PRACTICAL

ELECTRONICS

MAY 1977 40p

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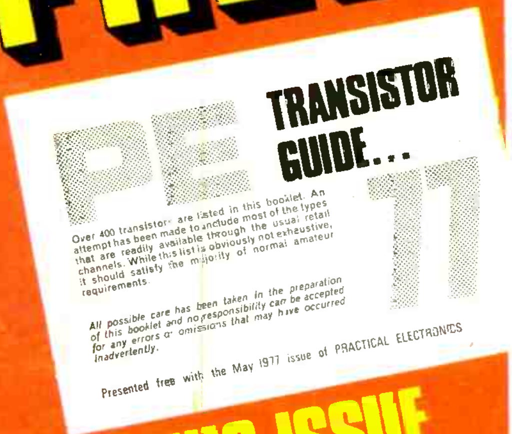

PE

TRANSISTOR GUIDE...

77

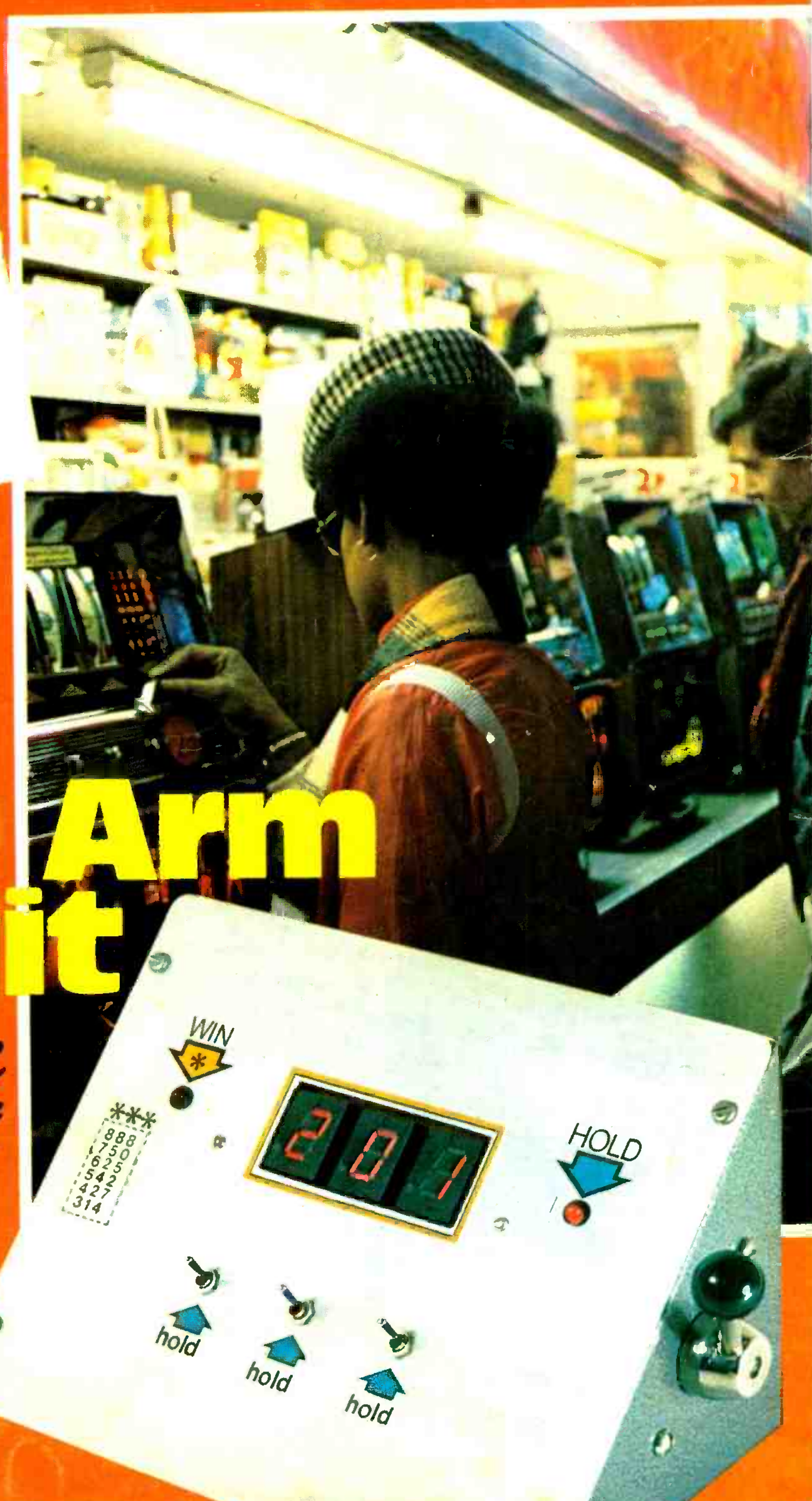
Over 400 transistors are listed in this booklet. An attempt has been made to include most of the types that are readily available through the usual retail channels. While this list is obviously not exhaustive, it should satisfy the majority of normal amateur requirements.

All possible care has been taken in the preparation of this booklet and no responsibility can be accepted for any errors or omissions that may have occurred inadvertently.

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

PRACTICAL
ELECTRONICS

VOLUME 13 No. 5 MAY 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our June issue will be on sale Friday, May 13, 1977
(for details of contents see page 365)

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7410	**13p**	7474	**29p**	74150	**173p**
7413	**28p**	7475	**51p**	74154	**144p**
7414	**82p**	7476	**29p**	74155	**73p**
7420	**14p**	7483	**91p**	74157	**66p**
7430	**14p**	7486	**40p**	74159	**200p**
7432	**18p**	7490	**46p**	74174	**110p**
7437	**18p**	7491	**75p**	74179	**120p**
7440	**15p**	7492	**52p**	74180	**120p**
7447	**84p**	7493	**52p**	74367	**120p**

SLD2128, dual 128 bit static shift register £2.
DIL Sockets—8 pin **12p**; 14 pin **13p**; 16 pin **14p**. 100 + less 25%

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TO126 case 5V 600mA **80p**, 12V 500mA **80p**

TRANSISTORS

AC127	**15p**	BC183	**12p**	2N2646	**52p**
AC128	**15p**	BC184	**12p**	2N2926G	**12p**
AC176	**16p**	BC212	**14p**	2N3053	**18p**
AC187	**18p**	BC213	**14p**	2N3054	**49p**
AC188	**18p**	BC214	**14p**	2N3055	**38p**
AD161	**35p**	BCY70	**15p**	2N3440	**54p**
AD162	**35p**	BCY71	**15p**	2N3442	**£1·20**
BC107	**10p**	BCY72	**15p**	2N3702	**10p**
BC108	**10p**	BD131	**38p**	2N3703	**10p**
BC109	**10p**	BD132	**40p**	2N3704	**10p**
BC109C	**15p**	BFY50	**15p**	2N3705	**10p**
BC147	**10p**	BFY51	**15p**	2N3708	**10p**
BC148	**10p**	BFY52	**15p**	2N3819	**22p**
BC149	**10p**	TIP41A	**60p**	2N4059	**10p**
BC157	**10p**	TIP42A	**75p**	2N4418	**10p**
BC158	**10p**	TIP2955	**96p**	2N5294	**30p**
BC159	**10p**	TIP3055	**42p**	40673	**60p**
BC161	**18p**	2N2219	**28p**		
BC182	**12p**	2N2369	**22p**		

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17 × 3¾ × 0·1in sheets **£1·90**; 0·15 **£1·60**.
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1N4002 **5p**; 1N4004 **6p**; 1N4007 **9p**; 1N4148 **4p**; BY127 **12p**; 100V 3A **12p**; 400V 3A **15p**; OA81 **5p**; OA91 **5p**; OA47 **10p**
50V 1A bridge **22p**; 800V 1A **40p**; 250V 2½A **40p**; 200V 5A **70p**.
Zeners—400mW BZY88. All voltages from 3V to 30V **10p**
1·3W plastic from 3V to 200V **20p**

RESISTORS

Carbon film 5% ½W miniature. All values in E12 series from 1Ω to 10MΩ (over 1MΩ 10%) **1½p** each.
Metal Film 5% 1W. All values in E12 series from 27Ω to 10MΩ **2½p**.
Sub-min presets, vert or horiz, all values from 20Ω to 4M7Ω, **7p**.
Standard pots, lin or log, **22p**.
Wirewound 2½W 0·25, 0·33, 0·47 1Ω **8p**.
Wirewound 5W all values from 1Ω to 47K **10p** each

TRANSFORMERS

6-0-6V 100mA **90p**; 9-0-9V 100mA **95p**; 12-0-12V 50mA **90p**; 12-0-12V 100mA **£1**; 12-0-12V 1A **£2·80**; 20V 55mA **90p**; 22V 100mA **£1**; 29V 50mA **85p**; 6·3V 1½A **£1·95**; 6-0-6V 1½A **£2·30**; 30-0-30V 1A **£3·70**.

REEDS

1in Inserts, **5p**; 10/**40p**; 100/**£3·50**. DIL relay, 3·7–10V, **£2·60**.

WIRE

Enamelled copper wire on 2oz reels SWG/price **16/36p**, **18/38p**, **20/40p**, **22/42p**, **24/44p**, **26/46p**, **28/48p**, **30/50p**, **32/52p**, **34/54p**, **36/56p**, **38/58p**, **40/60p**.

RF CHOKES

0·75, 2·95, 6·8, 10, 22, all **10p** each. 1·5, 2·5, 5·0, 7·5, 10mH, all **30p** each

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Ceramic plate, 22pF to 1,000pF **2p**; polyester 1,000 to 6,800pF **5p**; 0·01, 0·015, 0·022, 0·033, 0·047, 0·068, 0·1mF **4p**; 0·15 0·22mF **5p**; 0·33 **6p**; 0·47 **8p**; 0·68 **10p**; 1mF **12p**; 2·2mF **16p**; 3·3mF **24p**. 1,000pF feedthrough **5p**.
1%, 1,000pF, 10,000pF **15p**; 0·1μF, 0·2μF, 0·25μF **30p**; 2·2μF **55p**.
Polystyrene 10pF to 1,000pF **4p**; 1,200pF to 10,000pF **6p**. All 2½%.

Electrolytics:
All 25V 0·47, 1, 2·2, 4·7, 10, 22, 33, 47μF **7p**. 100μF, 150μF **8p**; 220μF **10p**; 330μF **12p**; 470μF **15p**; 1,000μF **23p**; 2,200μF **33p**; 3,300μF **45p**; 4,700μF **58p**. 40V 10, 22, 47μF **8p**; 100μF **9p**; 220μF **12p**; 330μF **14p**; 470μF **17p**; 1,000μF **30p**; 2,200μF **56p**; 4,700μF (can) **72p**.
Tantalum Bead: μF/V 0·1, 0·22, 0·33, 0·47, 0·68, 1, 1·5, 2·2, 3·3/35V 4·7/25, 6·8/35, 10/25, 15/10, 22/16, 33/10, 47/6, 68/6, 100/3, **12p** each

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See Practical Wireless for details of packs of components, surplus goods, etc. All prices quoted include VAT at 8 or 12½%. Add 20p postage on orders under £3. **Minimum order £1.** Most orders despatched on day of receipt. SAE with enquiries. Send 10p for Multimeter catalogue—free on request on orders over £3. Official Orders accepted from Schools, etc. Export wholesale enquiries welcome. Surplus components always wanted.

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21	4·5mm
22	6·0mm

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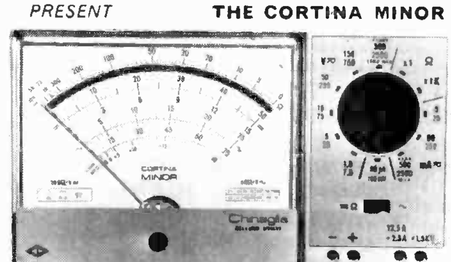

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4	150	0-115-200-220-240	6·51
66	300	0-115-200-220-240	8·62
67	500	0-115-200-220-240	13·10
84	1000	0-115-200-220-240	20·75
93	1500	0-115-200-220-240	23·62†
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73	3000	0-115-200-220-240	47·83†

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2000VA	£37·82†	Ref 95W

60 VOLT RANGE
Prim. 220–240V
Sec. 0–24–30–40–48–60V

Ref.	Amps	£
124	0·5	4·51
126	1·0	5·84
127	2·0	8·15
125	3·0	11·23
123	4·0	13·59
40	5·0	14·95
120	6·0	17·53
121	8·0	19·56†
122	10·0	24·09†
189	12·0	26·57†

SCREENED MINIATURES

Ref mA	Volts	£
238 200	3-0-3	2·65
212 1A, 1A	0-6, 0-6	3·27
13 100	9-0-9	2·39
235 330, 330	0-9, 0-9	2·49
207 500, 500	0-8·9, 0-8·9	3·14
208 1A, 1A	0-8·9, 0-8·9	4·51
236 200, 200	0-15, 0-15	2·49
214 300, 300	0-20, 0-20	3·22
221 700 (DC)	20-12-0-12-20	3·90
206 1A, 1A	0-15-20, 0-15-20	5·37
203 500, 500	0-15-27, 0-15-27	4·77
204 1A, 1A	0-15-27, 0-15-27	6·00
S112 500	12, 15, 20, 24, 30	3·30

MAINS ISOLATING SCREENED
PRI. 120/240V
SEC. 120/240V C.T.

Ref	VA(Watts)	£
07*	20	4·96
149	60	6·93
150	100	7·65
151	200	12·32
152	250	14·47
153	350	17·74
154	500	21·16
155	750	28·20†
156	1000	37·97†
157	1500	45·51†
158	2000	53·24†
159	3000	80·78†

*115V or 240V Sec. only.

12 and or 24 Volt
PRIMARY 220–240 VOLTS

Ref.	12V Amps	24V Amps	£
111	0·5	0·25	2·44
213	1·0	0·5	3·10
71	2	1	3·88
68	3	–	5·26
18	4	2	4·90
85	5	–	5·62
70	6	3	6·58
108	8	4	7·83
72	10	5	8·37
116	12	6	9·66
17	16	8	11·12
115	20	10	15·42
187	30	15	19·50
226	60	30	24·78†

30 VOLT RANGE
Prim. 220–240V
Sec. 0–12–15–20–24–30V

Ref.	Amps	£
112	0·5	3·30
79	1·0	4·20
3	2·0	6·04
20	3·0	7·30
21	4·0	8·40
51	5·0	9·75
117	6·0	11·29
88	8·0	14·15
89	10·0	14·52

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Sec. 100/120 or 200/240

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350	247	16·25
1000	250	35·92†
2000	252	54·80

50 VOLT RANGE
Prim. 200–240V
Sec. 0-19-25-33-40-50V

Ref	Amps	£
102	0·5	4·17
103	1·0	5·38
104	2·0	7·61
105	3·0	9·82
106	4·0	11·92
107	6·0	17·27
118	8·0	18·67
119	10·0	22·04†

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150 Mixed value capacitors (count by weight)
30 Mixed value precision resistors ¼W 2 %
15 Assorted pots and pre-sets
10 Reed switches
3 Micro switches
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STATE PACK REQUIRED 90p PER PACK

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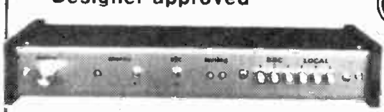

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PE TV SOUND SEPARATOR

Complete set of semiconductors £2·30, High quality glass fibre p.c.b. £1
POSTAGE AND PACKING 15p per order. Orders over £5 post free. All devices are top grade, brand new and to full manufacturer's spec. We do not sell seconds or rejects. Send S.A.E. for our data sheet and price list
Prices do not include VAT—add 8% to items marked*, and 12½% to all others

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Doram kits

DORAM KITS CONTAIN EVERYTHING DOWN TO THE LAST NUT!

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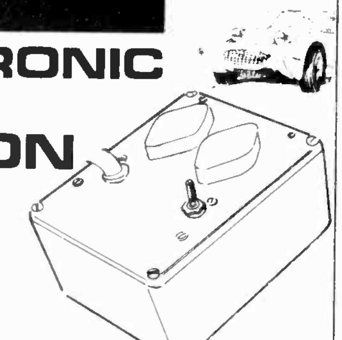

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Avoid difficulty in starting your car on cold mornings with the Doram C.D. Ignition Unit. The complete kit incorporates features such as single switch reversion to the standard ignition system for servicing etc. and also an immobilisation facility. Improved performance and fuel consumption, along with reduced points erosion and longer plug life makes this unit a must for any 12V neg. earth car.

