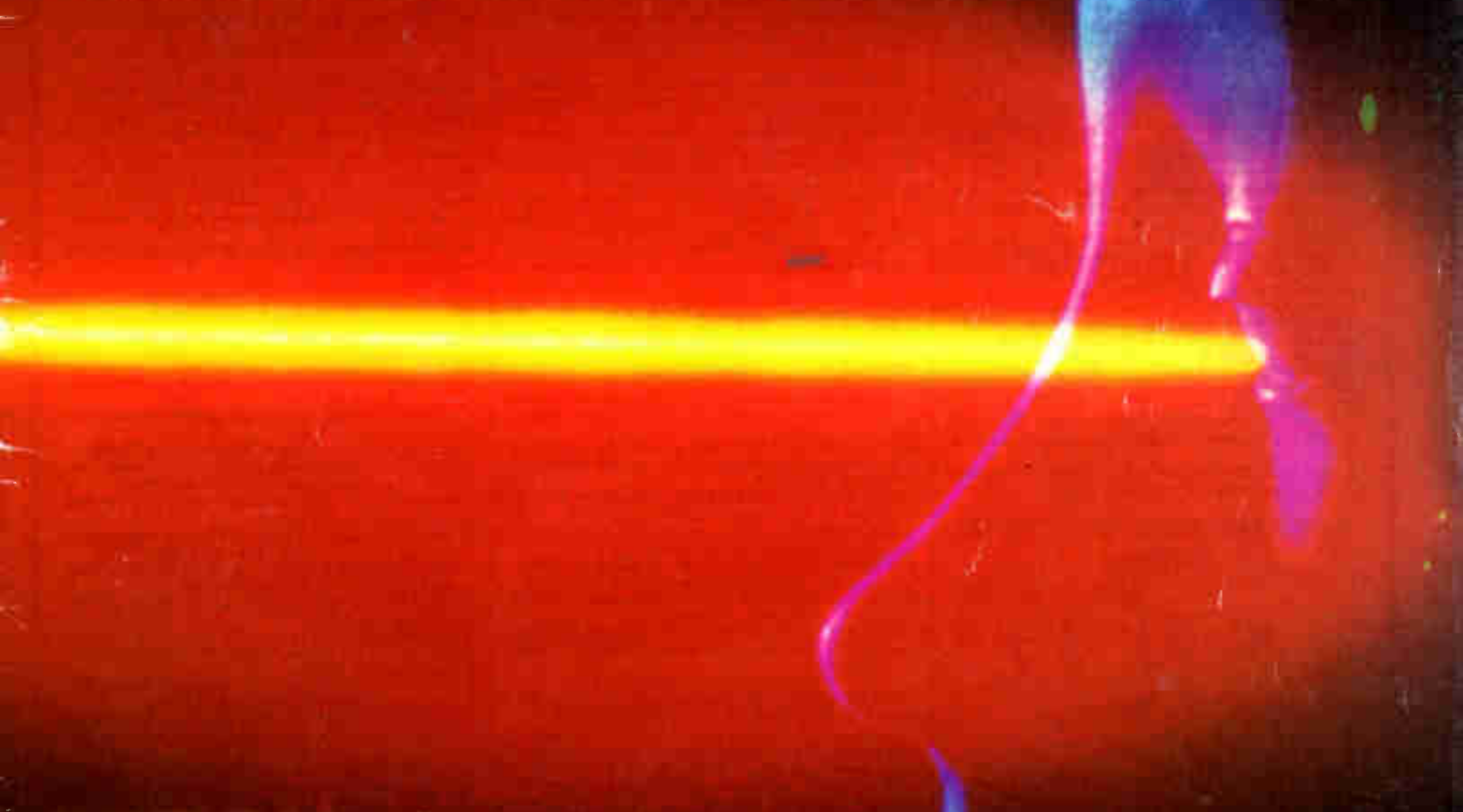
EVERYDAY ELECTRONICS

AUGUST 1991

INCORPORATING ELECTRONICS MONTHLY

£1.50

FREE INSIDE
16 PAGE GREENWELD
SUMMER SALE CATALOGUE SUPPLEMENT



OPTICAL COMMUNICATIONS LINK

PORTABLE PET SCARER

PEDOMETER

08
9 770262 361003

The No.1 Magazine for Electronics & Computer Projects

VOL. 20 No. 8 AUGUST 1991

EVERYDAY ELECTRONICS

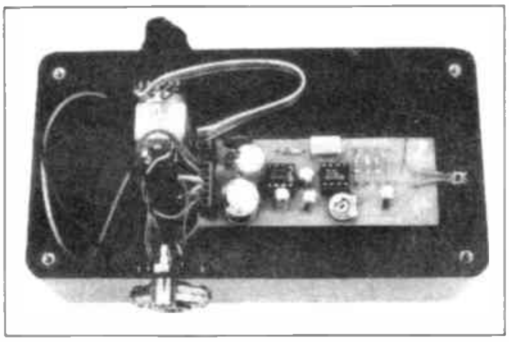
INCORPORATING ELECTRONICS MONTHLY

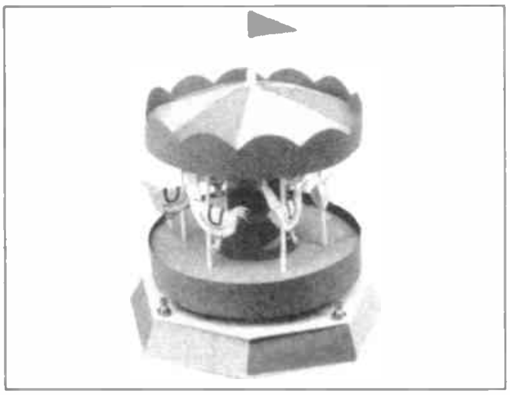
ABC

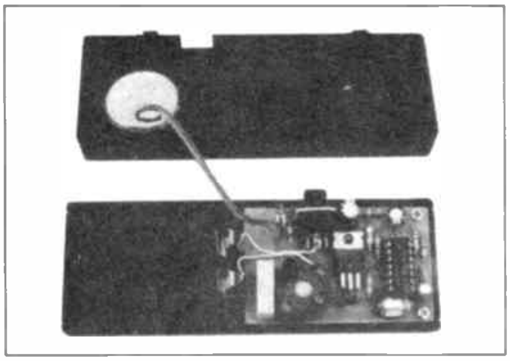
The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

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







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

Projects

Series

Features

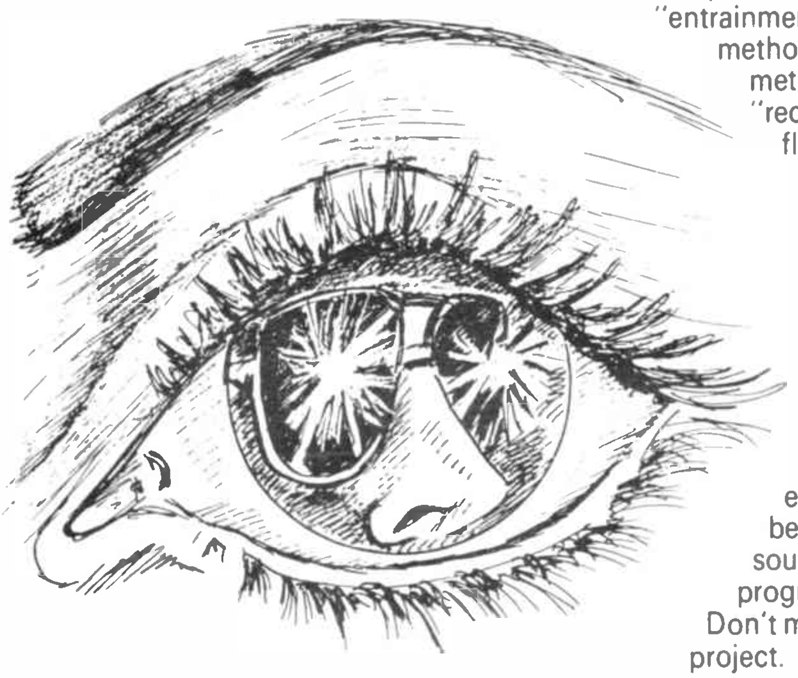
BRAINWAVE

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.

CAPACITANCE METER

An inexpensive piece of test gear that will measure capacitance in the range 10p to 1µ

12V LAMP DIMMER

An efficient filament lamp dimmer for low voltage lighting. Useful for boats, caravans, cars etc. Controls up to 20W of lighting.

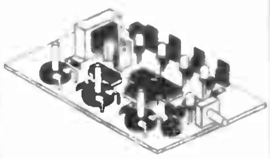
EVERYDAY ELECTRONICS

SEPTEMBER ISSUE ON SALE FRIDAY AUGUST 2, 1991

NEXT MONTH

TK FOR KITS

DISCO SEQUENCER



Four channels (up to 1kW each) to drive Rope lights Pin spots etc (Resistive/inductive loads) with 30 different eye catching sequences Variable speed and sequence change frequency AND built in audio input Ideal for mobile or permanent displays Complete KIT (less box)

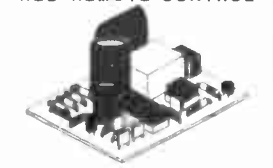
XK141 £28.85

Don't forget our other value for money DISCO KITS

DL8000 8 - channel 80 programme sequencer £48.85
DL3000 3 - channel sound to light £21.85
XK124 High power strobe with audio input £17.85
XK139 4 - channel sequencer £14.60

SEND 8x6 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 9 15V dc or 240V ac and switches a 3A relay on and off alternately each time the transmitter is operated at ranges up to 20ft (6m) Responds only to the transmitter frequency Great for lights TV alarm controls etc

XK134 £11.95

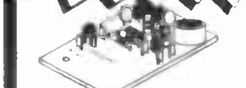
Suitable transmitter complete with box (9V PP3 battery required)

XK136 £5 95

For more channels use our popular MK12/MK18 IR transmitter receivers

MK9 4 - way keyboard £3 35
MK10 16 way keyboard £9 75
MK12 16 Channel Receiver £21 95
MK18 IR Transmitter range 60ft £9 75

SUPER – SENSITIVE MICROBUG



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

XK128 £7.25

TK ELECTRONICS
13 Boston Road
London,W7 3SJ

Tel: 081 – 567 8910
Fax: 081 – 566 1916

ORDERING INFORMATION Prices INCLUDE VAT but please add £1.25 P&P (UK) Overseas Customers divide total order by 1 175 then add P&P Europe £3 60, elsewhere £10 Send PO/cheque/VISA /MASTERCARD No with order GIRO NO 529314002 Local Authority and education orders welcome Office Hours Mon - Fri 9 30 am 6 pm Shop Hours Tues Thurs 10 am 5 pm Sat 10 am 1

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 :-

ELECTRONIZE DESIGN Tel. 021 308 5877
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 hifi 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 hifi 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

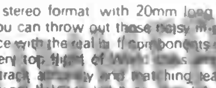
LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIER

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 ill-matched carbon pots and replace with the real hifi components only used selectively in the very top flight of World class amplifiers The improvement in track accuracy and matching really is incredible 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

2-Gang 100K Lin £8 86
2-Gang 10K or 100K Log £9 80
2 Gang 10K Special Balance zero crosstalk and zero centre loss £10 71
2 Gang 20K Log (Volume Control) MOTORISED £19 20
2 Gang 10K Special Blaance 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 1 500 hours

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

HC15 Standard Quality Stereo R/P Head £2.49
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 Sure Start Tape Circuits £13.64
998E 2 4 Erase Head 1mH Universal Mount £11.98

TAPE RECORDER CARE PRODUCTS

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

Our new SPRING '91 list is FREE in UK, Send for your copy now. Overseas customers welcome but please send 2 IRCs if you want a list, to cover surface post, or 5 for Airmail

Please write or telephone with your requirements to sample the friendly and efficient **HART** service Payment by cheque cash or credit card A telephoned order with your credit card number will get your order on its way to you THAT DAY

Please add part cost of carriage and insurance as follows
INLAND Orders up to £20 £1 Orders over £20 £2 50
Express Courier next working day £9
OVERSEAS Please see the ordering information with our lists

SPECIAL OFFER 30% OFF ALL CASSETTE KITS

QUALITY AUDIO KITS

24hr SALES LINE
(0691) 652894
Fax: (0691) 662864

ALL PRICES INCLUDE VAT AT 17.5%

HART ELECTRONIC KITS LTD
6 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

MAGENTA ELECTRONICS LTD

MAIL ORDER AND SHOP
EE107
135 Hunter St
Burton-on-Trent
Staffs, DE14 2ST
Tel: 0283 65435
Fax: 0283 46932

SWITCH

All prices include VAT at 17½%	
Shop open 9-5 Mon-Fri;	Add £2
9-2 Saturday	p&p to
Official orders welcome	all orders

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

1991 CATALOGUE AVAILABLE PRICE £1.00 INC. P&P

HAMEG HM 203-7 OSCILLOSCOPE

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

£338 + £59.15 VAT

Next Day Delivery £10 00
(cheques must be cleared)

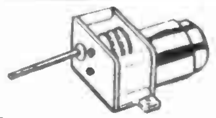
PORTABLE ULTRASONIC PEsT SCARER

EE AUG '91

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

KIT REF 842 KIT PRICE **£22.56**

D.C. MOTOR GEARBOXES



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

SMALL UNIT TYPE MGS £4.08
Speed range 3-2200 rpm. Size 37×43×25mm

LARGE UNIT TYPE MGL £4.65
Speed range 2-1150 rpm. Size 57×43×29mm

STEPPING MOTORS

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

ID36 PERMANENT MAGNET MOTOR– £16.86
48 steps per rev

MD200 HYBRID MOTOR– £17.10
200 steps per rev

MD35 ¼ PERMANENT MAGNET MOTOR– £12.98
48 steps per rev.

MD38 PERMANENT MAGNET MOTOR– £9.15
48 steps per rev

EVERYDAY ELECTRONICS KIT PROJECTS

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

Ref		Price
842	PORTABLE ULTRASONIC PEsT SCARER. Aug '91	££22.56
841	DIGITAL LCD THERMOSTAT May 91 with punched and printed case	£29.95
840	DIGITAL COMBINATION LOCK Mar 91 with drilled case	£19.86
839	ANALOGIC TEST PROBE Jan 91	£13.23
838	MICROCONTROLLER LIGHT SEQUENCER Dec 90 With drilled and labelled case	£57.17
835	SUPERHET BROADCAST RECEIVER Mar 90 With drilled panels and dial	£17.16
834	QUICK CAP TESTER Feb 90	£10.39
833	EE 4 CHANNEL LIGHT CHASER Jan 90	£32.13
815	EE TREASURE HUNTER Aug 89	Full Kit £45.95
814	BAT DETECTOR June 89	£21.44
812	ULTRASONIC PET SCARER May 89	£14.81
800	SPECTRUM EPROM PROGRAMMER Dec 88	£30.60
796	SEASHELL SYNTHESISER Nov 88	£28.55
790	EPROM ERASER Oct 88	£28.51
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£56.82
744	VIDEO CONTROLLER Oct 87	£33.29
740	ACOUSTIC PROBE Nov 87	£20.01
739	ACCENTED BEAT METRONOME Nov 87	£23.94
734	AUTOMATIC PORCH LIGHT Oct 87	£19.62
730	BURST-FIRE MAINS CONTROLLER Sep 87	£15.50
728	PERSONAL STEREO AMP Sep 87	£16.34
724	SUPER SOUND ADAPTOR Aug 87	£43.86
722	FERMOSTAT July 87	£13.88
719	BUCCANEER I B METAL DETECTOR July 87	£30.22
718	3-BAND 1 6-30MHz RADIO Aug 87	£30.30
715	MINI DISCO LIGHTS June 87	£14.39
707	EQUALIZER (IONISER) May 87	£17.75
700	ACTIVE I/R BURGLAR ALARM Mar 87	£40.74
584	SPECTRUM SPEECH SYNTH (no case) Feb 87	£23.90
581	VIDEO GUARD Feb 87	£9.59
569	CAR ALARM Dec 86	£14.24
563	200MHz DIG FREQUENCY METER Nov 86	£71.47
561	LIGHT RIDER LAPEL BADGE Oct 86	£11.65
560	LIGHT RIDER DISCO VERSION Oct 86	£22.41
559	LIGHT RIDER 16 LED VERSION Oct 86	£15.58
556	INFRA-RED BEAM ALARM Sep 86	£32.39
544	TILT ALARM July 86	£8.94
542	PERSONAL RADIO June 86	£13.17
528	PA AMPLIFIER May 86	£30.60
523	STEREO REVERB Apr 86	£30.21
513	BBC MIDI INTERFACE Mar 86	£31.93
512	MAINS TESTER & FUSE FINDER Mar 86	£10.07
497	MUSICAL DOOR BELL Jan 86	£21.41
493	DIGITAL CAPACITANCE METER Dec 85	£49.95
481	SOLDERING IRON CONTROLLER Oct 85	£6.25
464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£9.60
	1D35 STEPPER MOTOR EXTRA	£9.15
	OPTIONAL POWER SUPPLY PARTS	£5.86
461	CONTINUITY TESTER July 85	£7.08
455	ELECTRONIC DOORBELL June 85	£8.63
444	INSULATION TESTER Apr 85	£22.37
392	BBC MICRO AUDIO STORAGE SCQPE INTERFACE Nov 84	£40.82
387	MAINS CABLE DETECTOR Oct 84	£6.31
386	DRILL SPEED CONTROLLER Oct 84	£9.91
362	VARICAP AM RADIO May 84	£15.02
337	BIOLOGICAL AMPLIFIER Jan 84	£27.59
263	BUZZ OFF Mar 83	£6.49
242	INTERCOM no case July 82	£6.50
240	EGG TIMER June 82	£7.85
108	IN SITU TRANSISTOR TESTER June 78	£10.76
106	WIERD SOUND EFFECTS GEN Mar 78	£8.94
101	ELECTRONIC DICE Mar 77	£7.15

EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

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

ADVENTURES WITH ELECTRONICS £5 25
COMPONENT PACK (less book) £22 83

FUN WITH ELECTRONICS

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

FUN WITH ELECTRONICS Book £2 95
COMPONENT PACK (less book) £17 93

30 SOLDERLESS BREADBOARD PROJECTS

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

30 SOLDERLESS BREADBOARD PROJECTS Book 1 £2 95
COMPONENT PACK £27 74

ENJOYING ELECTRONICS

A more advanced book which introduces some arithmetic and calculations to electronic circuits. 48 chapters covering elements of electronics such as current, transistor switches, flip-flops, oscillators, charge, pulses, etc. An excellent follow-up to Teach-in or any other of our series. Extremely well explained by Owen Bishop who has written many excellent beginners' articles in numerous electronics magazines.

ENJOYING ELECTRONICS Book £3 60
COMPONENT PACK £14 62

Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. £13.98

A FIRST ELECTRONICS COURSE

A copiously illustrated book that explains the principles of electronics by relating them to everyday objects. At the end of each chapter a set of questions and word puzzles allow progress to be checked in an entertaining way. An S-DEC breadboard is used for this series – soldering is not required.

A FIRST ELECTRONIC COURSE BOOK £4 99
PACK £22 83

INSULATION TESTER

EE APRIL 85

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

KIT REF 444 — £22.37

PET SCARER

EE MAY 89

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

KIT REF 812 — £14.81

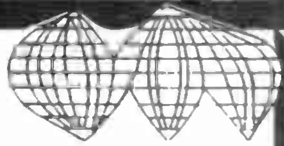
Mains Adaptor £2.02

DIGITAL LCD THERMOSTAT

EE MAY '91

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

KIT REF 841 — £29.95



3 BAND SHORT WAVE RADIO

EE AUG 87

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

KIT REF 718 — £30.30

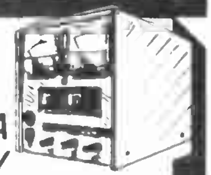
DIGITAL COMBINATION LOCK

EE MAR '91

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

KIT REF 840 — £19.86

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

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

KIT REF 769 — £56.82

DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

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.

KIT REF 563 — £71.47

ACOUSTIC PROBE

EE NOV '87

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

KIT REF 740 — £20.01

4 CHANNEL LIGHT CHASER

EE Jan '90

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

KIT REF 833 — £32.13

EE EQUALISER

EE MAY '87

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

KIT REF 707 — £17.75

MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90

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

KIT REF 838 — £57.17

EPROM ERASER

EE OCT '88

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

KIT REF 790 — £28.51

LIGHT RIDERS

EE OCT '86

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

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

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815

Including headphones — £45.95

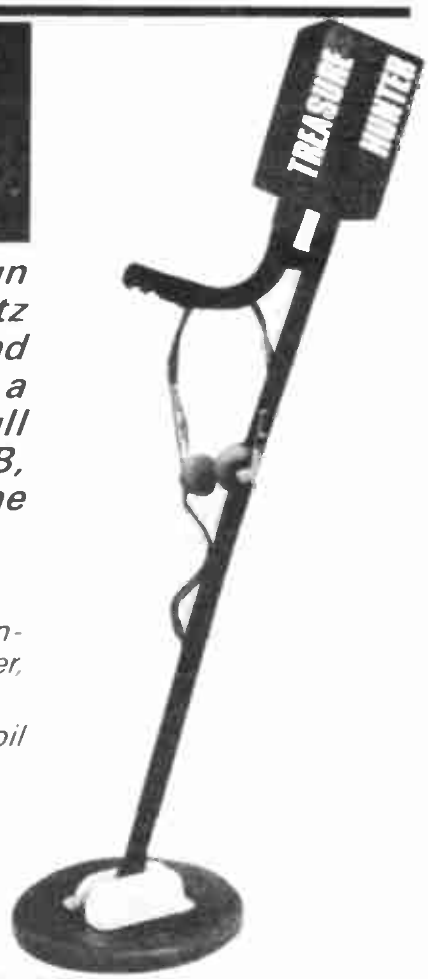
SUPERHET BROADCAST RECEIVER

EE MAR '90

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

KIT REF 835 — £17.16

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.

- *Kit includes punched and printed case, PCB, and all components.*
- *Large bright 5 Digit LED display.*
- *Direct read-out in uF, pF, nF.*
- *Calibration not required.*

KIT REF. 493..£49.95

MAIL ORDER AND SHOP
EE106
135 Hunter Street
Burton-on-Trent
Staffs, DE14 2ST
Tel: 0283 65435
Fax: 0283 46932

VISA

SWITCH

MAGENTA ELECTRONICS LTD

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects

VOL. 20 No. 8 AUGUST '91

Editorial Offices:
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
Fax: (0202) 841692. DX: Wimborne 45314.
See notes on **Readers' Enquiries** below – we regret that lengthy technical enquiries cannot be answered over the telephone.

Advertisement Offices:
EVERYDAY ELECTRONICS ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.
Phone (0255) 850596

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 vise 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 entiely 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 polution.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £17.00. Overseas: £21.00 (£39 airmail). Cheques or bank drafts (**in £ sterling only**) payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. **Subscriptions start with the next available issue.** We accept Access (MasterCard) or Visa payments, minimum order £5.

BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.70 (£2.20 overseas surface mail) inclusive of postage and packing per copy – **£ sterling only please.** Visa and Access (MasterCard) accepted, minimum order £5. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. In the event of non-availability one article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Jan, Feb, Mar, Apr, June, Oct, & Dec. 88, Mar & May 89 & Mar 90.**

BINDERS

Binders to hold one volume (12 issues) are available from the above address for £5.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.*

Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum order £5. Tel: 0202 881749

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

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

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

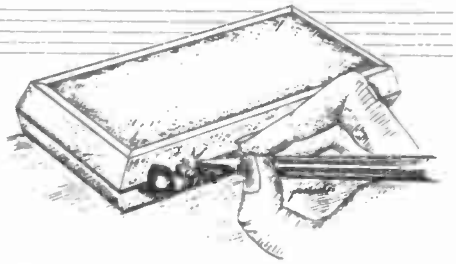
ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

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



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.

THIS 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 approxiamtely 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

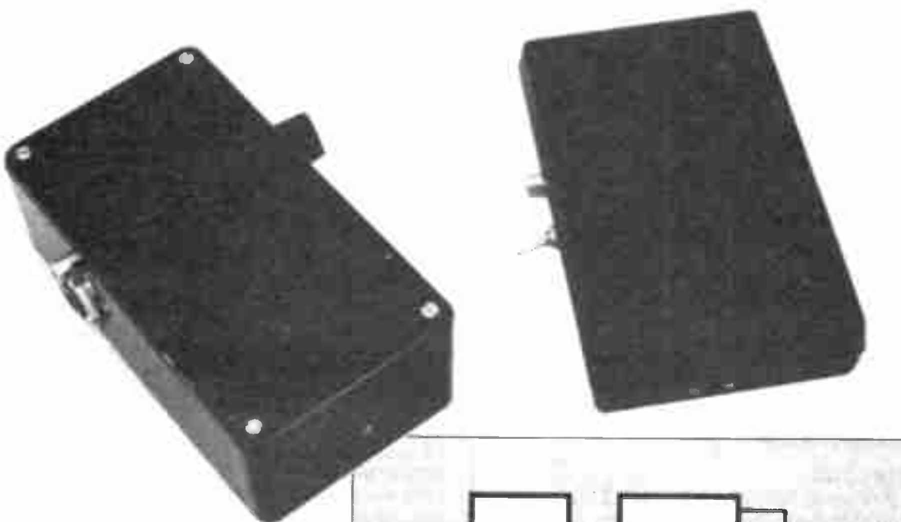
The complete circuit diagram for the Optical Transmitter is shown in Fig. 2. IC1, an operational amplifier, provides an inverting gain of about 20 (maximum). Its output is fed to emitter-follower TR1 along with a steady d.c. bias current from VR2 (via R5). The emitter current of TR1 thus comprises a 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



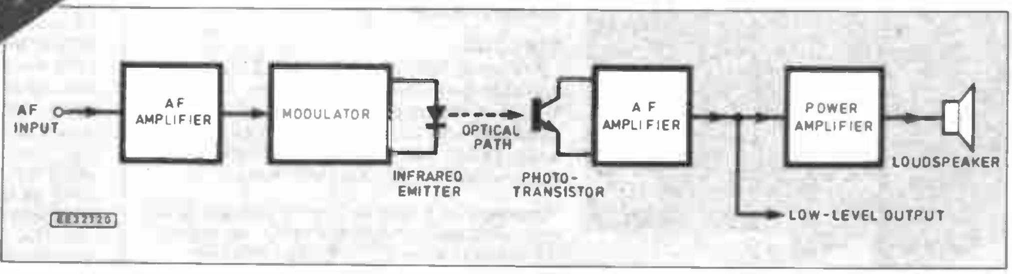


Fig. 1. Block diagram of the Optical Communications Link.

