FREE!

TRANSISTOR GUIDE...

Over 400 transistor applications can be found in this issue. An attempt has been made to include most of thepresent devices that are readily available through the usual channels. A number of texts are throughout the contents, and a selection of the various transistor requirements is included.

All possible care has been taken in the preparation of this material, and representations can be accepted for any errors or omissions that may have occurred.

Presented free with the May 1977 issue of PRACTICAL ELECTRONICS.

... IN THIS ISSUE

Electronic One Arm Bandit

for home amusement

Also inside...

Organ Tremolo

Digital Darkroom Timer

Burglar Alarm
A GOOD START FOR MOTORISTS!

SS 1100 POWER AMP. Delivers 100 watts R.M.S. into 4 ohms using a 70 volt/2A supply. Input sensitivity 500mV for full output. Response 10Hz to 50kHz ± 1dB, S/N ratio better than 75dB. Distortion at half power typically 0.1%. With heatsink mounting bracket, 5in x 3in x 1in.

SS 370 FULL SIZE HEAT SINK £1*

YOU PAY ONLY £12.50* FOR THE TWO TOGETHER

There is real power and reliability in this assembly. By buying them together you save nearly £2 on these already competitively priced units. IDEAL FOR DISCO, P.A. and such like applications. Send only £21 (plus P & P) for SS 1100H (with full size heatsink) and Power Unit SS 370.

More Q.V. Modules for Cost-Conscious Constructors

Power Supply Units

FM Tuning Modules

Unbeatable Value

A range of units to meet constructors' almost every requirement. Made in our own factory. Complete with mains transformer and low-volt take-off points (except SS 310). All at 8% VAT rate.

Quicker Delivery

We make delivery quicker by saving time in turning around your orders. Now when ordering you send direct to our factory where Q.V. (Quality and Value) modules are made. Our shop and showroom continue as usual for those calling personally. Watch how the STIRLING SOUND RANGE GROWS!

A company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound

A monor company of the 111-Pro-Pak group, Ear 195g

Stirling Sound
CONSTRUCTIONAL PROJECTS

ORGAN TREMOLO UNIT by L. F. Reeve
A solid state phase modulator for electronic organs

BURGLAR ALARM by P. J. Fasoli
A sensitive amplified bridge design

ONE ARM BANDIT by K. Amor
A scaled down version of the popular gaming machine

DARKROOM TIMER by A. Koltai & G. S. Brimble
An accurate, reliable timer with digital readout

GENERAL FEATURES

MICROPROCESSORS EXPLAINED—3 by R. W. Coles
The instruction set and programming techniques

SEMICONDUCTOR UPDATE by R. W. Coles
A look at some recently released devices

MOBILE DISCO TECHNIQUES—2 by N. McLeod
Equipment and operating techniques for the disco enthusiast

INGENUITY UNLIMITED
TV Tennis Score—Motor Driver—Programmable Melody Generator—Joanna Modification

NEWS AND COMMENT

EDITORIAL—New Voice for Components Industry

NEWS BRIEFS
DIY Computing Conference—All Electronics Show—Sound '77 Exhibition—Microprocessor Forum

SPACEWATCH by Frank W. Hyde
Venus—Infra Red Telescope—Landsat

MICROPROCESSOR REPORT
Products discussed at a Cambridge Seminar

MARKET PLACE
Interesting new products

STRICTLY INSTRUMENTAL by K. Lenton-Smith
Electronic music matters

POINTS ARISING
Digital Voltmeter—Putting It Together—Solar Heating Controller—Hazard Warning Flasher—pH Meter

INDUSTRY NOTEBOOK by Nexus
What's happening inside industry

PATENTS REVIEW
Thought provoking ideas on file at the British Patents Office

Our June issue will be on sale Friday, May 13, 1977
(for details of contents see page 365)
enquiries. Send 10p for Multimeter catalogue — free on request on orders over £2.30; 30-0-30V 1:A 0.70. 12-0-12V 50mA 1.10p; 12-0-12V 100mA 1.15p.

RESISTORS
- Zeners, 400mW 5% BZY88.
- Enamelled copper wire on 2oz 20.0mm. 22.5mm. 25mm.
- Sloping front version. ideal for mixers 75. 30. 50mm.
- 100pF. 1.000pF 4p; 1.200pF 0.05. 0.15.
- Insulation tested at 1500 Vac.

VEROBOARD
- Good quality. all packs contain 100 sq. in. (About 8 pieces) Each panel £1.20.
- Pack B, all 1p or 1s pitch.
- Pack C, mixed 01 and 015.
- Pack D, all 01 pitch.
- Also available by: weight 10p £4.45; 12.00p 1m sq. £4.95; 15.00p 1.5m sq. £5.00.

DIODE S AND LED S AND SCR S
- Double diode SCR 45p: 40V 34 A, Trac 8p.
- Diac BR132 25p, 40V 1A Trac 1£.
- LED 14p 28.00p.
- LED Red 0.9p: 22.00p.
- LED yellow or amber 2.7p.
- Yellow or amber 2.7p.
- Red or blue 2.7p.
- Blue or green 2.7p.
- Green or yellow 2.7p.

TRENDY F S
- Small general purpose plastic boxes.
- One of Italy's leading Test Equipment Makers.

ORGAN TREMOLO UNIT
- All parts required to build this project featured in this issue of P.E. obtainable from us either individually or as a complete kit. Pack S: E1 for individual parts. Complete kit only 8s Inc. VAT and post.

VEROBXES AND CASES
- Professional 2 part boxes made of dark and light grey high impact polystyrene. all with 100pF 0.10. 0.15.
- Sloping front version ideal for mixers 155. 175. 195.
- Cases: white plastic and bottom front and back aluminium panels.

BREDBOARDS
- S DEC Breadboard £12.00.
- T DEC Breadboard £7.50.

DEVELOPMENT PACKS
- Save £8.50 by buying a full range of components at one go! All transistor marked devices no rejects or old stock.
- PCM: complete package, resistors 5% of each.
- Complete kit for £10.00. Total 210 components.
- PCBs: all sizes available, from 0.10 to 10.00. All sizes available. Total 210 components.
- PCBs: all sizes available, from 0.10 to 10.00. All sizes available. Total 210 components.

RESISTORS
- Carbon film 5%, 1%, 5% miniature. All values in £2.00. 1000, 2000, 5000, 10000, 20000, 50000, 100000, 200000, 500000, 1000000, 2000000, 5000000, 10000000, 20000000, 50000000, 100000000, 200000000.
- Metal film 5%, 1%, 5% miniature. All values in £2.00.
- All values in £2.00.
- SAW: all values in £2.00.
- Wirewound 3% to 10%.
- All values in £2.00.

TRANSFORMERS
- 0-6V 100mA 12p; 0-9V 50mA 12p; 0-12V 25mA 12p; 0-24V 10mA 12p; 0-12-12V 1A £2.91; 20V 50mA 12p; 20V 25mA 12p; 25V 10mA 12p; 25V 5mA 12p; 0-0-6V 1.2V 150mA 12p; 30-0-30V 1.2V 150mA 12p.

TO ORDER
- All packs are delivered within a few days by parcel post. Orders under £3. Minimum order £1. Most orders dispatched on day of receipt. Details and orders sent to our addresses.
- All orders accepted from schools, etc. Export wholesale enquiries welcome. Surplus components always wanted.
The ZYCON

New range of Quality Electronic Watches

L.E.D.

KELDA

Ideal present! This stylish 3-function L.E.D. shows Hours, Minutes, Seconds. Beautifully finished with Stainless Steel back & FREE Stainless steel strap or matching Stainless Steel Bracelet.

Gold Plate £29.95

KEDB

6-Function. Shows Hrs, Mins, Secs, Mth & Date and Day.

£18.95

KEDC

A fantastic 5-Function watch. Window display shows:

£39.95

LADIES DIGITAL

The IDEAL PRESENT

An elegant 6-function watch. Shows Hrs, Mins, Secs, Date, Day. She'll love this piece of miniaturised electronic wizardry Gold Plate or with stylish Chrome Bezel, each with matching bracelet.

Gold Plate

£26.90

Silver Plate

£24.90

HEWLETT PACKARD

NEW ZYTRONIC TELE-GAMES

DE LUXE

THIS DELUXE MODEL HAS:

Tennis, Football, Squash, Solo, 2 bat sizes, 2 Ball speeds. 3 distinct pongs—one for point score, one for ball strike back, one for ball strike boundaries.

£39.90

These games are easy to play and a joy for all the family!

All items carry 1 Yr Guar. Prices include VAT.

* FREE R.S.1 adapter. (R) FREE Changer
Handy size Reels & Dispensers

OF THE WORLD'S FINEST CORED SOLDER TO DO A PROFESSIONAL JOB AT HOME

Ernis Multicore Solder contains 5 cores of non-corrosive flux that instantly cleans heavily oxidised surfaces and makes fast, reliable soldering easy. No extra flux is required.

SAVBIT
handy solder dispenser
Contains 2.3 metres approx. of 0.12 mm solder. Ernis Multicore Saviit Solder. Savvit increases life of copper bits by 10 times.
Size 5 49p
For soldering fine joints.

Two more dispensers to simplify those smaller jobs. PC115 provides 6.4 metres approx. of 0.71 mm solder for fine wires, small components and printed circuits. PC115 57p
Or size 19A for kit wiring
2.1 metres approx. of 1.22 mm solder.
Size 19A 53p

For radio and TV repairs.

THE `METAC' DIGITAL ALARM CLOCK

- Choice of Bright Orange 12 Hour Display, or
- Soft Green 24 Hour Display • 24 Hour Alarm
- 10 Minute Repetition • Alarm Set Indicator
- Accurate Silent Timekeeping • British Designed and Built

SAME DAY DISPATCH orders received before 2 pm are posted same day

£12.99 + £1.04 VAT

Cash, Cheque or Postal Order or if you wish to use Barclaycard or Access, simply quote name, address and card number when ordering

Eaton-Electronics and Time Centre
67 High St., Daventry, Northants
Tel. Daventry (032 72) 78545.
3 New Arcade, High St., Uxbridge, Midx
Tel. Uxbridge (0895) 56961

THE `METAC' DIGITAL ALARM CLOCK

SYNTHESESIERS?

The P.E. Minisonic Mk. 2 and the P.E. Sound Synthesiser are still available as complete kits, module kits, and as complete professionally built units, all at competitive prices—our kits are all designer approved using top quality components and incorporating the latest modifications.

We feel that the Minisonic 2 still represents the best value for money in synthesizers today, but if you require even greater flexibility, why not add a second P.C.B. with an extra oscillator, an extra envelope shaper/V.C.A. or even an extra filter.

Some examples of our prices are listed below for the Minisonic 2, but for full details of price breakdown and kit contents, including Minisonic Mk. 1 updating kits, send large S.A.E.

Prices shown are recommended retail, inc. VAT. From Electrical and Hardware Shops. In difficulty send direct, plus 20p P&P.

Prices and specifications subject to change without notice.

P.O. BOX 3
6 JUTLAND RISE
ST. NEOTS
CAMBS PE19 3JB

EATON AUDIO

 TERMS MAIL ORDER ONLY. C.O.D. MINIMUM ORDER £1. VAT Please add 15% to value of order inc. P & P unless otherwise stated. Cheques or P.O.s payable to Eaton Audio. Orders over £5 free of P. & P., otherwise please add 60p in the £1.

Practical Electronics May 1977
STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality audio controls on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity readout. 3mV (R I.A.A. comp.)


Size: 25in long x 6in high x 8in deep.

£115

AMPLIFIER MODULES

TL30  DC COUPLED 5 X 5 X 1in
- 30 watt R.M.S. continuous sine wave output
- 8 transistors 4 diodes

£12.50

TL60  5 X 5 X 3in
- 60 watt R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp trans-selector

£16.75

TL100  5 X 5 X 3in
- 100 watt R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp output trans-selector

£18.75

TP125  7 X 6 X 3in
- 125 watt R.M.S. continuous sine wave output
- 4 R.C.A. 150 watt 15 amp output trans-selector

£23.25

THE PIEZO SUPER HORN

AMPLIFIER MODULES

THE PIEZO SUPER HORN

has all the features! ONLY £10.95

- NEEDS NO CROSS-OVER NETWORK
- FREQUENCY RESPONSE 4000-30,000Hz ± 3dB
- PATENTED MOMENTUM DRIVE PRINCIPLE
- NO VOICE COILS OR MAGNETS
- HIGH INTERNAL IMPEDANCE
- ADAPTS TO ANY SYSTEM
- HIGH ACOUSTIC OUTPUT
- MANY CAN BE CONNECTED IN SERIES TO FORM AN ARRAY INCREASED OUTPUT
- POWER HANDLING CAPACITY 25 volts RMS—see chart

POWER HANDLING GUIDE

<table>
<thead>
<tr>
<th>System Impedance</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ohms</td>
<td>312 watts</td>
</tr>
<tr>
<td>4 ohms</td>
<td>156 watts</td>
</tr>
<tr>
<td>8 ohms</td>
<td>78 watts</td>
</tr>
<tr>
<td>16 ohms</td>
<td>39 watts</td>
</tr>
</tbody>
</table>

THE TUAC RANGE includes...

MONO DISCO MIXER with auto fade

- 4 Channel Sound to Light Sequence Chaser £39.75
- 3 Channel Light Modulator £18.75
- Auxiliary Sequence Dimmer £35.00

FRONT PANELS for above LIGHTING UNITS

- Complete with switches, neon and knobs £5.50

FUZZ LIGHTS. Red, Green, Blue and Amber £21.50

TUAC AMPLIFICATION

Lolle 125 watt with sustain £95.00
Lolle Slave 125 watt £80.00
Lolle 60 watt with sustain £75.00
Combo Twin 60 reverb £60.00
Combo 30 £50.00

(For Spec. see December P.E.)

TO ORDER BY POST

Make cheques/P.O.s payable to TUAC LTD. (PE 57) or quote Access/Barclaycard No and post to TUAC LTD. (PE57) 119 Charlington Road, London SW17 9AB. We accept phone orders from Access/Barclaycard Holders. Phone 01-672 9080.

SUPPLIERS TO H.M. GOVT. DEPTS. MANUFACTURED AND ASSEMBLED IN G.B. FULLY TESTED AND GUARANTEED.

MANUFACTURERS OF ELECTRONIC AND AMPLIFICATION EQUIPMENT

STOCKISTS-CALLERS ONLY

STOCKISTS-CALLERS ONLY

Scrib Malhes 85, 87 Hurst Street, Birmingham (Tel 021-622 1941)
Arthur Stave Ltd. 70 Gaddes Street (Tel. Brighton 60908)
Bristol Disco Centre. 25 The Promenades, Gloucester Road (Tel. Bristol 674441)
Sosodod 9 The Fields (Tel. Canterbury 09404)
Broadcast Equipment Centre, 42 West Street (Tel. Brighton 60908)
At Music Centre, 88 Oxford Street, Manchester (Tel. 061-236 0340)
Hill Electronics, 15 Bepton Road, Shipley (Tel. Grassington 55555)
Leighton Electronics Centre, 59 North Street (Tel. Leighton Buzzard 4969)
Garland Box Ltd., Desktop Broadway, London 01-692 4143
Dynamite Electronics, 109 Carrington Street (Tel. Nottingham 5808)
Luton Disco Centre, 88 Wellington Street, Luton (Tel. Luton 672 9080)
Mitchell Electronics, 27 Queen Street, (Tel. Salisbury 0423)
Session Music, 151 Oxford Street, Tooting (Tel. 01-672 3149)
Monfort 18 30, 50 & 100 Mc. Head Day Phone 3 4 3 6 7 4

PS500 for supplying 2 TP125s £28.00
PS200 for supplying to TL100 £26.00
PS600/60 for supplying 2 TL60s £25.50
PS125 = 45 volts for TP125 £16.75
PS100 = 43 volts for TL100 £15.50
PS60 = 38 volts for TL60 £14.50
PS30 = 25 volts for TL30 £9.50
PS 2 for supplying disco mixer £6.00

12 ELECTRONIC AND AMPLIFICATION EQUIPMENT PHONE 01-672 3137 672 9080
TRANSISTOR UNIVERSAL AMPLIFICATION Co. Ltd. PHONE 01-672 3137 672 9080
TRANSFORMERS

Price include VAT. P. & P. except where carriage will be according at 500mA (Order code 997-005)

Designer approved

Complete set of semiconductors
Mullard LP1186 tuner head
High quality glass fibre PCB £2.45

ORION STEREO AMPLIFIER
Complete set of high quality glass fibre PCB £2.99

PE DIGITAL VOLTAMETER
ZNA116 £6.00* with circuits and data

Electronic Car Ignition

DORAM KITS CONTAIN EVERYTHING DOWN TO THE LAST NUT!

Barrie Electronics Ltd. Ltd. 3, THE MINORIES, LONDON EC3N 1BJ
 TELEPHONE: 01-488 33167/8
 NEAREST TUBE STATIONS: ALDAGATE & LIVERPOOL ST

ONION

STEREO AMPLIFIER

Complete set of semiconductors
Mullard LP1186 tuner head
High quality glass fibre PCB £2.45

ORION STEREO AMPLIFIER
Complete set of high quality glass fibre PCB £2.99

Both the above PCBs are printed with component locations

PE TV SOUND AMPLIFIER
Complete set of semiconductors £2.30, high quality glass fibre p.c.b. £1

POSTAGE AND PACKAGING PER ORDER. Orders over 50 pence post free. All devices are top grade, brand new and to full manufacturers spec. We do not sell seconds or rejects 

Prices do not include VAT—add 5% to items marked*, and 12% to all others

DAVINIAN ELECTRONICS
13 Deepdale Avenue, Royton, Oldham OL2 6XD

DAVINIAN ELECTRONICS
13 Deepdale Avenue, Royton, Oldham OL2 6XD
Complete kits in stock for Radford Studio 90, Radford Monitor 180, Radford Studio 270, Radford Studio 360, Hi-Fi Answers Monitor (Rogers), Hi-Fi News No Compromise (Frisby), Hi-Fi News State of the Art, Wireless World Transmission Line (Bailey), Practical Hi-Fi and Audio Monitor (Giles), Practical Hi-Fi and Audio Triangle (Giles), Popular Hi-Fi (Colloms), etc.

On dem. Answers Monitor, State of Art, etc.

Construction leaflets for Radford, Kef, Jordan Watts, Tannoy, Hi-Fi Answers Monitor, free on request. P.A. amplifiers, microphones, etc., by Shure, Linear, Eagle, Beyer, AKG, etc.

FREE with orders over £10—‘Hi-Fi Loudspeaker Enclosures’ book.

Tannoy 12in Monitor HDP £85.00
Tannoy 15in Monitor HDP £99.00

**SPEAKERS**

<table>
<thead>
<tr>
<th>Speaker Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castle 8RSiDD 4 or 8 ohm</td>
<td>£13.00</td>
</tr>
<tr>
<td>Baker Regent 12in 8 or 15 ohm</td>
<td>£21.00</td>
</tr>
<tr>
<td>Baker Deluxe 124, 8 or 15 ohm</td>
<td>£23.75</td>
</tr>
<tr>
<td>Baker Major 8 or 15 ohm</td>
<td>£15.00</td>
</tr>
<tr>
<td>Baker Superb 8 or 15 ohm</td>
<td>£22.50</td>
</tr>
<tr>
<td>Baker Regent 12in 8 or 15 ohm</td>
<td>£21.00</td>
</tr>
<tr>
<td>Baker Auditorium 15in 8 or 15 ohm</td>
<td>£23.75</td>
</tr>
<tr>
<td>Castle 8RS/D 4 or 8 ohm</td>
<td>£9.95</td>
</tr>
<tr>
<td>Celestion G12M 8 or 15 ohm</td>
<td>£12.95</td>
</tr>
<tr>
<td>Celestion G12H 8 or 15 ohm</td>
<td>£12.95</td>
</tr>
<tr>
<td>Celestion G12/50 8 or 15 ohm</td>
<td>£18.00</td>
</tr>
<tr>
<td>Celestion G12/50TC 8 or 15 ohm</td>
<td>£20.00</td>
</tr>
<tr>
<td>Celestion G12/50 2395 s/cone</td>
<td>£18.15</td>
</tr>
<tr>
<td>Celestion G15C 8 or 15 ohm</td>
<td>£26.95</td>
</tr>
<tr>
<td>Celestion G18C 8 or 15 ohm</td>
<td>£38.95</td>
</tr>
<tr>
<td>Celestion HF1300 8 or 15 ohm</td>
<td>£7.50</td>
</tr>
<tr>
<td>Celestion 2000 8 or 15 ohm</td>
<td>£6.75</td>
</tr>
<tr>
<td>Celestion MI1000 8 or 15 ohm</td>
<td>£13.50</td>
</tr>
<tr>
<td>Elac 61in d/cone, roll sum, 8 ohm</td>
<td>£5.90</td>
</tr>
<tr>
<td>EMI 8in roll surr. bass</td>
<td>£7.75</td>
</tr>
<tr>
<td>EMI 10in 10RM239. 8 or 15 ohm</td>
<td>£4.50</td>
</tr>
<tr>
<td>Eagle FR4</td>
<td>£6.75</td>
</tr>
<tr>
<td>Eagle FR65</td>
<td>£11.95</td>
</tr>
<tr>
<td>Eagle FR8</td>
<td>£14.95</td>
</tr>
<tr>
<td>Eagle FR10</td>
<td>£16.80</td>
</tr>
<tr>
<td>Eagle HT15</td>
<td>£4.50</td>
</tr>
<tr>
<td>Eagle HT21</td>
<td>£4.50</td>
</tr>
<tr>
<td>Eagle MHT16</td>
<td>£5.25</td>
</tr>
<tr>
<td>Eagle FF28 Multicell horn</td>
<td>£7.90</td>
</tr>
<tr>
<td>Fane Pop 15, 16 ohm</td>
<td>£5.75</td>
</tr>
<tr>
<td>Fane Pop 337, 8 or 16 ohm</td>
<td>£9.95</td>
</tr>
<tr>
<td>Fane Pop 50, 8 or 16 ohm</td>
<td>£12.50</td>
</tr>
<tr>
<td>Fane Pop 50, 8 or 16 ohm</td>
<td>£12.50</td>
</tr>
<tr>
<td>Fane Pop 50, 8 or 16 ohm</td>
<td>£12.50</td>
</tr>
<tr>
<td>Fane Pop 103, 8 or 16 ohm</td>
<td>£13.95</td>
</tr>
<tr>
<td>Fane Crescendo 12, 8 or 16 ohm</td>
<td>£4.45</td>
</tr>
<tr>
<td>Fane Crescendo 13BL, 8 or 16 ohm</td>
<td>£4.45</td>
</tr>
<tr>
<td>Fane Crescendo 15/10X3A, 8 or 16 ohm</td>
<td>£4.45</td>
</tr>
<tr>
<td>Fane Crescendo 15/125, 8 or 16 ohm</td>
<td>£6.95</td>
</tr>
</tbody>
</table>

**SPEAKERS**

<table>
<thead>
<tr>
<th>Speaker Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fane Crescendo 18, 8 or 16 ohm</td>
<td>£75.95</td>
</tr>
<tr>
<td>Fane 910 Mk II horn</td>
<td>£15.75</td>
</tr>
<tr>
<td>Fane 920 Mk II horn</td>
<td>£46.95</td>
</tr>
<tr>
<td>Fane 55/19X80 crossover</td>
<td>£2.50</td>
</tr>
<tr>
<td>Fane 130 x 8in, 15W dual cone</td>
<td>£5.50</td>
</tr>
<tr>
<td>Fane 801T 8in d/c, roll surr.</td>
<td>£8.95</td>
</tr>
<tr>
<td>Gauss 15in</td>
<td>£115.00</td>
</tr>
<tr>
<td>Gauss 18in</td>
<td>£139.00</td>
</tr>
<tr>
<td>Goodmans Axient 100</td>
<td>£24.95</td>
</tr>
<tr>
<td>Goodmans Audiolum 200 8 ohm</td>
<td>£14.95</td>
</tr>
<tr>
<td>Goodmans Twiixdown 8, 8 or 15 ohm</td>
<td>£32.00</td>
</tr>
<tr>
<td>Goodmans 8P 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 10P 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 12P 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 12AP 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 15AX 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 15G 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans 18P 8 or 15 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans Hilcox 750P</td>
<td>£38.50</td>
</tr>
<tr>
<td>Goodmans Hilcox midrange 8 ohm</td>
<td>£38.50</td>
</tr>
<tr>
<td>Kef T27</td>
<td>£8.50</td>
</tr>
<tr>
<td>Kef T15</td>
<td>£10.75</td>
</tr>
<tr>
<td>Kef 1110</td>
<td>£10.95</td>
</tr>
<tr>
<td>Kef 1200</td>
<td>£11.95</td>
</tr>
<tr>
<td>Kef 1239</td>
<td>£8.50</td>
</tr>
<tr>
<td>Kef DNB</td>
<td>£12.95</td>
</tr>
<tr>
<td>Kef DN12</td>
<td>£17.75</td>
</tr>
<tr>
<td>Kef DN13 SP1015 or SP1017</td>
<td>£18.75</td>
</tr>
<tr>
<td>Lowerth PM6</td>
<td>£4.40</td>
</tr>
<tr>
<td>Lowerth PM6 Xk1</td>
<td>£3.26</td>
</tr>
<tr>
<td>Lowerth PM8</td>
<td>£3.25</td>
</tr>
<tr>
<td>Peerless KO100T 4 or 8 ohm</td>
<td>£28.25</td>
</tr>
<tr>
<td>Peerless KO34MRMF 8 ohm</td>
<td>£19.95</td>
</tr>
<tr>
<td>Peerless MT2E300CF 8 ohm</td>
<td>£10.50</td>
</tr>
<tr>
<td>Richard Allan HP8B</td>
<td>£3.75</td>
</tr>
<tr>
<td>Richard Allan LP8B</td>
<td>£12.50</td>
</tr>
<tr>
<td>Richard Allan DT20</td>
<td>£8.50</td>
</tr>
<tr>
<td>Richard Allan CN820</td>
<td>£10.75</td>
</tr>
<tr>
<td>Richard Allan Super Disco 60W 12in</td>
<td>£33.75</td>
</tr>
<tr>
<td>Richard Allan CG15 15in bass</td>
<td>£71.95</td>
</tr>
<tr>
<td>Richard Allan Super Disco 10in 50 watt</td>
<td>£71.95</td>
</tr>
<tr>
<td>Richard Allan Super Disco 30in 50 watt</td>
<td>£71.95</td>
</tr>
<tr>
<td>Radford BD05</td>
<td>£8.25</td>
</tr>
<tr>
<td>Radford MD6</td>
<td>£18.50</td>
</tr>
<tr>
<td>Radford T03</td>
<td>£18.50</td>
</tr>
<tr>
<td>Radford Cross Over Network</td>
<td>£18.50</td>
</tr>
</tbody>
</table>

**WILMSLOW AUDIO**

Dept PE

Loudspeakers, mail order and export: Swan Works, Bank Square, Wilmslow. Hi-Fi, Radio and TV: Swift of Wilmslow, 5 Swan Street, Wilmslow, Cheshire.

PA, Hi-Fi and Accessories: Wilmslow Audio, 10 Swan Street, Wilmslow, Cheshire.

Telephone: Loudspeakers, mail order and export—Wilmslow 29599; Hi-Fi, Radio, etc.—Wilmslow 26213.

Access and Barclaycard orders accepted by phone.
Sparkrite Mk2
Capacitive discharge electronic ignition kit

VOTED BEST OF 8 SYSTEMS TESTED BY POPULAR MOTORING MAGAZINE OCT. 74

* Smoother running
* Instant all-weather starting
* Continual peak performance
* Longer coil/battery/plug life
* Improved acceleration/top speeds
* Up to 20% better fuel consumption

Sparkrite Mk 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 minutes.

Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit timing. If the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. Most capacitive discharge ignitions are not completely foolproof in this respect.) All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISSES EVERYTHING NEEDED
Ready drilled pressed steel base coated in matt black epoxy resin, ready drilled base and heat-sink. Top quality 5 year guaranteed transformer and components. Cables, coil connectors, printed circuit board, nuts, bolts, silicon grease. Full instructions to make the kit negative or positive earth, and 10 page installation instructions.

OPTIONAL EXTRAS
Electronic/conventional ignition switch.
Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device, includes switch connectors, mounting bracket and instructions. Cables excluded. Also available RPM limiting control for dashboard mounting (fitted in case of ready built unit).

CALLERS WELCOME: For demo running and fitting service – phone (0922) 33088

PRICES INCLUDE VAT, POST AND PACKING Improve performance & economy NOW
NOTE – Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £1.35 inc.VAT, post & packing.

ELECTRONICS DESIGN ASSOCIATES, 82 Bath St., Walsall, WS1 3DE.

POST TODAY! Quick installation No engine modification required.

Electronic Design Associates, Dept. PE6
82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 33652

Name ________________________________
Address ______________________________________

Please send us your details.

Cheque/P.O./Credit Card

Name
Address
Postcode

Postage: £1.25

Quick installation
No engine modification required.

Practical Electronics  May 1977
Bring 'scope' to your interest.

'There's only one way to master electronics... to see what is going on and learn by doing.'

This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.

1 Build an oscilloscope.
As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

2 Read, draw and understand circuit diagrams.
In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

3 Carry out over 40 experiments on basic circuits.
We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v., etc.

All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

To find out more about how to learn electronics in a new, exciting and absorbing way, just clip the coupon for a free colour brochure and full details of enrolment.

Write to:- British National Radio & Electronics School, P.O. Box 156, Jersey, Channel Islands.

NAME

ADDRESS

PEB 5/7
Valve Mail Order Co.