O'seas orders—add 15% for P+P. All items offered for sale subject to the Terms of Business set out in Doram Edition 3 catalogue, price 60p. The Doram Kit brochure is also available, price 25p. Combined price only 70p which also entitles you to 2x25p vouchers, each one usable on any order placed to the value of £5.00 or more (ex. VAT).
DORAM ELECTRONICS LTD.
P.O. BOX TR8, WELLINGTON RD IND. EST., LEEDS LS12 2UF
An Electrocomponents Group Company

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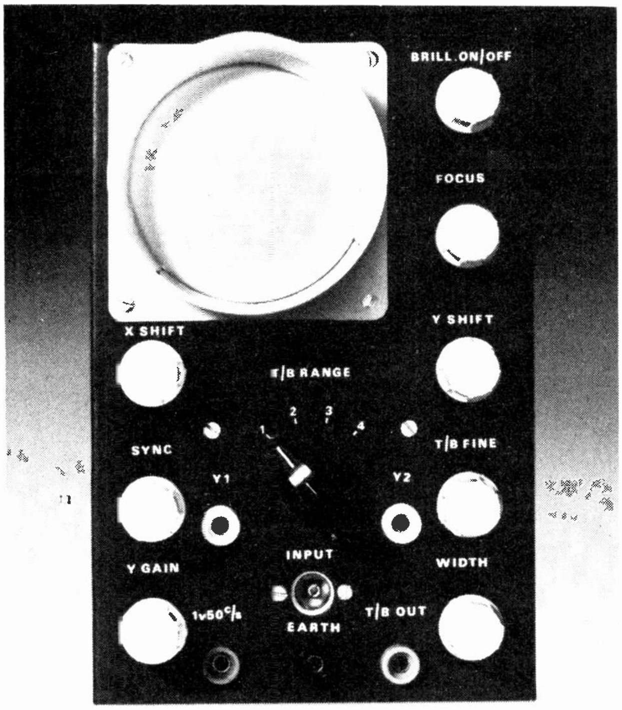
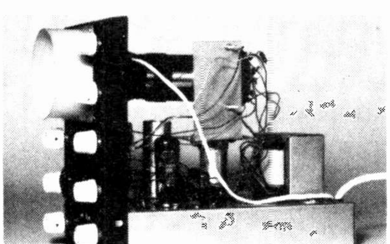


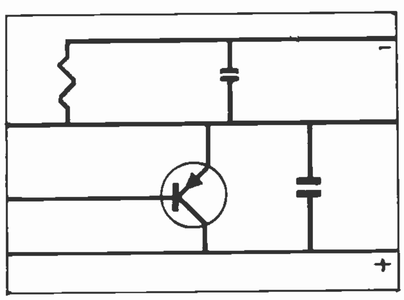
'There's only one way to master electronics... to see what is going on and learn by doing.'

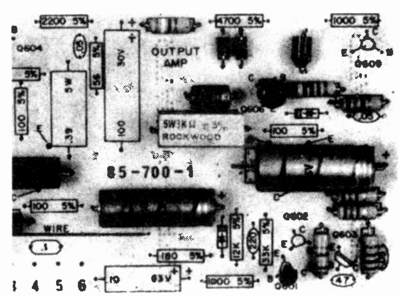
This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

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.

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PEB 5/7

SYNTHESISER AND SOUND EFFECT KITS

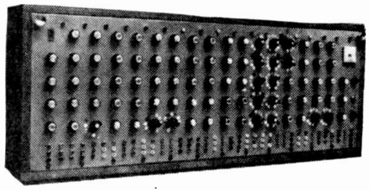
PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

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 may 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

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



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

The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists
- Set of basic component kits £83·03
- Set of printed circuit boards £11·45

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument) 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists
- Set of basic component kits £48·18
- Set of printed circuit boards £7·66

P.E. MINISONIC Mk. 1 SYNTHESISER (P.E. Nov. 74 to Mar. 75)
A portable, battery or mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, output amp and mixer, temperature stabiliser, power supply
- Set of basic component kits £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 £64·25
- Set of printed circuit boards £9·71

ELEKTOR "FORMANT" SYNTHESISER (Elektor Magazine 1977)
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, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit
- Component set with special foot operated switches £7·59
- Alternative component set with panel mounting switches £4·96
- Printed circuit board £1·43

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler
- Component set for above functions (excl SWs) £7·84
- Printed circuit board £1·81

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce jungle-drum" rhythms
- Component set (incl PCB) £2·88

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.
- Component set (incl PCB) £2·87

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing
- Component set (incl PCB) £4·48

WAH-WAH UNIT (P.E. Apr 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller
- Component set (incl PCB) £3·55

AUTOWAH UNIT (P.E. Mar 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played
- Component set and PCB, with special foot switches £7·27
- Component set and PCB, with panel switches £4·83

P.E. JOANNA (P.E. May/Sept. 75)
A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available
Main power supply, tone generator, 61 envelope shapers, voicing and pre-amp circuits
- Set of basic component kits for above £75·29
- Set of printed circuit boards for above £20·35
- Power amplifier £15·97
- Printed circuit board for power amp 95p

RHYTHM GENERATOR (P.E. Mar Apr. 74)
Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low, bass and snare drums, long and short brushes, blocks and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful.
Tempo, Timing, Logic, 8 Effects circuits PSU
- Set of basic component kits for above £36·14
- Set of printed circuit boards for above £7·03

SEE OUR OTHER ADVERT FOR KEYBOARDS, OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED—ALSO SOME NEW KITS!

REVERBERATION UNIT (P.W. Nov Dec. 72)
A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level
- Component set (excl. spring unit) £9·73
- Printed circuit board £1·96
- 9in spring unit £6·50
- Panel meter (50μA) (optional) £5·70

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds
- Component set (incl PCB) £3·72

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments
- Component set using dual slider pot £6·86
- Component set using dual rotary pot £6·20
- Printed circuit board £1·62

FUZZ UNIT
Simple Fuzz unit based upon P.E. Sound Design circuit
- Component set (incl PCB) £2·03

TREMOLO UNIT
Based upon P.E. Sound Design circuit
- Component set (incl PCB) £3·64

TREBLE BOOST UNIT (P.E. Apr 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable
- Component set (incl PCB) £2·40

ENVELOPE SHAPERS
Both of the kits below have manual control over their Attack, Decay, Sustain and Release functions. Both kits include PCB (VCA means Voltage Controlled Amplifier)
- **Envelope Shaper and VCA** (P.E. Apr 76) £6·68
- **Envelope shaper** (without VCA) (P.E. Oct 75) £4·66

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows
- Component set (incl PCB) £3·97

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)
An independently designed VCF that can be used with the P.E. Synthesiser
- Component set £3·80
- Printed circuit board £1·38

SOUND-TO-LIGHT (P.E. Aurora) (P.E. Apr.–Aug. 71)
Four channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities
- Basic component set (excl thyristors) £15·92
- Printed circuit board for above £3·90
- Power supply £5·78
- PCB for power supply £1·79

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr 76)
A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors, and by-pass switches
- Component set (incl PCB) £11·95

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation
- Basic component set £18·19
- Printed circuit board £3·45

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. An LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike
- Main component set (incl PCB) £15·59
- Power supply set (incl PCB) £7·03

P.E. SYNCHRONOME (P.E. Mar. 76)
An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply
- Component set (incl loudspeaker) £11·62
- Printed circuit board £2·04

PEAK LEVEL INDICATOR (P.E. Mar. 76)
A twin-channel visual display unit for monitoring the peak level of audio signals. Well suited for use when inter-coupling our many sound producing kits to help avoid signal over-loading
- Component set (incl PCB) (as published) £3·88

BIOLOGICAL AMPLIFIER (P.E. Jan. Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc
- **Pre-Amp Module** Component set (incl PCB) £4·22
- **Basic Output Circuits**—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp-driver circuits £6·59
- **Audio Amplifier Module** Type PC7 £7·35

TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs
- Standard tolerance set of components £2·96
- Superior tolerance set of components £3·76
- Regulated power supply (will drive 2 sets) £4·69

SEMI CONDUCTOR TESTER (P.E. Oct. 73)
Essential test equipment for the enterprising home constructor. While stocks last
- Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB £9·63
- Panel meter (500μA) £5·70

8-INPUT MIXER
A simple mixer having 8 inputs each of which has a preset level control and which are combined into one output channel having a preset over-all level control and a master output volume control. Designed for inter-coupling our various sound effects and synthesiser kits
- Component set (incl PCB) £3·95

POST AND HANDLING
U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £1·50 plus VAT

Optional Insurance for compensation against loss or damage in post, add 35p in addition to above post and handling.

Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates

LIST—Send Stamped Addressed Envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components
OVERSEAS enquiries for list send 40p

DON'T FORGET VAT!
Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders)

Prices are correct at time of press. E. & O.E. delivery subject to availability.

EXPORT ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list send 40p

PHONOSONICS · DEPT. PE55 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH

MAIL ORDER AND C.W.O. ONLY SORRY BUT NO CALLERS PLEASE

The Finest . . .

KEYBOARDS

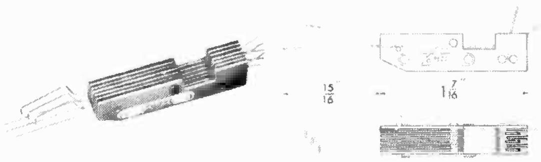
and CONTACTS

The "S.K.A." Plastic Keyboard was developed by Kimber Allen Ltd. in co-operation 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 strong section of aluminium extrusion upon which they are mounted is specially 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)

GJ—SPCO	24p each	GH—5 pairs	57p each
GB—2 pairs	27p each	4PS—SPCO and 3 pairs	53p each
GC—3 pairs	36p each	Palladium Wire Bus Bars, 1 octave lengths 50p each	
GE—4 pairs	45p each		



U.K. Post and Handling:

Keyboards: £1·50 each

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

37 Note C-C Keyboard £25·50

49 Note C-C Keyboard £32·25

61 Note C-C Keyboard £39·75

SEE OUR OTHER ADVERT FOR SYNTHESISER AND SOUND EFFECT KITS AND SEE OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED. SEND S.A.E. FOR FULL LIST (OVERSEAS SEND 40p)

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 B.F.P.O. classify 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

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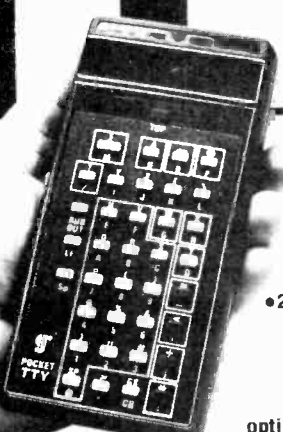
POCKET TTY



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 alphanumerics**
- **9 digit LED display of characters entered**
- **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.**

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Telephone: Newport (0633) 67426
Telex: 28604 Ref: 1796

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complete DIGITAL CLOCK KITS

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prompt order despatch

NON-ALARM
£10·65
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ALARM
£13·43
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(Prices include P. & P.)

"DELTA"

GENUINE TEAK OR PERSPEX CASE

DELTA DATA: 4 Radiant Red ½in 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 £9; Alarm £12·50 inclusive.

READY BUILT: Buy a working tested module and fit your own case—Non-Alarm £9·50; Alarm £13; Complete clock ready built. 2yr guarantee—Non-Alarm £13·50; Alarm £16·50.

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 controlled to suit lighting level.

"ALPHA"	4 Glowing Green ½in high digits 12 or 24 hour. Non-Alarm	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

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4in RANGE

Size 4½ × 3½ × 1¾in

Value	No.	Price
0–50µA	1302	£4·50
0–100µA	1303	£4·50
0–500µA	1304	£4·50
0–1mA	1305	£6·00
0–50V	1306	£6·00

2in RANGE

Size 2½ × 1½ × 1¼in

Value	No.	Price
0–50µA	1307	£3·50
0–100µA	1308	£3·50
0–500µA	1309	£3·50
0–1mA	1310	£3·50
0–50V	1311	£3·50

MR2P TYPE

Size 42 × 42 × 30mm

Value	No.	Price
0–50µA	1313	£4·80
0–1mA	1315	£3·20

EDGEWISE

Size 3½ × 1⅛ × 2¼in
Cut out 2¾ × 1¼in

Value	No.	Price
0–1mA	1316	£4·05
0–500µA	1317	£4·05

MINIATURE BALANCE/TUNING METER

Size 23 × 22 × 26mm
Sensitivity 100/0/100mA

No.	Price
1318	£1·95

BALANCE/TUNING

Size 45 × 22 × 34mm
Sensitivity 100/0/100µA

No.	Price
1319	£2·00

MIN. LEVEL METER

Size 23 × 22 × 26mm
Sensitivity 200µA

No.	Price
1320	£1·95

Vu METER

Size 40 × 40 × 29mm
Sensitivity 130µA

No.	Price
1321	£2·00

MINI MULTI-METER

Size 60 × 24 × 90mm
Sensitivity 1000 ohms/V
A.C. VOLTS 0–10, 50, 250, 1000
D.C. VOLTS 0–10, 50, 250, 1000
D.C. CURRENT 0–1 100mA
Resistance 0–150kΩ

No.	Price
1322	£5·95

P & P

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

TRANSISTORS

BRAND NEW—FULLY GUARANTEED

Type	Price
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AC127	£0·14
AC128	£0·12
AC128K	£0·26
AC132	£0·15
AC134	£0·15
AC137	£0·15
AC141	£0·18
AC141K	£0·30
AC142	£0·18
AC176	£0·12
AC176K	£0·26
AC178	£0·25
AC179	£0·25
AC180	£0·20
AC180K	£0·30
AC181	£0·20
AC181K	£0·30
AC187	£0·16
AC187K	£0·26
AC188	£0·16
AC188K	£0·26
AD140	£0·60
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AD149	£0·60
AD161	£0·36
AD162	£0·36
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AF114	£0·20
AF115	£0·20
AF116	£0·20
AF117	£0·20
AF118	£0·40
AF124	£0·30
AF125	£0·30
AF126	£0·30
AF127	£0·32
AF139	£0·58
AF180	£0·58
AF180	£0·58
AF181	£0·58
AF186	£0·58
AF239	£0·38
AL102	£0·95
AL103	£0·95
AU104	£1·00
AU110	£1·00
AU113	£1·00
BC107A	£0·08
BC107B	£0·08
BC107C	£0·08
BC108A	£0·08
BC108B	£0·08
BC108C	£0·08

Type	Price
BC109B	£0·08
BC109C	£0·08
BC147	*£0·09
BC148	*£0·09
BC149	*£0·09
BC157	*£0·12
BC158	*£0·12
BC159	*£0·12
BC167	*£0·12
BC168	*£0·12
BC169	*£0·12
BC169C	*£0·12
BC170	*£0·10
BC171	*£0·10
BC172	*£0·10
BC173	*£0·12
BC177	£0·16
BC178	£0·16
BC179	£0·16
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BC181	*£0·25
BC182L	*£0·10
BC183	*£0·10
BC183L	*£0·10
BC184	*£0·10
BC184L	*£0·10
BC207	*£0·11
BC208	*£0·11
BC209	*£0·12
BC212	*£0·11
BC212L	*£0·11
BC213	*£0·11
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BC214L	*£0·12
BC237	*£0·16
BC238	*£0·16
BC251	*£0·15
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BC301	£0·30
BC302	£0·28
BC303	£0·32
BC304	£0·38
BC327	*£0·16
BC328	*£0·15
BC337	*£0·15
BC338	*£0·15
BC440	£0·30
BC441	£0·30
BC460	£0·38
BC461	£0·38
BC477	£0·20
BC478	£0·19
BC479	£0·20
BC547	*£0·12
BC548	*£0·12