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)

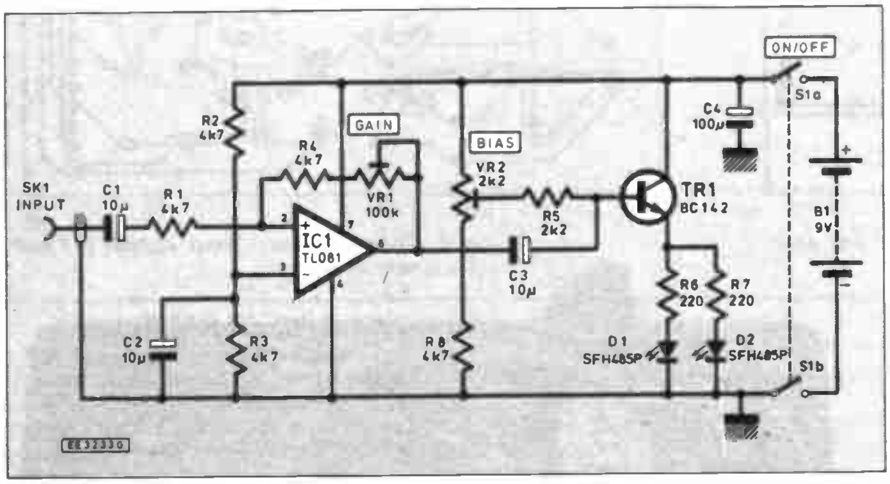


Fig. 2. Complete circuit of the Optical Transmitter.

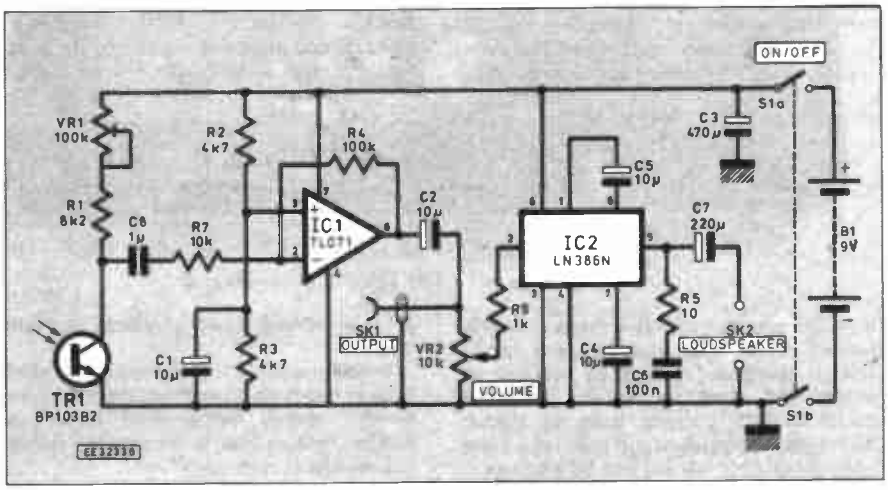
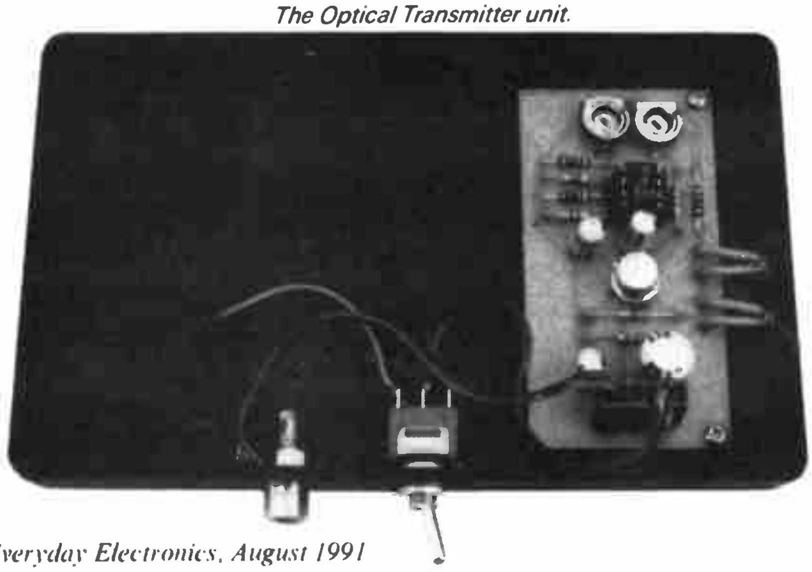


Fig. 3. Complete circuit of the Optical Receiver.

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.

See SHOP TALK Page

Receiver

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*

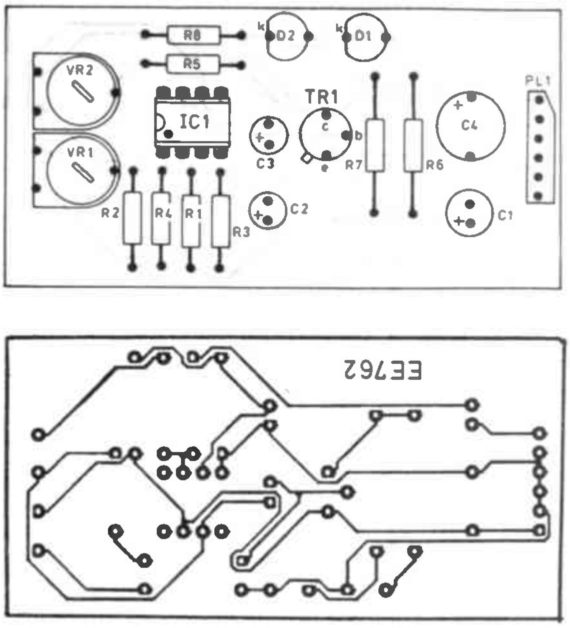


Fig. 4. Optical Transmitter p.c.b. copper foil and component layout.

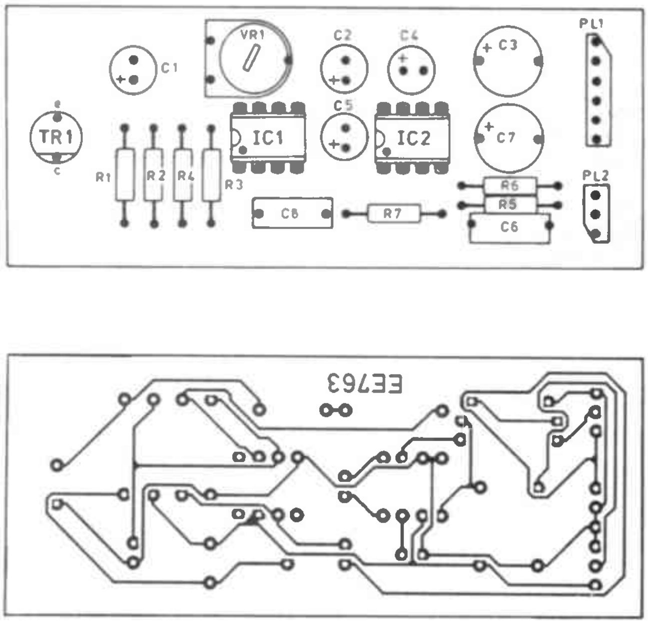


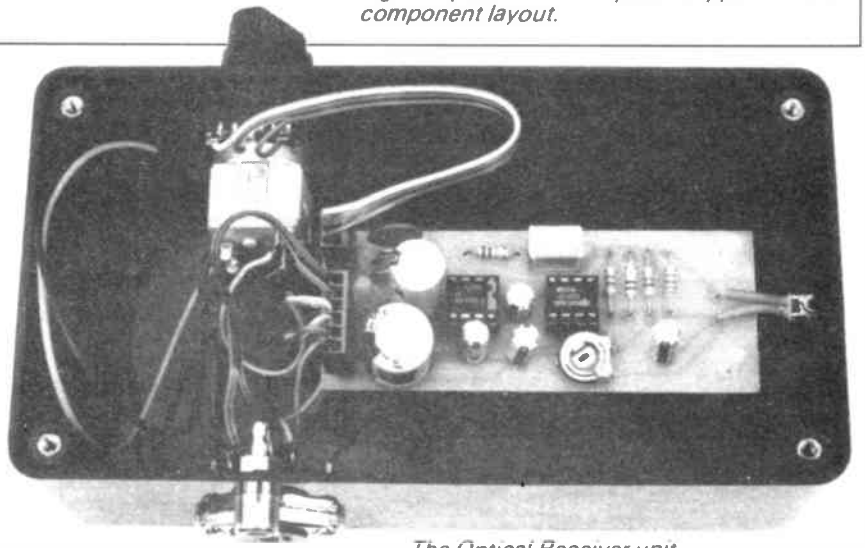
Fig. 5. Optical Receiver p.c.b. copper foil and component layout.

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 instrumental 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.

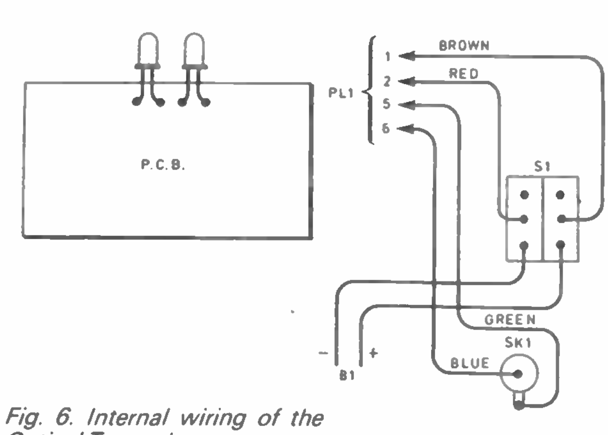


Fig. 6. Internal wiring of the Optical Transmitter.

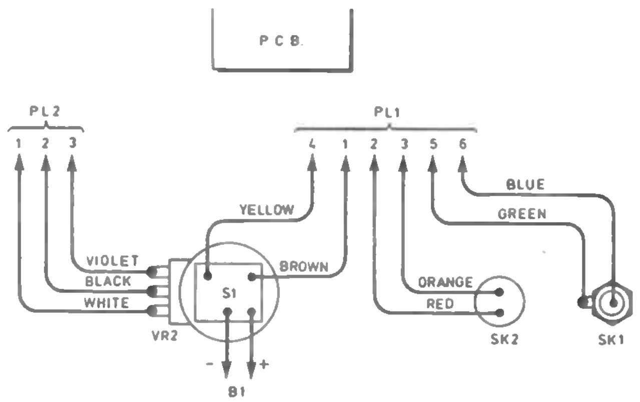


Fig. 7. Internal wiring of the Optical Receiver.

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.

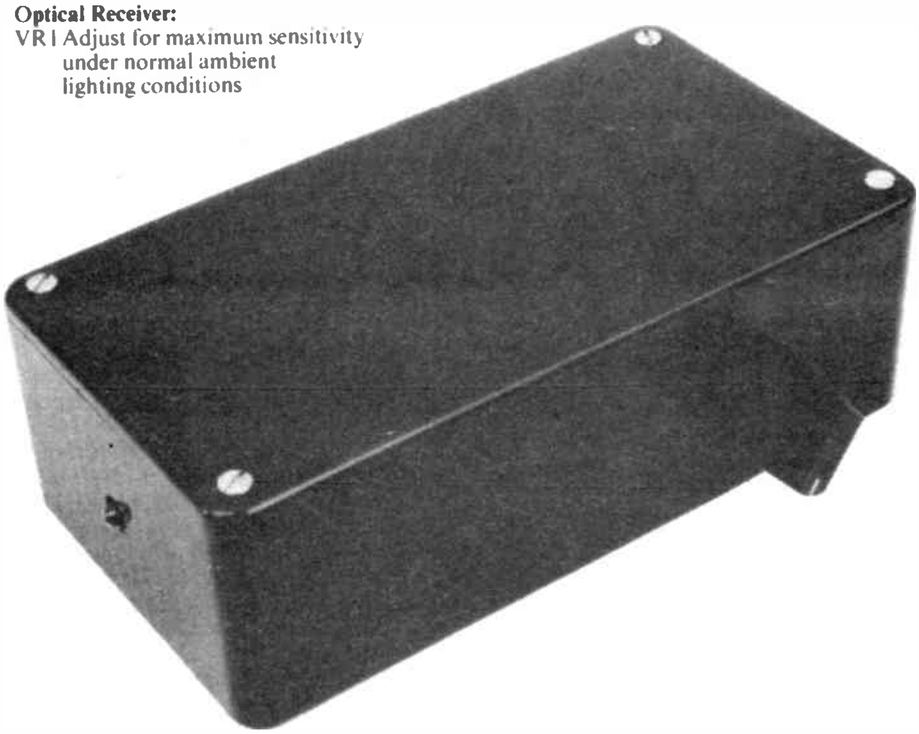
Finally, in applications where mains lighting is present, it may be necessary to fit the Optical Receiver with a black tube in order to shade the phototransistor and thus reduce the level of 50Hz hum which may be present. Such a tube can be made from a 50mm (approx.) length of 20 to 40mm diameter plastic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

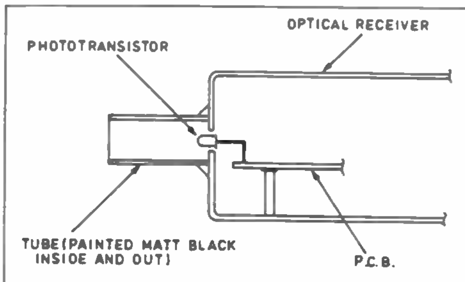


Fig. 8. Method of reducing hum and noise produced by mains lighting.

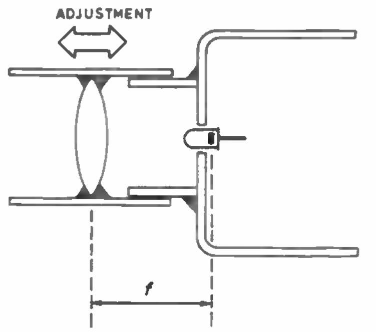


Fig. 10. Suggested lens arrangement.

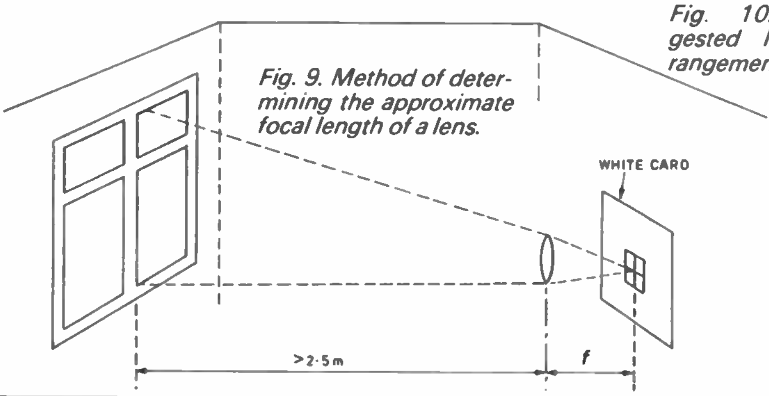


Fig. 9. Method of determining the approximate focal length of a lens.

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 **Greenweld 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 M23IM 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 slimline 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 multi-path 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, clasical 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 commerical 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 adddition 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.

THIS 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.

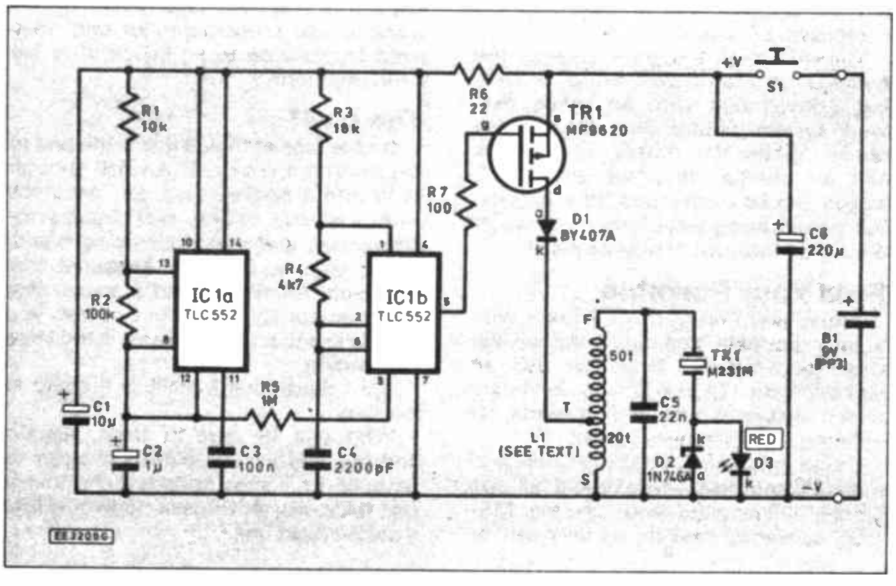
The low frequency oscillator is formed by IC1a which is half of a TLC552 oscillator i.c. This is a dual CMOS version of the familiar 555 timer i.c., the use of which gains very few marks for originality but succeeds in producing the necessary frequencies with a high degree of accuracy. This means that 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.

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



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 frequency 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 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 *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 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.

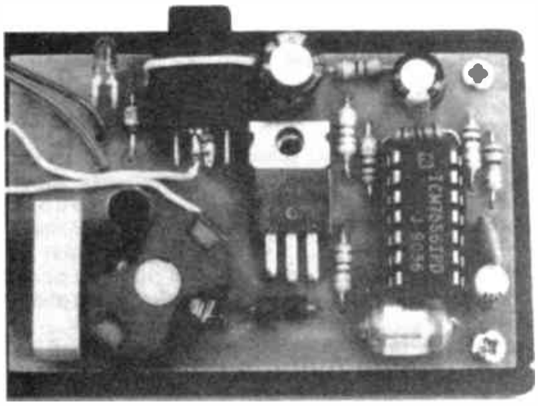
The greatest advantage of sweeping the frequency is that it ensures that the resonant frequency of the transducer is hit at some time during each sweep. Transducers vary from unit to unit and so this is a convenient way of allowing for this tolerance and getting good performance across the whole production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

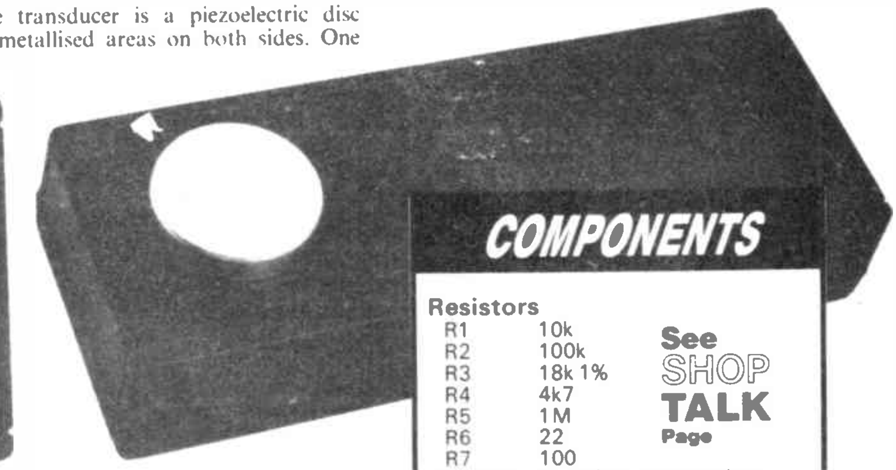
Electrically the transducer appears as a capacitor and so current can only pass when a.c. is applied. The current passing through the transducer is a good indication that the circuit is operating correctly and that the transducer is being driven with a.c.

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.

COMPONENTS

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 *p*-channel power MOSFET
IC1	TLC552 dual CMOS timer
TX1	M23IM ultrasonic transmitter (Magenta)

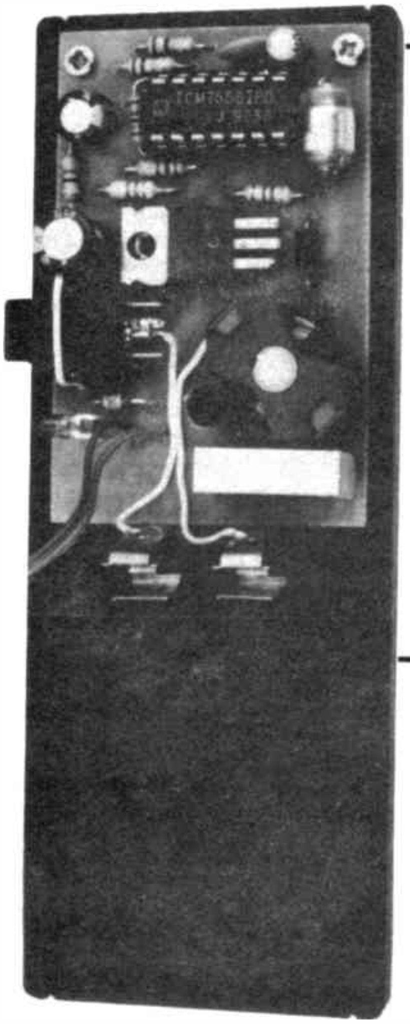
Miscellaneous

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 avialable form *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.

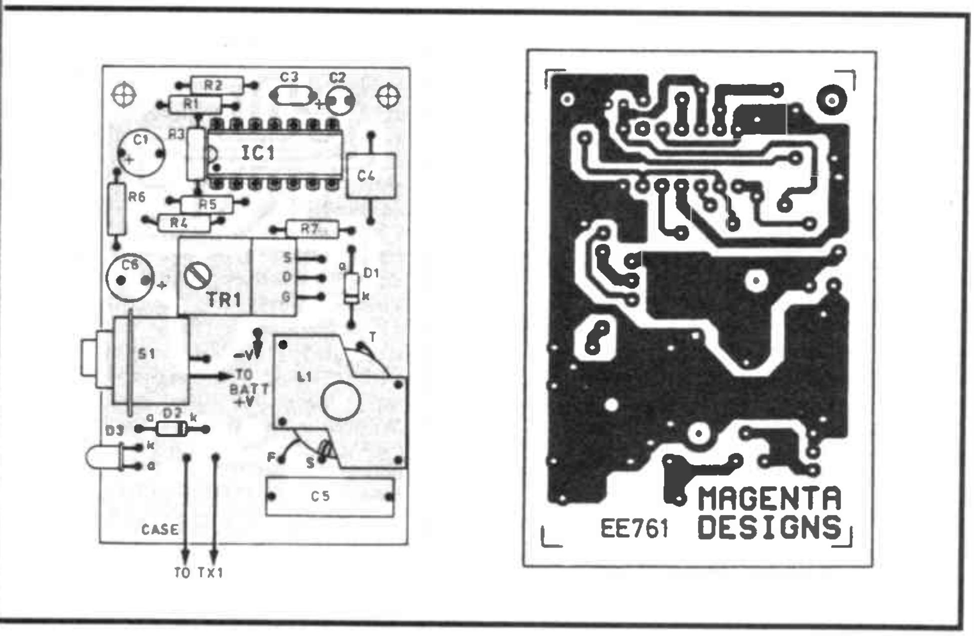


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The ferrite pot core, containing coil L1, must be secured to the board by a NYLON bolt.

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.

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 Superglue. 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 l.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 between 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 l.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.

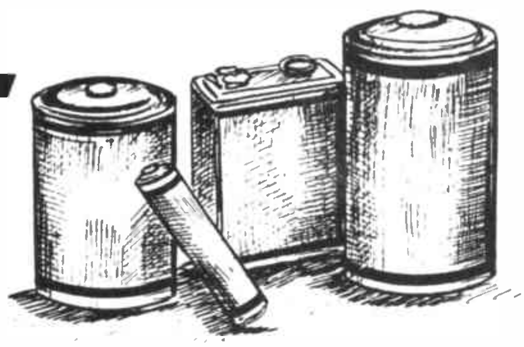
CONCLUSION

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. □

Special Feature

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"

IN 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

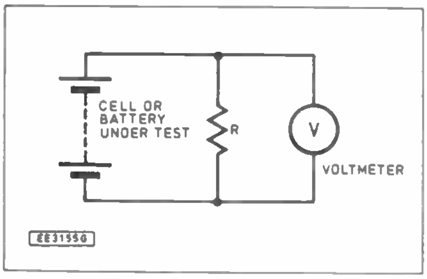


Fig. 1. Determining battery life.
For 1.5V cells R should be about 4.7Ω If the voltage is below 1V then the battery is in a poor condition. For 9V batteries R should be 100Ω. Voltages of about 6V indicate a flat cell.

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 Ohms 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.

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.

Table 2. Capacities for commonly used cells.

SIZE \ TYPE	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.

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

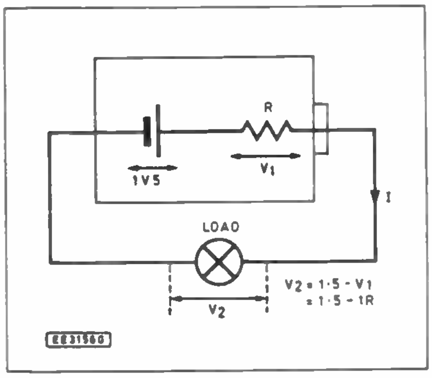


Fig. 2. A voltage source in series with a resistor (R) is a good analogy of the internal resistance of a cell. R is the internal resistance.

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 Lechlanche 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.

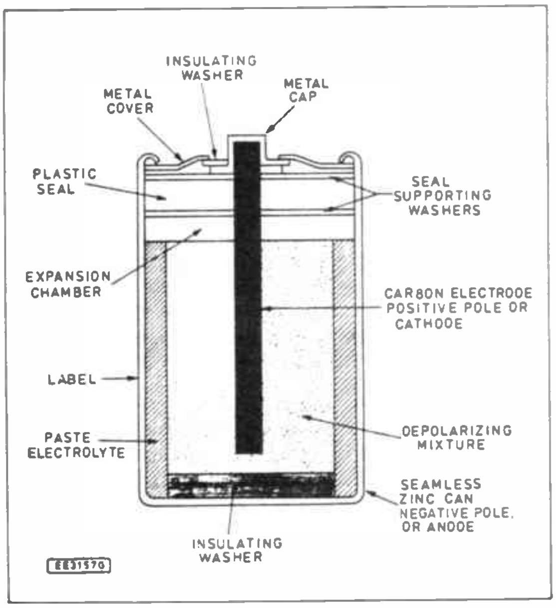
If during use the zinc fails to oxidise evenly the cell can rupture and the acidic electrolyte (zinc chloride and ammonium chloride) can leak. A leak can also occur if the cell is overdischarged by, say, leaving a radio on or inserting some fresh cells with weaker ones.