Climax House
159 Fallsbrook Road, London SW16 6ED
Special express service order price

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N23</td>
<td>0.75</td>
<td>BF150</td>
</tr>
<tr>
<td>1N29</td>
<td>0.85</td>
<td>BF142D</td>
</tr>
<tr>
<td>1N34</td>
<td>0.85</td>
<td>BF142C</td>
</tr>
<tr>
<td>1N38</td>
<td>0.90</td>
<td>BF142A</td>
</tr>
<tr>
<td>1N57</td>
<td>1.05</td>
<td>BF142H</td>
</tr>
<tr>
<td>1N98</td>
<td>1.25</td>
<td>BF142G</td>
</tr>
<tr>
<td>1N111</td>
<td>1.35</td>
<td>BF142F</td>
</tr>
<tr>
<td>1N113</td>
<td>1.40</td>
<td>BF142E</td>
</tr>
<tr>
<td>1N116</td>
<td>1.45</td>
<td>BF142D</td>
</tr>
<tr>
<td>1N119</td>
<td>1.50</td>
<td>BF142C</td>
</tr>
<tr>
<td>1N120</td>
<td>1.60</td>
<td>BF142B</td>
</tr>
<tr>
<td>1N121</td>
<td>1.65</td>
<td>BF142A</td>
</tr>
<tr>
<td>1N124</td>
<td>1.75</td>
<td>BF142G</td>
</tr>
<tr>
<td>1N127</td>
<td>1.80</td>
<td>BF142H</td>
</tr>
<tr>
<td>1N131</td>
<td>1.90</td>
<td>BF142I</td>
</tr>
<tr>
<td>1N134</td>
<td>2.00</td>
<td>BF142J</td>
</tr>
<tr>
<td>1N137</td>
<td>2.10</td>
<td>BF142K</td>
</tr>
<tr>
<td>1N140</td>
<td>2.20</td>
<td>BF142L</td>
</tr>
<tr>
<td>1N143</td>
<td>2.30</td>
<td>BF142M</td>
</tr>
<tr>
<td>1N146</td>
<td>2.40</td>
<td>BF142N</td>
</tr>
<tr>
<td>1N149</td>
<td>2.50</td>
<td>BF142O</td>
</tr>
<tr>
<td>1N152</td>
<td>2.60</td>
<td>BF142P</td>
</tr>
<tr>
<td>1N155</td>
<td>2.70</td>
<td>BF142Q</td>
</tr>
<tr>
<td>1N158</td>
<td>2.80</td>
<td>BF142R</td>
</tr>
<tr>
<td>1N161</td>
<td>2.90</td>
<td>BF142S</td>
</tr>
<tr>
<td>1N164</td>
<td>3.00</td>
<td>BF142T</td>
</tr>
<tr>
<td>1N167</td>
<td>3.10</td>
<td>BF142U</td>
</tr>
<tr>
<td>1N170</td>
<td>3.20</td>
<td>BF142V</td>
</tr>
<tr>
<td>1N173</td>
<td>3.30</td>
<td>BF142W</td>
</tr>
<tr>
<td>1N176</td>
<td>3.40</td>
<td>BF142X</td>
</tr>
<tr>
<td>1N179</td>
<td>3.50</td>
<td>BF142Y</td>
</tr>
<tr>
<td>1N182</td>
<td>3.60</td>
<td>BF142Z</td>
</tr>
</tbody>
</table>

Metal Can Transistors 8%.

Practical Electronics

May 1977
Join the Digital Revolution

Understand the latest developments in calculators, computers, watches, telephones, television, automotive instrumentation...

Each of the 6 volumes of this self-instruction course measures 11 1/2" x 8 1/2" and contains 60 pages packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and on to a complete understanding of the design and operation of calculators and computers.

Design of Digital Systems.

£6.20

plus 80p packing and surface post anywhere in the world.

Volumes 1 to 4 are suitable for Engineers, Scientists, Enthusiasts, Managers and Designers.

Volume 5 is especially useful for beginners, who have not tried to assemble electronic kits before.

£4.20

plus 80p P & P

Order all 6 volumes for £27.00, plus 80p P & P.

Also available—a more elementary course assuming no prior knowledge except simple arithmetic.

Digital Computer Logic and Electronics

In 4 volumes:

1. Basic Computer Logic
2. Logical Circuit Elements
3. Designing Circuits to Carry Out Logical Functions
4. Flipflops and Registers

£4.20

plus 80p P & P

Offer Order both courses for the bargain price £9.70, plus 80p P & P.

These courses were written so that you could teach yourself the theory and application of digital logic. Learning by self instruction has the advantages of being quicker and more thorough than classroom learning. You work at your own speed and must respond by answering questions on each new piece of information before proceeding to the next.

Designer

Manager

Enthusiast

Scientist

Engineer

Student

Guarantee—no risk to you

If you are not entirely satisfied with Design of Digital Systems or Digital Computer Logic and Electronics, you may return them to us and your money will be refunded in full, no questions asked.

To: Cambridge Learning Enterprises (Dept. ENG)
FREEPOST, Rivermill House, St. Ives, Huntingdon, Cambs. PE17 4BR
*Please send me... set(s) of Design of Digital Systems at £7.00 each, p & p included
*or... set(s) of Digital Computer Logic and Electronics at £5.00 each, p & p included
*or... combined set(s) at £10.50 each, p & p included

Name

Address

...delete as applicable

No need to use a stamp—just print FREEPOST on the envelope.

FREEPOST. Rivermill House. St. Ives, Huntingdon, Cambs. PE17 4BR

No need to use a stamp—just print FREEPOST on the envelope.

SEND FOR OUR FREE CATALOGUE

Practical Electronics May 1977

NEWS FROM JOSTY KIT

JOSTY KIT—a product from Denmark

HF 61-2 DIODE MEDIUM WAVE RECEIVER

By means of a very simple technique a reasonable reception is attained. HF 61-2 is built on a small circuit board of the same size as the general purpose amplifier AF 380. The two assemblies should be connected to produce power for a loudspeaker. HF 61-2 is especially useful for beginners, who have not tried to assemble electronic kits before.

£4.30

HF 305 VHF RADIO-CONVERTER

Extend the range of your transistor radio. Listen to Amateurs in the 2 metre band, Aircraft Transmitters, etc. Two transistor circuit with printed circuit coils, varactor diodes and superior circuit design. Converts radio signals in the 100-200MHz range to output signal at 100MHz. Pipe this into your VHF receiver and you’re in a new dimension.

£6.70

AT 365 3-CHANNEL DISCO LIGHT

A new concept in psychedelic lighting. Uses built-in microphone. Avoids awkward connections to amplifiers. Position light-show to best advantage without long trailing leads—just plug in to nearest power point. Circuit combines latest integrated circuit technique with solid-state power control. Quad op. amp. makes selection of base, midrange and treble frequencies easy. Three thyristors (SCRs) control three separate lampbanks. Kit includes fused dc power supply and FET zero light adjustment. WARNING: Only experienced persons should attempt the interconnection of mains equipment.

£17.00

HF 385-2 VHF/UHF AERIAL AMPLIFIER

A quality, printed circuit, no trimming, aerial amplifier. Fantastic frequency range due to use of printed coils. 21dB amplification at 400MHz. Two separate inputs for UHF and VHF. No loss of signal or intercommunication problems.

£5.80

NT 410 AERIAL AMPLIFIER CURRENT SUPPLY

NT 410 is a current supply, specially designed to power amplifier, such as HF 385-2, but can also be used for other aerial amplifiers. NT 410 is supplied with input and output clamps for 75 ohm or 50 ohm aerial cables. It is therefore not necessary to solder—just cut and strip the aerial cable and attach to NT 410. The aerial signal is therefore not necessary to solder—just cut and strip the aerial cable and attach to NT 410. The aerial signal is therefore not necessary to solder—just cut and strip the aerial cable and attach to NT 410. The aerial signal is therefore not necessary to solder—just cut and strip the aerial cable to nearest output point. Circuit combines latest integrated circuit technique with solid-state power control. Quad op. amp. makes selection of base, midrange and treble frequencies easy. Three thyristors (SCRs) control three separate lampbanks. Kit includes fused dc power supply and FET zero light adjustment. WARNING: Only experienced persons should attempt the interconnection of mains equipment.

£4.50

JOSTY KIT LTD

MAIL ORDER DIVISION
P.O. BOX 68, MIDDLESBROUGH,
CLEVELAND, ENGLAND B1 5CQ

SEND FOR OUR FREE CATALOGUE

331
PHONOSONICS
MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARD KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

P.E. SYNTHESIZER (P.E. Feb. 73) to Feb. 74)
The well acclaimed and highly, versatile large-scale mains-operated Sound Synthesizer complete with keyboard and circuits. Other units in this series may be used in conjunction with the Synthesizer to good advantage; notably P.E. Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bending, Voltage Controlled Filter, Guitar Effects Pedal and Overdrive, Fuzz, Tremolo and Wah-Wah units.

The Main Synthesizer: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverber amp, ring modulator, peak level circuit, envelope shaping network. Full details in last issue.
Component set (incl PCB) £33.03
Set of printed circuit boards £7.86

The Synthesizer Keyboard Circuits (can be used without the Main Synthesizer to make an independent musical instrument): 2 logarithmic VCOs, divisor, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in last issue.
Component set (incl PCB) £34.18
Set of printed circuit boards £7.86

P.E. MINISONIC Mk. 1 SYNTHESIZER (P.E. Nov. 74 to 75)
A portable, battery or mains-operated Miniature Sound Synthesizer plus Keyboard Circuits. Although having slightly fewer facilities than the large P.E. Synthesizer the unit is designed to give general scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shaping networks, variable tremolo, noise generator, output generator, envelope control circuit, oscillator, envelope detector and timer, noise generator, output generator, envelope control circuit, oscillator, envelope detector and timer, noise generator, output generator, envelope control circuit, oscillator, envelope detector and timer. May be used in conjunction with other electronic instruments.
Component set (incl PCB) £44.51
Set of printed circuit boards. While stocks last £8.05

P.E. MINISONIC Mk. 2
A more sophisticated version of the Mk. 1.
Set of basic component kits from £14.25
Set of printed circuit boards from £9.71

ELEKTOR "FORMANT" SYNTHESIZER (Eletor March 1973)
Details of component kits and PCBs are in our lists.

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source; provides 5 different switchable effects such as can be further modified by manual controls. Possibly the most interesting and useful of the sound effect instruments. Circuit does not duplicate the effects from the Guitar Overdrive pedal.
Component set with special foot operated switch £7.79
Alternative component set with panel mounting £8.16
Printed circuit board £1.43

SOUND BENDER (P.E. May 74)
A multi-purpose sound control functioning with a whole variety of instruments and sounds. It can be used for 3 purposes, tremolo, tape echo and aural delay. Additionally it can be used with the Fuzz, Tremolo and Rhythm Generator. Has built in volume control in addition to input and output levels.
Component set £16.81

GUITAR OVERDRIVE PEDAL (P.E. Aug. 76)
Gives a much shriller quality to audio signals fed through it. Ideal for strobos体制改革 and retaining the attack and decay as well as providing filtering. Supplied complete with PSU.
Component set incl. PCB £3.72

WIND AND RAIN UNIT
A manually controlled unit for producing the above named sounds
Component set (incl PCB) £3.72

FUZZ UNIT
A single Fuzz unit based upon P.E. Sound Design circuit design
Component set (incl PCB) £3.83

TREMOLI UNIT
Based upon P.E. Sound Design circuit
Component set (incl PCB) £3.64

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much higher audio level to signals fed through it. The depth of boost is manually adjustable
Component set (incl PCB) £2.40

ENVELOPE SHAPE
Both of the units below have manual control over their attack. Decay, Sustain and Release functions. Both require a matching PSU. The Fuzz (P.E. Aug '76) requires envelope shaping network.
Component set (incl PCB) £4.56

PHASING UNIT (P.E. July 73)
This is a simple but effective sound -to -light controller capable of operating 3 lamps each of approximately 700 watts. It has an output control, power amp and a bypass switch.
Component set (incl PCB) £1.95

3-CHANNEL SOUND LIMITER (P.E. July 74)
A simple but effective sound -to -light controller capable of operating 3 lamps. Each of approximately 700 watts. It has an output control, power amp and a bypass switch. The output is controlled by a potentiometer which is adjustable from 0 to 100.
Component set (incl PCB) £2.59

TUNING FORK (P.E. Nov. 75)
A simple instrument for giving a choice of sequential, random, or full strobe mode of operation
Basic component set £0.18
Printed circuit board £0.45

PRICE LIST:
- MOSFET SWITCHES AND TRANISTORS - a complete selection of high quality MOSFET switches and transistors available for immediate delivery. The complete list includes over 100 different types.
- SEMICONDUCTOR TESTER (P.E. Oct. 73)
- SEMI CONDUCTOR TESTER (P.E. Nov. 74)
- VOICE OPERATED FADER (P.E. Dec. 73)

For further information and prices please contact the nearest PHONOSONICS branch office.

RAY HILL HOUSE, 22 HIGH STREET, SIDCUP, KENT DA14 5EH
"MAIL ORDER AND C.W.O. ONLY" SORRY BUT NO CALLERS PLEASE

PHONOSONICS DEPT. PES55 • 22 HIGH STREET • SIDCUP • KENT DA14 5EH

VOL. 74, NO. 12 • FEBRUARY 1977

SOUND SYNTHESIZERS AND EFFECT KITS

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these can be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by PHONOSONICS.

PHOTOACTIVES of the P.E. texts for most of the kits are available—prices in our lists.

POST AND HANDLING
UK orders—under £15 add 35p plus VAT, over £15 add 65p plus VAT. Keyboards £15 plus VAT. Insurance for compensation against loss or damage in post. Add 35p in addition to above post and handling charges. Overseas send 65p in addition to above post and handling charges. "Eire, C.I., F.P.O., and other countries are subject to Export postage rates.

UV LAMPS
- U.V. LAMPS include over 50 different types, available in a variety of sizes and shapes. The list includes over 100 different lamp types.

DEPARTMENT STORES
- DEPARTMENT STORES include a complete selection of high quality department stores, available for immediate delivery. The complete list includes over 200 different types.

OVERSEAS ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as prices do change. Export postage is quoted. All payments must be made in full and no exchange is accepted.

AVAILABILITY
- AVAILABILITY is strictly limited and our stock is always decreasing. For further information and prices please contact the nearest PHONOSONICS branch office.

DON'T FORGET VAT!
Add 25% to the price if charged, this covers all goods, post and handling. (Does not apply to export orders)

VOL. 74, NO. 12 • FEBRUARY 1977

SOUND SYNTHESIZERS AND EFFECT KITS

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these can be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by PHONOSONICS.

PHOTOACTIVES of the P.E. texts for most of the kits are available—prices in our lists.

POST AND HANDLING
UK orders—under £15 add 35p plus VAT, over £15 add 65p plus VAT. Keyboards £15 plus VAT. Insurance for compensation against loss or damage in post. Add 35p in addition to above post and handling charges. Overseas send 65p in addition to above post and handling charges. "Eire, C.I., F.P.O., and other countries are subject to Export postage rates.

UV LAMPS
- U.V. LAMPS include over 50 different types, available in a variety of sizes and shapes. The list includes over 100 different lamp types.

DEPARTMENT STORES
- DEPARTMENT STORES include a complete selection of high quality department stores, available for immediate delivery. The complete list includes over 200 different types.

OVERSEAS ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as prices do change. Export postage is quoted. All payments must be made in full and no exchange is accepted.

AVAILABILITY
- AVAILABILITY is strictly limited and our stock is always decreasing. For further information and prices please contact the nearest PHONOSONICS branch office.

DON'T FORGET VAT!
Add 25% to the price if charged, this covers all goods, post and handling. (Does not apply to export orders)
The Finest...

The S.K.A. Plastic Keyboard was developed by Kimber Allen Ltd in cooperation with a Swedish company and the manufacturers state that in their opinion it is the finest moulded plastic keyboard made and is not to be confused with cheaper keyboards available.

The keys are moulded in Acrylic plastic, a material chosen for its hard wearing properties and ideal feel to the touch. They are moulded in two parts, the key face, which has to be perfect in appearance and finish, and the action, which has to be strong and carry the mechanism. The wiring section of aluminium extrusion upon which they are mounted is especially designed to take all the pressures of playing. Springs, felts, and contact actuators are supplied ready-fitted.

The contact assemblies are constructed of laminated bakelite, thus giving smooth slot walls and completely free movement of the gold-clad contact wires. Types available as follows (Contact pairs normally open):

- GL-SPCO: 24p each
- GB-2 pairs: 27p each
- GC-3 pairs: 36p each
- GE-4 pairs: 45p each
- GH-5 pairs: 57p each
- 4PS-SPCO and 3 pairs: 53p each
- Palladium Wire Bus Bars: 1 octave
- lengths: 58p each

See our other advert for synthesizer and sound effect kits and see our lists for other components and accessories stocked. Send S.A.E. for full list (overseas send 40p).

PHONASONICS
DEPT. PE55, 22 HIGH STREET
SIDCUP, KENT DA14 6EH

---

KEYBOARDS
and CONTACTS

U.K. Post and Handling:
37 Note C-C Keyboard £25.50
49 Note C-C Keyboard £32.25
61 Note C-C Keyboard £39.75

Contacts: orders under £15: 25p; orders over £15: 50p

VAT: Add 12½% to final total on all U.K. orders

Export orders are welcome, but please see our price list for Export Postage Rates: N. B. Eire, Channel Isles and S. F. P. O. classed as export.

Mail Order and C. W. O. only—Sorry but no callers please

Prices are correct at time of Press. E & O E. Delivery subject to availability.

---

POCKET TTY

The GR Electronics Pocket TTY offers the keyboard facilities of a teletype—at a fraction of the cost.

- Outputs serial ASCII code to any Teletype compatible device
- 20 mA loop or RS232 mode
- 36 keys giving full 64 character alphanumeric
- 9 digit LED display
- All solid-state with optical coupling for reliability

Pocket TTY can be used for microprocessor programming, production data entry, warehousing, mobile data collection, training and education.

For further details contact
G.R. ELECTRONICS LTD.
80 Church Road, Newport NPT 7EH, Gwent, England.
Telephone: Newport (0633) 67426 Telex 28604 Ref: 1796

---

complete DIGITAL CLOCK KITS

TEAK CASES
prompt order despatch
NON-ALARM
£10.65
ALARM
£13.43

“DELTA”

GENUINE TEAK OR PERSPEX CASE

DELTA DATA: 4 Radiant Red in high LEDs. 12hr display with a.m./p.m. indication. Beautiful Burma Teak Case or Pretty Perspex in white, black, blue, red, green. Power failure is indicated by flashing display.

MODULES: Kits can be bought without case—Non-Alarm £8; Alarm £12.50 inclusive.

READY BUILT: Buy a working tested module and fit your own case—Non-Alarm £3.50; Alarm £13. Complete clock ready built. 2yr guarantee—Non-Alarm £13.50; Alarm £18.50.

ALARM FEATURES: Pulsed tone. Tilt operated 10 minute “Snooze” period. Single switch setting. Optional extra mercury switch (45p) allows alarm reset by tilting clock. Digit brightness is automatically adjustable to suit lighting level.

“ALPHA”

Glorious Green in high digits 12 or 24 hour. Non-Alarm £11 incl.

Built and Tested
Module plus Perspex Case

£11 incl.

CLOCK CHIP: AYS-1202. Only £2.70 incl.

DISCOUNT on orders over 5 kits or clocks.
Overseas airmail: Add £2.50.

Send payment with order. S. A. E. for complete range.

Pulse Electronics Ltd
DEPT. PE11, 202 Shefford Road, Clifton Shetford, Beds.
Telephone: Hitchin (0462) 814477

Practical Electronics May 1977
### PANELL METERS

#### 4in RANGE

Size 4 x 3 x 1in

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50uA</td>
<td>1302</td>
</tr>
<tr>
<td>0-100uA</td>
<td>1303</td>
</tr>
<tr>
<td>0-250uA</td>
<td>1304</td>
</tr>
<tr>
<td>0-1mA</td>
<td>1305</td>
</tr>
<tr>
<td>0-5V</td>
<td>1306</td>
</tr>
</tbody>
</table>

#### 2in RANGE

Size 2 x 1 x 1in

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50uA</td>
<td>1307</td>
</tr>
<tr>
<td>0-100uA</td>
<td>1308</td>
</tr>
<tr>
<td>0-500uA</td>
<td>1309</td>
</tr>
<tr>
<td>0-1mA</td>
<td>1310</td>
</tr>
<tr>
<td>0-5V</td>
<td>1311</td>
</tr>
</tbody>
</table>

#### MR2P TYPE

Size 42 x 42 x 30mm

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50uA</td>
<td>1312</td>
</tr>
<tr>
<td>0-1mA</td>
<td>1315</td>
</tr>
</tbody>
</table>

#### EDGewise

Size 3 x 1 x 2in

Cut out 2 x 1in

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50uA</td>
<td>1313</td>
</tr>
<tr>
<td>0-1mA</td>
<td>1316</td>
</tr>
<tr>
<td>0-500uA</td>
<td>1317</td>
</tr>
</tbody>
</table>

#### MINIATURE BALANCE/TUNING METER

Size 23 x 22 x 26mm

Sensitivity 100/100mA

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1318</td>
<td>£1.95</td>
</tr>
</tbody>
</table>

### BALANCE/TUNING

Size 45 x 22 x 34mm

Sensitivity 100/100mA

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1319</td>
<td>£2.00</td>
</tr>
</tbody>
</table>

### MIN. LEVEL METER

Size 23 x 22 x 26mm

Sensitivity 200uA

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1320</td>
<td>£1.95</td>
</tr>
</tbody>
</table>

#### Vu METER

Size 40 x 40 x 29mm

Sensitivity 130uA

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1321</td>
<td>£2.00</td>
</tr>
</tbody>
</table>

#### MINI MULTI-METER

Size 60 x 24 x 90mm

Sensitivity 1000 ohms V

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10kV</td>
<td>1322</td>
</tr>
</tbody>
</table>

### TRANSISTORS

#### BRAND NEW—FULLY GUARANTEED

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF1080</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF159</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU301</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF167</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU306</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF168</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU307</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF169</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU308</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF170</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU309</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF171</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU310</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF172</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU311</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF173</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU312</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF174</td>
<td>£2.00</td>
</tr>
<tr>
<td>BU313</td>
<td>£2.50</td>
</tr>
<tr>
<td>BF175</td>
<td>£2.00</td>
</tr>
</tbody>
</table>

### 74 SERIES TTL ICs

#### FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>7440</td>
<td>£1.95</td>
</tr>
<tr>
<td>7441</td>
<td>£2.00</td>
</tr>
<tr>
<td>7442</td>
<td>£2.00</td>
</tr>
<tr>
<td>7443</td>
<td>£2.00</td>
</tr>
</tbody>
</table>

### CMOS ICs

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC14001</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14002</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14003</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14004</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14005</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14006</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14007</td>
<td>£0.20</td>
</tr>
<tr>
<td>MC14008</td>
<td>£0.20</td>
</tr>
</tbody>
</table>

### LINEAR ICs

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM324</td>
<td>£1.95</td>
</tr>
<tr>
<td>LM331</td>
<td>£2.00</td>
</tr>
<tr>
<td>MC14540</td>
<td>£2.00</td>
</tr>
<tr>
<td>MC14541</td>
<td>£2.00</td>
</tr>
</tbody>
</table>

---

**NEWNES TECHNICAL BOOKS**

- No. 229 Beginners Guide to Electronics
  - Price £2.25
- No. 230 Beginners Guide to Television
  - Price £2.25
- No. 231 Beginners Guide to Transistors
  - Price £2.25
- No. 233 Beginners Guide to Radio
  - Price £2.25
- No. 234 Beginners Guide to Colour Television
  - Price £2.25
- No. 235 Electronic Diagrams
  - Price £1.80
- No. 236 Electronic Components
  - Price £1.80
- No. 237 Printed Circuit Assembly
  - Price £1.80
- No. 238 Transistor Pocket Book
  - Price £3.90
- No. 225 110 Thyristor Projects using SCRs and Triacs
  - Price £2.90
- No. 227 110 COS/MOS Digital IC Projects for the Home Constructor
  - Price £2.50
- No. 226 110 Operational Amplifier Projects for the Home Constructor
  - Price £2.00
- No. 242 Electronics Pocket Book
  - Price £3.75
- No. 239 30 Photoelectric Circuits and Systems
  - Price £1.80

---

**SEE OUR 1977 CATALOGUE**

126 pages packed with valuable information

**ORDER NOW**

ONLY 50p plus 15p p & p

---

**P & P**

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1
### TRANSFORMERS

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT280 0-6V 6V RMS</td>
<td>£1.36</td>
</tr>
<tr>
<td>MT155 0-12V 6-12V RMS</td>
<td>£1.36</td>
</tr>
</tbody>
</table>

### MINIATURE MAINS 240V

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2033</td>
<td>1501</td>
<td>£0.40</td>
</tr>
<tr>
<td>2031</td>
<td>1502</td>
<td>£0.40</td>
</tr>
</tbody>
</table>

### 1 AMP MAINS 240 V

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2032</td>
<td>1501</td>
<td>£0.60</td>
</tr>
</tbody>
</table>

### STANDARD MAINS 240V

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2033</td>
<td>1501</td>
<td>£0.60</td>
</tr>
</tbody>
</table>

### AUDIO OUTPUT PRIMARY 1:2k, Secondary 5 ohms

| Dimensions (20 x 15 x 15mm) | £0.25 |

### MINIATURE INTER/DRIVER

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2038</td>
<td>£0.25</td>
</tr>
</tbody>
</table>

### LMT10 MIN. INPUT

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3051</td>
<td>£0.42</td>
</tr>
</tbody>
</table>

### LMT11 MIN. DRIVER

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2040</td>
<td>£0.35</td>
</tr>
</tbody>
</table>

### PRIMARY 500 ohm, Secondary 8 ohms 100mW, 15 x 16 x 13mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2041</td>
<td>£0.28</td>
</tr>
</tbody>
</table>

### LMT17 MIN. OUTPUT

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2042</td>
<td>£0.52</td>
</tr>
</tbody>
</table>

### PRIMARY 1000 Hz, Secondary 4k2, 10 x 15 x 13mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2043</td>
<td>£0.32</td>
</tr>
</tbody>
</table>

### PRIMARY 20k2, C.T. 20 x 15 x 15mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2044</td>
<td>£0.32</td>
</tr>
</tbody>
</table>

### PRIMARY 20k3, C.T. 20 x 15 x 15mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2045</td>
<td>£0.35</td>
</tr>
</tbody>
</table>

### PRIMARY 500 ohm, Secondary 3 x 8 ohms 200mW, Dimensions 20 x 15 x 15mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2046</td>
<td>£0.38</td>
</tr>
</tbody>
</table>

### PRIMARY 2000 ohm C.T. Secondary 3 and 8 ohms 400mW, Dimensions 25 x 20 x 20mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2047</td>
<td>£0.36</td>
</tr>
</tbody>
</table>

### PRIMARY 5000 ohm C.T. Secondary 3 and 8 ohms 200mW, Dimensions 20 x 15 x 15mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2048</td>
<td>£0.43</td>
</tr>
</tbody>
</table>

### PRIMARY 4k3, C.T. Secondary 4 and 8 ohms 200mW, Dimensions 20 x 15 x 15mm

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2049</td>
<td>£0.44</td>
</tr>
</tbody>
</table>

### NUTS AND BOLTS

#### BA BOLTS
- **Pack of BA threaded cadmium-plated screws, slotted choice head.**
- **Supplied in multiples of 100.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA6</td>
<td>£0.49</td>
</tr>
<tr>
<td>BA8</td>
<td>£0.47</td>
</tr>
<tr>
<td>BA10</td>
<td>£0.45</td>
</tr>
</tbody>
</table>

#### BA WASHERS
- **Pack of cadmium-plated plain stainless washers.**
- **Supplied in multiples of 100.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA6</td>
<td>£0.50</td>
</tr>
<tr>
<td>BA8</td>
<td>£0.49</td>
</tr>
<tr>
<td>BA10</td>
<td>£0.47</td>
</tr>
</tbody>
</table>

### SWITCHES

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPDT miniature slide</td>
<td>£0.18</td>
</tr>
<tr>
<td>DPDT standard</td>
<td>£0.16</td>
</tr>
<tr>
<td>Top entry SPST 1 amp 200Vac</td>
<td>£0.25</td>
</tr>
<tr>
<td>Dolly switch DPDT 1 amp 200Vac</td>
<td>£0.25</td>
</tr>
<tr>
<td>Rotary on-off switch</td>
<td>£0.25</td>
</tr>
<tr>
<td>Push switch - Push to break</td>
<td>£0.25</td>
</tr>
<tr>
<td>Push switch - Break to break</td>
<td>£0.25</td>
</tr>
</tbody>
</table>

### ROCKERSWITCHES

<table>
<thead>
<tr>
<th>Colour</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>£0.20</td>
</tr>
</tbody>
</table>

### MIDGET WAFER SWITCHES

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD770 3 in single</td>
<td>£0.80</td>
</tr>
<tr>
<td>BD774 5 in single</td>
<td>£1.50</td>
</tr>
<tr>
<td>BD776 5 in double</td>
<td>£1.60</td>
</tr>
</tbody>
</table>

### COLD CATHODE IIT586 ST

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVR 7815 5V</td>
<td>£1.25</td>
</tr>
<tr>
<td>MVR 7824 24V</td>
<td>£1.25</td>
</tr>
</tbody>
</table>

### DISPLAYS

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOL57 5 in single</td>
<td>£0.80</td>
</tr>
<tr>
<td>BOL57 5 in single</td>
<td>£1.10</td>
</tr>
</tbody>
</table>

### VOLTAGE REGULATORS

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVR 7815 5V</td>
<td>£1.25</td>
</tr>
<tr>
<td>MVR 7824 24V</td>
<td>£1.25</td>
</tr>
</tbody>
</table>

### ORDERING

**PLEASE WORD YOUR ORDERS EXACTLY AS PRINTED, NOT FORGETTING TO INCLUDE OUR PART NUMBER.**

**VAT ADD 12½% TO PRICES MARKED* ADD 8% TO OTHERS EXCLUDING THOSE MARKED; THESE ARE ZERO**

---

*Price in brackets includes VAT.**
GOOD NEWS FROM

Connoisseur
THE BD2/A

Based on the popular BD2, the new BD2/A offers the hi-fi enthusiast all the features usually associated with Connoisseur turntables, such as low rumble, wow and flutter, plus the addition of an automatic pick-up arm lift-off at the end of the record. This is achieved by an ingenious, though simple, electromagnetic system, which avoids having any physical contact with the pick-up arm. It is possible, therefore, to use top quality cartridges, tracking at less than one gram, without putting any extra side pressure on the stylus.

The BD2/A comes either as a chassis model, or mounted on a slimline plinth, standing on rubber anti-vibration feet, finished in genuine American walnut, and fitted with a bronze hinged dust cover. For those with restricted space, a compact plinth measuring only 13” x 15” x 5½” is still available.

Specification
Rumble—65dB when measured in accordance with DIN 45539 using weighting network, referred to 7cm/sec. at 330Hz
Wow and flutter—Less than 0.1%.
Hum level—80dB.

Ask your local hi-fi dealer, or write to the factory, for further details.

Manufactured by: A. R. Sugden & Co (Engineers) Ltd., Atlas Mill Road, Brighouse, West Yorkshire, HD6 1ES.
Telephone: Brighouse (0484) 7121421. Telegrams & Cables: Connoisseur, Brighouse.

