measurement	**£875.00**
V-523	Include Single Time Base Delayed Sweep	**£852.00**

UP TO 26% DISCOUNT!!

Prices include VAT and next day delivery UK mainland only (Cash/credit card; allow clearance time for cheques)

SPECIAL OFFER!!
Limited period only

V525	**£669**
V523	**£629**

ALSO V209 DC-20MHz dual channel battery operated portable model

Normally £875 **£669**

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT
MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

CAPACITOR CLEAROUT!!!

We've several million capacitors in stock, covering nearly every possible type - but the ones that take up the most room are large value smoothing caps - just look at these bargains!!!

POWER SUPPLY CAPACITORS

Incredible value - these two jumbo electrolytics are offered at a fraction of their normal price!! Screw top cans made by Siemens, type B41455:

Z5146 10,000µF 100V 105x64mm dia **£4; Box of 20 £60;** 100+ 2.00; 1k+ 1.70

Z5147 4700µF 100V 105 51mm dia **£3.00; Box of 35 £70;** 100+ 1.50; 1k+ 1.20

SALE PRICES ALL QTY'S: 50% OFF

POWER SUPPLY CAPACITORS

These high value, high ripple current cans are made by BHC/ LCR and are of excellent quality and value.

Code	Value	Voltage	Ripple	Mn f'r	l × d	Mfr's price
Z4343	2200µF	40V	2.7A	LCR	45 × 26	2.12
Z4345	10,000µF	40V	4.9A	BHC	56 × 41	3.89
Z4346	15,000µF	25V	5.5A	BHC	56 × 41	3.96

Prices:

Z4343	**60p**	25+ 0.45	100+ 0.30
Z4345	**£2.50**	25+ 1.80	100+ 1.50
Z4346	**£2.50**	25+ 1.80	100+ 1.50

ALL HALF PRICE

Resistors

Low value wirewound

Z1877	0R1 9W	**6 for £1**
Z1878	0R27 9W	**6 for £1**

Both available in boxes of 250 @ **£15 per box.**

Z0173	1R2 2½W	**All at the same price 100/ £3.00**
Z1086	1R5 2½W	
Z0873	2R2 2½W	
Z0102	56R 5W	

All available in boxes of 1000 @ **£15 per box.**

1 Watt Carbon Film

Z0872	1R2	**All £1/ 100**
Z0703	1k	
Z0226	2k2	

All available in boxes of 1000 @ **£5 per box.**

CAPACITANCE CLEARANCE

Z5322 1µF 50V radial 11.5x5mm. Pack of 100 £2.50; 1k+ 0.015; 10k+ 0.01

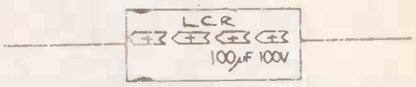
Z5323 47µF 16V radial 11.5x6mm. Pack of 100 £2.80; 1k+ 0.018; 10k+ 0.012

Z5324 470µF 10V radial 15x10mm. Pack of 100 £3.50; 1k+ 0.025

Z5325 470µF 35V radial 24x13mm. Pack of 20 £2.00; 100+ 0.06; 1k+ 0.045

Z4199 60 second timer. High quality instrument by Micron. Can be set by knob on top to any time from 0-60 seconds, after which time a pair of contacts close. Although these are 110V, they work off standard 230V mains with the series resistor included. Notes about its operation are also supplied. Overall size 105 × 63 × 80mm. Individually boxed.

Price **£3.75**



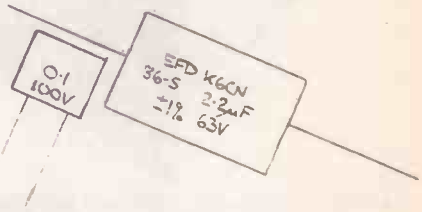
(b) Capacitors, electrolytic axial leads

Code	Value	Volts	Mnf'r	Size	1 +	100 +
Z4420	100	100	LCR	26 × 13	**70p**	0.40
Z4421	220	250	Novea	75 × 26	**£2.00**	1.20
Z4422	1000	63	Novea	40 × 21	**£1.00**	0.60

Z2319 Phillips bandoliered caps, 47µ 25V Radial. 12 × 6.5 dia.

Price .... **Pack of 20 £1.00** 100 + 0.025 1k + 0.015

ALL HALF PRICE



(c) Capacitors, non-electolytic axial leads
(*Radial 10mm pitch) inc close tolerance

Code	Value	Volts	Mnf'r	Size	1 +	100 +
Z4423	0.1	100		13 × 11 × 5*	**4p**	0.02
Z4425	1	63	EFD	18 × 7 × 7	**24p**	0.12
Z4426	1	63	EFD	18 × 7 × 7	**10p**	0.06
Z4427	1	630	EFD	31 × 27 × 19	**20p**	0.12
Z4428	2.2	63	EFD	32 × 18 × 7	**40p**	0.20

ALL HALF PRICE

Z02284 DIL multilayer ceramic caps - 2 pin, so can be packed closely together on PCB using standard DIL spacing. Only one value - 0.22µ. List price on these is 98p each.

Our price .... **Pack of 8/£1**
100 + 0.09 1k + 0.06

Z2320 Phillips MKT-P × 2 rated polyester axial lead caps, 0.1µF 250V AC.

Price .... **Pack of 6 £1.00** 100 + 0.10

2 PACKS FOR £1.00

Joystick

Z004 Skeleton Joystick, switch type. Good quality, made by AB. Brass spindle has 44mm long black plastic handle attached. Body has 4 mounting holes. These really are a fantastic bargain!!

Price .... **Only £1.00**

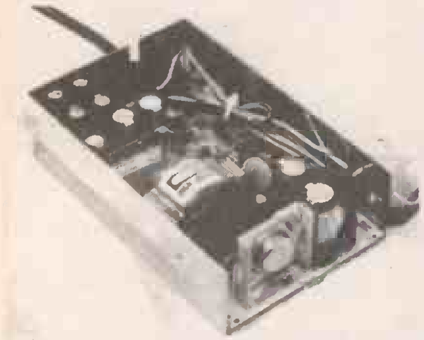
SALE PRICE 2 for £1.00

AUCTION

After our Summer Sale, we'll be holding a postal auction of much of our surplus stock. Lots will vary in size according to the quantity available for disposal. Goods may be viewed at our premises in Southampton by appointment, or you can rely on the description in the catalogue. To register for a catalogue when it becomes available in September, please quote Order Code Z5555

THE POW - POW -

SWITCH MODE POWER SUPPLIES



AA12531 Switch mode PSU by Astec partially cased. 160x104x45mm overall with 160x100mm Eurocard PCB. Inputs and outputs are on colour coded flying leads. Input 115/230V 50/60Hz. Outputs: +5V @ 5A; +12V @ 0.15A. Total wattage 50W.
£6.95; 25+ 5.43; 100+ 4.53

SALE PRICE £4.95

Conversion Kit
K725 This kit converts the AA12531 PSU into a much more versatile supply, giving +5V @ 2.5A; +12V @2A; −12V @ 0.1A and −5V @ 0.55A. Complete set of parts and full instructions **£3.50** Instructions only (K726) **£1.00**

BM41012 Superb switch mode PSU made by Astec. Enclosed case 175x136x65mm with switched and fused IEC mains inlet. 160x80mm PCB with output pins extended to external connector. Input 115/230V 50/60Hz. Outputs: +5V @ 3.75A; +12V @ 1.5A; −12V @ 0.4A. Total wattage 65W
£14.95; 25+ 11.70; 100+ 9.75

SALE PRICE £9.95

½ PRICE

Z8887 Made by STC, this 160 × 100mm panel is attached to an aluminium chassis. 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details, we can offer these at a fraction of their normal cost!
Price .... **£5.95** 10+ 4.30 100+ 3.43

SALE PRICE £2.95

Z8888 A larger version of the above, PCB 220 × 100mm and chassis 225 × 102 × 65mm providing a single 5V 10A output. Supplied with connection details.
Price .... **Only £8.95** 10+ 6.50 100+ 5.20

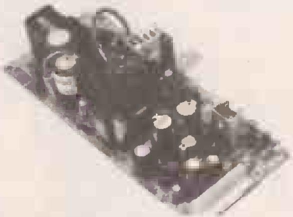
SALE PRICE £4.50

Z5280 Neat switch mode PSU on panel 120x100mm and only 32mm high. Mains input via skt supplied, 3 outputs on socket are +5V @ 2A; +12V @ 0.3A; −12V @ 0.2A. These have been removed from equipment, but are clean and in full working order. **£7.50**

SALE PRICE £4.95

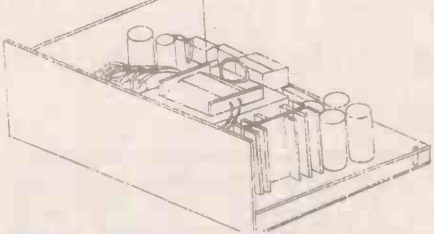
Z5256 Switch mode PSU made by Tamura Corporation. Board 195x100mm with outputs on PCB pins. Input 120/240V ac; Outputs: +5V @ 7.5A; +12V @ 1.25A (2A peak); −12V @ 0.1A. **All this for just £12.95**

SALE PRICE £8.95



Z5257 Switch mode PSU on PCB 190x78mm. 120/240V ac input. Outputs: +5V @ 3A; +12V @ 1.2A; −12V @ 0.1A. Made by Tamradio, Japan. **Only £7.95**

SALE PRICE £4.95



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**

SALE PRICE £14.95

Farnell NO55P Power Supplies

We've taken delivery of these popular supplies from several different sources, and now have the following models available. All are switch mode 115/230V input rated 55 watts max. Size of cased units 182x112x55mm, uncased size 160x100x40mm. Suffix E = ex-equip

Z5304 Model 326, cased. Outputs: +5V 3A; +12V 0.1A; -12V 0.1A. Price £12.95

SALE PRICE £7.95

Z5312E Model 401, cased. Outputs: +5V 6A; +12V 3A 12V 2A; 5V 1A. Price £11.95

SALE PRICE £6.95

Z5313E Model 210. Outputs: +5V 2.5A; +12V 1A . Price £5.95

SALE PRICE £3.95

Z5318E Model 400, cased. Outputs: +5V 6A; +12V 3A 12V 2A; 24V 1A. Price £11.95

SALE PRICE £6.95

Z5319E Model 413, cased. Outputs: +5V 6A; +12V 3A 12V 1A; 12V 1A. Price £11.95

SALE PRICE £6.55

Z5334 Model 314, Outputs: +5V 3.5A; +12V 3A -12V 1A. Price £14.95

SALE PRICE £10.95

Z5320E Model 430, cased. Outputs: +5V 6A; +12V 1A 10V 0.75A; 8V 0.75A. Price £11.95

SALE PRICE £6.95

Z5321E Model 430M, cased. Outputs: +5V 4.5A; +12V 1A 10V 0.75A; 9V 0.75A. Price £11.95

SALE PRICE £6.95

POWER PAGES!

Z4215 Siliconix mains input, 4.5V DC 150mA output to 3.5mm jack plug on 2m lead. Built-in continental 2-pin plug. Size 62×46×35mm **£1.50**

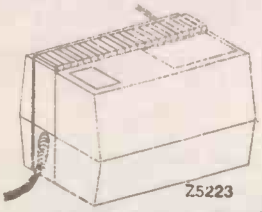
SALE PRICE £1.00

MW88 This popular versatile plug in power supply which gives 3, 4½, 6, 7÷, 9, or 12V at 300mA, is available as a wholesalers return. They have been tested to ensure the transformer is OK, but there may be minor faults on the switch/plug/skt. Complete with spider lead. Normally £3.95.