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. It's 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.

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.

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

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.

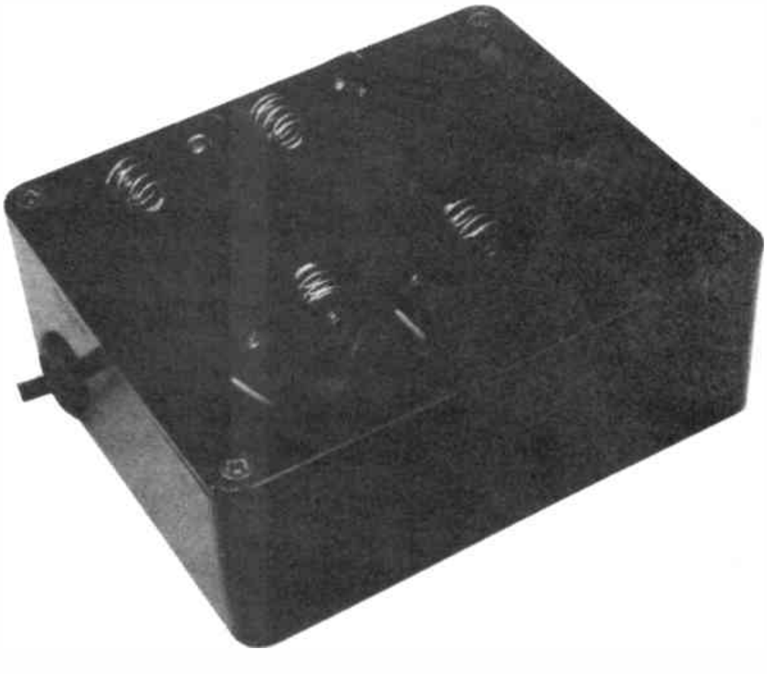
Use alkaline cells also for Motorised Toys, Cameras and CB Radios. Zinc chloride should be used for Clocks, Doorbells, and Calculators (provided they don't use PP3's or button cells). Zinc carbon should not be used in expensive equipment or left in equipment for long periods.

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.

Next Month: Recharging "dry cells". Build a low-cost Periodic Current Reversal (PCR) Charger.



Constructional Project

PEDOMETER

R. M. WORTHINGTON

A low-cost fun project that lets the l.e.d.s do the walking!!

A PEDOMETER measures the number of paces walked, giving a rough idea of the actual distance. Since this figure can only ever be approximate, the following low cost circuit should give quite acceptable results.

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.ds, 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)
R8	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)

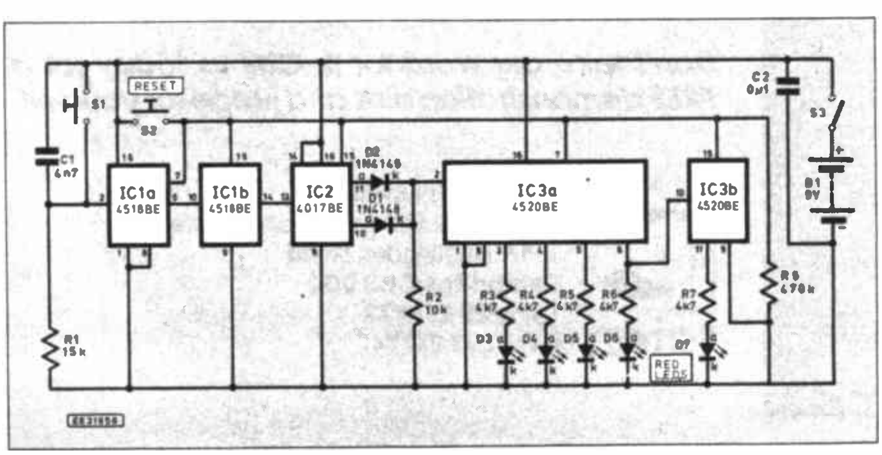
Miscellaneous

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..



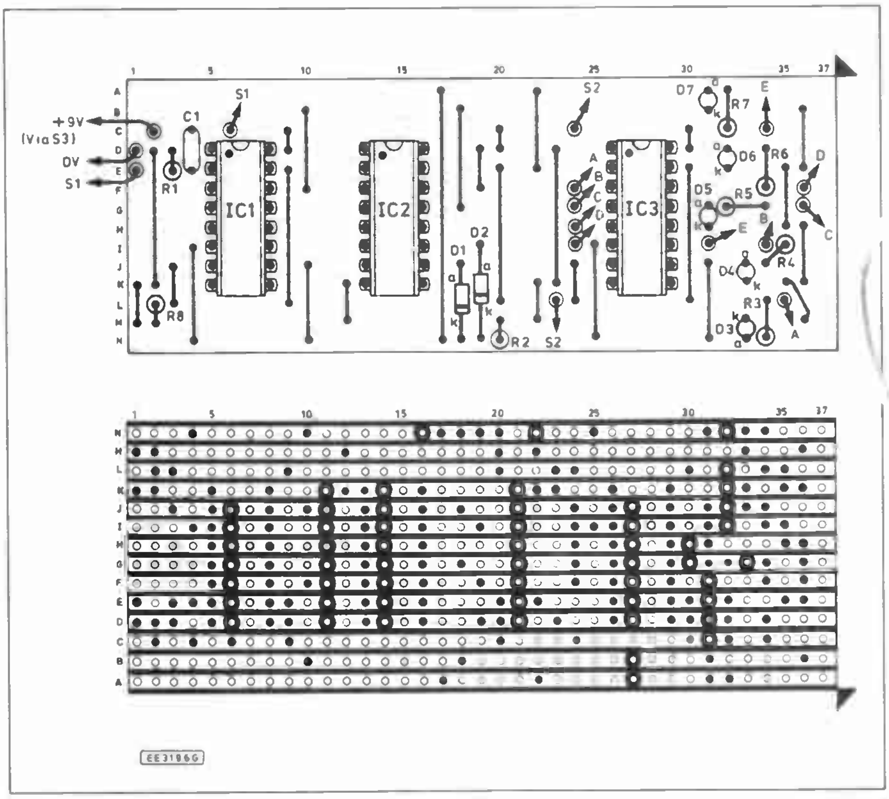
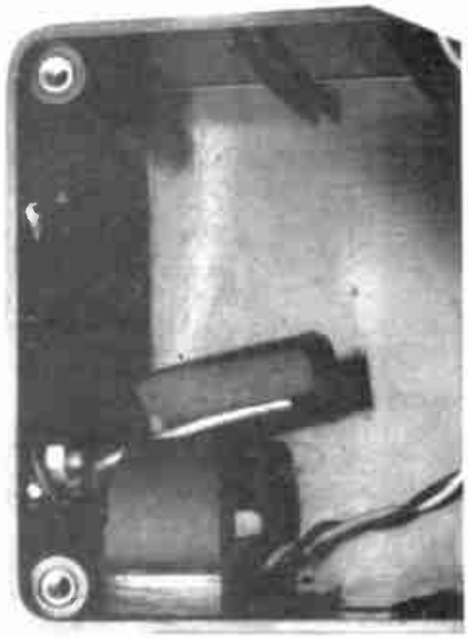


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. The lettered leads on the left of IC3 join up with identical letters on the right.



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.

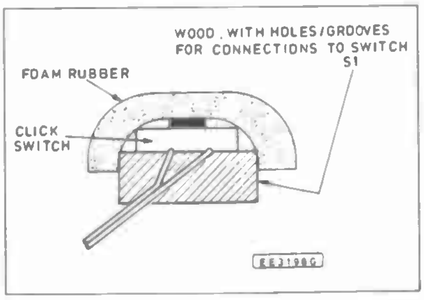


Fig. 4. The "pulse" switch S1 is mounted on a wooden block and covered with foam rubber.

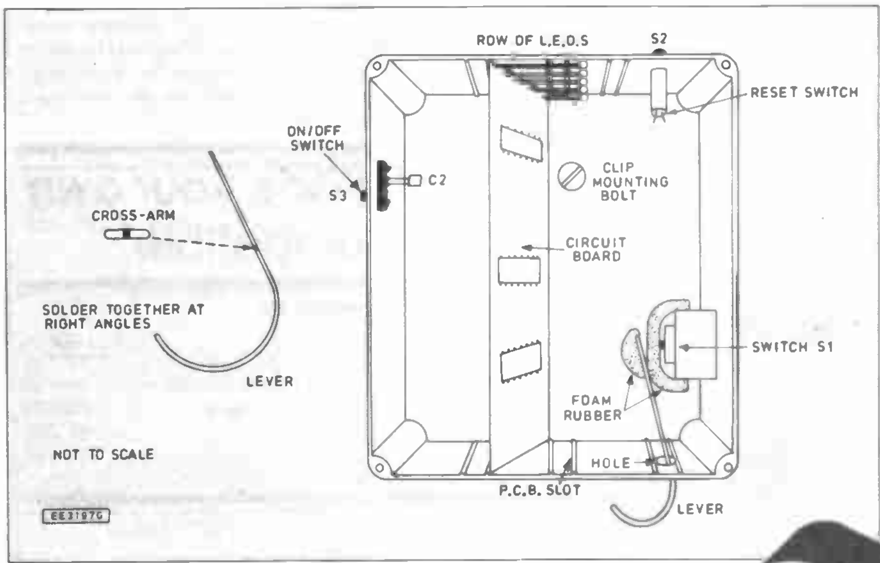


Fig. 3. Layout of components inside the case and details of the construction of the "trip" lever.

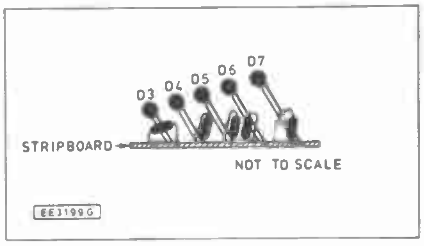


Fig. 5. Slanting the display l.e.d.s to align with holes drilled in the case.

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

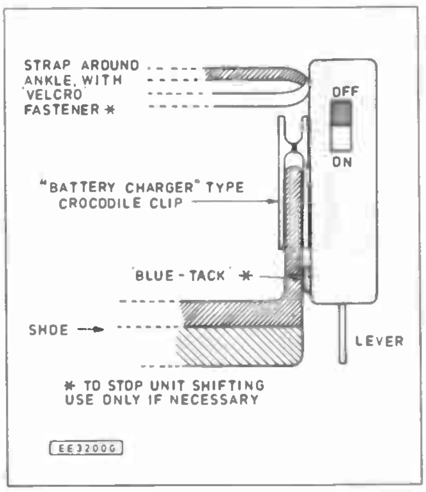
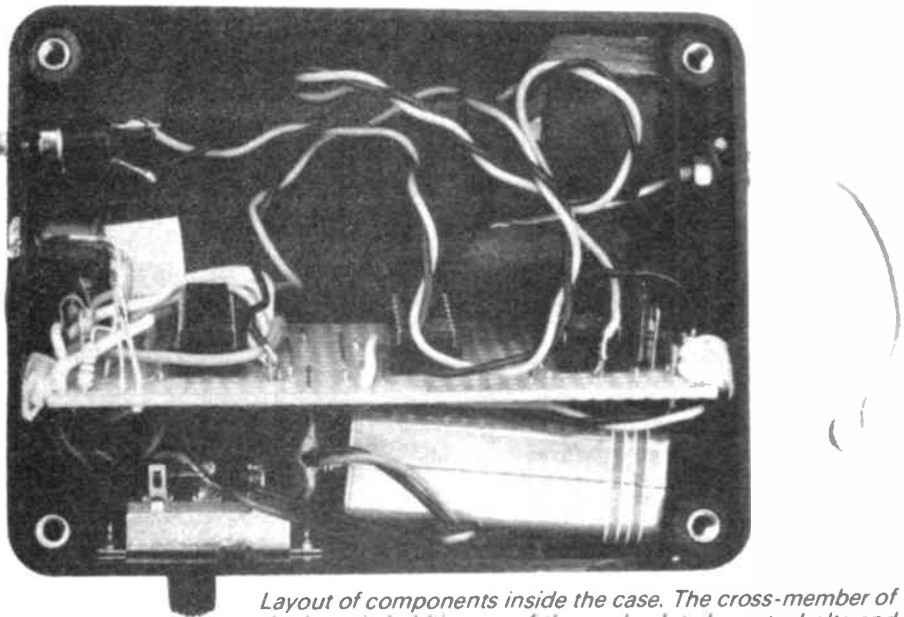
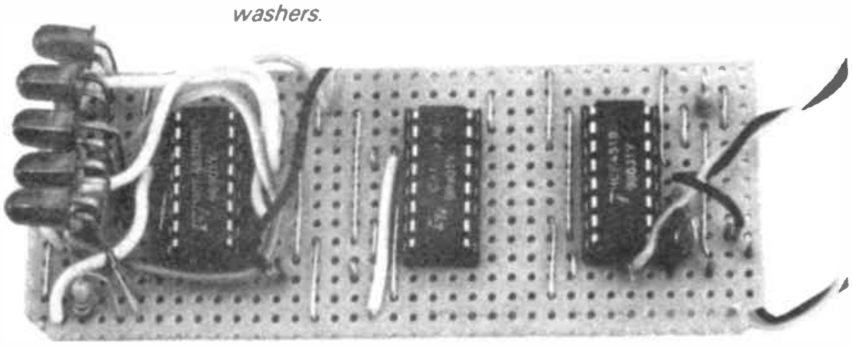


Fig. 6. One suggested method of securing the unit to the shoe and ankle.



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. □

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 carcase such as weight and configuration and adding vision information from a camera. The information 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 carcase 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 carcases 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 effecter design. Working from 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.

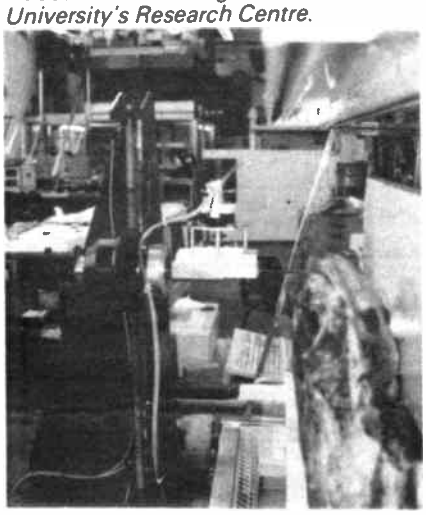
EAR DRILLING

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.

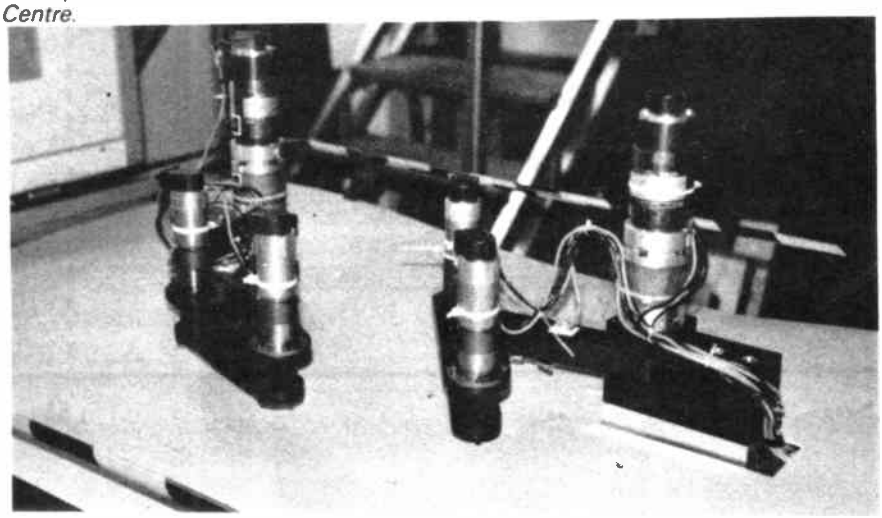
WALL CLIMBING

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.

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



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



SIMPLE MODEL SERIES SPECIAL EASIWIRE OFFER

FREE EASIWIRE IF YOU BUY ANY FOUR MODEL KITS OR EASIWIRE FOR £5 WHEN YOU PURCHASE A PROJECT KIT.

The two companies mentioned below have large stocks of Easiwire solderless wire wrapping systems, as used to build all our *Simple Model Series* projects. They have agreed to make these available to EE readers who purchase complete kits of components for the projects, **INCLUDING** printed cards to cut out and assemble for each model. If you are prepared to buy *any four* of the six model kits that kick off the series then you can get your Easiwire **FREE**.

If you buy *any one* model kit you can purchase an Easiwire kit for just **£5**. (These kits were previously advertised by BICC-Vero at £15, including p&p). To get your kit and Easiwire simply fill in the appropriate coupon and send it with your cheque (or credit card details) to *either of the companies*.

The six projects that kick off the series are: Police Car (July 91); Musical Roundabout (Aug 91); Micro Micro – a dolls house microcomputer (Sept 91); Centurion Tank (Oct 91); Mini Microwave - dolls house microwave oven (Nov 91); Christmas Novelty Decoration (Dec 91). These models all play tunes or make noises or flash lights etc. They will each cost about £8 or less to build, *the prices charged will be as given by EE in the "approximate cost box."*

All prices include VAT

All the kits will be available separately as the projects are published and the £5 Easiwire offer will be available with each kit when each project is published.

Please fill in the appropriate coupon below, tick the relevent boxes and send your cheque/PO/credit card number with *one* of the coupons to:

GREENWELD ELECTRONIC COMPONENTS
27 PARK ROAD,
SOUTHAMPTON SO1 3TB
Tel: 0703 236363
Fax: 0703 236307

OR

BULL ELECTRICAL
250 PORTLAND ROAD,
HOVE, SUSSEX
BN3 5QT
Tel: 0273 203500
Fax: 0273 23077

SEND EITHER COUPON TO EITHER COMPANY - YOU CHOOSE YOUR SUPPLIER

Overseas readers please add £3 to cover the extra postage charge.

FREE EASIWIRE

Please send me my FREE Easiwire kit. I understand that I must buy four model kits at the price given by EE –

I enclose a cheque/PO for £20 for the kits ticked below *and* as a deposit on further kits ☐

Please debit my credit card as each kit is sent ☐

Card No. ....

Ex. Date.................. Signature..............................

The kits I require are: (Tick four *or more* boxes.)

- Police Car (July '91)........ £5.95 plus £1 p&p ☐
- Musical Roundabout (Aug '91)........ £7.95 plus £1 p&p ☐
- Micro Micro (Sept '91)........ plus £1 p&p ☐
- Centurion Tank (Oct '91)........ plus £1 p&p ☐
- Mini Microwave (Nov '91)........ plus £1 p&p ☐
- Christmas Novelty (Dec '91)........ plus £1 p&p ☐

Name..............................

Address..............................

....

£5 EASIWIRE

Please supply the Roundabout Kit on its own at £7.95 plus £1 p&p ☐

Please supply an Easiwire at £5 with the above kit ☐

Overseas readers please add £3 to cover the extra postage charge.

I enclose a cheque/PO for £.............. (£8.95 or £13.95) ☐

Please charge my credit card – ☐

Card No. ....

Ex Date ....

Signature ....

Name ....

Address ....

....

....

FLASH! BLEEP!!

MUSICAL ROUNDABOUT

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.

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

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.

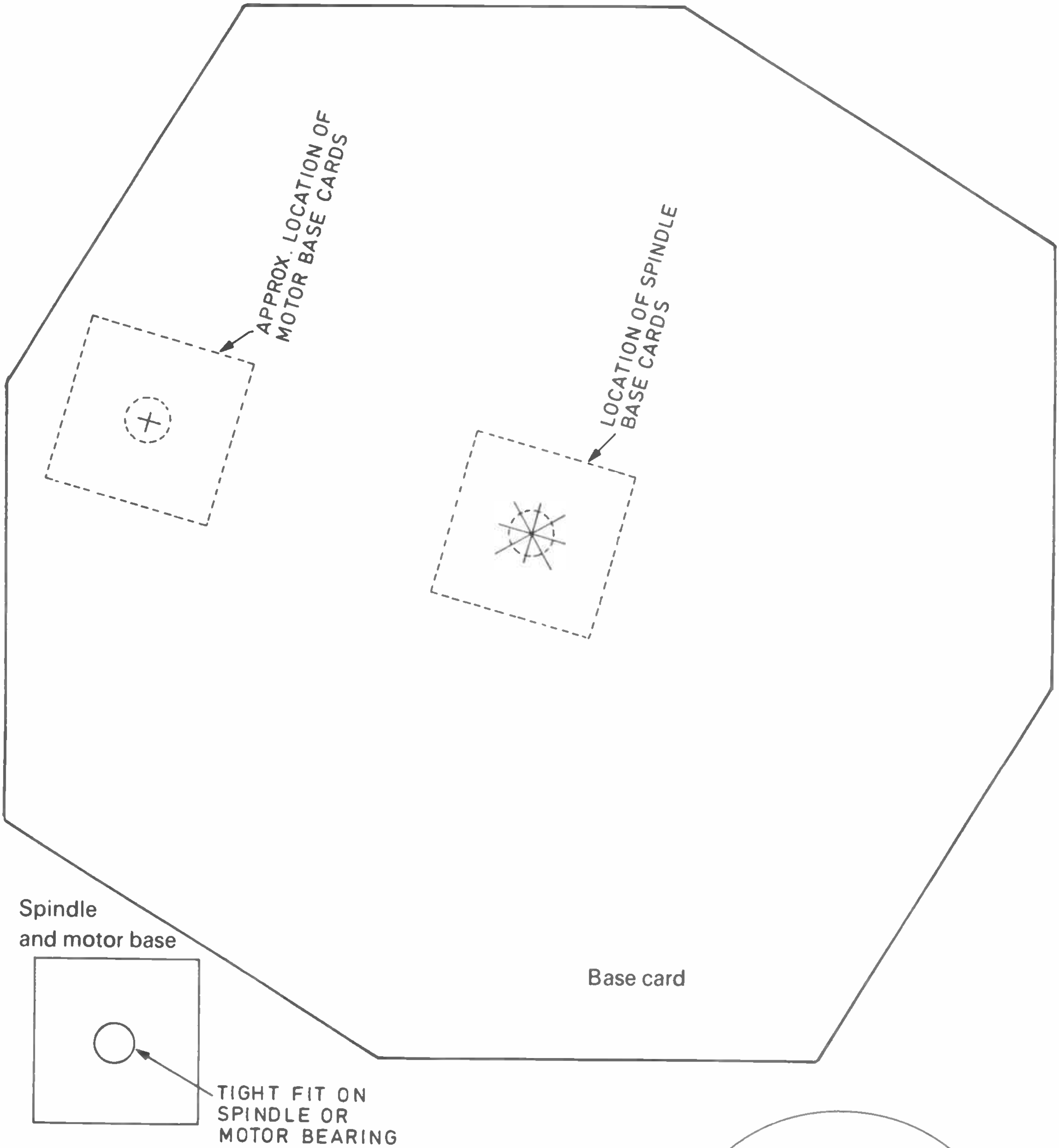
We continue this new series of electronically enhanced models with something to amuse the younger members of the family. It might evoke a little nostalgia in Mum and Dad too.

MUSICAL ROUNDABOUT

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^2) 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.