Type	Price
BC549	*£0·12
BC550	*£0·14
BC556	*£0·14
BC557	*£0·13
BC558	*£0·12
BC559	*£0·14
BD115	£0·50
BD116	£0·80
BD121	£0·65
BD123	£0·65
BD124	£0·70
BD131	£0·35
BD132	£0·38
BD131/132MP	£0·80
BD133	£0·60
BD135	£0·36
BD136	£0·36
BD137	£0·38
BD138	£0·45
BD139	£0·54
BD140	£0·60
BD139/140MP	£1·20
BD155	£0·80
BD175	£0·60
BD176	£0·60
BD177	£0·68
BD178	£0·68
BD179	£0·75
BD201/202MP	£1·70
BD203	£0·80
BD204	£0·80
BD203/204MP	£1·70
BDY20	£0·80
BDX77	£0·90
BF457	£0·37
BF458	£0·37
BF459	£0·38
BF594	*£0·15
BF596	*£0·17
BFR39	£0·25
BFR40	*£0·25
BFR79	*£0·28
BFR80	*£0·28
BFX29	£0·25
BFX30	£0·30
BFX84	£0·23
BFX85	£0·24
BFX86	£0·25
BFX87	£0·22
BFX88	£0·22
BFX90	*£0·55
BFY50	£0·14

Type	Price
BFY51	£0·14
BFY52	£0·14
BIP19	£0·38
BIP20	£0·38
BIP19/20MP	£0·80
BRY39	£0·45
BU105	£1·90
BU105/02	£1·95
BU204	£1·70
BU205	£1·70
BU208	£2·40
BU208/02	£2·95
E1222	£0·38
MJE2955	£0·88
MJE3055	£0·60
MJE3440	£0·45
MP8113	£0·45
MPF102	£0·35
MPF104	£0·39
MPF105	£0·39
MPSA05	*£0·20
MPSA06	*£0·20
MPSA55	*£0·20
MPSA56	*£0·20
OC22	£1·50
OC23	£1·50
OC24	£1·40
OC25	£0·60
OC26	£0·60
OC28	£0·90
OC29	£1·00
OC35	£0·90
OC36	£0·90
OC70	£0·15
OC71	£0·15
TIC44	*£0·29
TIC45	*£0·29
TIP29A	£0·44
TIP29B	£0·52
TIP29C	£0·62
TIP30A	£0·50
TIP30B	£0·60
TIP30C	£0·70
TIP31A	£0·54
TIP31B	£0·66
TIP31C	£0·68
TIP32A	£0·64
TIP32B	£0·76
TIP32C	£0·80
TIP41A	£0·66
TIP41B	£0·70
TIP41C	£0·80
TIP42A	£0·72
TIP42B	£0·78
TIP42C	£0·95

Type	Price
TIP2955	£0·95
TIP3055	£0·75
TIS43	£0·22
TIS90	*£0·18
UT46	£0·20
ZTX107	*£0·10
ZTX108	*£0·10
ZTX109	*£0·10
ZTX300	*£0·12
ZTX500	*£0·14
2N1613	£0·20
2N1711	£0·20
2N1889	£0·45
2N1890	£0·45
2N1893	£0·30
2N2147	£0·75
2N2148	£0·70
2N2160	£0·80
2N2192	£0·38
2N2193	£0·38
2N2194	£0·38
2N2217	£0·22
2N2218	£0·22
2N2218A	£0·20
2N2219	£0·20
2N2219A	£0·24
2N2904	£0·18
2N2904A	£0·21
2N2905	£0·18
2N2905A	£0·21
2N2906	£0·16
2N2906A	£0·19
2N2907	£0·20
2N2907A	£0·22
2N2926G	*£0·09
2N2926Y	*£0·08
2N2926O	*£0·08
2N2926R	*£0·08
2N2926B	*£0·08
2N3053	£0·16
2N3054	£0·40
2N3055	£0·40
2N3414	*£0·16
2N3415	*£0·16
2N3416	*£0·29
2N3417	*£0·29
2N3614	£0·85
2N3615	£0·90
2N3616	£0·90
2N3646	*£0·09
2N3702	*£0·08
2N3703	*£0·08
2N3704	*£0·07
2N3705	*£0·07
2N3706	*£0·08
2N3707	*£0·08

Type	Price
2N3708	*£0·07
2N3708A	*£0·07
2N3709	*£0·07
2N3710	*£0·07
2N3711	*£0·07
2N3819	£0·20
2N3820	£0·40
2N3821	£0·60
2N3823	£0·40
2N4058	*£0·12
2N4059	*£0·14
2N4060	*£0·14
2N4061	*£0·12
2N4062	*£0·12
2N4284	*£0·18
2N4285	*£0·18
2N4286	*£0·18
2N4287	*£0·18
2N4288	*£0·18
2N4289	*£0·18
2N4290	*£0·18
2N4291	*£0·18
2N4292	*£0·18
2N4293	*£0·18
2N4921	*£0·55
2N4923	*£0·65
2N5135	*£0·10
2N5136	*£0·10
2N5138	*£0·10
2N5194	£0·56
2N5245	*£0·28
2N5294	£0·34
2N5296	£0·35
2N5457	£0·32
2N5458	£0·32
2N5459	£0·38
2N5551	*£0·30
2N6027	£0·32
2N6121	£0·70
2N6122	£0·70
40311	£0·36
40313	£0·95
40316	£0·58
40317	£0·36
40326	£0·36
40327	£0·45
40346	£0·42
40347	£0·55
40348	£0·70
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40406	£0·40
40407	£0·28
40408	£0·48
40409	£0·52

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FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0·14	7409	£0·15	7441	£0·64	7482	£0·85	7493	£0·40	74122	£0·50
7401	£0·14	7410	£0·14	7442	£0·64	7483	£0·95	7494	£0·88	74123	£0·70
7402	£0·15	7411	£0·23	7445	£0·90	7484	£0·98	7495	£0·75	74141	£0·80
7403	£0·15	7412	£0·23	7446	£0·90	7485	£1·20	7496	£0·80	74154	£1·30
7404	£0·15	7413	£0·27	7447	£0·78	7486	£0·30	74100	£1·00	74180	£1·10
7405	£0·15	7414	£0·58	7448	£0·80	7489	£2·90	74110	£0·50	74181	£2·00
7406	£0·30	7416	£0·28	7475	£0·48	7490	£0·42	74118	£0·90	74190	£1·50
7407	£0·30	7417	£0·28	7480	£0·50	7491	£0·75	74119	£1·85	74198	£2·00
7408	£0·15	7440	£0·15	7481	£0·95	7492	£0·45	74121	£0·30	74199	£1·90

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·14	CD4012	£0·18	CD4022	£0·95	CD4031	£2·20	CD4046	£1·30	CD4071	£0·28
CD4001	£0·18	CD4013	£0·50	CD4023	£0·18	CD4035	£1·05	CD4047	£1·10	CD4072	£0·28
CD4002	£0·18	CD4015	£0·90	CD4024	£0·72	CD4037	£0·95	CD4049	£0·55	CD4081	£0·18
CD4006	£0·98	CD4016	£0·50	CD4025	£0·18	CD4040	£0·95	CD4050	£0·55	CD4082	£0·28
CD4007	£0·18	CD4017	£0·90	CD4026	£0·98	CD4041	£0·82	CD4054	£1·20	CD4510	£1·30
CD4008	£0·95	CD4018	£1·00	CD4027	£0·60	CD4042	£0·82	CD4055	£1·20	CD4511	£1·60
CD4009	£0·55	CD4019	£0·52	CD4028	£0·85	CD4043	£0·98	CD4056	£1·40	CD4516	£1·40
CD4010	£0·55	CD4020	£1·10	CD4029	£1·15	CD4044	£0·94	CD4069	£0·40	CD4518	£1·08
CD4011	£0·18	CD4021	£0·98	CD4030	£0·55	CD4045	£1·40	CD4070	£0·40	CD4520	£1·25

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	*£0·80	LM309K	£1·75	MC1469R	£2·50	UA711C	*£0·32	72748	*£0·35	TAA621A	*£2·00
CA3014	*£1·37	LM320-5V	£2·00	MC1496G	*£0·90	72711	*£0·32	72748P	*£0·35	TAA661A	*£1·50
CA3018	*£0·70	LM320 12V	£2·00	NE536	*£2·00	UA723C	£0·50	SN76013N	*£1·40	TAD100	*£1·30
CA3020	*£1·40	LM320-15V	£2·00	NE515A	*£2·10	72723	£0·50	SN76023N	*£1·40	TBA540Q	*£2·50
CA3028A	*£1·10	LM320-24V	£2·00	NE540	*£2·40	UA741C	*£0·20	SN76110	*£1·50	TBA641B	*£2·25
CA3035	*£1·30	LM380N	*£1·00	NE555	£0·40	72741	*£0·20	SN76115	*£1·90	TBA800	*£0·80
CA3036	*£1·35	LM381AN	*£1·15	NE556	£0·82	741P	*£0·20	SN76660	*£0·75	TBA810S	*£0·95
CA3042	*£1·15	LM3900N	*£0·63	NE561	*£3·25	UA747C	*£0·70	SL403D	*£1·75	TBA820	£0·90
CA3043	*£1·55	MC724P	£1·50	NE562B	*£2·95	72747	*£0·79	SL414A	*£1·75	TBA920Q	£3·40
CA3046	*£0·50	MC1303L	*£1·45	NE565A	*£2·00	UA748	*£0·35	TAA550B	£0·35	TCA270S	*£3·90
CA3052	*£1·60	MC1304P	*£3·50	NE566	*£1·50						
CA3054	*£1·94	MC1310P	*£1·80	NE567	*£2·50						
CA3075	*£1·50	MC1312PQ	*£1·50	UA702C	*£0·46						
CA3081	*£1·50	MC1330P	*£1·35	72702	*£0·46						
CA3089E	*£1·50	MC1339	*£1·50	UA703A	*£0·25						
CA3090AQ	*£4·25	MC1350	*£0·75	UA709C	*£0·25						
CA3123E	*£1·40	MC1351P	*£0·85	72709	*£0·46						
LM301AH	*£0·47	MC1352P	*£0·85	72709P	*£0·25						
LM304	£3·00	MC1456G	*£0·85	UA710C	*£0·40						
LM308H	*£0·95	MC1466L	£3·95	72710	*£0·30						

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MINIATURE MAINS Primary 240V with two independent secondary windings

No.	Type	Price
2024	MT280 0–6V, 0–6V RMS	£1·30*
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MINIATURE MAINS Primary 240V

No	Secondary	Price
2021	6V–0–6V 100mA	£1·30*
2022	9V–0–9V 100mA	£0·85*
2023	12V–0–12V 100mA	£1·30*

1 AMP MAINS Primary 240 V

No.	Secondary	Price	
2026	6V–0–6V 1 amp	£2·70*	P & P. 30p
2027	9V–0–9V 1 amp	£2·20*	P & P. 30p
2028	12V–0–12V 1 amp	£2·60*	P & P. 30p
2029	15V–0–15V 1 amp	£2·90*	P & P. 30p
2030	30V–0–30V 1 amp	£3·80*	P. & P. 30p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V
Voltages available by use of taps: 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 50, 25–0–25 V.

No.	Rating	Price	
2031	½ amp	£3·42*	P & P 30p
2032	1 amp	£4·40*	P & P 50p
2033	2 amp	£5·45*	P & P. 85p

AUDIO OUTPUT Primary 1·2kΩ, Secondary 5 ohms 200mW Dimensions 20 × 16 × 15mm
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MINIATURE INTER/DRIVER
Primary 20kΩ, Secondary 1kΩ, Ratio 5 : 1
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Primary 100kΩ, Secondary 1kΩ, 15 × 13 × 13mm.
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LT711 MIN. DRIVER
Primary 10kΩ, Secondary 2kΩ, C.T., 15 × 13 × 13mm.
Order No. 2040 — £0·35*

LT712 MIN. OUTPUT
Primary 500 ohm, Secondary 8 ohms, 100mW, 15 × 13 × 13mm
Order No. 2041 — £0·28*

LT717 MIN. INPUT
Primary 150kΩ, Secondary 1kΩ, 20 × 15 × 15mm.
Order No. 2042 — £0·52*

LT719 MIN. INPUT
Primary 20kΩ, Secondary 1kΩ, 20 × 15 × 15mm.
Order No. 2043 — £0·32*

LT722 MIN. DRIVER
Primary 10kΩ, Secondary 2kΩ, C.T., 20 × 15 × 15mm.
Order No. 2044 — £0·32*

LT724 MIN. OUTPUT
Primary 1·2kΩ C.T., Secondary 3·2 and 8 ohm, 200mW. Dimensions 20 × 15 × 15mm.
Order No. 2045 — £0·38*

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Order No. 2046 — £0·38*

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LT730 MIN. OUTPUT
Primary 500 ohm C.T., Secondary 3·2 and 8 ohm, 500 mW. Dimensions 25 × 20 × 20mm.
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Type	Size	Order No.	Colour	Price
TIL209	0·125in	1501	RED	12p
TIL211	0·125in	1502	GREEN	25p
TIL213	0·125in	1503	YELLOW	25p
FLV115	0·2in	1504	RED	12p
FLV310	0·2in	1505	GREEN	25p
FLV410	0·2in	1506	YELLOW	25p

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A pack of standard sizes and colours which fail to perform to their very ridged specification, but which are ideal for experiments.
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NUTS AND BOLTS

BA BOLTS—packs of BA threaded cadmium-plated screws, slotted cheese head. Supplied in multiples of 100

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·12	1in 4BA	845	£0·51
½in 0BA	840	£0·83	½in 4BA	846	£0·38
1in 2BA	842	£0·69	¼in 4BA	847	£0·33
½in 2BA	843	£0·54	1in 6BA	848	£0·50
¼in 2BA	844	£0·63	½in 6BA	849	£0·30
¼in 6BA	850	£0·33			

BA NUTS—packs of cadmium-plated full nuts in multiples of 100

Type	No.	Price	Type	No.	Price
0BA	855	£0·90	4BA	857	£0·42
2BA	856	£0·60	6BA	858	£0·36

BA washers—flat cadmium plated plain stamped washers supplied in multiples of 100

Type	No.	Price	Type	No.	Price
0BA	859	£0·19	4BA	861	£0·15
2BA	860	£0·15	6BA	862	£0·12

SOLDER TAGS—hot tinned supplied in multiples of 100

Type	No.	Price	Type	No.	Price
0BA	851	£0·42	4BA	853	£0·30
2BA	852	£0·36	6BA	854	£0·30

INSTRUMENT CASES. In two sections vinyl covered top and sides, aluminium bottom, front and back.

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156	11in	6in	3in	£1·80*
157	6in	4¾in	1¾in	£1·25*
158	9in	5¼in	2¼in	£1·60*

ALUMINIUM BOXES. Made from bright all., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	62p*
160	4in	4in	1½in	62p*
161	4in	2¼in	1½in	62p*
162	5¼in	4in	1½in	74p*
163	4in	2¼in	2in	64p*
164	3in	2in	1in	44p*
165	7in	5in	2½in	£1·04*
166	8in	6in	3in	£1·32*
167	6in	4in	2in	86p*

BRIDGE RECTIFIERS

SILICON 1 amp

Type	Order No.	Price
50V RMS	BR1/50	£0·25
100V RMS	BR1/100	£0·28
200V RMS	BR1/200	£0·30
400V RMS	BR1/400	£0·35

SILICON 2 amp

Type	Order No.	Price
50V RMS	BR2/50	£0·40
100V RMS	BR2/100	£0·45
200V RMS	BR2/200	£0·50
400V RMS	BR2/400	£0·55
1000V RMS	BR2/1000	£0·65

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Description	Order No.	Price
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1¼in × ¼in chassis mounting	507	£0·10*
1¼in car inline type	508	£0·20*
Panel mounting 20mm	509	£0·22
Panel mounting 1¼in	510	£0·24

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1·5A	616	4A	620
550mA	613	2A	617	5A	621
800mA	614	2·5A	618	All 5p each	

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
1·6A	636	3A	639	5A	642
2A	637				

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Toggle switch SPST 1½ amp 250V a.c.	1975	£0·33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0·36*
Rotary on-off mains switch	1977	£0·42*
Push switch—Push to make	1978	£0·13*
Push switch—Push to break	1979	£0·18*

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A range of rocker switches SPST—moulded in high insulation. Material available in a choice of colours ideal for small apparatus

Colour	No.	Price
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BLACK	1981	£0·22*
WHITE	1982	£0·22*
BLUE	1983	£0·22*
YELLOW	1984	£0·22*
LUMINOUS	1985	£0·22*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0·50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0·55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0·65*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0·85*
Push button SPST, 2 amp 250V a.c.	1962	£0·65*
Push button SPST, 2 amp 250V a.c.	1963	£0·68*
Push button DPDT, 2 amp 250V a.c.	1964	£0·80*

MIDGET WAFER SWITCHES
Single-bank wafer type—suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
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2 pole 6 way	1966	£0·48*
3 pole 4 way	1967	£0·48*
4 pole 3 way	1968	£0·48*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple on-off action. Rating 10 amp 250V a.c.	1969	£0·20
Button gives 1 pole change over action. Rating 10 amp 250V a.c.	1970	£0·25

DISPLAYS

Type	Order No.	Price
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BDL747 0·6in single	1511	£1·50
BDL727 0·5in double	1512	£1·80

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side viewing indicator tubes. Displays 0–9 and decimal points. Wide viewing angle—operates from 180V with 16kΩ series anode resistors—character height 16·5mm pin connections supplied.
Order no. 1513 Price £0·60

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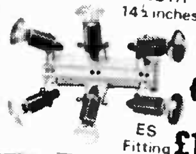

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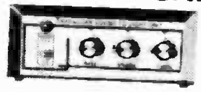

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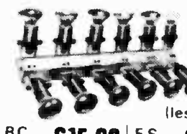

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NEW VOICE FOR COMPONENT INDUSTRY

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 co-operation 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.

