

**EVERYDAY**

AUGUST 1991

# **ELECTRONICS**

INCORPORATING ELECTRONICS MONTHLY

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**SUMMER SALE CATALOGUE SUPPLEMENT**

**OPTICAL  
COMMUNICATIONS LINK  
PORTABLE PET SCARER  
PEDOMETER**



The No.1 Magazine for Electronics & Computer Projects



# EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

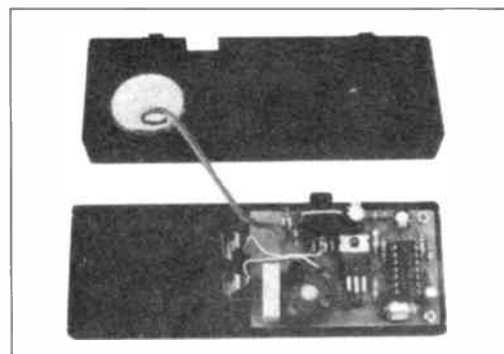
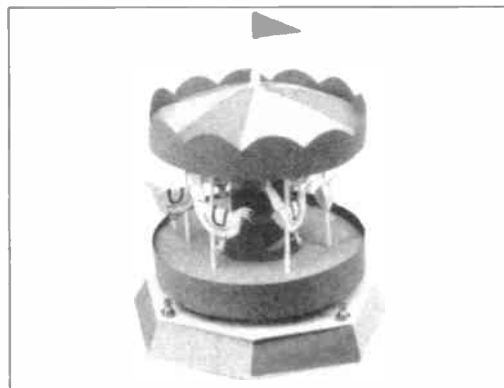
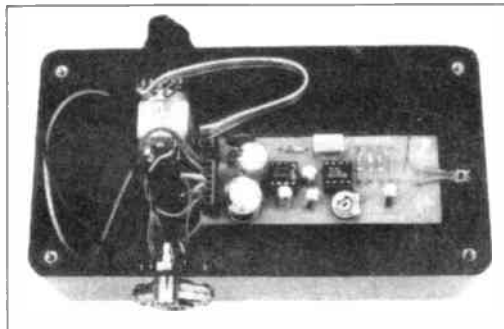
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VOL. 20 No. 8 AUGUST 1991

The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

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



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Our September '91 issue will be published on Friday, 2 August 1991. See page 475 for details.

## Projects

- OPTICAL COMMUNICATIONS LINK** by Mike Tooley 484  
Versatile infrared link for audio or remote control use
- PORTABLE ULTRASONIC PEST SCARER** by Mark Stuart 490  
A powerful handheld ultrasonic generator to keep unwanted animals at a distance
- PEDOMETER** by R. M. Worthington 498  
This project is made for walking
- SIMPLE MODEL SERIES - 2:** 503  
**MUSICAL ROUNDABOUT** by Owen Bishop  
All the fun of the fair in miniature with this carousel
- MODULAR DISCO LIGHTING SYSTEM** by Chris Bowes 522  
Customise your own light show. Part Four: Random Pattern Module

## Series

- INTERFACE** by Robert Penfold 512  
The spot for all computer enthusiasts - PC prototyping cards
- TEACH-IN '91 -** 514  
**DESIGN YOUR OWN CIRCUITS** by Mike Tooley  
Part Nine: Opto-electronics
- AMATEUR RADIO** by Tony Smith G4FA1 520  
The Juno Mission; Morse Bicentennial Success;  
No More Healthkit Rigs

## Features

- EDITORIAL** 483
- SHOPTALK** with David Barrington 488  
Component buying for EE projects
- FOR YOUR ENTERTAINMENT** by Barry Fox 489  
DAB; Dockables; Flash Price
- BETTER USE OF DRY CELLS** by Alan Tong 494  
Selecting the right battery for your equipment
- ROBOT ROUNDUP** by Nigel Clark 501  
News from the world of robotics
- SIMPLE MODELS SERIES SPECIAL** 502  
**EASIWIRE OFFER**
- DOWN TO EARTH** by George Hylton 526  
Indirect Bridge Measurements
- DIRECT BOOK SERVICE** 528  
Selected technical books and all the EE books by mail order
- PRINTED CIRCUIT BOARD SERVICE** 532

**FREE**  
**GREENWELD 16-Page Summer Sale Catalogue**  
between pages 504/505

**ADVERTISER'S INDEX** 536

Readers Services • Editorial and Advertisement Departments 483

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| 1028    | 4 WATT FM TRANSMITTER.....                                      | 14.46        |
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| 1059    | TELEPHONE AMPLIFIER.....  | 8.51         |
| 1065    | INVERTOR 12V D.C. TO 12V A.C.....                               | 21.27        |
| 1069    | 12V D.C. FLOURESCENT TUBE UNIT.....                             | 5.53         |
| 1073    | VOX.....  | 6.38         |
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| 1114    | ELECTRONIC LOCK.....  | 7.66         |
| 1119    | TELEPHONE LINE RECORDING.....                                   | 4.25         |
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# BRAINWAVE

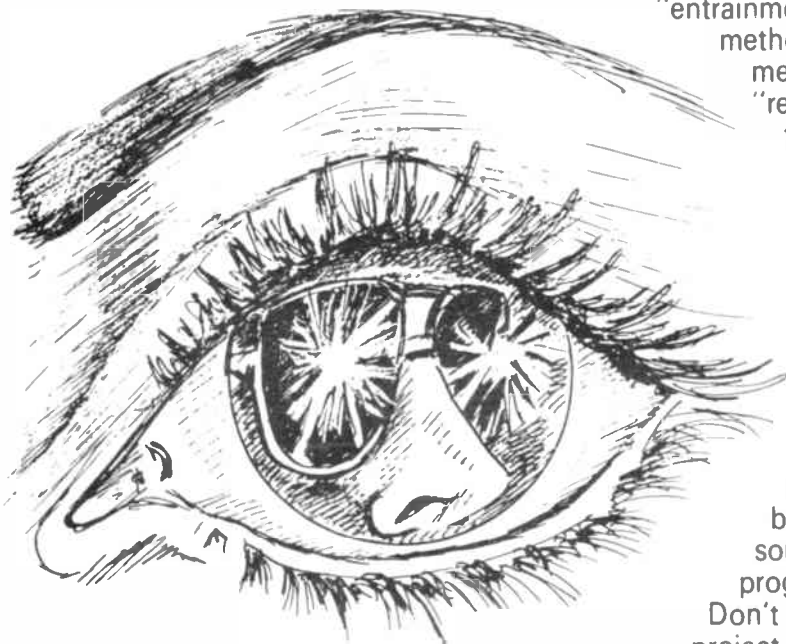
For readers new to biofeedback the aim is to encourage the generation of specific electrical frequencies within the brain. Success is claimed to induce mental states including "alert relaxation" and intense visual imagery, similar to those said to be attained by mystics after years of meditation.

Conventional EEG ("electro-encephalography") biofeedback tries to achieve this by detecting the electrical activity of the brain with electrodes on the surface of the scalp. The tiny signals received are amplified and filtered, so that when a desired frequency appears the user will know. In theory, if you know you are producing the signal, you can learn to create and enhance it at will.

A variation on this theme is based on the fact that the brain has two sections, or "hemispheres". If the electrical activity in these two parts can be synchronised, a special state of awareness, perhaps the mystics' "nirvana", is thought to be a possible result.

That's the theory. Producing these frequencies, even with the aid of a monitor, is usually quite difficult. It seems American experimenters gave up the effort a long time ago; instead they now try to artificially induce them!

This process is termed "entrainment", and various methods are employed. A method widely used in "recreational" units, is to flash lights in the user's eyes. This is easy to design and relatively safe (the only danger being that it may precipitate fits in epileptic subjects). Our initial project is a simple lights only unit, that will enable readers to get a feel of what entrainment is all about before venturing to later sound/lights and programmable projects. Don't miss this fascinating first project.



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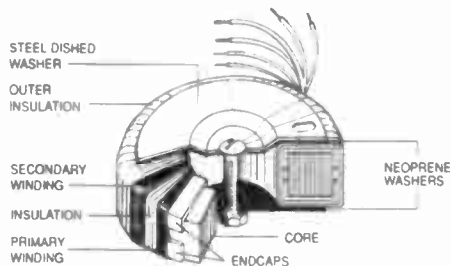
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|                 | 03013      | 15+15     | 0.50            |                 | 53014      | 18+18     | 4.44        |
|                 | 03014      | 18+18     | 0.42            |                 | 53015      | 22+22     | 3.63        |
|                 | 03015      | 22+22     | 0.34            |                 | 53016      | 25+25     | 3.20        |
|                 | 03016      | 25+25     | 0.30            |                 | 53017      | 30+30     | 2.66        |
|                 | 03017      | 30+30     | 0.25            |                 | 53018      | 35+35     | 2.28        |
| 30VA<br>£12.21  | 13010      | 6+6       | 2.50            | 53026           | 40+40      | 2.00      |             |
|                 | 13011      | 9+9       | 1.66            | 53028           | 110        | 1.45      |             |
|                 | 13012      | 12+12     | 1.25            | 53029           | 220        | 0.72      |             |
|                 | 13013      | 15+15     | 1.00            | 53030           | 240        | 0.66      |             |
|                 | 13014      | 18+18     | 0.83            | 225VA<br>£21.04 | 63012      | 12+12     | 9.38        |
|                 | 13015      | 22+22     | 0.68            |                 | 63013      | 15+15     | 7.50        |
|                 | 13016      | 25+25     | 0.60            |                 | 63014      | 18+18     | 6.25        |
|                 | 13017      | 30+30     | 0.50            |                 | 63015      | 22+22     | 5.11        |
| 50VA<br>£13.84  | 23010      | 6+6       | 4.16            | 63016           | 25+25      | 4.50      |             |
|                 | 23011      | 9+9       | 2.77            | 63017           | 30+30      | 3.75      |             |
|                 | 23012      | 12+12     | 2.08            | 63018           | 35+35      | 3.21      |             |
|                 | 23013      | 15+15     | 1.66            | 63026           | 40+40      | 2.81      |             |
|                 | 23014      | 18+18     | 1.38            | 63025           | 45+45      | 2.50      |             |
|                 | 23015      | 22+22     | 1.13            | 63033           | 50+50      | 2.25      |             |
|                 | 23016      | 25+25     | 1.00            | 63028           | 110        | 2.04      |             |
|                 | 23017      | 30+30     | 0.83            | 63029           | 220        | 1.02      |             |
|                 | 23028      | 110       | 0.45            | 63030           | 240        | 0.93      |             |
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| 80VA<br>£15.43  | 33010      | 6+6       | 6.66            |                 | 73015      | 22+22     | 6.82        |
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|                 | 33012      | 12+12     | 3.33            |                 | 73017      | 30+30     | 5.00        |
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|                 | 33014      | 18+18     | 2.22            |                 | 73026      | 40+40     | 3.75        |
|                 | 33015      | 22+22     | 1.81            |                 | 73025      | 45+45     | 3.33        |
|                 | 33016      | 25+25     | 1.60            | 73033           | 50+50      | 3.00      |             |
|                 | 33017      | 30+30     | 1.33            | 73028           | 110        | 2.72      |             |
|                 | 33028      | 110       | 0.72            | 73029           | 220        | 1.36      |             |
|                 | 33029      | 220       | 0.36            | 73030           | 240        | 1.25      |             |
| 33030           | 240        | 0.33      | 500VA<br>£29.57 | 83016           | 25+25      | 10.00     |             |
| 120VA<br>£16.45 | 43010      | 6+6       |                 | 10.00           | 83017      | 30+30     | 8.33        |
|                 | 43011      | 9+9       |                 | 6.66            | 83018      | 35+35     | 7.14        |
|                 | 43012      | 12+12     |                 | 5.00            | 83026      | 40+40     | 6.25        |
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| 43030           | 240        | 0.50      | 93026           |                 | 40+40      | 7.81      |             |
|                 |            |           | 93025           |                 | 45+45      | 6.94      |             |
|                 |            |           | 93033           |                 | 50+50      | 6.25      |             |
|                 |            |           | 93042           |                 | 55+55      | 5.68      |             |
|                 |            |           | 93028           |                 | 110        | 5.68      |             |
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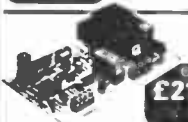
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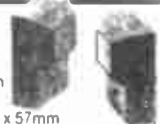


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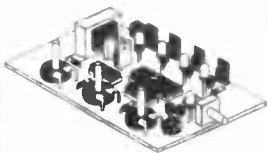


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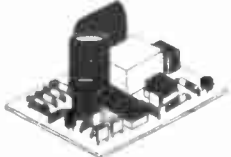
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SEND BEE SAE for our latest KIT LIST which includes details on more exciting kits such as Programmable Lock, Voice Record/Playback, Touch Dimmers, Temperature Controller, etc

## SINGLE CHANNEL INFRA RED REMOTE CONTROL

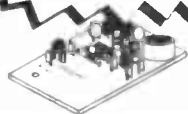


A simple yet highly versatile Infra Red remote control kit with a multitude of uses in the home or car. Operates from a 1.5V dc or 240V ac and switches a 3A relay on and off alternately each time the transmitter is operated at range up to 20ft (6m). Responds only to the transmitter frequency. Great for lights, TV, alarm controls etc.  
**KK134** £11.95

Suitable transmitter complete with box (9V PP3 battery required)  
**KK136** £5.85

For more channels use our popular MK12/MK19 IR transmitter receiver  
**MK9** 4-way keyboard £3.35  
**MK10** 16-way keyboard £9.75  
**MK12** 16 Channel Receiver £21.85  
**MK19** IR Transmitter range 80ft £9.75

## SUPER-SENSITIVE MICROBUG



Only 45x28x15mm including built-in mic. 88-100MHz (standard FM radio). Range approx 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm, etc.  
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**TK ELECTRONICS**  
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 Tel: 081-567 8910  
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ORDERING INFORMATION. Prices include VAT but please add £1.26 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. GIRD NO. 529314002. 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 - 5 pm.

# electronize CAR ELECTRONICS KITS

## NEW CODED IR REMOTE CONTROL

Our latest addition allows control of our alarms from outside the vehicle. Both transmitter and receiver use a chip designed specially for car security systems with 59,047 code combinations. You can even set your own code, with several vehicles on the same code or several transmitters for one vehicle if required.

The code transmitter, supplied complete with battery, is housed in a purpose made case to attach to your key-ring. A high power infra-red emitter gives a range of up to 5 metres.

**CODE TRANSMITTER** DIY parts kit £13.95 Assembled £17.95

The low profile receiver is designed to sit on the dashboard top and contains all the electronics to amplify and decode the infra-red signal. It also has a high intensity red L.E.D. which pulses continuously, when armed, to warn off intruders and a green L.E.D. which flashes to tell you the system has been disarmed. (When used with our Volt Drop or Micro-Pressure alarms a simple modification can remove the entry delay if required.)

**CODE RECEIVER** DIY parts kit £21.35 Assembled £26.55

## MICRO-PRESSURE CAR ALARM

This new type of alarm is triggered by a unique pressure sensing system. As any vehicle door is opened air is drawn out, causing a minute drop in air pressure. A sensor detects this sudden pressure change and sets off the alarm. A sophisticated arrangement of electronic filters and timers provide features to match more expensive ultra-sonic systems:-

- ★ Operates on all doors and tailgate - no switches needed.
- ★ Automatically armed 1 minute after leaving vehicle.
- ★ 10 second entry delay with audible warning.
- ★ Sounds horn or siren intermittently for 1 minute.
- ★ Easy fitting - only 3 wires to connect - no holes to drill.
- ★ Adjustable sensitivity.

**MICRO-PRESSURE ALARM** DIY parts kit £15.95 Assembled £22.35  
 Also available:-

**VOLT DROP CAR ALARM** DIY parts kit £14.90 Assembled £20.95

**120dB PIEZO SIREN** (optional for the above alarms) Assembled £11.95

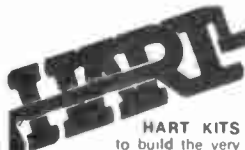
**MICRO-PRESSURE TRIGGER** DIY parts kit £10.95 Assembled £14.95

**EXTENDED CDI IGNITION** DIY parts kit £22.75 Assembled £28.45

All the above include cable, connectors and clear easy to follow instructions. All kits include case, PCB, everything down to the last washer, even solder. All prices now include post, packing and VAT on U.K. orders. Same prices apply to all European countries. For delivery outside Europe please add £3. Telephone orders accepted with VISA or ACCESS payment. Order direct (quote ref. E18) or send for more details from:-

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2 Hillside Road, Four Oaks, Sutton Coldfield, B74 4DQ



## HART AUDIO KITS - YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART KITS give you the opportunity to build the very best engineered hi-fi equipment there is designed by the leaders in their field using the best components that are available. With a HART KIT you not only get more performance for your money but also added free bonus of your own hands on experience of modern electronic assembly. The HART combination of innovative circuit techniques, sound engineering design and professional grade components is your recipe for success in the quest for affordable ultimate audio fidelity.

Telephone or write for your FREE LISTS giving full details of all our Kits, components and special offers. Featured this month is the:-

### AUDIO DESIGN 80 WATT POWER AMPLIFIER



This fantastic John Linsley Hood designed amplifier is the flagship of our range and the ideal powerhouse for your ultimate hi-fi system. This kit is your way to get £K performance at bargain basement prices. Unique design features such as fully FET stabilised power supplies give this amplifier World Class performance with startling clarity and transparency of sound allied to the famous HART quality of components and ease of construction.

Useful options are a stereo LED power meter and a versatile passive front end giving switched inputs, with ALPS precision, low noise volume and balance controls. Construction is very simple and enjoyable with all the difficult work done for you: even the wiring is pre-terminated, ready for instant use! Complete details of the different versions are in our free lists.

**RLH10** Reprints of latest Audio Design Amplifier articles £2.70

**K1100CM HART** Construction Manual with full parts lists £5.50

Why not buy the reprints and construction manual to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

### LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIER



This new circuit by John Linsley Hood uses latest generation integrated circuits in the sonically preferred shunt feedback configuration to give an accurate and musical sound, with the ability to use moving magnet and moving coil cartridges. The HART kit for this unit is exceptionally easy to build with all the specially selected components fitting directly on to the roller tinned fibreglass printed circuit board. Even the gold plated phono sockets mount directly on the board.

Kit complete with fully machined case and a 1 metre length of miniature power supply cable is HART ref K1500 £69.23

### ALPS PRECISION LOW-NOISE STEREO POTS



All in 2 gang stereo format, with 20mm long 6mm dia. steel shafts. Now you can throw out those noisy mismatched carbon pots and replace with the real hi-fi components only used selectively in the very top tier of hi-fi amplifiers. The improvement in track accuracy and tracking linearity is noticeable giving better tonal balance between channels and rock solid image stability.

Values available are 10K and 100K Log, 100K lin and 10K Special Balance (Zero loss in centre position). Also now added to the range are two values in MOTORISED version. These are 20K Log and 10K Special Balance with 5V DC drive motor.  
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 2-Gang 10K Special Balance zero crosstalk and zero centre loss £10.71  
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 2-Gang 10K Special Balance MOTORISED zero crosstalk and -10% centre loss £19.98

### HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do your tapes lack treble? A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1500 hours.

Fitting one of our high quality replacement heads could restore performance to better than new! Standard inductances and mountings make fitting easy on nearly all machines (Sony are special - see below) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see! All our heads are suitable for use with any Dolby system and are normally available ex stock. We also stock a wide range of special heads for home construction and industrial users.

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**HC66** High Quality Stereo R/P Head Hard Permalloy construction with Hyperbolic Face for improved tape to head contact £7.98

**HS16** Sendust Alloy Stereo Head High quality head with good frequency response and hyperbolic face for good tape to head contact £16.85

**HC60S** SONY Special Stereo R/P Head This head has the unusual Sony mounting bracket and is suitable for mains powered domestic HiFi recorders £37.82

**HQ551** 4-Track RECORD & Play Permalloy Head for auto reverse car players or quadraphonic recording £14.90

Many other SPECIAL cassette heads in stock - see our LIST

**REEL TO REEL HEADS**

**999R** 2 4 Record Play 110mH Sweep Stereo Cassette £13.64

**998E** 2 4 Erase Head 1mH Universal Mount £11.98

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Please add part cost of carriage and insurance as follows:

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In-dash fitting controls for volume, tuning, fast forward and wave change. Output for two speakers. Total power output 10 watts. Size 178(W) x 124(D) x 43(H) mm (Supplied with instructions and circuit diagram)

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Mains and battery operated High quality VHF/FM Medium and Long Wave reception, 6 push button selected preset stations

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Size 230H x 150W x 65D

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An easy to build amplifier with a good specification. All the components are mounted on the single PCB which is already punched and back-printed.

- 30W x 2 (DIN 4 ohm)
- CD/Aux, tape 1, tape II, tuner and phono inputs
- Separate treble and bass
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Size (H.W.D.) 74 x 400 x 195mm.

Kit enclosed case PCB, all components, scale and knobs £36.80 + £3.50 pp

(Featured project in *Everyday Electronics*, April 1989 issue). Reprint Free with kit

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Output power 125W RMS max per channel

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Sensitivity 450V at 22K ohms

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Power 220-240V a.c. 50Hz

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Suitable for remote control of telephone answering machines, videos, appliances etc. requiring DTMF signals over telephone lines.

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100mW mini bug. Built on a neat little fibre glass pcb with condenser mic. Fully tunable over the FM band. 9V DC £8.75 + £0.90 pp

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Transmitters listed on this page are not licensable in the UK

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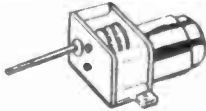
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| 840 | £19.86 | 563 | £71.47 |
| 839 | £13.23 | 561 | £11.65 |
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| 835 | £17.16 | 559 | £15.58 |
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| 833 | £32.13 | 544 | £8.94  |
| 815 | £45.95 | 542 | £13.17 |
| 814 | £21.44 | 528 | £30.60 |
| 812 | £14.81 | 523 | £30.21 |
| 800 | £30.60 | 513 | £31.93 |
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| 740 | £20.01 | 464 | £9.60  |
| 739 | £23.94 | 461 | £9.15  |
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| 730 | £15.50 | 444 | £7.08  |
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| 724 | £43.86 | 392 | £22.37 |
| 722 | £13.88 | 387 | £40.82 |
| 719 | £30.22 | 386 | £6.31  |
| 718 | £30.30 | 362 | £9.91  |
| 715 | £14.39 | 337 | £15.02 |
| 707 | £17.75 | 263 | £27.59 |
| 700 | £40.74 | 242 | £6.49  |
| 584 | £23.90 | 240 | £6.50  |
|     |        | 240 | £7.85  |
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|     |        | 101 | £7.15  |

## 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.

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An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

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## ACOUSTIC PROBE

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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 nosy 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.

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£57.17

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EE OCT '88

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

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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.

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KIT REF 560 DISCO LIGHTS

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KIT REF 561 LAPEL BADGE

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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.

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Including headphones

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## SUPERHET BROADCAST RECEIVER

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KIT REF 835

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# E.E. TREASURE HUNTER P.I. METAL DETECTOR

*A highly developed and acclaimed Magenta design giving excellent performance and reliability. Quartz crystal controlled circuit with MOSFET coil drive and high slew-rate DC coupled amplification. Detects a 10p coin at 20 cm and larger objects much deeper. Full kit includes ALL components, drilled and tinned PCB, search head, handle, case and all plastic parts. Some simple drilling is required.*

- Efficient CMOS design with low battery drain.
- Single winding search coil needs no sensitive adjustments.
- No 'ground effect' - works normally with search head immersed in sea water.
- Variable pitch audio output to lightweight headphones.
- Simple operation using single one-touch control.
- Powerful coil drive.
- Detects Ferrous and non-ferrous metal - Gold, Silver, Copper etc.
- 190mm diameter search coil gives large area coverage.
- Kit includes headphones.

**KIT REF. 815**  
**£45-95**



# DIGITAL CAPACITANCE METER

*A wonderfully easy to use instrument giving direct read-out of capacitors from 1pF to 1000uF. Quick and accurate to use even by absolute beginners. 1% accuracy circuit using close tolerance charging resistors and quartz crystal timing.*

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- Large bright 5 Digit LED display.
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**KIT REF. 493..£49.95**



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# MAGENTA

ELECTRONICS  LTD

# EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects  
**VOL. 20 No. 8**                      **AUGUST '91**

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## FUEL

As we go to press the "hot" news is of cars running on water using fuel cells. Of course the basic technology is not new. I can remember seeing an army Land Rover at Farnborough around 15 years ago with a fuel cell fixed in the back - of course the cell took up all the space on the vehicle but it could convert electricity to hydrogen and vice versa.

Now the hydrogen storage has been sorted out and the space required by the whole thing reduced about ten times, it will obviously soon be a "consumer" item. What has all this got to do with electronics? Well no doubt it will result in an entirely new range of control and instrumentation circuits for each vehicle.

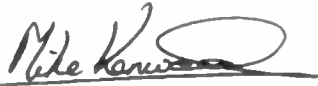
This should keep the various design, development and manufacturing companies happy for a few years. The whole vehicle will, of course, provide a multitude of problems for the car servicing industry - not the least of which will be the training of staff in this "new" area of propulsion, namely electricity. I doubt if the fuel cell itself will be a serviceable item.

Of course all this is pure conjecture as the whole idea may never see the light of day, particularly in view of the fact that the resulting loss of oil sales will affect various governments and multinational oil companies in quite a big way - time will tell. The cell may be kept under lock and key (so to speak) for quite some time yet!

## DOGS

In this issue we publish an improved version of the *Ultrasonic Pet Scarer* we described back in May '89. While the output of this new version is considerably greater than the original, I should make it quite clear that it is not intended to fend off a vicious attacking animal - it would be unlikely to have any effect on such a beast and most certainly should not be seen as some form of protection.

Used to keep unwanted animals away from certain areas - as it is intended it should provide excellent results without generating any "noise" or other pollution.



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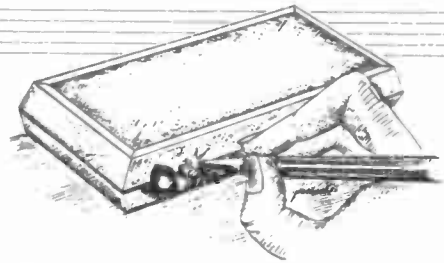
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# OPTICAL COMMUNICATIONS LINK



MIKE TOOLEY BA

*This companion project to our circuit design series features an experimental Optical Communications Link. As with all of our practical projects, a number of modifications are suggested so that the more intrepid constructor can customise the units to his or her own particular requirements.*

**T**HIS final project in our series has been designed to offer the constructor maximum scope for experimentation. The project comprises two separate modules; an Optical Transmitter and an Optical Receiver. The two modules are designed to be used together in order to provide an audio link which can function over distances of up to 10 metres, or so. Alternatively, the two modules can form the basis of a "cordless headphone" or a simple remote control system or could be used as an educational aid to demonstrate the propagation of infrared waves.

The block diagram of the Optical Communications Link is shown in Fig. 1. The low-level audio input signal (between 10mV and 500mV peak-peak) is applied to an audio amplifier stage, the output of which is used to modulate the current supplied to an infrared emitting diode. The electromagnetic energy produced by the diode is thus amplitude modulated (see Part Seven, Fig. 7.2(c)).

The received infrared light (at a wavelength of approximately 900nm) is detected by means of a light sensitive transistor (phototransistor) where the

incident amplitude modulated light is converted into an alternating collector current. This current produces a corresponding alternating voltage which is amplified and passed to a subsequent audio amplifier stage. (Readers may wish to compare Fig. 1 with the arrangement shown in Part Seven, Fig. 7.3 which relates to a simple radio communication system).

## OPTICAL TRANSMITTER

The complete circuit diagram for the Optical Transmitter is shown in Fig. 2. IC1, an operational amplifier, provides an inverting gain of about 20 (maximum). Its output is fed to emitter-follower TR1 along with a steady d.c. bias current from VR2 (via R5). The emitter current of TR1 thus comprises a standing d.c. component onto which appears an alternating component which is an inverted and amplified version of the input signal present at SK1. The emitter current of TR1 is shared equally between the two infrared emitting diodes, D1 and D2.

## OPTICAL RECEIVER

The complete circuit diagram for the Optical Receiver is shown in Fig. 3. The collector current output of phototransistor, TR1, is converted into a corresponding voltage drop by means of the series combination of R1 and VR1. Any alternating component present is amplified by means of IC1 (which offers a fixed gain of approximately 20). IC2 provides further amplification together with a low power audio output stage which is capable of directly driving a small loudspeaker. Low-level audio output is available at SK1 whilst the high-level (loudspeaker) output is available at SK2.

## CONSTRUCTION

Construction of both units is relatively straightforward and both units use small

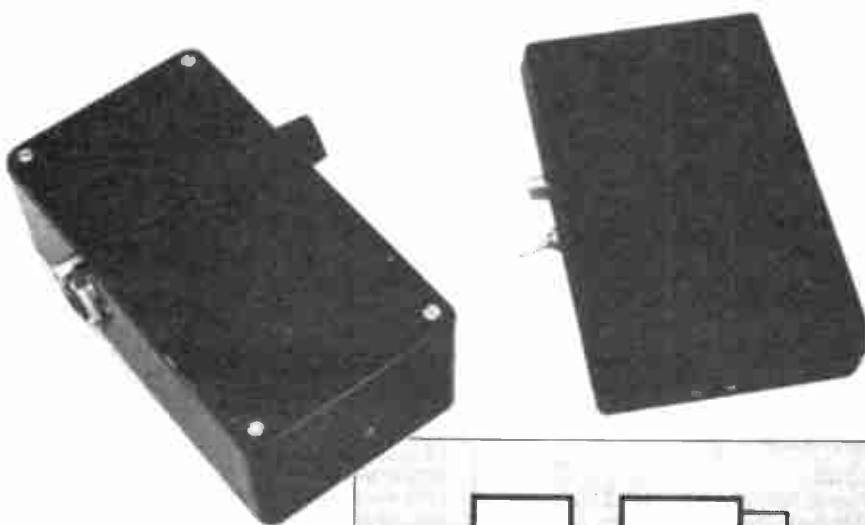
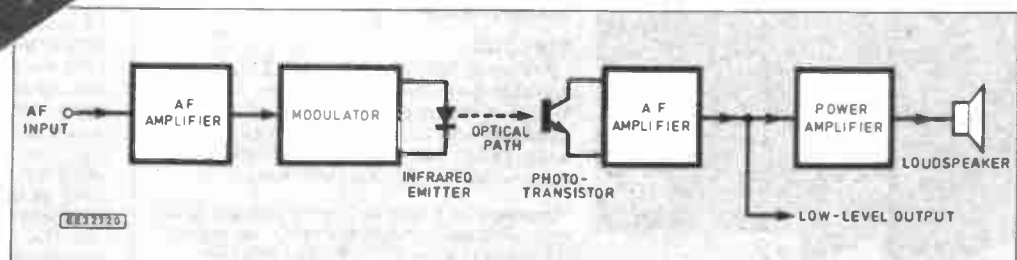


Fig. 1. Block diagram of the Optical Communications Link.



## Specifications

|                         |   |
|-------------------------|---|
| Nominal wavelength:     | 900nm   |
| Optical bandwidth:      | 80nm  |
| Optical beamwidth:      | ± 15 degrees  |
| Range:                  | 4 metres to 10 metres (typical, depending upon ambient lighting)                            |
| Frequency response:     | 20Hz to 10kHz at -3dB (typical)   |
| Signal input impedance: | 5kilohm (approx.) at 1kHz   |
| Input sensitivity:      | 10mV to 500mV pk-pk (typical)   |
| Low level output:       | 500mV pk-pk (typical)   |
| High level output:      | 250mW r.m.s. into 8 ohm   |
| Supply:                 | 9V d.c. (PP3) at 35mA (Transmitter), 10mA (Receiver, standby), 80mA (Receiver, full-output) |

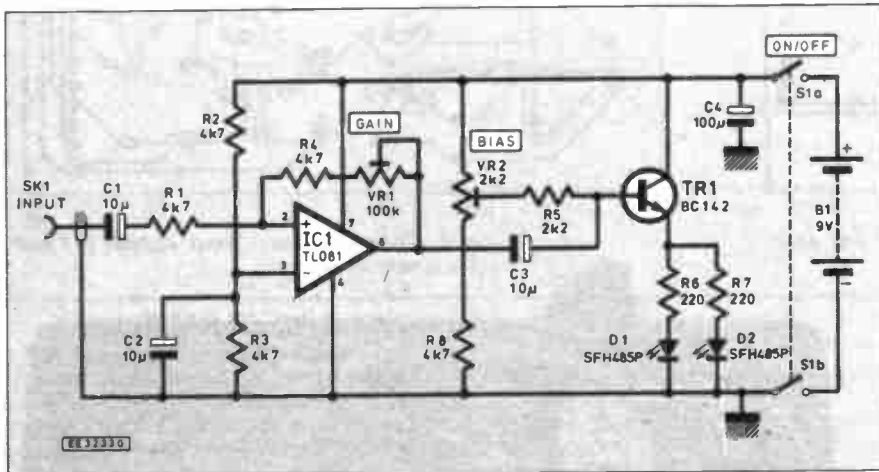


Fig. 2. Complete circuit of the Optical Transmitter.

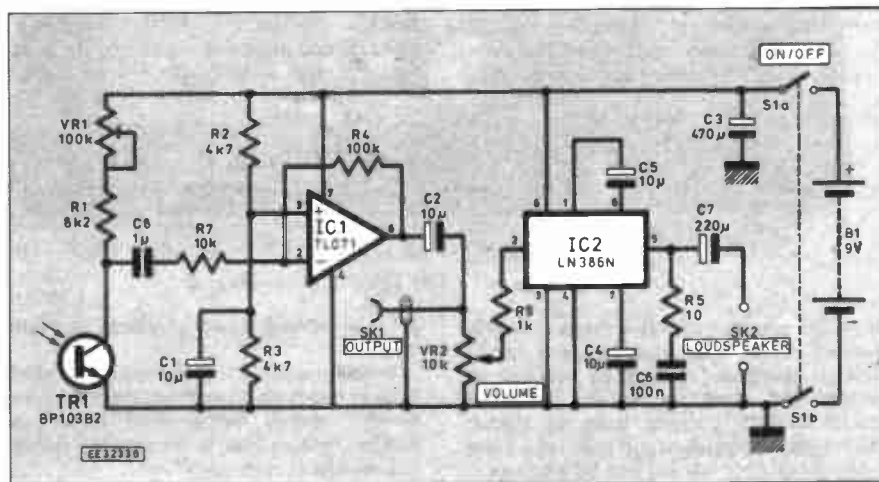
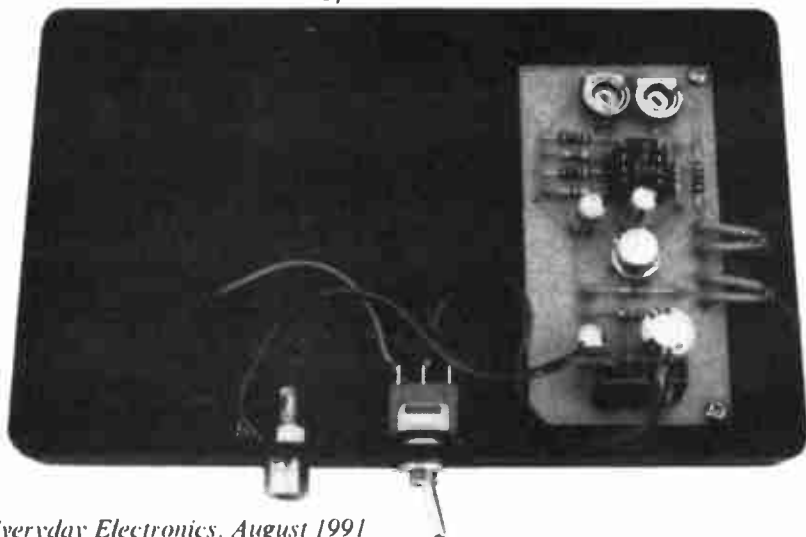


Fig. 3. Complete circuit of the Optical Receiver.  
The Optical Transmitter unit.



## COMPONENTS

### Transmitter

#### Resistors

|    |     |    |     |
|----|-----|----|-----|
| R1 | 4k7 | R5 | 2k2 |
| R2 | 4k7 | R6 | 220 |
| R3 | 4k7 | R7 | 220 |
| R4 | 4k7 | R8 | 4k7 |

All ¼W ± % carbon.

#### Potentiometers

|     |                              |
|-----|------------------------------|
| VR1 | 100k min. horizontal pre-set |
| VR2 | 2k2 min. horizontal pre-set  |

#### Capacitors

|    |                        |
|----|------------------------|
| C1 | 10µ radial elect. 16V  |
| C2 | 10µ radial elect. 16V  |
| C3 | 10µ radial elect. 16V  |
| C4 | 100µ radial elect. 16V |

#### Semiconductors

|     |                          |
|-----|--------------------------|
| D1  | SFH485P infrared emitter |
| D2  | SFH485P infrared emitter |
| TR1 | BC142 npn transistor     |
| IC1 | TL081 op.amp             |

#### Miscellaneous

|     |   |
|-----|---|
| PL1 | 6-way straight p.c.b. header (0.1 inch pitch) |
| S1  | D.P.D.T. miniature toggle switch              |
| SK1 | Panel mounting phono socket                   |

Battery connector (to suit PP3 battery); 8-pin low profile d.i.l. socket; ABS enclosure (see text); p.c.b. available from the *EE PCB Service*, order code EE762.

### Receiver

See  
**SHOP  
TALK**

#### Resistors

|    |      |                    |     |
|----|------|--------------------|-----|
| R1 | 8k2  | R5                 | 10  |
| R2 | 4k7  | R6                 | 1k  |
| R3 | 4k7  | R7                 | 10k |
| R4 | 100k | All ¼W ± 5% carbon |     |

#### Potentiometers

|     |   |
|-----|---|
| VR1 | 100k miniature horizontal pre-set           |
| VR2 | 10k log. with integral D.P.D.T. switch (S1) |

#### Capacitors

|    |                              |
|----|------------------------------|
| C1 | 10µ radial elect. 16V        |
| C2 | 10µ radial elect. 16V        |
| C3 | 470µ radial elect. 16V       |
| C4 | 10µ radial elect. 16V        |
| C5 | 10µ radial elect. 16V        |
| C6 | 100n disc ceramic            |
| C7 | 220µ radial elect. 16V       |
| C8 | 1µ miniature polyester layer |

#### Semiconductors

|     |  |
|-----|--|
| TR1 | BP103B2 phototransistor (this device is spectrally matched to the SFH485P infrared emitters) |
| IC1 | TL071 op.amp   |
| IC2 | LM386N amplifier   |

#### Miscellaneous

|     |   |
|-----|---|
| PL1 | 3-way straight p.c.b. header (0.1 inch pitch) |
| PL2 | 6-way straight p.c.b. header (0.1 inch pitch) |
| SK1 | Panel mounting phono socket                   |
| SK2 | Panel mounting DIN loudspeaker socket         |

Battery connector (to suit PP3 battery); ABS enclosure (see text); 8-pin low-profile d.i.l. socket (2 off); p.c.b. available from the *EE PCB Service*, order code EE763.

Approx cost  
guidance only

**£22**  
plus case

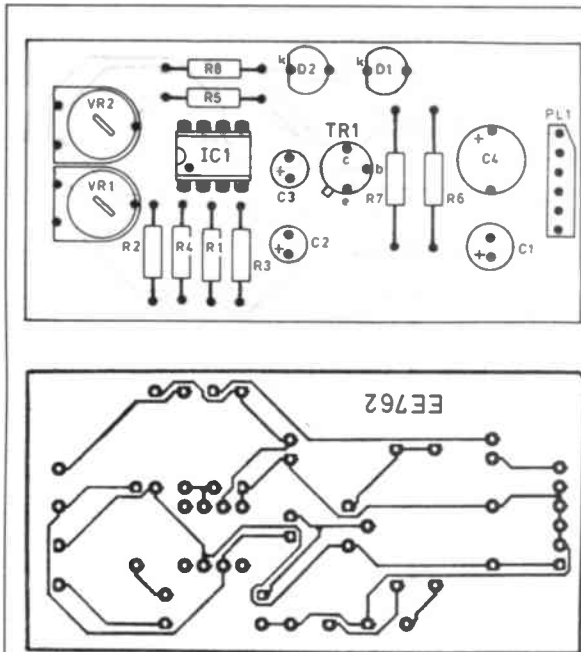


Fig. 4. Optical Transmitter p.c.b. copper foil and component layout.

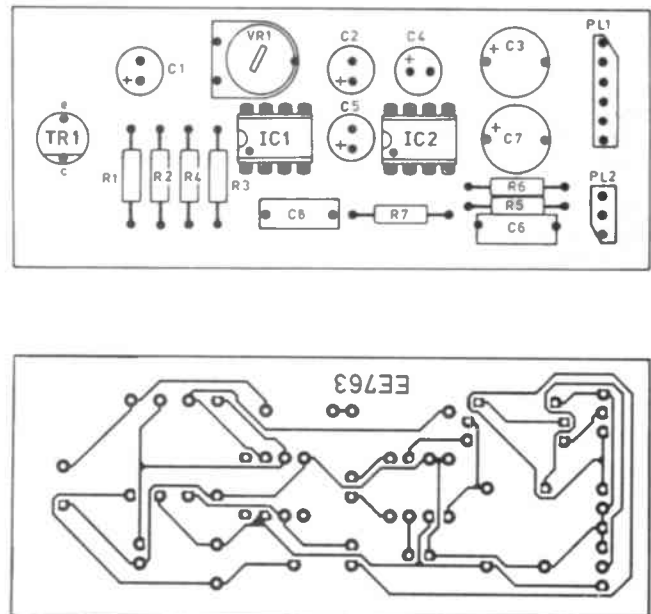


Fig. 5. Optical Receiver p.c.b. copper foil and component layout.

single-sided printed circuit boards. The copper foil and component layout of the Optical Transmitter is shown in Fig. 4. Similarly, the layout of the Optical Receiver is shown in Fig. 5.

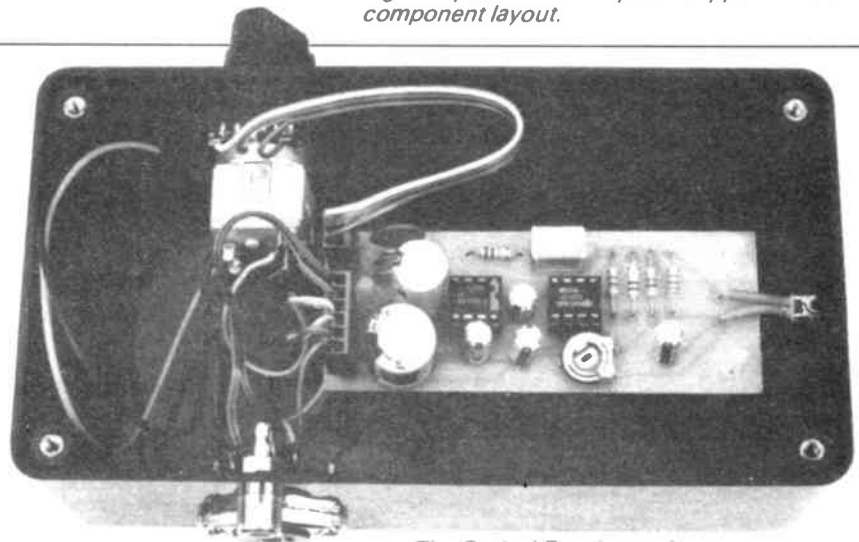
In both cases, components should be assembled on the printed circuit boards in the following sequence: p.c.b. headers, d.i.l. sockets, preset resistors, resistors, capacitors, and infrared semiconductor devices. As with all of our projects, it is vitally important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as the electrolytic capacitors, integrated circuits, infrared emitting diodes and phototransistor) it is absolutely essential to ensure that each component is correctly orientated.

When construction of the printed circuit boards has been completed (and before inserting the integrated circuits into their respective sockets) it is well worth carrying out a careful visual check of both the upper and lower sides of the board. The upper (component) side of the printed circuit board should be examined to ensure

that the components have been correctly located whilst the lower (copper track) side of the board should be checked to ensure that there are no dry joints or solder bridges between adjacent tracks. This simple precaution will only take a few minutes to carry out but can be instrumen-

tal in preventing much heartache at a later stage!

When assembly of the printed circuit boards has been completed, the integrated circuits should be inserted into their holders (taking care to observe the correct orientation in each case).



The Optical Receiver unit.

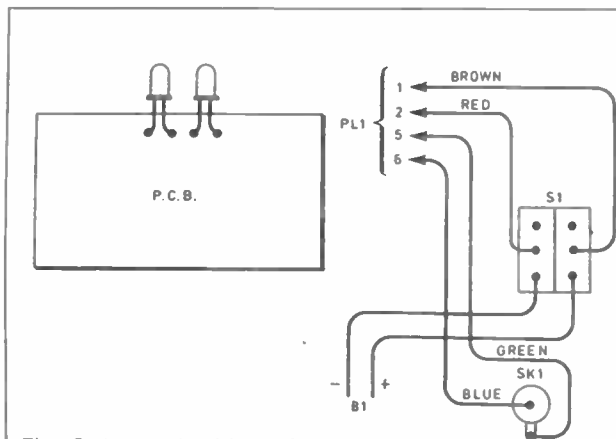


Fig. 6. Internal wiring of the Optical Transmitter.

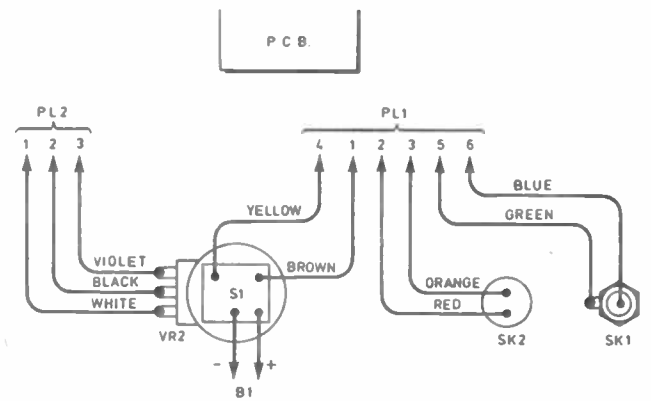


Fig. 7. Internal wiring of the Optical Receiver.

## CASE

The Optical Receiver and Optical Transmitter modules may be housed in almost any small ABS enclosure of appropriate size. The prototype Optical Transmitter was housed in a small hand-held case (with integral battery compartment for a PP3 size 9V battery) measuring 146 × 92 × 31mm.

The enclosure used for the prototype Optical Receiver, on the other hand, was a box measuring 150 × 80 × 58 mm. In practice, the precise dimensions of the two enclosures are unimportant, provided adequate room is made available to accommodate the printed circuit boards and controls.

The two enclosures should be drilled to accommodate the controls, sockets, and infrared semiconductor devices. The circuit boards can be mounted by means of snap-fit p.c.b. mounting pillars secured to the base of the enclosure however care should be taken when positioning them in order to ensure that the infrared semiconductor devices can be positioned correctly.

As usual, connections to the printed circuit boards are made using 0.1 inch pitch printed circuit board headers. The recommended method of terminating the female connectors which mate with the headers was described in the first of our constructional projects which appeared in the December 1990 issue of *Everyday Electronics*.