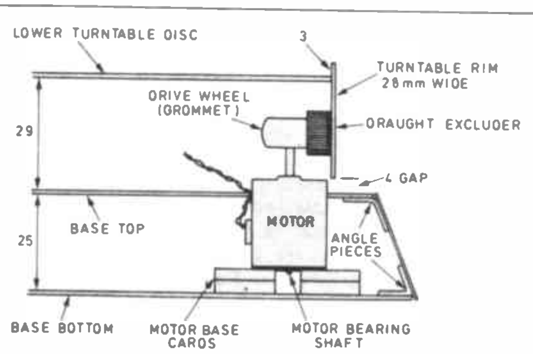
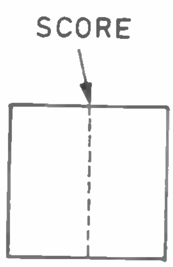
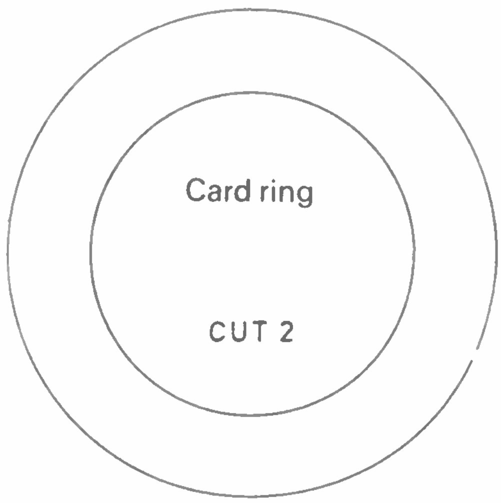
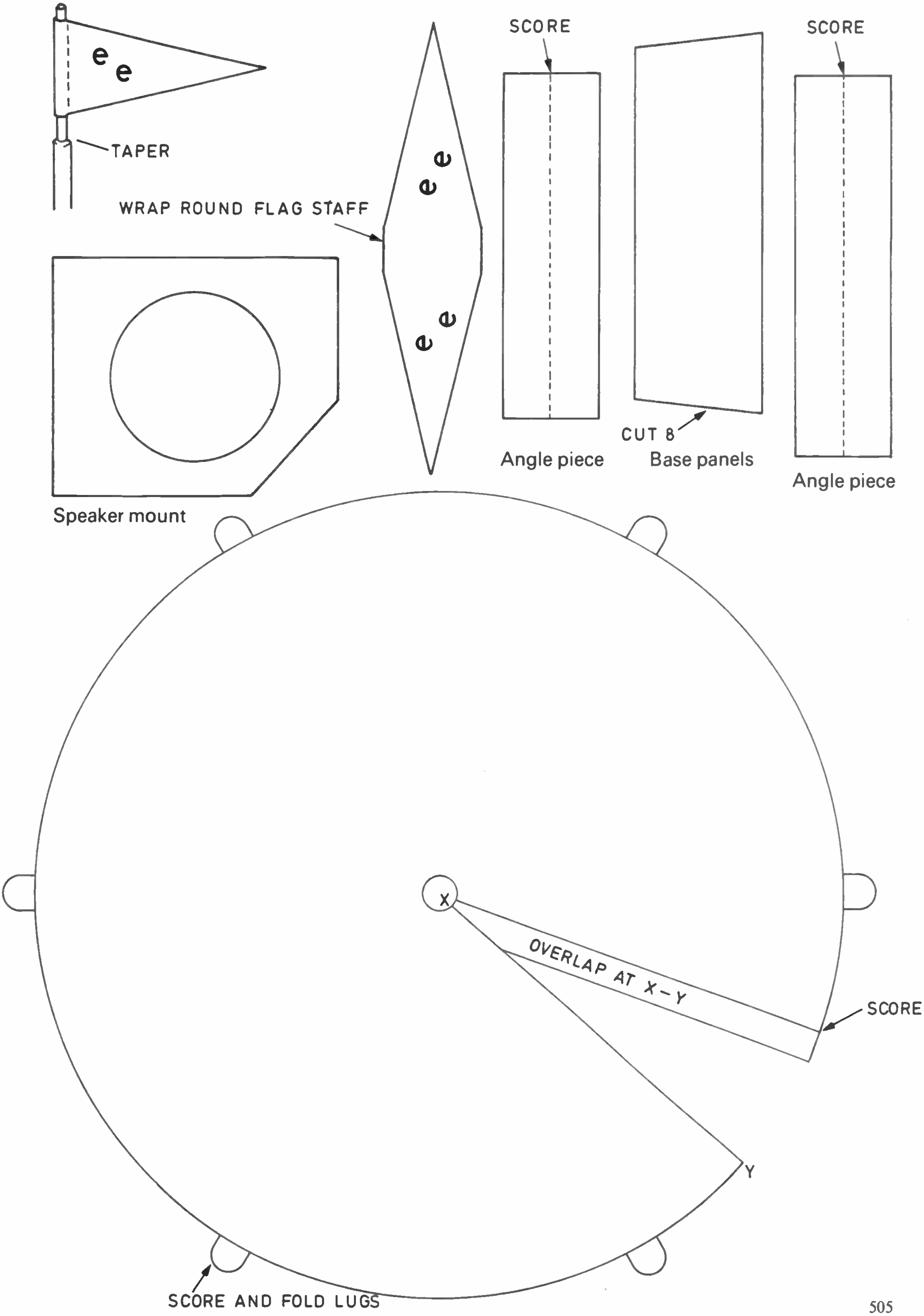


Fig. 1. Drive arrangements for the roundabout

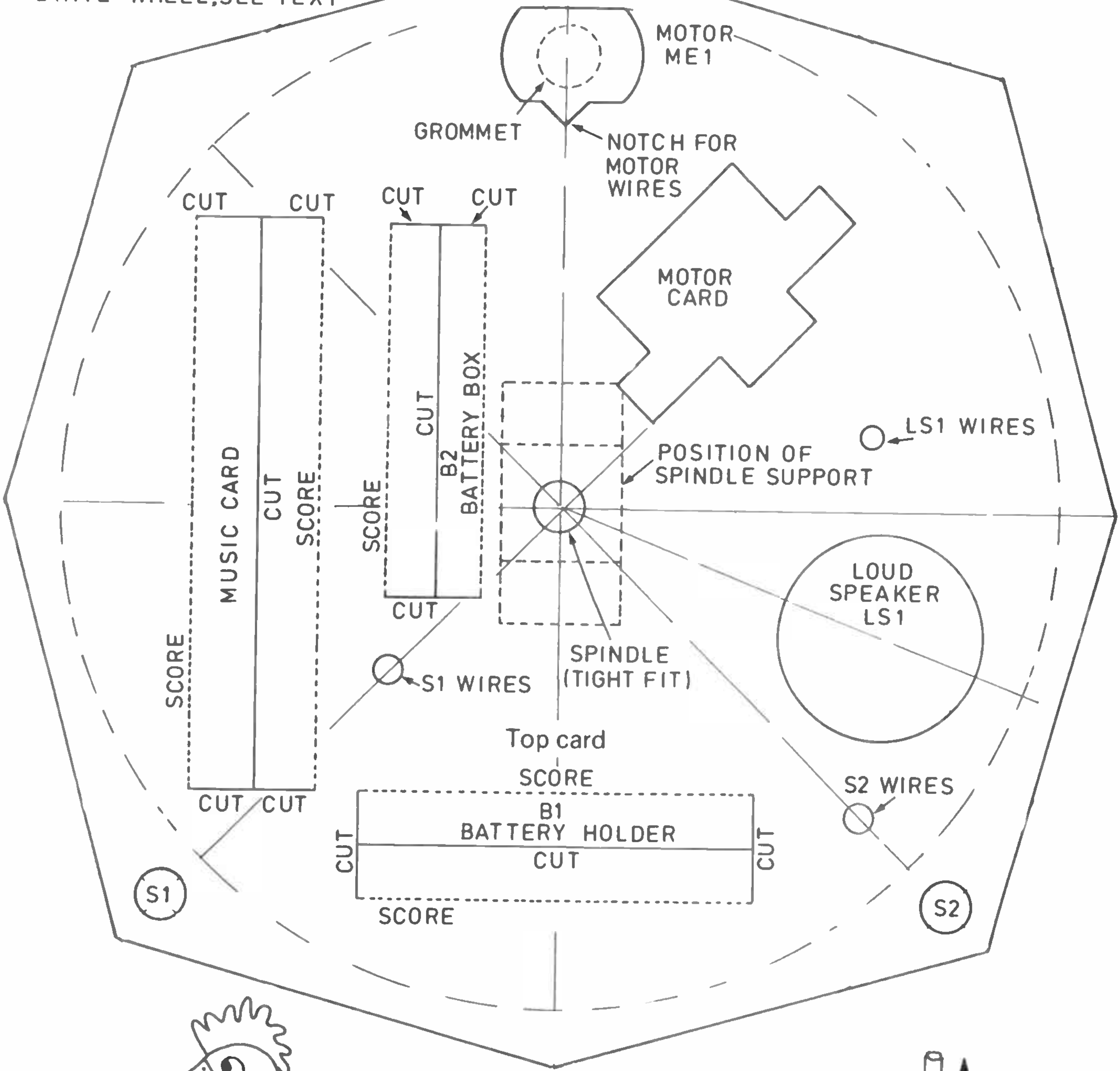
Angle piece

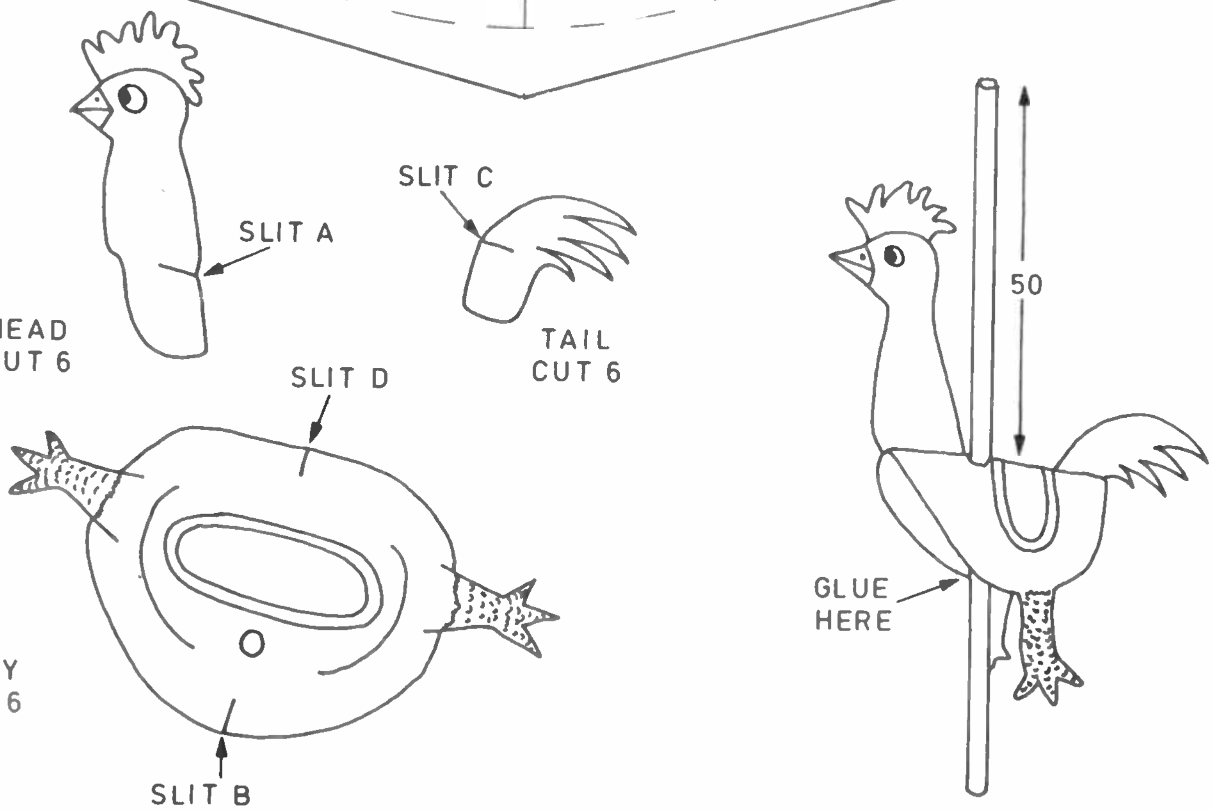


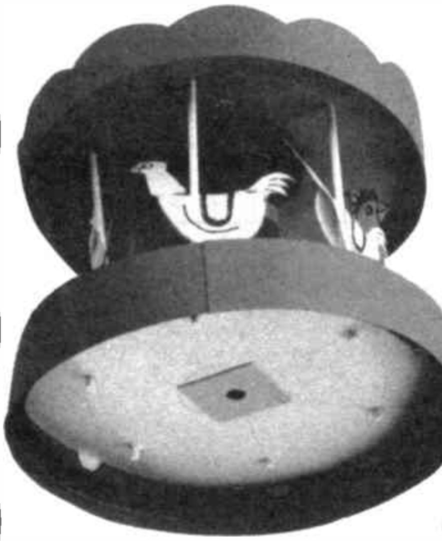


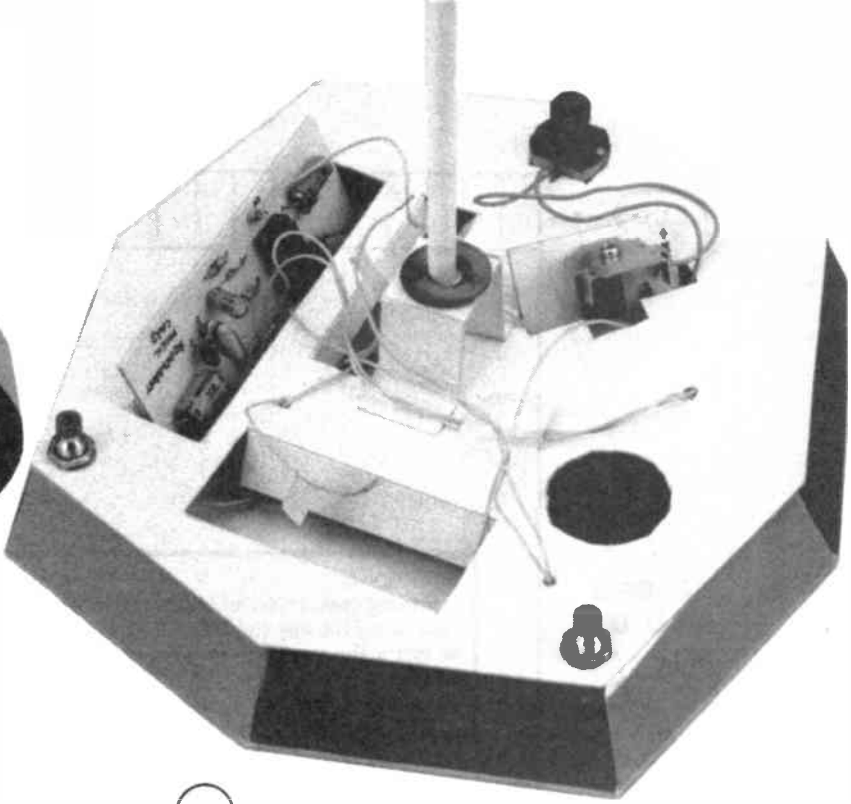

TAPER
WRAP ROUND FLAG STAFF
SCORE
SCORE
CUT 8
Angle piece
Base panels
Angle piece
Speaker mount
X
OVERLAP AT X – Y
SCORE
Y
SCORE AND FOLD LUGS

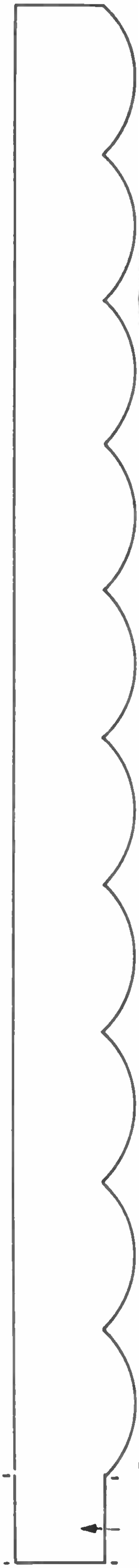
NOTE :– MOTOR POSITION MAY VARY. DEPENDING ON SIZE OF DRIVE WHEEL, SEE TEXT

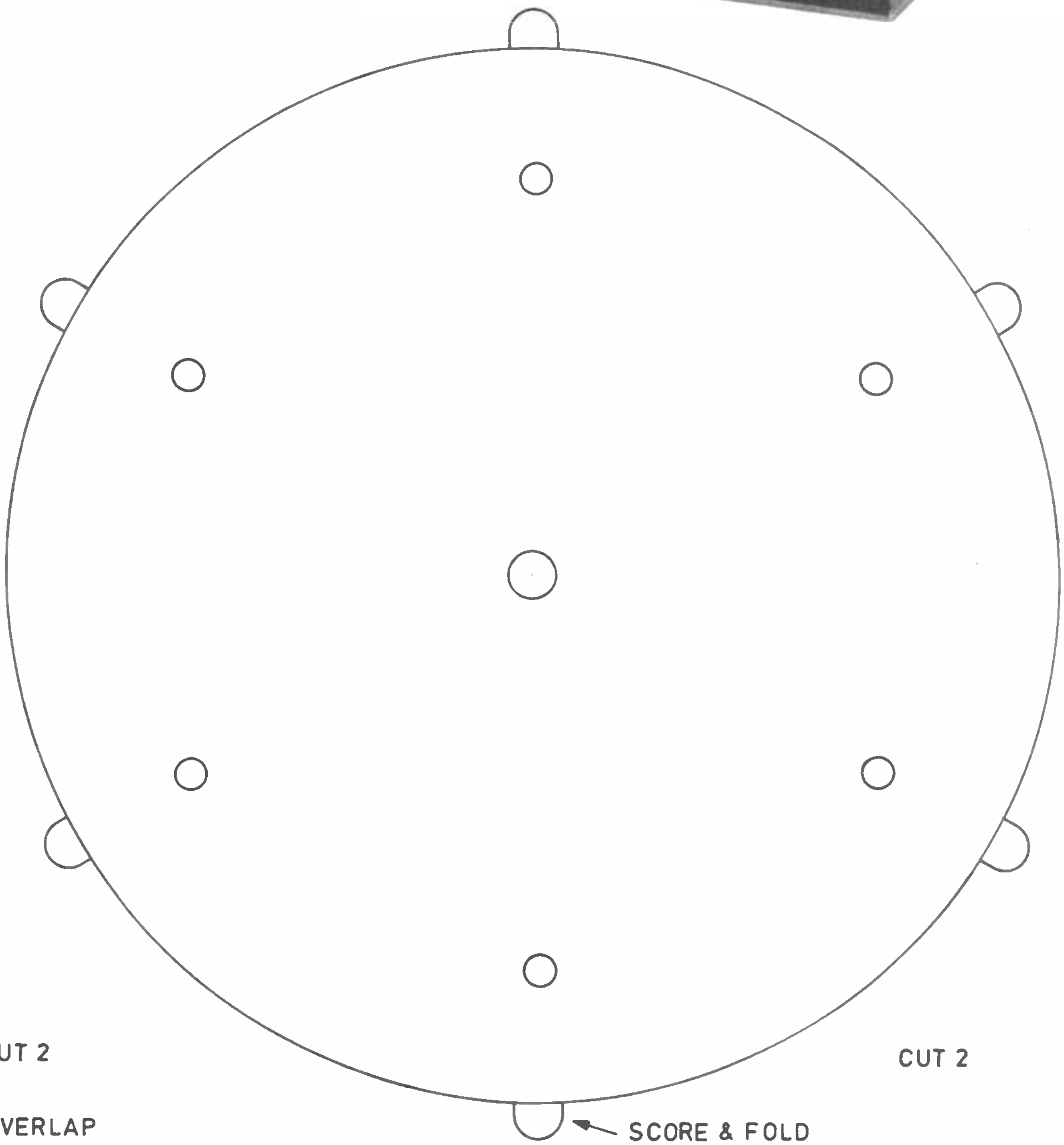


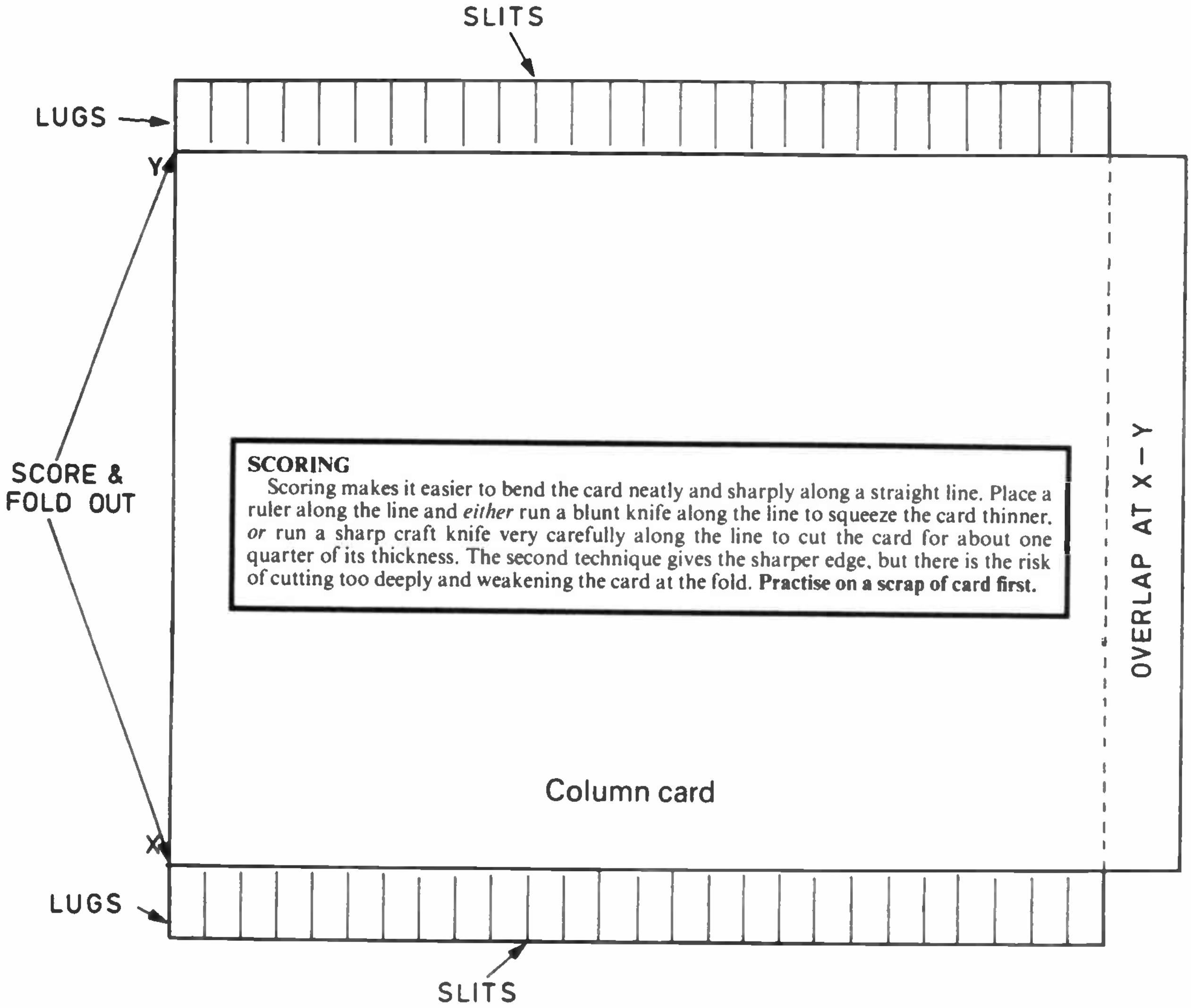







CUT 2
OVERLAP


CUT 2
SCORE & FOLD



SCORING
Scoring makes it easier to bend the card neatly and sharply along a straight line. Place a ruler along the line and *either* run a blunt knife along the line to squeeze the card thinner, *or* run a sharp craft knife very carefully along the line to cut the card for about one quarter of its thickness. The second technique gives the sharper edge, but there is the risk of cutting too deeply and weakening the card at the fold. **Practise on a scrap of card first.**

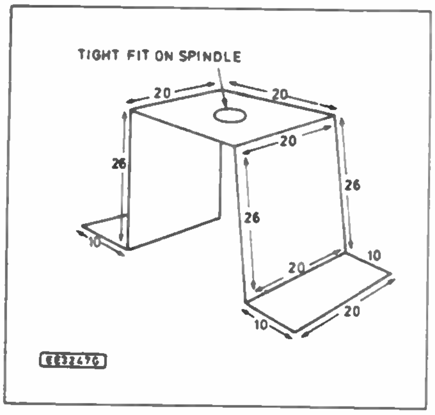


Fig. 2. Spindle Support construction.

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

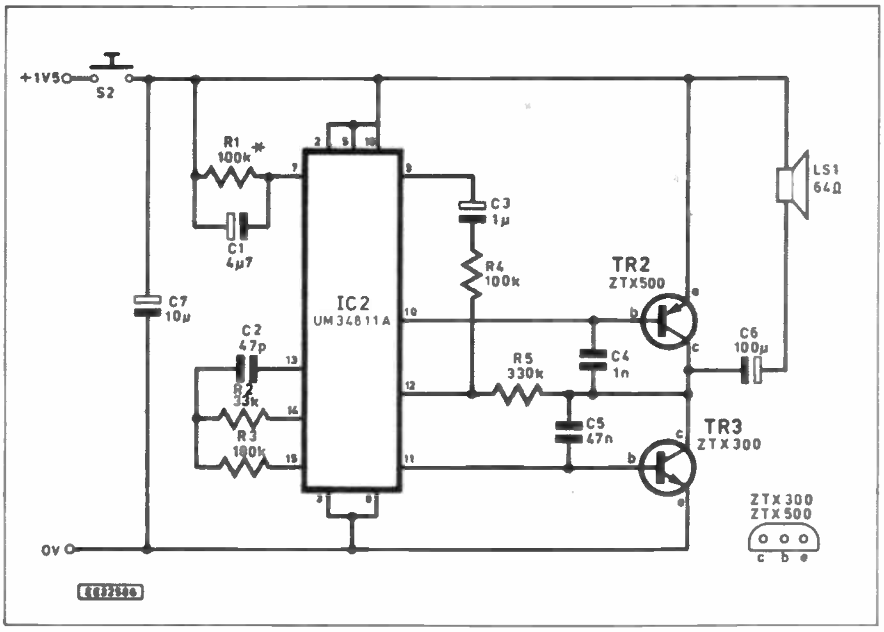


Fig. 3. Musical circuit.

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 "footrests" 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.

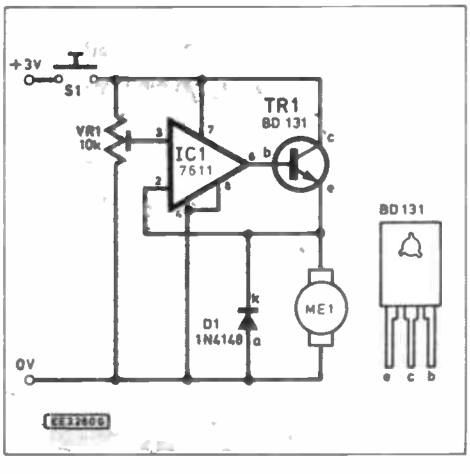


Fig. 4. Motor control circuit.

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 *npn* high power transistor
TR2	ZTX500 *pnp* transistor
TR3	ZTX300 *npn* transistor
IC1	7611 CMOS operational amplifier
IC2	UM3481 1A 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/m²), piece of medium card (800g/m²), about 250mm x 300mm, piece of thick card (1200g/m²), about 250mm x 300mm – or printed model card (see Shop Talk and Special Offer page) *plus* four sheets of plain 400g/m² 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**

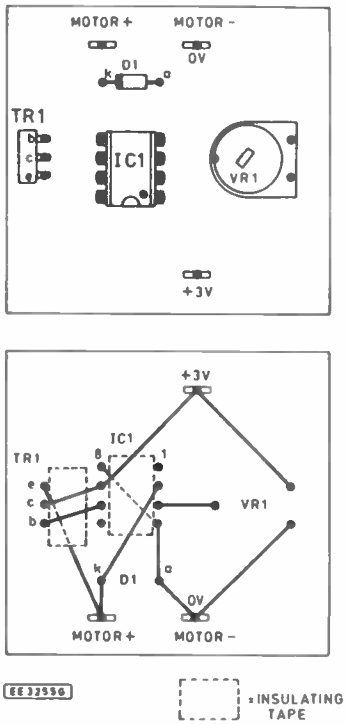


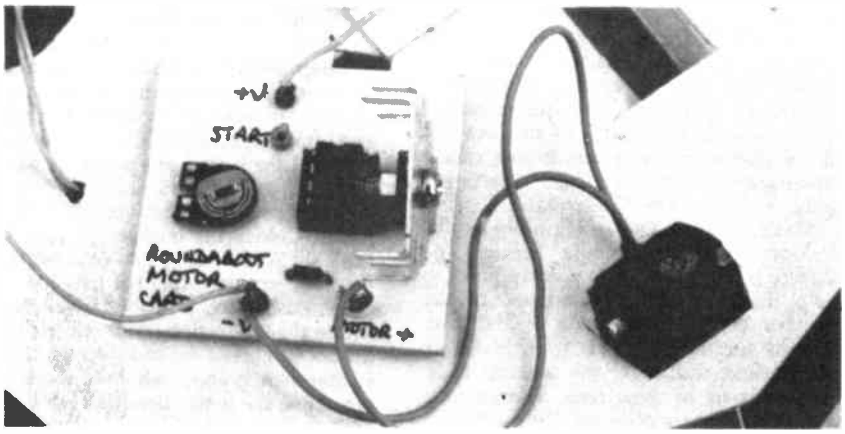
Fig. 5. Motor Control circuit card.