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Organ TREMOLO

By L. F. Reeve

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 electro-mechanical 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.

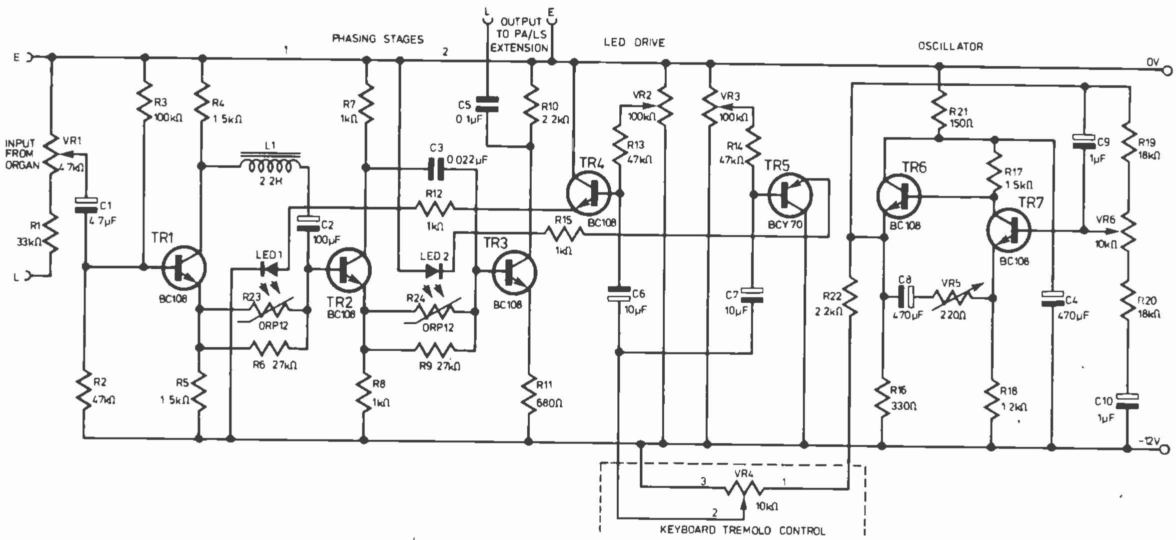


Fig. 1. Circuit diagram of Organ Tremolo Unit. LED1 is optically coupled to R23, and likewise LED2 with R24

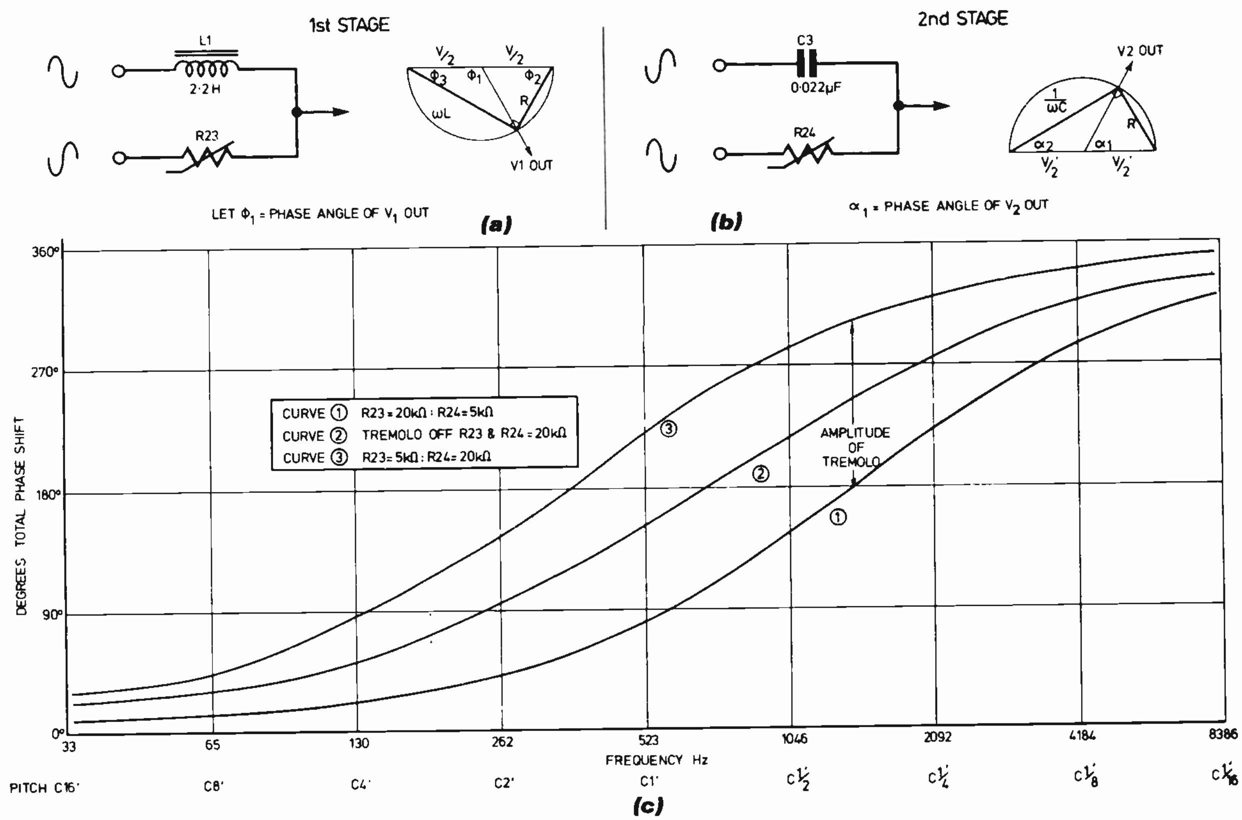


Fig. 2. (a) Vector diagram of inductive stage. (b) Capacitive stage. (c) Phase shift versus frequency

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 θ_1, and the capacitive stage produces a phase lead of α_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.

ORGAN TREMOLO BOARD

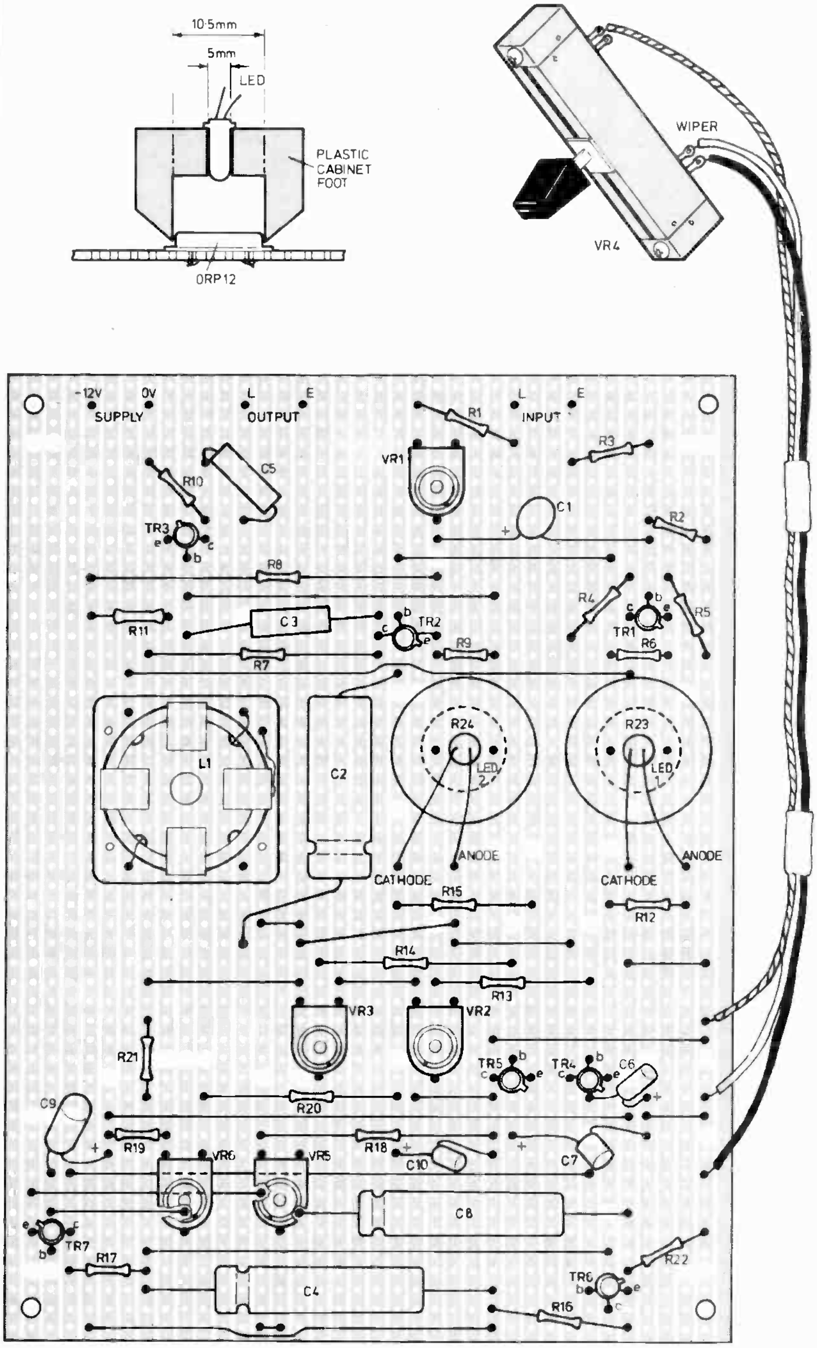


Fig. 3. Component layout on 0·1 inch Veroboard. The arrangement of the optical couplings using cabinet feet is shown

COMPONENTS . . .

Resistors

R1	33kΩ	R13	47kΩ
R2	47kΩ	R14	47kΩ
R3	100kΩ	R15	1kΩ
R4	1·5kΩ	R16	330Ω
R5	1·5kΩ	R17	1·5kΩ
R6	27kΩ	R18	1·2kΩ
R7	1kΩ	R19	18kΩ
R8	1kΩ	R20	18kΩ
R9	27kΩ	R21	150Ω
R10	2·2kΩ	R22	2·2kΩ*
R11	680Ω	R23	ORP12 l.d.r.
R12	1kΩ	R24	ORP12 l.d.r.

All ½W carbon 5% min

Potentiometers

VR1 4·7kΩ
VR2 100kΩ
VR3 100kΩ
VR4 10kΩ linear slider
VR5 220Ω
VR6 10kΩ
All miniature horizontal presets unless otherwise stated

Capacitors

C1 4·7μF tantalum bead
C2 100μF 16V Teletron
C3 0·022μF polyester
C4 470μF 16V Teletron
C5 0·1μF or 4·7μF*
C6 10μF 16V elect
C7 10μF 16V elect
C8 470μF 16V Teletron
C9 1μF 25V elect. or tantalum
C10 1μF 25V elect. or tantalum

Inductors

L1 800 turns of 40 s.w.g. enamelled copper wire on FX2239 ferrite pot core assembly*

Semiconductors

TR1–TR4 BC108
TR5 BCY70
TR6–TR7 BC108
D1–D2 0·2 inch dia. red (*must be clear encapsulation*)*

Miscellaneous

0·1 inch Veroboard (127 × 95mm)
Veropins
2 × rubber bushes for l.e.d./l.d.r. subassembly*
* see text

CONSTRUCTOR'S NOTE

The following components:

Clear encapsulated red l.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:

$\text{Tan } \theta_2 = \frac{\omega L}{R}$ . . . . . equation (1)

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

Since $\theta_3 = 90 - \theta_2$ degrees

and also $\theta_3 = \frac{180 - \theta_1}{2}$ degrees.

Therefore $90 - \theta_2 = \frac{180 - \theta_1}{2}$

Multiplying by 2: $180 - 2\theta_2 = 180 - \theta_1$

$\therefore \theta_1 = 2\theta_2$ . . . . . equation (2)

Combining equations (1) and (2) we get

$$\theta_1 = 2 \tan^{-1}\left(\frac{\omega L}{R}\right)$$

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

Similar rules define α_1 as being $2 \tan^{-1} (2\pi fCR)$.

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 R1, 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 R1.

The purpose of R22 is to regulate the maximum depth of tremolo available at VR4. The value of 2·2kΩ found suitable in the prototype, can be changed up or down in value, to cover tolerances in l.e.d. performance.

Capacitor C5 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 R19—22kΩ, R20—12kΩ, C9—10μF‖4·7μF (14·7μF), and C10—50μF. The decoupling components R21 and C4 may be omitted in this instance. The period of oscillation is about 1 to 1·5 seconds.

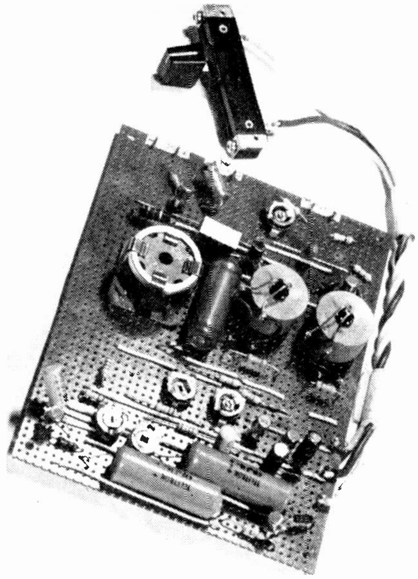
CONSTRUCTION

The two l.e.d./l.d.r. sub assemblies need no explanation, being put together as indicated in Fig. 3. It should be borne in mind that the l.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 handbrace 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

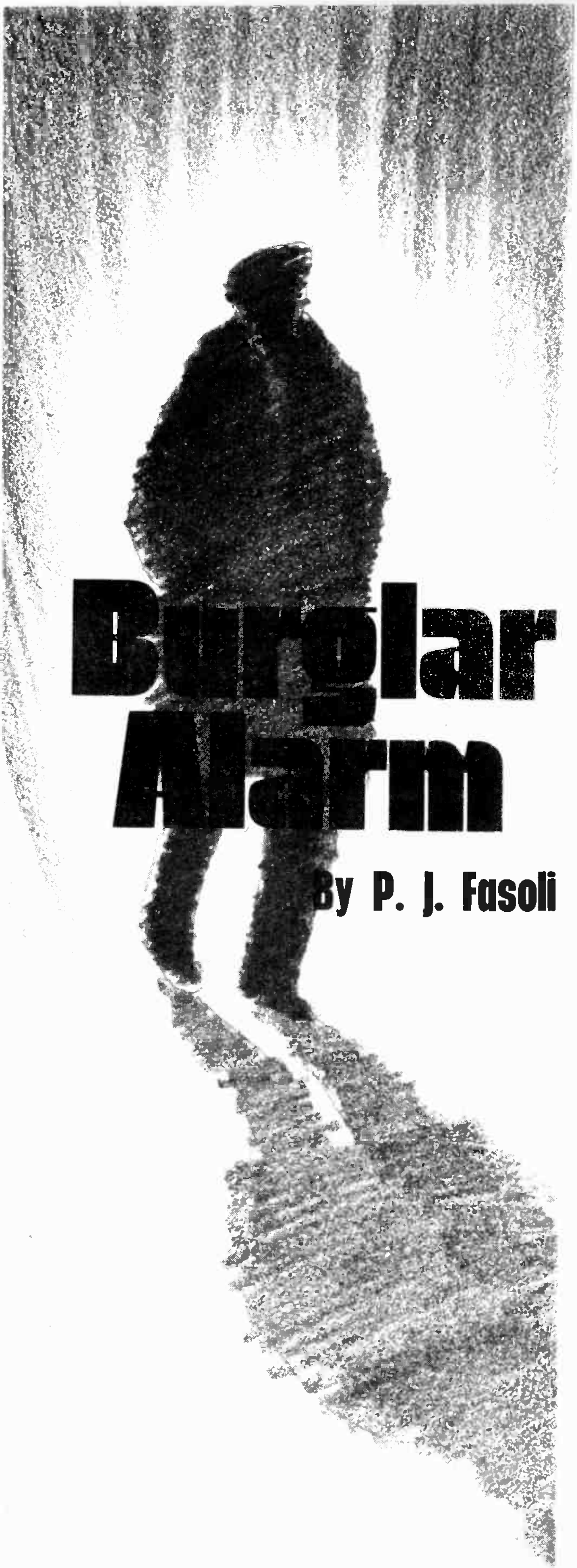
(1) Before switching on, VR2 and VR3 should both be turned to an almost fully clockwise position, thus cutting off TR4 and TR5.