Price .... **Only £2.00**

Also available untested in bulk 25/26.10 100/87.00

SALE PRICE £1.00



Z5223 Psion printer power supply, input 220/240V ac via lead and 2 pin Euro plug. 10.4V 600mA DC output on 2m lead with 2.5mm power plug. **£3.00**

SALE PRICE £2.50

Z5133 'Touchmaster' PSU. 2 pin plug in wall type with 2.5mm power socket. Output 6V 300mA DC. **Price £1.50**

SALE PRICE £1.00

Z5143 Plug in power supply giving 7.5V 600mA on the end of a 2m lead with a 2.5mm power plug. **£2.50** 100+ 1.80

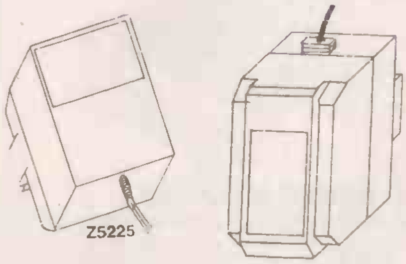
SALE PRICE £1.50

Z5307 Adastra A130 3 way mains adaptor 80x52x51mm, brand new and boxed plug in type. Switched output 3-4.5-6V @ 100mA, unregulated DC. White case. Complete with 4 way spider lead and reversing plug and socket. **£2.50**; 25+ 1.55; 100+ 1.00

SALE PRICE £1.50

Z5308 Plug in wall power supply 77x50x43mm giving 24V at 100mA AC at the end of a 2m lead. **£1.50**; 25+ 0.85; 100+ 0.60

SALE PRICE £1.00



Z5225 Universal mains adaptor, plug in type 240V ac. Output switchable 3-6-9V @ 300mA on end of short lead with 2 pin socket **£2.00**

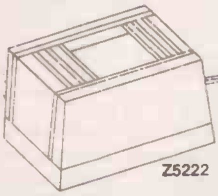
SALE PRICE £1.25

Z5226 Plug in 240V ac unlabelled power supply with short lead and 5 pin DIN socket. Outputs: 18V @ 250mA ac and 10V @ 500mA ac. **£3.00**

SALE PRICE £2.00

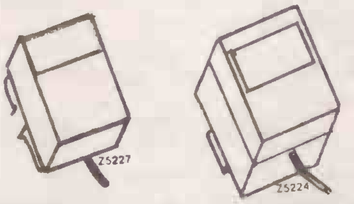
Z5276 Plug-in-wall power supply with 2m lead fitted with 2.5mm power socket. Output 12V 0.2A DC. Fitted with thermal fuse. **£2.00**

SALE PRICE £1.50



Z5222 Psion Organiser power supply. Plug in type, 220/240V ac . Output 10.4V 175mA on 2m lead with 2.5 po wer plug **£2.00**

SALE PRICE £2.50



Z5227 Plug in 240V ac Beautronix power supply. Output 9V 333mA on 2m lead with 2.5 power socket. **£2.00**

SALE PRICE £1.50

Z5224 Jupiter Ace mains adaptor (there's a bit of history!) plug in type 240V, output 9V 800mA on 2m lead with 3.5mm plug. **£3.20**

SALE PRICE £2.50

Z5278 Plug in wall type, 24V ac 100mA output on 2m lead. **£1.75** 100+ 1.10

SALE PRICE £1.25

Z5279 Plug in wall type switchable non-regulated 3-6-9V 100mA. Comes complete with multiway reversible spider lead (worth 99p on it's own!). **Special Price £2.00** 100+ 1.25

SALE PRICE £1.50

BBC POWER SUPPLIES

Z5300 BBC (early model) computer power supply returns. All complete, but may be faulty. **£2.50**

SALE PRICE £1.50

Z5301 Complete panel including transformer from BBC computer PSU. Believed unused - some are very dusty! **£3.00**

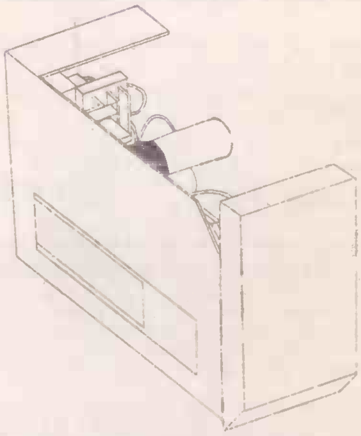
SALE PRICE £2.00

½ PRICE

Z975 PSU - Mains input via 13A built in plug. Output 14V 600mA AC. Case 00 × 00 × 00.

Price **£3.50**

SALE PRICE £1.75



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

Price **£12.95**

SALE PRICE £9.95

Two 5 watt regulators PCB mounting, DC-DC converters. These are encapsulated in a 51x51x10mm package with output pins on 0.1 pitch. These are ex-equip but guaranteed. DP £59.75.

Z1893 Input 48V (43-52V), output 5V 1A.
Price .... **£2.50** 100+ 1.00

SALE PRICE £1.25

Z1894 Input 48V (43-52V), output 12V 420mA.
Price .... **£2.50** 100+ 1.00

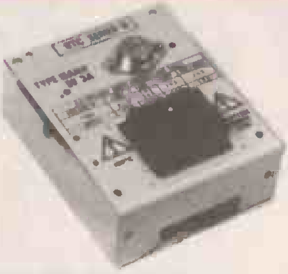
SALE PRICE £1.25

Z660 Astec switched mode PSU type AA7271. This small PCB, just 50 × 50mm will accept 8-24V input and give a stable 5V dc at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at a remarkably low price.
Price **£5.00**

SALE PRICE £2.50

Z8890 DC-DC CONVERTER BOARD
These panels 220 × 195 require 50V DC input for 5V 19.5A output. Inputs and outputs on DIN41612 connector. These brand new panels made by STZ are now being offered at just:
Prices .... **£7.95** 25+ 5.20 100+ 3.89

SALE PRICE £5.95



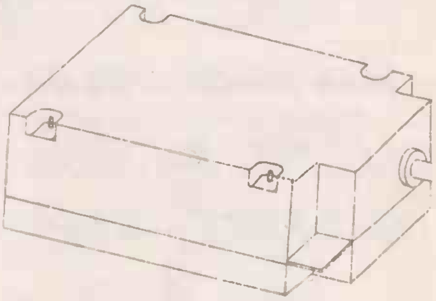
STC POWER SUPPLIES

These are extremely well made linear power supplies by STC (series 15) offering exceptional value for money. Chassis size 124 × 100 × 41mm. Input voltage can be 100, 120, 220, 230, 240V. There is over-voltage protection on both models.

Z8898 Type 15AAA. Output 5V@3A. STC price in 1987 £43.99.
Our Price **£8.00**

SALE PRICE £4.00

HIGH QUALITY NICAD CHARGER



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. Fast charge set at 700mA, but internally adjustable. Slow charge set to 70mA. Both outputs switch to 25mA trickle charging after their respective periods of 1.5 hours and 16 hours. Supplied new with instructions and circuit diagram. Was originally supplied for charging cellphone batteries.
Price **£12.95**

Z568 Transformer, large auto rated 8.3A £12.00

SALE PRICE £7.50

Z8971 Transformer rated 100VA - 0-120, 0-120V primary and 0-20, 0-20V secondary (5A total). Size 89x75x68mm. DP 19.06. Our price £9.50

SALE PRICE £6.95

MODEL RAILWAY CONTROL & SWITCHING UNIT

This ready built versatile piece of equipment allows:

- ★ Full forward and reverse control of trains using regulated and smoothed supply (1.5A)*.
  *Requires 3 components (supplied) to be soldered into panel.
- ★ Relay control of 5 separate circuits. (10A change over contacts; Ideal for points operation).
- ★ Powering of auxiliary equipment - 2 separate 5V 1A outputs.

A mains powered panel 185 × 105mm contains all electronics. All voltages are fully stabilized and both input and output are fused.

Connections, both input and output are by screw terminals which are clipped onto the on-board pins.

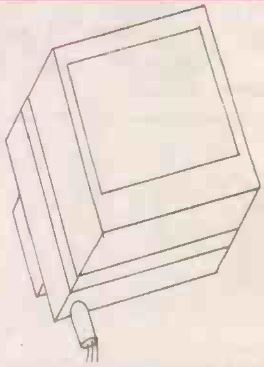
The five 12V relays are controlled by transistor circuits which require only 5V 30mA, supplied by the on board power supply.

Supplied uncased with circuit and wiring diagram. (SAE for free copy.)

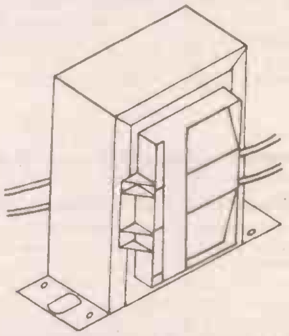
Suitable black ABS plastic case **£3.50**
Order Code Z8897

SALE PRICE £9.95

Price Reduced to £14.95



Z5135 Nicad charger; plug in the wall type power supply with a 5.3V 140mA output, ideal for charging 4 × AA cells. Output is on a 1.8m long lead terminated in a 3.5mm plug.
Only **£2.50**



Z5206 Super transformer for railway and other modellers. Mains primary, secondary 16V 3A. Size 50x55x60mm high. 61mm FC. Great value for money, **only £3.00** 100+2.00 1k+1.50

SALE PRICE £2.00

Some new mains transformers, ideally suited for PSU's:

Z5212 21V 1A Clamp, wires 60x45x50mm £1.50

SALE PRICE £1.00

Z5214 11V 0.5A PC mntg 53x40x44mm £1.00

SALE PRICE 75P

Z5215 15V 0.25A PC mntg 43x33x36mm 75p

SALE PRICE 50P

All the following are mains transformers, and have secondaries as shown. Current rating is estimated from size of transformer.

Z5233 17V 1A 56x67x53mm £1.50

SALE PRICE £1.00

Z5234 14V 0.5A 45x54x41mm £1.00

SALE PRICE 75P

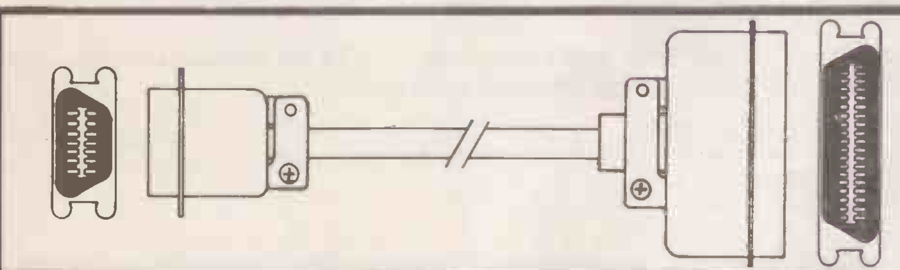
Z5235 9V + 10.5V 15VA max. 56x67x50mm £2.00

SALE PRICE £1.50

Z5236 21V 500mA 50x60x45mm £1.50

SALE PRICE £1.00

LEAD LUNACY

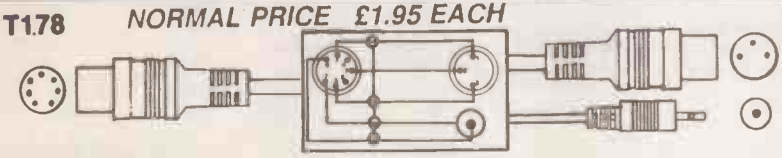


NORMAL PRICE £5.95

T190B SALE PRICE **£2.00**

14-way Centronics plug to 36-way Centronics plug. MSX printer lead.
Length 2m

T178 NORMAL PRICE £1.95 EACH



7-pin DIN plug to 3-pin DIN plug and 2.5mm jack plug. Colour grey.
Length 1m

SALE PRICE **5 FOR £1.00**

High Quality Audio/ Video Leads

Packed in poly bags with header cards, these 'Nu-Way' leads are offered at a surprisingly low price. 16 types available, all 2m long except * which are 1.5m long. All connectors on all leads are screened - none of your cheapo plastic plugs here!!

