EVERYDAY ELECTRONICS

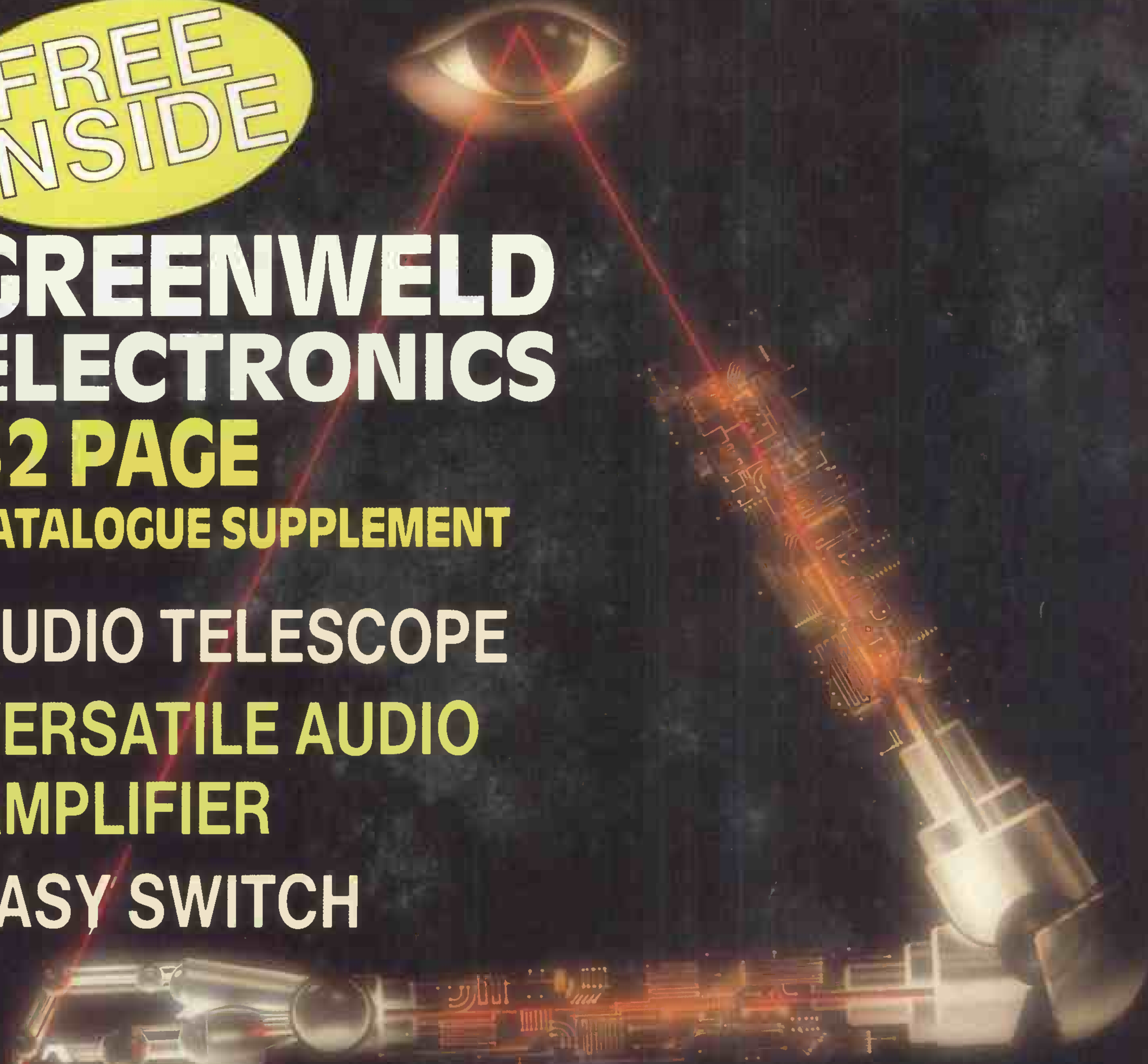
858

APRIL 1992

INCORPORATING ELECTRONICS MONTHLY

£1.60

FREE INSIDE



GREENWELD ELECTRONICS 32 PAGE CATALOGUE SUPPLEMENT

AUDIO TELESCOPE

VERSATILE AUDIO AMPLIFIER

EASY SWITCH

NEW FEATURE CIRCUIT SURGERY

READERS FORUM, HINTS & TIPS, TROUBLE SHOOTING, ETC.

04

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

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

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

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

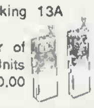
PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

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. £25.00 ref 25P21R.

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

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power ampl 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

1992 CATALOGUE AVAILABLE NOW
IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated 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.

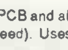
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.

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 c. 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

COLOUR MONITORS
AMSTRAD CTM644
RGB INPUT
£75.00 REF A75P1

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

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18R.

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

ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207R

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

240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40.00 ref 40P200R

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

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
NEXT DAY DELIVERY £8.00
FAX 0273 23077
VISA

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

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 +3 LIGHT GUN PACK
complete with software and instructions £8.00 ref 8P58R

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

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

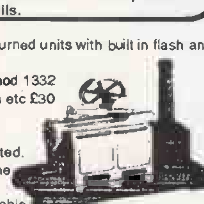
NEW SOLAR ENERGY KIT
Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

POTENTIOMETER PACK NO 1
30 pots for £3.00! ideal for projects etc. Ref CD45R

286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) 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 14P200R

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

USED SCART PLUGS
Pack of 10 plugs suitable for making up leads only £5.00 ref 5P209R

C CELL SOLAR CHARGER
Same style as our 4 x AA charger but holds 2 C cells. Fully cased with flip top lid. Our price £6.00 Ref 6P79R

IN SUSSEX? CALL IN AND SEE US!

VOL. 21 No. 4 APRIL 1992

EVERYDAY ELECTRONICS

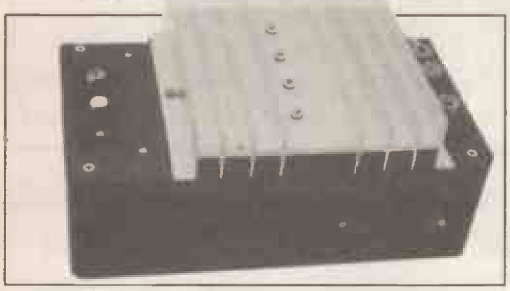
INCORPORATING ELECTRONICS MONTHLY

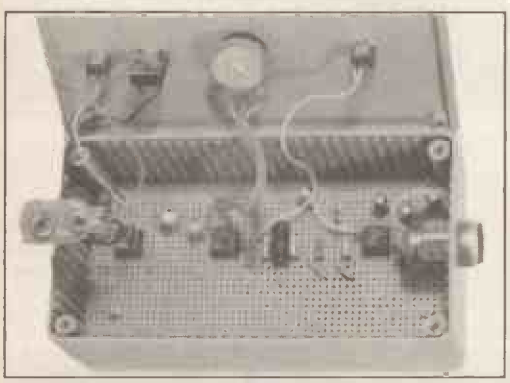
ABC

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

ISSN 0262 3617

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





Projects

Series

Features

Our May '92 issue will be published on Friday, 3 April 1992. See page 195 for details.

Front cover photograph Phil Jude/Science Photo Library

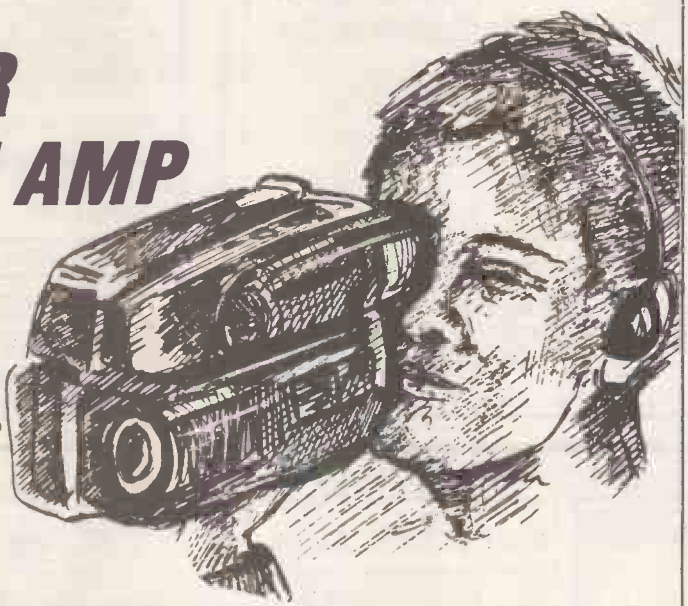
NEXT MONTH

SPECIAL 8-PAGE SUPPLEMENT

MAKING YOUR OWN P.C.B.s

This supplement looks at p.c.b.s in general and at their various forms, it then goes on to investigate p.c.b. fabrication techniques available to the hobbyist. Follow up parts will cover Ultra-Violet Processing Techniques and Originating Your Own Artwork. We will also publish a couple of associated projects – an Artwork Light-Box and a U.V. Exposure Timer – in later issues

CAMCORDER HEADPHONE AMP



Many modern camcorders have a jack socket for headphone output but often users find that suitable medium impedance headphones are very expensive. This neat little amplifier is designed to allow the use of inexpensive headphones to monitor the sound being recorded. It is cheap and easy to build, with only a dozen or so components.

IT'S A KNOCKOUT

A novel electronic box-of-tricks to make your party, garden fete or social evening go with a swing. A compendium of games with electronic dice, an on-the-button precedence indicator and automatic scoring for a number of popular games.

Although most of the suggested games can be played using the display on the Knockout box, separate large-scale, easy-to-make electronic displays can be added so that everybody knows what's going on and can join in the fun.

*The games include **Out For A Duck** – hit a duck with a ball; **Cat O' Nine Lives** – steady hand game; **Wheel of Misfortune** – questions determined by the spin of a wheel; **Bull's Eyes** – shooting gallery; **Buried Treasure** – use a special treasure detector; **Get Any Row** – reaction and question game.*

PLUS

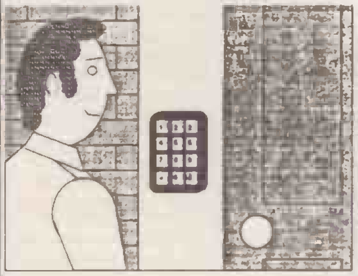
*Our new **Circuit Surgery** and **Everyday Readout** pages will be featured so why not write in?*

EVERYDAY ELECTRONICS

MAY ISSUE ON SALE FRIDAY 3RD APRIL 1992

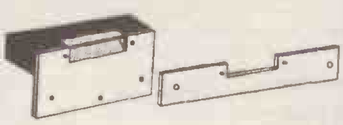
TK FOR KITS

PROGRAMMABLE DIGITAL LOCK



- ★ Easily changed combination via the keypad
- ★ 4-digit sequence with over 38000 combinations
- ★ Error detection triggers alarm and locks out keyboard after preset number of incorrect entries
- ★ Latched (toggle) or momentary output will drive relay or electric door latch
- ★ Provision for standby battery
- ★ 5-15V DC supply (120μA standby)
- ★ Piezo alarm and keyboard supplied
- ★ Size: 15x50x70mm Keyboard - 10x50x65mm
- ★ Ideal for garages, cars, burglars alarms or even your front door

XK131 Lock Kit £22.50



Optional Parts
High Quality Lock Mechanism £13.95
12V Relay with 10A contacts £2.25
Stabilised mains adaptor £7.95
9V Rechargeable battery £5.40

SUPER-SENSITIVE MICROBUG

- ★ High Quality Audio
- ★ Only 45X25X15mm, including built-in mic.
- ★ 88-100MHz Varicap tuned (FM radio)
- ★ Range approx. 300m
- ★ 9V (PP3) battery required
- ★ Ideal for baby alarm, surveillance

XK128 £7.25

ALL TK KITS CONTAIN

- ★ CIRCUIT DIAGRAMS AND DESCRIPTION
- ★ FULL ASSEMBLY INSTRUCTIONS WITH COMPONENT IDENTIFICATION AND SOLDERING GUIDE
- ★ HIGH QUALITY FIBREGLASS PCB
- ★ HIGH QUALITY COMPONENTS

DISCO LIGHTING KITS

A range of disco lighting kits ideal for incorporating into your lightshow with all the following common features.

- ★ Mains powered
- ★ Outputs 300W/channel – can be uprated to 1KW by mounting the isolated tab triacs on a heatsink
- ★ Mimic LEDs included
- ★ Built-in opto-isolated 'beat response' audio input stage overrides manual control
- ★ Zero crossing detector to minimise interference with your audio system
- ★ Cases or frontpanel hardware not supplied
- ★ Ideal for discos, displays, advertising, shop windows, etc.

XK139 Single Direction 4-Way Chaser

- ★ Incorporates all the above features
- ★ Manual speed control
- ★ Ideal as a simple rope light controller
- ★ Size: 70x65x25mm

£14.50

XK141 4-Way Chaser

- ★ 32 different displays
- ★ 8 programmes of four sequence selected by a switch
- ★ Displays one sequence continuously or alternates between 2 or 4 sequences
- ★ Suitable for inductive loads
- ★ Manual speed control
- ★ 2 controls for display frequency
- ★ Perfect for rope lights, pin spots etc.
- ★ Size: 85x110x35mm

£26.95

DL8000K 8-Channel Sequencer

- ★ 80 eyecatching sequences – flashing, chase left, chase right, build up, etc.
- ★ Sequence selected by two switches
- ★ Manual speed control
- ★ Size: 130x85x35mm

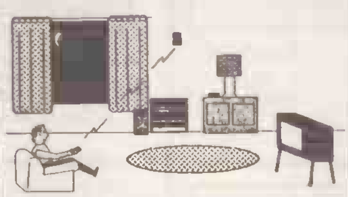
£46.95

REMOTE CONTROLLED LIGHT DIMMER

- ★ Controls up to 300W of lighting (not fluorescent)
- ★ Touch control on front plate
- ★ Toroidal interference suppression choke
- ★ Front plate included, fits shallowest wall box
- ★ Requires XK135 transmitter

XK132 £19.95
XK135 IR Transmitter £5.95
XK136 TOUCHDIMMER
*As XK132 excluding remote control function £13.25

VERSATILE REMOTE CONTROL SYSTEM



- ★ Infra Red
- ★ Controls up to 16 pieces of equipment or 16 functions
- ★ 12-24V DC or 240V AC operation
- ★ Mains supply included
- ★ Range: approx. 18 metres
- ★ Circuits included for driving relays, triacs, opto-isolators, etc.
- ★ Transmitter requires a PP3 9V battery and keyboard
- ★ Perfect for controlling lights, TV, radio, audio, curtains, heating, garage doors, locks, etc.

MK12 IR Receiver £21.95
MK18 High Power IR Transmitter £9.75
MK9 4-Way Keyboard £3.35
MK10 16-Way Keyboard £9.75
601 133 Black transmitter Box with battery compartment.
Size: 118x66x33mm £2.95

TEMPERATURE CONTROLLER

- ★ Mains powered with LED indicator
- ★ Controls up to 3KW if a heatsink is fitted
- ★ Maintains set temperature to within 0.5 deg.C
- ★ Uses burst fire technique with zero switching to reduce interference
- ★ Temperature range up to 60deg. C with components supplied
- ★ Size: 50x40x25mm

XK140 £9.95

SINGLE CHANNEL REMOTE CONTROL SWITCH

XK134 Infra Red Receiver

- ★ 240V AC or 5-15V DC supply
- ★ 3Amps/240V relay output
- ★ Toggle action switching
- ★ Virtually immune to spurious switching 20ft. range with XK135 transmitter
- ★ Compact Size: 60x42x24mm
- ★ Great for switching lights, TV, car alarms and garage doors. £11.95

XK135 Infra Red Transmitter

- ★ Includes pre-drilled box 75x55x25mm
- ★ Only requires a PP3 battery £5.95

STROBOSCOPES

XK130

- ★ Operates directly from the mains
- ★ Variable flash rates from 0.5-10Hz
- ★ Audio input mode to synchronise flash to music
- ★ Slave mode responds to other strobes
- ★ Manual switch produces one flash when button is pressed

£18.85

XK153 High Power Strobe
As above but uses a more powerful Xenon tube at a higher voltage to produce a much brighter flash.
£22.85

TK ELECTRONICS

ORDERING INFORMATION: Prices **INCLUDE VAT** but please add £1.25 P&P (UK). Overseas Customers: divide total order by 1.175 then add P&P: Europe £3.50, elsewhere £10. Send PO/Cheque/VISA/MASTERCARD No. with order. Local Authority and education orders welcome. Office Hours: Mon-Fri. 9.30 am - 5 pm. Shop Hours: Tues.-Thurs. 10 am - 5 pm. Sat. 10 am - 1 pm.

ORDERS: **081-567 8910** 24 HOURS

VISA

TK ELECTRONICS

13 BOSTON ROAD, LONDON, W7 3SJ. Fax: 081 579 9794.

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.

KIT REF 444 — £22.37

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).

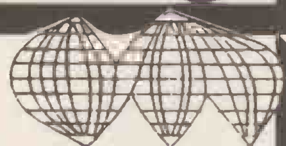
KIT REF 812
Mains Adaptor £2.02 — £14.81

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

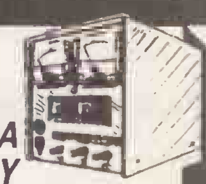
DIGITAL COMBINATION LOCK

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.

KIT REF 769 — £56.82

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

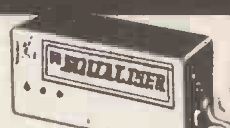
4 CHANNEL LIGHT CHASER

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

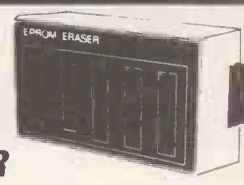
MICROCONTROLLER LIGHT SEQUENCER

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.

KIT REF 838 — £57.17

EPROM ERASER



EE OCT '88

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

KIT REF 790 — £28.51

LIGHT RIDERS

EE OCT '86

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

KIT REF 559 CHASER LIGHT	£15.58
KIT REF 560 DISCO LIGHTS	£22.41
KIT REF 561 LAPEL BADGE	£11.65

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815
Including headphones — £45.95

SUPERHET BROADCAST RECEIVER

EE MAR '90

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

KIT REF 835 — £17.16

ESR ELECTRONIC COMPONENTS

Station Road, Cullercoats,
Tyne & Wear NE30 4PQ
Tel. 091 251 4363 Fax. 091 252 2296

PCB EQUIPMENT

UV EXPOSURE UNIT – 229 x 159mm working area, built in timer, 2 x 8w tubes £62.57
PHOTO RESIST BOARD – single sided pre-sensitised FR4 glass fibre board. 3 x 4 in. £0.86 4 x 6 in. £1.62 6 x 6 in. £2.41
PLASTIC DEVELOPING TRAY £1.35
FERRIC CHLORIDE (0.5Kg) £2.45
TIN PLATING POWDER (90g) £8.33
STRIPBOARD 0.1 pitch 64 x 127mm £1.30 64 x 431mm £4.03 95 x 127mm £1.52 95 x 95mm £1.33 95 x 431mm £5.27
BREADBOARD 81 x 60mm 390TP £2.98 175 x 42mm 640TP £3.40 175 x 67mm 840TP £5.34 *203 x 75mm 840TP £7.00
* inc plate & 4mm posts

KITS

Complete with screen printed & solder mask board, components and full instructions.
CAR ALARM voltage drop £12.99
200W CAR BOOSTER 12/24V CD/line/speaker input. inc housing. £91.88
ELECTRONIC DICE (dual) £9.15
SOUND GENERATOR 10 tunes, line & speaker output £19.11
2.5W UNIVERSAL AMPLIFIER £6.86
AF SIGNAL INJECTOR/TRACER adjustable o/p & i/p £8.39
DIGITAL CODE LOCK 4 digit code flip/flop or latch o/p £19.11
AC MOTOR/DRILL CONTROLLER carbon brush 24-240Vac 5A £15.28

D CONNECTORS

	Plug	Socket
9 pin	£0.29	£0.30
15 Pin	£0.39	£0.39
15 Pin H.D.	£0.81	£0.90
23 Pin	£0.40	£0.42
25 Pin	£0.48	£0.50
9 Way plastic cover		£0.30
15 Way plastic cover		£0.33
23 Way plastic cover		£0.36
25 Way plastic cover		£0.36

CAPACITORS

Ceramic Disc 100V 10pF to 100nF £0.07
Ceramic Plate 100 & 63V 1.0pF to 12nF 1pF-1nF £0.06, 1n2-2n7 £0.09, 3n3-4n7 £ 0.12, 10n & 12n £0.06
Polystyrene 160V 5% 47pF to 10nF 47p-2n2 £0.09, 2n7-10n £0.12

SOLDERING IRONS

Antex Soldering irons
M 12 Watt £7.11
C 15Watt £7.11
G 18Watt £7.30
CS 17Watt £7.21
XS 25Watt £7.30
ST4 STAND £2.75
New PORTASOL HOBBY 35Watt gas iron £11.17
DESOLDER PUMP £3.00
ANTISTATIC PUMP £4.30
22SWG 0.5Kg Solder £7.40
18SWG 0.5Kg Solder £6.60
1mm 3 yds Solder £0.50

RESISTORS

0.25W 5% CF E12 Series £0.60/100
0.5W 5% CF E12 Series £0.95/100
0.25W 1% MF E24 Series £1.72/100
POTS Log or Lin 470R – 1MO 25mm dia 0.25in shaft £0.40
PRESETS Enclosed Horz or Vert 100R – 1 MO 0.15W £0.15
PRESETS Skeleton Horz or Vert 100R – 1 MO 0.1W £0.11

HARDWARE

PCB Nylon Stand-offs clip into board, screw from base.
5mm spacing £0.24/10 £1.68/100
10mm spacing £0.26/10 £1.82/100
13mm spacing £0.30/10 £2.10/100
SELF TAPPING SCREWS Pan head
No 6 x 6.4mm £0.14/10 £0.88/100
No 6 x 9.5mm £0.12/10 £0.78/100
No 6 x 13mm £0.13/10 £0.85/100
No 6 x 19mm £0.16/10 £1.04/100
T2 Box 75 x 56 x 25mm £0.76
T3 Box 75 x 51 x 25mm £0.72
T4 Box 111 x 57 x 22mm £0.92
MB1 Box 79 x 61 x 40mm £1.36
MB2 Box 100 x 76 x 41mm £1.48
MB3 Box 118 x 98 x 45mm £1.72
MB5 Box 150 x 100 x 60mm £2.36

AUDIO CONNECTORS

PHONO PLUG inc strain relief, Red or Black £0.17
PHONO PLUG right angle, Red or Black £0.23
PHONO Chassis Socket £0.16
6.35mm Plastic Mono Plug with strain relief £0.25
As above but Stereo £0.45
6.35mm Chassis Socket, switched Mono £0.36, switched Stereo £0.49
3.5mm Mono Plug £0.17
3.5mm Stereo Plug £0.29
3.5mm Mono line skt £0.24
3.5mm Stereo line skt £0.29
PLASTIC DIN PLUGS
2 pin £0.15, 5/360 £0.27, 3 pin £0.24, 6 pin £0.30, 4 pin £0.29, 7 pin £0.33, 5 /180 £0.26, 8 pin £0.45, 5 /240 £0.30
XLR Chassis Socket £1.65
XLR Chassis Plug £1.32
XLR Line Socket £1.45
XLR Line Plug £1.36

TEST & MEASUREMENT

HM103S ANALOGUE METER
19 ranges (inc 10Adc), fuse & diode protection, battery test, shock resistant tilted case, mirrored scale, supplied with battery, leads & instructions. Dim. 154 x 77 x 43mm £11.47

HC2020S ANALOGUE METER
20 Ranges (inc 10Adc), fuse & diode protection, transistor & diode tester, polarity reverse switch, high impact shock resistant case. Supplied with battery, leads, stand & instructions. Dim. 150 x 102 x 45mm £18.45

HYT07 LOGIC PROBE
TTL & CMOS, displayed in light & sound, pulse enlargement, pulse detection down to 25nsec, max freq. 20MHz. Supplied with full instructions. £7.72

MX190 DIGITAL METER
19 ranges, 3.5 digit 12mm LCD, signal injector, diode test, fuse protection, auto polarity & zero, supplied with battery, leads & instruction manual. Dim. 126 x 70 x 24mm £14.73

M2316B DIGITAL METER
17 Ranges (inc 10Adc), 3.5 digit 12mm LCD, diode test, buzzer, auto polarity & zero, over-range & low bat indication, supplied with battery, leads & instructions. Dim. 130 x 72 x 33mm £23.40

TL34 DIGITAL METER
33 Ranges (inc 20A ac/dc) PTC & fuse protection, 5 capacitance ranges, transistor test. 3.5 digit large 24mm display. Heavy duty case with tilt stand. Supplied with battery, leads & Instructions. Dim. 191 x 88 x 36mm £27.59

HC213 ANALOGUE METER
12 ranges, diode protection, mirrored scale, 2mm leads. Pocket sized, supplied with battery & instructions. Dim. 90 x 60 x 30mm £5.96

4000 Series

4000	£0.20
4001	£0.17
4002	£0.19
4006	£0.32
4007	£0.20
4008	£0.31
4010	£0.19
4011	£0.16
4013	£0.17
4014	£0.30
4015	£0.31
4016	£0.18
4017	£0.25
4018	£0.27
4022	£0.32
4024	£0.21
4025	£0.15
4026	£0.40
4027	£0.18
4029	£0.27
4030	£0.17
4033	£0.56
4035	£0.31
4040	£0.29
4042	£0.22
4046	£0.31
4047	£0.25
4049	£0.20
4051	£0.25
4052	£0.25
4053	£0.24
4055	£0.30
4060	£0.31
4063	£0.29
4066	£0.18
4069	£0.20
4072	£0.17
4075	£0.17
4076	£0.30
4077	£0.15
4082	£0.17
4089	£0.55
4093	£0.15
4094	£0.31
4095	£0.56
4510	£0.26
4511	£0.29
4515	£0.78
4520	£0.26
4521	£0.84
4534	£2.48
4538	£0.37
4541	£0.31
4572	£0.25
4584	£0.24
4585	£0.48
40106	£0.24
40174	£0.34

TRANSISTORS

BC107	£0.14
BC108A	£0.12
BC109C	£0.15
BC177	£0.16
BC178	£0.16
BC179	£0.16
BC182LB	£0.09
BC183LB	£0.09
BC184L	£0.11
BC212L	£0.09
BC212LB	£0.09
BC213LC	£0.09
BC214	£0.11
BC307	£0.11
BC308	£0.10
BC327	£0.12
BC328	£0.10
BC337	£0.12
BC338	£0.08
BC527	£0.24
BC528	£0.24
BC537	£0.24
BC538	£0.24
BC547C	£0.09
BC548C	£0.08
BC549C	£0.10
BC557C	£0.09
BC558C	£0.09
BC559C	£0.09
BC637	£0.21
BC638	£0.21
BC639	£0.21
BD135	£0.29
BD138	£0.29
BDX33C	£0.46
BDX34C	£0.54
BFY50	£0.24
BFY51	£0.24
BFY52	£0.24
TIP29C	£0.33
TIP30C	£0.33
TIP31C	£0.33
TIP32C	£0.34
TIP33C	£1.02
TIP41A	£0.36
TIP42C	£0.28
2N2222	£0.16
2N2905A	£0.28
2N3704	£0.09
2N3705	£0.09
2N3706	£0.09
2N3771	£1.22
2N3772	£1.28
2N3773	£1.88
2N3904	£0.10
2N3905	£0.10
2N3906	£0.09

BRIDGE RECTIFIERS

W005 1.5A 50V £0.19
WO2 1.5A 200V £0.20
BR32 3A 200V £0.36
BR62 6A 200V £0.64
1004 10A 400V £1.39

74LS-Series

74LS00	£0.14
74LS01	£0.17
74LS02	£0.18
74LS03	£0.17
74LS04	£0.14
74LS05	£0.17
74LS08	£0.17
74LS09	£0.17
74LS10	£0.17
74LS11	£0.17
74LS12	£0.16
74LS20	£0.16
74LS21	£0.16
74LS26	£0.16
74LS30	£0.17
74LS32	£0.17
74LS37	£0.16
74LS42	£0.25
74LS51	£0.19
74LS86	£0.20
74LS92	£0.40
74LS93	£0.25
74LS107	£0.30
74LS109	£0.21
74LS123	£0.40
74LS125	£0.21
74LS133	£0.22
74LS138	£0.24
74LS153	£0.25
74LS154	£0.90
74LS157	£0.25
74LS164	£0.26
74LS165	£0.53
74LS175	£0.24
74LS191	£0.24
74LS193	£0.24
74LS367	£0.21
74LS374	£0.32

LINEAR ICs

TL071CP	£0.32
TL072CP	£0.34
TL074CN	£0.48
TL081	£0.29
TL082CP	£0.34
TL084CN	£0.46
TBA120S	£0.60
LM301A	£0.25
CA311E	£0.28
CA324	£0.23
LM348N	£0.31
LF351N	£0.36
LM358N	£0.27
LM377	£2.57
LM380N	£1.12
LM381	£2.70
LM386	£0.48
LM387	£1.60
LM392N	£0.79
LM393N	£0.28
CA555	£0.22
NE556N	£0.36
NE567N	£0.36
UA733	£0.64
CA741CE	£0.18
LM748CN	£0.31
TBA810S	£0.68
TBA820M	£0.39
LM1458	£0.26
ULN2004	£0.48
TDA2030	£1.35
CA3046	£0.37
CA3080	£0.72
CA3130	£0.98
CA3140	£0.44
CA3240	£1.22
LM3900	£0.72
LM3914	£2.70
LM3915	£2.70
MC4558	£0.36
NE5532	£0.80
ICL7621	£1.70

SWITCHES

Miniature Toggle Switches 3amp 250v 6.4mm ϕ mounting
SPST Toggle £0.58
SPDT Toggle £0.54
SPDT CO Tog £0.62
DPDT Toggle £0.68
DPDT CO Toggle £0.74
DPDT CO Toggle (biased) £1.20
DPDT CO Toggle (biased 1 way) £1.20
DPDT mini slide £0.15
Rotary Wafer 1P-12W, 2P-6W, 3P-4W, 4P-3W £0.78
Key Switch SPST £2.70
Push to make £0.25
Push to break £0.24
Latching Push Sqr £0.58
PCB Tact 6 x 6mm £0.25

CONNECTORS

CROC CLIPS 33mm Red or Black £0.12
CROC CLIPS 45mm Red or Black £0.20
PP3 Battery Snap £0.10
PP9 Battery Snap £0.14
4mm BANANA PLUG Red or Black £0.09
4mm BUNCH PIN PLUG Red or Black £0.30
4mm BINDING POST Red or Black £0.54
SCART PLUG £0.60
SCART PCB Skt £0.78
SCART LINE Skt £1.35
IEC LINE SOCKET £0.78
IEC CHASSIS PLUG £0.72
IEC CHASSIS Skt £0.56
CAR AERIAL PLUG £0.19
CIGAR LIGHTER PLUG £0.30

RF CONNECTORS

BNC Solder Plug £0.85
BNC Crimp Plug £0.68
BNC Solder Skt £1.08
BNC Chassis Skt £0.78
PL259 5.2mm £0.58
PL259 11mm £0.58
RND UHF socket £0.48
SQR UHF socket £0.40
F Plug RG58 £0.27
F Plug RG6 £0.27
N Plug RG8 £1.64

OPTO DEVICES

5mm Red LED £0.09
5mm Green LED £0.10
5mm Yellow LED £0.10
5mm Orange LED £0.10
3mm Red LED £0.08
3mm Green LED £0.12
3mm Yellow LED £0.13
3mm Orange LED £0.13
5mm Flashing Red £0.50
5mm Flashing Green £0.54
5mm Bi Colour £0.36
5mm Tri Colour £0.48
5mm Plastic Bezel £0.04
3mm Plastic Bezel £0.05
0.3" 7 Segment Display Red
common anode £1.14
common cathode £1.14

RELAYS

6V SPDT 6A £0.70
12V SPDT 6A £0.70
6V DTDP 6A £1.96

REGULATORS

78L05, 78L12, 78L15 £0.24
79L05, 79L12, 79L15 £0.28
7805, 7812, 7815 £0.28
7905, 7912, 7915 £0.38
LM317T 1.5A 1.2-37V £0.44
LM723 150mA 2-37V £0.29

THYRISTORS & TRIACS

PO102AA 0.8A 100V SCR £0.22
TIC106D 5A 400V SCR £0.40
TIC206D 4A 400V Triac £0.65
BTA08-400BW 8A iso £1.74

DIODES

Zener Diodes 2V7-33V
BZY88 400mW £0.08
BZX85 1.3W £0.14
1N4001-1N4005 £0.07
1N4006-1N4007 £0.08
1N5400-1N5402 £0.09
1N5404-1N5406 £0.11
1N5407-1N5408 £0.15
1N4148 Signal £0.05
OA47 Signal £0.28
OA90 Signal £0.07
OA91 Signal £0.10

ADAPTORS

BNC Plug – PHONO Skt £0.78
BNC Plug – BNC Plug £1.96
BNC Skt – BNC Skt £1.00
BNC Plug – UHF Skt £1.38
BNC Plug – 2 x BNC Skt £1.89
BNC Skt – 2 x BNC Skt £1.89
UHF Plug – BNC Skt £1.59
F Socket – F Socket £0.33
3.5mm Plug – 2 x Skt £1.20
3.5mm Plug – .25in Skt £0.57
0.25in Plug – 3.5mm £0.57

ELECTROLYTIC RADIAL CAPACITORS

uF	16V	25V	63V	100V
0.47	–	–	£0.05	£0.07
1.0	–	–	£0.05	£0.06
2.2	–	–	£0.05	£0.06
4.7	–	–	£0.05	£0.08
10	£0.05	£0.05	£0.06	£0.08
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	–	–

VELLEMAN KITS

Stockists of the full range of Velleman kits. Catalogue available upon request.

AUDIBLE WARNING

400Hz 75dB 9-20V £0.72
450Hz 80dB 9-12V £1.14
4KHz 90dB 3-15V £0.92
2.8KHz 100dB pulsed £1.60
3.5KHz 75dB 240Vac £1.22
4KHz 80dB 30V pk-pk £0.58

DIL SOCKETS

8 Pin	£0.07
14 Pin	£0.11
16 Pin	£0.15
18 Pin	£0.15
20 Pin	£0.16
24 Pin	£0.19
28 Pin	£0.22
40 Pin	£0.25

ORDERING INFORMATION

All prices exclude VAT.
Please add 85p carriage to all orders and VAT (17.5%).
No minimum order charge.
Please send payment with your order
PO/Cheques made payable to
ESR Electronic Components
Access & Visa cards accepted
Offical orders from schools & colleges welcome.

CALL IN – OPEN: MON-FRI 8.30-5.00 SAT 10.00-5.00

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

VOL. 21 No. 4 **APRIL '92**

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See notes on **Readers' Enquiries** below – we regret that lengthy technical enquiries cannot be answered over the telephone.

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EVERYDAY ELECTRONICS ADVERTISEMENTS,
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GREAT HOLLAND, ESSEX CO13 0JS.
Phone/Fax: (0255) 850596

TREND SETTER

In a year which has been very difficult for most businesses in the U.K. it is nice to know that the industry which operates around the hobby and training of electronics seems to be bucking the trend. When most consumer magazines have been reporting large circulations drops *Everyday Electronics* has remained consistent through the year. Many of our advertisers are also reporting good levels of sales and Maplin tell us that both their direct mail and shop sales are increasing.

KEEPING IT UP

We intend to capitalise on the success of *Everyday Electronics* and regular readers will find two new regular features starting in this issue. Whenever we have asked readers what they would like to see in EE that we presently do not cover, they most often say a readers' letter page. I must admit that if I pick up any magazine, whatever the subject matter, I often turn to the letters page first.

One request; we do not want *Everyday Readout* to become full of praise for EE and we are not prepared to concoct letters to fill the space. So, if you have something interesting to say about any aspect of our hobby, the magazine or electronics in general, please feel free to write in.

SURGERY

The second new feature is Mike Tooley's *Circuit Surgery*. We can take no credit for this, it is Mike's idea and we feel it is an excellent one. Again, please write in if you have any circuit, theory or constructional problems. Mike is unable to answer such queries individually by post but hopefully he can satisfy most of your requests through this regular clinic. His vast experience in electronics in general and through training thousands of students in a wide range of disciplines of electronics, make him ideally suited to getting to grips with all sorts of areas that give readers problems.

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Constructional Project

AUDIO TELESCOPE

ROBERT PENFOLD

Join the nature trail with this super sensitive amplifier. An audio equivalent of the telescope that will pick up those weak wildlife sounds which could so easily remain undetected.

TRADITIONALLY, when going on a trek through the countryside in search of wildlife you take along visual aids such as binoculars, a monocular, or a low power telescope, plus perhaps a camera. In recent times there has been increasing interest in wildlife sounds, and many animal enthusiasts now set off with cassette recorders and aids to hearing, as well as binoculars, cameras, etc. In a previous article in *Everyday Electronics* we published a very popular design for a *"Bat Detector"* (June '89), which is a device that picks up ultrasonic frequencies and converters them to lower frequencies that can be heard by humans.

The unit featured here is a purely audio device, and it simply amplifies sounds so that weak sounds can be heard more clearly. A sort of audio equivalent to a telescope in fact, or it could be regarded as a hearing aid, but for those with healthy hearing.

The output of the unit feeds a pair of personal stereo type headphones. Loudspeaker operation is not really feasible at it would produce audio feedback, and so-called "howl-around" (screeching and whistling sounds).

Even using headphones it is possible that the amount of amplification will need to be held back in order to avoid this problem. As discussed later, some types of headphone are better than others in this respect.

SYSTEM OPERATION

On the face of it, all that is needed is an amplifier having a microphone at one end and a pair of headphones at the other. Such a setup would do the job, but there are a couple of refinements that can improve results. The block diagram for the Audio Telescope project is shown in Fig. 1.

The microphone feeds into a low noise preamplifier. It is essential that this stage has a very low noise level because the input voltages will typically be a matter of microvolts rather than millivolts.

Mediocre noise performance would result in a background "hiss" level that would swamp most of the quiet sounds picked up by the microphone. In this case a low noise level is achieved by using a very low noise operational amplifier in the preamplifier stage.

A highpass filter is included at the output of the preamplifier stage, and this can be switched in to reduce low frequency sounds. Most of the sounds in nature, with a couple of obvious exceptions in the form of wind and thunder, are at quite high frequencies. Bird songs in particular, tend to have strong high frequency components, including ultrasonic frequencies, but very little bass content. In most cases, a lack of bass response will not therefore have an adverse affect on results.

The attenuation of the unit's low frequency response does not help much in terms of reducing the background "hiss" level, but it does help to reduce unwanted noises picked up by the unit. These noises are mainly the inevitable vibrations that occur when you handle the unit in use. Even just tightening or relaxing your grip slightly can produce quite loud "clangs" and "clunks" through the headphones.

HIGH GAIN AMPLIFIER

The output from the highpass filter is coupled to a high gain amplifier via a volume control. Two stages of amplification are needed in order to obtain the very high overall level of gain that the unit must have in order to function properly.

The output of the unit is fed to the headphones via an attenuator. The attenuator is used to limit the output of the unit to a level that provides comfortable listening. The unit will respond to very quiet sounds, and will therefore be overloaded by loud noises, or even sounds of average intensity. This would result in painfully loud signals from the headphones unless steps were taken to limit the output level.

In the original design an automatic level control was used to avoid excessive outputs, but the simple limiting method used in this circuit seems to be better in practice. Strong sounds will produce a very distorted output, but these sounds are not the ones that the unit is designed to detect. An advantage of the limiting method is that when a strong sound has ceased, the unit operates at full sensitivity, and does not require a recovery period (as would an automatic gain control system).

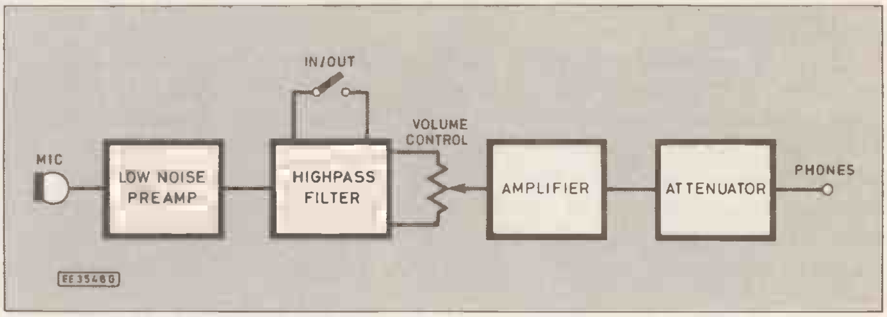


Fig. 1. Block diagram for the Audio Telescope.

CIRCUIT OPERATION

The full circuit diagram for the Audio Telescope is shown in Fig. 2. The circuit is designed to operate with an electret microphone insert.

A microphone of this type is actually a microphone *plus* a built-in f.e.t. preamplifier. These are connected in the arrangement shown in Fig. 3. The f.e.t. operates as a simple source follower buffer stage.

Although the basic electret element has an extremely high output impedance, the f.e.t. preamplifier gives the microphone insert a low output impedance. For the prototype a unidirectional electret microphone insert, which will work on supply voltages from 1.5V to 10V, is used. In this case it is provided with a supply of just under 9V, via a supply decoupling network made up of resistor R1 and capacitor C1.

If you use an alternative microphone insert there are a few points to bear in mind. Firstly, make sure that it is guaranteed to work safely on a 9V supply. Secondly, not all inserts include the load resistor for the f.e.t. This is a point which should be checked with the retailer's catalogue.

If there is no internal load resistor, then a resistor of about 47k in value *must* be connected between the negative terminal of capacitor C2 and the 0V supply rail. Life will be easier if the specified insert (see *Shoptalk*), or a very similar type is used.

In this application there is an advantage in using an unidirectional insert rather than an omnidirectional one. An omnidirectional insert will pick up sounds over a wide angle of "view". This means that you do not have to aim the unit very accurately at the sound source in order to pick it up correctly, but it also means that the unit may be swamped by masses of unwanted sounds for much of the time. The much

IC2 acts as the buffer stage in the highpass filter. This filter is a conventional active four stage filter having an attenuation rate of 24dB per octave. In other words, below the cutoff frequency a halving of the input frequency causes the circuit's gain to reduce by a factor of sixteen.

CUTOFF FREQUENCY

The cutoff frequency has to be something of a compromise. Setting it low gives good output quality with some bass response, but even with the steep slope of the filter's response it would give poor attenuation of low frequency "clangs".

Setting the cutoff frequency quite high would virtually eliminate unwanted noises, but would have unacceptable consequences for the audio quality. A figure of about 300Hz is provided using the specified values, and this seems to be about optimum in practice. The cutoff frequency is inversely proportional to the value used for capacitors C4 to C7, and can easily be changed if you would prefer a different cutoff point.

Capacitor C8 couples the output of IC2 to the Volume control VR1. From here the signal is coupled to a simple non-inverting amplifier based on IC3. This has a voltage gain of around 180 times. Capacitor C10 couples the output of IC3 to the headphone socket via attenuator resistor R15. The headphones must be medium impedance types having the two phones connected in series.

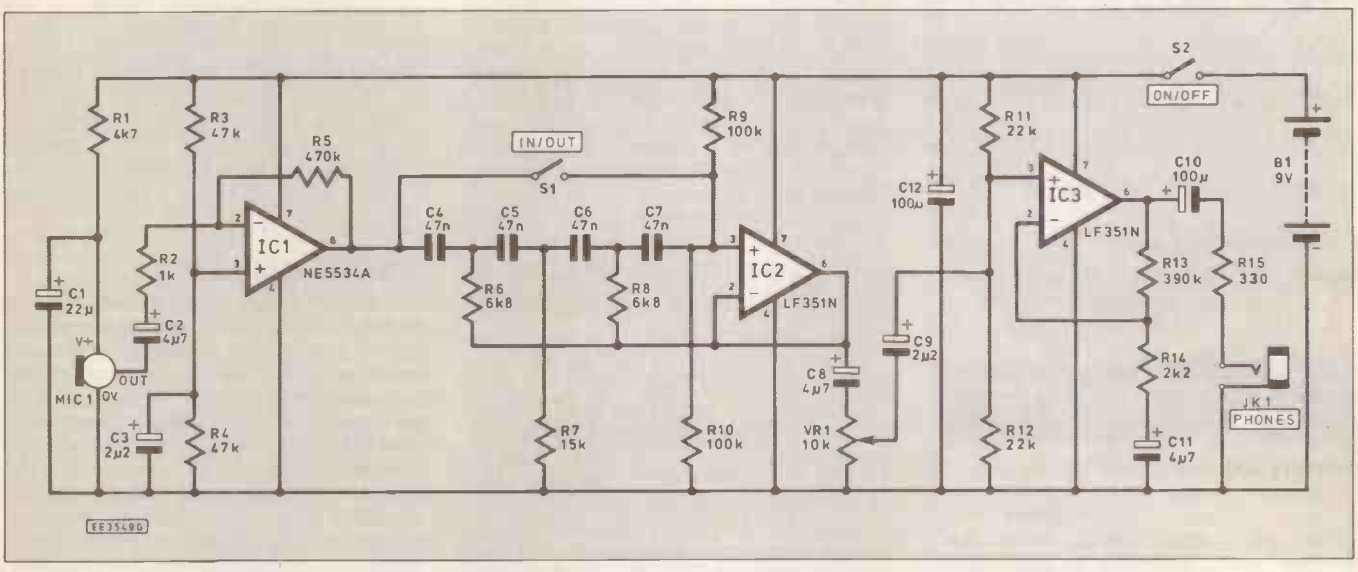


Fig. 2. Full circuit diagram for the Audio Telescope. Switch S1 enables the highpass filtering to be switches in and out of circuit.

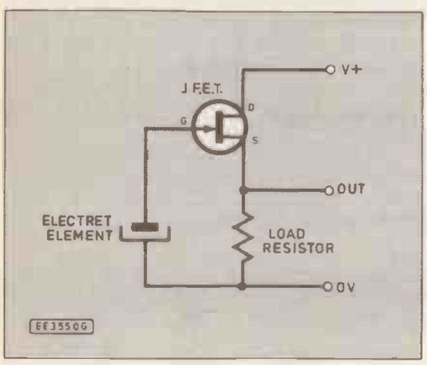
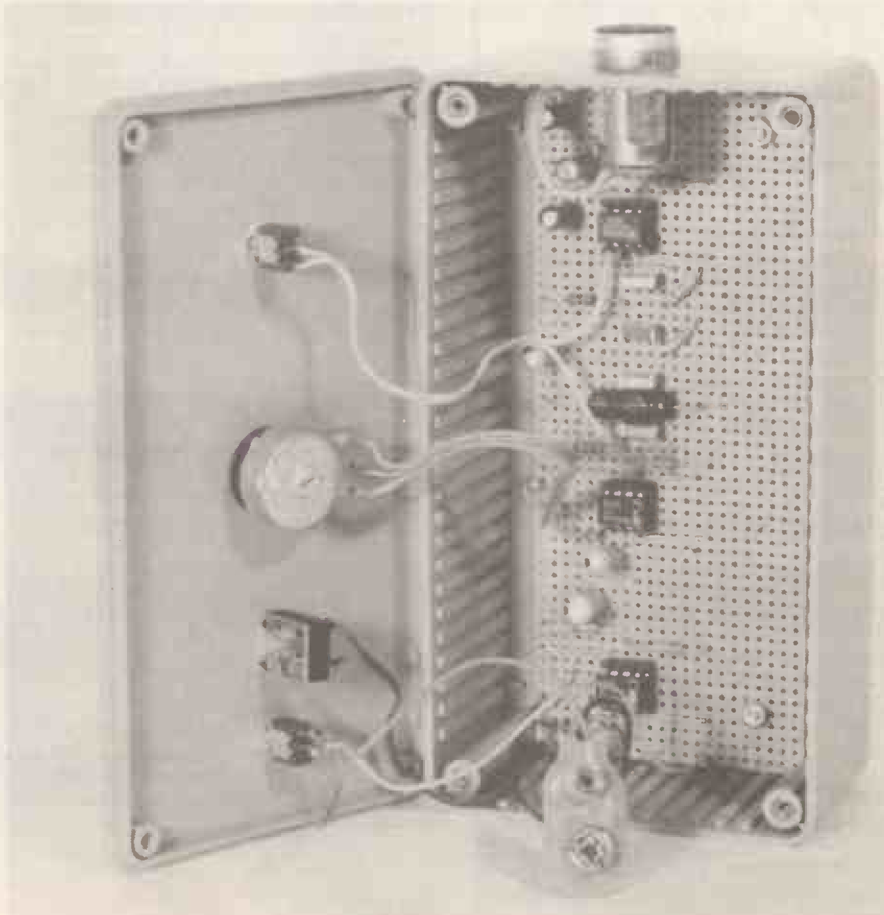


Fig. 3. An electret microphone insert includes a built-in f.e.t. preamplifier.



narrower angle of "view" of a unidirectional insert gives much better results, but you do need to aim the unit a little more carefully in order to pick up the required sounds.

The preamplifier is an inverting circuit which is based on a very low noise operational amplifier IC1. This is an NE5534A i.c.. This stage has an input impedance of one kilohm and a voltage gain of about 470 times.

The circuit will work using a device such as a 741C or LF351N for IC1, but with about ten times the noise level provided by the NE5534A. Increasing the noise level by a factor of ten effectively reduces the sensitivity of the unit by the same factor. Although the NE5534A is relatively expensive, its extra cost is fully justified in this application.

COMPONENTS

Resistors

R1	4k7	
R2	1k	See SHOP TALK Page
R3, R4	47k (2 off)	
R5	470k	
R6, R8	6k8 (2 off)	
R7	15k	
R9, R10	100k (2 off)	
R11, R12	22k (2 off)	
R13	390k	
R14	2k2	
R15	330	

All 0.25W 5% carbon film

Potentiometer

VR1 10k rotary carbon, log

Capacitors

C1	22µ radial elect. 25V
C1, C8, C11	4µ7 radial elect. 63V (3 off)
C3, C9	2µ2 radial elect. 63V (2 off)
C4, C5, C6, C7	47n polyester 10% or better (4 off)
C10	100µ radial elect. 10V
C12	100µ axial elect. 10V

Semiconductors

IC1	NE5534A ultra low noise op. amp
IC2, IC3	LF351 bifet op. amp (2 off)

Miscellaneous

MIC1	Electret insert (see text)
S1, S2	s.p.s.t. sub-min toggle
JK1	3.5mm stereo jack socket
B1	9 volt (PP3 size)

Stripboard 0.1in. matrix, size 56 holes by 22 strips; case, about 150mm x 80mm x 50mm; 8-pin d.i.l. holder (3 off); medium impedance headphones (see text); control knob; battery connector, solder pins; wire; solder; etc.

Approx cost – guidance only **£18** *(excl. phones)*

The specified value for resistor R15 should give good results. However, if necessary it can be made higher in value to give reduced maximum volume, or lower in value to give greater maximum volume.

The current consumption of the circuit is only about 7mA to 8mA, and a PP3 size 9 volt battery is therefore adequate as the power source.

CONSTRUCTION

Details of the stripboard component layout and the breaks required in the underside copper tracks are provided in Fig. 4. This is based on a 0.1 inch pitch stripboard which has 56 holes by 22 copper strips.

A board of this size must be cut down from one of the larger sizes in which the board is sold. Use a hacksaw to cut along the appropriate rows of holes, and then smooth the edges using a small flat file.

The two mounting holes are 3.3 millimetres in diameter, and they will accept metric M3 or 6BA mounting bolts. The twenty six cuts in the strips can be made using the special spot face cutter tool, or a handheld twist drill bit of about five millimetres in diameter.

The board is now ready for the addition of the components, link wires, and solder pins. The latter are used at the points on the board where it will be connected to off-board components. Single-sided pins will suffice, and they should be generously "tinned" with solder so that wires can be easily connected to them.

The link wires can be made from 22 s.w.g. tinned copper wire. However, as few of them are required, and they are all quite short, trimmings from the resistor leadout wires should be adequate to complete all the links.

Fitting the resistors and capacitors is quite straightforward, but resistors R4 and R15 must be mounted vertically in order to fit them into the available space. Be careful to fit the electrolytic capacitors the right way round. Capacitors C4 to C7 must be printed circuit mounting types having 7.5 millimetre (0.3 inch) lead spacing if they are to fit neatly onto the board.

Although none of the integrated circuits require any anti-static handling precautions, it is still recommended that they be fitted in 8-pin d.i.l. holders. Make sure they are fitted with the correct orientation.

CASE

The length of the stripboard panel means that a case having a minimum length of about 150 millimetres is needed for this project. There are several plastic boxes of about this size available, any of which should be well suited to this project.

The component panel is bolted on the base of the case, and some extra nuts or short spacers should be fitted between the board and the case. The microphone insert is fitted at one end of the case, close to terminals on the circuit board to which it will be connected. Drill a hole in the case the same diameter as the body of the microphone insert, and then glue the insert in place using any good general purpose adhesive.

Mount the controls and headphone socket on the top panel of the case, (see photographs). The exact layout is not overly important, but it is always a good idea to use one that will avoid lots of crossed over wires when the unit is wired up. JK1 is a 3.5 millimetre p.c. mounting stereo jack socket. Despite its name, this does have the usual 6.35 millimetre mounting nut and bush, and it is suitable for use as an ordinary panel mounting component.