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 *pnp* transistor but TR3 is an *npn* 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-



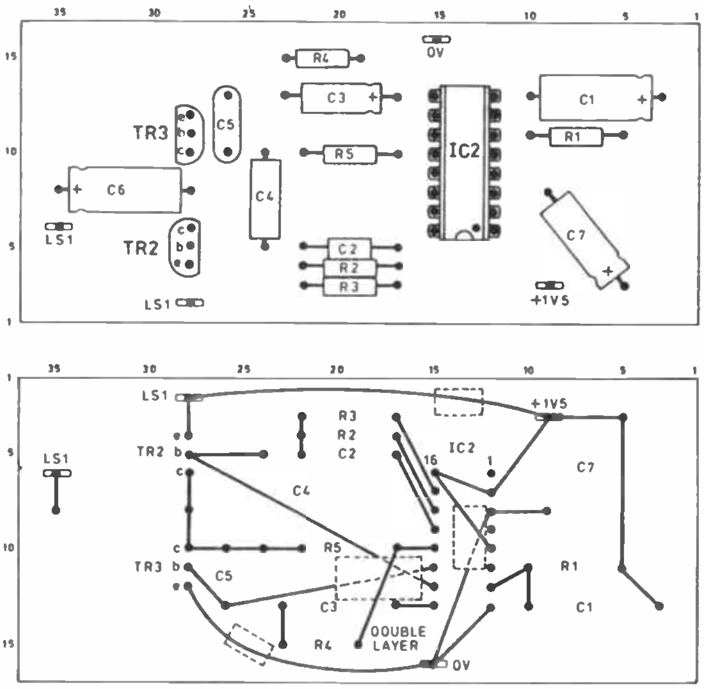


Fig. 6. Layout and wiring of the Music Card.

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.

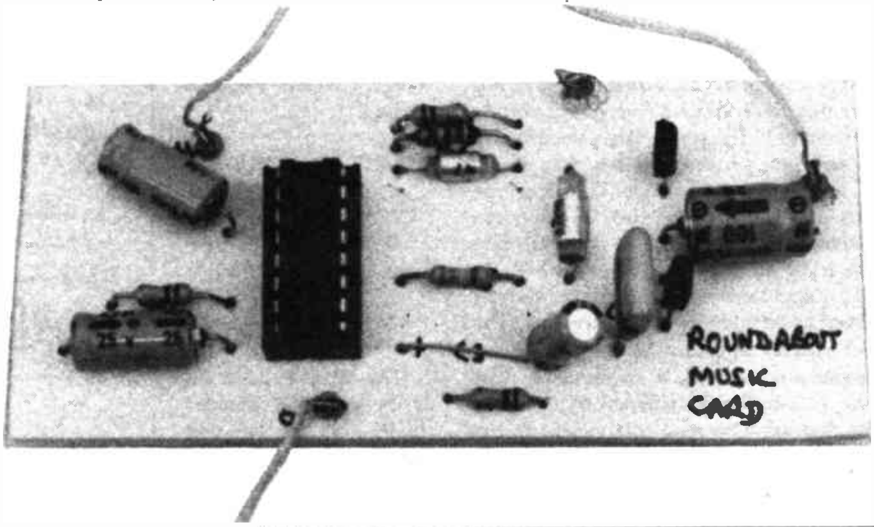
Wire-wrapping joints are surprisingly strong and survive normal handling. To make them more secure, spray the completed board with a printed circuit lacquer.

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 oscilloscope, 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. □



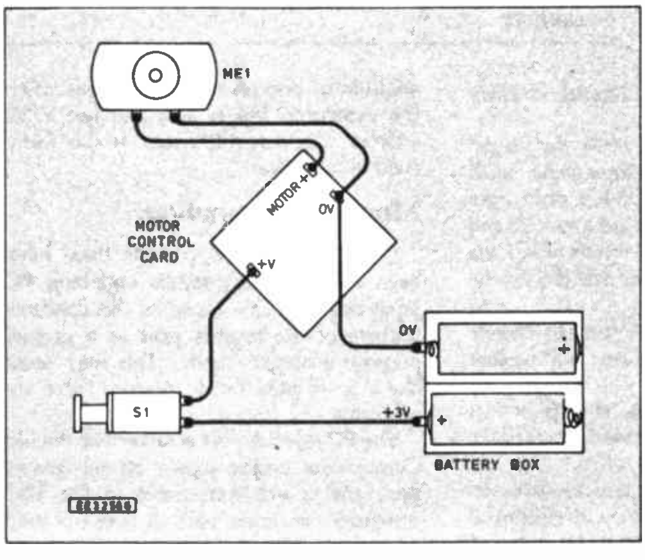


Fig. 7. Wiring of the motor circuit.

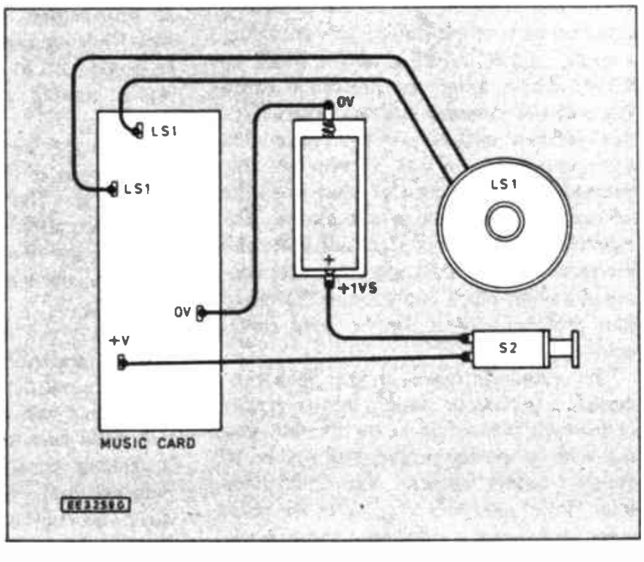


Fig. 8. Wiring of the music circuit.

INTERFACE

Robert Penfold

AS 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 UK.

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 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.

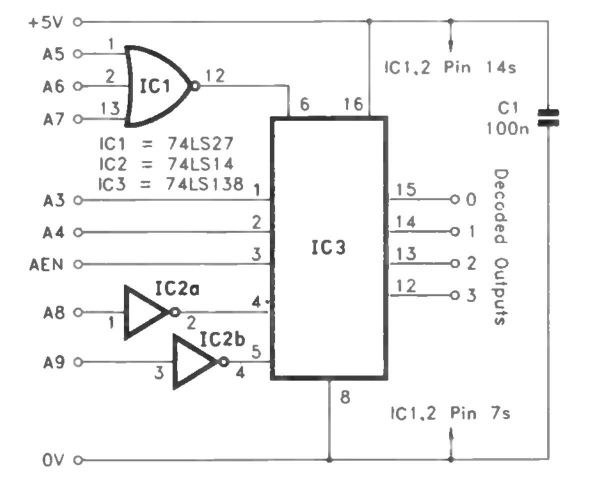


Fig. 1. PC address decoder which provides four outputs.

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.

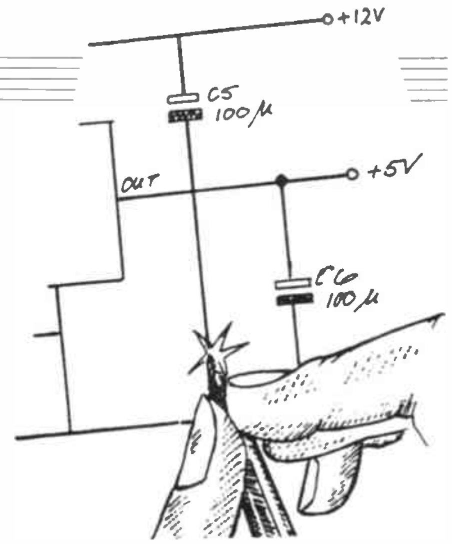
Function 4 is used to set the mouse pointer position. It is normally used at the start of a program to centre the pointer on the screen, if this is not done by calling function 0.

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.



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.	$\gamma_{(PEAK)}$	$\theta_{(TYP)}$
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.

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 $I_{F(TYP)}$)
$\gamma_{(PEAK)}$ = wavelength of peak response
$\theta_{(TYP)}$ = typical viewing angle

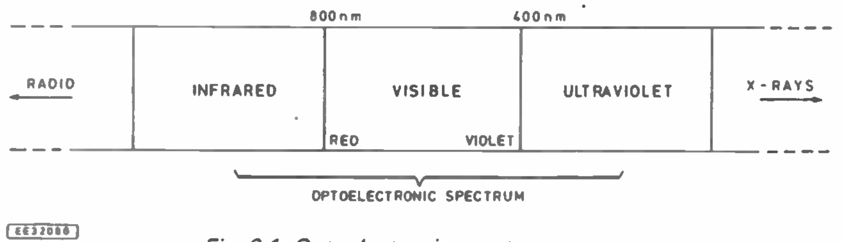


Fig. 9.1. Optoelectronic spectrum.

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

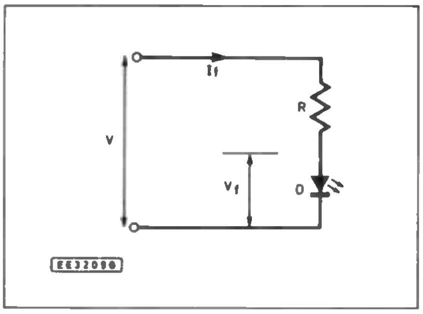


Fig. 9.2. Basic circuit of an l.e.d. indicator.

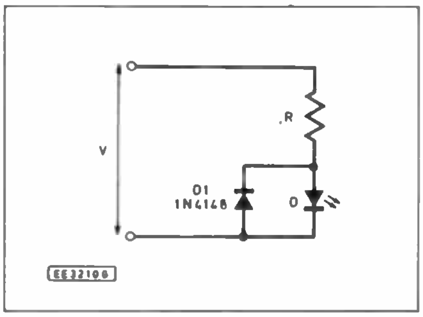


Fig. 9.3. L.E.D. indicator for a.c. voltages.

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

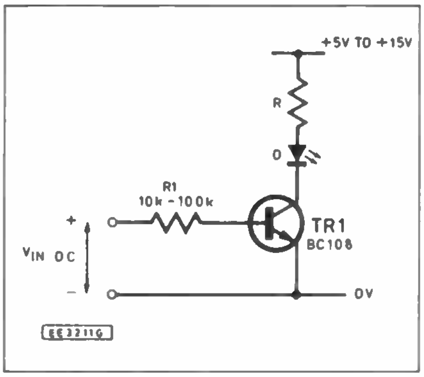


Fig. 9.4. L.E.D. signal indicator.

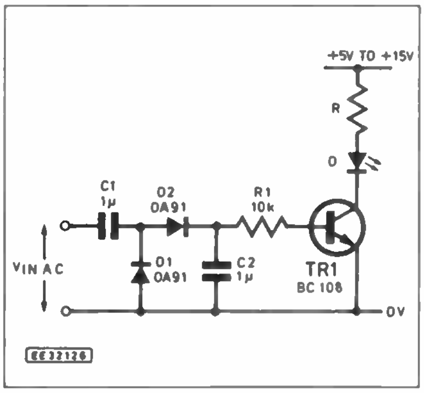


Fig. 9.5. Signal indicator for audio signals.

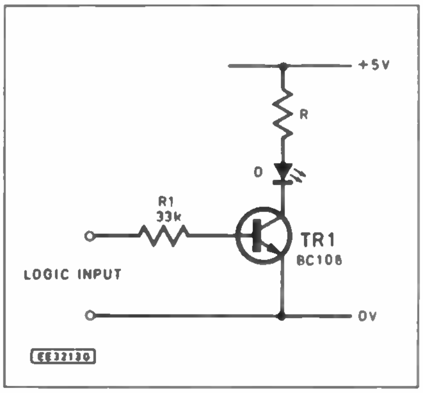


Fig. 9.6. Logic indicator using a transistor driver.

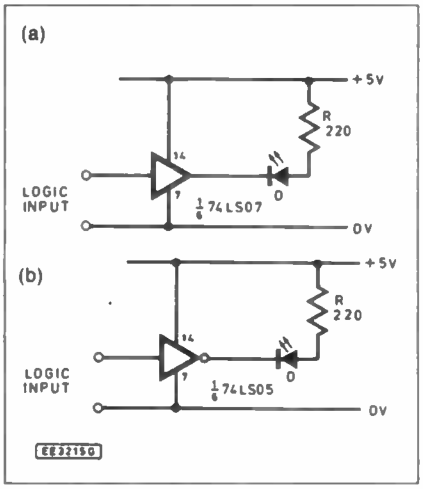


Fig. 9.7(a) Logic indicator (logic 0 to operate) (b) Logic indicator (logic 1 to operate).

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.

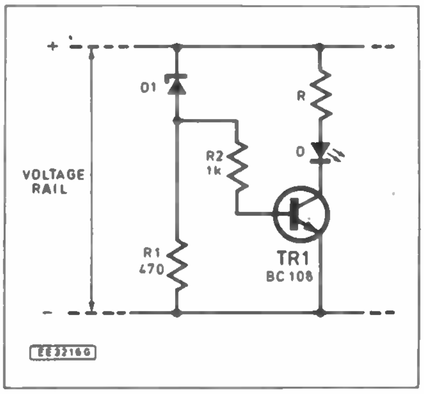


Fig. 9.8. Over-voltage sensing circuit.

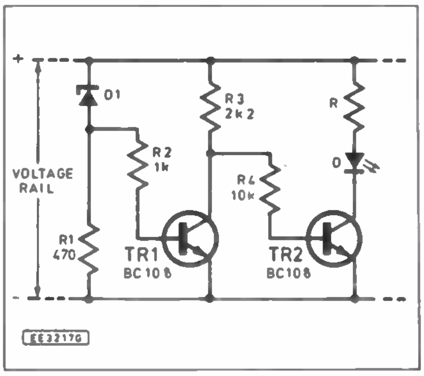


Fig. 9.9. Battery level indicator.

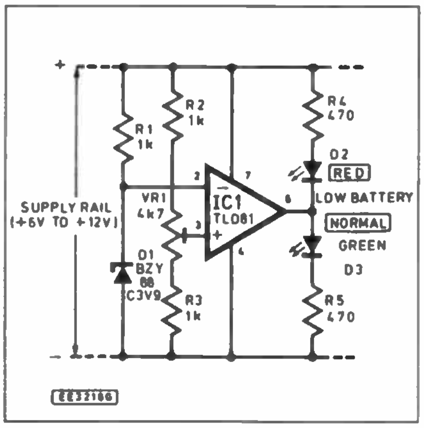


Fig. 9.10. Improved battery level indicator.

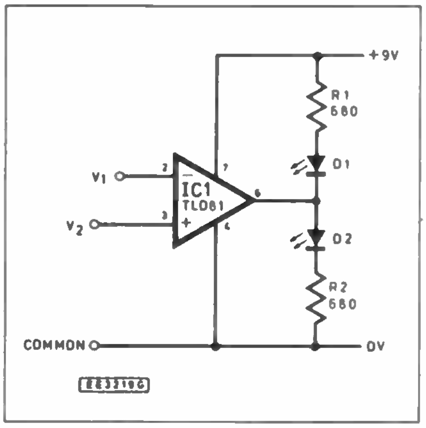


Fig. 9.11. Voltage comparator.

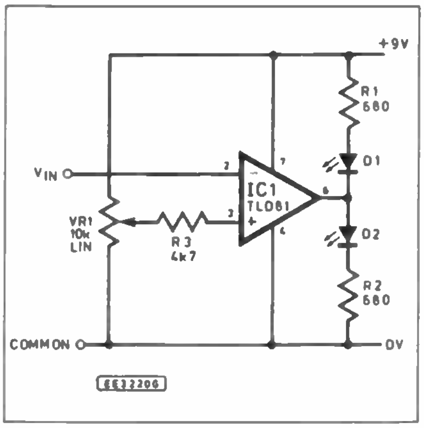


Fig. 9.12. Modification to Fig. 9.11 to provide a variable reference voltage.

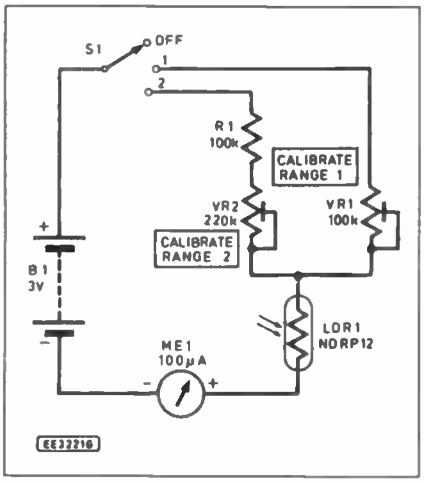


Fig. 9.13. Simple light meter based on an LDR.

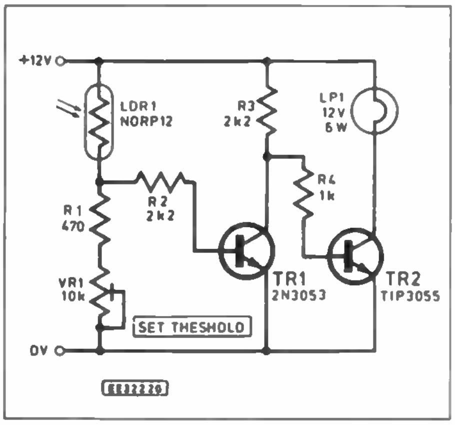


Fig. 9.14. Automatic parking light based on an LDR.

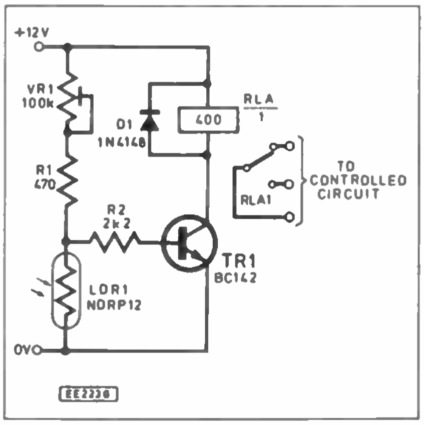


Fig. 9.15. Simple light operated switch.

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" 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 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.

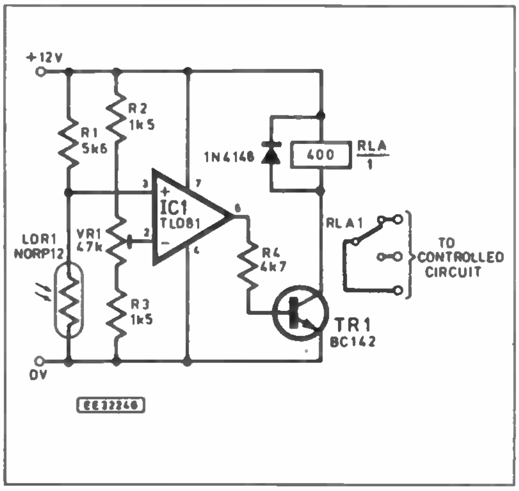


Fig. 9.16. Improved light operated switch.

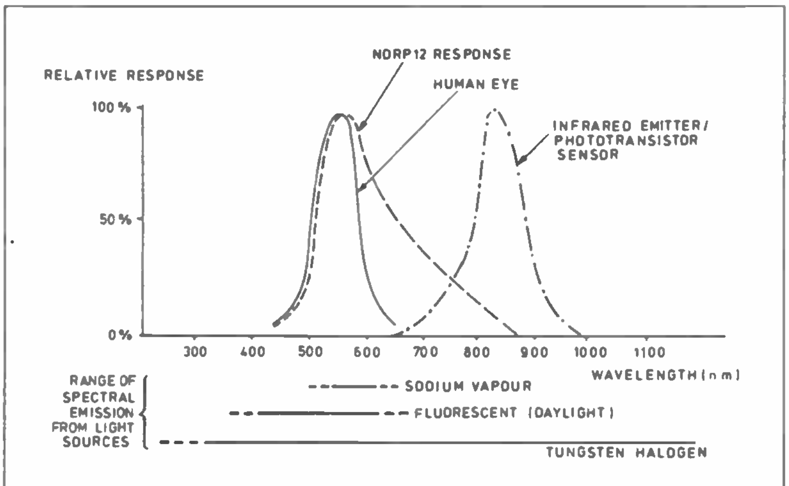


Fig. 9.17. Comparative response of photo-sensing devices.

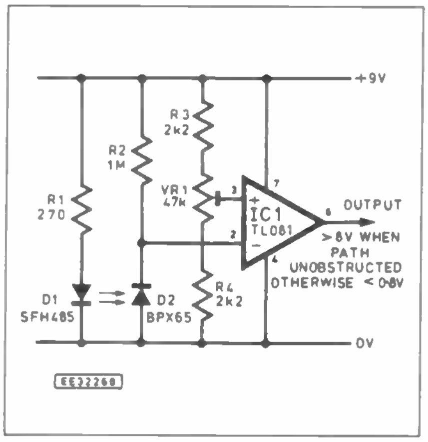


Fig. 9.18. Object sensor based on a photodiode.

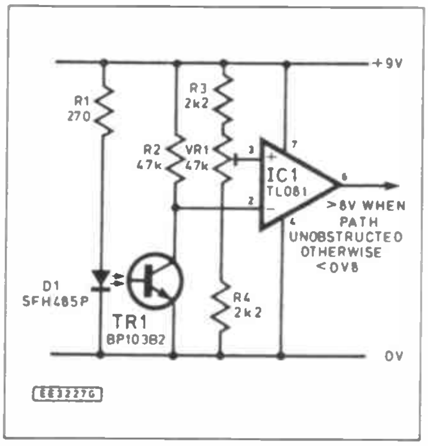


Fig. 9.19. Object sensor based on a phototransistor.

COMPONENTS

Resistors
R1 330 (see text)
R2 2k2 0.25W
R3 270 0.25W
All ± 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**

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.

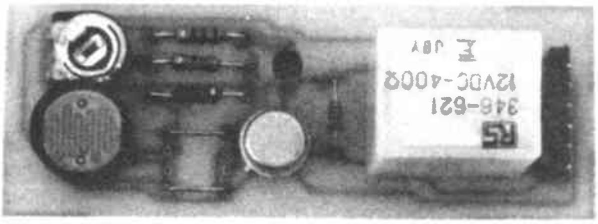
The circuits in Figs. 9.18 and 9.19 show simple interrupted light beam object sensors based on infrared emitters and a photodiode and phototransistor, respectively.

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)



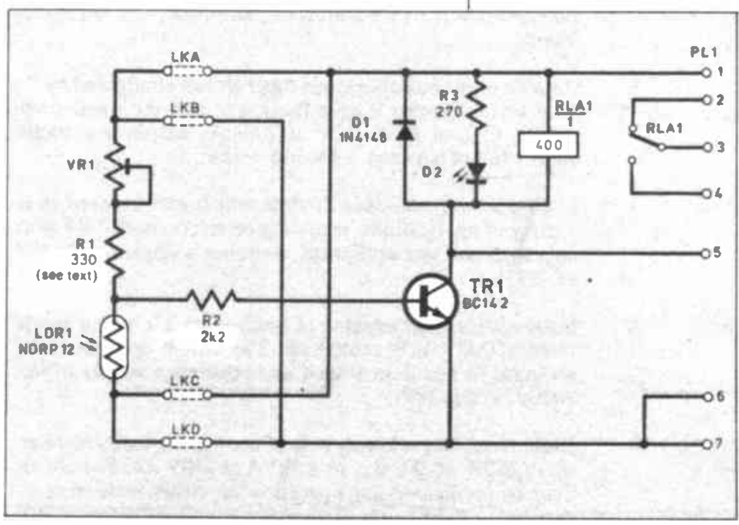


Fig. 9.20. Complete circuit diagram for the Light Sensitive Switch module.

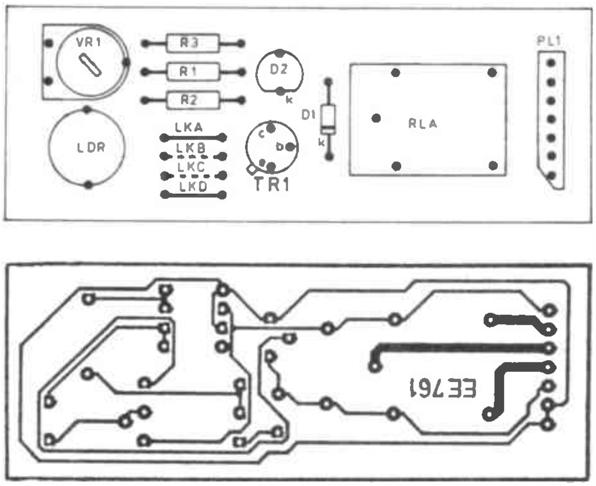


Fig. 9.21. P.C.B. track and component layout for the Light Sensitive Switch module.

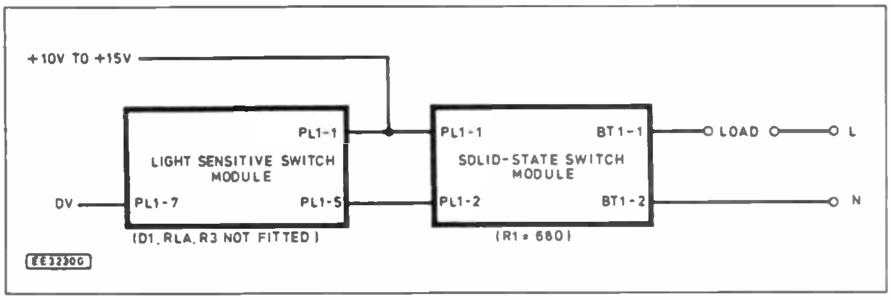


Fig. 9.22. Using the Light Sensitive Switch module in conjunction with the Solid-state Switch module.