"Manta"
THE NEW, HIGHER RELIABILITY VERSION OF THE P.E. SCORPIO MK II’ IS NOW AVAILABLE IN KIT FORM!! Our thousands of satisfied customers report:

More miles per gallon (customers reports give 10%-25% saving—letters available).
An increase in overall performance—your 4 cylinder car feels like a 6 cylinder.
No more cold morning splutters—saves you even more petrol through much less use of choke.
The price? A snip at only £16.50, fully inclusive of all parts, instructions, postage/packing and V.A.T. (ready built unit available—£19.85 fully inclusive)

All parts to high specification, first quality and brand new.

Construct this invaluable accessory, following our easy step by step instructions (also available separately, price 30p post paid). Send for our free interesting six page brochure—Electronic Ignition—How it Works (S.A.E. Please) to:

ELECTRO SPARES
Dept. P.E., 187a Sheffield Road, Chesterfield, Derbyshire S41 7JO. Telephone: Chesterfield (0246) 36638
NEW VOICE FOR COMPONENT INDUSTRY

The formation of the Electronic Components Industry Federation (ECIF) by a marriage between the Radio and Electronic Component Manufacturers' Federation and the Electronic Components Board provides the UK components industry with a single and powerful voice to represent its interests.

The creation of this new body coincides with the recognition by the Government of the component industry's importance to our economic affairs. For the electronic component industry is one of five selected industries from an original list of 40, that have been deemed of strategic importance for the future. With this recognition comes the establishment of a Department of Industry support scheme for British-based component makers, with an initial sum of £20m to be made available. The new streamlined association ECIF will be working in very close cooperation with the NEDO Sector Working Party on components.

The ECIF is important in that it represents about 90 per cent of the entire component manufacturing business in the United Kingdom. The list of 145 member companies embraces the smaller firms, many of these producing the less exalted components without which the glamorous components like semiconductor devices would be deprived of their chance to shine, as well as the big companies with household names. Included amongst the latter are well-known American semiconductor makers who have established factories in the UK.

But the exclusion of other well-known names in the semiconductor field is equally notable. General Instrument Microelectronics, for one, has a manufacturing establishment in Scotland and many of their current i.c. devices have been designed and developed here. Yet this multi-national company has declined the invitation to join ECIF. Apparently GIM are rather sore at being treated as "foreigners" whenever there is any Government hand-out to help finance research and development work by UK firms. So they feel reluctant to chip-in for the common cause by contributing to an organisation such as ECIF.

Wholly British owned firms such as Ferranti, GEC and Plessey have, from time to time, received financial backing from the Government. This is part of a determined effort to strengthen the indigenous semiconductor industry. But facts of life concerning the semiconductor industry in general suggest that those US firms that have set up development and manufacturing facilities in the UK should be equally encouraged in their efforts, which do of course contribute directly to our economy. On the very important technological plane, these companies keep the UK in the main stream of big developments originating in their home bases across the Atlantic. How better to encourage them develop their roots over here than by making them eligible for consideration for financial backing? There are signs that the Government is beginning to think this way; if so, any coolness towards the ECIF will no doubt disappear and that body will become all the more relevant to the component situation in the UK and thus be better able to fulfil its intended purpose: to help maintain a thriving and forward looking components industry in this country.

F. E. B.

Editor
F. E. BENNETT
Editorial
G. C. ARNOLD Assistant Editor
D. BARRINGTON Production Editor
G. GODBOLD Technical Editor
M. ABBOTT
Art Dept.
J. D. POUNTNEY Art Editor
D. J. GOODING
R. J. GOODMAN
K. A. WOODRUFF
Advertisement Manager
D. W. B. TILLEARD
Phone: 01-634 4504
P. J. MEW
Phone: 01-634 4181
C. R. BROWN Classified
Phone: 01-261 5762
Make-up and Copy Dept.
Phone: 01-634 4372
Editorial & Advertising Offices:
Fleetway House, Farringdon St.
London EC4A 4AD
Phone: Editorial 01-634 4452
Advertisements 01-634 4504
Electronic organ fans will be familiar with the pleasant sound produced by a Leslie rotating type loudspeaker unit, and most would probably agree that what gives rise to this pleasing effect, is the mechanically induced phase modulation of the sound.

It may seem sacrilegious to suggest that there are other, more flexible and less clumsy ways of achieving phase modulation of audio signals, but an organ which has enjoyed almost legendary popularity over the years, does produce its modulation at the electrical signal stage. The Hammond A100 employs an electromechanical device consisting of a short period delay line, which is mechanically scanned in such a way as to induce undulating phase changes in the signal, controllable at the keyboard.

The circuit described in this article goes one stage further, producing an aural appeal virtually equal to the "true Leslie effect", by a completely electronic process.

Fig. 1. Circuit diagram of Organ Tremolo Unit. LED1 is optically coupled to R23, and likewise LED2 with R24
TREMOLO EFFECTS

The unit was specifically designed for injecting phase modulation into the electrical signal available at the organ's auxiliary output socket; this signal then being fed to a conventional power amplifier loudspeaker extension. The tremolo speed is approximately 5Hz, which will blend acoustically with the tremolo from the organ's Leslie speaker system, regardless of the latter's precise speed. With both tremolos on, the effect is similar to theatre organ tremolo, and a modified effect can also be obtained by running the organ's unit at "chorus" speed (about one cycle in 1.5 seconds), with full external tremolo. If the control of the external tremolo is now eased back to a low level, a very reasonable "straight" organ sound is obtained.

Although the author disliked the idea of having both the internal and external units running at chorus speed, there is no reason why an experimental oscillator, running at the slower speed, should not be added to this unit in conjunction with suitable changeover switching.

Obviously the electronic tremolo unit can be used on its own, with an organ not fitted with its own system. In this case the tremolo unit and the PA/LS extension can be regarded as a relatively inexpensive alternative to a rotation loudspeaker type extension, with considerable improvement in tone ambience as a whole.

CIRCUIT DESCRIPTION

Referring to the diagram in Fig. 1, the organ signal passes through two phasing stages, and then a conventional output stage. The first stage contains an inductance/resistance combination and the second stage, a capacitance/resistance combination, the latter being subjected to a 180 degree phase inversion by the second transistor.

The resistance element in each case is a light dependent resistor coupled to a light emitting diode, and mounted in a light-proof container.

The oscillator section (TR6 and TR7) drives the two transistors TR4 and TR5 through the tremolo control potentiometer VR4. Because TR4 is npn and TR5 is pnp the two l.e.d.s are driven in antiphase. This causes the respective resistances of R23 and R24 to swing alternately between the arbitrary limits of 5kΩ and 20kΩ.

The phase changes imposed on the signal by the two stages are shown in Figs. 2a and 2b, and as can be seen, the inductive stage creates the phase lag $\theta_1$, and the capacitive stage produces a phase lead of $\alpha_1$. The maximum total phase variation for any given frequency can be read from the graph in Fig. 2c, and this is $\theta_1 + \alpha_1$ degrees. The plots were produced mathematically with formulae derived from the vector diagrams.
Fig. 3. Component layout on 0.1 inch Veroboard. The arrangement of the optical couplings using cabinet feet is shown.

CONSTRUCTOR'S NOTE
The following components:
- Clear encapsulated red i.e.d.
- Suitable plastic cabinet feet for optical couplers
- Ferrite pot core assembly, and suitable wire,

are available from:
Greenweld Electronics, 443 Millbrook Road, Southampton SO1 0HX.
From the trigonometrical ratios applicable to a right-angle triangle:

\[ \tan \theta_2 = \frac{o_2}{L} \quad \text{equation (1)} \]

It can be shown that \( \theta_1 = 2\theta_2 \) degrees.

Since \( \theta_3 = 90^\circ - \theta_2 \) degrees

and also \( \theta_3 = \frac{180^\circ - \theta_1}{2} \) degrees.

Therefore \( 90^\circ - \theta_2 = \frac{180^\circ - \theta_1}{2} \)

Multiplying by 2: \( 180^\circ - 2\theta_2 = 180^\circ - \theta_1 \)

\[ \therefore \theta_1 = 2\theta_2 \quad \text{equation (2)} \]

Combining equations (1) and (2) we get

\[ \theta_1 = 2 \tan^{-1} \left( \frac{o_2}{L} \right) \]

or \( \theta_1 = 2 \tan^{-1} \left( \frac{2\pi fL}{R} \right) \)

Similar rules define \( x_1 \) as being \( 2 \tan^{-1} (2\pi fR) \).

The graphical plots of these formulae correspond closely to measurements taken with the unit in operation.

Most electronic organs have a high signal level at their extension output sockets, and for this reason the value of 33kΩ has been chosen for \( R_1 \), to give an audio output signal which is about -10dB with respect to the input level. This attenuation can be reduced if required, by lowering the value of \( R_1 \).

The purpose of \( R_2 \) is to regulate the maximum depth of tremolo available at \( VR_4 \). The value of 2-2kΩ found suitable in the prototype, can be changed up or down in value, to cover tolerances in i.e.d. performance.

Capacitor \( C_5 \) should be 0-1μF for a 200kΩ output, or 4-7μF for a 10kΩ impedance output.

If the second oscillator is required for the chorus effect, it can be constructed using the same circuit as the oscillator section of Fig. 1, and making \( R_19 = 22k\Omega, R_20 = 12k\Omega, C_9 = 10\mu F \). \( 14.7\mu F \), and \( C_{10} = 50\mu F \). The decoupling components \( R_{21} \) and \( C_4 \) may be omitted in this instance. The period of oscillation is about 1 to 1-5 seconds.

CONSTRUCTION

The two i.e.d./i.d.r. sub assemblies need no explanation, being put together as indicated in Fig. 3. It should be borne in mind that the i.e.d.s are required to be withdrawn from their housings, to carry out the adjustments detailed later.

The winding of the inductor coil can be done using a handbraced held in a bench vice. The bobbin is lightly clamped between two oversize washers on a 50mm long 2BA screw, and secured with a nut, the end of the screw being held in the handbrace chuck. The nut is lightly tightened, after the bobbin has been centred to rotate concentrically. It is advisable to clean the end of the wire and anchor it to the chuck with adhesive tape, before starting to wind.

Have a piece of sticky tape cut to size and ready to wrap around the coil after the 800 turns of 40 s.w.g. enamelled copper wire have been wound on. There is plenty of room on the bobbin, and ordinary "pile" winding is satisfactory.

The coil ends should be brought out of diametrically opposite slots, which after assembly of the inductor, are soldered to the pins as shown on the circuit board layout. An earth connection is soldered between the fifth pin, and the adjacent clip.

Components are mounted on Veroboard, the layout of which is shown in Fig. 3. It is recommended that the complete panel should be mounted in a vacant space inside the organ’s housing, to allow the audio and tremolo control connections to be made more readily. The only outgoing signal will then be the phase processed output lead.

POWER SUPPLY

The total current consumption of this 12 volt positive earth system is 25mA, and may be available from the organ’s supply. If this is not possible, and a mains power pack is not desired, then two PJ996 or similar batteries would provide a generous source of supply.

ADJUSTMENTS

(1) Before switching on, \( VR_2 \) and \( VR_3 \) should both be turned to an almost fully clockwise position, thus cutting off \( TR_4 \) and \( TR_5 \).

(2) After switching on, \( VR_5 \) and \( VR_6 \) should be adjusted to obtain a sinusoidal waveform from the oscillator. This is best done by connecting an oscilloscope across \( VR_4 \), but it can also be done by ear, as a non-sinusoidal waveform will produce audible harmonics if connected to the p.a./l.s. extension. This of course would be done after installation.

(3) With zero drive from the oscillator, and with the i.e.d.s removed from their housings, turn \( VR_2 \) anticlockwise until LED1 begins to glow. Similarly turn \( VR_3 \) anticlockwise until LED2 begins to glow. Replace the two i.e.d.s in their housings.

(4) Adjust VR1 to the point where the unit accepts full organ signal without overloading.

This completes the adjustments, and the unit should now be ready for use.
This alarm is suitable for all types of security application, in a house, shop or any other place that needs to be protected from an intruder.

It can be used with open and closed circuit sensors, and is of bridge design to give the maximum protection. Entry and exit delays are provided, allowing one to enter and leave the building without need for a key switch at the door.

The alarm is run from internal batteries, an HP1 was used in the prototype. This battery will give up to six amperes. Since the unit consumes only 10mA in the Guard condition, the cost of providing a mains power supply unit was hardly felt to be justified.

THE CIRCUIT

As will be seen from Fig. 1, the alarm is built around a 741 operational amplifier, operating in the open loop mode as a voltage comparator. The alarm voltage $V_1$ is set by the divider chain comprising resistors $R_x$ and $R_y$. The voltage at the junction is applied to the inverting input (pin 2) of IC1. A similar voltage $V_2$ is set on the non-inverting input (pin 3) by the potential divider formed by $R_1$, $VR_1$ and $R_2$.

Providing that $V_1$ remains more positive than $V_2$, the output of the 741 (pin 6) will stay at about two volts.

COMPONENTS...

<table>
<thead>
<tr>
<th>Resistors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_1$, $R_2$</td>
<td>3.9kΩ</td>
</tr>
<tr>
<td>$R_3$, $R_4$</td>
<td>39kΩ</td>
</tr>
<tr>
<td>$R_5$</td>
<td>12kΩ</td>
</tr>
<tr>
<td>$R_6$</td>
<td>22kΩ</td>
</tr>
<tr>
<td>$R_7$</td>
<td>560Ω</td>
</tr>
<tr>
<td>$R_8$</td>
<td>47Ω</td>
</tr>
<tr>
<td>$R_9$</td>
<td>220Ω 1W</td>
</tr>
<tr>
<td>All unspecified</td>
<td>1W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potentiometers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$VR_1$</td>
<td>50kΩ lin.</td>
</tr>
<tr>
<td>$VR_2$</td>
<td>1MΩ min. preset</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>470μF 16V electrolytic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$TR_1$</td>
<td>BFY91</td>
</tr>
<tr>
<td>$TR_2$</td>
<td>TIS43</td>
</tr>
<tr>
<td>$IC_1$</td>
<td>741</td>
</tr>
<tr>
<td>$D_1$</td>
<td>1N4148</td>
</tr>
<tr>
<td>$CSR_1$</td>
<td>BTY79-400R (400V 6A thyristor)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>Push-on, delay switch (see text)</td>
</tr>
<tr>
<td>$S_2$</td>
<td>3-pole, 4-way key-operated switch*</td>
</tr>
<tr>
<td>$S_3$</td>
<td>S.P.C.O. microswitch</td>
</tr>
<tr>
<td>$RLA$</td>
<td>D.P.C.O. relay, 185Ω 12V coil, continental type</td>
</tr>
<tr>
<td>$WD_1$</td>
<td>Audible warning device, 12V (RS Components 248-808)</td>
</tr>
<tr>
<td>$LP_1$</td>
<td>12V lamp with holder, green lens</td>
</tr>
<tr>
<td>$LP_2$</td>
<td>12V lamp with holder, red lens</td>
</tr>
<tr>
<td>$B_1$</td>
<td>HP1 battery</td>
</tr>
<tr>
<td>Plug for $B_1$</td>
<td>heat sink for $CSR_1$ (see Fig. 2); socket for $IC_1$ (if required); 12-way terminal strip; aluminium box (see text); alarm bell, 12V; $R_x$, $R_y$ and sensors (see text)</td>
</tr>
</tbody>
</table>

*The key-operated switch is available from F & G Electronics (Manchester), 28 Middleham Street, Manchester M14 7NG
In this condition, the forward bias on TR1 is not sufficient for RLA to be energised. If, however, the resistance of line A increases or line B decreases, the balance will be upset, changing the state of the input stage and making the output rise to about 10 volts. As soon as this happens, transistor TR1 will saturate and energise relay RLA/2. When the unit is in the Guard condition, the relay will latch when set off, thus keeping the bell powered. The only way to stop it is by means of the key-operated switch S2.

When the alarm is triggered, power will be applied via RLA2 and S2c to the timer, based on the unijunction TR2. The delay, set by the charging rate of C1 via R6/VR2, will allow up to eight minutes to enter and switch off the alarm. Power will also be applied to an audible warning device WD1, to indicate that the timer has started. The bell will not ring until the timer has completed its cycle and fired thyristor CSR1.

A microswitch S3 fitted to the case operates if the lid is opened. The switch contacts place a short circuit across the gate and anode of the thyristor, causing the bell to ring if the unit is tampered with.

EXIT DELAY

The exit delay is simply a push-to-make, delay switch S1 connected across the base emitter junction of TR1 to hold off the alarm until the exit door has been closed. This type of switch is intended for use on the stairways of blocks of flats, etc. turning the lights on when pushed, but turning them off again after a period of a couple of minutes or so, depending upon its setting, to save power. Such switches are available from most good electrical shops.

If an intruder enters he will not be able to silence the alarm by pushing S1, as the relay will have latched on via its contact RLA1. Lamps LP1 and LP2 are for setting the unit, and for indicating the state of the alarm loops when switching the unit on. If the alarm loops are upset, RLA will be energised, illuminating the red lamp instead of the green when S2 is turned to the Set Balance position. The doors and windows should then be checked before turning S2 to Guard, otherwise the bell will ring.

Resistor R9 maintains a holding current of about 30mA through the thyristor, which would otherwise switch off when the bell trembler contacts open.

CONSTRUCTION

The prototype unit was built in an aluminium box 180 x 205 x 75mm, large enough to accommodate the battery and all the electronics. Most of the components are mounted on a printed board, as shown in Fig. 2. Of the remainder, VR1, LP1, LP2, S1 and S2 are mounted on the lid, and the audible warning device is mounted at the top of the box, with a hole to let out the sound. All external connections are made via a 12-way terminal strip.

SETTING UP

To set up the alarm, fit R_x and R_y, which can have any value from 10kΩ to 56kΩ. In the prototype system, 33kΩ and 27kΩ were used. Place the key in S2 and

---

**Fig. 1.** Circuit diagram of the complete burglar alarm. The values of R_x and R_y are discussed in the text. Circled numbers identify connections to the 12-way terminal block.
Fig. 2. Printed board pattern shown full size and component layout. The thyristor heat sink is in contact with the mounting stud (anode) and is therefore live. Keep clear of earthed metalwork or wiring.
turn to Set Balance. Adjust the balance potentiometer VR1 to the point where the green lamp just comes on, then remove Rr and short out Rr in turn. In each case the green should go out and the red come on. This indicates that all is well.

Next turn S2 to Test, and as before open and short circuit the resistors. The relay should latch and not reset until S2 is returned to Set Balance.

To set the timer, connect two links, one from No. 7 on the terminal strip to battery positive, and one from No. 8 to battery negative. Disconnect the audible warning device to stop the noise while setting up. Connect a 12 volt lamp to terminals 9 and 10 to indicate when the thyristor has fired, and adjust preset VR2 to give the required delay.

The only remaining item to be tested is the tamper switch. To do this remove all the links and reconnect the audible warning device. Remove the temporary lamp from terminals 9 and 10 and wire in the bell. Turn S2 to Guard, i.e. alarm on, and remove the lid, whereupon the bell should ring.

The setting of VR1 should be checked when the unit is installed with the external sensors connected to lines A and B. These sensors may be reed switches, microswitches, pressure mats, etc. as required.

To make the alarm more difficult for an intruder to bypass, line A and line B can be run in one four-core cable. The intruder will then not know the correct ones to cut or join.

---

**NEWS BRIEFS**

**First UK Conference on DIY Computing**

A one-day conference entitled “Build Your Own Computer” is being staged by Online Conferences at the Institution of Electrical Engineers, Savoy Place, London WC2, on Saturday, 14 May. Designed to cater for the home computer builder and for companies considering building their own microcomputer system from scratch, the conference will deal with the principles of computer construction, availability of components, costs, use of domestic TV and audio equipment as peripherals, programming, and the effect of microelectronics on consumer goods.

Tickets are £8 in advance, or £9 at the door. Further details from Online, Cleveland Road, Uxbridge, Middlesex.

**See Us at the All Electronics Show**

The All Electronics Show is being held from 19-21 April at Grosvenor House, Park Lane, London W1. Among the 200 or so exhibitors will be PRACTICAL ELECTRONICS (Stand 127, Great Room) showing a selection of recent and future projects.

The show is open from 10am to 6pm daily, admission 50p.

**Sound '77 Exhibition**

The Sound '77 Exhibition, organised by the Association of Sound and Communication Engineers, will take place at the new Wembley Conference Centre from April 19-21. On display will be a wide range of alarm systems, amplifiers, microphones, loudspeakers, sport event timing equipment, music systems and public address and audio equipment. The exhibition is open daily from 10am to 6pm (5pm on the last day) and admission is free.

The organisers were formerly the Association of Public Address Engineers. Their new name is intended to acknowledge the ever-widening scope of sound communications, in industry, commerce, public services, and entertainment.

**London Meeting a Great Success**

PRACTICAL ELECTRONICS joined forces with a large semiconductor manufacturer and a component retailer to present a Microprocessor Forum for Constructors. The first date, Saturday, 26 February, was soon over-subscribed, and a repeat of the Forum was organised for the following Saturday, 6 March. PE's associates in this unique presentation were National Semiconductor (UK) Ltd., one of the world's foremost microelectronics manu-

---

Competition winners A. Mackintosh and A. Challinor receiving their Introkit prizes from Mrs. J. L. Marshall

facturers, and A. Marshall (London) Ltd., one of the largest distributors of electronic components.

Audiences of about 200 attended each staging of the Forum at Berners Hotel, London W1, listening attentively to two National Semiconductor engineers, Dave Brown and Stewart May, who spoke on different aspects of microprocessors and answered questions from the audience.

A feature of the first Forum was the presentation by Mrs J. L. Marshall of prizes to the first two winners of the PE Microprocessor Competition, A. Mackintosh of Brighton, and A. Challinor of Stoke-on-Trent.

An elimination competition is under way to find the third main prize winner, and we hope to publish a full list of winners in our June issue.

---

Left to right, Colin Wemyss, Distribution Manager, National Semiconductor (UK) Ltd., Fred Bennett, Editor PE, Graham Clifton, General Manager A. Marshall Ltd., Stewart May and Dave Brown

---

Practical Electronics May 1977
A "Miss World" contest for microprocessor chips would be difficult to judge. There would be those who liked their MPUs well stacked (see Part 2), the bipolar brigade who preferred speed to comfort, and of course the "leg men" hooked on long graceful instruction sets! At the end of the day, though, the vital statistic which would receive the most scrutiny, and receive the most admiration and wolf-whistles, would undoubtedly be the instruction set. It is the very existence of the instruction set which sets MPU chips apart from standard LSI, and as far as we are concerned, "Vive la difference!"

The instruction set is, in effect, a rudimentary "language" through which we earthlings can communicate our desires to the inner recesses of the semiconductor chip, a language which is designed by the chip makers in most cases. Of course the ideal language for microprocessor programming would be English, or if you happen to be French, French, but microprocessors are far removed from our intellectual level (thank goodness!) and require us to "talk down" to them using a basic language with a very limited vocabulary, namely, the instruction set.

With larger computer systems much effort has been expended in writing special programs called compilers which translate instructions written in "almost English" into the currency of the computer instruction set, but while this is a universally practised technique for large systems, it is a newcomer to microprocessors and can only be used on MPU systems with a lot of memory space available.

It seems unlikely that we will see microprocessor systems in our price range which are capable of running compilers for some time yet, which means that when we do use microprocessors we have to think in terms of the basic instruction set that the MPU is born with, and be familiar with the way the MPU chip operates in a hardware sense. This fact of life is not unpalatable since it gives the whole subject a distinct "hardware" or "gates and wire" flavour which should make using microprocessors a natural and exciting experience for most electronics enthusiasts.

**INSTRUCTION CODING**

Fig. 3.1 gives some examples from an MPU instruction set, and as you can see, there is an English sentence or two to describe the effect of the instruction to us mortals, and a binary code word which specifies the instruction to the MPU. Now the MPU can't read English, and we find it very difficult to remember and use patterns of 1's and 0's, and so to write a program we would use a list of instructions like the one in Fig. 3.1 to "look-up" the binary code for a specific operation so that we can use it in our program.

To make it a little easier for us to remember the binary patterns of MACHINE CODE as it is called, most people find it best to use a notation called HEXADECIMAL which represents groups of four binary bits as a single character from the set 0 to 9 and A to F which provide the necessary 16 possibilities.

Using hexadecimal the eight-bit instruction 11101000 becomes E8, which is both easier for us to use and straightforward for a program to convert into binary if required.

An alternative to hexadecimal is OCTAL code where the binary is split into groups of three bits, each represented by a decimal digit from the set 0-7, so that the binary instruction above would be coded as 350 in this notation.

Octal is losing a lot of ground these days to hexadecimal which is undoubtedly a more powerful and easy-to-use technique for microprocessor use, especially since it has the added protection that in a list of
**INSTRUCTION SET**

Summary of Processor Instructions

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
<th>Instruction Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF</td>
<td>No Operation</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>HLT</td>
<td>Halt</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>BBS</td>
<td>Branch Back and SRC</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>LCR</td>
<td>Command Register to Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DR4</td>
<td>Logical DR, Index Register 4 and Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DR5</td>
<td>Logical DR, Index Register 5 and Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>AN6</td>
<td>Logical AND, Index Register 6 and Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>AN7</td>
<td>Logical AND, Index Register 7 and Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DB0</td>
<td>Designate ROM Bank 0</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DB1</td>
<td>Designate ROM Bank 1</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>SR0</td>
<td>Select Index Register Bank 0</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>SR1</td>
<td>Select Index Register Bank 1</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>EIN</td>
<td>Enable Interrupt</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DIN</td>
<td>Disable Interrupt</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>RMP</td>
<td>Read Program Memory</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
</tbody>
</table>

**Two Cycle Instructions**

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
<th>Instruction Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>*JCN</td>
<td>Jump Conditional to Address</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>*JFP</td>
<td>Fetch Immediate, ROM Data to Index Register</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>SRC</td>
<td>Send Register Control</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>*FIN</td>
<td>Fetch Indirect, Data from ROM to Index Register</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>JIN</td>
<td>Jump Indirect to Address in Register</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>*JUN</td>
<td>Jump Unconditional to Address</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>*JMS</td>
<td>Jump to Subroutine at Address</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>INC</td>
<td>Increment Register RRR</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>*ISZ</td>
<td>Increment Register RRR, Go to Address A, if result is not zero, otherwise go to next instruction</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
</tbody>
</table>

**Branch DR, Index Register and Accumulator**

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
<th>Instruction Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD</td>
<td>Add Register RRR to Accumulator with Carry</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>SUB</td>
<td>Subtract Register RRR from Accumulator with Borrow</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>LD</td>
<td>Load Contents of Register RRR to Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>XCH</td>
<td>Exchange Contents of Register RRR and Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>BBL</td>
<td>Branch Back and Load Data DDDD to Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>LDM</td>
<td>Load Data DDDD to Accumulator</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
</tbody>
</table>

**Machine Group**

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
<th>Instruction Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOP</td>
<td>No Operation</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DIN</td>
<td>Disable Interrupt</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>DIN</td>
<td>Disable Interrupt</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
<tr>
<td>RMP</td>
<td>Read Program Memory</td>
<td>D1 D2 D3 D4 D5 D6</td>
</tr>
</tbody>
</table>

**Instruction Code**

<table>
<thead>
<tr>
<th>Instruction Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 D2 D3 D4 D5 D6</td>
<td>I/O and RAM Group</td>
</tr>
<tr>
<td>D1 D2 D3 D4 D5 D6</td>
<td>MPU Group</td>
</tr>
</tbody>
</table>

**Instruction Code**

<table>
<thead>
<tr>
<th>Instruction Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 D2 D3 D4 D5 D6</td>
<td>MPU Group</td>
</tr>
</tbody>
</table>

**Notes:**

1. The condition code is assigned as follows:
   - C1 = 0: Jump condition
   - C1 = 0: Not jump condition
   - C2 = 1: Jump if accumulator is zero
   - C2 = 1: Jump if carry/take is 1
   - C3 = 1: Jump if test signal is a 0

2. (R)RRR is the address of 1 of 8 index register pairs in the CPU.

3. (R)RRR is the address of 1 of 16 index registers in the CPU.

4. Each RAM chip has 4 registers, each with twenty 4-bit characters subdivided into 16 main memory characters and 4 status characters. Chip number, RAM register and main memory character are addressed by an SRC instruction. For the selected chip and register, however, status character locations are selected by the instruction code (OPA).

The answer is that the MPU cannot differentiate between these two possibilities at all; it interprets anything that is placed in its instruction register as an instruction, and it will interpret any part of the store content (including instructions) as data if told to do so by the program.

This means in practice that if, for example, a programmer inadvertently jumps the program counter into a table of data in store, the MPU would endeavour to use the data as a program sequence, probably with bizarre results!
INSTRUCTION TYPES

Even small, four-bit MPU chips have a repertoire of about fifty distinct instructions, and powerful eight- and sixteen-bit devices may boast one hundred or more. At first reading, the instruction repertoire of a microprocessor can be a bit bewildering, and it’s not easy to see the potential usefulness of such instruction names as RAR, POP, PSW, JCN, or even BRA!

Rather than examine each instruction in isolation it is better to group instructions which perform similar operations under common headings, and very often the manufacturers do this for us in their handbooks.

Unfortunately, no two manufacturers have the same ideas as to what the group titles should be, and so we have picked four general headings into which it should be possible to place any of the instructions of any microprocessor currently available. (You might like to examine the instruction set of Fig. 3.1 and decide which group each instruction belongs to.)

(a) DATA TRANSFER INSTRUCTIONS

Data transfer instructions are used to move data about in the microprocessor system, either word by word (parallel transfers) or bit by bit (serial transfers). Data is the raw material upon which the MPU chip operates, and it is important that the MPU chip should be able to fetch data from input ports, store data in RAM, move data from register to register and manipulate the position of individual bits in the accumulator, and so on.

Examples are:

STA — Store accumulator in memory (Intel 8080)
TSX — Transfer stack pointer to index register (Motorola MC6800)
LD — Load data from memory into the accumulator (National SC/MP)
RAR — Rotate accumulator and carry to the right (Intel 4040)

INDEXED ADDRESSING—A form of Indirect Addressing which uses a special location known as an Index register to hold the address of the operand. Index registers can be incremented or decremented under program control.

INDIRECT ADDRESSING—An addressing mode where the address of the location where the address of the operand is located is contained in the instruction.

LANGUAGE—A systematic means of communicating instructions and data to a microprocessor (or computer) system.

MACHINE CODE—A “low-Level” language understood directly by a microprocessor chip and using binary notation.

MULTI-WORD (BYTE) INSTRUCTIONS—Instructions which require more than one line or location, in program memory.

OCTAL—A base-8 number system using the character set 0 to 7 which can be used interchangeably with binary. Not as popular as Hexadecimal.

OPERANDS—Data used in machine operations (e.g. Addends, Subtrahends, Dividends, etc.).