Code	Type	Description	1 +	25 +
Z5033	677	PL259 + 5 pin DIN 180° plug to phono plug + 5 pin DIN 180° plug.	**£1.64**	0.82
Z5034	686	PL259 + 2 phono plugs to phono plug + 5 pin 180° plug.	**£1.96**	0.98
Z5035	687	Phono plug + 5 pin 180° plug both ends.	**£1.24**	0.62
Z5037	680	PL259 + phono plug to BNC plug + 3.5mm plug.	**£2.46**	1.23
Z5038	685	PL259 + phono plug both ends.	**£2.12**	1.06
Z5039	683	PL259 + 2 × phono plug to BNC plug + 5 pin DIN 180° plug.	**£2.62**	1.31
Z5040	VTV015*	BNC plug + 3.5mm plug to 6 pin DIN plug.	**£1.77**	0.88
Z5050	682/ 764	BNC plug + 5 pin DIN 180° plug both ends.	**£2.56**	1.28
Z5051	VTV025*	PL259 + phono plug to 6 pin DIN plug.	**£1.43**	0.71
Z5052	691	6 pin DIN plug to 5 pin DIN 180° plug + phono plug.	**£1.04**	0.52
Z5053	669	PL259 + phono plug to 2 phono plugs.	**£1.72**	0.86
Z5054	672	PL259 + 5 pin DIN 180° plug to 3 phono plugs.	**£1.96**	0.98
Z5055	675	PL259 + 5 pin DIN 180° plug to PL259 + 2 phono plugs.	**£2.36**	1.18
Z5056	689	6 pin DIN plug to 2 BNC plugs + 2 phono plugs.	**£2.96**	1.48
Z5057	VTV065*	8 pin DIN plug to BNC plug + 3.5mm plug.	**£1.90**	0.95

Quantity prices apply to any mix. (Don't forget to add VAT!)

ALL 50% OFF

Telephone Leads

Z5361 Curly lead, new, BT handset plug one end, 4 spade terminals the other. Pale grey. DP 4.11 **Our Price £2.00**

SALE PRICE **£1.25**

Z5362 4 core telecom lead 3m long with BT line plug one end, 4 way socket the other. DP 4.40. **Our Price £2.00**

SALE PRICE **£1.50**

Z5363 4 core telecom lead 3m long with BT line plugs both ends. DP 4.65 **Our Price £2.40**

SALE PRICE **£1.85**

Z4309 BT 'breakout' lead. One end has moulded housing with 6 pin BT plug and socket. Other end has 6 pin FCC68 plug (as used on some computers). Overall length 3m
Price **£2.20**

SALE PRICE **£1.50**

PL616 DC adaptor lead for Walkman, 1.8m long.
Price .... **30p** 100 + 0.15

PL528 2 pin DIN line socket to phono plug 0.2m long.
Price .... **20p** 100 + 0.10

PL708 Video lead. PL259 plug to F type plug. 3m low loss coax.
Price .... **85p** 100 + 0.45

PL608 5 pin DIN - 3 pin DIN audio lead 1.2m long.
Price .... **40p** 100 + 0.20

PL541 Intercom extension lead 3.5m line socket to 3.5m plug. 6m long.
Price .... **40p** 100 + 0.20

DIN Leads

Z487 3 pin DIN to 3 pin DIN 1.8m long.
Price **3/ £1.00** 100/ 21.75

50% OFF

Z4353 6 way DIN lead; 1.5m lead terminated one end with a 6 pin DIN plug. Bare wires the other end.
Prices ..... Pack of 4/£1.00; 100/£12.00; 1000/£90.00

PACK OF 8 £1.00

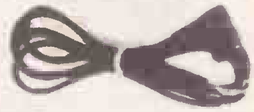
Z5087 Lead - 6 PIN DIN to 3 coloured phono plugs (video + L and R audio) using flat splittable screened lead. Nice and long-2M. Cheap enough to cut the DIN plug off and reterminate with phonos!
Price .... **2/£1.00** 10 + 0.35 100 + 0.25

PACK OF 4 £1.00

MAINS LEADS

Z4338 3 core black mains lead 2m long. One end is fitted with a 2 pin continental plug. the other with a 6A 3pin IEC socket. Both are moulded on.
Price **£1.20**

SALE PRICE **75P**



Z03561 Mains cable 5m long fitted with right angle CEE22 plug. DP £4.99
Price **£2.50**

SALE PRICE **£1.50**

Z4376 Scart plug to 15W mini 'D'. All circuits connected. Length ½m. **£2.50**

SALE PRICE **£1.25**

Z5332 PC keyboard cable – standard heavy duty high quality curly lead with 5 pin DIN plug one end, push in connectors the other. Ex-new equipment. £2.00

SALE PRICE **£1.00**

Computer Cables

Computer cables by Mitsubishi. 25 way 'D' socket both ends, connected 1-1, 2-3, 3-2, 4-5, 5-4 6-20, 7-7, 13-19, 14-16 & 25-25. (RS232 Asynchronous Cable for Data transfer Null modem.)

Z5017 10 metres long.
Price **£8.00**

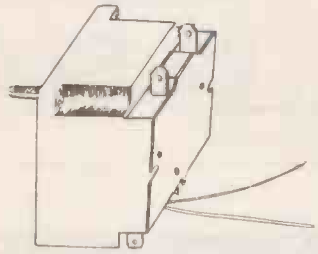
Z5018 5 metres long.
Price **£5.00**

ALL HALF PRICE

Z4186 3m multicore lead terminated both ends with 50 way centronics (IEEE-488) socket. Ideal for stripping down for flex – total 150m of multicoloured 7/0.2. Connectors alone worth £12.80
Price .... Only **£9**.95

SALE PRICE **£4.00**

Spiffing Switches



Z5174 Timer switch by Diehl of Germany. Superb geared mains motor, (1 rev per 12 hours) operates a cam that switches 2 change over contacts with centre - off positions rated 16A 250V. Size 60x54x43mm. Spindle is 14x6mm dia. Only **£3.00** 100+ £1.50.

SALE PRICE £1.50

Great switch bargains for railway modellers - these small switches 18mm wide and 12mm high (excluding lever) and just 4mm thick with 14mm FC come in two versions:

Z2363 2 position, 2 pairs make and 2 pairs break. Pack of 5 **£1.00** 100+ 0.10

Z2364 3 position, 6 pairs contacts (2 pole 3 way). Pack of 5 for **£1.00** 100+ 0.10

2 PACKS FOR £1.00

Z2168 Superb quality British made (TOK). Gold plated DPCO contacts. Key can be removed in either position. PC mounting or clip fix - needs 15x15mm cut-out. Ideal for alarms etc.

Price .... **£1.95** 25+ 1.20 100+ 0.80

SALE PRICE £1.00

Mercury Switches

Z2118 Metal enclosed in case 7.5mm dia × 9mm long. 10mm flange one end.

Price .... **2/ £1.00** 100+ 0.25 1k+ 0.18

2 PACKS FOR £1.00

A range of rocker and push switches, clip fit by Russenberger. Top quality, complying to all relevant approvals.

MINIATURE ROCKER

Size 14x21x15mm require, 19.3x13mm contact. All single pole rated 8A 250V DC. Solder tags.

CODE	CONTACTS	BODY	ROCKER	QTY	£1 PACK	100+	1000+
21102	ON/OFF	BLACK	WHITE	4583	6	.12	.08
21201	ON/OFF	WHITE	BLACK	3000	6	.12	.08
21202	CHANGE OVER	WHITE	WHITE	6779	5	.14	.10

SALE PRICE 50% OFF

STANDARD ROCKER

Size 20x14x16mm requires 27x12mm cutout. * Size 31.5x14x22mm requires 30x12mm cutout. All single pole, 12A 250V ac or 12-28V DC 0.25" tabs.

CODE	CONTACTS	BODY	ROCKER	QTY	£1 PACK	100+	1000+
51101	CHANGE OVER CENTRE OFF	BLACK	BLACK	4262	6	.12	.08
51802	CHANGE OVER CENTRE OFF	WHITE	WHITE	3116	6	.12	.08
1600 NBS	ON/OFF	WHITE	RED NEON	2000	5	.14	.10
*51102	ON/OFF	BLACK	WHITE	1739	6	.12	.08
*51291	ON/OFF	WHITE	AMBER NEON	1600	5	.14	.10

SALE PRICE 50% OFF

Size 31.5x25x34mm requires 28x22.5mm cutout.

CODE	CONTACTS	BODY	ROCKER	QTY	£1 PACK	100+	1000+
51180	SP ON/OFF	BLACK	RED NEON	2755	5	.14	.10
51182	SP ON/OFF	BLACK	GREEN NEON	6907	5	.14	.10
51202	SP ON/OFF	WHITE	WHITE	3814	6	.12	.08
51390	DP ON/OFF	BROWN	RED NEON	1498	4	.16	.12

SALE PRICE 50% OFF

ILLUMINATED PUSH SWITCHES

Size 31.5x 25x34 requires 28x22.5mm cutout. (Same as large rocker switches). Mains Neon. The difference between the two types listed is that 21200 has solder tags; 51200 has 0.25" tabs.

CODE	CONTACTS	BODY	INSERT	QTY	£1 PACK	100+	1000+
21200	SPCO	WHITE	WHITE	4912	6	.12	.08
51200	SPCO	WHITE	WHITE	1000	6	.12	.08

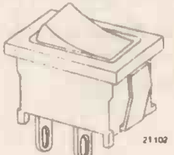
SALE PRICE 50% OFF

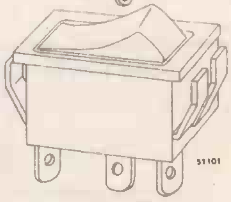
INDICATORS

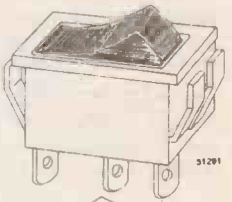
Size 31.5x25x34mm requires 28x22.5 cutout. These match above push switches and rockers. Available with a black body and lens colour as listed. Mains Neon.

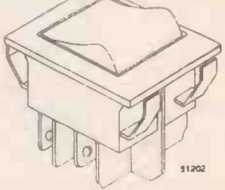
CODE	COLOUR	BODY	QTY	£1 PACK	100+	1000+
51100A	AMBER	BLACK	500	6	6	.09
51100C	CLEAR	BLACK	600	6	6	.09
51100G	GREEN	BLACK	100	6	6	.09
51100N	NO LENS	BLACK	2500	14	14	.03

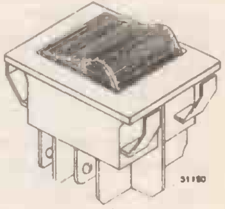
SALE PRICE 50% OFF

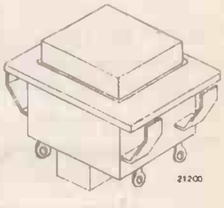








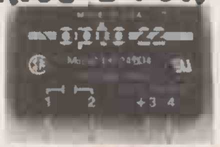




Z280 Relay, DIL 24V coil 288R. SP contacts. OMRON G6B-1114P.

Price **£1.00**

SALE PRICE 2 FOR £1.00

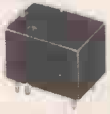


Z1718 Solid state relay 43 × 25 × 70mm. Control voltage 3-24V DC switches 240V ac 4A. DP £7.82

Price **£3.00**

SALE PRICE £1.50

12V relay bargain



Z2137 Superb quality potted relay 29x20.5x12.5mm with pins on 0.1 pitch. Coil 12V DC. Single contact relay 5A 12V DC or 5A 230V AC.

Price .... **50p each** 10+ .39 25+ .31 100+ .25

SALE PRICE 2 FOR £1

Z2120 Same size and contact arrangement as W853 in our catalogue at £1.42 (15.6 × 10.6 × 10.5mm, SPDT contacts rated 1A@ 28V DC) but different pinout. Standard DIL spacing.

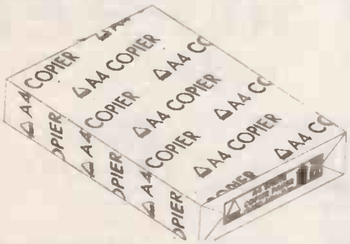
Only .... **£1.00** 25+ 0.70 100+ 0.60

SALE PRICE 4 FOR £1

STATIONERY SENSATION!!!