Coloured stranded 0.1 inch pitch ribbon cable is used to make connections to the controls and sockets. The following colour coding is recommended:

### Optical Transmitter, PL1

| Pin | Colour | Connection to: |
|-----|--------|----------------|
| 1   | Brown  | S1a (+9V)      |
| 2   | Red    | S1b (0V)       |
| 3   | none   | not connected  |
| 4   | none   | not connected  |
| 5   | Green  | SK1 (common)   |
| 6   | Blue   | SK2 (signal)   |

### Optical Receiver, PL1

| Pin | Colour | Connection to: |
|-----|--------|----------------|
| 1   | Brown  | S1a (+9V)      |
| 2   | Red    | SK2 (signal)   |
| 3   | Orange | SK2 (common)   |
| 4   | Yellow | S1b (0V)       |
| 5   | Green  | SK1 (common)   |
| 6   | Blue   | SK1 (signal)   |

### Optical Receiver, PL2

| Pin | Colour | Connection to:   |
|-----|--------|------------------|
| 1   | White  | VR1 (common end) |
| 2   | Black  | VR1 (slider)     |
| 3   | Violet | VR1 (top end)    |

The internal wiring of the Optical Transmitter and Optical Receiver units is shown in Figs. 6 and 7 respectively.

## TESTING

Before testing the Optical Transmitter and Optical Receiver, it is important to carefully check the wiring of the printed circuit boards, controls, sockets, and battery connectors.

The three pre-set controls should be adjusted initially to their fully anti-clockwise settings, VR2 on the Optical Receiver set to minimum, PP3 batteries inserted into

both units and no external connections made. Each unit should be switched on in turn and the supply current should be measured. In the case of the Optical Transmitter, this should be in the range 30mA to 45mA whilst for the Optical Receiver it should be between 6mA and 15mA. If one or other of these currents is not within the range suggested, it is worth carrying out a careful visual check of the printed circuit board and wiring of the unit in question.

Having confirmed that the supply current is within the suggested range, the two units should be set up on a bench or table approximately one metre apart and with the infrared semiconductor devices facing each other (making sure that there is an unobstructed path between the transmitting and receiving devices).

A loudspeaker (of between 8 ohm and 80 ohm impedance) should be connected to SK2 on the Optical Receiver and the volume control (VR2) should be advanced to about 30 per cent of its clockwise travel. At the same time, a signal source should be connected to SK1 on the Optical Transmitter. If a signal generator is available, this should be adjusted to produce a sine wave of 50mV pk-pk at 1kHz however, if such a device is unobtainable, an input signal may be derived from the headphone or "aux" output of a tape recorder or radio. Finally, ensure that the level of mains lighting in the vicinity of the Optical Receiver is not excessive (otherwise this may generate an unacceptable amount of 50Hz hum!).

Both units should now be switched on and VR2 adjusted for a comfortable volume setting. The received signal should be clear and reasonably loud. The following adjustments should then be made to improve the sensitivity and signal quality:

### Optical Transmitter:

VR1 Adjust for adequate signal to noise ratio. If set too low there may be an appreciable level of noise at the receiver, if set too high the signal may become distorted due to excessive modulation depth

VR2 Adjust for minimum distortion (this control sets the standing d.c. bias current applied to the infrared emitters)

### Optical Receiver:

VR1 Adjust for maximum sensitivity under normal ambient lighting conditions

(different settings of this control are recommended for daylight and night operation). If in doubt, the control may be adjusted for a d.c. voltage of approximately 4.5V between the collector and emitter of TR1 (under normal light conditions).

Note that it may be necessary to perform these adjustments several times in order to produce the optimum settings for all three controls.

Having adjusted the two units, it should be possible to increase their separation to at least four metres without severe loss of signal (the volume control may need re-adjustment, however). Note that the infrared output from the Optical Transmitter is highly directional and that, as the distance between the two units is increased, it will become increasingly important to ensure that the two modules are correctly aligned with respect to each other.

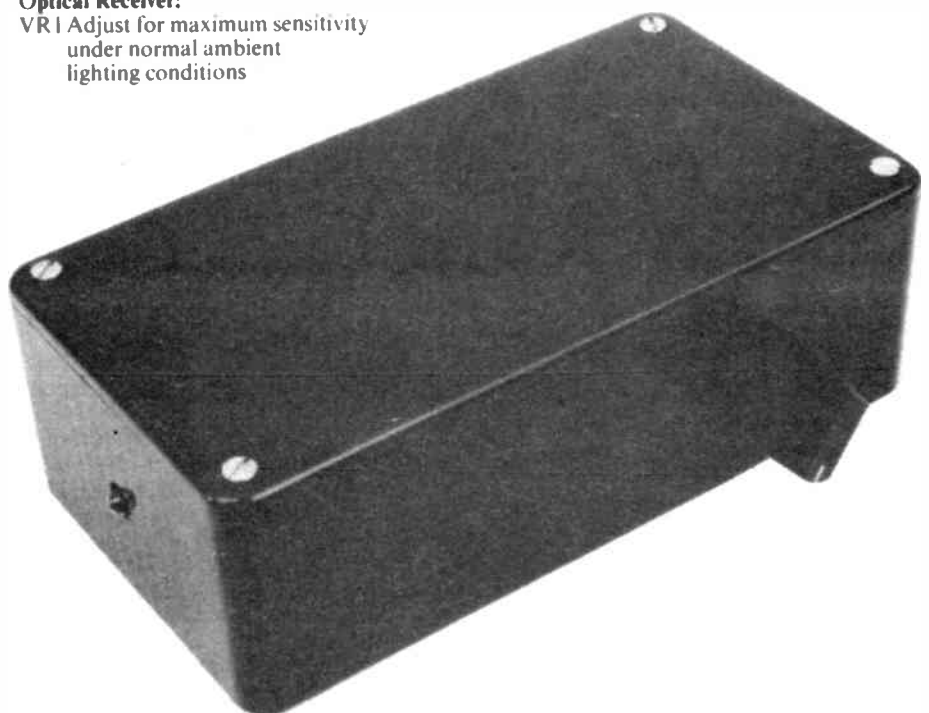
Finally, in applications where mains lighting is present, it may be necessary to fit the Optical Receiver with a black tube in order to shade the phototransistor and thus reduce the level of 50Hz hum which may be present. Such a tube can be made from a 50mm (approx.) length of 20 to 40mm diameter plastic or cardboard tubing glued to the outside of the case (see Fig. 8).

## MODIFICATIONS

A number of modifications can be made in order to enhance the performance of the basic Optical Communications Link. As always, the suggestions made here are provided as "food for thought" and should make a starting point for further development. Constructors are invited to report their own modifications to be incorporated in the Readers' Feedback which will appear in the final part of our Design series.

## Mains operation

Either (or both) of the units (Optical Receiver and Optical Transmitter) may be modified for mains operation. A suitable mains supply is the Dual Output Power Supply module which appeared in Part One of the series. The module should be fitted with a 7809 regulator (IC1) and used in conjunction with a mains transformer having two secondaries rated at 9V, 0.25A.



## Increased range

There are various ways in which the operational range of the system can be increased:

- (a) Increased output from the Optical Transmitter: R6 and R7 can be reduced to 120 ohm in order to increase the output power by a factor of about four (roughly doubling the effective range of the unit).

Note that this modification will result in increased battery current and consequently much reduced battery life. This, however, will be of little importance if the unit is mains powered!

- (b) Use of an optical system: The effective range of the unit can be greatly increased by fitting the Optical Receiver with a lens. This should be positioned so that the semiconductor chip within the phototransistor (approx. 4.4mm from the tip of the domed transparent package) is located precisely at the focal point of the lens.

A method for determining the approximate focal length of a lens is shown in Fig. 9 and a suggested lens arrangement (with adjustable focus) is shown in Fig. 10.

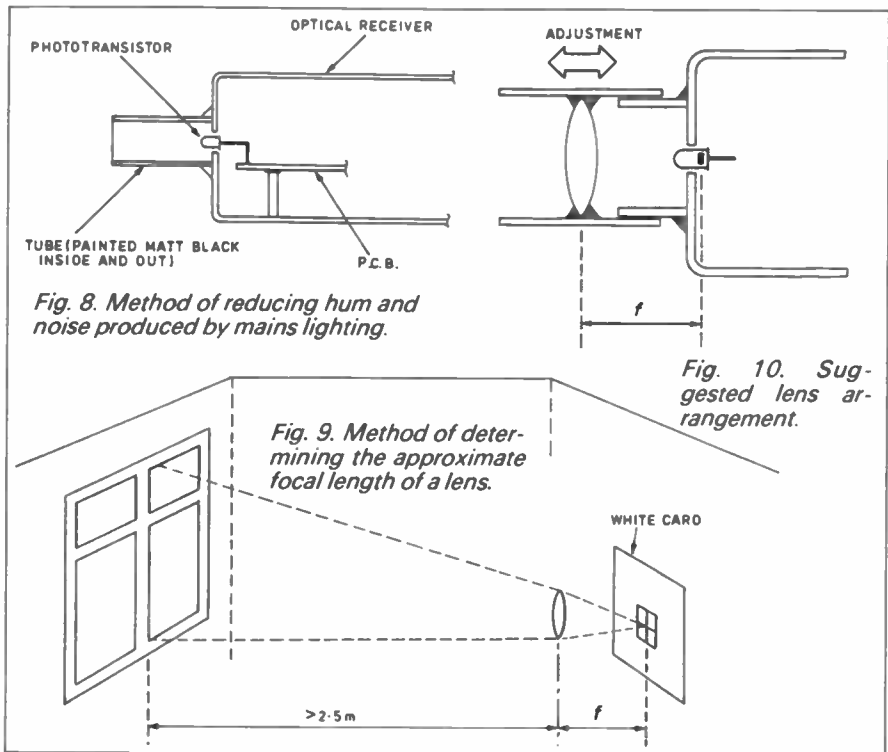


Fig. 8. Method of reducing hum and noise produced by mains lighting.

Fig. 10. Suggested lens arrangement.

Fig. 9. Method of determining the approximate focal length of a lens.

# SHOP TALK

with David Barrington

## Musical Roundabout – Simple Model Series

Assembly and wiring of the electronics for the *Musical "Carousel"*, this month's *Simple Model Series* project, is by the use of the "no soldering" Easiwire wire-wrapping system. The model and circuits are built up on printed card, which can be obtained from the EE Editorial Offices for the sum of £2.50 (including postage). You can, of course, photostat the published diagrams onto your own card.

To help with assembly, Bull Electrical (☎ 0273 203500) and Greenwell Electronic Components (☎ 0703 236363) have put together a complete kit, including cards, for the sum of £7.95 plus £1 postage.—See *Special Offer* page 502.

The above mentioned companies have large stocks of Easiwire solderless wiring packs and have agreed to make these available to EE readers who order kits from them. If you purchase any one *single* kit an Easiwire pack will set you back £5. However, if you are prepared to order four or more of the kits listed they will supply an Easiwire kit *FREE*.

For those readers who wish to go their own way, all components appear to be standard off-the-shelf items, with the exception of the melody generator chip and d.c. motor which may prove difficult to locate locally. However, most of our components advertisers should be able to obtain suitable motors and the melody i.c.

## Portable Ultrasonic PESt Scarer

Some of the parts required to build the *Portable Ultrasonic PESt Scarer* are special items and, as far as we are able to uncover, are only available from one source. The M231M ultrasonic transmitter transducer (£6.95+postage), MF9620 MOSFET and the ferrite pot core, bobbin and wire are only available from **Magenta**.

A complete kit of parts (£22.56), including p.c.b., transducer and slim-line case, is available from **Magenta Electronics, Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST** (☎ 0283 65435). Add a further £2 for post and packing.

The small printed circuit board is available from the *EE PCB Service*, code EE764. See page 532.

## Teach-In '91

A couple of items look as though they will cause followers of the *Teach-In '91* series, *Design Your Own Circuits*, certain local difficulties.

Practically all our advertisers will know the light dependent resistor, called up for the *Light Sensitive Switch*, as an ORP12 device, without the prefix N at the front of the code number. The miniature relay used in the prototype module is the 3A, 400 ohm coil, 12V d.c. version from **Electromail**, code 345-529. Other relays with similar electrical ratings may be used, but check they will fit on the circuit board first.

The matched phototransistor and infra-red emitters have been a

nightmare to locate and the only source we have been able to find is from **Electromail** (☎ 0536 204555), the mail order operation of RS Components. These appear to be RS devices and are coded, Phototransistor 585-220 and emitters 585-242 (narrow beam). The reason for this is that, at the time of writing, the designer is away in Russia setting up a "training exchange" for pupils and the type numbers quoted do not appear in any of our component catalogues, including Electromail's.

The three printed circuit boards for this month's series are all available from the *EE PCB Service*, see page 532 for prices.

## Modular Disco Lighting System

We do not expect any component buying problems to be encountered by constructors of the *Random Pattern Module*, this month's *Disco Lighting System* module.

The metal instrument case for this module is the same for all modules in the series and is the Maplin Blue case 233, code XY84C. Other cases can be used but they must be METAL. It is also essential that the case be "Earthed".

The printed circuit board is available from the *EE PCB Service*, code EE760.

## Pedometer

We cannot foresee any component problems when shopping for parts for the *Pedometer*. The "trip" lever for operating the "count" switch should be made from steel rod, as a copper one will not withstand the pounding from the ground surface.

The click switch used is the type that can also be used to make up keyboard layouts. An alternative switch would be a lever-operated microswitch. It may need adapting and the heavy duty type is particularly suited to this application.



# FOR YOUR ENTERTAINMENT

by Barry Fox



## DAB

I have recently been looking at the new technology of DAB, digital audio broadcasting. You will be hearing a lot about DAB in the months and years to come. The Western world is hoping to standardise on a common system which will allow car radios to receive digital stereo, either direct from a satellite or via terrestrial relay stations.

Technically this is a very tall order. The system must have a high enough bit rate to give good sound quality, but a low enough bit rate to cope with multipath interference caused by reflections and by reception on the same frequency from more than one transmitter (e.g. satellite and relay) at the same time.

I'll return in a later column to DAB and how the European system solves all these problems. Everything now depends on an allocation of frequencies, at around 1500MHz, at the next World Administrative Radio Conference to be held in Spain early next year.

## Leading Edge

Recently when I mentioned DAB at a conference someone popped up from the audience and said "Japan is ahead, they are just starting broadcast services". Although it is true that Japan's Ministry of Posts and Telecommunications has licensed six consortia to provide a digital radio service (three channels each), the technology to be used in Japan for digital radio is completely and utterly different from the DAB system proposed for Europe and the USA. In this field, at least, Japan is years behind the West.

The Japanese broadcasters are using satellite TV technology to provide a satellite radio service. A TV channel is used to carry digital sound instead of analogue TV pictures - much as a video recorder can be used to store digital audio.

Japan's BS direct broadcasting satellite already transmits some digital radio programmes (from Japan Satellite Broadcasting). These use PCM Mode A, with a bandwidth of 15kHz. The new services will use Mode B PCM which has an audio bandwidth of 22kHz.

Neither mode uses anything resembling the heavy data compression on which the European DAB system relies. The bit streams are thus so fast, and the systems require so much bandwidth, that they are only applicable to satellite broadcasting. There is no resistance to multipath and programmes can only be received with a fixed satellite dish aerial and domestic satellite receiver.

One of the service operators, Nippon Television Network, is in partnership with the Yomiuri Shimbun newspaper

and Mitsubishi, in a consortium called PCM Japan. Tokyo Broadcasting (TBS) heads PCM Zipang Communications. The other four consortia (Music Bird, Herald Films, Japan PCM Music Broadcasts and Satellite Music) are backed by various film, music, publishing and even railroad companies.

## Subscription Only

NTV admits that it will not be easy to sell the new idea to Japanese listeners. The music signals (a spread across channels of rock, pop, classical and traditional Japanese styles) will be scrambled and be available only to paying subscribers.

Although PCM Japan plans to start broadcasting on 1 November, with capital of six billion yen, receivers are not yet ready. Because of the directional dish aerial needed, they will not work in cars. It will be the first commercial radio station to charge a subscription fee.

"It will be difficult to convince the public that these broadcasts are worth paying for" NTV admits. "expansion will be slow at first".

Remember this if you read somewhere that Japan has lead the world into digital radio.

## Dockables

First the computer companies offered portables or lap-tops. They were so heavy that users dubbed them luggables. Then came mobiles, which save on the size and weight of batteries by using a liquid crystal screen which draws only a little power. But the LC display is never as bright or clear as a mains-powered office monitor screen.

The latest mobiles "dock" with a mains-powered desk-top unit. But their screen is still designed for mobile use. Olivetti now claims the best of all worlds with a docking mobile which has a detachable LC screen.

Olivetti's desk-top dock charges the batteries in the mobile while providing a fixed link with an office network system, printer, and disk or tape drives. While the mobile is in dock and on charge, its power-saving LC screen can be exchanged for a brighter but power-hungry cathode ray tube, or electroluminescent or plasma panel.

## Fold Your Portable

Psion was first into the market with a truly portable computer, the pocket Organiser. But the Organiser had an alphanumeric (A,B,C,D ...) keyboard which makes it well nigh useless for entering large passages of text.

Psion then launched the MC range of mobile computers. These have a full-size QWERTY keyboard and use the MS-DOS operating system, so they can be

compatible with IBM PCs. Inevitably, because of the large keyboard, the MC is a lot larger than the Organiser.

Now Psion have launched the HC, which looks like an Organiser, but uses the same processor (8086) as an IBM PC and stores data in MS-DOS file format.

## Flash Price

Both the MC and HC store data on Flash EPROM chips, rather than magnetic disks. Because these "solid state disks" have no moving parts, they can store large quantities of data with low drain on the batteries. The penalty is the horrendous cost.

Even though Psion has just reduced prices, a one megabyte SSD still costs £195. It used to be £245. This is between 100 and 200 times the price of a similar-sized floppy disk. Small wonder that SSD drives show no sign of replacing floppy drives on consumer portables.

But the HC pocket unit is aimed at business and industrial users, for whom the high price of SSD is a small price to pay for massive storage capacity in a pocket-sized unit with long battery life. The HC has two SSD drives, which means it can store up to two megabytes in non volatile memory, in addition to several hundred kilobytes in RAM.

But the HC still has only an alphanumeric keyboard. Why, I asked Psion's founder David Potter, does Psion not offer a Qwerty keyboard as a plug-in accessory?

"These are designed as hand-held units", says Potter of the HC. "They are for people on the move, not sitting down. We find that corporate customers need a vertical, portrait layout. They are not entering large quantities of data by hand. The data goes in by bar code scanner or magnetic card reader. If they want to use a computer for text, they need to move on to an MC, with a full sized keyboard".

## The End?

On the face of things this is the end of the story. If a computer is small enough to fit into a pocket, then you are stuck with a portrait design, with small window screen and alphanumeric keyboard. If you want a QWERTY keyboard that feels right for typing, and a screen that shows reasonable quantities of text, you are stuck with a computer that is too large for a pocket.

But I doubt that it really is the end of the story.

Who will be first to think laterally and use flexible thin film technology to produce a full sized keyboard and screen that folds, like an Origami paper toy, into a pocket sized unit?

# PORTABLE ULTRASONIC PEST SCARER



**MARK STUART**

*A truly portable device that will fit in the pocket or handbag. Keep the neighbour's and your own pet from your flower beds with this harmless, high power, ultrasonic generator.*

**T**HIS HAND-HELD device is designed to produce an intense ultrasonic wailing which many animals find unpleasant. The operating frequency of 23kHz is above the range of human hearing but well within that of dogs, and cats.

It is probable that rabbits, squirrels, birds, and other pests such as mice and rats can also hear it, but its effect on such animals has not been tested and leaves interesting areas for experiment.

Whilst being unpleasant, ultrasound from this unit will not stop an angry dog in full flight, but it *could* distract less determined animals. The best defence is to avoid dangerous animals altogether with or without this device.

As well as hand-held operation the circuit can be modified to give unattended

continuous operation for the protection of driveways and garden areas, or to keep pests from around caravans. It is also possible to operate the circuit at lower frequencies with a different transducer as an effective personal attack alarm. These variations are all available in appropriate kit form based on the same circuit board but are not described in detail here.

## CIRCUIT DESCRIPTION

The complete circuit diagram for the Portable Ultrasonic PEST Scarer is shown in Fig 1. Two separate oscillators (IC1a and IC1b) are used, one develops a low frequency triangular wave which modulates the frequency of the other oscillator which generates the ultrasonic frequency.

The low frequency oscillator is formed by IC1a which is half of a TLC552 oscillator i.c. This is a dual CMOS version of the familiar 555 timer i.c., the use of which gains very few marks for originality but succeeds in producing the necessary frequencies with a high degree of accuracy. This means that the circuit does not need any form of alignment or special test equipment, and so has no trimmers or pre-sets.

The frequency from IC1a is not critical as it only determines the modulating speed, it is determined by capacitor C2 which is charged via resistors R1 and R2 in series and discharged via R2 and the internal discharge f.e.t. at pin 13 of the i.c. As R2 is very much larger than R1 the charge and discharge times are almost the same so a regular triangular waveform appears across C2 which is charged and discharged between 1/3 and 2/3 of the supply voltage.

These voltage levels are set inside IC1 by an accurate potential divider chain. Detailed operation of 555 type circuits has been very well covered before in these pages and so is not necessary here.

The cycle time using the specified values is 0.14sec. giving a frequency of 7Hz. C2 is a standard electrolytic capacitor which can be anywhere between -20% and +80% of the marked value and so the cycle time may vary by this amount.

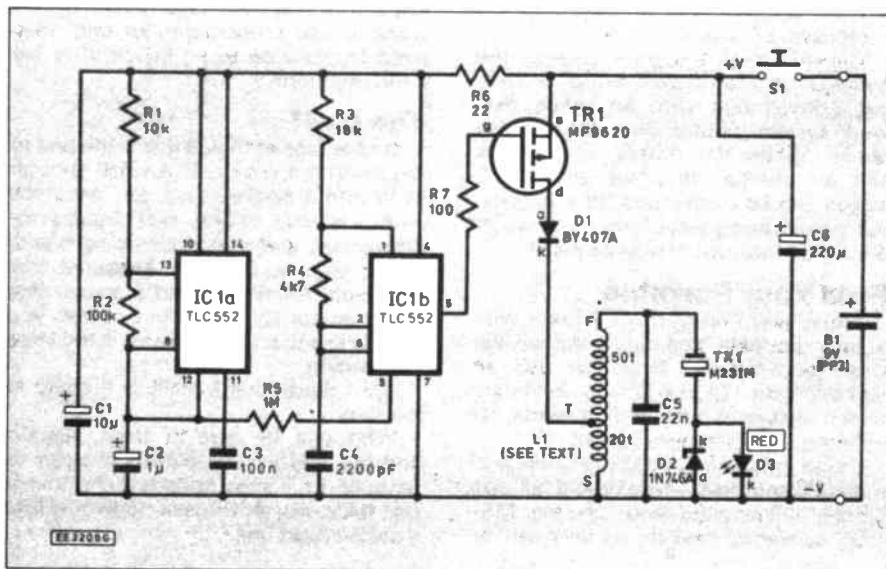
## ULTRASONIC OSCILLATOR

The ultrasonic oscillator frequency is set by IC1b, capacitor C4 and resistors R3 and R4. Close tolerance components are specified throughout so that the exact frequency is produced to get the maximum efficiency from the transducer.

The values of R3 and R4 are selected so that capacitor C4 has a much shorter discharge time than charge time. This is done to produce an output waveform with a mark-space ratio of approximately 5:1 to drive the power MOSFET TR1.

The frequency is modulated by applying a small amount of the voltage from capacitor C2, via resistor R5, to the control terminal (pin 3) of IC1b. This terminal allows access to the potential divider chain inside the i.c. which determines the voltages between which C2 charges and discharges. As these voltages vary so do the charge and discharge times and hence the frequency. The value of R5 sets the amount of fre-

Fig. 1. Full circuit diagram for the Portable Ultrasonic PEST Scarer.



quency shift to approximately eight per cent.

The power to IC1 is decoupled by resistor R6 and capacitor C1 to ensure a clean supply even from a low battery. Capacitor C3 decouples the control terminal of IC1a to prevent stray signals being picked up and causing erratic operation.

## OUTPUT DRIVER

From the oscillator the output pulse waveform is taken via resistor R7 to drive the power output device TR1. The output has an uneven mark-space ratio of 5:1, as discussed before, with the voltage being high for five parts and low for one. TR1 must be turned on only when the output is low and so a *p*-channel MOSFET is required.

This arrangement is slightly unusual but is simple and has the advantage that the case of the transducer is close to the negative supply voltage. However *p*-channel MOSFETS cost more than *n*-channel and are not as freely available.

The device chosen is a compromise between cost and output efficiency and has ample power rating. Resistor R7 is not strictly necessary but protects IC1b in the

not be less than 20 turns from the negative end of L1. Wherever the tapping is situated, the total number of turns on the coil must remain the same.

Capacitor C5 and the transducer capacitance combine to tune the coil to the correct frequency. During operation there is a substantial a.c. current through C5 which causes standard polyester capacitors to heat up by a surprising amount. The specified polypropylene type has much lower dielectric loss (less than 10 per cent of polyester's) and so stays cool, increasing the circuit's efficiency and reliability.

Diode D1 is fitted to allow the voltage across coil L1 to swing freely above the positive supply rail as the tuned circuit resonates. Without it the MOSFET would conduct in reverse, energy would be lost from the coil into the supply, and the voltage swing across L1 would be reduced. The additional forward voltage drop across D1 when TR1 is turned on is a minor penalty for the high output voltage gain that this circuit produces.

## TRANSDUCER

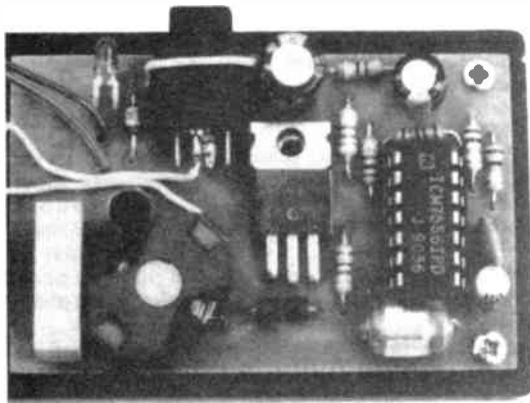
The transducer is a piezoelectric disc with metallised areas on both sides. One

capacitor and so current can only pass when a.c. is applied. The current passing through the transducer is a good indication that the circuit is operating correctly and that the transducer is being driven with a.c.

The l.e.d. D3 connected in series with the transducer monitors this current and gives a reliable indication of acoustic output. The Zener diode D2 is connected across the l.e.d. to provide a path for reverse current.

A Zener diode has been used here so that if the l.e.d. becomes open circuit (a fairly common occurrence usually due to physical damage) there is still a path in both directions for the transducer current. The Zener requires slightly more voltage to conduct than the l.e.d. forward voltage so that normally all of the current flows in the l.e.d.

Capacitor C6 is a supply decoupling capacitor which enables the circuit to take the necessary short pulses of high current without the supply voltage dropping each time TR1 is turned on. A biased-off single pole push-to-make switch S1 applies power to the circuit only whilst pressed.



The completed prototype board showing the MOSFET device (TR1) bent over flush with the board. The timer chip IC1 has been changed for a TL552 type. The ultrasonic transducer is mounted on the outside of the lid - see photo above right.

event of a short circuit or a fault around TR1.

## TUNED CIRCUIT

The output from TR1 drives the transducer TX1 via the matching network made up of coil L1 and capacitor C5. These components along with the transducer form a tuned circuit which converts the pulsed drive waveform into a much higher voltage Sine Wave.

The tapping position shown on the coil gives a step-up ratio of 70 turns to 20 turns or 3.5 to 1, which combined with the action of the tuned circuit has the capability to drive the transducer with over 300V peak-to-peak. This is well in excess of its rating but is acceptable in short bursts without damaging the transducer.

The circuit power can be reduced and its efficiency increased by moving the tapping nearer to the top end (closer to diode D1 cathode(k)) or removing the tapping altogether and connecting the cathode of D1 to the top of the coil. This is recommended when first setting up the circuit and for general use. The 20-turn tapping is rather extreme but demonstrates how to obtain the highest power.

With enough wire different positions may be tried for the tapping which should

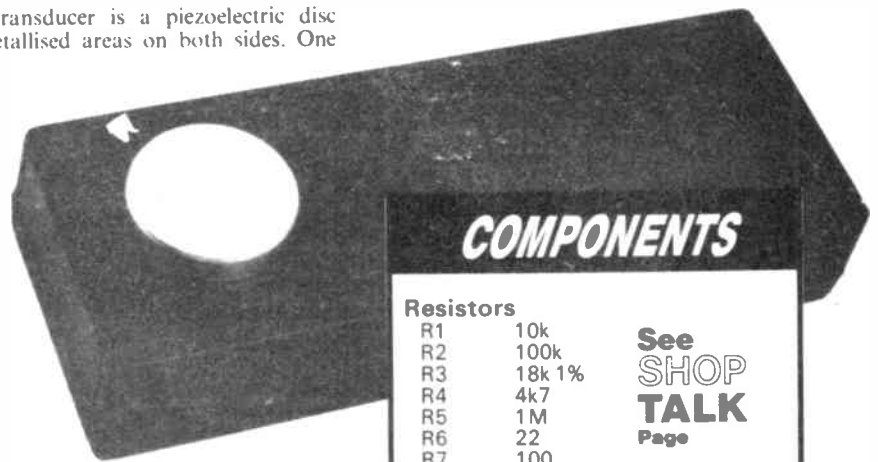
side is bonded mechanically and connected electrically to the inside of the metal housing, the other side is connected to an insulated terminal pin on the rear of the transducer with a thin wire.

Applying voltage to the transducer makes the disc flex into a dome in either direction according to the polarity. With an a.c. voltage applied the transducer rapidly flexes in and out moving the metal case with it as it goes. By correct choice of the disc and metal housing thickness and material the front of the transducer can be tuned to resonate mechanically like the skin of a drum.

Applying a.c. at this frequency causes the maximum flexing and acoustic output. This is the designed operating frequency of the transducer. At frequencies either side of this the transducer is still efficient and so driving it with a sweeping ultrasonic frequency produces acoustic output over the whole range.

The greatest advantage of sweeping the frequency is that it ensures that the resonant frequency of the transducer is hit at some time during each sweep. Transducers vary from unit to unit and so this is a convenient way of allowing for this tolerance and getting good performance across the whole production spread.

Electrically the transducer appears as a



### Resistors

|    |        |
|----|--------|
| R1 | 10k    |
| R2 | 100k   |
| R3 | 18k 1% |
| R4 | 4k7    |
| R5 | 1M     |
| R6 | 22     |
| R7 | 100    |

See  
SHOP  
TALK  
Page

All 0.25% carbon film, except where stated.

### Capacitors

|    |                            |
|----|----------------------------|
| C1 | 10µ radial elect, 10V      |
| C2 | 1µ radial elect, 10V       |
| C3 | 100n ceramic disc, 25V     |
| C4 | 2200p polystyrene, 1% 63V  |
| C5 | 22n polypropylene, 5% 250V |
| C6 | 220µ radial elect, 10V     |

### Semiconductors

|     |  |
|-----|--|
| D1  | BY407A 1A fast rec.                    |
| D2  | 1N746A Zener diode                     |
| D3  | 3mm standard red l.e.d.                |
| TR1 | MF9620 <i>p</i> -channel power MOSFET  |
| IC1 | TL552 dual CMOS timer                  |
| TX1 | M23IM ultrasonic transmitter (Magenta) |

### Miscellaneous

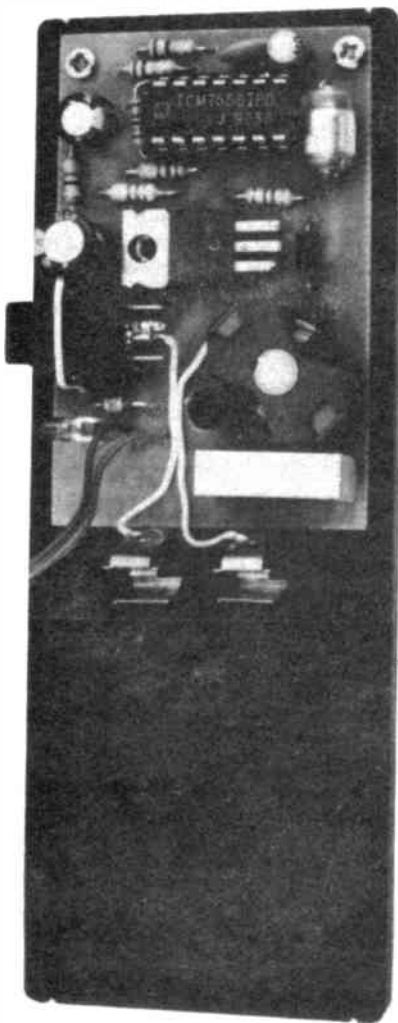
|    |   |
|----|---|
| L1 | Ferrite core, bobbin and wire (see text) (Magenta)                |
| S1 | Miniature non-latching push-to-make, release-to-break push switch |

Plastic case, size 45mm x 126mm x 25mm; 14-pin low profile d.i.l. socket (see text); nylon nut and screw to mount coil L1; multi-strand connecting wire; self-tapping screws for mounting p.c.b. (2 off); solder etc.

Printed circuit board available from EE PCB Service, code EE764

Approx cost  
guidance only

£25



The completed circuit board mounted inside the hand-held case showing wiring to the battery compartment contacts.

## CONSTRUCTION

The Portable Ultrasonic PESt Scarer is built on a small printed circuit board. The component layout and full size copper foil master pattern is shown in Fig.2. This board is available from the *EE PCB Service*, code EE764.

Check the board and make sure it fits correctly in the case before fitting any components. If necessary file the board edges and drill out the mounting holes so that it will mount easily into the case when the components have been fitted.

In order to fit the compact case used and to keep the profile as slim as possible it is necessary to fit the components under the transducer close to the board. This means that IC1 must be soldered directly on the board or fitted in a very low profile socket. As the i.c. is unlikely to be damaged by other component faults it is not impractical to solder it straight in. Resistors R6 and R7 prevent high currents flowing even if short circuits happen in that area.

Begin assembly by fitting all of the resistors and diodes. Note the polarity marking bands on the diodes which must be fitted as shown. Next fit all of the capacitors making sure that C1, C2 and C6 are the right way round. These three are miniature electrolytic types and are fitted with plastic sleeves, their polarity is normally marked with a line of negative signs down the sleeve on the side adjacent to the negative lead. The other capacitors can be fitted either way round.

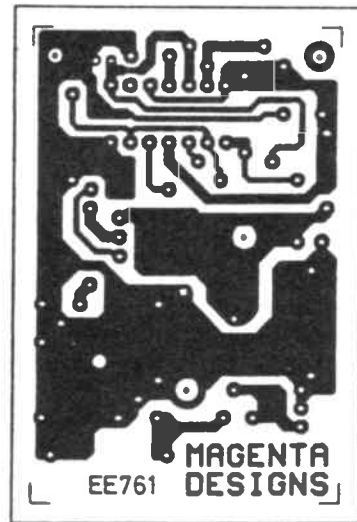
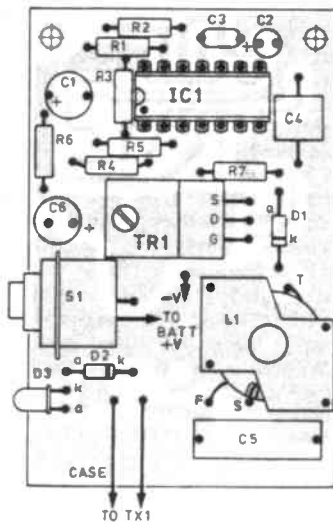


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The ferrite pot core, containing coil L1, must be secured to the board by a NYLON bolt.

Next carefully bend the leads of TR1 using a pair of pointed nose pliers so that the metal tab will lie flat against the board when the leads are soldered in. The tab can be screwed down to the board but an M3 nylon screw MUST be used as the tab must not connect to the copper track underneath. The leads are stiff enough to hold the device firmly in place so the use of the screw is optional.

## COIL

The coil should be made next by winding 20 turns around the coil former making a loop for the tapping and then continuing in the SAME direction for a further 50 turns. Mark the finish of the winding with a small piece of adhesive tape, and twist the tapping loop closely but not too tightly. A layer of tape should be wound over the finished winding to hold the wire in place.

The position of the tapping may be altered as discussed earlier. A good compromise setting is to put it halfway at 35 turns. This will reduce the output voltage by 40 per cent and will still give a very good output (it also saves remembering which end is the start and which the finish!). Note that wherever the tapping is made it is simple to leave it disconnected and use the whole coil by linking the points marked T and F on the board.

The wire used is 0.234mm diameter insulated with solderable self-fluxing enamel. The ends and the tapping loop can be tinned simply by applying a hot iron and solder to the enamelled ends. Do not be tempted to scrape the enamel as this can weaken the wire and cause it to fracture.

The ferrite cores come as a matched pair and must be handled with care as all ferrite materials are brittle (like china). A single M3 nylon screw is used to fit the cores together and hold them on the board. This must pass through the cores and down through the board and be fitted with a steel nut on the track side.

The wires from the coil can now be connected to their positions on the board as shown in Fig.2. A reasonable length of wire can be left free before testing so that the coil can be removed easily if necessary.

The l.e.d. D3 can be fitted anywhere on the case and wired to the connection points on the board. The short lead is the cathode and must be connected to the point marked k.

Take care soldering to the l.e.d. as the plastic is soft and the leads can move around if overheated. It is best to use a pair of pointed nose pliers to act as a heat shunt between the l.e.d. body and the point of soldering. This is easier to do if the pliers are made self-closing by fitting a rubber band to hold the handles together.

In the prototype the l.e.d. was fitted directly to the board and a small hole drilled in the case so that it could be seen. This works well and saves extra wiring but the l.e.d. is not in the ideal position for viewing. It may be better to leave the l.e.d. leads straight and make a viewing hole in the case top, provided it can be drilled accurately. A 3mm diameter hole is needed.

## POWER SWITCH

Switch S1 is fitted to the board on one of its wider sides using a good quality Super-glue. Inspect the switch first as one side is slightly different from the other having two long raised ridges which lie better on the board surface.

Take care to get the position right and not to let glue enter the mechanism. A wire loop can be soldered over the switch to provide extra support.

Connect the switch terminal closest to the board to the adjacent connecting point using a short length of wire. The opposite terminal of the switch is the connection point for the battery positive and should be fitted with a short length of thin red flexible wire for connection to the positive battery spring in the case. A similar piece of black wire should be fitted to the battery negative connection point on the board for connection to the negative battery spring.

The cut out for S1 is made by sawing two notches in the side of the case and cutting out the middle section. A fine file can then be used to tidy up the resulting notch. It is important to measure the position as carefully as possible so that a neat, close fitting hole is obtained. The board can be mounted in the case whilst this is done and

repeated trials made to get a good fit. Care at this stage will give a very neat final appearance.

The transducer terminals must be cut short so that it can fit as closely inside the case as possible. The prototype case top was drilled carefully using a tapered reamer to produce a clean hole into which the transducer was a tight push fit.

This is a luxury that most constructors will not have and so a large mounting grommet is supplied with the kit. This requires a larger hole to be cut out but covers the cut edge so that a hole cut using an Abrafile saw or by drilling a circle of smaller holes and filing will be satisfactory.

Connections to the transducer should be made using two lengths of flexible wire twisted together. Make sure that the connection marked 'CASE' in Fig.2 connects to the transducer metal housing. A small piece of insulating tape over the back of the transducer will make sure that its terminals do not make accidental contact with the printed circuit board.

As the transducer should be a tight fit in the grommet it should not be necessary to use any glue to retain it firmly in position. If necessary the grommet can be sealed to the case using a flexible silicon rubber type sealant of the type used around baths.

The circuit is now ready for testing. This is easier if the transducer is pushed carefully out of the grommet. Take care when doing this to push only near the edges. *Excessive pressure on the centre of the transducer can reduce its output or even fracture the piezoelectric disc.*

## TESTING

Before connecting any power to the board, double check the soldering and the component polarities and types. Most project failures are due only to these points so extra care here will be well rewarded.

A PP3 battery, or a standard power supply, can be used for testing but make sure that the voltage does not exceed 9V. A 10 ohm series resistor is recommended to be fitted in the positive power supply lead to limit the current in the event of a short circuit.

To keep the transducer power level down during testing the coil tapping should be disconnected from the board and left out of circuit, and the cathode of D1 should be

connected to the top of the coil by fitting a wire link between the points marked T and F on the board.

As the ultrasonic output is inaudible it is not easy to assess the circuit's performance directly. The best way to establish that both oscillators are working is to increase the value of C4 by temporarily fitting a 10nF ceramic disc capacitor across it. When switch S1 is then pressed the transducer should emit a sweeping frequency audible tone centred at about 3.5kHz.

Do NOT leave the circuit operating for long in this state as the tuning of L1 and C5 is obviously miles out and TR1 will get hot very quickly. No harm will be done however provided the 10 ohm resistor is fitted, and this method will quickly check the operation of IC1a and IC1b without calling for any test equipment.

If the tone does not sweep in frequency, check R1, R2, R5, C2 and C3. If there is no tone at all check everything else.

In the event of TR1 being faulty it is possible to hear the oscillator output by connecting a crystal earpiece (or a miniature loudspeaker fitted with a 100 ohm series resistor) between pin 5 of IC1 and negative. If the tone can be heard here but not in the transducer then check TR1, D1, L1, C5 and D2.

The transducer and its connections should also be checked. The transducer must be disconnected from the circuit and tested separately by connecting 9V across it first one way, then the other. Each time the polarity is changed there should be a click.

Once the tone is established correctly the 10nF capacitor should be disconnected and power applied. The i.e.d. should now light and flicker slightly as the frequency sweeps and the supply current should be around 100mA. The 10 ohm protection resistor can now be taken out of circuit and power connected directly.

## TRANSDUCER OUTPUT

The transducer output, although not audible is detectable in a curious way that resembles a ringing in the ears.

If a multimeter is available it can be set to read a.c. volts and connected across capacitor C5. The reading should be be-

tween 40 and 60V, but will vary from meter to meter as the frequency response of multimeters varies widely. Some digital multimeters will be practically useless whilst others will give much higher or lower incorrect readings.

An oscilloscope is the best tool of all and will show between 100 and 200V peak-to-peak. The waveform will be a sine wave with a flat section where TR1 conducts.

Once the circuit is operating correctly it can be fitted into the case and the connecting wires tidied up. The use of the tapping on coil L1 depends on the application.

The transducer is already overdriven with the connection of diode D1 cathode to the top of the coil, additional output can be obtained by employing the step-up effect of the tapping but at the risk of damage to the transducer if switch S1 button is held down for too long. Setting it at 35 turns (half way) probably represents the best compromise.

The current drain also increases as the tapping moves nearer to the start of the coil, but for the type of irregular momentary use envisaged, current drain is not an important issue. An alkaline PP3 will provide around one hour of continuous operation corresponding to several month's use.

When operating, the surface of the transducer has a peculiar smooth feel, due presumably, to the undetectable vibration of the surface allowing the skin to slide freely. This is another means of checking for output. The brightness of the i.e.d. gives some indication of battery condition as it dims as the voltage falls.

The output frequency of the oscillator is practically unchanged right down to 4V when the output from TR1 is negligible. TR1 can get quite hot when operated for a long time, but when used in short bursts there is very little heating.

## CONCLUSION

Remember that whilst frightening some animals, and being completely ignored by others, the ultrasound could also possibly annoy and arouse.

It is not a toy and should be used only by those with an understanding of its effects. Its use near busy roads should be avoided if possible as animals running out could be injured or cause road accidents. □

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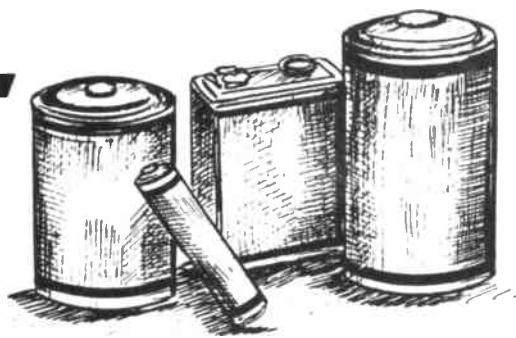
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# BETTER USE OF DRY CELLS



ALAN TONG

*How important is choosing the right battery for your equipment? Read this two-part article and find out how you could possibly save yourself pounds!*

*"Last year in the UK 440 million batteries were sold costing over £250 million"*

**I**N THE last few years the price of batteries has risen rapidly. In many applications the cost of batteries quickly exceeds the original cost price of the equipment they are used in. Last year in the UK 440 million batteries were sold costing over £250 million. Worldwide 20 billion batteries were sold. Battery power is perhaps the most expensive form of energy commonly in use, for example a standard AA battery contains just enough energy to boil one tenth of a cup of tea, or light a 100W bulb for less than a minute. In addition to this inefficient use of energy there is an environmental cost. The disposal of 20 billion batteries containing toxic heavy metals such as cadmium and mercury is a serious source of pollution.

## Reducing Waste

There are three ways to reduce this waste (And save money in the process). To start with, batteries can be recycled in the same way as paper and glass bottles. In a "green" gesture Varta are giving customers a 50p refund for returning batteries to be broken down for re-use. Secondly the energy contained within cells can be used more efficiently; this is the purpose of the first part of this article.

The third way of reducing this waste is to put more energy in to cells; *recharging*. Contrary to popular belief almost all batteries can be recharged, provided the correct techniques are used. In this country battery companies will insist that it is not possible or even dangerous. In other countries such as Japan battery recharging is officially encouraged. *However a cautionary note: Do not attempt to recharge ordinary batteries until you have read next month's article.*

## Using Cells More Efficiently

Most manufacturers publish guides on how to use batteries efficiently, however these guides have to be written with the general public in mind. By applying some simple electronics and a few facts the battery companies don't want you to know, a more informed choice of battery can be made.

Some confusion seems to exist between cells and batteries. A battery is a group of cells. For example a PP3 battery is usually made of six 1.5V cells. So 1.5V "batteries" are in fact cells.

When batteries were first invented by Volta in 1800 they consisted of many cells (up to 2000). As technology progressed batteries required less cells until one cell "batteries" became available. In most circumstances the two words are interchangeable, but for the purposes of this article the actual definitions are used.

Another source of confusion is battery sizes. In this article AAA, AA, C, D and PP3 cells are mentioned. Table 1 gives some typical equivalents if you use a different code.

Some method of determining how much life is left in a cell or battery is necessary. Commercial battery testers are fine but an ordinary multimeter and a resistor will do just as well, see Fig.1.

## Cell Characteristics

Before looking at particular types of cell we need to consider what are the important characteristics of these cells.

**Capacity:** Capacity can be defined as how much power a cell can supply and for how long. Capacity is measured in Amp-Hours (Ah). For example, a cell rated at 0.1Ah could ideally supply current at 1A for six minutes or 0.01A for ten hours.

To allow comparison between different cells, (and batteries) a cells useful life is said to be over when its voltage has dropped below a certain threshold. Usually 0.9V for 1.5V cells.

Table 2 gives the capacities for the cells most commonly used in the home. Unfortunately because a cell has twice the capacity of another this does not mean that it will last twice as long in a given application, there are several other factors to consider.

Table 1. Equivalent codes

| Battery | Voltage | Equivalents             |
|---------|---------|-------------------------|
| AAA     | 1.5V    | HP16, UM4, LRO3, MN2400 |
| AA      | 1.5V    | HP7, UM3, LR6, MN1500   |
| C       | 1.5V    | HP11, UM2, LR14, MN1400 |
| D       | 1.5V    | HP2, UM1, LR20, MN1300  |
| PP3     | 9.0V    | 6F22, E-Block, MN1604   |

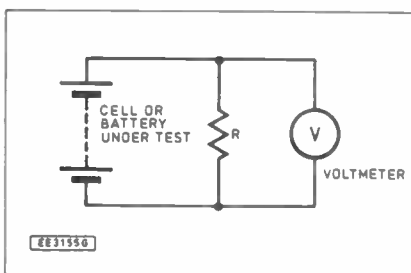


Fig. 1. Determining battery life.