RELATIVE ADDRESSING—An addressing mode where the address of the operand is built up by combining the current program count with a displacement value which is part of the instruction.

Glossary of Terms

ASSEMBLERS—Software programs which translate instructions in Assembly Code (e.g. mnemonics) into Machine Code instructions which can be recognised by an MPU chip.

COMPILERS—Software programs which are used to translate instructions written in a High Level Language into Machine Code instructions which can be recognised by an MPU chip.

DIRECT ADDRESSING—An addressing mode where the address of the operand is contained in the instruction.

HEXADECIMAL—A base-16 number system using the character set 0 to 9 and A to F which can be used interchangeably with binary. This coding system is easier to use and remember than binary, and is widely used in microprocessor literature.

HIGH LEVEL LANGUAGE—A computer language which is easy to use and understand but which requires extensive translation (compiling) into Machine Code before it can be used to control an MPU chip.

IMMEDIATE ADDRESSING—An addressing mode which uses part of the instruction itself as the operand data.

INDEXED ADDRESSING—An addressing mode where the address of the operand is contained in an Index register and is not immediately available to the MPU chip.

HIGH LEVEL LANGUAGE—A computer language which is easy to use and understand but which requires extensive translation (compiling) into Machine Code before it can be used to control an MPU chip.

IMMEDIATE ADDRESSING—An addressing mode which uses part of the instruction itself as the operand data.

<table>
<thead>
<tr>
<th>BINARY</th>
<th>HEX</th>
<th>DECIMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0001</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>0010</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>0011</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>0100</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>0101</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>0110</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>0111</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>1001</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>1010</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1011</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>1100</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>1101</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>1110</td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>1111</td>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

Fig. 3.2. Binary to hexadecimal conversion table

<table>
<thead>
<tr>
<th>BINARY</th>
<th>OCTAL</th>
<th>DECIMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0001</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0010</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>0011</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>0100</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>0101</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>0110</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>0111</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Fig. 3.3. Binary to octal conversion table
(b) ARITHMETIC AND LOGICAL INSTRUCTIONS

Arithmetic and logical instructions generally operate on a pair of data words, one of which is resident in the accumulator. The result of the instruction is generally on a pair of data words, one of which is

Examples are:

OR 4 — Logical or the accumulator with index register 4 (Intel 4040)
ADC — Add with carry (Motorola MC6800)
SUBR — Subtract register from accumulator (Intel 8080)
DAD — Decimal add to accumulator (National SC/MP)

(c) BRANCH INSTRUCTIONS

Branch instructions are used to modify the sequence in which the instructions in a program are carried out. Without these instructions program operation would start at address zero and continue by incrementing the address counter after each instruction until address N was reached and the counter recycled to zero.

Branch instructions allow the contents of the program counter to be replaced by some address which may be unrelated to its previous contents, so that program flow continues by incrementing from the new start address.

This group contains a sub-group which may be termed the "conditional-branch" group, which is especially important because it allows a microprocessor to make decisions on the basis of the nature of data with which it is provided. Conditional branch instructions replace the program counter content only if some specified conditions are true; if these conditions are false, program flow continues unchanged, by counter increment.

Examples are:

INZ — Jump if accumulator content is not zero (National SC/MP)
JUN — Jump unconditionally (Intel 4040)
JSR — Jump to subroutine (Motorola MC 6800)
RET — Return (e.g. from subroutine) (Intel 8080)

(d) CONTROL AND MISCELLANEOUS

The group control and miscellaneous contains a bit of a hotch-potch of instruction types, and is included really to provide a home for those instructions which do not fit into the other three groups!

Examples are:

HALT — Halt processor and do not carry out any further instructions (National SC/MP)
NOP — No operation. Do nothing but move on to next instruction (Intel 8080)
EIN — Enable interrupt detection logic (Intel 4040)
CLR — Clear (Motorola MC 6800)

INSTRUCTION FORMAT

By now you should be getting a feel for the sort of things we can tell the MPU chip to do when we write an instruction in a program, but you may be wondering how the microprocessor knows which memory locations it must use as OPERANDS when carrying out instructions such as LOAD, of ADD.

Taking an ADD instruction as an example, just what does the microprocessor need to be told, or to assume, in order to carry out the addition in the required way? Well, it needs to know...

(i) The operation to be performed (In this case ADD)
(ii) Where the first operand is
(iii) Where the second operand is
(iv) Where it must put the result
(v) Where the next instruction is

An instruction word could be imagined where all these facts are specified by certain sections of the instruction code, but a moment's thought reveals that this would demand a very long word length, say four bits to specify ADD, eight bits for the first operand address, eight bits for the second, and so on.

An MPU chip using explicit instructions like this would be extremely versatile and powerful, but impossibly clumsy and difficult to work with, and so unsuited to the low cost applications microprocessors are intended for.

A less versatile but much more compact instruction word format is generally used for MPU chips where most of the required information is assumed by microprocessor rather than being explicitly stated when the instruction is written into the program.

(i) The operation to be performed remains explicit (e.g. ADD)
(ii) The first operand remains explicit and is coded as a memory or register address
(iii) The second operand address is assumed to be the accumulator
(iv) The result is automatically stored back into the accumulator
(v) The next instruction address is assumed to be the next in numerical sequence (unless a branch instruction is involved) and so is found by incrementing the program counter.

Even with this more compact instruction format it is often necessary to use more than one instruction word to store the necessary code, giving rise to what are termed "multi-word" or "multi-byte" instructions, of which course carry with them the necessity to increment the program counter by more than 1 to find the next separate instruction in sequence.

ADDRESSING MODES

We saw above that most microprocessor instruction words contain a single address, the address of the first operand, but we now have to examine the way in which the address is specified because there are a variety of addressing modes which can be employed, and using them wisely can make our programs more efficient.

As an example, the Motorola MC 6800 has no fewer than seven addressing modes, which puts it ahead of the SC/MP and 8080 with four, and the 4040 with three, unless you happen to be of the opinion that seven modes are excessive and tend to leave you "spoilt for choice".

MPU chip manufacturers all have their own ideas about what their addressing modes should be called, and how they should operate, and it will be necessary to study these in the handbooks when the use of a particular chip is contemplated.

For the purposes of this introductory series we have chosen to describe four modes which can be considered fundamental, and from which the others have evolved.
You may find it useful to compare the addressing modes of a particular MPU chip with the modes described here, trying to spot the similarities and the differences, where there are any.

**IMMEDIATE ADDRESSING**

The most straightforward mode of the lot is IMMEDIATE ADDRESSING because the instruction does not actually contain an address: it contains the data itself which may be part of the first instruction word or contained in a subsequent word.

This mode is useful for fetching constants which do not change once the program has been written; this "unchanging" quality is vital because instructions, and therefore immediate data, are often stored in ROM.

**DIRECT ADDRESSING**

DIRECT ADDRESSING is the mode which one would instantly recognise as being a necessary part of any processing system. In this mode the instruction contains the address in an explicit form, so that for an ADD instruction for example, the MPU chip is told precisely where to go in store to find the number to be added to the accumulator.

**INDIRECT ADDRESSING**

INDIRECT ADDRESSING is a very useful but at first rather tricky-to-understand mode where the instruction contains the address of the address of the data (now read that again!). That is to say that the address contained in the instruction does not point to the data itself but to a location (which may be a location in store or a register) which contains the address where the data is to be found. A particularly common form of indirect addressing is called INDEXED ADDRESSING where the instruction points to a special register called the index register which contains the required address.

The strength of indirect addressing lies in the fact that it is not necessary to know precisely what the final address is when the program is being written, it can be computed in, say, the index register so that it is in effect data dependent rather than program dependent.

**RELATIVE ADDRESSING**

In RELATIVE ADDRESSING the instruction contains not the address of the data, but a displacement value which is added to the program counter contents to make the effective address. This addressing mode is used only with branch type instructions where it allows looping backwards or forwards through a program without the need to specify absolute addresses. Looping backwards is possible because the displacement can be a negative number in "twos-complement" binary notation.

**PROGRAMMING TECHNIQUES**

Programming a microprocessor is a fascinating and rewarding experience and well worth the investment in time required to learn the necessary fundamentals. The best way to learn is by actually doing, and to get to the stage where you are ready to try your hand at simple programs, you should start by studying examples of the type which MPU manufacturers often provide in their literature. The Intel "MCS-40 USERS MANUAL" is particularly rich in programming tips and examples, although of course these are restricted to the particular case of the 4040 chip.

Even if you are quite used to writing programs for a large computer in a high level language like Fortran, you will find the strict format of microprocessor machine code a challenge at first, but by becoming familiar with the hardware and instruction set of your choice of MPU you will soon become adept at the art!

**HARDWARE/SOFTWARE TRADE OFF**

The success of the microprocessor is due to the fact that it enables a large amount of hardware to be replaced by changeable software in the form of programs. When an MPU is applied to a particular application, however, the designer has to decide just how to create a balance between the amount of hardware and the amount of software employed, so as to suit his particular circumstances.

Take the case of a decimal keyboard connected to an MPU system. Should the designer provide a series of gating functions to turn each of the "one out of ten" key closures into a corresponding four bit BCD code, or should he read all ten lines into the MPU and provide a program which does the job? Should he provide a TTL monostable key-debounce circuit, or should he incorporate some timing routines into his program which achieve the same result?

---

Fig. 3.4 Switch Check flow chart

Practical Electronics May 10
A PROGRAMMING EXAMPLE

We do not have sufficient space here for a comprehensive programming course, but in order to at least set the scene, we can trace through the evolution of a particular program example.

The job is to examine four toggle switches and depending on which one of them is set (if any) to jump to a particular segment of a program. The microprocessor to be used is the Intel 4040, and the switches are connected to ROM input port number four.

The first step in writing the program is to draw up a flow chart which describes in an easy to understand, graphical form the operations necessary to complete the task. Flow charts can be of a very general form which can be understood by everyone and could be adapted for use with any microprocessor, or they can be detailed, and suited only to a particular chip architecture and instruction set. We find it helpful to let flow charts evolve from the general to the detailed form as ideas are added and the constraints of the chip are taken into account. Our final flow charts usually detail the actual instructions we intend to use.

SWITCH CHECK

Fig. 3.4 shows the flow chart for our Switch Check program in an "Inbetween" stage which is flavoured by the 4040 but nevertheless easy to follow for those new to the concept.

The flow chart already shows that a strategy has been chosen to achieve the goals set down, but it should be remembered that there are several other ways to achieve the same ends, and this one is not necessarily the best. The strategy used is that of a "skip chain", a simple but effective technique for examining the state of input lines, which in this case also incorporates a "wait loop".

When the Switch Check routine is entered (from the larger program of which it is a part) it begins by reading the state of the four switches into the accumulator by first addressing port 4 (FIM, SRC) and then reading it (RDR). The switch states can be examined by shifting each bit in turn into the carry flip-flop and using the JCN (jump on condition) instruction to either vector the program to the appropriate routine if a switch is set, or to continue round the loop if it is not.

Once "Switch Check" has been entered there is no way of leaving it until a switch is closed, hence the "wait loop" tag, although this feature could be dispensed with, if appropriate, by leaving out the JUN instruction and allowing a further exit from the bottom of the routine if no switches are set.

Notice that the switches are ranked into a priority order by the fact that switch one is checked first and so on. If the routine is entered with more than one switch set, the lowest number switch will be the only one recognised.

The JCN instruction can be used to test for a variety of different conditions such as jump if carry is 0, jump if carry is 1, jump if accumulator contains all zeros, etc. In our case we wish to test bits individually and so we rotate them into the carry flip-flop one at a time using RAR which rotates the accumulator and the carry data one bit at a time as shown in Fig. 3.5.

The complete program, using mnemonic instruction codes is shown in Table 3.1. Before this could be entered into a PROM and used, the mnemonics would have to be replaced by their hex and binary equivalents and the addresses which here are represented by names such as LOOP or ROUTINE NO 1 would have to be specified absolutely.

ASSEMBLERS

If an ASSEMBLER facility was available on a larger computer or a development system it would be possible to enter the mnemonic codes as shown in Fig. 3.6, complete with address names, or labels as they are called. In this case the assembler program would convert the mnemonics into the required machine code and insert absolute addresses where necessary, a facility which helps the programmer a great deal but which of course is expensive in storage space and not available for use with the cheaper prototyping and development systems.

NEXT MONTH: Peripheral Chips and Hardware.
VENUS
The Russians have tackled the problem of the brilliant but hostile planet Venus with great vigour. Mythology would have us believe that Venus represented love and happiness in the form of a goddess and that Mars was the warlord and the mark of aggression. In the event it is clear that the roles are reversed. However, in spite of the millennia of observations it is only in the last few years, the space years, that knowledge of the planet and its puzzles has been brought to the stage of acceptance in some detail.

Before the advent of the Mariner and Venera spacecraft the cloud cover was all but completely opaque. Many enterprising amateurs spent countless hours observing the planet. The members of a section of the British Astronomical Association devoted to observations of Venus produced drawings which were built up into a conjectured picture of the surface features. As it turned out these pictures and the drawings were remarkable for their anticipation of the real surface. These features were first confirmed by radar measurements.

CHANGES
The rotation period of the planet had undergone many changes and the figures varied from a few days to hundreds of days. Finally it was found to be 243 days, and that its direction was opposite to that of the Earth. Thus the Sun would rise in the west and set in the east. Its year is shorter than that of the Earth, just over 224 days. The poles are only tilted by 3 degrees and therefore the planet does not experience seasonal changes like the Earth.

CLOUDS
The cloud cover rotates very rapidly and the tops of these clouds have a rotation period of about four days. Their velocity is therefore very high reaching as much as 100 metres a second.

The white clouds of the Earth consist of drops of water but Venus is very different. The quantity of water vapour is very small being only 5 parts in $10^4$. This was established spectrographically. The nature of the spectogram showed that there were liquid drops in the clouds. Such a condition at the temperature of 233K indicated that the liquid could not be water.

The surprise that awaited the investigators was that it could only be due to sulphuric acid. It was found that these liquid drops were 75 per cent concentrated sulphuric acid. This was finally resolved in 1973.

Between the years 1967 and 1975 the Russians launched seven vehicles of the Venera class and in addition there were probes which entered the atmosphere. In 1971 Venera 4 indicated that there was at least 97 per cent of carbon dioxide in the atmosphere.

Though liquid water cannot exist on the surface of Venus, a reaction between the surface and the carbon dioxide of the atmosphere takes place. On Earth this reaction is a slow one. On Venus, with a temperature of the order of 750K, such a reaction is very rapid. The other similar reactions that take place include hydrochloric and other acids. The whole chemical effect in the atmosphere contrasts with that of the Earth.

There is little or no magnetic field on Venus but an ionosphere does exist. This does fit in with current thinking, that the intensity of a dipole field depends on the angular velocity. A great deal of data is now available about the Venusian atmosphere and the ionosphere. One interesting fact that emerges is that short wave radio signals would be limited to the daylight hours for global communication.

There are few signs of mountains though some radio-astronomy telescopes have shown 2km high hills. It is possible that as a result of the high surface temperature, the crust is more malleable and that the possibility of mountain formations is remote. There is no sign of impact modification of the surface and this could mean that almost all the effects will have been by volcanic action.

Much still remains to be done before a conclusive picture of Venus can be drawn. The effect of the solar wind shows quite a different picture as compared with the Earth. The density of the corona is directly dependent on solar activity.

HAWAIIAN INFRA-RED TELESCOPE
A new development is possible in connection with the Hawaiian telescope. The £2.5 million telescope is being built by Grubb Parsons and is to be put into service next year. The mirror is 3.8 metres in diameter and is the largest of its kind in the world.

Designed for infra-red operation the tolerances can be much wider than for optical work. This is reflected also in the guidance systems. The original tolerance was set at 2-3 arc seconds, but Grubb Parsons have indicated that the mirror now in the polishing stage is so good that a little extra polishing could bring the tolerance to 1.0 arc second.

This would effectively halve the time for observations. This will not be to the standard for optical work except for very short exposures. In view of this there would be a demand for optical astronomers. The improvement for the infra-red application is very great.

The cost of doing this extra polishing is £12,000. Surely this is a small price to pay for such an improvement. Since this means that the instrument will carry out a programme in half the time originally scheduled it is the same as saying that for an extra £12,000 the astronomers will have the equivalent of two telescopes at a cost of £2.5 million each. This is a bargain too tempting to be ignored. No doubt the SRC will see it this way.

LANDSAT
The value of the services that can be offered by Landsat has been so much in evidence that the Soviet Union is pursuing plans to build a terminal for themselves. So far applications have come from a number of countries. These include Australia, Norway and Sweden, India, Japan and at least one Arab State.

For over a year a new 13-channel scanning system has been the subject of a developing up process. Interference has been very considerably reduced and the false colour reproduction developed to a specialised degree. This enables colour to indicate differing conditions of surfaces, leaves and plants as well as tree growth.

Extensive research has shown that water, because of its changed state when taken up in plants, can be an indicator of great value. It is certainly the case that the value of the pictures for countries which have plans for long term development in agriculture and forestry will be considerable.
Still soldering on?

You may be that rare person who gets his circuit designs right first time, everytime.
But it's much more likely that you experiment to see what works, and what doesn't.
In which case you ought to know about Bandridge Decs.
Bandridge Decs enable you to try almost any number of possible circuits, without having to use your soldering iron.
You simply push the wires of your circuit components into the holes in the Dec to make a perfect solderless contact.
Which means that you can use the components over and over again.
And, of course, we don't have to tell you how much time it will save you.
There are four Decs available to suit every possible circuitry requirement.
From simple discrete work to 2xDIL or 4xTOS Station work.
And for larger or more complex circuits you can use any number of Decs linked together.
Eventually of course, you'll need that soldering iron to make up the permanent version of your circuit design.
And when you do you'll probably want to use one of the matching Bandridge Blob boards, to make your job that much easier.
But until then we suggest you put your soldering iron aside and get yourself a Bandridge Dec.

Bandridge Decs - Available at all good component stockists, where you see the Bandridge sign.

S-DEC: for use with discrete components only. (70 contacts)
T-DEC: for discrete work or lineare IC's. (208 contacts)
U-DEC 'A': allows 2xDIL or 4xTOS Stations but also takes discrete components. (208 contacts)
U-DEC 'B': As DEC 'A' but includes two 16 lead IC sockets. (208 contacts)

A free circuit design booklet is supplied with every Dec.
For your nearest stockist contact Bandridge Ltd., 80a Battersea Rise, London SW11 1EH. Tel: 01-228 9227.
The Blob Story.

Yes, they have got a funny name: Blob Boards.
And if you've never heard of them, you might wonder what on earth they're for.
After all they sound more like sci fi than practical electronics.
But in fact there is a good reason for the name.
It actually describes the way these printed circuit boards work. You just put a tiny blob of solder onto circuit board and component and you've made a perfect contact.
Every time.
There are of course a few other printed circuit boards around.
But we think the prices are a bit shocking.
Our prices, we think you'll agree, are more down to earth.
These Blob Boards are about half the price of the few comparable alternatives.
And unlike those alternatives, on most Bandridge Blob Boards you won't have to break the contact rails to make your circuit. So you'll be able to use them again and again.
The roller tinned copper on Blob Board makes soldering easy, and it won't corrode, so they'll work for as long as you want them to.
You'll find a Bandridge Blob Board for every circuit you'll ever want to make, from the simplest to the most complex.
And if you're using Bandridge solderless DEC's for your prototypes you'll be pleased to learn that there's a Blob Board that exactly matches every DEC.
So when you're looking for a circuit board it'll be worth your while remembering Blob Boards.
As if you'd ever forget a name like that.

Bandridge BLOB BOARDS

"V" Range - Easy to use, 1" or 15" matrix board.
"IC" Range - For integrated circuit work.
"D" Range - For discrete work, but will take IC package.
HI-Z PRE. AMP

Are you bored with analogue integrated circuits which do everything but polish your shoes, and digital integrated circuits which, boasting so many gates and functions that it sometimes seems that their IQ is higher than yours? Do you yearn for the simple life again, a return to the days when an individual transistor was treated as something to be revered, rather than as a sort of plastic giveaway? You do? Well then perhaps I can interest you in the T100 and T300 devices from Siliconix, which do not boast kilo-transistors or mega-gates, but simply a well designed single JFET stage which, with the aid of a simple four-pin package, forms a useful and capable high-Z preamplifier stage for use with microphones and other transducers.

Inside the TO72 can there lives just the JFET, a source load resistor, and back-to-back Schottky diodes which form the high impedance gate bias resistance. The devices feature an input impedance of at least 200 megohms and an output resistance of between 500 and 1,300 ohms, together with a very low noise voltage output of less than 40 microvolts in a 10kHz audio bandwidth.

These integrated circuits are, of course, high-to-low impedance converters, and can be used wherever such a function is required. The T100 is intended specifically for low power applications such as hearing aids, input stages, where its 50 microamp supply drain is important, while T300 is a general purpose device drawing 350 microamps. Both can operate from supplies of from 1.3 volts to 30 volts, and are ideal for matching to ceramic, electret-capacitor, air-capacitor, and piezoelectric microphones.

GOODBYE ZENERS

If you could design your own ideal Zener regulator diode what would you list as desirable characteristics? Would want low impedance, a sharp knee, temperature compensation, low noise, high dissipation, and a really easy to use package. If you added to that list a programmable voltage rating, so that only one type of component has to be purchased to provide any voltage between three and thirty volts, you would have designed yourself a Texas Instruments' TL430 which must surely replace standard Zeners in most applications.

The manufacturers call it a "precision three terminal shunt regulator" but it is almost as easy to use as a standard Zener, and no more than as pricey as it sounds. "Zener" voltage is normally programmed with the aid of two fixed resistors, but if you like, you could use a skeleton pot, and hence build yourself a "Variable-Zener" which could be very useful in a wide variety of applications which at present require numerous resistors and an op. amp., in addition to a conventional reference diode.

Performance of the TL430 is better than its predecessor in every respect, slope impedance is only 1.5 ohms, over the current range 600 microamps to 100 milliamps, as compared with 5 ohms to 100 ohms for standard Zeners over a more restricted current range. Temperature stability is 0.005 per cent per degree Celsius, which is as good as the most expensive Zener devices, which are themselves restricted to a voltage of around 5 to 6 volts to achieve that sort of performance. Noise output is low, and the three-lead TQ92 or eight-pin MiniDIP package will dissipate a creditable 775 milliwatts to make the TL430 almost twice the regulator that the standard 400 milliwatt BZY88 is!

BRITANNIA RULES — O.K.?

I sometimes get a bit demoralised when I realise that most of the devices I talk about in this column actually originate in that former colony of ours, where they eat hamburgers and chew gum!

Wouldn't it be nice, I muse, if just for once, a British firm could summon the courage, the know-how and the money, to produce a real world-beater of a product which would give us something to be really proud of, something which would demonstrate that we really do have a part to play in advanced semiconductor technology.

Well, I can stop musing, because Ferranti have actually gone out and done it, by producing a super, wonderful, powerful, 16-bit, and above all, BRITISH processor, which really promises to deliver the goods in this, the most challenging semiconductor technology of them all!

The name of this patriotic new chip is the F100L, and it has the distinction of being the first microprocessor which has been wholly designed, developed and manufactured in Europe, without any American connection at all. Development was sponsored by the Ministry of Defence, God Bless them, and this will no doubt guarantee a market in a host of advanced defence projects and give a hefty boost towards profitability. The F100L can stand on its own, though, and should provide some healthy competition for other 16-bit micros such as the Texas 9900 and the National Pace, which it can outperform in many respects.

The chip is produced in the home-grown Ferranti CDI process which is a bipolar technology providing LSI circuit density and low power (375mW) along with typical instruction execution times of only 3 to 4 microseconds. The chip is just 0.23 inches square and uses no less than six feet of aluminium track interconnections to hook up about 7,000 separate components into a microprocessor which is not far short of a full sized computer in the performance that it offers.

As far as we, as amateurs, are concerned, the F100L will enable us to put together a home computer of formidable power and ability when the chips become freely available during the next year or two. The single phase TTL clock and the simple 5 volt supply requirements should make the assembly of an F100L computer fairly straightforward, and Ferranti are going to back up the basic MPU chip with a range of CDI interface chips in the near future to replace those standard TTL components so deplorably necessary.

This is a chip we can all be proud of (after all we do have an investment in it) so let us wish it every success for the future.
MICRO '77 is the name of Cramer's current series of microprocessor seminars being given at various points in the country, culminating with one in London on April 25. Cramer call themselves the "Heavyweight Microcomputer Team"; perhaps because for each of their three main franchises, Microelectronics Instruments and Zilog, they have two specialists available, one with hardware and one with software knowledge.

We went along to the Cambridge seminar held on February 8.

THE PAST AND THE FUTURE

The first part of the programme was an extremely lively introduction to microprocessors presented by Ian Perry. It is almost impossible to talk about the history of microprocessors without mentioning Intel; the first microprocessor was the 4004, designed in 1971 by them for Decimo, the calculator manufacturer, who saw that the way their small firm could compete in the mass calculator market would be to divide the single calculator chip into its four parts: the CPU, RAM, ROM and I/O. A whole range of calculators could then all use the same CPU and RAM, differing only in the ROM programme and in the I/O and keyboard.

Today about 50 per cent of CPUs produced go into data terminals. Most second-generation CPUs, such as Motorola's 6800 and the Intel 8080, have followed along similar lines but now the trend seems to be going full circle with the re-integration of all the parts onto one chip. Again the innovator is Intel, and their 8748, to be released later this year, will combine the CPU, a PROM and programmable I/O onto one chip.

In a glance into the future Ian Perry predicted some interesting advances. Memory is to grow ever cheaper, and 16K dynamic RAMs should soon be available at a competitive price. The first low-power CMOS PROM is now available from Harris, though the price is prohibitive. The greatest possibilities lie in the area of subfunctions: chips which work alongside a CPU to extend its capabilities.

For example, Advanced Micro Devices have a number-cruncher chip on its way which will give multiply and divide functions; also in the pipeline are floppy-disc controllers, C.P.U. controllers, keyboard interfaces and sophisticated I/O packages, all of which leave the CPU free to do greater things.

Low power systems are still a year away; although TI make an PLI version of their 9900, the price is prohibitive. The present CMOS CPUs from Intersil and RCA have reduced instruction sets due to the unsolved problems of mass integration, but silicon on sapphire CMOS may provide the answer.

MOTOROLA

The M6800 from Motorola is now the most popular CPU in Europe, and perhaps because of its familiarity, this part of the programme was less interesting. This popularity may in part be due to Motorola's sensible policy of providing a wide spread of development products, and the whole range was on show at the seminar. Although Cramer will be glad to sell you an Excerciser plus TI Silent 700 terminal for around £4,000, for the impecunious among us there is now the self-contained D2 kit which, like the SCM/P kit with keyboard, eliminates the need for a terminal by enabling you to enter programs directly in machine code from a hex keyboard, with readout of the address and data on six seven-segment displays.

The problem of how to store programs is overcome by the provision of an audio cassette interface, and the system includes 256 words of RAM and a PIA. At £188 it seems good value. (A review of this kit will appear in a subsequent issue.)

In the mid-price range there is the Polyvalent Development System, comprising an ASCII keyboard, a tiny VDU with interface board, and various computer boards which can be bought separately, or together for £771. For example, the Display Interface board will convert any TV into a VDU with the addition of a keyboard, and costs £200.

ZILOG

In presenting the Zilog Z80, Roger Phebey was understandably enthusiastic as the Zilog story seems to be one of the most uninterrupted. Zilog Corp. was founded in 1974 by two Intel executives, who have since been joined by top men from Intel, Motorola and Fairchild. In 1975 M. Shima came from Intel, where he had designed the masks for the 8080, and developed the Z80 CPU. The first units were manufactured in mid-1976 by Mostek for Zilog while their factory was being completed, and now Mostek second-source it.

From the start Zilog decided to make a souped-up 8080, and in fact the Z80 contains the actual 8080 codes as a subset. But the likeness ends there; the Z80 has twice as many registers, twice the number of instructions including additional 16-bit operations, block transfer and search within one instruction operate on blocks of up to 256 words of memory, and there are two modes of interrupt besides the 8080 mode. The chip uses a single 5V power rail, and a single-phase clock. The Z80 is not very accessible to the amateur as yet; the cheapest complete system includes two floppy discs and sells for £4,200, and the only board available as yet is the MCB at £347; for this you get 4K of RAM though.

TEXAS

The Texas Instruments' TMS9900 is one of the few 16-bit CPUs currently available, and with its multiply and divide instructions it seems very minicomputer-like. It has none of the usual on-chip registers; instead a block of 16 contiguous RAM locations pointed to by the workspace pointer provides 16 "primary" registers, making interrupt and subroutine handling especially efficient. The chip has 16 data lines and so needs an impressive and expensive 64-pin package; furthermore it requires a four-phase clock.

Prospective computer builders may prefer to wait for the TMS9900 due later this year, which provides an on-chip oscillator and uses multiplexing to fit the same functions in a 40-pin package. At present there is only the 9904 development system available which with a Silent 700 terminal costs about £4,000, but Cramer is developing in collaboration with TI a Micro-99 microcomputer board which, when it is available, will be £310.

Finally a point stressed at the seminar was: do not feel obliged to buy the whole system from one manufacturer. It is perfectly good practice to link up one CPU with a different memory and a third I/O device. Also once the application is decided upon it is probably cheaper to replace general purpose I/O devices by custom wired latches. Amateurs now have an extremely wide range of devices to choose from, and can construct a complete microcomputer for well below the cost of comparable ready-built development systems.

D.J.D.


**POWER AMPLIFIER MODULES 30—240 WATTS**

- Fully tested & guaranteed.
- Complete W.B. Sigma Wave output.
- Distortion typically 0.2%.
- 10 Transistors, 4 Diodes.
- Response 30HZ—20KHz.
- Fully short & open circuit proof.
- Twin in-line multi transistors.
- Built-in surge suppression & compensation.
- Twin D.C. & output filters.
- Top-grade components throughout.

**SYSTEM 7000 COMPLETE DISCO MIXERS (With Autofade)**

- Mono or Stereo.
- Ready to plug in & use.
- Automatic Mic OVERRIDE.
- Two tone panel.
- Twin deck & mic & tape inputs.
- Left/Right deck fader.
- 20Hz—20KHz Noise —77db.

**SYSTEM 7000 LIGHTING CONTROL UNIT MK II (Four channel)**

- Has your light unit got?
  - 4,000 W handling.
  - Sequence facility.
  - 2 Tone panel.
  - Advanced I.C. circuitry.
  - Top grade components.
  - All your needs in one superbly designed unit.