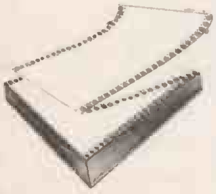
DEDUCT 10% FROM THESE PRICES

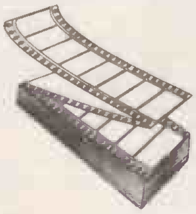
(a) Paper & Labels
80gsm high grade copier paper, sold in reams (500 sheets)



Code	**Description**	**1+**	**10+**
A701	A3 size 420x297mm	**£9.95**	5.73
A702	A4 size 297x210mm	**£3.70**	2.31

Laser Copier Paper
A high quality paper giving excellent results with all laser printers. Price per ream.
A703 A4 size 297x210mm **£4.50** 3.30

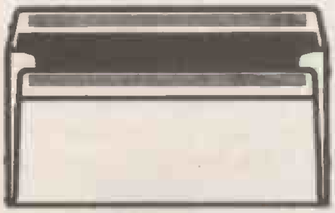




Computer Paper
A458 Computer Listing Paper 11x9½" plain. 60gsm wood free, microperf. Sold in cases of 2000 sheets. **£15.00** 11.06

CL01 Continuous labels 3½x1.7/16". One label across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 8000 32.00+VAT

CL02 Continuous labels 4x1.7/16". Three labels across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 12000 51.00+VAT

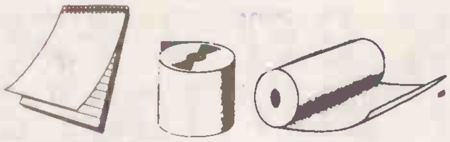


(b) Envelopes
White DL, size 220x110mm (takes A4 folded in 3) Self-seal. Sold in packs of 100

Code	**Description**	**1+**	**10+**
A711	80gsm opaqued, plain	**£2.00**	1.15
A712	80gsm opaqued, window	**£2.20**	1.29

Brown C4, size 325x230mm (takes A4 unfolded). Sold in packs of 100

Code	**Description**	**1+**	**10+**
A716	80gsm gummed	**£4.20**	2.27
A717	80gsm self seal	**£4.60**	3.09



(c) Pads and Rolls
A721 Shorthand notepad, spiral bound 8x5". 80 sheets (160 pages)
1+ 40p; 12+ 0.22; 144+ 0.18

A725 Adding machine rolls. Standard 2¼x2¼". Sold in cases of 20 rolls.
1+ £4.75; 5+ 3.36 25+ 2.68

A721 Fax Roll. Standard for most makes of machine. 210mm wide x 30m long (equivalent to 100 A4 sheets) 12.5mm tube. **Reduced Price:**
£2.95; 12+ 1.80; 72+ 1.68.

Stapler and Staples
R2 Office 26/6 metal stapler in black.
£4.50; 10+ 3.43

R3 Office 26/6 staples in boxes of 5000
75p; 10+ 0.56

Paper Clips
R4 Large lipped in boxes of 1000
1 box £1.50; 10+ 0.86

Tippex
S7 The popular white opaquing fluid in 30ml bottles.
83p; 10+ 0.58

A4 Transparent Pockets
Open at the top and multipunched to fit most files.
Pack of 100 £4.40; 10+ 2.81

Adhesive Tape
A731 1" wide clar adhesive tape, polypropylene 30 micron
60p; 12+ 0.36; 72+ 0.29

A735 2" wide buff packaging tape, polypropylene 30 micron.
£1.30; 12+ 0.83; 36+ 0.66

Ballpoint Pens
Low cost ball pens with ventillated caps, in 3 popular colours:

Code	Description		
HPE01	Black	**10 for £1;**	100+ 0.06
HPE02	Blue	**10 for £1;**	100+ 0.06
HPE03	Red	**10 for £1;**	100+ 0.06
HPE50	Box of 50, any assortment		**£3.95**

Kuratake

A range of top quality supplies from a company established in 1902. Kuratake has been established in the UK for 5 years, providing graphic markers and equipment to education, industry and commerce.

Ceramic Rollerball Pen
The Zig ball 200 is a low cost high quality 0.3mm rollerball pen, available in 4 colours. Waterbased ink.

Code	**Description**	**1+**	**12+**	**96+**
KCB220K	Black	**70p**	0.43	0.34
KCB220R	Red	**70p**	0.43	0.34
KCB220G	Green	**70p**	0.43	0.34
KCB220B	Blue	**70p**	0.43	0.34

Gold & Silver Pen
Double ended pen 210mm long with valve action and fine tip - Gold one end, Silver the other. Instant drying, high opacity.

Code	**Description**	**1+**	**12+**	**48+**
KFMP20	Gold & Silver	**£3.80**	2.28	1.83

Changin' Glue
Instant adhesive for paper and card - on application the glue is blue, but dries clear. Non-toxic emulsion based. Can be used as permanent (stick while blue) or temporary (wait till clear - can be repositioned as required). Available in 2 sizes:

Code	**Description**	**1+**	**12+**	**96+**
KMSB15	10gm, 6mm tip	**£1.69**	1.02	0.81
KMSB30	25gm 15mm tip	**£3.37**	2.03	1.63

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT
MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

GREENWELD 27 PARK ROAD, SOUTHAMPTON, S01 3TB TEL: (0703) 236363 FAX: 236307

£1 PACK CLEARANCE

BUY 10 PACKS, GET 3 FREE; BUY 25, GET 10 FREE; BUY 100, GET 50 FREE

PLEASE GIVE ALTERNATIVES - STOCKS ARE LOW ON SOME NUMBERS!

3 Capacitors (Tant bead)

Code	Value	Description	Qty
K173	1.5µF	25V Tant bead caps	12
K246	0.1µF	35V Tants	20
K351	15µF	16V	10
K353	220µF	10V	1
K354	2.2µF	35V	10

4 Capacitors (Electrolytic)

Code	Value	Description	Qty
K135	4.7µF	10V Radial elecs.	30
K146	330µF	4V Axial caps.	25
K201	1000µF	6.3V PC mntg electrolytics.	25
K205	0.33µF	50V Radial lead electrolytics.	40
K206	0.47µF	50V Radial lead electrolytics.	40
K259	10,000µF	6.3V long leads.	6
K264	10,000µF	16V can.	2
K266	4,700µF	16V Mullard can. Tag end 50 × 25mm dia.	3
K267	10,000µF	25V Elma can, with clip; tag ends 50 × 31mm dia.	2
K268	4,700µF	16V ITT Radial leads. 37 × 18mm dia.	3
K269	330µF	100V ITT Axial leads. 50 × 22mm dia.	3
K271	8µF	25V Sprague axial leads. 13 × 6.5mm dia.	20
K359	1µF	50V axial 12.5 × 5mm.	12
K360	1500µF	16V radial 40 × 16mm.	
K407	470µF	25V Axial.	10
K408	10µF	16V radial.	30
K409	220µF	16V radial.	15
K412	10µF	63V radial.	15
K413	100µF	25V radial.	15
K414	2200µF	40V can.	5
Z822	800µF 250V can 76 dia 38.		1

5 Capacitors (Ceramic)

Code	Value	Description	Qty
K124	0.02µF	Disc ceramic.	50
K126	3000pF	63V Polystyrene preformed caps.	100
K278	0.1µF	32V disc ceramic 14.5mm dia.	25
K279	2200pF	2kV ceramic.	10
K356	0.47µF	Dipped multilayer, 50V.	5
K357	0.022µF	Ceramic plate, 50V.	20
K358	0.047µF	Ceramic disc, 12V.	25
K518		Disc ceramic mix.	200
Z1539	4700pF	Disc ceramic 380Vac. 15mm dia.	15
Z1540	2200pF	Disc ceramic 380Vac. 9mm dia.	25

6 Capacitors (Polyester etc)

Code	Value	Description	Qty
K140	0.05µF	50V Mylar caps.	30
K361	0.33µF	63V mini-polyester 5mm pitch.	6
K362	0.47µF	63V mini-polyester 5mm pitch.	6

10 Coils, chokes and transfomers

K149	Ferrite rods, cat type Z036.	12
K402	Transformer 12-0-12V 100mA.	1
K588	TOKO Can type 113CN12249HM.	10
K589	TOKO Can type 113CNK1881EK.	10
K590	SIGMA Axial choke type SC10. 150µH.	10
Z1386	Ferrite core.	10
Z1537	Choke 16mm long × 11mm dia. 3.3mH.	5

11 Computer Accessories

Z610	Enterprise demo cassette.	6
Z4132	Joystick firing speed adjuster.	1
Z4159	Fabric black for qume no. 80009-02.	1

12 Connectors

K133	3 way term block 5A.	20
K157	16 pin QIL-QIL IC sockets.	12
K240	2W tag strip.	25
K261	Mini 2 way tag strips.	25
K314	22pin gold plated IC socket 0.4 spacing.	10
K315	3.5mm mono screened plug.	4
K404	Push on crimp connectors.	100
K413	40 way 0.1" header plug.	5
K414	34 way 0.1" header plug.	6
K415	44 way 0,1" header plug.	5
K416	20 way 0.1" header plug.	8
K417	26 way 0.1" header plug.	8
K418	34 way IDC card edge connector.	2
Z522	Amp terminal pins on carrier strip. 0.1" pitch.	200
Z576	2.1mm power socket, chassis mntg.	10
Z586	Phono PC mntg socket.	10
Z743	24 way socket. Connector on 5mm centres.	10
Z1370	Amp connector, 3 way 0.156" pitch.	100
Z1381	10 way PCB mntg 0.1" pitch, single sided edge connector.	10
Z1382	10 way commoning block, 2 × 5 way 0.1" pitch.	10
Z1476	Sealectro connector contex 75R.	1
Z1477	Sealectro connector SRM 50R.	1
Z1543	3 row DIN 41612 socket. Rows 6, 7, 13 + 14 missing.	1
Z1545	3 row DIN 41612 96 way plug. Rows 2, 5, 8, 11, 14, 17, 20, 23, 26, 32 missing.	2
Z1551	12 way DIL header socket 0.1"pitch.	25
Z1552	12 way DIL header plug with standoff.	10
Z1555	CRT socket. 10 way green plastic.	4
Z1557	'F' socket, single hole female RF connector.	4
Z1652	31 way 0.15 pitch single header plug, gold plated.	6
Z1688	Edge connector. S/ S 0.1 pitch 38 way, solder tags.	2

14 Diodes (Bridge)

K249	800V 4A in-line bridge rect.	2
K301	Semikron Bridge SKB2/02 (like BY164).	4
K306	BSK B80 C600 Semikron Bridge.	5
K307	µE B380C800W Bridge.	4

15 Diodes

K450	AA132100V 10mA Ge point contact.	8
K451	AA133130V 10mA Ge point contact.	8
K452	BA12875V 50mA Si diode.	10
K453	BA13025V 75mA Si diode.	10
K454	BA14715V 50mA Si diode.	10
K455	BA155150V 100mA Si diode.	10
K456	BA21850V 10mA Si switching.	10
K322	BAX12A Silicon glass 90V 400mA.	20
K323	BAX16 Silicon glass 150V 200mA.	25
K457	BB104 Dual capacitance Si 34-39 pF.	3
K324	BB121A	
K325	BB142	
K326	BB221 Variable capacitance diode 1.8-2.2pF 28V.	5
K327	BB329 Variable capacitance diode 2.5-3.2pF 28V.	4
K458	BY196100V 1.2A fast rect.	5
K328	BY197200V 1.2A fast rect.	5
K459	BY198400V 1.2A.	4
K329	BY199600V 1.2A fast rect.	4
K460	BY212-750R 800V 1A Si 'tophat' rect.	10
K330	BY250 Pinnacle supplied in a neat clear plastic case.	5
K461	BY4011A rect.	15
K462	BY550-100100V 5A Si rect.	
K463	BYX22-400 400V 1.4A Si 'tophat' rect.	10
K464	BYX36-300 300V 1A rect.	20
K331	BYX55-300 Silicon rect 330V 1A.	25
K465	DK14 80V 120mA Ge diode.	8
K466	HG5085 Small signal diode.	20
K332	IN277 Germanium diode 125V 100mA.	8
K467	IN446 Si.	20
K468	IN459 175V 3mA Si.	20
K469	IN627 100V 30mA switching Si diode.	20
K470	IN643 200V 5mA switching Si diode.	20
K471	IN916A 75V 10mA switching Si diode.	20
K333	IN2069 Silicon rect 200V 0.75A.	25
K472	IN3890 100V 40A rect.	2
K473	IN4149 75V 10mA Si.	20
K474	IN4154 25V 30mA Si.	20
K475	IN4446 75V 10mA Si.	20
K476	IN4447 75V 20mA Si.	20
K477	IN4448 75V 5mA Si.	20
K478	IN4454 75V 10mA Si.	20
K479	IN4744 15V 1W 10% zener diode.	15
K480	IN4752 33V 1W 10% zener diode.	15
K334	IN4821 Silicon rect 500V 1.5A.	15
K335	IN4933 Fast (150ns) rect 50V 1A plastic.	12
K481	IN5062 800V 1A Si rect.	15
K482	IN5257 33V 400mW 20% zener diode.	20
K483	I5021 Top hat.	10
K484	I5410 Stud mntg 3A 100V.	6
K485	I5423 Stud mntg 10A 400V.	2
K112	3A 50V wire ended rects.	14
K113	DA002 150V 0.5A rects.	30