For 1.5V cells R should be about 4.7Ω if the voltage is below 1V then the battery is in a poor condition. For 9V batteries R should be 100Ω. Voltages of about 6V indicate a flat cell.

**Internal Resistance:** All cells have some internal resistance. A good approximation of a cell is a voltage source in series with a resistor. (See Fig.2.)

The maximum current (I) that a cell can supply is given (using Ohm's Law) by  $I = V/R$  where R is the value of the internal resistance. Zinc carbon cells have a relatively high internal resistance (typically one ohm) so cannot supply high currents.

Consider a 1.5V zinc carbon cell used in an application that requires 700mA, say a camera flash or a motorised toy. This means that 700mA is dropped across one ohm. Using Ohm's law we see that 0.7V is dropped across the internal resistance. If 0.7V is dropped within the cell only 0.8V will appear at it's terminals and the cell will appear dead.

In practice the cell would work for a few minutes and then stop. If the cell is then given a "rest" allowing its internal chemical reactions to catch up, the cell will recover, and provided it is used in a lower current application it will perform normally.

Internal resistance is related to cell size. As cells get smaller their internal conducting surfaces are reduced in size, hence the internal resistance rises so for example a button cell can only supply a fraction of the current of a "D" sized cell.

The internal resistance of a cell also rises as a cell is discharged. This means that a cell which has failed in one (high current) application will continue to perform for some time in a lower current application. It is this rise in internal resistance that causes a cell to fail.

Alkaline magnesium cells have a much lower internal resistance than zinc carbon cells, so can supply higher currents. Lower internal resistance also means a longer life since the resistance has further to rise before a cell can not supply a given voltage.

**Shelf Life:** All cells discharge and decay on standing i.e. standing on a shelf awaiting purchase or in store - Shelf Life. This is why cells should not be left in equipment that is not going to be used for a considerable time.

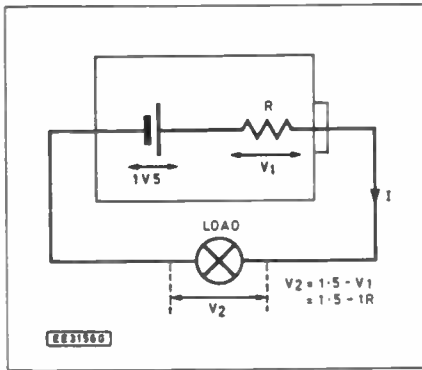
Shelf life is normally defined as the time taken for a cells capacity to fall to 85 per cent of its original. Shelf life is an important factor in low current drain applications such as calculators, clocks and smoke alarms. As the current drain is so low the cells can last for a year or more, so failure is often due to internal decay and discharge.

When buying cells choose a shop with a fast turnover as cells fresh from the manufacturer will last longer than those which have been sitting in a store room for six months.

**Table 2. Capacities for commonly used cells.**

| TYPE<br>SIZE | PRIMARY     |               |                    | SECONDARY       |                     |
|--------------|-------------|---------------|--------------------|-----------------|---------------------|
|              | ZINC CARBON | ZINC CHLORIDE | ALKALINE MAGNESIUM | STANDARD Ni-Cad | 'INDUSTRIAL' Ni-Cad |
| AAA          | N/A         | 0.54 (40)     | 0.7 (90)           | 0.18            | N/A                 |
| AA           | 0.9 (24)    | 1.1 (31)      | 2.3 (28)           | 0.5             | 0.6                 |
| C            | 1.8 (20)    | 2.8 (20)      | 7 (16)             | 1.2             | 2.0                 |
| D            | 5.2 (7.6)   | 7.5 (8.5)     | 14 (9.1)           | 1.2             | 4.0                 |
| PP3          | 0.3 (260)   | 0.4 (268)     | 0.5 (470)          | 0.11            | N/A                 |

Figures in brackets show approximate cost per Ah.



*Fig. 2. A voltage source in series with a resistor (R) is a good analogy of the internal resistance of a cell. R is the internal resistance.*

## Types of Cell

**Ordinary Zinc Carbon dry cell:** Zinc carbon dry cells are the cheapest available (often coloured blue) and have changed very little since their invention by Georges Leclanche in 1860. These were the first practical cells and as such were used in the first Telegraphs, Telephones, Radios and Flashlights. The term "flashlight" was a descriptive term as the early batteries could only produce power for short bursts of light.

Zinc carbon cells have quite a high internal resistance so cannot supply much current. They also have a poor shelf life and decay internally when in use. These cells are best suited to low power applications where use is intermittent, an example would be a small Radio used for an hour or so a day.

Another serious drawback with this type of cell is that it is prone to leakage. To reduce costs the cell's zinc can (casing) serves both as a anode and a cell container, see Fig.3.

If during use the zinc fails to oxidise evenly the cell can rupture and the acidic electrolyte (zinc chloride and ammonium chloride) can leak. A leak can also occur if the cell is overdischarged by, say, leaving a radio on or inserting some fresh cells with weaker ones.

Zinc carbon cells are not suitable for continuous use in any application as to get a reasonable life out of them they need frequent "rests" to recover. These cells should not be left in equipment for extended periods as they are prone to leakage. They are also not suitable for "standby" applications such as emergency torches or in applications where they will be exposed to wide temperature ranges.

Despite having the lowest capacity of commonly available cells they remain popular as they are very cheap.

**Zinc Chloride Cell ("Heavy Duty" or "High Power" zinc carbon):** Zinc chloride cells are improved versions of ordinary zinc carbon ones. The main difference is that the electrolyte is zinc chloride only. This causes the cell to become drier as it is used, so reducing the chance of leakage.

Improved construction as well as chemical composition combine to give the cell better capacity and lower internal resistance, allowing higher currents to be drawn for longer periods. They can produce up to about 500mA for a large cell.

Zinc chloride cells have a much higher shelf life than zinc carbon ones, this can be a major factor in choosing a cell. They are best suited to moderate intermittent use, such as Cycle Lamps, where their performance can be comparable to alkaline cells. Zinc chloride cells are also suited to low drain continuous use such as Clocks. Like zinc carbon, zinc chloride cells are not suitable for standby applications where they will remain unused for long periods.

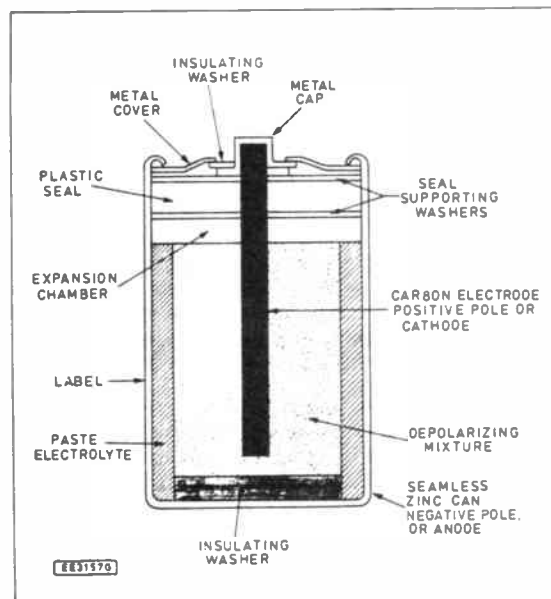
*"When batteries were first invented by Volta in 1800 they consisted of up to 2000 cells"*

Be careful when buying zinc chloride cells, some zinc carbon cells, especially from far eastern countries, are disguised as zinc chloride cells.

**Alkaline:** During World War 2 there was a need for cells that could supply high currents for long periods of time (such as for radio transmitters); cells that were reliable, had a long shelf life and could perform well in a wide range of environments (jungles, deserts and arctic conditions). The alkaline cell was developed as a result. It is known as alkaline because its electrolyte is alkaline potassium hydroxide rather than the acidic electrolytes of zinc carbon cells.

Alkaline cells have low internal resistances so they can supply high currents and this allows them to be used in applications such as Camera Flashlights where zinc carbon cells simply do not work.

*Fig. 3. The cell casing of a zinc type is also used as the negative or anode terminal.*



"Worldwide 20 billion batteries were sold"

The cell is totally different in construction to zinc carbon cells. Its internal components are contained within a separate steel can which gives the cell a high resistance to leakage.

The shelf life of alkaline cells is typically three years so they are ideal for emergency lighting etc. These cells are also much more tolerant of temperature extremes, so for example a torch kept in the car should be fitted with alkaline cells. Having said this they do not respond well to continuous low current drain applications.

Adverts for alkaline cells claim that they will last for "up to six times" as long as zinc carbon cells. In the adverts they are usually shown powering motorised toys in continuous tests. It is the *continuous* nature of these tests that is the key. Alkaline cells are best suited to moderate to high power applications where the use is heavy or continuous. In normal intermittent use the ratio between alkaline and zinc carbon will be two or three times.

**Lithium:** Lithium cells are a relatively new development. Lithium button cells have been used in calculators and watches for some time, but lithium batteries have only recently become available in more common sizes. Unfortunately, lithium cells have a basic voltage of 3V unlike the most common 1.5V cells. However, for 9V batteries such as PP3's lithium is ideal.

Lithium is a very reactive substance and it is this that gives lithium cells their high capacity. Lithium's high reactivity causes an immediate reaction with the atmosphere to form a layer of inert lithium oxide, it is this layer that gives lithium cells a shelf life measured in decades. Lithium cells can withstand very wide temperature variations and are virtually leakproof.

A PP3 (9V) battery is made of only three (3V) lithium cells as opposed to six (1.5V) alkaline or zinc carbon cells. Since larger cells are more efficient a lithium PP3 can last ten times as long as a zinc carbon PP3. Unfortunately they are not cheap to buy costing nearly £4.

Lithium PP3s are ideal for low drain applications such as smoke detectors and digital multimeters where their high cost is justified by a life measured in years.

#### **Nickel Cadmium Rechargeable Batteries:**

The use of rechargeable Ni-Cad batteries and cells seems at first glance to be an obvious replacement to alkaline and zinc carbon cells. Unfortunately they have several problems which has prevented them from becoming very popular.

The capacity is around one-fifth of zinc carbon cells, this means that during the lifetime of a conventional cell a zinc carbon cell will have to be recharged several times. Secondly they discharge on standing, cells fully charged a couple of weeks ago may be flat when you come to use them. This means that Ni-Cad's are not suitable for low current drain applications as they will discharge themselves rather than be discharged by the equipment they are powering.

The basic voltage for Ni-Cad cells is 1.2V as opposed to 1.5V for most cells which makes them unsuitable for some applications. The number of times a cell can be recharged is also severely limited, manufacturers often claim that cells can be recharged several thousand times, in normal use it tends to be a few hundred. The high costs of Ni-Cad's cannot be overlooked either.

If all this seems rather hard on Ni-Cad's it should be remembered that Ni-Cad's are a first generation answer to the problems of recharging. The time and money spent on the research and development of Ni-Cad's is small when compared to other cells. There is some evidence that manufacturers are not very concerned about developing or promoting Ni-Cad's.

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*The disposal of 20 billion batteries containing toxic heavy metal is a serious source of pollution"*

---

For example, why are the capacities of most C and D type cells identical? And why are the capacities of these cells only 1200mAh when "industrial" versions of these cells have 4000mAh? If high capacity cells can be bought from electronics catalogues why are they not available in the high street?

The usual reason for failure and problems in Ni-Cad's is dendrite growth, dendrites growing inside cells are miniature metal spikes that eventually short circuit the cell, more dendrites cause more problems. Dendrite growth is caused by the metal inside the cell not plating out evenly (similar to electroplating with copper as done in many a chemistry lesson).

Fortunately it can be prevented (though not cured) by recharging in a different way. The recharging circuit in part two of this article can help prevent dendrite growth.

## Applications

To conclude this first part it seems to make sense to consider some of the most common applications of batteries and what type of battery is most suited.

**Flashlights:** These account for around 25 per cent of all batteries bought. Depending on size, they consume between 200mA and 500mA. This means that the choice of batteries is between zinc chloride and alkaline.

If the torch is going to be used for long periods of time then alkaline batteries are the answer as they will last five or six times as long as zinc chloride. If the torch is used for short periods of time, say to find a keyhole at night, then zinc chloride will last nearly as long as alkaline, so is the obvious choice considering its cost. If it is not going to be regularly used (say only in power cuts) or is going to be exposed to high or low temperatures then alkaline cells should be used.

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*"Contrary to popular belief almost all batteries can be recharged."*

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**Radios:** These account for around 20 per cent of batteries used. With small radios needing say 10mA to 20mA the choice depends on the amount of use received. For radios used less than around one hour a day zinc carbon is a good choice, if it is used more than this then choose zinc chloride and if it is left on all day (e.g. at a building site) then use alkaline. For larger radios (i.e. loud stereo's) use zinc chloride if use is less than a couple of hours a day, alkaline if more.

**Tape Recorders:** These account for approximately 15 per cent of the market. Again if use is less than a couple of hours a day use zinc chloride, more than this use alkaline. For people who use Personal Stereos all day long then Ni-Cad's can make sense.

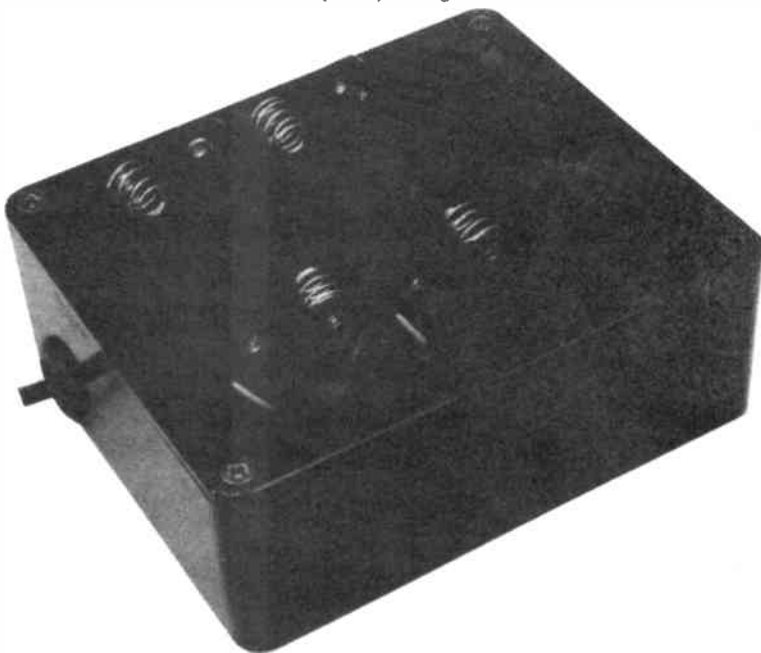
Use alkaline cells also for Motorised Toys, Cameras and CB Radios. Zinc chloride should be used for Clocks, Doorbells, and Calculators (provided they don't use PP3's or button cells). Zinc carbon should not be used in expensive equipment or left in equipment for long periods.

A word about using PP3 9V batteries, don't. PP3's are the least efficient source of battery power. Avoid buying equipment which uses them.

If you do have equipment which uses them then, space permitting, it is worth adapting them with a DC-DC Converter to use 1.5V cells (see electronic catalogues for more details). Certain applications such as Smoke Alarms are only available with PP3's, in these cases use alkaline or lithium. (Zinc carbon, Zinc Chloride and Ni-Cad PP3's are really non starters).

A final note about using batteries, whenever possible use a mains adaptor, remember mains power is 5000 times cheaper than batteries.

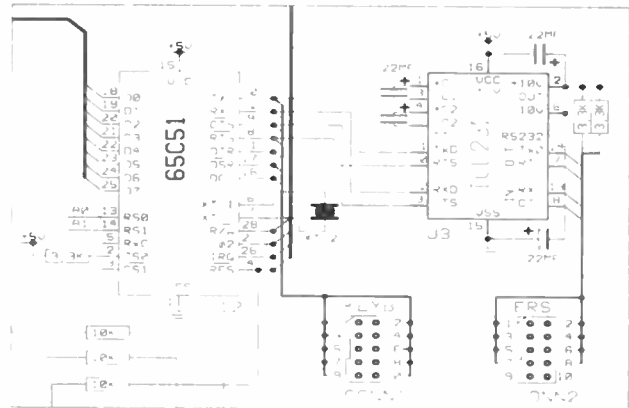
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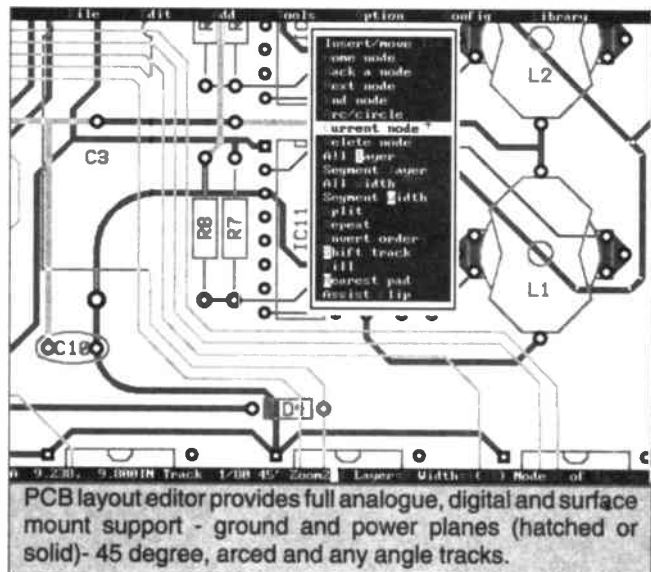
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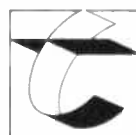
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# PEDOMETER

**R. M. WORTHINGTON**

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The unit clips onto the side of the walker's shoe, five l.e.d.s counting the number of paces in 500s. This gives a maximum reading of 15,500 paces — around 13 miles, with a resolution of around 0.4 miles.

## COUNTERS

The circuit consists of five counters — two BCD up-counters, two binary up-counters and the 4017 decade counter, connected to give a divide by five action. All are triggered on the negative-going transition.

Component IC1a (Fig.1) counts in Binary Coded Decimal, resetting to 0000 as it reaches 1010 (ten). The Q4 output of IC1a (pin 6) is connected to the "enable" input of IC1b (pin 10), giving an overall divide by 100 action. IC2 is the familiar 4017, with two of its ten outputs used — since the 4017 resets with output "0" high, outputs "4" and "9" are chosen. Finally, IC3a b counts the number of "half-thousand" paces — five outputs are used, the last three outputs unconnected. This gives a cheap and simple display — five l.e.d.s, indicating 8, 4, 2, 1 and 0.5 thousand paces.

Switch S1 provides one pulse every time the shoe the unit is attached to is placed to

the ground. Thus triggering the counter on every other step.

## HARDWARE

The prototype was fitted in a MB2 box — probably the smallest size to allow the use of a single piece of stripboard. The component layout given in Fig. 2 fits this case exactly (no fixings needed), and the moulded p.c.b. slots are used to support the lever cross-arm — see Fig. 3 — two nuts, bolts and washers hold the cross-arm in place.

A small block of wood is used to support switch S1, with a layer of foam rubber glued over the switch — see Fig. 4. This should improve reliability and help avoid damage to the lever. A few layers of foam plastic (the sort used to wrap electrical goods), glued together, should also be suitable. Alternatively a lever operated microswitch could be used provided the lever can be made to operate correctly on each pace. Be aware that mud and dirt should not interfere with switch operation.

## CONSTRUCTION

A 14 strip by 37 holes piece of stripboard is used, minus two corners — cut to allow the lid to close. Care should be taken with the large number of wire links and track cuts. The board is mounted diagonally in the space between two sets of p.c.b. slots, six wires running to the battery, reset switch and trigger switch.

A double-pole power slide switch was used in the prototype, the power supply

connections taken to both poles for convenience. The supply decoupling capacitor C2 can be tucked in around here — not the most effective location, but CMOS i.c.s aren't usually fussy.

The far right of the board is reserved for resistors R3 to R7 and their l.e.d.s, which are set slightly back from holes in the case, to reduce ambient light. The series resistors are relatively large, giving a maximum supply current of 9mA (all l.e.d.s on). If non-rechargeable batteries are used or another l.e.d. added, it might be worth increasing these values; a lot depends on the brightness of the l.e.d.s, which seems to vary between suppliers.

The l.e.d.s are mounted sloping, and at different heights, see Fig. 5. This isn't as complex as it sounds, and the end result is supposed to be a neat line of l.e.d.s, behind a neat line of holes in the top of the

## COMPONENTS

### Resistors

|                       |             |
|-----------------------|-------------|
| R1                    | 15k         |
| R2                    | 10k         |
| R3 to R7              | 4k7 (5 off) |
| RB                    | 470k        |
| All 0.25W ± 5% carbon |             |

See  
**SHOP  
TALK**  
Page

### Capacitors

|    |             |
|----|-------------|
| C1 | 4n7 ceramic |
| C2 | 0µ1 ceramic |

### Semiconductors

|          |                            |
|----------|----------------------------|
| IC1      | 4518BE dual BCD counter    |
| IC2      | 4017BE decade counter      |
| IC3      | 4520BE dual binary counter |
| D1, D2   | 1N4148 diode (2 off)       |
| D3 to D7 | red l.e.d. (5 off)         |

### Miscellaneous

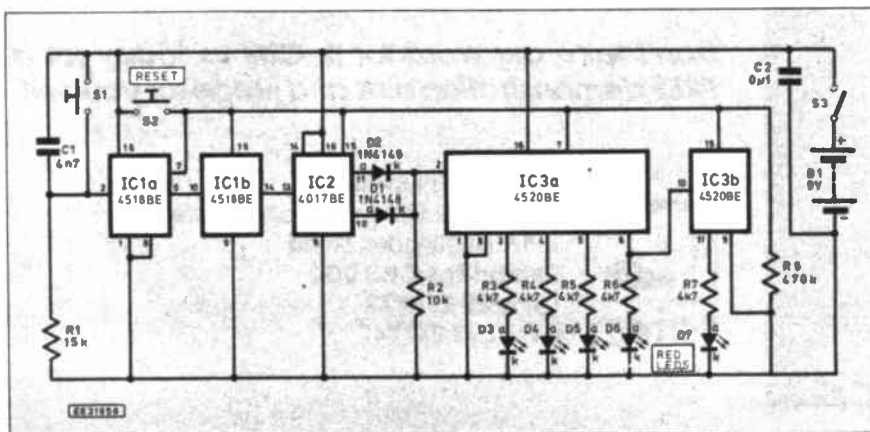
|    |   |
|----|---|
| S1 | s.p.s.t. push-to-make "click" switch or lever operated microswitch (see text) |
| S2 | s.p.s.t. push-to-make pushbutton  |
| S3 | d.p.d.t. slide switch — see text  |
| B1 | 9V PP3 rechargeable battery and connecting clip — see text                    |

Stripboard 14 strips by 37 holes; plastic case approx 100 x 75 x 40mm; plastic foam and wire for switch operating lever — see text; case mounting clip — see text; connecting wire etc.

Approx cost  
guidance only

**£7**

Fig. 1. Circuit diagram for the Pedometer. Switch S1 is lever operated.





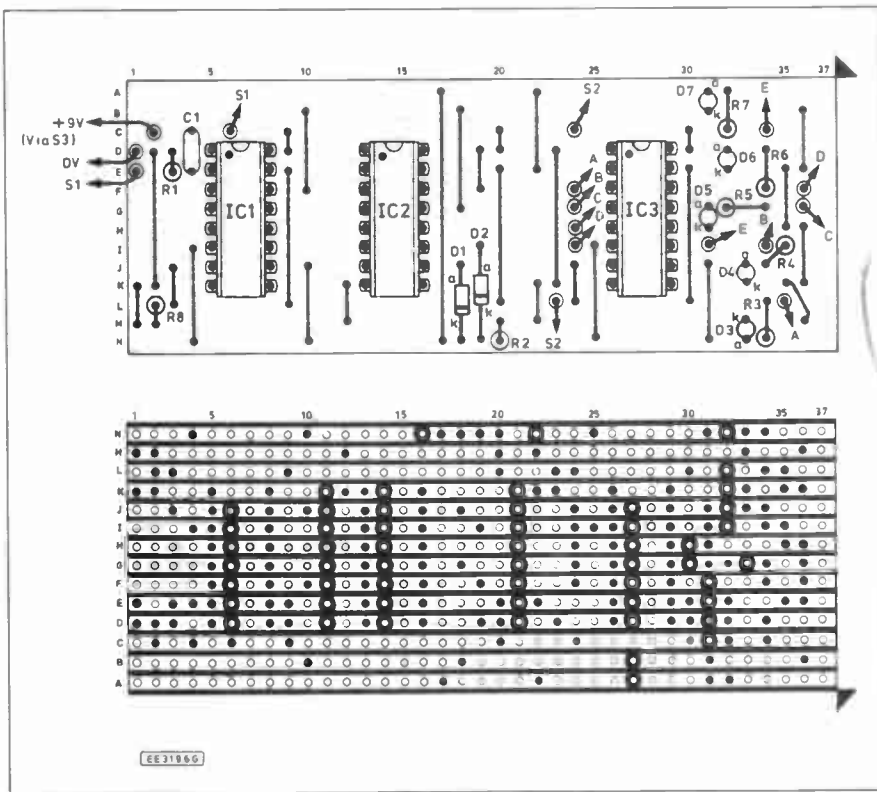


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. The lettered leads on the left of IC3 join up with identical letters on the right.

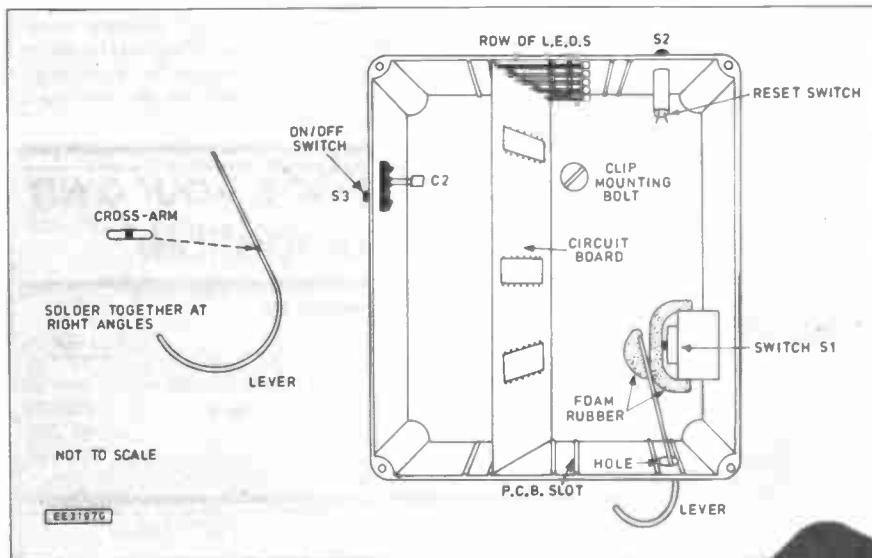


Fig. 3. Layout of components inside the case and details of the construction of the "trip" lever.

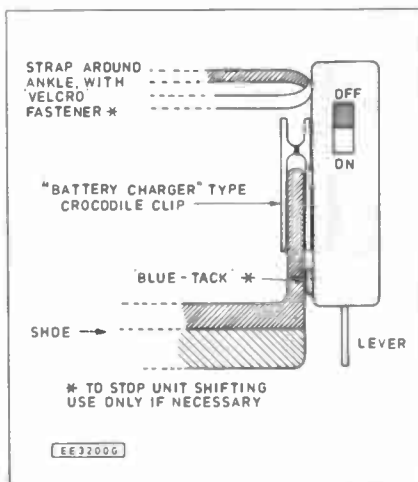
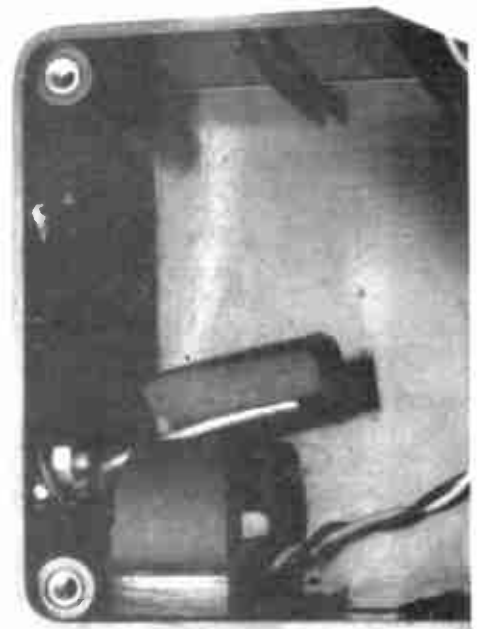


Fig. 6. One suggested method of securing the unit to the shoe and ankle.



Close-up of the "trip" lever and foam covering surrounding the click-switch. The lever is made from steel as copper is not rigid enough.

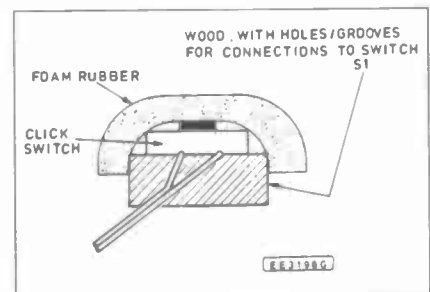


Fig. 4. The "pulse" switch S1 is mounted on a wooden block and covered with foam rubber.

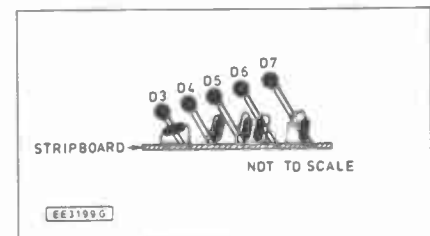
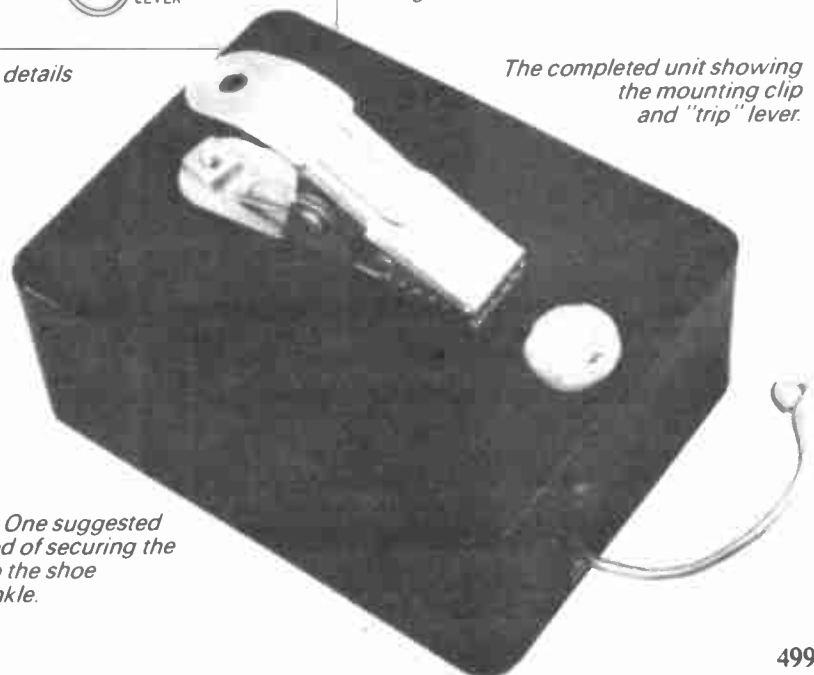
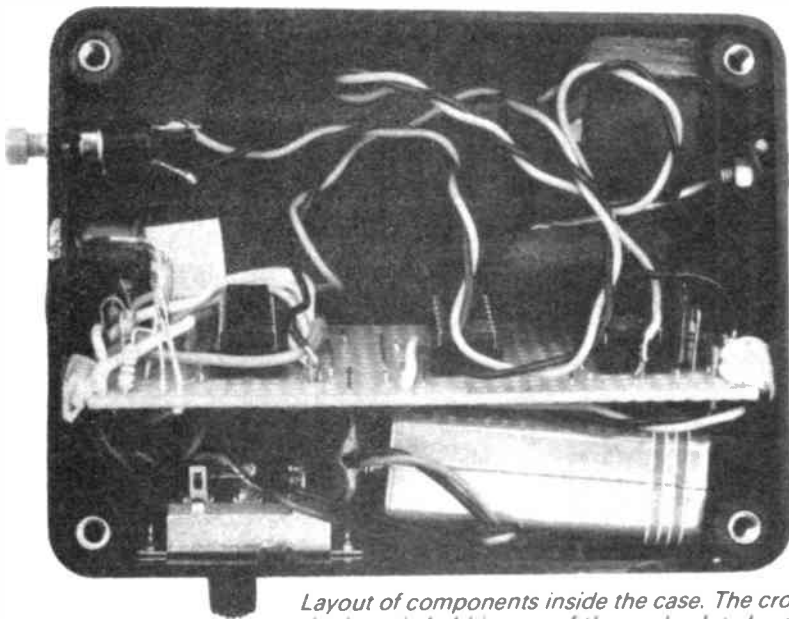


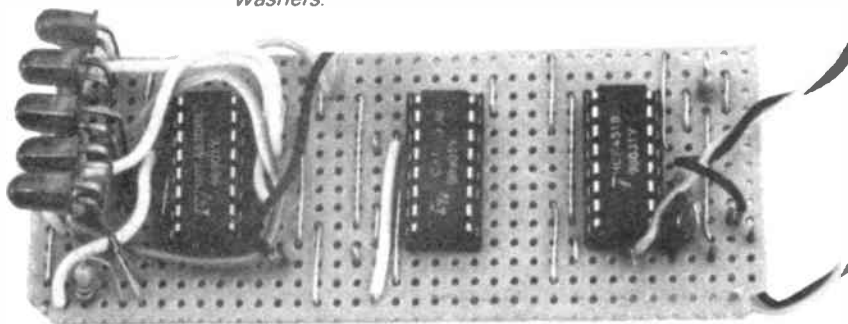
Fig. 5. Slanting the display l.e.d.s to align with holes drilled in the case.



The completed unit showing the mounting clip and "trip" lever.



Layout of components inside the case. The cross-member of the lever is held in one of the p.c.b. slots by nuts, bolts and washers.



The completed circuit board. The corners of the board are cut off at points A1 and A37 to allow the lid of the case to close.

box. Most of the relevant connections to IC3 are on the opposite side of the i.c. to the l.e.d.s, so wires pass around the i.c. to the appropriate hole on the other side.

## TESTING

With no l.e.d.s lit, the supply current should be almost zero. To actively test IC1 to IC3, you *could* walk ten or twenty miles, watching the l.e.d.s! An easier way is to find two test leads and connect one end of each across S1. Lightly rub the remaining two clips together, and the l.e.d.s should start lighting in the familiar pattern. If not, recheck the wiring and track cuts, make sure the reset line is low, then use S1 or the test leads while checking the outputs.

## ATTACHMENT

Probably the most reliable method of attaching the unit to a shoe is to use a "battery-charger" type crocodile clip. One side of the clip is bolted to the unit, the other side bent towards the unit (away from the foot). The clip should be positioned so the unit is only triggered with the shoe fully down. Adjustments can be also be made, of course, by bending the lever.

Using a battery charger clip isn't as masochistic as it sounds, and the unit is only uncomfortable if it bangs around; Fig.6 gives some solutions to this.

## AND FINALLY

All that remains is to find your own number of "paces per km mile". Find an average figure over, say, 100 metres/yds, then convert up.

Also, the approximate distance walked would be the average of the maximum and minimum possible values; for a reading of 2.5 thousands paces, use the average of 2500 and 3000, 2750. □

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# ROBOT ROUNDUP

*Nigel Clark*

## AUTOMAN

The selling potential of Automan was brought home to Bristol University's Advanced Manufacturing and Automation Research Centre when a visitor to its stand proffered a wad of notes for a gripper it has been developing. The offer was turned down but it certainly made an impression on the people staffing the stand. The centre had been invited to this year's show at the NEC, Birmingham, as part of a special stand intended to highlight new developments.

As well as the usual industrial robots doing Heineken pirouettes, reaching the parts others have difficulty reaching, and other related equipment, there was a collection of stands displaying the latest work being done in a number of areas. These included the food industry, construction and pharmaceuticals.

Bristol provided the most interesting stand, not just from the point of view of the quality of work, but from the presentation. Whereas the others in the area were quite static Bristol had a number of prototypes and videos. Apart from the gripper, there was an early version of a device for cutting meat off the bone, a video of the department's snooker playing machine and software for a two-armed device. There was even an explanation of a creation for extending the useful life of ear surgeons.

The gripper has three fingers made of flexible cylinders with a metal strip down one side causing it to bend when inflated. A number of these can be added together to make up each finger, allowing its possible curvature to be varied. The result is a device which can gently pick up items like bunches of grapes or oranges. Fitting touch sensors to the fingers is being considered.

## MEAT CUTTER

The meat cutter is being developed for the industrial cutting of beef forequarters. As one of the staff on the stand said people would not like their steak with saw marks on it. However Bristol's device is more than acceptable for taking off meat to be used for processing into things like sausages and beefburgers.

The cutter works by first getting the initial statistics for each carcass such as weight and configuration and adding vision information from a camera. The in-

*Robot meat cutting trials at Bristol University's Research Centre.*



formation so gleaned is compared with a databank of previous carcasses. From this a series of cut starting points, start directions and paths to be followed is created. On the basis of this the meat will be cut from the carcass using a knife mounted on an arm with a force sensor telling the knife when it has reached the bone and providing feedback to the controller guiding the knife along the bone.

The path being followed is compared with historical data of the cutting of previous carcasses and any significant variation from the previous information activates an error recovery routine.

The prototype on display was limited in its abilities by being only two-dimensional. A three-dimensional device is being developed which will allow the knife to roll round the bone as well as along it.

## SNOOKER PLAYER

Snooker playing robots have attracted good publicity to the centre. A video showed the first attempt and the development was covered by a television programme.

The early version was limited as to the size of the table on which it could play by the size of the gantry the playing devices were attached. The latest version uses a larger gantry but it will still not be able to challenge for the world title.

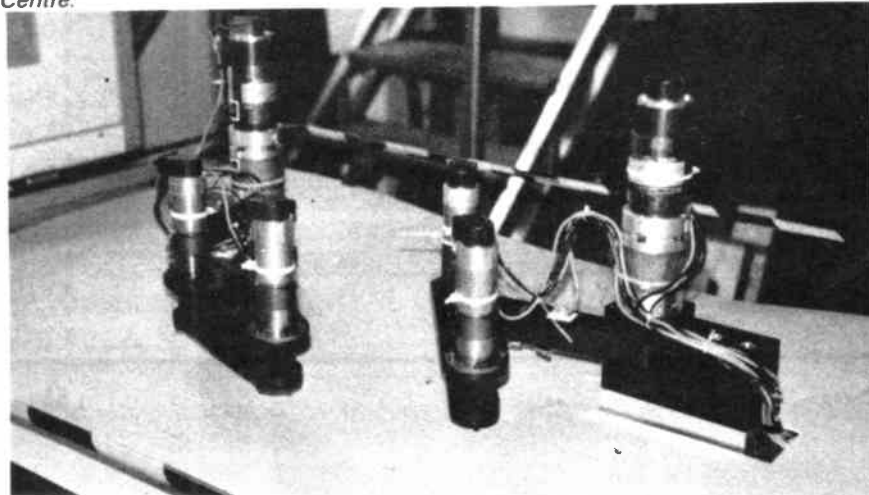
The Director of AMARC, Mr Koorosh Khodabandehloo, said that the project had a serious purpose. It allowed the combination of automation, vision and artificial intelligence in an environment that could be controlled and where it was possible to measure the systems development.

## TWO ARMS

One area of the centre's work which should be employed by many companies is the two-armed robot. A number of companies have attempted to build one but none have been able to produce a marketable version as yet.

There are a number of advantages which a two-armed robot has over two conventional arms working in tandem. Most of these relate to improved handling which in some cases can lead to a relaxation in the requirements for gripper design. These in turn increase the range of tasks which can be completed with a single end effector design. Working from

*An experimental two-arm system at Bristol University's Automation Research Centre.*



a single base enables a greater area to be accessed.

Bristol's version allows one arm to take notice of what the other is doing and react accordingly. Both arms are given instructions which one limb executes even though it may have moved slightly from the perfect position to carry them out. The other limb however takes account of any changes in its partner's position and makes the necessary adjustments.

As part of the development a method for calculating differing areas of difficulty has been created. This allows the system to highlight any areas where it might have problems in carrying out the designated task. For example if the two arms are being used to carry an object from one place to another there will be points within its reach where, because of the limitations of the movements of each arm, they would be unable to work together effectively. The software highlights these areas, enabling the operator to choose a path to avoid them.

The development at the moment is, to a certain extent, theoretical in that software has been developed to operate an experimental test facility and a 3-D simulation package for any multi-arm robot. The next stage, building an industrial four arm robot, is getting nearer with an agreement with Oxim, an Oxford automation company.

## EAR DRILLING

The ear surgeon's friend is an intelligent drill which can drill a hole into the inner ear and know when to stop. This is another device using force levels as feedback. Based on previous knowledge of the amount of force needed at each stage of the drilling process the drill knows when it is about to complete the hole and when to stop.

## WALL CLIMBING

In the construction area it was Bristol Polytechnic which provided the most interesting display with its newly-built prototype wall-climbing robot. While not as complex or agile as Zig Zag, the wall-climbing robot from Portsmouth Polytechnic, the developers believed that it was sturdier, allowing a bigger payload to be carried. Zig Zag was on display but stationary, with a few words of explanation but no-one to answer questions.

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Simple Model Series

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# MUSICAL ROUNDAABOUT

**WHIRR!!!**



**OWEN BISHOP**

## PROJECT 2

*A novel series which combines two hobbies in one - electronics and model-making. Simple electronics circuits combined with easy-to-assemble models will cover a wide range of interests. There will be whimsical models and realistic scale models. There will be models for the railway enthusiast, miniature furniture for the doll's house, and toys for all ages. The models that form the first six parts of the series are; Police Car; Musical Roundabout; Micro Micro; Centurion Tank; Mini Microwave; Christmas Novelty.*

In this series we use integrated circuits as much as possible to keep the wiring simple and to cut down on the size of the circuit boards. Assembly by the Vero Easiwire wire-wrapping system means that model-makers need not worry about soldering.

Circuit-boards made of card are provided by us. They show where all the components should go, so there should be no problems with getting everything to work first time. All projects are battery-powered for safety.

Models are made of easily handled materials such as cardboard, plastic, modelling compound and other inexpensive items that can be obtained from any modelling shop. You will also need some adhesives and paints or crayons.

Few tools are required other than a pair of scissors, a steel ruler and a craft knife.

**W**E continue this new series of electronically enhanced models with something to amuse the younger members of the family. It might evoke a little nostalgia in Mum and Dad too.

### MUSICAL ROUNDAABOUT

We have all the fun of the fair when the roundabout whirls, playing its medley of lively tunes. The music is provided by an integrated circuit which includes a memory of 512 notes - enough space for short but very recognisable versions of 16 different tunes, from *Twinkle, Twinkle, Little Star* to *London Bridge is Falling Down*.

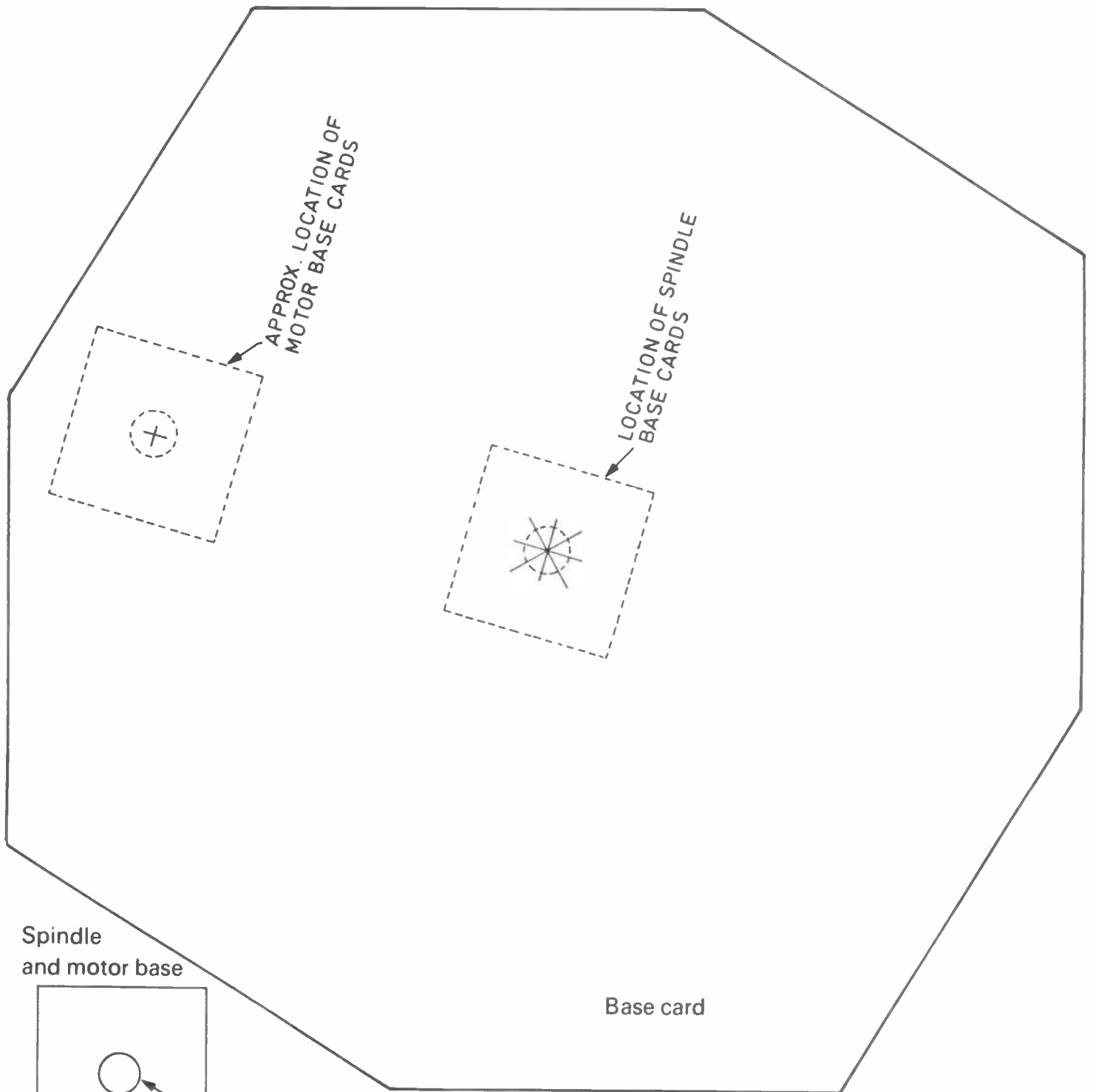
The tunes are played one after another, the sequence repeating for as long as the music button is pressed. A small and inexpensive electric motor spins the turntable of the roundabout when the motor button is pressed. The roundabout is in two parts, the base and the turntable, which we shall consider separately.

You can either photostat the layouts for the Musical Roundabout onto thin card (400g/m<sup>2</sup>) or send for the printed card - see components box. Shop Talk and the Special Offer page. If you use the printed card you will require extra sheets of plain card (see components box) to make up the model.