(2) After switching on, VR5 and VR6 should be adjusted to obtain a sinusoidal waveform from the oscillator. This is best done by connecting an oscilloscope across VR4, 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 l.e.d.s removed from their housings, turn VR2 anticlockwise until LED1 begins to glow. Similarly turn VR3 anticlockwise until LED2 begins to glow. Replace the two l.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. ★



Burglar Alarm

By P. J. Fasoli

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 R1, VR1 and R2.

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

COMPONENTS . . .

Resistors
R1, R2 3·9kΩ
R3, R4 39kΩ
R5 12kΩ
R6 22kΩ
R7 560Ω
R8 47Ω
R9 220Ω 1W
All unspecified resistors ½W

Potentiometers
VR1 50kΩ lin. VR2 1MΩ min. preset

Capacitor
C1 470μF 16V electrolytic

Semiconductors
TR1 BFY51 TR2 TIS43
IC1 741 D1 1N4148
CSR1 BTY79-400R (400V 6A thyristor)

Miscellaneous
S1 Push-on, delay switch (see text)
S2 3-pole, 4-way key-operated switch*
S3 S.P.C.O. microswitch
RLA D.P.C.O. relay, 185Ω 12V coil, continental type
WD1 Audible warning device, 12V (RS Componets 248-808)
LP1 12V lamp with holder, green lens
LP2 12V lamp with holder, red lens
B1 HP1 battery
Plug for B1; heat sink for CSR1 (see Fig. 2); socket for IC1 (if required); 12-way terminal strip; aluminium box (see text); alarm bell, 12V; R_x, R_y and sensors (see text)
*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 × 205 × 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 be any value from 10kΩ to 56kΩ. In the prototype system, 33kΩ and 27kΩ were used. Place the key in S2 and

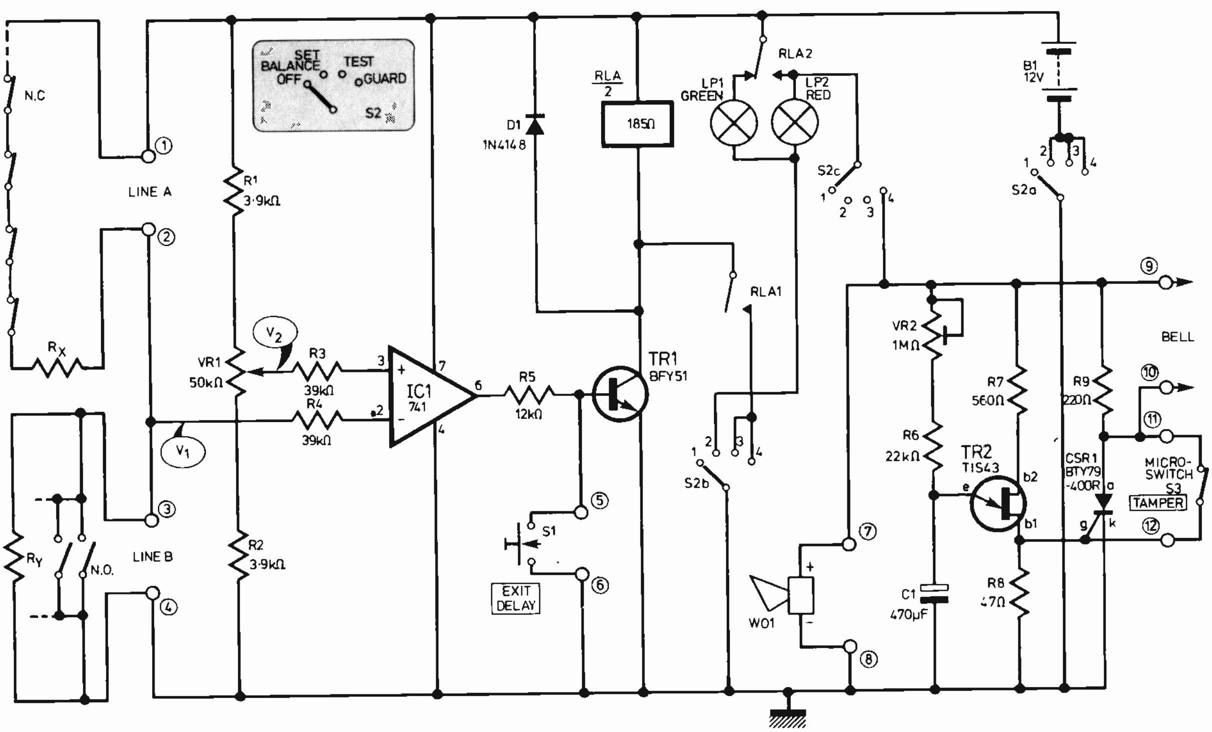


Fig. 1. Circuit diagram of the complete burglar alarm. The values of R_x and R_y are discussed in the text. Circled numbers identify connections to the 12-way terminal block

Burglar Alarm Board

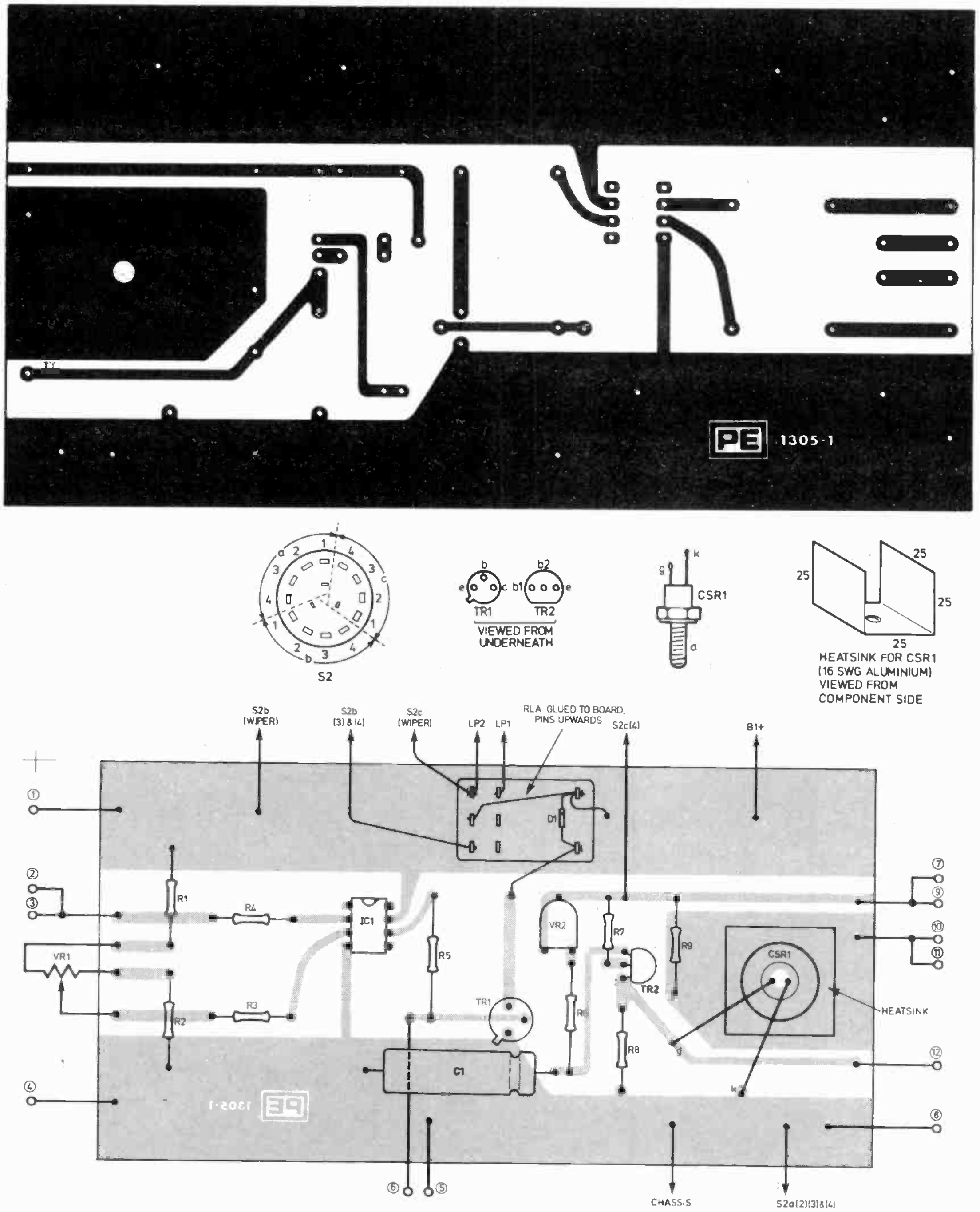


Fig. 2. Printed board pattern shown full size and component layout. The thyristor heat sink is in contact with the mounting stud (anode) and is therefore live. Keep clear of earthed metalwork or wiring

turn to Set Balance. Adjust the balance potentiometer VR1 to the point where the green lamp just comes on, then remove R_x and short out R_y 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 oversubscribed, 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 manufacturers, and A. Marshall (London) Ltd., one of the largest distributors of electronic components.

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

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 eliminati. 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

Part 3 – THE INSTRUCTION SET AND PROGRAMMING TECHNIQUES

MICROPROCESSORS explained

By R.W.Coles

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

•Two Cycle Instructions

Mnemonic	Description	OPR D_3	OPR D_2	OPR D_1	OPR D_0	OPA D_3	OPA D_2	OPA D_1	OPA D_0
	MACHINE GROUP								
NOP	No Operation	0	0	0	0	0	0	0	0
HLT	Halt	0	0	0	0	0	0	0	1
BBS	Branch Back and SRC	0	0	0	0	0	0	1	0
LCR	Command Register to Accumulator	0	0	0	0	0	0	1	1
OR4	Logical OR, Index Register 4 and Accumulator	0	0	0	0	0	1	0	0
OR5	Logical OR, Index Register 5 and Accumulator	0	0	0	0	0	1	0	1
AN6	Logical AND, Index Register 6 and Accumulator	0	0	0	0	0	1	1	0
AN7	Logical AND, Index Register 7 and Accumulator	0	0	0	0	0	1	1	1
DB0	Designate ROM Bank 0	0	0	0	0	1	0	0	0
DB1	Designate ROM Bank 1	0	0	0	0	1	0	0	1
SB0	Select Index Register Bank 0	0	0	0	0	1	0	1	0
SB1	Select Index Register Bank 1	0	0	0	0	1	0	1	1
EIN	Enable Interrupt	0	0	0	0	1	1	0	0
DIN	Disable Interrupt	0	0	0	0	1	1	0	1
RPM	Read Program Memory, Half-Byte per Instruction	0	0	0	0	1	1	1	0
•JCN	Jump Conditional to Address	0	0	0	1	C_1	C_2	C_3	C_4
	$A_2A_2A_2A_2A_1A_1A_1A_1$ Condition Code, $C_1C_2C_3C_4$	A_2	A_2	A_2	A_2	A_1	A_1	A_1	A_1
•FIM	Fetch Immediate, ROM Data D_2D_1	0	0	1	0	R	R	R	0
	to Index Register Pair RRR	D_2	D_2	D_2	D_2	D_1	D_1	D_1	D_1
SRC	Send Register Control	0	0	1	0	R	R	R	1
FIN	Fetch Indirect, Data from ROM to Index Register Pair RRR	0	0	1	1	R	R	R	0
JIN	Jump Indirect to Address in Register Pair RRR	0	0	1	1	R	R	R	1
•JUN	Jump Unconditional to Address	0	1	0	0	A_3	A_3	A_3	A_3
	$A_3A_2A_1$	A_2	A_2	A_2	A_2	A_1	A_1	A_1	A_1
•JMS	Jump to Subroutine at Address	0	1	0	1	A_3	A_3	A_3	A_3
	$A_3A_2A_1$	A_2	A_2	A_2	A_2	A_1	A_1	A_1	A_1
INC	Increment Register RRRR	0	1	1	0	R	R	R	R
•ISZ	Increment Register RRRR. Go to	0	1	1	1	R	R	R	R
	Address A_2A_1 if result is not zero, otherwise go to next instruction	A_2	A_2	A_2	A_2	A_1	A_1	A_1	A_1
ADD	Add Register RRRR to Accumulator with Carry	1	0	0	0	R	R	R	R
SUB	Subtract Register RRRR from Accumulator with Borrow	1	0	0	1	R	R	R	R
LD	Load Contents of Register RRRR to Accumulator	1	0	1	0	R	R	R	R
XCH	Exchange Contents of Register RRRR and Accumulator	1	0	1	1	R	R	R	R
BBL	Branch Back and Load Data DDDD to Accumulator	1	1	0	0	D	D	D	D
LDM	Load Data DDDD to Accumulator	1	1	0	1	D	D	D	D

Mnemonic	Description	OPR D_3	OPR D_2	OPR D_1	OPR D_0	OPA D_3	OPA D_2	OPA D_1	OPA D_0
	I/O and RAM GROUP								
WRM	Accumulator to Selected RAM Main Memory Character	1	1	1	0	0	0	0	0
WMP	Accumulator to Selected RAM Output Port	1	1	1	0	0	0	0	1
WRR	Accumulator to Selected ROM Output Port	1	1	1	0	0	0	1	0
WPM	Accumulator to Selected Half-Byte in Read/Write Program Memory	1	1	1	0	0	0	1	1
WR0	Accumulator to Selected RAM Status Character 0	1	1	1	0	0	1	0	0
WR1	Accumulator to Selected RAM Status Character 1	1	1	1	0	0	1	0	1
WR2	Accumulator to Selected RAM Status Character 2	1	1	1	0	0	1	1	0
WR3	Accumulator to Selected RAM Status Character 3	1	1	1	0	0	1	1	1
SBM	Subtract Selected RAM Main Memory Character from Accumulator with Borrow	1	1	1	0	1	0	0	0
RDM	Selected RAM Main Memory Character to Accumulator	1	1	1	0	1	0	0	1
RDR	Selected ROM Input Port to Accumulator	1	1	1	0	1	0	1	0
ADM	Add Selected RAM Main Memory Character to Accumulator with Carry	1	1	1	0	1	0	1	1
RD0	Selected RAM Status Character 0 to Accumulator	1	1	1	0	1	1	0	0
RD1	Selected RAM Status Character 1 to Accumulator	1	1	1	0	1	1	0	1
RD2	Selected RAM Status Character 2 to Accumulator	1	1	1	0	1	1	1	0
RD3	Selected RAM Status Character 3 to Accumulator	1	1	1	0	1	1	1	1
	ACCUMULATOR GROUP								
CLB	Clear Accumulator and Carry	1	1	1	1	0	0	0	0
CLC	Clear Carry	1	1	1	1	0	0	0	1
IAC	Increment Accumulator	1	1	1	1	0	0	1	0
CMC	Complement Carry	1	1	1	1	0	0	1	1
CMA	Complement Accumulator	1	1	1	1	0	1	0	0
RAL	Rotate Left, Accumulator and Carry	1	1	1	1	0	1	0	1
RAR	Rotate Right, Accumulator and Carry	1	1	1	1	0	1	1	0
TCC	Transmit Carry to Accumulator, Clear Carry	1	1	1	1	0	1	1	1
DAC	Decrement Accumulator	1	1	1	1	1	0	0	0
TCS	Transfer Carry Subtract and Clear Carry	1	1	1	1	1	0	0	1
STC	Set Carry	1	1	1	1	1	0	1	0
DAA	Decimal Adjust Accumulator	1	1	1	1	1	0	1	1
KBP	Keyboard Process	1	1	1	1	1	1	0	0
DCL	Designat Command Line	1	1	1	1	1	1	0	1

NOTES:

(1) The condition code is assigned as follows:
- $C_1 = 1$ Invert jump condition
- $C_1 = 0$ Not invert jump condition
- $C_2 = 1$ Jump if accumulator is zero
- $C_3 = 1$ Jump if carry/link is a 1
- $C_4 = 1$ Jump if test signal is a 0

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

(3) RRRR 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).