WIRING UP

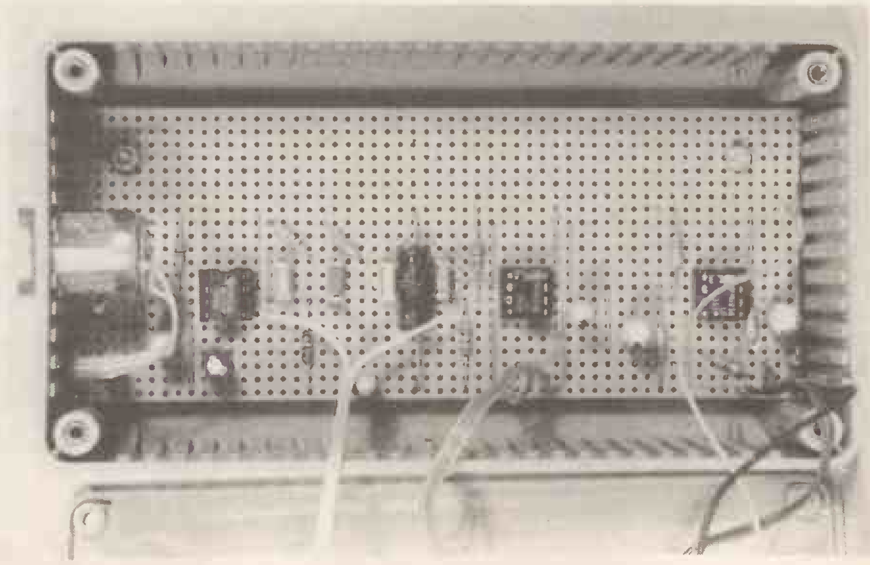
Details of the inter wiring are also shown in Fig. 4. Use ordinary multi-strand hook-up wire, or pieces of ribbon cable. The leads from the microphone insert to the board can be kept down to about 20 to 30 millimetres in length, making it unnecessary to bother with a screened lead here.

It is advisable to fill the inside of the case with some sound absorbing wadding of some kind. This helps to minimise problems with sounds caused by leads flapping around inside the case, battery rattles, etc. It can also help to keep down problems with general vibration of the case and resonances. Some wool, cotton wool, old socks, or material of this general type should do the job quite well.

IN USE

The Audio Telescope should work using any medium impedance headphones of the type sold as replacements for use with personal stereo units. However, the "inner-

Complete board mounted inside the case. The microphone insert can be seen mounted on the left. The front (lid) panel layout is shown in the photograph at the top of the page.



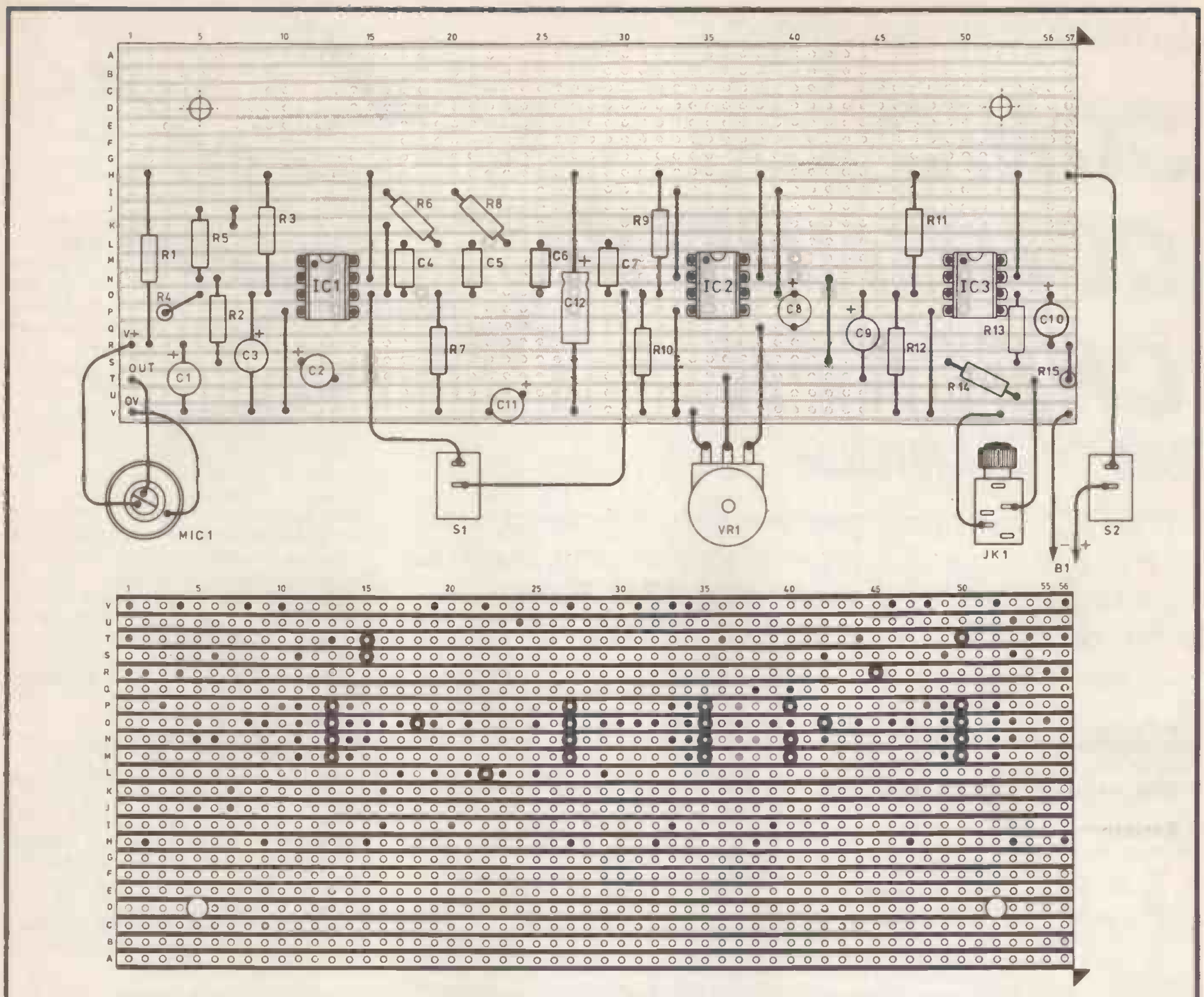


Fig. 4. Stripboard component layout, interwiring and details of breaks required in the underside copper strips.

ear" type are the best choice as these are largely free from problems with acoustic feedback. Ordinary "mini" headphones are usable, but the maximum gain that can be used may well be limited slightly by feedback problems.

In use Volume control VR1 must be well advanced if the unit is to work effectively. It is not necessarily with VR1 fully advanced that optimum results will be obtained. If there is a lot of background noise (wind rustling the leaves of trees etc.) then it may be preferable to back-off VR1 slightly.

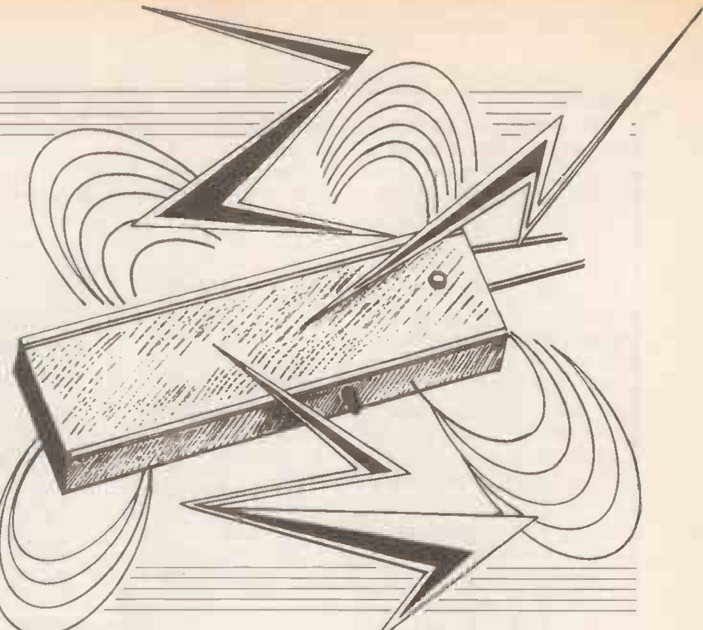
Note that the unit simply cannot operate effectively if there is too much background noise. It is much better on calm days well away from roads, than on windy days in a small park in the middle of a town.

You might like to try making the unit more directional by adding a tube in front of the microphone. This needs to be done carefully if it is to give the desired effect.

Simply gluing a piece of metal or plastic tube in place over the microphone will probably produce an odd directional response. Rather than shielding the microphone from off-axis sounds, the tube can easily act as an extension of the diaphragm that will pick up sounds over a wide range of directions.

For the tube to be effective it must be covered with a soft foam material, or something similar, that has good sound absorbent properties. It can be tricky to get the desired effect, but this is an interesting area for experimentation. □

Constructional Project



SONIC CONTINUITY CHECKER

MARK DANIELS

A handy, low cost, gadget for checking p.c.b. tracks and many other applications, such as fuses, cables, electrolytics (470μF and above) and semiconductor junctions

CONTINUITY testing is one of those seemingly simple operations that are so often fraught with unforeseen complications. Checking printed circuit board tracks for breaks and short circuits with a multimeter is a good example of this. Whilst moving the test prods along the track under test an eye has to be kept on the meter in order to spot any faults.

An audible tester enables both eyes to be kept on the job whilst giving immediate indication of the presence of a short or open circuit. Unfortunately most continuity testers of this type do not give any indication of impedance. This may sometimes indicate that no fault is present when the track has a resistance of 100 ohms or more, due to it being damaged somewhere along its length. This is the type of fault which ordinarily requires the use of a multimeter in order to trace it.

An audible test device that gives an indication of the resistance in the circuit under test would be an advantage in circumstances such as these. The Sonic Continuity Checker described in this article does this by producing an audible tone that changes in frequency with variations in the resistance across its test terminals.

VOLTAGE CONTROLLED OSCILLATOR

The Sonic Continuity Checker uses the voltage controlled oscillator (v.c.o.) section of the 4046B phase locked (p.l.l.) integrated circuit. It also uses one of the phase comparators as an inverter in order to produce the required complementary outputs for driving a piezoelectric transducer with an a.c. signal.

A v.c.o. produces an output frequency that is proportional to the value of the voltage on its control voltage terminal. The frequency range may be set to give the required minimum frequency with the control voltage at zero volts. The maximum frequency is obtained when the control voltage is equal to the positive supply rail value. This frequency may also be pre-set.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Sonic Continuity Checker is shown in Fig. 1. IC1 is a phased locked loop (p.l.l.) which in common with any other p.l.l. is based on a voltage controlled oscillator (v.c.o.). The frequency range of this device is set by capacitor C1 and resistors R3 and R4. Resistor R3 sets the minimum operating frequency which is given by the formula:

$$f_{min} = \frac{1}{R3 \times C1} \qquad \text{(Eq. 1)}$$

This gives the value of 45.45Hz for the low frequency.

The maximum frequency, set by resistor R4, is given by the following equation:

$$f_{max} = \frac{1}{R4 \times C1} + f_{min} \qquad \text{(Eq. 2)}$$

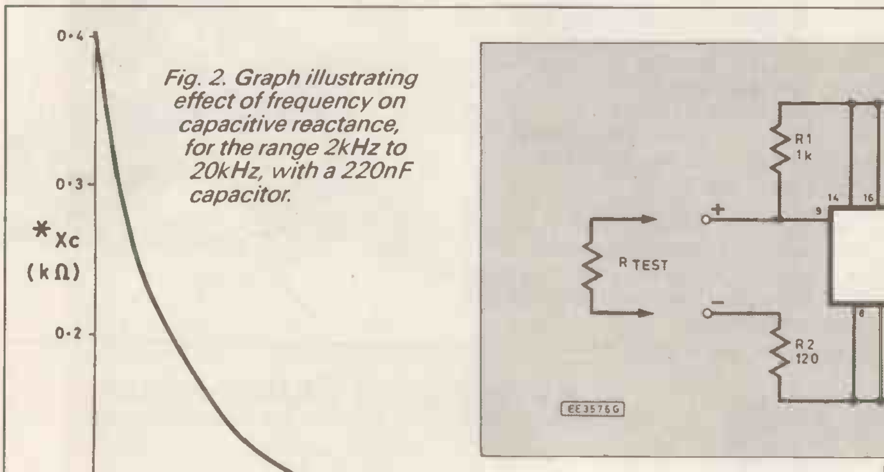


Fig. 2. Graph illustrating effect of frequency on capacitive reactance, for the range 2kHz to 20kHz, with a 220nF capacitor.

*Xc = Capacitive Reactance (apparent impedance).

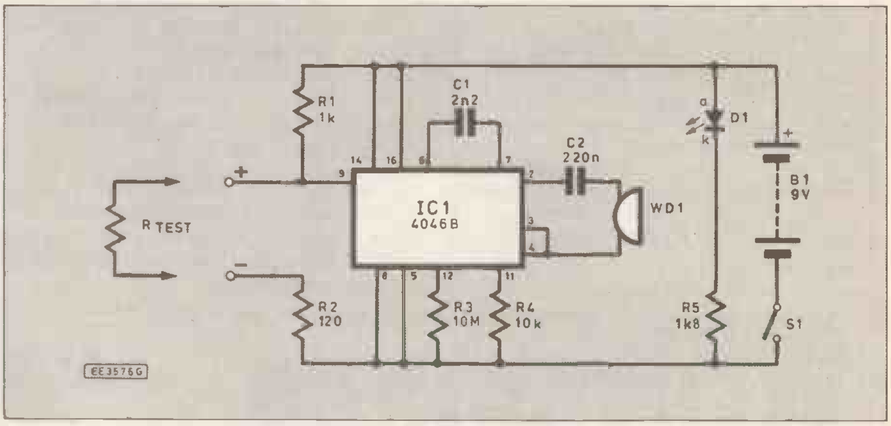


Fig. 1. Full circuit diagram for the Sonic Continuity Checker.

This gives 45.5kHz as the upper frequency.

Obviously, with f_{max} being so much higher than f_{min}, the component of f_{min} in Equation 2 may be ignored and still give a very close approximation for f_{max}.

These frequencies are only approximate as they are dependent to some extent on battery voltage and also component tolerances.

The 4046B does not have complementary outputs, but these may be obtained by using one of the on chip phase comparators as an inverter. This is done in the Sonic Continuity Checker by connecting the output at pin 4 of IC1 to pin 3 and taking the inverted output at pin 2.

D.C. blocking capacitor C2 is provided to prevent any d.c. component from reaching the piezo electric transducer WD1. It also acts as a very simple high pass filter by attenuating the signal more at low frequencies than higher ones, as shown in the graph of Fig. 2. This has the additional advantage of increasing the volume automatically at the high frequencies to which the ear is less sensitive.

Resistors R1 and R2 along with the resistance of the item under test form a potential divider which gives a suitable control voltage for IC1 at pin 9.

The control voltage (c.v.) is given by the following formula:

$$\text{c.v.} = \frac{R2 + R_{TEST}}{R1 + R_{TEST} + R2} \times \text{p.d.} \qquad \text{(Eq. 3)}$$

Where p.d. is the battery voltage (about 9 volts).

From Equation 3 the minimum control voltage (obtained when R_{TEST} is zero ohms) is 964mV. The max control voltage is obviously 9 volts when R_{TEST} is infinite (or open circuit). It can be seen that the minimum frequency given by Equation 1 is unobtainable in this circuit due to the c.v. not going down to zero volts. This gives a modified low frequency of approx. 100Hz.

Light emitting diode (l.e.d.) D1 and its associated current limiting resistor R5 are included to remind the user to turn the Sonic Continuity Checker off when it is not in use.

The unit is powered from a PP3 9 volt battery to give complete portability and a degree of safety.

CONSTRUCTION

All the components, with the exceptions of the transducer WD1 and the battery, are mounted on a single-sided glass fibre printed circuit board (p.c.b.), the foil pattern and component overlay for which is shown in Fig. 3. It is strongly recommended that an i.c. socket be used for IC1. This will greatly simplify matters if the i.c. needs changing later.

Fit the resistors and i.c. socket to the board first and solder them in. Solder pins are suggested for the test leads, battery and transducer connections. Bond the switch S1 to the board in the position shown in Fig. 3 using cyanoacrylate adhesive ("Superglue"). Pass three short lengths of 24s.w.g. bright tinned copper wire through the holes in the switch terminals and p.c.b. and solder these to the pair of terminals on the switch that each wire passes through. Turn the board over and solder the other ends of these leads to the pads. Fit the two capacitors and l.e.d. to the board ensuring that the

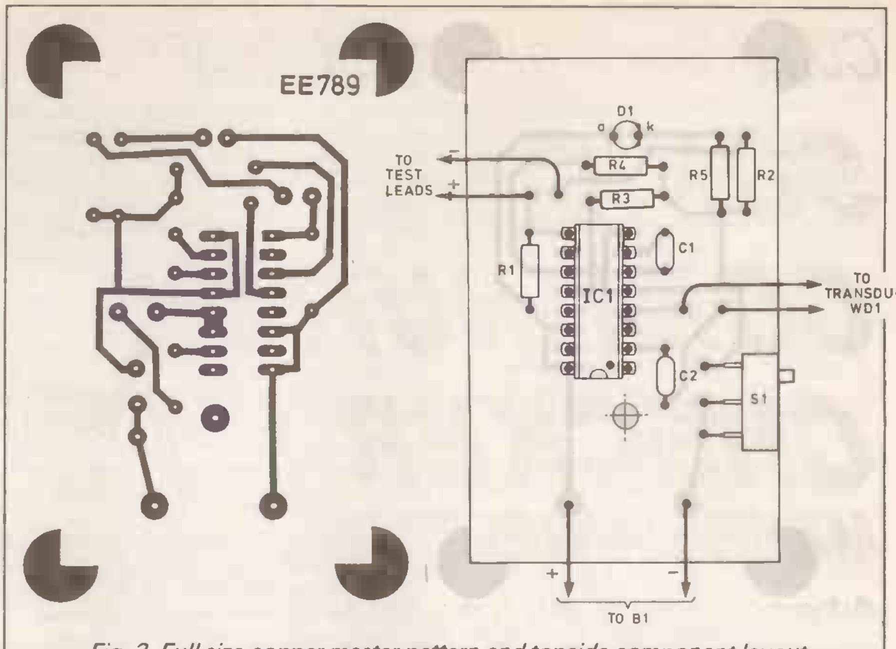
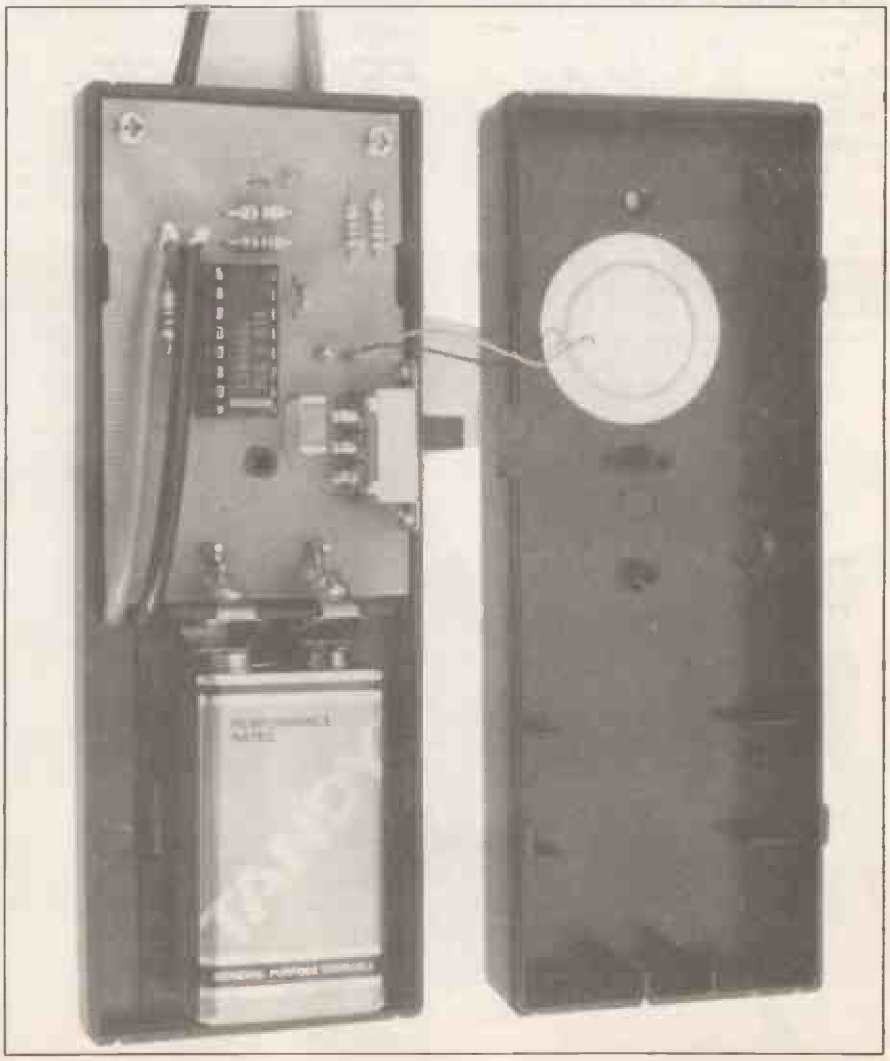


Fig. 3. Full size copper master pattern and topside component layout.



COMPONENTS

Resistors
R1 1k
R2 120
R3 10M
R4 10k
R5 1k8
All 0.25W 5% carbon film

See SHOP TALK Page

Capacitors
C1 2n2 monolithic ceramic
C2 220n polyester layer

Semiconductors
D1 3mm green l.e.d.
IC1 4046B phase locked loop

Miscellaneous
WD1 25mm piezoelectric transducer
S1 d.p.d.t. sub-min slide switch
B1 PP3 9 volt battery
Plastic box with battery compartment, 127mm x 46mm x 24mm; red and black test lead wire; pair of red and black test prods or clips; 16 pin d.i.l. socket.
Printed circuit board available from *EE PCB Service*, code EE789.

Approx cost guidance only **£10**

top of the l.e.d. stands about 16mm above the top of the p.c.b.

CASE

Drill the three holes in the case and make the cut-out for S1 as shown in Fig. 4 and photographs. Mark around the transducer inside the case lid and apply a thin layer of contact adhesive inside the circle. Coat the brass side of the transducer with the same.

Allow about 15 minutes for the solvent to evaporate before bonding the transducer in place. Ensure that the leads are facing the correct direction before placement as bonding will be virtually instantaneous.

Solder two lengths of test lead wire to their respective solder pins and pass them underneath the board before threading them through the two holes in the end of the case. Secure the board with the two screws. Make connections between the board and the battery terminals using 24s.w.g. copper wire. Connect the transducer to its p.c.b. terminals – the polarity is unimportant here. Finally, before assembling the box, fit the i.c. into its socket, (remember that it is static sensitive!), ensuring that it is the correct way around. See the photographs for the case layout and interwiring.

Fit two suitable test prods to the ends of the test leads. Spring loaded test clips were used on the prototype but in practice anything the constructor finds suitable may be used.

TESTING

Fit the battery, observing polarity, and switch on. If the l.e.d. does not illuminate switch off immediately and check battery polarity. If this is correct it is likely that the l.e.d. is connected the wrong way round in which case simply unsolder it and turn it around. It is unlikely to have suffered any permanent harm.

If the l.e.d. lights, touch the tips of the test prods together. The transducer should emit a low pitch note, if not recheck all internal wiring, component positioning and values and IC1 for correct orientation. Note: If resistors R3 and R4 have accidentally been swapped around the unit will produce only an ultrasonic pitch under any test conditions.

Once a low pitch is obtained, try connecting various resistors, from about 33ohms to 390ohms across the test leads. The pitch of the note should increase with any increase in resistance, reaching an ultrasonic pitch with around 500ohms connected across the leads.

USING THE SONIC CONTINUITY CHECKER

The unit should now be fully functional and tested. Its primary design function is testing p.c.b. tracks for shorts, bad tracks which show some resistance and open circuits. These tests can only be satisfactorily performed before the board is assembled.

Testing is carried out simply by placing one test prod at one end of a track and the other one at the opposite end of the same track. If the note is low pitched (as when the prods are shorted together) the track can be assumed to be good.

However, if no pitch or a high pitch is produced a fault exists. The location of the fault may be found by sliding one test prod along the track until a low pitch is obtained, the fault is then just behind the moving probe.

Short circuits between adjacent tracks or pads may be found by placing a prod on one track and the other on the adjacent track. Any audible note indicates a fault.

The Sonic Continuity Checker has many uses in addition to the one described above. Checking fuses and cables are well within its capabilities.

Some other, perhaps less obvious uses are; checking large power supply smoothing capacitors of 470µF or above, and semi-conductor junctions.

To test an electrolytic capacitor, connect it to the Sonic Continuity Checker such that its negative terminal is connected to the black-lead and its positive terminal to the red-lead (the capacitor *MUST* be fully discharged before starting this test). As the capacitor charges the pitch of note produced by the tester will increase until it can no longer be heard. Small capacitors will do this rapidly while large ones will take much longer.

Diodes will produce a tone of 1kHz to 2kHz when connected with their anodes to the red lead and cathodes to the black lead. Reversed connections should produce no audible tone with a good device.

The two junctions of a silicon transistor may be checked as diodes, (see Fig. 5). This will give no indication of gain but will indicate possible serviceability or otherwise of the device.

Before testing any component which is still in circuit **ALWAYS** ensure that the power is disconnected first!

MODIFICATIONS

As the circuit stands it has a usable resistance range of about 30ohms to 400ohms. To extend the lower end of the range increase the value of R2, up to a maximum of about 220ohms. This will also reduce the maximum resistance which will give an audible tone.

To increase maximum resistance (at the expense of sensitivity at the lower end) increase the value of R1, which may be taken up to about 1M. The maximum resistance for R_{TEST}, which will produce an audible tone, is around half the value of R1.

Altering resistors R3 or R4 should not be necessary since these only affect the upper and lower frequency limits as does capacitor C1. □

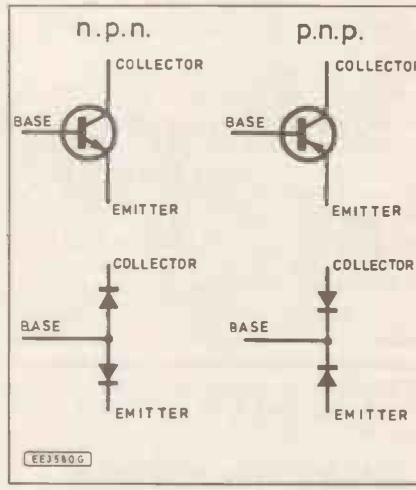
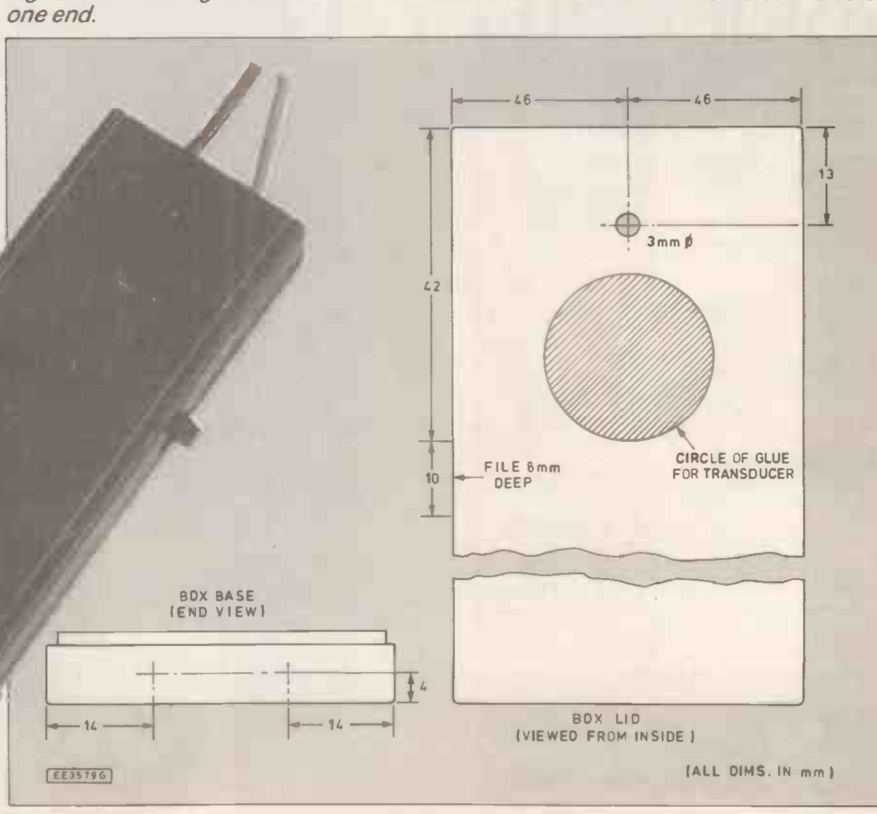


Fig. 5. Diode representation of transistors.

Fig. 4. Case drilling details. The "test" leads enter the case via two holes drilled at one end.

The completed tester and "probes".



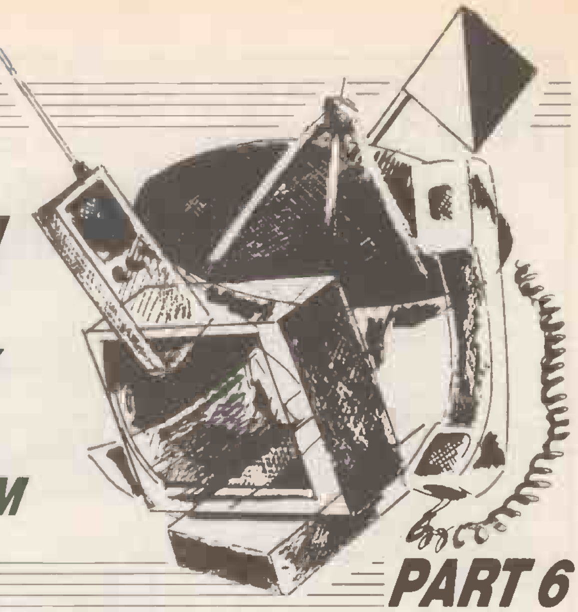
Special Series

INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 6



THIS IS the sixth in a 12-part series concerning Information Technology, Microelectronics and related matter in the Science National Curriculum.

This month we shall look at the uses of switches and relays in simple circuits. We shall then go on to examine logic gates and their use in decision-making circuits.

USING MODULES

For these experiments, a modular electricity kit (such as one from Unilab) is best. The complete kit of parts is not needed and costs may be saved by buying only the items listed below from the Basic Kit and the 11-13 Kit (see Fig. 1).

An alternative approach is to buy the unmounted components from a mail-order supplier and attach the connecting wires yourself. This is a cheaper method but would demand more time and possibly involve soldering. It may also turn out to be less reliable. If doing this, note that some of the components have been used in previous experiments so check your kit of parts. The number in brackets is that required for one group of children.

- "D" size cell holder and cell (1)
- Lamp holders fitted with 1·25V bulbs (3)
- Push-to-make switches (2)
- Changeover switches (2)
- Several short leads with 4mm plugs on each end (or crocodile clips if using basic components).
- Reed relays (2)

CIRCUIT SYMBOLS

Before proceeding to build simple circuits, the children should be shown the various items listed above (apart from the reed relay which follows later) and encouraged to learn their circuit symbols (see Fig. 2). Unfortunately, there are some alternative symbols and you may need to explain these if they occur (for example, if they are marked on the plastic body of the device).

The words *cell* and *battery* often cause confusion. Strictly speaking, a single unit is called a cell and a collection of cells, a battery. However, it is not usually clear that a battery has more than one cell inside it. On the whole, it is probably best to use the word "cell" yourself but accept "battery" as well. Some children find great difficulty for some reason in realizing circuit diagrams and you will need great patience with them. Others pick it up very quickly and easily.

The purpose of using symbols should be made clear. This is to simplify circuit drawing and to make a circuit easy to understand at a glance. The actual appearance of a circuit should be compared with its symbolic form (see Fig. 3).

USING SWITCHES

A switch is one of the simplest electrical components. It consists basically of two or more pieces of metal which can be made to touch and thus allow an electric current to flow. The children should understand that the switch controls the flow of electricity so that it is either *on* or *off*.

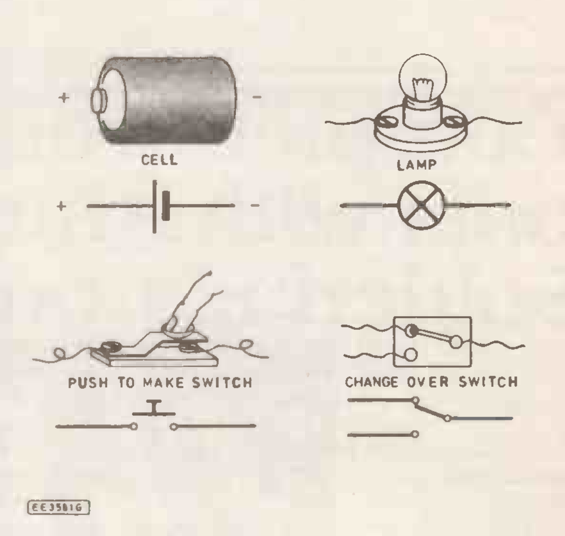


Fig. 2. Components and their circuit symbols.

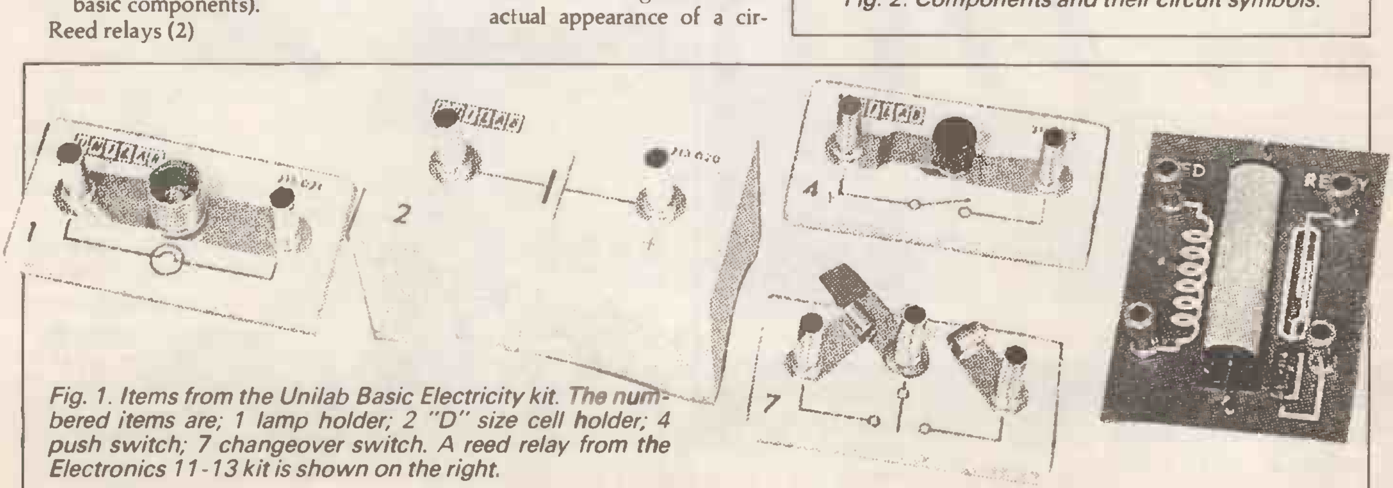
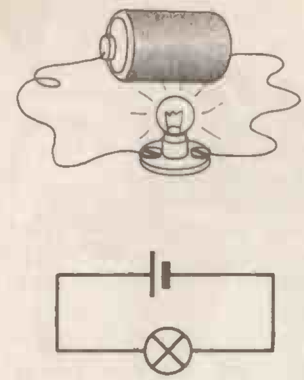
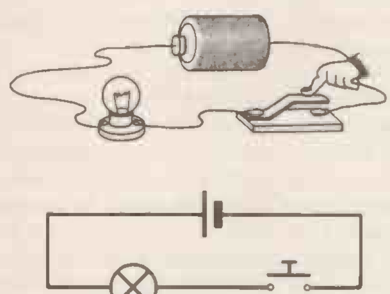


Fig. 1. Items from the Unilab Basic Electricity kit. The numbered items are; 1 lamp holder; 2 "D" size cell holder; 4 push switch; 7 changeover switch. A reed relay from the Electronics 11-13 kit is shown on the right.



(a)

Fig. 3. Drawing circuits using circuit symbols.



(b)

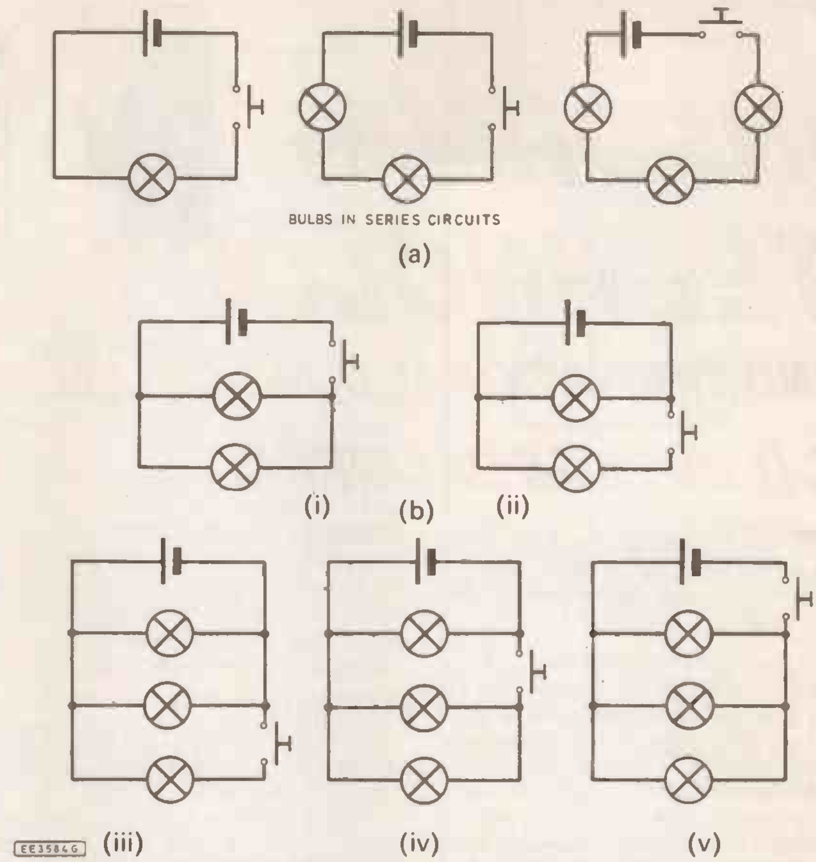


Fig. 5. Some series and parallel circuits to try.

This on/off effect is important – there is no half-way state. Emphasize this because it will link with digital work later on.

The children should set up the circuit shown in Fig. 3a and note that the lamp lights – there is a *complete circuit*. Next, they should break the circuit by removing one of the plugs or crocodile clips – the lamp goes *off* – and bridge the gap with a push-to-make switch (see Fig. 3b). The best type of switch is one where the pieces of metal can be seen to touch clearly – switches from the Unilab 11-13 Kit are of this type but if you are using basic components, a "knife" switch could be used.

When the metal strips touch, the circuit is re-made and the lamp lights once again. At this point it would be a good idea to stress to the children that experiments such as these are perfectly safe using batteries and bulbs, but that mains electricity is another matter and that such liberties must never be taken with it. This is why switches for mains equipment, such as wall-switches, are always fully enclosed.

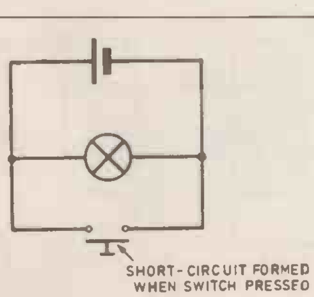


Fig. 4. A short circuit, this **must** *be avoided.*

The children should realize that, to work, there must be a *complete circuit* – an uninterrupted path from one end of the cell to the other through, for example, wires bulb(s) and switches. Make sure they understand that there must always be a lamp (or something similar such as a buzzer or motor) for the electricity to flow through. If a circuit is made with no such components, it is a *short-circuit* and this drains the battery very quickly.

Children often produce the type of circuit shown in Fig. 4, and report that the switch turns the lamp off. It does – but when the switch is pressed, a short-circuit is formed – most of the current now bypasses the lamp so it goes off. **This must be avoided.**

Note that everything used in a circuit must conduct electricity and children should know that metals are usually used – copper is a particularly good conductor of electricity. This could be checked by building a circuit with a gap in it. The gap could then be bridged with everyday objects such as coins, pencils, etc. to see whether they conduct electricity or not.

It is fairly common for children to think that a switch must be place *before* a bulb in a circuit. Allow them to find out that this is not so – the switch may be placed before or after the bulb and it will work equally well – a break *anywhere* in the circuit will prevent the current from flowing.

The children should learn that where components such as bulbs are connected together like a chain – so that the current has to flow through one component before it can reach another – is called a *series circuit* – see Fig. 5a. Two or more bulbs in a series circuit will be dim because the current finds it more difficult than going through only one.

Get them to build the parallel circuits shown in Fig. 5b. Parallel circuits have at least one branch where the electricity can follow alternative routes. Let them find out where a switch could be placed to behave as a "master" switch to control all bulbs such as (Fig. 5b(i)) and where to place switches to control individual bulbs (such as in Fig. 5b(ii)).

Build the circuits shown in Fig. 6. Let the children find out that in (a) *both* switches must be pressed but in (b) *either* switch may be pressed for the electricity to flow. They should get the idea that the lamp lights when certain conditions are met i.e. it is a *decision-making* circuit (this will link with Logic Gates later).

CHANGEOVER SWITCHES

Children should know that there are several different types of switch. The one used up to now is a *make* switch where two pieces of metal touch – or "make" – when the switch is in one position (pressed) and part – or "break" – when it is in the other position (released).

It is possible to have more complicated contact arrangements and a *changeover switch* is an example of this. A changeover

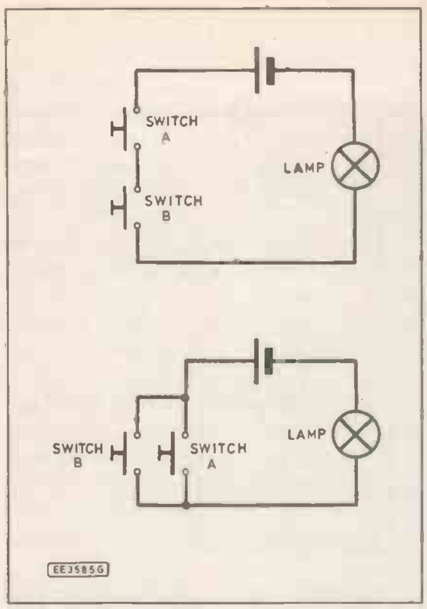


*Fig. 6. (top) Both A **and** B must be pressed for the lamp to light. (below) Either A **or** B may be pressed for the lamp to light.*

switch works as follows (see Fig. 7). When in Position A as shown, the common or moving contact, X, is connected to Terminal A. When in the alternative position it is connected to Terminal B. This switch could be used to control one circuit when in Position A and another circuit in Position B. In one position, Lamp A is on and when in the other position Lamp B is on. This could be used for a WAIT and COME IN sign used in a doctor's surgery.

TWO-WAY SWITCH

It is interesting and instructive to make a two-way switch circuit. This simulates the type of switching found in houses where a light may be switched on in one place and off in another – for example, to control a landing light from either upstairs or downstairs. This needs two two-way switches arranged in the circuit shown in Fig. 8.

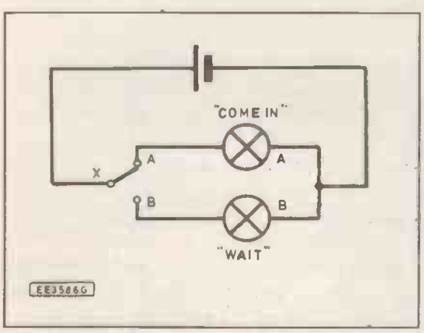


Fig. 7. A changeover switch circuit.

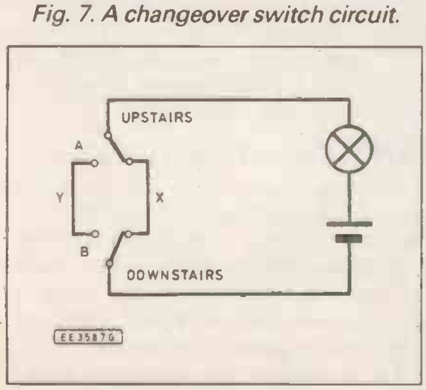


Fig. 8. A two-way switch circuit.

Begin by considering both switches A and B in the positions shown. A circuit is established via wire X and the lamp could be switched off by placing either switch in the other position. It could then be switched on again by placing the other switch in the alternative position – a circuit would now be established via wire Y.

THE RELAY

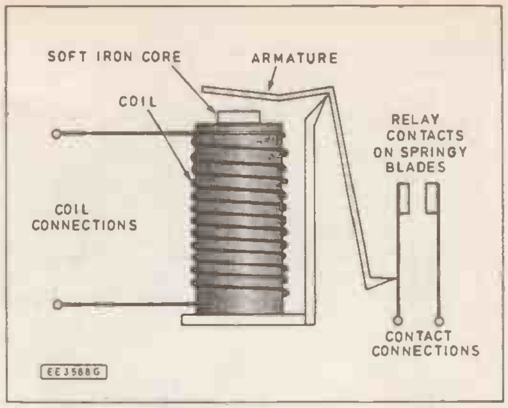


Fig. 9. A traditional relay.

A relay is a special type of switch. Its action is not controlled directly but by the magnetic effect which is produced when a current flows in a wire. In the traditional pattern of relay (Fig. 9), a small current flows through a coil of copper wire wrapped around a soft (that is, pure) iron core. The core becomes magnetised and this attracts an arm – called the armature. The armature in its turn "makes" switch contacts (there may be more than one set of these). Some relays have at least one set of "break" contacts too – that is, contacts which move apart when the coil is energized and, perhaps, some changeover contacts.

An alternative type of relay is the *reed* relay where the coil is wrapped around the body of a reed switch. The reed switch consists of a glass encapsulation with a pair of "reeds" inside made of magnetic material (see Fig. 10a). When current flows through the coil, the magnetic field produced magnetizes each reed with opposite polarity. These therefore attract and complete the circuit (see Fig. 10b and 10c).

Reed relays are very small and reliable but cannot have such a versatile switching arrangement as a traditional relay. A modular reed relay (Unilab 11-13 kit) is best for the following experiments although a basic unmounted reed relay could be used with wires soldered to the coil and contact terminals.

Using a relay may seem a very roundabout way of switching on a circuit. However, the current needed to energize the coil is very small and may be supplied by transistors and integrated circuits. The relay contacts may then go on to switch all manner of high current or high voltage equipment. For example, in the light meter circuit (described last month), the output from the transistor could, instead of operating a small bulb, be used to operate a relay. The relay contacts could then switch on a street light.

A relay may be regarded as an interface between the low current *electronic* world and the *real* world of high-powered lights, motors, heaters, etc. In this way, electronic control circuits may be used to

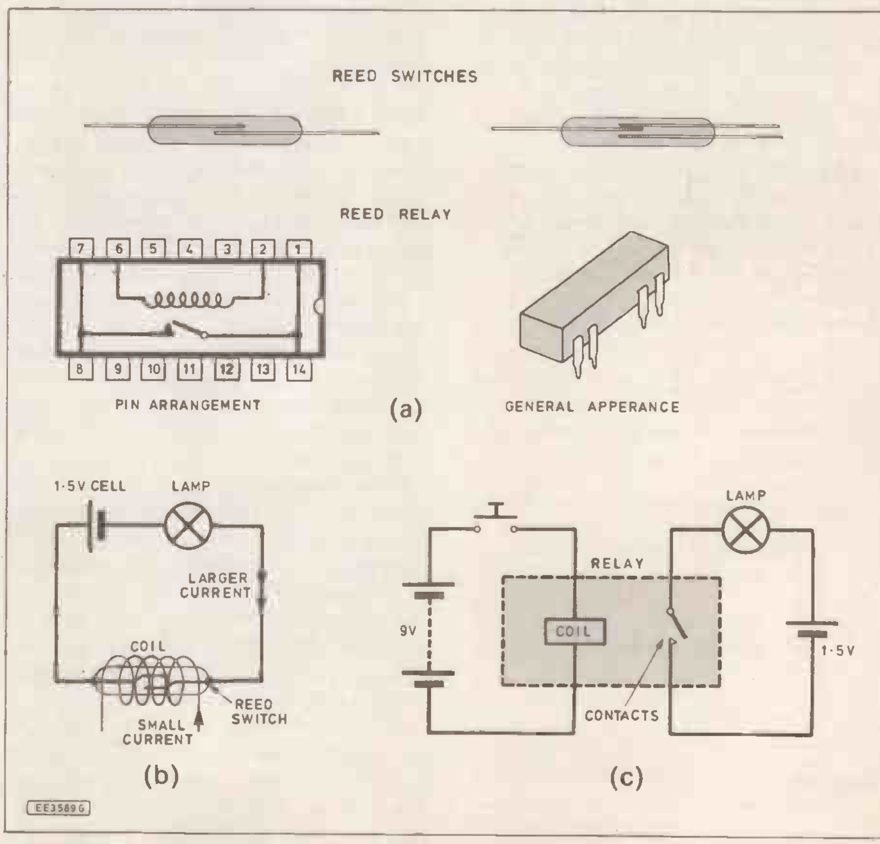


Fig. 10. Reed switches a reed relay and relay circuits.

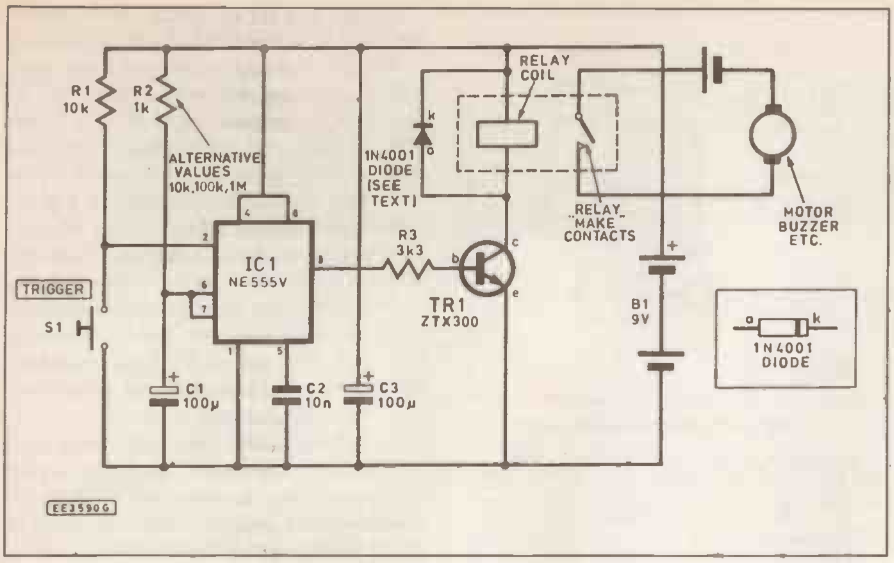


Fig. 11. Monostable with relay output.

operate high-power equipment such as pumps and motors in a factory. ***Note that it would be extremely dangerous to attempt to switch mains equipment without proper knowledge.*** Also the relay contacts would need to be correctly rated for mains operation.

RELAY EXPERIMENT

Operation of a relay may be demonstrated using the circuit shown in Fig. 10c. When the switch is pressed, current flows from the 9V battery through the coil. The reeds move into contact and the lamp lights. Note that there are two distinct circuits with no electrical connection between them.

The monostable circuit last month could be made more versatile by using a relay in the output. All that is required is to remove the lampholder and connect the relay coil in its place (Fig. 11). It would also be necessary to add the diode shown – this removes the destructive high-voltage pulse which occurs as the magnetic field in the relay coil collapses. The relay contacts could then switch on other equipment such as a buzzer or a motor.

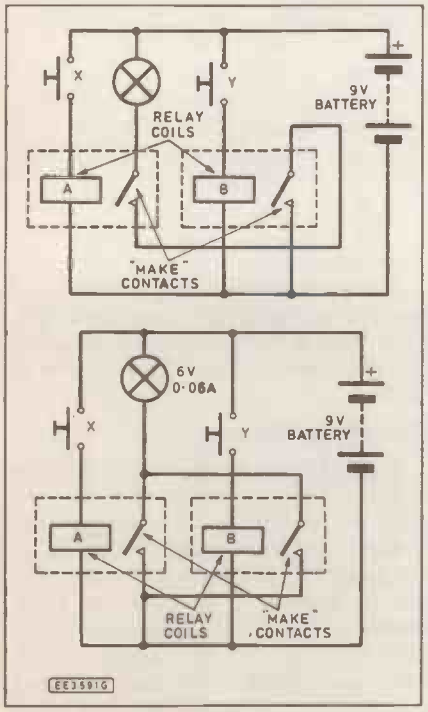


Fig. 12. Relay contacts in series (top) and in parallel (below).

RELAY LOGIC

Consider the circuit shown in Fig. 12a. Here, the relay contacts are connected *in series*. For the bulb to light, the coils of *both* relays need to be energized (both switches X and Y pressed). In the circuit shown in Fig. 12b, the contacts are connected *in parallel*. Now, the lamp will light if *either* coil is energized (either switch X or Y pressed).

These are called *logic systems* because the lamp will only light when the correct conditions are met. This is another type of decision-making circuit similar to those using real logic gates which are considered next.

THE DIGITAL WORLD

In the world of digital electronics, a circuit is either *on* or *off*. An ordinary switch is digital because the lamp, or whatever it controls, is either on or off – there are no states in between. A dimmer switch is not digital because the light can be set to any brightness level – the changes are smooth.

Ask the children to note some other digital and non-digital devices – not necessarily of an electrical or electronic nature. For example, a gas or water tap is not digital and neither is a farm gate (it can be open, closed or left in any intermediate position). The lid on a chest, however, is digital – it is either open or closed and is only in the intermediate state momentarily. The lock on a door is also digital – it is either locked or unlocked.