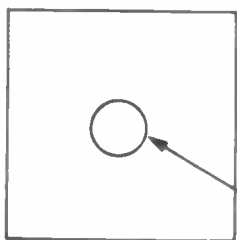
*The first six models of the series. To give an idea of scale the police car is approximately 215mm long.*







Spindle and motor base



TIGHT FIT ON SPINDLE OR MOTOR BEARING

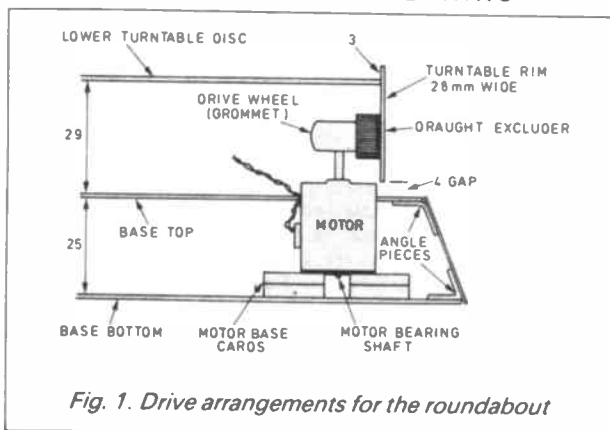
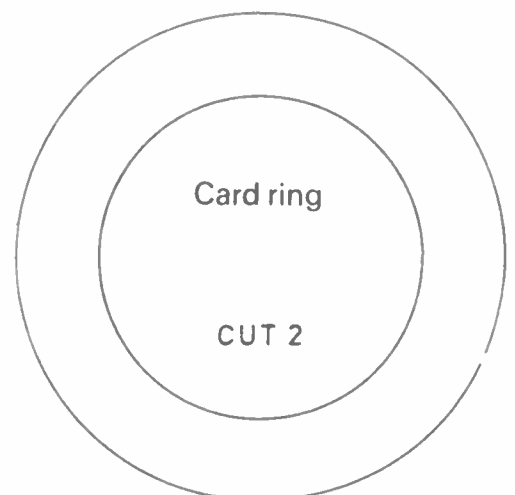
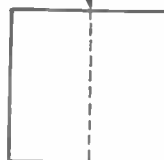
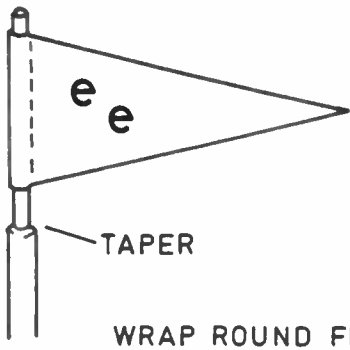


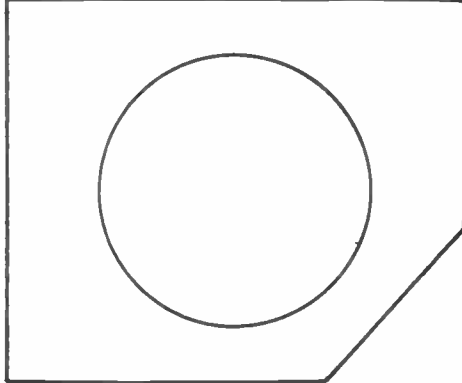
Fig. 1. Drive arrangements for the roundabout

Angle piece SCORE

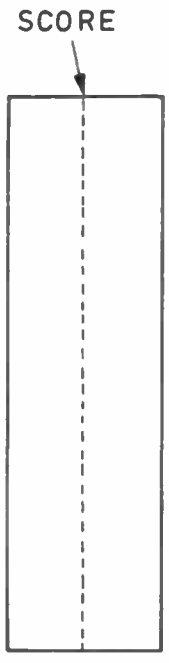
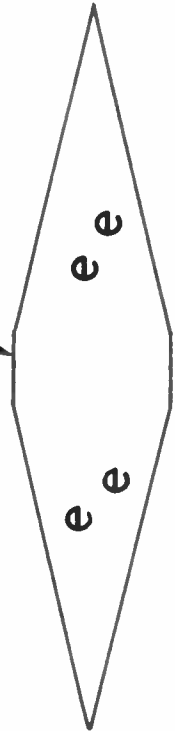




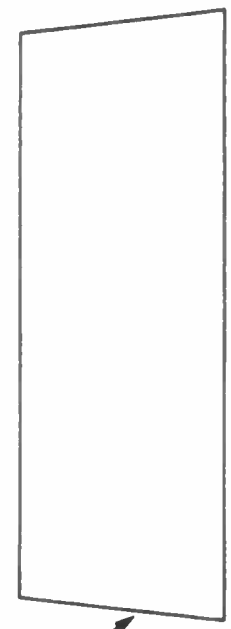
WRAP ROUND FLAG STAFF



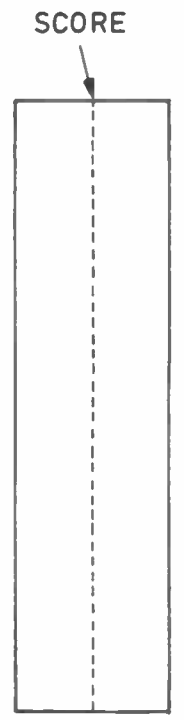
Speaker mount



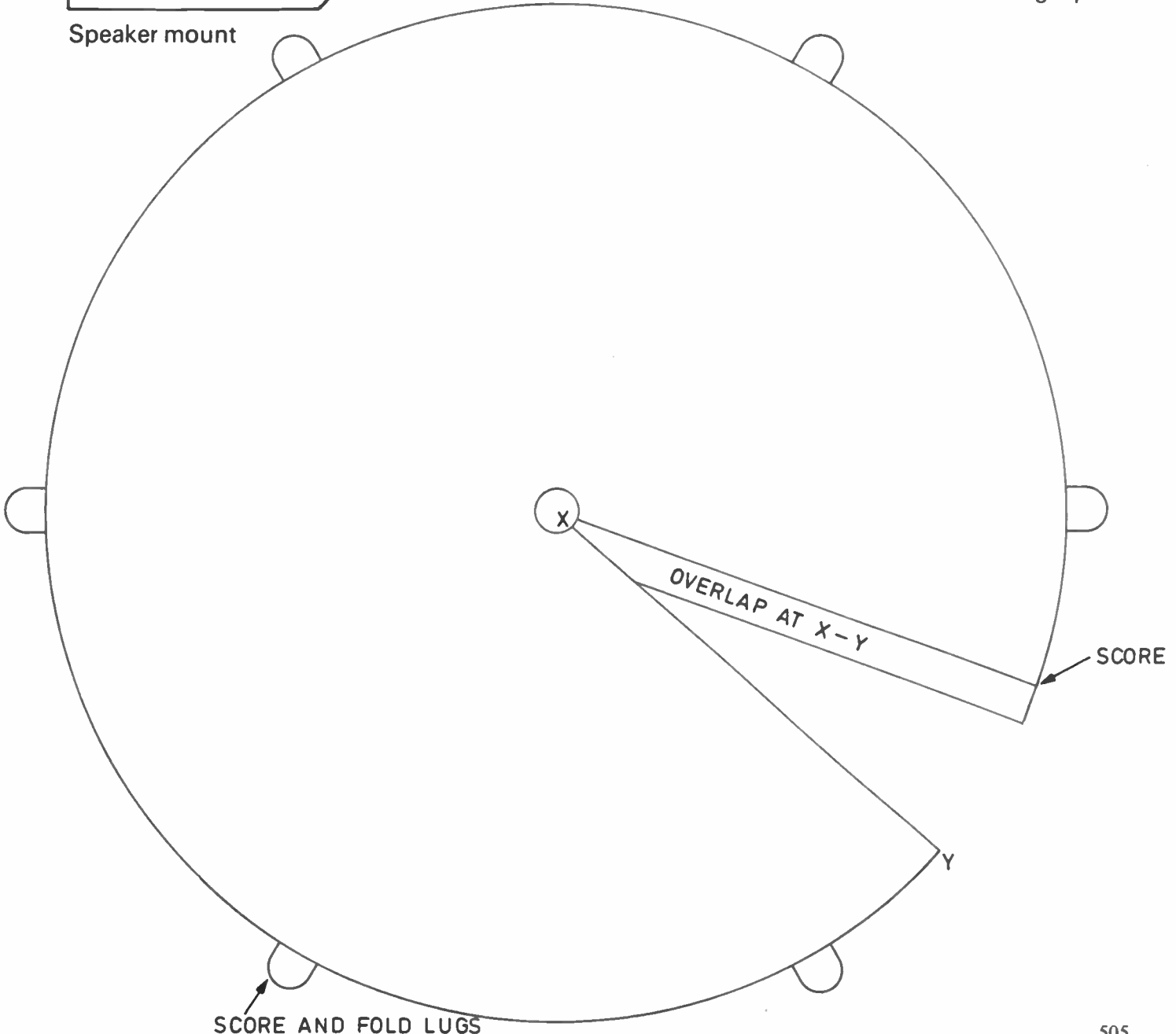
Angle piece



CUT 8  
Base panels

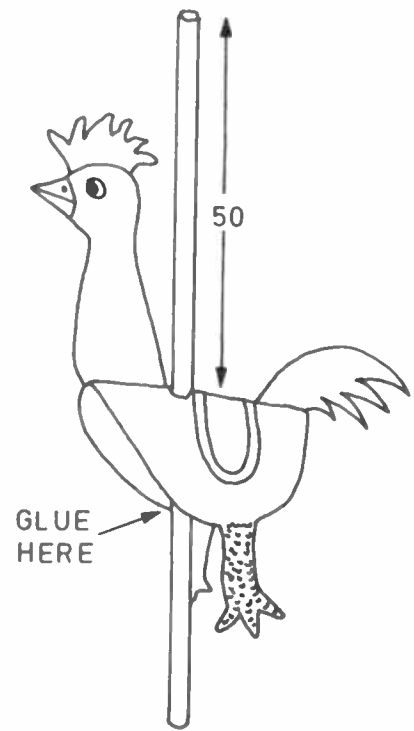
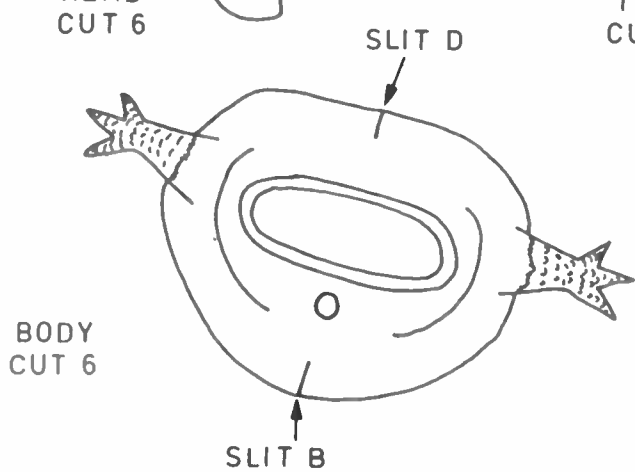
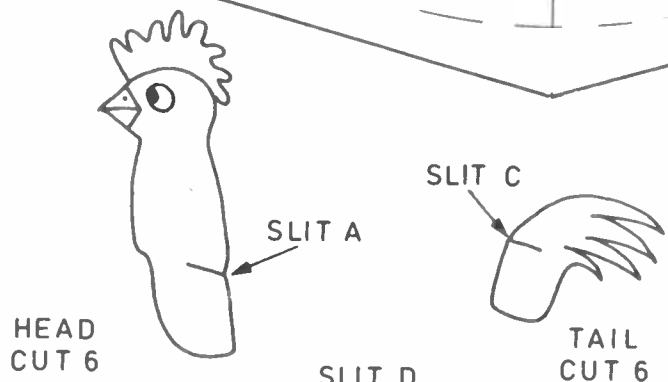
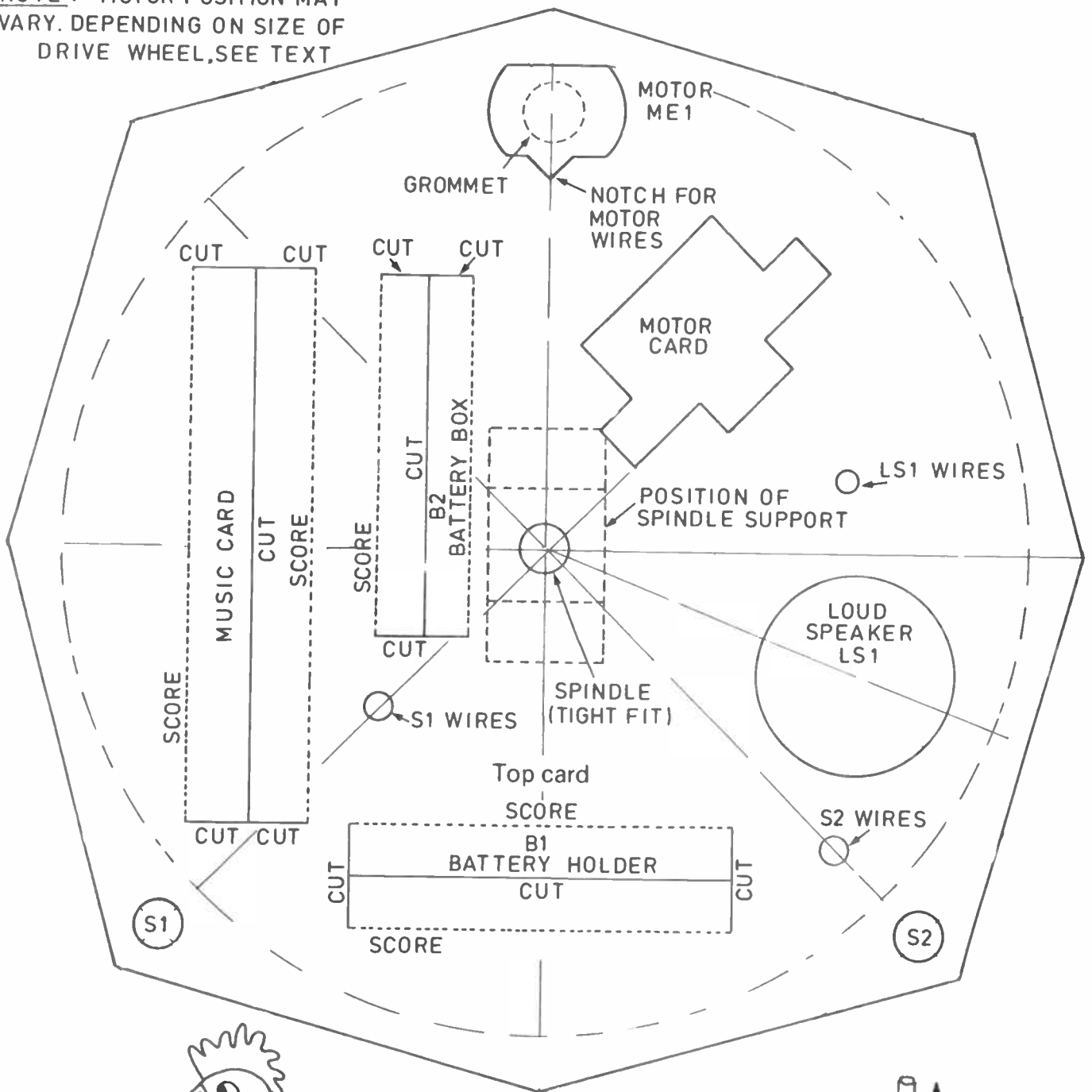


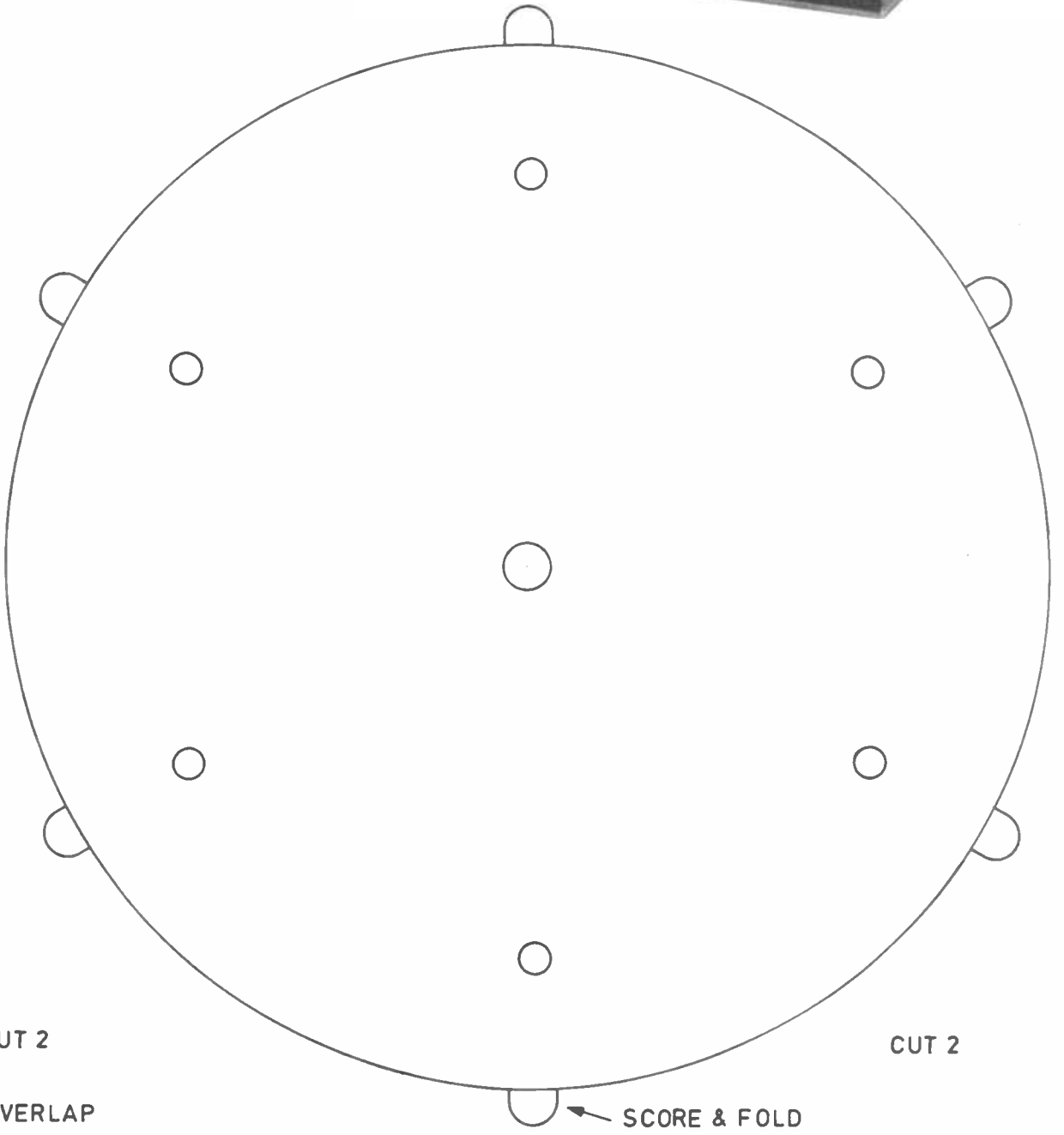
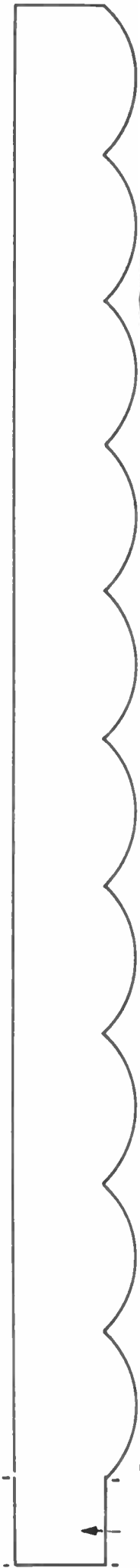
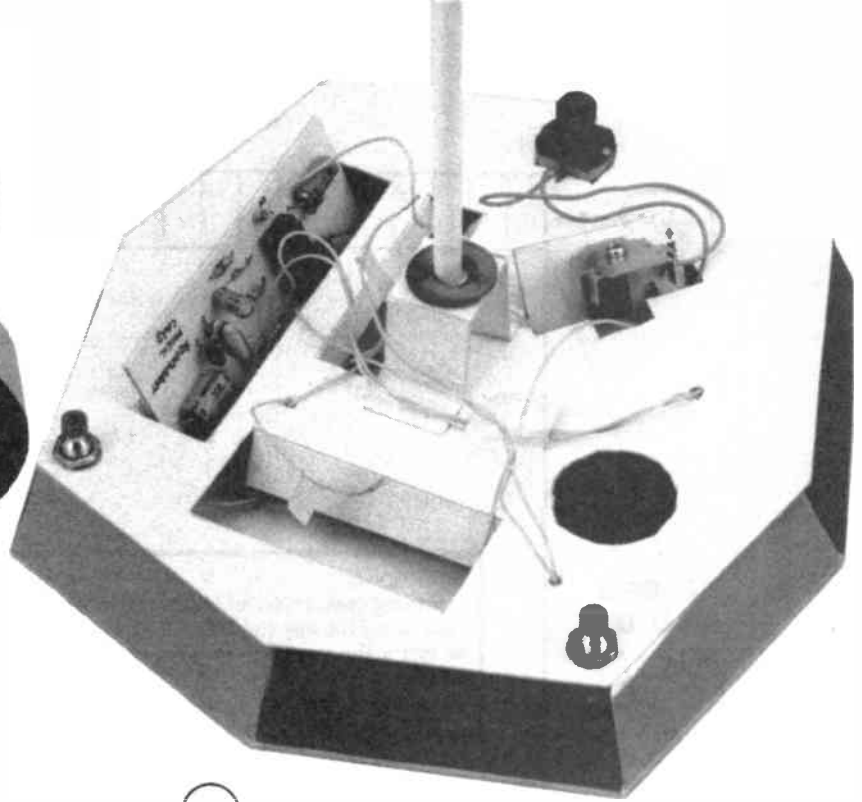
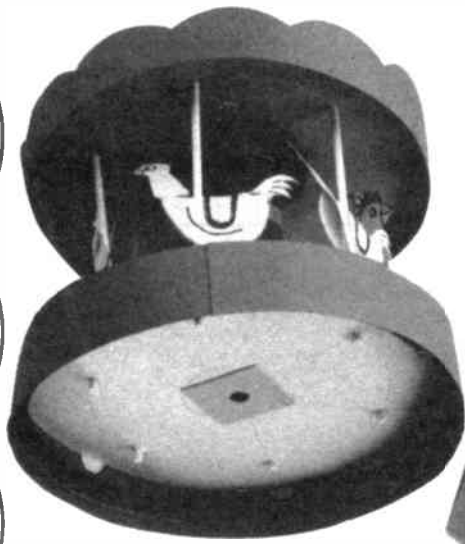
Angle piece



SCORE AND FOLD LUGS

**NOTE :-** MOTOR POSITION MAY VARY. DEPENDING ON SIZE OF DRIVE WHEEL,SEE TEXT





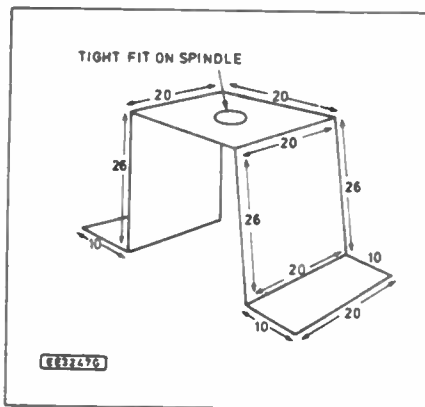
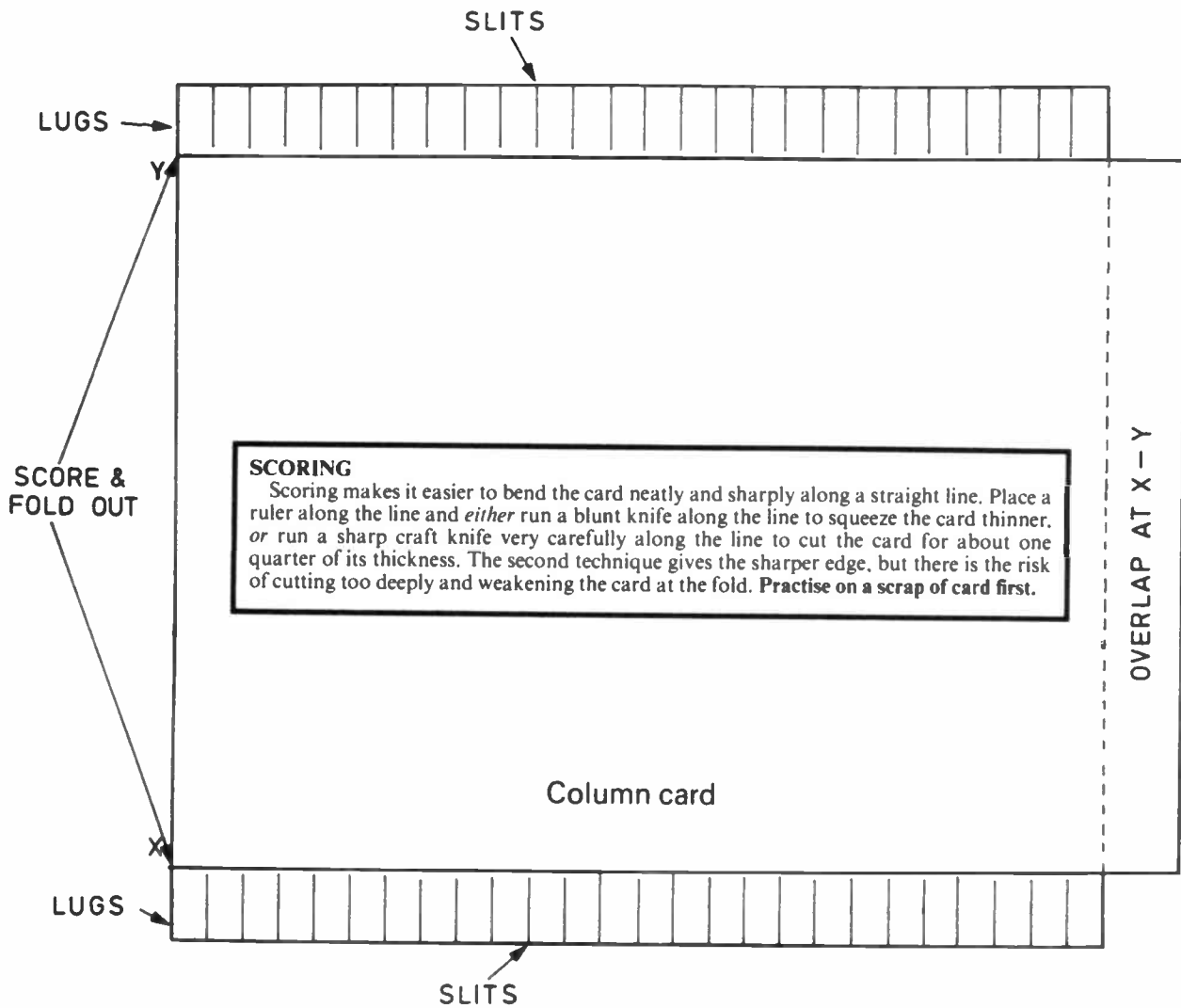


Fig. 2. Spindle Support construction.

## ASSEMBLING THE BASE

The base of the roundabout consists of an eight-sided bottom card and a slightly smaller top card, also eight-sided. These are cut out from rather thicker card than we normally use; this can be made up of three layers of card glued together for the bottom and two layers glued together for the top.

The top and bottom are joined by eight base panels cut from thin card. We used red and green painted card for alternate panels. The pieces of card are joined by angle-pieces, strips of card of various lengths, scored and folded along the middle. Glue an 80mm length along each side of the base

bottom, trimming the ends of the angle pieces obliquely so that they do not overlap at the corners.

When the glue has set, glue a base panel to each angle piece. Glue a short (20mm) angle piece between the ends of adjacent panels. Finally glue a 73mm angle piece to the upper edge of each panel, trimming their ends to avoid overlaps. Do not glue the top in place yet.

The spindle is 190mm long and about 6mm in diameter. We used a length of white a.b.s. plastic tube bought from a model shop, but you could use wooden dowelling instead. The lower end of the tube is held in a base consisting of four pieces of card glued together. The cards have a central hole which is a tight fit on the spindle.

Coat the bottom end of the spindle with glue and push it into the base cards. Stick the base cards to the centre of the base bottom, where indicated in. Check that the spindle is vertical, then leave the assembly to dry.

The base top holds all the electronics. Using a sharp craft knife, cut H-shaped slits for the batteries and the music card. Score the card where shown and push the flaps down. This helps keep the base top rigid and the flaps grip the batteries and card.

The opening for the motor card is to allow the card to be inserted and to rest on the base bottom. There must be free space around the heat sink. If in doubt, make this opening after you have assembled the motor control card.

The loudspeaker aperture has a radius about 2mm less than that of the speaker; check your speaker before cutting this hole. Cut a speaker mount from thin card, with a hole of radius about 1mm less than that of the speaker. One corner is trimmed off to keep the card clear of the motor battery B1.

## TURNTABLE DRIVE

The opening cut for the motor is to be a firm fit around the motor; its exact shape and position depend on the type of motor used. The opening shown is based on a common type of 3V motor that is used in many motorised toys and is also available from electronics suppliers. As Fig.1 shows, the turntable has rim drive (in common with the better hi.f. equipment!) but we have had to make allowances for the lack of precision in construction and the fact that thin card is flexible.

The motor has a rubber drive wheel, which in the prototype is a 10mm grommet pushed on to the motor shaft. This is in contact with a strip of self-adhesive draught excluder (as used for draught-proofing windows and doors) fixed inside the rim of the turntable. The motor is positioned so that the drive wheel bears firmly on the draught excluder, compressing it slightly. This keeps it in contact, even if the rim is not perfectly cylindrical.

Using a grommet as the wheel was just a matter of convenience. Any other small cylindrical rubber or soft plastic object can be used. Other possible "drive wheels" include a small rubber stopper, or a plastic



"foot" (as used on project cases). The wheel diameter should not be more than 10mm; the smaller it is, the slower the roundabout turns.

The lower end of most motors of this type has a brass bearing with the shaft of the motor projecting slightly from it. If the motor were to rest on this end of the shaft, the friction would retard the motor. The motor rests on two motor base glued to each other and to the base bottom. The cards have a hole that is a tight fit on the brass bearings. The cards locate the lower end of the motor securely and also hold the shaft end clear of the base bottom. The exact position of the motor base cards depends on the dimensions of the motor and drive wheel.

Place the base top over the spindle and rest it on the base bottom. Push the spindle support (Fig.2) on the spindle and glue the two lugs to the base top.

## ASSEMBLING THE TURNTABLE

There is a lot of scope for creativeness in modifying this design. We built the turntable from thin card painted the same two colours as used for the base panels, but you can use other colours, or more colours, or use plain white card (as supplied by EE) painted with designs as elaborate as you choose.

Cut out the lower turntable disc, and bend the lugs down. The hole in the disc is several millimetres greater in diameter than the spindle. Cut two 30mm squares from a thin (about 0.7mm) sheet of stiff but not brittle plastic. We cut pieces from a yellow photographic slide box. These squares are to be the bearings for the turntable.

Make a hole that is *just* big enough to be a loose fit on the spindle. Scratch one surface of the plastic with a sharp point to help the glue adhere. Glue one of the squares on the under side of the disc, making sure the hole is central. Make six holes where shown for the cockerel rods. You need six of these rods, 110mm long and about 3mm in diameter. We used white a.b.s. rods, purchased at a model shop, but there are plenty of possible substitutes.

Cut two rectangles of card 270mm x 28mm for the rim. Draw a line parallel to and 3mm from one edge. Wrap the strips around the edge of the disc, with the line to the inside, gluing the overlapping ends of the strips to each other and gluing the lugs to the inside of the strip, so that the edge of the disc is level with the line. In a similar way assemble the roof of the turntable from the upper disc and its scalloped rim. Glue the second plastic bearing to the upper surface of the upper disc.

Cut out the column card, wrap it round a rod or bottle about 40mm diameter so that it curls evenly, and glue the over-lapping edge. As a decorative touch, we painted a 5mm wide strip of contrasting colour around the column in a spiral. When the roundabout is rotating, this appears to move upward because of the "barber's pole" effect. Bend the lugs outward. Apply glue to the lugs and place the column centrally on the lower disc. Press the lugs firmly down. When they are dry, stick a card ring over them to make the assembly look neater.

Thread the other ring on the column, then stick the other end of the column to the upper disc in the same way, covering the lugs with the ring. Make sure that the two sets of six holes in the discs are aligned

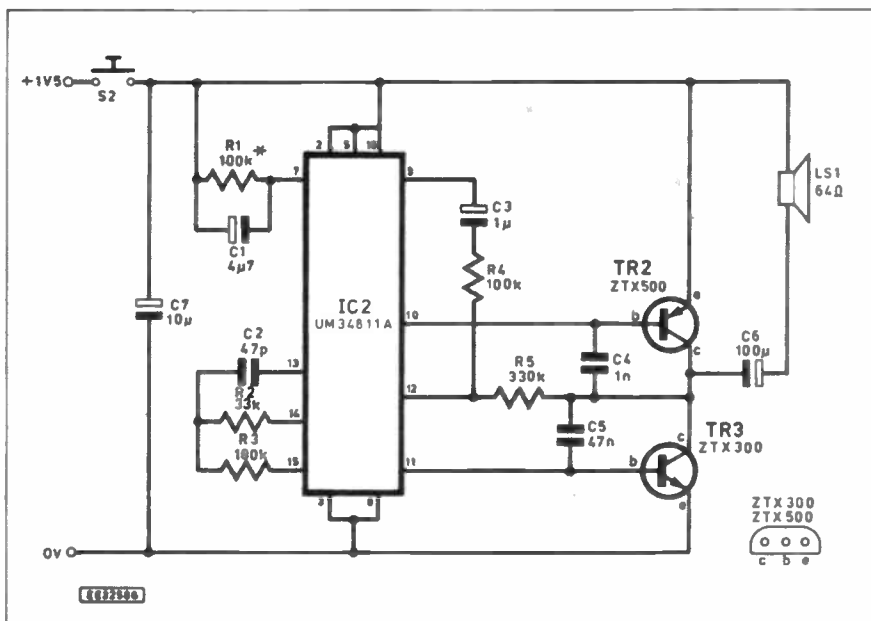


Fig. 3. Musical circuit.

with each other. It helps to thread three of the cockerel rods through the holes at this stage.

There is no limit to the variety of "seats" that the roundabout can have. We opted for the traditional cockerels, less often seen nowadays, but you can select from scores of other animals, such as zebras, giraffes, and horses, or perhaps make vehicles, such as cars, double-decker buses, aeroplanes and bizarre spacecraft.

Model the seats from paper, as we have done, or mould them from modelling compound. The cockerels are made from three pieces. Colour the outlines to your taste. Push slit A into slit B and glue the lug on the head section inside the left side of the body. Push slit C into slit D and glue the lug on the tail section inside the left side of the body. Thread the rod through the hole so that there is about 50mm of rod projecting above the body. Bend the body round until the legs meet; place a large dab of glue between the legs and work the rod into this. Splay the feet apart so as to make "foot-rests" for the passenger. Hold the assembly with the legs and rod pinched together until the glue has dried.

Push the rods into the holes in the top and bottom discs; apply glue to the ends of the rods and the surrounding area of disc. Cut out the roof-top and glue it to form a shallow cone which just fits within the scalloped rim. The hole at the apex is very loose on the spindle. Bend the lugs to point inward, apply glue and press the roof-top down on the upper disc. As decoration the roof-top can be painted in three sectors of contrasting colour.

The flag is made of card, glued to a post (e.g. a spare piece of the cockerel rod), tapered if necessary to fit into the hollow of the spindle.

## HOW IT WORKS

There is not much to be said about the music circuit (Fig.3) as, apart from timing, envelope control and final amplification, the bulk of the circuit is concealed within the i.c. The motor control circuit Fig.4 is an interesting application of an operational amplifier.

When a motor is turning, a voltage known as the *back e.m.f.* is generated which opposes the voltage applied to the motor.

The back e.m.f. depends on the speed of the motor and this, in turn, depends on the mechanical load that the motor is having to deal with. The heavier the load, the slower the rate of rotation and the lower the back e.m.f. If the motor stalls, there is no back e.m.f. In this case the applied voltage may be sufficient to burn out the coil! This cannot happen in this circuit.

The voltage across the motor is fed back to the inverting (-) input of the operational amplifier. There is also a fixed (but adjustable) voltage fed from VR1 to the non-inverting (+) input. The amplifier acts so as to keep these voltages equal.

If the motor suddenly experiences extra mechanical load, there is less back e.m.f. and the voltage across the motor and at (-) rises. This causes a fall in the amplifier's output, and TR1 is turned slightly off. Less current flows to the motor; lowering the voltage across it until the (-) and (+) inputs are once again receiving equal voltages. The opposite happens if the motor starts to run fast. The corollary of this is that, by adjusting VR1, we can raise or lower the voltage at the (+) input and so control the speed of the motor. This circuit gives stable running conditions and makes it possible to control the motor speed accurately, which is particularly important here, as we want to run the motor steadily at a low speed.

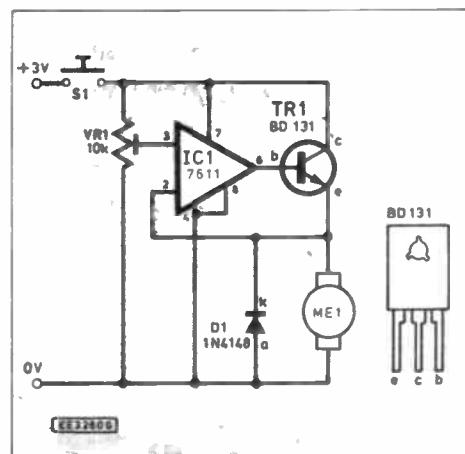


Fig. 4. Motor control circuit.

## MOTOR CONTROL CARD

The Motor Control Card is shown in Fig.5. TR1 requires a small bolt-on heat sink if the motor is to be run for more than 10 to 20 seconds. The battery consists of two AA cells in a battery box. To test the circuit, connect it as in Fig.7. Press and hold S1. Adjust VR1 to control the motor speed. Set this to run as slowly as possible without stalling. After you have switched off, you will need to turn the drive wheel to get the motor started again.

## COMPONENTS

### Resistors

|        |                                   |
|--------|-----------------------------------|
| R1     | 100k (possibly smaller, see text) |
| R2     | 33k                               |
| R3, R4 | 100k (2 off)                      |
| R5     | 330k Carbon, 0.25W ± 5%           |

### Potentiometer

|     |                                 |
|-----|---------------------------------|
| VR1 | 10k miniature horizontal preset |
|-----|---------------------------------|

### Capacitors

|    |                 |
|----|-----------------|
| C1 | 4µ7 elect. 12V  |
| C2 | 47p polystyrene |
| C3 | 1µ elect. 12V   |
| C4 | 1n polystyrene  |
| C5 | 47n polystyrene |
| C6 | 100µ elect. 12V |
| C7 | 10µ elect. 12V  |

See  
**SHOP  
TALK**  
Page

### Semiconductors

|     |  |
|-----|--|
| D1  | 1N4148 silicon diode                   |
| TR1 | BD131 <i>nnp</i> high power transistor |
| TR2 | ZTX500 <i>npn</i> transistor           |
| TR3 | ZTX300 <i>nnp</i> transistor           |
| IC1 | 7611 CMOS operational amplifier        |
| IC2 | UM34811A melody generator              |

### Miscellaneous

|        |  |
|--------|--|
| S1, S2 | miniature push-to-make push-button (2 off) |
| LS1    | 64-ohm loudspeaker, approx 38mm diameter   |
| M1     | small 3V d.c. motor                        |

8-way d.i.l. socket; 16-way d.i.l. socket; bolt-on heat sink for TR1; p.c.b. eyelet terminals (7 off); battery box for 2 AA cells; battery box for 1 AA cell; Easiwire wiring system - see *EE Special Offer* page; connecting wire etc.; circuit cards, available from EE - see *Shop Talk* or *Special Offer* page

### Materials required

Sheets of thin card (240g/m<sup>2</sup>), piece of medium card (800g/m<sup>2</sup>), about 250mm x 300mm, piece of thick card (1200g/m<sup>2</sup>), about 250mm x 300mm - or printed model card (see *Shop Talk* and *Special Offer* page) plus four sheets of plain 400g/m<sup>2</sup> card (approx 250 x 300mm).

Plastic a.b.s. rod/tube 190mm long, approx. 6mm diam; plastic a.b.s. rod 110mm long, approx 3mm diam (6 off); plastic a.b.s. rod about 60mm long, approx 3mm diam; scrap of plastic sheet (a.b.s. or p.v.c.) about 30mm x 60mm; metal washer, hole about 8mm diameter; tube clear adhesive (Uhu or Bostick Clear).

Approx cost  
guidance only

£8

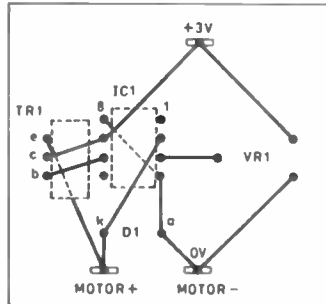
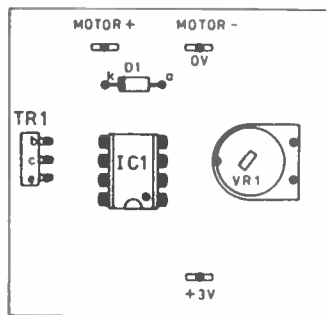
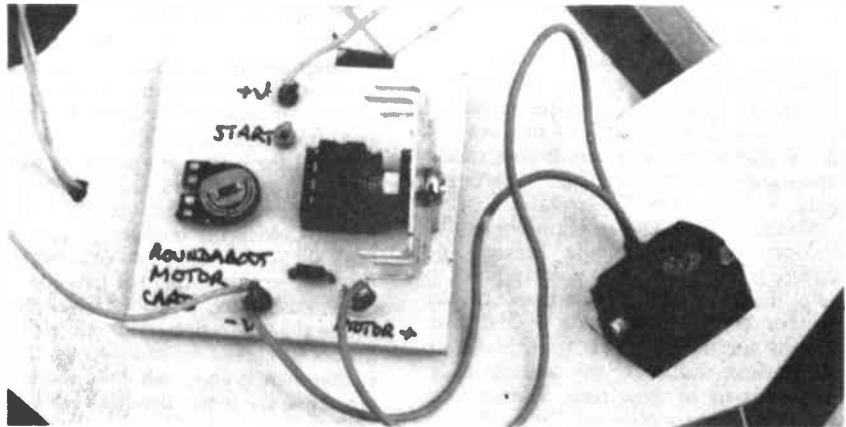


Fig. 5. Motor Control circuit card.



Check that the drive wheel turns clockwise when viewed from above. If it does not, reverse the connections to the motor. The motor requires a fairly heavy current. Having a push-button instead of a switch for S1 leads to economy of power, as a child is not able to leave the motor running unattended. Also, it is more exciting to "press the button and make it work".

Slip a metal washer on the spindle, making sure that there are no loops of wire or anything else that can impede its rotation and that the drive wheel is in firm contact (i.e. about one-third embedded) with the draught strip. Press S1, and give the turntable a light clockwise push. It should continue to spin until S1 is released. If it does not spin, the setting of the motor is too slow; remove the turntable and re-adjust VR1.

## MUSIC CARD

When wiring up the Music Card (Fig.6) remember that TR2 is a *npn* transistor but TR3 is an *nnp* transistor. These are wired with their plastic cases orientated oppositely. There are three wires crossing in the region of R5 and C3, so two layers of insulating tape are required here. The values of R1 and C1 give some control over the type of note produced. With the values shown in Fig.3, we obtain a smooth organ-

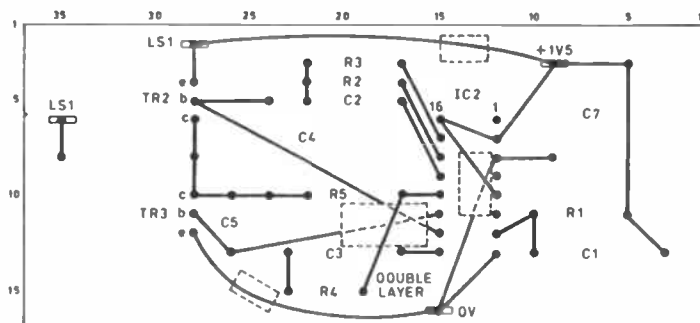
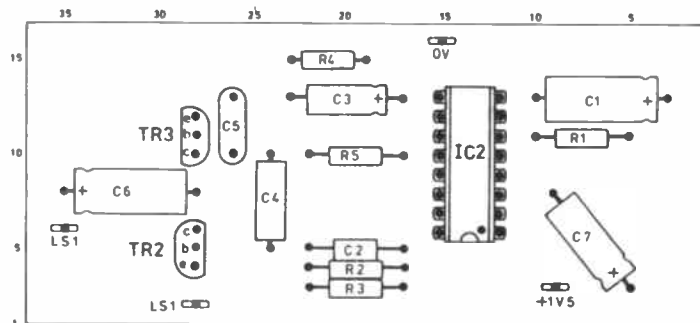
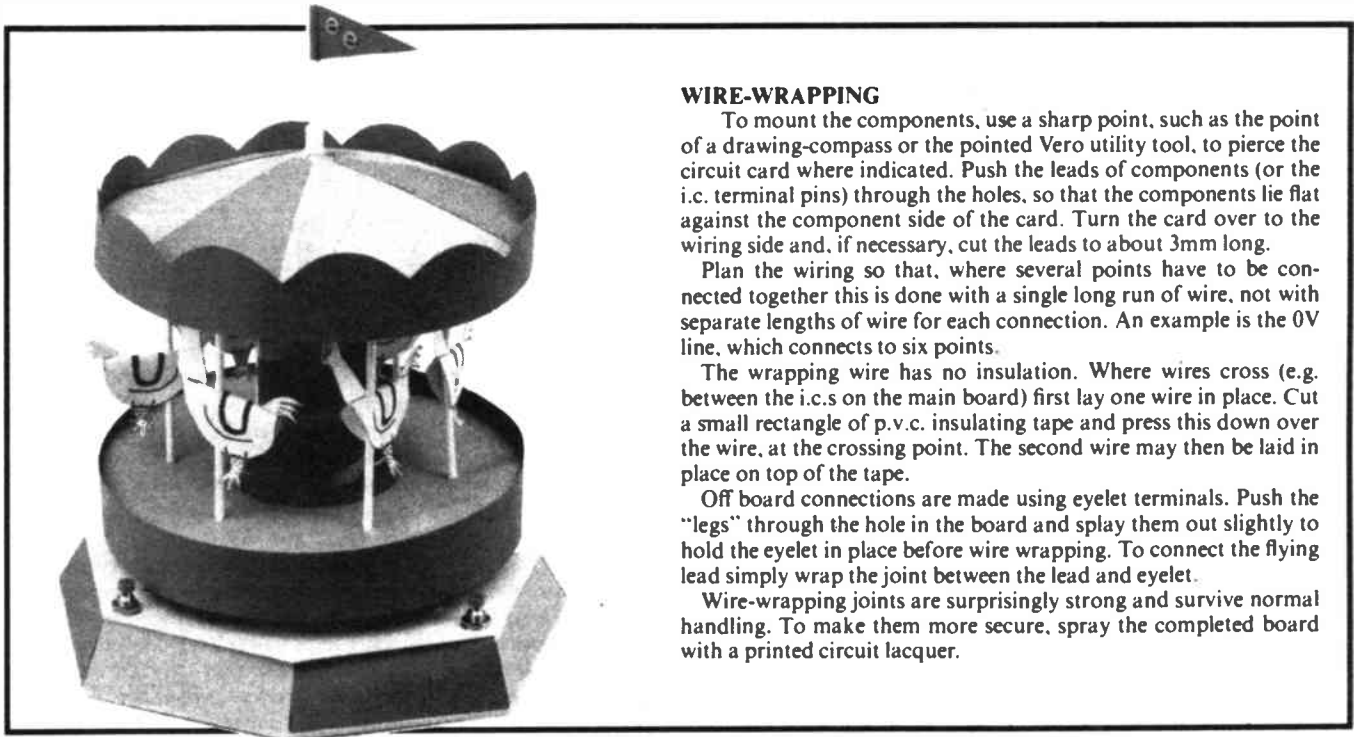


Fig. 6. Layout and wiring of the Music Card.