Fig. 3.1. The complete instruction set of the Intel 4040. Note that although the 4040 is a 4 bit MPU, it uses an 8 bit instruction code

"hex" code there are always a few letters to remind you that this *is* "hex" whereas a list of "octal" can look very like a list of decimal numbers which of course it is not, since, for example, 77 octal equals 63 decimal when interpreted as a numerical value. See Fig. 3.2 and Fig. 3.3.

INSTRUCTIONS AND NUMBERS

This last point concerning octal code raises the interesting question of just how the MPU differentiates between 11101000 the **instruction** which means (say) "subtract from memory", and 11101000 the **number** which has a value of 232 in decimal.

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 jumped 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)

BINARY	HEX	DECIMAL
0 0 0 0	0	0
0 0 0 1	1	1
0 0 1 0	2	2
0 0 1 1	3	3
0 1 0 0	4	4
0 1 0 1	5	5
0 1 1 0	6	6
0 1 1 1	7	7
1 0 0 0	8	8
1 0 0 1	9	9
1 0 1 0	A	10
1 0 1 1	B	11
1 1 0 0	C	12
1 1 0 1	D	13
1 1 1 0	E	14
1 1 1 1	F	15

EXAMPLE: 1 1 0 1 / 0 0 1 1 / 1 1 1 1 / 0 1 0 0 BINARY
= D 3 F 4 HEX

Fig. 3.2. Binary to hexadecimal conversion table

BINARY	OCTAL	DECIMAL
0 0 0	0	0
0 0 1	1	1
0 1 0	2	2
0 1 1	3	3
1 0 0	4	4
1 0 1	5	5
1 1 0	6	6
1 1 1	7	7

EXAMPLE: 1 / 1 0 1 / 0 0 1 / 1 1 1 / 1 1 0 / 1 0 0 BINARY
= 1 5 1 7 6 4 OCTAL

Fig. 3.3. Binary to octal conversion table

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—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.

(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 a single word which is stored back into the accumulator. The execution of this group of instructions requires the arithmetic and logic unit (ALU) described last month.

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:

JNZ — 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, or 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, which of 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?

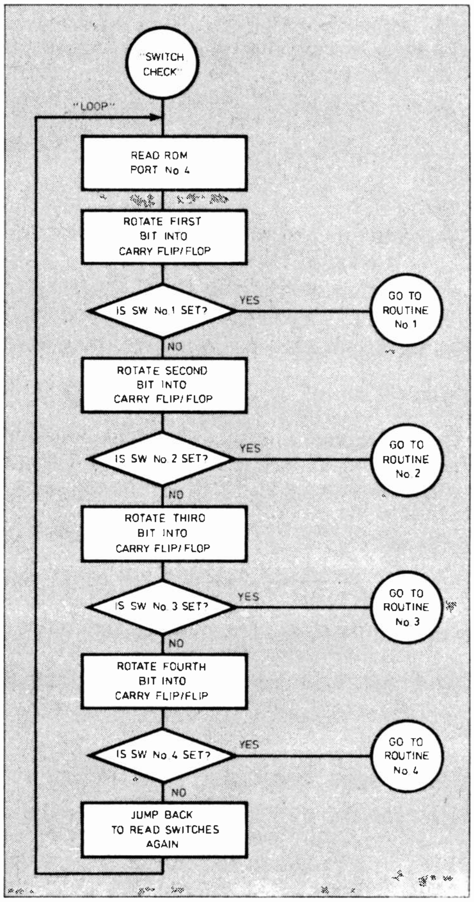


Fig. 3.4 Switch Check flow chart

These are questions which can only be answered in context, depending as they do on how much program space is available and how much it costs, and how much room there is for extra hardware, and how much it, in turn, costs.

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.

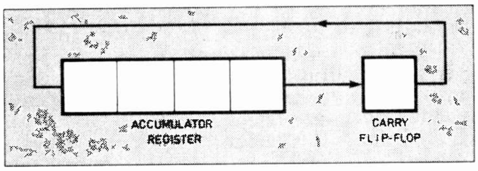


Fig. 3.5. Action of RAR instruction

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.

Table 3.1
"SWITCH CHECK" PROGRAM SEGMENT

LABEL	MNEMONIC	OPERAND	COMMENT
LOOP	FIM	RP0, 40 Hex	Load port address code to register pair 0.
	SRC	RP0	Select port.
	RDR		Read port into accumulator.
	RAR		Rotate switch 1 into CARRY.
	JCN	CARRY SET, "ROUTINE 1"	Jump to address "Routine 1" if CARRY is set.
	RAR		Switch 2 to CARRY.
	JCN	CARRY SET, "ROUTINE 2"	Test switch 2.
	RAR		Switch 3 to CARRY.
	JCN	CARRY SET, "ROUTINE 3"	Test switch 3.
	RAR		Switch 4 to CARRY.
	JCN	CARRY SET, "ROUTINE 4"	Test switch 4.
	JUN	"LOOP"	Jump to LOOP since no switches set.

RP = Register Pair Hex = Hexadecimal

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.

BY FRANK W. HYDE

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 millenia 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 1967 *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 spite of this there would be a gain 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 cleaning 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.

SEMICONDUCTOR UPDATE... By R.W. COLES

T100 T300
TL340 F100L

HI-Z PRE. AMP

Are you bored with analogue integrated circuits which do everything but polish your shoes, and digital integrated circuits which boast so many gates and functions that it sometimes seems that their I.Q. 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* j.f.e.t. 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 j.f.e.t., 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 4·0 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 aid input stages, where its 50 microamp supply drain is important, while the 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 piezo-electric microphones.

GOODBYE ZENERS

If you could design your own ideal Zener regulator diode what would you list as desirable characteristics? *I* 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 nowhere near 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 Celcius, 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 TO92 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 microprocessor 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 the standard TTL components presently 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.

MICROPROCESSORS: A SEMINAR REPORT

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, Motorola, Texas 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 high. The greatest possiblities 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.r.t. 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 I²L 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 Exorciser 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 SC/MP 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 uninterrupted success. 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 which in 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 TMS9800 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 990/4 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.

ONE ARM BANDIT

...for home amusement

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.

COMPONENTS...

Resistors

R1	33kΩ	R9	180Ω
R2	82Ω	R10	47kΩ
R3	180Ω	R11	15kΩ
R4	33kΩ	R12	1kΩ
R5	82Ω	R13–34	220Ω
R6	180Ω	R35	1kΩ
R7	33kΩ	R36	220Ω
R8	82Ω		

All $\frac{1}{4}$W 20% tolerance

Capacitors

C1	4,700pF	C4	100μF elect. 25V
C2	5,700pF	C5	2,200μF elect. 25V
C3	9,400pF	C6	0·33μF

Note: C2 and C3 are made up

Semiconductors

TR1	BC184
TR2–4	2N4853 (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 6·5V 1A mains transformer

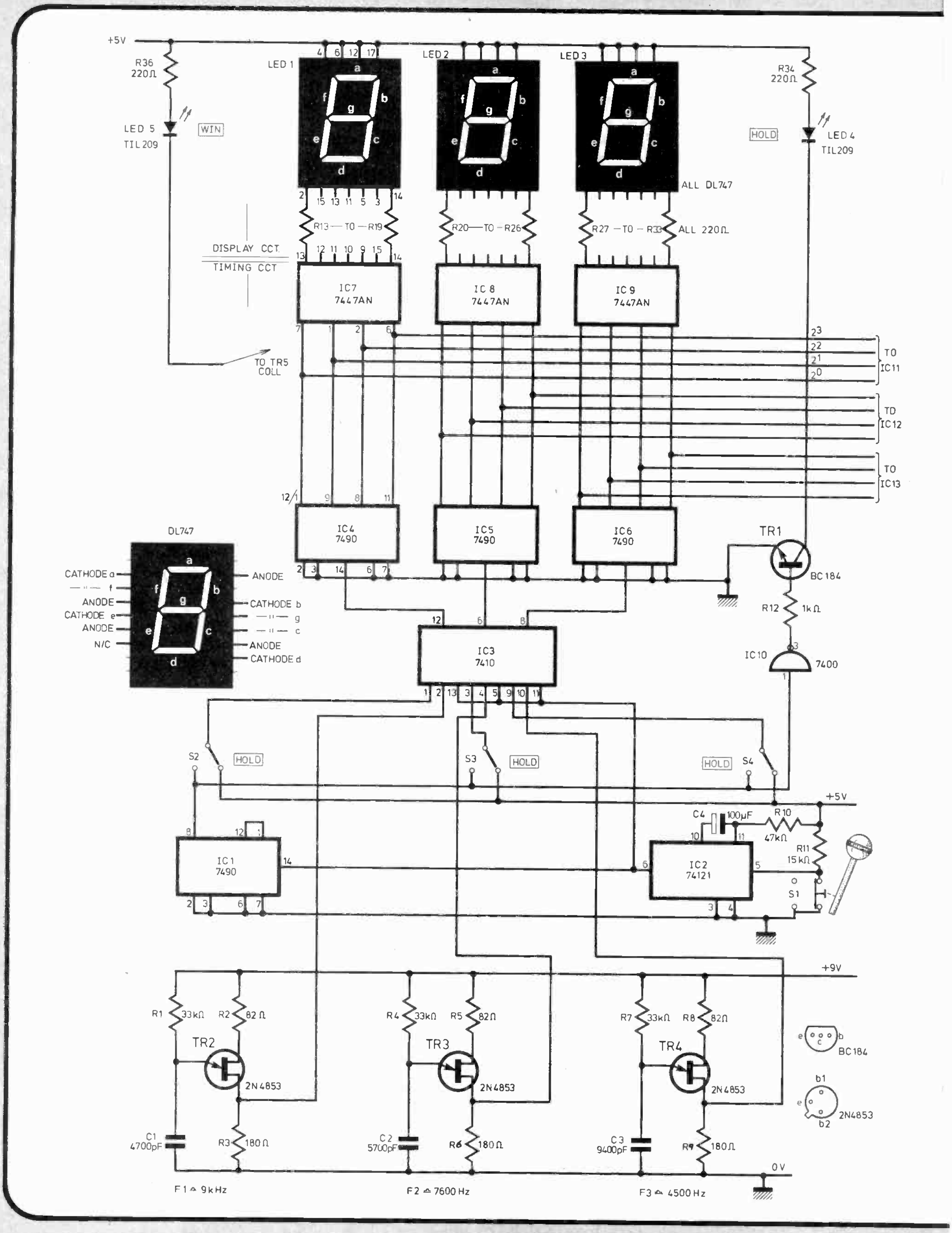
Switches

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)


+5V
R36 220Ω
LED 5 TIL209
WIN
LED 1
LED 2
LED 3
ALL DL747
R34 220Ω
HOLD
LED 4 TIL209
R13 — TO — R19
R20 — TO — R26
R27 — TO — R33
ALL 220Ω
DISPLAY CCT
TIMING CCT
IC7 7447AN
IC8 7447AN
IC9 7447AN
TO TR5 COLL
TO IC11
TO IC12
TO IC13
IC4 7490
IC5 7490
IC6 7490
TR1
BC184
R12 1kΩ
IC10 7400
DL747
CATHODE a
ANODE
CATHODE e
N/C
CATHODE b
CATHODE d
IC3 7410
S2
S3
S4
+5V
C4 100µF
R10 47kΩ
R11 15kΩ
S1
IC1 7490
IC2 74121
+9V
R1 33kΩ
R2 82Ω
TR2
2N4853
R4 33kΩ
R5 82Ω
TR3
R7 33kΩ
R8 82Ω
TR4
C1 4700pF
R3 180Ω
C2 5700pF
R6 180Ω
C3 9400pF
R9 180Ω
0V
F1 ≙ 9kHz
F2 ≙ 7600Hz
F3 ≙ 4500Hz
BC184
2N4853