When an electrical or electronic device is on, we call its state "Logic 1" or simply "1" or "High". When it is off, we call it "Logic 0", or "0" or "Low". Logic 1 usually means the same state as the battery positive terminal and Logic 0 the same state as the negative battery terminal.

The digital world is, then, a very simple place where everything is either on (Logic 1) or off (Logic 0). It is rather like a world where every question would have an answer and this answer would always be "Yes" or "No". Moreover, the same question would always have the same answer.

We know, however, that the human world is not the digital world! If you were to ask a friend if you could borrow £5 then the answer could be "Yes", or "No", but it could also be something else – "Get lost!" or "You can borrow £3 but not £5!" or "Come back tomorrow". Furthermore, the same question will not necessarily always have the same answer – it would depend on the mood your friend happened to be in at the time – a "Yes" today may very well be a "No" tomorrow!

The digital world would be a very boring world for humans. On the other hand – it is a very good world for machines. For example, you might want a cup of coffee from a drinks machine. It must always answer "Yes" – that is, give you a cup of coffee providing you have asked the correct "questions" – i.e. you have pressed the correct buttons and put in the money and, or course, it has a supply of paper cups and the other things it needs. We could say that the logic circuit in a coffee machine has made a decision – that is, it gives an answer based on the questions you have asked it.

DECISIONS, DECISIONS

Decisions such as these are usually made using electronic *Logic Gates*. These generally have two inputs (called A and B) and one output (called Q). The inputs and output may only be Logic 1 (High) or Logic 0 (Low) – nothing else is allowed. The only possible states of the inputs, then, are:

A	B
0	0
0	1
1	0
1	1

The logic state of the output, Q, will depend on the states of A and B and on what type of gate it is. If it is the type of gate called an AND gate, the output, Q, will be Logic 1 when both A *AND* B are Logic 1. In all other cases it is 0.

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

The table above is called a *Truth Table* (in this case, the truth table for an AND gate) – it tells the whole truth about the gate – nothing else can happen! Try to make the children draw the inputs in the order stated. It is not wrong to do it in a different order, for example:

A	B	Q
0	1	0
1	1	1
1	0	0
0	0	0

However, this is not conventional and could cause trouble if the subject were to be studied in depth later. There are several other types of gate. One is called the *OR* gate. The output of this is Logic 1 if either A *OR* B (or both) is Logic 1:

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

In some previous experiments using switches and relays, circuits were constructed which behaved as AND and OR gates (although they were not called by these names at the time). In one arrangement – Fig. 12a – the lamp only lit when *both* relay coils were energized and in the other – Fig. 12b – the light came on when *either* (or both) coils were energized. This is an example of *relay logic*.

Relay Logic is rarely used in real applications today (although it used to be) because relays are large, relatively expensive, slow to operate (by today's standards), use a relatively large current for the coil to energize and are prone to sticking and failure. In real life, purpose-made integrated circuit logic gates are

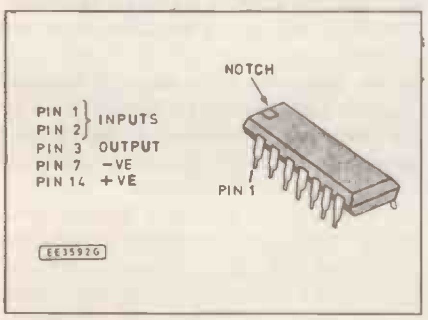


Fig. 13. General appearance of a gate i.c. package.

used. These are very inexpensive, extremely fast in operation, small and almost totally reliable. They also require very little current. The general appearance of a logic gate is shown in Fig. 13.

OTHER GATES

There are three other common types of gate called NAND, NOR and NOT respectively. The output of a NAND or NOR gate is the opposite of the AND and OR gate – a 0 becoming a 1 and a 1 becoming a 0. NAND stands for *NOT AND* and NOR stands for *NOT OR*. The NOT gate (sometimes called an invertor) is the simplest gate of all and has only one input, A, and one output, Q. Its purpose is to turn a Logic 1 input into a Logic 0 output and vice-versa.

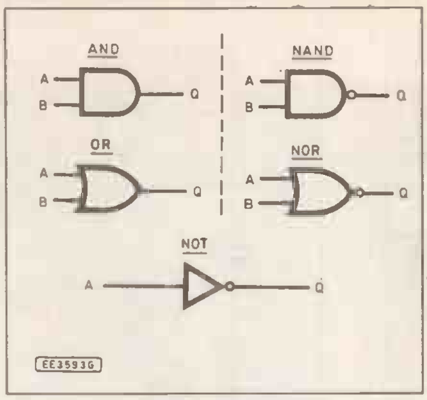


Fig. 14. Gate symbols.

NAND GATE

A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

NOT GATE

A	Q
0	1
1	0

Gates are valuable in computers and control circuits (such as coffee machines) because they can make *decisions*. These may be very simple – almost trivial – decisions but many such decisions can be made at great speed and, providing there are many gates, the decision may be quite complex and based on many different inputs. Here are some of the things which a coffee machine must take account of before it decides to give you a cup of coffee.

Is there a supply of paper cups?
AND is there hot water and coffee powder?
AND has the correct money been inserted?
AND have the correct buttons been pressed?

All these questions would be called *Logic 1* if the answer was "Yes" and *Logic 0* if the answer was "No". If they are all "Yes", then the output would be Logic 1 and you would get your coffee. This is an example of a complex decision-making system.

There are other situations where not all the answers need to be "Yes" for the output to be Logic 1. For example, if the price of coffee was 20p the following would apply:

Have two 10p coins been inserted?
OR one 20p coin?
OR four 5p coins?
etc.

Any one of these – and other – statements having a "Yes" answer would result in the coffee being delivered.

Before using integrated circuit gates, the symbols shown in Fig. 14 should be introduced. These are the American Standard symbols and are used by most examination boards and text books.

GATE EXPERIMENTS

For these experiments you will need either some modular Logic Gates (such as those in the Unilab Alpha Kit) – AND, OR, NAND and NOR and follow the instructions supplied with them. If using an Alpha kit you will also need certain other parts to make them work, in particular, you will need a battery connector and a set of yellow "Alpha links".

An alternative approach is to buy the basic chips listed below and use them on the Vero Plugblock (the procedure for using this was explained last month). It is not worth buying NOT gates since these are easily made using other gates as shown later. Here is a list of the things you would need if choosing this method. The transistor amplifies the small output current from the gate and enables it to light the filament lamp. Check your kit of parts since the starred items have been used in previous experiments.

★ Vero Plugblock
★ 9V PP3 battery and connector
★ 6V 0.06A lamp in lampholder
★ ZTX300 transistor
★ 10k resistor – 2 off
★ 3k3 resistor
AND gate 4081BE
OR gate 4071BE
NAND gate 4011BE
NOR gate 4001BE
It would help to buy several of each gate to do combinational logic work later.

The circuit diagram is shown in Fig. 15 but there is no need to understand this. It is more important to be able to insert the gates in turn into the Plugblock layout shown in Fig. 16. Note that the circuit is "universal" since it applies to all the gates being used. For this reason, a box-type symbol has been used to avoid having to draw a whole set of near-identical diagrams. This is the pin arrangements for the gates:

Pin	Function
1	input
2	input
3	output
7	negative supply
14	positive supply

If anyone wonders why there are so many unused pins – the reason is simple. Each of these integrated circuits contains four gates and we are using only one of them!

CONNECTIONS

The gates used are members of a family called *C-Mos*. In theory, they can be destroyed by touching the pins if you are charged up electrostatically. this could be the result of walking on a nylon carpet, for example. It is unlikely to cause damage unless the charge is very high since the chips are internally protected. You could remove any charge on the body by touching an earthed object such as a water tap just before handling them but this is hardly worthwhile.

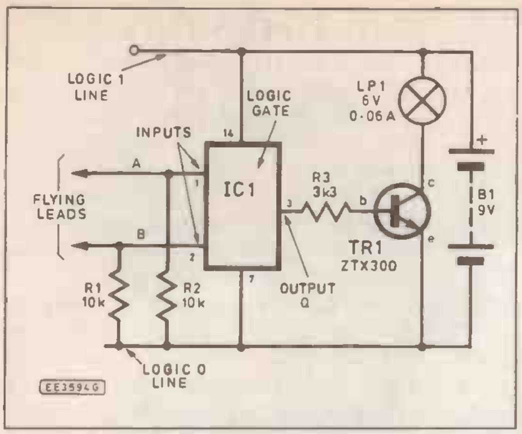


Fig. 15. Gate investigation circuit.

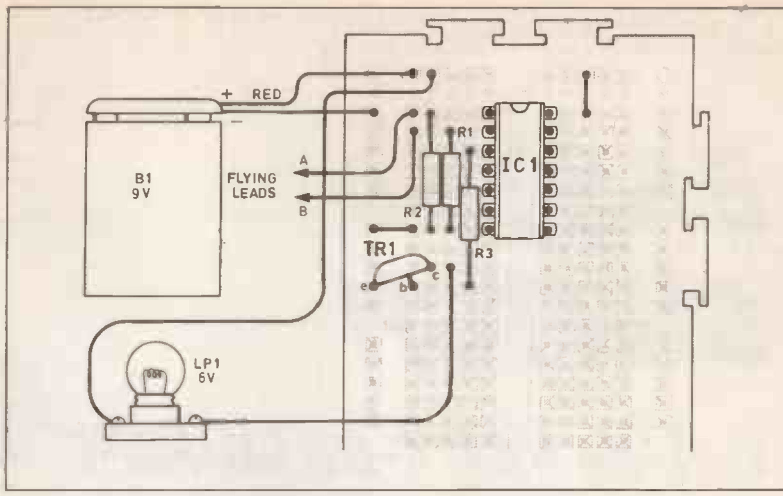


Fig. 16. Plugblock layout for gate circuit.

To try out the logic, you need to use short "flying leads" – two short pieces of wire with 5mm of insulation removed from each end connected to the inputs as shown. If these are touched on the battery positive line this makes them Logic 1 and if left unconnected they will automatically assume a Logic 0 state (due to the effect of the "pull-down" resistors, R1 and R2). If the lamp is on, this indicates a Logic 1 output and if it is off, Logic 0. Follow the truth table for each gate and check that the output takes the logic state predicted.

To make a NOT gate, connect the two inputs of a NAND or NOR gate together to make one input (see Fig. 17). Check that the output is "1" when the input is a "0" and the output is a "0" when the input is a "1". The reasoning behind this is as follows. Consider the truth table for the NAND gate. When the inputs are connected together it makes it impossible for them to have different logic states. That is, if one input is Logic 0 the other must also be a 0 and likewise with a 1. This means that the middle two lines of the truth table are impossible. The top line states that an input of 0 gives an output of 1 and the bottom one states that if the input is a 1 the output must be a 0. This gives the NOT gate required.

If you examine the truth table for a NOR gate, similar reasoning applies. If you look at the truth tables for the AND and OR gates, you will see that these cannot be used to make a NOT gate. If you try, the output state will be the same as the input one.

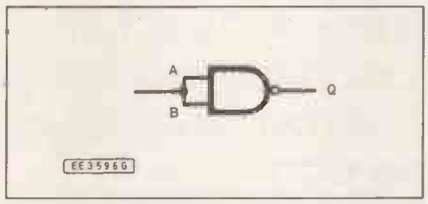


Fig. 17. A NOT gate made from a NAND gate.

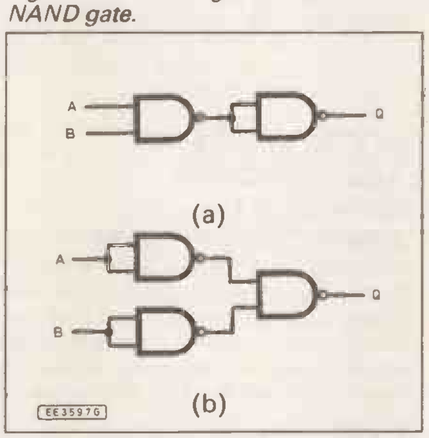


Fig. 18. (a) Inverting the output of a NAND gate. (b) Inverting the inputs of a NAND gate.

COMBINATION LOGIC

Connecting gates together to make new ones is called *combinational logic*. Try this arrangement where the output of the NAND gate is inverted by the home-made NOT gate (Fig. 18a). Common sense predicts that this will make an AND gate and this may be shown to be so. However, putting gates together in combinations sometimes leads to surprising results.

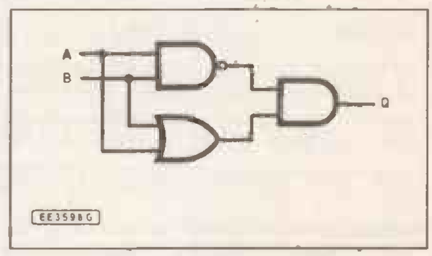


Fig. 19. Mystery gate.

Make the arrangement of gates shown in Fig. 17b. Here, the *inputs* to the NAND gate are inverted. This may be constructed either on the Plugblock (but you will need to make our own layout) or with the modular gates. Don't forget that each gate needs its own battery connections. Most people think that this will be an AND gate. In fact, it makes an OR gate – try it and see!

An arrangement to make a "mystery gate" is shown in Fig. 19. Build it and draw its truth table. With care, you could work it out without actually making it. The result will be published next month.

Next time we shall look at logic gates being used in simple control circuits. We shall then look at the differences between analogue and digital signals and instruments. Also, since many of the "children" are now growing up, we start using the word "student" instead!

EASY SWITCH

T. R. de VAUX-BALBIRNIE

Two versions of an optically-isolated mains switch with extra-light action. The "featherlight" touch makes it ideal for appliances that may be used by an elderly or disabled person.

THIS Easy Switch circuit was originally designed to replace the standard switch on an elderly person's lawnmower. Due to arthritis, he was unable to maintain sufficient hand pressure to keep it on.

Many lawnmowers have a switch which requires quite a large hand pressure – even people with normal hands can find it difficult keeping it pressed for long periods. This is where loops of string, wire, or "Jubilee" clips are sometimes used to keep it on. Doing this is very dangerous since the whole point of this type of switch is to cut off the supply *instantly* when released.

This replacement provides a much easier action. The switch may be of any light-duty push-to-make pattern chosen for its light touch, feel, size, ease of operation, etc. There is no need for it to be mains-rated or capable of carrying a high current.

The switches used in the prototype units were keyboard switches. These have a very light action, are inexpensive, work reliably and have a long life. They may also be fitted with tops of various sizes.

The standard circuit maintains the safety requirement of cutting off the supply instantly when the switch is released and being optically-isolated from the mains is entirely safe in operation. The control circuit itself is battery-powered.

TWO VERSIONS

The Easy Switch is very versatile and readers will, no doubt, turn their ingenuity to using it for other purposes. For this reason a further version is described. This has a press-on press-off action using two switches. ***On no account should this SECOND type be used for lawnmowers or, indeed, any appliance where INSTANT*** cut-off of the mains is needed in an emergency.

Note that in constructing either version of the Easy Switch various mains connections need to be made ***Any reader who is unsure of being able to make a safe job, or does not understand the need or not for Earthing, or is not absolutely certain on any points of construction must consult a qualified electrician.***

Also, the quality of all soldered joints must be guaranteed. Note that lawnmowers should *always* be used in conjunction with an RCD (Powerbreaker) and a fused plug and must never be used in the rain whether using the Easy Switch or not.

STANDARD VERSION – CIRCUIT DESCRIPTION

The Easy Switch (Standard Version) is built in two separate sections, interconnected using a short piece of 2-core wire. The first part houses the switch itself and will be clipped in a convenient place on the lawnmower handle. The second part is situated near the bottom of the handle. This contains the control circuit, battery and screw terminal blocks for making all mains and switch connections.

The entire circuit for the Easy Switch – Standard Version is shown in Fig. 1. IC1 is an optically-isolated triac which contains an infra-red l.e.d., D1, and a triac, CSR1 built into a 6-pin integrated circuit package.

With the mains connected and switch S1 (Operate) pressed, current flows from the 3V battery, B1, through D1 via current-limiting resistor, R1 and preset VR1. D1 operates and this triggers the triac, CSR1. A conducting path is now established between CSR1 main terminals, pins 4 and 6.

The triac can handle mains voltage but only at a low current which would be insufficient for the present purpose. Mains current flowing between pins 4 and 6 is therefore used to energize the coil of relay, RLA, and the double-pole "make" contacts, RLA1 and RLA2, which direct current to the lawnmower motor or other appliance.

Note that the correct type of relay must be used as specified. In particular, its coil MUST be designed for direct connection to the 240V a.c. mains supply. Most relays have a low-voltage coil – for example, 6V or 12V. ***Such a relay would be catastrophically destroyed if used in this circuit.***

The relay contacts must also be designed for switching mains current and be generously rated. The specified relay may be used with lawnmowers and other appliances rated up to 1500W on 240V mains. Beware of small, cheap relays which seem just adequate "on paper" – these would quickly fail in service.

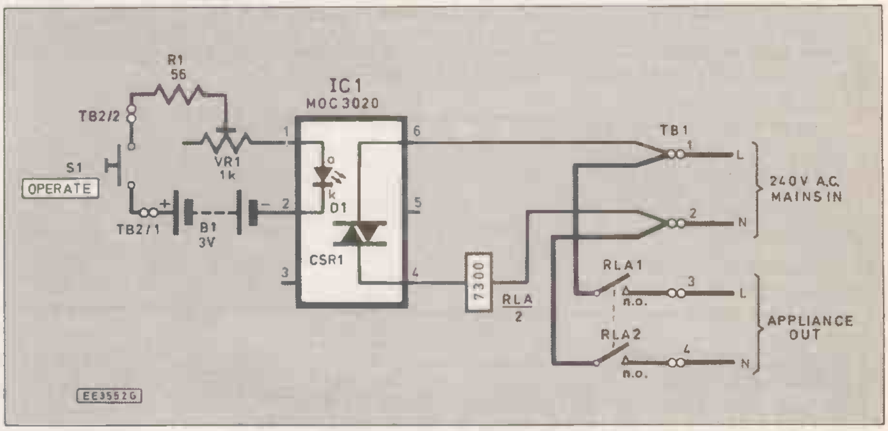


Fig. 1. Circuit diagram for the Standard Version of the Easy Switch.

When S1 is released, D1 and the triac switch off and the mains supply is interrupted instantly. The relay then "drops out" and the motor switches off.

Since the l.e.d., D1, is not electrically connected to the mains section of the circuit, S1 and associated wiring carry current at battery voltage only. Providing the unit is correctly constructed it will therefore be entirely safe.

The purpose of preset potentiometer VR1 is to allow the l.e.d. operating current to be reduced to a minimum value consistent with reliable triggering. This is because D1 will often trigger CSR1 with a much lower current than the published data suggests. This fact can be exploited to minimise battery drain. Resistor R1 prevents excessive current from damaging D1 if VR1 is adjusted to zero resistance. The prototype needs 3mA while S1 is pressed so the two AA size cells will last for many months in normal service. No current is drawn with S1 released.

CONSTRUCTION - STANDARD VERSION

A plastic box must be used for housing the main(s) section. It is advisable to use a splashproof one – this will help to protect the internal components should the mower be left accidentally in damp conditions. ***No metal parts, for example, metal bolt heads may appear on the outside of the box where they could be touched – nylon fixings must be used for mounting all internal components.***

Providing the appliance has no Earth wire (that is, it uses two-core mains cable) – it may be used without an Earth when connected to the Easy Switch. For appliances with an Earth connection (that is, using 3-core mains cable) it is essential to maintain earth continuity and further information for this is given later.

Construction of the Standard Version is based on a main circuit panel made from a piece of 0.1in. matrix stripboard, size 8 strips x 19 holes. The component layout and details of breaks required in the underside copper strips is shown in Fig. 2.

Cut the board to size, drill the two fixing holes and make all track breaks as indicated. The double row of broken tracks at IC1 position must be carefully checked since they isolate the mains section from the low-voltage part of the circuit.

Safety depends on all track breaks being complete so check carefully with a magnifying glass. Take care, however, not to weaken the panel by over enthusiastic use of the spot-face cutter.

Solder the on-board components into position. Note that IC1 needs a 6-pin i.c. socket but this size is not freely available. If necessary use an 8-pin socket and cut and file it to size. Make a careful check for errors particularly for accidental solder "bridges" occurring between adjacent copper tracks.

Connect a 5cm piece of light-duty stranded connecting wire to strip *F* and the negative battery holder connection to strip *D* on the left-hand side of the panel as shown. The wires connected to IC1 pins 4 and 6 should be mains type of 1A rating – these are made *direct* to the pins *not* through the copper tracks.

Check that these wires are totally secure – the unit could become dangerous if they or anything else became detached in service. Leave VR1 sliding contact adjusted fully anti-clockwise (as viewed from IC1).

Prepare the box by drilling holes for the relay, terminal blocks TB1 and TB2 also for battery holder and circuit panel mounting. Mount these using NYLON fixings. Note that the circuit panel should be mounted on short stand-off insulators.

Referring to Fig. 3, complete the internal wiring. The four wires interconnecting the relay "make" and moving contacts to TB1/1 to TB1/4 (shown bold or thicker than the rest of the wiring) must be of stranded mains type having a rating of *6A*

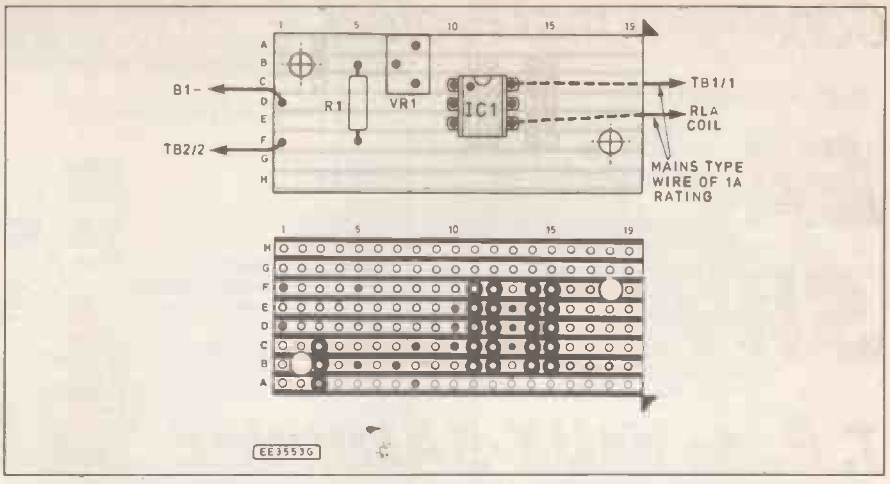


Fig. 2. Standard version stripboard component layout and underside copper strip breaks. Note the dotted, 1A rated, leads are soldered directly to IC1 pins 4 and 6 on the underside.

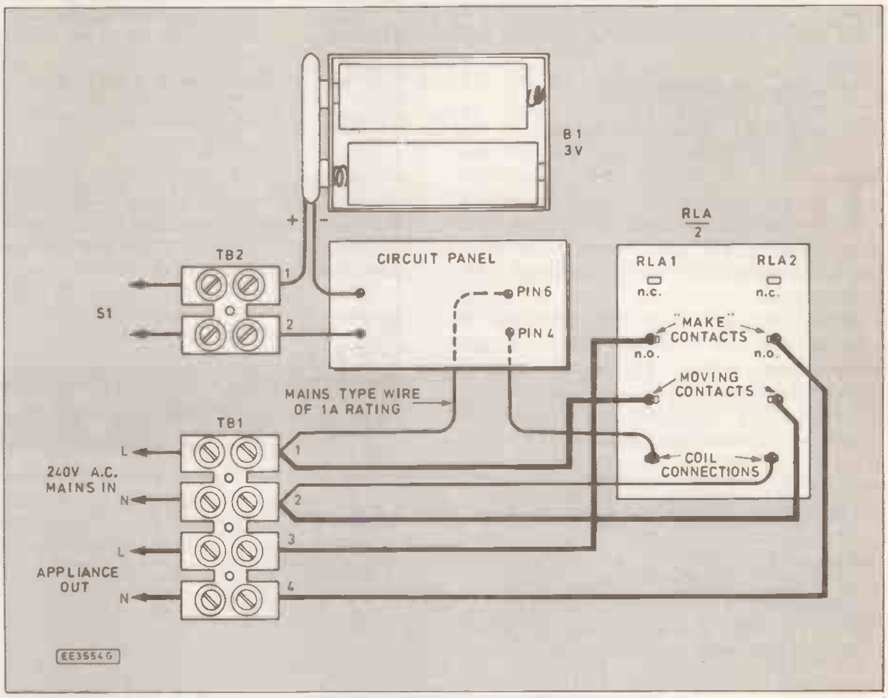
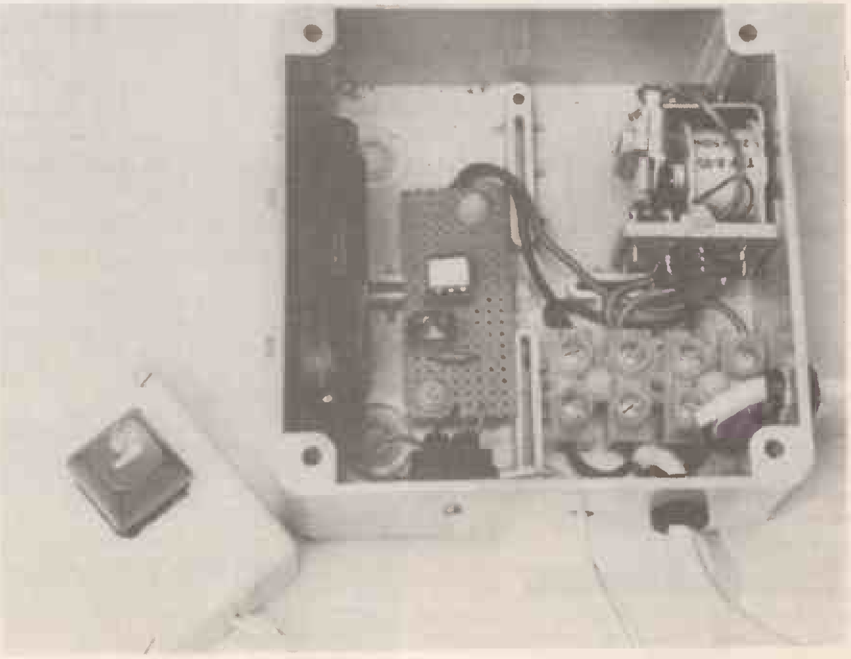


Fig. 3. Interwiring between the main unit components. The switch S1 is housed in a separate small case, see below.



minimum. Place two used batteries – nearing the end of their life – in the battery holder observing the polarity.

EARTHING

In the event of the appliance having an Earth wire this will require terminal block TB1 to have an additional section, TB1/5, so that the earth wire (E) of the mains input cable may be connected to the earth wire (E) of the appliance cable. ***On no account may an appliance requiring an earth be used on a non-earthed supply.***

Prepare the smaller "switch" box by drilling a hole for the switch and for the wire passing through to the main unit. This wire may be of any light-duty flexible two-core type.

Measuring the length of wire needed, pass it through the hole in the box and secure with a strain relief grommet. Solder it to the switch terminals and connect the other end to terminal block TB2/1 and TB2/2 in the main unit. Press the top on the switch (if it is of that type) – in the prototype unit the logic symbol 1 was used to mean "on".

TESTING

Important: Whenever the unit is connected to the mains, the lid of the case must be on.

Test the unit with a mains table lamp connected to the output, TB1/3 and TB1/4 rather than the lawnmower. Connect a piece of mains wire with a plug fitted with a 3A fuse on the end to TB1/1 (Live) and TB1/2 (Neutral). Plug the unit into the mains and press switch S1 – the lamp should light and go off instantly when the switch is released.

Preset VR1 may now be adjusted for minimum current requirement. Do this in a series of small adjustments with the lid replaced each time as explained above. Adjust it clockwise until the lamp fails to light when S1 is pressed. It should then be adjusted anti-clockwise rather more than necessary to give stable operation. At the critical point relay "chatter" will be heard and the lamp will flicker.

The batteries should now be replaced with new ones. This setting-up procedure ensures that best service is obtained from the batteries. Make certain that they are secure and cannot fall out under vibration.

INSTALLATION

Assuming the appliance has no Earth wire, connect TB1/3 and TB1/4 to the lawnmower motor using the existing 2-core cable. The mains input connection is now made to TB1/1 (Live) and TB1/2 (Neutral) using a short "flying lead" with a 2-pin "Black & Decker" garden tool type plug on the end – note this is a plug not a socket.

The matching socket is attached to the mains input lead. Note that all wires passing into and out of the main(s) section box must be fitted with strain relief bushes so that they cannot pull free in service – do not use makeshift methods.

Secure the main unit to the bottom of the handle using a plastic bracket and nylon fixings. Attach the switch section to the top of the handle. The Easy Switch may now be put into service. The batteries should be replaced if ever the motor shows signs of unstable operation and, in any case, annually.

Due to the very light action of the switch it is absolutely essential to unplug the lawnmower from the mains before touching the blade or making any adjustments. Since vibration will occur in service, all fixings inside the main unit must be checked periodically for tightness.

COMPONENTS

STANDARD VERSION

See SHOP TALK Page

Resistor
R1 56
0.25W 5% carbon

Potentiometer
VR1 1k min. enclosed vertical preset

Semiconductor
IC1 MOC3020 optically-isoloated triac

Miscellaneous
S1 Light-action switch – see text
RLA Mains relay with 7300 ohm 230/240V coil and 7.5A d.p.d.t. contacts rated for 240V a.c. mains operation
TB1 15A screw terminal block – 4 sections (or 5 – see text) required
TB2 3A screw terminal block – 2 sections required
B1 "AA" size alkaline cells (2 off)

Stripboard 0.1in. matrix, size 8 strips x 19 holes; 8-pin socket (see text); splashproof box, size 100mm x 100mm x 50mm internal; PP3-type battery connector or as appropriate for battery holder; strain relief bushes (3 off); solder; light-duty connecting wire; 1A and 3A flexible mains wire etc.

Approx cost guidance only **£16**

ALTERNATIVE VERSION

IMPORTANT: Read carefully the Standard Version and take note of all *safety points* before proceeding.

The following notes for the Alternative Version are not detailed. Only important differences between this and the Standard Version are fully described.

The circuit receives power from a 9V PP3 battery and although an alkaline one could be used, a lithium one is recommended for long life and better operating characteristics. A battery holder with hinged cover is used so that the lid of the case does not need to be removed to change the battery (see photograph).

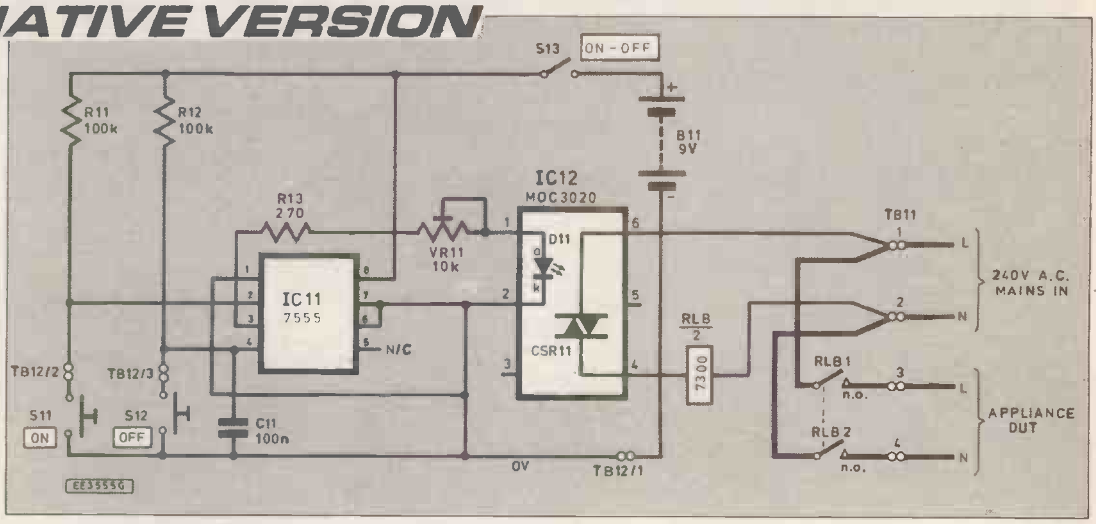


Fig. 4. Complete circuit diagram for the Easy Switch – Alternative Version.

A splashproof box will probably not be required since this circuit is designed for indoor use. On and Off switches, S11 and S12, are mounted in a separate box connected to the main unit using light-duty 3-core wire. This wire may be of any reasonable length.

CIRCUIT DESCRIPTION

The circuit for the Alternative Version is shown in Fig. 4. Note that components are numbered from 11 onwards to distinguish them from those in the standard circuit. On and Off switches, S11 and S12 are identical and may be of the same pattern as S1 in the Standard Version.

A CMOS version of the 555 timer integrated circuit is used for IC11, but in this application it is used as a bistable. This is achieved by making pins 6 and 7 permanently low.

The device may be "set" that is, switched on by applying a low pulse (battery negative voltage) to pin 2 using switch S11 whereupon the output (pin 3) will become high (battery positive voltage). It may be subsequently "reset" (switched off) by making pin 4 low for an instant using switch S12. Resistors R11 and R12 keep both set and reset inputs normally high and this prevents possible false operation.

The output from IC11 operates the l.e.d., D11, in the optically-coupled triac through current-limiting resistor, R13 and preset VR11. Capacitor, C11 ensures that the reset input is low at the instant of switching on so prevents possible self-triggering.

The CMOS timer IC11 requires 100µA approximately when the circuit is on standby (that is, when switched off using S12). Although this may be regarded as

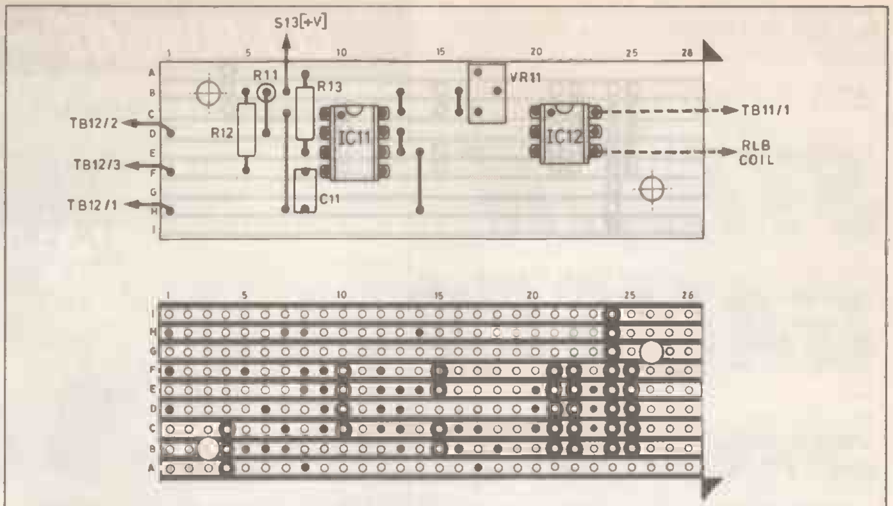


Fig. 5. Alternative Version stripboard component layout and underside details.

COMPONENTS

ALTERNATIVE VERSION

Resistors
R11, R12 100k (2 off)
R13 270
All 0.25W 5% carbon

Potentiometer
VR11 10k min. enclosed vertical preset

Semiconductors
IC11 ICM7555 low-power CMOS timer
IC12 MOC3020 optically-isolated triac

Miscellaneous
S11, S12 Light-action switches – see text (2 off)
S13 Light-duty s.p.s.t. toggle or rocker switch
RLB Mains relay with 7300 ohm 230/240V coil and 7.5A d.p.d.t. contacts rated for 240V a.c. mains operation
TB11 15A screw terminal block – 5 sections required
TB12 3A screw terminal block – 3 sections required
B11 PP3 lithium or alkaline battery, connector and battery holder with hinged cover

Stripboard 0.1in. matrix, size 9 strips x 28 holes; plastic box, size 118mm x 98mm x 45mm external (MB3 box); 8-pin d.i.l. socket (2 off); strain relief bushes (3 off); solder; light-duty connecting wire; 1A and 3A mains wire, etc.

Approx cost guidance only **£18**

negligible, supply switch S13 may be switched off when the unit is to be left unused for a long period of time.

CONSTRUCTION

Construction of the Easy Switch – Alternative Version is based on a main circuit panel made from a piece of 0.1in. matrix stripboard, size 9 strips x 28 holes. The component layout and details of breaks required in the underside copper strips is shown in Fig. 5.

Solder 8cm pieces of light-duty stranded connecting wire to strips *D*, *F* and *H* on the left-hand side of the circuit panel. Solder 1A mains type wires directly to IC12 pins 4 and 6.

Make the holes in the boxes and mount all internal components. Refer to Fig. 6 and complete the internal wiring.

Insert IC11 into its socket without touching the pins. This is because it is a CMOS device and could be damaged by any static charge existing on the body. Insert IC12.

Press the tops on the switches – in the prototype unit logic symbols were used: 1 for "on" and 0 for "off" but this, of course, is optional. Adjust VR11 fully anti-clockwise (as viewed from IC11) and connect the battery.

EARTHING

If the appliance to be used with the Easy Switch has an Earth wire then this must be connected to the earth pin (E) of the mains plug. This is done using section TB11/5 of the terminal block. This section is simply ignored if no Earthing is required.

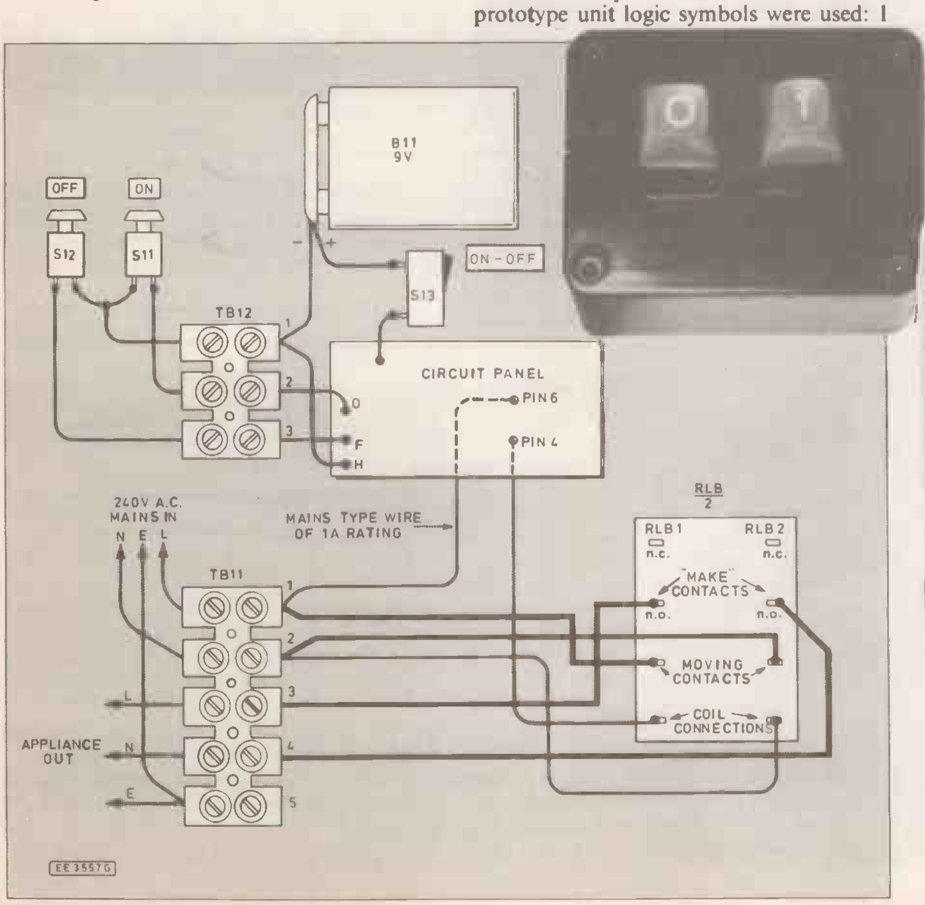
TESTING AND OPERATION

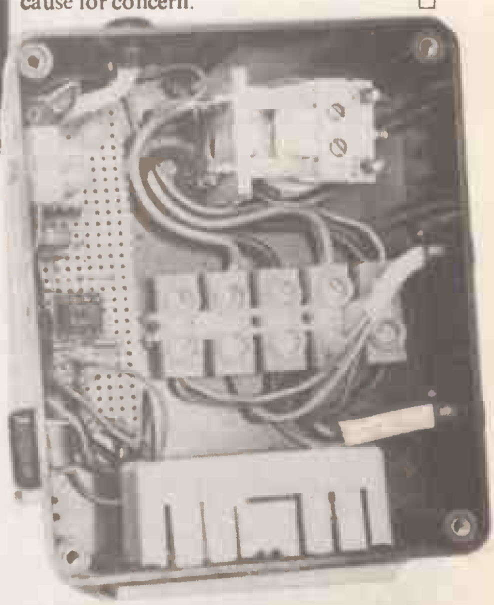
Connect a reading lamp to the terminal block (TB11) at points TB11/3 and TB11/4. Connect the mains input wire to TB11/1 (Live), TB11/2 (Neutral) and TB11/5 (Earth). Replace the lid and plug the unit into the mains.

Switch on S13 and check that the lamp comes on when switch S11 is pressed and goes off when S12 is pressed. If all is well, preset VR1 may be adjusted clockwise for minimum l.e.d. operating current and the unit put into permanent service.

Sometimes when the unit is first plugged into the mains (either version) the unit triggers for an instant and the relay may be heard to click momentarily. This is no cause for concern. □

Fig. 6. Alternative Version main unit interwiring.





Completed Alternative Version showing (top) keyboard on/off switches and (above) main unit component layout, including hinged battery holder.

Feature

STRAIN GAUGES

CHRIS WALKER

PART 1

Electronics can be used to measure force with a strain gauge. This article looks at the theory and next month we describe a simple weighing scale.

HAVE you ever stopped to wonder how you would attempt to use an electronic circuit to measure the size of a force? How, for example would you attempt to measure the weight of an object? One possible solution would be to utilise the elastic properties of a spring by hanging the object from the spring and measuring its extension by mechanically linking it to a potentiometer.

This method is rather crude, and a much more elegant solution involves using strain gauges for the job. These industry-standard force-measuring transducers are beginning to appear on several physics and technology examination syllabuses and yet very little has been written about them and some constructors are afraid to experiment with them because they have a reputation of being difficult to use successfully.

This two-article feature hopes to dispel some of the mystery and fear about using strain gauges for useful applications in the home, school, college or at work. It is also hoped that students taking A-level (or higher) courses and teachers of these courses will find the feature instructive and interesting.

We start by looking at the theory behind strain gauge operation and, in the next article, go on to see how they can be used to make a simple, but sensitive, electronic weighing scale.

GAUGE STRUCTURE

A foil strain gauge consists of a very fine zigzag grid of copper-nickel alloy called "constantan" which is photographically etched onto a polyester or polyimide backing material, see Fig. 1. In most modern gauges the grid is hermetically sealed and so protected from moisture and other contaminants. The entire gauge is very compact, typically 9mm by 4mm.

Two leadout wires permit connection to a circuit, without the risk of damaging the grid by soldering directly to it. These leads are, however, very delicate and are normally soldered to a simple self-adhesive lead terminator (supplied with the gauge) which prevents undue flexing.

The strain gauge is bonded, using adhesive, to the surface of the material under investigation. The marks printed on the backing material allow it to be accurately aligned along the direction of principal strain. When a "stress" is applied, the material undergoes "strain" and extends slightly causing the strain gauge to extend also.

As the gauge stretches, the constantan conductors become longer and thinner. The electrical resistance of a conductor is proportional to its length and inversely proportional to its cross-sectional area. Therefore, straining the gauge will result in the resistance of the grid increasing by a small amount.

Constantan alloy is used because the fractional change of the grid's resistance is nearly proportional to the applied strain. The exact relationship is shown by the formula in Fig. 1. The quantity K_G in this formula is called the "Gauge Factor" and typically lies in the range 2.0 to 2.1. The unstrained resistance of most popular gauges is 120 ohms.

STRESS AND STRAIN

Of course, if you are not a physicist or engineer, the terms **stress** and **strain** may be unfamiliar to you in this context. Let us consider a simple **tensile** situation as shown in Fig. 2.

If a material with a length "l" and a cross-sectional area "A" has a force "F" pulling on its ends, then the **tensile stress** in the material is:

$$\text{stress} = \frac{F}{A}$$

If this stress causes the material to extend (stretch) by an amount "e" then the **tensile strain** it experiences is:

$$\text{stress} = \frac{e}{l}$$

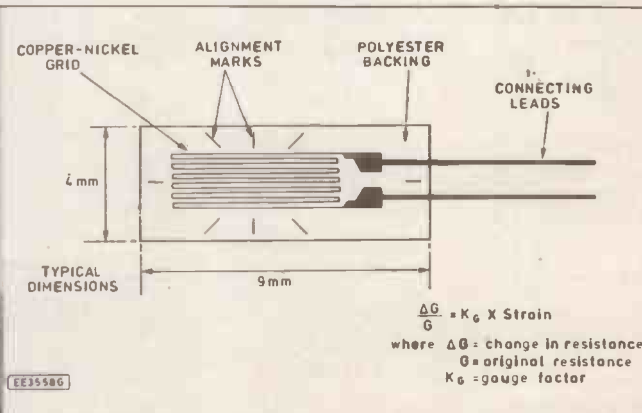


Fig. 1. Structure of a foil strain gauge. The photograph indicates the size of the gauge and shows a lead terminator.

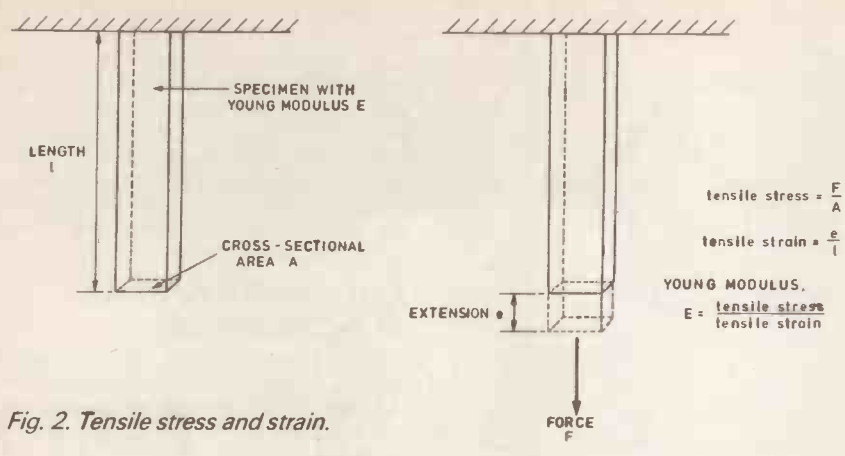


Fig. 2. Tensile stress and strain.

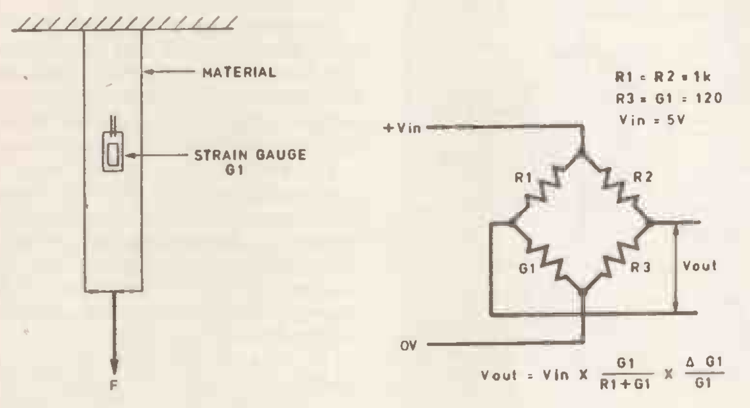


Fig. 3. Using a single strain gauge.

The ratio of **tensile stress** to **tensile strain** is called the **Young Modulus** (given the symbol "E") of the material being used:

$$\text{Young Modulus (E)} = \frac{\text{tensile stress}}{\text{tensile strain}}$$

Let's work through an example. Suppose the strip in question is made from aluminium and measures 16mm by 3mm and is 300mm long. A force of 200 newtons (200N), which is about equal to the weight of twenty 1kg bags of sugar, is applied to its end.

The cross-section area of the aluminium is:

area = $0.016 \times 0.003 = 4.8 \times 10^{-5}\,\text{m}^2$ remembering to work in S.I. units of metres, not millimetres. Therefore, the tensile stress is:

$$\text{stress} = \frac{200}{4.8 \times 10^{-5}} = 4.17 \times 10^6\ \text{N/m}^2$$

Now, the Young Modulus (E) for aluminium (found from a data book) is 7.1×10^{10} N/m², so to find the tensile strain in the strip:

$$\text{strain} = \frac{\text{stress}}{\text{E}} = \frac{4.17 \times 10^6}{7.1 \times 10^{10}} = 5.87 \times 10^{-5}$$

Notice that strain is a ratio and has no units. The extension produced by this strain is very small (about one hundredth of a millimetre) and you would have trouble measuring it directly, and yet it poses little problem for a strain gauge.

It is not intended for this feature to substitute a full course on material mechanics or elasticity. If you wish to know more about how materials behave under the influence of external forces then you should absorb yourself in a little light reading from an engineering textbook!

Suffice it to say that if you can calculate how much strain a particular gauge experiences then you can also predict the fractional change in the resistance of the gauge (an vice-versa).

WHEATSTONE BRIDGE

A single strain gauge G1 can be bonded to the surface of a material, as shown in Fig. 3. If it is bonded properly, then **the strain gauge will experience the same strain as that present in the surface of the material.**

The gauge is then connected into a "Wheatstone Bridge" as shown. (In case you are interested, Sir Charles Wheatstone, who developed this resistance-measuring bridge, also invented the Concertina and the Stereoscope 3D viewer amongst other things. How's that for trivia?!)

Although the bridge is drawn in a diamond shape, it actually consists of two potential dividers connected across a voltage source V_{in}. The output from the bridge is the potential difference between the mid-points of the two dividers. The bridge is said to be balanced when V_{out} is zero.

Under these conditions it can be shown that the resistor values R1 to R3 and gauge resistance G1 have to satisfy the equation:

$$\frac{R1}{G1} = \frac{R2}{R3}$$

In order to balance the bridge, resistor R3 would need to be equal to the resistance of the strain gauge, whilst resistors R1 and R2 would typically have a resistance of 1k.

A higher resistance is used for resistors R1 and R2 for two reasons. Importantly, it ensures that the current through the strain gauge is kept to a safe, low level to prevent unwanted heating of the gauge. Also for this reason, the bridge supply voltage is quite low, about 5V.

The second reason for choosing a high resistance for R1 and R2 is that it reduces the common-mode voltage present at the output. Although the voltage difference at the output is zero when the bridge is balanced, each terminal is at a potential of about 0.5V above the 0V rail. This common-mode voltage needs to be kept as low as possible or it will create problems in the following amplification stage.

OUTPUT VOLTAGE

If the gauge G1 is strained so that it undergoes a fractional resistance change of $\Delta G1/G1$ then (assuming the bridge is initially balanced) it can be shown that the output voltage from this Wheatstone Bridge is given approximately by the formula in Fig. 3.

To continue with our example involving the aluminium, we have calculated above that the strain produced by a 200N force was 5.87×10^{-5}. Therefore, if a strain gauge with a gauge factor of 2.0 is fastened to the aluminium, its fractional resistance increase (given by the formula in Fig. 1) is:

$$\Delta G/G = 2.0 \times 5.87 \times 10^{-5} = 1.17 \times 10^{-4}$$

The output voltage from the bridge shown in Fig. 3 would, therefore, be:

$$V_{out} = 5 \times \frac{120}{(1000+120)} \times (1.17 \times 10^{-4}) = 0.06\text{mV}$$

This is a pretty small signal and needs amplification before it can be easily measured but before we discuss amplifiers, let's look at some other Wheatstone Bridge arrangements.

DUAL GAUGE BRIDGE

If, instead of exerting a tensile force to stretch a material, we apply a "torque" as shown in Fig. 4 then the strip will bend. Its top surface will be under tension whilst the bottom surface is in compression. If we fix a strain gauge G1 to the top surface and another one to the bottom (G2) and wire them into the bridge as shown in Fig. 4 then the equal and opposite effects from the gauges will give double the output voltage from the bridge for a given strain compared to the output from a single gauge.

It is important to realise that this cantilever is a different and more complex situation from the simple tensile example of Fig. 2, although the same basic physical principles still apply.

This arrangement is used to construct the weighing scale in the next article and, for small forces, the output from the bridge is roughly proportional to the applied load. It could also form the basis of an electronic torque wrench.

For increased sensitivity, commercial load-cells may contain four gauges in a complete bridge as shown in Fig. 5. A possible mechanical arrangement for the gauges is also shown. When the cell is

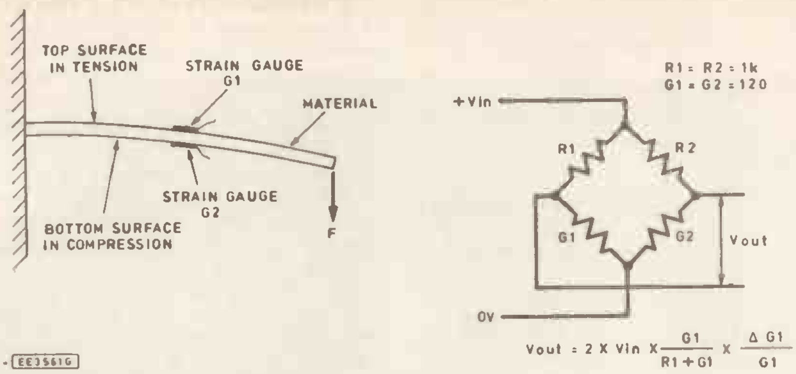


Fig. 4. A dual gauge arrangement.