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT

MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

K222	GR05R 50V 4A stud mntg rects.	**5**
K229	IN4006 Rectifier diodes 1A 600V.	**30**
K245	BYX10 1400V rects.	**10**
K248	S05M1 1A 50V rects.	**30**
K292	BY299, 2A 800V diode preformed for H mntg.	**8**
K295	SK4G4/ 04 switching diode 400V 1A preformed for H mntg.	**10**
K302	BYX10 Diodes.	**10**
K308	CV8308 Diodes.	**10**
K313	BY206 Diode. Fast recovery 0.5A 400V.	**4**
K316	31 DQ03 Diode by IR. Schottky 3.3A 40V.	**3**
K319	IN4001.	**30**
Z728	Stud rect 6A 300V BYX38-300.	**10**

17 Diodes (Zener)

K121		7V5 400mW zeners.	**20**
K123		56V 1W zeners.	**10**
K171		11V 400mW zeners preformed.	**25**
K194		22V 400mW Preformed for horiz mntg.	**30**
K224		12V 1W zeners.	**10**
K225		33V 1W zeners.	**10**
K226		20V 400mW zeners.	**20**
K227		9V1 400mW zeners.	**20**
K228		56V 1.3W zeners.	**10**
K247		24V 5W plastic zener.	**5**
K275		BZY88CV7 400mW 4.7V zeners. Long preformed leads for horiz mntg on 15mm pitch.	**25**
K281		BZX79C 6V2 zener, preformed leads.	**30**
K340	IN754A	6V8 400mW Zener.	**20**
K341	IN755A	7V5 400mW Zener.	**20**
K342	IN758A	10V 400mW Zener.	**20**
K343	IN959A	8V2 400mW Zener.	**20**
K344	IN960B	9V1 400mW Zener.	**20**
K345	IN963B	12V 400mW Zener.	**20**
K346	IN965B	15V 400mW Zener.	**20**
K347	IN973B	33V 400mW Zener.	**20**
K348	BZX70C12	12V 2.5W Zener.	**6**
K431		12V 400mW.	**20**
K433		18V 1.3W.	**10**

29 Hardware

K148	Transformer formers. Cat type X228.	**30**
K244	Nylon cupboard latch.	**6**
K255	Terry clips 8-12mm.	**12**
K434	0.5" pillar ID6 0D9.5.	**30**
K435	M3 × 10mm BOLT, PAN, POZI.	**100**
K436	M3.5 × 40mm PAN, POZI.	**50**
K437	2BA × 1" HEX head.	**30**
K438	4BA × 0.75" HEX head.	**100**
K439	2BA shakeproof washer.	**300**
K444	Magnet 20mm dia × 5mm.	**6**
K445	Magnet 26 × 11 × 9mm.	**5**
Z611	Enterprise heatsinks.	**1**
Z718	Black plastic knob.	**20**
Z740	Clip on TO220 type heatsinks.	**10**
Z4053	Antistatic bags.	**4**
Z4174	Knob, push on grey 28mm dia with clear skirt marked with red line 47mm dia. Push fit for ¼" spindle.	**4**
Z4204	White rubber feet. 12.5 dia × 6.5mm screw fix.	**40**
Z4203	Cable gland 21mm max requires 28mm dia hole.	**5**

33 IC's (Linear)

K223		RC4131T Op-Amps.	**3**
K339	LA1385	TV chip.	**1**
K311		UDN 6116A driver chip.	**4**
Z732		XK1444 CMOS buffer 16 pin chip.	**10**

34 IC's (Digital)

BP801	7401	**10**
BP802	7407	**10**
BP803	7410	**10**
BP804	7413	**10**
BP805	7437	**10**
BP806	7440	**10**
BP807	7443	**10**
BP808	7450	**10**
BP809	7460	**8**
BP810	7470	**8**
BP811	7472	**10**
BP812	7480	**10**
BP813	7481	**10**
BP814	7482	**10**
BP815	7483	**10**
BP816	7484	**10**
BP817	7491	**8**
BP818	7492	**8**
BP819	7493	**8**
BP820	7494	**8**
BP821	7495	**8**
BP822	7496	**8**
BP823	74104	**8**
BP824	74105	**8**
BP825	74110	**8**
BP826	74118	**8**
BP827	74119	**8**
BP828	74141	**5**
BP829	74151	**8**
BP830	74153	**8**
BP831	74155	**8**
BP832	74156	**8**
BP833	74157	**8**
BP834	74160	**8**
BP835	74161	**8**
BP836	74164	**8**
BP837	74165	**8**
BP838	74167	**8**
BP839	74173	**8**
BP840	74174	**8**
BP841	74175	**8**
BP842	74181	**5**
BP843	74182	**8**
BP844	74191	**8**
BP845	74193	**8**
BP846	74195	**8**
BP847	74196	**8**
BP848	74197	**8**
BP849	74199	**8**
BP850	74LS11	**10**
BP851	74LS14	**8**
BP852	74LS20	**10**
BP853	74LS26	**10**
BP854	74LS33	**10**
BP855	74LS42	**6**
BP856	74LS55	**8**
BP857	74LS73	**8**
BP858	74LS74	**8**
BP859	74LS76	**8**
BP860	74LS93	**6**
BP861	74LS95	**8**
BP862	74LS122	**6**
BP863	74LS148	**6**
BP864	74LS153	**6**
BP865	74LS173	**8**
BP866	74LS221	**6**
BP867	74LS273	**6**
BP868	74LS275	**6**
BP869	74LS279	**8**
BP870	74LS393	**6**
BP871	74LS669	**3**
K363	4040 surface mount.	**4**

35 IC's (Micro)

K233	C500 calc chips + data	**2**
K303	SL-A-4032 chips by GI. 14DIL	**4**
K305	SL-D-2128 chips by GI. 14DIL	**4**

38 Indicators

K142	Wire ended neons cover case size 90V.	**25**
K277	28V 0.04A min flange lamps by GI.	**10**
Z321	Lamp LES 6V 0.06A L15 dia 5mm.	**7**
Z323	Lamp MF 6V 0.1A L15 dia 6mm.	**6**
Z324	Lamp MF 12V 0.1A L15 dia 6mm S × 6s.	**6**
Z325	Lamp MF 28V 0.08A L15 dia 6mm S × 6s.	**6**
Z330	Lamp MES 50V 0.05A L28 dia 10mm.	**10**
Z335	Lamp MBC 240V neon L28 dia 10mm.	**6**
Z337	Lamp MBC 6.5V 0.3A L24 dia 11mm.	**10**

40 LED's

K151	3mm Red LEDs.	**12**
K152	5mm Red LEDs.	**10**
K284	Large (7 × 5.5mm) rectangular pink LED.	**6**
K309	LD261-4LED. Infra red emitter, sub min 0.1 pitch.	**4**

43 Miscellaneous

Z1655	Xenon flash tube. 56mm long × 3.5 dia.	**1**
Z1656	Xenon flash tube. 40mm long × 3 dia.	**1**
Z4081	CB Aerial eliminator.	**1**

48 Pots and Presets

K130	470RV 0.1W Presets.	**25**
K159	0.3W presets 500kV knurled knob.	**20**
K161	0.3W presets 2K5V.	**20**
K162	0.3W presets 2M5V knurled knob.	**20**
K176	150R 0.1W V presets.	**24**
K177	470R 0.1W H presets.	**24**
K178	470R 0.1W V presets.	**24**
K179	2k 0.1W H presets.	**24**
K181	2k2 0.1W H presets.	**24**
Z004	Skeleton joystick.	**1**
Z577	5k edgewise pot with switch, no knob.	**10**
Z1398	Cermet open preset. Horiz mntg 2k5.	**10**
Z1471	1¼" trimpot. Plessy type 200P 10k.	**4**
Z1535	Convergence type pot with knob 1k.	**6**
Z1572	100R carbon preset by AB.	**25**
Z1573	100R carbon preset by Piher.	**25**
Z1583	220k Carbon preset by AB.	**25**

53 Resistors

K219	OR47 0.7W resistors.	**30**
K294	SIL resistor network, 8 × 500R.	**10**
K366	OR47 10% ½W resistor.	**100**
K367	1R 10% ½W resistor.	**100**
K401	1R2 2½W W/W.	**25**
K402	1R5 2½W W/W.	**25**
K403	100R 2½W W/W.	**25**
K404	60Vac varistor.	**12**
K405	Bourns 3386W trimpot, 1k.	**5**
K406	Bourns 3296X multiturn pot, 100R.	**3**
Z1468	H2 10K 0.1% 25ppm precision by Holsworthy.	**3**
Z1469	H2 5M0 1% 25ppm precision by Holsworthy.	**1**

65 Switches and Reeds

K150	Switches (cat type W430).	**10**
K158	SPCO centre off white rocker switch.	**6**
K231	4W DIL switch.	**4**
K232	8W DIL switch.	**2**
Z1522	Switch. Alps SRS 40 way. As used in CB's for channel switching. Body 20 × 20mm 6mm dia. Shaft with M9 fixing nut. 7 bits per strip. Data sheet supplied.	**1**
Z1694	S103/ 14 thermal switch. Glass encased with B7G base. At 24V cold start 70 secs to energise, hot start 10 secs. 5A.	**1**

68 Thermistors

K276	15k Siemens thermistors.	**6**
K289	PTC thermistor marked 630H. Measures 4R @25°C and rises to 30M @ 200°C.	**6**
K290	NTC thermistor 8.3k @ 25°C reducing to 100R@ 100°C.	**5**
K293	Dual thermistor 2322 662 98009.	**3**
Z1472	Thermistor as sused on BT phones. Bead type with negative temp co-efficient. R@25°C = 120K.	**1**