### WIRE-WRAPPING

To mount the components, use a sharp point, such as the point of a drawing-compass or the pointed Vero utility tool, to pierce the circuit card where indicated. Push the leads of components (or the i.c. terminal pins) through the holes, so that the components lie flat against the component side of the card. Turn the card over to the wiring side and, if necessary, cut the leads to about 3mm long.

Plan the wiring so that, where several points have to be connected together this is done with a single long run of wire, not with separate lengths of wire for each connection. An example is the 0V line, which connects to six points.

The wrapping wire has no insulation. Where wires cross (e.g. between the i.c.s on the main board) first lay one wire in place. Cut a small rectangle of p.v.c. insulating tape and press this down over the wire, at the crossing point. The second wire may then be laid in place on top of the tape.

Off board connections are made using eyelet terminals. Push the "legs" through the hole in the board and splay them out slightly to hold the eyelet in place before wire wrapping. To connect the flying lead simply wrap the joint between the lead and eyelet.

Wire-wrapping joints are surprisingly strong and survive normal handling. To make them more secure, spray the completed board with a printed circuit lacquer.

like sound. The shorter notes tend to run into one another, but this is in keeping with a fairground organ sound.

If you prefer a sound more like plucked strings, reduce the value of R1; a value of 22k is a suitable starting point. The loudspeaker is a low-cost miniature type with a coil resistance of 64 ohms. This is intended for direct drive by transistors. Note that most loudspeakers have much lower resistance (e.g. 8 ohms) but these will not produce an audible sound with this circuit.

Connect the circuit as in Fig.8. The maximum voltage for the i.c. is 1.5V, so *only one cell* is used. This is in its own battery holder, to which wires may be attached. When S2 is pressed and held, the tunes begin. The starting point in the sequence varies but, once started, the sequence continues indefinitely. If no sound is heard, release S2, and check the wiring; possibly the amplifier section (to the right of the i.c. in Fig.3) is at fault.

If the sound is heard, but plays much too slowly and with too low a pitch, the clock section (C2, R2 and R3) is wrong. Possibly the value of C2 is not correct; try a different capacitor. If you have an oscillo-

scope, monitor the waveform at pin 12; this is an approximate square wave of frequency around 125kHz. If you want to alter the speed of play, try varying the values of R2 and R3. □

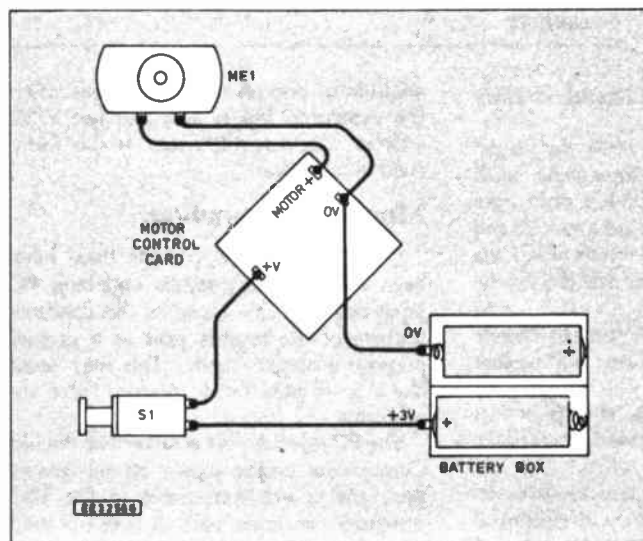
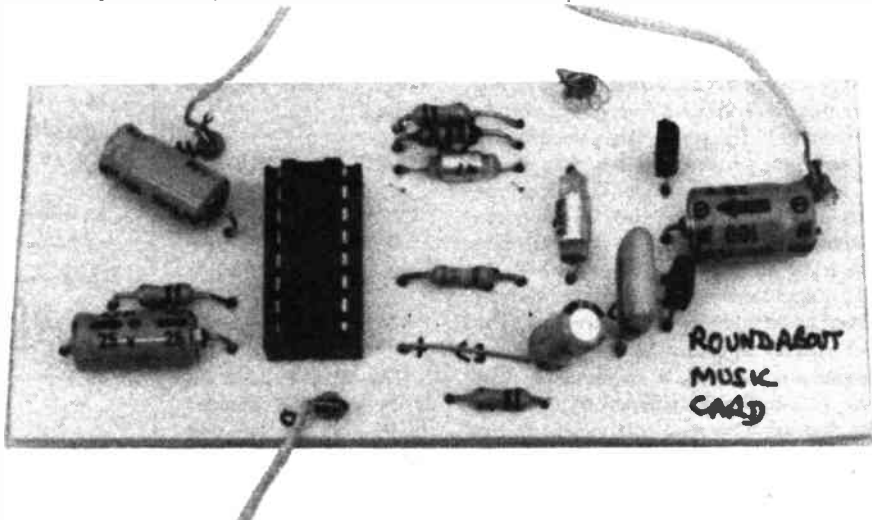


Fig. 7. Wiring of the motor circuit.

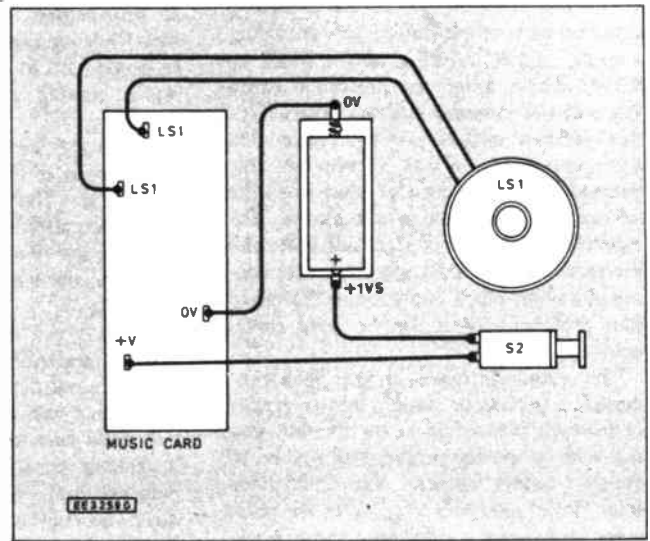


Fig. 8. Wiring of the music circuit.

# INTERFACE

**Robert Penfold**



**A**S EXPLAINED last month, it was my intention to include in this month's *Interface* article a printed circuit design for a PC prototyping card having built-in address decoding. Unfortunately, due to technical difficulties (the "dongle" of my p.c.b. design program has developed a fault and locked me out of the program!) the printed circuit design will have to wait until next month. We will then consider some simple add-on port cards for the PC as well.

## DIY Approach

Probably the most convenient form of PC prototyping card is the kind which has a built-in address decoder plus some solderless breadboards. The built-in address decoding is important with this type of card since it is often not possible to get a great deal of circuitry onto the solderless breadboards.

Having the address decoder ready-made and tucked away in a corner of the board leaves the solderless breadboard free for the main prototype circuit. Apart from this, it is obviously much more convenient if you do not have to build up an address decoder circuit each time you try out a new design.

I have seen ready-made PC prototype cards of this type advertised in American computer magazines such as *Byte*, but they seem to be difficult to obtain in the U.K. In fact a quick search for equipment of this type proved to be completely unsuccessful. The do-it-yourself approach is likely to be far cheaper anyway, but it seems likely that there is actually no alternative means of obtaining equipment of this variety in the U.K.

## Addressing The Problem

The address and control bus decoding could be very simple indeed, just providing a single output covering all the  $\&300$  to  $\&31F$  address range for prototype cards. We will not consider address decoders of this type here, as they have been covered in a previous *Interface* article. A more versatile method is to have a decoder which splits the address range up into several blocks. For example, four blocks of eight addresses still leaves sufficient address space for most add-ons in a single block, and it means that up to four prototype cards can be used simultaneously.

This avoids problems if you have converted a prototype design into a proper card which is installed in the PC, but you still wish to use the prototyping system to develop further boards. You could have three prototype cards installed in the computer, each using a different address block, and there would still be one free for use with the prototyping system.

The number of blocks into which the address range is divided has to be something of a compromise. The address range of  $\&300$  to  $\&31F$  covers just thirty two addresses, which is not a particularly generous quota. Dividing it into just two or three blocks gives a very useful number of addresses per block, but it severely limits the number of user add-on cards that can be used at one time. Using more than about four blocks is not very practical since the PC is not likely to have enough free expansion slots to make this worthwhile. Remember that there are usually only about six to eight expansion slots, and that some of these will be occupied by essential hardware such as disk controllers and the display adaptor.

## Address Circuit

The circuit diagram for a simple address decoder which gives four decoded outputs is shown in Fig.1. The table below shows the address range covered by each output:

### OUTPUT ADDRESS RANGE

|   |                 |
|---|-----------------|
| 0 | $\&300 - \&308$ |
| 1 | $\&309 - \&30F$ |
| 2 | $\&310 - \&318$ |
| 3 | $\&319 - \&31F$ |

The circuit is based on a 3- to 8-line decoder (IC3). This also has two "low" enable inputs and one "high" enable input, permitting up to six lines to be decoded. In this case there are eight lines to decode (A3 to A9 plus AEN), making some additional circuitry necessary.

A5 to A7 are used to drive the "high" enable input of IC3 via a three input NOR gate (IC1). The output of IC1 only goes high when all three inputs are low. A8 and A9 drive the "low" enable inputs of IC1 via inverters, and are therefore decoded to the high state.

Inputs 0 to 2 of IC3 are used to decode A3, A4, and AEN. The latter will be low when the prototype card is accessed. This means that one of outputs 0 to 3 of IC3 will pulse low when the card is accessed, depending on the states of A3 and A4. Address lines A0 to A2 are available to drive the register select lines of peripheral chips, or for additional address decoding, if the prototype circuit has more than one read/write. This circuit is just one of many

possible ways of tackling the problem. The chip count could probably be reduced to two by using the two spare gates in IC1 to act as the inverters, but I have not tried this in practice. Either way, the circuit uses only inexpensive logic chips and is a very inexpensive method of obtaining four decoded outputs.

If you decide to experiment with more exotic address decoder circuits I would warn against using some of the complex TTL decoder chips. These tend to be quite expensive, and in some cases they are very much slower than gates and simple decoders.

Although computers are not fast by general logic circuit standards, some PCs operate at quite high clock frequencies and the bus timing is always quite critical regardless of the clock frequency. The situation is usually eased somewhat by the

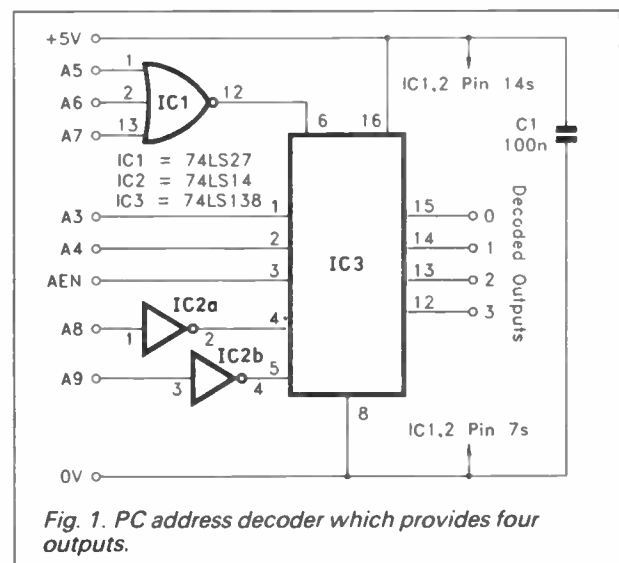


Fig. 1. PC address decoder which provides four outputs.

addition of one or more wait states when the expansion bus is accessed, but a PC address decoder still needs to be fairly swift in operation.

## Mouse Programming.

Over the past few months there have been a few reader's letters regarding PC input devices. One aspect of this concerns the use of the joystick port as a general purpose analogue input. This may seem like a good idea, but in practice there are problems.

The PC joystick port is rather like the old Commodore paddle inputs on the games port, and is not comparable to the BBC computer's analogue port. It does not read an input voltage, but responds directly to the resistance of the potentiometer which is in a C-R timing circuit.

Although a voltage to resistance conversion is possible, I have never obtain worthwhile results using such a system. The effective resolution of a joystick port does not seem to be very high, and it is probably unsuitable for any sort of precision analogue application.

Surprisingly, most programming languages for the IBM PC and compatibles do not include direct support for the use of a mouse. About the only one I have used which does is Locomotive Basic 2, as supplied with the original Amstrad models. This runs under GEM, so mouse support is understandable. As Windows programming languages arrive, mouse support in these would also be essential.

For users of other languages, mouse support may be provided in a library, either supplied with the language or available as an extra. For example, Microsoft supply a disk with their *Microsoft Mouse Programmer's Guide*, which includes library support for nearly all Microsoft languages. One exception is QuickPascal, which is supplied with a mouse "Unit" in source code form.

If such support is not available for the language you use, it may be possible to write your own mouse routines, depending on the support your language offers for low-level access. The mouse driver is accessed via an interrupt, INT 33H. The driver provides a number of functions, and the function required is passed in the AX register.

Other parameters are passed in other registers, and these are also used for return values. So, to write your own mouse routines you must have some means of setting register values, calling an interrupt, and reading the registers on return.

### Mouse Functions

There are something like 20 mouse functions provided by most drivers conforming to the Microsoft standard. The most useful ones are described here.

Function 0 is used to determine if a mouse driver is present. If it is, AX will be non-zero on return, and BX will contain the number of buttons on the mouse. If AX is zero, no mouse driver is present. This function also initialises the mouse driver, for example, placing the pointer in the middle of the screen, and zeroing all "counts".

Functions 1 and 2 show and hide the mouse cursor respectively. It is normally desirable to hide the cursor while updating the screen, to avoid a "ghost" pointer being left behind. These calls are "nested". In other words, if you make two consecutive calls to hide the cursor, you will have to make two calls to show it again. However, a call to show the cursor when it is already visible does nothing.

Function 3 reads the position of the mouse pointer relative to the virtual screen. The values returned are in graphics units and depend on the screen mode. The X position is returned in the CX register, and the Y position in the DX register. The BX

register contains the current button status. Bit 0 is set for the left button, bit 1 for the right button, and bit 2 for the centre button if present.

Function 4 is used to set the mouse pointer position. It is normally used at the start of a program to centre the pointer on the screen, if this is not done by calling function 0.

Functions 5 and 6 return a count of how many times the mouse button has been pressed (5) or released (6) since the last call to the respective function. You pass the mask for the button you want to test in BX, and this register is also used to return the count. On return, CX and DX contain the last X and Y positions, and AX contains the current button status.

It is possible to limit the mouse pointer movement on the screen. Function 7 limits the horizontal movement and function 8 the vertical movement. In each case, the minimum value is set in CX and the maximum in DX. I have used one or two programs which use these functions. Frankly, they are a pain in the serial port!

Most mouse programming can be done with just these calls, though you may also need functions 9 (graphics) and 10 (text) if you want to change the cursor shape. You may find some example routines in your mouse instruction book, though some of these give very little technical information.

The aforementioned *Microsoft Mouse Programmers Reference Guide* is the "bible" for mouse programmers.

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# DESIGN YOUR OWN CIRCUITS

## Optoelectronics

MIKE TOOLEY BA

PART 9

This ninth part deals with the fascinating world of optoelectronics. Our design problem is based on an automatic porch light whilst our companion project deals with the construction of an Optical Communications Link.

In Part Seven of this series we introduced the electromagnetic spectrum as a prelude to some of the basic concepts of radio transmitters and receivers. In this part we are also concerned with electromagnetic waves but of a much shorter wavelength, i.e. those which extend from infrared through the visible spectrum to ultra violet (see Fig. 9.1).

Optoelectronics deals with the interface between electronic circuits and electromagnetic waves within the broad spectrum shown in Fig. 9.1. Optoelectronic devices, therefore, may offer a response which is outside that associated with normal visible light (i.e. the range of wavelengths which extend from approximately 800nm to 400nm). Particularly notable is the range from 700nm to about 1000nm which corresponds with the peak in response characteristic of a variety of infrared emitting and sensing devices.

### Optoelectronic devices

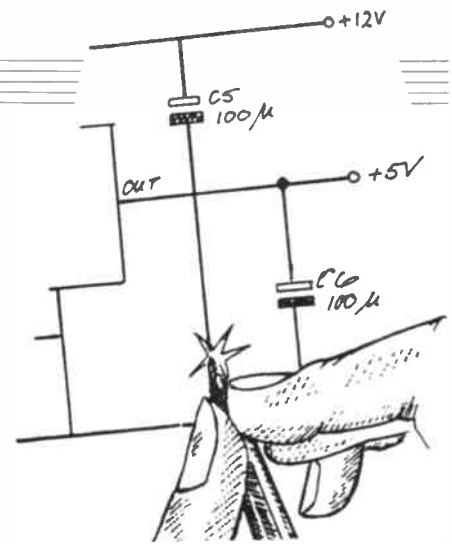
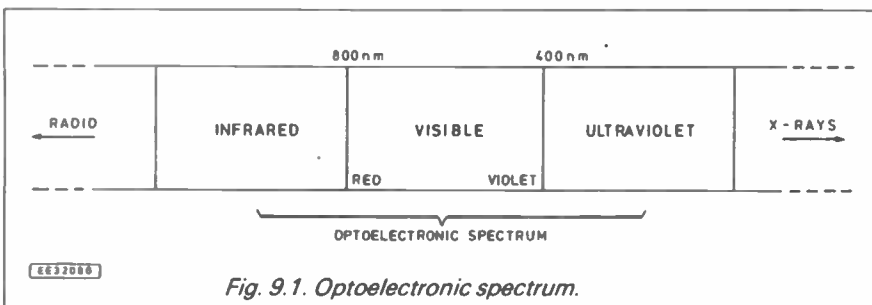
Optoelectronic devices can be divided into two basic camps; those which emit light or infrared radiation (often known as "emitters") and those which respond

to light (often referred to as "sensors"). We shall deal with each type of device separately.

### Emitters

The most obvious type of emitter is the familiar light emitting diode (l.e.d.). Like any other semiconductor *p-n* junction, this device conducts current in one direction but not in the other. However, when forward conducting, the diode emits visible light and has a peak spectral response at about 600nm. The following table summarises the characteristics of several commonly available types of l.e.d.:

| Device         | Diam | Colour | $I_{F(MAX)}$ | $I_{F(TYP)}$ | $V_{F(TYP)}$ | $P_{D(MAX)}$ | Int.  | $\lambda_{(PEAK)}$ | $\theta_{(TYP)}$ |
|----------------|------|--------|--------------|--------------|--------------|--------------|-------|--------------------|------------------|
| Miniature      | 3mm  | red    | 40mA         | 12mA         | 2.1V         | 150mW        | 2mcd  | 690nm              | 30deg.           |
| Miniature      | 3mm  | green  | 40mA         | 25mA         | 2.4V         | 150mW        | 2mcd  | 565nm              | 30deg.           |
| Miniature      | 3mm  | yellow | 40mA         | 25mA         | 2.4V         | 150mW        | 4mcd  | 585nm              | 30deg.           |
| Low current    | 3mm  | red    | 7mA          | 2mA          | 1.8V         | 24mW         | 2mcd  | 635nm              | 50deg.           |
| Standard       | 5mm  | red    | 30mA         | 10mA         | 2V           | 100mW        | 5mcd  | 635nm              | 30deg.           |
| Standard       | 5mm  | green  | 30mA         | 10mA         | 2V           | 115mW        | 5mcd  | 565nm              | 30deg.           |
| Standard       | 5mm  | yellow | 30mA         | 10mA         | 2V           | 115mW        | 5mcd  | 585nm              | 30deg.           |
| Wide angle     | 5mm  | red    | 40mA         | 10mA         | 2V           | 100mW        | 4mcd  | 635nm              | 80deg.           |
| High intensity | 5mm  | red    | 30mA         | 10mA         | 2.2V         | 135mW        | 30mcd | 635nm              | 35deg.           |



There are a number of important points which may not be obvious from the foregoing table. Firstly, it is important to note that, for similar levels of light output, l.e.d.s of different colours may require different forward currents. Secondly, that the viewing angles are usually somewhat limited (the wider the angle the better the visibility will be as the viewer moves away from the major axis of the device). Thirdly, the maximum reverse voltage for an l.e.d. (not quoted in the table) is usually *no more than 5V*. If this voltage is exceeded (even momentarily) the device will be permanently damaged and thus care should always be taken to connect l.e.d. devices with the correct polarity (anode positive, cathode negative).

### L.E.D. indicators

The humble l.e.d. is a most versatile device and can be used in a variety of indicating applications. Indeed, l.e.d.s offer a number of significant advantages over filament lamps when used as indicators. They are small, robust, reliable, inexpensive and require very low current!

In order to operate the l.e.d. a series resistor will be required to set the operating current of the device. The basic circuit of an l.e.d. indicator is shown in Fig. 9.2 and

Where:

- $I_{F(MAX)}$  = maximum forward current
- $I_{F(TYP)}$  = typical forward current
- $V_{F(TYP)}$  = typical forward voltage
- $P_{D(MAX)}$  = maximum power dissipation
- Int. = intensity (at  $I_{F(TYP)}$ )
- $\lambda_{(PEAK)}$  = wavelength of peak response
- $\theta_{(TYP)}$  = typical viewing angle

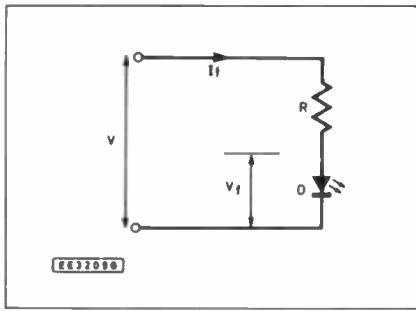


Fig. 9.2. Basic circuit of an l.e.d. indicator.

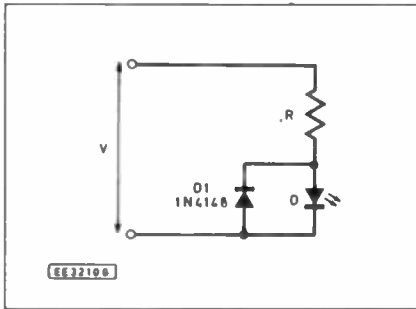


Fig. 9.3. L.E.D. indicator for a.c. voltages.

the value of series resistor can be calculated from:

$$R = \frac{V - V_F}{I_F}$$

where V is the input voltage (i.e. the voltage to be sensed),  $V_F$  is the forward voltage of the l.e.d. ( $V_{F(TYP)}$  in the table given previously) and  $I_F$  is the forward current ( $I_{F(TYP)}$  in the table given previously).

**Question 1** A miniature red 3mm diameter l.e.d. is to be used to indicate the presence of a 9V d.c. supply. Determine the value of the series resistor required.

**Question 2** A standard yellow 5mm diameter l.e.d. is to be used to indicate the presence of a 6V d.c. supply. Determine the value of series resistor required.

Since the maximum reverse voltage is strictly limited, l.e.d.s must be protected (as shown in Fig. 9.3) when used in low voltage a.c. indicating circuits. The silicon diode conducts when the reverse voltage exceeds about 0.6V and thus the full peak reverse voltage is prevented from appearing across the l.e.d. The circuit of Fig. 9.3 is suitable for a.c. voltages of up to about 24V r.m.s. and the following formula may be applied in order to determine the requisite value of series current limiting resistor:

$$R = 0.32 \frac{V - V_F}{I_F}$$

where V is the r.m.s. input voltage (i.e. the a.c. voltage to be sensed),  $V_F$  is the forward voltage of the l.e.d. ( $V_{F(TYP)}$  in the table given previously) and  $I_F$  is the forward current ( $I_{F(TYP)}$  in the table given previously).

**Question 3** A standard green 5mm diameter l.e.d. is to be used to indicate the presence of a 12V r.m.s. a.c. supply. Determine the value of series resistor required.

### L.E.D. signal indicators

The circuits of Figs. 9.2 and 9.3 require an appreciable current to operate and

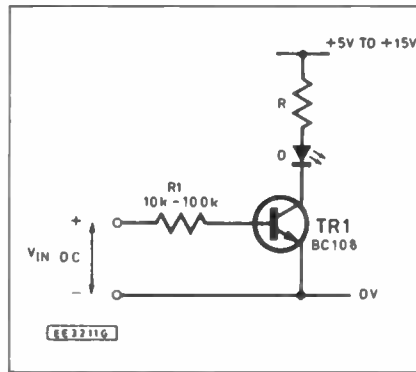


Fig. 9.4. L.E.D. signal indicator.

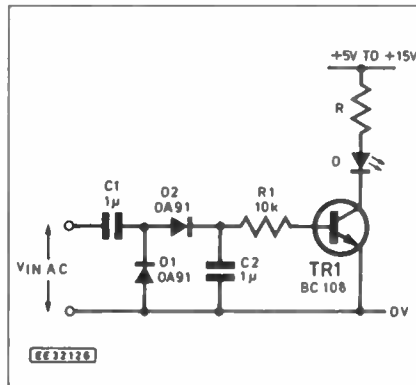


Fig. 9.5. Signal indicator for audio signals.

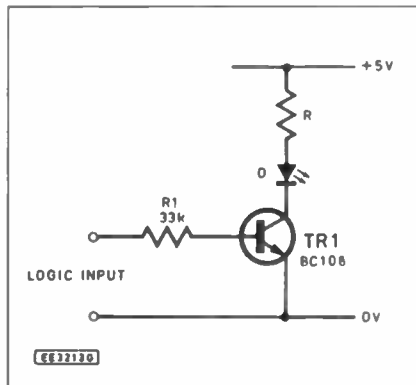


Fig. 9.6. Logic indicator using a transistor driver.

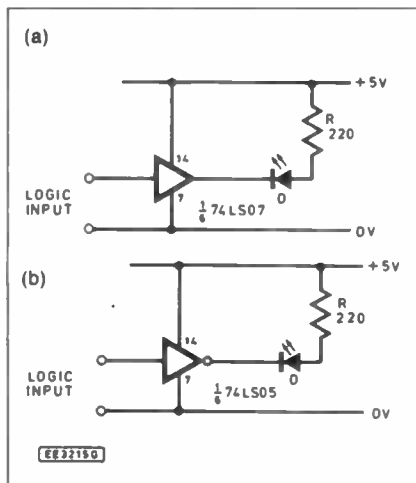


Fig. 9.7(a) Logic indicator (logic 0 to operate) (b) Logic indicator (logic 1 to operate).

hence, although useful for power rail sensing applications, may benefit from some additional current amplification when the l.e.d. is required to be operated from a small signal. Fig. 9.4 shows how a single transistor can be used to drive a l.e.d. The l.e.d. will become illuminated whenever the input voltage exceeds 1V, or so (the input current need only be a few tens of microamps in order to drive the l.e.d. to full brightness).

Where the signal is alternating (e.g. an audio signal), a diode detector circuit will be required. Fig. 9.5 shows an arrangement which will operate satisfactorily from audio signals of greater than about 1.5V pk-pk (note that it should be driven from a low impedance source and not connected directly to a high impedance point within a circuit).

### Logic interface

Light emitting diodes are frequently used as indicators in conjunction with logic circuits. Figs. 9.6 and 9.7 show two forms of interface which can be used with conventional TTL voltage levels (note that the device in Fig. 9.7(a) is an "open-collector" buffer whilst that in Fig. 9.7(b) is an "open-collector" inverter).

### Over and under-voltage sensing

The diagram of Fig. 9.8 shows a simple over-voltage sensing arrangement. The l.e.d. will become illuminated whenever the supply voltage rail exceeds the Zener voltage by 1V, or more.

L.E.D. indicators can be invaluable as means of indicating battery level in portable equipment. Fig. 9.9 shows a simple circuit arrangement in which the l.e.d. will become illuminated whenever the supply voltage falls to about 1V more than the Zener voltage.

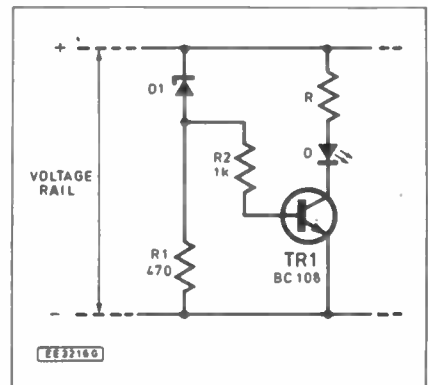


Fig. 9.8. Over-voltage sensing circuit.

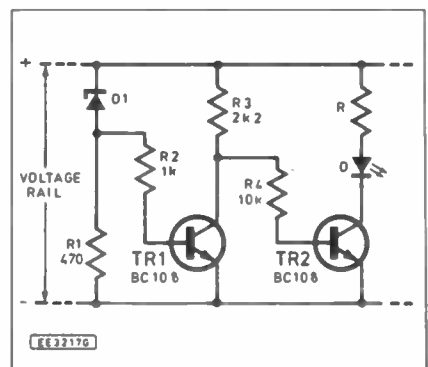


Fig. 9.9. Battery level indicator.

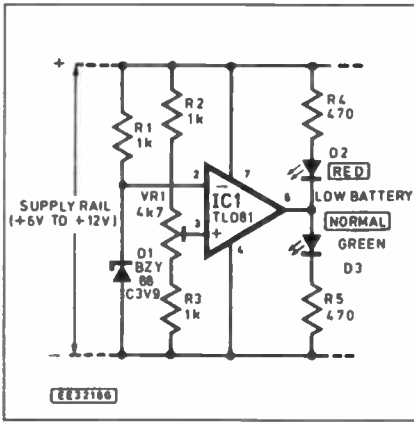


Fig. 9.10. Improved battery level indicator.

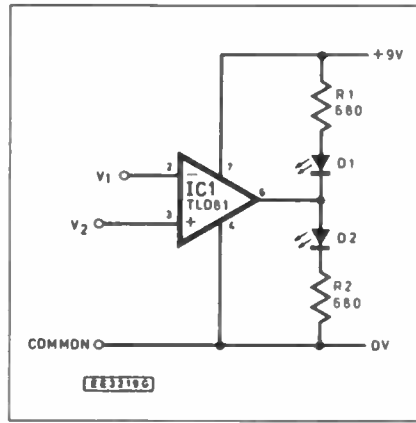


Fig. 9.11. Voltage comparator.

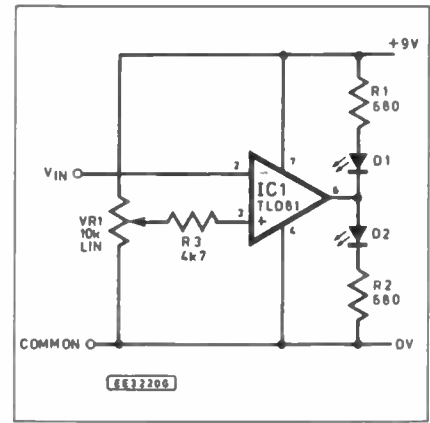


Fig. 9.12. Modification to Fig. 9.11 to provide a variable reference voltage.

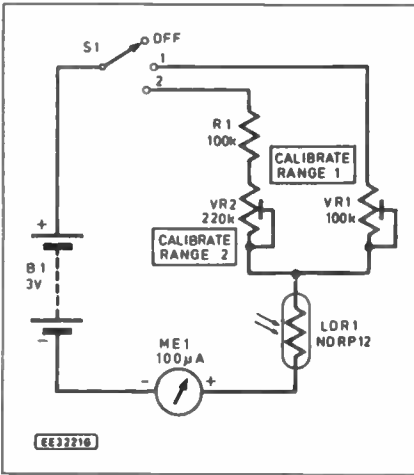


Fig. 9.13. Simple light meter based on an LDR.

An improved voltage sensing arrangement which provides "normal" and "low supply" voltage indications and an adjustable threshold between the two is shown in Fig. 9.10.

### Voltage comparator

A voltage comparator is shown in Fig. 9.11 in which D1 will become illuminated whenever  $V_1$  is greater than  $V_2$  whilst D2 will become illuminated whenever  $V_2$  is greater than  $V_1$ . This circuit can be used in a variety of applications including "balance" detectors and level sensing arrangements (in which the "reference"

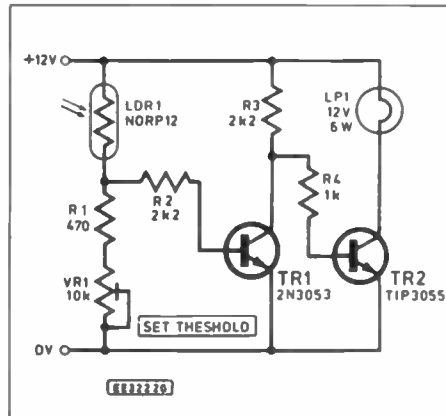


Fig. 9.14. Automatic parking light based on an LDR.

voltage,  $V_2$ , is derived from a potentiometer, as shown in Fig. 9.12).

### Sensors

Various types of optical sensor are available. For general purpose applications (in which the sensor should have a spectral response which is similar to that of the human eye), a light dependent resistor (LDR) should be employed. Typical of these is the NORP12, a cadmium sulphide (CdS) photoconductive cell which exhibits a resistance which varies from 400 ohm under bright room lighting (1000 lux) to as great as 1M in total darkness.

The spectral response of the NORP12 peaks at about 550nm and falls rapidly

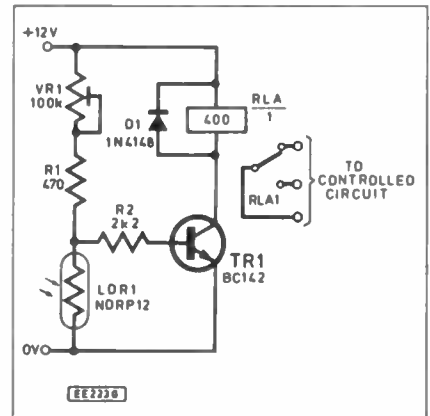


Fig. 9.15. Simple light operated switch.

below 500nm and above 650nm. The device is thus useful in light metering equipment and illumination level sensing applications generally. Fig. 9.13 shows a simple light meter based on a NORP12 device whilst Fig. 9.14 shows an automatic parking light circuit based on the device.

### Light operated switches

Figs. 9.15 and 9.16 show how the NORP12 LDR can be used to form the basis of a light operated switch. The circuit of Fig. 9.16 provides a more positive switching action by virtue of the high gain inherent in the operational amplifier comparator arrangement.

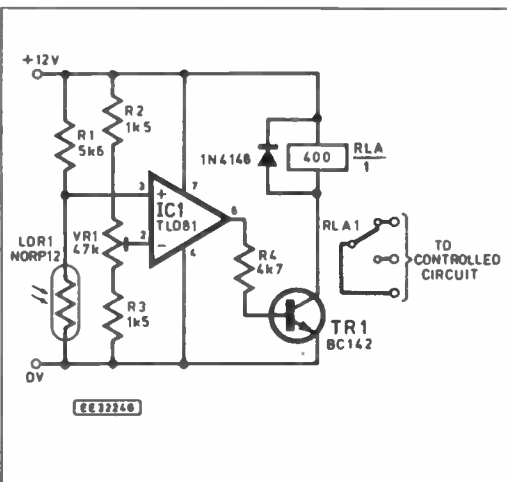


Fig. 9.16. Improved light operated switch.

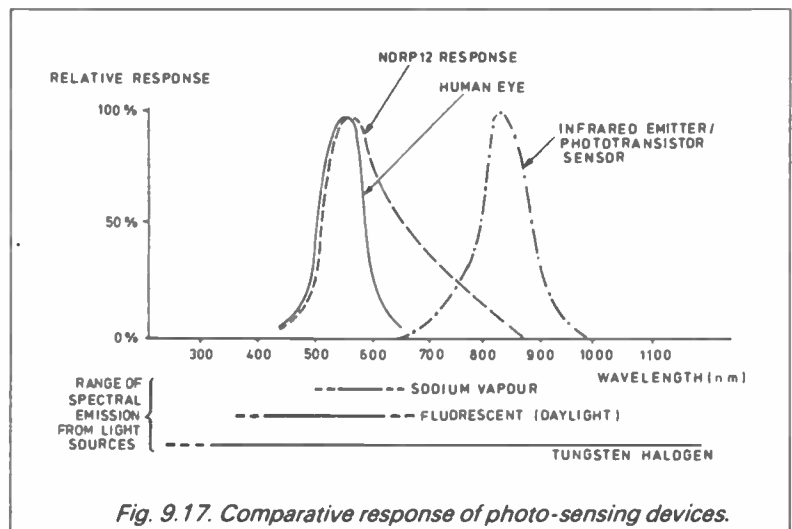


Fig. 9.17. Comparative response of photo-sensing devices.

# COMPONENTS

## Resistors

- R1 330 (see text)
  - R2 2k2 0.25W
  - R3 270 0.25W
- All  $\pm 5\%$  carbon

## Potentiometer

- VR1 47k miniature horizontal pre-set (see text)

## Semiconductors

- TR1 BC142
- D1 1N4148
- D2 Red l.e.d.

See  
**SHOP  
TALK**  
Page

## Miscellaneous

- LDR1 NORP12 (or similar) light dependent resistor
- RLA1 Relay miniature p.c.b. mounting relay with s.p.c.o. contact set and 400 ohm coil resistance (3A light duty version) or 300 ohm coil resistance (10A heavy duty version).
- PL1 7-way straight p.c.b. header (0.1 inch pitch)

Printed circuit board available from the *EE PCB Service*, order code EE761; tinned copper wire for p.c.b. links (see text).

Approx cost guidance only

**£7**

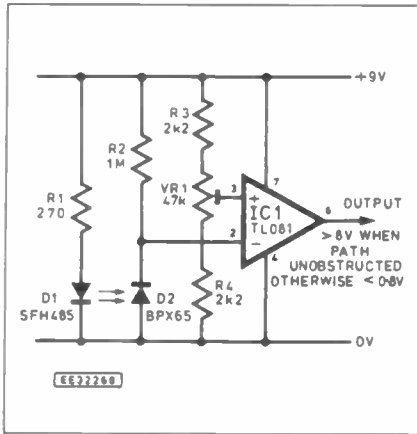


Fig. 9.18. Object sensor based on a photodiode.

## Photodiodes and phototransistors

Semiconductor devices such as photodiodes and phototransistors provide another means of sensing light and infrared radiation. Unlike the cadmium sulphide based LDR, such silicon devices generally have a response which peaks within the infrared spectrum (at typically 800 to 900nm) and thus should normally be used in conjunction with spectrally matched infrared emitters. Fig. 9.17 shows a comparative response for such devices.

Infrared emitters operate in a similar fashion to conventional light emitting diodes (though their output is generally *not* visible!). The current through a reverse biased photodiode (or the collector current of a phototransistor) will depend upon the amount of incident light.

Under strong levels of illumination (particularly towards the infrared end of the spectrum) the reverse current (or collector leakage current in the case of a phototransistor) will increase markedly. In total darkness, however, the corresponding current will be very small.

The circuits in Figs. 9.18 and 9.19 show simple interrupted light beam object sensors based on infrared emitters and a photodiode and phototransistor, respectively.

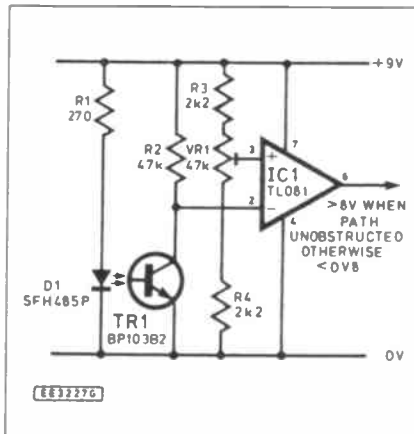


Fig. 9.19. Object sensor based on a phototransistor.

## Light Sensitive Switch Module

The complete circuit of a simple Light Sensitive Switch Module which can be used to control loads of up to 3A at 28V d.c./120V a.c. (84W/360VA) using a standard (400ohm coil resistance) relay or up to 10A at 28V d.c./250V a.c. (280W 1.2kVA) using a heavy-duty (300ohm coil resistance) relay, is shown in Fig. 9.20. The copper foil p.c.b. and component layout of the Light Sensitive Switch Module is shown in Fig. 9.21.

## Light Sensitive Switch Module Specifications

- Supply voltage: 10V (min.) to 15V (max.)
- Supply current (light duty version): 1mA (standby), 50mA (operating) (measured at 12V)
- Supply current (heavy duty version): 1mA (standby), 60mA (operating) (measured at 12V)
- Controlled voltage: 28V d.c. max., 120V a.c. (light duty version) or 240V a.c. (heavy duty version)
- Maximum load: 3A, 84W/360VA (light duty version) or 10A 280W/1.2kVA (heavy duty version)

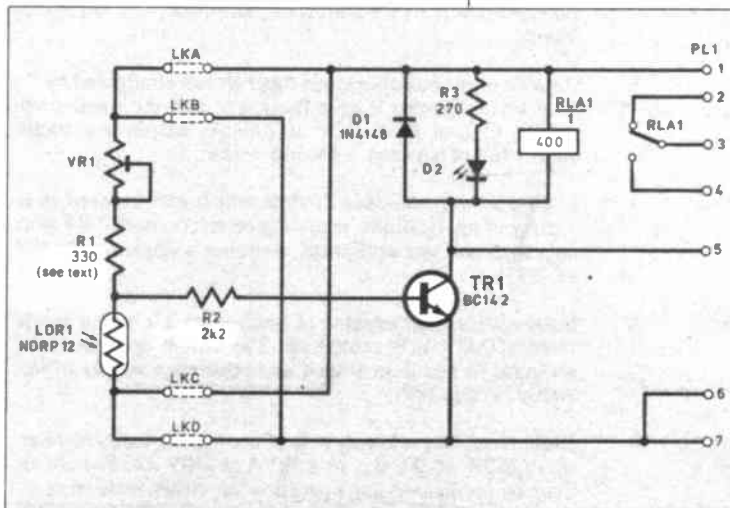
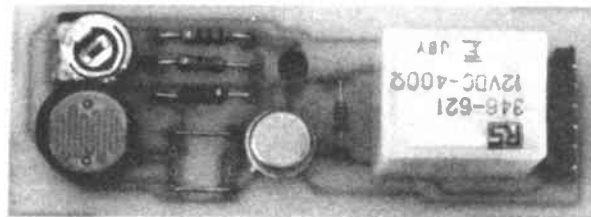


Fig. 9.20. Complete circuit diagram for the Light Sensitive Switch module.

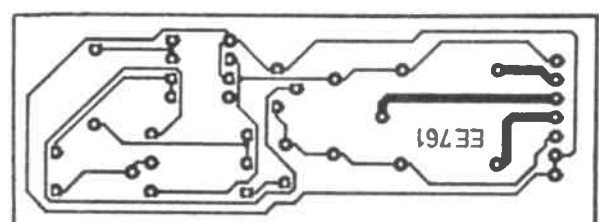
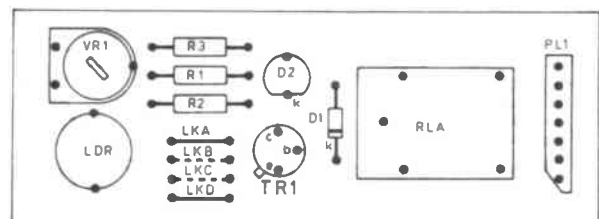


Fig. 9.21. P.C.B. track and component layout for the Light Sensitive Switch module.

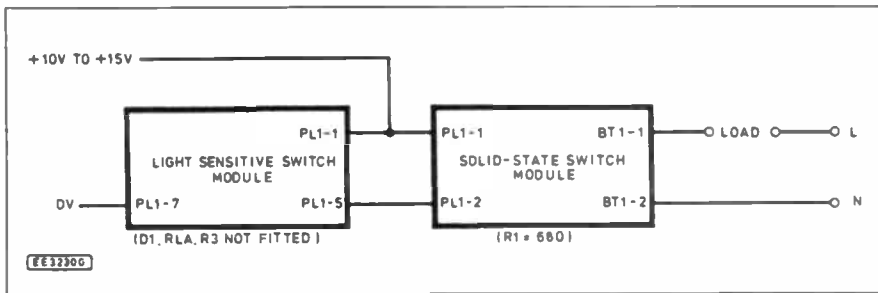


Fig. 9.22. Using the Light Sensitive Switch module in conjunction with the Solid-state Switch module.

Connections to the Light Sensitive Switch Module are all made via a seven-way header (PL1). Connections to PL1 are as follows:

| Pin Number | Function                       |
|------------|--------------------------------|
| 1          | + V supply (+ 10V to + 15V)    |
| 2          | Normally open (N.O.) contact   |
| 3          | Common (COM) contact           |
| 4          | Normally closed (N.C.) contact |
| 5          | Test/manual                    |
| 6          | Test/manual                    |
| 7          | Ground/0V                      |

The Light Sensitive Switch Module can be configured so that the relay operates on either falling or rising light level. The necessary changes and link positions are given in the following table:

| Relay operates when light level: | R1  | VR1 | Links fitted |
|----------------------------------|-----|-----|--------------|
| Falls                            | 1k  | 47k | LKA and LKD  |
| Rises                            | 330 | 4k7 | LKB and LKC  |

Finally, it is possible to use the Light Sensitive Switch Module in conjunction with the Solid-state Switch Module described in Part Eight. In this case, RLA, D1, R3 and D2 should be omitted from the p.c.b. The arrangement is shown in Fig. 9.22 whilst the necessary component changes and configuration links are given in the following table:

| Solid-state Switch operates when light level: | R1  | VR1 | Links fitted |
|---|-----|-----|--------------|
| Falls   | 330 | 4k7 | LKB and LKC  |
| Rises   | 1k  | 47k | LKA and LKD  |

## Design Problem

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

This month's problem involves designing an interface circuit:

*An automatic porch light is to operate up to 300W of mains lighting whenever the ambient light level falls below a pre-set threshold point. Devise a suitable circuit arrangement based on an LDR and solid-state relay.*

**Next month:** Next month's instalment rounds off our series with some ideas for future projects and a few hints and tips on component layout and printed circuit board design.