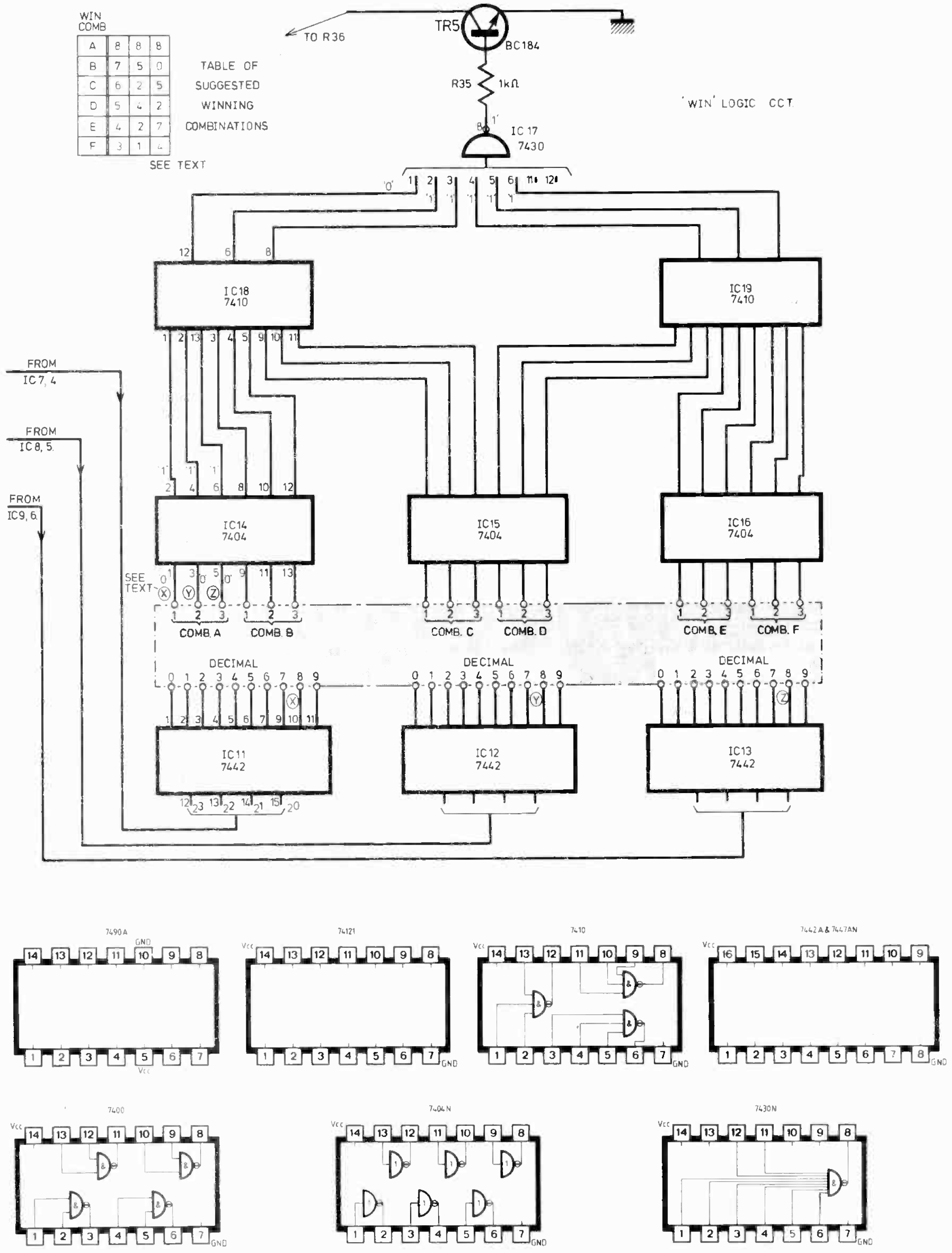
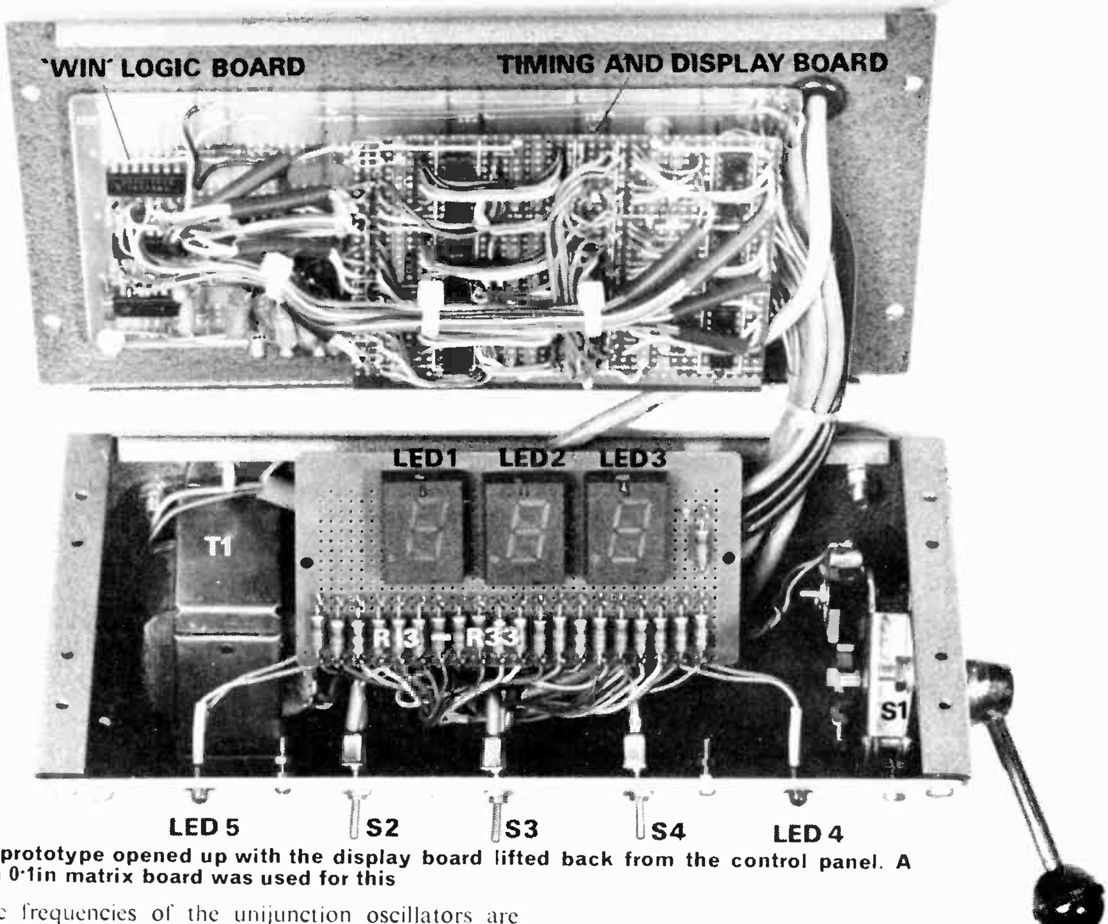


Fig. 1. The timing, display and win logic circuitry for the One Armed Bandit. The shaded panel embraces the Veropins used for patching arbitrary winning combinations. The six combinations used in the prototype are in the top table with patching for combination "A" indicated by linking the Xs, Ys and 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, 7·6 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.

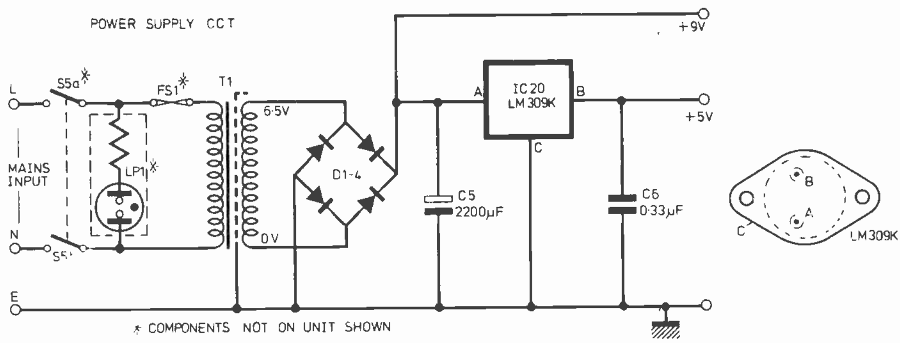


Fig. 2. The power supply circuit

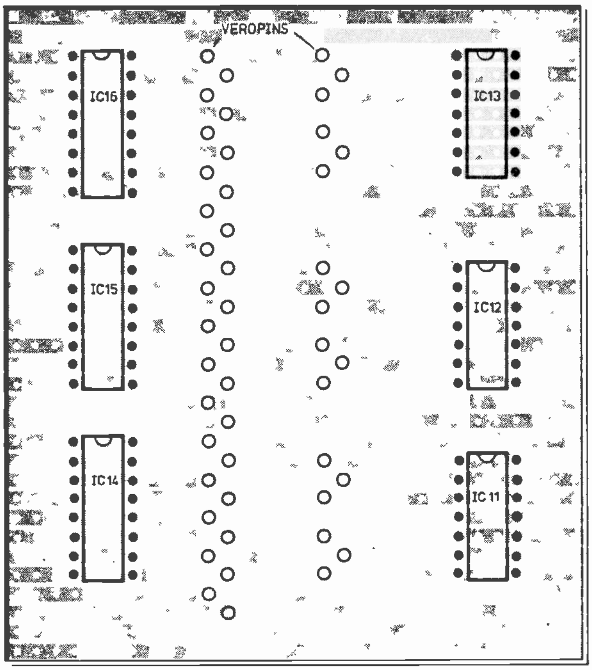


Fig. 3. Suggested i.c layout for the 0·1in matrix win logic Veroboard. A Veropin arrangement for patching is shown

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.

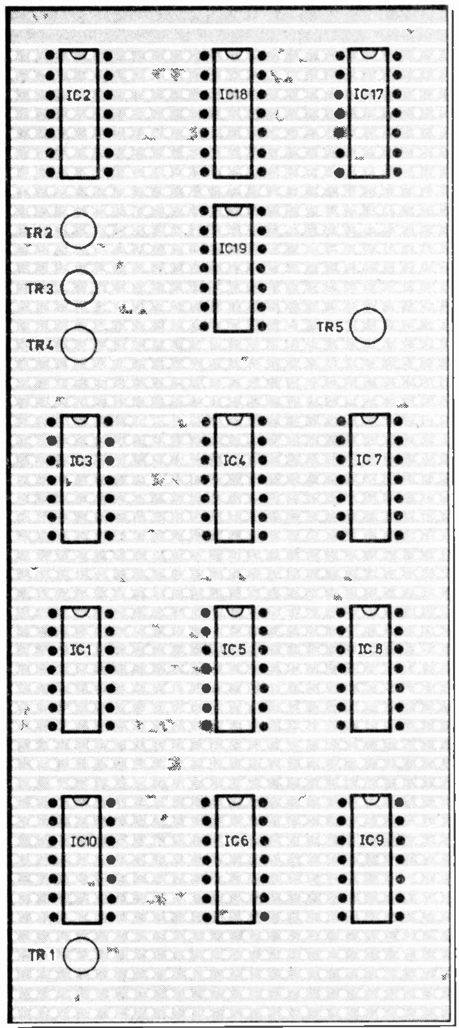
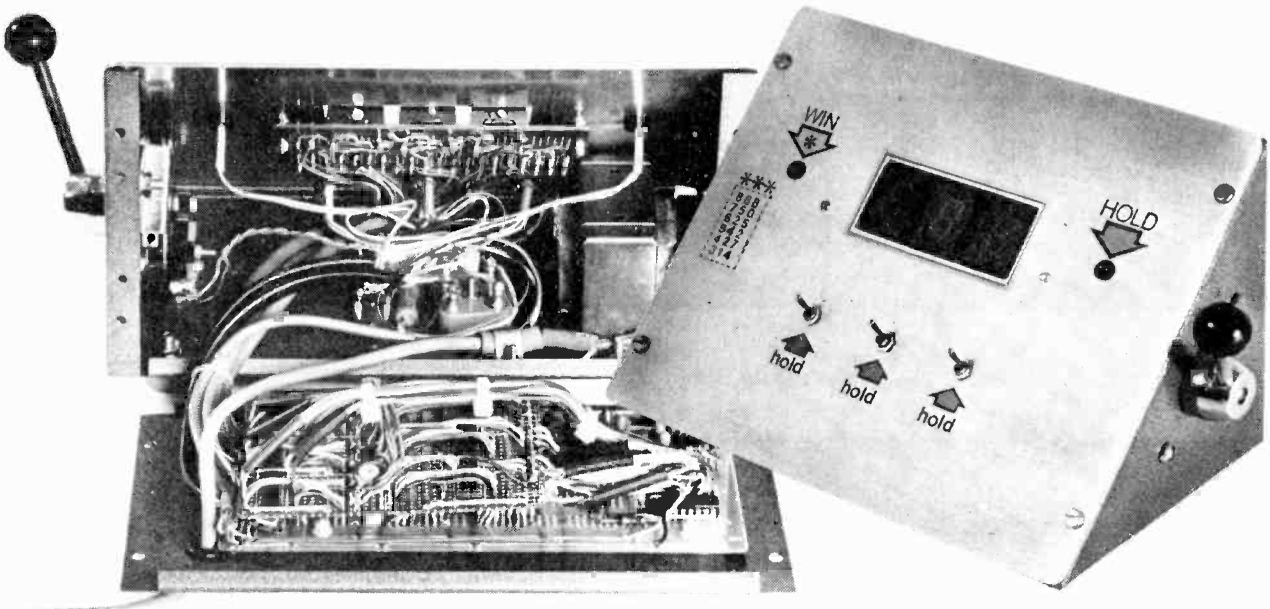


Fig. 4. In the prototype the timing and display logic circuitry was mounted on an ITT ISEP dilboard. Since this could be difficult to obtain and expensive, an alternative Veroboard layout for just the semiconductors is given



Showing the control panel and internal assembly of the prototype. The p.s.u. is mounted on the base panel. The timing and win circuit boards are shown sandwich mounted on the rear panel using nylon nuts and screws. Cable ties should be used with looms

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 ¼in shaft multiway 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. ★

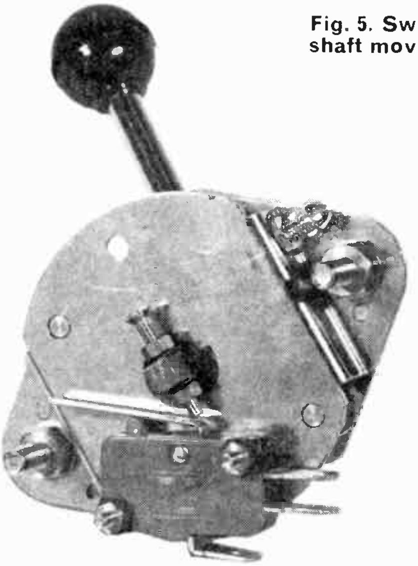
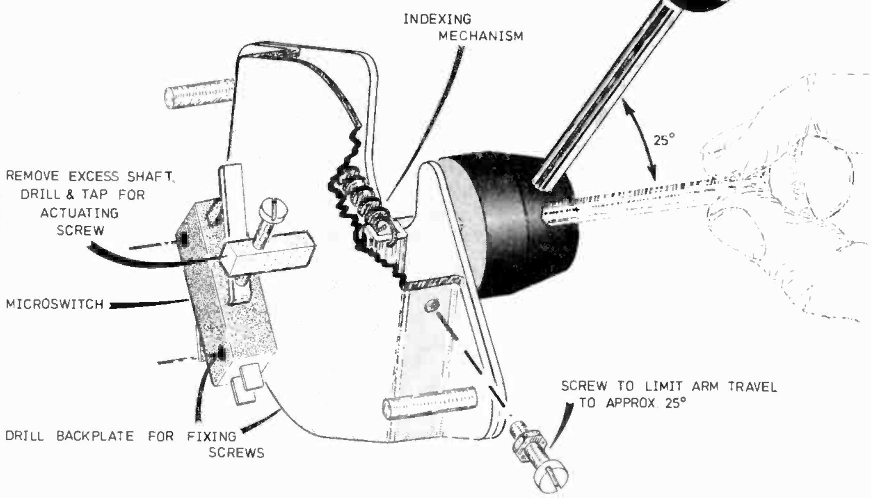


Fig. 5. Switch assembly modification for both limiting the shaft movement and actuating a microswitch



..NEXT MONTH in PE

TV SPORTCENTRE

FOOTBALL : HOCKEY
TENNIS : SQUASH, ETC.

Full constructional details of a television games unit based on the General Instrument AY-3-8500 l.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

DARKROOM TIMER

By A. Koltai and G. S. Brimble B.Sc

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 l.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.

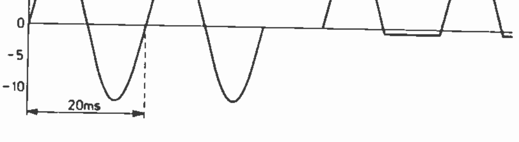


Fig. 1. The a.c. output of T1 is rectified and clipped by Zener D1 to provide a 50Hz square wave drive to the divider chain