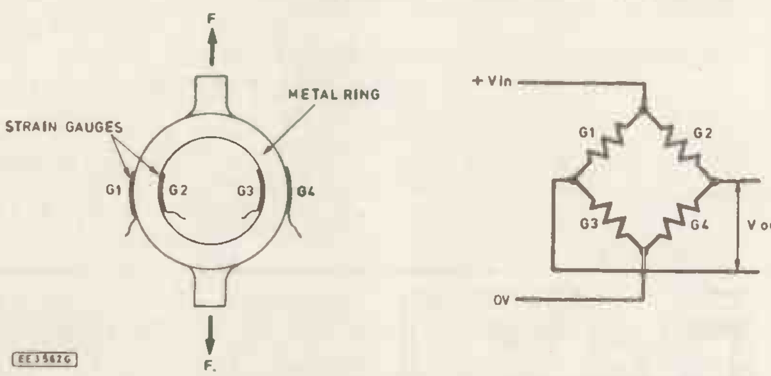


Fig. 5. Arrangement of a typical commercial tensile load cell.

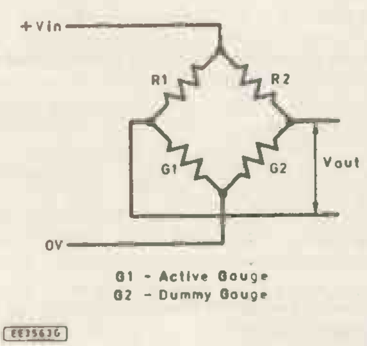


Fig. 6. Temperature compensated Wheatstone Bridge.

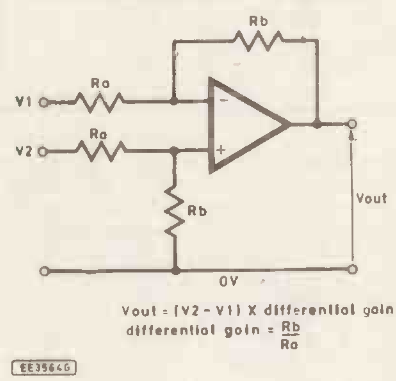


Fig. 7. A basic differential amplifier.

stretched, gauges G1 and G4 experience compression whilst gauges G2 and G3 undergo tension.

TEMPERATURE STABILITY

As shown earlier, the output from the bridge is very small (typically less than one millivolt) and it is important to prevent environmental changes from affecting the gauges and creating an output which could swamp the effects of strain. Temperature changes create the biggest problems and have two significant effects on the gauges.

An increase in temperature can cause the material (to which the strain gauge is attached) to expand, and this could stretch the gauge and cause it to register apparent strain. To eliminate this effect, a strain gauge is chosen which has a linear expansivity equal to the expansivity of its host material.

During a temperature change, both the gauge and its host will expand and contract by the same extent. Gauges matched to aluminium or mild steel are commonly available.

The other temperature effect is a more fundamental one which affects the strain gauge directly. As with all metallic conductors, when the temperature of the constantan grid increases its resistance rises, and this will cause the Wheatstone bridge to become unbalanced.

When using a single strain gauge, the simplest way around this undesirable problem is to introduce a second, dummy strain gauge as shown in Fig. 6. The dummy gauge is placed in close proximity to the active gauge, **but it undergoes no strain.** A temperature change will affect both gauges identically and their equal resistance changes will not unbalance the bridge, which is now described as "temperature compensated".

Of course, in two-gauge or four-gauge bridges, temperature compensation is automatically achieved by the presence of more than one active gauge.

All this care to achieve stability could be labour-in-vain if the 1k bridge resistors you use are el-cheapo "carbon" types with poor stability. Ideally, "precision wirewound" versions are the bees-knees, but if you are not in the habit of spending a week's wages on a single resistor than the modestly priced "metal film" types work quite satisfactorily.

DIFFERENTIAL AMPLIFIER

We have now reached the stage where we need to amplify the small output voltage from the strain gauge bridge so that it can be displayed on a calibrated voltmeter or digitised for storage in a data logger, etc. Remember that the bridge output is the voltage difference between the two arms and, so, a differential amplifier is needed.

An operational amplifier is ideal in this application and Fig. 7 illustrates how the addition of four resistors develops the op-amp into a differential amplifier where the output voltage is proportional to the voltage difference between its two inputs.

To obtain a 0.5V output from a 0.5mV input, a differential voltage gain (G_{diff}) of 1000 is required. At these high gains, the **common mode rejection ratio (CMRR)** of the amplifier is important. The CMRR is a measure of the amplifier's ability to ignore voltages common to both inputs (common-mode voltages).

$$CMRR = \frac{G_{diff}}{G_{cm}} \quad \left(\text{where } G_{cm} \text{ is the common mode voltage gain}\right)$$

and this ratio should be as high as possible. More commonly expressed in decibels:

$$CMRR\,(dB) = 20 \times \log_{10} \frac{G_{diff}}{G_{cm}}$$

An inexpensive op-amp may have a CMRR of 90dB. Without wishing to become too involved in the maths, it turns out that this figure is not high enough to prevent a high gain differential amp from suffering undesirable common-mode effects which could swamp small output signals.

There are two ways around this problem; either use a better op-amp with a higher CMRR, or use a better circuit.

CROSS-COUPLED DIFFERENTIAL AMPLIFIER

A cross-coupled differential amplifier is shown in Fig. 8 and represents a better approach to circuit design in this application. In the input stage, two cross-coupled op-amps (IC1a and IC1b) amplify differential signals but offer only unity gain to common-mode signals.

In the second, differential stage, amplifier IC1c amplifies the differential output from the first stage but rejects the common-mode output. The second stage can provide additional gain, if required.

Since the input stage offers no amplification to common-mode inputs, the CMRR of the second stage is effectively improved by an amount equal to the gain of the first stage. Adjustable gain can be achieved by replacing resistor Ry with a variable resistor.

As an example, if we require an overall

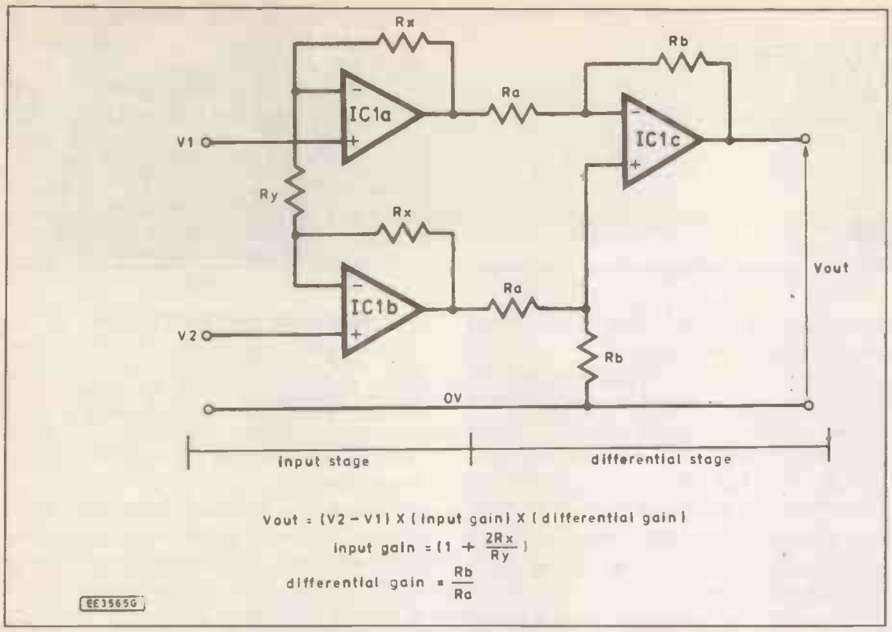


Fig. 8. A cross-coupled differential amplifier.

gain of 1000, this could be achieved by giving the input stage a gain of about 100 followed by a gain of 10 in the differential stage.

Setting Rx = 470k and Ry = 10k will set the input gain to 95, and if Rb = 100k and Ra = 10k this will set the gain of the differential stage to 10.

TEMPERATURE DRIFT

The two input amplifiers should be part of a single chip so that they experience the same temperature fluctuations. This makes sure that the effects of temperature drift are common to both amps and are cancelled out in the differential stage.

The choice of amplifier depends on the performance you require. A simple fet-input type such as the LF353 is a dual-amp package with a CMRR of 100dB and it will probably give good results at fairly low differential gains. However, an instrumentation grade device such as the quad-package OP-470GP, although expensive, has an excellent CMRR of 120dB along with a very low noise figure and would be a superior choice.

The op-amps should be run from a split-rail power supply; for example +9V and −9V, which can be conveniently supplied from a pair of batteries.

In the next article, we will apply the design principles discussed here and look at the practical aspects involved in using strain gauges to construct a sensitive weighing scale.

EVERYDAY READOUT

MINE OF INSPIRATION

Dear Ed.,

Just to inform you that I am not renewing my subscription to *Everyday Electronics* as I have now retired from my work as a teacher of CDT Technology.

May I say that I have found the magazine to have been a tremendous source of help in interesting pupils in electronics, and it has been a mine of inspiration for suggestions on project work.

No doubt I shall still be picking up the occasional copy from W. H. Smith for my own enjoyment!

One suggestion that I wonder may be of help for the many school students who read the magazine. Why not an examination question, taken from past GCSE papers in Electronics or Technology, showing model answers, one question per month? This should supplement the excellent series you have done on project work for GCSE and Information Technology.

Here's wishing all success to EE, an excellent magazine for beginners (and old hands too!)

B. A. Hollowell
Kettering

We are pleased to have been of assistance. A new GCSE Electronics/A level Electronics series will start in the October issue (Teach-In '93 no less), this will contain GCSE questions and model answers. Thanks for the suggestion.

DIESEL TACHO

Dear Ed.,

I write to ask if you can help me to find a circuit for a tachometer for a diesel engined car. I believe that the digital tacho featured in last June issue relied on the ignition pulses which of course are absent from the diesel.

Some diesel cars are fitted with a tacho as standard and I believe that they sense pulses or current from the alternator "W" terminal. I have connected my multimeter to the "W" terminal but can get no reading on any scale.

It occurs to me that the "W" may be cast onto all the alternator end plates but the terminal not connected if the vehicle was not intended to have a tacho. If this is the case can you tell me what the output from a "W" terminal should be, how to achieve it and how to make use of it.

The system presumably would present this information on a readily available meter and be adjusted to calibrate out any difference in the ratio of the engine and the alternator pullies.

A tip for anyone seeking soft iron for electro-magnetic projects. Florists support fragile flower stems in wreaths and bouquets by inserting Swedish iron wires which are available in various gauges and lengths. It is a farily good quality soft iron – very prone to rusting.

B. Pike
South Humberside

Unfortunately diesel tacho's are not something we know anything about. If any reader can help with information and/or a project we would be interested to hear from you.

PCW ALIVE AND WELL

Dear Ed.,

I read Barry Fox's article in the Feb. issue and felt I simply could not let it pass. He was far too pessimistic about the future of the PCW, and may well have spread gloom and despondancy among many readers who own these excellent machines.

Sales of the PCW really took off, and whether intended for planned obsolescence or not, a 3-inch disc became the standard for domestic and many small, as well as not-so-small businesses. Accurate figures are not available, but well over 600,000 probably approaching one million PCW's have been sold in this country, with a similar number going overseas.

These have created a huge demand for discs. About a year ago six million were supplied to Amstrad from Panasonic, and European makers were also reported as getting in on the act. As readers of the specialized PCW magazines will know, there are many adverts for unbranded 3-inch discs which are made in various parts of the Far East. I have used many of these and found them to be actually more reliable than the Amstrad Amsoft discs.

To further show that the 3-inch PCW is far from being a dead end, is the large amount of hardware that has been produced specially for it, some quite recently. For any who wish to use 3½-inch or 5¼-inch discs, there are external drives by Teac and others that can be easily fitted to the 8256 by simply plugging in.

The same situation exists with software. There is an immense range specially produced for the 3-inch format and more are appearing all the time.

So it can be seen that a large support industry has grown up around the original PCWs. Even though Amstrad have pulled out, with over 600,000 UK users it is much too big a market to let slip. Amstrad of course is happy to play the obsolescence card and stand aloof, as the thought of all those PCW users ditching their machines and buying the latest would surely put a twinkle in Alan Sugar's eye.

So there is no need to panic, the 3-inch format is likely to be around for some while yet, and supplies of discs from eager Oriental gentlemen as long as there is a demand. But if the worst does come, an easily fitted and operated extra drive will enable both 3-inch and 3½-in discs to be read and written on the PCW. Much cheaper than buying a new computer.

Vivian Capel
Bristol

WRITE IN

Many readers have requested a letters page, here it is. Now it's up to you to ensure Readout continues and that it is lively and interesting. Let's hear from you!

INTERFACE

Robert Penfold

IN LAST month's *Interface* article a simple d.c. power controller of the constant voltage type was described. In conjunction with a digital-to-analogue converter based on a ZN426E this provides computerised speed control of a small d.c. electric motor.

A controller of this kind is very simple and straightforward, but it does not provide particularly good performance. The main problem being the starting performance.

A typical application for a controller of this type is as a model train controller. One would expect that sending steadily increasing values to the converter would result in the train steadily moving off and accelerating away.

Jump Starting

Anyone who has used an elementary model train controller will know that a smooth start of this type is virtually impossible to produce. Steadily advancing the speed control results in the train stubbornly refusing to move until the control has been well advanced. It then suddenly moves off at around half speed. Much the same happens if a controller of this type is used under computer control.

Control is much more precise once the train has started. There is still another problem though, in that reliability is not very good at low operating speeds. The motor tends to stall rather easily.

There is a way around the poor starting performance, and this is to give a brief burst of high power to get the train moving. The length of this initial pulse has to be carefully controlled if it is to provide the desired result.

If the pulse is too short the train will simply fail to start. If it is too long the train will have an initial burst of speed which will not give very realistic results.

Getting this just right with a manual controller is tricky, but possible. With a computerised controller it should be much easier, since the software routine used to provide the initial burst will provide consistent results. Some trial and error will be needed to get things optimised, but thereafter the setup should give consistently good starting performance.

There is no easy solution to the poor low speed performance though. Probably the best simple solution is a "panic" key which can be pressed when the train stalls. This just sends a brief pulse of high power to nudge the train back into action.

Pulsed Controller

For reliable operation at low speeds a more sophisticated form of controller is required. Pulsed controllers offer much better performance but are still reasonably simple and inexpensive. These do not provide steady output voltages, but instead produce a pulsed output signal.

For example, in order to produce half power the output signal is a squarewave having a 1 : 1 mark-space ratio. The output is switched fully on for half the time, and is fully switched off for the rest of the time. The average output voltage is therefore equal to half the peak output potential, and it is this average voltage that governs the speed of the motor.

A higher mark-space ratio gives a higher average output voltage – a lower mark-space ratio produces a lower average output potential. Using this method it is therefore possible to produce any effective output voltage from zero to the peak output voltage of the controller.

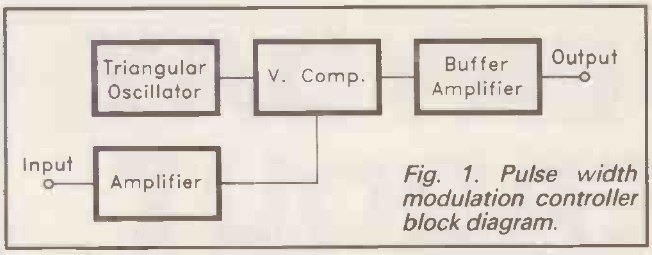


Fig. 1. Pulse width modulation controller block diagram.

Provided the output frequency is not very high or very low, a small d.c. motor will work perfectly well from a pulsed signal. A frequency of around 100Hz to 200Hz is satisfactory.

The point of using this method of control is that the pulses of full power from the controller are good at nudging the motor into action, giving much improved starting performance. They also resist the tendency of the motor to stall, producing much better reliability at low speeds.

Direct Drive

There are several ways of producing a suitable pulse width modulated signal under computer control. From the hardware point of view the most simple is to use a constant voltage controller, but to omit the digital-to-analogue converter. Instead, the controller circuit is driven direct from a digital output of the computer (or an add-on PIA card). Although this only seems to give simple on/off control, by using software routines to generate suitable pulse signals on the digital output, pulse width control is obtained.

This method is perfectly feasible, but needs some carefully written software if it is to work properly. A fast computer language is needed in order to provide an output signal having suitably precise timing.

Also, the computer must be left with some spare computing capacity and not be fully tied up just generating the pulse signal. An interpreted BASIC, even running on a fairly powerful computer, will probably not be fast enough.

Unless you are fairly expert at the software side of things it is probably best to use a controller that produces the pulse width modulation (p.w.m.) signal via a digital to analogue converter. The block diagram for a standard p.w.m. controller is shown in Fig. 1.

The amplifier at the input is needed in this case because the 0 to 2.55 volt output from the converter is too small to drive the main circuit properly. The buffer amplifier at the output is needed to permit the circuit to provide the high output currents required by a d.c. electric motor.

The pulse width modulator is formed by the triangular oscillator and the voltage comparator. The voltage comparator's output goes high if the input voltage is higher than the voltage from the oscillator, or low if it is not.

Three sets of waveforms for the modulator are shown in Fig. 2. In each case the top triangular waveform is the output from the oscillator, the broken line is the d.c. input level, and the lower waveform is the output signal.

It will be seen that the higher the input voltage, the higher the mark-space ratio of the output signal. In fact the average output voltage is identical to the d.c. input level.

Controller Circuit

The circuit diagram for the Model Train Pulsed Controller Unit is given in Fig. 3. Starting at the output, transistor TR1 is an emitter follower output stage. As very high gain is needed here and high currents are involved, a Darlington power device is used for TR1.

The power dissipation in TR1 is less than one might expect due to the switching mode in which it operates. However, it should still be mounted on a medium sized heatsink to ensure that it is kept reasonably cool.

Resistor R8 is a load resistor for TR1, capacitor C4 attenuates high frequency harmonics on the output which might otherwise cause radio interference, and diode D1 suppresses any reverse voltage spikes generated by the motor. Incidentally, the method of reversing described last month is applicable to this controller.

The voltage comparator function is performed by IC3, which is actually just an operational amplifier used in the comparator mode. The inverting (-) input is driven from the output of a conventional triangular waveform generator. This has IC2a as the integrator and IC2b as the trigger circuit. It operates at about 100Hz, which should suit any small d.c. electric motor. However, the operating frequency is easily altered, and is inversely proportional to the value of capacitor C2.

The input amplifier, IC1, drives the non-inverting input of IC3. Although it was stated earlier that the average output voltage is equal to the d.c. input level to the modulator, in practice matters are not normally quite as neat as this.

This relationship only applies if the output from the oscillator has a peak-to-peak level equal to the supply voltage. This is very difficult to achieve in practice, and is not very important anyway. If the output of the oscillator is between (say) 0·5 volts and 9·5 volts, then an input signal over this voltage range will give zero to maximum output.

In this case the output from the oscillator is over the approximate voltage range mentioned previously. IC1 provides a nominal voltage gain of 3·7 times, which means that the basic 0V to 2·55V output from the digital-to-analogue converter will give from zero to something approximating to full output (this circuit should be driven direct from the output of the ZN426E).

If you would prefer to trim the gain of IC1 to give precisely maximum output at maximum voltage from the converter, replace R1 with a 22k resistor and a 10k preset potentiometer wired in series. The preset is then given the lowest value that permits the full output voltage to be achieved. Of course, the circuit should work perfectly well with other converters provided the gain of IC1 is altered to suit the output voltage of the particular converter used.

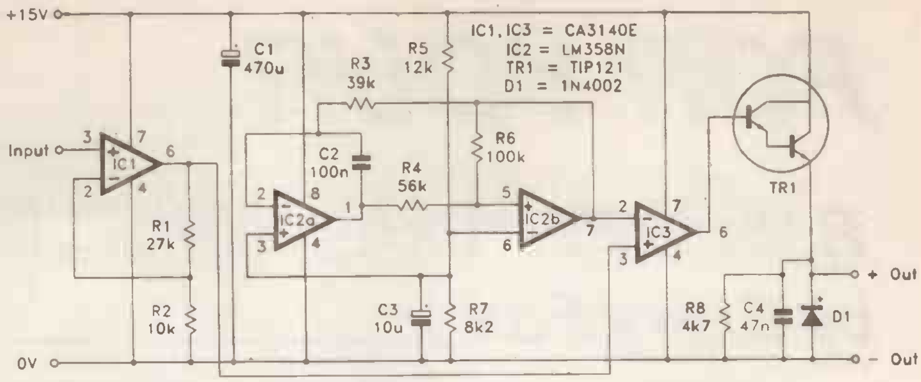


Fig. 3. Model Train Pulsed Controller circuit diagram.

There will be a small range of low values which give zero output, but it is probably not worthwhile trying to remove this offset. There would still be a limited range of values which gave a low output power but did not cause the motor to operate. These factors are not normally of any practical significance, but compensation can be made for them in the software if necessary.

Note that the integrated circuits specified for this circuit are types which can operate with their outputs at voltages right down to the 0V supply potential. Most other operational amplifiers cannot do this, and will not operate properly in this circuit. The CA3140E used for IC1 and IC3 has a PMOS input stage, and therefore requires the normal anti-static handling precautions.

Power Supply Unit

The constant voltage controller described last month operates perfectly well with a non-stabilised supply having a high ripple content. The same is not true of this pulsed controller circuit (Fig. 3). It requires a reasonably stable 15V supply having no more than a moderate amount of ripple on the output. The supply should also include current limiting since no overload protection circuitry is included in the controller circuit.

A suitable mains power supply circuit is shown in Fig.4. This is a conventional design having full-wave bridge rectification and stabilisation provided by a monolithic voltage regulator. Note that decoupling capacitors C2 and C3 should be fitted close to the regulator IC1 where they can be fully effective.

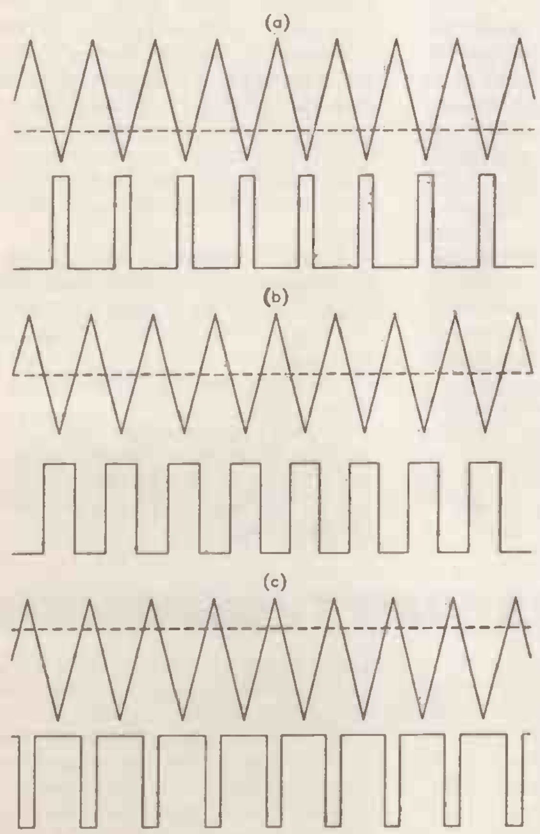


Fig. 2. Example p.w.m. waveform. The average output voltage is equal to the d.c. input level.

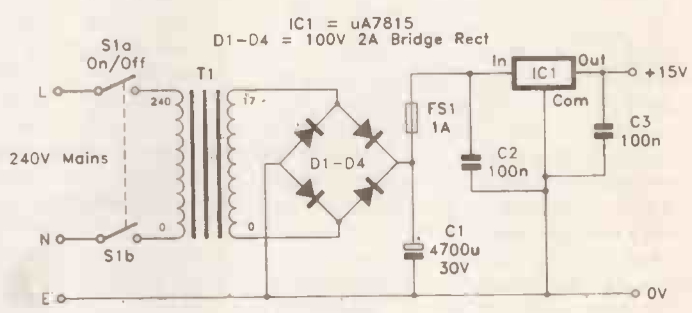


Fig. 4. Suggested power supply circuit for the Pulsed Controller.

Mains transformer T1 should have a current rating of about two amps or more. As with any circuit that connects to the *dangerous* mains supply, *only construct the unit if you are sure you know what you are doing, and you have the necessary experience in electronics construction.*

The regulator IC1 has built-in current limiting which prevents the output current from going much over one amp. An output current of one amp is sufficient for most model trains, but larger types can take up to about two amps. The controller circuit should be able to handle currents of up to two amps provided the Darlington transistor TR1 is mounted on a large enough heatsink.

The mains power supply unit (Fig. 4) needs some changes to the components in order to accommodate higher currents. Transformer T1 should have a current rating of at least three amps, and FS1 should be a two amp fuse. Incidentally, the fuse should be a "quick-blow" type and IC1 must be a type having a current rating of two amps or more, such as the RS L78S15V two amp regulator.

There is insufficient space available to consider software matters this month, but next month we will consider the ins and outs of using popular PC languages. Some train controller software will also be described.

FOR YOUR ENTERTAINMENT

by Barry Fox

Tape Format War?

The consumer electronics industry loves a format war. The best the industry ever waged were on home video. First there was the Philips N 1500 one hour VCR, then the two hour N 1700, then the Grundig four hour SVR and finally Philips' V2000.

All failed when VHS beat Sony's Beta. Now VHS is fighting Sony's Video 8.

Canon has for several years been selling Ion, the snapshot video camera which records still pictures on a magnetic disc. More accurately Canon has been trying, but failing, to sell Ion. Now Canon is repositioning Ion as a business tool, to be used with a Personal Computer. But magazines complain that even when they show interest and offer to review an Ion PC kit they cannot get hold of one to try.

Toshiba has for a year now been promising to start selling its memory card camera. This records still pictures into the same standard size credit card memories used by Sharp's IQ organiser. The Toshiba still picture camera will record 6 full frame pictures (with twice the resolution of Ion) in a nine megabit memory card. In Japan the camera with player and charger costs around £2000 and the card £220. So it will not be a consumer product. There will later be an 18 MBit card to store 12 pictures at an even more horrendous price.

Samsung had plans a few years back for a camcorder using DAT cassettes. But these were dropped in favour of Video 8. Now Aiwa, a subsidiary of Sony, has two DAT units which are designed to store still video pictures of the type shot by the Toshiba camera.

The Aiwa HDV-2000 portable records up to 3,600 still pictures on a two hour DAT tape. It connects to a video recorder, still camera or TV tuner. Pressing a "shutter" button records one-off pictures. Pressing "auto" records a picture every two seconds, making it ideal for security surveillance.

The MMD-100 is a table-top machine that records 1,384 pictures on a two hour tape, but with higher resolution.

Both provide running stereo sound to accompany the pictures. The higher picture quality comes from using 8 bits of each 16 bit word for audio and 8 bits for video. The portable uses 10 bits for audio and 6 bits for video. Aiwa has no firm plans yet for the UK.

Now Aiwa promises the storage of moving video on DAT, with the DVI digital compression system which is similar to that which Philips will use to record moving video as digital code on CD-Interactive discs.

This would take us into a new video tape format war.

Digital Camera System

Kodak believes that domestic photographers are better off with film. The new Photo CD system will rely on the electronic transfer of film pictures onto a blank CD. A standard size disc stores around a hundred pictures, each in several levels of digital code. The lower levels give rapid display on a TV screen, using a Photo CD player; the higher levels are used to make high quality prints.

Kodak does, however, believe in electronic imaging for professionals and has developed what it describes as a "brute force" system for digitally recording large quantities of high quality still pictures. The Digital Camera System will cost $20,000 in the USA and £17,500 pounds in the UK.

DCS works with a Nikon F3 film camera, usually the favoured tool of the trade for professional photographers. The removable back of the Nikon is replaced with Kodak's back which contains a solid state image sensor. This has 1.3 million light sensitive picture points or pixels arranged as a 1280 x 1024 matrix. By comparison the image sensors used in consumer video cameras usually have less than 0.5 million pixels.

Kodak makes these sensors, nominally known as 1 Megapixel chips, in Rochester, NY. They cost around $1000 a time, for a monochrome model. Colour models cost more because the sensors must be overlaid with a grid of Red, Green and Blue filters (usually arranged in RG, BG, RG, BG order to give at least twice as many Green as Blue and Red). Kodak also makes 4 Megapixel sensors for High Definition image scanners, as used for converting photographic negatives or positives into video format. The price on these is not even quoted.

Because the DCS system only modifies the camera back, a photographer can uses the Nikon front with its conventional lenses. Because the image sensor has only half the area of a 35mm film frame, the focal length of the lenses on the Nikon are doubled, to make telephoto shooting easier.

The electrical output from the sensor is converted into digital code and fed by cable to a portable digital storage unit, DSU, which contains a 200 MByte Winchester computer hard disc driven by rechargeable batteries. The disc can store 158 images in the raw form delivered by the camera back. Alternatively the DSU can compress the images, by discarding redundant information (e.g. in wide expanses of white sky or blue sea) and store around 600 pictures. The penalty is weight, 4.5 kilograms for the DSU.

The stored pictures can either be transferred directly to a computer by connecting lead or sent by telephone line with a modem. Kodak does not claim that picture quality matches 35mm film, but says that the pictures are clearer than anything yet available from the existing analogue disc cameras, or even Toshiba's digital card camera. The key point is that DCS is free from TV standards.

Kodak is offering DCS to professionals who want to take a large number of pictures, often in poor light, without the need to process film. The system is thus ideal for photojournalism, security surveillance, medical examination and microscopy.

Where photographers need to take pictures faster than the Winchester can store them, up to 24 rapid fire images can be buffered in solid state memory before storage.

PAY-PER-VIEW TV

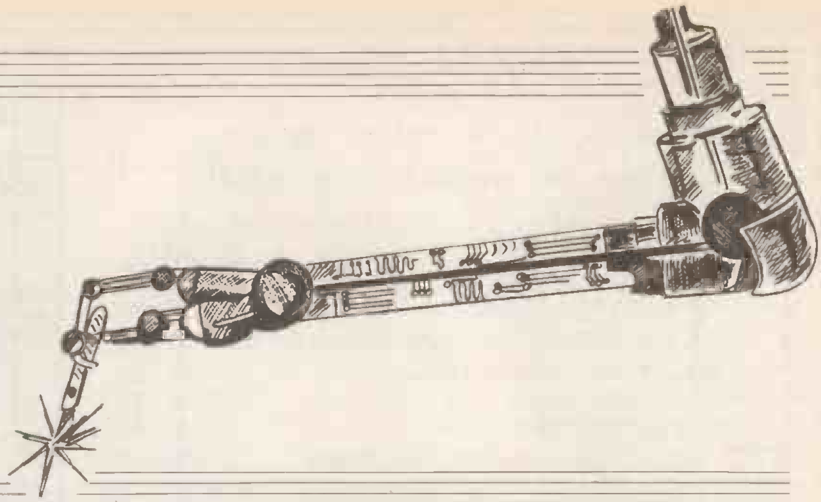
As more and more people subscribe to BSkyB's movie channels, more and more people realise that they are continually paying for a service which they often do not use, either because they are busy, away on business or away on holiday. This realisation is sowing the seed for pay TV.

In a pay-per-view system, you pay nothing until you take a considered decision to watch something. Then you pay. And that makes a whole lot more sense than paying a regular subscription.

As TV, cable and satellite choice widens, pay-per-view becomes an increasingly attractive option. All the modern encryption systems already make provision for pay-per-view working. The industry is just waiting for public dissatisfaction to make the time right to offer the service.

Regular Clinic

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Welcome to Circuit Surgery - our new clinic especially for Everyday Electronics' *constructors. Circuit Surgery aims to provide a regular cocktail of practical hints and tips. It also intends to act as a "self-help" forum for readers as well as a means of providing rapid feedback (including modifications and trouble-shooting information) concerning many of the projects which appear in* Everyday Electronics. *For good measure, we also hope to put paid to some popular myths and misconceptions. This column will rely heavily on your input so please make one more New Year's resolution and drop me a line to let me know what topics you would like me to cover!*

Keeping it warm

Andrew Dunn writes from Loughton with a plea for help. Andrew is a keen constructor and usually finds something in each issue of *Everyday Electronics* to whet his appetite. Andrew writes:

"I find that a miniature 15W soldering iron is just not powerful enough for my needs and so have settled upon a cheap-and-cheerful 25W mains iron. However, having gone through three elements in as many years, I am now wondering whether this was a good idea!

Used on a spasmodic basis, my soldering iron remains switched on whenever I am at the bench. This is important as it allows me to use the iron whenever I need it; I just cannot wait for it to warm up from cold every time I need to make a soldered connection.

I had thought about purchasing a temperature controlled soldering station but as a student I can't justify the expense. Have you got any ideas?"

Well, Andrew, I think that the answer is closer to hand than you might think; just take a look in your junk box and locate a 1N4004 diode and a good quality mains switch (either single or double pole will do). Then connect them as shown in Fig. 1 (the l.e.d. indicator circuit is optional). This will allow you to keep your soldering iron ticking over on "standby" when it is not in use and quickly bring it up to the correct temperature when you actually need to use it. This will not only increase the life of the soldering iron element but it will also prevent the bit from becoming oxidised when it is left for long periods without use.

Before moving on, a brief word of warning is required. Readers should observe the usual precautions associated with mains wiring when carrying out a modification of the type shown in Fig. 1. In particular, the components should be mounted in an insulated enclosure, well away from inquisitive fingers!

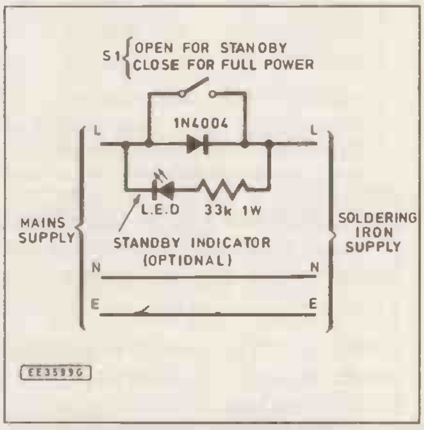


Fig. 1. Soldering iron standby circuit.

Resistance range extender

The resistance ranges on most low-cost analogue multimeters leave a great deal to be desired. Such instruments are usually only reliable up to about 200kΩ, beyond this the scale calibration becomes so cramped that it becomes impossible to read the value with any degree of accuracy.

Some time ago, I was approached by an ex-student who had purchased a particular type of analogue meter on my recommendation. Unfortunately, he had quickly discovered the limitations of the instrument and had come to me for a cure!

Not wishing to miss the opportunity for a little impromptu revision, I asked him to sketch the circuit of a simple common emitter transistor amplifier stage. I suggested that, with a little imagination on his part, this might be the answer to his problem.

To cut a long story short, John obliged by drawing a workable circuit to which I added his existing meter (switched to the 5mA d.c. current range), a 9V battery, and a pair of terminals to facilitate connection of an unknown resistor (see Fig. 2).

John's resistance range extender is quite easy to set up. The variable resistor (VR1) is first adjusted to provide full-scale indication with the unknown resistor replaced by a short circuit. A calibration graph is then produced using readily available preferred value resistors (in the range 330k to 10M). A typical calibration graph is shown in Fig. 3.

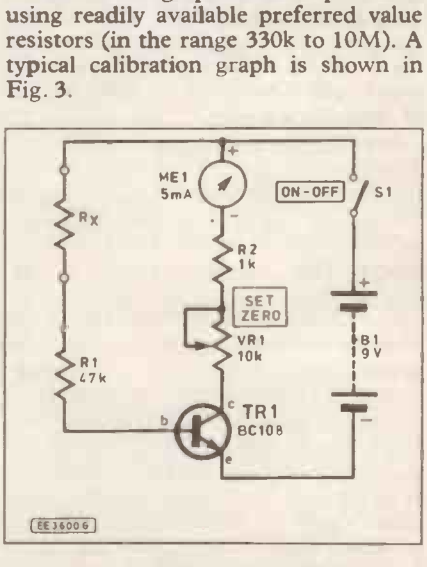


Fig. 2. Circuit of the resistance range extender.

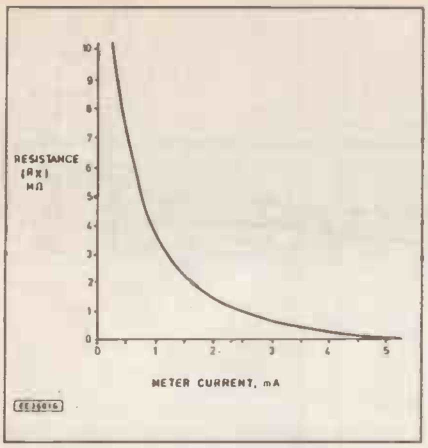


Fig. 3. A typical calibration chart for the circuit of Fig. 2.

With his newly designed circuit, John is able to measure high value resistors with reasonable accuracy and his £15 multimeter is finding a new lease of life. His next project is building a sound-level meter based on his analogue multimeter. I will let you know how he gets on in a future Surgery!

Go/no-go transistor tester

Like most readers, I tend to be partial to the occasional electronic bargain and keep a close watch on the advertisements in *Everyday Electronics*. Recent purchases have included a useful switched-mode power supply, a modem, and a parcel containing approximately 200 mixed silicon transistors.

Unfortunately, this last purchase presented me with a few problems since its contents, although predominantly of the TO-18 variety, were unmarked and of uncertain pedigree (the supplier had merely indicated that most were "good but untested"). The situation was further complicated by the fact that the batch appeared to contain a roughly equal mix of *p.n.p.* and *n.p.n.* types.

I regularly use a large quantity of BC108/BC478 general purpose transistors and thus the reason for acquiring this particular bargain parcel was simply to replenish my rapidly diminishing stocks. What was needed, therefore, was a simple method of sorting them into *n.p.n.* and *p.n.p.* types and rejecting any device which was faulty or of relatively low gain.

Bearing in mind the number of devices which needed testing, I decided to construct a test circuit which would provide me with a simple go/no-go indication (thus avoiding the need to submit each device in turn to my conventional transistor tester).

The go/no-go tester (see Fig. 4) is ideal for anyone who needs to bulk test unknown transistors. It is both simple to use (no adjustments are necessary) and inexpensive to build (a moving coil meter is not required). The state of the device (go/no-go) is indicated by means of an l.e.d. A double-pole switch (miniature toggle or slide variety) is used to select *n.p.n.* or *p.n.p.* If the l.e.d. does not become illuminated on either setting of the switch, the transistor is rejected.

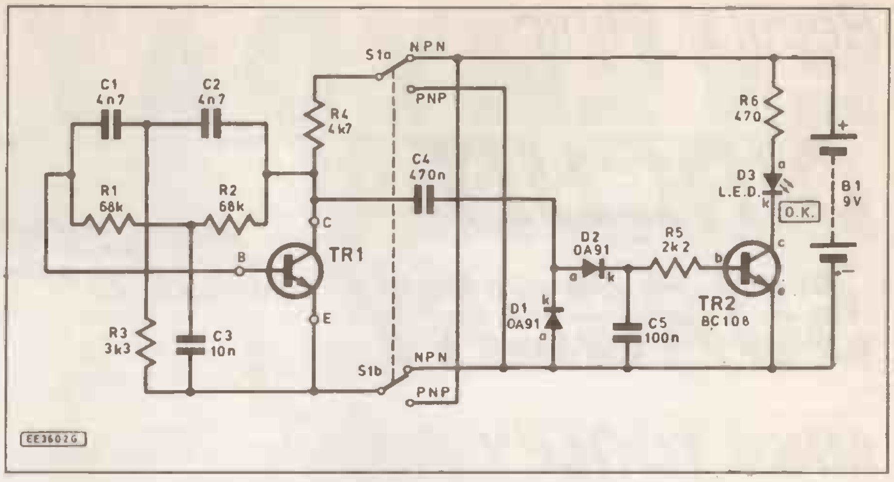


Fig. 4. Circuit of the go/no-go transistor tester.

The transistor on test forms the active device within the twin-T oscillator circuit based on R1, R2, R3, C1, C2 and C3. Provided the transistor (TR1) is functional and provides a modest value of current gain, this circuit will produce a sinusoidal output at about 1.2kHz. The circuit is designed so that it will operate identically with either *n.p.n.* or *p.n.p.* transistors with the supply polarity switched by means of S1.

The output signal produced by the oscillator circuit is rectified (by D1 and D2) and the resulting d.c. output is passed to a single stage transistor current amplifier (TR2) which drives the l.e.d. indicator (D3).

Next month: In next month's Circuit Surgery we shall be taking a look at a novel use for the ubiquitous LM380. We also have details of a circuit modification for the popular *EE Telesound* which can be used to add baby monitoring facilities to your TV. In the meantime, if you have any comments or suggestions for inclusion in Circuit Surgery, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT. Please note that I cannot undertake to reply to individual queries from readers, however I will do my best to answer all questions from readers through the medium of this column.

COMPONENTS

GO/NO-GO TRANSISTOR TESTER

Resistors

R1	68k
R2	68k
R3	3k3
R4	4k7
R5	2k2
R6	470

All resistors are 0.25W 5% carbon film

Capacitors

C1	4n7 ceramic
C2	4n7 ceramic
C3	10n ceramic
C4	470n polyester
C5	100n polyester

Diodes

D1	OA91
D2	OA91
D3	Green l.e.d.

Transistors

TR1	Device under test (*n.p.n* or *p.n.p.*)
TR2	BC108

Miscellaneous

TO5/TO18 transistor socket; battery connector (for 9V PP3 battery); DPDT miniature toggle or slide switch; 0.1inch matrix stripboard (measuring 30mm x 40mm approx); small ABS enclosure.

Approx cost guidance only **£6**

EVERYDAY NEWS

NCC SALARY SURVEY

The effects of the economic recession are clearly evident in this year's National Computing Centre's (NCC) *1992 Annual Salary Survey*. The most significant effects are on labour turnover and shortages, both significantly down on last year's levels and at their lowest levels for over ten years. These are some of the trends highlighted in the survey based on the salary and benefit details of some 14,000 Information Systems (IS) staff in the UK.

Despite the fact that the depression has kept computer staffing and staff shortages at a low level the actual take-home pay of computer professionals increased between 6 per cent and 9 per cent over the previous year. The north-south divide remained significant in salary terms although the divergence was not as high as that observed in 1990 and 1991. The survey showed strong indications that the overall predictions of employment growth prospects by respondents were influenced by the current economic climate, although there were also strong indications that support specialists and networking skills are still in demand.

Salaries

Regional differences between salaries in Greater London and the South East and those in the rest of the UK remain significant, although the divergence is not as high as that observed in 1989 and 1990. Salaries in Greater London were 19 per cent above the sample average and those in the South East were 4 per cent above.

Employment

The NCC Salary Survey monitors labour market trends by asking respondents to indicate, under broad job groups, the numbers of staff in post in the current year and the numbers expected to be employed in two years and five years time. Respondents are also asked to report the numbers of staff joining and leaving the organisation over the previous 12 months and the numbers of any current perceived staff shortage.

The analysis is based on returns from 642 installations which answered the labour market monitor questions in full. Most of the 100+ incomplete responses were from managers who were unable to predict their demand for staff five years ahead.

Growth

Although the overall picture is one of relatively slow growth, there are certain skills where demand is predicted to increase rapidly. The end-user support function, responsible for easing the spread of PCs and end-user computing into the organisation, continues to show high levels of expected growth, with an expected 26 per cent increase over the next two years and a 49 per cent growth over the next five.

The other high growth job category, also concerned with the spread of the IT function into user areas and the increased emphasis on PCs, is the network specialist. They are predicted to grow rapidly from the current small base 25 per cent over the next two years and 46 per cent over the next five.

On Display

Lascar Electronics have introduced an LED backlit version of their most popular meter. The new DPM 700 gives a clear display in all lighting conditions with an extremely low current consumption. Features include Auto-zero, Auto-polarity, Low battery indication, 200mV FSR, 12.7mm digit height and programmable decimal points. On-card pads for essential interconnections make selection of operating modes a quick and convenient operation. Calibration is by a 20-turn potentiometer allowing sensitive adjustment of the instrument.

The DPM 700 costs £32.45. The larger DPM 950 (19mm charcters) is £36.07.

SALE SALE SALE

If you are quick you can catch the Maplin Electronics shop sale – it started on March 4 and lasts a month, with selected items reduced by between 20 per cent and 50 per cent. The half price items include a keypad door alarm, a graphic equaliser and various temperature modules.

New products available now include a Digital Data Link Module (£22.95) using fibre optics, and an eight-way Distribution Socket (£19.95) for those with every gadget and not enough sockets.

By the way, Maplin will soon have opened eight new stores in twelve months and are planning for a further 14 new shops to open over the next two years, two other shops have also recently been relocated. We have heard that Maplin put nearly everything "on the line" when they took massive national press advertising for their security lights but, in a year when crime figures are up, it paid off handsomely.

NEWSLINE

You can now get information on the continually changing stock of one of the major hobbyist electronics suppliers. Greenweld Electronics have installed what they claim to be the first 0891 phone information service for customers.

Greenweld are purchasing increasing amounts of surplus electronic items – some of which are in such small quantities that they are not worth advertising elsewhere. Just by dialling 0891 505 121 you get a weekly update on their stock.

Calls are charged at 36p per minute cheap rate and 48p per minute at other times. They are presently offering a *free* gift to callers who place an order – details are on the line, we can't tell you what the gift is because the line is so new it had not come into operation as we went to press.

Go-anywhere Scopemeter

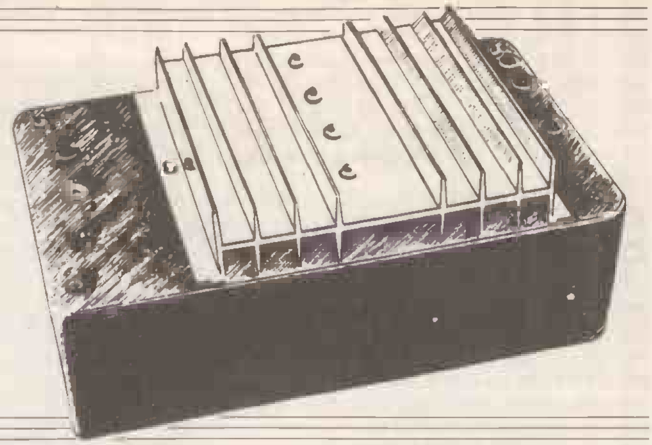
The combining of a top digital multimeter and an easy to operate digital storage oscilloscope has resulted in the Philips Scopemeter and is now available from Alpha Electronics (0942 873434). This new and versatile instrument has many applications, is battery operated and can be taken just about anywhere.

Ease of operation has been given priority in a unit which will capture, display, store and print out hard copy at a later date for detailed examination, measurement, analysis or comparison. Parameters viewed simultaneously on the 84mm x 84mm super twist liquid crystal display, as a waveform or alphanumeric function, include: Noise; Waveform; Distortion; Signal Quality; Pre and Post Trigger; Single Shots; Power Spikes; Autoranging; Touch and Hold; Min/Max Average and Audible Continuity.

The only drawback is the price – £1150!

Constructional Project

VERSATILE AUDIO AMPLIFIER



PAUL HENDERSON

An inexpensive hybrid design that will run from a wide input power supply spread. Output power: 4W into 8ohms; 8W into 4ohms at 9V d.c. supply; rising to 40W into 8ohms and 80W into 4ohms at 35V d.c.

As an avid electronic enthusiast with an interest in audio, it was often felt that a need existed for a spare power amplifier. Most projects have some kind of audio output and they cannot be tested, or enjoyed without further amplification.

Usually, it was found that if a spare amplifier module was available in the workshop that there was no suitable power supply to hand or vice versa. After this situation had occurred for the umpteenth time recently, it was decided to do something about it and this circuit is the result.

When the problem was thought through, it became evident that an amp with the following characteristics was needed:

First and foremost it should be able to use almost any available mains transformer or low voltage d.c. supply (35V max.). Also, it should produce a fairly high Audio output and give acceptable Hi-Fidelity (hi fi) performance.

Finally, a circuit that was reasonably cheap and used easily available components was wanted. Having encapsulated these basic specifications, the search was on for a suitable circuit!

DESIGN

The first thought was to use an i.c. power amp. However, those available did not fit all the criteria. Despite their increased performance they still have some way to go to be truly considered hi fi.

The next thought was to go back to transistors. These are available fairly cheaply, but to design a circuit that will work properly on a range of supply and output loads is difficult.

Weighing up the options, a hybrid approach was chosen using a readily available op. amp. chip driving high power Darlington output devices. This gives the best of all possible worlds.

Using 10A Darlington power transistors gives plenty of poke to the output stage whilst requiring very little drive current. By choosing a suitable low noise op.amp a very high quality power amp can be built for very little expenditure.

The only problem that remained to be solved was that the output power was rather less than planned for. The solution was to use a bridge circuit. This enables an output power of 4W into 8 ohms; 8W into 4 ohms, at 9V d.c. supply; rising to 40W into 8 ohms and 80W into 4 ohms at 35V d.c. To understand how this works look at Fig. 1.

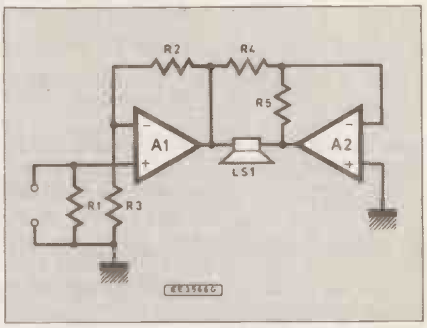


Fig. 1. Schematic circuit diagram for a basic bridge amplifier.

HOW IT WORKS

A basic bridge amplifier circuit, in schematic form, is shown in Fig. 1. Both A1 and A2 can be considered as power op. amps for the purposes of description.

Input signals are coupled into the non-inverting (+) input of A1, resistor R1 sets the input impedance. A1 is wired as a non-inverting amplifier whose gain is set by the ratio of resistor R2 to R3 so that gain = R2/R3 + 1.

On the other hand, A2 is wired as an inverting amplifier. The non-inverting input is grounded and the gain of the circuit = −R5/R4. Note the minus sign. This means that the input is 180 degrees out of phase with the input signal applied to resistor R4.

Now R4 is connected to the output of A1 so that A2's output is out of phase with that from A1. If R4 = R5 the gain of A2 is −1 and the signal across loudspeaker LS1, the load is double that provided by A1 alone.

Since the power supplied to the load is determined by the stature of the applied voltage it follows that the bridge circuit delivers four times the power of A1 alone to the load. As a point of interest this circuit is a direct development from the paraphrase phase splitter circuit used in valve amplifier to drive a push-pull output stage.

COMPONENTS

Resistors

R1, R2, R3, R4, R12, R13	100k (6 off)	
R5, R14	3k9 (2 off)	
R6, R11	3k3 (2 off)	
R7, R8, R9, R10	1 3W (4 off)	

All 0.25W 1% metal film, except where indicated.

See SHOP TALK Page

Potentiometers

VR1, VR2	4k7 horizontal enclosed presets, lin. (2 off)

Capacitors

C1, C3, C4	10µ radial elect., 25V (3 off)
C2	100µ radial elect., 25V
C5	4,700µ radial elect., 40V (see text)

Semiconductors

TR1, TR6	BC109C *npn* silicon transistor (2 off)
TR2, TR4	TIP142 *npn* Darlington power transistor (2 off)
TR3, TR5	TIP 147 *pnp* Darlington power transistor (2 off)
IC1	TL072CN dual low-noise op. amp
Rec. 1	W005 1·5A 50V bridge rectifier

Miscellaneous

SK1	Twin chassis mounting phono socket
SK2-SK5	4mm chassis mounting socket (4 off)

Stripboard 0.1in matrix, size 21 strips x 36 holes; Plastic (2006) or aluminium case, size 190mm x 110mm x 60mm; TO66 power transistor mounting kit (4 off); finned heatsink, size approx. 115mm x 125mm; capacitor mounting clip (35mm dia.) for C5; screened cable; multi-strand connecting wire; fixing nuts, bolts and washers; 10mm rubber grommet (2 off); solder etc.

Approx cost guidance only **£23**

The advantage gained from the bridge circuit are not just confined to extra output power. For the same output the voltage gain can be halved and with it the distortion and noise generated by the circuit. Also if any noise voltage or supply line variations are present these tend to cancel one another out producing a cleaner sound.

CIRCUIT DESCRIPTION

Having described the circuit in general terms, Fig. 2 shows the full circuit diagram for the Versatile Audio Amplifier. Input signals are fed into the non-inverting input, pin 3 of IC1a, via capacitor C1 which isolates the circuit from any d.c. that might also be present.

As a single supply voltage is used a potential divider, formed by resistors R1 and R2, sets a reference half the supply voltage to bias the circuit. Capacitor C2 decouples the bias voltage to ground at a.c. The input impedance is set by resistor R3 at R3's value.

The output stage of the op. amp would normally operate in class AB. This is a potential source of distortion which is avoided by sinking current through transistor TR1, preset VR1 and resistor R6. The net effect is to bias the output stage into class A. Transistor TR1 and VR1 form a V_{be} multiplier.

The voltage drop across TR1 is set by the setting of VR1 and this voltage is required to stabilise the current flowing through the Darlington power transistor output stage. If this were not done the output devices, TR2 and TR3 would be biased off.

DISTORTION

Because the transfer characteristic of a transistor is very non-linear at low levels severe distortion would result. This distortion is termed crossover distortion because it occurs when the signal is going through zero and hence when the output transistors are switching on and off.

This can be cured by turning the transistors slightly on, hence the need for bias voltage and TR1, VR1. Resistors R7 and R8 are also used to help stabilise the output stage against thermal runaway. Unfortunately, when a transistor is heated it's base emitter [V_{be}] voltage falls.

If these resistors were absent TR1 and TR2 would turn on harder as they became hot which in turn would lower V_{be} turning the transistors on harder still. More current would flow and the eventual result would be the destruction of the output stage. R7 and R8 prevent this by current limiting and also provide a little local negative feedback which improves the action of the circuit.

Negative, feedback is applied from the junction of R7 and R8 back to the inverting input, pin 2 IC1a, via resistor R4. The voltage gain is determined by the ratio of R4 to R5.