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)

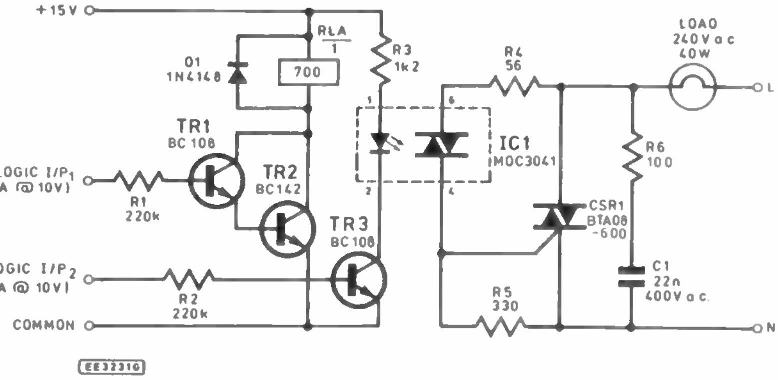
Cumulative index to modules

Title	Part	Function/specification
Dual output power supply module	1	Dual ± 5V, ± 12V or ± 15V regulated power supply rated at 1A max. output
723 variable power supply module	1	Single variable output of + 2V to + 37V at up to 5A max. Output voltage and current limit are set by means of preset controls.
L200 variable power supply module	1	Single variable output of + 2.7V to + 35V at up to 2A max. Inutput voltage and current limit are set by means of variable controls.
General purpose transistor amplifier module	2	Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.
General purpose operational amplifier module	2	Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between ± 5V and ± 15V at 10mA nominal.
High-quality power amplifier module	3	Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between ± 12V and ± 20V at up to 2A.
TBA820 i.c. amplifier	3	Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between + 5V and + 15V.
Sine wave oscillator	4	Low distortion sine wave oscillator capable of providing outputs over the range 50Hz to 50kHz. Frequency and amplitude adjustable. Requires + 12V to + 15V supply at 10mA (nominal).
8038 waveform generator	4	Provides sine, square and triangle outputs adjustable the range 0.01Hz to 20kHz. Requires ± 9V supply at 10mA.
Digital counter module	5	Single stage decade counter with seven-segment l.e.d. display. Standard TTL input levels. Requires + 5V supply at 90mA.
General purpose timer module	6	Astable or monostable mode timer circuit configured by wire links. Extenal 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 100µA 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

The following books have been reprinted from various Teach-In Series and will be of particular interest to many readers of this series. See our Direct Book Service pages for full ordering details.

ELECTRONICS TEACH-IN 88/89– INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)

ELECTRONICS TEACH-IN No. 3 – EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop

ELECTRONICS TEACH-IN No. 4 INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft

See Direct Book Service pages for ordering details.

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 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!

NO MORE HEATHKIT RIGS

For over forty years Heathkit radio equipment from the USA has been well known to radio amateurs round the world, offering high quality kits ranging from state-of-the-art transmitting and receiving equipment to simple operating aids. Unlike some amateur radio equipment made from kits, Heathkit products have a good re-sale value on the second-hand market.

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.

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.

THE 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.

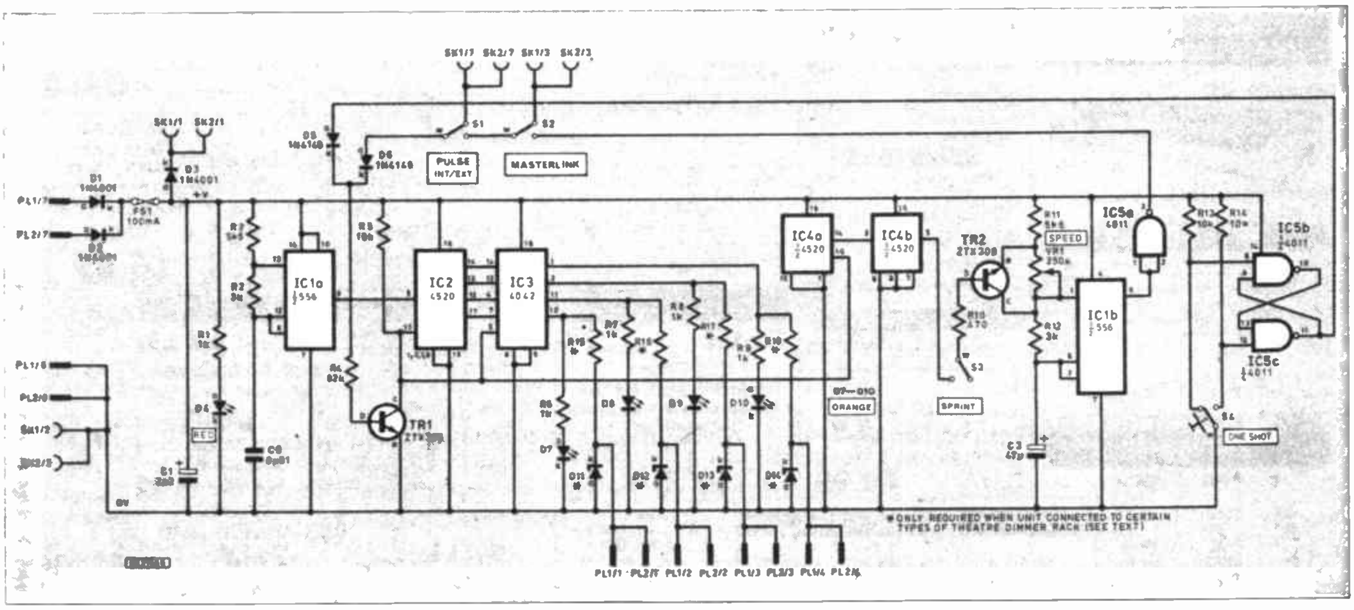
The red power on l.e.d. D4 is wired across the power supply via it's series resistor R1. This resistor has been chosen to restrict the flow of current through the l.e.d. to control the current through it to a safe value (approximately 10mA).

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_0 to I_3) of the latch at the instant when the latch was triggered. The logic states are made available at outputs (O_0 to O_3) 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_0 input (pin 9) of IC2 which is a 4520 dual binary counter, only one half of which is used. The other, CP_1, 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_0 to I_3 of IC3 which is a 4042 quad latch. The latch enable input (pin 5) of IC3 is connected in parallel with the CP_1 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_0 to O_3). 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_0 to O_3) 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 l.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 ¼W 5% carbon film

Potentiometer

VR1	250k rotary carbon, lin.

Capacitors

C1	2µ2 tantalum, 25V
C2	0µ01 polyester
C3	47µ p.c.b. elect., 25V

Semiconductors

D1-D3	1N4001 1A 50V rec. diode (3 off)
D4	Standard Red l.e.d.
D5, D6	1N4148 signal diode (2 off)
D7-D10	Standard Orange l.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

See SHOP TALK Page

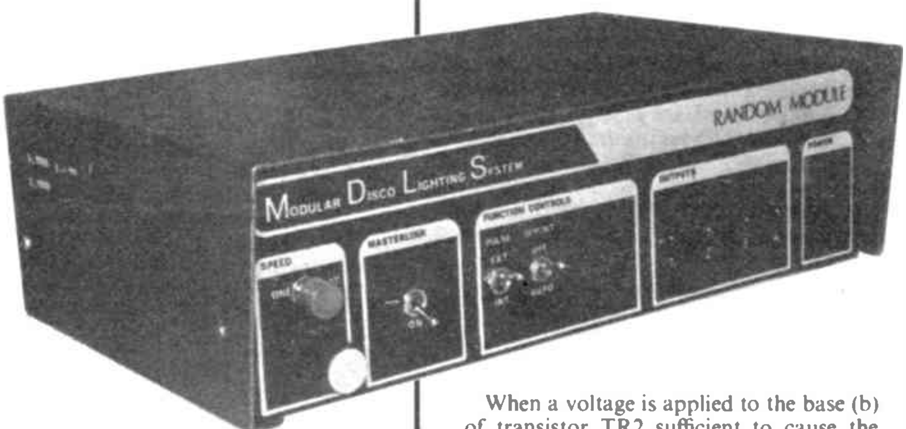
Miscellaneous

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; l.e.d. clips; nuts and bolts for socket fittings; solder etc.

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

Approx cost guidance only **£28** plus case



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_4 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_4 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 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 from 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

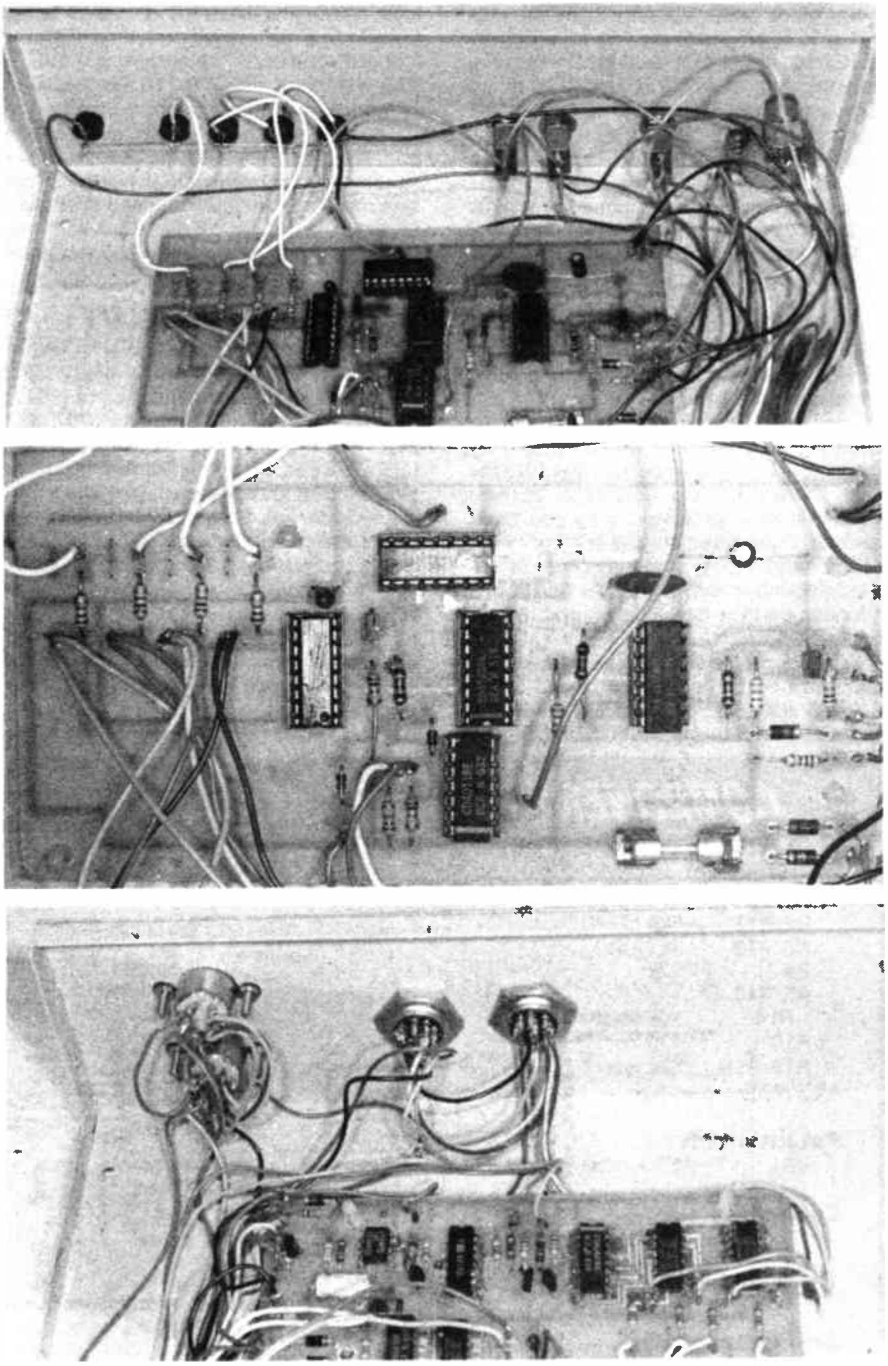
As well as using the internal clock to provide pulses to the random unit the facility exists to use a "One-Shot" circuit an so manually pulse forward the random unit at any time. The one-shot circuit is made up of IC5b and IC5c, together with their associated resistors (R13 and R14) and switch S4.

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 irrespective 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.



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

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.

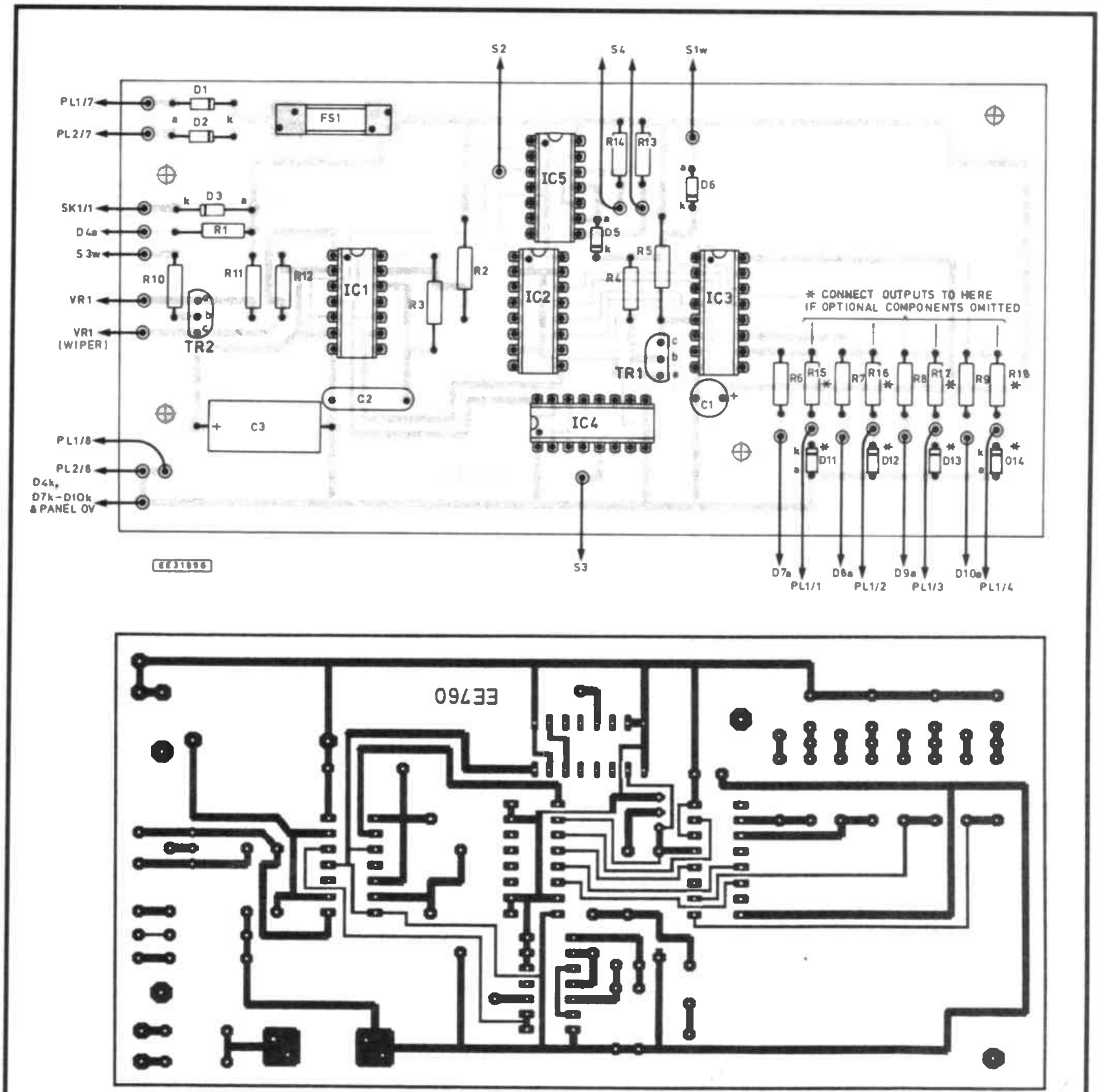


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The wiper (w) contact of switch S2 should have a lead connected directly to one of the contact tags of S1 and the other two contacts of S1 and S2 should be wired directly to the two DIN sockets, see Fig. 1.

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.

DOWN TO EARTH

George Hylton

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".

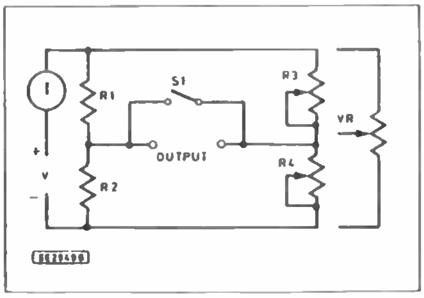


Fig. 1. D.C. bridge circuit. The ratio arms R3, R4 can be replaced by a potentiometer VR. At balance, closing switch S1 does not change current I.

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 bride but actually isn't one. Following classical precedents it can be called a Quasi-Bridge.

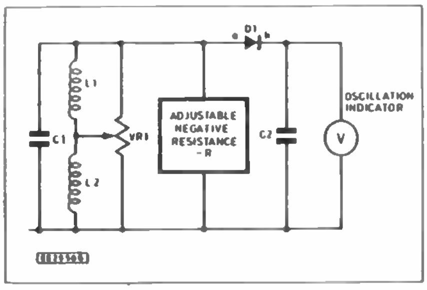


Fig. 2. Quasi-bridge for inductance comparison. At balance, VR, gives the ratio of L1 to L2.

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.

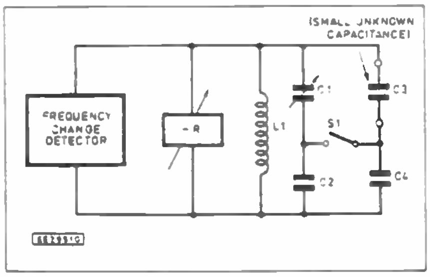


Fig. 3. Quasi-bridge for small capacitance measurement.

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 standard capacitors, and C1 by an inductor.

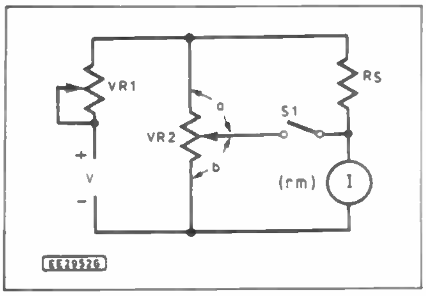


Fig. 4. Finding the resistance of a meter coil.

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.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full details are given on the last book page.

For another selection of books see next month's issue.

ELECTRONIC PROJECTS — BOOK 1

Published by *Everyday Electronics* in association with Magenta Electronics.

Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

128 pages (A4 size) Order code EP1 £2.45

MORE BOOKS NEXT MONTH — MORE BOOKS NEXT MONTH

PROJECT CONSTRUCTION

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

96 pages Order code BP110 £2.50

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages Order code BP121 £2.50

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.

112 pages Order code No. 227 £1.95

ELECTRONIC SCIENCE PROJECTS
O. Bishop

These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.

144 pages Order code BP104 £2.95

A BEGINNERS GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold

The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between different components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages Order code BP285 £3.95

CIRCUITS & DESIGN

PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 1
PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 2
R. A. Penfold

These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators—sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers—simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous—noise generators, rectifiers, comparators and triggers, etc.

BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* **Order code BP117 £1.95**
BOOK 2 *112 pages* **Order code BP118 £1.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston

One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.

124 pages Order code NE11 £12.95

DESIGNING DC POWER SUPPLIES
G. C. Loveday C.Eng MIERE

Covers all aspects of the design of regulated power units, using discretes, i.c. regulators and switched units. It also covers protection circuits and reference supplies. Many design examples and exercises all with fully worked solutions are given.

131 pages Order code BM2 £6.95

ELECTRONIC POWER SUPPLY HANDBOOK
Ian R. Sinclair

This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

136 pages Order code PC108 £7.95

MODERN OPTO DEVICE PROJECTS
R.A. Penfold

In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.

While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.

104 pages Order code BP194 £2.95

DIGITAL LOGIC GATES AND FLIP-FLOPS
Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

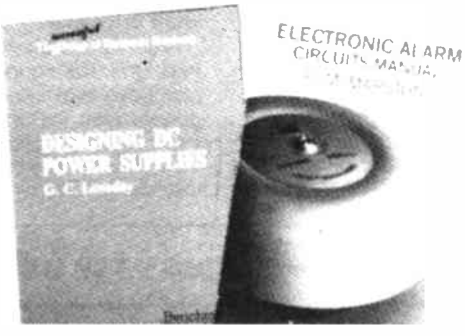
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages Order code PC106 £8.95

HOW TO USE OP-AMPS
E. A. Parr

This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages **Order code BP88 £2.95**



MICRO INTERFACING CIRCUITS–BOOK 1
MICRO INTERFACING CIRCUITS–BOOK 2
R. A. Penfold

Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer. Book 2 deals primarily with circuits for practical applications.

Book 1 *112 pages* Order code BP130 £2.25
Book 2 *112 pages* Order code BP131 £2.75

SENSORS AND TRANSDUCERS
Keith Brindley

There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the ideal, and only then can a totally satisfactory decision be made to use one in particular.

179 pages Order code NE17 £14.95

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold

Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.

92 pages Order code BP179 £2.95

50 SIMPLE LED CIRCUITS
R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components—the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

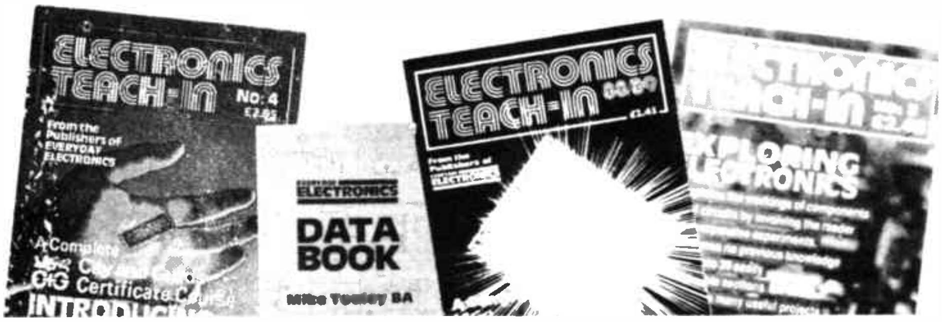
64 pages **Order Code BP42 £1.95**
BOOK 2 50 more l.e.d. circuits Order code BP87 £1.95

ELECTRONICS SIMPLIFIED —CRYSTAL SET CONSTRUCTION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.

80 pages **Order Code BP92 £1.75**

TEACH-IN, THEORY, AND REFERENCE



EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.
It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.
A must for everyone involved in electronics!
256 pages **Order code DATA** **£8.95**

ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.
Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.
The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book
112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS
Owen Bishop
This book describes over 60 modular electronic circuits – how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control.
200 pages **Order code BP266** **£3.95**

FROM ATOMS TO AMPERES
F. A. Wilson
Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.
Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?
Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.
244 pages **Order code BP254** **£3.50**

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.
Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) **Order code TI3** **£2.45**

ELECTRONICS TEACH-IN 88/89— INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject
80 pages (A4 size) **Order code TI-88/89** **£2.45**

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr
Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op amp applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.
315 pages (hard cover) **Order Code NE02** **£10.95**

ELECTRONICS – A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

ELECTRONIC HOBBYISTS HANDBOOK
R.A. Penfold
Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.
88 pages **Order code BP233** **£4.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics
128 pages **Order Code 228** **£2.50**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
208 pages **Order code PC100** **£6.95**

COMPUTING

NEWNES COMPUTER ENGINEER'S POCKETBOOK (Second Edition)
Michael Tooley
An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This first edition covers a vast range of subjects at a practical level, with the necessary explanatory text. The data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit
205 pages (hard cover) **Order code NE01** **£10.95**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range form simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.
This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors, Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM. RAM disks and disk caches, Floppy disk drive formats and compatibility. Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!
104 pages **Order code BP282** **£3.95**

COMPUTERS AND MUSIC — AN INTRODUCTION
R.A. Penfold
Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone. Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.
If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.
This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.
174 pages **Order code PC107** **£7.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
64 pages **Order code BP232** **£2.95**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128
144 pages **Order code BP152** **£2.75**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals
112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.
144 pages **Order code BP119** **£2.50**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., C.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.
192 pages **Order Code BP112** **£3.50**

AUDIO & MUSIC

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
148 pages **Order Code BP256** **£2.95**

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages **Order code PC101** **£6.95**

DATA & COMPONENT IDENTIFICATION

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c to then be identified with reference to manufacturers' or other data. An i.c signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
Chart **Order code BP7** **£0.95**

TESTING & TEST GEAR

TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller
Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.
Chart **Order code BP70** **£0.95**

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold
This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits. Plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.
104 pages **Order code BP267** **£3.50**

RADIO, TV, SATELLITE

AN INTRODUCTION TO AMATEUR RADIO
I.D. Poole
Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.
This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.
150 pages **Order code BP257** **£3.50**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:
Listening to Short Wave Radio; ITU Country Codes; Worldwide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.
320 pages **Temporarily out of print**

AERIAL PROJECTS
R. A. Penfold
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.
Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
96 pages **Order code BP105** **£2.50**

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold
Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.
The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver; Contains everything you need to know in order to get started in this absorbing hobby.
88 pages **Order code BP275** **£3.95**

AN INTRODUCTION TO SATELLITE TELEVISION
F.A. Wilson
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
There is also plenty for the DIY enthusiast with practical advice on choosing and installing the most problematic part of the system—the dish antenna.
104 pages **Order Code BP195** **£5.95**

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmissions assessment are included, finally a short chapter on optical transmission.
256 pages **Temporarily out of print**

AN INTRODUCTION TO VHF/UHF FOR RADIO AMATEURS
I. D. Poole
This book covers the essentials required to gain the most from using the VHF and UHF bands. As such it will be of use to both the newcomer and more experienced operator alike.
Topics included in this book include propagation, descriptions of the bands with outlines of the bandplans and channels, aerials, receivers, transmitters and a special chapter on scanners. In addition to this repeater and mobile operation are included as well as DXing and data modes together with a section on packet radio.
102 pages **Order Code BP281** **£3.50**

AN INTRODUCTION TO AMATEUR COMMUNICATIONS SATELLITES
A. Pickard
Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies. Even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.
There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.
This book describes several currently available systems, their connection to an appropriate computer and how they can be operated with suitable software.
102 pages **Order code BP290** **£3.95**

COMPUTERS AND MUSIC
— see computer section

DIRECT BOOK SERVICE
(A Division of Wimborne Publishing Ltd.)