PRICES IN BOLD INCLUDE VAT; PRICES IN LIGHT DO NOT

MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

70 Tools

Z314	Bow compass.	1

71 Transducers

Z945	5" × 3" 80R 1W speaker.	1

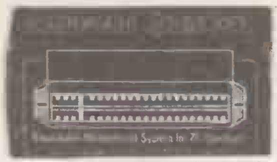
72 Transistors

K102	BC349A transistors.	15
K103	BC546B transistors.	10
K109	BC114 transistors.	15
K114	XK6116 (BF241) transistors.	15
K134	Unmarked untested OC71 type transistors.	50
K182	PN72 plastic BCY72 TO92 case.	15
K208	SGS127212 NPN TO5 H_{FE} 75 V_{CE} 50V.	10
K209	SGS26907 NPN TO5 H_{FE} B_{CE} 40V.	11
K211	ED1502B TO106 NPN Si switching .	16
K212	TJ525 TO92 NPN Si 60V .	20
K213	FW5247 TO5 NPN Si .	25
K215	E5444 TO92 NPN Si 30V .	25
K216	22-6025 TO5 PNP Si 80V H_{FE} 50 .	10
K217	7-4659C TO18 NPN Si H_{FE} 100 40V. Sim BC107.	12
K218	648005 TO3 GE Hi-Gain 30V.	2
K221	LD270 Sub-min transistors.	10
K291	BC238 preformed TO5 spacing.	20
K304	Matched pair 2SD96 & 2SB496 TO1 case.	4
K310	TO39 case transistor, like BFY51.	8
K317	2N6666	2
K318	BD676	3
K419	TIP132	4
K420	TIP137	4
K421	TIPP31	12
K422	TIPP32	12
K423	TIP111	6
K424	BC327A	20
K425	BDW93	2
K426	BDW94	2
K427	BCX38B	15
K428	ZTX601B	15
VP701	AC141K	6
VP702	AC176K	6
VP703	AC179	8
VP704	AC180	8
VP705	AC181K	6
VP706	AC186	8
VP707	AC187K	6
VP708	AC188	10
VP709	ACY40	6
VP710	ADY26	2
VP711	AF116	4
VP712	AF118	4
VP713	AF127	5
VP714	AF200	5
VP715	BC115	15
VP716	BC136	12
VP717	BC149C	12
VP718	BC154	15
VP719	BC157	20
VP720	BC159	20
VP721	BC159B	20
VP722	BC172B	20
VP7152	BC173B	20
VP723	BC175	8
VP724	BC178	15
VP725	BC181	15
VP726	BC182B	15
VP727	BC186	15
VP728	BC208	15
VP729	BC208A	20
VP730	BC209B	20
VP731	BC214L	20
VP732	BC214B	20
VP733	BC251A	20
VP734	BC302	7
VP735	BC312	6
VP736	BC328	20
VP737	BC546	20
VP738	BC558	20
VP7153	BCY31	5
VP739	BCY32	5
VP740	BCY33	5
VP741	BCZ11	5
VP742	BDZ12	5
VP743	BD177	4
VP7101	BD244A (TIP2955)	3
VP744	BD312	4
VP745	BD609	4
VP746	BF152	10
VP747	BF160	10
VP748	BF254	10
VP749	BF255	10
VP750	BF257	8
VP751	BF355	10
VP752	BF355	5
VP753	BF494	20
VP754	BF495	12
VP755	BF649	6
VP756	BF679S	6
VP757	BF961	4
VP758	BF595	10
VP759	BFR50	8
VP760	BFT83	8
VP761	BFX19	8
VP762	BFX29	8
VP763	BFX30	8
VP764	BFX84	8
VP765	BFX86	8
VP766	BFX87	8
VP767	BFX88	8
VP768	BFY43	8
VP769	BFY52	8
VP770	BRY56	4
VP771	BSX21	8
VP772	BSY95A	8
VP773	CV7001	10
VP774	CV7735	5
VP775	CV7580	5
VP776	CV9507 (BFX30)	10
VP777	CV9790 (2N2905A)	10
VP778	GET885	6
VP779	2G401	5
VP780	ME1120	20
VP781	MPSA06	10
VP782	MPSA56	10
VP783	OC41	8
VP784	OC42	8
VP785	OC45	8
VP786	OC70	8
VP787	OC72	8
VP788	OC74	8
VP789	OC75	8
VP790	OC76	8
VP791	OC79	8
VP792	OC82	8
VP793	OC200	4
VP794	OC201	3
VP795	OC203	4
VP796	OC204	3
VP797	OC205	3
VP798	OCP71	10
VP799	TIS43	10
VP7100	TIS90	12
VP7102	ZTX109	15
VP7103	ZTX504	12
VP7104	ZTX531	10
VP7105	ZTX550	10
VP7106	2N696	10
VP7107	2N706	15
VP7108	2N708	12
VP7109	2N717	8
VP7110	2N718	8
VP7111	2N726	10
VP7112	2N727	10
VP7113	2N743	12
VP7114	2N914	12
VP7115	2N929	6
VP7116	2N1131	10
VP7117	2N1132	10
VP7118	2N1613	10
VP7119	2N1711	8
VP7120	2N1893	6
VP7121	2N2102	6
VP7122	2N2193	6
VP7123	2N2217	10
VP7124	2N2218	10
VP7125	2N2219	8
VP7126	2N2219A	8
VP7127	2N2220	10
VP7128	2N2221	10
VP7129	2N2221A	10
VP7130	2N2368	10
VP7131	2N2369	12
VP7132	2N2411	4
VP7133	2N2412	4
VP7134	2N2904	10
VP7135	2N2904A	10
VP7136	2N2906	12
VP7137	2N2906A	12
VP7138	2N2907A	12
VP7139	2N3011	12
VP7140	2N3114	8
VP7141	2N3416	20
VP7142	2N3704	20
VP7143	2N3708	20
VP7144	2N3710	20
VP7145	2N3711	20
VP7146	2N4058	15
VP7147	2N4060	15
VP7148	2N4061	15
VP7149	2N4220FET	3
VP7150	2N5172	12
VP7151	2N6122	5
Z506	2N3055B transistors.	4
Z724	BDX88A TO3 case PNP 60V 12A 117W H_{FE} 750@6A.	2
Z1534	PNP TO39 transistor. Sim to BC303.	10

Z4081 CB Aerial Eliminator, enables ordinary car radio aerial to be used with CB set. Black metal case 75 × 70 × 30mm contains 2 × 500pF trimmers 2 switches, coil, R's etc. 2 × 10.5m leads from unit connect to CB rig and car radio. Socket on unit takes car radio plug, thus enabling either car radio or CB to be used at the flick of switch. These were originally selling (during the CB boom) for around £7.95. We've got 3000 to clear.

Prices **£1.00ea** 100/ 0.52

SALE PRICE 2 FOR £1



Z4138 μSlot. 'T' connector (1 female, 2 male) for the Spectrum enabling 2 peripherals to be connected at one time. Further μ slots can be added allowing more peripherals to be added. New and boxed.

Price **£2.00**

SALE PRICE £1.00

Z4139 As above but skeleton version - no plastic case.

Price **£1.00**

SALE PRICE 50P

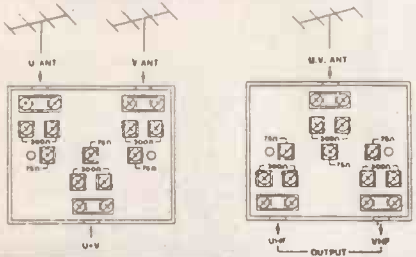
P161A FM MONITOR INTERCOMM

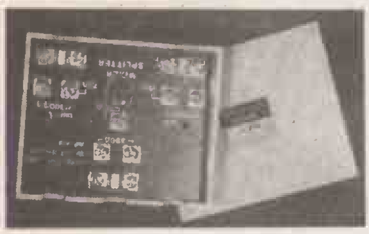
FM wireless Intercomm/baby monitor with built in ultrasonic motion detector. The transmitter has a voice activated microphone with sensitivity control to monitor sound, and an ultrasonic detcector with range control to monitor movement. The receiver will sound an alarm if motion is detected by the monitor. Transmitter and receiver are connected by the mains supply (no wiring needed). Ideal for monitoring baby's room. Power: 240V ac. Size 150x100x45mm. **Price £39.95**

T125A **VHF/UHF MIXER/SPLITTER** **MX47**

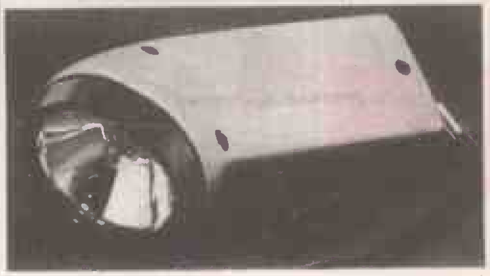
A masthead VHF/UHF splitter/combiner which allows the mixing of signals from separate VHF and UHF aerials into a single download or will split the signal from a single aerial into VHF and UHF signals.

Input .... 300Ω or 75Ω
Output ... 300Ω or 75Ω





NORMAL PRICE £2.30
SALE PRICE
£1.00



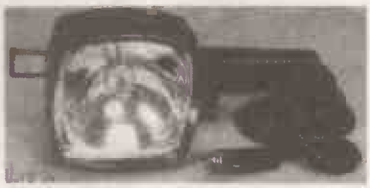
NORMAL PRICE £3.30
SALE PRICE
£2.50

L101 **DYNAMO TORCH** **771**

Handy dynamo powered torch which requires no batteries. Well designed body fits neatly into hand and gives an easy hand-pumped action to generate sufficient power to light bulb brightly. Yellow plastic body with robust shock-proof construction. A must for every glove compartment.

Dims .... 130 x 55mm

NORMAL PRICE £8.95
SALE PRICE
£5.00



L120 **QUARTZ HALOGEN SPOTLIGHT** **ML328**

Hand held quartz halogen spotlight. 55W bulb produces more than 50,000 candle power. Highly polished reflector. Black plastic body. On/off slide switch. Retractable hanger. 3.6m coiled lead fitted with car cigar lighter plug.

Power 12V 4.5A 55W
Dims .... 120 x 120 x 80mm (less handle)

NORMAL PRICE £3.95
SALE PRICE £2.00

TV SWITCH
T123A EUAB37

Push button selector switch to give three inputs to one TV. Blue body with aluminium faceplate, Co-axial socket inputs, co-axial plug output. Automatic substitution of 75Ω load when channel not in use. Screw fixing.

Dims .... 90 x 47 x 39mm

GREENWELD
ELECTRONIC COMPONENTS

UHF/VHF MIXER
T125 **EU385**

Masthead UHF/VHF signal mixer. Mixes the signals from UHF and FM aerials into a single download. Inputs 75/300Ω. Output 75Ω. All plastic case.

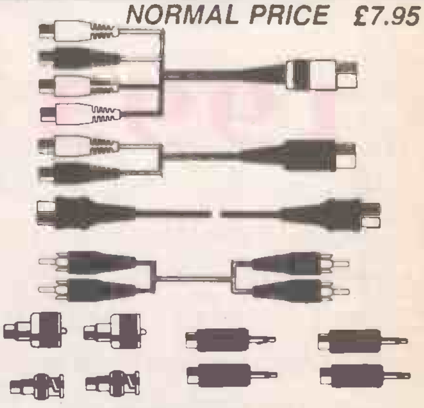
NORMAL PRICE £2.45
SALE PRICE £1.00

Low impedance microphone in white. All plastic body with black metal mesh head. Fitted with 3m white lead. On/off switch. Holder included

Type .... Uni-directional. Dynamic
Impedance 500Ω
Response .... 80—12000Hz
Sensitivity .... —77dB @ 1kHz
Head dia 53mm
Length 182mm

NORMAL PRICE £7.95
SALE PRICE £4.00

NORMAL PRICE £7.95



SALE PRICE £4.00

T120A Video/audio dubbing kit.

- ★ 1 screened lead - 5-pin DIN plug to 5-pin DIN plug. Mirror image. 1.5m.
- ★ 1 twin, screened lead - 2 phono plugs to 2 phono plugs. 1.5m.
- ★ 1 twin, screened lead - 2 phono sockets to 5-pin DIN. 180mm.
- ★ 2 twin, screened leads - 4 phono sockets to 5-pin DIN. 180mm.
- ★ 2 adaptors - phono socket to PL259 (UHF plug)
- ★ 2 adaptors - phono socket to BNC plug
- ★ 4 adaptors - phono socket to 3.5mm jack plug

Bib®

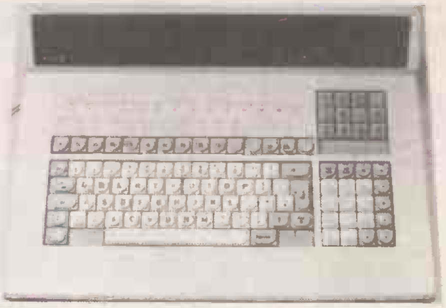
Some 'BIB' accessories have come our way. These are all new and boxed, offered at a fraction of their original cost.

BCC8 Computer terminal maintenance kit for screen, keyboard and printer. Content: Soft brush for keyboard and stiff brush for printer and print cleaning fluid. Aerosol can of air-blast; Kleen-Screen, an antistatic liquid; cleaning cloths. All this is contained in a presentation pack for just **£2.95**

SALE PRICE £1.50

BCC11 Liquid Static Eliminator. A spray can of special formula liquid giving long term neutralisation of all harmful static charges from all glass and plastic surfaces. Comes complete with cloth...................... **£1.00**

SALE PRICE 50P



VISTEL II

Total Communication for Deaf People

Vistel II is a visual telephone plus 'answerphone' which allows everyone to communicate over the telephone network.

By simply dialling a number and typing in your message you can be in touch with anyone else with similar equipment - whether they are across the road or at the other end of the country.

By pressing one clearly marked button you can send or receive typed messages even when you are out. Additionally you can prepare and send a message at a particular preset time (during cheap periods to save you money).