**IN MODULAR FORM—THE QUADRAFECT**

- Only £42.50 (Panel £2.50)

**CUSTOM MIXER MODULES**

- Make your own mixer, mono or stereo, up to 2 channels, with full monitoring facilities, and provision for echo/echo return etc.
- Inputs for low and high 2 mic, ceramic & magnetic cartridge etc.
- Up to 20 input modules per single mixing module.
- Feed most types of amplifier accepts all inputs.
- Professional low noise circuitry 20Hz—30KHz.
- Infinitely adaptable—extremely economical.

**COMPLETE MODULES**

- With facia panel.
- Knobs, sockets, Monitor buffer, Ready wired & tested.
- Mono Input £5.50
- Mono mixing stage £6.50
- Stereo Input £12.00
- Stereo mixing stage £13.00

**SYSTEM 7000 HEAVY DUTY AMPLIFIER**

- Monostereo £19.50
- Stereo £29.50
- Panel £3.50
- Supply unit £8.50

**SYSTEM 7000 COMPLETE DISCO MIXERS**

- Mono £20.50
- Mono £30.50
- Stereo £59.50

**IN MODULAR FORM—THE QUADRAFECT**

- Only £42.50 (Panel £2.50)

**CUSTOM MIXER MODULES**

- Make your own mixer, mono or stereo, up to 2 channels, with full monitoring facilities, and provision for echo/echo return etc.
- Inputs for low and high 2 mic, ceramic & magnetic cartridge etc.
- Up to 20 input modules per single mixing module.
- Feed most types of amplifier accepts all inputs.
- Professional low noise circuitry 20Hz—30KHz.
- Infinitely adaptable—extremely economical.

**COMPLETE MODULES**

- With facia panel.
- Knobs, sockets, Monitor buffer, Ready wired & tested.
- Mono Input £5.50
- Mono mixing stage £6.50
- Stereo Input £12.00
- Stereo mixing stage £13.00

**PRINTED CIRCUIT MODULES**

- With controls fitted, requires only sockets, facia & knobs.
- Mono Input £5.50
- Mono mixing stage £5.50
- Stereo Input £10.00
- Stereo mixing stage £11.00

**POWER SUPPLIES FOR THE ABOVE MODULES—READY WIRED & FUSED ON GLASS FIBRE PCB**

- 30 Watts rms
- 60 Watts rms
- 90 Watts rms
- 120 Watts rms
- 180 Watts rms
- 240 Watts rms

**SYSTEM 7000 COMPLETE & READY-FOR-USE EQUIPMENT**

**CENTAUR—the 100W RMS STEREO DISCO**

- Complete with sound-to-light sequencer & lights.

**SAXON MINI-DISCO**

- 50W RMS £119.00
- Complete with twin heavy duty loudspeakers.
- Includes mic input & headphone monitor circuit.
- Twin BSR decks with lifter.
- Tremendous value—just plug in & go.
- Wide range bass & treble controls.

**STROBES & PROJECTORS**

- Sturdy vynide cabinets with separate mic., music bass, & treble controls.
- Includes mic input & headphone monitor.
- Twin BSR decks with lifter.
- Tremendous value—just plug in & go.
- Wide range bass & treble controls.

**SHELF ORDER**

- Send cheque or crossed P.O.'s or 50p for COD.
For details of this and the many other exciting instruments in the Chnaglia range, available.

fused leads, handbook and full

Automatic overload protection and high current range timing.

EVER NEED

motion motor to drive cams, not supplied.) 9 switch

with 9 rotating cams, all

2N3055 type Transistors.

DOLOMITI

5 for Et

PLASTIC BOXES 33" square, 13" deep (wall -

3W. E1.75 each.

British manufacturer. Size approx. 73 x 23 x 4in.

limiting at 500mA

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,

SPECIAL OFFER...

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,

SPECIAL OFFER...

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,

SPECIAL OFFER...

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,

SPECIAL OFFER...

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,

SPECIAL OFFER...

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

BY185 (new) 35kV 2 5mA C1

SIUCON HIGH VOLTAGE RECTIFIER STICKS,
ONE ARM BANDIT

...for home amusement

COMPONENTS...

By K. Amor

This unit was designed with the younger generation in mind. However, it has certain differences with its popular electromechanical counterpart. First, instead of the usual apples, plums and cherries forming combinations, numbers from 0–9 are displayed in the form of three seven segment displays. Second, the machine will only indicate when a player has won, but will not actually pay out. However, it is possible to bring a signal out to operate an electromechanical device if a prize giving feature is required.

FEATURES

Six winning numbers are internally set-up and when displayed the “Win” l.e.d. will light. As can be seen from the prototype these selectable numbers must be carried on the panel for the player’s reference when making a decision for “holding” one or two numbers.

It is possible to change the six winning combinations from time to time as desired.

74 series TTL logic is used in the main which allows a compact unit to be made-up.

TIMING CIRCUITRY

When the start lever is operated a positive going pulse is produced as a result of the microswitch opening (Fig. 1). This pulse triggers monostable IC2 into operation so that pin 6 goes high (+5V) for approximately five seconds. The pulse period is not critical, hence the use of the electrolytic in the timing circuit.

As pin 6 is high the three gates that form IC3 are all enabled so that pulses from the three unijunction oscillators can pass through and be counted by the three 7490 divide-by-ten counters.

Resistors

<table>
<thead>
<tr>
<th>R1</th>
<th>33kΩ</th>
<th>R9</th>
<th>180Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>82Ω</td>
<td>R10</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R3</td>
<td>180Ω</td>
<td>R11</td>
<td>15kΩ</td>
</tr>
<tr>
<td>R4</td>
<td>33kΩ</td>
<td>R12</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R5</td>
<td>82Ω</td>
<td>R13-34</td>
<td>220Ω</td>
</tr>
<tr>
<td>R6</td>
<td>180Ω</td>
<td>R35</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R7</td>
<td>33kΩ</td>
<td>R36</td>
<td>220Ω</td>
</tr>
<tr>
<td>R8</td>
<td>82Ω</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All 1/2W 20% tolerance

Capacitors

<table>
<thead>
<tr>
<th>C1</th>
<th>4,700pF</th>
<th>C4</th>
<th>100μF elect. 25V</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>5,700pF</td>
<td>C5</td>
<td>2,200μF elect. 25V</td>
</tr>
<tr>
<td>C3</td>
<td>9,400pF</td>
<td>C6</td>
<td>0.33μF</td>
</tr>
</tbody>
</table>

Note: C2 and C3 are made up

Semiconductors

TR1  | BC184 |
TR2-4 | 2N4483 (3 off) or TIS43 |
TR5  | BC184 |
IC1  | 7490  |
IC2  | 74121 |
IC3  | 7410  |
IC4-6 | 7490 (3 off) |
IC7-9 | 7447AN (3 off) |
IC10 | 7400  |
IC11-13 | 7442 (3 off) |
IC14-16 | 7404 (3 off) |
IC17 | 7430  |
IC18-19 | 7410  |
LED1-3 | DL747 (3 off) |
LED4-5 | TIL209 (2 off) |
IC20 | MVR-5V 5V 1A regulator (RS) or LM309K |

Transformer

T1  | 6-9V 1A mains transformer |

Switches

S1  | Lever microswitch |
S2-4 | Spdt switches (3 off) |
S5  | Double-pole mains on/off |

Miscellaneous

D1-4 | 1A full wave bridge rectifier |
A suitable case is the Type “U” 8in × 6in × 6in (H. L. Smith, 287 Edgware Road, London W2)
Fig. 1. The timing, display and win logic circuitry for the One Armed Bandit. The shaded panel embraces the Veropins used for patching arbitrary winning combinations. The six combinations used in the prototype are in the top table with patching for combination "A" indicated by linking the Xs, Ys and Zs. Pin diagrams for all semiconductors are given.
The prototype opened up with the display board lifted back from the control panel. A plain 0-1in matrix board was used for this.

The frequencies of the unijunction oscillators are determined by the value of the resistor and capacitor connected to the emitter and the actual running frequency value is 1/0.7 CR Hz.

As can be seen from Fig. 1 the oscillators run at three different frequencies of approximately 4.5, 7.5 and 9kHz.

These frequencies are sufficiently high and different so as to reduce the possibility of the same number appearing in successive operations of the machine. Also, since they are free running, random number selection is better.

**NUMBER DISPLAY**

The gated serial pulses from the unijunction oscillators are converted to parallel binary form at the counter outputs. When the monostable pulse finishes, the gates of IC3 are cut-off inhibiting the drive to the counters. Since these will have rippled through many times during the five second period, random binary numbers will be stored at their outputs.

To convert these to decimal at the l.e.d. displays they are fed to 7447 decoder/drivers. Resistors R13-R33 are for limiting current to the segments. With the values given the current is approximately 10mA/segment which is an economical figure but provides adequate display brilliance.

**“HOLD” CIRCUITRY**

The negative going edges of the five second start pulses are counted by IC1 which forms the basis of the “Hold” circuitry.

Every four start pulses will cause IC1 pin 8 to go low. This stays low for a further six operations of the machine.

During this time a “Hold” will be available since the 7410 gates can be inhibited by the operation of the switches S2-S4. When any one of these are thrown the associated gates are connected to the “Hold” counter which means that the number in this arm is retained.

To show “Hold Available” the output from IC1 is inverted by IC10 to drive TR1 so lighting the l.e.d. At the end of a “Hold Available” period the circuit will automatically release the display irrespective of switches in the “Hold” position. However, it is advisable to clear switches prior to the “Hold Available” light coming on again.

**“WINNING” LOGIC**

Six winning number combinations in groups are available but the selection of groups is arbitrary. In the prototype these were 888, 750, 625, 542, 427 and 314.

To implement the “Win” light signal Veropins are arranged as in Fig. 1. Three groups of ten take the 0-9 outputs from the decoders and six groups of three provide the inputs to inverter.
Fig. 2. The power supply circuit

Fig. 3. Suggested i.c layout for the Olin matrix win logic Veroboard. A Veropin arrangement for patching is shown.

To wire a “Win” combination, say 888, leads are connected from the 8s at the decoder outputs and then to a group of three pins (the order of wiring is shown as X, Y, Z in the figure).

The inverters and gates are used to get the logic levels right.

An eight input NAND gate receives the six levels from IC18 and IC19. When any one of these is low a “Win” condition will be indicated due to base current flow. For illustration, the various required logic levels to achieve an 888 win are shown.

POWER SUPPLY

The power unit is shown in Fig. 2. Here a mains transformer supplies 6.5V r.m.s. to a full wave rectifier. The rectified output appears at C5 as +9V for supplying the u.j.t. circuits.

For the logic and display a 5V 1A regulator is used. This is short circuit protected and will allow almost an amp to be drawn before limiting.

Fig. 4. In the prototype the timing and display logic circuitry was mounted on an ITT ISEP dilboard. Since this could be difficult to obtain and expensive, an alternative Veroboard layout for just the semiconductors is given.
CONSTRUCTION DETAILS

A suitable case is the "U" type from H. L. Smith Ltd. With all the holes drilled and display cutout completed, the panel is ready for lettering. Before this is carried out the aluminium front panel should be rubbed with steel wool. This produces a very pleasing brushed surface.

The front panel lettering can now be carried out having decided what the winning sets of numbers are. This type of dry transfer lettering can be purchased at a good stationers.

Numbers, letters and lines come in sheet form and are best applied by rubbing over the top of the transfer with a soft lead pencil, taking care that no grease is allowed on the surface below. It is advisable to spray the whole panel with a protective lacquer to prevent lettering from being removed and the aluminium discolouring. Leave this to harden for about three hours before mounting components. The back, bottom, and sides may be finished off by spraying with a cellulose aerosol paint.

A dark colour is suggested so as to contrast with the front panel.

LEVER ASSEMBLY

The mechanism in the prototype for the microswitch S1 is made-up of an Arrow-Hart rotary switch shaft unit. The modification to the assembly for limiting the rotary switch action and operating S1 is shown in Fig. 5.

It should be possible for constructors to modify some ½in shaft multi-way switch, making up a handle and so achieve this assembly cheaply. Others will probably opt for a simple press switch rather than this elaboration for authenticity.

Fig. 5. Switch assembly modification for both limiting the shaft movement and actuating a microswitch

364
Practical Electronics  May 1977
Full constructional details of a television games unit based on the General Instrument AY-3-8500 I.S.I. chip. The games offered include Tennis, Hockey, Football and Squash, each with on-screen scoring and sound effects, plus variable bat size and ball angle and speed.

...also in this issue

CAR LIGHTS REMINDER...
This simple unit provides an audible warning if lights are left on unintentionally at the end of a journey, but allows parking lights to be used when required.

SOUND TO LIGHT CONVERTER
A low cost, three channel converter which should prove popular at parties. It offers good channel separation whilst avoiding the generation of mains interference.

PRACTICAL ELECTRONICS
OUR JUNE ISSUE WILL BE PUBLISHED ON FRIDAY, MAY 13, 1977
AMATEUR photographers often express a need for an accurate, reliable and repeatable timer for enlarger control or for timing various darkroom jobs; such a need also occurs in other hobbies. This article describes an accurate, repeatable solid state counter-timer. By using digital techniques, an accuracy of about ±0.5 seconds is achieved with no need for calibration, and the circuit has been designed to be as simple and cheap as possible to construct.

THE DESIGN

Analogue circuits which provide these facilities have been described in the past, but these always depend ultimately on CR networks for timing accuracy. As home constructors have found, it is neither cheap nor easy to obtain components, especially capacitors, of sufficient accuracy and stability to produce useful results. Furthermore, accurate calibration of the control element (usually a variable resistor) implies access to an accurate timer, which is rarely the case.

This circuit overcomes both these problems by using the mains power frequency as a standard frequency source. The electricity generating boards maintain this frequency to better than one per cent; since the frequency and thus the period of the mains is well known (50Hz, 20ms), and the division factor in counting this frequency is known, the timer is self-calibrating.

Another requirement in darkroom timers is a visible indication of elapsing time. In an analogue circuit this can only be provided by a meter, with attendant problems of lighting and reading accuracy. It is often difficult for the home constructor to provide safe-light illumination of the meter movement. The present design takes advantage of light-emitting diode seven-segment displays as numeric digit indicators. The great majority of I.e.d.s emit in a narrow band of wavelengths in the red part of the spectrum, and consequently provide self-illuminating digits which are inherently "safe".

CIRCUIT DESCRIPTION

Mains power is transformed down to 9V r.m.s. which is rectified by D2 and regulated by IC3 to provide +5V d.c. (see Fig. 2). This regulator is more expensive than a Zener diode or simple series-pass transistor regulator, but it is overload- and overheat-protected and virtually impossible to destroy. It automatically limits current to about one ampere and this feature provides excellent protection of expensive components during testing.

The 9V a.c. is also passed through a current limiter to a Zener diode D1 which half-wave rectifies and clips the top off the remaining half cycle to provide an approximately square 50Hz waveform, as shown in Fig. 1. Note that the low level of the waveform is not 0V due to the diode forward drop (about 0.6V). However, TTL manufacturers guarantee that any voltage below 0.8V will be accepted as a low so this 50Hz is fed directly into a scaler or divider. This consists of two chips, type 7490, which each contain a divide-by-five scaler and a flip-flop to divide by two. The first chip IC1 divides the 50Hz by 5 to give 10Hz, then the next, IC2, divides by 10 to produce a 1Hz signal, i.e. a square wave of period exactly one second. This constitutes the standard frequency which is counted in the timer section.

Fig. 1. The a.c. output of T1 is rectified and clipped by Zener D1 to provide a 50Hz square wave drive to the divider chain.
Fig. 2. Circuit diagram of the complete darkroom timer. Relay RLA is a twin-coil reed type with the two coils connected in parallel for 5V operation (see Components list).
TIMING

The actual timing is done by a chain of up-down decade counters type 74192. These devices count up from zero to nine, then provide a carry out to the next stage, or count down from nine to zero, then provide a borrow signal to the next stage. Control of direction of counting is simply a matter of routing pulses to either count up or count down inputs. As well as this serial mode (one bit at a time), the counters can be preset by a parallel load (all four bits which define a decimal digit are used at the same time). This facility is the key to the timer mode of operation. The contents of the counter appear as a parallel 4-bit binary-coded decimal (BCD) digit on the four output lines, which can be displayed on a l.e.d. digit by using a BCD decoder chip.

In this design, three such counters are connected in series; that is, the carry and borrow outputs of the low digit IC10 (units) connect to the up and down inputs respectively of the higher digit IC9 (tens), and similarly for the tens digit to hundreds digit (IC8) connections. The BCD output from each stage is taken to a Fairchild 9368 decoder-driver which converts BCD to 7-segment code suitable for driving common-cathode l.e.d. digits, which in this case are Fairchild FND 357 0.375in digits. If needed, more digits can be included by simply adding identical stages.

PARALLEL LOAD

The 74192 chips are provided with a “clear” input which when pulsed high sets the contents to zero. These pins are connected together and taken to a push-button S4 to provide zeroing of the counter. Each chip also has its “parallel load enable” input taken to an individual button S5–S7, which when pressed, causes the contents of that counter to be set to the BCD digit coded on its input lines. Since both these functions set a determined state in the counter, switch bounce cannot alter the contents, so simple, inexpensive switches can be used.

The prototype timer was built in a specially made aluminium case providing separate compartments for the logic and mains wiring for improved interference rejection.

THUMBWHEEL SWITCH

The preset input digit is set on a BCD-coded thumbwheel switch. The switch is wired up to produce complement or inverted code, that is, logic one is low and logic zero is high. The code is then inverted to the correct levels by part of a hex inverter type 7404 (IC10). The reason for this is that if the code is generated directly by the switch, each bit in the digit must be connected to 0V by a low resistance to provide current sinking for the inputs of the 74192 chips when logic zero is selected; so when logic one is selected, this resistor draws heavy current from the +5V supply (see Fig. 3). The inverter chip is needed anyway to provide the alarm clear function, to be described shortly.

Two gates of a triple three-input NAND chip are used to make a set-reset flip-flop to detect and operate the alarm function which indicates timeout in timer mode; this flip-flop is set by the start switch and reset by either the clear switch or a carry output from the top digit of the counter chain. The outputs of this flip-flop and of the start switch are used with the 1Hz pulse input in IC4a to inhibit this pulse from reaching the counter if the flip-flop is reset or the start button is being held down.

The output of the flip-flop drives a reed relay RLA via a switching transistor TR1. This arrangement isolates the logic and mains portions of the circuit. The relay switches a triggering signal to a triac to connect and disconnect mains power to an output socket SKA. A s.p.s.t. switch in parallel with the relay allows the socket to be permanently powered independent of the timer for focusing, etc.
OPERATION

To see how the unit operates, first consider the counter mode of operation. When the CLEAR button is pressed, the flip-flop is reset which means the output which feeds back to the start gate IC4a is low, forcing the output of that gate to be high. This line is switched to the count up input of the counter chain, which contains all zeros. Thus the digits displayed are all "0", and the carry output of each chip is high, and in particular, the top digit whose carry is connected to the flip-flop.

When the START switch is pressed, it holds the start gate IC4a off but sets the flip-flop so that input to the start gate goes high. Releasing the START switch then allows the 1Hz signal through the gate, where it is inverted, to the count up input of the counter chain. Thus seconds are counted and the current count is displayed. Note that up to one second error can occur here because the counter will increment when the 1Hz signal goes high regardless of when in the previous second the button was released.

TIMER

Operation in the timer mode is similar, except that the up-down switch S8 connects the output of the start gate to the count down input of the counter chain, and the borrow output of the chain to the flip-flop. The CLEAR button initialises the logic as before. Then each digit of the time interval to be measured is set in the counter by dialling it on the thumbwheel switch S9 and latching it into the counter by the appropriate parallel load switch S5-S7.

Thus to time 54 seconds the numbers 0, 5 and 4 would be set into the hundreds, tens, and units digits respectively. When the START switch is pressed and released RLA is energised via TR1, and the 1Hz pulses from the standard frequency source cause the counter to subtract seconds until zero is reached. When the digits are all zero, and the clock signal into the count down input goes low, the borrow output of each counter and thus the input to the flip-flop goes low which resets the flip-flop. This switches off the transistor and thus the relay which turns the triac off and interrupts the power to the output socket.

Note, however, that the clock signal goes low half a second after the high transition which caused the zero to appear. Thus the alarm operates half a second late: this effect couples with the +0. -1 second error in this effect couples with the +0. -1 second error in the zero second the button was released.

CONSTRUCTION

The prototype unit was housed in a specially-made folded aluminium box, as shown in the photograph. With this arrangement it is possible to keep all mains voltages in the rear compartment which is shielded from the TTL circuit to avoid interference problems. The rectifier and regulator circuit is constructed on a piece of stripboard and mounted in this compartment. The regulator itself requires a 4°C/W heat-sink.

The seven-segment displays and decoder-drivers are mounted on a further piece of i.c. stripboard, forming a single module requiring only power and data bits to be connected. This module bolts behind the top panel which has a cutout to let the displays show through.

Layout is not critical in this circuit but it is best to keep all wires as short as possible and to shield the logic from mains, because in the high state logic gates have high input impedance.
INFRA-RED LISTENING

Complete freedom of movement as well as uninterrupted listening to your favourite hi-fi record or radio and television programme is possible with the new range of infra-red transmitters and headphone receivers manufactured by Sennheiser and being marketed by Hayden Laboratories.

For home use there are mono and stereo systems available. The prices are not cheap but for the housewife who can keep an eye on her children or carry on with the housework while listening to a programme. Using infra-red techniques means that there are no wires to the headphones for people to trip over. This makes it ideal for business and educational lectures.

The two channel headphone receiver, type HDI 434, is claimed to be a completely new development. A feature of the headphones is the three position channel selection. The centre gives stereo reception. In position 1 only the sound of the 95kHz channel is fed to both headphone capsules. In position 2 the signal of the 250kHz channel is received. This allows true two-channel operation even of completely different audio signals.

The volume and also the balance for stereo operation can be easily set by two slider controls. The receiving lens of the infra-red diodes is mounted in the edge of the earpiece. The companion two-channel transmitter, type SI 434, is specially designed for covering an area the size of most large living rooms. The electronics for both transmitting channels and the 12 necessary infra-red luminescent diodes are contained in a small case measuring only 200 x 80 x 17mm. The transmitter is powered from an external supply.

The transmitter audio connection cable is plugged in to a DIN headphone output socket of the selected equipment, i.e. radio, television or hi-fi, and the transmitter is then modulated with the available signal. These modulated signals are picked up by the receiving lens in the headphones.

The cost of the two channel HDI 434 headphones is £86·50 and the SI 434 transmitter is £72·50, excluding VAT. A lightweight mono stethoscope type headphone type HDI 40 is available from £44·66 and a mono transmitter, type SI 406, from £44·10, excluding VAT.

Further information and technical details of the Sennheiser range of domestic and professional infra-red equipment is available from Hayden Laboratories Ltd., Hayden House, Church Road, Chalfont St. Peters, Bucks, SL9 9EW.

CLOCK/CALCULATOR

“The all action time computer” is the simplest way of describing the new Casio CQ-1 Computer Quartz available from Tempus.

Ideal for the executive to salesman and the sportsmen/women to the student, the CQ-1 is a timepiece (including day/date), stopwatch, alarm and calculator all in one very small case.

The clock function has a useful four alarm feature which can be used for numerous applications. The alarm can be set in four time positions and at intervals of one minute or more. The command for a.m. and p.m. setting is also possible. The alarm output is generated by a miniature buzzer and emits a different tone for each alarm setting.

For the sports enthusiasts the stopwatch facility has a stop/start key and a lap key. The stopwatch will read hours, minutes, seconds and elapsed time up to 9 hours, 59 minutes and 59·99 seconds. The lap key enables the timing display to be “frozen” for lap times to be recorded, the timing sequence continuing until the lap key is again pressed and the readout reverting to a total time elapsed.

The calculator is a basic four function (+, –, x, ÷) type including constant. Calculations up to 8 digits are possible and by operating the keys, time and date calculations are possible. Also, as the calendar is programmed from 1901 to 2099 inclusive, any day of the week or the number of days for a certain period of time can be calculated.

With suggested functions such as setting for the time to leave for school, office, shopping, taking medicine, as well as a reminder for important business appointments, telephone calls and meetings. Not to mention the usefulness of the calculator for homework, household and business accounts, the Casio CQ-1 Computer Quartz would seem a reasonable family investment at £29·75; particularly for late risers and for keeping parking meter fines to a minimum.

Whilst still in time, Tempus have an excellent range of digital watches, including attractive ladies’ slim-line types and a range of World time watches.

For full details of Casio CQ-1 Computer Quartz and the complete range of digital watches readers should contact Tempus, 19–21 Fitzroy St., Cambridge (0223–312866)

BREAKDOWN TESTER

Some time ago now we published a design for a “Breakdown Tester”. An instrument using similar principles is now being manufactured by Stoneleigh Electronics.

The type 3C15 Tester determines the breakdown voltage of transistors and diodes (including Zener diodes) at the current you select. The device to be tested is connected across the test terminals of the instrument and when the “test” button is pressed, a constant current source is applied to the device. The constant current source can be set within the range 1–15mA and has an output potential of up to 300V.

The breakdown voltage is displayed on a voltmeter which has switched ranges of 10, 30, 100 and 300 f.s.d. A polarity switch allows rapid checking of forward and reverse characteristics. There is visual indication when the device is either open circuit or the breakdown voltage is in excess of the 300 volt capability of the instrument.

Details of price and further information on the 3C15 Breakdown Tester can be obtained from Stoneleigh Electronics, Ltd., Mawney Road, Romford, RM7 7SE.

BOUNCING CHEQUES

We have been informed by A. Marshall (London) Ltd., that because so many cheques have not been honoured by several banks they are forced to announce that in future most cheques will be cleared before any goods are despatched.

Postal orders, cash and approved accounts will be dealt with as normal.
Old habits die hard, we are told, and this is particularly true when playing piano or organ. With the organ especially it is necessary to extemporise to a large degree and thus easy to develop bad habits such as chord clichés, the same old key changes and registrations. However hard the grey matter is working, one of the most difficult habits to break is playing "chords" on a monophonic keyboard. A number of synthesisers will give a rude response to this oversight.

The Wurlitzer organs were among the first to be fitted with a small synthesiser but the shape of its manuals was a reminder in itself: white keys were only as long as the index finger (black keys being about an inch in length), so that it was almost impossible to play chords—let alone three voices, but is sufficient to provide a most desirable extra keyboard for the one-man performance.

Needless to say, it is essential to place the additional keyboard on top of the organ so that the keys line up at & pitch! The only real disadvantage is its short compass but extending this to 88 notes would rule out the advantage of portability. The classicist would, in any case, prefer to play the acoustic parent instrument.

ORGANISATION

Mention of the Electronic Organ Constructor's Society may seem a little out of place at this point. My first reason is because a number of readers have enquired about this Society following my note in last December's edition on the demonstration of MES 53 at their London meeting.

ONE MAN BAND

Most commercial organs include a Rhythm Unit these days which, used in moderation, is a useful device. Adding an R.U. is not difficult at present as chips which will generate the various patterns are freely available; several pulse-operated "voices" and the switching are the only additional requirements. Like TV sets, the essential control is the off switch! Even so, with the tempo control set to enable him to count the beats, the beginner will be helped to struggle through new music. The more expert performer is spurred on by his "sideman", especially in the Latin-American vein.

Something else to play as well? My choice would be Electric Piano, rather than synthesiser, because of its polyphonic nature. Faced with pedals, three keyboards and their controls, there is plenty to think about but the technique is the same for all.

For some weeks past I have experimented with organ/piano versus organ/synthesiser and there is no doubt in my mind which is the better combination. Although most organs are fitted with percussion, the piano envelope complements the organ admirably. The tonal capability of the piano is purposely limited to perhaps

on adding a "Minisonic II" to an existing organ might best be answered by joining that Society. Under the heading "Technical Enquiries" he also mentioned the different playing technique required and the possibility of using a gating system to ensure response from one key only.

In case my previous remarks on combining electric piano (such as "Joanna", also in Sound Design), rather than synthesiser, with an organ sound biased, perhaps I should pursue my theme. For "live" playing, there is not enough time to do justice to a synthesiser; minute adjustments to its many controls are not possible, except perhaps for solo performance. Attempting to play it whilst also manipulating two other manuals, pedals and their controls must relegate the synthesiser to a "Univox" type of keyboard (which had a short-lived existence three decades ago).

Listening to the expert synthesiser player on disc, and reading the record sleeve notes, brings one message home forcibly. A few minutes of a L.P. recording probably involved many hours work. It needs time to obtain the precise effect you are looking for, so multi-recording at leisure is the only respectful way to treat one of Moog's progeny. My experience shows that the "Minisonic II" sounds impressive through a reverberated system and Leslie speaker but its resources can only be used in a cursory fashion when playing an organ with it.

HOOK-UP

Notwithstanding these comments, there should be no problem in adding a "Minisonic II" to an existing organ or including it in a constructional project. If space is at a premium, the synthesiser could be placed on top of the organ console: the music stand has to be raised in this case, bifocal-wearing readers should be warned!

The low-level outputs should couple into the organ's main amplifier quite satisfactorily, though it should be noted that d.c. levels are present. For this reason it is best to use 0.1p.F coupling capacitors, between synthesiser and organ as a permanent feature, otherwise there is the possibility of upsetting the amplifier by directly connecting the output of IC18 to a d.c. carrying point on the organ. In the case of a single-channel organ, these coupling capacitors can be joined at the organ end to produce a monophonic input signal. The signals from the "Minisonic II" can be inserted before or after the swell pedal according to taste. On the whole, I would suggest using the synthesiser unenclosed, i.e. after the swell control, if signal levels allow.

Strictly

by K. Lenton-Smith

The E.O.C.S. was founded some twenty years ago by a small group of enthusiasts headed by Arthur L Boutillier. In those days there was very little technical information available and the idea of the Society then as now, was pooling of data and experience. Publications sent to members eventually developed into the Society's own "organ", the Electronic Organ magazine. Membership now extends across the world and regular meetings are held in London, Coventry and Manchester.

The Society's brief does not cover electronic organs alone: it is interested in all forms of electronic music and pipe organs. Membership is mixed, from church organists to pop group performers, but most are simply concerned with building an organ to their own specification. Readers interested in this Society should write to Ralph Purdy (Membership Secretary, E.O.C.S.), 11 The Avenue, Station Road, Billericay, Essex.

TECHNICAL ENQUIRY

While on the subject of E.O.C.S., Douglas Shaw has suggested in Sound Design (page 32) that enquiries
PART 2

This month we deal with monitoring systems, speakers and ancillaries.