Capacitor C3 is connected in the circuit to perform two functions. First it has an infinite resistance at d.c. so reducing the gain of the amplifier to unity at d.c. At the same time it looks like a short circuit to a.c. signals thus coupling resistors R5 and R4 together. This component ensures that the output d.c. level is within a few millivolts of the bias voltage generated across resistor R2.

Looking at the circuit built around IC1b you will see that it is essentially identical to that just described. The main difference is that the non-inverting input (pin 5) is connected directly to the junction of resistors R1, R2 and capacitor C2. Effectively this input is "earthed".

The same feedback arrangement is used except for the addition of resistor R13 which is coupled to the inverting input (pin 6) by capacitor C4. Resistor R13 has the same value as R12 giving the amplifier built around IC1b a gain of −1. As this is fed directly from the output of the amp built around IC1a the conditions for bridge operation are established.

POWER SUPPLY

Lastly the power supply needs to be discussed. This circuit is intended to be used with any available transformer with a secondary voltage between 6V and 24V. For this reason the circuit Fig. 1 shows the bridge rectifier, Rec.1, and the main smoothing component, electrolytic capacitor C5.

There is some latitude in the choice of value for smoothing capacitor C5. Normally a 4700µF cap, with a 40V rating, is used, but this may be reduced to 2200µF

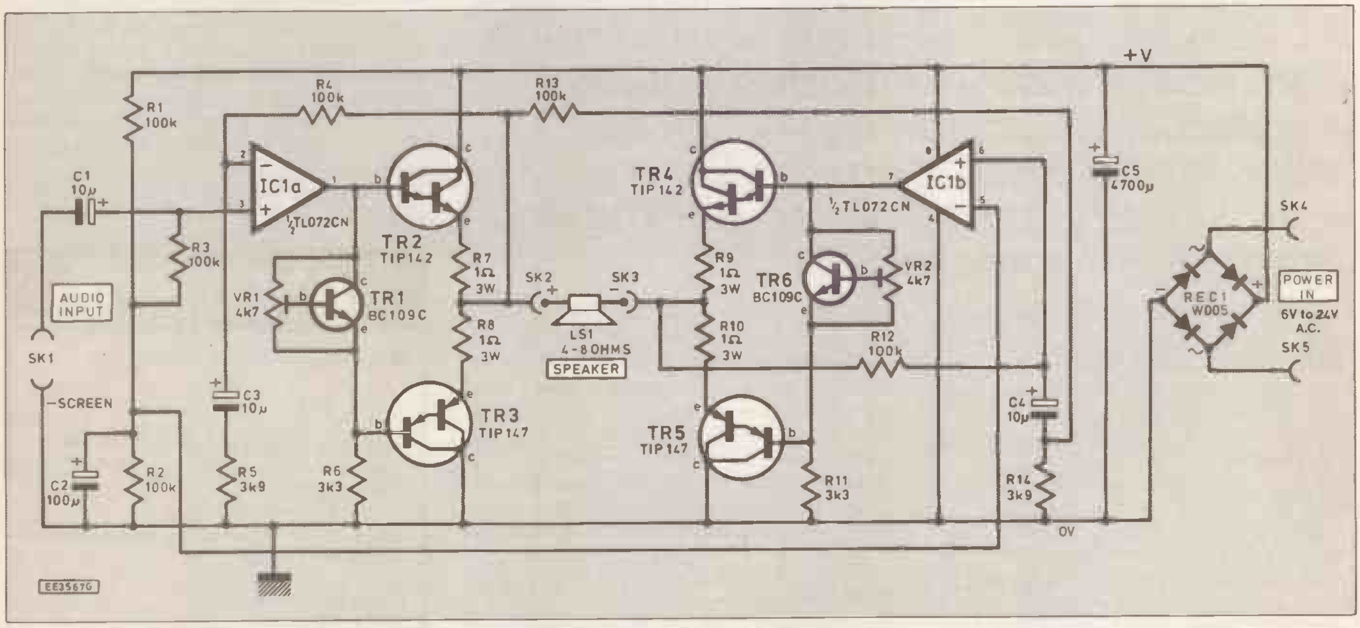
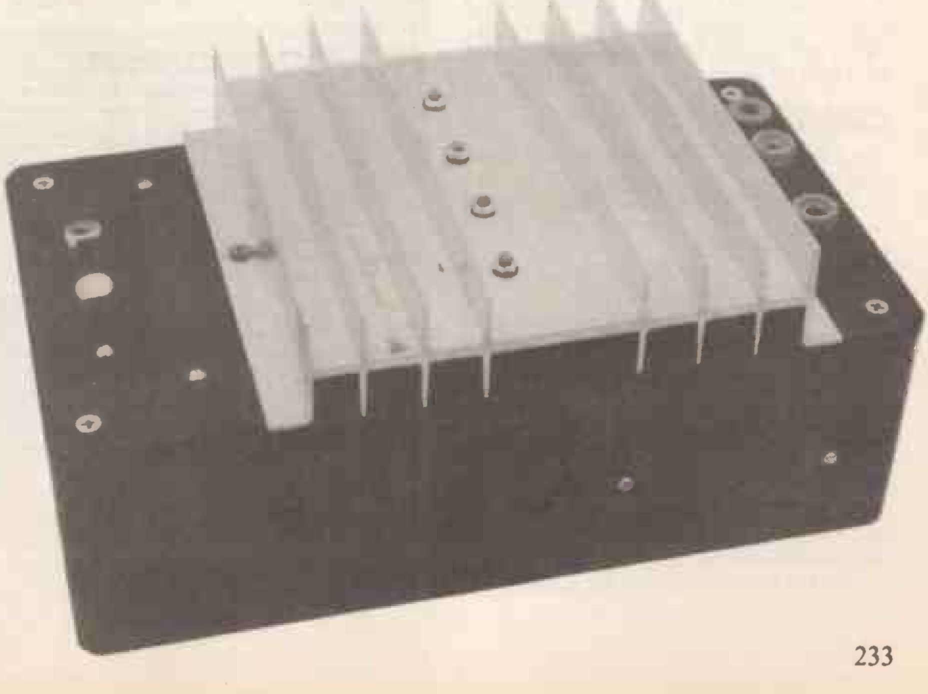


Fig. 2. Complete circuit diagram for the Versatile Audio Amplifier. The d.c. supply output (9V-35V) from the bridge rectifier (Rec.1) will, of course, be higher than the input supply (6V-24V) at SK4/SK5.



without significant deterioration in circuit performance. Similarly the rating can be anything from 35V upward.

The action of the power supply is very conventional. After the mains voltage has been stepped down by whatever transformer is employed the secondary voltage is full wave rectified by Rec. 1. The resulting raw d.c. is then smoothed by C5 before being applied to the circuit.

An advantage of using the bridge rectifier, Rec. 1, is that a d.c. power supply can also be applied to the input and one doesn't have to worry about the polarity of the connection. In this event the voltage applied must not exceed 35V or IC1 will be destroyed. This opens the way for auto applications as a car battery makes a nice power supply.

CONSTRUCTION

The amplifier is constructed on a piece of 0.1in matrix stripboard, size 21 strips by 36 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 3.

The construction of this project consists mainly of wiring up the stripboard, the wiring requiring little further comment. An i.c. socket can be used for IC1 but is not essential. What does need attention is to ensure that all the electrolytics are inserted the correct way round.

Once the board has been completed turn it over and ensure that you have no unwanted solder blobs between tracks. Next ensure that the breaks in the tracks are in the right places and that the track has been cut completely at these points.

If you are happy that all is well, the next task is to adjust presets VR1 and VR2. If this is done now there is no chance of excessive bias being inadvertently applied to the output transistors. Using a small screwdriver turn the presets so that you have short circuits between TR1 base (b) and collector (c) and TR6 base and collector respectively. Check this with a multimeter, set to ohms range.

Before turning your attention to the output stage it is as well to connect flying leads to the board. These should be left at least 230mm long to facilitate easy connection. Note that the *input* lead needs to be *screened* otherwise you will probably have to put up with unnecessary hum.

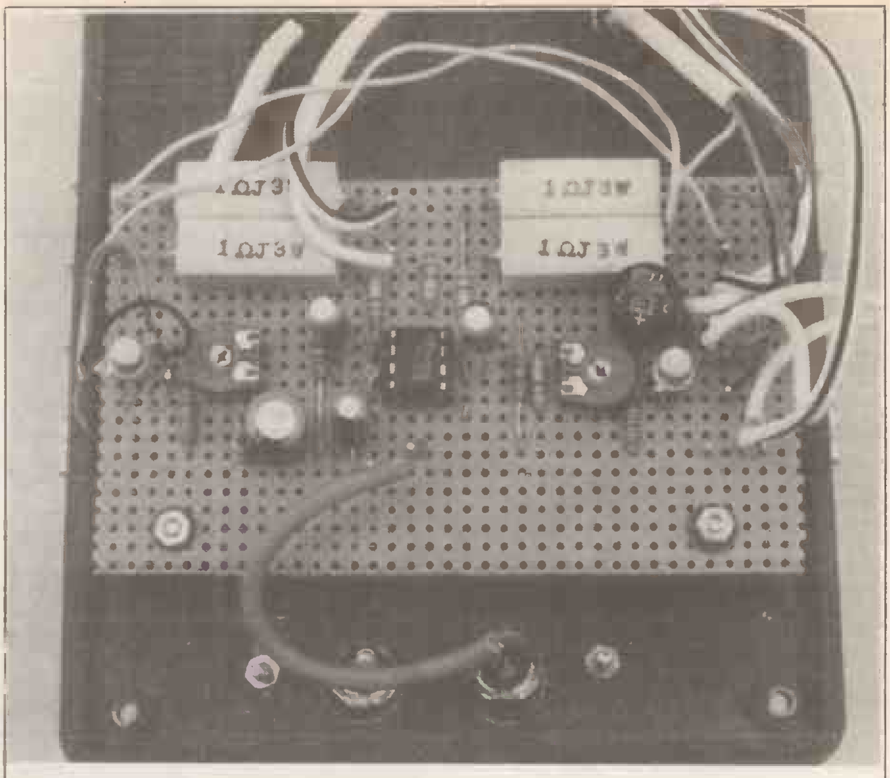
OUTPUT

Now you can turn your attention to the output stage. The model used TIP142/147 power Darlingtons here. But the cheaper TIP141/146 transistors, lower voltage versions of the above, work just as well. In any event the specified transistors come in a plastic flatpack. These need to be mounted on a heatsink with the usual TO66 insulating kits.

A 152mm (6") by 102mm (4") finned heatsink is used in the prototype, but a piece of 38mm x 12mm x 3mm thick aluminium channel, 203mm long has been successfully used. So if you have something similar already it will probably be suitable. Remember to deburr the mounting holes otherwise you run the risk of puncturing the insulating washer, shorting the transistor case to the heatsink.

The new Teflon washers were used in the prototypes. These cost only a few more pence than the traditional mica washers and have the advantage of lower thermal resistance. No more messing around with conductive grease!

Having mounted the output stage power



The completed circuit board is mounted on spacers on the lid of the case. The two "grommetted" holes at the top of the photograph take the leads to the power Darlington transistors located on the underside of the heatsink.

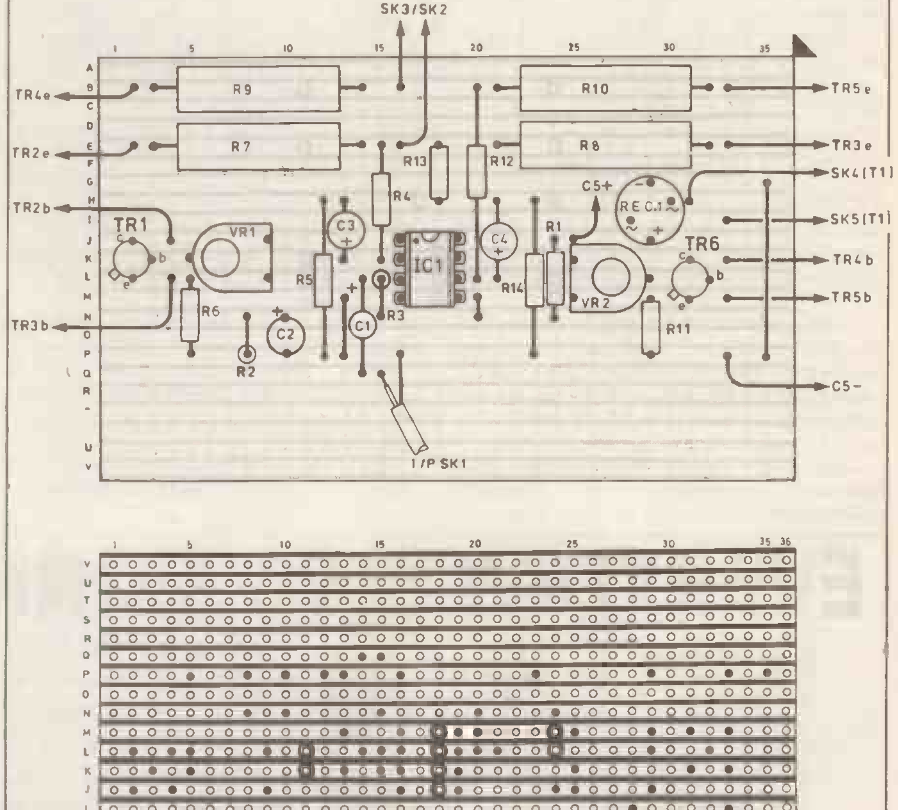


Fig. 3. Stripboard component layout and details of breaks required in the underside copper tracks.

transistors on the heatsink, the next task is to connect them to the board with the flying leads. In the prototype the finned heatsink is mounted on the lid of the case, having drilled a couple of 10mm diameter holes beforehand for the connecting leads. A pair of 10mm grommets are used to ensure that the leads do not get frayed.

The flying leads from the board are fed through the grommets and soldered to the power transistor leads, see Fig. 4. Then the heatsink is bolted to the lid.

The stripboard panel itself is fitted to the base of the box supported on spacers to ensure that the board cannot short out to the case. Similarly capacitor C5 is mounted by a suitable cap. clip inside the case. The input phono and input/output sockets are also mounted on the case lid.

At this stage give your project a thorough check to ensure that all the connections are correct and soundly made.

SETTING IT UP

To set the project up you need a multimeter, two 100 ohm 0.25W resistors and a suitable transformer. First temporarily connect one of the resistors between TR2 collector and the positive supply line on the circuit panel. Similarly connect the other resistor between TR4 collector and the positive supply line.

Plug the transformer secondary into the power supply sockets, SK4 and SK5, DO NOT connect the loudspeaker at this point. Switch on. If the "test" resistors get hot you have a fault somewhere. Disconnect the power and rectify it.

Assuming all is well nothing should happen. First check the voltage across the output terminals. This should be less than 50mV. Again if not switch off and rectify.

Next connect the multimeter, switched to a range that will give you a clear indication of 1V across the 100 ohm resistor in TR2's collector. Slowly adjust VR1 for an indication of 1V. Repeat the procedure for the other resistor, adjusting VR2 for a 1V drop. About 100mV either way is of no consequence.

Having adjusted the quiescent current in this way connect the loudspeaker LS1 to the output sockets SK2 and SK3. Now touching the input socket "hot" connector will produce a buzz from the speaker. All that remains is to remove the two "test" resistors and reconnect TR2 and TR4 collectors to the positive line and the amplifier is functional. □

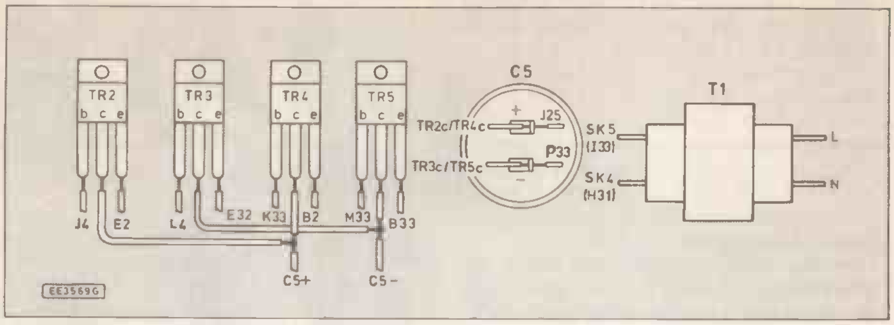
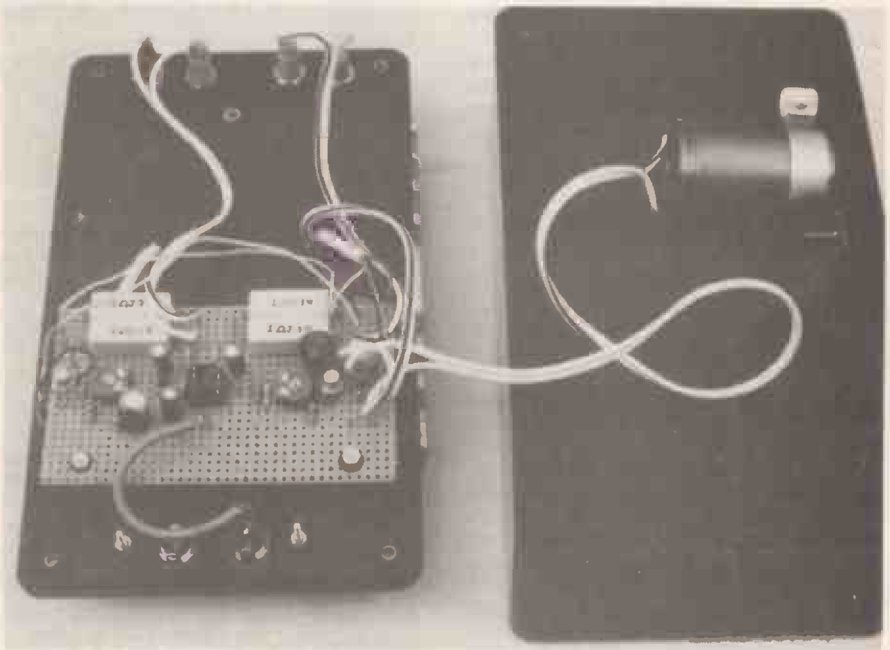


Fig. 4. Wiring from the power Darlingtons and smoothing capacitor C5 to the circuit board. The power transistors are mounted on the underside of the heatsink using insulating kits. If using a metal case it MUST be earthed using a solder tag or socket bolted to a metal surface.



The completed amplifier showing the circuit board mounted towards one end of the lid and the main smoothing capacitor C5 clamped on a side panel to clear the board when the lid is closed.

SHOP TALK

with David Barrington

Audio Telescope

Having looked through our library of components catalogues, to check on availability of the electret microphone insert for the *Audio Telescope*, we found that most of them listed electret inserts. However, they do not indicate if they are the required "undirectional" type and readers should check with their supplier before purchasing. The unidirectional insert used in the model is the type UE16 purchased from **Maplin**, code QY63T.

When ordering the rotary volume control be sure to specify a "*log*" type. Also, although other op. amps can be used in this circuit, for best results the specified ultra low noise NE55334A op. amp should be adhered to. This device should be readily available and is currently listed by **Cricklewood, Greenweld, Maplin** and **Omni Electronics.**

The 3.5mm stereo jack socket used in the prototype unit is the p.c. mounting type with a front panel mounting bezel. This socket was also bought from Maplin, code FK20W.

Telephone Ringer

Having studied the components list for the *Telephone Ringer* project, some of the components required further comment. Most of the components appear to be readily available and should not cause too many sourcing problems. But first a warning on safety.

For personal safety, all exposed mains connections should be covered with insulating sleeving to prevent accidental contact. Some live test have to be made with the case lid removed, exposing the wiring, and it is very dangerous to work in close proximity to bare, high voltage connections. This makes it doubly important that a good Earth connection is made to the metal case.

Note that resistor R6 is used as a protection limiting device in case of a short on the telephone line. In view of this, it is most important that the recommended 10W wirewound type is used. Wirewound 10watt resistors are stocked by most of our component advertisers.

The toroidal mains transformer used in the prototype model is rated at 30VA and has a label indicating that it was made by "Airlink Transformers". Toroids are now carried by quite a number of suppliers as stock items, and **Jaytee Electronic Services** (☎ *0227 375254*) who specialise in toroid transformers should be able to meet the specification from their vast stocks.

The relay used in the model is a "Iskra TRM 3003" type, rated at 12V 200 ohm coil, with 6A 250V a.c. contacts. This was obtained from **Maplin** and they list it as a 5A mains relay, code YX98G. Other relays may be used but they may not fit directly on the printed circuit board.

Since the privatisation of the telephone networks, advertisers are stocking quite a range of Telecom accessories and the master socket and leads should be available as "off-the-shelf" items.

The printed circuit board for the Telephone Ringer is obtainable from the *EE PCB Service*, code EE790 (see page 252).

Easy Switch

The most important points that must be taken into account when building up the *Easy Switch* project is to use only the specified mains type wires where indicated and only use a relay with correctly rated *mains* coil (7300 ohms) and high power contacts. It must be emphasised that due to the presence of mains voltages extreme care must be exercised when building and testing this project. It is NOT a substitute for a "power breaker" type mains trip.

The relay purchased was the "open construction" power relay, with double-pole contacts rated at 7.5A and a 250V a.c. coil, from Maplin, code FX49D. Other relays can be used but they must have similar ratings or even higher, depending on application.

The MOC3020 or similar optically-isolated triac should not prove difficult to locate. The MOC3020 contains a l.e.d., rated at 50mA max, and a triac capable of low current a.c. switching, rated at 400V 100mA. Most good components suppliers should be able to offer this device or suggest a suitable equivalent.

Sonic Continuity Checker

We cannot foresee any component buying problems for anyone constructing the *Sonic Continuity Checker*. The phase locked loop i.c. and piezoelectric transducer element (with leads) seem to be widely stocked.

Having just said that all components are standard items, the case appears to be a bit of a mystery and cannot be found listed anywhere. However, as the circuit is built on such a small printed circuit board, it should be possible to build the unit in one of the numerous handheld cases, some with a special battery compartment, stocked by most advertisers.

The small printed circuit board for the tester is available from the *EE PCB Service*, code EE789 (see page 252).

Versatile Audio Amplifier

We do not expect constructors undertaking the *Versatile Audio Amplifier* to experience any component purchasing difficulties. All items are readily available "off-the-shelf".

PLEASE TAKE NOTE

Programmable Timer *(February 1992)*

We apologies for omitting the formulae for calculating frequency from this article, this is:

$$f = \frac{1}{R2 \times C3}$$

The frequencies quoted in the article are the actual frequencies measured on the prototype and therefore vary with component tolerances.

Readers should note that switch S9 should not be operated when the unit is in the "dual delay" mode.

Economy Seven Timer *(March 1992)*

In view of the possible varying loads put on the specified relay, it might be advantageous to upgrade the relay to Maplin's more robust 12V 16A (contacts: 20A a.c. make, inductive; and 10A a.c. break, inductive) version, code YX99H. It does, of course, mean that the relay will not sit directly on the p.c.b. and it will have to be sited to one side and "hardwired" from the contacts to the relevant pads on the board. It is most important that wire capable of handling the high currents be used for this operation.

It is also necessary to bolster up the power (mains) carrying copper tracks by soldering lengths of 13A tinned wires along their lengths.

REPORTING AMATEUR RADIO

Tony Smith G4FAI

A FEW ANTENNAS!

Dxpeditions usually comprise a group of radio amateurs who take their equipment to some part of the world not noted for regular amateur radio activity. To be successful, they must be well organised but inevitably there is some limitation on what they can take with them due to transportation difficulties.

One would have expected such restrictions to apply to a Finnish Dxpedition to the island of Curacao, in the Netherlands Antilles, set up to participate in the 1990 CQ World-wide contest. RadioTeam Finland, as it became known, comprised 100 operators and mounted what has become accepted as the largest ever Dx or contest operation in the history of amateur radio. This annual contest is organised by *CQ* magazine (USA), which reported the logistics of the Finnish operation in its November 1991 issue.

Over ten tons of aluminium towers and beam antennas were shipped from Finland to Curacao, including 18 crank-up towers, some as high as 180ft, and 25 monoband beams of varying complexity, the total representing 508 metres of aluminium tubing. There were also wire antennas of various types, strung up on the towers which were raised by an 18-ton crane.

WINNING TEAM

To feed these antennas 10,300ft of coaxial cable was used. The antennas were rotatable so 4,500ft of rotator control cable was required, and to keep everything standing 8,600ft of guy wires and 11,300ft of nylon rope was used. Another essential item was 3,000ft of mains cable.

For the actual radio operation, 15 new Yaesu FT-1000 digital transceivers were used, complete with all accessories including logging computers, which were installed in two air-conditioned portable buildings. With all this effort and organisation it is not surprising that RadioTeam Finland, operating as PJ9A/PJ9W, won the contest with a score of 52.2 million points!

MORE COMPUTERS USED

After noting the use of logging computers by RadioTeam Finland I was interested to see a comment in *FOCUS*, journal of the First Class CW Operators' Club, recently that in the 1991 ARRL Dx Contest over 50 per cent of entrants used computerised logging and of these about half sent in disc entries. Among the big scorers the percentage rose to 90 with nearly all sending in discs.

It makes a lot of sense. Preparing entry logs after contests has always been a time-consuming task, including a lot of tedious writing, and now programs exist to do all the hard work. Point losing duplicate contacts are automatically deleted, and the contest entry is scored and ready for mailing just minutes after the contest.

INTERNATIONAL LISTENERS' ASSOCIATION

Judging from the number of publications available on the subject, shortwave listening continues to be a popular activity, providing much pleasure in its own right and serving as a useful introduction to the possibility of taking up amateur radio.

Several organisations exist to serve the interests of SWLs, one of which is the International Listeners' Association, founded in 1985 by Trevor Morgan, GW40XB, together with a group of dedicated readers of his SWL column from the now defunct *Amateur Radio* magazine.

ILA has members in many countries and offers awards for achievements in shortwave listening, contests for the competitive minded and a quarterly newsletter, *Just Listening*. The Association offers a number of listeners' "sundries" to members, including log books, QSL cards, Spectrum computer programs, club insignia, lists of prefixes, oblasts, countries, etc, and a useful book "Get the best from your ICF2001D".

The December 1991 28-page newsletter has information and articles on a year-long listeners' contest organised by UBA, the Belgian national radio society; v.h.f. dipole aerials; the Soviet amateur scene; Jamboree-on-the-Air 1991; Valentia Radio; a review of the Easyreader DM1000 data decoder which decodes RTTY and Morse signals when connected to the audio output of a receiver; a medium wave column; an airband column, including details of an airband pre-amplifier; radio scouting; the broadcast scene; and more.

Annual membership of ILA costs £5 (UK), and full details can be obtained from The International Listeners' Association, 1 Jersey Street, Hafod, Swansea, SA1 2HF.

NEW ISWL PUBLICATIONS

The International Short Wave League, previously mentioned in this column, has produced two new publications of interest to SWLs. *A guide to English shortwave broadcasts to Europe (winter schedules 1991/1992)* lists the English language broadcasts likely to be heard in Europe in time order, over 24 hours, indicating country, station name, frequency and type of programme.

It also gives details, on a day-by-day basis, of the many programmes aimed at SWLs and Dxers which can be heard throughout the week. This very useful booklet (23 pages of A4), which is now an essential accessory to my world band radio, costs just £1.00 or two IRCs.

The second publication, *Standard Frequency and Time Signal Stations of the World* (25 pages of A4), includes explanations of the various time and transmission systems used by such stations. It lists them in frequency order from 16 to 22536kHz and from 95.00 to 171.13MHz; it also lists them by callsign in alphabetical order, including location and frequencies; and by country, in alphabetical order, with frequencies, transmission times, addresses, system used and QSL card policies.

This booklet would be of value in either a listener's or transmitter's shack to assist in identifying which signal paths on particular frequencies are open at any given time, and to help with calibration of station equipment. Its cost is £1.75 or three IRCs, and both publications can be obtained from International Short Wave League, 10 Clyde Crescent, Wharton, Winsford, Cheshire CW7 3LA.

THE END IS NIGH

My apologies to Bruce Morris GW4XXF, and to those readers who wrote to him about his cassette, *500kHz. The End is Nigh,* which I mentioned in the February column. Since I received my own copy, Bruce has produced a second edition of his unique collection of recordings of historic last transmissions from coast stations and ships on the wireless telegraphy distress and calling frequency, and the price is now £7.50, not £5.00 as I stated.

The process of closure continues and no less than five Australian coast stations were due to close down at the end of January. Bruce was trying to ensure that they went down in "a blaze of glory", fully recorded, with the results sent to him. It will be all over by the time this appears in print of course, and no doubt he will then be turning his attention to recording further planned closures. For those interested, Bruce's address is 62 Gerllan, Tywyn, Gwynedd, LL36 9DE.

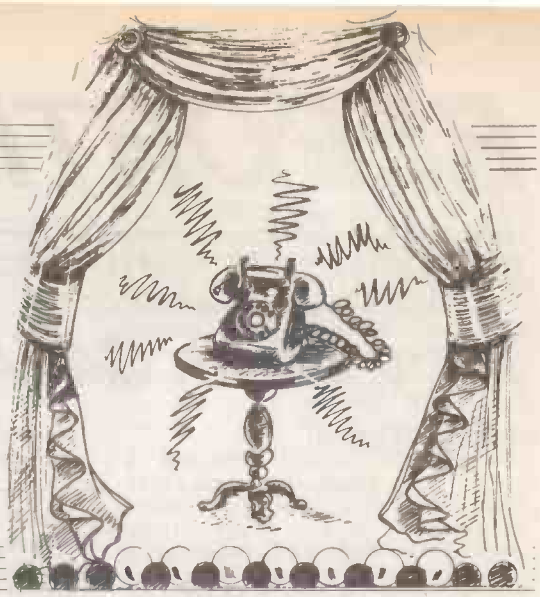
USSR AWARD

Gennadiy Shul'gin, UZ3AU, senior editor at the Moscow based *Radio* magazine, was recently awarded the Order "For Personal Courage" for his work at Chernobyl in 1986. He went immediately to the scene (as did about 50 other radio amateurs) to provide emergency communications and stayed more than six months. He was exposed to eight times the permissible dosage of radiation but survived probably because of his excellent physical condition.

Reporting the award, the magazine *Sovetskiy Patriot* commented "Amateur radio is not a hobby but a state of mind. It unites people into a peculiar kind of fraternity almost like an order of knights. A piece of news spreads to practically all of the world's radio amateurs in a single day. It is impossible to overestimate the value of such a real-time system of communication."

Constructional Project

TELEPHONE RINGER



CHRIS WALKER

Put your actors at ease with this authentic sounding telephone "prop" for amateur or professional productions.
Even Beattie would be proud of it!

IN THE exciting world of amateur dramatics (or even professional dramatics), it is often necessary to make a telephone ring on the stage during a production. The actor then answers the telephone and pretends to hold a conversation with a non-existent person at the other end! The audience are, of course, convinced that there is a two-way dialogue taking place; or rather they should be convinced, it all depends upon the skill of the performer.

Having been involved with various productions staged at schools and at the local theatre, the question that the author is often asked is: *"How do you make a telephone ring?"*

The answer is quite simple, you require an a.c. voltage source of about 70 volts r.m.s. This is an awkward voltage to obtain and theatre companies often resort to using an ordinary low voltage bell to simulate the telephone ring.

This has several drawbacks not least of which is that nothing quite sounds like a real telephone bell! Also, unless the bell is placed near to the telephone, it is pretty obvious to the audience that the phone is not really ringing.

In a modern play it may be more appropriate to use a "warbling" ringer rather than a bell, and this creates yet more problems when trying to simulate the sound. A taped recording is not a very satisfactory substitute.

Away from the theatre, in the home there could be occasions where it would be useful to be able to ring a phone; perhaps for paging purposes, for testing after repair or just for fun since this unit will "breathe life" into an old telephone which has been handed down for the children to play with.

Perhaps it should be stated here that the *Telephone Ringer* is ***NOT*** at all designed to be connected to the Public Switched Telephone Network (the telephone line from the exchange). To make such a connection would be illegal and could damage exchange equipment, under no circumstances should anyone do this.

CADENCE

In the past the designer has obtained the 70V a.c. from a combination of a mains step-down transformer followed by a step-up transformer. This rings the bell or warbler satisfactorily but it relies on a human operator to switch the power on and off to create the familiar burr-burr

COMPONENTS

See SHOP TALK Page

Resistors

R1	470k
R2	1M2
R3	10k
R4	680
R5	3k3 1W carbon
R6	470 10W wirewound

All 0.6W metal film unless otherwise stated.

Capacitors

C1	22µ radial elect. 25V
C2	0µ1 polyester layer
C3	470µ radial elect. 63V

Semiconductors

D1-D5	1N4148 silicon (5 off)
D6	5mm l.e.d. (any colour)
D7	BZY88C13V 13V Zener
D8	1N4001 1A 50V rect. diode
TR1	BC548 *npn* silicon
TR2	BD135 *npn* silicon
IC1	NE555 timer/astable
IC2	4029BE up/down counter
IC3	4028BE BCD to Dec. decoder

Miscellaneous

T1	Toroidal transformer 30VA rating (or greater) 240V primary, 30V-30V secondaries
RLA	Relay: coil 12V 200 ohms, contacts 240V 5A
S1, S2	Momentary action pushbutton, or single pole biased toggle switch (2 off)
LP1	240V indicator neon, with limit resistor
FS1	20mm 1A fuse with panel mounting holder

Master Telephone Socket; printed circuit board available from *EE PCB Service*, code EE790; aluminium case, size 150mm x 150mm x 75mm; d.i.l. sockets: 8-pin, 16-pin (2 off); strain relief grommet; 3-core mains cable; mounting kit for TR2 (TO126 case); solder tag; terminal pins; flexible interconnecting wire; sleeving; nuts and bolts for fixings.

Approx cost guidance only **£35**

... burr-burr ... burr-burr cadence (or rhythm) of the British ringing phone.

Most people, when asked to simulate a ringing telephone, will ring too quickly or leave a shortened gap between pairs of rings. Worse still they are inconsistent, generating some long bursts and some short ones.

The Telephone Ringer described here is a single unit which supplies the necessary voltage and cadence to ring a phone. In addition to a cadenced ring, the phone may be sounded continuously as long as a switch is held pressed so that different rhythms or special effects can be created.

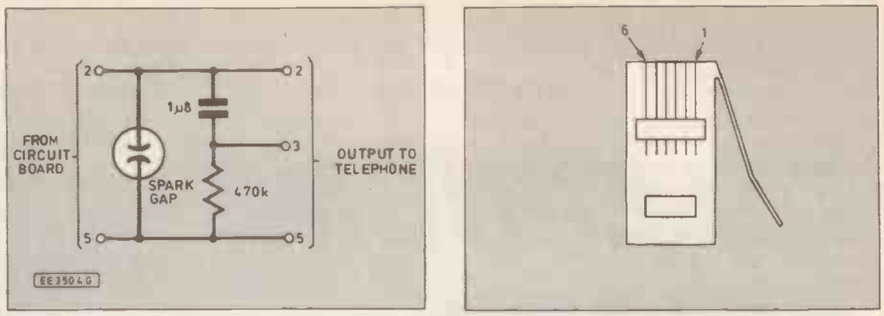


Fig. 2. Circuit diagram for a "Master Telephone Socket" and pin assignment of the telephone plug connector. Connections 1, 4 and 6 are not normally used.

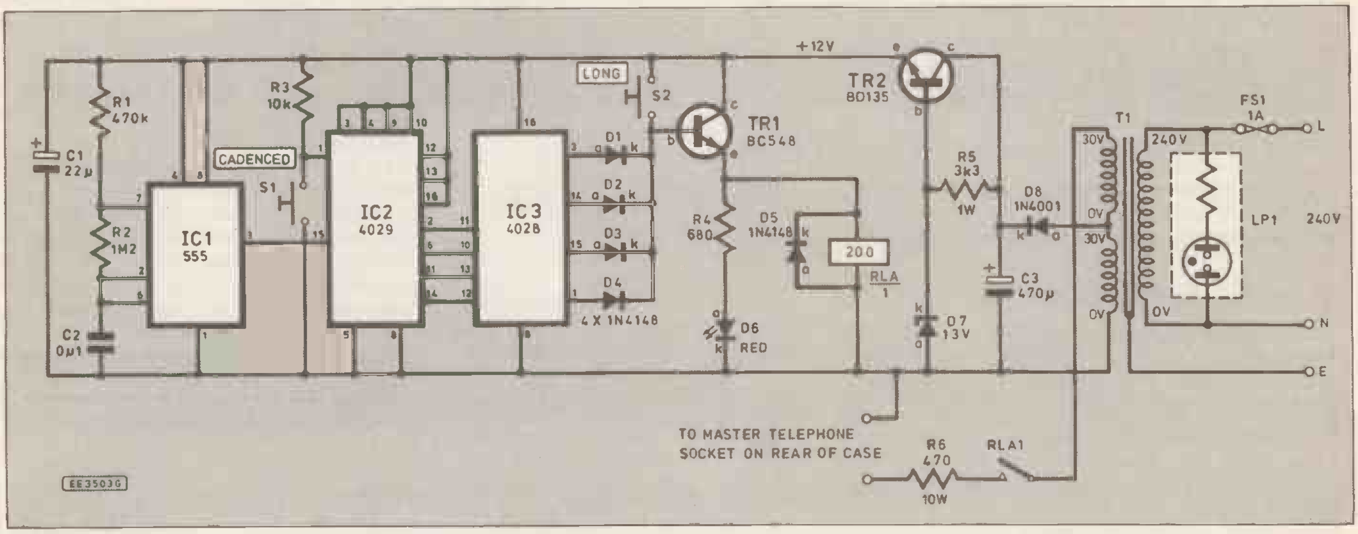


Fig. 1. Complete circuit diagram for the Telephone Ringer.

The American phone system, for example, has a different ringing cadence to the British system.

Ringing will cease as soon as the handset is picked up because the telephone "hookswitch" interrupts power to the bell. This prevents the rather embarrassing situation where the phone continues to ring after the actor has answered the call!

RINGING VOLTAGE

The telephone exchange rings the phone in your home by sending a large a.c. voltage along the line, typically 75V r.m.s. at a frequency of about 25Hz. In actual fact the voltage at your receiver could vary between about 50V to 100V depending on the exchange and the line length. The frequency could also vary between 14Hz and 66Hz.

This project obtains its ringing voltage from a mains transformer with a 60V r.m.s. secondary winding (two 30V windings in series). Since the transformer has a quoted regulation of 18 per cent the actual off-load ringing voltage obtained is about 73V r.m.s. The frequency is (obviously) that of the mains, 50Hz, which is above the usual ringing frequency but still within usable limits.

Using a higher ringing frequency is of no consequence if an electronic warbling phone is used since the first thing these machines do is to rectify and smooth the ringing voltage to obtain a d.c. power source for the ringer circuit. In an electromechanical bell the a.c. current is actually used to move the bell hammer, and so a higher frequency results in a more "urgent" ringing sound, if you can imagine this.

CIRCUIT DESCRIPTION

Most of the components in the Telephone Ringer are involved with generating the UK ringing cadence. The complete circuit diagram of the unit is given in Fig. 1.

The 555 timer IC1 and its surrounding components form an astable multivibrator, creating a square wave of 5Hz frequency at pin 3. IC2 is configured as a 4-bit binary counter which is clocked by the square wave signal from IC1.

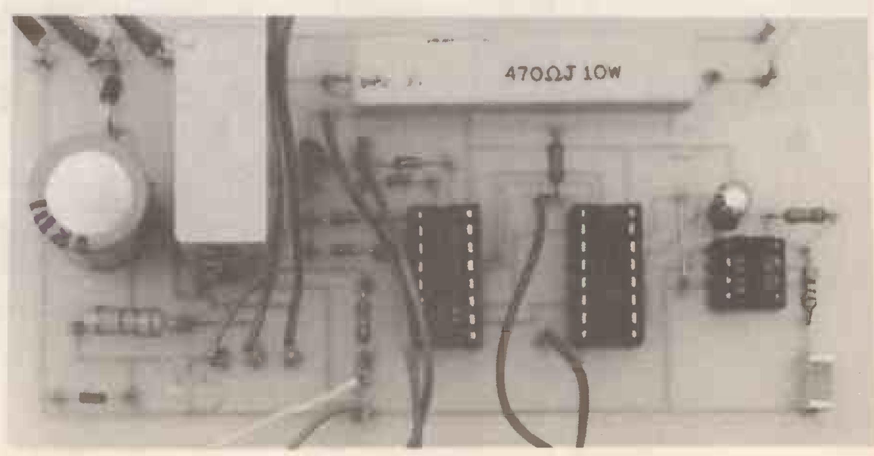
With switch S1 open, pin 1 of IC2 is held high (+12V) by resistor R3 and the counter is reset so that all its outputs are high, i.e. the counter is reset to 15. When S1 is closed, the next rising edge at pin 15 IC2 causes the counter to increment to zero and then proceed to count upwards through all sixteen possible states.

The binary output from IC2 (pins 2, 6, 11 and 14) is decoded by IC3 into ten decimal outputs. Therefore, counts 0 to 9 from IC2 will cause one of ten outputs from IC3 to go high.

Outputs 0, 1, 3 and 4 (IC3 pins 3, 14, 15 and 1 respectively) are OR-ed through diodes D1 to D4 so that a high output from the decoder feeds current into the base of transistor TR1, switching it on and energising the coil of relay RLA and also illuminating light emitting diode D6.

As the relay contacts (RLA1) close, 73V

Completed circuit board and "telephone socket" mounted on rear of the case.



a.c. (off-load voltage) from the two secondary windings of transformer T1 is applied to the "Master Telephone Socket" (described later) into which the telephone is plugged. Older phones which don't have a plug connector can be wired directly to terminal posts which would be mounted on the rear of the "Telephone Ringer" case.

Resistor R6 is a protection resistor which limits the a.c. current to a maximum of 150mA in the case of a short circuit on the telephone "line". Note that R6 is a *10W wirewound* device.

The relay will be energised only when IC3 decoder outputs 0, 1, 3 or 4 are high. The counter strobes through the outputs at a rate of 5Hz, so each one remains high for 0.2 seconds. Therefore, the relay is switched on for 0.4s (counts 0 and 1), off for 0.2s (count 2), on again for 0.4s (counts 3 and 4) and, finally, off for 2.2s while the counter counts from 5 to 15. The continuous cycling of the counter results in the burr-burr . . . burr-burr . . . ringing cadence.

Pressing switch S2 allows current to flow continuously into the base of TR1 which will, consequently, ring the telephone continuously.

POWER SUPPLY

One secondary winding of T1 is used to supply 30V a.c. power to the circuit. Diode D8 rectifies the a.c. and capacitor C3 smooths out the ripple.

A steady potential difference (p.d.) of 13V is developed across Zener diode D7. This p.d. is buffered by transistor TR2 to result in about 12.4V at the emitter of this transistor which is used to feed the rest of the circuit.

Transistor TR2 will become rather warm during operation. If a metal case is used the transistor can be bolted to the chassis, otherwise some form of heatsink will be required.

The 240V mains side of the transformer is protected by fuse FS1, whilst neon lamp LP1 provides power indication. This neon indicator MUST be fitted with an internal current-limiting resistor for use at 240V.

MASTER TELEPHONE SOCKET

The pin assignment of a modern telephone plug is shown in Fig. 2 along with the circuit diagram of a "Master Socket"; the kind of socket which terminates the telephone line in your house. Pins 1 and 6 on the plug are often omitted.

The capacitor inside this socket is there to remove the d.c. line voltage but allow the a.c. ringing voltage to reach the ringer circuit in the phone. Most modern phones require the ringing voltage to be applied between pin 3 and pin 5 on the plug.

The author has, however, encountered phones which will only ring when the ringing voltage is applied directly across the line terminals, pins 2 and 5. Of course, there is no d.c. line voltage generated by the "Telephone Ringer" unit, but by using a Master Socket complete with capacitor the output connection should be compatible with all telephones.

As mentioned previously, screw-down terminal posts may be used if desired, **but extreme care should be exercised when using exposed connections because the 70V r.m.s. output is capable of giving a mild electric shock.**

CASE

The main circuit is constructed on a printed circuit board, component layout and copper foil master are shown in Fig. 3. This board is available from the *EE PCB Service*, code EE790.

Solder all of the components onto the printed circuit-board (p.c.b.). Use d.i.l. sockets for the integrated circuits but do not insert the i.c's just yet. The electrolytic capacitors, the diodes and transistor TR1 all have to be placed the correct way around; study the component layout care-

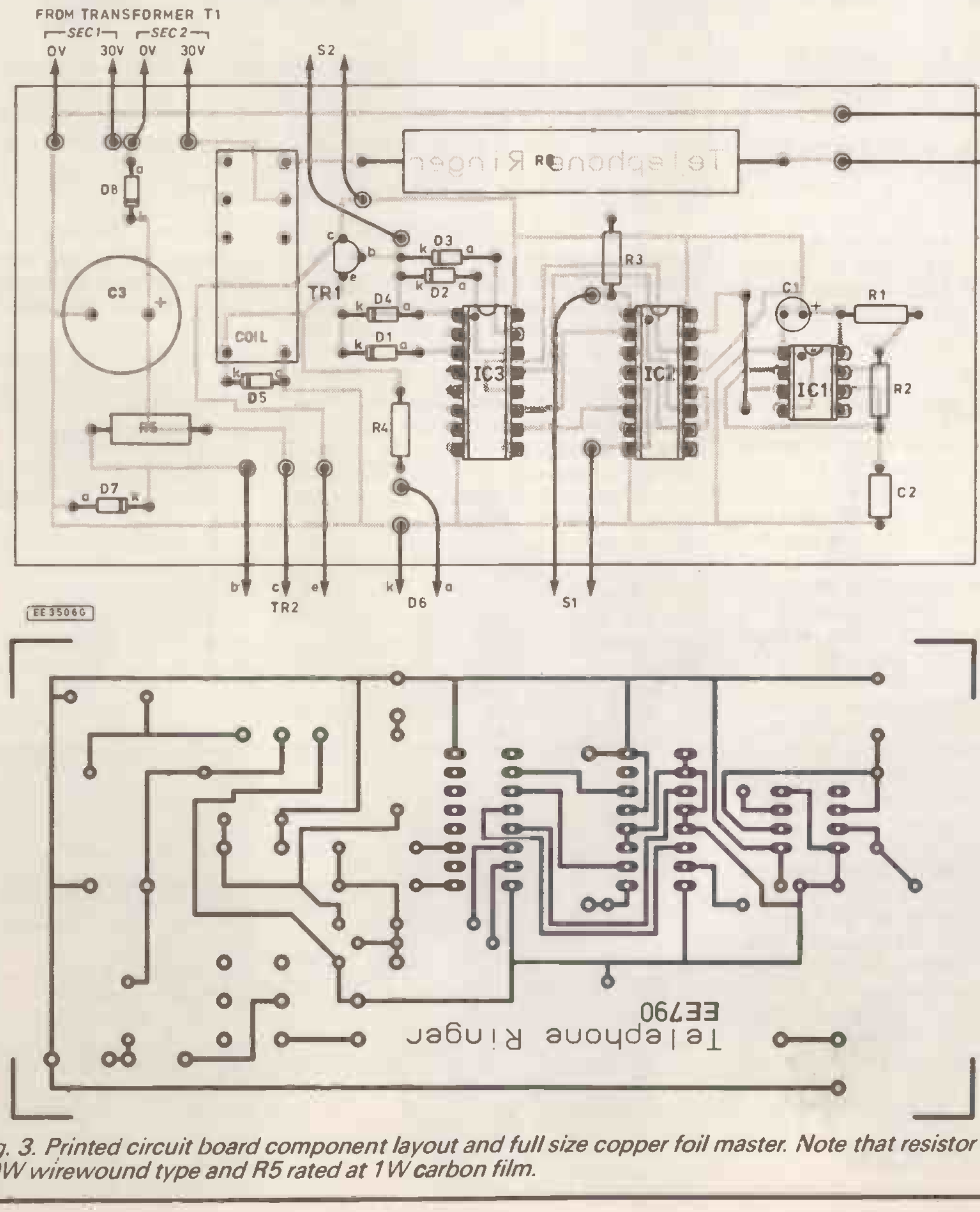


Fig. 3. Printed circuit board component layout and full size copper foil master. Note that resistor R6 is a 10W wirewound type and R5 rated at 1W carbon film.

fully to avoid mistakes. One wire link needs to be inserted just to the left of IC1.

If a different relay to that specified is used, you will probably need to modify the p.c.b., or alternatively mount the relay off the p.c.b. and connect it to the board with short lengths of wire.

There are a large number of flying-lead connections to be made as shown in Fig. 4 and you will find these easier to do if you solder terminal pins (p.c.b. pins) to the board, and then solder flexible wires to the terminal pins once the p.c.b. is fastened in the case. Connection within the Master Telephone Socket is made to terminals 2 and 5, as described in Fig. 2.

The wires from transformer T1 are colour coded, usually as follows:

240V primary – orange
Secondary 1, 0V – grey, 30V – blue
Secondary 2, 0V – yellow, 30V – red.

For safety, all the exposed mains connections MUST be insulated to prevent accidental contact. Some live tests have to made with the case lid removed and it is extremely dangerous to work in close proximity to bare, high voltage connections.

It is also most important to make a good Earth connection to a solder tag bolted to the metal case as shown in Fig. 4. To prevent the 3-core mains cable from being pulled out of the case, use a strain-relief grommet or similar anchoring device at the point of entry.

CONSTRUCTION

The prototype unit was housed inside an aluminium instrument case measuring 150mm x 150mm x 75mm high. An aluminium box is better suited to the back-stage environment and it also acts as a good heatsink for transistor TR2.

The case will require drilling to accept the panel-mounted components. Do this first, and then label the controls as desired. A suggested layout of the components within the case is shown in Fig. 4.

Transformer T1 is a toroidal device and is mounted by sandwiching it between the two rubber washers which are provided with the device. The circuit board should be mounted on two supports so that the soldered connections do not touch the case.

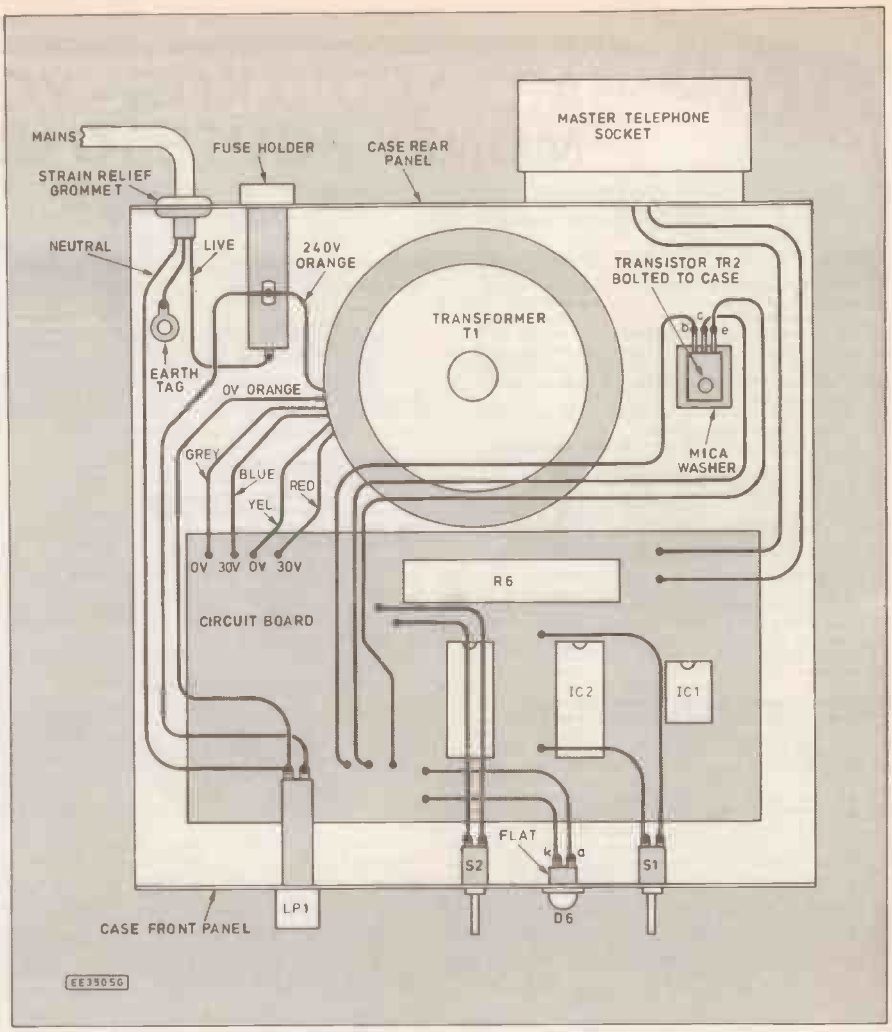
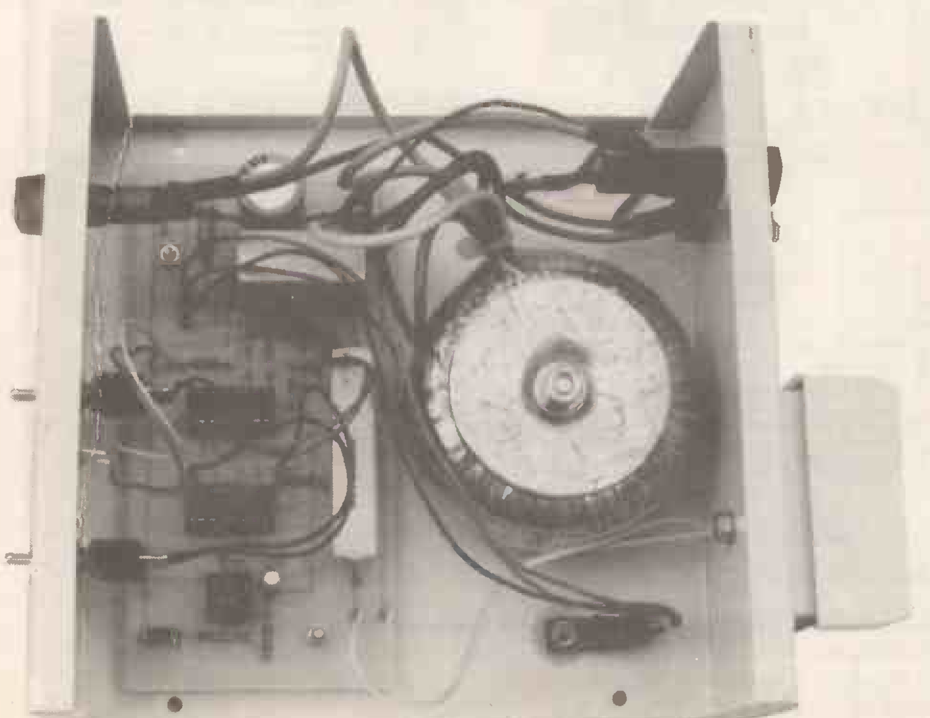


Fig. 4. Interwiring and layout of components inside the case.