With Vistel II not only can you talk to other Vistel II users but Vistel I (of which there are over 1,000 already in use by deaf people throughout the UK), Telecom Gold, Breakthrough trust's BKU Mailbox Network, Mailink, the RNID telephone exchange or any other computer with a modem.

Specification

- Dimensions: 34cm × 45cm × 13.7cm
- Weight: 4.5kg
- Full 'QWERTY' keyboard plus 'function' keys for ease of use.
- 40 character screen which displays your messages quickly, clearly and quietly.
- Text editor for preparing recording and storing information.
- Memory for up to 9,500 characters.
- Auto-answering capability for receiving calls even when you are not there.
- Auto-dialling capability for sending messages during cheap rate telephone periods.
- Real time clock.
- Personal telephone directory for storing your most commonly used numbers.
- Calculator.
- Printer interface for connection to a printer.
- Telecom Gold, or BKU mail box, function key.
- Vistel II runs from mains with battery back-up so memory is retained even when Vistel II is turned off.
- For connection your only requirements are a power point and a British Telecom jack plug socket.

Options:
- Printer

This unit formed a telecommunications link for deaf people. The basic unit is the Vistel II which has an internal modem that handles the following standards V23 auto hunt, V23 originator, V23 answer, V21 originator, V21 answer. Note the auto hunt is a special function that allows the modem to determine the nature of the modem at the other end, either V23O or V23A.
All files from the transmitting terminal can be stored in memory or sent directly to a printer. Messages can be composed and stored in memory before transmission.
Other useful features include time, date, calculator, storage of often used numbers, parallel printer port, costing of calls, alarm clock, all PSTN features are fully BT approved.
On a component level useful items include a 105 key keyboard with serial output. A linear power supply with the following outputs +12V (a 1A, 2 × +5V (a 2A, -5V (a 100mA, -12V (a 100mA, useful components include 2×78T05 3A regulators with heatsinks, assorted fuses. A main circuit board containing a µPD8085 micro processor, 3 µPD8255 universal peripheral interface IC's, 3×27126 EPROM, 2×µPD4364 memory IC's, 1×µPD8251A USART programmable communications interface ic, HD146818P RTC (real time clock with 12/24 hour time date and leap year day) IC, and various other micro processor related IC's, other board parts include assorted resistors and capacitors, a 4.8V memory backup nicad. A 40 character 5×7 dot matrix VFD with cursor. A communications board with assorted approved relays, capacitors and opto-isolators.

Although the unit can only be used as a stand alone unit, it is possible to modify it so that it can talk to other equipment via a RS232 port.

These units are new and boxed, but because the company who manufactured them has gone bankrupt they are offered without guarantee. There is a comprehensive 143 page instruction manual provided. These units originally sold for over £500.
Our Bargain Basement Price **£75**

SALE PRICE £37.50

1993 CATALOGUE

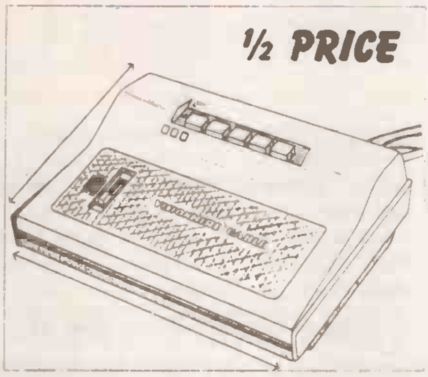
It's not too early to start thinking about next years Catalogue - there'll be lots of new products with expansion of many sections. If you're a hobbyist, modeller, computer buff or techno freak the 1993 Greenweld Catalogue is an essential requirement. Naturally, we'll also be producing a new Bargain List containing an amazing variety of new surplus products in an ever-widening range of interests and monthly update lists will be issued throughout the year. There are various options - see the table below and include your requirements on the Order Form. Don't miss the Bargains - become a subscriber!

		UK/BFPO	Overseas (inc Eire)
Z1111	1993 Catalogue and current Bargain List	£2.00	£4.00
Z2222	Annual subscription to all brochures, Bargain Lists and the 'Greenweld Guardian'	£6.00	£12.00
Z3333	Both the above - Save £1.00	£7.00	£14.00

All subscribers receive a personalized first class reply paid Order Form with all mailings

EVERYTHING ON THIS PAGE HALF PRICE!!

CABLEVISION CALAMITY !!!

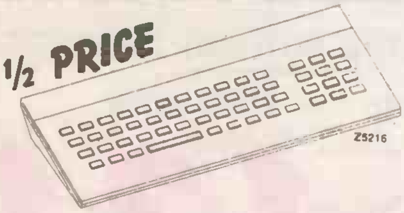


Seems like Visionhire became a bit overstocked on their cablevision consoles - we've just purchased a quantity of these superb brand new units which contain some great electronics and as ever can offer them at an absolute BargainPrice!!

Two tone brown case (dimensions as shown) contains PCB 192x195mm with easily removed UHF modulator made by Labgear (Sound and Vision); video preamp; stabilized 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 (4 channels and on/off mains switch). There are 4 cables coming from the rear (these alone are worth what we are asking for the whole thing!) - 2m mains lead, 1.5m 8 core screened cable with 9 pin plug, 2m video in lead with coax plug and 2m video out lead with coax socket. As you would expect from a company like Visionhire, everything is top quality. 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!!

Z8939 £6.95 ***SALE PRICE £3.50***

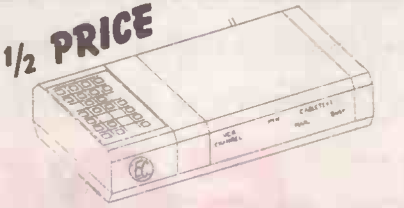


Z5216 Tandata "Homedeck". These are later versions of Z8963 and are (a) smaller and (b) remote controlled. The two tone grey case is 270x110x28mm and has a full qwerty keyboard and seperate numeric keypad. Inside, on the PCB are a few components to transmit the data via 2 IR LED's to the receiver. The unit is powered by a PP3 battery. Super value at just **£3.00**

SALE PRICE £1.50

Z5200 Spirit Burner. Very useful in science labs or for the home experimenter. Chromed steel container 93mm diax48mm high has absorbent material covered in wire mesh. Adjusting lever allows variations in temperature. Complete with 70mm dia dish for heating substances in. **Only £2.50**

SALE PRICE £1.25



Z8970 Remote control cable TV unit made by GEC. Attractive black plastic case 205x120x40mm with membrane pushbutton keypad (22 keys). Front panel has 4x5mm red LED's to indicate status and a dual 7 seg display to show channel. On the 195x102mm PCB is a small regulated power supply (12V & 5V) derived from Z5226 plug in PSU (not supplied). The main chip is a KS49429 and there are also TBA120T, ULN2003B, 4049 + 4.000MHz crystal & 3 small signal transistors as well as the IR detector diode. 2 screened cases contain (a) a PCB with some filter circuitry utilizing surface mount technology, few small chokes, couple of trimmer caps and input and output sockets; and (b) the infra red decoding circuitry using a TDA3047 chip. Regrettaby, we don't have any remote controllers, but these units offer great value for money – **just £5.95 each**

SALE PRICE £3.00

Viewdata Terminal/Modem

Tandata TD1100 alphanumeric Viewdata/Prestel Adaptor.

These units were used with a home banking system. The console was hooked up to your TV and telephone line, and by using the standard qwerty keyboard with seperate numeric keypad, you could access your account. The well styled black and grey case 300x180x75/40 has a 75 key keyboard connected inside by a DIL plug to the main PCB. This has mounted on it the modem sub-panel + 3 relays, UM1286 Astec colour modulator with sound, + SAA5020, 5050, 5070, SY6504, 68B10, MCM51101P45, 2x2114 & 2732 EPROM all in sockets, as well as over 20 other LS and linear chips, transistors etc. There's a back up nicad battery and a regulated power supply. On the rear panel is an on/off rocker switch, UHF output socket, printer skt(15 way D), and cassette DIN socket for recording data.

There are 3 leads attached; 4m long mains lead with 13A plug, 4m long BT lead with old-style plug, and a 3m long TV co-ax lead.

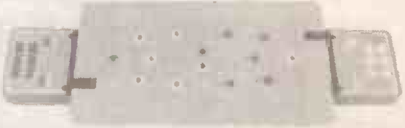
All in all, a versatile, useful compact unit either to use as it is or for the parts within. The component value alone is over £60, so you can see what a bargain this is – it even comes with a photocopied handbook!!

Order Code Z8963. The whole unit as described for just **£12.95**

SALE PRICE £6.50

'JIMMY'

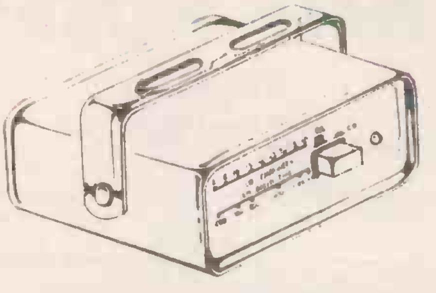
the electronic football game of skill



Z817 Exciting electronic football game - Waddingtons' 'JIMMY'. Brand new models in full working order, but without plastic peripherals, stickers etc. Red plastic case 420mm long × 93mm wide contains keypad and 7 segment LEDs to keep score either end. The centre section 'players' are represented by red 5mm LEDs, 14 altogether. The main chip is the TMS1000, programmed to make odd noises whilst playing and a tune when a goal is scored. Also inside are 13 plastic transistors, 57mm 8R speaker, power supply socket, Rs, Cs etc. Powered by 2 × PP3 batteries. Solo or dual play. Supplied with instruction sheet, playing field complete with coloured 'players'. Good fun to play as a game with good value for the electronics within. Originally retailed at £19.95.

Price .... Only £5.00

SALE PRICE £2.50

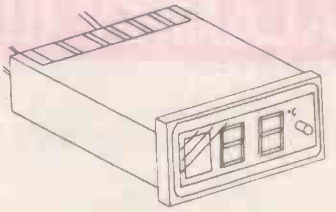


Z4347 CB Converter. We had some of these a year or two ago and they went like hot cakes! It's in a neat case 108 × 68 × 44mm with a drilled mounting bracket for installation. By simply connecting the power leads, plugging your aerial into the converter and feeding output to your AM radio, you have the facility to tune through channels 1-40. A switch is fitted to the front panel so the unit can be by passed. Comes complete with box with instructions.

Price **£3.00**

SALE PRICE £2.00

A nice parcel of digital thermostats has just been delivered – these are high quality units badged BIRCH and manufactured by Wrynech.



Z5228 Complete unit in panel mounting clip-fix case (requires 60x27mm cut out). 2 digit display. Range 40–99°C. Independant on/off set points. Uses LM35CZ sensor, supplied on a 3m long lead (DP 5.93). Has 5V relay on board with 240V 8A c/o contact. Exceptional value for money £14.95

SALE PRICE £9.95

Z8885 TAPE DECK PANEL. A type of telephone answering machine believed to have been used as an alarm system - a recorded message was sent down a BT line if premises were being entered illegally. Steel chassis 245 × 220 × 35mm contains PCB 228 × 145mm and an 8 track cassette unit almost Identical to Z4307. This is attached to the panel by 3 screws and is easily removable, being connected to the PCB with a 5 way socket. The output from the tape head is fed into an MC3301 quad op - amp. The PCB also has 10 CMOS gates, 3 relays, isolator transformer, several transistors, R's, C's etc. 12 way connector for BT line, 12V supply etc, also plug and socket arrangement for Auto/ Manual and Bell delay. Made by Munford & White PLC.

Price .... **Reduced to £7.95**

SALE PRICE £4.95

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LOGIC PROBE

Suitable for displaying the logic state of each gate of TTL, CMOS etc. Logic state displayed in light and sound. Pulse enlargement capability allows pulse detection down to 25ns. Supplied with comprehensive instruction manual

Order Code Y132

SPECIAL PRICE

£8.88

Working voltage: 4-16V
Threshholds: Hi 70% Vcc; Lo 30% Vcc
Input Z: 1M. Max input freq: 20MHz

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MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER

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   - ☐ **with Everyday Electronics** ☐ **With ETI** ☐ **with Elektor**
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All orders are accepted under our terms and conditions on page 129 of our 1992 catalogue. A copy of this page will be sent on receipt of an SAE

SALE PRICES FOR ALL CATALOGUE AND BARGAIN LIST ITEMS:

Listed below by page number are our **SALE** prices for all goods listed in our 1992 Catalogue, Bargain Lists 75 and 75A, and 1992 Spring /Summer Supplement.