VU METER

By far the most logical place to put any VU meters in your system is right at the end, so that they measure, albeit roughly, the actual power supplied to the loudspeakers. They should be calibrated so that 0VU (the transition point from black to red) occurs comfortably before the amplifier starts to clip. This can be done with a test tone and an oscilloscope, or failing that, a sensitive pair of ears.

A suitable circuit for driving a VU meter directly from the output of a power amplifier is shown in Fig. 6a. Note that it draws all its power from the signal itself.

If you wish to include a meter prior to the main volume control, it should be calibrated so that with the main output control at maximum, 0VU on the console meter corresponds to 0VU on the power amplifier(s). When the limiter is in circuit, 0VU on the console should correspond to the maximum output from the limiter, and a preset volume control, connected in series with the main output control, will probably be needed to match the level from the limiter to the sensitivity of the power amplifier. A circuit for driving VU meters from signals in the range 200mV upwards is shown in Fig. 6b.

PRE-FADE

All disco equipment ought to have some form of pre-fade listening. This is a means by which the DJ can listen to any of his inputs on a pair of headphones, regardless of whether they are being used to play through the mixer or not. By this means he can cue up records and tapes while a record is playing, and with an effective system this can be done very efficiently and simply. All that is basically required is a switch which will select any of the inputs, or the main output, and present them, via a low-power amplifier, to his headphones.
A simple rotary switch can be used, but more elegantly, PO keyswitches, of the type used on telephone switchboards, can be used in a series arrangement which supplies the main output to the headphones except when one switch is operated, whereupon the output of that particular channel will be heard instead. Each channel has a switch of its own, which can be arranged in a logical position on the control panel.

The wiring of a four-channel bank of pre-fade switches is shown in Fig. 7, with all the switches in their "normal" position. As you can see, operating any one of the switches causes the series line carrying the main output to be interrupted, and the channel output (taken from the top of the channel fader) is substituted for it.

It will be necessary to attenuate the main output in order to avoid deafening the operator when switching from the relatively quiet output of a record deck to the amplified main output. The preset shown in the diagram could be set so that with the VU meter reading normally, that is, peaking around -3, the output from the record decks whether heard directly through pre-fade only, or after having passed through the disco mixer, is more or less the same.

HEADPHONES

When choosing a pair of headphones, bear in mind that you could be wearing them for up to five or six hours at a stretch. Above all, therefore, they must be light and comfortable. Personal favourites are the AKG K140, a fairly new model available at around £13 from the discount stores, with the lightweight Sennheisers, just as comfortable but a little shrrill, a close second.

![Fig. 7. How a bank of PO keyswitches may be used to select pre-fade inputs or the main output from the console mixer](image)

Table 1: POWER OUTPUT FOR VARIOUS SUPPLIES AND LOUDSPEAKER IMPEDANCES

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>Load Impedance</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>40V</td>
<td>8Ω</td>
<td>20W</td>
</tr>
<tr>
<td>70V</td>
<td>8Ω</td>
<td>35W</td>
</tr>
<tr>
<td>100V</td>
<td>8Ω</td>
<td>50W</td>
</tr>
<tr>
<td>120V</td>
<td>8Ω</td>
<td>60W</td>
</tr>
<tr>
<td>140V</td>
<td>8Ω</td>
<td>70W</td>
</tr>
<tr>
<td>160V</td>
<td>8Ω</td>
<td>80W</td>
</tr>
</tbody>
</table>

My preference is for high impedance headphones, as they can be driven by a simple but very high-quality Class A driver circuit (Fig. 8). Lower impedance phones, such as Class AB drivers, are better suited to lower power applications. Reference should also be made to the loudspeakers. For details, the author recommends consulting the Note section.

![Fig. 8. High quality Class A headphone driver circuit for high impedance headphones (600Ω and above)](image)

Notes:
1. The supply voltages refer to total supply volts, e.g. 60V or ±30V.
2. Output figures are for typical amplifier modules using direct-coupled output stages, and assume unlimited current capability.

STereo

Four years ago I would have said that stereo was a waste of time for a mobile discotheque. Nowadays, with nearly all new singles recorded in stereo, and having tried it in practice, I am not so sure. The problem with stereo is that people have to be roughly equidistant from the two loudspeakers in order to appreciate it, and with a mobile set-up this is difficult to achieve. Of course there is great benefit to be drawn from having all your circuitry duplicated, since any failure can, with the addition of a stereo/mono switch at input and output, be quickly by-passed, and the equipment run in mono.

THE POWER AMPLIFIER

The power amplifier is the link between the duly processed low level signal from the control circuits of your console and the loudspeakers. Its purpose is to take a signal of a few hundred millivolts and amplify it to a power of tens or even hundreds of watts at an impedance level suitable for driving loudspeakers. It is better to have a power output less than the maximum output of the loudspeakers can handle so that a fault, such as an open-circuit earth connection on the input, can never cause enough power to be delivered to the speakers to damage them.

Kits for this application are legion and represent a cheap and effective way of obtaining the necessary power. Bear in mind, though, that the use of units originally designed for domestic applications may cause problems when they are subjected to the gruelling conditions at a disco. In short, the poor little things may overheat and expire, much to your dismay and embarrassment. So use one capable of more power than you actually require, and then limit its power output by using the minimum supply voltage which will deliver the necessary swing. A table of supply voltages for particular outputs is given in Table 1. The figures are approximate but should prove useful.
LOUDSPEAKERS

Avoid using 12 or 15in bass units as your only link with the outside world. All you will get is a murky, muddy sound, and nobody will be able to hear the words of the songs, or anything you try to say to them. That many disco devotees do not seem to mind this is no excuse for sloppiness in this department.

Do not expect to right matters with the inclusion of a couple of tweeters from domestic hi-fi units. Either they will be too quiet to be effective, or you will blow them up.

Consider a domestic loudspeaker system, containing, say, one 8in bass/midrange unit and a 3in tweeter. This achieves a reasonable "balance of power" over the whole frequency range. But a 15in bass unit, with four times as much cone area, will require four such tweeters to achieve the same balance. Plus, in all probability, some midrange units to fill in the gap between the two widely different systems. So unless you use tweeters specifically designed for high power use (and they should be labelled as such), or your tweeters fall off the back of lorries, you will have an expensive time making up multi-way systems for your disco.

A good idea is to use twin-cone units, where one large assembly handles most of the frequency range fairly comfortably, or, if you can afford them, the excellent Tannoy "dual concentric" speakers where the bass unit and matched tweeter are mounted concentrically together with a crossover all in a single chassis.

When making cabinets for your speakers, preferably stick to one of the manufacturers' recommended designs. Although the larger the cabinet the more efficient the system and the deeper the bass (as a rough rule), do not go berserk; you will, after all, have to cart them about. Castors, too, are one of man's greater inventions.

PLACEMENT OF SPEAKERS

The absorption of sound by a thick layer of human flesh is quite rapid at frequencies above about 200Hz and it simply does not make sense to put your speakers on the floor unless they are about 7ft high and with the business end at the top! They must be placed so that the axes of the speakers are at least 6ft from the ground so that people can hear them with as few obstructions as possible between speaker and ear.

If this is impossible, they should at least be tilted upwards so that sound may be reflected back over the audience from the ceiling. Having them tilted has the additional advantage that people will usually then refrain from putting their half-consumed drinks on them. Drinks at parties have a habit of getting spilt, and brown ale does little to improve the acoustic properties of a sound cabinet.

With your speakers up high you will be able to cover a greater area at less power than you would were your speakers below shoulder height. This technique is just as valid for small parties, where the music is provided by a normal domestic stereo system, usually pushed to the limits of its endurance. Placing the speakers on a high shelf or on top of a wardrobe will enable your guests to hear the music much more clearly when the room is full.

THE LIGHT SHOW

Once upon a time, dances and discos frequented by young people took place in near darkness, and lots of unkind jokes were told about discoveries made by eager young men on bringing their chosen partner into better lighting conditions. Nowadays, however, matters are somewhat different, and many operators take an almost savage delight in exposing their audience to varying coloured lights.

The heart of many a lighting system is the miniature spotlight bulb, usually rated around 75 to 100 watts and driven by a thyristor or triac to flash either sequentially with its neighbours or in time to a selected part of the audio spectrum. These bulbs are available in two formats, BC, which is a bayonet fitting like an ordinary light bulb, and ES (Edison Screw) which, as its name suggests, screws into the holder like a torch bulb. BC is to be recommended for lower power lamps, up to 150 watts, as it is cheaper, and screw-in types tend to unscrew themselves. Higher power bulbs are almost universally screw fitting.

There is a large number of commercially-made units, as well as a host of constructional designs for flashing spotlights on and off. A well designed one should take an utterly minimal amount of current from the audio power amplifier but unfortunately this is not always the case. It is a good idea to use a rough old amplifier solely to drive your light show if you have any doubts on this score. The spikes produced by the thyristors turning on and off can play havoc with your sound system if the light cables come near any sensitive part of the mixer circuitry, so do keep them well out of the way.

EFFECTS PROJECTORS

Effects projectors work on two principles; first there is the wheel, which is spun round like a gramophone record between the bulb and the lens, heating up and causing the coloured oils inside to drift in and out of each other.

Then there is the cartridge, which is driven from its edge and produces moire patterns as its two sides interact with each other. Both can be very pretty, though you may have to look around before you see one you really like.

STROBES

Stroboscopic lighting has been used for a long time in industry to observe moving pieces of machinery as if they were stationary by arranging that the moving part is always in the same place when the flash occurs. Recently, though, it has found a less precise application in conjunction with discotheques. You take a strobe light, set it at a few cycles per second, and shine it on the dancers. Hopefully you stop before they start falling over or being sick.

People with epileptic tendencies of which they may themselves be unaware, may even throw fits when exposed to lighting of a particular strobe frequency. That apart, it can still be fun but do not use the strobe for more than five minutes in any hour and if anyone complains or looks disturbed by the flashing light, stop using it immediately.

SAFETY PRECAUTIONS

Your equipment should be earthed at all times to the mains earth and if you are using an extension lead it should be checked regularly for continuity along the
earth lead. All mains connections should be made with proper plugs and sockets and kept well out of any areas where drink may be spilled or where people may trip over them.

Connections to spotlights should be of stout cable and all the holders should be securely earthed. The greatest care should be exercised when operating on spotlights with the power on, since the output from sound/light or sequencer units is usually not isolated from the mains, as all audio equipment would be.

Always string your cables well out of harm's way; if you have them up along the ceiling they will not get dirty or wet but be sure they will not fall down, either.

**INTERCONNECTIONS**

By far the easiest way of interconnecting your audio department is to use standard jack sockets, available everywhere. They are robust, positive and reliable, which is more than can be said for most of the miniature connectors that adorn hi-fi systems. Of course, they do not have to stand up to such rigorous use. Have a set of leads exclusively for use with your disco. If you use jacks throughout, all you will need are a series of jack-to-jack leads of various lengths. It is useful to have a short and a long set of loudspeaker leads, so that you need not have an excessive amount of cable trailing around.

All the pluggery needed with sound to light units usually comes with the unit, or can be bought from the same shop. This should not present any problems if the plugs are wired securely.

**STORAGE**

On an average night you will get through roughly a hundred singles. To ensure an adequate selection, you will need to take perhaps three to five times as many as this. Any more is really a bit excessive. Whatever sort of order you decide to keep them in, you will soon learn where to find everything provided nobody messes about with your collection.

Cardboard boxes are useful for keeping singles in, but have a rather limited life. Smart record boxes made out of half-inch chipboard can be fitted with a lid and a padlock to keep marauding fingers out while you go and fetch your car at the end of the evening.

A travelling bag can be filled up with leads, note-paper for requests, your advertising material, a soldering iron and all the other odds and ends that come in useful.

**MUSIC**

It is outside the scope of this article to go deeply into the fraught waters of musical taste. However, the music papers feel free to pontificate on electronic equipment so perhaps a word or two on their subject might not be amiss.

Lately the disco audience has been polarising swiftly into two camps; broadly, soul and rock. There has always been a split of this kind but in the last couple of years it has become much worse. The problem now is that if you play two soul records in a row someone with more persistence than imagination will insist on the Rolling Stones or Status Quo.

Conversely, play too much rock and the soul freaks will descend on you breathing fire—their requirements are usually more diverse but no less enthusiastic. Of course, if the event is specifically a soul or rock or reggae disco this problem will not arise, but you may still find yourselves bombarded with requests for things you have never heard of. Do not fret, but do take a note of what you are asked for and attempt to hear it on your next trip to the record shop.

Do not waste too much time buying up the latest releases; many people, quite understandably, will not dance to anything they have not heard at least a dozen times and by then the record in question is probably available from one of the second-hand shops at half the original price. Always note requests on a piece of paper, whether or not you have the records asked for; not only can you use this to guide your choice of material but it is also much easier to read a dedication from paper than it is to try and memorise it.

**COPYRIGHT**

Round every record label is the legend "Unauthorised Copying, Public Performance and Broadcasting of this record prohibited", or words to that effect. Most DJs ignore it completely. The organisation concerned with administering the public performance of gramophone records is the Performing Rights Society Ltd., 33 Berners St., London, W1P 4AA, who will send you on request details of the legal position regarding the public performance of gramophone records, the gist of which is that you can please yourself what you do at Johnny's birthday party, and if you are playing somewhere where there is a fee for admission then the onus for obtaining a licence falls on the person hiring you.

**CONCLUSION**

Don't kid yourself: despite the claims of the advertisers, "easy money earned with our £350 disco console" (for whom?)—operating a mobile discotheque is really hard work—the public only sees the easy bit. You may not get home till 2 or 3 o'clock in the morning and you'll be worn out when you do.

You will have to put up with requests for records you have played so often you wish they had never been recorded, and you may have to cart your equipment up and down stairs cluttered with people who display as much reluctance to move out of your way as they did to dance to your music. Don't underprice yourself; better to do two discos for £40 than three!

All the same, it can still be a rewarding pastime, and a great deal of enjoyment can be had from your mobile disco, especially when you've built some or all of it yourself. I hope this article has made clear to you something of the art of running a mobile discotheque. Good Luck!
TV TENNIS SCORE UNIT

The TV tennis Score Unit is designed to attach to the Videomaster TV tennis game, to display the score on the television screen immediately after each goal or point is scored. The score is displayed in the seven segment format, with each score being shown on its own side of the screen, as shown in Fig. 2b. The game progresses until one or other player reaches a score of nine, at which point that player is the winner. This condition is detected by G5, which prohibits the game from proceeding any further. A new game is started by pressing the reset button.

The four input gates (G1 to G4), update each player's score counter (CTR A and CTR B). Switch A is controlled by the Line Sync timing circuits, and switches at the correct time during the sweep, to display each counter score on its side of the screen. The timing circuits consist of two Line "single shots" and three Frame "single shots", and these define the character position and size. The gating at the Video Output (G9 to G18), suitably blanks the seven segment decoded counters to give the correct television screen representation of the score, and also inhibits the display during play.

Fig. 3 shows how the third Line "single shot" (LS3) produces double score, by pulling up LS1, and switches the two-way switch giving "ghost" figures which do not mask the bats or ball.

The prototype was constructed on two d.i.l. circuit board offcuts, which fitted within the lid of the Videomaster unit. The logic is COSMOS throughout, which consumes very little current from the Videomaster batteries.

D. E. Launchbury, Shirley, Solihull.

A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.
Fig. 1b

Fig. 2a  Fig. 2b

Fig. 3

LS1 is pulled by LS3 on alternate lines

Practical Electronics May 1977
The circuit in Fig. 1 was originally designed to be highly stable, and to drive a small induction motor at various frequencies, which would in turn drive a telescope at different tracking rates. The circuit was built using readily available cheap components.

Package IC1 forms the oscillator using a 4MHz crystal, and IC2 divides this symmetrically by 10. The 400kHz squarewave is then counted by the line of BCD decade counters (IC3 to IC6), the outputs of which are compared to the outputs of four binary coded switches, partly producing logical 0. Outputs from the 16 exclusive or gates are fed to a line of inverters. When all the gates show zero (the decade counters have counted up to the number set on the four switches), the AOK line is no longer held low. This condition lasts for 2.5μs, during which time the JK flip-flop toggles, and the counters are cleared after the propagation delay of IC13e and IC13f. This cycle of events continues to repeat itself. Hence, a number set on the switches, say 2000, will cause the circuit to count up to this figure in 2.5μs pulses, taking 5ms, which is further divided by 4 (IC14) giving a symmetrical squarewave of 20ms (50Hz). Therefore the number set on the switches relates directly to the wavelength of the output frequency. Current consumption for this part of the circuit is about 390mA depending on the switch settings.

This signal is used to drive the inverter shown, which provides 240 volts to drive the motor. The 2N3055s should be mounted on a heatsink, and also the LM309K.

The circuit has many possible applications, and could be adapted to work outside its present range of 99.99ms to 0.01ms.

A. P. Wilkinson,
Morley,
Leeds
**TRANSISTORS AND DIODES**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Voltage</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N3904</td>
<td>SOT-23</td>
<td>50V</td>
<td>0.1A</td>
<td></td>
</tr>
<tr>
<td>2N3905</td>
<td>SOT-23</td>
<td>50V</td>
<td>0.1A</td>
<td></td>
</tr>
<tr>
<td>2N3926</td>
<td>SOT-23</td>
<td>50V</td>
<td>0.1A</td>
<td></td>
</tr>
</tbody>
</table>

**ELEKTRON KITS**

- **Audio fuel filter**
- **Rectangular**

**CAPACITORS ELECTROLYTIC**

<table>
<thead>
<tr>
<th>Value</th>
<th>Tolerance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10uF</td>
<td>±20%</td>
<td></td>
</tr>
<tr>
<td>470uF</td>
<td>±20%</td>
<td></td>
</tr>
</tbody>
</table>

**RESISTORS**

- **Potentiometers**
- **Tandem**

**THYRISTORS AND TRIACS**

- **Thyristors**

**TRANSFORMERS**

- **Primary-24V a.c. (100V available on request)**

**POWER SUPPLIES**

- **12VDC**

**CMOS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>74C00</td>
<td>DTL</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ICS**

**ELEKTRON KITS**

- **Audio fuel filter**
- **Rectangular**

**CAPACITORS ELECTROLYTIC**

<table>
<thead>
<tr>
<th>Value</th>
<th>Tolerance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10uF</td>
<td>±20%</td>
<td></td>
</tr>
<tr>
<td>470uF</td>
<td>±20%</td>
<td></td>
</tr>
</tbody>
</table>

**RESISTORS**

- **Potentiometers**
- **Tandem**

**THYRISTORS AND TRIACS**

- **Thyristors**

**TRANSFORMERS**

- **Primary-24V a.c. (100V available on request)**

**POWER SUPPLIES**

- **12VDC**

**CMOS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>74C00</td>
<td>DTL</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ICS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ELEKTRON KITS**

- **Audio fuel filter**
- **Rectangular**

**CAPACITORS ELECTROLYTIC**

<table>
<thead>
<tr>
<th>Value</th>
<th>Tolerance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10uF</td>
<td>±20%</td>
<td></td>
</tr>
<tr>
<td>470uF</td>
<td>±20%</td>
<td></td>
</tr>
</tbody>
</table>

**RESISTORS**

- **Potentiometers**
- **Tandem**

**THYRISTORS AND TRIACS**

- **Thyristors**

**TRANSFORMERS**

- **Primary-24V a.c. (100V available on request)**

**POWER SUPPLIES**

- **12VDC**

**CMOS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ICS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ELEKTRON KITS**

- **Audio fuel filter**
- **Rectangular**

**CAPACITORS ELECTROLYTIC**

<table>
<thead>
<tr>
<th>Value</th>
<th>Tolerance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10uF</td>
<td>±20%</td>
<td></td>
</tr>
<tr>
<td>470uF</td>
<td>±20%</td>
<td></td>
</tr>
</tbody>
</table>

**RESISTORS**

- **Potentiometers**
- **Tandem**

**THYRISTORS AND TRIACS**

- **Thyristors**

**TRANSFORMERS**

- **Primary-24V a.c. (100V available on request)**

**POWER SUPPLIES**

- **12VDC**

**CMOS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ICS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ELEKTRON KITS**

- **Audio fuel filter**
- **Rectangular**

**CAPACITORS ELECTROLYTIC**

<table>
<thead>
<tr>
<th>Value</th>
<th>Tolerance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10uF</td>
<td>±20%</td>
<td></td>
</tr>
<tr>
<td>470uF</td>
<td>±20%</td>
<td></td>
</tr>
</tbody>
</table>

**RESISTORS**

- **Potentiometers**
- **Tandem**

**THYRISTORS AND TRIACS**

- **Thyristors**

**TRANSFORMERS**

- **Primary-24V a.c. (100V available on request)**

**POWER SUPPLIES**

- **12VDC**

**CMOS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>

**ICS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Type</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>741</td>
<td>opamp</td>
<td>5V</td>
<td></td>
</tr>
</tbody>
</table>
JOANNA MODIFICATION

By means of simple modifications, the PE “Joanna” by A. J. Boothman, may be given an alternative organ sound. Figure 1 shows one Joanna envelope circuit. The resistor (RS), and two diodes (DA and DB) are added to each key circuit, and one control switch with pull-up resistor are common to all sixty-one circuits. A switch is also added to the 19 volt connection to the keyswitch bus bar, labelled attack control.

With the organ switch “on” and the attack control “off”, when a key is depressed CT charges through RT but has no effect on the signal output. CS charges through RT, RS and DA, up to about +5 volts, at which point DB conducts and prevents any further increase in voltage. When the key is released, the discharge of CS is via the normal path, variable by means of the sustain pedal. When the organ switch is “off”, diode DB clamps point A to about +0.7 volts, and prevents CS charging through DA.

The result of this is an output signal which rises slowly, remains constant as long as the key is held down, and fades out slowly when the key is released. There are now a number of variations in the sound available. Resistor RS determines the rate of attack, and may be between 10kΩ and 100kΩ as required. A variable attack time may be provided by varying VT as shown in Fig. 1. With both organ and attack control switches “on”, the keyboard touch sensitivity gives a further increase in the speed of attack. The organ output level may be varied by altering the clamp voltage of DB (as in Fig. 2), and when set to a low level gives the familiar organ percussion sound.

If the organ control line and +19 volt keyswitch bus bar are split into two at note 25, with suitable switching the lower two octaves can play the organ, and the top three octaves can play the piano, or vice versa. In this case it is advisable to provide two separate organ level controls, otherwise the piano can be drowned by the organ sound. Extra filters to give the “flute” organ voice are also useful, especially when sustained chords are played in the lower octaves.

The above modification adds less than five pounds to the cost of the Joanna. However, for anyone who is prepared to completely rebuild the master oscillator board, a circuit is given in Fig. 3 which includes vibrato, and the possibility of switching to 2, 4, 8, or 16 foot pitches as required. The higher pitches, used with the organ stop, slow attack, and vibrato, give a useful “string synthesiser” sound. As the frequencies of the piano filters are fixed, alternative voice filters are required to make the best use of the higher pitches. The pitch selector inputs are shown in Table 1.

If miniature resistors have been used, there is room on the envelope boards for the extra components.

Three extra holes are drilled for each envelope circuit, and RS fits between R57 and C16, DA between D12 and D17, and DB between D17 and R72 with a bend in the anode lead to pass between R57 and D17. The DB cathodes are strapped together on the copper side of the board, using uninsulated wire, and are brought out to a Veropin near the +5 volt connection.

All earth wiring should be as low resistance as possible, otherwise the discharge of CT when a key is released, can cause a “thump” to be heard! Finally, a warning is given that heavy vibrato, when using one of the piano stops can produce a most sickening sound.

D. A. Boyd, Walton, Liverpool.

Table 1

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Point E</th>
<th>Point F</th>
</tr>
</thead>
<tbody>
<tr>
<td>2'</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4'</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>8'</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>16'</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Pitch Selector control inputs
The melody generator shown in Fig. 1, makes use of subminiature preset resistors acting as a small analogue "memory bank", enabling a short tune to be stored. A continuous cycle of ten notes of equal duration is produced, permitting a considerable variety of simple tunes to be set up.

The overall circuit consists of three blocks; a pulse generator, a decade counter, and an audio frequency oscillator driving a loudspeaker. The decade counter consists of two TTL i.c.s which require a power supply of 4-5 to 6 volts. This is derived from the 9 volt supply via resistor R10.

The pulse generator comprises TR1 and TR2, and is powered by the same 5 volt supply line used by the i.c.s, to avoid too high a voltage being applied to the input of ICl from the collector of TR2. TR1 is a unijunction transistor operating as a relaxation oscillator producing pulses at intervals dependent on the setting of VR1 (approx. 0.5 to 5Hz with specified values). This pulse is boosted by TR2, which operates as a switching transistor to advance the decade counter.

The counter consists of IC1 and IC2, in which the former counts the pulses appearing at pin 14, and represents the count in binary at pins 12, 9, 8 and 11. The 7490 counts from zero, and may be reset to zero after any number. As wired in Fig. 1 the circuit resets to 0 after 9 in order to make full use of IC2. The latter i.e. converts the binary output of IC1 to decimal in the ten output lines, each one sequentially dropping to almost the potential of the negative supply rail, while the other nine remain at very high resistance.

Transistors TR3 and TR4 form an oscillator producing an audio frequency square wave which is amplified by TR5 and fed to the loudspeaker. Frequency may be varied by changing the time constant at the base of TR3. Thus by connecting ten different resistances in the outputs of IC2, the time constant at TR3 base, and therefore the frequency of oscillation, will change as the decade counter goes through its cycle. By making these resistors independently variable, a tune may be programmed into the device.

To ensure that the multivibrator will oscillate when the presets are at their minimum setting, VR12 is used to provide a threshold resistance such that each preset may cover two full octaves.

A note may be blanked by inserting a slip of paper between the wiper and track of the relevant preset. A good tune to start with is the chime of Big Ben: A F G C blank C G A F blank.

The most obvious application of the unit is a doorbell. Callers, and the constructor can both be kept entertained by changing themes. Alternatively the unit might be included in a communication system as a station identifier. The prototype ran from a 6 volt 100mA mains power pack, but would work from a 9 volt battery.

J. R. Skeels, Upminster, Essex.

HAZARD WARNING FLASHER (November 1976)
A reader has pointed out to us a potential danger in this unit. If the hazard flasher is switched on whilst the turn indicator switch is not returned to the off position, power can be fed back through the latter switch into the ignition system, possibly causing damage.

This may be overcome by inserting a diode in series with the live supply feed to S1 in Fig. 1, with polarity appropriate to the car's electrical system (anode to supply for negative earth systems, and vice versa). A 10A device is required, such as the RS Components 261-018, mounted on a suitable heat-sink with an insulating kit.

pH METER (March 1977)
As a result of the pH Meter featured in our March 1977 edition, Uniprobe Instruments Ltd have made a special offer to the PE reader, of the combination glass and reference electrode used with their 300 series pH meters.

Suitable for the PE pH Meter, this probe set is available at the special price of £9.50 including VAT, from:
Uniprobe Instruments Ltd, Clive Road, Cardiff, CF5 1HG.
INFRA RED BINOCULARS
Made for military purposes during and immediately after the last war to ensure that every vehicle driver, etc. can see to the limit. The binoculars have to be designed to withstand a high voltage source (55kV approx.) and providing the objects are in the rays of an infra red beam, then the binoculars will enable these objects to be identified. Each binocular eye-tube contains a complete optical lens system as well as the infra red cell, technical data on this is available. The binoculars are excellent but fitted with a hard rubber case. A simple battery operated switch for setting up to 20 amps at mains voltage,

NEED A SPECIAL SWITCH
All in module form, each ready built complete intended for use with mains operating 14-25 including POST & VAT.

SMITHS CENTRAL HEATING CONTROLLER
Multispeed motors
Six speeds are available 500, 860 & 1500 rpm, and approximately 10 rev/s per month). Specs:
- $0.30°C
- Push Button Double Changeover Switch. Honeywell type No. 14 DMG. Contact rated at 10 amps $0.50 + 3p. Post $0.30 + 1p.
- 2 x 10 amp appliances. Price $0.75 + 6p. Post $0.50 + 1p.
- MOTORISED DISCO SWITCHES
Wired group of 20 lots, each $0.50 + 3p. Price $5.00 + 0p. Post $0.50 + 0p.

STEREO PUMP
A simple Dito 5 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

Mains RELAYS
A 15 amp changeover contactor operating 24 hour coil wound for 250 volts AC, chassis mounting, one screw fixing, ex-military equipment 40p each, 10 for $0.50 post and VAT paid.

8 POWERFUL BATTERY MOTORS
Models: Electrically remote control plate, boats, etc., etc. $2.00.

ROTOR PUMP
Self priming, portable fits drill or electric motor. Sizes 12 mm, 25 mm and 32 mm, 96 mm, 150 mm, 200 mm, 250 mm and 300 mm. Price $0.50 + 3p. Post $0.30 + 1p.

MOTORISED DISCO SWING DISCS
With either two separate 12" motors mounted on a single three phase motor (ex-military type) this would provide an impressive display. For musical uses. Dito 6 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

TERMS: Where order is under $6 please add 50p surcharge to offset postage expenses.

J. BULL (ELECTRICAL) LTD.
(Dept. P.E.), 103 TAMWORTH ROAD, CROYDON CR9 1SG.

P.S. THE BARGAIN LIST CONTINUES...
DIBY 10 Switch $0.50 + VAT Post.

SOFTWARE CRYSTAL SET
Although this uses no battery it gives really amazing results. You will be looking up the stars on 12 hour basis and 15 minute intervals. Price $0.50 + VAT Post.

SPIT MOTOR WITH CARTER GEAR BOX
Probably the best of its type, it motor will run a carpet, but will switch with all electrically operated or powered units. Price $0.50 + VAT Post.

MULTISPEED MOTORS
Its speeds are: 600, 860, 1500 rpm, and approximately 10 rev/s per month. Price $0.50 + VAT Post.

DIAL COUNTERS
There are two separately switchable adjustable switches are rated at 10 amp each so that the total of 1000"s is displayed. For musical uses. Dito 6 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

-finals trees—As a normal slow motion type counter suitable for above cabinet. Price $0.50 + 3p. Selsyn adhesive strip. Price $0.50 + 3p.

DIESEL LIGHT LAMP
We have just received a very special price for these lamps but regret to say that the price has increased and now costs $0.50 + 5p. Post $0.40 + 0p.

For battery use the 24 volt lamp we wish to point out that it is probably the most useful ultra violet lamp available especially for disco work. Use for only the most urgent or required motors. Price $0.50 + 3p. Post $0.40 + 0p.

DIESEL HEATER MOUNTED WITH THERMO-HEAT ELEMENTS
Price $0.50 + 5p. Post $0.40 + 0p.

DIESEL HEATER MOUNTED WITH THERMO-HEAT ELEMENTS
Price $0.50 + 0p. Post $0.40 + 0p.