Similarly, transistor TR2 should be insulated from the case using a mica washer and insulating bush. These pieces are often sold as an "insulating kit" for power transistors; the type of transistor used here has a TO126 type case.

Fasten all of the case-mounted components in place before wiring them to the circuit board. Switches S1 and S2 can either be "momentary" (push-and-release) push buttons or the more easily operated "biased" (spring loaded) toggle switches, as used in the prototype.



TESTING

Double check the 240V wiring within the unit before connecting to the mains. Then, with the i.c's still out of their sockets, switch on the unit. Neon lamp LP1 should light. If it does not then check the condition of fuse FS1.

During this next test, take care not to touch any of the mains connections. Connect a d.c. voltmeter between pin 8 (negative) and pin 16 (positive) of IC2's empty socket. The meter should read about 12 to 13 volts.

If the voltage is significantly outside this range then switch off and check your construction and wiring. Make sure that the transformer T1 and transistor TR2 have been correctly wired to the circuit board.

Once the power supply is satisfactory, switch off and then insert the three i.c's with their identification notches orientated as shown in Fig. 3. IC2 and IC3 are CMOS devices and the usual handling procedure should be followed to avoid damaging them with static electricity.

Plug a telephone into the Master Socket and then re-apply power. Switch S1 (Cadenced ring) should cause the phone to ring (and l.e.d. D6 to illuminate) as though it was being called by the telephone exchange. Switch S2 (Long ring) will ring the phone continuously. □

ACTUALLY DOING IT!

by Robert Penfold

FROM time to time I get requests for printed circuit board (p.c.b.) or stripboard layouts for circuits of mine that have been published in books and magazines. I also get occasional requests for advice on producing stripboard or p.c.b. layouts. There is usually no easy answer to these requests.

If a neat and copyable component board design exists for a circuit, then it will normally be published along with the circuit. If something has been published as just a circuit plus notes, then the circuit has been thoroughly tested, but it has probably not been built in a neat form. It may have only been built on a solderless breadboard or crudely wire-wrapped.

There is no way that a lesson on circuit layout can be condensed into a short letter! In this article I will try to give some guidance on producing stripboard layouts.

Before proceeding further it is only fair to point out that trying to make up projects working from just a circuit diagram is not a good starting point. You really need to gain a certain amount of experience first, using ready-made printed circuit boards, stripboard layouts in magazines, or whatever. However, once you have a certain amount of experience, and are familiar with the basic techniques involved, it is not too difficult to convert circuit diagrams into working stripboard layouts.

INSTANT STRIPBOARDS

There are several approaches to producing stripboard layouts, and the obvious way is to draw out and check over the layout before actually soldering anything in place. This is easy enough to do, but it is not the method I use.

I have always preferred to simply make up stripboard layouts as I go along, working on a piece of board that is much larger than necessary. Having completed the layout, the excess board is carefully cut away, leaving the finished board ready for installation in the case.

This may seem to be a difficult and wasteful way of doing things, with mistakes being difficult to correct. Admittedly, it is possible to make a mistake that could be difficult or impossible to correct, making it necessary to start again on a new piece of board.

In practice this is not likely to happen very often, if at all. The direct approach has definite advantages, with the main one being that it provides very rapid results. It seems to be the way that many people design stripboards.

One problem with drawing out a layout is that you will normally have to work at two or three times (EE uses twice) actual size. Drawing layouts at actual size tends to be rather awkward and fiddly. When drawing up a layout larger than actual size you need to be careful about under-estimating the size of components.

It is easy to draw up a very plausible looking layout that is totally impractical, with areas of board occupied by two or more components when you try it with real components. When designing stripboard layouts it is a good idea to have a piece of board and all the components handy, so that you can fit components onto the board in order to determine the closest spacing that can be used.

THINKING AHEAD

Probably the most important thing when designing component layouts is to think ahead. Try to work on groups of components rather than just on a bit by bit basis. Ensure that you always leave free areas of board for any components or interconnections that will follow later.

As a point of interest, one of the main problems with computer programs that automatically design printed circuit layouts is that they tend to "paint themselves into corners". Human designers are much better at looking ahead and avoiding this type of thing. With a little practice you should soon find that this problem is totally avoided.

GETTING STARTED

Whether you decide to jump straight in and make up the board as you go along, or draw up the design before you reach for the soldering iron, the basic method described here should help you to produce working stripboard layouts. It has to be emphasised that there is no single correct layout for each circuit, and for a medium sized project there must be hundreds of different layouts that are perfectly satisfactory. Provided it is reasonably neat, compact, *and it works,* then the layout is quite acceptable.

Getting started tends to be the most difficult part of any design work. It definitely helps if you are methodical in your approach.

Most circuits have an input and an output, so work through from the input to the output, or vise versa. Where this is not appropriate, work from the left hand side of the circuit diagram to the right hand side.

It helps to bear in mind that most component layouts are firmly based on the circuit diagram. The person who draws up the circuit diagram has effectively done the first stage of the design work for you.

SIMPLE AMPLIFIER

For the basis of this example layout we will use the Simple Amplifier circuit diagram of Fig. 1. This is a simple preamplifier based on an operational amplifier i.c.

We will assume that sockets JK1, JK2, switch S1, and battery B1 are all mounted off-board. While it is possible to use some printed circuit mounting sockets etc. with stripboard, in most cases it is more trouble than it is worth to do so.

The obvious starting point is to put in a couple of solder pins to take the connections to JK1. The convention is to have the bottom copper strip as the "earth" or 0V rail (except for dual supplies), so the earth pin for JK1 would go in the bottom left-hand hole. The non-earth pin for JK1 can go a couple of strips higher up the board.

I would recommend having pins spaced at least two holes apart, since having them in adjacent holes can cause problems. The main one is that there is a tendency to get short circuits across the pins when you wire them up to the off-board components. Spacing of more than two holes is acceptable, but the board will be neater and easier to wire to the off-board components if the pins are in neat groups, with one group for each off-board component.

Continuing to work from the input to the output, capacitor C1 is the next component to deal with. This is a non-electrolytic type, which these days often means a printed circuit mounting component having very short leadouts. This limits your options, since you are more or less obliged to use whatever pin spacing the component has. When using stripboard it is easier if, as far as possible, you avoid components of this type.

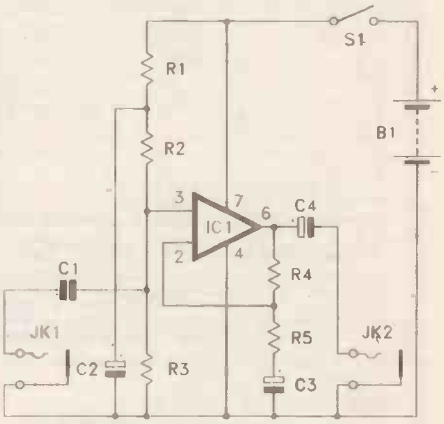


Fig. 1. Circuit diagram for a simple amplifier; used for the component layout example.

In this case we will assume that C1 has 7·5mm (0·3in.) lead spacing. The obvious place for it is just to the right of the non-earth input pin, going vertically up the board.

This makes the sixth copper strip up the board the one to which pin 3 of IC1 and resistors R2, and R3 will connect. It is possible to change this by adding a link wire to connect the upper end of C1 to another copper strip, but in this case there seems to be no point in doing this.

Next resistors R1 to R3 and electrolytic capacitor C2 must be added. We already know which two strips R3 must connect to (the bottom one and the sixth one up). It can therefore be wired between these two strips, just to the right of C1.

The convention is to have the uppermost strip as the one which carries the non-earth supply rail, which in this case is the positive supply rail. Resistors R1 and R2 can therefore be added above C1, going vertically up the board.

The "natural" lead spacing for most miniature resistors is 10mm (0·4 in.). You are not forced into using this, and there is no difficulty in using a longer lead spacing if this would be beneficial. In this case it would not, and it would simply make the board "taller" than it really needs to be.

Using a smaller lead spacing is awkward as it means mounting the resistor on-end rather than flat against the board. This is a physically weak method of construction which should be avoided as much as possible, but often it is the "least worst option".

In normal printed circuit design components are not fitted to the board at odd angles. With stripboard you often have to make compromises, and it is better to fit a component on the board at an odd angle than to mount it on-end.

As finished stripboard panels are quite light, a couple of mounting bolts will usually suffice. With large boards it would obviously be advisable to work in one or two extra mounting holes somewhere on the board i.e. at the four corners.

Continuing with the component layout, IC1 is the next component to put into the layout. Its vertical position must be such that pin 3 connects to the same copper strip as C1, etc. For most newcomers to constructng, it is to be recommended that i.c. holders be used for all multi-pin devices.

Horizontally, IC1 holder can be placed just to the right of C2, but a spare column of holes must be left between C2 and IC1. These are for a link wire from pin 4 to the negative supply ("earth") strip, and a link wire that will carry the "common" connection from resistors R4/R5 to pin 2 of IC1.

It would be possible to mount R4 over the top of IC1 so that it could connect directly between pins 2 and 6. This type of thing looks rather scrappy though, and is not a very reliable method of construction. Also, how do you remove the i.c. from its holder if a breakdown occurs?

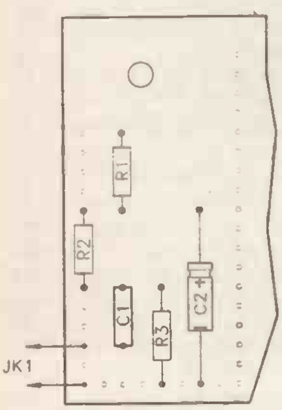


Fig. 2. The initial stages of the component layout.

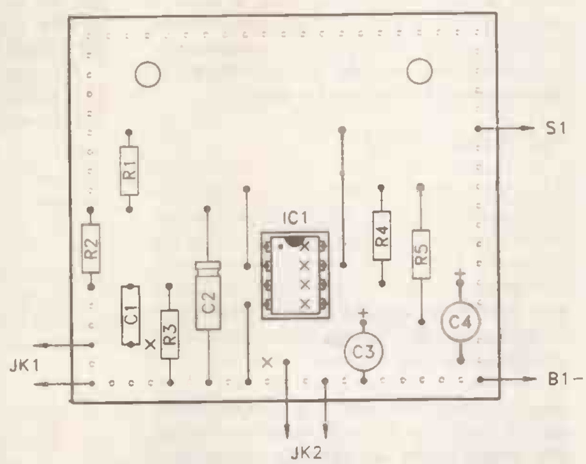


Fig. 3. The finished component layout. "X"s indicate the breaks in the copper strips.

With R1 and R2 in place, the electrolytic capacitor C2 can then be added to the right of R3, from the bottom strip to the one which connects to R1 and R2 (*being careful to get its polarity correct*). The lead spacing of C2 works out at 23mm (0·9in.), which makes an axial component the natural choice. However, most radial electrolytic capacitors have quite long leads, so a radial electrolytic could probably be fitted without any difficulty.

FINISHING OFF

So far we have a layout something along the lines of Fig.2. I have allowed some generous spacing of the components to allow for the fact that the actual capacitors might be somewhat fatter than depicted in Fig. 2.

Apart from this the board space has been used quite efficiently. The layout has not been allowed to spread unnecessarily over to the right, leaving large areas of board wasted.

Obviously the board will usually need to have some mounting holes so that it can be bolted inside the case. I usually have five extra copper strips at the top of the board to provide an area which will accommodate a couple of mounting holes.

When using stripboard you have to accept that a number of link wires will be needed, and avoid taking shortcuts which could be less than satisfactory. In this case only one other link will be needed, and this is from pin 7 of IC1 to the positive supply strip.

Resistor R4 can be mounted to the right of IC1, going vertically up the board from the strip that connects to pin 6 of IC1. There are several unused strips available for the opposite end of R4, and it does not really matter which one you choose. The link wire from R4 to pin 2 of IC1 can then be added between the appropriate two strips, just to the left of IC1.

You might like to work out the rest of the design yourself. I ended up with the final layout of Fig. 3.

A few connections between the off-board components will usually be required. In this instance only one is needed, and this is from the positive battery lead to one side of switch S1.

TAKE A BREAK

You must be careful not to omit any of the breaks in the underside copper strips. In this case the only essential breaks are between IC1's two rows of pins, to prevent them from being short circuited together.

This board is for a simple single stage circuit. Most of the layouts you design will be for circuits having several stages, and you will then need to add breaks between adjacent stages to keep them properly isolated from one another. When designing layouts you must make sure that vacant holes are left for these breaks.

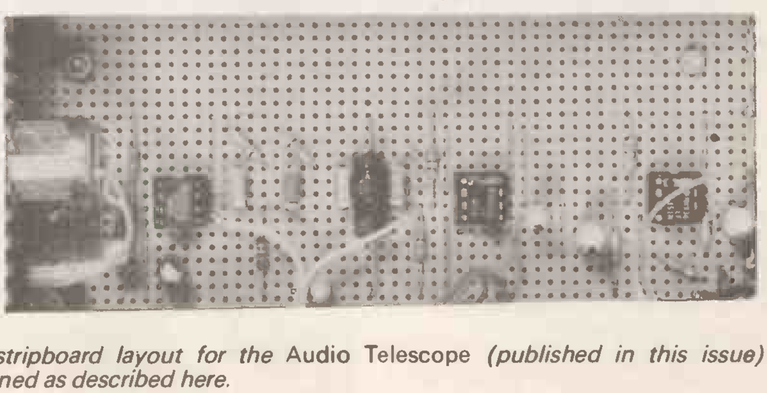
With the old and now obsolete 0·15in. pitch stripboard it was quite easy to put in breaks between two holes. Using 0·1in. pitch matrix board it is very difficult to do this, and it is something that should only be reserved for emergency use.

In Fig.3 I have added a couple of extra breaks (marked with X's) in the strips. There is a major problem when using stripboard, and this is the capacitance between the copper strips. This capacitance is very good at coupling signals from one part of a circuit to another and needs to be avoided.

In this example there is a risk of stray feedback from the output to the input of the circuit, which could result in the amplifier breaking into oscillation. This is actually quite likely to occur with this layout, since the input and output of the circuit connect to adjacent strips.

Problems of this type can usually be avoided by making some extra breaks in the copper strips, as in this example, so that the unused pieces of copper strip are disconnected from the input and output of the circuit. With very sensitive circuits this might not be sufficient, and it would also be necessary to add a couple of link wires to connect the unused pieces of track to the earth rail. These pieces of copper strip should then act like screens, preventing any significant feedback.

Probably the best advice for anyone thinking about trying to design stripboard layouts is to get stuck in and give it a try. You can only become competent at this sort of thing by getting some practical experience, and it will probably be much easier than you expected.



The stripboard layout for the Audio Telescope *(published in this issue) was designed as described here.*

DOWN TO EARTH

George Hylton

Equalizers

EQUALIZERS correct errors in frequency response. An early use was in telephone engineering. Telephone cables have greater loss at high frequencies (h.f.) than at low frequencies (l.f.). This h.f. loss can be quite serious, as a few figures illustrate.

Suppose that, on an audio phone cable, the response is required to be flat to 4kHz. If the loss in the cable is 1dB per kilometre at low frequencies and 1·2dB at 4kHz, what is the effect of 100km of cable?

At low frequencies the total attenuation is 100dB, but at 4kHz it is 120dB, so 4kHz signals are now 20dB down. This has to be corrected, for example by incorporating "top lift" in the amplifiers (repeaters) which are inserted at intervals along the cable route.

Recording

Equalization has become familiar in the field of sound recording and reproduction. When disc recording was developed the engineers hit a problem. The recording machine registered audio signals by cutting a groove which wobbled from side to side in proportion to signal strength. If this wobble was too large the part of the spiral groove now being recorded might veer too close to the previously cut part.

This can of course be avoided by increasing the pitch of the spiral so as to leave more spaces between one turn and the next. But this reduces the number of turns which can be accommodated on a disc, hence reduces the playing time. You could reduce the amount of wobble by turning down the gain, but signal output from the pickup is then also reduced.

It turns out that the greatest amounts of wobble occur at the lower frequencies. So disc recording engineers apply bass cut. The playback machine must then incorporate just enough bass lift to correct the frequency response, this is called "playback equalization". (In practice the required equalization is more complicated but the principle is the same.)

When tape recording arrived on the scene the problem was to correct a loss of treble inherent in the recording process. Standard equalization curves were derived which make the overall response level.

In f.m. radio it pays (from the point of view of getting a good signal to noise ratio) to boost treble at the transmitter and cut treble at the receiver. Hence the presence of equalization ("de-emphasis") circuits in f.m. receivers.

Fig. 1. The acoustic response of a room or other enclosure contains relatively sharp peaks and troughs.

Acoustic Variations

The equalization required in the systems which I've been talking about so far is standardized. It can be built into audio equipment and doesn't need to be adjusted by the user. But there are also elements in the audio chains which cannot be dealt with by preset equalization.

The acoustics of a typical bathroom illustrate the point. Your voice sounds louder in the bathroom because the typical hard walls and small dimensions produce strong acoustic resonances which colour the tone of your voice. Comparable effects occur in any small closed space such as the interior of a car.

However flat they be the internal response of a car radio or tape player and however hi-fi the loudspeakers, the car interior itself will colour the tone. Different cars will do this in different ways, and even the same car will change acoustically as its contents (including passengers) are varied.

You may think that an adjustment of the tone controls should correct this. The trouble is that the resonances which need equalizing may be rather sharp, giving a response full of peaks and troughs (Fig. 1). Ordinary tone controls give only gentle changing responses, over relatively broad parts of the audio spectrum. They just can't cope with peaky responses.

Solutions

The natural way to cancel a peak is to use a resonant *LC* circuit to create a dip in the response at the peak frequency. A circuit for doing this (Fig. 2) uses a series-resonant circuit (C1, L1, R3) to shunt signals to earth.

With the slider or wiper contact of potentiometer VR1 at *A* this produces a dip in the response. If the wiper is at *B* the series resonant circuit bypasses resistor R2. Since R2 reduces the gain of the transistor (by emitter negative feedback), bypassing it in this way restores gain at the *LC* resonance frequency, producing a peak in the response.

At some intermediate settings of VR1 wiper there is neither an increase or decrease in gain and the response is flat. Thus VR1 controls the amount of cut or lift at or near the resonant frequency. At remote frequencies the *LC* circuit has a high impedance and little effect.

The op.amp (IC1) version of the circuit (Fig. 3) works in a similar way. In this case it is practicable to add more potentiometers in parallel with VR1, each with its own *LC* circuit. By staggering the tuning of the *LC* circuits a number of cut/lift frequencies can be provided.

Fig. 2. The resonant frequency of L1, C1 can give either a peak or a trough, depending on the setting of VR1.

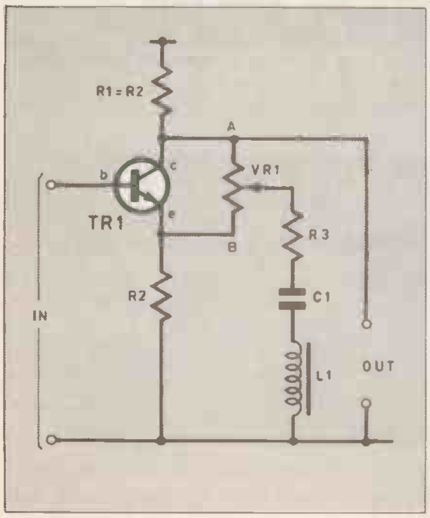
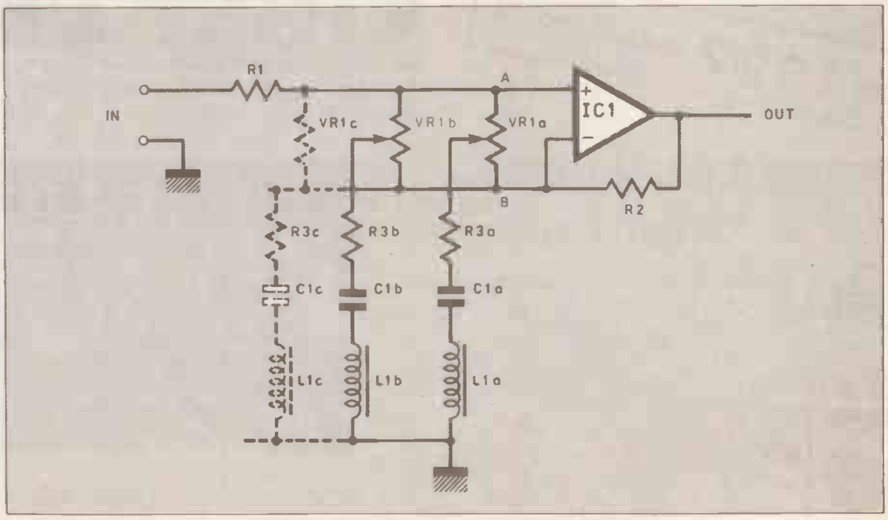


Fig. 3. Graphic equalizer using an op.amp. Extra bands can be added as shown dotted.



Graphic Equalizers

The circuit (Fig. 3) then lends itself to use as a graphic equalizer. If the VR1 potentiometers are of the slider type, mounted in parallel on a front panel, the positions of their knobs can be made to indicate graphically the response at the resonant frequencies.

The maximum lift and cut are determined by resistor R3 along with R1 (for cut) or R2 (for lift). In practice the coil which creates L1 has resistance, which effectively adds to R3, and this can be allowed for in determining the actual size of R3 on each range. In a typical case the maximum cut or boost is around 15dB.

There is no guarantee that the selected *LC* frequency will correspond to the frequencies of acoustic resonances in any particular case. The chance of hitting the right frequency is improved by using a large number of equalization bands. The absolute minimum is three; one low frequency; one middle frequency; and one high frequency. More is better.

The best plan is to make the centre frequency of each band a fixed multiple of the next lower frequency. A possible value for the multiplexer is the square root of 10 (about 3·16).

This gives ranges such as 100, 316, 1,000, 3,160, 10,000, covering most of the audio band in five steps. More steps can be provided by making the multiplier the cube root of ten, or the fourth root, etc.

Since inductors are expensive, designers may seek to avoid them by using active *RC* circuits which simulate *LC* circuits. For installations with no built in graphic equalizer it is possible to add a graphic equalizer booster amplifier and extra speakers.

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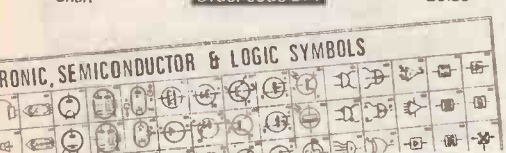

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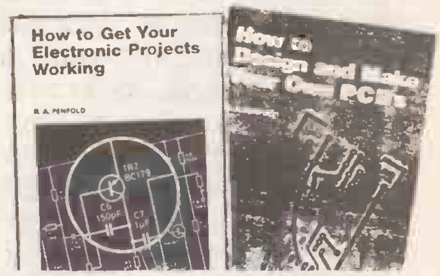

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PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for 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 in the latest issue.

Boards can only be supplied on a payment with order basis.

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Power Supplies – Fixed Voltage	SEP'89	654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	646	£3.85
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30V 1A		657	£4.55
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Logo/Lego & Spectrum Interface		664	£5.60
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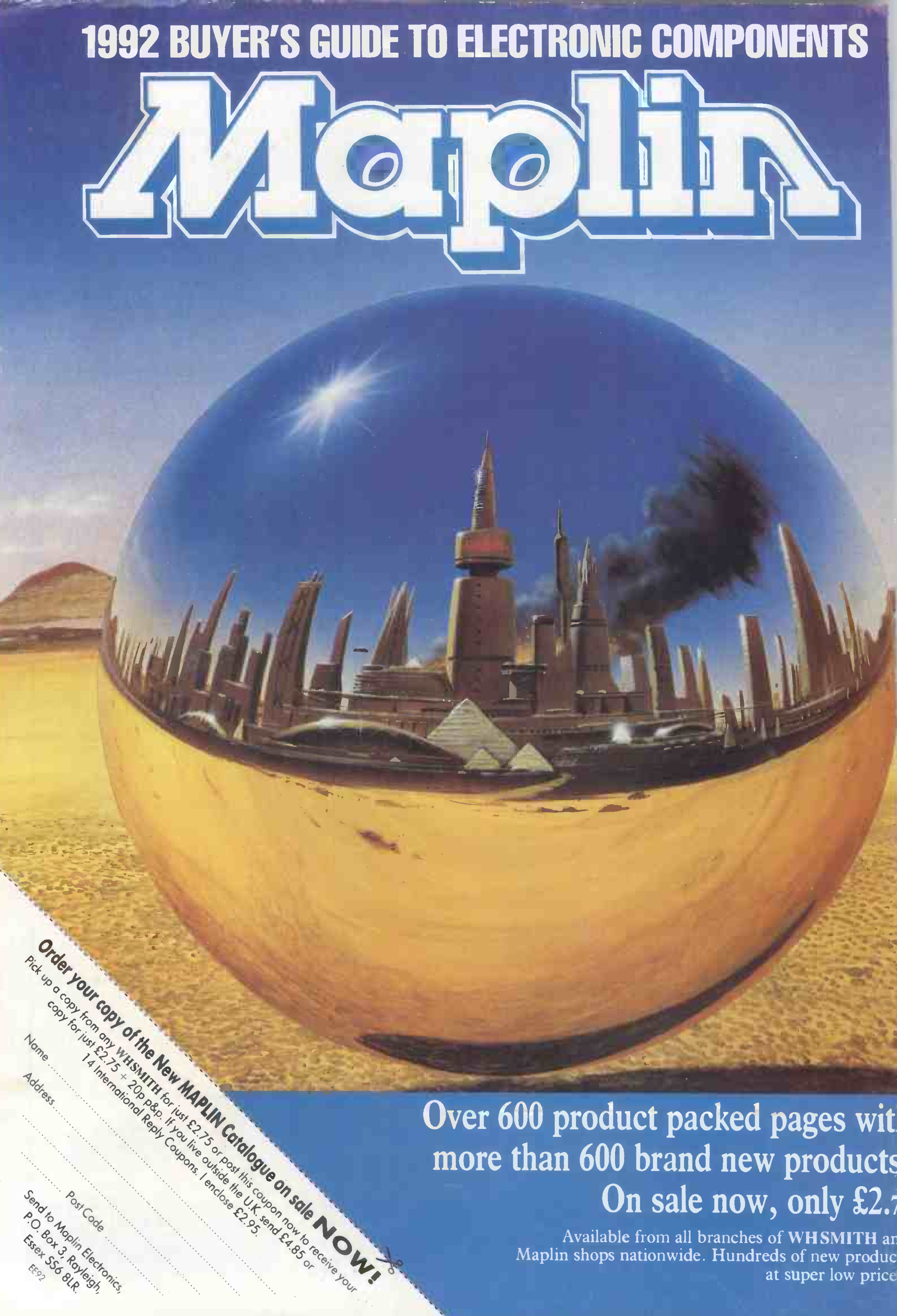

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1992 SPRING SUPPLEMENT

Welcome to our 1992 Spring Supplement - free with our compliments with your favourite monthly magazine! Inside its 32 pages you'll find the usual mix of new and surplus items, together with a preview of a new category to be included in future Catalogues - Graphic Design Products. We're now stocking Staedtler and Kuretake pens, pencils, markers, drawing instruments, boards and cutting mats, as well as Humbrol airbrushes and a wider selection of paper, labels, staplers etc. Every constructor has to write and draw circuits from time to time, so we hope these additions prove useful to you. There's a wide range of new surplus lines all offering exceptional value for money, and don't miss the remarkable offer of a Hitachi scope with 25% discount on the back page! We look forward to receiving your order soon - the Order Form is on Page29.

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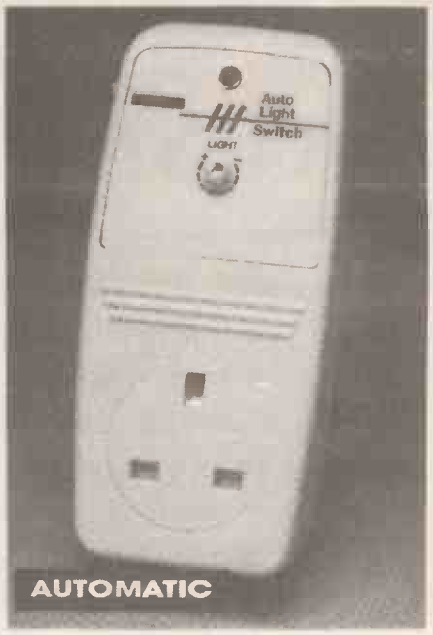
Max. load	500W



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Power	220/240Vac 50Hz
Max. load	500W
Dims	145 x 65 x 42mm

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Power	220/240Vac 50Hz
Max. load	3000W
Dims	145 x 65 x 42mm

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PIR coverage	100m²
Exit delay	2.5 minutes
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Exit delay time .... 40 seconds
Entry delay time .... 20 seconds
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Dims .... 174 x 60 x 190mm

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Power: 220/240Vac 50Hz

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ROPE LIGHT

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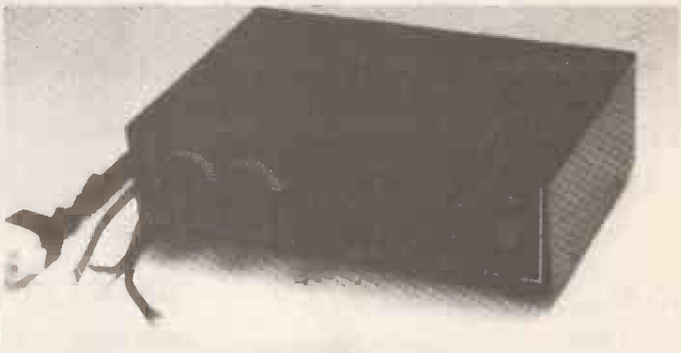
Length 5m

G006P £39.95 3+ 26.73

4-CHANNEL CONTROLLER

4-channel lighting controller with built-in mic, sensitivity control and speed control. Four front panel LEDs mimic the lighting effect. Output via 8-pin Bulgin socket

Max output .... 1000W/channel resistive
.... 600W/channel inductive
.... 2500W total
Power........ 220/240Vac 50Hz
Dims........ 184 x 100 x 55mm



G006M £49.95 3+ 32.83

4-CHANNEL CONTROLLER

4 channel lighting controller with five built-in sound activated effects: 1 on/3 off, 2 on/2 off, 3 on/1 off, 4 on/0 off plus random, forward and reverse for all four sequencies. Outputs via Bulgin socket and short lead with connector for rope lights.

Max output 1000W/channel,
.... 2500W total
Power........ 220/240Vac 50Hz
Dims........ 184 x 100 x 55mm

VIDEO/AUDIO BARGAINS!

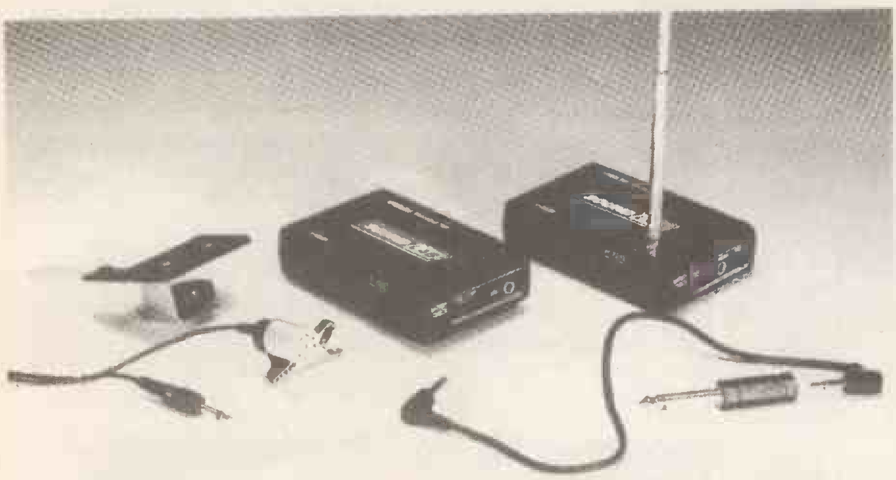
ENHANCE YOUR HOME VIDEOS WITH THESE PRODUCTS!!

G164G £32.95 3+ 22.11

CAMCORDER DUBBING MIC

A unique mic designed for direct dubbing of an external soundtrack, voice-over, etc. at source, whilst the camcorder is recording. A stereo 3.5mm input is provided in the side of the mic for insertion of the soundtrack and a rotary control provides balance between mic and soundtrack. An earphone jack is provided for monitoring the mix. Supplied with a mono in-ear phone.

Type	Super uni-directional electret condenser
Impedance	1kΩ
Response	80-15000Hz
Sensitivity	-48dB (@ mix max.)
Length	185mm



G211 £49.95 2+ 35.52

WIRELESS MICROPHONE

A 3-channel 2-part wireless microphone system designed for use with video cameras. The tie-clip mic has a remote belt clip transmitter with on/off switch. The receiver has a hot shoe for mounting on the video camera. The system allows greater mobility with a microphone than can be achieved with the camcorder mic.

WITH VINYL CARRYING CASE

T081 £47.95 3+ 32.09

VIDEO LIGHT

30W halogen video light with 6V 1700mAh battery pack. The video light is provided with a synchronisation lead which, when the light is switched to "remote", allows the light to switch on when the camcorder is switched on (Sony and Panasonic camcorder). The on/off/remote switch has a lock button to prevent accidental movement.

Packed: BOX

T081AA Spare bulb **£4.95** 5+ 3.28

T081A £15.95

VIDEO LIGHT 4+ 10.63

30W video camera light with hot shoe fitting and power on/off switch. Accepts 6V 1700mAh battery pack (Sony NP55 and NP77 typically)

Packed: BOX

T081AA Spare bulb **£4.95**

T081B £66.95 3+44.89

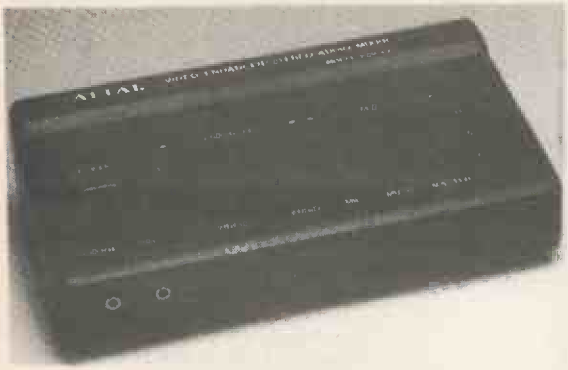
VIDEO LIGHT KIT

A semi-professional video light kit comprising 100W halogen lamp, remote 12Vdc 7Ah sealed lead acid battery in carrying case with shoulder strap, 220/240Vac operated battery charger and camcorder power supply adaptor.

Packed: BOX

T081BA Spare bulb **£3.75** 5+ 2.80

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT



T128D £36.95 5+ 24.79

VIDEO ENHANCER/AUDIO MIXER

A 3-channel stereo video sound mixer with a built-in video enhancer, specificially designed for video dubbing. The audio input from the camera/VCR, mic and music sources can be mixed at will, with overall output conrolled by a master slider. The video enhancer will clean up the picture on older recordings. Powered by an external 12Vdc power supply (not supplied). Complete with all connecting leads and adaptors.

T122D £12.95 10+ 8.56

VHS-C TO VHS ADAPTOR

All mechanical adapter cassette allowing the playback of VHS-C tapes on VHS video players. The action of closing the door moves the tape into position.

T122K £6.95 10+ 4.80

45 minute tape.

T122J £6.95 10+ 4.80

30 minute tape.

GAFFA TAPE

50m rolls of 2" wide self adhesive Gaffa tape

L099R Silver £6.50 10+ 4.36

L099S Black £6.50 10+ 4.36

A163A £2.95 40+ 1.03

CD RACK

A unique CD storage system which will hold up to 20 CD's, in their cases, allowing them to flip back and forth as you search for the CD you want. Free standing and interlocking.

DC POWER LEAD

Useful universal lead - reversible socket on the end of a DC power lead with 4 interchangeable plugs - 1.3, 2.1, 2.5DC & 3.5mm mono jack. 1.8m long.

A133A £1.25 50+ 0.75

A005A £27.95 5+ 19.03

STEREO PRE-AMP

Mains powered stereo pre-amp suitable for insertion between turntables, mics and other low level sources and aux/line inputs on mixers, amps, stack systems etc.

Input impedance	50kΩ
Max. input level	33mV (@ 1kHz)
Max output level	3.8V (@ 47kΩ load)
S/N ratio	more than 50Hz
Input sensitivity	2.5mV (output 300mV)
Frequency response	30 - 15kHz (RIAA)
Power	220/240Vac 50Hz
Dims	140 x 75 x 40mm

G170C £5.95 10+ 3.35

DYNAMIC MIC 200Ω

Pair of matched dynamic microphones. Black plastic body with chrome metal grille and chrome trim. On/off switch. Independent 1.2m leads terminating in 3.5mm jack plugs. Mic stands and 6.35mm adaptors included.

Type	Omni-directional dynamic
Impedance	200Ω
Response	90-10000Hz
Sensitivity	-76dB @ 1kHz
Dia: Head	32mm.
Body	17mm
Length	120mm

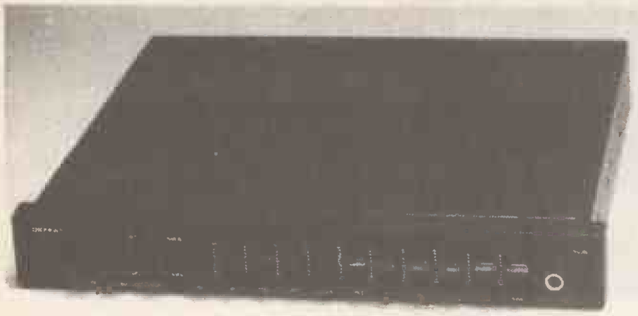
A170A £2.95 10+ 1.88

TAPE HEAD DEMAGNETIZER

A compact and easy to use tape head demagnetizer. Simply plug the demagnetizer in, press the red button and place the tip gently in contact with the tape head. Rotate the tip across the surface and withdraw slowly. Demagnetizng every 50 hours of play time improves playback and record quality.

Power: 220/240Vac 50Hz

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

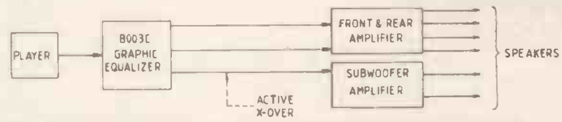


B003C **£39.95** 5+ 26.40

GRAPHIC EQUALIZER

11-band graphic equalizer with sub-woofer output and CD input. The sub-woofer output has an adjustable cut-off frequency and level control. The case is standard DIN width for in-dash or under-dash mounting. Low level inputs and outputs only, via phono sockets.

Frequency response	20 - 25000Hz
Total harmonic distortion	Less than 0.05%
S/N ratio	85dB
Separation	65dB
Control frequencies	60, 120, 250, 380, 500, 750, 1k, 2k, 4k, 8k and 16kHz
Control range	12dB boost or cut
Power	12 - 14Vdc
Dims	178 x 25 x 140mm



A085 **£99.95** 2+ 73.70

RADIO HEADPHONE SYSTEM

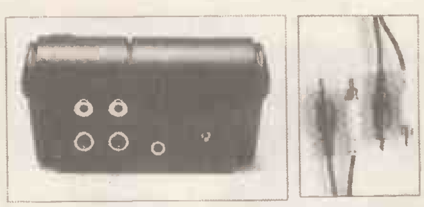
A radio headphone system comprising a radio transmitter, a belt-clip receiver and a pair of high quality headphones. The transmitter will accept inputs from three separate sources; CD, DAT, tape etc and additionally has a built-in mic with talk button for contacting the headphone wearer. The system allows complete freedom of movement within a range of approximately 100 feet of the transmitter.

Transmitter:

Input sensitivity	Source 1 & 2: 10kΩ/100m
	Source 3: 22kΩ/100m
Power	12Vdc 150mA

Receiver:

Frequency response	48 - 16000Hz
Power output	30mW/channel
Range	100ft (36m)
Power supply	PP3 battery
Battery life	8hrs nominal



A162B **£1.20** 50+ 0.66

REPLACEMENT CD CASES

Replacement CD storage cases designed to be direct replacements for the originals supplied with compact discs. Two cases per pack.

A087F **£8.95** 10+ 5.15

STEREO HEADPHONES WITH BOOM MIC

Lightweight stereo headphones with adjustable dynamic boom mic. Tough plastic headband with stainless steel adjusters. Foam padded earpieces containing high quality samarium cobalt transducers for clear sound reproduction. High sensitivity miniature dynamic mic cartridge with foam windshield. Straight screened lead terminates in 6.35mm stereo plug for headphones and a 3.5mm mono plug for mic.

Headphones:

Type	Mylar transducer
Impedance	32Ω
Response	20 - 20000Hz
Power	150mW

Microphone:

Type	Omni-directional dynamic
Impedance	250Ω
Sensitivity	-78dB @ 1kHz

General:

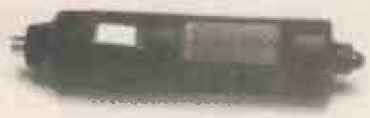
Lead	2.5m straight screened
Plugs	6.35mm stereo and 3.5mm mono
Weight	80g

B049A £12.95 6+ 7.50

12Vdc TRAVEL KETTLE

12Vdc kettle complete with mounting stand, cup and cup holder with a self-adhesive base. Plugs directly into a car cigar lighter socket for power. A power-on light is provided at the base of the kettle. Ideal for cars, vans, campers etc.

Capacity........0.5 pints (0.3lts)
Power........12Vdc 9A, 14Vdc 11A
Dims........143 x 125 x 112mm (approx)



B200Z £1.95 20+ 1.14

PLUG-IN FLASHING LED

A flashing LED built into a car cigar lighter plug to give visual warning that an alarm is activated (whether or not an alarm is fitted). Simply plugs into the car's cigar lighter socket.

B201 £17.95 10+ 11.93

CAR ALARM

Keyless, self-contained car alarm with simple, three wire connection into the car's wiring harness. The alarm is self arming one minute after the ignition is switched off. The alarm is current sensing and will operate 10 seconds after a door is opened. Once triggered the alarm will sound for 30 seconds before re-setting.

Operation........Current sensing
Reset time........45 seconds
Power........12 - 14Vdc

B047D £12.95 10+ 8.84

AIR PURIFIER AND IONIZER

A compact, stylish ionizer and air purifier with a coverage volume of 14m³. Ideal for in car use with the DC lead provided or as a room purifier with the AC adaptor provided. Removes unpleasant smells, airborne dust, bacteria, tobacco smoke etc.

Power........9-15Vdc or 220/240Vac via adaptor
Dims........160 x 95 x 43mm

B047E £9.95 10+ 6.50

AIR PURIFIER AND IONIZER

A compact, stylish ionizer and air purifier designed specifically for car, truck and bus use with a coverage volume of 14m³. Removes unpleasant smells, airborne dust, bacteria, tobacco smoke etc. Supplied with a double sided self adhesive pad.

Power........12Vdc 1.8W
Dims........110 x 110 x 65mm

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

Y122HR *£99.95* *2+ 66.73*

10MΩ

The Y122HR (M3650CR) multimeter is capable of communicating either the current LCD readout or up to 5 stored measurement values direct to data acquisition systems, PC's, pen plotter, printer, etc. via its MT/RS232C Interface cable. Interface cable and program disc included with meter.

- ★ 3.5 digit 17mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Data hold
- ★ Max/min value capture
- ★ 40 point analog bargraph
- ★ Frequency counter
- ★ Logic test with auto level
- ★ Capacitance test
- ★ Continuity test with buzzer
- ★ Transistor and diode test
- ★ Built and tested to IEC 348
- ★ Fully shrouded test leads

Battery, Instruction manual and carrying case included.

AC volts	0-200m-2-20-200-750Vac ± 0.8%
DC volts	0-200m-2-20-200-1000Vdc ± 0.3%
AC current	0-2m-200m-20Aac ± 1.8%
DC current	0-200μ-2m-200m-20Adc ± 0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ± 0.5%
Capacitance	0-2000pf-200n-20μF ± 2.0%
Frequency	0-20k-200kHz ± 2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

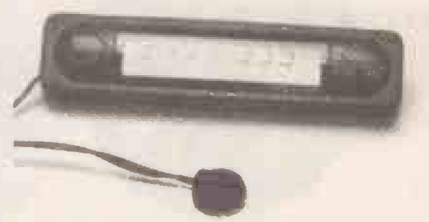
Packed: BOX

Y137M *£8.95* *5+ 6.03*

DIGITAL THERMOMETER

A dual sensor digital thermometer designed for comparative temperature measurement, for example inside/outside temperature. The thermometer can be free standing or mounted with the Velcro strips provided. The remote sensor is fitted with a 3m lead and mounted with double sided tape. A digital clock is built in.

Temperature range	-20 O to +70OC ± 1OC
Resolution	0.1OC
Power	P009H button cell



Y137N *£11.95* *5+ 7.50*

DIGITAL THERMOMETER

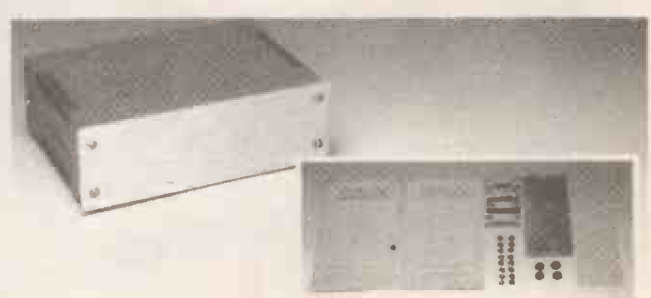
Dual channel inside/outside comparative temperature thermometer with dual readout display. Dual thermocouple, one internal and one on a 3m extension lead. Free standing or double sided tape attachment.

Temperature range	-50 to +70°C
Power	1 x P009H battery
Dims	107 x 25 x 13mm

COMPARTMENT BOXES

A range of three strongly constructed polypropylene compartment storage boxes with hinged lids. Semi-transparent finish.

F662	180 x 97 x 43mm	5 compartments	***£1.20***	*40+ 0.74*
F662A	185 x 142 x 42mm	9 compartments	***£1.60***	*40+ 1.03*
F662B	275 x 180 x 42mm	18 compartments	***£1.99***	*40+ 1.33*

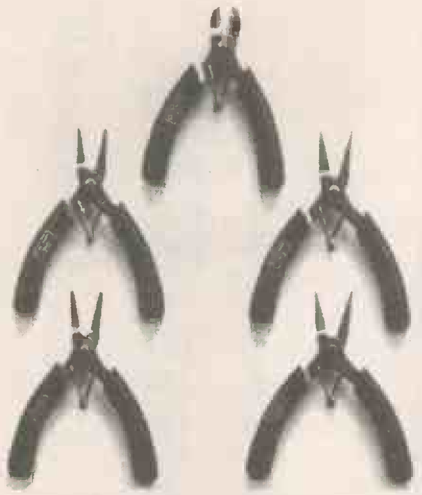


METAL CASES

A range of flat pack steel cases with aluminium front and rear panels. Rust proof finish, ready for painting.

Ref:	Size		
F660	80 x 46 x 85mm	***£3.96***	*10+ 2.65*
F660A	110 x 50 x 80mm	***£4.78***	*10+ 3.20*
F660B	140 x 56 x 110mm	***£5.96***	*10+ 3.99*
F660C	180 x 56 x 130mm	***£7.90***	*10+ 5.29*
F660D	230 x 56 x 190mm	***£10.99***	*10+ 7.37*

*PRICES IN **BOLD** TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT*



Y030B **£12.95**
5+ 8.01

PRECISION TOOL SET

5-piece precision, pressed stainless steel tool set with precision ground blades. The set comprises side cutters, bent nose pliers, round nose pliers, long nose pliers and flat nose pliers. Sprung, insulated handles.

Length........4" (100mm)

Y060S **£6.95** 10+ 4.42

PORTABLE SOLDERING IRON

Battery operated portable soldering iron. Powered by 4 'C' cells in the handle (not supplied). Tip heats up in seconds from operation of the biased off slide switch. Tip retracts into the body for safety. Supplied with one spare tip and 300mm of solder.

Power ....6Vdc (4 x C cells)
Dims..190 x 66 x 30mm

A150B **£6.95**

MINI VACUUM CLEANER 10+ 3.95

A battery powered mini vacuum cleaner which is ideal for removing the dust from turntables, cameras, video recorders, computer keyboards etc. 5 piece kit. Powered by four AA alkaline battieries (not supplied).

Power ....4 x AA alkaline batteries

Y006E **£6.95**
10+ 4.29

PRECISION MAGNIFIER

Precision made magnifer with a fixed focus. The lens fits directly over a graduated scale for magnified measurement. Metric and imperial scales. All metal construction. Folds down for storage in the vinyl wallet provided.

Dims......................53 x 48 x 39 (in use)
............................47 x 39 x 14 (folded)

Y012C **£9.95**
10+ 6.67

40-PIECE TOOL KIT

A 40-piece tool kit comprising a ratchet driver handle with a lockable knuckle, 100mm extension bar, 7 torque driver tips, 8 hex key tips, 6 screwdriver tips, 2 square drive tips, 1 hex to square drive adaptor, 7 metric sockets and 7 imperial sockets in a hinged plastic case.

Y006C **35p**
100+ 0.19

PRISMATIC MAGNIFIER

Credit card size prismatic magnifier. All plastic.

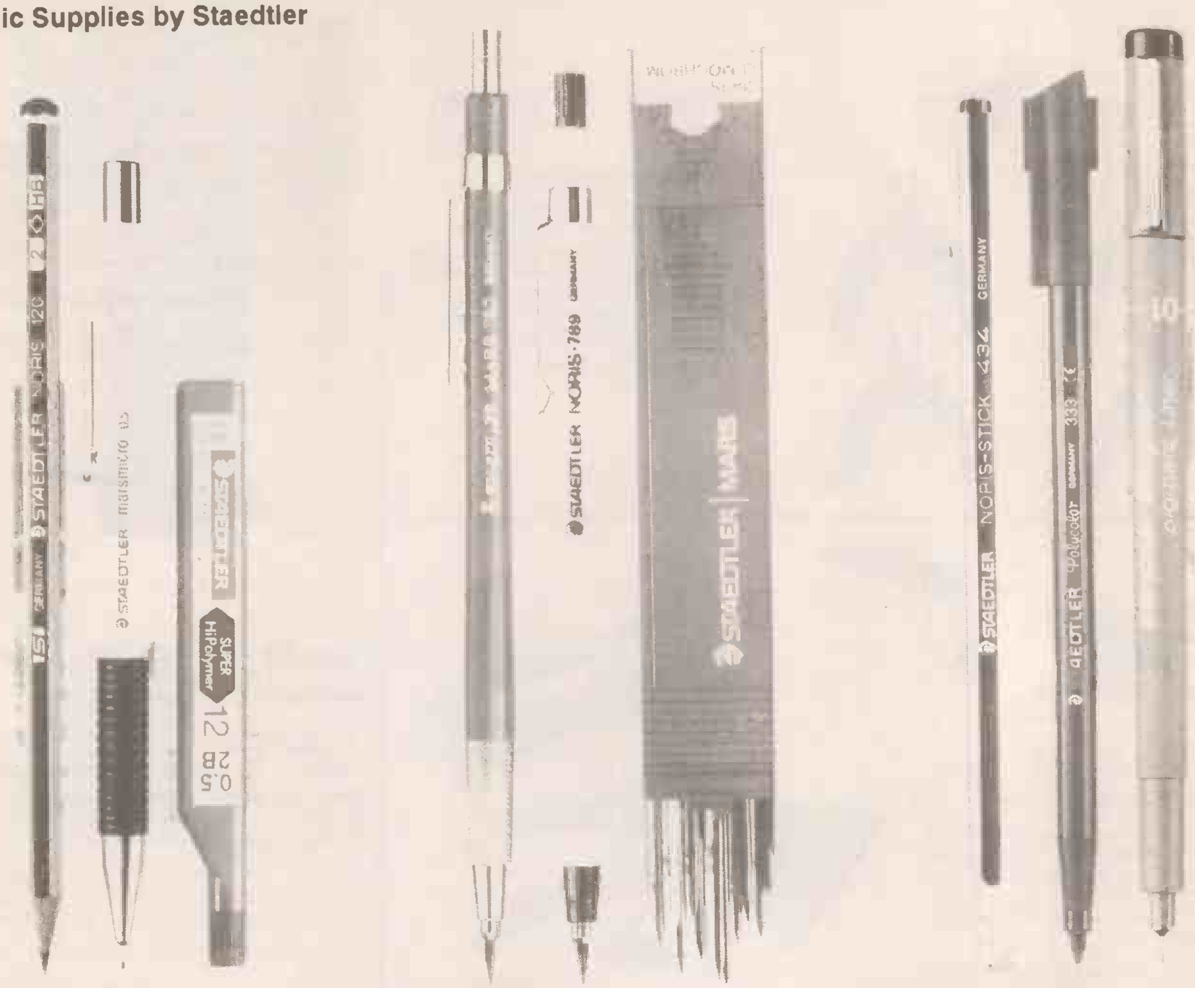
Y006D **£7.95**
10+ 5.29

GOOSENECK MAGNIFIER

2X magnification 3" diameter on a flexible 13" gooseneck with heavy base. Useful for close, precise work.