TO ORDER

Please state the title and order code clearly, print your name and address and *add the required postage* to the total order.

Add 75p *to your total order* for postage and packing (overseas readers add **£1.50** for countries in Europe, or add **£2.00** for all countries outside Europe, surface mail postage) and send a PO, cheque or international money order (£ sterling only) made **payable to *Direct Book Service* quoting your name and address,** the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET, BH21 1RW** (mail order only). We accept Access (MasterCard) and Visa payments, minimum order £5.

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of Everyday Electronics) before ordering from old lists.

Note – our postage charge is the same for one book or one hundred books!

MORE BOOKS NEXT MONTH

PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to **The PCB Service, *Everyday Electronics,* 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* **(Payment in £ sterling only).**

We do 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	AUG'88	615	£3.12
EPROM Eraser	OCT'88	620	£4.07
Doorbell Delay	NOV'88	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	DEC'88	629	£4.84
Phasor		631	£5.64
Continuity Tester	FEB'89	619	£2.67
Sound-to-Light Interface	MAR'89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
Light Sentinel – Main Board	APR'89	632	£9.20
Remote Interface (4 boards)		633	£4.59
4-Channel Auto-Fade Interface		642	£6.80
Electron A/D Interface	MAY'89	645	£4.84
Spectrum EPROM Programmer	JUN'89	628	£7.87
Bat Detector		647	£4.95
Programmable Pocket Timer	JUL'89	648	£3.82
Electronic Spirit Level	AUG'89	649	£3.85
Distance Recorder		651	£5.23
Xenon Beacon	SEP'89	650	£4.13
Power Supplies – Fixed Voltage		654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	646	£3.85
Power Supplies – 25V 700mA		656	£4.35
30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Quick Cap Tester	FEB'90	668	£3.92
Weather Station			
Anemometer – Freq./Volt Board		670	£3.94
Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR'90		
Display Driver		672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver- Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR'90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser	MAY'90	689	£4.68
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
Encoder Board B		695	£4.78
The Tester		696	£4.15
Mains Appliance Remote Control	AUG'90		
Mains ON/OFF Decoder (5 or more 697's ordered *together* £3.25 each)		697	£4.55
Simple Metronome		698	£3.94

PROJECT TITLE		Order Code	Cost
Hand Tally	SEP'90		
Main Board (double-sided) Display		699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control Temperature Controller (p.c.b. only)		702	£5.20
Ghost Walker	OCT'90	703	£4.32
Frequency Meter		704	£5.25
Freq. Meter/Tachometer	NOV'90	705	£3.98
EE Musketeer (TV/Video/Audio)		706	£5.78
Colour Changing Christmas Lights	DEC'90	707	£4.39
Microcontroller Light Sequencer		708/709	£10.90
Versatile Bench Power Supply Unit		710	£4.24
Teach-In '91, Part 1 – L200 Module		711	£3.93
Dual Output Module		712	£4.13
LM723 Module		713	£4.21
Spatial Power Display	JAN'91	714	£5.33
Amstrad PCW Sound Generator		715	£5.03
Teach-In '91, Part 2 – G.P. Transistor Amp		717	£3.77
Dual Op.Amp Module		718	£3.83
Intercom (Teach-In '91 Project 2)		719	£4.41
Analogic Test Probe		720	£3.24
MARC Phone-In	FEB'91	721	£6.87
Teach-In '91 Part 3 – TBA820M Amplifier		723	£4.05
High Quality Power Amp		724	£4.93
Bench Amplifier (Teach-In '91 Project 3)		725	£4.45
Gingernut 80m Receiver R.F. section (726), Voltage Regulator (727) Audio Amplifier (728)		726/7/8	£3.06 per board
		all 3 together	£8.16
Pocket Tone Dialler	MAR'91	729	£4.36
Battery To Mains Inverter		730	£4.97
Simple Basic Alarm		731	£4.50
Car Code Lock (pair)		732a/b	£4.69
Teach-In '91 Part 4 – Sinusoidal Oscillator		733	£4.39
8038 Oscillator		734	£4.15
Waveform Generator (Teach-In '91 Project 4)		735	£4.72
Humidity Tester	APR'91	716	£4.97
Model Train Controller (double-sided)		736	£9.75
Electronic Die (Teach-In '91 Project 5)		737	£4.93
Teach-In '91 Part 5 – Digital Counter Module		738	£4.35
Modular Disco Lighting System	MAY'91		
Switched Power Output Module		739	£5.91
Digital LCD Thermostat–Control Board	£5 for pair	740	£4.05
–Power/Relay Board		741	£3.76
Pulse Generator (Teach-In '91 Project 6)		742	£4.97
Teach-In '91 Part 6 – Timer Module		743	£4.62
Digilogue Car Tachometer	JUN'91	744	£5.63
Modular Disco Lights – Simple Chaser		745	£5.00
Sweeper Module		746	£5.17
Automatic Light Control – PSU Board		747	£4.88
Logic Board		748	£5.17
Radio Receiver (Teach-In '91 Project 7)		749	£4.57
Teach-In '91 Part 7 – R.F. Amplifier Module		750	£4.23
Modular Disco Lights – Masterlink	JULY'91	752	£6.36
Ultrasonic Proximity Meter Display Unit (753) & Sensor Unit (754)		753/754	£7.06
Disco Lights (Teach-In '91 Project 8)			
PSU and Pre-amplifier		755	£4.54
Low, Mid, High Filter/Triac (set of 3 boards)		756	£11.00
Teach-In '91 Part 8 – Solid State Switch Module		757	£4.24
	AUG'91		
Modular Disco Lights – Random Pattern Gen		760	£6.79
Teach-In '91 Part 9 – Light Sensitive Switch		761	£4.74
Opto-Link (Teach-In '91 Project 9) – Transmitter		762	£4.85
Receiver		763	£4.88
Portable PEsT Scarer		764	£3.77

EE PRINTED CIRCUIT BOARD SERVICE

Order Code   Project   Quantity   Price

....

Name..

Address..

....

VISA

I enclose payment of £ .... (cheque/PO in £ sterling only payable to Everyday Electronics) Access (MasterCard) or Visa No.
Minimum order for credit cards £5

Signature.......................................Card Ex. Date...........................
Please supply name and address of card-holder if different from the address shown

BLOCK CAPITALS PLEASE

EVERYDAY ELECTRONICS CLASSIFIED

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

PLEASE MENTION EVERYDAY ELECTRONICS WHEN REPLYING TO ADVERTISEMENTS

ADVERTISERS INDEX

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Limited, Colchester, Essex. Distributed by Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Sole Agents for Australia and New Zealand –Gordon & Gotch (Asia) Ltd., South Africa –Central News Agency Ltd. Subscriptions INLAND £17.00 and OVERSEAS £21 (£39 airmail) payable to "Everyday Electronics" Subscription Department, 6 Church Street, Wimborne, Dorset BH21 1JH. EVERYDAY ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever

OMP POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

* PRICES INCLUDE V.A.T. * PROMPT DELIVERIES * FRIENDLY SERVICE *
LARGE S.A.E., 30p STAMPED FOR CURRENT LIST.

OMP POWER AMPLIFIER MODULES

Supplied ready built and tested.

OMP POWER AMPLIFIER MODULES Now enjoy a world-wide reputation for quality reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market, i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE all models include Toroidal power supply. Integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP100 Mk 11 Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz – 30KHz –3dB, T.H.D. 0.01%, S.N.R. –118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115×65mm.
PRICE £33.99 + £3.00 P&P.

NEW SERIES II MOS-FET MODULES

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor, >300, Slew Rate 45V uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. –125dB. Size 300 × 123 × 60mm.
PRICE £39.99 + £3.00 P&P.

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 50V uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. –130dB. Size 300 × 155 × 100mm.
PRICE £62.99 + £3.50 P&P.

OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 60V uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. –130dB. Size 330 × 175 × 100mm.
PRICE £79.99 + £4.50 P&P.

NOTE:— MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS STANDARD — INPUT SENS 500mV BAND WIDTH 100KHz PEC (PROFESSIONAL EQUIPMENT COMPATABLE) — INPUT SENS 775mV BAND WIDTH 50KHz ORDER STANDARD OR PEC

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE S.A.E. (30p STAMPED) FOR COMPLETE LIST.

McKENZIE:— INSTRUMENTS, P.A., DISCO, ETC.

ALL McKENZIE UNITS 8 OHMS IMPEDENCE

8" 100 WATT C8100GPM GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO
RES. FREQ. 80Hz FREQ. RESP. TO 14KHz SENS. 99dB — **PRICE £29.30 + £2.00 P&P**

10" 100 WATT C10100GP GUITAR, VOICE, ORGAN, KEYBOARD, DISCO, EXCELLENT MID
RES. FREQ. 70Hz FREQ. RESP. TO 6KHz SENS. 100dB — **PRICE £35.58 + £2.50 P&P**

10" 200 WATT C10200GP GUITAR, KEYBOARD, DISCO, EXCELLENT HIGH POWER MID
RES. FREQ. 45Hz FREQ. RESP. TO 7KHz SENS. 103dB — **PRICE £48.67 + £2.50 P&P**

12" 100 WATT C12100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO
RES. FREQ. 45Hz FREQ. RESP. TO 7KHz SENS. 98dB — **PRICE £37.59 + £3.50 P&P**

12" 100 WATT C12100TC TWIN CONE) HIGH POWER WIDE RESPONSE, P.A., VOICE, DISCO
RES. FREQ. 45Hz FREQ. RESP. TO 14KHz SENS. 100dB — **PRICE £38.58 + £3.50 P&P**

12" 200 WATT C12200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 40Hz. FREQ. RESP. TO 7KHz SENS. 100dB — **PRICE £65.79 + £3.50 P&P**

12" 300 WATT C12300GP HIGH POWER BASS LEAD GUITAR, KEYBOARDS, DISCO, ETC
RES. FREQ. 45Hz FREQ. RESP. TO 5KHz SENS. 100dB — **PRICE £87.51 + £3.50 P&P**

15" 100 WATT C15100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO
RES. FREQ. 40Hz FREQ. RESP. TO 5KHz SENS. 98dB — **PRICE £55.05 + £4.00 P&P**

15" 200 WATT C15200BS VERY HIGH POWER BASS
RES. FREQ. 40Hz FREQ. RESP. TO 4KHz SENS. 99dB — **PRICE £75.10 + £4.00 P&P**

15" 250 WATT C15250BS VERY HIGH POWER BASS
RES. FREQ. 40Hz FREQ. RESP. TO 4KHz SENS. 99dB — **PRICE £82.54 + £4.50 P&P**

15" 400 WATT C15400BS VERY HIGH POWER, LOW FREQUENCY BASS
RES. FREQ. 40Hz FREQ. RESP. TO 4KHz SENS. 102dB — **PRICE £96.47 + £4.50 P&P**

18" 400 WATT C18404BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS
RES. FREQ. 27Hz FREQ. RESP. TO 3KHz SENS. 99dB — **PRICE £172.06 + £5.00 P&P**

EARBENDERS:— HI-FI, STUDIO, IN-CAR, ETC.

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedence tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED FOAM SURROUND

8" 50 WATT EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR
RES. FREQ. 40Hz. FREQ. RESP. TO 7KHz SENS. 97dB — **PRICE £8.90 + £2.00 P&P**

10" 50 WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR
RES. FREQ. 40HZ FREQ. RESP. TO 5KHz SENS. 99dB — **PRICE £12.00 + £2.50 P&P**

10" 100 WATT EB10-100 BASS, HI-FI, STUDIO
RES. FREQ. 35Hz FREQ. RESP. TO 3KHz SENS. 96dB — **PRICE £27.76 + £3.50 P&P**

12" 60 WATT EB12-60 BASS, HI-FI, STUDIO
RES. FREQ. 28Hz FREQ. RESP. TO 3KHz SENS. 92dB — **PRICE £21.00 + £3.00 P&P**

12" 100 WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO
RES. FREQ. 26Hz FREQ. RESP. TO 3KHz SENS. 93dB — **PRICE £38.75 + £3.50 P&P**

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60 WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC
RES. FREQ. 63Hz. FREQ. RESP. TO 20KHz SENS. 92dB — **PRICE £9.99 + £1.50 P&P**

6½" 60 WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC
RES. FREQ. 38Hz FREQ. RESP. TO 20KHz SENS. 94dB — **PRICE £10.99 + £1.50 P&P**

8" 60 WATT EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC
RES. FREQ. 40Hz FREQ. RESP. TO 18KHz SENS. 89dB — **PRICE £12.99 + £1.50 P&P**

10" 60 WATT EB10-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC
RES. FREQ. 35Hz FREQ. RESP. TO 12KHz SENS. 86dB — **PRICE £16.49 + £2.00 P&P**

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W FM TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 × 123mm, SUPPLY 12V @ 0.5AMP
PRICE £14.49 + £1.00 P&P

FM MICRO TRANSMITTER (BUG) 100-108MHz VARICAP TUNED COMPLETE WITH VERY SENS FET MIC. RANGE 100-300m. SIZE 56 × 46mm. SUPPLY 9V BATT. PRICE £8.62 + £1.00 P&P

3 watt FM Transmitter

Access — POSTAL CHARGES PER ORDER £1.00 *MINIMUM*. OFFICIAL ORDERS WELCOME FROM SCHOOLS, COLLEGES, GOVT. BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA ACCESS ACCEPTED BY POST, PHONE OR FAX — BARCLAYCARD VISA

OMP VARISPEED TURNTABLE CHASSIS.

★ MANUAL ARM ★ STEEL CHASSIS ★ ELECTRONIC SPEED CONTROL 33 & 45 ★ VARI PITCH CONTROL ★ HIGH TORQUE SERVO DRIVEN DC MOTOR ★ TRANSIT SCREWS ★ 12" DIE CAST PLATTER ★ NEON STROBE ★ CALIBRATED BAL WEIGHT ★ REMOVABLE HEAD SHELL ★ ½" CARTRIDGE FIXINGS ★ CUE LEVER ★ POWER 220/240V 50/60Hz ★ 390×305mm ★ SUPPLIED WITH MOUNTING CUT-OUT TEMPLATE

PRICE £59.99 + £3.50 P&P.

OPTIONAL MAGNETIC CARTRIDGES

STANTON AL500
PRICE £16.99 + 50p P&P

GOLDRING G850
PRICE £6.99 + 50p P&P

OMP MOS-FET POWER AMPLIFIERS, HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

NEW MXF SERIES OF POWER AMPLIFIERS

THREE MODELS:— **MXF200** (100w + 100w)
MXF400 (200w + 200w) **MXF600** (300w + 300w)

All power ratings R.M.S. into 4 ohms.

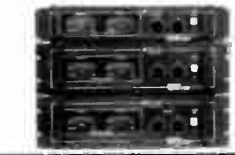
FEATURES: ★ Independent power supplies with two Toroidal Transformers ★ Twin L.E.D. Vu meters ★ Rotary indented level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 Fan Cooled with D.C. Loudspeaker and Thermal Protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

SIZES:— MXF 200 W19"×H3½" (2U)×D11"
MXF 400 W19"×H5¼" (3U)×D12"
MXF 600 W19"×H5¼" (3U)×D13"

PRICES: **MXF200 £171.35**
MXF400 £228.85
MXF600 £322.00

SECURICOR DELIVERY £12.00 EACH



OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

MADE ESPECIALLY TO SUIT TODAY'S NEED FOR COMPACTNESS WITH HIGH OUTPUT SOUND LEVELS, FINISHED IN HARDWEARING BLACK VYNIDE WITH PROTECTIVE CORNERS, GRILLE AND CARRYING HANDLE. INCORPORATES 12" DRIVER PLUS HIGH FREQ. HORN FOR FULL FREQ. RANGE 45Hz-20KHz BOTH MODELS 8 OHM. SIZE H18" × W15" × D12".

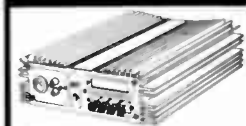
CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100 (100W 100dB) PRICE £159.99 PER PAIR
OMP 12-200 (200W 102dB) PRICE £209.99 PER PAIR

SECURICOR DEL.:— £12.00 PER PAIR

IN CAR STEREO BOOSTER AMPLIFIER



TWO SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

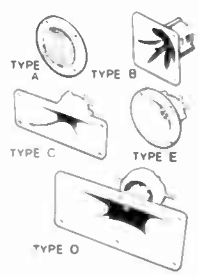
150 WATTS (75+75) INTO 4 OHMS
300 WATTS (150+150) INTO 4 OHMS
FEATURES:—
* HIGH & LOW INPUT IMPEDANCES
* HIGH & LOW INPUT SENSITIVITIES
* VARIABLE INPUT GAIN CONTROL
* SHORT CIRCUIT OUTPUT PROTECTION
* POWER REQUIREMENT 12V DC

PRICES: 150 WATT £43.00
300 WATT £95.00 + £3.00 P&P EACH

PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 50p P&P.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each + 50p P&P.**

TYPE 'C' (KSN6016A) 2"×5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each + 50p P&P.**

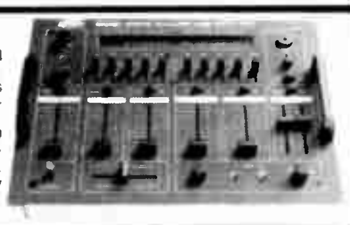
TYPE 'D' (KSN1025A) 2"×6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 50p P&P.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each + 50p P&P.**

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85×85mm. **Price £3.99 + 50p P&P.**

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:— 3 Turntables (Mag), 3 Mics, 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360×280×90mm. Supply 220-240v.
Price £134.99 — £4.00 P&P



B. K. ELECTRONICS Dept EE

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL: 0702-527572 FAX: 0702-420243

BRITAIN'S BEST VALUE FLOODLIGHT SECURITY SYSTEM

GUARANTEED!

UNBEATABLE VALUE!

£29.95

YMS01

(500 watt halogen tube YMS02 £3.75 not included in this price)

HELPS YOU PROTECT YOUR HOME AND YOUR FAMILY!

HIGH DEMAND

Because of high demand for our security products and our increased buying power, Maplin Electronics can now offer this exclusive lamp at Britain's lowest price, guaranteed!

GUARANTEE

We guarantee you can't find better value, or all your money back. Absolutely no risk to you.

QUALITY CONFIDENCE

Every detector purchased comes with a FULL MONEY-BACK, NO QUIBBLE GUARANTEE

YOUR TOP TEN FEATURES

- ★ Automatic infra-red sensor, lights up *500 watt tube, when people approach your property
- ★ Adjustable on time ★ Easy installation
- ★ Full 15m detection range
- ★ Fireproof ultraviolet material
- ★ Water resistant and weatherproof
- ★ Approved to international standards
- ★ Automatic on off and manual override
- ★ Heavy duty zinc alloy body
- ★ 110 degree detection angle

The Detector Security Floodlight has the latest infra-red technology that detects movement over your chosen area and illuminates it with a 500 Watt Halogen lamp for up to approx 12 minutes which gives you time to park your car, unload the shopping, find your keys, greet your guests or avoid obstructions.

With 500 watts of halogen lighting beaming down on them, any potential burglar becomes clearly visible – so visible it could well be daylight!

Feel safer, more confident with the Maplin security floodlight. Economical – the system automatically switches off in the daytime to save power.

For your enjoyment the Detector can be permanently switched on, for EVENING BARBEQUES etc. by turning the main light switch on, off and on again within 2 seconds.

The range of the Detector is such that it is ideal for both residential and commercial use.

COMPARISON WITH SIMILAR SECURITY SYSTEMS

SE Essex Branch	Heavy Duty	500 Watt Power	Weatherproof	Automatic Infra-red	Adjustable Timer	Complete with Halogen Tube	Cost of 500W Halogen Tube	Cost of Security System
DO-IT-ALL	●	●	●	●	●	●	£4.15	£69.99
HOMEBASE	●	●	●	●	●	●	£7.99	£69.95
TEXAS	●	●	●	●	●	●	£5.99	£59.99
ARGOS	●	●	●	●	●	●	Not supplied	£46.99
PAYLESS	●	●	●	●	●	●	£7.59	£74.99
B&Q	●	●	●	●	●	●	£3.95	£79.99
MAPLIN	●	●	●	●	●		£3.75	£29.95

(Survey conducted on 21st February 1991)

WELCOME? WARNING?

AVAILABLE AT MAPLIN SHOPS NATIONWIDE

Maplin ELECTRONICS

CREDIT CARD HOTLINE

Access VISA

PHONE BEFORE 5pm FOR SAME DAY DESPATCH

24 HOUR SERVICE - PHONE NOW!

0702 554161

All items are subject to availability, all prices include VAT

Access Amex Visa Delete as required

If ordering by Credit Card please sign

Expiry date of Credit Card

Order Coupon Send this coupon to P O Box 3 Rayleigh Essex SS6 8LR

Quantity	Description	Code	Price	Total
	Infra-red detector	YMS01	£29 95	
	500 watt halogen tube	YMS02	£3 75	
			Carriage for 1	£3 75
			Add further £1 25 if more than 1 YMS01	
			Handling	£1 00
		EE7	Total	

Name

Address

Post Code

I authorise you to debit my Credit Card account for the cost of goods despatched

Credit Card No

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

Although this unit may deter intruders, no warranty is given or implied that the unit will provide security or prevent illegal entry

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 ELECTRONIC COMPONENTS

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

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

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 0.6mCd / 10mA

Code	7/ · 1	DP	CC/CA	1 ·	25 ·	100 ·
Z1937	7 seg	LH	CA	31p	0 20	0 16
Z1938	7 seg	RH	CA	31p	0 20	0 16
Z1939	7 seg	RH	CC	31p	0 20	0 16
Z1940	· 1	LH	CA	20p	0 13	0 10

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 0.8mCd / 10mA

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

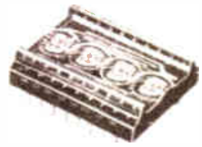
H - 27 7
W- 19.9
D - 8.38

Pin spacing 2 54
Row spacing 15.24

(c) 0.8" (20.32mm) display height; luminous intensity 0.8mCd / 10mA

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

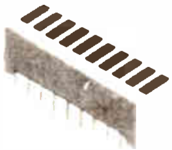


DL1416 Alphanumeric 4 character intelligent display 0 16"
Price **£7.00**

SALE PRICE £3.50

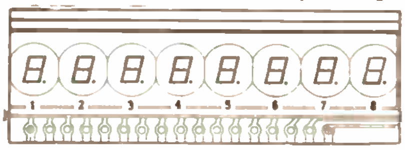
Z4294 Above chip on panel with switching and LED s · ribbon cable and connector
Price **£5.00**

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 TIL100/ TIL38!
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 3½ digit with LO-BATT 12 7mm high digits Op voltage 4 12 RMS 32Hz type Consumes only 25μA with all segments on Trade price £7 97 each Supplied with data but no edge connector
Prices .... **£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 · 39mm Overall size 180 · 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

GREENWELD SUMMER SALE LIST 3

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

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!!

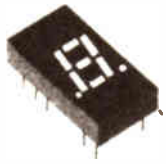
Code	Colour	Size	Shape	Manf'r/ Type	Lead length	Qty in £1 pack	100 +	1k +
Z2089	Red	5mm	std	FDL4601	25	15	0 032	0 025
Z2090	Red	5mm	std	QTMV5752	28 5	15	0 032	0 025
Z2091	Red	5mm	std	Liton LTL9223A	29 5	12	0 038	0 030
Z2092	Green	5mm	std	-	13 5	14	0 035	0 028
Z2093	Yellow	5mm	std	-	13 5	14	0 035	0 028
Z2094	Red	3mm	min	MLR327	17	18	0 030	0 022
Z2098	Red	7 × 2 55	Rect	Senior elec SE6511D	32	12	0 038	0 030
Z2095	Red	5mm	Rect*	Phillips HR44DL	26	12	0 038	0 030
Z2096	Clear (IR)	4 5 × 1 5	Rect	Honeywell 8406	20	8	0 060	0 040
Z2099	Clear (IR)	4 5 × 1 5	Rect	Honeywell 8706	20	8	0 060	0 040
Z2097	Red	5 × 2	Rect	GIMV57123	29	12	0 038	0 030

* Square with rounded corners

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

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

BBCC8 Computer terminal maintenance kit £2 95 in our catalogue

Box of 10 £15

Box of 100 £100

BBCC11 Liquid static eliminator £1 00 in our catalogue

Box of 50 £20

BZ914 1 Watt Amp Panels £1 50 in our catalogue

Box of 128 £40

BZ1522 40 Channel CB Switches List price £3 +

Box of 100 £40

BZ4132 Firing Speed Adjuster £1 00 in our catalogue

Box of 200 £60

Speakers

BA303 (LS010) 57mm 8R Min speaker Catalogue price £1 10

Box of 100 £35

BZ578 Fuji 30 × 30 × 3mm speaker

Box of 1000 £100

Panels

BZ1815 27C256 Panel. Facilities cartridge containing above chip in socket Catalogue price £2.00

Box of 100 £60

Map Lights

BZ4071 Catalogue price £1 95.