## Answers to questions in Part Nine

- Question 1: 575 ohm (nearest preferred value = 560 ohm)
- Question 2: 400 ohm (nearest preferred value = 390 ohm)
- Question 3: 320 ohm (nearest preferred value = 330 ohm)

## Cumulative index to modules

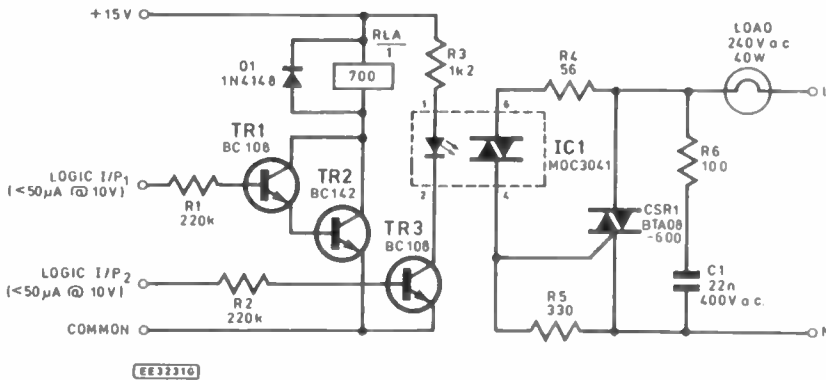
| Title  | Part | Function/specification  |
|--|------|---|
| Dual output power supply module              | 1    | Dual $\pm 5V$ , $\pm 12V$ or $\pm 15V$ regulated power supply rated at 1A max. output   |
| 723 variable power supply module             | 1    | Single variable output of + 2V to + 37V at up to 5A max. Output voltage and current limit are set by means of pre-set controls.   |
| L200 variable power supply module            | 1    | Single variable output of + 2.7V to + 35V at up to 2A max. Input voltage and current limit are set by means of variable controls.   |
| General purpose transistor amplifier module  | 2    | Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.   |
| General purpose operational amplifier module | 2    | Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between $\pm 5V$ and $\pm 15V$ at 10mA nominal.   |
| High-quality power amplifier module          | 3    | Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between $\pm 12V$ and $\pm 20V$ at up to 2A.  |
| TBA820 i.c. amplifier                        | 3    | Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between + 5V and + 15V.  |
| Sine wave oscillator                         | 4    | Low distortion sine wave oscillator capable of providing outputs over the range 50Hz to 50kHz. Frequency and amplitude adjustable. Requires + 12V to + 15V supply at 10mA (nominal).  |
| 8038 waveform generator                      | 4    | Provides sine, square and triangle outputs adjustable the range 0.01Hz to 20kHz. Requires $\pm 9V$ supply at 10mA.  |
| Digital counter module                       | 5    | Single stage decade counter with seven-segment l.e.d. display. Standard TTL input levels. Requires + 5V supply at 90mA.   |
| General purpose timer module                 | 6    | Astable or monostable mode timer circuit configured by wire links. External trigger (both a.c. and d.c.) and reset inputs. Output up to 12V at 200mA. Requires a single supply rail of between + 5V and + 15V.  |
| RF amplifier module                          | 7    | High gain r.f. amplifier module which can be used in a variety of applications, including receivers (both TRF and superhet) and test equipment. Requires a single supply rail of + 9V.  |
| Solid-State switch module                    | 8    | Solid-state switch capable of controlling a.c. mains loads rated at 240V 1kW maximum. The switch operates from an input of less than 100 $\mu$ A and requires a supply of between 5V and 24V.   |
| Light sensitive switch module                | 9    | Light sensitive switch capable of controlling loads rated at up to 280W at 28V d.c. or 1.2kVA at 240V a.c. The circuit may be configured for operation on either increasing or decreasing light levels. Requires a supply of between 10V and 15V and requires 1mA (standby), 60mA (operating) when operating from a 12V supply. |



## Answer to last month's design problem:

A CMOS logic circuit operates from a +15V supply rail. One of the outputs is to drive a relay having a coil resistance of 700 ohm whilst another is to control an 240V a.c. lamp load of 60W. Assuming that the maximum current available from the logic is 50µA at 10V, design a suitable interface circuit.

One solution to last month's design problem is shown in Fig. 9.23 below.



## TEACH-IN BOOKS

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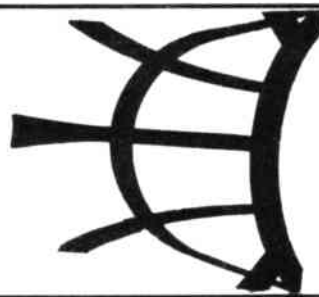
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# REPORTING

# AMATEUR RADIO

**Tony Smith G4FAI**



## THE JUNO MISSION

When the space shuttle *Atlantis* took off on April 5th, all five crew members were licensed radio amateurs. During the mission there were two-way contacts between the shuttle and schools in the USA and Australia on amateur frequencies, with the astronauts answering questions from pupils. Slow and fast-scan TV pictures were also transmitted from the shuttle to the American schools. This activity was extensively reported in the States, giving good publicity to amateur radio, but it was not until the following month that the British public heard about similar activities, this time from the Soviet space station *Mir* and involving UK schools.

The Soviet *JUNO* mission received such widespread publicity in the media that it is almost "old hat" to repeat the story here. Nevertheless here are the basic facts from the amateur radio point of view, some of which undoubtedly got lost in the "popular" reporting of the event.

On May 18, Helen Sharman became the first British astronaut. Aboard the space station, she operated an amateur radio station, call-sign GB1MIR and communicated with nine school groups across the UK, who used special call-signs GB0JUNO to GB8JUNO. Several of the experiments planned for the eight day mission were sponsored by the schools and GB1MIR reported back to the schools on the progress of some of these, and answered their questions about life on the space station.

With thousands of other amateurs, I listened in to some of these transmissions. Each "pass" lasted about 10 minutes and the frequency used was hotly guarded in advance by "watchdogs" who pounced on anyone coming up on it, asking them to "keep the frequency clear."

As the space station approached the UK for the first time, Helen Sharman's voice, strong, clear and calm, was heard calling GB0JUNO, the station located at Harrogate Ladies College. It was the first time that I had heard transmissions direct from an orbiting spacecraft and they generated a surprising amount of excitement and awe. Excitement at successfully receiving the signals so well with simple equipment (see below), and awe at the realisation of just where the signals were coming from and the organisation and technology which had made it all possible.

## FIRST CONTACTS

On the first pass Helen was unable to establish contact with Harrogate, but did hear GB7JUNO at The Royal Grammar School, Guildford, leaving a message with them that she would try again in the next orbit some 90 minutes later.

As the time drew near someone on frequency announced "all stations stand by, she's on the horizon," and shortly after GB1MIR was heard in contact with the Harrogate station describing problems with a solar panel. During a third pass, she answered questions about life on board *Mir* and the training she had received in preparation for it.

When it was all over excited amateurs gathered on the bands to discuss the events of that first evening, to analyse the results, play back recordings they had made of the transmissions from space, and note details of further scheduled contacts to be made. It was an extraordinary experience.

## EXISTING AMATEUR STATION

Helen Sharman was able to use amateur radio aboard *Mir* thanks to the previous activities of cosmonaut Musa Manarov and two of his colleagues. While on a one-year tour of duty, Manarov expressed an interest in operating amateur radio to help counteract the monotony and boredom associated with long spells in space.

With the help of the Flight Control Centre and Soviet amateurs he and his fellow cosmonauts acquired amateur radio licences; Manarov was allocated the call U2MIR, and a YAESU transceiver donated by another Russian amateur was shipped to *Mir* on a regular flight of the freight vehicle Progress-37. Later, during routine work outside the station U2MIR installed a suitable amateur radio antenna.

To help overcome their inexperience in amateur QSOs (contacts), radio amateurs visited the ground control centre to provide teaching sessions for the cosmonauts, and the first amateur QSO from *Mir* took place on 8th November 1988. Other amateurs quickly realised what the unusual call signified and by the time the crew returned to Earth on 21st December they had made over a thousand contacts. Since then other cosmonauts serving on the station have also operated the equipment installed by U2MIR and there has even been an amateur-to-amateur contact between *Mir* and the American space shuttle.

## SIMPLE EQUIPMENT

Although many amateurs listened to GB1MIR with their existing earth-to-space communication stations, using tracking antennas and other specialist equipment, others were able to hear it with their regular day-to-day 2 metre stations as the transmissions were on a standard f.m. frequency, 145.550MHz, known as channel S22.

I don't have a 2m f.m. station so as an experiment I used my Sangean ATS-803A worldband receiver! I used a simple 2 meter "halo" antenna (in effect a bent

dipole), just 11½" square, which fed into a 2m-to-10m converter allowing the Sangean, when tuned to 29.550MHz, to receive the 145.550MHz transmissions. The receiver has no facility for f.m. at 29MHz but in the a.m. mode all that was necessary was to off-tune from the transmitted frequency by 2 or 3kHz to receive Helen Sharman from space "loud and clear" during a number of her passes.

This is obviously no way to listen to amateur space communications on a serious long-term basis but it does show what can be done with even modest equipment. I wanted to prove that it could be done and I was more than delighted with the results.

## MORSE BICENTENNIAL SUCCESS

While the communications from space generated much interest, there was also a lot of excitement and activity at the end of April in celebration of an amateur mode which gains its inspiration from a man born 200 years ago!

April 27 was the bicentennial of the birth of Samuel F.B. Morse, after whom the Morse code is named. On the amateur bands the day was marked by a great deal of C.W. (Morse) activity as stations bearing special commemorative call-signs dealt with enormous "pile-ups" of amateurs wishing to work them.

Stations taking turns to use the unique call sign MORSE were on the air for the whole month and amassed over 25,000 contacts, while other special calls were active in the UK and in many other countries on the anniversary day itself. Such was the enthusiasm for this event that when I got up especially early on the 27th I found many stations already celebrating on-the-air at 4 a.m.!

Incidentally, stations using Morse code regularly make contacts via amateur satellites. An intriguing mixture of old and new!

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Now, according to the W5YI REPORT, the company has decided to concentrate on products aimed at the home and the self-study education market. They have produced a "Heathkit Sale" catalogue and their entire amateur radio range is being cleared at extremely low prices. Heathkits are, of course, available in the UK, and it may be worth looking out for bargains as stock begins to be cleared out in this country.

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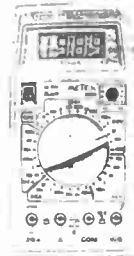
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| Power                | 12V/1.2A    | Vertical Blanking        | 750uS    |
| Line Frequency       | 15-19KHz    | Video Input unterminated | 12K      |
| Vertical Frequency   | 50-60Hz     | terminated               | 75R      |
| Resolution at Centre | 900 lines   | Video Response           | 22MHz    |
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# MODULAR DISCO LIGHTING SYSTEM

## Part Four: RANDOM PATTERN MODULE

**CHRIS BOWES**

*Light up your party or disco road show with these easy-build effects modules.*

**T**HE MODULE described in this month's article is another effects module, the function of which is to provide a random pattern of combinations of the four output circuits. With four output circuits available there are 16 possible combinations (ranging from all circuits off through intermediate stages to all circuits on.)

These patterns can be made to change under the control of either an internal timer, the output pulses from a sound activated module or, through the Masterlink (last month) facility, the unit can be synchronised with all units in the system.

### CIRCUIT DESCRIPTION

The circuit diagram for the Random Pattern Module is shown in Fig.1. In common with all of the effects modules the power supply for the module is obtained, through the 10-way output plug "sockets" PL1 and PL2, via pins 7 and 8, from the Output Modules to which the effects module is connected. Pin 8 of PL1 and PL2 contains

the common 0V connection and hence the connections are commoned on the printed circuit board (p.c.b.).

The positive power supply is obtained from pins PL1/7 and PL2/7 of the output sockets and the connections to these points are made, via diodes D1 and D2 and fuse FS1, to the printed circuit board. The inclusion of the two diodes enables two power supplies to be connected in parallel, without them interfering with each other. Fuse FS1 is a 100mA anti-surge fuse which protects the module from damage in the event of a current overload within the module or the connections from it.

Diode D3 is used in a similar way to the diodes in the Output Modules to pass power from this module to the Masterlink module via the Masterlink connection socket. Capacitor C1 is a tantalum capacitor which is used to decouple the integrated circuits in the module and prevent the operation of the gates within these components from causing spikes on the power supply line, which would interfere with the operation of the circuit.

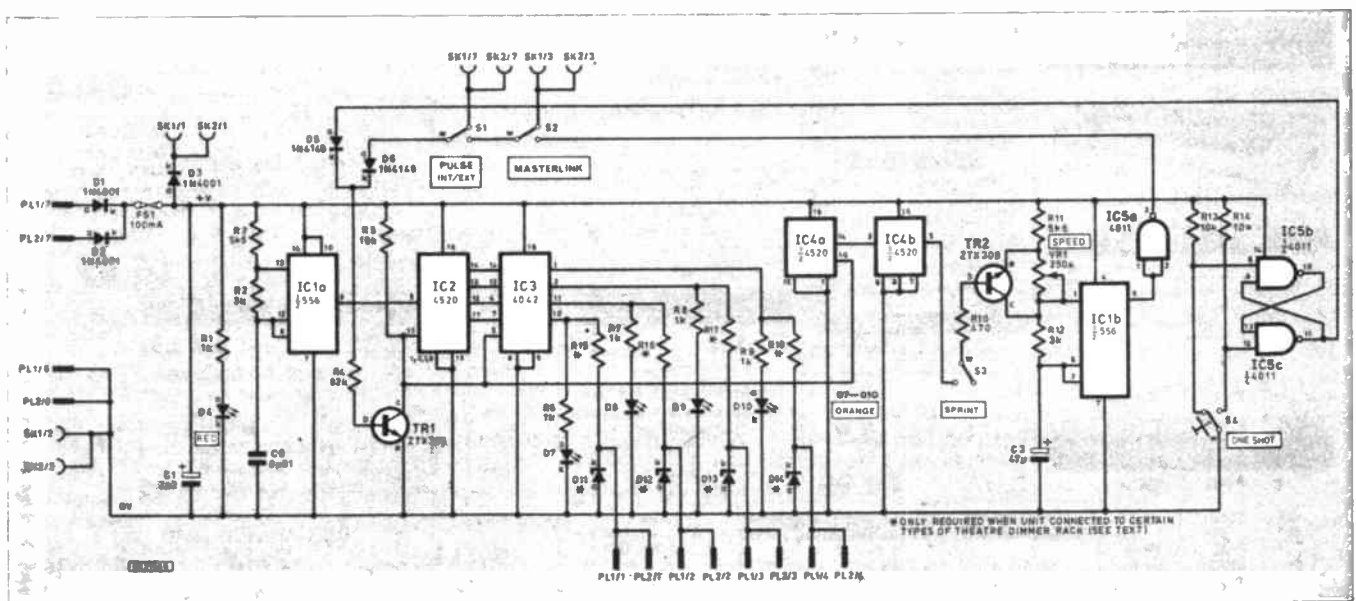
The red power on l.e.d. D4 is wired across the power supply via its series resistor R1. This resistor has been chosen to restrict the flow of current through the l.e.d. to control the current through it to a safe value (approximately 10mA).

### RANDOM NUMBER GENERATOR

The random output required from this module is obtained by feeding clock pulses from a high speed oscillator IC1, through a counter IC2, into a latch IC3 which is triggered in such a way as to hold the logic states present at the inputs (I<sub>0</sub> to I<sub>3</sub>) of the latch at the instant when the latch was triggered. The logic states are made available at outputs (O<sub>0</sub> to O<sub>3</sub>) until such time as the latch is retriggered, irrespective of any logic states which may be present at the inputs in the meantime.

In this project the high speed pulses are obtained from IC1a which is one half of a dual CMOS 556 timer. This component is configured in the Astable mode, with the output frequency being determined by the values of resistors R2, R3 and capacitor C2. In this application the frequency of oscillation of the astable circuit is not critical so the precise values of these components is similarly not critical.

Fig. 1. Circuit diagram for the Random Pattern Module. Components marked with an asterisk are optional and switch contacts marked with a "w" represents the moving contact (wiper).



The clock pulses obtained from the output of IC1a are fed to the CP<sub>0</sub> input (pin 9) of IC2 which is a 4520 dual binary counter, only one half of which is used. The other, CP<sub>1</sub>, input (pin 10) of IC2 is held in the Logic 1 state by being connected to the positive power supply rail, via the pull up resistor R5. Whilst pin 10 is in this state then each clock pulse at pin 9 causes the counter to advance by one binary step.

The four binary outputs from this counter (pins 11, 12, 13 and 14) are fed to inputs I<sub>0</sub> to I<sub>3</sub> of IC3 which is a 4042 quad latch. The latch enable input (pin 5) of IC3 is connected in parallel with the CP<sub>1</sub> input of IC2, so as to interlink the action of the counter and the latch.

The latch operation of IC3 and the counting action of IC2 are controlled by the logic state at the respective inputs to the i.c.s. When a Logic 1 state exists at these points the counter advances by one count for each input pulse but the latch provides at it's outputs only the logic states which were present at the four inputs on the last occasion that the latch enable input was in the Logic 0 state.

When the logic state at the latch enable and clock enable inputs is changed to the Logic 0 state, the counter is stopped and the latch passes the information of the logic

state of the four latch inputs, which is the same as the logic states present at the now stopped counter, to the outputs (O<sub>0</sub> to O<sub>3</sub>). This will be any one of the 16 possible combinations, chosen at random.

The randomness of the selection has been improved by connecting the outputs of the counter to the inputs of the latch in an order which is intended to make the design to the p.c.b. easier rather than with the counter outputs being connected to the input of the same designation.

## OUTPUT CIRCUIT

Each of the four outputs (O<sub>0</sub> to O<sub>3</sub>) of IC3 is used to drive a separate output from the module. These are connected to pins 1, 2, 3, and 4 of the output "plugs" PL1 and PL2. The output state indicators D7 to D10 are wired, each in series with it's dropping resistor, to the outputs concerned.

Provision has been made, both in the circuit design and the printed circuit board of this project, for the outputs of the module to be made compatible with certain commercially available Theatrical Dimmer Racks. This is made possible by means of the voltage clamping circuits consisting of the Zener diodes D11 to D14 and their associated resistors R15 to R18.

If this facility is required then the value

of these components will need to be calculated in accordance with the specification of the input voltages acceptable to the theatrical equipment concerned. If the module is only to be used in conjunction with other modules in the *Modular Disco Lighting System* then these components may be omitted and the connections to the output sockets taken directly from the outputs of IC3 by means of connections made at the unused junction of the appropriate voltage clamping resistor (R15 to R18) and it's associated i.e.d. series resistor.

## PATTERN CHANGE CLOCK GENERATOR

The clock pulses which are used to drive transistor TR1 are obtained internally, from a slow speed astable circuit comprising IC1b, R11, VR1, R12 and C3.

The operation of the slow speed astable is identical to that of the high speed one but the component values have been chosen so as to produce a very much slower speed of operation. Potentiometer VR1 is used to manually increase the time period between the clock pulses, over and above that set by the values of resistors R11 and R12.

## SPRINT CIRCUIT

Transistor TR2, and it's associated safety resistor (R10), is used to provide a "sprint" facility to override VR1. As long as no voltage is present at the base of TR2 then the frequency of the output of IC1b is governed by the resistance of VR1 plus the resistance of R11 and R12.

## COMPONENTS

### Resistors

|           |             |
|-----------|-------------|
| R1, R6-R9 | 1k (5 off)  |
| R2, R11   | 5k6 (2 off) |
| R3, R12   | 3k (2 off)  |
| R4        | 82k         |
| R5, R13,  |             |
| R14       | 10k (3 off) |
| R10       | 470         |
| R15-R18   | See text    |

All 1/4W 5% carbon film

### Potentiometer

|     |                          |
|-----|--------------------------|
| VR1 | 250k rotary carbon, lin. |
|-----|--------------------------|

### Capacitors

|    |                        |
|----|------------------------|
| C1 | 2μtantalum, 25V        |
| C2 | 0μ01 polyester         |
| C3 | 47μ p.c.b. elect., 25V |

### Semiconductors

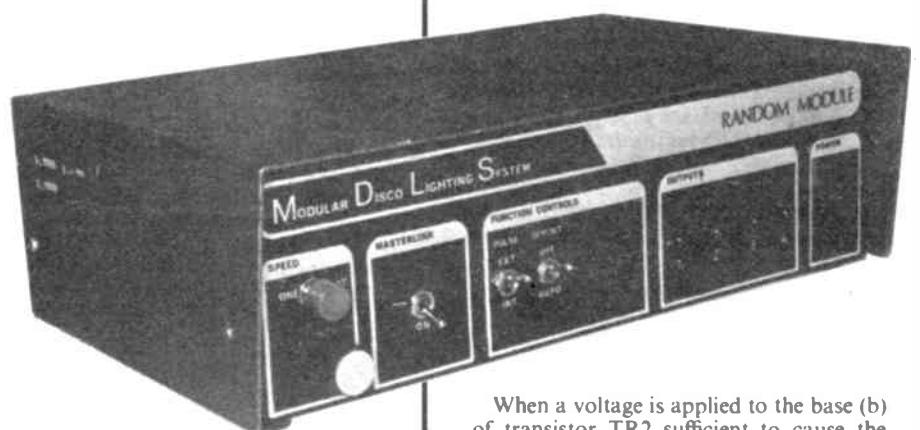
|          |                                       |
|----------|---------------------------------------|
| D1-D3    | 1N4001 1A 50V rec. diode (3 off)      |
| D4       | Standard Red i.e.d.                   |
| D5, D6   | 1N4148 signal diode (2 off)           |
| D7-D10   | Standard Orange i.e.d. (4 off)        |
| D11-D14  | Zener diode (see text)                |
| TR1, TR2 | ZTX300 npn silicon transistor (2 off) |
| IC1      | 556 Dual CMOS timer                   |
| IC2, IC4 | 4520 Dual binary counter (2 off)      |
| IC3      | 4042 Quad latch                       |
| IC5      | 4011 Quad 2-input NAND gate           |

### Miscellaneous

|          |  |
|----------|--|
| S1, S2   | Min. s.p.c.o. toggle switch (2 off)              |
| S3       | Min. s.p.s.t. toggle switch                      |
| S4       | S.P.C.O. push-to-change switch                   |
| PL1, PL2 | 10-way "video" chassis mounting plug (2 off)     |
| SK1, SK2 | 7-pin DIN chassis socket (2 off)                 |
| FS1      | 100mA Anti-Surge 20mm fuse and p.c.b. fuse clips |

Aluminium instrument case (Maplin "Blue Case 233"), size 250mm x 150mm x 75mm; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (3 off); plastic knobs for VR1 and S4; p.c.b. stand-off pillars (4 off); connecting wire; solder pins; i.e.d. clips; nuts and bolts for socket fittings; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE760.



When a voltage is applied to the base (b) of transistor TR2 sufficient to cause the voltage at the base to be at a higher potential than the voltage present at the emitter (e), then the transistor saturates and in effect creates a short circuit between it's emitter and the collector (c). This in turn shorts out VR1 and so causes IC1b to operate at the highest frequency set by the values of R11, R12 and C3.

Transistor TR2 is under the control of the output of IC4, which is both halves of a 4520 (dual binary counter) with the output O<sub>4</sub> of one counter connected to the input of the second counter, so as to form a 256 step counter. The input clock pulse to the first counter is obtained from the input pulses fed to reset the random output generating circuit. The effect of this is that, after 128 pulses into the random generating circuit, the output O<sub>4</sub> or IC4b (pin 5) goes to the Logic 1 state.

If switch S3 is in the closed position this causes TR2 to saturate and cause IC1b to sprint at the frequency set by the values of the fixed components for the next 128 counts. (If VR1 is set at the lowest possible resistance then this effect is masked by virtue of the fact that the transistor is in effect paralleling the short circuit set

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£28 plus case



by VR1.) If S3 is in the "open" position then the transistor is disconnected from the "sprint" circuit.

The nature of the output from IC1b is that it is predominantly in the Logic 1 state, with the pulses produced being negative going (from Logic 1 to Logic 0 and back to Logic 1) for only a short period of time for each pulse. This would cause the output to permanently override the one-shot input to transistor TR1 routed via D5 except for when the output of IC1b was in the Logic 0 state.

To overcome this problem the output from IC1b is fed through an inverter made up of one of the four two-input NAND gates contained in IC5, a 4011 quad, two-input NAND gate. The two inputs of IC5a are connected together so that a Logic 1 state at the commoned inputs is converted into a Logic 0 state at the output. Similarly a Logic 0 state at the inputs is converted into a Logic 1 state at the outputs.

The result of this is that the input to the base of TR1 via D6 is predominantly in the Logic 0 state so that when a Logic 1 state, generated by the one-shot circuit is present at the junction of D5 and D6 it can be used to clock the circuit except for the very short period of time when the pulse from the clock circuit (or other input being selected by switches S2 and S1) is being passed through D6 to the base of TR1.

Switches S1 and S2 are routing switches which are used to switch in other inputs to pulse the Random Module. Their full operation will be explained when the appropriate modules which are connected via these switches are described.

Diodes D5 and D6 form a simple "OR" gate which causes transistor TR1 to be operated whenever a pulse is received at the cathode (k) of D5 or D6. The action of these diodes prevents a positive voltage (Logic 1 state) present at the cathode of one diode being passed to the cathode of the other diode and thus interfering with any part of the circuit connected to the other diode.

### ONE-SHOT CIRCUIT

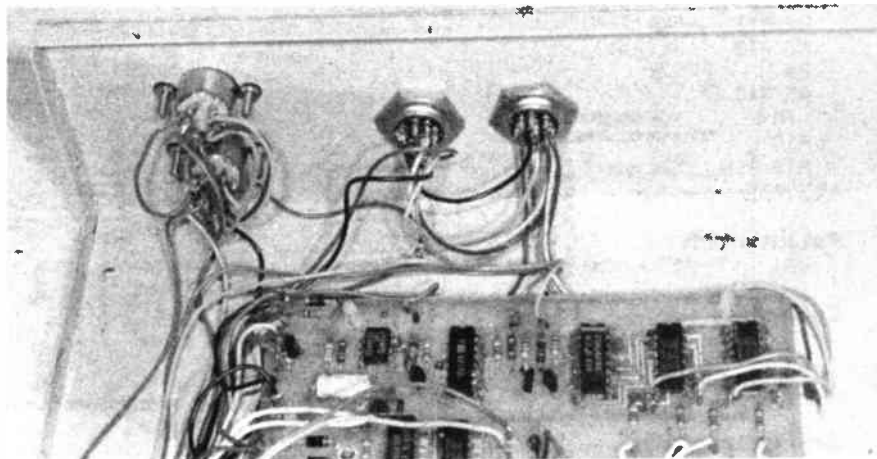
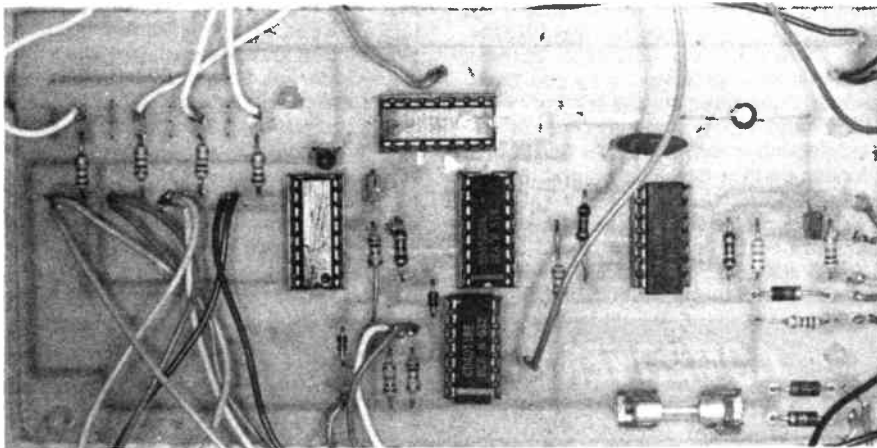
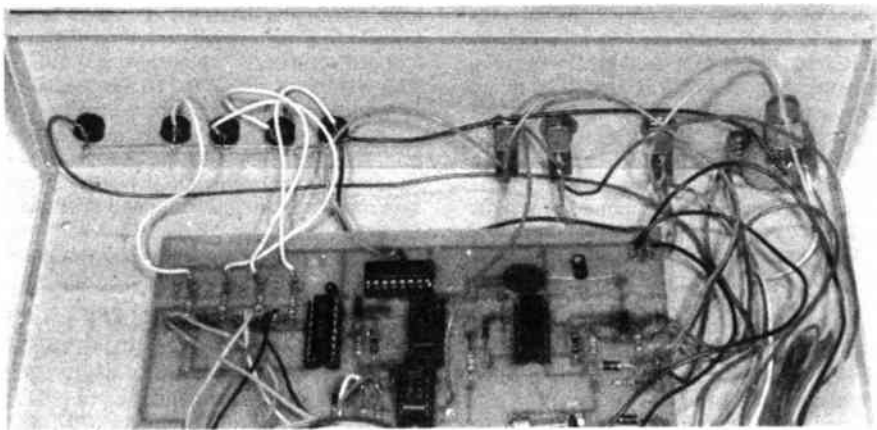
As well as using the internal clock to provide pulses to the random unit the facility exists to use a "One-Shot" circuit and so manually pulse forward the random unit at any time. The one-shot circuit is made up of IC5b and IC5c, together with their associated resistors (R13 and R14) and switch S4.

The purpose of this circuit is to provide a single pulse every time switch S4 is operated. Because of the high speed of operation of CMOS logic circuits it is necessary to "debounce" S4 and thus prevent more than one pulse being generated every time it is operated.

This is done by making use of a cross coupled NAND gate, made up of two of the four two-input NAND gates contained in IC5. The operation of this circuit is such that when S4 is unoperated a Logic 0 state exists at one of the inputs to the paired gates (pin 8) of IC5b.

Similarly a Logic 1 state exists at pin 12 which is the input to the other half of the cross coupled gates. This causes a Logic 1 state to exist at pin 10, the output of IC5b and a Logic 0 state to exist at pin 11 — the output of IC5c.

When switch S4 is operated the logic states of the two inputs connected to it are changed to the opposite state and the two outputs similarly change their logic states, remaining in the new state irrespec-



(Top). Wiring from the board to the front panel components, completed board (middle) and (above) interwiring to rear panel "sockets".

tive of any "switch bounces" which may be detected, until S4 is released, at which point they change back to their original states. The output from this circuit is fed via D5 to the base of TR1 and thus can be used to trigger the random selection circuit at any desired moment, effectively giving a manual override facility.

### CONSTRUCTION

The Random Pattern Module is constructed on a single-sided printed circuit board (p.c.b.), the component layout and full size copper foil pattern is shown in Fig.2. The foil patterns should be transferred to a suitable piece of board which is then etched and drilled in the normal way. (A ready-drilled and solder tinned board is available from the EE PCB Service, code EE760).

Once the board has been prepared, the components may be assembled onto the board. Although operation of the circuit will not be affected by the order in

which the components are inserted onto the board you will find it easier to construct this project if they are inserted and soldered into place in ascending order of size.

All of the integrated circuits should be connected by means of i.c. holders which are soldered onto the board during the process of construction, with the i.c.s being inserted as the final stage of the construction process. Care must be taken with polarity sensitive components to ensure that they are inserted the correct way round as shown in Fig.2.

### CASE

You will find it easier to connect the printed circuit board to the case mounted components if the connection points are fitted with terminal pins as the first stage of constructing the circuit. Before the circuit board can be installed, and the case mounted components connected, it is necessary to prepare the case for the project.



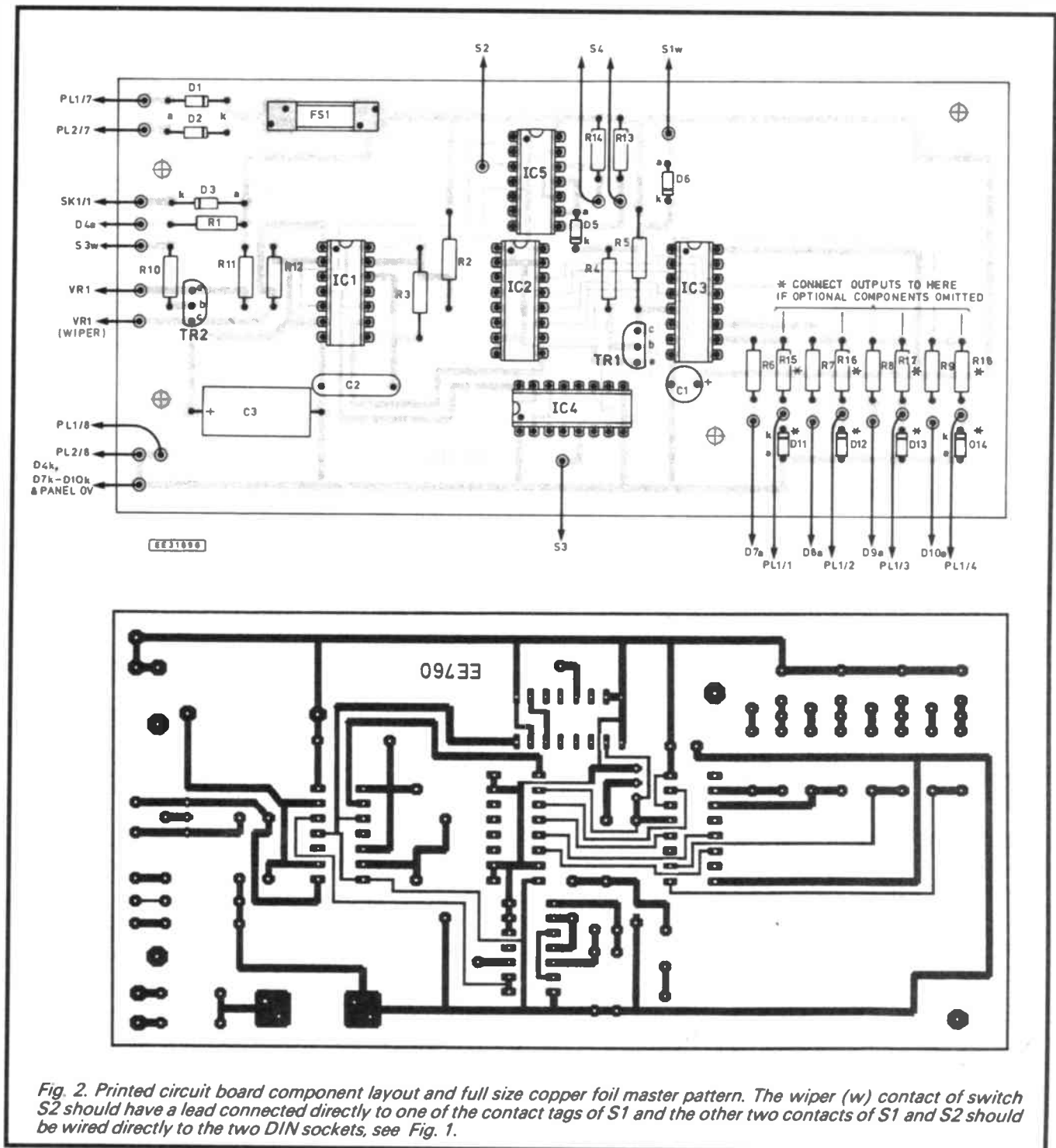


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The wiper (w) contact of switch S2 should have a lead connected directly to one of the contact tags of S1 and the other two contacts of S1 and S2 should be wired directly to the two DIN sockets, see Fig. 1.

Because of the fact that the items in the *Modular Disco Lighting System* have been designed to have a distinct "design look", it is advised that the front and rear panels of the system should be laid out in accordance with the photographs and style of the rest of the modules in this series. Before the lettering of the case can commence it is necessary to mark out the correct positions for the case mounted components and to drill holes of the appropriate size in the case material. Once this has been done the case can be lettered as desired and the case mounted components mounted in the correct places.

### WIRING-UP

The components mounted on the case should be interwired to the appropriate connection points on the circuit board by means of coloured wire. Because there

are a large number of solder connections to be made it is advisable to use as many different colours of wire as are available. When connecting the printed circuit board to the case mounted components it is advisable to ensure that there is a sufficient length of wire available so that the p.c.b. can be completely removed from the case for testing and fault finding.

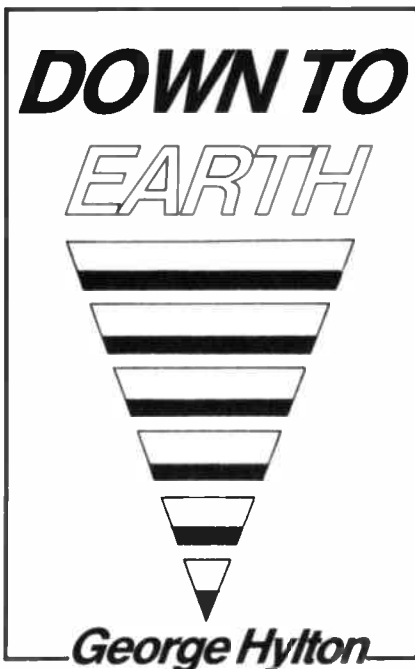
When all of the connecting wires have been terminated on the board it may be positioned in the centre of the inside of the case. If self-adhesive stand-offs are used this is easily accomplished by placing the stand-offs in the holes already drilled out on the printed circuit boards and offering the board into position inside the case. When the correct position has been found then pressure can be applied so that they stick firmly to the inside of the case.

### TESTING AND USING

Before testing the module a careful visual check should be made to ensure that there are no solder bridges between tracks and that all polarity sensitive components are installed the correct way round before connecting it to a source of power for testing. Once this visual check has been made then the module is easily tested by connecting it to any Output Module by means of a suitable cable and checking that the adjustment of the various controls produces the random changes in the outputs as described in the circuit description.

In use the module is connected to a suitable Output Module. Controls VR1 and S1, S2 and S3 are then set to the desired positions. The Random Module will then continue to run unattended.

**Next Month:** Dimmer Interface.



## INDIRECT BRIDGE MEASUREMENTS

IN THESE days of data banks, knowledge need never be lost. But if it is merely stored away and never used it's as good as lost. One form of the technique I'm about to describe has existed for a very long time, but few people seem to be aware of it.

Consider the traditional Wheatstone bridge shown in Fig. 1. The normal method of using it is to connect a centre-zero current meter (galvanometer) across the output terminals and adjust calibrated resistors R3 and R4 until the meter reads zero. Then  $R1/R2 = R3/R4$ .

Usually, R2 is the resistance to be measured (the "unknown") and resistor R1 is a precise standard. At balance, (no current across bridge)  $R2 = R1(R4/R3)$ . Here only the ratio of R4 to R3 needs be known, not the actual values of R4 and R3. In bridge terminology R3 and R4 are the "ratio arms".

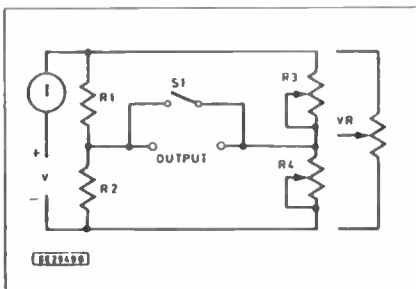


Fig. 1. D.C. bridge circuit. The ratio arms R3, R4 can be replaced by a potentiometer VR. At balance, closing switch S1 does not change current I.

## LOOK, NO GALVO

To understand the alternative method of detecting balance, imagine that the output terminals are fitted with a shorting switch S1 (Fig. 1). At balance, each terminal is at the same voltage, so on closing S1 no current flows across the output.

By the same token the currents through R1, R2, R3 and R4 are unchanged. This means that when S1 is closed there is no change in the current registered by the meter I.

If, however, the bridge is unbalanced, then when S1 is closed some current must flow across the bridge. Any extra current has to come from the battery so I now changes.

The upshot of all this is that meter I and switch S1 are a means of detecting balance and unbalance. All you need to do is open and close S1 and note whether the current registered by meter I changes in sympathy. Quite small changes are detectable so the method is reasonably sensitive.

This indirect way of detecting balance is by no means new. I first came across it many years ago in a National Physical Laboratory publication about a method of measuring small capacitances.

Recently, while on holiday, I needed to improvise some a.c. bridge measurements but had no high-impedance headphones to act as a balance indicator. I tried using the switch S1 technique along with a sensitive way of detecting changes in bridge impedance (see below). In the process I stumbled on a fact which makes the indirect method very easy to use.

## ADJUST FOR MAXIMUM

Detecting balance, I realised, is made easier if the "arms" are provided by a single potentiometer VR. Then, if the output is permanently shorted by switch S1, as the ratio potentiometer is adjusted a position can be found where I is minimum. This is the balance position.

It follows that the circuit can be used as a sort of "bridgeless bridge", something that gives the same results as a bridge but actually isn't one. Following classical precedents it can be called a Quasi-Bridge.

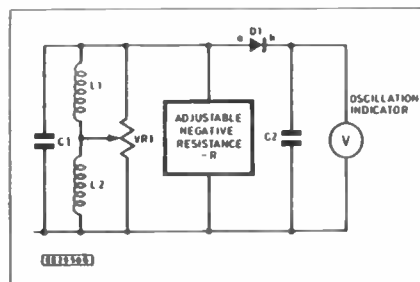


Fig. 2. Quasi-bridge for inductance comparison. At balance, VR gives the ratio of L1 to L2.

## A.C. MEASUREMENTS

There is no reason, in principle, why the quasi-bridge should not be used for a.c. measurements. The essential thing is that the ratio arms should consist of a single potentiometer and that some means is available for telling when current I is minimum.

You don't have to be a genius to work out that when I is minimum the impedance of the bridge as seen by the signal source must be maximum. Instead of measuring current we could detect balance by sensing maximum impedance in some way.

If the bridge can be made to act as a resistance at some frequency then there is an easy way of doing this. When a resistance RX is connected across a negative resistance -RY oscillation occurs if RX is greater than RY.

At the point where the circuit is just on the verge of oscillation  $RX = RY$ . A very

small change in RX can start or stop oscillation, so this gives a sensitive method of detecting when RX is maximum.

Negative resistance is not a commodity which can be bought over the counter at your local component shop! But it can be created by applying positive feedback to an amplifier. Adjusting the gain then varies the negative resistance. I recently gave details of one handy form of adjustable negative resistance (*The Tester*, EE, July 1990) but there are many others.

## INDUCTANCE COMPARISON

An example of a practical measurement (Fig. 2) shows how inductances L1 and L2 can be compared. Connecting capacitor C1 in parallel forms a resonant LC circuit which behaves as a resistance at its resonant frequency.

To find the balance point, the negative resistance (-R) is adjusted until oscillation begins then VR1 is adjusted to maximise the amplitude. Once an approximate balance is found, the negative resistance circuit can be reset carefully. This greatly increases the sensitivity and the balance can be found more precisely.

(There may be a false peak when the "slider" of VR1 is at either end of the track. This cuts out L1 or L2 and leaves capacitor C1 in parallel with the remaining inductance, forming a new tuned circuit. But this is no problem in practice.)

## SMALL CAPACITANCES

As mentioned earlier, a shorted-bridge technique was developed many years ago at the National Physical Laboratory for measuring small capacitances. This is often difficult with a conventional bridge because stray capacitance caused by connecting a conventional detector across the output terminals upsets the balance.

The quasi-bridge needs only a shorting switch, which can easily be arranged to have very low stray capacitance. Nowadays one could use a miniature reed switch operated by a magnet or coil spaced far enough away to reduce strays to negligible amounts.

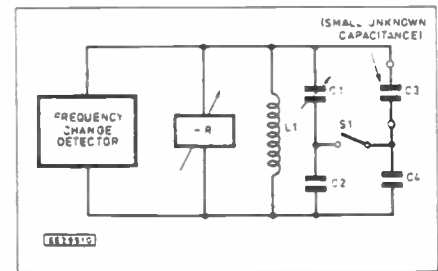


Fig. 3. Quasi-bridge for small capacitance measurement.

One possible arrangement is shown in Fig. 3 and depends on detecting not an impedance maximum but a change in tuned frequency. If the circuit is set oscillating by adjusting -R, the frequency does not change if switch S1 is closed when the bridge is balanced. The frequency-change detector could be a receiver fitted with a beat frequency oscillator (b.f.o.).

By making capacitors C1, C2 and C4 large enough residual stray capacitances can be swamped. Using a high resonant frequency (or high harmonics), a sensitive indication can be obtained.

## LASH-UPS

Quasi-bridges can't compete with really precise modern commercial types of bridge. But to the experimenter they can be a means of lashing up a circuit which will make some measurements easily and cheaply. The circuit arrangement of Fig. 2 is particularly useful because it gives a one-step balance.

With conventional inductance bridges the resistances of the two inductors can blur the balance point. It may be necessary to adjust a separate potentiometer to sharpen up the balance. This can be tedious.

Another advantage is that with a negative resistance you can select capacitor C1 to give the frequency you want. With a commercial bridge you may be stuck with one fixed frequency, good for some inductance values but less than good for others.

To compare capacitances, L1 and L2 can be replaced by the unknown and

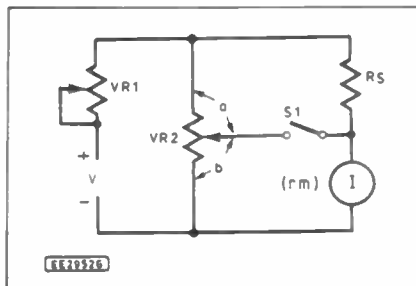


Fig. 4. Finding the resistance of a meter coil.

standard capacitors, and C1 by an inductor.

## SENSITIVITY

The condition for maximum sensitivity is similar to that for an ordinary bridge: VR1 should have a track resistance about equal to the sum of the reactances of L1 and L2. This can often be achieved

by selecting capacitor C1 to set the frequency to a suitable value.

However, the negative resistance method is quite sensitive and wide departures from the ideal value of VR1 are tolerable. A good all-round compromise is to use a linear potentiometer with a resistance of about 5k.

## METER RESISTANCE

A quasi-bridge method (Fig.4) can be used to find the resistance  $r_m$  of the coil of a current meter,  $I$ . With switch S1 open, adjust VR1 to give any convenient reading on the meter. Close S1. This changes the reading. Adjust VR2 to restore the original reading. Then  $r_m = RS(b/a)$ .

With this technique you don't need to know  $V$  nor is accuracy affected by non-linearity of the meter indication. Now I come to think of it, this is the only example of a quasi-bridge technique which I've ever seen mentioned in a magazine.

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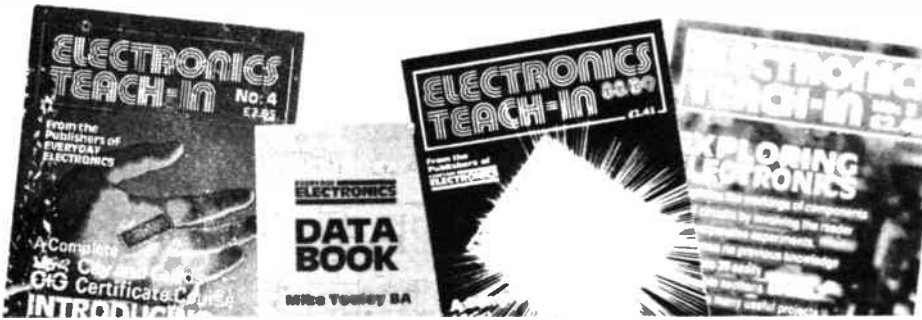
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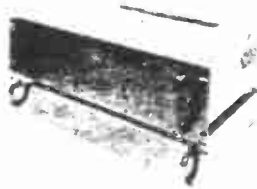
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# PCB SERVICE

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 overseas airmail. Remittances should be sent to The PCB Service, *Everyday Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to *Everyday Electronics* (Payment in £ sterling only).