STEREO PUMP
A simple Dito 5 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

Mains RELAYS
A 15 amp changeover contactor operating 24 hour coil wound for 250 volts AC, chassis mounting, one screw fixing, ex-military equipment 40p each, 10 for $0.50 post and VAT paid.

SOFTWARE CRYSTAL SET
Although this uses no battery it gives really amazing results. You will be looking up the stars on 12 hour basis and 15 minute intervals. Price $0.50 + VAT Post.

SPIT MOTOR WITH CARTER GEAR BOX
Probably the best of its type, it motor will run a carpet, but will switch with all electrically operated or powered units. Price $0.50 + VAT Post.

MULTISPEED MOTORS
Its speeds are: 600, 860, 1500 rpm, and approximately 10 rev/s per month. Price $0.50 + VAT Post.

DIAL COUNTERS
There are two separately switchable adjustable switches are rated at 10 amp each so that the total of 1000"s is displayed. For musical uses. Dito 6 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

-finals trees—As a normal slow motion type counter suitable for above cabinet. Price $0.50 + 3p. Selsyn adhesive strip. Price $0.50 + 3p.

DIESEL LIGHT LAMP
We have just received a very special price for these lamps but regret to say that the price has increased and now costs $0.50 + 5p. Post $0.40 + 0p.

For battery use the 24 volt lamp we wish to point out that it is probably the most useful ultra violet lamp available especially for disco work. Use for only the most urgent or required motors. Price $0.50 + 3p. Post $0.40 + 0p.

DIESEL HEATER MOUNTED WITH THERMO-HEAT ELEMENTS
Price $0.50 + 0p. Post $0.40 + 0p.

Mains RELAYS
A 15 amp changeover contactor operating 24 hour coil wound for 250 volts AC, chassis mounting, one screw fixing, ex-military equipment 40p each, 10 for $0.50 post and VAT paid.

SOFTWARE CRYSTAL SET
Although this uses no battery it gives really amazing results. You will be looking up the stars on 12 hour basis and 15 minute intervals. Price $0.50 + VAT Post.

SPIT MOTOR WITH CARTER GEAR BOX
Probably the best of its type, it motor will run a carpet, but will switch with all electrically operated or powered units. Price $0.50 + VAT Post.

MULTISPEED MOTORS
Its speeds are: 600, 860, 1500 rpm, and approximately 10 rev/s per month. Price $0.50 + VAT Post.

DIAL COUNTERS
There are two separately switchable adjustable switches are rated at 10 amp each so that the total of 1000"s is displayed. For musical uses. Dito 6 switch $0.50 + VAT Post. P.S. But 12 Switch $0.75 Post + VAT.

-finals trees—As a normal slow motion type counter suitable for above cabinet. Price $0.50 + 3p. Selsyn adhesive strip. Price $0.50 + 3p.

DIESEL LIGHT LAMP
We have just received a very special price for these lamps but regret to say that the price has increased and now costs $0.50 + 5p. Post $0.40 + 0p.

For battery use the 24 volt lamp we wish to point out that it is probably the most useful ultra violet lamp available especially for disco work. Use for only the most urgent or required motors. Price $0.50 + 3p. Post $0.40 + 0p.

DIESEL HEATER MOUNTED WITH THERMO-HEAT ELEMENTS
Price $0.50 + 0p. Post $0.40 + 0p.

Mains RELAYS
A 15 amp changeover contactor operating 24 hour coil wound for 250 volts AC, chassis mounting, one screw fixing, ex-military equipment 40p each, 10 for $0.50 post and VAT paid.
EDGewise 20A; A CENTRE ZERO METERS, 90p each
CATHODES, 5mA 10V type, 50p each, 100mA 10VA, type, 5p each.
MINIATURE 4mm dia. 8 ohm LOUDSPEAKERS, 75p each.
20 PHOTO DARLINGTON and PHOTO TRANSISTORS, asorted units tested for £1.
20 ASSORTED TRANSISTORS, 10mA type between 0.5mA, £1 10.
1.000V 40V W ELECTROLYTES, size 1p x 14p, 15p, 4 for 50p.
AUDIBLE ALARM SYSTEM with transistors and I.C. 12V, 75p.
20 ASSORTED CRYSTALS, 10kHz type between 0kHz, £1 10.
1.000V 40V W ELECTROLYTES, size 1p x 14p, 15p, 4 for 50p.
M40 A PLASTIC TO3 NP POWER TRANSISTOR, 30p each.
BRANDED T092 TRANSISTORS, BC108/109, 70p each.
STANDARD IMPERIAL POWER TRANSISTORS, 3 for £1.
TRANSISTORS AND DIODES,
200/500 10p, 1000/25 1/2/10/50/100 7p, 50V 10p.
METAL HOUSING 50p.
BLACK PLASTIC CASES 42mmx17mm 0.2 FACE CUTTER 65p.*
GAS DETECTOR TGS 308 etc 0.1.
DIN:PLUGS all 15p.
PRESETS 6p.
WIRE RESISTORS 2p.
12V 35mA 01.206.
1A 50V 37p.
C100D 4A 400 60p.
BACK IF NOT SATISFIED.
FULL VAT}

EDGewise 20A; A CENTRE ZERO METERS, 90p each
CATHODES, 5mA 10V type, 50p each, 100mA 10VA, type, 5p each.
MINIATURE 4mm dia. 8 ohm LOUDSPEAKERS, 75p each.
20 PHOTO DARLINGTON and PHOTO TRANSISTORS, asorted units tested for £1.
20 ASSORTED TRANSISTORS, 10mA type between 0.5mA, £1 10.
1.000V 40V W ELECTROLYTES, size 1p x 14p, 15p, 4 for 50p.
AUDIBLE ALARM SYSTEM with transistors and I.C. 12V, 75p.
20 ASSORTED CRYSTALS, 10kHz type between 0kHz, £1 10.
1.000V 40V W ELECTROLYTES, size 1p x 14p, 15p, 4 for 50p.
M40 A PLASTIC TO3 NP POWER TRANSISTOR, 30p each.
BRANDED T092 TRANSISTORS, BC108/109, 70p each.
STANDARD IMPERIAL POWER TRANSISTORS, 3 for £1.
TRANSISTORS AND DIODES,
200/500 10p, 1000/25 1/2/10/50/100 7p, 50V 10p.
METAL HOUSING 50p.
BLACK PLASTIC CASES 42mmx17mm 0.2 FACE CUTTER 65p.*
GAS DETECTOR TGS 308 etc 0.1.
DIN:PLUGS all 15p.
PRESETS 6p.
WIRE RESISTORS 2p.
12V 35mA 01.206.
1A 50V 37p.
C100D 4A 400 60p.
BACK IF NOT SATISFIED.
FULL VAT
RATIONALISING with only 4,000 devices to choose from. Motorola's who uses what for which purpose, an analysis of all applications and Motorola has decided to call a halt, vices USA.ies an F8 microprocessor and delivering an entertainment system centred round the consumer market. The newest in digital watches and TV games in as in Japan and Hong Kong.iers reported to be thinking of applying for take-over raises in the UK. Fairchild is also starting to buy in companies then the extra capital will probably be raised in the UK. Fairchild is also reported to be thinking of applying for listings on other major stock exchanges in Europe, as well as in Japan and Hong Kong. The company is currently strong in digital watches and TV games in the consumer market. The newest Fairchild TV game is actually an entertainment system centred round an F8 microprocessor and deliveries have already started in the USA.

MOVING IN . . .
The President of Fairchild Camera and Instrument Corporation, Wilfred Corrigan, has now got his Stock Exchange listing allowing Fairchild shares to be traded through London. Sales world-wide were up 52 per cent last year to 433.2 million dollars and Corrigan says Fairchild has moved aggressively to obtain funds for future growth.

Reading between the lines, it would seem that he sees the growth coming in Europe and specifically in the United Kingdom where he is looking for take-over opportunities. If Fairchild does start buying in companies then the extra capital will probably be raised in the UK. Fairchild is also reported to be thinking of applying for listings on other major stock exchanges in Europe, as well as in Japan and Hong Kong.

The company is currently strong in digital watches and TV games in the consumer market. The newest Fairchild TV game is actually an entertainment system centred round an F8 microprocessor and deliveries have already started in the USA.

COMPONENT BOOST
The British electronic components industry is one of five industry sectors selected for special government assistance in the industrial strategy programme. A figure of £20 million is suggested as the sort of support expected to be made available. Brave plans for a brave future.

This new initiative is a re-run of a similar initiative of ten years ago. Only the names have changed. In the old days the slogan was 'the white heat of technological revolution' and its instrument was the Ministry of Technology. Today the slogan is "the regeneration of British industry" and its focal point is the NEDC. The only real change is that today the trade unions have an equal say in the strategy, more than an equal say according to some commentators. Even the amounts of money involved, allowing for inflation, are practically the same.

These endlessly sitting industrial strategy committees are no substitute for action. In fact they are mostly counter-productive. Who in their right minds will use their own money today when government money will be available tomorrow? So those who hope to gain from the scheme defer their investment plans until more details are available, the applications for aid submitted, further committee meetings held, the recommendations of the civil servants put forward, the Minister's and Union's final approval given, the ordering of new equipment, the arguments at shop floor level over new manning agreements, the negotiation of new rates of pay. Let's be optimistic and say that this tortuous process takes only two years. By that time, in a volatile industry like electronics, the market has changed and the opportunity missed. And like all forms of heavily institutionalised charity the administrative costs eat deep into the capital sum.

How much simpler and faster to give the money in the form of tax relief in general and an additional relief on profits from exports, thus assisting all firms equally. As it is, only firms with schemes costing £50,000 or more will qualify for aid, which eliminates many worthy enterprises. It is also uncertain what the attitude of the Government and Unions will be towards aid for foreign-owned multinationals in Britain which, between them, form a very large part of the components manufacturing industry, especially semiconductors.

All signs point to a stiffening of resistance by well-run companies against Government meddling. A number of public companies are thinking of reorganising themselves into private companies to obtain more freedom of action, and I have already heard of contingency plans being made by some businessmen to move overseas should the Bullock Report be implemented in its present form by the Government.

WINNERS
Despite all the difficulties there is still ample vigour in the industry. Hewlett-Packard Ltd., the UK arm of H-P has not only turned in its best results ever but is the most profitable of all H-P's 27 manufacturing plants round the world. The Scottish plant is the world design centre for communications instrumentation with 80 per cent of production exported to 65 countries. Export sales are up 49 per cent, home sales up 32 per cent in a turnover of £36 million and pre-tax profit was nearly £6 million.

The electronics content of record aerospace exports (£904 million in 1978) has risen dramatically. The category of airborne radio, navigation and radar aids exports shot up to over £15 million and instruments to almost £40 million. Plessey Electronic Systems has an export order book of over £130 million. The BAC Rapier Missile Systems export order book has now topped £600 million. The add-on radar units for Rapier are built by Marconi and feed millions into the electronics industry.

If only all manufacturing industry did as well, or is that asking too much?

LIKE JEWELLERY — BUT DEARER
I have often commented on semiconductor prices tumbling so that simple items like transistors and diodes are two a penny—or almost. But move up to the quality end of the market and look at the prices. I see from H-P some new Schottky diodes at £17.89 each in lots of 10–100 and if you want a low-noise microwave transistor you can pay as much as £97.56 each for a 1–100 but value metalised, gold metallising thrown in.
ENERGY CONVERTER BP 1 458 702

In BP 1 458 702, Siegfried Reinhold Lehr of Munich claims a miniature device for converting mechanical to electrical energy. Although this is intended for implant into the human body it may well have other applications.

The claimed object is to provide a converter small enough to be implanted into a blood vessel or heart muscle which will produce enough power to trigger a heart pacemaker and so makes the additional implant of nuclear or storage batteries unnecessary.

The patent shows a small cobalt-samarium magnet and a soft magnetic core with yokes. An armature completes the magnetic circuit and the generator coil is wound round the soft magnetic core. The armature is secured to a spring steel membrane surrounded by a corrugated support.

The spring and corrugation force constant are balanced with respect to the magnetic force, so that when the ambient pressure around the device increases, for instance due to contraction of a muscle in which it is implanted, the membrane and armature move closer to the yokes and snap-latch. This stores energy in the corrugations. When the ambient pressure falls, as for instance when the muscle relaxes, the spring force exceeds the magnetic force and the membrane jumps back into its rest position, inducing an e.m.f. in the coil as it does so.

It is claimed that because most of the energy available from the pressure change is converted instantly when the armature jumps, simple diode rectification, with half the voltage drop compared to full wave rectification, can be employed. The rectified output may be led direct to a pacemaker, which actsuates a stimulating tip via another core of the same cable which connects the generator to the pacemaker.

SURROUND SOUND

Two patents, BP 1 348 643 (taken out a few years ago) and more recently BP 1 454 894, for an interestingly different approach to the derivation of 4-channel surround sound from a 2-channel stereo amplifier are held by EMI.

The conventional approach is to use an extra pair of loudspeakers connected in so-called Hafler fashion, to reproduce the difference signal between left and right at the rear. For the Hafler system, the extra rear loudspeakers are of conventional type; the EMI proposal is to use modified loudspeakers at the rear.

Each of the two extra rear loudspeakers has not one but two voice coils, operable on the same cone. The two coils of each loudspeaker are dissimilar in impedance and are wound in opposite senses. The coil windings and their connection to a stereo amplifier are shown in detail in Fig. 1 and in simplified equivalent form in Fig. 2.

Voice coils 3 and 6 are connected in series to the left channel output of the stereo amplifier and coils 4 and 5 in series to the right channel output. Coils 3 and 5 have 5 ohm impedance and coils 4 and 6 have 11 ohm, to give an impedance ratio of 2:1. Coil 3 operates in opposite sense to coil 4, and coil 5 operates in opposite sense to coil 6.

As a result of this combination, rear right loudspeaker reproduces sound representing a proportion of the left channel output subtracted from a proportion of the right channel output, rear left loudspeaker reproduces sound representing a proportion of the right channel output subtracted from a proportion of the left channel output. The front left and front right outputs are unaffected.

IN BRIEF

BP 1 451 090—Nippon Gakki Seizo KK: Audio Power Amplifier. Circuit for an audio amplifier, including a power stage and a driver stage, with the driver stage bias switchable between three settings, to provide a choice of A, B or AB class operation.

BP 1 456 541—Greenwood Mills: Colour Measuring Spectrophotometer. A digital spectrophotometer intended to enable the colour of a cloth or material to be scientifically analysed and recorded.

Several different photosensitive "eyes" are used, each with a different sensitivity to different colours. The outputs of their devices are registered and a definitive analysis of the object's colour derived from a comparison.
15-240 WATTS!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuit merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. Power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack, multi-function equalisation, low noise, low distortion, high overload, audio equalisation for stereo

APPLICATIONS: hi-fi, mixers, discos, guitar and organ; public address

SPECIFICATION: Input: high level magnetic pickup 3mV, ceramic pickup 3mV, tuner 100mV microph. 10mV, auxiliary 30-100mV; Output: tape 100mV, main output 500mV R.M.S. Active Tone Controls: treble ±12dB at 1kHz, bass ±12dB at 100Hz. Distortion: 0.1% at 1kHz, signal/noise ratio 98dB. Overload: ±3dB on magnetic pick-up. Supply Voltage: ±15-30V

Price £5.22 + 65p VAT. P. & P. free

HY5 mounting board B.1 48p + 6p VAT. P. & P. free

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust high fidelity modules in the world.

FEATURES: low distortion, integral heatsink: only five connections, 7 amp output transistors, no external components.

APPLICATIONS: medium power hi-fi systems, low power disco, guitar amplifier.

SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8Ω. Load Impedance—4-16Ω. Distortion—0.04% at 25W at 1kHz. Signal/Noise Ratio—95dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage—±25V. Size—105 x 50 x 25mm.

Price £5.22 + 65p VAT. P. & P. free

TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

I.L.P. Electronics Ltd., Crossland House, Nackington, Canterbury, Kent CT4 7AD
Tel (0227) 63218

Registered office No. 1032630

Please supply

Total Purchase price

I Enclose: Cheque ❑ Postal Orders ❑ Money Order ❑
Please debit my Access account ❑ Barclaycard account ❑

Account number

Name and Address

Signature
BEFORE YOU BUY AN AMPLIFIER MODULE—CHECK:

DOES IT HAVE

* 30A power transistors
* Glass fibre P.C.B
* 3A drivers (100W unit)
* Integral output capacitor

Then compare with the Tamba range—excellent value—25, 50 and 100W R.M.S.

TAM1000 100W 4 ohms 65V £9.80
TAM500 50W 4 ohms 45V £7.50
TAM250 25W 8 ohms 45V £4.75

POWER SUPPLIES
For 1 or 2 TAM250/500 £7.50
For 1 or 2 TAM1000 £9.80
(Carriage 50p on supplies)

- Suits loads 4-16 ohms
- 20-20,000 Hz ±1dB
- Silicon circuitry throughout
- Glass fibre P.C.B
- High sensitivity (100mV 10k)

High grade components used throughout: Texas, Mullard, R.C.A., Plessey, etc.

Low distortion (0.1%)
Low profile (1in high & 3in x 3in)
75% efficient
Accepts most mixer/pre-amplifiers
Four simple connections

Use up to 10 PRE-AMPS with 1 power

You may order as follows: C.W.O. (crossed cheques, P.O.s, M.O.s etc)—C.O.D. (60p extra). We accept Access and Barclaycard—send or telephone your number—do not send your card. Add VAT at 8% to orders for 50 and 100W units and at 12½% for 25W units.

A MINIATURE POWER TOOL
to speed your building

- Super 30 Kit (30 Tools) (incl. drill without stand) £17.62 plus P. & P. 85p
- Mk. II Drill Stand £4.40 plus P. & P. 35p
- Mk. II Drill only £6.79 plus P. & P. 35p
- Flexible Drive Shaft £5.46 plus P. & P. 25p
- Transformer 240V a.c./12V d.c. £6 plus P. & P. 70p
- Variable Speed Transformer £8.25 plus P. & P. 70p

Replacement drills, stones, burrs, etc. 40p each. Circular saw blades 50p each. £2 per set of 4 sizes. P. & P. any quantity 20p.

All VAT inclusive

PRECISION PETITE LTD.
119a High Street, Teddington, Middlesex TW11 8HG
Tel. 01-977 0878 (24-hour answering service)

4-STATION INTERCOM

£18.95 + VAT £1.99

Solve your communications problems with this 4-Station Transistor Intercom system (1 master and 3 subs), in robust plastic cabinets for desk or wall mounting. Unlimited listeners from master to sub and subs to master. Ideally suited for business, surgery, schools, hospitals, office and home. Operates on one 9V battery, on/off switch, volume control. Complete with 3 connecting wires each 60ft and other accessories. P. & P. 90p.

MAINS INTERCOM NEW MODEL


NEW AMERICAN TYPE CRADLE TELEPHONE AMPLIFIER

£13.95 + VAT £1.32

Latest transistorised Telephone Amplifier with detachable plug-in speaker. Placing the receiver onto the cradle activates omni switch for immediate two-way conversation without holding the handset. Many people can listen at the same time. Increase efficiency in office, shop, workshop. Perfect for "conference" calls: leaves the user's hands free to make notes, consult files. No long waiting, saves time with long-distance calls. Volume, Direct tape recording model at £16.95 + VAT £1.92 P. & P. 73p. 10-day price refund guarantee.

WEST LONDON DIRECT SUPPLIES (PE5)
169 KENSINGTON HIGH STREET, LONDON, W.8

TAMBA ELECTRONICS
Bensham Manor Road Passage, Bensham Manor Road, Thornton Heath, Surrey.
Consider the following information for the new catalog:

**TOP 400 SEMICONDUCTORS FROM THE LARGEST RANGE IN THE U.K.**

"SEE US AT THE ALL ELECTRONIC SHOW GROSVENOR HOUSE 19-21 APRIL"

- **SN74013**
- **SN7410**
- **SN7405**
- **2N2219A**
- **2N2218A**
- **2N4060**
- **2N3823**
- **BC149**
- **BC1430-30**
- **BC140**
- **BC116A**
- **BC116**
- **AF125**
- **SN7475**
- **SN74151**
- **SN74141**
- **SN74100**
- **SN74199**

**INTEGRATED CIRCUITS**

- **CA3001**
- **CA3002**
- **CA3003**
- **CA3004**
- **CA3005**
- **CA3006**
- **CA3007**
- **CA3008**
- **CA3009**
- **CA3010**

**BRIDGES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR01</td>
<td>40p</td>
</tr>
</tbody>
</table>

**DISPLAYS**

<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20p</td>
<td>Segment</td>
</tr>
<tr>
<td>24p</td>
<td>Character</td>
</tr>
</tbody>
</table>

**SEE MARSHALL'S FOR CMOS**

**CLOCK MODULES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td></td>
</tr>
</tbody>
</table>

**POLYMER**

- **BFS980**
- **BFY52**
- **BFX89**

**ACCESSORIES**

- **MA1002**
- **TBA5400**
- **TBA5402**
- **TBA400**
- **TAA930A**

**MICROPROCESSOR SYSTEM**

**SC/MM**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC/MM</td>
<td></td>
</tr>
</tbody>
</table>

**SWITCHES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
</tr>
</tbody>
</table>

**POTENTIOMETERS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NEW CATALOGUE 77**

168 page catalogue with new lines. 55p post paid (40p to callers)
INTERNATIONAL ELECTRONICS UNLIMITED

P.E. JOANNA
ELECTRONIC PIANO

ALL PARTS CAN BE SUPPLIED
Keyboard, Keyswitch, P.C.B.s, Hardware, Semiconductors, Resistors, Capacitors, Cabinets Complete kits or easy stages
Send S.A.E. for details

Clef Products
31 Mountfield Road
Bramhall, Stockport, Cheshire SK7 1LY

THE OPEN DOOR TO QUALITY

4th ISSUE INCLUDES NEW METERS
as well as new switches and items from advanced opto-electronics to humble (but essential) washers. Many things listed are very difficult to obtain elsewhere. The company’s own computer is programmed to expedite delivery and maintain customer satisfaction. Attractive discounts continue on many purchases; Access and Barclaycard orders are accepted.

SEMI-CONDUCTORS • COMPONENTS • ACCESSORIES, ETC.
* FREE POSTAGE on all C.W.O. mail orders over £2 list value (excluding VAT) in U.K. If under, add 15p handling charge

Mail Order Protection Scheme
The Publishers of Practical Electronics are members of the Periodical Publishers Association which has given an undertaking to the Director General of Fair Trading to refund monies sent by readers in response to mail order advertisements, placed by mail order traders, who fail to supply goods or refund monies owing to liquidation or bankruptcy. This arrangement does not apply to any failure to supply goods advertised in a catalogue or in a direct mail solicitation.

Mail Order Protection Scheme
The Publishers of Practical Electronics are members of the Periodical Publishers Association which has given an undertaking to the Director General of Fair Trading to refund monies sent by readers in response to mail order advertisements, placed by mail order traders, who fail to supply goods or refund monies owing to liquidation or bankruptcy. This arrangement does not apply to any failure to supply goods advertised in a catalogue or in a direct mail solicitation.

THE MAIL ORDER TRADE - THROUGH THE MOUTH OF TRADING ECONOMICS

Mail Order Protection Scheme
The Publishers of Practical Electronics are members of the Periodical Publishers Association which has given an undertaking to the Director General of Fair Trading to refund monies sent by readers in response to mail order advertisements, placed by mail order traders, who fail to supply goods or refund monies owing to liquidation or bankruptcy. This arrangement does not apply to any failure to supply goods advertised in a catalogue or in a direct mail solicitation.

THE MAIL ORDER TRADE - THROUGH THE MOUTH OF TRADING ECONOMICS

Mail Order Protection Scheme
The Publishers of Practical Electronics are members of the Periodical Publishers Association which has given an undertaking to the Director General of Fair Trading to refund monies sent by readers in response to mail order advertisements, placed by mail order traders, who fail to supply goods or refund monies owing to liquidation or bankruptcy. This arrangement does not apply to any failure to supply goods advertised in a catalogue or in a direct mail solicitation.
BETTER JOB WITH MORE PAY!

Do you want a promotion, a better job higher pay? "New opportunities" shows you how to get them through a low-cost home study course. There are no books to buy and you can pay as you learn.

CHOOSE A BRAND NEW FUTURE HERE

CUT OUT THIS COUPON

Tick or state subject of interest. Post to address below.

- ELECTRICAL & ELECTRONICS
  - Practical Radio & Electronics (with kit)
  - Electronic Engineering Certificate
  - General Elect. Eng. Certificate
  - C. & G. Elect. Installations
  - Elect. Install. & Work
  - C. & G. Elect. Technicians

- RADIO & TELECOMMUNICATIONS
  - Colour TV Servicing
  - C. & G. Telecoms. Technician's Cert.
  - Radio & TV Engineering Course
  - Radio, Servicing & Repairs
  - Radio Amateur's Exam

- AUTO & AERO
  - Motor Mechanics
  - C. & G. Motor V. Mechanics
  - General Auto Engineering
  - A.M.I.M.I.

- MECHANICAL
  - A.M.S.E. (Mech.)
  - Inst. Engineers & Technicians
  - Maintenance Engineering
  - Welding

- MANAGEMENT & PRODUCTION
  - Computer Programming
  - Inst. of Cost & Managements Accts.

- DRAUGHTSMANSHIP & DESIGN
  - General Draughtsmanship
  - A.M.I.E.D.
  - Electrical Draughtsmanship

Air Registration Board Certificate
MAA/IMI Dip.
CONSTRUCTIONAL Heating Ventilating & Air Conditioning
Architectural Draughtsmanship & Design
C.I.O.B.
Carpentry & Joinery
Plumbing Technology
General Building
Painting & Decorating

- G.C.E.
  - 58 'O' & 'A' Level Subjects
  - over 10,000 Group 'Passes!'

Aldermaston College
Dept. TPE 22, Reading RG7 4PF

Tick or state subject of interest. Post to address below.

- ELECTRICAL & ELECTRONICS
  - Practical Radio & Electronics (with kit)
  - Electronic Engineering Certificate
  - General Elect. Eng. Certificate
  - C. & G. Elect. Installations
  - Elect. Install. & Work
  - C. & G. Elect. Technicians

- RADIO & TELECOMMUNICATIONS
  - Colour TV Servicing
  - C. & G. Telecoms. Technician's Cert.
  - Radio & TV Engineering Course
  - Radio, Servicing & Repairs
  - Radio Amateur's Exam

- AUTO & AERO
  - Motor Mechanics
  - C. & G. Motor V. Mechanics
  - General Auto Engineering
  - A.M.I.M.I.

- MECHANICAL
  - A.M.S.E. (Mech.)
  - Inst. Engineers & Technicians
  - Maintenance Engineering
  - Welding

- MANAGEMENT & PRODUCTION
  - Computer Programming
  - Inst. of Cost & Managements Accts.

- DRAUGHTSMANSHIP & DESIGN
  - General Draughtsmanship
  - A.M.I.E.D.
  - Electrical Draughtsmanship

Air Registration Board Certificate
MAA/IMI Dip.
CONSTRUCTIONAL Heating Ventilating & Air Conditioning
Architectural Draughtsmanship & Design
C.I.O.B.
Carpentry & Joinery
Plumbing Technology
General Building
Painting & Decorating

G.C.E.

- 58 'O' & 'A' Level Subjects
- over 10,000 Group 'Passes!'

Aldermaston College
Dept. TPE 22, Reading RG7 4PF
also at our London Advisory Office, 4 Fore Street Avenue, Moorigate, London EC2Y 5JL. Tel. 01-618-2721.

NAME (Block Capitalis)
ADDRESS

Age

POST NOW

HOME OF BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER

- 4 Transistor Expande Radio
- Signal Tracer
- Signal Injector
- Transistor Tester N.P.T.
- 4 Transistor Push Pull Amplifier

- 5 Transistor Push Pull Amplifier
- 5 Transistor Locamper Speaker Radio MW/LW
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator

- 24 Resistors
- 24 Capacitors
- 10 Transistors
- 2 x 3 Loudspeaker
- Earpieces
- Mica
- PCB
- R.O.S. Wire 30 yards
- 1 yard of sleeving, etc.

Complete kit of parts including construction plans.

Total building costs £6.55 P.P. and Ins. 60p.

EDU-KIT JUNIOR

Completely Soldered Electronic Construction Kit. Build these projects without Soldering Iron or Solder.

- Crystal Radio Short Wave Coverage—No Battery necessary

- One Transistor Radio

- 2 Transistor Regenerative Radio

- 2 Transistor Expande Radio Medium Wave Coverage

- 4 Transistor Medium Wave Loudspeaker Radio

- Electronic Noise Generator

- Electronic Metronome

- 4 Transistor Push/Pull Amplifier

All parts including loudspeaker, etc. including construction plans.

Total building costs £4.95 P.P. and Ins. 60p.

V.H.F. AIR CONVERTER KIT

Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to Medium Wave. Use a retractable chrome plated telescopic aerial, gain control, V.H.F. tuning capacitor, etc. Operates from a 9 volt P.P. battery (not ready wound ferrite rod aerial, V.H.F. tuned capacitor, resistors, gain control, and rotary switch. 7 Short Wave Bands. Receiver Kit.

- 3 Transistors
- 6 tuneable wavebands, MW, LW, Trawler Band.
- Complete kit of parts 17.05 P.P. and Ins.
- Supercap sensitive ferrite rod aerial. Attractive black and white gold case. Building Costs: £3.60 P.P. and Ins.
- 3 Knobs
- Ready Wound MW/LW/SW Coils
- 61 yards of wire
- 1 yard of sleeving, etc.

Complete kit of parts including construction plans.

Total building costs £9.00 P.P. and Ins. 85p.

POCKET FIVE

Now with 3in Loudspeaker. 3 tuneable wave bands, MW, LW and Trawler Band. 7 stages, 3 transistors and 2 diodes, supercap sensitive ferrite rod aerial, Alternate black and gold case. Size 5in x 11in x 3in in approx.

Complete kit of parts including construction plans.

Total building costs £3.60 P.P. and Ins. 60p.

ELECTRONIC CONSTRUCTION KITS

E.C.K. 2 Self contained Multi-Band V.H.F. Receiver Kit.

- 8 transistors and 3 diodes. Push pull output.
- 3in Loudspeaker, gain control, superb 9 section chrome plated telescopic aerial. V.H.F. Tuning Capacitor, Resistors, Transistors, etc.
- Will receive T.V. Sound, Public Service Band, Aircraft, R.V.S. Stations, etc. and Multiband A.M. section with Awsomed Slow Motion Drive Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands SW1, SW2, SW3, Tuned Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc. Chrome Plated Traction Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push Pull output using 600mW Transistors. Gain, Wave Change and Tone Controls. Plus two Slider Switches. Negative Feedback circuit and SPECIAL POWER BOOSTER SOCKET AND RESISTOR, to virtually double gain if required. Powered by P.P.9—9 volt batteries.