Box of 100 £60

Switch Mode PSU

BZ660 Catalogue price £5.00

Box of 180 £200

Spectrum Connector

BZ4139 Catalogue price £1 00

Box of 100 £25

CEE22 Connector

BZ1799 Fused switched mains inlet List £3 75

Box of 100 £40

Pots

BZ1363 50R 2W pot ideal for speaker volume control Standard spindle

Box of 200 £20

Panel Clearance

BK641 20kg of assorted populated PCB's All sorts **£40**

FM Aerials

BX361 Ribbon aerial

Pack of 100 £20

Wheels

Type A from Catalogue. 100mm dia × 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 Ti lamp

Box of 50 £7

BZ577 5k edgewise pot with switch, as used on small radios walkmans, etc. Normally 10p

Bag of 500 £15

BZ576 2 1mm power plug, chassis mounted Normally 10p

Bag of 500 £15

BZ8928 4700µ 16V Mullard can 50mm long × 25 4mm dia

Box of 100 £5

BZ8929 11000µ 25V computer cans 105mm long × 51mm dia

Box of 49 £10

BA3915 9V Buzzers Our catalogue price 80p

Box of 50 £15

BZ4138 Microslots In our catalogue at £2 00

Box of 100 £75

81E Morganite cermet trimmers type 81E-TO5 size Only one value - 50R

Box of 50 £7.50

BZ4224 Meter cases 135 × 120 × 45mm Normally £1 00

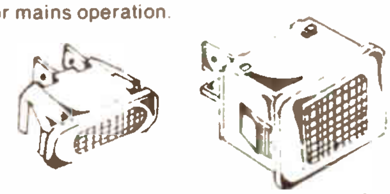
Box of 100 £25

BZ4135 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 × 15mm with 0 25" tags Clip fix requires 25 × 12 5mm cut-out

Z1899 Green

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

Type B - Panel mounting 36 5 × 26 5mm with 0 25" tags Clip fix requires 30 × 22 5mm cut-out

Z1901 Red
Z1902 Green
Z1903 Amber
Z1904 White

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

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

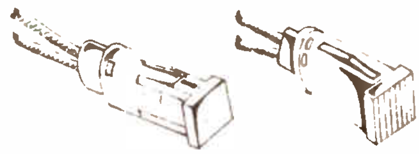
Z1905 Red
Z1906 Green
Z1907 Amber
Z1908 White

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

Type D - Large round face 13 5mm dia Clip fix, requires 12 5mm dia hole

Z1910 Green
Z1911 Amber
Z1912 White

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



Type E - Small square face 10 5mm Clip fix, requires 9 5mm dia hole

Z1913 Red
Z1914 Green
Z1915 Amber
Z1916 White

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

Type F - Large square face 13 5mm Clip fix, requires 12 5mm dia hole

Z1917 Red
Z1918 Green
Z1919 Amber
Z1920 White

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

Type G - Small round face 7 5mm dia, threaded body, requires 6 5mm dia hole

Z1921 Red

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

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

SALE PRICES ON ALL NEON INDICATORS 50% OFF

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

BATTERY BONANZA!!

LEAD-ACID + NICADS AT UNBEATABLE PRICES

EX-POLICE BATTS

Z4150 Ex mobile radio battery 56 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rate 1.25V 600mA

Price **£3.00**

SALE PRICE £2.50

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

Price **£4.50**

SALE PRICE £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 × 26 × 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

Z8918 YUASA NP6-12 12V 6Ah sealed lead acid batery. These have been regularly trickle charged whilst in store. Size 150 × 95 × 65mm. List price £28.00

Prices .... **£14.95** 10 + 11.20

SALE PRICE £12.50 10 + 9.00

Z8920 YUASA sealed lead acid battery NP10-6 6V 10Ah. Size 150 × 95 × 50mm. List £18.00

Our low price **£10.00** 100 + £6.00

SALE PRICE £8.00 10 + 6.00

Nicads

Z1830 Saft 40 RF310 back up Nicad battery PC mounting on 70 × 22.5mm centres. Rated 3.6V 10mAh (20mA). Overall size76 × 28 × 8mm

Price **£2.00**

SALE PRICE £1.50

Z1829 Nicad 25mm dia × 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 × 16 dia. Ideal for paralleling. **(Slight corrosion.)**

Price .... **99p each** 10 + 0.75 25 + 0.60 100 + 0.52

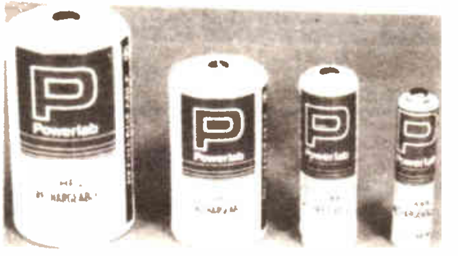
CLEARANCE PRICE 4/ £1.00 100 + 0.15

Z1409 PC mntg deac 6V 100mA. Rating made by Memec 30 × 15 × 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	5¼" DSDD	£6.20	£55
3.5" DSHD	£19.30	£171	5¼" DSHD	£11.20	£99

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

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 ½ 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, SCRs, 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.
Prices 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 1000!!
Super value at £3.95
SALE PRICE **£2.50**

K582 Polystyrene Caps. An amazing range of values from a few pF to 01. Tolerances 1-20%. Voltages to 500V.
Price .... Pack of 200/ £4.00
SALE PRICE **£2.00**

K714 Power Supply Capacitors. All cans, mostly computer grade including popular values like 10,000µ 40V etc. Big mix of values and voltages up to 100V or more and 50,000µF.
Price for box of 25 .... £12.50
SALE PRICE **£10.00**

RESISTORS

K540 Resistor Pack. Mostly ⅛, ¼ and ½W, 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 ½W 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 ¼/ ½/ 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 ¼W and ½W tolerances from 0.1% to 2% - ideal for meters, test gear etc.
Prices 250/ £3.00
SALE PRICE £1.50

K572 Resistor Networks. Both SIL and DIL in here, from 6 to 16 pin. Plenty of popular values like 1k, 4k7 and 10k, and a good sprinkling of many other values.
Pack of 100 £4.50
SALE PRICE £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 cermets are all included. Wide range of values from 20R to 5M. 100 assorted.
Prices £6.75
SALE PRICE £3.50

K505 20 Assorted Potentiometers. All types including single, ganged, rotary and slider.
Price £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 × 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, mosly 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 from 1-20mm bore, OD's from 2-24mm. Lengths from 10mm to 76mm. Well over 25 different types, including PVC, rubber, silicone etc.
Price 200/ £2.00
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 × 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 × 1½" up to 8 × 1¼" also washers, some BA, metric and Whit. Screws plus other miscellaneous brackets, captive nuts and bits and pieces. 1kg (up to 1000 pieces)
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 · 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

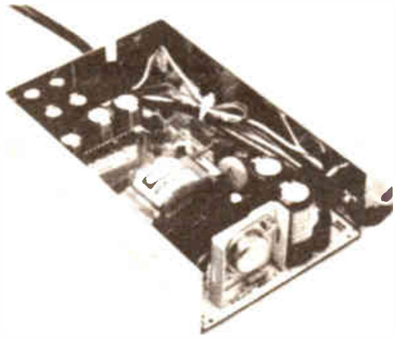
Power Supply Parcel
K586 This one's an absolute gem! Contains a selection of conventional and switch mode power supplies, including AA12531, Z4215, Z4311 + 7 others!! Parcel of 10 originally selling for £40 +
SALE PRICE £15.00

PHOTOGRAPHIC

K716 Odds and ends of Flash units, dedicated Flash Modules, Lens converters, incomplete cameras (at least 3).
Excellent value at £10

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

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

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.

ONLY £6.95 each

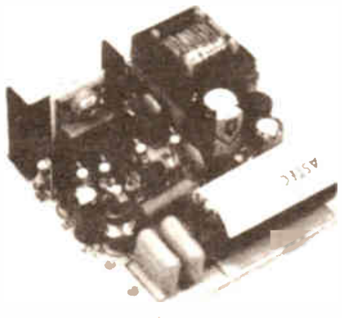
100+ £3.50+VAT 1000+ £2.80+VAT

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

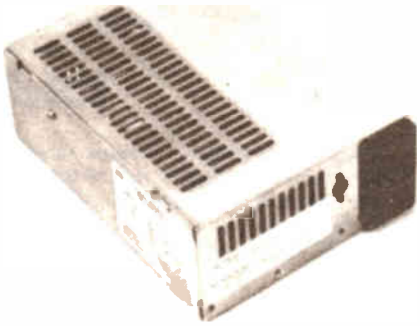
Complete Kit of parts + Instructions **K725**	**£3.50**
Instructions only **K726**	**£1.00**



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 transitor 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

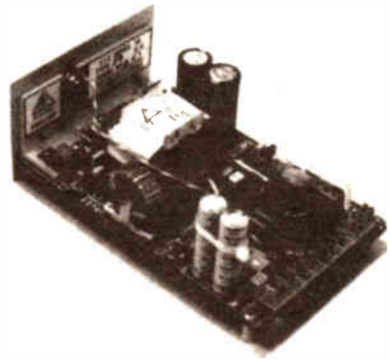
* 3½ digit 8mm LCD display
* Fully autoranging
* Display hold facility
* Diode and continuity test
* Probe styling
* Automatic polarity and zero
* Protective carrying case

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 × 100mm panel is attached to an aluminium chassis 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details we can offer these at a fraction of their normal cost!

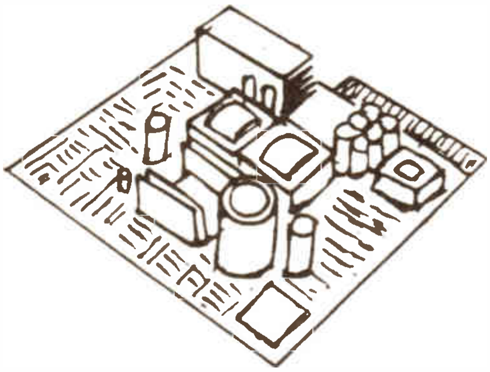
Price £5.95

SALE PRICE £4.95 100 + 3.00

Z8888 A larger version of the above PCB 220 × 100mm and chassis 225 × 102 × 65mm providing a single 5V 10A output. Supplied with connection details.

Price .... Only £8.95

SALE PRICE £7.95 100 + 4.50



Z8890 DC-DC Converter Boards. These panels 220 × 195 require 50V DC input for a 5V 19.5A output. Inputs and outputs on DIN41612 connector. These brand new panels made by STZ are now being offered at just

Price .... Only £7.95

SALE PRICE £6.95 100 + 3.20

High Power Inverters

Gardeners square wave type **GR75108** 50V 85A DC IN 240V 50Hz 4kVA OUT

Price		£345 + CARR
GR75107	2kVA	£230 + CARR
GR75106	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 × 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 pdwer supplies by STC (series 15) offering exceptional value for money. Chassis size 124 × 100 × 41mm. Input voltage can be 100, 120, 220, 230, 240V. There is over-voltage protection on both models.

Z8898 Type 15AAA. Output 5V @ 3A. STC price in 1987 £43.99.
Our Price £8.00

Z8899 Type 15AAB. Output 15V @ 0.5A twice. STC price in 1987 £60.09.
Our Price £10.00

Z8915 Type 15AAC. Ouput ± 15V @ 0.5A. STC price in 1987 was £60.38
Our price £10.00

Z8916 Type 15AAH. Ouput 15V @ 1A with OVP. STC price £43.99
Our price £10.00

Z8917 Type 15AAJ. Ouput 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 × 57 × 52mm

Price £3.50

SALE PRICE £2.50

Z4311 Power supply by Thorn-EMI. Built in 13A plug. Case size 95 × 55 × 50mm. Ouput 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

Z425 Siliconix mains input 4.5V dc 150mA output to 3.5mm jack plug on 2m lead. Built-in continental 2-pin plug. Size 62 × 46 × 35mm

Price £1.50

SALE PRICE £1.00

Z8802 Battery charger unit. 2 part vacuum formed black plastic case 570 × 210 × 85mm with room for 10 × 2.6AH 6V sealed lead acid batteries. Inside is a neat PSU. RS torroidal transformer 207-958 120/240V primary 0-9 0-9 secondary each at 10VA. There is a bridge rectifier and smoothing cap. The output is taken to a PCB 510 × 45mm containing 10 identical charging circuits. Each has a TIP31A 741 IN4002 and couple of Rs and a 3 pin connector.

Clearing at .... £8.00 each

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

Power Supply Capacitors

Code	Value	Voltage	Ripple	Mnf'r	l · d	Mnf'rs 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 tags

Code	Value	Volts	Mnf'r	Size	1 ·	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	4μ7 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 2½W	All at the
Z1086	1R5 2½W	same price
Z0873	2R2 2½W	100/ £3.00
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	£8.00

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-006SF	E1S-00	3U 0 3	£12.62
129B-PCB-007SF	E2S-00	3U 0 6"	£12.62
129B-PCB-011SF	EBP-02	Extender 3U-220	£8.46
129B-PCB-012SF	EBP-03	Extender 6U-160	£18.18
129B-PCB-014SF	EBP-05	Horizontal Mntg 6U-112	£11.00

SALE PRICES 75% OFF

Memorex Tape

Z9012 Memorex MRX IV ½ 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

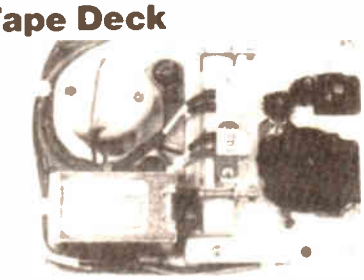
Tick-tock, Tick-tock Timers!!!

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

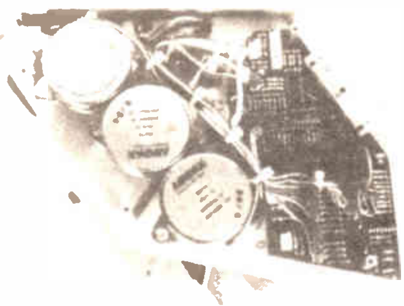
SALE PRICE 2 for £1.00

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

GREENWELD

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

Dual Sheet Feeder



Z8837 Exxon Dual Sheet Feeder Z200 Overall 395 × 210 × 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 × 12V 36R 7.5 stepper motors by Airpax and associated gear trains drive belt etc
2 × 12V Solenoids
1 × 12V Electronic buzzer
2 extremely sensitive micro switches
1 PCB containing 4 × TIP115 4 × TIP110 2 × 7407 LM3302 comparator + 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 × POB703A opto coupler & 1 × OPB7111 opto coupler

SALE PRICE £12.50

Dragon Interface

S89 Dragon interface - case 1'6 × 62 × 29mm with 2 × 9 pin D Plugs 2 leads with 5 pin DIN plug Inside is a PCB with 4 transistors and 20 resistors

Box of 50 **£20.00 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 × 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 KLEARANCE

Z8842 Tatung VT4100 keyboard Cased 85 key unit with separate numeric keypad With circuit Has 2 or 3 broken keys 450 × 65 × 125mm Was £9 95

SALE PRICE £5.00

Z4116 24 way (8 × 3) membrane keypad Large (200 × 90mm) area - these were originally used as a teaching aid Overlay template and pinout supplied Now only £2 00

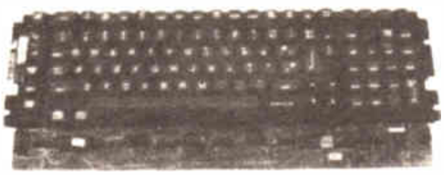
SALE PRICE £1.00

Z8882 Keyboard from Librator Computer 278 × 124mm 62 keys Some of these have been used Output to 20 way connector

Price £5.00

Z8852 Superb keyboard 392 × 181mm with LCD displaying 1 line of 10 characters + another line of symbols 100 keys Has 2 × 74HCO5 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 × 2 LS374 LM3086 × 2 LS138 × 3 555 LS08 6805 Size 442 × 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 × 128mm PCB on which it s mounted is 285 × 170mm Excellent value at £12 00

SALE PRICE £6.00

Z1797 'Membrane keyboard 155 × 113mm with 80 × 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 × 67 × 12mm Ally frame supports a membrane keyboard which has 22keys On the rear of the panel are 6 yellow submin LED s a 3mm red LED and 2 × 19W edge conns

Price £1.00

SALE PRICE 60p

Z4363 Membrane keyboard 225 × 84mm with 11 keys 1-9 & 2 others Output (common bus) on 12 way ribbon cable Could be cut down to 95 × 70mm if only 1-9 needed

Price 60p

SALE PRICE 40p

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

ORDER FORM

SALE 1 2 3 4 5 6

Send your order to:

GREENWELD ELECTRONIC COMPONENTS

27 Park Road, Southampton, SO1 3TB
(A different postcode is correctly shown on reply paid envelopes)

Customer No: .... **Date:** ....

Name: ....

Address: ....

....

....

.... **Post code** ....

OFFICE USE	ORDER CODE	QTY	No of Pcks	Description		Price	£	p
	Z9999			Bargain List Subscription Service Our next 6 Lists with reply paid envelope	UK/BFPO O'SEAS	2.00 4.00		
	Z0000			1991 132 page Catalogue	UK/BFPO O'SEAS	1.50 3.00		
	C1992			1992 Catalogue - sent on publication, 1st Oct 1991	UK/BFPO O'SEAS	2.00 4.00		
						Add 2.17% VAT		

Postage*	**£3**	**00**
Sub-Total		
Deduct Cr		
TOTAL		

* UK/BFPO only. O'Seas extra

IMPORTANT: Please fill in the following information. Thank you

1. **Did you receive this SALE supplement (Tick all that apply):**
   - ☐ **with your previous order** ☐ **As a Bargain list Subscriber** ☐ **Unsolicited**
   - ☐ **with Everyday Electronics** ☐ **with Practical Electonics** ☐ **with Elektor**
   - ☐ **with Television** ☐ **Other (Please state how)**
2. Please let us know if you want this order:
   - ☐ Sent as soon as possible with a credit note for any parts out of stock;
   - ☐ Sent as soon as possible with any out of stock items to follow: (only if value over £10);
   - ☐ Held for expected deliveries for up to .... days (state how long);
   - ☐ Other (please specify) ....
3. Have you ordered from us before? YES ☐ NO ☐ Are you already a Bargain List Subscriber? YES ☐ NO ☐
4. Please tick method of payment: Cheque ☐ PO ☐ Cash ☐ Credit Card ☐ Other ☐

Credit Card No (Visa/Access/Connect): .... Ex Date ....

(If ordering by credit card, only goods supplied will be charged, on the date of despatch) **SIGNED** ....

CQ/PO:	EX?:	C/N	C/C	CASH	B/T	G/V	ST	
CO:		CH:		P:		D:		

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

SALE PRICES FOR ALL CATALOGUE ITEMS:

Listed below by page number are our **SALE PRICES** for all goods listed in our 1991 catalogue, our 1991 Spring Supplement and Bargain List 68:

1991 CATALOGUE

Pages 4-14	10%
Pages 15-23	10%
Pages 28-31	10%
Pages 39-42	5%
Pages 49-68	10%
Pages 94-97	10%
Pages 103-105	10%

BARGAIN LIST PAGES:

Page 107
All ½ price except Towers
Page 108
All ½ price except Z345 & 6116
Page 109
All ½ price except Z4190
Page 110
All ½ price
Page 111
All ½ price except PAR111 & TIC226B
Pages 112-113
See Pages 5-7 of this supplement
Page 114
All ½ price
Page 116
All ½ price
Page 116
All ½ price
Page 117
All ½ price except 5A regs
Page 118

Z4150	£2 75	
Z4149	£4 00	
Z802	£8 00	Rest 25% off

Page 119
See Pages 8 & 9 of this supplement
Page 120
All ½ price
Page 121
All ½ price
Page 122
All ½ price
Page 123
All ½ price
Page 124
All ½ price
See Page 6 of this cat for switch packs
Page 126-8
25% off
Page 131
See Page 16 of this supplement

1991 SPRING SUPPLEMENT

Page 3-12	10
Page 13-18	All ½ price
Page 19	25%
Page 20	All ½ price except BYW20
Page 21	
Z652	10%
Z1434	50%
Z4355	50%
Z2032	25%
Z4368	50%
Z1438	50%
Z4090	50%
SB16	20%
Page 22	
Z901	40%
Z22454	20%
Z22455	20
Z22468	20%
Z22297	40%
Z9012	20%
Z4352	25%
Z4089	25%

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
½ 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
Z8897	50% off
Page 9	
MOSFETS/ FETS	25% off
Rest	50% off
Page 10	All ½ price
Page 11	All ½ price
Page 12	All ½ price
Page 14	All ½ price
Except 1 million R s	
Page 15	All ½ 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

1991 Catalogue
Page 107
TITS
Z8851
Z4091
Z4092
Z8867
Page 108
J128
Z4036
Z8827
Page 109
Modulator
Z4172
Page 110
VE13
Z4310
Page 111
Z806
Z807
Page 112
K589
K554
Page 113
K532
K578
K552
K565
K566
K588
K581
Z886
Page 114
Z912
Page 115
Z497
Z955
Z4223
Z4319
Page 116
Z4236
Z4285
Z4287
Z495
Page 117
Z4272
Z1702
Z1604
Z4197
Z1729
Z1730
Page 118
Z656
Z1809
Z1810
Z1705
Z4097
Z4170
Z1587
Z4302

1991 Spring Supplement
Page 119
Z993
Z8861
Hi-Flex 750
Z4112
Z8889
Page 120
Z101
Z102
Z103
Z104
Z108
Z109
Page 121
Z713
Z687
Z4191
Z818
Z1814
Z4284
Z4095
Z1630
Z1631
Page 122
Z481
Z799
Page 123
Z351
Z8857
Z8848
Page 124
Z1617
Z1650
Z1638
Z1639
Z1640
Z1641
Z1642
Z1648
Z1645
Z1621
Z229
Z263
Z262
Z203
Z255
Z245
Z228
Z234
Z249
Z236
Z231
Z216
Z254
Page 125
All S switches have now been made into packs
Page 126
Most packs still available but give alternatives where possible please
Page 131
Z4332
Page 13
Z2039
Z01155
Page 14
Z2040
Z1982
Z2028
Page 15
Z1954
Z1976
Page 16
Z30157
Z30257
Z30162
Z30212
Z30188
Z30158
Z30226
Z30223
Z8901
Z8902
Z8903
Z8904
Page 17
Z2044
Z2040
Z4366
Z4368
Z1433
Z2050
Page 18
Z1369
K185
Z1969

Bargain List 68
Page 19
K120
Page 20
Z02936
Z27245
Page 21
Z4347
Z22278
SB16
Page 22
Z22468
Software Simon
Z4352
Z05054
Z8867
Page 23
K552
K596
K597
Page 24
Z4112
Z4168
AC9231
Page 25
Z4359
Page 26
Page 27
Z1922
Z1936
Z2043
Page 28
Z8827
Z610
Page 2
Page 3
Page 4
Page 5
Z2052
Z2070
Z2072
Z0283
Page 6
Most still available
Page 7
Z8912
Z5022
Z8913
Z4377
Z2048
Page 8
K819
Z5007
Page 9
2µ 250
9µ 440
Z1756
(listed as Z1765)
Z1759
J305 18
K578
5ST215
Page 10
2N7002
Z1512
Z1688
Page 11
Z1399
Z1674
J055
J056
Page 12
Z4341
Page 14
EC948
EC993/ 1
20965
129-PCB-006
Page 15
Z535
Page 16
Z1802
Z1804

HITACHI SCOPES

10% DISCOUNT ON ALL MODELS!

V212	£385	SALE PRICE **£346.50**
V223	£545	SALE PRICE **£490.50**
V522	£730	SALE PRICE **£657.00**
V209	£860	SALE PRICE **£774.00**

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 5¼" disk + computer tape, 16 page handbook, C60 stereo cassette with backing tune of popular tracks like 'Ghostbusters', 'Chariots of Fire', and 'Superman'
Original Price £17.95
SALE PRICE **£2.00**

Music Master - Comprises microphone to attach to recorder + processing device, 5¼" disk; 12 page handbook.
Original Price £52.78
SALE PRICE **£4.00**

Mupados Recorder Tutor - Comprises 5¼" 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

CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

Acoustic Couplers

Z8884 Acoustic coupler for use with Liberator. Made by Sendata 700F series. One end has PCB with lots of chips plus 4 × 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 × 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. 92.2mm² × 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 Kilostream Multiplexer Panel 300 × 210mm with 4 × 25 way D sockets 15W D socket Z84C42 × 3 Z84C30 × 2 CMOS, Z80 CPU, 6264 RAM, 30 assorted CMOS/ TTL/ Linear chips and nice power supply comprising a potted transformer with mains input and 0-9V 0-9V outputs both at 1A 7812 7915 and 7805 regs. Also Xtal, 64 way 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 collett 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 + transitors Rs Cs xtal etc.

Both for £4, or individually Z035 £3.00; Z036 £1.00

SALE PRICES Z035 £1.60 Z036 60p **Both £2.00**

'JIMMY'

the electronic football game of skill

Z817 Great fun to play or take it apart for bits. Originally £19.95

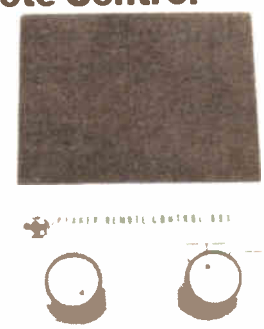
SALE PRICE £2.50

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

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**

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**

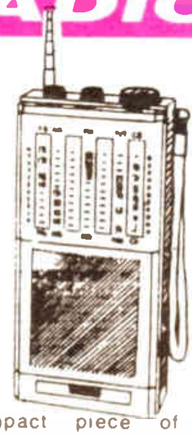
Extraordinary Easiwire Offer!!!

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**

MULTIBAND RADIOS!

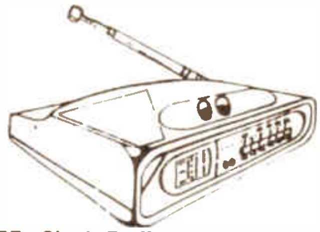


This compact piece of equipment 200 × 95 × 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

1) CB, channels, 1-80
2) TV1 54-87 MHz & FM 88-108 MHz
3) AIR 108-145 MHz & PB 145-176 MHz

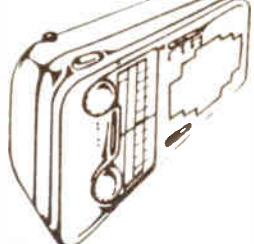
The large 3" full range speaker delivers 280mW of undistorted power. There is an earphone jack and DC adaptor jack. The unit is powered by 4 × AA cells. All this technology for just **£17.95**

Order Code **MB100**



Z4357 Clock Radio by Ross. Extremely neat unit measuring 140 × 80 × 35mm. MW/FM bands, telescopic aerial, stand, carrying pouch and strap. Clock has LCD display and can be used in 12 or 24 hr mode. Alarm. Light. Earphone socket. Takes 2 × AA cells.

Great value at **£13.95**



Z8891 Superb 4 waveband radio by Ross, model RR5. Covers FM 88-108MHz, MW 518-1610kHz, LW 150-275kHz SW 5 7-18.1MHz (16.5-52.6m). Nicely styled case measuring 210 × 145 × 70mm with clear scale markings. Telescopic aerial, headphone socket. Volume, tone and tuning controls. ON/OFF switch/waveband selector switch and AFC switch. Mains/battery. (Takes 4 × C cells). Originally retailed at £19.95

Our Price **£14.95**

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