*We do have some older boards in stock - please enquire.*

**NOTE:** While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery - overseas readers allow extra if ordered by surface mail. Please check price and availability in the latest issue. Boards can only be supplied on a payment with order basis.

| PROJECT TITLE                                 | Order Code        | Cost  |
|---|-------------------|-------|
| Car Alarm                                     | <b>AUG 88</b> 615 | £3.12 |
| EPROM Eraser                                  | <b>OCT 88</b> 620 | £4.07 |
| Doorbell Delay                                | <b>NOV 88</b> 616 | £3.56 |
| Infra-Red Object Counter Trans                | £9.28 622         | £4.61 |
| Receiver                                      | as a 623          | £3.23 |
| Display                                       | set 624           | £3.05 |
| Downbeat Metronome                            | <b>DEC 88</b> 629 | £4.84 |
| Phasor  | 631               | £5.64 |
| Continuity Tester                             | <b>FEB 89</b> 619 | £2.67 |
| Sound-to-Light Interface                      | <b>MAR 89</b> 637 | £6.24 |
| Midi Pedal                                    | 639               | £7.00 |
| Midi Merge                                    | 640               | £3.00 |
| Audio Lead Tester                             | 641               | £5.77 |
| Light Sentinel - Main Board                   | <b>APR 89</b> 632 | £9.20 |
| Remote Interface (4 boards)                   | 633               | £4.59 |
| 4-Channel Auto-Fade Interface                 | 642               | £6.80 |
| Electron A/D Interface                        | <b>MAY 89</b> 645 | £4.84 |
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| Bat Detector                                  | 647               | £4.95 |
| Programmable Pocket Timer                     | <b>JUL 89</b> 648 | £3.82 |
| Electronic Spirit Level                       | <b>AUG 89</b> 649 | £3.85 |
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| Xenon Beacon                                  | <b>SEP 89</b> 650 | £4.13 |
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| 30V 1A  | 657               | £4.55 |
| EE Seismograph - Control                      | 658               | £4.08 |
| Detector                                      | 659               | £4.22 |
| Lego/Logo & Spectrum                          | 660               | £6.49 |
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| Mains ON/OFF Decoder                          | 697               | £4.55 |
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| Simple Metronome                              | 698               | £3.94 |

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| Alarm Bell Time-Out                              | 701                | £4.10           |
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| Ghost Walker                                     | <b>OCT 90</b> 703  | £4.32           |
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| Freq. Meter/Tachometer                           | <b>NOV 90</b> 705  | £3.98           |
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| Colour Changing Christmas Lights                 | <b>DEC 90</b> 707  | £4.39           |
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| Versatile Bench Power Supply Unit                | 710                | £4.24           |
| Teach-In '91, Part 1 - L200 Module               | 711                | £3.93           |
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| LM723 Module                                     | 713                | £4.21           |
| Spatial Power Display                            | <b>JAN 91</b> 714  | £5.33           |
| Amstrad PCW Sound Generator                      | 715                | £5.03           |
| Teach-In '91, Part 2 - G.P. Transistor Amp       | 717                | £3.77           |
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| Intercom (Teach-In '91 Project 2)                | 719                | £4.41           |
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The book contains a wealth of information about PC hardware and gives practical advice for PC builders and upgraders. Written in a light-hearted style, it is suitable reading for beginners but includes information for the more experienced too.

There are eight chapters: the first is a brief introduction. The second chapter gives a potted history of the PC range, and details some of the characteristics of each model. Chapter three will be of particular interest to those who are undecided about which type of PC to build. It gives the pros and cons of all the usual combinations of cases, boards and display types.

The fourth chapter is where the real work of assembling the parts is described. It includes many practical tips not published elsewhere. If the beast won't go when you have built it you need to read chapter 5!

If you already have a PC, but it has failed in some way, chapter six may help, whereas chapter seven deals with upgrades, to existing machines. Software is briefly discussed in chapter eight and there are Appendices with useful data. The book has 112 pages and is in paperback format.

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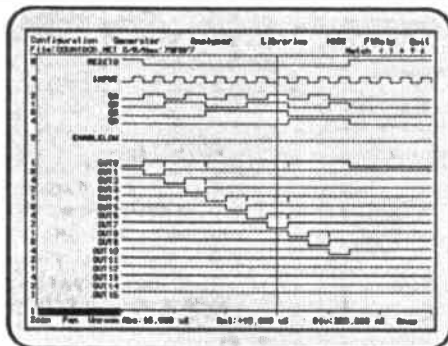
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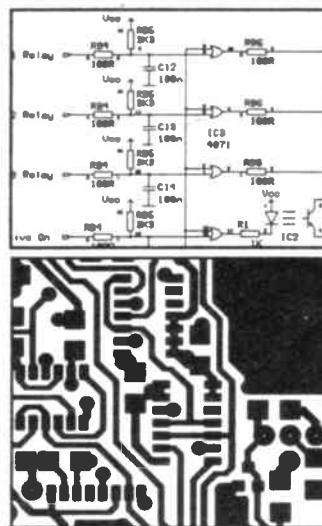


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|                          |             |                         |            |
|--------------------------|-------------|-------------------------|------------|
| AUTONA                   | 476         | MAGENTA ELECTRONICS     | 480/1/2    |
| N. R. BARDWELL           | 534         | MAPLIN ELECTRONICS      | Cover (iv) |
| 8K ELECTRONICS           | Cover (iii) | MARAPET                 | 535        |
| BULL ELECTRICAL          | Cover (ii)  | MARCO TRADING           | 521        |
| CAMBRIDGE COMP SCIENCE   | 535         | MAURITRON TECH. SERV.S. | 534        |
| CHIPLINK                 | 513         | NUMBER ONE SYSTEMS      | 533        |
| COMPELEC                 | 531         | OMNI ELECTRONICS        | 536        |
| CRICKLEWOOD ELECTRONICS. | 531         | PARK GATE PUBLISHING    | 533        |
| CR SUPPLY COMPANY        | 536         | PARTRIDGE ELECTRONICS   | 534        |
| ELECTRONIC DESIGN.       | 478         | QUANTEK ELECTRONICS     | 535        |
| E.P. ELECTRONICS         | 513         | RADIO & TV COMPONENTS   | 479        |
| ESR ELECTRONIC COMP      | 535         | RICH ELECTRONICS        | 536        |
| HART ELECTRONIC KITS     | 478         | SERVICE TRADING CO.     | 535        |
| HIGH-Q-ELECTRONICS       | 533         | SHERWOOD ELEC COMP      | 535        |
| HOBBYKIT                 | 474         | SUMA DESIGNS            | 531        |
| ICS                      | 535         | TK ELECTRONICS          | 478        |
| JAYTEE ELECTRONIC SERV.S | 476         | TSIEN                   | 497        |
| JPG ELECTRONICS          | 534         | TYPESETTING BUREAU      | 519        |
| KNOWLES & ASSOCIATES     | 500         | WEKA                    | 477        |
| LYS ELECTRONIC COMP      | 536         |                         |            |

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| Metal Film resistors 1/4W 10R to 1 MO 5% E12 series - 2p 1% E24 series                       | 3p     |
| Mixed metal/carbon film resistors 1/4W E24 series 1R0 to 10M0                                | 1 1/2p |
| 1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms                               | 5p     |
| Linear Carbon pre-sets 100mW and 1/4W 100R to 4M7 E6 series                                  | 7p     |
| <b>Miniature polyester capacitors 250V working for vertical mounting</b>                     |        |
| 015, 022, 033, 047, 068-4p 01 - 5p 012, 0.15, 0.22 - 6p 047 - 8p 0.68 - 8p 10 - 12p          |        |
| <b>Mylar (polyester) capacitors 100V working E12 series vertical mounting</b>                |        |
| 1000p to 8200p - 3p. 01 to .068 - 4p. 01 - 5p 0.12, 0.15, 0.22 - 6p 0.47/50V - 8p            |        |
| <b>Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series</b>               |        |
| 2% 1 8pf to 47pf - 3p. 2% 56pf to 330pf - 4p 10% 390p - 4700p                                | 4p     |
| Disc/plate ceramics 50V E12 series 1P0 to 1000P, E6 Series 1500P to 47000P                   | 2p     |
| <b>Polystyrene capacitors 63V working E12 series long axial wires</b>                        |        |
| 10pf to 820pf - 4p 1000pf to 10,000pf - 5p 12,000pf  | 6p     |
| 741 Op Amp - 20p 555 Timer   | 22p    |
| cmos 4001 - 20p 4011 - 22p, 4017   | 40p    |
| <b>ALUMINIUM ELECTROLYTICS (Mfds/Volts)</b>  |        |
| 1/50, 2/250, 4/750, 10/25, 10/50   | 5p     |
| 22/16, 22/25, 22/50, 47/16, 47/25, 47/50   | 6p     |
| 100/16, 100/25 7p; 100/50 12p, 100/100   | 14p    |
| 220/16 8p; 220/25, 220/50 10p, 470/16 470/25   | 11p    |
| 1000/25 25p, 1000/35, 2200/25 35p; 4700/25   | 70p    |
| <b>Submin. tantalum bead electrolytics (Mfds/Volts)</b>                                      |        |
| 01/35, 0.22/35, 0.47/35, 1.0/35, 3/316 4/7/16  | 14p    |
| 2/2/35, 4/7/25, 4/7/35, 6.8/16 15p; 10/16, 22/6  | 20p    |
| 33/10, 47/6, 22/16 30p; 47/10 35p, 47/16 60p, 47/35  | 80p    |
| <b>VOLTAGE REGULATORS</b>  |        |
| 1A + or - 5V, 8V, 12V, 15V, 18V & 24V - 55p, 100mA 5.8, 12, 15, V +                          | 30p    |
| <b>DIODES (piv/amps)</b>   |        |
| 75/25mA 1N4148 2p 800/1A 1N4006 4p 400/3A 1N5404 14p 115/15mA OA91                           | 8p     |
| 100/1A 1N4002 3p 1000/1A 1N4007 5p 60/1.5A S1M1 5p 100/1A bridge                             | 25p    |
| 400/1A 1N4004 4p 1250/1A BY 127 10p, 30/15A OA47   | 10p    |
| Zener diodes E24 series 3V3 to 33V 400mW - 8p 1 watt   | 12p    |
| Battery snaps for PP3 - 6p for PP9   | 12p    |
| L.E.D.'s 3mm & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p 5mm                          | 2p     |
| Red flashing L.E.D.'s require 9-12V supply only  | 50p    |
| Mains indicator neons with 220k resistor   | 10p    |
| 20mm fuses 100mA to 5A. O. blow 5p A/surge 8p Holders, chassis. mounting                     | 6p     |
| High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 30p Machines 12V dc                          | £7.00  |
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| AA/HP7 Nicad rechargeable cells 90p each Universal charger unit                              | £6.50p |
| Glass reed switches with single pole make contacts - 8p. Magnets                             | 12p    |
| 0 1" Stripboard 2 1/2" x 1" 9 rows 25 holes - 25p 3 1/2" x 2 1/2" 24 rows 37 holes           | 70p    |
| Jack plugs 2.5 & 3.5m  | 12p    |
| Sockets Panel Mtg. 2.5 & 3.5m  | 12p    |
| <b>TRANSISTORS</b>   |        |
| 8C107/8/9 - 12p, 8C547/8/9 - 8p 8C557/8/9 - 8p 8C182, 182L, 8C183, 183L,                     |        |
| 8C184, 184L, 8C212, 212L - 10p,  |        |
| 8C327, 337, 337L - 12p 8C727, 737 - 12p 8D135/6/7/8/9 - 25p, 8CY70 - 15p                     |        |
| 8FY50/51/52 - 20p,   |        |
| 8FX88 - 15p, 2N3055 - 50p, TIP31, 32 - 30p, TIP41, 42 - 40p 8U208A - £1.20, 8F195, 197 - 12p |        |
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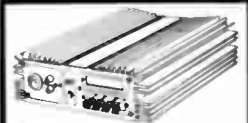
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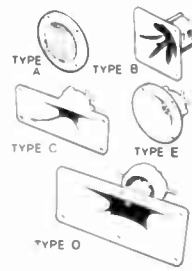
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**PIEZO ELECTRIC TWEETERS — MOTOROLA**

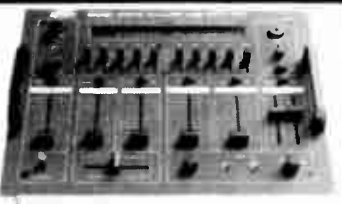
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- ★ Fireproof ultraviolet material
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- ★ Heavy duty zinc alloy body
- ★ 110 degree detection angle

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|------------------|------------|----------------|---------------|---------------------|------------------|----------------------------|---------------------------|-------------------------|
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(Survey conducted on 21st February 1991)

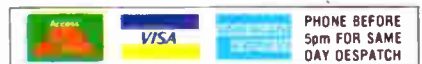


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|          | 500 watt halogen tube | YMS02 | £3.75          |       |
|          |                       |       | Carriage for 1 | £3.75 |
|          |                       |       | Add further    |       |
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Although this unit may deter intruders, no warranty is given or implied that the unit will provide security or prevent illegal entry.

**HURRY... THE FLOODLIGHT SECURITY SYSTEM IS A LIMITED OFFER SEND YOUR ORDER TODAY!**



# SUPER SUMMER SALE

## BARGAIN LIST 71A - JULY 1991

**The biggest & best ever!!** - This year's **SALE** is something else! - or to use current parlance, these **Megadeals** are **AWESOME!!!** To cut our ever-increasing costs, we must clear thousands of square feet of storage space containing literally **millions** of components!!

## YOU CAN'T AFFORD TO MISS THESE SPECTACULAR DEALS!!!

Dip inside for a delightful display - don't dally!!

This catalogue features not only **SALE** items at greatly reduced prices, but also surplus and regular stock at our normal low, low prices!!

**Please note:** This **SALE** Catalogue is being distributed with several different magazines - by the time it reaches you, some items may be sold out. Please give alternatives where possible to avoid disappointment. Thank you.

**HOW TO ORDER:** Use the order form on Page 13 - Please tick box to indicate how you obtained this supplement, and don't forget your name & address! Send to the address below with your remittance - Cheque/ PO/ Cash/ Access/ Visa/ Connect:



**Greenweld Electronics Ltd**

**27 Park Road**

**Southampton, SO1 3TB**

**Tel: (0703) 236363**

**Fax: (0703) 236307**

**All 1 off or first quoted prices in all our leaflets, brochures and catalogues include VAT @ 15%. Please add 2.17% to order total to take into account VAT rate of 17½%. Quantity prices DO NOT include VAT, which must be added at the current rate. Thank you.**

There are only 3 special conditions if you order from these pages:

- 1) The **MINIMUM GOODS VALUE IS £12.00** (although this can include goods from any of our lists or catalogues).
- 2) **POST & PACKING CHARGE IS £3.00**
- 3) Free gifts and reduced price offers from previous catalogues and supplements are not available with sale goods.

Regrettably, we cannot accept orders for **Sale Goods** that do not meet these requirements.

**MINIMUM ORDER VALUE £12 + £3 POSTAGE/ PACKING PER ORDER**

## OPTO OPPORTUNITIES!!

LED's, LCD's, SINGLE POINT, SEVEN-SEG - YOU NAME IT, WE'VE GOT IT - AND AT THE RIGHT PRICE!!

### LED DISPLAYS

0.3in (7.62mm) Display Height



H - 19.05  
W - 10.16  
D - 5.4

Pin spacing 2.54  
Row spacing 7.62

(a) 0.3 (7.62mm) display height; luminous intensity

| Code  | 7/1   | DP | CC/CA | 1   | 25   | 100  |
|-------|-------|----|-------|-----|------|------|
| Z1937 | 7 seg | LH | CA    | 31p | 0.20 | 0.16 |
| Z1938 | 7 seg | RH | CA    | 31p | 0.20 | 0.16 |
| Z1939 | 7 seg | RH | CC    | 31p | 0.20 | 0.16 |
| Z1940 | 1     | LH | CA    | 20p | 0.13 | 0.10 |

SALE PRICES **50% OFF**

0.5in (12.88mm) Display Height



H - 19.0  
W - 12.7  
D - 8.0

H - 19.05  
W - 25.0  
D - 8.0

Pin spacing 2.54  
Row spacing 15.24

(b) 0.5 (12.88mm) display height; luminous intensity

| Code  | 7/1        | DP | CC/CA | 1   | 25   | 100  |
|-------|------------|----|-------|-----|------|------|
| Z1941 | 7 seg      | RH | CA    | 35p | 0.23 | 0.18 |
| Z1942 | 7 seg      | RH | CC    | 35p | 0.23 | 0.18 |
| Z1943 | 1          | RH | CA    | 23p | 0.15 | 0.12 |
| Z1944 | 1          | RH | CC    | 23p | 0.15 | 0.12 |
| Z1945 | Dual 7 seg | RH | CA    | 58p | 0.38 | 0.30 |
| Z1946 | Dual 7 seg | RH | CC    | 58p | 0.38 | 0.30 |

SALE PRICES **50% OFF**

0.8in (20.32mm) Display Height



H - 27.7  
W - 19.9  
D - 8.38

Pin spacing 2.54  
Row spacing 15.24

(c) 0.8 (20.32mm) display height; luminous intensity

| Code  | 7/1   | DP | CC/CA | 1   | 25   | 100  |
|-------|-------|----|-------|-----|------|------|
| Z1947 | 7 seg | RH | CA    | 47p | 0.30 | 0.24 |
| Z1948 | 7 seg | RH | CC    | 47p | 0.30 | 0.24 |
| Z1949 | 7 seg | LH | CA    | 47p | 0.30 | 0.24 |
| Z1950 | 7 seg | LH | CC    | 47p | 0.30 | 0.24 |

SALE PRICES **50% OFF**



DL1416 Alphanumeric 4 character intelligent display 0.16"  
Price ..... £7.00

SALE PRICE **£3.50**

Z4294 Above chip on panel with switching and LED's - ribbon cable and connector

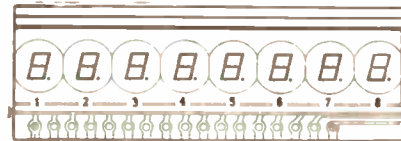
Price ..... £5.00

SALE PRICE **£2.50**



Z1850 9100R Red Bargraph 10 20 DIL package  
Price ..... £1.00

SALE PRICE **3 for £2.00**



Z415 Display 8 digit LED multiplexed With data 31 - 16mm  
Price ..... 80p

SALE PRICE **2 for £1.00**

Z416 Display 9 digit LED multiplexed With data 42 - 10mm  
Price ..... 90p

SALE PRICE **2 for £1.00**

Vacuum Display



Z1731 NEC Vacuum Fluorescent Display FIP8BII 8 digit multiplexed output 10mm high Heater voltage 2V grid/ anode voltage 24V (Use Z4248 transformer to power)  
Price ..... £3.00

SALE PRICE **£1.50**

Opto Slotted Switch



Vactel Type VTL 10DI IR emitter and detector can be removed from the plastic housing if required An extremely cheap version of TIL 100/ TIL 38!  
Order Code Z2122

Prices ..... Pack of 5 **£1.00**  
100 + 0.10; 1k 0.07

### LCD DISPLAYS



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



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



Z1732 Epson LCD 4 digit 8mm high  
Price ..... **£2.00**

SALE PRICES **Z4115 £2.00**  
**Z4148 £1.50**  
**Z1732 £1.00**



Z1637 LCD Display - Direct drive 3 1/2 digit with LO-BATT 12.7mm high digits Op voltage 4.12 RMS 32Hz type Consumes only 25µA with all segments on Trade price £7.97 each Supplied with data but no edge connector  
Prices ..... **£2.00** 10 + 1.52 25 + 1.30 100 + 0.85

SALE PRICES: **75p** 10 + 0.50  
100 + 0.40



LCD 4 digit 12.5mm high with low batt and clock symbol Complete with edge connector Can you believe the price?!

Order Code Z2119  
Prices ..... **£1.00 each**  
25 + 0.60; 100 + 0.45; 1k + 0.35



Z4335 Dot graphics LCD Module Hitachi type LM200 240 - 64 dot display area 132 x 39mm Overall size 180 x 75mm These can be driven by the HD6183 controller which has a built in character generator etc Supplied with data Farnell's price £100.00

Our Price ..... **£30.00**  
HD61830 chip. Supplied at our cost price ..... **£20.00**

SALE PRICES: Module **£20.00**  
Chip **£10.00**

## BULK LED's

Now! Standard LED's at prices from less than 2p each! This parcel was supposed to contain a variety of shapes and colours for our LED packs - but there are too many standard red ones to mix in, hence this too good to miss offer!!

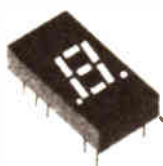
| Code  | Colour     | Size      | Shape | Manf'r/ Type        | Lead length | Qty in £1 pack | 100 + | 1k +  |
|-------|------------|-----------|-------|---------------------|-------------|----------------|-------|-------|
| Z2089 | Red        | 5mm       | std   | FDL4601             | 25          | 15             | 0.032 | 0.025 |
| Z2090 | Red        | 5mm       | std   | QTMV5752            | 28.5        | 15             | 0.032 | 0.025 |
| Z2091 | Red        | 5mm       | std   | Liton LTL9223A      | 29.5        | 12             | 0.038 | 0.030 |
| Z2092 | Green      | 5mm       | std   | -                   | 13.5        | 14             | 0.035 | 0.028 |
| Z2093 | Yellow     | 5mm       | std   | -                   | 13.5        | 14             | 0.035 | 0.028 |
| Z2094 | Red        | 3mm       | min   | MLR327              | 17          | 18             | 0.030 | 0.022 |
| Z2098 | Red        | 7 x 2.55  | Rect  | Senior elec SE6511D | 32          | 12             | 0.038 | 0.030 |
| Z2095 | Red        | 5mm       | Rect* | Philips HR44DL      | 26          | 12             | 0.038 | 0.030 |
| Z2096 | Clear (IR) | 4.5 x 1.5 | Rect  | Honeywell 8406      | 20          | 8              | 0.060 | 0.040 |
| Z2099 | Clear (IR) | 4.5 x 1.5 | Rect  | Honeywell 8706      | 20          | 8              | 0.060 | 0.040 |
| Z2097 | Red        | 5 x 2     | Rect  | GIMV57123           | 29          | 12             | 0.038 | 0.030 |

\* Square with rounded corners

**10k + mix of any of the above**      **0.02**      **100k + mix**      **0.016**

## 7-SEG LED CLEARANCE!

| Type  | Size  | CC/CA | DP |
|-------|-------|-------|----|
| 4710  | 0.43" | CA    | RH |
| 4710A | 0.43" | CA    |    |
| 4720  | 0.43" | CA    | LH |
| 3719  | 0.3"  | CA    | RH |
| 3729  | 0.3"  | CA    | LH |



**ALL THE SAME PRICE:**

**20p each**  
**ANY 10 £1.60    100 £10.00**

## BULK OFFERS

### BIB Accessories

■BCC8 Computer terminal maintenance kit    £2.95 in our catalogue

**Box of 10**      **£15**

**Box of 100**      **£100**

■BCC11 Liquid static eliminator    £1.00 in our catalogue

**Box of 50**      **£20**

■Z914 1 Watt Amp Panels    £1.50 in our catalogue

**Box of 128**      **£40**

■Z1522 40 Channel CB Switches    List price £3+

**Box of 100**      **£40**

■Z4132 Firing Speed Adjuster    £1.00 in our catalogue

**Box of 200**      **£60**

### Speakers

■A303 (LS010) 57mm 8R Min speaker    Catalogue price £1.10

**Box of 100**      **£35**

■Z578 Fuji 30 x 30 x 3mm speaker

**Box of 1000**      **£100**

### Panels

■Z1815 27C256 Panel. Facilities cartridge containing above chip in socket    Catalogue price £2.00

**Box of 100**      **£60**

### Map Lights

■Z4071 Catalogue price £1.95.

**Box of 100**      **£60**

### Switch Mode PSU

■Z660 Catalogue price £5.00

**Box of 180**      **£200**

### Spectrum Connector

■Z4139 Catalogue price £1.00

**Box of 100**      **£25**

### CEE22 Connector

■Z1799 Fused switched mains inlet    List £3.75

**Box of 100**      **£40**

### Pots

■Z1363 50R 2W pot ideal for speaker volume control    Standard spindle

**Box of 200**      **£20**

### Panel Clearance

■K541 20kg of assorted populated PCB's    All sorts    **£40**

### FM Aerials

■X361 Ribbon aerial

**Pack of 100**      **£20**

### Wheels

Type A from Catalogue. 100mm dia x 17mm wide    9mm dia hole

**Pack of 100**      **£25**

### Reed Switches

DTA202 Heavy duty single pole switch with 47mm long body    5mm dia    Normally 40p

**Box of 100**      **£8**

DRA200 As above, but gold plated tags

**Box of 100**      **£10**

PL11 Omron 11 pin valve/relay bases    Normally 58p each

**Box of 100**      **£15**

■RSM83-1A Top quality illuminated keyswitches by Flight Refuelling    Single pole reed switch and fitted min 5V bi-pin T1 lamp

**Box of 50**      **£7**

■Z577 Skedgewise pot with switch, as used on small radios walkmans, etc.    Normally 10p

**Bag of 500**      **£15**

■Z576 2 1mm power plug, chassis mounted    Normally 10p

**Bag of 500**      **£15**

■Z8928 4700µ 16V Mullard can 50mm long x 25.4mm dia

**Box of 100**      **£5**

■Z8929 11000µ 25V computer cans    105mm long x 51mm dia

**Box of 49**      **£10**

■A3918 9V Buzzers    Our catalogue price 80p

**Box of 50**      **£15**

■Z4138 Microslots    In our catalogue at £2.00

**Box of 100**      **£75**

81E Morganite cermet trimmers type 81E-T05 size    Only one value - 50R

**Box of 50**      **£7.50**

■Z4224 Meter cases 135 x 120 x 45mm    Normally £1.00

**Box of 100**      **£25**

■Z4135 Headphones - mini 'Stethophone' complete with 2 stereo jackplugs    Hinged headbands    8R    Normally £1.75

**Box of 40**      **£25**

## NEON INDICATORS

A parcel of IMO Neon indicators and various other lamps has just been delivered and offers the hobbyist a selection of top quality components at rock-bottom prices! Why are they so cheap? They're all for 110/120V! However, that's no problem because with every indicator we supply a suitable resistor for mains operation.



Type A - Panel mounting 33 x 15mm with 0.25" tags    Clip fix requires 25 x 12.5mm cut-out

Z1899 Green

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06

Type B - Panel mounting 36.5 x 26.5mm with 0.25" tags    Clip fix requires 30 x 22.5mm cut-out

Z1901 Red  
Z1902 Green  
Z1903 Amber  
Z1904 White

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06



Type C - Small round face 10mm dia    Clip fix, requires 9mm dia hole

Z1905 Red  
Z1906 Green  
Z1907 Amber  
Z1908 White

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06

Type D - Large round face 13.5mm dia    Clip fix, requires 12.5mm dia hole

Z1910 Green  
Z1911 Amber  
Z1912 White

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06



Type E - Small square face 10.5mm dia hole

Z1913 Red  
Z1914 Green  
Z1915 Amber  
Z1916 White

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06

Type F - Large square face 13.5mm dia hole

Z1917 Red  
Z1918 Green  
Z1919 Amber  
Z1920 White

Price:      (Any mix) 5 for £1  
100 + 0.10    1k + 0.06



Type G - Small round face 7.5mm dia, threaded body, requires 6.5mm dia hole

Z1921 Red

Price:      5 for £1; 100 + 0.10; 1k + 0.06

K700 Pack of indicators types A-G    May include any of those listed above    Great value for money!    20 for £2.50

**SALE PRICES**  
**ON ALL**  
**NEON INDICATORS**      **50% OFF**



# BATTERY BONANZA!!

## LEAD-ACID + NICADS AT UNBEATABLE PRICES

### EX-POLICE BATTS



**Z4180** Ex mobile radio battery 56 x 63 x 33mm case (sometimes damaged) contains 8 x AA size rechargeable Nicads These can be removed by breaking the case open Each cell rate 1.25V 600mA

Price ..... £3.00  
**SALE PRICE £2.50**

**Z4149** As above but 84 x 66 x 33mm There are again 8 cells but they are longer than AA size being 73mm long Each cell rated 1.25V 900mA

Price ..... £4.50  
**SALE PRICE £3.00**



**Z1951** Varta Memopac PCB Nicad 8.4V 100mAh Although new, these batteries are not in pristine condition, so are offered at way below normal costs Size 41 x 26 x 14mm

Price ..... £1.50  
**SALE PRICE £1.00**

**Z1952** AA Nicads - 2 sleeved end to end Easily split into 2 if required

Price ..... £1.50 25 + 1.10 100 + 0.75  
**SALE PRICE £1.00**

### YUASA



### Sealed lead acid batteries

**Z8018** YUASA NP6-12 12V 6Ah sealed lead acid battery These have been regularly trickle charged whilst in store size 150 x 95 x 65mm List price £28.00

Price ..... £14.95 10 + 11.20

**SALE PRICE £12.50** 10 + 9.00

**Z8020** YUASA sealed lead acid battery NP10-6 6V 10Ah Size 150 x 95 x 50mm List £18.00

Our low price ..... £10.00 100 + £6.00

**SALE PRICE £8.00** 10 + 6.00

### Nicads



**Z1830** Salt 40 RF310 back up Nicad battery PC mounting on 70 x 22.5mm centres Rated 3.6V 10mAh (20mA) Overall size 76 x 28 x 8mm

Price ..... £2.00  
**SALE PRICE £1.50**

**Z1829** Nicad 25mm dia x 34mm long rated 4.8V 500mA PC mounting tags

Price ..... £2.00  
**SALE PRICE £1.50**



**Z4216** Much sought after 4.8V 150mA batteries with PCB mounting tags on 25mm pitch Battery size 25 x 16 dia Ideal for paralleling (Slight corrosion.)

Price ..... 99p each 10 - 0.75 25 - 0.60 100 - 0.52

**CLEARANCE PRICE 4/ £1.00** 100 + 0.15

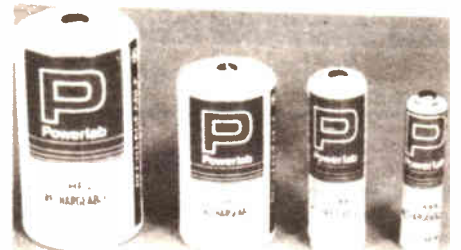


**Z1409** PC mntg deac 6V 100mA Rating made by Memec 30 x 15 x 27mm List £4.65

Our price ..... £1.50

**SALE PRICE £1.00**

### Regular Nicads



### Rechargeable Nicads

| Code | Type | Rating  | 1 -   | 25 - | 100 + |
|------|------|---------|-------|------|-------|
| X131 | AAA  | 180mA/H | £1.20 | 0.85 | 0.68  |
| X132 | AA   | 500mA/H | 99p   | 0.72 | 0.58  |
| X133 | C    | 1.2A/H  | £2.20 | 1.76 | 1.41  |
| X134 | D    | 1.2A/H  | £2.30 | 1.82 | 1.46  |
| X135 | PP3  | 110mA/H | £3.95 | 3.26 | 3.10  |

**SALE PRICE 10% off**

### Regular Dry Cells

A range of batteries from Hi-Tech featuring long life and reliability at a competitive price



| Code | Type       | 1 -   | 20 + | 100 + |
|------|------------|-------|------|-------|
| X111 | AA/RG/HP7  | 29p   | 0.15 | 0.12  |
| X112 | C/R14/HP11 | 50p   | 0.26 | 0.21  |
| X113 | D/R20/HP2  | 58p   | 0.30 | 0.24  |
| X114 | PP3/6F22   | 99p   | 0.52 | 0.42  |
| X115 | 1289/3R12  | 99p   | 0.52 | 0.42  |
| X116 | PJ996/4R25 | £2.57 | 1.34 | 1.07  |

### Low cost dry cells

2 popular sizes of battery on a card of 4 at very attractive prices

**X107**  
 Price per pack of 4 ..... 69p 10 + 0.46 100 + 0.31

**X109**  
 Price per pack of 4 ..... 76p 10 + 0.51 100 + 0.34

## AAA Nicads by Sanyo

**SUPERDEAL PRICE!!** These superb quality batteries are rated 1.2V 200mAh, and may be charged at 20mA or quick-charged at 60mA. Normally costing around £1.50 each, we can offer these at the SUPERDEAL prices below:

**Z2117** AAA Nicad ..... **£1.00**  
 25 + 0.75 100 + 0.60

## 3M COMPUTER DISKS

New boxed full spec 3M disks at low, low cost. All prices in this box include VAT @ 15%.

|           | Per Box | 10 Boxes |             | Per Box | 10 Boxes |
|-----------|---------|----------|-------------|---------|----------|
| 3.5" DSDD | £9.30   | £83      | 5 1/4" DSDD | £6.20   | £55      |
| 3.5" DSHD | £19.30  | £171     | 5 1/4" DSHD | £11.20  | £99      |



## PACKS - PACKS - PACKS - PACKS

Many of the Packs listed will be increased in price when our new catalogue comes out later in the year - so take this last golden opportunity to stock up at never again prices!!!

Please note most packs are calculated by weight: quantities quoted are approximate, but we do try to ensure contents are at least the number specified.

## SEMICONDUCTORS

**K538 Diode Pack** - untested small signal diodes like IN4148 etc at a price never before seen!!

Price/ 1000 ..... £2.50  
**SALE PRICE** ..... **£1.50**

**K547 Zener Diodes.** Glass and plastic, 250mW to 5W ranging from 3V to 180V. All readily identifiable, with list supplied.

Price ..... 100 for £4.50  
**SALE PRICE** ..... **£2.50**

**K709 Bridge Rectifiers.** Another superb value pack - could include anything from 1/2 amp to 35A, 25V to 1000V, plastic and metal.

Price ..... 20 for £5.95  
**SALE PRICE** ..... **£4.00**

**K710 SCR's & TRIACS.** Big mixture could include all types from TO92 plastic up to DO5 stud mounting with a chance of everything in between! 25V to 1000V, 100mA to tens of amps. Marvellous value.

Price ..... 25 for £4.95  
**SALE PRICE** ..... **£3.00**

**K708 Voltage Regulators.** This is an excellent pack, made up from a huge variety of the +ve, -ve, fixed and variable regulators from 1.2V to 37V, 100mA to 5A, plastic and metal.

Price ..... 20 for £6.95  
**SALE PRICE** ..... **£5.00**

**K517 Transistor pack.** 50 assorted full spec. marked plastic devices PNP NPN RF AF. Type numbers include BC114, 117, 172, 182, 183, 198, 239, 251, 214, 255, 320, BF198, 255, 394, 2N3904 etc. etc. Retail cost £7.00+

Special low price ..... £2.75  
**SALE PRICE** ..... **£1.50**

**K575 Plastic Power pack.** Mainly TO126 and TO220 transistors, SCR's, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.

Price ..... 50/ £7.50  
**SALE PRICE** ..... **£4.00**

**K576 Mixed pack of TO220 and 4 pin power mosfets with data and pinouts.** Types may include: 2N7004/5/6/14, IRF620/710/720/820, IRF9520/9620, VN0300D etc.

Price ..... Pack of 25/ £8.00  
**SALE PRICE** ..... **£4.50**

**K577 Surface mount FETs** including SM versions of 2N4340/1, 4392, 4857, 5488/9/60/1, also 2N7001/2 etc. Big variety at a low price!

Price ..... Pack of 50/ £4.00  
**SALE PRICE** ..... **£2.50**

**K536 74 Series Pack.** 'On board' chips for you to desolder - containing many LS and other types. Good mix.

Price ..... 100/ £4.00  
**SALE PRICE** ..... **£2.50**

**K536A Bonanza pack of 74 series chips** on panels. 200+ chips, may include L, LS, H, HC, HCT etc. (These are actually the Z8900 computer panels with all the memory missing.)

Price ..... £7.00  
**SALE PRICE** ..... **£5.00**

**K711 74 Logic Pack.** All brand new full spec devices from basic gates to complex logic. May include 54 & 64 types as well as 74 in L, LS, S, ALS, H, HC, HCT, etc.

Price for pack of 100 ..... £6.00  
**SALE PRICE** ..... **£4.50**

**K537 IC Pack** - a mix of linear and logic chips, from 6 to 40 pin. All are new and marked, but some may not be full spec.

Price/ 100 ..... £6.75  
**SALE PRICE** ..... **£4.00**

## CAPACITORS

**K544 Mullard Polyester Caps.** Cosmetic imperfections, electrically OK. Wide range of values from 0.01 to 0.47µF in 100, 250, 400V working.

Price ..... 200/ £4.75  
**SALE PRICE** ..... **£2.50**

**K546 Polystyrene/ Mica/ Ceramic Caps.** Lots of useful small value caps up to about 0.01µF in voltages up to 8kV. Good variety.

Price ..... 100/ £2.75  
**SALE PRICE** ..... **£1.75**

**K528 Electrolytic Pack.** Axial and radial, some ready cropped for PCB mounting. This pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF, 6V to 100V.

Price ..... 100/ £3.95  
**SALE PRICE** ..... **£2.50**

**K518 200 Disc Ceramic Caps.** Big variety of values and voltages from a few pF to 2.2µF: 3V to 3kV.

Price ..... £1.00  
**SALE PRICE** ..... **95p**

**K530 100 Assorted Polyester Caps** All new modern components, radial and axial leads. All value from 0.01 to 1µF at voltages from 63 to 1000V!!

Super value at ..... £3.95  
**SALE PRICE** ..... **£2.50**

**K582 Polystyrene Caps.** An amazing range of values from a few pF to 0.1. Tolerances 1-20%. Voltages to 500V.

Price ..... Pack of 200/ £4.00  
**SALE PRICE** ..... **£2.00**

**K714 Power Supply Capacitors.** All cans, mostly computer grade including popular values like 10,000µ 40V etc. Big mix of values and voltages up to 100V or more and 50,000µF.

Price for box of 25 ..... £12.50  
**SALE PRICE** ..... **£10.00**

## RESISTORS

**K540 Resistor Pack.** Mostly 1/8, 1/4 and 1/2W, also some 1 and 2W in carbon, film, oxide etc. All have full length leads. Tolerances from 2 to 20%. Excellent range of values.

Prices ..... 500/ £2.50  
**SALE PRICE** ..... **£1.50**

**K523 Resistor Pack.** 1000 - yes, 1000 mainly 1/2W 5 & 10% carbon/ carbon film resistors with preformed leads for PCB mounting. Fair range of preferred values.

Prices ..... Only £2.50  
**SALE PRICE** ..... **£1.25**

**K529 Bandoliered resistors** in bulk, ideal for schools and colleges etc for soldering practice. Up to 5k (depending how they are packed) of one value. Our choice of values and types may include 1/4/ 1/2/ 1W, 1/ 2/ 5/ 10%.

Prices ..... Pack of 100,000 ..... £85.00  
**SALE PRICE** ..... **£50.00**

**K580 Metal Oxide resistors.** TR4, 0.25W by ElectroSil. Wide range of values, mostly 5%, few closer tolerances. Super value pack.

Price ..... Pack of 200/ £2.00  
**SALE PRICE** ..... **£1.20**

## - PACKS - PACKS - PACKS - PACKS -

**K531 Precision Resistor Pack** - High quality, close tolerance R's with an extremely varied selection of values mostly 1/2W and 1/4W tolerances from 0.1% to 2% - ideal for meters, test gear etc  
**Prices** ..... 250/ £3.00  
**SALE PRICE** ..... **£1.50**

**K572 Resistor Networks** Both SIL and DIL in here, from 6 to 16 pin Plenty of popular values like 1k, 4k7 and 10k, and a good sprinkling of many other values  
**Pack of 100** ..... £4.50  
**SALE PRICE** ..... **£3.00**

**K503 100 Wirewound Resistors** From 1W to 12W, with a good range of values  
**Price** ..... £2.00  
**SALE PRICE** ..... **£1.50**

**K525 Preset Pack.** Big, big variety of types and sizes - sub-min, min and std, MP, slider, multiturn and cermet are all included Wide range of values from 20R to 5M 100 assorted  
**Prices** ..... £6.75  
**SALE PRICE** ..... **£3.50**

**K505 20 Assorted Potentiometers.** All types including single, ganged, rotary and slider  
**Price** ..... £1.70  
**SALE PRICE** ..... **£1.20**

### OPTO

**K539 LED Pack.** Not only round but many shaped LEDs in this pack in red, yellow, green, orange and clear Fantastic mix  
**Price** ..... 100/ £5.95  
**SALE PRICE** ..... **£3.95**

**K806 LED Pack** Contains only Red LED's - round, square, rectangular etc, from 3mm to 7 x 2.5mm.  
**Price** ..... 100/ £5.00  
**SALE PRICE** ..... **£3.00**

**K524 Opto Pack** A variety of single point and 7 segment LEDs (incl dual types) of various colours and sizes, opto isolators, numicators, multi digit gas discharge displays, photo transistors, infra red emitters and receivers.  
**Price** ..... 25 asstd/ £3.95  
**SALE PRICE** ..... **£2.50**

**K801 Seven seg LED pack.** Big variety of sizes in this pack. May include Red and Green, also overflow/ polarity displays, single/ double digit, also 7/ 8/ 9 digit magnified displays. Sizes from 0.11" to 0.8". 20 pieces for just ..... £3.95  
**SALE PRICE** ..... **£2.50**

**K804 Lamp Pack.** A superb quality pack containing a wide variety of small lamps Many different types - wire ended, bi-pin, slide, MBC MES, LES, TI, wedge, miniflange etc in voltages from 2.5V to 220V Most are marked with voltage/ current  
**Pack of 50** ..... £4.00  
**SALE PRICE** ..... **£2.50**

### SWITCHES AND RELAYS

**W4700 Push Button Banks.** An assortment of latching and independent switches on banks from 2 to 7 way. DPCO to 6PCO A total of at least 100 switches  
**Prices** ..... 100/ £6.50  
**SALE PRICE** ..... **£3.50**

**K587** A selection of toggle switches, mainly from page 122 of our 1990 Catalogue Includes single pole to 4 pole sub min and min Pack of 50, £30 at cat prices  
**Price** ..... £14.95  
**SALE PRICE** ..... **£9.95**

**K520 Switch Pack.** 20 different assorted switches - rocker, slide, push, rotary, toggle, micro etc Amazing value!  
**Price** ..... £2.00  
**SALE PRICE** ..... **£1.50**

**K542 Reed relays.** Mostly DIL, single pole & double pole also some changeover, these are manufacturers rejects, but a good proportion work 5V-50V coils 50 assorted  
**Price** ..... £3.30  
**SALE PRICE** ..... **£1.50**

**K569 Reed Switch Pack.** A selection of about 15 types of reed switch from submin 12mm long to 5A rated 50mm long, mostly form A (make), few form C (changeover)  
**Pack of 30** ..... £2.75  
**SALE PRICE** ..... **£1.75**

**K715 DIP Switch Pack** Tremendous selection of DIP switches, mostly from Page 121 of 1991 catalogue Everything from 1-9 way at an astonishingly low price! Pack of 20  
**SALE PRICE** ..... **£2.00**

### PLASTIC/ SLEEVING

**K534 Sleeving Pack** - we've now accumulated enough sleeving to offer this very popular pack again A terrific variety of types sizes and colours form 1-20mm bore, OD's from 2-24mm Lengths from 10mm to 76mm Well over 25 different types, including PVC, rubber, silicone etc.  
**Price** ..... 200/ £2.00  
**SALE PRICE** ..... **£1.75**

**K564 PCB Stand-offs.** A mixture of 8 different styles and sizes from 4.75 to 12.7mm high  
**Price** ..... 100/ £2.40  
**SALE PRICE** ..... **£1.50**

**K565 Miniature PCB Supports in Nylon.** 6 different styles and sizes from 6.35 to 13.24mm high  
**Price** ..... 100/ £2.20  
**SALE PRICE** ..... **£1.20**

**K533 Silicon Rubber Sleeves.** 20mm long, 2mm bore, 1mm wall  
**Price** ..... 100/ 50p  
**SALE PRICE** ..... **40p**

### CONNECTORS

**K557 Terminal Blocks.** In all shapes and sizes, solder and screw from single way to 12 way in many different current ratings  
**Price** ..... 20/ £2.40  
**SALE PRICE** ..... **£2.00**

**K803 PCB headers pack with/ without ears** straight and right angle from 10-64 way  
**Pack of 20** ..... £5.50  
**SALE PRICE** ..... **£3.00**

**K802 Pack of DIN41612 connectors** These popular PCB connectors come as 32/ 64/ 96 way Both plugs and sockets, some with pins missing Normally costing £1-£3 each  
**Pack of 25** ..... £8.00  
**SALE PRICE** ..... **£5.00**

### MOTOR + GEAR PACK

**K579** This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc, 16 - 60mm dia + worms and shafts Amazing value  
**Price** ..... £7.95  
**SALE PRICE** ..... **£6.95**

**Are you a Bargain List Subscriber? If not, fill in the Order Form on Page 13 and become one - then you won't miss the Bargains!!**



## PACKS - PACKS - PACKS - PACKS

### HARDWARE

**K553** 2BA screw mix. Mostly steel, few brass/nylon etc, cheesehead and countersunk, mainly in lengths from 3-38mm. Excellent selection

Price ..... 100/£2.50  
**SALE PRICE** **£2.00**

**K551** 6BA/ 8BA screw mix. Again an amazing mixture of lengths from 3-38mm. Nearly all cheesehead and countersunk in steel

Price ..... 200/£2.40  
**SALE PRICE** **£2.00**

**K811** 6BA screws. Nearly all pan head pozi in plated steel. Lengths to 16mm

Pack of 100 ..... £1.50  
**SALE PRICE** **£1.20**

**K805** M2 screws. Good mix, this Cheesehead, c/s, pan, mostly pozi, few slot. Lengths to 12mm. All steel with various plating.

Price ..... £1.80  
**SALE PRICE** **£1.50**

**K806** M2.5 screws. Various heads - mostly pan and c/s pozi. All plated steel. Lengths to 10mm.

Pack of 100 ..... £1.50  
**SALE PRICE** **£1.20**

**K807** M3 screws. Good selection of sizes including a few brass. Most heads. Lengths to 35mm.

Pack of 100 ..... £1.50  
**SALE PRICE** **£1.20**

**K808** M4 screws. Huge variety! Pan, c/ s, cheese, set, slot, pozi. From 4-50mm long. All steel, plated, black/ hi-tensile.

Pack of 100 ..... £1.60  
**SALE PRICE** **£1.30**

**K809** M5 screws. As above.

Pack of 100 ..... £2.00  
**SALE PRICE** **£1.60**

**K820** Large bolts and set screws. Could weigh as much as 150g each (up to 16mm dia x 90mm long). Practically all are steel. Many different heads.

Parcel weighing 5kg ..... £10.00  
**SALE PRICE** **£8.00**

**K816** Large washers 16mm and over (up to 30mm) Internal dia 8.5-17mm. Mostly plain steel, some shakeproof

Pack of 200 ..... £2.00  
**SALE PRICE** **£1.60**

**K817** Small washers. Big variety including shakeproof, spring and plain. A few brass and non-metal. 5-16mm OD, 2.4-8mm ID

Pack of 500 ..... £2.00  
**SALE PRICE** **£1.60**

**K599** Captive, shakeproof and locking nuts in sizes from 2BA to 6BA, mostly alloy

Price per pack of 100 ..... £3.20  
**SALE PRICE** **£2.00**

**K598** Solder tags. Good variety of sizes from 3-11.5mm ID. Includes some small crimp types. Most are double ended. Great value

Price ..... 200/ £2.20  
**SALE PRICE** **£1.60**

**K527 Hardware Pack.** This has a large variety of PK (caps) and self tapper screws from 2 x 1 1/2" up to 8 x 1 1/4" also washers, some BA, metric and Whit. Screws plus other miscellaneous brackets, captive nuts and bits and pieces. 1kg (up to 1000 pieces)

Prices ..... 1kg/ £4.00  
**SALE PRICE** **£2.50**

**K535 Spring Pack.** Approx 100 assorted compression, extension and torsion springs up to 22mm diameter and 30mm long

Price ..... £1.70  
**SALE PRICE** **£1.00**

**K814** Roll pins in a variety of sizes from 1.7mm-5mm dia, 8-29mm long. Some are a little rusty

Pack of 100 ..... £2.00  
**SALE PRICE** **£1.30**

**K815** Pillars and stand-offs. This includes conventional threaded pillars and standoffs also unusual shaped types too, up to 60mm long. Mostly steel, some ally and non-metal. Nearly all M3/6BA or larger

Pack of 50 ..... £2.00  
**SALE PRICE** **£1.30**

### MISCELLANEOUS

**K555 Fuses.** A marvellous selection of 15, 20, 25 and 32mm fuses both cartridge and wire ended in quickblow and antisurge varieties. May be anything from 32mA to 50A!!