Complete kit of parts including carrying strap. Building Instructions and Operating Manuals. £13.99 Inc. P.P. and Ins.

E.C.K. 4

- 7 Transistors, 8 tuneable wavebands, MW, LW, Trawler Band.
- 3 Short Wave Bands Receiver Kit.

With 5in x 3in loudspeaker. Push pull output stage, gain control, and rotary switch. 7 transistors and 4 diodes. 9 section chrome plated telescopic aerial. Super sensitive radio tuned ferrite rod aerial, tuning capacitor, Resistors, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit).

Complete kit of parts £7.95 P.P. and Ins. 70p.

NEW ROAMER TEN MODEL R.K. 3

MULTIBAND V.H.F. AND A.M. RECEIVER.

13 Transistors and Five Diodes. QUALITY 5" LOUDSPEAKERS.

WITH Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Aarspeed Slow Motion Drive Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands SW1, SW2, SW3, Tuned Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc. Chrome Plated Traction Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push Pull output using 600mW Transistors. Gain, Wave Change and Tone Controls. Plus two Slider Switches. Negative Feedback circuit and SPECIAL POWER BOOSTER SOCKET AND RESISTOR, to virtually double gain if required. Powered by P.P.9—9 volt batteries.

Complete kit of parts including carrying strap. Building Instructions and Operating Manuals.


NEW EVERYDAY SERIES

Build this exciting new series of designs.

E.V.5. 5 Transistors.

- 5 Transistors
- 3 diodes MW/LW. Powered by 41V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in loudspeaker. Attractive case with red speaker grille. Size 5in x 3in x 2in approx. All parts including Case and Plans.

Total building costs £4.30 P.P. and Ins. 60p.

E.V.6. Case and looks as above. 6 Transistors

- 3 diodes
- Powered by 7V battery. Ferrite rod aerial, 3in loudspeaker, etc. MW/LW coverage. Push/Pull output.

Complete kit of parts including Case and Plans.

Total building costs £4.95 P.P. and Ins. 60p.

E.V.7. Case and looks as above. 7 Transistors and 3 diodes

- Six wavebands, MW/LW, Trawler Band MW1, MW2, SW3, Powered by 7V battery. Push pull output. Telescopic aerial for short waves. 3in Loudspeaker.

All parts including Case and Plans.

Total building costs £6.95 P.P. and Ins. 70p.

To: RADIO EXCHANGE LTD. 61A High Street
Bedford MK40 1SA
Tel: 0234 528797 RGO No. 7928272

Callers side entrance "Lavelle" Shop.
Open 10-1, 2-3 Mon- Fri 9-12 Sat.
1 Enclose £10 for

New

Address
240v-50Hz from your 12v car battery
25 watt - £4 75
50 watt - £8 27
100 watt - £12 03
150 watt - £12 27
300 watt (12v) - £33 03
5kW (110v) - £140 80

All above inverters are in kit form but may be purchased built up in metal case and ready for use. Price list sent on receipt of s.a.e. Prices include post & packing.

P.W. AUTOMATIC EMERGENCY SUPPLY

240v-50Hz-150 watt inverter built in battery charger. In event of power failure switches over automatically from battery charging to inverter operation. Ct. as appeared in Dec. 72 P.W Complete kit of parts (excluding meters) £24 50 + £1 70 p & p.

DIGITAL WATCH

L.E.D. display giving hours, minutes, seconds and date. Design based on American technology, and fantastic value at £16 + 30p p. & p.

One year guarantee.

TRANSFORMERS & COILS

Both high volume & small order capacity available. Special offer. Miniature mains transformer 60-6v-6V A - £49 plus 10p p. & p. TRADE & EXPORT ENQUIRES WELCOMED

20 + 20 Watts r.m.s. into 8 ohm load. Distortion less than 0.01% 100Hz-10KHz. Frequency response = 1dB 20 Hz to 20 kHz. Hum level virtually nil with volume full on.

This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc, tape, tuner, etc.

Complete kit of parts including slim line bookend case, silk screened front panel & knobs. £47.30 incl. VAT & p. & p.

The bookend case. IC's & semiconductors, P.C. board, Transformer, etc. may be purchased separately if desired. Send S.A.E. for further information.

P.E. ORION TUNER

Full kit of parts for this superb tuner unit to compliment the now well established amplifier. Parts may also be purchased separately. Send S.A.E.

ASTRO IGNITION SYSTEM

Complete kit of parts for this proven and tested system £18.45 incl. VAT. Ready built with only two connections to alter £13.75 incl. VAT. Thousands have used this system both home and abroad. Consider these advantages more power, faster acceleration, fuel economy, excellent cold starting, smoother running, no contact breaker burning. Also because of the high energy spark, the fuel mixture can be made weaker giving further economy and fewer plug problems. Fitting time when built 5 minutes approx. Please state whether positive or negative earth. Trade and export enquiries welcomed.

Astro Electronics

Spring Bank Road, West Park
Chesterfield.

WHAT IS IT?

1977 Casio Casiotron Watches
8 functions and backlight
Stopwatch. Dual time zones

Arguably the best watches in the world— at any price. Certainly the most versatile.

R15A (R.R.P. £75.95) £58.50
S16B (R.R.P. £89.95) £68.50
S15B (R.R.P. £99.95 Illustrated) £78.50
Other Casiotron watches from £38.50

IT'S-
A QUARTZ DIGITAL CLOCK
Hr. Min. AM/PM Day. Date
AN ALARM CLOCK
4 Alarm Memories
A STOPWATCH
To 5 hrs., 59 mins., 59.9 secs.
A CALCULATOR
Time and date calculations
ANOTHER WORLD FIRST FROM CASIO

THE CO-1
ONLY £19 95 (R.R.P £35 95)

NEW

CASEL ELECTRONICS

New 1977 Casio Casiotron Watches
8 functions and backlight
Stopwatch. Dual time zones

Arguably the best watches in the world— at any price. Certainly the most versatile.

R15A (R.R.P. £75.95) £58.50
S16B (R.R.P. £89.95) £68.50
S15B (R.R.P. £99.95 Illustrated) £78.50
Other Casiotron watches from £38.50

New 1977 Casio Casiotron Watches
8 functions and backlight
Stopwatch. Dual time zones

Arguably the best watches in the world— at any price. Certainly the most versatile.

R15A (R.R.P. £75.95) £58.50
S16B (R.R.P. £89.95) £68.50
S15B (R.R.P. £99.95 Illustrated) £78.50
Other Casiotron watches from £38.50

Tempus

DEPT. PE, 15-21 FITZROY STREET
CAMBRIDGE CB1 1EH. TEL: 0223 312866

Fairchild Timeband L.C.D.A.
Battery Watch for Self-Change
Free Replacement Battery
Lower prices—Higher quality
5 + 4 functions Round watch on strap
5 + 4 functions Illustrated
TC413. Chrome £31.00. TC412. Gold £33.95.

New Timeband Digital Alarm Clock with snooze button £14.95
Send £5 for our ILLUSTRATED CATALOGUE. Probably the WIDEST RANGE of the B E T watches at the LOWEST prices. Accurate. Inco.
National Semiconductor. Optim. SEIKO. Texas, etc. Also LADIES Watches.

240v-50Hz-150 watt inverter built in battery charger. In event of power failure switches over automatically from battery charging to inverter operation. Ct. as appeared in Dec. 72 P.W Complete kit of parts (excluding meters) £24 50 + £1 70 p & p.

DIGITAL WATCH

L.E.D. display giving hours, minutes, seconds and date. Design based on American technology, and fantastic value at £16 + 30p p. & p.

One year guarantee.

TRANSFORMERS & COILS

Both high volume & small order capacity available. Special offer. Miniature mains transformer 60-6v-6V A - £49 plus 10p p. & p. TRADE & EXPORT ENQUIRES WELCOMED

20 + 20 Watts r.m.s. into 8 ohm load. Distortion less than 0.01% 100Hz-10KHz. Frequency response = 1dB 20 Hz to 20 kHz. Hum level virtually nil with volume full on.

This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc, tape, tuner, etc.

Complete kit of parts including slim line bookend case, silk screened front panel & knobs. £47.30 incl. VAT & p. & p.

The bookend case. IC's & semiconductors, P.C. board, Transformer, etc. may be purchased separately if desired. Send S.A.E. for further information.

P.E. ORION TUNER

Full kit of parts for this superb tuner unit to compliment the now well established amplifier. Parts may also be purchased separately. Send S.A.E.

ASTRO IGNITION SYSTEM

Complete kit of parts for this proven and tested system £18.45 incl. VAT. Ready built with only two connections to alter £13.75 incl. VAT. Thousands have used this system both home and abroad. Consider these advantages more power, faster acceleration, fuel economy, excellent cold starting, smoother running, no contact breaker burning. Also because of the high energy spark, the fuel mixture can be made weaker giving further economy and fewer plug problems. Fitting time when built 5 minutes approx. Please state whether positive or negative earth. Trade and export enquiries welcomed.

Astro Electronics

Spring Bank Road, West Park
Chesterfield.

TECHNICAL TRAINING IN ELECTRONICS AND TELECOMMUNICATIONS

ICS can provide the technical knowledge that is so essential to your success, knowledge that will enable you to take advantage of the many opportunities open to trained people. You study in your own home, in your own time and at your own pace and if you are studying for an examination ICS guarantee coaching until you are successful.

City & Guilds Certificates:
Telecommunications Technicians
Radio, TV, Electronics Technicians
Technical Communications
Radio Servicing Theory
Radio Amateurs
Electrical Installation Work
MPT Radio Communications Certificate

Diploma Courses:
Colour TV Servicing
Electronic Engineering and Maintenance
Computer Engineering and Programming
Radio, TV, Audio Engineering and Servicing
Electrical Engineering, Installation and Contracting

POST OR PHONE TODAY FOR FREE BOOKLET

To: International Correspondence Schools

ICS

Dept. 771F Interess House, London
SW4 4UJ or telephone 01-622 9911

Subject of Interest

Name

Address
The famous Home Radio Components catalogue comprises 200 pages, listing about 5,000 items, nearly 2,000 of them illustrated. Everything is set out so clearly and concisely that the catalogue is a pleasure to use. When you buy one we also send you a free mini catalogue filled with extra special bargains. The saving on some purchases from this bargain list alone can more than cover post. Everything is set out so clearly and concisely that the catalogue customers are proving the advantages of joining the Home Radio Credit Scheme. Whichever method you opt for you'll need a Home Radio catalogue. Read all about it in the paragraph below.

Forgive the terrible puns. If you don't quite twig 'em just have a look. If you don't quite twig 'em just have a look.

Op-Amp Circuit design and application by J. Carr

UNDERSTANDING MICROPROCESSORS by Motorola

RADIO COMMUNICATION HANDBOOK Vol. I by R. G. B.

HI FI YEAR BOOK 1977

MASTER ELECTRONICS IN MUSIC by T. D. Towers

110 ELECTRONIC ALARM PROJECTS FOR THE HOME CONSTRUCTOR by R. M. Marston

BUILD YOUR OWN WORKING ELECTRONIC GADGETS by R. S. G. B.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST of British and American Technical Books

Op-Amp Circuit design and application by J. Carr

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST of British and American Technical Books

The practical electronics you may be creating. Thousands of constructors have proved that they get good advice, good components, good value, good service from Home Radio. Many buy over the counter at Mitcham, many purchase by Mail Order, sending a cheque or P.O. for £1-40 now. The catalogue and bargain list will come to you by return post.

Op-Amp Circuit design and application by J. Carr

UNDERSTANDING MICROPROCESSORS by Motorola

RADIO COMMUNICATION HANDBOOK Vol. I by R. G. B.

HI FI YEAR BOOK 1977

MASTER ELECTRONICS IN MUSIC by T. D. Towers

110 ELECTRONIC ALARM PROJECTS FOR THE HOME CONSTRUCTOR by R. M. Marston

BUILD YOUR OWN WORKING ELECTRONIC GADGETS by R. S. G. B.
SMALL ADS

The prepaid rate for classified advertisements is 15 pence per word (minimum 12 words), box number 40 p extra. Semi-display setting £12.00 per single column inch (2.5cm). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with balance, must be sent to the Classified Advertisement Manager, Practical Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St. London, SE1 9LS. (Telephone 01-261 5918).

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and are not transferable without the written consent of the British Code of Advertising Practice.

2. The publishers reserve the right to refuse or withdraw any advertisements.

3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

RECEIVERS AND COMPONENTS
BRAND NEW COMPONENTS BY RETURN

<table>
<thead>
<tr>
<th>Company</th>
<th>Part Number</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEL2</td>
<td>Type</td>
<td>Carbon film Mal</td>
<td>0.68p</td>
</tr>
<tr>
<td>AC126/C/294</td>
<td>480</td>
<td>Resistor</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC107/8/9</td>
<td>900</td>
<td>Polypropylene film</td>
<td>0.15p</td>
</tr>
<tr>
<td>BC175/7/8</td>
<td>900</td>
<td>polyester, electrolytics</td>
<td>0.68p</td>
</tr>
<tr>
<td>BC177/9</td>
<td>100</td>
<td>plastic</td>
<td>0.5p</td>
</tr>
<tr>
<td>BC282/4/2</td>
<td>500</td>
<td>Carbon film</td>
<td>0.68p</td>
</tr>
<tr>
<td>BC386/7</td>
<td>800</td>
<td>polyester, electrolytics</td>
<td>0.33p</td>
</tr>
<tr>
<td>BC487/8</td>
<td>900</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC147/8/9</td>
<td>100</td>
<td>polyester, electrolytics</td>
<td>0.25p</td>
</tr>
<tr>
<td>BC155/6/7</td>
<td>120</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC157/8/9</td>
<td>130</td>
<td>polyester, electrolytics</td>
<td>0.25p</td>
</tr>
<tr>
<td>BC160/1/2</td>
<td>140</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC161/1/2</td>
<td>200</td>
<td>polyester, electrolytics</td>
<td>0.25p</td>
</tr>
<tr>
<td>BC163/1/2</td>
<td>250</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
</tbody>
</table>

R. T. SERVICES

MAIL ORDER ONLY

75 Hayford Rd., Salford 6, Lancs.
BRAND NEW S'S P.C. BOARD, 85x, x 72.5mm

<table>
<thead>
<tr>
<th>Panel</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>2.2p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>2.0p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>1.8p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>1.6p</td>
</tr>
</tbody>
</table>

Mains input transformers 20V/20V, 30V/30V, 40V/40V

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 115v at 1amp</td>
<td>0.45p</td>
</tr>
<tr>
<td>1 x 12v at a amp</td>
<td>0.45p</td>
</tr>
</tbody>
</table>

All prices include VAT and P. & P.

Tel. 061-236 1541

All prices include VAT and P. & P.

LED'S

Mixed bags of 4 different sizes and 4 different colours. 50. £25; 100, £25, including VAT and post and packing. C. M. DEAN, 88-92 PRESTON ROADS, BLACKPOOL, LANCASHIRE.

SMALL ADS

The prepaid rate for classified advertisements is 15 pence per word (minimum 12 words), box number 40 p extra. Semi-display setting £12.00 per single column inch (2.5cm). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with balance, must be sent to the Classified Advertisement Manager, Practical Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St. London, SE1 9LS. (Telephone 01-261 5918).

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and are not transferable without the written consent of the British Code of Advertising Practice.

2. The publishers reserve the right to refuse or withdraw any advertisements.

3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

RECEIVERS AND COMPONENTS

BRAND NEW COMPONENTS BY RETURN

<table>
<thead>
<tr>
<th>Company</th>
<th>Part Number</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEL2</td>
<td>Type</td>
<td>Carbon film Mal</td>
<td>0.68p</td>
</tr>
<tr>
<td>AC126/C/294</td>
<td>480</td>
<td>Resistor</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC107/8/9</td>
<td>900</td>
<td>Polypropylene film</td>
<td>0.15p</td>
</tr>
<tr>
<td>BC175/7/8</td>
<td>900</td>
<td>polyester, electrolytics</td>
<td>0.68p</td>
</tr>
<tr>
<td>BC177/9</td>
<td>100</td>
<td>polyester, electrolytics</td>
<td>0.68p</td>
</tr>
<tr>
<td>BC282/4/2</td>
<td>500</td>
<td>Carbon film</td>
<td>0.68p</td>
</tr>
<tr>
<td>BC386/7</td>
<td>800</td>
<td>polyester, electrolytics</td>
<td>0.33p</td>
</tr>
<tr>
<td>BC487/8</td>
<td>900</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC147/8/9</td>
<td>100</td>
<td>polyester, electrolytics</td>
<td>0.25p</td>
</tr>
<tr>
<td>BC155/6/7</td>
<td>120</td>
<td>polyester, electrolytics</td>
<td>0.22p</td>
</tr>
<tr>
<td>BC157/8/9</td>
<td>130</td>
<td>polyester, electrolytics</td>
<td>0.25p</td>
</tr>
</tbody>
</table>

R. T. SERVICES

MAIL ORDER ONLY

75 Hayford Rd., Salford 6, Lancs.
BRAND NEW S'S P.C. BOARD, 85x, x 72.5mm

<table>
<thead>
<tr>
<th>Panel</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>2.2p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>2.0p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>1.8p</td>
</tr>
<tr>
<td>1 x 35055</td>
<td>transistors plus 6 N.P.N.</td>
<td>1.6p</td>
</tr>
</tbody>
</table>

Mains input transformers 20V/20V, 30V/30V, 40V/40V

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 115v at 1amp</td>
<td>0.45p</td>
</tr>
<tr>
<td>1 x 12v at a amp</td>
<td>0.45p</td>
</tr>
</tbody>
</table>

All prices include VAT and P. & P.

Tel. 061-236 1541

All prices include VAT and P. & P.
TURN YOUR SURPLUS capacitors, transistors, etc., into cash. Contact COLES-HARDING & CO., 103 South Ilfracombe, Bideford, Devon. Tel: 0945 4188. Immediate settlement.

Educational

COLOUR TV SERVICING

Learn the techniques of servicing Colour TV sets through new homestudy course approved by leading manufacturers. Covers principles, practice and alignment with numerous illustrations and diagrams. Other courses for radio and audio servicing. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. 771F, Interex House, London SW 8 4UJ
Tel. 01-622 9911 (all hours)

MICROSCOPES

{}
Printed Circuits and Hardware

Readily available supplies of Constructors’ hardware, Aluminium sheet and sections. Printed circuit boards, top quality for individual or published designs.

Prompt service.

Send 15p for catalogue.

Ramar Constructor Services
Masons Road, Stratford on Avon
Warwick.

Tel: 4079
SITUATIONS VACANT

Instrument Tradesman
Another professional for our expanding plant

Our pharmaceuticals division's new production plant, which is situated near Irvine, is now in its second phase of major expansion which will substantially increase our production capacity.

Responsible for the launch of the world's first semi-synthetic penicillin, we are now market leaders and are presently a major name in the field of antibiotics.

We are looking for an instrument tradesman (male or female) with a sound working knowledge of both electronic and pneumatic instrumentation and/or experience in the control and servicing of electronic equipment.

The factory is located in a most attractive part of Ayrshire where housing both for rent or purchase is more readily available than in other areas.

Excellent conditions of employment are offered which include:
- Highly competitive rates of pay
- Four weeks annual holiday
- Non-contributory pension scheme
- Subsidised canteen facilities
- Free life assurance
- Staff bonus after qualifying period

Written application, giving brief career details, should be made to the Personnel Department, Beecham Pharmaceuticals U.K. Division, Shewalton Road, Irvine, Ayrshire KA11 5AP.

Beecham Pharmaceuticals

RADIO TECHNICIANS
Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over.

Standards required call for a sound knowledge of the principles of electricity and radio, together with 2 years experience of using and maintaining radio and electronic test gear.

Duties cover highly skilled telecommunications/electronic work, including the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer and analytic machinery.

Qualifications: Candidates must hold either the City and Guilds Telecommunications Part I (Intermediate) Certificate or equivalent HM Forces qualifications.

Salary scale from £2,230 at 19 to £2,905 at 25 (highest pay on entry) rising to £3,385 with opportunity for advancement to higher grades up to £3,780 with a few posts carrying still higher salaries. Pay supplement of £313.20 per annum.

Annual leave allowance is 4 weeks rising to 6 weeks after 27 years service.

Opportunities for service overseas.

Candidates must be UK residents.

Further particulars and application forms available from:
Recruitment Officer, Government Communications Headquarters
Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ
Tel.: Cheltenham (0242) 21491 (Ext. 2270)

COURSES
LINCOLNSHIRE
GAINSBOROUGH COLLEGE OF FURTHER EDUCATION
RADIO, ELECTRONICS AND TELEVISION MECHANICS COURSE
Full time course leading to City and Guilds Certificates suitable for those wishing to prepare for a career in radio and television servicing and maintenance of electronic equipment.

Courses start in September. Full details from:
GAINSBOROUGH COLLEGE OF FURTHER EDUCATION
Morton Terrace, Gainsborough, DN21 2SU
Telephone (0472) 2942

ELECTRICAL
STYLUS, CARTRIDGES AND AUDIO LEADS, etc. For the best at keenest prices send S.A.E. for free illustrated list to: FEISTEAD ELECTRONICS (PE), Longley Lane, Gatley, Cheadle, Cheshire, SK8 4EE.

WANTED
WANTED, NEW VALVES, TRANSISTORS, top prices, popular types—KENSINGTON SUPPLIES (10), 267 Remington Street, Bradford 8, Yorkshire.

LADDERS

FOR SALE
NEW ISSUES of "Practical Electronics" available from April 1974 edition up to date. Price 55p each—WILL'S TELEVISION SERVICES, 190 Kings Road, Harrogate, N. Yorkshire. Tel. (0423) 55885.


VERO INSTRUMENT CASES 19in x 4in x 12in new £75. Cat. No. ICD-2U-S. Tel. 01-555 3755.

FOR SALE

Practical Electronics May 1977

399
**RELAYS**

SIEGELMANN, PLESSEY, Etc. MINIATURE RELAYS

RELAYS, WIDE RANGE OF A.C. AND D.C. RELAYS AVAILABLE from stock, phone or write in your enquiries.

**CONTACTOR**

mfg by Hendrey Relays type C3619 220/250 AC 60p.
Contact AC Or 20 amp at 440 volts AC price £6.50 P. & P. 75p.

**CITENCO**

FHP motor type C3733 15 220-240 volts AC. 19 RPM reversing, 14.5 4, gear ratio 41 1/2.

**2 WAY SELECTOR SWITCH WITH RESET COIL**
The ingenious electrolyte mechanical device can be switched up to 121 positions and can be reset from any position. The coil is the reset coil. 230/240V a.c. operation. Unit is mounted on strong chassis, complete with cover. Price £5.50. P. & P. 75p.

**NEW HEAVY DUTY SOLENOIDS**

mfg by Magnetic Devices. 240V a.c. operation. All types available at £19.50 each.

**UNISELECTOR SWITCHES**

4 bank, 25 way 75 ohm.

**MINIATURE UNISELECTOR**

211/2 way, 4 bank (nonmoulded, no housing). £2.30, p. a 15p.

**RODENE UNISET TYPE T**


**MICRO SWITCH**

M. Switch Type V15 FL 22/1C. 1D.
For £2. Post 50p. (Min. order 10)
Sub miniature Burstedt Bursten Type V.A.T. 10 for £2.50. 50p. £0.25. Price paid.

**24 VOLT DC SOLENOIDS**

UNIT containing I heavy duty solenoid approx. 25lb pull 1 inch travel. Two approx. 1b pull 1 inch travel. 6 approx. 1lb pull 1 inch travel. One 24 V D.C. miniature solenoid single make release. Price £3.00. Post £1.

**600 WATT DODDLEDGER**

Easily fitted. Fully guaranteed by makers. Price £5.00 off 600W, £8.50 off 1200W. Ex. fluorescent, mains voltage. Continental, complete with simple instructions £6.65, Post £2.75.

**CENTRIFUGAL BLOWER**

Mfg by Smiths Industries. 220-240V 2.25 AMP. 56 mm 1.5K. 24V 3.5 AMP. 30 mm 1.0K. 115V 1.0K. 35 mm 1.0K.
C.F.M. £1.75. Post 50p.
Other types available—phone for details.

**INSULATION TESTERS NEW!**

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Range 50, 250, 500, 1000, 2500, 5000 volts. £10.50, 12.50, 15.00, 19.50, 26.00, 30.00. Price £12.50. Post 50p.

**BLOWER UNIT**

200/240V a.c. precision German built. Dynamically balanced, quiet, open type bearings. Consumption 60W Size 120 mm dia. 60 mm deep.

**VARIABLE VOLTAGE TRANSFORMERS**

<table>
<thead>
<tr>
<th>INPUT 230/240V a.c.</th>
<th>50/60 OUTPUT</th>
<th>VARIABLE 0-250V</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 watt (1 amp)</td>
<td>AC voltmeter</td>
<td>£14.00</td>
</tr>
<tr>
<td>0 V KA (2 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
<tr>
<td>1 KA (2 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
<tr>
<td>2 KA (1 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
<tr>
<td>4 KA (1 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
<tr>
<td>6 KA (1 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
<tr>
<td>10 KA (2 amp) MAX</td>
<td>£14.00</td>
<td></td>
</tr>
</tbody>
</table>

**CARRIAGE AND PACKING EXTRA**

**L.T. TRANSFORMERS**


**STROBE:**

**HY-LIGHT STROBE KIT MK IV**

**INSULATION TESTERS**

|-------------------|--------------------|

**NEW HEAVY DUTY SOLENOIDS**


**NEW HEAVY DUTY SOLENOIDS**


**GEARED MOTORS**

100 rpm. 115 b. i. 110V, 50r.p.m. 2.8A, single phase, split capacitor motor. Immense pull power. Continuously rated. Total output ft.-lb. incl. line gear set. Length 250 mm. Dia. 135 mm. Spindle dia. 15.5 mm. Length 155 mm. Ex-employment clearance £15.25. Post £1.50. Suitable transformer 230/240V operation £8. Post 75p.

**DRAYTON MOTOR**

Type RQR

230/250V 50c. Continuously rated 1.6 rpm. 90 lb. in. in Reversible Motor. Two, 150 mm diameter shaft, 140mm by 125mm. Shaft 50mm by 8mm. £7.95. Post 75p. £12.00. Post 50p.

**BODIN TYPE N.C.I.**

(Price £1) for 1 inch or 2 inch reversible I/0700 h.p. 50Hz.
The robust precision made U.S.A. motor is offered in as new condition. Input voltage of motor £25. C. Supplied complete with transformer for 230/240V A.C.

**METERS NEW**

90 mm Diameter

Type: 55CS D.C. 0.5 2.5 2.5 50 250 500 1k 2.5k 5k 10k 25k 50k
£3.10 3.50 3.75 4.00 5.00 6.00 6.25 7.50 9.00 10.00 12.50 15.00

**SOCKET SWITCHES**

Similar to above approx. 10Ib pull £1.25. P. & P. 75p.

**SOLENOID**

mfg by Magna Devices. 230/240V A.C. Input. 10 amp (30V I amp), 12.50 (P. & P. 8.75). 0-12V at 20 amp or 24V 10 amp, £12.50 (P. & P. 100). 0-24V at 20 amp or 240V/1500V at 10 amp, £12.50 (P. & P. 75p). 0-6V/12V/24V at 2 amp, £12.50 (P. & P. 75p).

**SERVICE TRADING CO.**

All Mail Orders — Calls.—Ample Parking
Dept. PEI!, 57 BRIDGMAN ROAD
CHISWICK, LONDON W4 SSB
Phone 01-995 1560


Subscriptions not available at home or overseas.

Practical Electronics is sold subject to the following conditions, namely, that it shall not, without the written consent of the Publishers first given, be lent, hired out or otherwise disposed of by way of Trade or more than the recommended selling price shows on the cover, excluding Eire where the selling price is subject to V.A.T., and that it shall not be resold, or otherwise disposed of in a mutilated condition or in any unauthorised form by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

For Trade enquiries: Robert J. Thomas, 95 Avenue Road, London NW3 6XX, Phone 01-995 1560
The only organ you can build in stages and tailor to your requirements as you go along — and at each stage you'll have a fully working instrument! We haven't got the gimmicks (yet — they're coming soon), but we have got the most beautiful sounds — you won't find them on any organ less than twice our price. So get our MES50 series leaflets now! 65p buys the three available so far.

This high quality Graphic Equaliser will enhance even the most sophisticated system at a fraction of the cost of a ready-made equaliser of equal quality. You can get all the parts from us (except woodwork) including drilled and printed metalwork. Construction details in our leaflet. 50p.

We stock a wide range of switches including a really low-priced high quality interlocking push-button switch system, which is extremely versatile. We've got toggle switches, slide switches, push switches, rotary switches — there are dozens to choose from, but it's only a tiny part of our fantastic range.

A completely self-contained pedal unit. 13-note, 2-octave range. 4-organ stops. It can be added to any organ! A really unusual extra is the bass guitar stop which uses four envelope shapers to give a really bass guitar sound. A must for the solo guitarist! Full construction details in our catalogue — post the coupon below now.

A completely self-contained switch: added to any organ. A really unusual extra is the bass guitar stop which uses four envelope shapers to give a really bass guitar sound. A must for the solo guitarist! Full construction details in our catalogue — post the coupon below now.

Play fascinating games NOW on your own TV in your own living room. The kids will think it's magic when the scores pop up on the screen. Lay your bets — anyone could win with Maplin's prices everyone can win. All parts at remarkably low prices (I.C. alone £1.99). Send for our latest newsletter for details. All prices include VAT and P & P.

Our bi-monthly newsletter keeps you up to date with latest guaranteed prices — our latest special offers (they save you pounds) — details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).

IT'S A FANTASTIC BESTSELLER!
216 big (11" x 8") pages! Over a thousand illustrations!
Over 30 pages of complete projects to build!
Thousands and thousands of useful components described and illustrated! No wonder it's a bestseller!
DON'T MISS OUT! SEND 50p NOW!

POST THIS COUPON NOW FOR YOUR COPY OF OUR CATALOGUE
PRICE 50p

Please rush me a copy of your 216-page catalogue by return of post. I enclose 50p, but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 50p refunded immediately.

NAME ________________________________
ADDRESS ________________________________

MAPLIN ELECTRONIC SUPPLIES
P.O. BOX 3 RAYLEIGH ESSEX SS6 8LR
Telephone: Southend (0702) 715155
Shop: 284, London Road, Westcliff-on-Sea, Essex
©Dued on Monday Telephone Southend (0702) 47379