1992 CATALOGUE
Pages 3-15 10% off
Pages 16-25 10% off
Pages 31-34 10% off
Pages 40-42 10% off
Pages 58-63 5% off
Pages 75-84 10% off
Pages 112-115 10% off
Pages 126-128 10% off

Bargain List 75A
(Page contents are mostly the same as 75, except 7, 15 & 48)
Page 2 All items appear in this catalogue
Page 3 All books and leads half price; all remaining batteries are listed in this catalogue. (Page 2)
Page 4 50% off
Page 5 See this cat for most items; everything else half price
Page 6 50% off
Page 7 See Spring Supp
Page 8 20% off
Page 9 50% off
Page 10 50% off
Page 11 50% off except Z1881-9
Page 12 50% off except SB15 20%; Z345 £4.95; Z4284 £5.00
Page 13 50% off except Z5099 20%; 128 20%; Z5122 25%; Z8837 £9.95
Page 14 P161A £24.95; Vistel 50%; Z6104/6114/6128 £5.00; Z6147/6160 £7.50; 1655/6 50%
Page 15 See Spring Supp
Page 16 50% off except Z4160 10%; MT55 20%
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Page 44-45 50% off
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Page 47 50% off except radios
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Page 21 See Pages 16-18 of this Cat
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Page 27 50% off except Z5228-30 25% off
Page 28 50% off
Page 31 Z5045 50%; Z8939 50%; Z2171 25%; Z8852 50%; Z345 £4.95; Z5294/6 10%

Some of the above items are offered at a greater discount elsewhere in this catalogue

Speakers

Z5266 15R 45mm
5 FOR £1.00
Z5267 75R 57mm
5 FOR £1.00
Z945 5 x 3 80R 1W
2 FOR £1.00
Z578 30 x 30 x 3 16R 0.4 W
3 FOR £1.00

SEMICONDUCTORS

2KB02 Bridge Rectifiers 200V 2A
Z2347 **SALE PRICE £2** Pack of 8

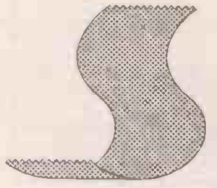
Z2321 Semikon 25A 400V thyristor/diode module
DP 15.00 **SALE PRICE £2**

Z2323 Controlled bridge rectifier 600V 25A - 2 SCR's & 2 Diodes. DP 24.00
SALE PRICE £3

CABLE

Z8978 16 way rainbow ribbon cable

100ft REEL



£5

HEADPHONES

Adastra H8 Stereo with boom microphone!!

£5.95

MOTORS & FANS

Z5171 Fan 110mm dia. mains
Ex-equip £1.50
Z5054 12V Stepper motor
Half Price - £1.50
Z5046 Motor Panel
Half Price - £1.75

TWEEZERS

Half Price Packs

Z4192 6 large pairs over 130mm **£2.95**
Z4193 6 small pairs under 150mm **£2.50**
Z4194 6 Assorted **£2.75**
Z4255 130mm **3 FOR £1.00**

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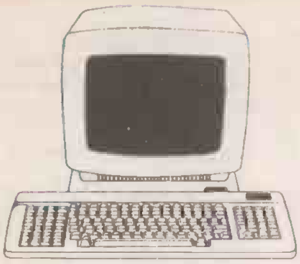
MINIMUM ORDER VALUE £12 + £3 P&P PER ORDER



Z8946 Micronet 12 text terminals. Top quality kit by Sidereal Corporation of USA consists of 12" mono white screen monitor in cream case, and 117 key keyboard. Monitor is supplied with Z5123 modem (needs fitting) and has brightness and volume controls. On rear panel is mains inlet and power on/ off switch, batt on/ off switch, keyboard socket, parallel printer port and 2 RS232 ports. PCB inside has 68B09 processor and 16k of memory. Brand new units, originally selling for several hundred pounds.

Our special price to you is **£50.00**

SALE PRICE £25.00

Z8909 GNT3606 Tape/Punch station. Brand new in original packaging. This is a self contained punch station for data registration on 8 channel paper tape. 19" rack mounting. Punching speed 75c/s; TTL parallel input. RS232. Can be programmed from 50-1200 baud. Takes up to 8" roll. List price is £1,997.55.

Our special price **£500.00**

SALE PRICE £100

COMPUTER TAPES

Z9012 Memorex MRX IV ½" computer tape. 600 ft on 175mm dia spool. 6250BPI. In case, in sealed poly bag. List £7.49.

Our price .... **£3.50** 50+ 2.00

SALE PRICE £2.00

Z22297 Disk pack CDC1204 16MB CMD cartridge.

Price **£20.00**

SALE PRICE £10.00

Z8940 2400 ft of superb quality used 0.5" tape on 10" reels. 6250 CPI. Various manufacturers. Supplied in carrier. New, they cost £12.00. Could probably be used as video tape - we're checking this out. Meanwhile, why not buy a few reels - useful as cheap 'twine' for tying up garden plants etc!!

Price .... **Only £2 a reel**

- or come and collect .... **100 for £50 + VAT**

SALE PRICE £1.00

Z22454 Emulex Intelligent Host Adaptor. MSCP Compatible. Panel with lots of expensive chips, plus a very comprehensive 208 page handbook. Must have cost a fortune originally.

Our price **£30.00**

(Handbook only on approval if required; £10 refundable deposit +£2 post).

SALE PRICE £10.00

Z22455 Similar to above: Emulex MTO3 Controller. For interfacing SC51 hosts and controllers to a model TDC3309 0.25" streaming cartridge tape drive. Handbook available as above.

Price **£30.00**

SALE PRICE £10.00

Z9010 Tape streamer. Tandberg TDC3319. Internal fitting (same size as 5¼" disk drive). Takes DC600 tapes. Unsure of capacity - possibly 60Mb. Does anyone know?

Price **£250.00**

SALE PRICE £100

Magnetic card reader head - used for detecting when credit card or similar is swiped. Made by DRH. Type no 01.635. No other info (but our technical expert is working on it).

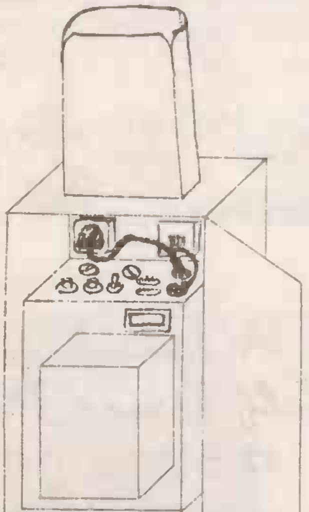
Order Code **Z2121**

Prices .... **£2.00** 100+ £1.00

SALE PRICE £1.00

ZONEPHONE ZAPPED!!!

You've probably seen in the press the much hailed personal phone has been a dismal flop - with 3 different systems and the restraints imposed on its use meant it had little practical value. Failure seemed inevitable - but there's a silver lining to every cloud and its an ill wind that blows nobody any good, etc, etc ... we've purchased some of the goods with more to follow.



ZONEPHONE TERMINAL

Z8956 These were the units screwed to various buildings throughout the UK which you stood next to whilst making a phone call with your incredibly useful handset! Too bad if you weren't in range (99.9% of the UK wasn't!) but it was a nice toy while it lasted. There was a lot of clever technology involved, and we're selling these at probably about 1% or 2% of their real cost! So what do you get for your money?

Well, a lot of case for a start - in the outer steel case (a) 480 × 300 × 150mm with fibreglass aerial case on top (b) 250 × 160 × 75mm* there's another steel case (c) 325 × 245 × 130mm and inside this there's a plastic box (d) 200 × 15 × 75mm.

(a) contains a metal surface mounting 13A socket and a BT line socket.

(b) has 2 whip aerials 200mm long terminated in PL259 plugs.*

(c) contains 8V 3.8Ah sealed lead acid battery, mains transformer (10V 2A Sec), mains filter and a plethora of plugs and sockets mounted on top - 3 BNC and 2 × 9 pin 'D' type, also 2 fuseholders, a lead with 13Aplug and another lead with BT plug, and a power on/ off toggle. Screwed to the inside of the lid is a PCB 250 × 160 with lots of nice bits - 64180 CPU, 27C256 EPROM, 5256-15 256k RAM × 3, LM2940, LM317T, BD680 × 2, 3.6V AA size lithium cell in holder, about 30 various linear/ logic chips, 3 xtals etc, etc. (You're getting great value for money here!)

(d) contains the Tx/Rx panel 170 × 135mm. Lovely bit of kit, this, all surface mount - about 20 chips. Inputs and outputs are taken to 2 min PCB sockets.

There's another panel the same size in this box, with lots of hi-tech devices - 2 × TMS77C82 programmable 8 bit microcontroller, 77C01, TMS320MC10FNL 16/ 32 bit signal processor, LM2984 triple 5V output regulator and another 10 chips, 4 'D' plugs/ sockets and lots of other bits.

And that's about it!

The whole complete unit is yours for just **£29.95**

SALE PRICES

COMPLETE Z8956 £17.95

LESS AERIALS & FIBREGLASS CASE Z8985 £12.95

3 INCREDIBLE METER OFFERS

Y123AC (TL3310)

- 3.75 digit 25mm LCD display (2999 count) with 40 point bargraph
- True RMS measurement
- Auto/manual ranging
- 20A ac/dc measurement capability
- Frequency measurement
- Memory mode for relative measurement
- Data hold
- Diode test
- Full overload protection

AC voltage: Auto	0-20-200-700Vac ±1%
Manual	0-30-300-700Vac ±1%
DC voltage: Auto	0-200m-2-20-200-1000Vdc ±0.7%
Manual	0-300m-3-30-300-1000Vdc ±0.7%
AC current	0-30m-300m-20Aac ±1.8%
DC current	0-30m-300m-20Adc ±1%
Resistance: Auto	0-200-2k-20k-200k-2MΩ ±0.8%
Manual	0-300-3k-30k-300k-3M-30MΩ ±0.8%
Frequency	10Hz to 20kHz ±0.5%
Dims	190 x 85 x 40mm

NORMAL SELLING PRICE £89.95

SALE PRICE £39.95

Y122MD 10MΩ M2355

AC volts	0-200m-2-20-200-750V
DC volts	0-200m-2-20-200-1000V
AC current	0-200µ-2m-20m-200m-10A
DC current	0-200µ-2m-20m-200m-10A
Resistance	0-200-2k-20k-200k-2000k-20M-2000MΩ
Frequency	0-2k-20k-200kHz
Transistor hFE	0-1000 NPN/PNP
Logic test	TTL
Protection	Fuse
Dims	130 x 72 x 33mm

NORMAL PRICE £49.95

SALE PRICE £24.95

- ★ 32 ranges including 10A ac/dc
- ★ 3½ digit 12mm LCD display
- ★ Diode and transistor test
- ★ Frequency counter
- ★ Logic test
- ★ Continuity buzzer
- ★ Auto zero and polarity
- ★ Over range and low battery indication
- ★ Test leads with part shrouded 4mm plugs

Battery and instruction manual included

10MΩ MULTIMETER

Y130 (KD4100)

Y130A (KD4200)

- ✱ 3,999 count resolution
- ✱ 40 segments bargraph
- ✱ Max., min. and average function
- ✱ Ratio measurement Function
- ✱ Error correction function
- ✱ Relative magnitude function

NORMAL SELLING PRICE £120.00

SALE PRICE £49.95

AC volts	0-4-40-400-750Vac ±1%
DC volts	0-400m-4-40-400-1000Vdc ±0.5%
AC current	0-40m-400-10Aac ±2%
DC current	0-40-400m-10Adc ±1%
Resistance	0-400-4k-400k-4M-40MΩ ±1%
Temperature (Y130A ONLY)	-50 to 1200°C
Dims	165 x 78 x 35mm

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