Price ..... 100/ £3.95  
**SALE PRICE** **£2.50**

**K574** Wire link pack. A wide range of sizes from 3mm to 50mm for use with Breadboards or PCBs. Some are bare a few are not preformed.

Price per pack of 250 ..... £1.00  
**SALE PRICE** **75p**

**K561 Coils and Chokes.** Pot cores, IF cans, open wound coils, chokes, etc from a few µH upwards in a wide variety of sizes and values

Prices ..... 50/ £2.80  
**SALE PRICE** **£2.00**

**K573** Pack of assorted TOKO RCL coils, mainly in 10 x 10mm screened cans

Price ..... 100/ £6.00  
**SALE PRICE** **£3.00**

**K541 Printed Circuit Boards.** A wide variety of high quality printed circuit boards including audio RF digital etc all covered in components - resistors, capacitors, transistors, ICs, LEDs, switches etc. etc. A big pack of 2kg

Price ..... Only £7.00  
**SALE PRICE** **£4.00**

**K712 Crystals.** Mostly HC60 and HC18U in a wide variety of frequencies from a few hundred kilohertz to many megahertz and the odd crystal oscillator module or two

Price ..... 20 for £4.95  
**SALE PRICE** **£4.00**

**K713 Fuseholders.** Panel and chassis mounting from a basic clip to high current enclosed types for 15, 20 and 32mm fuses.

Price for pack of 50 ..... £4.00  
**SALE PRICE** **£3.00**

**Transducer/ Sounder Parcel**

Remains of STC sounder on P120 of 1991 cat. + other piezo devices. A parcel of 10 assorted

**SALE PRICE** **£6.00**

**Power Supply Parcel**

**K586** This one's an absolute gem! Contains a selection of conventional and switch mode power supplies, including AA12531, Z4215, Z4311 + 7 others!! Parcel of 10 originally selling for £40.

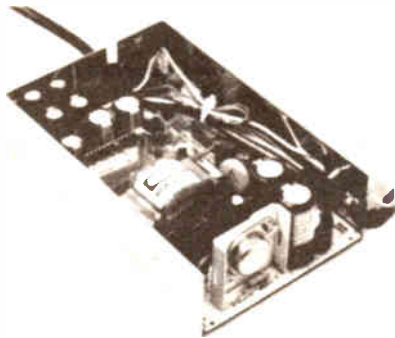
**SALE PRICE** **£15.00**

### PHOTOGRAPHIC

**K716** Odds and ends of Flash units, dedicated Flash Modules, Lens converters, incomplete cameras (at least 3).

Excellent value at **£10**

**THE POW - POW -**



**ASTEC Model AA12531  
Switch Mode Power Supply**

Input: 115/ 230V ac 50/ 60Hz  
 Outputs: V1 + 5V 5A  
           V2 + 12V 0.15A  
 Size: 160 × 104 × 45mm

**ONLY £6.95 each**

**100 + £3.50 + VAT 1000 + £2.80 + VAT**

Partially enclosed panel with fixing holes in steel case on 120 × 125mm centres. Inputs and Outputs are on colour coded leads, there is also an EEC socket on a flying lead.

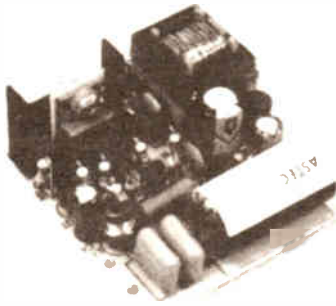
**CONVERSION KIT GIVES TWO EXTRA OUTPUTS!**

Max Current from each output + 5V @ 6A, + 12V @ 3A, -12V @ 300mA, -5V @ 500mA

**Note:** Max Total Wattage is 40W - eg + 12V @ 2A, -5V @ 2.5A, -12V @ 200mA, -5V @ 20mA etc

Complete Kit of parts + Instructions **K725**  
 Instructions only **K726**

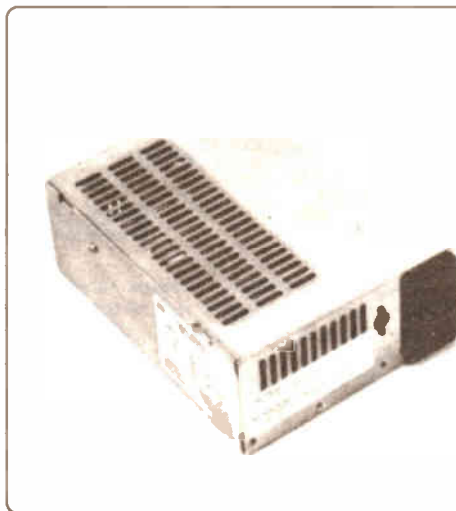
**£3.50**  
**£1.00**



**Z660** Astec switched mode PSU type AA7271  
 This small PCB, just 50 × 50mm will accept 8-14V input and give a stable 5V dc at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at a remarkably low price.

**Price** ..... **£5.00**

**SALE PRICE** ..... **£3.00**



Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 × 136 × 65mm, which has incorporated in it a switched and fused IEC mains inlet. Inside, the PCB is 160 × 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.

Specification  
 Model Number: **BM41012**  
 Input: 115/230V, 50/60Hz  
 Outputs: +5V 3.75A  
           +12V 1.5A  
           -12V 0.4A  
 Total Wattage 65W  
**Prices** ..... **£12.95**; 100 + 9.00

- ★ 3½ digit 8mm LCD display
- ★ Fully autoranging
- ★ Display hold facility
- ★ Diode and continuity test
- ★ Probe styling
- ★ Automatic polarity and zero
- ★ Protective carrying case

**A £34.95 AUTORANGING  
 MULTIMETER  
 (1991 Catalogue)  
 LESS THAN  
 ½ PRICE !!  
 YOURS FOR  
 JUST**

**£16**

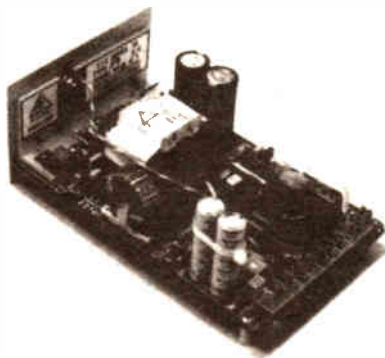


**Order Code** ..... **DM1360**  
 AC volts ..... 0-2-20-200-500 Vac ± 2.3%  
 DC volts ..... 0-200m-2-20-200-500 Vdc ± 1.3%  
 Resistance ..... 0-200-2k-20k-2M-20MΩ ± 2%  
 Dims ..... 133 × 29 × 17mm



# POWER PAGES!!!

## Switch Mode PSU's



**Z8887** Made by STC this 160 x 100mm panel is attached to an aluminum chassis 165 x 102 x 65mm and has a single 5V 6A output. Supplied with connection details we can offer these at a fraction of their normal cost!

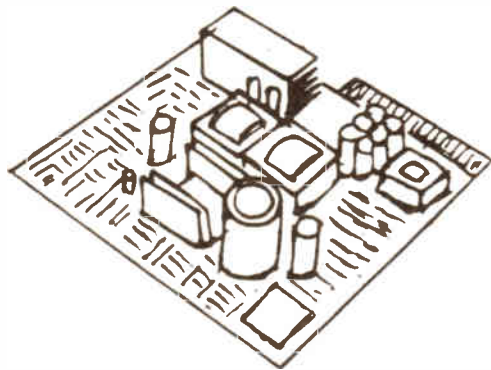
Price ..... **£6.95**

**SALE PRICE £4.95** 100 + 3.00

**Z8888** A larger version of the above PCB 220 x 100mm and chassis 225 x 102 x 65mm providing a single 5V 10A output. Supplied with connection details.

Price ..... **Only £8.95**

**SALE PRICE £7.95** 100 + 4.50



**Z8890 DC-DC Converter Boards.** These panels 220 x 195 require 50V DC input for a 5V 19.5A output. Inputs and outputs on DIN41612 connector. These brand new panels made by STZ are now being offered at just

Price ..... **Only £7.95**

**SALE PRICE £6.95** 100 + 3.20

## High Power Inverters

Gardeners square wave type **QR75108** 50V 85A DC IN 240V 50Hz 4kVA OUT

Price ..... **£345 + CARR**

**QR75107** 2kVA **£230 + CARR**

**QR75106** 1kVA **£175 + CARR**

## Constant Voltage Transformers

These give a constant 240V AC out with 1% regulation for a wide tolerance input voltage

**Centronic Reguvolt Model 6000C.**

Input 240V -20 + 10% or 220V +20-12% (192-264V)

Output 240V 1% 25A (6kVA) or 220V 1% 27.27A

Price ..... **£333.50 + CARR**

As above, but 5kVA **£287.50 + CARR**

As above, but 4kVA **£253.00 + CARR**

As above, but 2kVA **£184.00 + CARR**

## MODEL RAILWAY CONTROL & SWITCHING UNIT

This ready built versatile piece of equipment allows

★ Full forward and reverse control of trains using regulated and smoothed supply (1.5A)\*

\* Requires 3 components (supplied) to be soldered into panel

★ Relay control of 5 separate circuits (10A change over contacts, ideal for points operation)

★ Powering of auxiliary equipment - 2 separate 5V 1A outputs

A mains powered panel 185 x 105mm contains all electronics. All voltages are fully stabilized and both input and output are fused.

Connections, both input and output are by screw terminals which are clipped onto the on-board pins.

The five 12V relays are controlled by transistor circuits which require only 5V 30mA, supplied by the on board power supply.

Supplied uncased with circuit and wiring diagram (SAE for free copy)

Suitable black ABS plastic case

**£3.50**

Order Code **Z8897**

Price

**£19.95**

**SALE PRICE 50% off: ONLY £9.95**

## STC POWER SUPPLIES

These are extremely well made linear power supplies by STC (series 15) offering exceptional value for money. Chassis size 124 x 100 x 41mm. Input voltage can be 100, 120, 220, 230, 240V. There is over-voltage protection on both models

**Z8898** Type 15AAA. Output 5V @ 3A. STC price in 1987 £43.99.

Our Price ..... **£8.00**

**Z8899** Type 15AAB. Output 15V @ 0.5A twice. STC price in 1987 £60.09.

Our Price ..... **£10.00**

**Z8915** Type 15AAC. Output ± 15V @ 0.5A. STC price in 1987 was £60.38

Our price ..... **£10.00**

**Z8916** Type 15AAH. Output 15V @ 1A with OVP. STC price £43.99

Our price ..... **£10.00**

**Z8917** Type 15AAJ. Output 15V @ 1A. STC price £41.69

Our price ..... **£10.00**

**Any 2 in this Box £12.00**

**Z975** PSU - Mains input via 13A built in plug. Output 14V 600mA ac. Case 92 x 57 x 52mm

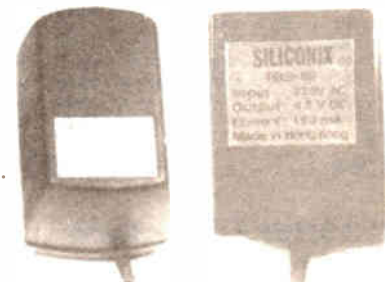
Price ..... **£3.50**

**SALE PRICE £2.50**

**Z4311** Power supply by Thorn-EMI. Built in 13A plug. Case size 95 x 55 x 50mm. Output 11.4-0-11.4V ac @ 0.45A 10.3VA total. Has 3 core 2m lead attached

Price ..... **£2.00**

**SALE PRICE £1.20**



## Oric Power Supply

**Z4208** Moulded plastic case with built in 13A plug. Output 9V dc at 600mA delivered to 2m lead with 2.5mm power plug

Price ..... **£3.50**

**SALE PRICE £2.50**

**Z426** Siliconix mains input 4.5V dc 150mA output to 3.5mm jack plug on 2m lead. Built-in continental 2-pin plug. Size 62 x 46 x 35mm

Price ..... **£1.50**

**SALE PRICE £1.00**



**Z8802** Battery charger unit. 2 part vacuum formed black plastic case 570 x 210 x 85mm with room for 10 x 2.6AH 6V sealed lead acid batteries. Inside is a neat PSU 'RS toroidal' transformer 207-958 120/240V primary 0.9 0.9 secondary each at 10VA. There is a bridge rectifier and smoothing cap. The output is taken to a PCB 510 x 45mm containing 10 identical charging circuits. Each has a TIP31A 741 IN4002 and couple of Rs and a 3 pin connector.

Clearing at ..... **£8.00 each**

# 10 SUMMER SALE LIST

# GREENWELD

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

## Power Supply Capacitors



| Code  | Value    | Voltage | Ripple | Mnf'r | l · d   | Price |
|-------|----------|---------|--------|-------|---------|-------|
| Z4343 | 2200µF   | 40V     | 2.7A   | LCR   | 45 · 26 | 2.12  |
| Z4344 | 4700µF   | 63V     | 4.4A   | BHC   | 56 · 36 | 3.77  |
| Z4345 | 10 000µF | 40V     | 4.9A   | BHC   | 56 · 41 | 3.89  |
| Z4346 | 15 000µF | 25V     | 5.5A   | BHC   | 56 · 41 | 3.96  |

Prices:  
 Z4343 ..... 60p 25 · 0.45 100 · 0.30  
 Z4344 ..... £2.00 25 · 1.60 100 · 1.30  
 Z4345 ..... £2.50 25 · 1.80 100 · 1.50  
 Z4346 ..... £2.50 25 · 1.80 100 · 1.50

**SALE PRICES 50% off**

All these have screw terminals except those marked \* which have lugs

| Code  | Value | Volts | Mnf'r | Size      | l · d | 100 · |
|-------|-------|-------|-------|-----------|-------|-------|
| Z4404 | 100   | 350   | Novea | 48 · 30*  | £1.00 | 0.60  |
| Z4405 | 220   | 400   | Novea | 84 · 36   | £2.50 | 1.50  |
| Z4406 | 470   | 400   | Novea | 84 · 51   | £3.00 | 2.00  |
| Z4407 | 680   | 400   | Novea | 116 · 51  | £3.00 | 2.00  |
| Z4408 | 2200  | 160   | Novea | 84 · 51   | £2.00 | 1.20  |
| Z4409 | 2200  | 250   | LCR   | 116 · 64  | £3.00 | 2.00  |
| Z4410 | 3300  | 16    | LCR   | 45 · 26*  | 30p   | 0.15  |
| Z4419 | 3300  | 25    | LCR   | 50 · 26   | 40p   | 0.25  |
| Z4411 | 3300  | 80    | LCR   | 55 · 35*  | £1.00 | 0.60  |
| Z4412 | 3900  | 63    | Novea | 115 · 35  | £1.20 | 0.75  |
| Z4413 | 5600  | 50    | Novea | 84 · 35   | £1.50 | 0.90  |
| Z4414 | 10000 | 6.3   | Novea | 50 · 35   | £1.00 | 0.60  |
| Z4415 | 10000 | 25    | Novea | 84 · 35   | £2.00 | 1.20  |
| Z4416 | 10000 | 85    | LCR   | 105 · 40* | £3.00 | 2.00  |
| Z4417 | 15000 | 40    | Novea | 115 · 50  | £2.50 | 1.50  |
| Z4418 | 15000 | 63    | Novea | 115 · 66  | £3.00 | 2.00  |

**SALE PRICES 50% off**

## Capacitor Clearance

| Code | Value        | per 100 | 1k +  |
|------|--------------|---------|-------|
| YV   | 220µ 10V     | £3.00   | 0.015 |
| KB   | 470µ 25V AX  | £3.00   | 0.015 |
| KB   | 4700µ 16V AX | £3.00   | 0.015 |
| KB   | 10µ 16V R    | £3.00   | 0.015 |
| KB   | 220µ 16V R   | £3.00   | 0.015 |
| KB   | 4µ 7 63V R   | £3.00   | 0.015 |
| KB   | 1µ 100V R    | £3.00   | 0.015 |
| KB   | 10µ 63V R    | £3.00   | 0.015 |
| KB   | 100µ 25V R   | £3.00   | 0.015 |



## DIL Socket Delights!

Low Profile, tubed.

| Code  | per 100 | 1k +  |
|-------|---------|-------|
| ST 8  | £2.25   | 0.015 |
| CS 14 | £3.00   | 0.020 |
| ST 16 | £3.75   | 0.025 |
| ST 18 | £3.75   | 0.025 |
| CS 20 | £3.75   | 0.025 |
| ST 24 | £5.25   | 0.035 |
| ST 28 | £6.00   | 0.040 |
| ST 40 | £9.00   | 0.060 |

## Resistors

### Low value wirewound

|       |         |          |
|-------|---------|----------|
| Z1877 | 0R1 9W  | 6 for £1 |
| Z1878 | 0R27 9W | 6 for £1 |

Both available in boxes of 250 · £15 per box.

|       |             |                       |
|-------|-------------|-----------------------|
| Z0173 | 1R2 2 1/2 W | All at the same price |
| Z1086 | 1R5 2 1/2 W | 100/ £3.00            |
| Z0873 | 2R2 2 1/2 W |                       |
| Z0102 | 56R 5W      |                       |

All available in boxes of 1000 · £15 per box.

### 1 Watt Carbon Film

|       |     |         |
|-------|-----|---------|
| Z0872 | 1R2 | All     |
| Z0703 | 1k  | £1/ 100 |
| Z0226 | 2k2 |         |

All available in boxes of 1000 · £5 per box.

**RESISTOR STOCK CLEARANCE - One million assorted resistors for just £300 + VAT + Carr (That's 3p/ 100)**

## Wire & Cable

### Ribbon Cable Bonanza!

14 & 16 way Grey 100ft reels

|        |        |       |
|--------|--------|-------|
| Z30176 | 14 way | £6.00 |
| Z30197 | 16 way | £6.00 |

## Joystick

Z004 Skeleton Joystick switch type Good quality made by AB Brass spindle has 44mm long black plastic handle attached Body has 4 mounting holes These really are a fantastic bargain!!

Price ..... Only £1.00

**SALE PRICE 2 for £1.00**

## Uniqard

### Development Boards

E1S, E2S & E10 series are circuitry development boards for memory (both dynamic and static RAM and ROM) and also for combined CPU-memory function

EPB series have backplane and motherboard uses (both 3U and 6U) and the smaller lengths are also used for extender cards A range of profiles with and without mounting flanges and extra busbars are available Used as high density memory development boards they only require a small amount of extra wiring

| Order Code     | Type   | Size                   | Price each |
|----------------|--------|------------------------|------------|
| 129B-PCB-0065F | E1S-00 | 3U 0.3                 | £12.62     |
| 129B-PCB-0075F | E2S-00 | 3U 0.6"                | £12.62     |
| 129B-PCB-0115F | EBP-02 | Extender               |            |
|                |        | 3U-220                 | £6.46      |
| 129B-PCB-0125F | EBP-03 | Extender               |            |
|                |        | 6U-160                 | £16.18     |
| 129B-PCB-0145F | EBP-05 | Horizontal Mntg 6U-112 | £11.00     |

**SALE PRICES 75% OFF**

## Memorex Tape

Z9012 Memorex MRX IV 1/2" computer tape 600ft on 175mm dia spool 6250BPI in case in sealed poly bag List £7.49

Our price ..... £3.50 50 + 2.00

## Audio Amplifier Panels



### 1W Amplifier - mono

Z914 Audio amp panel 95x65mm with TBA820 chip Gives 1W output with 9V supply Switch and volume control Just connect battery and speaker Full details supplied Only £1.50 10 for £12.00 25 for £25.00 100 for £75.00

**SALE PRICES £0.75 each**

10 + 0.50: 25 + 0.40: 100 + 0.32

### 1W Amplifier - stereo

Z915 Stereo version of above 115x65mm featuring 2xTBA820M and dual volume control

£3.50 10 for £30.00 25 for £65.00 100 for £200.00

**SALE PRICES £1.75 each**

10 + 1.30: 25 + 1.10: 100 + 0.85

## Tick-tock, Tick-tock Timers!!!

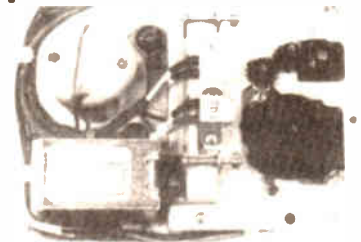


Z4199 60 second timer High quality instrument by Micron Can be set by knob on top to any time from 0-60 seconds after which time a pair of contacts close Although these are 110V they work off standard 230V mains with the series resistor included Notes about its operation are also supplied Overall size 105 · 63 · 80mm individually boxed

Price ..... £3.75

**SALE PRICE £2.00**

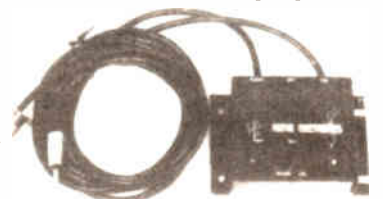
## Tape Deck



Z4274 Micro cassette mechanism 100x74x35mm as used in dictaphones/ answerphones etc Complete with head optical sensing and hall effect switch solenoid and motor Was £2.00

**SALE PRICE £1.00**

## CB Aerial Eliminator



Z4081 Enables any ordinary car radio aerial to be used with a CB set Originally sold at £7.95

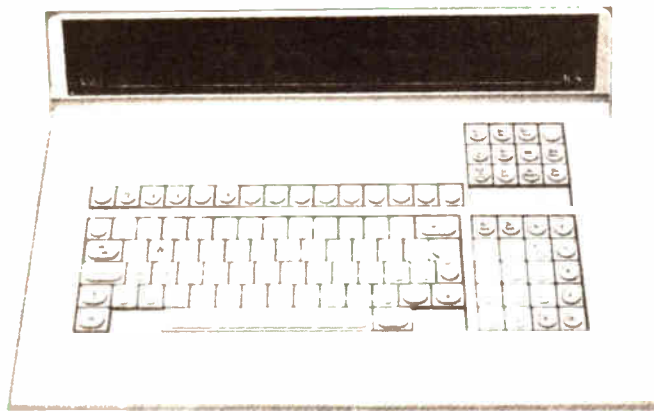
**SALE PRICE 2 for £1.00**

**MINIMUM ORDER VALUE £12 + £3 POSTAGE/ PACKING PER ORDER**



## VISTEL II

## Total Communication for Deaf People



Vistel II is a visual telephone plus 'answerphone' which allows everyone to communicate over the telephone network.

By simply dialling a number and typing in your message you can be in touch with anyone else with similar equipment - whether they are across the road or at the other end of the country

By pressing one clearly marked button you can send or receive typed messages even when you are out. Additionally you can prepare and send a message at a particular preset time (during cheap periods to save you money).

With Vistel II not only can you talk to other Vistel II users but Vistel I (of which there are over 1,000 already in use by deaf people throughout the UK), Telecom Gold, Breakthrough trust's BKU Mailbox Network, Mailink, the RNID telephone exchange or any other computer with a modem.

### Specification

- Dimensions: 34cm x 45cm x 13.7cm
- Weight: 4.5kg
- Full 'QWERTY' keyboard plus 'function' keys for ease of use
- 40 character screen which displays your messages quickly, clearly and quietly
- Text editor for preparing recording and storing information
- Memory for up to 9,500 characters
- Auto-answering capability for receiving calls even when you are not there
- Auto-dialling capability for sending messages during cheap rate telephone periods
- Real time clock
- Personal telephone directory for storing your most commonly used numbers
- Calculator
- Printer interface for connection to a printer
- Telecom Gold, or BKU mail box, function key
- Vistel II runs from mains with battery back-up so memory is retained even when Vistel II is turned off
- For connection your only requirements are a power point and a British Telecom jack plug socket

### Options

- Printer

These units are new and boxed, but because the company who manufactured them has gone bankrupt they are offered without guarantee. There is a comprehensive 143 page instruction manual provided. These units originally sold for over £500.

**Our Bargain Basement Price**

**£150**

**Sale Price**

**£75**

If you want to look through the manual first, send £12 (£10 deposit + £2 post) £10 refunded on its return

**SEMICONDUCTORS** - If you're seriously into Semi's, ask for our Bulk Buyers list - Diodes, Transistors, IC's etc, all at knockout prices!!

### MEMORIES ETC

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| 261B | SAAS231      | 55   | £4.00 | 2.00  |
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| 503  | Z80A CTC     | 52   | 60p   | 0.40  |
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| 503  | R6502        | 56   | £2.00 | 1.10  |
| 503  | M80C85A-2    | 144  | £2.50 | 1.30  |
| 503  | P8259A       | 21   | £1.00 | 0.60  |

### Dynamic RAM Modules

Z1988 Dynamic 256k RAM modules SIMM 8 - 41256-12 with room for 9th chip. Similar to types costing £100 -

Our low price ..... just £10.00 each

**SALE PRICE** **£7.50**

Z1818 Dynamic RAM modules by NEC type MC41256A8A-12. These SIPs are on panels 79mm x 17mm and have 8 x 41256 RAMs, giving 256k of memory. Similar to their price £107.00

Our price ..... £30.00

**SALE PRICE** **£7.50**

### Bridge Rectifiers

|         |          | 1 -      | 100 - |
|---------|----------|----------|-------|
| 26MB20A | 25A 200V | £1.50    | 0.75  |
| 5VW20   | 25A 50V  | £1.00    | 0.50  |
| 5V4B20  | 4A 200V  | 3/ £1.00 | 0.20  |

### Speech Chip Bargain

The 5P0256 is probably the best known speech chip available with lots of circuits published by various magazines. Our competitors sell this for £7.95. We'll send you one with our info pack for a lot less!

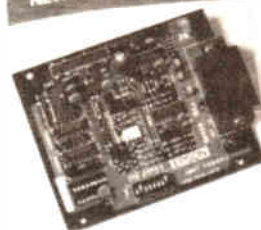
**SALE PRICE** **£2.00** 100+ 0.50  
1000+ 0.40

### Epson Serial Printer Interfaces

DOT MATRIX PRINTER OPTION

user manual

NEW SERIAL INTERFACE



Z4163 Type 8148. Can be built into any Epson FX and RX series dot matrix printers for connection to any asynchronous data transmission system with bit rate from 750-9600 BPS. Ready built PCB comes with comprehensive user manual 2K Buffer. These cost £60.00 normally.

Our special low price **£25.00**

**SALE PRICE** **£12.50**

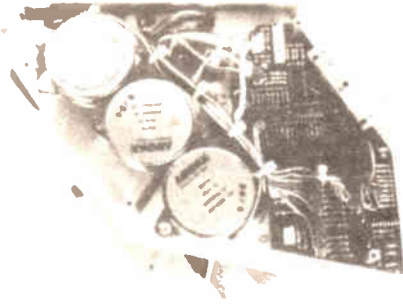
**1992 Catalogue** - Yes we know we're only half way through 1991, but if you want to be first with the Bargains, you can place an advance order now - just add it to your order where indicated. This will be sent to you on publication 1st October, 1991.

# 12 SUMMER SALE LIST

# GREENWELD

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## Dual Sheet Feeder



**Z8837** Exxon Dual Sheet Feeder Z200 Overall 395 x 210 x 285mm Brand new and containing some very high class electronics. Although of little practical use as it stands it makes a great break down unit. It contains  
 3 x 12V 36R 7.5 stepper motors by Airpax and associated gear trains drive belt etc  
 2 x 12V Solenoids  
 1 x 12V Electronic buzzer  
 2 extremely sensitive micro switches  
 1 PCB containing 4 x TIP115 4 x TIP110 2 x 7407 LM3302 comparator x T s R s C s plugs sockets etc  
 1 Control panel containing 4 LED illuminated push buttons - green LED on small PCB £24.95  
 1 x POB703A opto coupler & 1 x OPB7111 opto coupler

**SALE PRICE £12.50**

## Dragon Interface



**889** Dragon interface - case 116 x 62 x 29mm with 2 x 9 pin D Plugs 2 leads with 5 pin DIN plug Inside is a PCB with 4 transistors and 20 resistors

**Box of 50 £20.00 or 70p each**

## BOOKS

**K585** From page 104 of the 1990 Catalogue plus others not listed, a selection of computer books. Will include Sensing & control for the BBC and Go Forth A pack of 10 books, originally retailing for £50 +

**SALE PRICE £6.00**

**Sensing and Control Projects for the BBC by T Nunns**

Shows how ANALOGUE IN and the 'USER PORT' sockets can be interfaced to the real world Fully explained projects in non technical language No soldering required  
 82pp 241 x 182 £5.95

**SALE PRICE £2.00**

**'Go Forth' by Paul Kail**

An introduction to Forth Language It's as easy to use as BASIC, but is much faster This book is a complete foundation course in Forth programming, and contains a number of complete programs Originally published at £8.95

**SALE PRICE £2.00**

# KRAZY KEYBOARD CLEARANCE



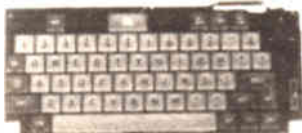
**Z8842** Tatung VT4100 keyboard Cased 85 key unit with separate numeric keypad With circuit Has 2 or 3 broken keys 450 x 65 x 125mm Was £9.95

**SALE PRICE £5.00**



**Z4116** 24 way (8 x 3) membrane keypad Large (200 x 90mm) area - these were originally used as a teaching aid Overlay template and pinout supplied Now only £2.00

**SALE PRICE £1.00**



**Z8882** Keyboard from Liberator Computer 278 x 124mm 62 keys Some of these have been used Output to 20 way connector

**Price £5.00**



**Z8852** Superb keyboard 392 x 181mm with LCD displaying 1 line of 10 characters - another line of symbols 100 keys Has 2 x 74HC05 and 80C48 Was £15.00

**SALE PRICE £7.50**



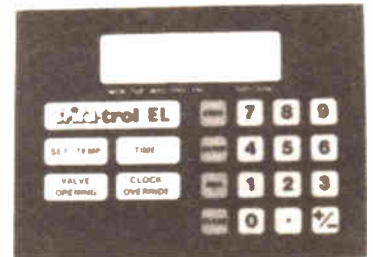
**Z8848** Keyboard by Cherry Room for 104 keys all normal keys (65) fitted Chips on board LS373 x 2 LS374 LM3086 x 2 LS138 x 3 555 LS08 6805 Size 442 x 175mm

**SALE PRICE £4.00**



**Z8863** Keyboard High quality unit made by Micro Switch 69 pale grey and blue keys 6 red 5mm LED s 15 various LS chips and socketed D8048 by Intel Output via 7 way plug and there s a 4 way edge connector too Keyboard frame is 317 x 128mm PCB on which it's mounted is 285 x 170mm Excellent value at £12.00

**SALE PRICE £6.00**



**Z1797** Membrane keyboard 155 x 113mm with 80 x 22mm aperture for display from case Z4245 22 keys Output to 11 way flexible connector Self adhesive

Price ..... Only £1.00

**SALE PRICE 50p**



**Z4354** Computagraph Colorwriter panel 352 x 67 x 12mm Ally frame supports a membrane keyboard which has 22keys On the rear of the panel are 6 yellow submin LED s a 3mm red LED and 2 x 19W edge conns

Price ..... £1.00

**SALE PRICE 60p**

**Z4363** Membrane keyboard 225 x 84mm with 11 keys 1-9 & 2 others Output (common bus) on 12 way ribbon cable Could be cut down to 95 x 70mm if only 1-9 needed

Price ..... 60p

**SALE PRICE 40p**

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| Page 23    | See Pages 5-7 of this supplement   |
| Page 24    | See Pages 8 & 9 of this supplement |
| Page 25    | See Pages 4 & 8 of this supplement |
| Page 26    | See Page 2 of this supplement      |
| Page 27    | See Page 3 of this supplement      |
| Page 31    | 1/2 price                          |

### BARGAIN LIST 68

|                      |               |
|----------------------|---------------|
| Page 2               | 25% off       |
| Pages 3-4            | 25% off       |
| Page 5               | 25% off       |
| Page 7               | 25% off       |
| Page 8               | 25% off       |
| Page 9               | 50% off       |
| MOSFETS/FETS         | 25% off       |
| Rest                 | 50% off       |
| Page 10              | All 1/2 price |
| Page 11              | All 1/2 price |
| Page 12              | All 1/2 price |
| Page 14              | All 1/2 price |
| Except 1 million R s |               |
| Page 15              | All 1/2 price |
| Except 5A regs       |               |
| Page 16              | All 25% off   |
| Except Bulk LED s    |               |

## BARGAIN LIST GOODS SOLD OUT:

LISTED IN THE ORDER THEY APPEAR ON THE PAGE

|                       |                               |  |                        |                      |
|-----------------------|-------------------------------|--|------------------------|----------------------|
| <b>1991 Catalogue</b> | Z1729                         | Z1641  | Z8902                  | <b>Page 2</b>        |
| <b>Page 107</b>       | Z1730                         | Z1642  | Z8903                  | <b>Page 3</b>        |
| TITS                  | <b>Page 118</b>               | Z1648  | Z8904                  | <b>Page 4</b>        |
| Z8851                 | Z656                          | Z1645  | <b>Page 17</b>         | <b>Page 5</b>        |
| Z4091                 | Z1809                         | Z1621  | Z2044                  | Z2052                |
| Z4092                 | Z1810                         | Z229   | Z2040                  | Z2070                |
| Z8867                 | Z1705                         | Z263   | Z4366                  | Z2072                |
| <b>Page 108</b>       | Z4097                         | Z262   | Z4368                  | Z0283                |
| J128                  | Z4170                         | Z203   | Z1433                  | <b>Page 6</b>        |
| Z4036                 | Z1587                         | Z255   | Z2050                  | Most still available |
| Z8827                 | Z4302                         | Z245   | <b>Page 18</b>         | <b>Page 7</b>        |
| <b>Page 109</b>       | <b>1991 Spring Supplement</b> | Z228   | Z1369                  | Z8912                |
| Modulator             | <b>Page 119</b>               | Z234   | K185                   | Z5022                |
| Z4172                 | Z993                          | Z249   | Z1969                  | Z8913                |
| <b>Page 110</b>       | Z8861                         | Z236   | <b>Bargain List 68</b> | Z4377                |
| VE13                  | Hi-Flex 750                   | Z231   | <b>Page 19</b>         | Z2048                |
| Z4310                 | Z4112                         | Z216   | K120                   | <b>Page 8</b>        |
| <b>Page 111</b>       | Z8889                         | Z254   | <b>Page 20</b>         | K819                 |
| Z806                  | <b>Page 120</b>               | All S switches have now been made into packs                           | Z02936                 | Z5007                |
| Z807                  | Z101                          | <b>Page 126</b>  | Z27245                 | <b>Page 9</b>        |
| <b>Page 112</b>       | Z102                          | Most packs still available but give alternatives where possible please | <b>Page 21</b>         | Z1756                |
| K589                  | Z103                          | <b>Page 131</b>  | Z4347                  | (listed as Z1765)    |
| K554                  | Z104                          | Z4332  | Z22278                 | Z1759                |
| <b>Page 113</b>       | Z108                          | <b>Page 13</b>   | SB16                   | J305 18              |
| K532                  | Z109                          | Z2039  | <b>Page 22</b>         | K578                 |
| K578                  | <b>Page 121</b>               | Z01155   | Z22468                 | 55T215               |
| K552                  | Z713                          | <b>Page 14</b>   | Software Simon         | <b>Page 10</b>       |
| K565                  | Z687                          | Z2040  | Z4352                  | 2N7002               |
| K566                  | Z4191                         | Z1982  | Z05054                 | Z1512                |
| K588                  | Z818                          | Z2028  | Z8867                  | Z1688                |
| K581                  | Z1814                         | <b>Page 15</b>   | <b>Page 23</b>         | <b>Page 11</b>       |
| Z886                  | Z4284                         | Z1976  | Z01155                 | Z1399                |
| <b>Page 114</b>       | Z4095                         | <b>Page 16</b>   | Z30157                 | Z1674                |
| Z912                  | Z1630                         | Z351   | Z30257                 | K597                 |
| <b>Page 115</b>       | Z497                          | Z8857  | Z30162                 | <b>Page 24</b>       |
| Z955                  | Z955                          | Z8848  | Z30212                 | Z4112                |
| Z4223                 | Z4223                         | <b>Page 124</b>  | Z30188                 | Z4168                |
| Z4319                 | Z4319                         | Z1617  | Z30158                 | AC9231               |
| <b>Page 116</b>       | Z4236                         | Z1650  | Z30226                 | <b>Page 25</b>       |
| Z4285                 | Z4285                         | Z1638  | Z1639                  | Z4359                |
| Z4287                 | Z495                          | Z1639  | Z8901                  | <b>Page 26</b>       |
| <b>Page 117</b>       | Z4272                         | Z1640  | <b>Page 117</b>        | <b>Page 27</b>       |
| Z1702                 | Z1702                         | <b>Page 117</b>  | <b>Page 117</b>        | Z1922                |
| Z1604                 | Z1604                         | <b>Page 117</b>  | <b>Page 117</b>        | Z1936                |
| Z4197                 | Z4197                         | <b>Page 117</b>  | <b>Page 117</b>        | Z2043                |



## HITACHI SCOPES

**10% DISCOUNT ON ALL MODELS!**

|             |      |                   |                |
|-------------|------|-------------------|----------------|
| <b>V212</b> | £385 | <b>SALE PRICE</b> | <b>£346.50</b> |
| <b>V223</b> | £545 | <b>SALE PRICE</b> | <b>£490.50</b> |
| <b>V522</b> | £730 | <b>SALE PRICE</b> | <b>£657.00</b> |
| <b>V209</b> | £860 | <b>SALE PRICE</b> | <b>£774.00</b> |

## BBC 'B' SOFTWARE - FINAL CLEARANCE

This has been cluttering up our stores for far too long - now being sold at not much more than the media value. (SAE for more information, colour leaflets).

**Micro Maestro** - Comprises 5 1/4" disk + computer tape, 16 page handbook, C60 stereo cassette with backing tune of popular tracks like 'Ghostbusters', 'Chariots of Fire', and 'Superman'  
**Original Price £17.95**

**SALE PRICE £2.00**

**Music Master** - Comprises microphone to attach to recorder + processing device, 5 1/4" disk; 12 page handbook.  
**Original Price £52.78**

**SALE PRICE £4.00**

**Mupados Recorder Tutor** - Comprises 5 1/4" disk, 38 page large format spiral bound handbook, C90 stereo cassette with 52 tunes.  
**Original Price £30.94**

**SALE PRICE £2.50**

MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER

## Acoustic Couplers



**Z8884** Acoustic coupler for use with Liberators Made by Sendata 700F series One end has PCB with lots of chips plus 4 x AA Nicads to power Other end has socket to take mains power supply (supplied) Also included is a communications cartridge and a comprehensive 46 page manual New

Price ..... £20.00  
**SALE PRICE** **£10.00**

## Stationery products

**Pentel Rolling Writers.** These fine point cartridges are essentially complete pens without an outer casing, so can be used as they are Current price is around 60p Now look at our prices! (State 2nd choice)

**Z23199** Black  
**Z23201** Blue  
**Z23200** Red  
 Prices (any mix) **30p each**  
 24 + 0.20 96 + 0.15

**SALE PRICE** **50% off**

**Drawing ink** Staedtler/Mars 23ml plastic bottles in 4 colours Normally £1.87

**Z23183** Black  
**Z23184** Red  
**Z23186** Green  
 Prices (any mix) **£1.00 each** 10 + 0.70

**SALE PRICE** **50% off**

## Black/ Blue/ Green Leads

**Z01268** Staedtler/ Mars lumochrom leads. Pack of 12 in dispenser. Blue 2mm. Fits all standard lead holders.

Prices ..... **30p** 10 + 0.20 50 + 0.15

**Z01158** Tube of 12 x 2H leads 2mm dia.

Prices ..... **25p** 10 + 0.17 50 + 0.12

**Z01159** Tube of 12 Green leads 2mm dia.

Prices ..... **30p** 10 + 0.20 50 + 0.15

**SALE PRICE** **50% off**



## BIB Accessories

**BCC8** Computer Terminal Maintenance Kit + **BCC11** Liquid Static Eliminator £3.95 in catalogue.

**SALE PRICE** **£2.00** 100 + 1.20

## Instrument Fans



**Z5005** Excellent quality instrument fan by Toyo Model TF92230A 230V AC 92.2mm<sup>2</sup> · 25.5mm deep Silent operation List around £19.50

Our price **£6.00**  
**SALE PRICE** **£4.00** 25 + £3.00  
 100 + £2.40

## Modem Panels

Another parcel of parcels from Dowty These are all believed to have come from discontinued units and as far as is known are not faulty However please note some have missing chips or boards are cut to prevent re-use They are therefore being sold for their component value only not as working units

**Z4320** Khostream Multiplexer Panel 300 · 210mm with 4 · 25 way D sockets 15W D socket Z84C42 · 3 Z84C30 · 2 CMOS, Z80 CPU, 6264 RAM 30 assorted CMOS/ TTL/ Linear chips and nice power supply comprising a potted transformer with mains input and 0-9V 0-9V outputs both at 1A 7812 7915 and 7805 regs Also Xtal 64 way connectors switches etc Great value

Price ..... **£6.50**  
**SALE PRICE** **£3.50**

**Z4321** Expander Panel for above. 230 · 170mm with 4 · 25 way D sockets 2 · Z84C42 Z84C30 8 · 45406 · 7 74 chips Also short length of 64 way ribbon cable with IDC socket This panel is complete

Price ..... **£3.50**  
**SALE PRICE** **£2.00**

**Z4322** Panel 310 · 205mm with 2 · 25 way D sockets 5 other sockets Over 40 chips on board including Z85C3010 and TLC 32040 (both in sockets) TL074 · 2 MOC3021 · 2 ULN2803 and lots of logic 3 DIL relays Rs Cs etc etc

Price ..... **£3.00**  
**SALE PRICE** **£1.50**

## Electronic Organ Kit

**EK2** High quality kit by OK All parts supplied in attractive plastic case which becomes the housing for the finished project Covers a full octave £3.34

**SALE PRICE** **£2.00**



## Knobs

**Z4054** High quality collet knob in matt black 35mm dia · 17.5mm high with clip on cap and pointer

**SALE PRICE** **£1.75** Pack of 10  
 100 + 0.10

**Z4198** Black body coloured top 20mm dia · 19mm high Push on

**SALE PRICE** **£2.00** Pack of 25  
 asst'd colours  
 200 + 0.06

## Line Termination Unit

Comes in 2 parts  
**Z035** Grey ABS case 197 · 106 · 60mm with lid contains PCB with 2 relays transformer etc A 3m lead with 4 pole plug (old type) is fitted one end and a 6 way lead 1m long the other which connects to

**Z036** a PCB 265 · 143mm This contains 5 · LM348 4016 4093 & ZNA2H006E chips · transistors R s C s xtal etc

Both for **£4**, or individually **Z035 £3.00; Z036 £1.00**  
**SALE PRICES** **Z035 £1.60** Both **£2.00**  
**Z036 60p**

## 'JIMMY'

the electronic football game of skill



**Z817** Great fun to play or take it apart for bits Originally £19.95

**SALE PRICE** **£2.50**  
**Map Light**



**Z4071** Magnetic map light with magnifier This useful accessory is fitted with a cigar plug and has a curly cord extending to 3m The white plastic housing for the lamp has an integral magnet and a swing out powerful magnifying lens £1.95

**SALE PRICE** **£1.00**

## Remote Control



**Z4134** Speaker remote control box This is a cream case 125 · 95 · 42mm housing a 57mm diameter speaker and 2 control knobs one for volume and one to switch main-remote-dual The 3 core 6m long lead enables volume to be controlled from chair or bed Simple to fit instructions included £3.95

**SALE PRICE** **£2.00**



## Keyboard Enclosure

**J063** High quality keyboard enclosure 550 · 225 · 70mm with black aluminium mask Top professional quality - made by Data Packaging Normally £38.69

Our price **£11.00**  
**SALE PRICE** **£5.00**



# 16 SUMMER SALE LIST

# GREENWELD

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

## CAMERA CLEARANCE

Job lot of 'returns' just arrived, offering the amateur photographer a bargain buy in 110 & 35mm cameras. We've been asked not to mention the manufacturer's name, but it's well known for its equipment and available in all photographic and chemist shops (Boots) etc. There are a number of different models, but to simplify matters we've grouped them into 3 main types:

(a) 110mm manual, (b) 110mm motor driven; (c) 35mm manual. All are complete and intact and look OK, so the faults (if any) are probably minor. Because they're so cheap, you can afford to buy 2 or 3 - we're sure you'll be delighted with the value we're offering! - but please do remember these are **returns** and are sold without guarantee. NB order by Z number - there is no choice of model.

**Z5028** 110mm Manual models include 110LF and 110TF, many have built in flash (our choice)

**Prices** ..... **£3.50 ea 5 for £14.00**

**Z5029** 110mm Motor driven. Models include 110IF

**Prices** ..... **£4.00 ea 5 for £16.00**

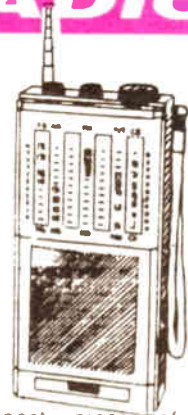
**Z5030** 35mm Manual. Models include 35HL, 806, 35CT, DL10, DL7. Most have built in flash (our choice)

**Prices** ..... **£4.50 ea 5 for £18.00**

**Z5032** Broken cameras. These have parts missing. A parcel of 6 assorted, all 35mm including manual, motor driven, autofocus, twin lens types.

**Price** ..... **£15.00**

## MULTIBAND RADIOS!



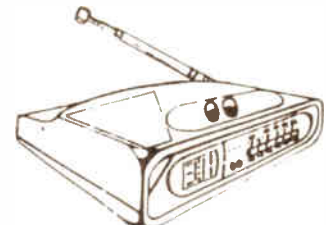
This compact piece of equipment 200 x 95 x 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

- 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 x AA cells. All this technology for just **£17.95**

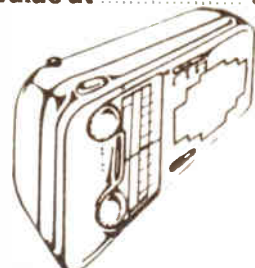
**Order Code**

**MB100**



**Z4357 Clock Radio by Ross.** Extremely neat unit measuring 140 x 80 x 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 x 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 x 145 x 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 x C cells). Originally retailed at £19.95

**Our Price** ..... **£14.95**

## HIGH QUALITY SLIMLINE LOGIC PROBE/ PULSER

Top quality slim (18mm dia) precision instrument for troubleshooting and analysis of logic circuits. It works as a level detector, pulse detector and pulse stretcher. It is circuit powered, has LED indicators and comes with additional probe lead and clip, and instruction sheet. An excellent addition to your Test Gear at an unrepeatable price. We have purchased all available supplies and can offer this superb instrument for around half the normal selling cost.



**Order Code M625**

**ONLY £10.00**

## Extraordinary Easiwire Offer!!!

The easy to use no-soldering wiring tool which makes construction of small electronic projects so simple!

All included in the kit are: Wiring pen, Utility tool, Punched wiring board, Self adhesive sheet, Spring loaded terminals and jacks, Spare spool of wire, Excellent instruction book. Catalogue price £15.00

**SALE PRICE**

**£5.00**

**MINIMUM ORDER VALUE £12 + £3 POSTAGE/ PACKING PER ORDER**