PRICES IN **BOLD** TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

Graphic Supplies by Staedtler



(a) Pencils
The Noris school and office pencil available in 5 colour coded degrees:

Code	Description	1-11	12+	144
S120-2B	2B Pencil	**24p**	0.17	0.14
S120-B	B Pencil	**24p**	0.17	0.14
S120-HB	HB Pencil	**24p**	0.17	0.14
S120-H	H Pencil	**24p**	0.17	0.14
S120-2H	2H Pencil	**24p**	0.17	0.14

(b) Propelling Pencils
Fineline propelling pencils. Available in 4 sizes for technical applications. Contoured slip-proof finger grip. Perfectly balanced for convenience and precision. Has 3mm retractible safety sleeve. Replaceable eraser with cleaning pin under push button.

Code	Description	1-9	10+	30+
S775-03	0.3mm lead	**£2.75**	1.95	1.56
S775-05	0.5mm lead	**£2.75**	1.95	1.56
S775-07	0.7mm lead	**£2.75**	1.95	1.56
S775-09	0.9mm lead	**£2.75**	1.95	1.56

Replacement leads. Fineline black leads with extraordinary point strength, slow wear and opacity. Supplied in tubes of 12.

Code	Description	1-9	10+	30+
S250-03	0.3mm HB lead	**£1.70**	1.20	0.97
S250-05	0.5mm HB lead	**£1.05**	0.74	0.60
S250-07	0.7mm HB lead	**65p**	0.46	0.37
S250-09	0.9mm HB lead	**65p**	0.46	0.37

(Available in different degrees of hardness to order)

(c) Lead Holders
The MARS Technico lead holder with sliding pocket clip. Lead sharpener built into the push button. For all 2mm leads.

Code	Description	1-9	10+	30+
S780CCA	Mars holder	**£3.25**	2.30	1.84

Lightweight plastic model for 2mm leads

Code	Description	1-9	10+	30+
S789OOC	Noris holder	**£1.85**	1.31	1.05

Lumograph 2mm leads for above holders, sold in boxes of 12:

Code	Description	1-5	6-11	12+
S2002B	2B leads	**£3.85**	2.72	2.18
S200B	B leads	**£3.85**	2.72	2.18
S200HB	HB leads	**£3.85**	2.72	2.18
S200H	H leads	**£3.85**	2.72	2.18
S2002H	2H leads	**£3.85**	2.72	2.18

(Other degrees from EB to 9H available to order)

Lumochrom Coloured 2mm drawing leads for use on paper or film. Pack of 12 assorted colours

S204S12	12 colours	**£4.10**	2.91	2.33

(d) Ball point pens
Ventilated caps. Fine point.

Code	Description	1-9	10+	30+
S430F-9	Black	**16p**	0.11	0.09
S430F-2	Red	**16p**	0.11	0.09
S430F-5	Green	**16p**	0.11	0.09
S430F-3	Blue	**16p**	0.11	0.09

(e) Fibre Pens
Low cost fibre tipped pens – 0.8mm robust point, ventilated cap. Available in a range of colours:

Code	Description	1-9	10+	30+
S333-9	Black	**25p**	0.17	0.14
S333-2	Red	**25p**	0.17	0.14
S333-5	Green	**25p**	0.17	0.14
S333-3	Blue	**25p**	0.17	0.14
S333-1	Yellow	**25p**	0.17	0.14
S333-W1	Pack of 10 assorted colours	**£2.50**	1.70	1.40
S333-W2	Pack of 20 assorted colours	**£5.00**	3.40	2.80

(f) Graphic Liners
Pigment liner, multipurpose fibre tip pen. Fade proof black pigment ink. Excellent reproduction qualities. In 4 line widths:

Code	Description	1-9	10+	30+
S308-01	0.1mm liner	**£1.45**	1.02	0.82
S308-03	0.3mm liner	**£1.45**	1.02	0.82
S308-05	0.5mm liner	**£1.45**	1.02	0.82
S308-07	0.7mm liner	**£1.45**	1.02	0.82
S308WP4	Plastic wallet with one each of the above 4 pens	**£5.80**	4.11	3.29

(g) AV Pens & Markers
A range of high quality Lumocolour markers with permanent waterproof ink that will write on all smooth surfaces. Fadeproof. Ideal for OHP - available in 8 colours. Ventilated caps.

Fine Points 0.4mm

Code	Description	1-9	10+	30+
S318-9	Black	72p	0.51	0.41
S318-2	Red	72p	0.51	0.41
S318-5	Green	72p	0.51	0.41
S318-3	Blue	72p	0.51	0.41
S318-W8	Pack of 8; one each black, red, green, blue, yellow, brown, orange and purple	£5.76	4.10	3.30

Medium Points 0.8-1mm

Code	Description	1-9	10+	30+
S317-9	Black	72p	0.51	0.41
S317-2	Red	72p	0.51	0.41
S317-5	Green	72p	0.51	0.41
S317-3	Blue	72p	0.51	0.41
S317-W8	Pack of 8; one of each as S318-W8	£5.76	4.10	3.30

Broad Points 1-2.5mm

Code	Description	1-9	10+	30+
S314-9	Black	£1.00	0.71	0.57
S314-2	Red	£1.00	0.71	0.57
S314-5	Green	£1.00	0.71	0.57
S314-3	Blue	£1.00	0.71	0.57
S314-W8	Pack of 8; one of each as S318-W8	£8.00	5.67	4.54

(h) Highlighters
In 3 popular colours. Universal pigment ink, lightfast for all types of paper including fax, telex and carbonless copy paper. Chisel point.

Code	Description	1-9	10+	30+
S364-1	Yellow	£1.10	0.77	0.62
S364-23	Pink	£1.10	0.77	0.62
S364-5	Green	£1.10	0.77	0.62

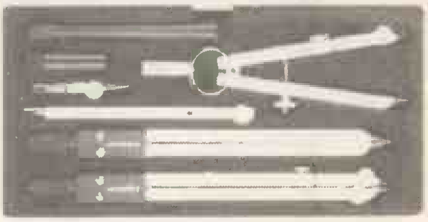
Marsmatic Techniset
S700C7 Compact desktop set with 2 slide out trays. Upper tray contains 3 Marsmatic 700 technical pens (0.25, 0.35, 0.5mm), 4 ink cartridges, an eraser, fineline pencil and tube of leads, and a compass attachment for technical pens. The lower tray is empty.
£29.30 5+ 20.79

Erasers

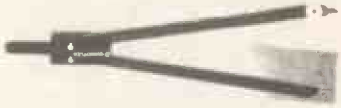
Code	Description	1-9	10+	30+
S526-B20	Rasoplast Soft white vinyl eraser 58x22x12mm	23p	0.16	0.13
S526BT30	Duoplast dual eraser. Removes ink and graphite	35p	0.25	0.20

S526-61 Rasor eraser pencil with brush
75p 0.53 0.42

Drawing Sets
High quality student compass sets. The Arco range Is sturdy and robust, and incorporates features normally only found on more professional models.



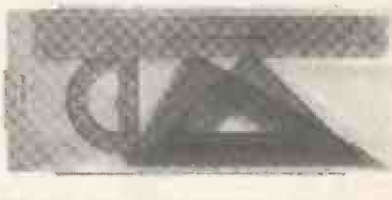
S559-09 Arco drawing set - compass, dividers, extn bar, springbow and lead box.
£9.95 5+ 6.66



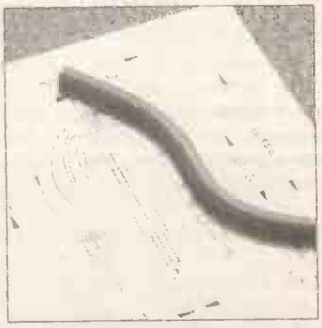
S559-50 Low cost school compasses and lead box £1.35 10+ 0.96

Rolling Ruler
Versatile instrument for drawing parallel lines both vertically and horizontally; drawing angles, circles, curves and arcs. Comes with full instructions.

Code	Description	1-9	10+	30+
S962-31	6" model	£4.50	3.19	2.55
S962-30	12" model	£6.25	4.43	3.55



S569-22 Set of 45° and 60° set squares, 6" ruler and protractor 75p 0.51 0.41

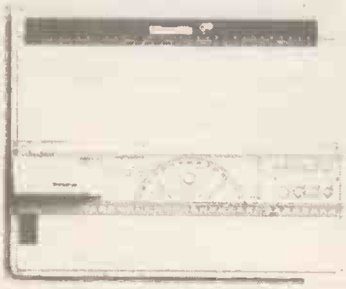


S971-12 Flexible Curve £2.60 1.92 1.63

S571-40 French curve set - set of 3 in plastic wallet £3.75 2.66 2.13

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

Drawing Boards
Portable drawing boards suitable for student and technical draftsperson alike. Advanced features make these quality products excellent value for money. They are made of especially break resistant plastic

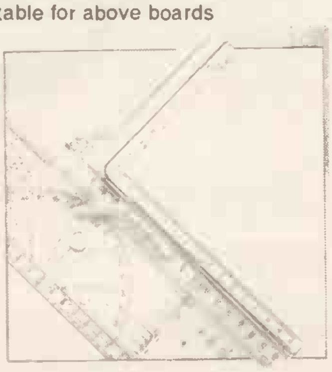


S661A4 DIN A4 size has perimeter guide grooves, a recessed sheet clamp with locking key, paper alignment edges and reduction scales. Fixmatic drafting arm has 2 guide grooves for a drafting head. **£24.95** 5+ 14.18

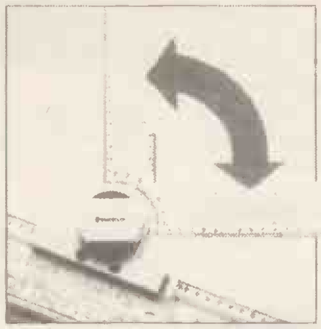
S661A3 DIN A3 size with fixmatic drafting arm **£34.95** 5+ 19.86

S660A3 DIN A3 Mars Technico drawing board with additional features a s shown for the professional. **£46.50** 5+ 26.38

Accessories
All suitable for above boards



S660-15 The quickmatic drafting head. Quickset angle can be set in the guide grooves and moved along the entire length of the drafting arm for hatching. Locks at 15° intervals. **£4.25** 5+ 3.62



S660-20 Variomatic drafting head – fits the guide grooves of the parallel drafting arm. It allows instant drawing of 30° angles, has opposing scales 0-90° and automatic locking at 15° intervals **£14.50** 5+ 8.23

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.

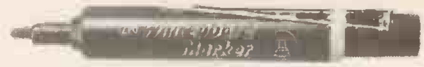
Code	Description	1+	12+	96+
KCB220K	Black	**70p**	0.43	0.34
KCB220R	Red	**70p**	0.43	0.34
KCB220G	Green	**70p**	0.43	0.34
KCB220B	Blue	**70p**	0.43	0.34

Textile Markers
Double ended pens to give a hard line (2mm) and a brush effect. Waterbased pigment ink exclusively for marking on cloth and fabric that once dry will not wash out. Available in a range of colours and packs as shown:

Code	Description	1+	12+	48+
KTC4000K	Black	**£2.23**	1.34	1.08
KTC4000R	Red	**£2.23**	1.34	1.08
KTC4000G	Green	**£2.23**	1.34	1.08
KTC4000B	Blue	**£2.23**	1.34	1.08
KTC4000Y	Yellow	**£2.23**	1.34	1.08
KTC4000A	Pack of 12 assorted colours: Black, Red, Green, Blue, Yellow, Brown, Orange, Violet, Grey, Pink, Light blue, Light Green.	**£16.92**	10.13	8.10

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

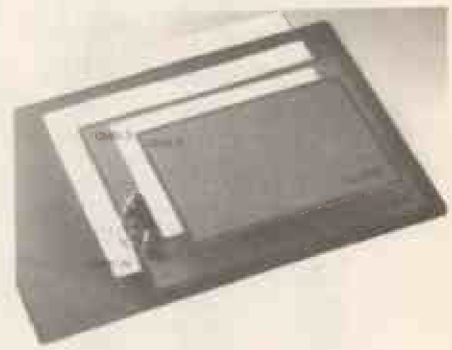


Whiteboard & Markers
A revolutionary new product – a flexible whiteboard! The Flexiwipe needs no fixing, just peel off backing sheet and smooth on to any non-absorbent surface. Easily removable for storage in tube supplied. Available in 3 sizes as shown:

Code	Description	1+	3+
FWA2P	A2 (594x420mm)	**£27.23**	15.73
FWA1P	A1(840x594mm)	**£55.46**	31.15
FW2M	2m x 930mm	**£126.12**	70.85

Markers for above and other whiteboards. Alcohol based ink that simply wipes away when dry. Sold in packs of 4 bullet tipped markers – Black, Red, Green and Blue.

Code	Description	1+	12+	48+
KOMW35	Pack of 4 pens	**£4.51**	3.17	2.54



Cutting Mats
High quality double sided green cutting mats with high durability and elasticity. Self healing surface on both sides. Printed with a 2mm grid.

Code	Description	1+	12+
CMG/ES	220x300mm	**£7.47**	4.20
CMG/S	300x450mm	**£14.95**	8.40
CMG/M	450x600mm	**£29.68**	16.67

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

Airbrushes
The Humbrol range of airbrushes and spray guns is designed to offer both modellers and graphic artists an inexpensive introduction to this medium.

H30003 Modellers airbrush designed to give a cost effective method of applying paint. Features include adjustable air jet pattern, air volume and paint flow volume adjustments. The set includes an aerosol power pack and three additional storage jars. **£19.95** 3+ 13.58

H30006 Hobbicraft airbrush set. This offers greater precision and finer atomisation than the above model. It features a dual action control trigger, controlling both paint volume and airflow, with an additional air supply volume control for attachment to aerosol power packs. Included in this set are an aerosol power pack and three spare storage jars. **£46.50** 3+ 31.66

Aerosol Power Packs

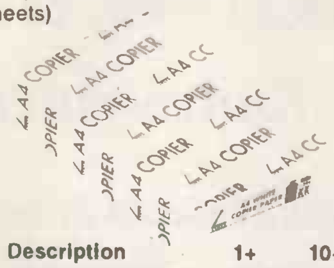
H30201	Standard size	**£2.95**	12+ 2.00
H30202	Large size	**£4.99**	12+ 3.40

OHP Film
Clear acetate film for overhead projection, also ideal for PCB layouts. Available in A4 size only, 0.1mm thick. Supplied in packs of 10 sheets

Code	Description	1-9	10+	30
S632-1021		**£1.60**	1.06	0.71

Other Stationary Products

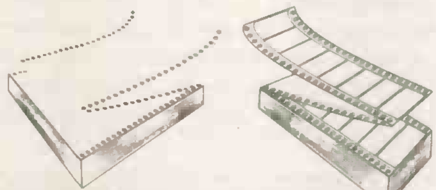
(a) Paper & Labels
80gsm high grade copier paper, sold in reams (500 sheets)



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.

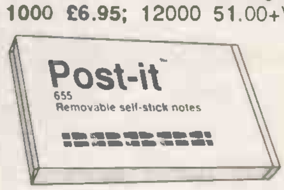
A703	A4 size 297x210mm	**£4.50**	3.30



Computer Paper
A458 Computer Listing Paper 11x9½" plain. 60gsm wood free, microperf. Sold in cases of 2000 sheets. **£15.00** 11.06

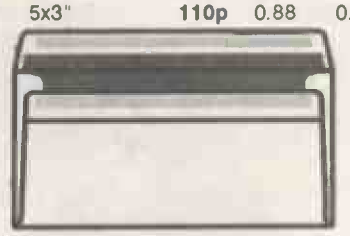
CL01 Continuous labels 3½x1.7/16". One label across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 8000 32.00+VAT

CL02 Continuous labels 4x1.7/16". Three labels across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 12000 51.00+VAT



3M Post-it notes.
The original removable self-stick notes, available in 3 sizes:

Code	Description	1+	12+	144+
S16	1½x2"	**36p**	0.28	0.23
S17	3x3"	**75p**	0.59	0.48
S18	5x3"	**110p**	0.88	0.70

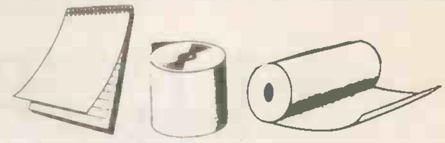


(b) Envelopes
White DL, size 220x110mm (takes A4 folded in 3) Self-seal. Sold in packs of 100

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

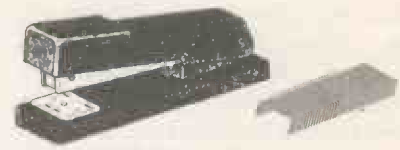
Code	Description	1+	10+
A716	80gsm gummed	**£4.20**	2.27
A717	80gsm self seal	**£4.60**	3.09



(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.



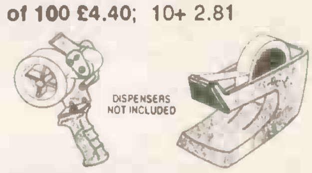
Stapler and Staples
R2 Office 26/6 metal stapler in black.
£4.50; 10+ 3.43

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**	

ELECTRONICS BOOKS

Reference Tools written for you!

Three books from a well-known and best-selling electronics author!

The Laser Cookbook
Gordon McComb

A hands-on introduction to laser theory and operation, with over 80 practical and easy-to-follow projects. These projects range from simple acoustic modulation of laser beam to super-accurate interferometers that precisely measure the speed of light, light wave-lengths, and light frequencies. Readers wanting to increase their knowledge of this subject should look no further than "The Laser Cookbook". ***"...provides a fascinating tour through the world of lasers. It is well written, amply illustrated, and lots of fun."***

(Modern Electronics)

404 pages Size 190 x 235mm
ISBN: 0830693904 £18.15 (SC)

The Complete Shortwave Listener's Handbook, 3rd edition
Bennett

The bible of shortwave for over a decade, revised and updated for todays electronics market. It has been expanded to include all the very latest equipment, procedures, and operating practices.This book will be a useful reference for all those interested in shortwave radio. All the basics of SWL are covered - receivers, antennas, frequencies, radio-wave propagation, how to keep a logbook, and prepare and send reception reports. ***"...a comprehensive guide to the basics of shortwave listening."***

(New Technical Books)

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ISBN: 0830626557 £13.55 (SC)

Designing, Building and Testing Your Own Speaker System
Weems

For those who would like to be able to build a durable, low-cost speaker system that is as good as or better than the most expensive units on the market, now they can, with this completely revised edition of David Weem's best-selling book. There is no better source of clear, step-by-step construction techniques and project plans than Designing, Building and Testing Your Own Speaker System.

224 pages Size 190 x 235mm
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The Robot Builders Bonanza
Gordon McComb

A collection of almost 100 tried and tested project modules that can be mixed and matched to create a range of intelligent and workable robot creatures. Clearly illustrated and fun to use, this is a must for electronics enthusiasts interested in the area of robots. The 99 different robot components described in this ingenious guide can be combined in an almost endless variety of intelligent and workable robots of all shapes, sizes, and abilities.

326 pages Size 190 x 235mm
ISBN: 0830628002 £14.45 (SC)

Compact Disc Player Maintenance and Repair Manual
Gordon McComb

Specific guidelines for maintaining and repairing more than 100 brands of CD players. Packed with quick and reliable answers to the problems of maintaining and repairing CD players, this illustrated do-it-yourself guide takes the apprehension out of first-time repairs. ***"A valuable accompaniment to a CD purchase...should be in the reference library of anyone who owns or is planning to own a CD player."***

(Midwest Book Review)

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Solid-State Electronics Theory with Experiments
Sanfilippo

Pragmatic rather than mathematic in approach, this book is a comprehensive introduction to solid-state technology. There are a number of interesting projects at the end of each chapter which reinforce concepts and allow readers to experiment with the solid-state applications described in the text by actually building circuits. Careful attention is given to how to test solid-state devices and how to design circuits using them.

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How to Build a Small Budget Recording Studio from Scratch - 2nd edition
Everest

This is an excellent book about small studios: how to build them and treat them acoustically, with emphasis on budget studios suited to the efficient day-to-day production of radio, audio-visual, film, and television recording. No special skills or training are required to use this book - it is of interest to anyone planning to build or remodel a small recording studio. The author has been involved with TV broadcasting since 1936.

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The Encyclopedia of Electronic Circuits - Volumes 1 - 3
Graf

This fully comprehensive best-selling series includes coverage of all aspects of the electronics world. There are fascinating insights into schematics for the latest available alarm amd security circuits; smoke, moisture and metal detectors; computer, fiber optic and laser circuits; and hundreds of other areas.

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The GIANT Book of Easy-to-Build Electronic Projects
Editor of Elementary Electronics

Here's a giant collection of useful, low-cost electronic projects for both the beginner and experienced hobbyist. Ranging from simple circuits to state-of-the-art electronic gadgets, there are dozens of fascinating projects that simply aren't available elsewhere. There are construction and assembly details, and printed circuit board templates reproduced in actual size

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Homemade Holograms: The Complete Guide to Inexpensive, Do-It-Yourself Holography
John Iovine

This is an ideal 'first-step' into the fascinating world of holograms. The author describes new procedures - using equipment readers can make themselves - that take the complexity out of producing simple white-light reflection and transmission holograms of people, as well as computer graphics, and solid objects.

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500 Electronic IC Circuits with Practical Applications
Whitson

Comprehensive and detailed coverage of 500 electronic IC circuits. Electronics enthusiasts will value the easy-to-follow practical circuit applications and will learn from the basic theory behind each one. A handy tool for anyone working with IC circuits.

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The Illustrated Dictionary of Electronics - 5th Edition
Turner

Featuring more than 27,000 entries, an exhaustive list of abbreviations, and appendices packed with schematic symbols and conversion tables, this is by far ***the*** most comprehensive dictionary of practical electronics and computer terms available today.

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The Thyristor Book - With 49 Projects
Delton Horn

With this new collection of 49 projects, the author simply and clearly demystifies these useful components. He explains in simple terms thyristor construction and operation and uses dozens of designs to illustrate the many practical application of thyristors.

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Physics for Kids: 49 Easy Experiments with Electricity and Magnetism
Robert Wood

An outstanding guide for young scientists to the phenomena of electricity and magnetism. There are exciting experiments such as: tracing a magnetic field with a bar magnet, tracing lines of force with a compass, making a battery, making a motor, and many more.

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R A Ford

The electronics ethusiast's guide to designing, building, and using classic high-voltage generators and associated equipment. There is a fascinating collection of experiments that reveal the wide-ranging impact of electrostatics on such topics as motor design, aerodynamics, gravity, photography, and meteorology.

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£3.95 **R.A.PENFOLD**
Utilizing the expansion slots for do-it-yourself projects is quite straightforward, and this book gives you detailed descriptions of the relevant parts of the PC. There are practical circuits for a number of projects including address decoder, simple TTL 8 bit input and output ports, 8255 PIA, D-A annd A-D converter circuits etc. In fact, all you need in order to produce successful PC add-ons.
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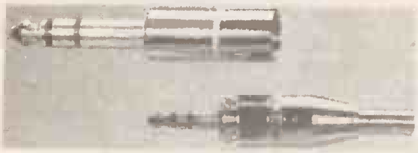
120 pages

If you like what you see in this supplement make sure you don't miss future bargains - only £2 (UK/ BFPO; £4 O'seas) for the next 6 issues - see order form for details.

LS037B - Great offer on 12" bass speaker! High efficiency woofer with rubber surround - wil handle 150W music power. Freq. response 20-3500Hz. Magnet weight 100oz, Overall weight 4.4kg. 8R impedance. Normally cost over £60 - **Our Offer Price £75 per pair**



F217G Metal stereo combination plug assembly. 3.5mm plug with metal spring outlet with adaptor togive 6.35mm plug. Assembly screws together to give compact solid unit. Would normally sell for over £1.00 each - **Our Low Price 2 for £1.00;** 100+ 0.25

FANTASY DECO ROPE

FDRI 9 meter long tube with 120 lights and special effects controller and power supply. Uses cool and long lasting LED's. 8 different programs on controller - chasing back and forwards at various rates. **£49.95**

SUPER HEADPHONE DEAL!

H8 Excellent quality Adastra stereo headphones with boom microphone. Freq. response 20-20,000Hz, 32R impedance. Microphone 600R. 2m leads fitted with 3.5mm plug for mic, and 3.5 mm plug +adaptor for headphones. Padded earpieces and leatherette headband.
ONLY £9.95

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High quality optomechanical mouse by Bondwell
- Microsoft compatible
- IBM PC XT or AT compatible
- Hardware selectable mouse standard
- Programmable resolution 29-1450 DPI
- High tracking speed 500 mm/s
- Silcone rubber coated tracking ball

Includes
- Universal mouse driver
- Performance Test Programme
- D9-D25 connector adaptor

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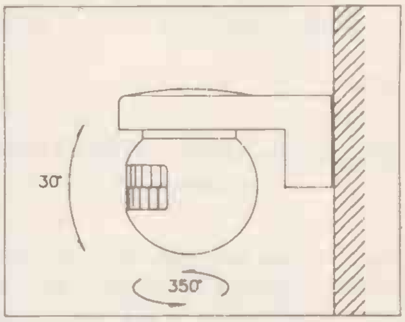
PRICE £24.95 6+ 16.10

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



SECURITY SENSOR

BPW1 Outdoor light control motion sensor. This automatic sensor is powered from the mains and will handle up to 1000watts. It has 110° elliptical view field, 9 meters on each side and 12m forward. Automatic turn on and off of lights.

Features:

Security - instantly reacts to intruders by turning light on
Sensing motion, turns on/off lights automatically in daylight
Adjustable light sensitivity and shut off time
Manual override
Easy installation
For both incandescent and fluorescent lights.

Ideal for outdoor areas:
- Front or back porch
- Deck or patio
- Secluded walkway
- Garage and driveway
- Cluttered areas

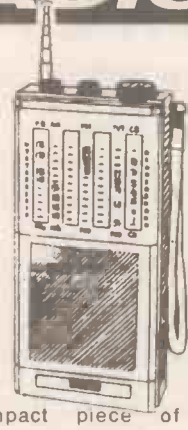
The globe shape makes adjustment exceptionally simple - just rotate to direction and angle required.. Overall size 110mmx100x75mm.
Price: £29.95 5+ 21.30

D90 TDK low noise high output cassette tape, normal bias **£1.20** 10+ 0.80

Goods sent in error

We have received a batch of leads which are not normally stocked - so we'd like to clear them at a Bargain Price!
Z5273 AV lead - 4 pin mini DIN plug both ends. 2m long
£1.95

MULTIBAND RADIOS!

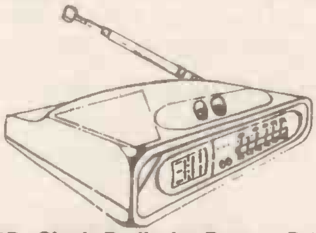


This compact piece of equipment 200 × 95 × 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume, squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

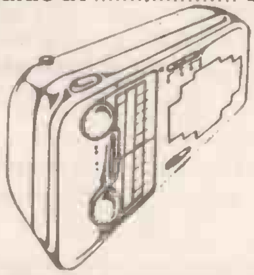
1) CB, channels, 1-80
2) TV1 54-87 MHz & FM 88-108 MHz
3) AIR 108-145 MHz & PB 145-176 MHz.

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

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

BARGAIN LIST 78

March 1992

Greenweld Electronics Ltd
27 Park Road
Southampton
SO1 3TB

Tel (0703) 236363
Fax (0703) 236307

The next few pages feature goods that have arrived recently - some are available only in small quantities, so don't delay, order today!!

Changes to Bargain Lists.

We're making a few improvements to our Bargain Lists to make them even more interesting reading!

Quite soon, you'll find included a few circuit ideas for the surplus parts we sell – maybe even a complete project or two. We know our customers' range of knowledge, ability and interests is extremely varied – from the novice who has problems identifying a resistor to eminently qualified experts engaged in design and research of leading edge technology – so we'll try and include a wide variety of ideas. Contributions are welcome, and any published will be paid for.

We're aware that some of our surplus comes without any information, and that this can be very frustrating, but the cost reflects this – the quantities involved are usually too small to justify chasing data. In future, those items that do include data will have a 'D' suffix to the Z number: i.e. **Z8963D**. If the info runs to several pages, there will be a seperate charge quoted.

Data can be supplied seperately at 20p per item + SAE if not ordering any goods

SWITCHES

The parts listed below have come from a manufacturer of aids for the physically handicapped. There's a lot more hardware to sort out, but below is a selection from this parcel. As you would expect, there are quite a few switches and relays:

(a) Microswitches

Z2486 Burgess type V12K 41x14x18mm, short lever SPCO, probably 15A rating. 2 for £1.00.

Z2487 Honeywell heavy duty with brass screw terminals and brass threaded plunger. SPCO rated 15A 380V ac. **£1.50**

Z2488 Std 5A microswitch with roller lever on steel bracket with steel plunger. **£1.20**

Z2489 Std 5A microswitch with plastic assembly enabling operation by blowing down tube. **£1.50**

Z2490 2 std 5A microswitches on plastic bracket with lever arrangement. Operate each switch by blowing or sucking. **£3.50**

(b) Other Switches

Z2491 Single pole heavy duty push switch with screw terminals made by Burgess, type KB5-A2 **2 for £1.00**; 100+ 0.30

Z2492 The above switch mounted in a plstic box 49x54x18mm with plunger assembly **£1.60**

Z2493 Very large light action rocker switch, SPCO. Lever is 43mm square. Clip fix mounting. **£2.00**

Z2494 Celing switch with pull cord DP on/off rated 30A 250V ac. Red bezel, but no neon fitted. **£2.50**

Z5258 Air operated indicator(?) Plastic box 83x40x34mm with rocker type top. 2m length of twin tubing – and by blowing or sucking the rocker moves. **£2.50**

Z5259 Twin version of above **£3.50**

Z5260 AEG LS07 contactor rated 600V 16A. 4 pole and subsidary circuit **£3.50.**

Z2495 Small suppressor 28mm long x 12mm dia by LCR. Rated 250V ac **2 for £1.00**

Z2498 Unimax high quality illuminated push switch, DP contacts. Needs 16mm dia fixing hole and takes wedge lamps. Available with green **(Z2498G)**, orange **(Z2498R)** or black **(Z2498B)** bezel. **£1.00**

Z8970 Lift control panel. Self contained metal box 265x90x60mm with fascia plate 292x100mm and 5 heavy duty double pole push switches fitted with 12V MBC lamps inside. **£15.00**

Z2387 PC mounting push switch – 1 pr make and 1 pr break contracts. Right angle plunger is 5mm long x 2mm dia. With protective cover. Again, very high quality. **2 for £1.00**

Z2499 Neat limit switch with lever and microswitch action, 1 pr make and 1 pr break contacts. 18.5 x 10 x 7.8mm. Lever is 30mm long. **4 for £1.00** 100+ 0.14 1000+ 0.10

Z2485 PCB mntg keyboard click switch, low profile, only 3.8mm thick. 10mm sq. SP make. **12 for £1;** 100+ 0.04

K591 Pack of 25 miniature toggle switches from page 125 of the 1991 catalogue **£4.00**

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**

FUSES

Thermal Fuse Offer

A job lot of thermal fuses allows us to offer these at much less than our normal selling price (60p each). Available in the following values:

Z2525 104°C short leads – 12.5mm long. **5 for £1.00** 100+ 0.10

Z2526 109°C full length leads. **3 for £1.00**; 100+ 0.15

Z2527 121°C one lead cut to 17mm. **4 for £1.00**; 100+ 0.12

Z2528 152°C full length leads **3 for £1.00**; 100+ 0.15

K834 Pack of 20 assorted thermal fuses (4 values), some with cropped leads. **£2.95**

Thermal circuit breakers. Voltage rating 32V dc, 250V ac. Right angle PCB mounting with manual off/reset button and aux contact. Size 20x6x10. DP 4.33

Z5191 2A rating **£1.00** 100+ 0.40

Z5192 3A rating **£1.00** 100+ 0.40

Z439 Wire ended fuse. 20mm 1.5A antisurge. **Pack of 20 £1.00**

Z2440 Miniature circuit breaker (MCB) rated 250V ac 1.5A. Size 51x40x19mm. Made by Heinemann. **Only £2.00**

Z2444 Protector 14A. This surge arrestor made by Beswickis designed to protect equipment from voltage surges. DP 5.27. Our prices: **£1.00 each,** 100+ 0.60, 1k+ 0.40

Z8962 8 way industrial fusebank, 32A 415V ac. Totally shrouded incoming terminal will accept conductors up to 120mm². DP(1987) 30.55. **Our clearance price £10.00**

HARDWARE

More Hardware - seems to be very popular, especially the smaller sizes for modelmakers. However, most of this lot is a bit on the large side - you don't really need M16 nuts to hold bit of veroboard in a case!!

K830 M8 screws/bolts. Good assortment from 16-90mm long c/s, hex, pozi, some hi-tensile. All steel! **Pack of 50 £3.80.**

K831 M10 Bolts - mostly high tensile hex head , lengths from 16-90mm. **Pack of 20 £3.20**

K832 M12 Bolts-mostly high tensile hex head, lengths from 40-150mm. **Pack of 10 £ 2.40**

K833 M6 pack. Excellent value - contains screws in various lengths and head. Mostly steel, some hi-tensile. **Pack of 100 £4.50**

K553 2BA screws - c/s, cheese, hex, pan heads, slot and pozi in lengths from 7-63mm. **Pack of 100 £2.60.**

Z7001 M16 Full nut-you really shouldn't be with out some of these! **Pack of 12 £1.00.**

Z7002 Threaded hoop overall length 490mm. Ends are threaded. M10 to a length of 75mm. They are 125 mm apart. **Pack of 3 for £1.00**

Z7003 M18 nut and hex bolt 30mm long. **3 pairs £1.00**

Z7004 M10 Masonry anchor. Drill 12.5 mm hole 40mm deep and insert. Use M10 screw to force anchor into brickwork. **Pack of 8 £1.00**

Z7005 Screw and nut pack- 1/4 " Whit: 25 each of 38mm C/S, 25mm C/S, 63mm (threaded 14mm) hex bolts and 25 mm (threaded 14mm) hex bolts +100 steel nuts. **Pack of 200 parts £5.00**

Z7006 Supertwin tufscrew, 8x1.25" combination pozi/straight pan head. Zinc plated. Great as woodscrews. **Boxes of 250 £3.00**

Z7007 M3 x 50 mm csk pozi steel screws. **Boxes of 250 £4.00**

Z9029 M4 x 50mm pan head pozi steel screws **50/£1.00; box of 200 £3.00**

Z9030 M6 x 50mm csk slot steel screws **16/£1.00; box of 100 £3.00**

Z9031 M8 x 60mm (23mm threaded hex head steel bolt **8/£1.00; box of 200 £12.00**

Z9032 M10 x 35mm hex head bolt HT steel **8/£1.00; box of 100 £6.00**

Z9033 M10 x 90mm hex head bolt HT steel **4/£1.00; box of 100 £12.00**

Z2373 M16 Full nuts, steel – **pack of 6 £1.00**

Z2374 M16 Half nuts, steel – **pack of 8 £1.00**

Z2371 5/16"x1" UNC hex head bolts. **A pack of 10 costs £1.00**

Z2372 3/8 x 1.25" set screws, hex head, **pack of 6 for £1.00**

Z2365 M6x16 Hex head set screws, pack of 25 for £1. **Box of 200 is £4.00**

Z2366 M6x1/4 as above. **Pack of 50 for £1.00**

Z2367 5/8" UNC half nut, **pack of 10 £1.00**

Z2368 5/8" UNC thin nut, **pack of 20 £1.50**

Z2369 1/4"x1.5" UNF hex head high tensile steel screws, **Pack of 25 for £1.50.** Box of 200, £8.50

Z2370 1/2"x1/2" as above, **pack of 10 for £2 or a box of 50 for £8**

K552 4BA Screw mix 200 **£2.75**

K812 M6 Screw mix **100 for £2.50**

K596 Pack of 200 assorted nuts, believed to be all BA , from 2BA to 8BA. Mostly steel. **£2.40**

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 a s 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**

K812 Pack of 100 assorted rivets **£1.80**

K813 Pack of 100 self tapping screws, sizes 4–8, lengths to 20mm most with pozi head **£1.50**

Z2378 T03 Silicone impregnated insulated washers. **Pack of 25, £1.00**

Z5175 High quality heavy duty ball type castor 63mm dia, chromed steel with brass insert with 9.3mm threaded insert. DP 6.25 **Our price £4.00**

Z5176 Smaller brown ball type castor 50mm dia made by Kenrick. Stel insert with 8mm threaded Insert. DP 3.15 **Our price £2.50**

Z2429 Black plastic foot 19mm dia x 5mm thick with 4.5mm dia hole. **Pack of 20 £1.00** 100+ .03

Z2375 High quality Sifam 1/4" collet knob S150, 15.5 dia x 14 high black knob, cap, and nut cover. **Pack of 10 of each £4.20**

Z5269 Olivetti cartridge ribbon - correctable carbon type 16.5mm wide x 120mm long, lexicart 90/92 Type No. 568N **£1.00 each**

Z5270 Black nylon ribbon type NCR 499 12.4 mm wide by Caribonum. Box of 4 **£2.00**

Z2502 Olivetti Summa Add ribbon. Twin spools, black **£1.00.**

Z23154 Nylon printer ribbon type N465, ref KSR430. Boxed. **£1.50**

NEWSLINE weekly update on new stock. Call 0891 505121 (48p per min. peak 34p off peak)

Z2437 Nylon stand off 2.5mm high. OD 5.8mm ID 3.2mm. **Pack of 1000 £3.00**

Z2438 White plastic oblong stand off (for 7 seg LED's) 19.5x10.2x12.2mm high. **Pack of 100 £2.00**

Z5261 Orange ABS case by boss, type 2002. 100x50x25mm. Threaded brass inserts and PC slots. 2 BIMdaptors included. DP 1.56. **Our price 80p**

Z9028 Strong compression spring 125mm long x 31mm dia. **£1.00**

Z2431 Compression spring 62mm long x 12 mm dia. **Pack of 6 £1.00**

Z5177 Self adhesive grey cable clip 38mm long. Will take up to 6mm dia cable. DP 3.48. **Pack of 20 £1.00** 10+ packs 0.60

Z2391 Cable gland in black nylon for 8–13mm dia cable. **Pack of 5 £1.50**

Z2392 As above best for 7–10.5mm cable. **Pack of 5 (DP 2.22) £1.20**

Z5152 Plastic Bits. 100 assorted stand offs etc. **£1.00**

Z635 Digital multimeter case DP2010, 110x80x20mm with cut outs for switches and terminals. Aluminium fascia plate. **2 for £1.00**

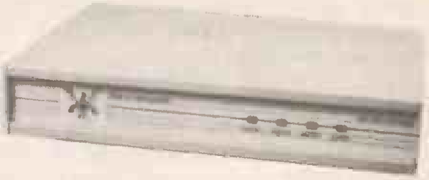
Z343 Ceramic insulating beads. **Pack of 100 £1.00**

Z1669 Veropins, wirewrap 18–0226. **Pack of 500 £2.00**

Z2443 TO3 heatsink – bolts on top of transistor using same fixing screws. Diecast ally 25x41x27mm. 7.3°C/W.DP 1.93. **Our price 75p**

Z2381 Small heatsink, 25 x 7 x 6mm, for sticking on top of DIL IC's. **Pack of 5 £1.00**

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**

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

SEMICONDUCTORS

MICROPROCESSOR CHIPS

P8035AHL Intel 8 bit CPU, 11MHz **Our Price £3.00**

8051AH Phillips 8 bit CPU **Our Price £1.00**

M80C31F OKI 8 bit CPU 16MHz **Our Price £2.00**

N8097-90 Intel 16 bit H-MOS CPU 12MHz PLCC 68 pin. DP 13.86. **Our Price £6.00**

R80C186-12 Intel 16 bit CMOS CPU. 12MHz clock. PLCC 64 pin. DP 28.37 **Our Price £12.00**

CP82C59A CMOS programmable interrupt controller. DP 3.00 **Our Price £1.50**

P8256AH UART, DP 7.00 **Our Price £2.50**

Z2507 L4962 1.5A switching regulator, 16DIL. 5.1-40V. DP 2.50 **Our Price £1.50**

Z2513 L4960 2.5A switching regulator, 7 pin TO220. 5.1-40V. DP 2.64 **Our Price £1.80**

Z2508 LF13331 quad SPST J-FET analogue switch. 16DIL. DP 7.58 **Our Price £3.00**

Z2509 OPA27 low noise precision op-amp 8DIL. DP 1.86 **Our Price £1.00**

Z2510 SL670C gain controlled pre-amp. 8DIL DP 2.31 **Our Price £1.50**

Z2511 TCA785 16DIL chip by Siemens **£1.50**

Z2512 LF398N sample and hold amp 8DIL. DP 2.64 **Our Price £1.50**

Z2514 ZTX751 PNP TO92 transistor rated 80V, 2A, 1W. DP 0.48 **Our Price 5 for £1.00**; 100+ 0.14; 1k+ 0.10

Z2524 2N3703 PNP TO92 transistor rated 50V 0.2A 360mW. Our normal price is 12p. Surplus stock offered at **15 for £1.00**; 100+ 0.04; 1k+ 0.025

Few SGS Chips:
Z2481 M491BB1 List 11.10. **Our price £4.50**
Z2482 M293B1 List 7.40. **Our price £3.00**
and an ITT chip:
Z2483 SAA1293-02 List 7.64. **Our price £3.00**

Z2484 2N3903 TO92 transistor. **12 for £1.00**; 100+ 0.04

Z2112 Ceramic filter 5.5MHz by Murata. **5 for £1.00**

Z2515 VN2410L TO92 N-channel MOSFET. 1A 0.4W. DP 1.08 **Our Price 3 for £1.00**; 100+ 0.18; 1k+ 0.14

Z2516 AD517JH TO99 converter **£3.00**

Z2517 LM350K steel variable voltage regulator, 1.2 to 33V at 3A. DP 7.20 **Our Price £3.50**

Z2523 TICP106D TO92 SCR rated 400V 100mA. DP 0.56. **Our Price 6 for £1.00**; 100+ 0.09; 1k+ 0.06

Z2518 BYT13-1000 fast recovery diode rated 3A 1000V. Plastic body, axial leads. DP 0.35 **Our Price 5 for £1.00**; 100+0.13; 1k+ 0.09

Z2519 AD667JN 28DIL D/A converter, 12 bit uP compatible. Extremely flexible. DP **£28.18 Our Price £10.00**

Z2520 SN75372 8 pin dual MOSFET driver. DP 1.74 **Our Price £1.00**

Z2521 Crystal, HC60 20.000MHz. **Only 50p** 100+ 0.25

Z2522 Watch crystal 32.768kHz, case 2.7mm dia x 8mm. **Pack of 3 £1.00** 100+ 0.15

OPTO

Z2498 Toshiba TLC501 LCD. 24 x 2 line display with standard connexions (supplied). V. similar to our **Z2171 £9.95**

A couple of small matching rectangular LED's, 3.8 x 1.75 mm :
Z2500 Green **Pack of 12 £1** 100+ .05 1k+ .04
Z2501 Red **Pack of 12 £1** 100+ .05 1k+ .04

Z2505 HCPL2531 dual optocoupler, 7% CTR. DP 3.52 **Our Price £1.00**

Z2506 HCPL2630 dual optically coupled high speed logic gate. DP 5.24 **Our price £2.00**

Z1935 LED clip for right angle mounting to PC board. Plastic holder for 5mm LED has 2.3mm dia spigot. Great value at **40 for £1.00**; 1000+ 0.015

PANELS

Z5264 Handy black plastic panel 102 x 22mm with 5 pin 180° DIN skt, 2 phono skts and a single wire aerial/earth socket. Pack of 10 £1.00 100+ 0.05 1K+ 0.035

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**

Z5262 Panel in the Z5089 etc. series as listed in main Bargain List. This one has 8 x 2764 in sockets + 10 74LS chips. **Only £4.00**

Z2529 Thick film circuit - small PCB 51x12mm with 13 surface mount transistors. R's are etched into substrate. **Pack of 5 £1.00**

Z4252 Seat belt alarm kit. Just a few of these remaining at **£3 each**

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.

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!!**

SOFTWARE

COMMS SOFTWARE
A few odds and ends delivered with a parcel. As far as we can see, all are new and complete as described below:

Z6003 Multicom - handbook + 5.25" disk for Epson QX10/4.1A

Z6004 Multicom - handbook + 3,5" disk for Apricot PC/XI 4.24

Z6005 Multicom + handbook + 3.5" disk version 4.16

Z6006 Vicom - handbook + 5.25" disk for Apple

Z6007 Sage Chit-Chat - Handbook + 3.5" disk for Apricot V2.2

Z6008 Dial-Up Educational - handbook + 5.25" disk + dongle for RML480Z

Z6010 Dial-Up Educational - handbook + 5.25" disk for RML Nimbus

Z6011 Dial-Up Personal - handbook + 5.25" 80 track disk for BBC B, B+ & Master

Z6013 Dial up Personal - handbook + 3" disk for Amstrad PCW

All the above are at the same price - now reduced to just **£10.00 each** - please give 2nd/3rd choice as numbers are very limited.

Z4266 Software tape for Spectrum - "Mountains of Ket". Returns - may not work. **4 for £1.00**

SOUNDERS

Z2376 Sub-min buzzer 12 dia x 8mm high. PC mounting by Star QMB111P. **Only £1.00**

Z2377 Star CMB 6V buzzer 22.5 x 15.8 x 14.4 mm. PCB mounting. High quality, low cost - **only £1.00**

Z1771 Sounder QMB06 by Star. **3 for £1.00**

CONNECTORS

Z042 2 pin DIN speaker sockets, PC mntg. **Pack of 25 £1.20**
Z4350 A set of 3 different pairs of test leads, offering great value! – a) 67mm long, 2mm probes both ends; b) 110mm long, 2mm probes one end, 4mm plugs the other; and c) 90mm long silicon rubber, 2mm probes one end, shrouded 3mm sockets the other. All are red and black pairs. **All three for just £2.00**
Z739 40 way DIL header plug, gold plated. **3 for £1.00**
Z1485 RC4200-8S 8 way gold plated socket – matches McMurdo red range, but blue **£1.50**

Edge Connectors
Z1828 31 way double sided 0.1" pitch gold plated PC mntg **£1.00**

Z1668 38 way single sided 0.1" pitch solder tags. **40p**

Z5117 19 way single sided 0.1" pitch – takes flexible wiring and locks into place. Sample free. **20/£1.00**; 100+ 0.03; 1k+ 0.02

Z2504 PS2 Keyboard adaptor 6 pin mini -DIN plug to 5 pin 180° socket. Carded. **£2.00**

Z2504 Useful battery holder - 3AA side by side with lead and attached. Supplied with double sided sticky pad. Bagged. **25p**

Z5265 9 way ribbon cable just under 1m long with 10 pin DIL plug (0.1 pitch) one end and 9 way header skt the other. Pack of 10 leads £2.00

SURFACE MOUNT

SURFACE MOUNT SURPRISE !!

A parcel of 650,000 devices has been purchased and reveals a wide selection of mainly transistors and resistors. We're selling this in a variety of packs as described below :

KS102 Transistors – about a dozen different types plus a few diodes, mostly SOT23. Type numbers include BCF29/30, BSR15, BC856, BCV71, BCW29/71/72/81. Supplied with code sheet. **Pack of 100 for £3.00**

KS103 Resistors. 0.125W 2% in a range of values from 3R3 to 10M. Although there is a fair range (about 50 values), many are E24. **Pack of 1000 for £3.00.**

ALSO AVAILABLE INDIVIDUALLY ARE THE FOLLOWING PARTS:

Type	Mark	P/N	Equiv	Vceo	Ic	£1 pk	100+	1k+
BC856	3AR	P	BC556			15	.03	.02
BCF29R	C77					15	.03	.02
BCF30R	C9	P	BC559			12	.04	.03
BCV71	K7	N	BC546A	60	0.1	15	.03	.02
BCW29R	C4,	P	BC558A	20	0.1	15	.03	.02
BCW71R	K1,4	N	BC547A	45	0.1	15	.03	.02
BCW72R	K5	N	BC547B			15	.03	.02
BCW81R	K31	N	BC547C			15	.03	.02
BSR15R	T71	P	2N2907			12	.04	.03

(b) Diodes
BZX84 – C18V(Y6) 18V 350mW zener. **Pack of 10 for £1.00.** 100+ .05 1k+ .03

RESISTORS

Z320 1 Watt wirewound pots – 2 additional values, 250R and 1k.
Z761 0R056 wirewound resistors 10% type HWR21. 0.5W **10 for £1.00**
Z1983 Thermistor, pack of 20, type VA1040. **£2.00**
Z414 30M 10% resistors. **Pack of 10 £1.00** 100+ .06
K446 Bourns mini cermet trimpot type 3362. 200R. **3 for £1.00**

SIL networks In original packing. 9 pin, 8 resistors. DP 38p. Available in these values, all the same price: **Pack of 10 £1.00**; 100+ .05; 1k + .04
Z5195 330R
Z5196 10k
Z5197 47k

Z2394 TO5 case cermet trimpots type 81E. Value 50R. **Pack of 6 £1.00.** Plastic case of 50 £4.00. 10+ cases £3.00

Z2359 miniature pot 17mm diameter with 6.75mm bush and splined spindle, PC mounting. 1k lin. **Pack of 4 for £1.00.**

Z2388 Plastic stand-off for 3/4" trimpots (our 75CER type) **Pack of 50 £1.00**

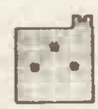
Z5208 PR52 2.5W wirewound resistors, 10k. **In boxes of 500 £5.00**

Z5209 As above but 1k2. **Box of 500 £5.00**

Some more Diplohmatic trimmers, to go with those on page 35 of B/L75

Type156 (like 146)
Values available:
200R 500R 10k 20k 50k 100k 500k 2M
Prices (any mix) 1+ 56p 100+ 0.28

Type 382
Value available: 500R
Price 1+ 44p 100+ 0.22



382

Type 386: (like 383)
Values available:
1k 10k 50k 100k
Prices: 1+ 44p 100+ 0.22

386

Z2447 Siemens dual thermistor type P6350. **Pack of 10 £1.00** 100+ 0.05

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 **£4.00; Box of 20 £60.00;** 100+ 2.00; 1k+ 1.70
Z5147 4700µF 100V 105x51mm dia **£3.00; Box of 35 £70.00;** 100+ 1.50; 1k+ 1.20

STOP PRESS -STOP PRESS-STOP PRESS-STOP PRESS-STOP PRESS

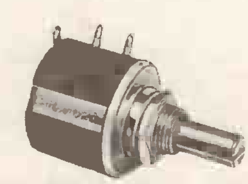
Z5292D 'Power one' power supply. Conventional unit, 120/240V input, output 15V @ 1.5A fully stabilized. Part enclosed size 123x102x54mm. Comprehensive data supplied **£10.00**

Z5293D 'Power One' power supply. Conventional unit, 120/240V input, outputs +5V @ 2A; + or –12V @ 0.4A; –5V @ 0.4A. Each output uses a 723 regulator and has a preset for adjusting voltage. With data **£14.50**

Z5289 Push button bank – 11 switches, all DPCO interlocking. **£1.00**

Z5290 Push button bank – 6 switches, 4 interlocking DPCO and a further 2 DPCO interlocking **60p**

Z5291 Push button bank – 6 switches, 4 interlocking DPCO and a a further 2, one non-locking DPCO, the other locking 4 pole changeover. **60p**



Z2530 Precision helical pot by Spectrol, model 534. 3Watt 10 turn, linearity ±0.25%. Value 100R ±5%. DP 4.23 Our Price **£1.00**

THE POW-POW-POWER PAGE!!!

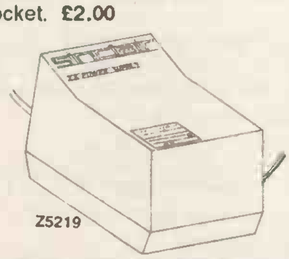
Some great value power supplies - both conventional and switched mode - all offered at a fraction of their original cost!!

Z5278 Plug in wall type, 24V ac 100mA output on 2m lead. **£1.75** 100+ 1.10

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

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**

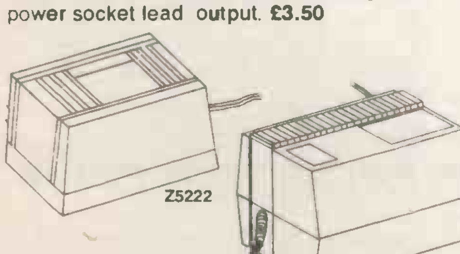
Z5227 Plug in 240V ac Beautronix power supply. Output 9V 333mA on 2m lead with 2.5 power socket. **£2.00**



Z5219 Sinclair ZX powers supply model UK700. 240V ac in, 9V 0.7A DC out. 2 core mains lead. 3.5mm jack lead output. **£2.50**

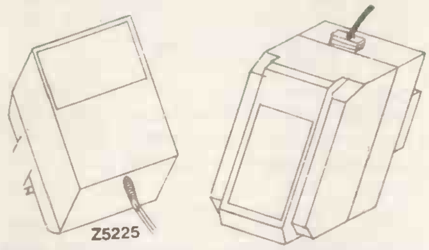
Z5220 Sinclair ZX powers supply model Euro1200. 220V ac in, 9V 1.2A DC out. 2 core mains lead. 3.5mm jack lead output. **£3.00**

Z5221 Sinclair ZX powers supply model Euro1400. 220V ac in, 9V 1.4A DC out. 2 core mains lead with 2 pin Euro plug. 2.1mm power socket lead output. **£3.50**



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**

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**



Z5225 Universal mains adaptor, plug in type 240V aç. Output switchable 3-6-9V @ 300mA on end of short lead with 2 pin socket **£2.00**

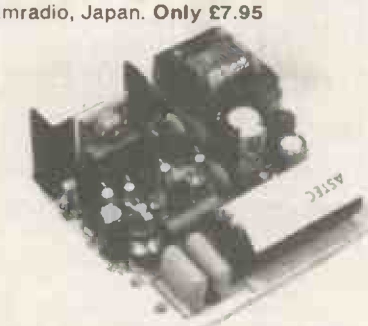
Z5226 Plug in 240V ac unlabelled power supply with short lead and 5 pin DIN socket. Outputs: 18V @ 250mA ac and 10V @ 500mA ac. **£3.00**

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**

SWITCH MODE PSU's

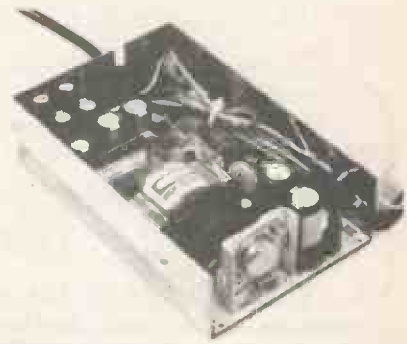
Z5256 Switch mode PSU made by Tamura Corporation. Board 195x100mm with outputs on PCB pins. Input 120/240V ac; Outputs: +5V @ 7.5A; +12V @ 1.25A (2A peak); -12V @ 0.1A. **All this for just £12.95**

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**



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**

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**



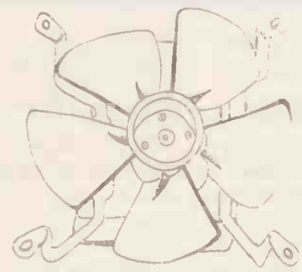
AA12531 Switch mode PSU by Astec partially cased. 160x104x45mm overall with 160x100mm Eurocard PCB. Inputs and outputs are on colour coded flying leads. Input 115/230V 50/60Hz. Outputs: +5V @ 5A; +12V @ 0.15A. Total wattage 50W.
£6.95; 25+ 5.43; 100+ 4.53

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

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

MOTORS



Z5171 Open construction mains fan. Five blade plastic blade 110mm dia (easily removable). Ex-equip in good condition, **£2.50.**

Z5246 Mains synchronous motor with easily accessible gearbox giving a final speed to the 5.5mm dia 12 toothed gearwheel of 0.2RPM (12 revs per hour). **Only £3.95**; 100+ 2.50

ARE YOU A BARGAIN LIST SUBSCRIBER? DON'T MISS THE BARGAINS!!

CAPACITORS

Z5218 22,000µF 16V electrolytic can 35mm dia x 102mm long. Tag ends. Silly price – **only £1.00 each**

K265 4700uF 40V Phillips can, PC mntg 47x35 dia. **2 for £1.00**

Z5180 1000uF 10V radial electrolytic by Nippon 13 dia x 25mm. **Pack of 10 £1.00** 100+ 0.05

Z5181 330uF 16V radial electrolytic by ITT. 13dia x 21mm. **Pack of 14 £1.00** 100+ 0.035

Z5274 40 µF 2.5kV capacitor by Bosch. Size 155x100mm dia. Superb quality **£3.50.**

Z1529 0.22uF ceramic cap. 5mm pitch. **Pack of 30 £1.00**

Z1965 0.01uF disc ceramic 6mm dia. **Pack of 40 £1.00**

Solid dielectric trimmer caps in 3 values, all PC mounting:

Z2454 5:5pF Phillips 808 series, polyethylene film DP 36p **8 for £1.00**; 100+ 0.06

Z2455 10pF Phillips 809.05 series PTFE film. DP 1.66 **3 for £1.00;** 100+ 0.15

Z2456 18pF As above, **3 for £1.00;** 100+ 0.15

PANELS

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!**

Z5217 Relay panel – Eurocard 160x100mm with 64 pin DIN41612 plug, containing 8 x Omron G2V 24V min DPCO, LS00, 125 and 14 all in sockets, 4 red LED's, R's, C's, etc. **£2.00**

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**

Z5231 Memory panel, contains 208 4164 64k RAM chips all in sockets. **£30.00**

Z5232 As above, but chips are soldered in. **£20.00**

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.

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**

Z5205 Larger diecast housing 252x140x57mm with 2 PCB's each containing a number of HF parts, pot cores, crystals, etc. These are input modules – 1 traffic and 1 data panel **£4.40**

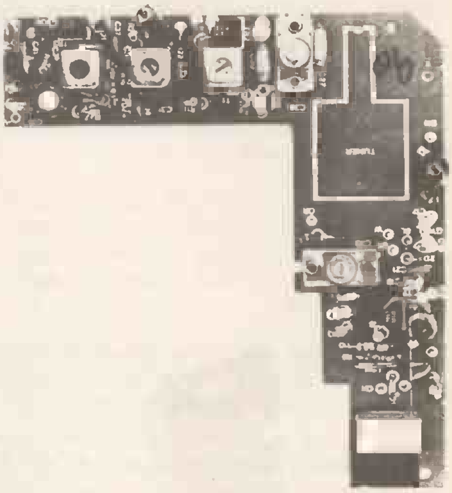
Z4295 Although listed in our main Bargain List, we have large stocks of this panel, and it's not selling very quickly – although it contains a number of interesting and useful parts. There's a 27C64 Eprom in a socket, 80C85A microprocessor, 2x82C51A support chips + 5864 RAM, as well as 8x74HCT chips. There's a small length of ribbon cable to a small sub-panel with 2xMC1488 and 1489, and 3 DIL header plugs. These error correction cards by Tulsedata originally cost over £70 each – they were in last year's catalogue at £10, reduced this year to £5. Will you buy them at **£2.50?**

Z1641 PCB. Printer driver board by Teijin. Contains M5L8041A, 8x74 series, 3.579545MHz xtal etc **£2.00**

Z5167 'S' module-like Z492/3. 11 pin plug in module 80x50x50mm with a small PCB inside containing 2xBC184L, R's, C's, etc. **4 for £1**

Z5210 Power supply panel – PCB 150x65mm that has been partially assembled but nit soldered. Contains 79M05, 741, BDX339, FRC730, 4x1N4001, 10,000uF 10V cap + R's, C@s etc. (No transformer) **Only £1.00**

Z5211 Another smaller PSU panel 97x55mm, again not soldered. Each board contains 9x1N4001, 121C thermal fuse etc. **8 panels (72 rects) for just £1.00**



Z911 Found some more of this useful 135x135 L shaped panel – nearly a complete radio front end. Although the tuning cap is missing, there are 2 trimmers, IFT's, lots of R's and C's, 2xBF241 FET, BF194, BC208A, 2xBC148C, 2xBC149C etc. Best of all, the board hasn't been soldered, so the components are easily removeable. All this for just **£1.00**

OPTO

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

Z2435 Single 7 seg LED 10mm high digit. Type LN514RK. Common cathode. **4 for £1.00;** 100+ 0.15; 1k+ 0.10

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**

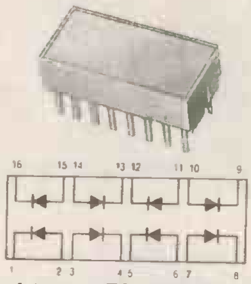
2 more LCD's in small quantities, both fitted with pins;

Z2357 6 digit 0.5" 50 pin device **£2**

Z2358 2 digit 0.5" 18 pin device **£1**

Z2432 LCD 8 digit 10mm high. Single sided 36 way edge connector. **Only £2.00** 100+ 1.00 1k+ 0.80

LED BAR MODULES



A couple of large LED light bars in 16 DIL package, 10mm high. Made by HP.

Z2462 HLMP2685 HE red 80mcd @ 20mA. DP 2.19. **Our price £1.00;** 20+ 0.70

Z2463 HLMP2785 Yellow 70mcd @ 20mA. DP 2.19. **Our price £1.00;** 20+ 0.70

Using these. you could build up a massive 7 seg display - each module being 1 element. (In practise, to maintain proportions, you'll need 10 displays for each 70mm high digit - details on request)

Z1854 7 seg LED 81720R - giant 1" digit, red. Common anode. **£1.00 each**
Z1855 As above but common cathode **£1.00**

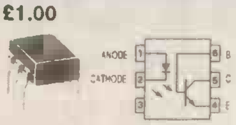
Z1857 Single 7 seg LED LA6480, matches above - green 0.56" **4 for £1.00**
Z1858 7 seg LED LA301MA green 0.3", CA. **4 for £1.00**
Z1859 7 seg LED LA301MK green 0.3" CK **4 for £1.00**

Z2436 3mm red LED's with preformed cropped leads 7.5mm long. Super buy for quantity user - **pack of 100 £3.00** 1000+ 0.02

Z2461 PC mntg packaged red LED - mounts at right angles to PCB. 10.5x8x3.9mm. LED is 3mm. Ore type 9301A. **Pack of 10 £1.00** 100+ 0.05; 1k+ 0.04

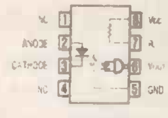
Z1934 Stackable red LED - white casing round 6x3.5mm. **Pack of 10 for £1.00**

Z1932 Red square LED with rounded corners, 5mm. Pack of 15 **for £1.00**
Z1933 Thin rect. red LED - 5x1.5mm. **Pack of 20 £1.00**



Transistor

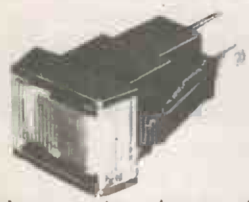
Z2467 4N25 optocoupler - transistor output. DP 0.80. **Our price 3 for £1.00**
Z2469 CNY17-1B optocoupler, transistor output 6DIL. DP 0.67. **3 for £1.00**



HCPL2300

Z2470 HCPL2300 optocoupler by HP. Logic gate output. DP is astaggering 6.33 - **our price £2.00**

Z2466 ILQ1 16 pin DIL device, probably quad opto isolator, but no info. **2 for £1.00**



Lampholders - rectangular snap in type that take LES bulb. Needs 16.1x11.6mm cut-out. DP (1978) 92p
Z5193 Red **3/£1.00** 100+0.15
Z5194 Green **3/£1.00** 100+ 0.15
Z2385 6V 5W SBC bulb. **Box of 10, £1.50**
Z2459 Neon bulbs 5.5mm dia x 15mm long - wire ended 90V neons at a great saving over normal prices! Made by VCH International. **In packs of 100 at £4.00** 10+ 3.00

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Fibre Optic Cable

Z5245 Fibre optic cable, multistrand sheathed, 2.28mm od, 0.095mm sq. Type A181. **Approx 5m length £4.00**

Z2476 Similar to above, but 3.6mm od. **£2/metre**

Z2477 Single strand 1mm dia. **Approx 5m length £2.00**

Z2478 Single strand 0.2mm dia. Approx 10m (may not be in one length) **£2.00**

SEMICONDUCTORS

(a) Diodes

Z2439 BZY88C36. 36V 400mW zener diodes. **Pack of 100 £2.00.** 1000 £10.00
Z2465 Dual fast recovery diode BYW51-150A 150V 20A. TO220 case. DP 0.99. **Our price 2 for £1.00**
K129 8 AA113 diodes **£1.00**
K197 50 AA139 diodes preformed for horiz. mntg **£1.00**
K237 200 SD3 diodes, 2 joined back-to-back, preformed **£1.00**
K242 10 S2AR2 rects, 200V 1A **£1.00**
K283 100 1N922 silicon diodes preformed **£1.00**
K285 25 CV8790 signal diodes **£1.00**
K286 10 Germanium signal diode **£1.00**

Z2454 MPS5010 1.2V voltage ref, 2 pin TO92. **3 for £1.00** 100+ 0.15

Bridge Rectifier Clearance

Z2347 4A 200V in line **6 for £1.** 100+.09 1k+.06

(b) Transistors

Z2383 2N6027 P.U.T DP 49p, Our price **6 for £1.00** ;100+.08 1k+ .05

Z2384 MPSA13 30V Darlington TO92 transistor. Hfe 10,000 @ 0.1A DP 32p. **Pack of 8 for £1.00.** 100+ .06 1k+ .04

Z2453 TIPL762 NPN 6A 120W 350V transistor. DP 4.02 **£2.00**
K448 12 MPSA92 **£1.00**
K449 20 BC258A **£1.00**
K447 10 BF419 **£1.00**

(c) Voltage Regs

Z2460 78M12 500mA 12V voltage regulator at a super price - **6 for £1.00** 100+ 0.09 1k+ 0.06
Z2455 7805 riveted to small ally heatsink (unused) **5 for £1.00**
Z950 LAS1510 voltage regulator. 10V 1.5A TO3 case. **2 for £1.00**

(d) Digital IC's

Z2452 74HCT164 **4 for £1.00**

(e) Linear IC's

Z2456 CA3161E BCD-7 seg decoder driver, with pin out **£1.00**
Z2457 CA3162E A-D converter, 3 digit display, with data. **£2.50**
Z4160 TDA1035. Versatile audio amp chip, with IF amp and demodulator. Electronic volume control. Max output 4 watts into 8R. Supplied with cct and data. **Only £1.00**

LOW COST SOUND CHIPS

A new range of sound effect chips is now being stocked. Supplied with typical circuit.

UM34811A Melody generator **£1.20** 100+ 0.75
UM3562 3 gun sound generator **75p** 100+ 0.38
UM66 3 Christmas carol medley **75p** 100+ 0.38

Z2471 SN75372 interface chip **50p**

Z2472 LF398N sample and hold amp. 8DIL DP 3.94 **Only £2.00**

Z2473 OP27 low noise precision op amp. 8DIL. DP 1.70. **Only £1.00**

Z722 TDA2653A vertical deflection chip. 13 lead SIL package, with comprehensive data **£1.00**

(f) Crystals

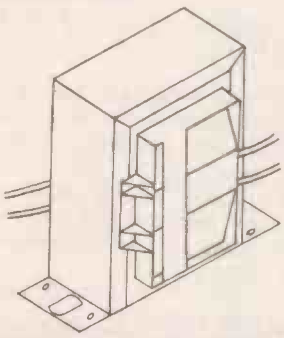
Z2464 8.000MHz crystal HC16 case **50p**

Data sheets giving pin-outs and brief spec are available on all above items at 10p each

TRANSFORMERS

Z5207 Torroidal transformer rated 75VA. Mains primary, 3 secondaries: 7V @ 7A, 8V @ 1.5A, 14V @ 1.5A. Useful voltages at a low price - **£4.50**

Z5202 Torroidal transformer. This is the same series as our Z4290 type by Belclere - 75mm dia x 33mm thick. Fixing by means of a tapped bush. Mains primary, secondary 14-7.5-0-7.5-14V @ 1.25A **Excellent value at £2.95 each** 100+ 1.50



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

Some new mains transformers, ideally suited for PSU's:

Z5212 21V 1A Clamp, wires 60x45x50mm **£1.50**

Z5214 11V 0.5A PC mntg 53x40x44mm **£1.00**
Z5215 15V 0.25A PC mntg 43x33x36mm **75p**

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**
Z5234 14V 0.5A 45x54x41mm **£1.00**
Z5235 9V + 10.5V 15VA max. 56x67x50mm **£2.00**
Z5236 21V 500mA 50x60x45mm **£1.50**

Z568 Transformer, large auto rated 8.3A **£12.00**

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**

Z8972 Transformer rated 100VA by Majestic, 0-240V pri, 25V 4A sec. 100x85x70mm. **£6.50**

Z1773 DC-DC Converter - 5V in, 15-0-15V 10-34mA (1W) Size 34x26x10. **Only £3.00**

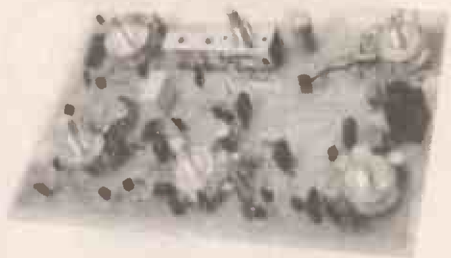
FINISHED GOODS

Z5285 Oscillator /amplifier type RT5001 by GEC, housed in an aluminium and bakelite case 180x52x50mm. The PCB has on it a small transformer, 3x100μF 16V tant bead caps, 2xBCY40 etc. **Only £1.50**

Z5287 Here's an oldie - we had a batch of these some time ago - the "Tyrometer" - used to indicate tyre pressures on HGV's, this is the pod that fitted into the drivers cab. On the front panel are two small push and a toggle switch. Inside is a PCB with 11 miniature wire ended bulbs, a choke, 2 caps and a buzzer. There's a short length of 14 way ribbon cable, too. **£3.95**

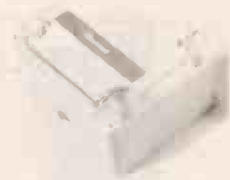
Z5268 Boxed suspension cord set. White painted steel domed ceiling plate 137mm dia with 0.5m twin lead terminated to ES plastic hanging socket, also white. (250V 500W max rating). **£2.50** 25+ 1.75

Z2109 Dynamic microphone with lead by Adastra, model M8. **£3.50**



Z5286D Metal detector panel 185x115mm. This is the complete PCB from an expensive (£80+) "treasure detector" - just add wire coil and meter to make a working unit. Circuit uses 15 transistors and 3 IC's. There are 5 pots and a rotary switch. Detailed info inc. cct diagram and coil windings supplied.. **£12.95**

Z5201 Ingenious level indicator for LPG tanks. Magnetic strip attaches to exterior of tank and works by pouring hot water down gauge. Colour change will indicate level of gas left. 220mm long. Supplied on card with full instructions. **Only £1.00**



Z5288 Polycarbonate grey sealed box 82x80x55mm with clear lid (DP 9.11!). Inside is a steel panel with loud 12V buzzer and a PCB with push button (operates when lid is removed) a green LED and 1N4005. There's a 12mm hole in the side of the box and a cable gland to fit. **Exceptional value at £4.00**

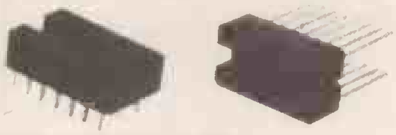
We buy surplus stock - send details to the Managing Director, Greenweld Electronics, 27 Park Road, Southampton, SO1 3TB

LIGHT UP YOUR LAYOUT

K692 Super deal for modellers - we supply a mains power supply, 100 miniature lamps for wiring into your railway layout or dolls house, and 100m of flex. Circuits and details of how to wire up the lamps in series/parallel are provided. Everything for just **£19.95**

CONNECTORS

Extra special price on gold plated DIL sockets – a parcel of Vero DIL sockets has arrived:



(a) PCB mntg, std profile:

Z5237 28 way **£1/10** 100+ .06
Z5238 40 way **£1.50/10** 100+ .08

(b) Wirewrap

Z5239 18 way **£3.80/10** 100+ 0.20
Z5240 20 way **£4.30/10** 100+ 0.25
Z5241 28 way **£7.00/10** 100+ 0.40
Z5242 40 way **£10.00/10** 100+ 0.65

Z2360 Turned pin DIL socket – 24 pin, but 0.3" pitch not 0.6". **Pack of 5 for £1.** 100+ 0.10

ARE YOU A BARGAIN LIST SUBSCRIBER? DON'T MISS THE BARGAINS!!

P5430 14 pin DIL header plug, gold plated solder type. As listed in our cat at 65p – special purchase price **3 for £1.00;** 100+ 0.16; 1k+ 0.12

Z739 40 way DIL header plug, gold plated. **3 for £1.00**

P9016 16 way IDC header socket. **Pack of 5 £1.00** ; 100+ .10

Z2379 IDC 16 pin DIL socket. **Pack of 5 £1.00**

Z2382 Double row 0.1 socket PCB/chassis mounting 16 way x 2, but only 1 row of pins. **Pack of 5 £1.00**

High quality 3.5mm mono jack plugs with coloured plastic sleeves made by Cliff:
Z2457 Red **10/£1.00** 100+0.06
Z2458 Green **10/£1.00** 100+ 0.06
Z2479 White **10/£1.00** 100+ 0.06
Z2480 Cream **10/£1.00** 100+ 0.06

Z1485 RC4200-8S 8 way gold plated socket – matches McMurdo red range, but blue **£1.50**

Z1768 Numicator/CRT base 13 pin PC mntg by Cinch. **Pack of 4 £1.00**

Z042 2 pin DIN speaker sockets, PC mntg. **Pack of 25 £1.20**

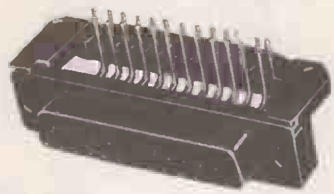
Z2448 Phono plug. Black plastic cover. We have a large quantity of these to dispose of, so are clearing them at **25 for £1.00**, 100+ 0.03, 1000+ 0.02

The 1992 GREENWELD Catalogue is out now! 132 pages of electronic and modellers supplies.

Only £2 (UK/ BFPO; £4 O'seas)

ORDER NOW!
See order form for details

Z2397 25 way 'D' type shells. Can be used as either plugs or sockets, according to pins fitted. (No pins available) **Pack of 6 £1.00**

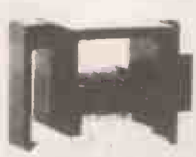


Z2395 Right angle 50 way 'D' plug, PCB mounting, plastic housing. **£2.00**

Z2396 Right angle 9 way 'D' socket. **40p**

Z2430 37 way 'D' type plug, IDC type **£2.00** 100+ 1.00

Z2429 15 way 'D' connector sliding lock retainer by ITT type DA51220-1 DP £3.45, **Only £1.00** 100+ 0.40



Z2445 Data connector – like BT skt – 6 way PCB mntg for right hand plug. DP 1.74 **Our price 2 for £1.00,** 100+ 0.30

Z2398 DIN 41612 IDC socket, C body, rows A and C only. List £6.65. **Our price £2.50**

Z2399 20 way card edge IDC socket. DP 2.47. **Our price £1.00**

Z2426 25 way double sided 0.1" pitch edge connector, gold plated, solder tags. **£1.00**

Z2427 50 way double sided 0.125" pitch edge connector, gold plated, wirewrap terminals. **£2.00**

Z2428 PC mounting edge connector, 13 way double sided 0.15" pitch. Gold plated. **Pack of 2 £1.00** 100 + 0.25

NEED A LEAD?

Here's a selection from a recent parcel:

Z5247 1.1m long twin thick flex, 2x3mm wander plugs one end, 3.5mm mono jack plug the other. Assorted colours. **Pack of 3 £1.00;** 100+ 0.18

Z5248 1.8m long twin flex, 3.5mm mono jack plug to open end. Fitted with sleeved square grommet. **Pack of 5 £1.00;** 100+ 0.10

Z5249 2m long twin flex, 2 pin socket to open end. Fitted with sleeved round grommet. **Pack of 5 £1.00;** 100+0.10

Z5250 1.1m long 3 core sheathed cable with odd socket one end, yellow 5mm LED in plastic housing the other. **Pack of 8 £1.00;** 100+ 0.06

Z5251 1m long twin flex, 2.5mm power socket to open end. Fitted with sleeved square grommet. **Pack of 3 £1.00;** 100+0.18

Z5252 Super ***heavy duty extra long*** (2.7m) twin sheathed cable with moulded on 2.5mm power socket to open end. **2 for £1.00;** 100+0.25

Z5254 2m long 4 core sheathed cable fitted with a sleeved grommet. 4 pin DIN socket to open end. **4 for £1.00;** 100+ 0.12

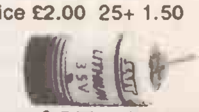
Z5255 2m long 2 core black sheathed mains cable (3A). Moulded 2 pin Euro plug one end, 0.25 tags the other. **3 for £1.00;** 100+ 0.18

BATTERIES

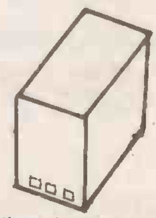
Z2452 Lithium battery – inorganic type by Tadiran, type TL5104. AA size, 3.6V PC tabs. Date code 06/88 **£1.70**

Z2453 As above, but type SL360, date code 4/87. **£1.50**

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



Z2451 Tadiran 0.5AA size battery, 3.6V PC mntg. Date code 8/86. DP 4.58 Our price **£1.75** 25+ 1.35 100+ 1.05



Z4150 AA Ni-cads at a price never before seen! Pack of 8 in a tough plastic case 56x63x33mm – either use as a 10V battery pack or remove and use cells individually. Special low price **£1.60 each;** 25+ 1.10 100+ 0.80

PRICES IN **BOLD** TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

RELAYS

Code	Mnf'r	Type	Coil V	Coil R	Contacts		Base	Type	Size l.w.h	Qty	Pic	Price
Z2423	VARLEY	VP4	48V	5800R	4PCO	1A	ST	C	29.18.29	93	A	1.00
Z2414	SIEMENS	V23154	12V	800R	4PCO	1A	PC	C	29.18.29	96	A	2.00
Z2421	ITT	A2825	24V	1000R	6PCO	1A	PC	C	33.30.29	57	B	1.00
Z2424	ITT	A2446	48V	3000R	DPCO	1A	PC	C	29.16.13	59	C	1.00
Z2425	FEME	RCP11	110V	10K	3PCO	10A	11PIN	C	35.35.56	84	D	2.00
Z2420	AMF	KUP14D	24V	450R	3PCO	10A	ST	C	37.34.51	82	E	2.00
Z2419	NATIONAL	AE1324	24V	2000R	DPCO	1A	PC	C	30.20.10	218	F	1.00
Z2413*	AX	481F	12V	1500R	SPCO	1A	PC	M	32.10.10	533	G	1.00
Z2408*	CLARE	HGR2M	5V	500R	DPCO	1A	PC	M	40.25.10	117	H	1.00
Z2418	OUB	SS124D	24V	1200R	SPCO	5A	PC	C	21.17.15	118	I	1.00
~~Z2412~~	~~OUB~~	~~SS-212D~~	~~12V~~	~~800R~~	~~DPCO~~	~~2A~~	~~PC~~	~~C~~	~~18.10.12~~	~~20~~	~~J~~	~~1.00~~
Z2417	OUB	SS-224D	24V	1200R	DPCO	2A	PC	C	18.10.12	196	J	1.00
Z2422		AZ1530-04Y	36V	4300R	SPCO	2A	PC	C	26.14.11	648	K	1.00
Z2400*	GENTECH	G42F	3V	130R	SPB	1A	PC	M	33.16.11	127	L	1.00
Z2416	HAMLIN	HE221A4860	24V	11K	SPM	1A	PC	R	32.10.09	799	M	1.00
Z2411	HAMLIN	HE221A7080	12V	800R	SPM	1A	PC	R	32.10.09	1501	M	1.00
Z2407	HAMLIN	HE262A7780	5V	470R	DPM	1A	PC	R	32.12.09	135	N	1.00
Z2406*	ELLIOTT	36876/5	5V	130R	SPB	1A	PC	R	32.15.10	345	O	1.00
Z2410	ALMA	CPR3	12V	1100R	3PM	1A	PC	R	38.23.12	38	P	1.00
Z2405*	CLARE	PRME15005AB	5V	470R	SPM	500MA	DIL	R	20.07.05	354	Q	1.00
Z2404*	HAMLIN	HE721A5262	5V	520R	SPM	500MA	DIL	R	20.07.07	51	Q	1.00
Z2415	AX	132A-1	12V	180R	SPM	500MA	DIL	R	20.07.07	31	Q	1.00
Z2403*	AX	132A-4	5V	520R	SPM	500MA	DIL	R	20.07.07	65	Q	1.00
Z2402*	CLARE	CUPV10201	5V	170R	SPB	1A	PC	R	25.10.9.5	50	N	1.00
Z2409*	CLARE	CUPV10302	12V	370R	SPB/SPM	1A	PC	R	31.12.04	27	O	1.00
Z2401*	AX	175A-4	5V	500R	SPM	1A	PC	R	32.15.9.5	47	R	1.00

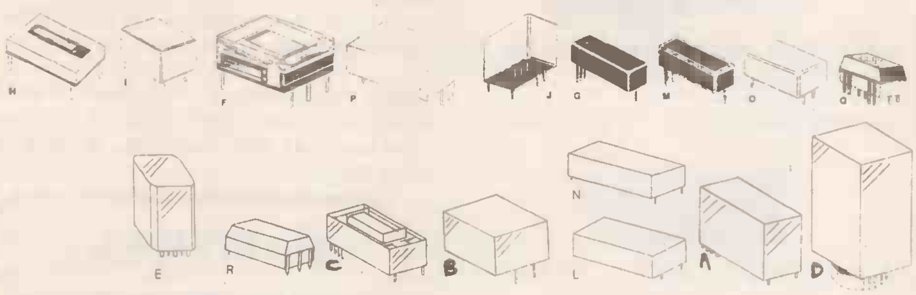
Discounts for larger purchases: 100+ (any mix) less 40% 1000+ less 60%

Type: C= conventional
M= mercury
R= reed

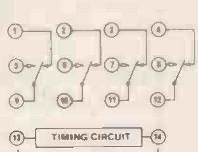
*Internal diode protection

Contacts: 4PCO Four Pole Changeover
DPCO Double Pole Changeover
SPCO Single Pole Changeover
SPM Single Pole Make
SPB Single Pole Break
3PM Three Pole Make

Base: ST Solder Tags
PC PCB mntg
DIL 0.3" pitch dual in line



TIME DELAY RELAYS



These all originate from the largest component distributor in the UK and are in original packing. Sub min 4 pole changeover plug in type, delay before energize. Same as Omron H3Y4 series

Code	Volts	Time	DP	Price
Z5186	240V ac	5s	25.83	**£5.00**
Z5198	240V ac	10s	25.83	**£5.00**
~~Z5190~~	~~240V ac~~	~~10m~~	~~25.83~~	~~£5.00~~
Z5183	110V ac	5s	25.83	**£4.00**
Z5184	110V ac	10s	25.83	**£4.00**
Z5185	110V ac	60s	25.83	**£4.00**
Z5186	110V ac	5m	25.83	**£4.00**
Z5187	24V DC	5s	24.19	**£5.00**
Z5188	24V DC	10s	24.19	**£5.00**
Z5189	24V DC	60s	24.19	**£5.00**
Z5190	24V DC	5m	24.19	**£5.00**

Z2350. Open construction 12V relay with 0.25 tabs. Ideal for car use. Single pole make contact rated 15A. **£1**

Z2496 Omron MY4 relay. 48V ac coil, 4PCO contacts rated 5A **£1.00**

Z2497 IMO 60.32 relay. 12V DC coil, DPCO contacts rated 10A **£2.50**

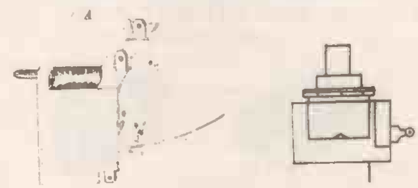
Z5178 Ex-equip PCB mntg 12V heavy duty rela - DPCO contacts rated 10A 250V. IMO model 60.42. **£1,50**

Z5179 As above but 3 pole changeover IMO 60.43. **£2.00**

Z2442 PCB mounting relay 30x24x10mm. 4PCO. 1150R coil, operates from 15-30V. **£1.50**

Z2433 Hermetically sealed mains relay, miniature plug in type with 4PCO contacts. Size 22,5x29x32mm. DP (1987) 17.75. **Our special low price £4.75**

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.

Z2361 Heavy duty push switch - push to change over, locking. Needs 12mm hole. Plunger is 8mm dia x 9mm high, **3 for £1.00**

Z2387 PC mounting push switch - 1 pr make and 1 pr break contracts. Right angle plunger is 5mm long x 2mm dia. With protective cover. Again, very high quality. **2 for £1.00**

POINTS LEVER SWITCHES

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

TRANSDUCERS

Z5266 Miniature 15R speaker 45mm(1.75") dia. **3 for £1.00;** 100+ 0.16; 1k+ 0.10

Z5267 75R miniature speaker 57mm dia. **3 for £1.00**

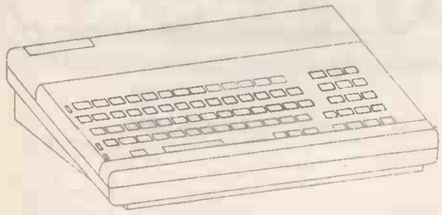
Z5275 57mm 8R speaker with 0.5m twin flex and socket attached. **3 for £1.00**

Z2503 Sub-min 8R speaker with mylar cone. 30mm dia with short lead fitted. **2 for £1.00**

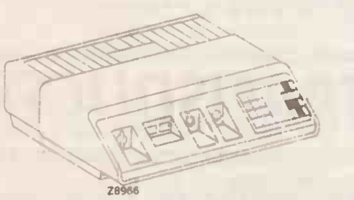
We are always looking for new lines to add to our lists. Send details/ samples of goods available to: The Managing Director
Greenweld Electronics Ltd
27 Park Road
Southampton SO1 3TB

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

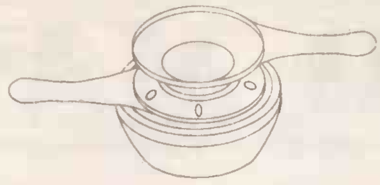
Viewdata Terminal/Modem



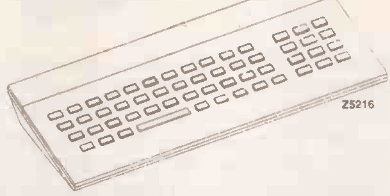
Tandata TD1100 alphanumeric Viewdata/Prestel Adaptor.
These units were used with a home banking system. The console was hooked up to your TV and telephone line, and by using the standard qwerty keyboard with seperate numeric keypad, you could access your account. The well styled black and grey case 300x180x75/40 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**
Also available brand new and boxed, **Z8964 £16.95**



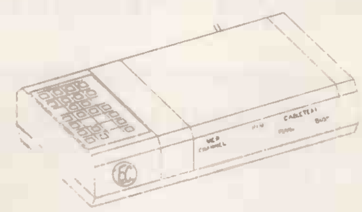
Z8966 Prestel set less monitor. This cased unit 420x430x100mm made by Phillips, model HU01 contains all the logic and control circuitry for Prestel - the monitor (not supplied) sits on top. On the back panel there is an 8 pin DIN socket for text output to monitor, mains outlet to monitor and an 8 pin DIN printer socket. There's also a mains lead and old type lead to telephone socket. On the front panel there is a detachable (on curly lead) keypad (20 keys) on/off keyswitch, tape and keyboard sockets and indicator lamps. Inside there's a large transformer and power supply and 4 PCB's - one is a modem panel; one has 8048 and SBB2626 in sockets + 15 other chips, transistors etc; the third has SAA5030/5042/5020/5050, a bit of memory (2x2114) + a few other chips. The fourth panel has SAA5010 in socket, 9xBSX20, 4xBC548/558. All boards are interconnected with plugs and sockets. These units are complete but not new and may well be in working order - but we're selling them for the parts value only - just **£16.00**



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**

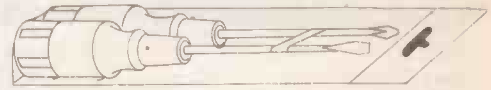


Z5216 Tandata "Homedeck". These are later versions of Z8963 and are (a) smaller and (b) remote controlled. The two tone grey case is 270x110x28mm and has a full qwerty keyboard and seperate numeric keypad. Inside, on the PCB are a few components to transmit the data via 2 IR LED's to the receiver. The unit is powered by a PP3 battery. Super value at just **£3.00**



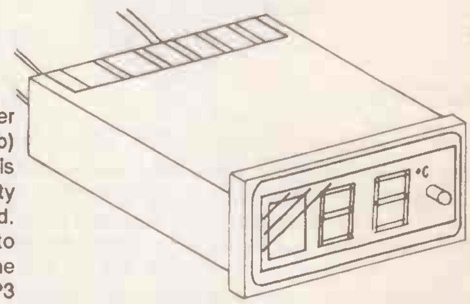
Z8970 Remote control cable TV unit made by GEC. Attractive black plastic case 205x120x40mm with membrane pushbutton keypad (22 keys). Front panel has 4x5mm red LED's to indicate status and a dual 7 seg display to show channel. On the 195x102mm PCB is a small regulated power supply (12V & 5V) derived 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**

MONSTER SCREWDRIVER BARGAIN !!!



Tremendous value - 2x200mm screwdrivers, 1 pozi, 1 straight blade in plastic pouch. Wooden handles. Overall length 340mm. **ONLY £1.50.** Order code **Z5172**

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**

Z5229 Case for above unit with red bezel and front clip. Overall dimensions 57.5x25x70mm deep. **Only £1.50 each** 100+ 0.80

Z5230 Complete panel to fit in above case (no probe) **£9.95**

Greenweld
27 Park Road
Southampton
SO1 3TB
Tel (0703) 236363
Fax (0703) 236307
We are open to callers from 9-5.30 Mon-Sat

DRAGON INTERFACE

SB9 £1.00

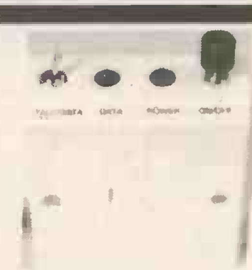
Interface unit to convert digital input (as obtained from Atari-compatible joysticks) to the correct analogue level for use with such home computers as Dragon. Tandy Colour. Radio Shack. etc. Two separate channels for competitive games. Two 5-pin 240° DIN plugs to compact case with two 9-pin plugs, with internal circuitry and connections for Atari-type joysticks. Black plastic.
Dims:.................................(Body) 116 x 62 x 29mm

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

Z8973 Modem.
A compact V21/V23 300 or 1200/75 baud modem made for a major British telephone company. The units are new, boxed and complete with power supply but are without the official instruction manual, and have had the manufacturers label removed. Some instructions have been worked out by our technical department and these will enable you to use it as a working modem - further information gratefully received. Plugs directly into a standard BT 600 series socket and a RS232 port on any computer. Tone/auto dialling + last number re-dial. Dimensions 205mm x 195 mm x 30mm. Front panel has reset button, and 5 status LED's. Excellent value for money - **£49.95**

Z8974D Transam M1 mobile/mains intelligent modem. New and boxed with mains plug in power supply (9.5V 800mA). Auto dial and answer, V21/23, 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, S5/8 serial data socket (use our **Z4284** S5/8-RS232 converter, price **£6.00** if required), and 12V input socket. On the front panel there's an ext/batt/off switch; auto/manual answer switch; originate/answer switch; 300/1200 switch; normal/intelligent switch. Comprehensive 36 page user manual. (photocopied for £1.50). **Our Price £50.00**

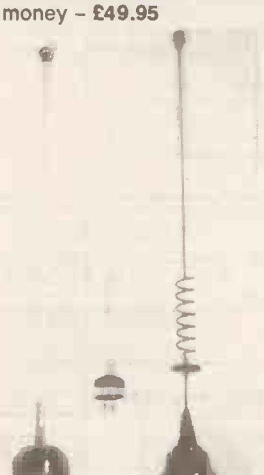


Z5284 Modified BT socket.
Unusual item believed to be used in conjunction with the above modem. It consists of a standard BT socket that has 6 way flat type cable wired into it; this probably plugged into a special outlet that could provide power as the centre pair (blue and green wires) are connected to a switch which links to a 6 pin DIN wired as per above modem power supply. A second switch enables selection between the modem and 'phone plugged into the socket. Power and Data LED's indicate the state of the junction box. **£3.00**

Z8975 Data Switch
Another item from this package of data communication hardware. Powered from a modified RS232 connector that has a 12V supply on line 5 it is believed that the above telephone socket plugged into this device to provide power for the modem and enabled selection between speech and data communication by both the switch on the unit and the "remote" socket switch. Steel case 170x102x45mm has main PCB with 2 relays, pot cores, chips etc, and a small power supply sub panel with an Astec voltage converter, 7805 etc. **All for £4.50**

Z8976 This is the above two items - they are boxed together. (Z5284 + Z8975). **£6.95**

Z8958 Modem returns - model 21/23IAD (Same as our Z8937-see P7 of B/L 75). No idea what's wrong with them - some have fault labels on them. Supplied complete with plug in PSU. **£15**



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**

Z5282 ZS Electroniques ZS914-09 claw mount with 4m cable and fitting instructions **£3.00**

Z5283 Jaybeam MU904-ZG/h with 4m of cable attached. **£3.00**

ORDERING INFORMATION

Prices in bold include VAT @ 17½% - quantity prices in light type do not include VAT which should be added at the current rate. We accept cheques, PO's, Money orders, Bank drafts, cash including foreign currency bank notes, book tokens, Access and Visa. We are happy to process Official Orders from Education and other government funded sources. Don't forget to include your name and address. Send the completed order form to:

Greenweld Electronics Ltd
27 Park Road
Southampton
SO1 3TB
United Kingdom

Most orders are despatched within a day or two but some may be delayed because of temporary non-availability of goods.

HOW TO CONTACT US:
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SPECIAL OFFER - SAVE £10!!

Z8973 Modem + Z8953 Maximiser

Details of maximiser on Page 7 of B/L 75 or Page 5 of B/L 75A

Normally £69.95 - **Offer Price £59.95**

ORDER FORM SS92 1 2 3 4 5 6

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	C1992			1992 Catalogue	UK/BFPO inc Post O'SEAS inc Post	2.00 4.00		

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   ☐ **with Everyday Electronics** ☐ **With ETI**
   ☐ **with Television** ☐ **Other (Please state how)**
2. Please let us know if you want this order:
   ☐ Sent as soon as possible with a credit note for any parts out of stock;
   ☐ Sent as soon as possible with any out of stock items to follow: (only if value over £10);
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(If ordering by credit card, only goods supplied will be charged, on the date of despatch) **SIGNED** ....

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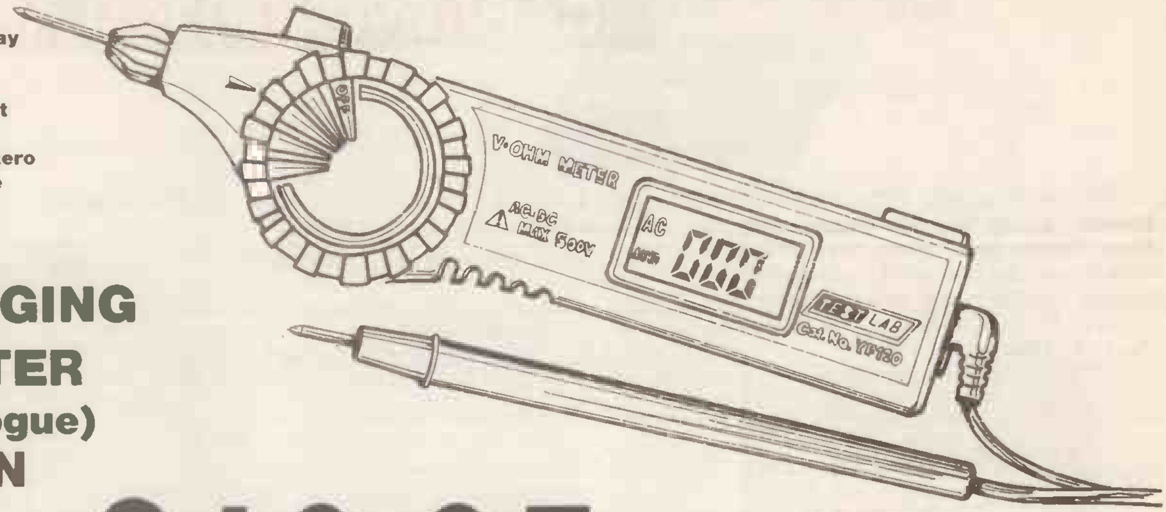
CO:	CH:	P:	D:					

TWO STUNNING DIGITAL MULTIMETER OFFERS!!

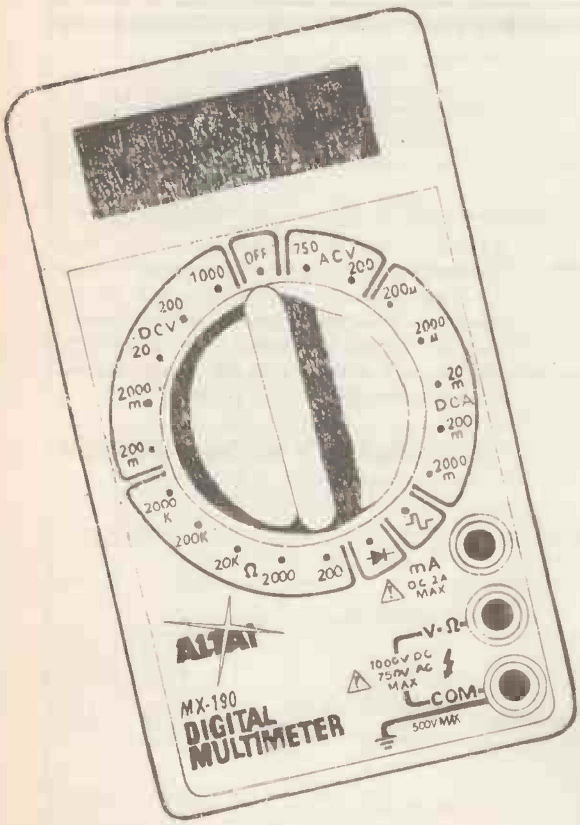
- ★ 3½ digit 8mm LCD display
- ★ Fully autoranging
- ★ Display hold facility
- ★ Diode and continuity test
- ★ Probe styling
- ★ Automatic polarity and zero
- ★ Protective carrying case



A £39.95 AUTORANGING MULTIMETER (1991 Catalogue) LESS THAN ½ PRICE!! YOURS FOR JUST

£19.95

Order Code	**DM1360**
AC volts	0-2-20-200-500 Vac ±2.3%
DC volts	0-200m-2-20-200-500 Vdc ±1.3%
Resistance	0-200-2k-20k-2M-20MΩ ±2%
Dims	133 × 29 × 17mm



- ★ 19 ranges
- ★ 3½ digit 12mm LCD display
- ★ Signal injector function
- ★ Diode test
- ★ Fuse protection
- ★ Automatic polarity and zero
- ★ Test leads with 4mm plugs
- ★ Battery and instruction manual included

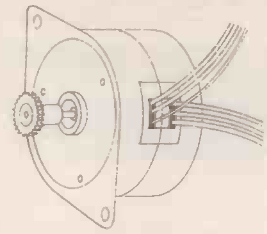
PRICE

£14.95

Specification

AC volts	0-200-750Vac ± 1.2%
DC volts	0-200m-2-20-200-1000Vdc ± 0.8%
DC current	0-200μ-2m-20m-200m-2Adc ± 1.0%
Resistance	0-200-2k-20k-200k-2mΩ ± 0.8%
Signal Injector	50Hz square wave 5V peak to peak
Dims	126 × 70 × 24mm
Order Code	**MX190**

PRICES IN ***BOLD*** *TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT*



Z5045D Superb little 12V stepper motor by Airpax. 35mm dia x 21mm deep with a 16 tooth 9.5mm dia gear wheel mounted on the 2mmdia spindle. Fixing centres 42mm. 7.5° 48 step. Supplied with data. 100+ DP 9.04; **Our Price £3.00;** 100+ 2.00

AC MILLIVOLTMETER

Y134A **MV3002A**

A highly sensitive and precise AC millivoltmeter used for measuring AC voltages in the range of 300µV to 100V between 5Hz and 1MHz. The output terminals allow this unit to be used as a wide-band high gain amplifier or pre-amplifier. Calibrated with AC volts and two decibel scales.

Voltmeter:
Voltage range .... 300µ to 100Vac ±3%
Frequency range .... 5Hz to 1Mhz
Input resistance 10MΩ
Input capacitance .... Below 50pF

Amplifier:
Output voltage .... 1V no load
Frequency range .... 10Hz to 500kHz
Output impedance .... 600Ω ±20%

Power 240Vac 50Hz
Dims .... 142 x 195 x 205

PRICE £60.00

SURPLUS STRIPBOARD

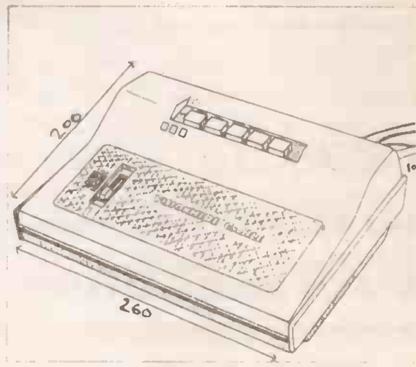
Factory reject stripboard at approx half price!. Very minor blemishes - almost all totally usable. In sheets or packs as listed:

Z5294 Large sheet 390x205mm **£4.00**

Z5295 4 or 5 pieces, total approx 800 sq cms **£3.50**

Z5296 4 long strips, total approx 1800 sq cms **£7.95**

CABLEVISION CALAMITY !!!

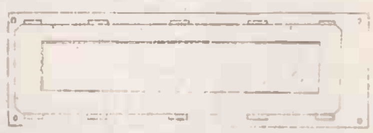


Seems like Visionhire became a bit overstocked on their cablevision consoles - we've just purchased a quantity of these superb brand new units which contain some great electronics and as ever can offer them at an absolute BargainPrice!!

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 £6.95 100+ 3.50 1k+ 2.50.



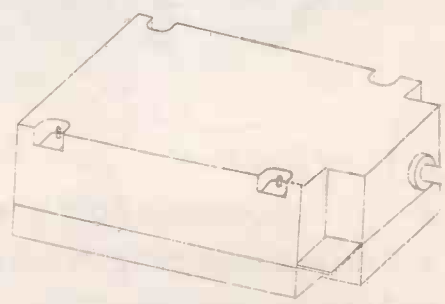
Z2171 24 character × 2 lines LCD by Optrex. High quality display with 192 character ROM; other characters can be displayed by generation in RAM. Other features include: EL type back light (details of high voltage generator supplied); cursor with control, blink character, scroll display, read and write display data. +5V and -7V supply with 150V AC required for backlight, data and power inputs by solder contacts on board, pin outs standard and compatible with other Optrex displays, extended temperature range (253 to 343°K), easily interfaced with either 4 or 8 bit uP's. Supplied complete with data.
Characters are 5 × 7 dot arrays with separate cursor. 1 Character measures 3.2 × 6.0 mm
Display size 93 × 16mm Module size 118 × 35mm
DP around £30.00. **Our Price £10.00**

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**

Optical Shaft Encoder

Z345 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 £48.18.
Our Price £8.50
Data sheet available separately **30p**

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

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

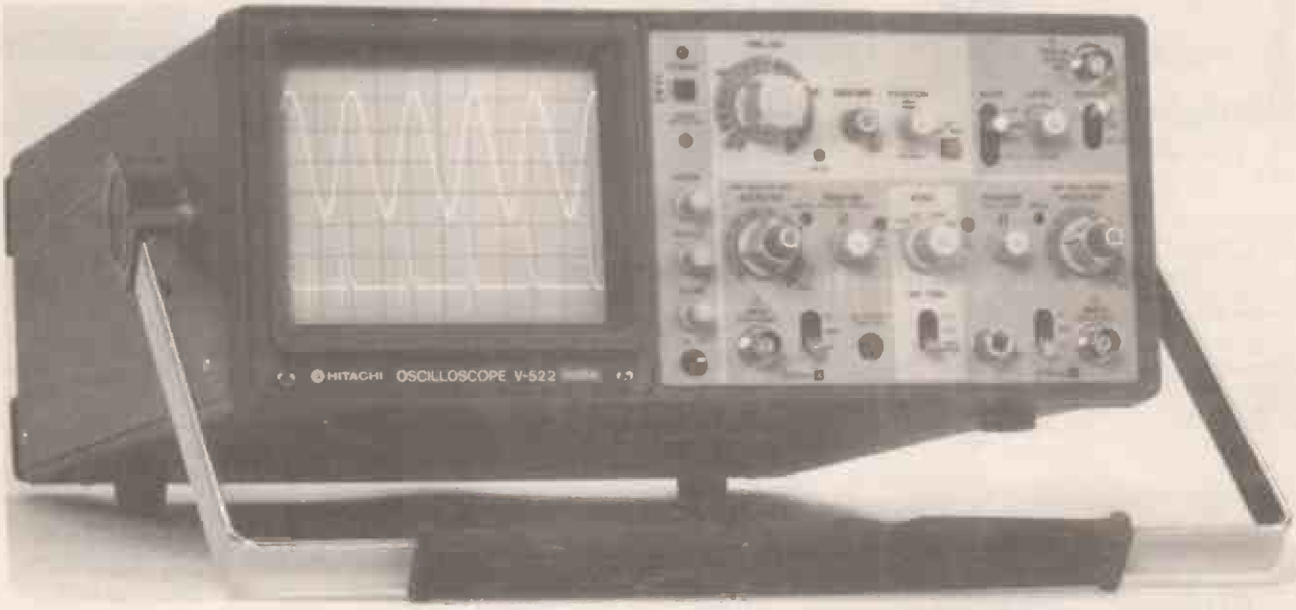
Cadillac Coupe de Ville

Z8976 1967 model, white with blue interior. 2 door. 7¼ litre V8 engine. Auto gearbox, Power steering, brakes, seats, windows and aerial! Tilt and tele column. Original working AM/FM radio with front and rear speakers. Air conditioning. Original/Import documentation. Excellent chrome. Tinted glass. Recent new whitewall tyres and exhaust. Superb bodywork and low mileage. A true full size American car - all 19ft 4ins of it! **Our Price (1 only) £6995**

EASY-TO-USE

HITACHI

50MHz SCOPES



- ★ Dual Channel
- ★ DC to 50MHz - 3dB Bandwidth
- ★ Large 6 inch Screen with Internal Gratical
- ★ 1mV Vertical Sensitivity
- ★ Slim, Compact & Lightweight Design
- ★ DC Offset Function
- ★ Alternate Magnification
- ★ Vertical Trigger Mode
- ★ TV Sync Trigger Circuit

V522 DC-50MHz, 1mV/div, Dual Channel, DC offset function, Alternate Magnifier Function **£745.00**

25% OFF

and FREE next day delivery!

Limited Offer - Order Now!

£555.55

Price Includes VAT- free delivery UK mainland only

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