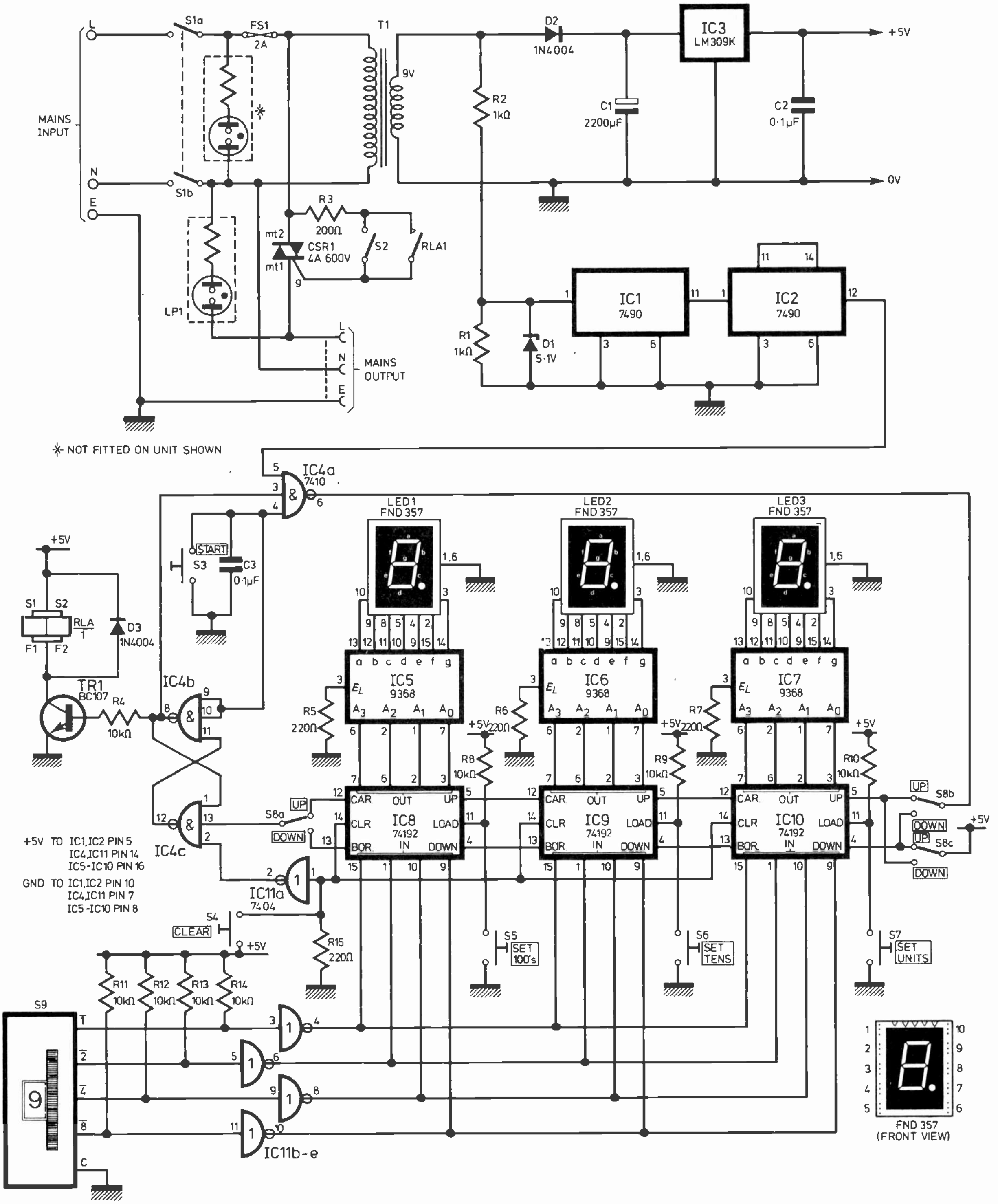
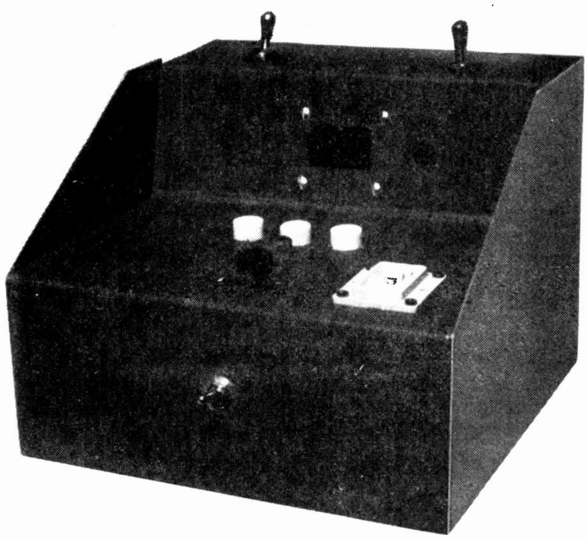


Fig. 2. Circuit diagram of the complete darkroom timer. Relay RLA is a twin-coil reed type with the two coils connected in parallel for 5V operation (see Components list)

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.



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

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.

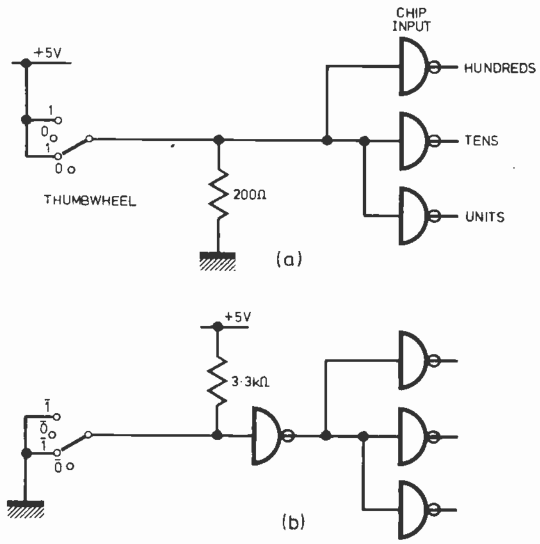


Fig. 3. (a) A heavy current is drawn from the 5V supply via the low value resistor if a BCD thumbwheel switch is used to drive the counter chip direct
(b) Using a BCD complement switch and one inverter considerably reduces the load on the 5V supply as a higher value resistor can be used

THUMBWHEEL SWITCH

The preset input digit is set on a BCD-coded thumb-wheel 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 ORed 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 starting to yield $\pm 0{\cdot}5$ second accuracy. This is a fraction of a stop at normal processing times.

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 counter circuit is easily constructed on i.c. stripboard. This assembly bolts beneath the panel carrying the pushbuttons. In the prototype these buttons were home-made to provide large size (for finding in the dark) without being expensive.

DISPLAYS

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. ★

COMPONENTS . . .

Resistors

R1, R2	1kΩ	
R3	200Ω	1W
R4, R8–R14	10kΩ	(8 off)
R5–R7, R15	220Ω	(4 off)

½W unless otherwise specified

Capacitors

C1	2,200µF 16V electrolytic
C2, C3	0·1µF ceramic disc

Semiconductors

IC1, IC2	7490
IC3	LM309K 5V regulator
IC4	7410
IC5–IC7	9368PC Fairchild (3 off)
IC8–IC10	74192 (3 off)
IC11	7404
TR1	BC107
LED1–LED3	FND357 Fairchild (3 off)
D1	BZY88 C5V1 5·1V 400mW Zener
D2, D3	1N4004
CSR1	6A 400V Triac

Switches

S1	D.P.S.T. mains toggle
S2	S.P.S.T. mains toggle
S3–S7	S.P. push-to-make push buttons, see text (5 off)
S8	3-pole 2-way rotary or toggle (e.g. RS Components 339–471)
S9	Thumbwheel edge switch, BCD complement output (e.g. RS Components 338–181, plus mounting cheeks 338–197)

Miscellaneous

T1	9V 2A secondary
RLA	Reed relay, 5V coil, 240V a.c. contacts (e.g. RS Components coil 349–030, windings paralleled, plus reed switch 338–147)

LP1 240V neon indicator; F1 2A fuse with holder; Heat-sinks for IC3 and CSR1

Note:

The 9368PC and FND357 are available from S.C. European Components Ltd., Unit 9, M40 Industrial Centre, Blenheim Road, High Wycombe, Bucks. Prices are £2·07 and £1·29 each respectively, plus 50p post and packing per order, plus 8% VAT

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

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 she 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 × 80 × 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 stethoset 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 lapsed time up to 9 hours, 59min 59·9secs. 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 (+, −, ×, ÷) 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.


The Casio CQ-1 from Tempus


Stoneleigh 3C15 Tester

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 on 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 in the normal way.

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 manual 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 forget!

Strictly

by K. Lenton-Smith

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 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 up at 8′ 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.

The E.O.C.S. was founded some twenty years ago by a small group of enthusiasts headed by Arthur le 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 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).

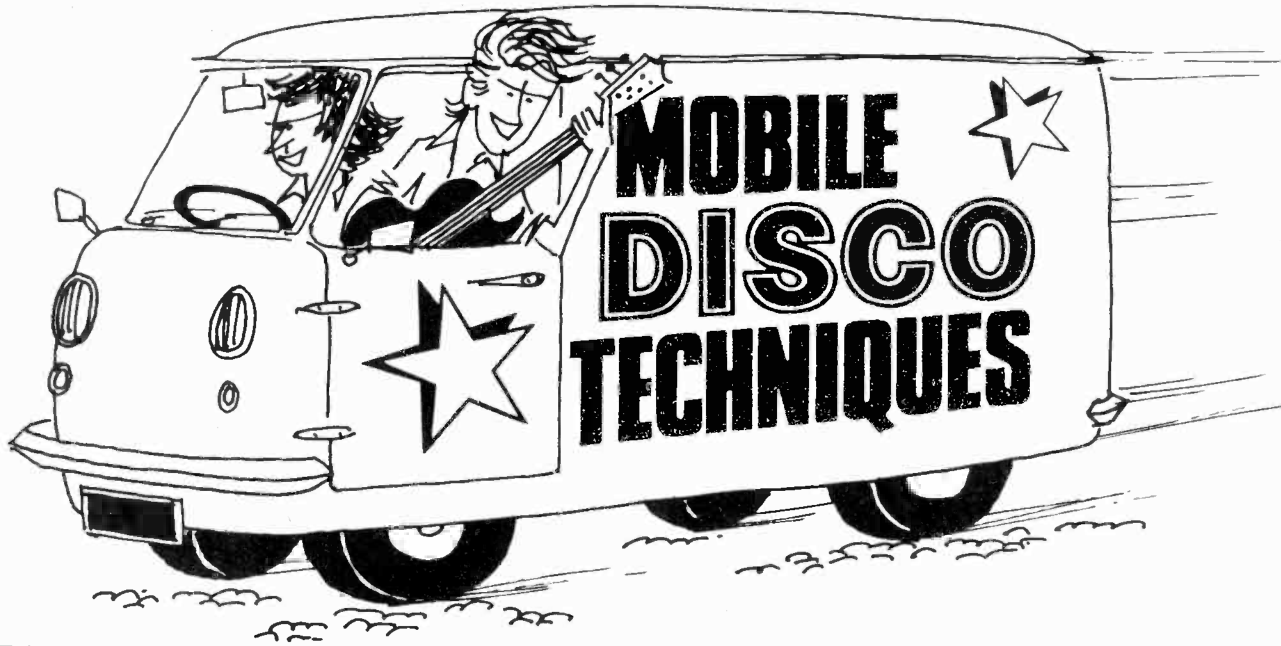
Listening to the expert synthesiser player on disc, and reading the record sleeve notes, brings one message home forcibly. A few minutes of a L.P. recording probably involved many hours work. It needs *time* to obtain the precise effect you are looking for, so multi-recording at leisure is the only respectful 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" 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 0·1μF 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.

Signals from the "Minisonic" 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.



PART 2 **By N. McLeod**

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 direct 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.

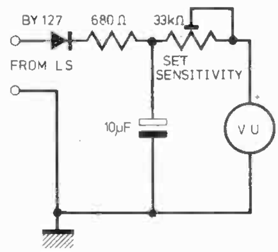


Fig. 6a. How to drive a VU or similar meter directly from the loudspeaker terminals of an amplifier

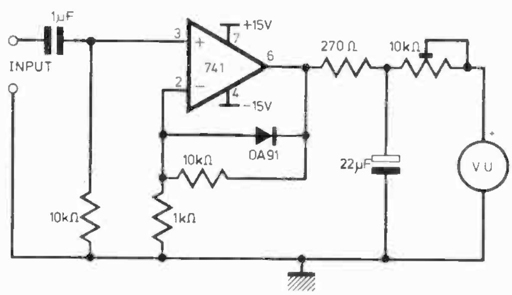


Fig. 6b. This circuit will drive VU meters from ordinary line-level sources

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 shrill, a close second.

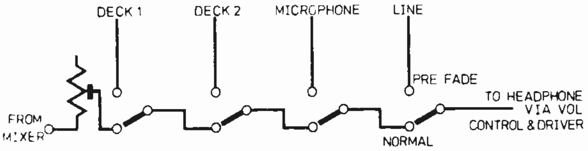


Fig. 7. How a bank of PO keyswitches may be used to select pre-fade inputs or the main output from the console mixer

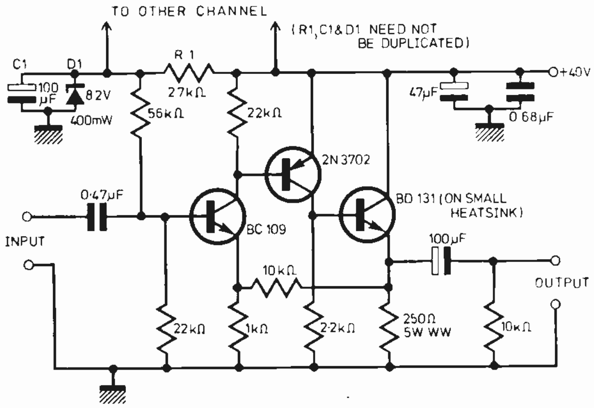


Fig. 8. High quality Class A headphone driver circuit for high impedance headphones (600Ω and above)

Table 1: POWER OUTPUT FOR VARIOUS SUPPLIES AND LOUDSPEAKER IMPEDANCES

Supply Voltage	Load Impedance 4Ω	8Ω	16Ω
80	178W	89W	45W
70	134W	67W	34W
60	96W	48W	24W
55	80W	40W	20W
50	64W	32W	16W
45	50W	25W	13W
40	38W	19W	10W
35	28W	14W	7W
30	20W	10W	5W

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.

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, below about 300 ohms, will require a Class AB driver—there are a multitude of integrated circuits which will do this job adequately.

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 your 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 accoustic 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 moiré 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, notepaper 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

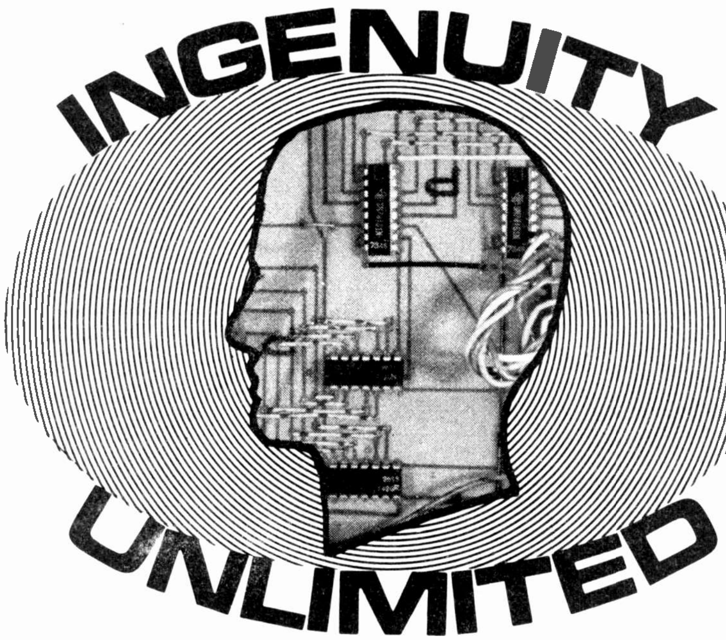
Round every record label is the legend "Unauthorised Copying, Public Performance and Broadcasting of this record prohibited", or words to that effect. Most DJs ignore it completely. The organisation concerned with administering the public performance of gramophone records is the Performing Rights Society 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! ★



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.

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.

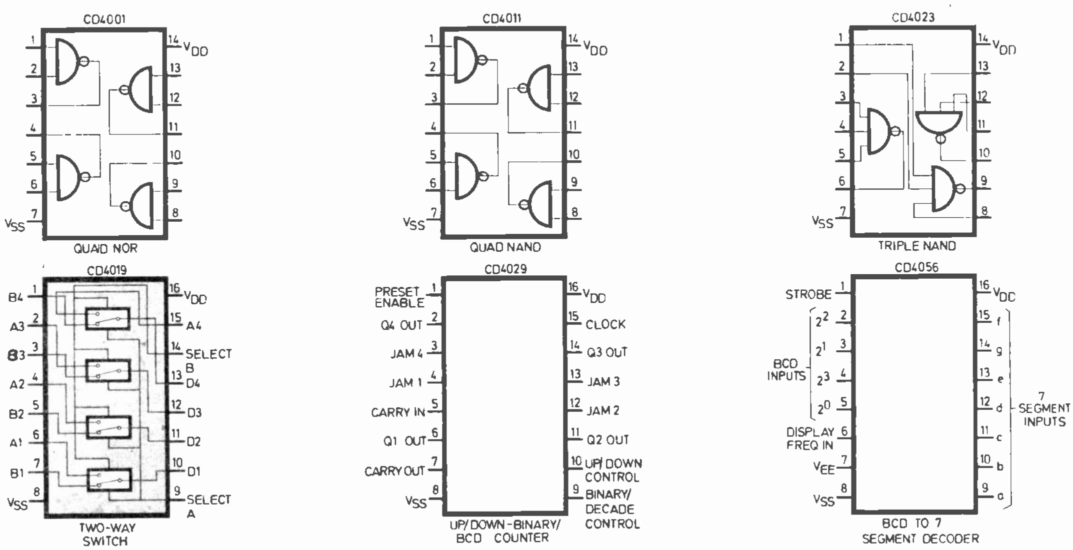


Fig. 1a

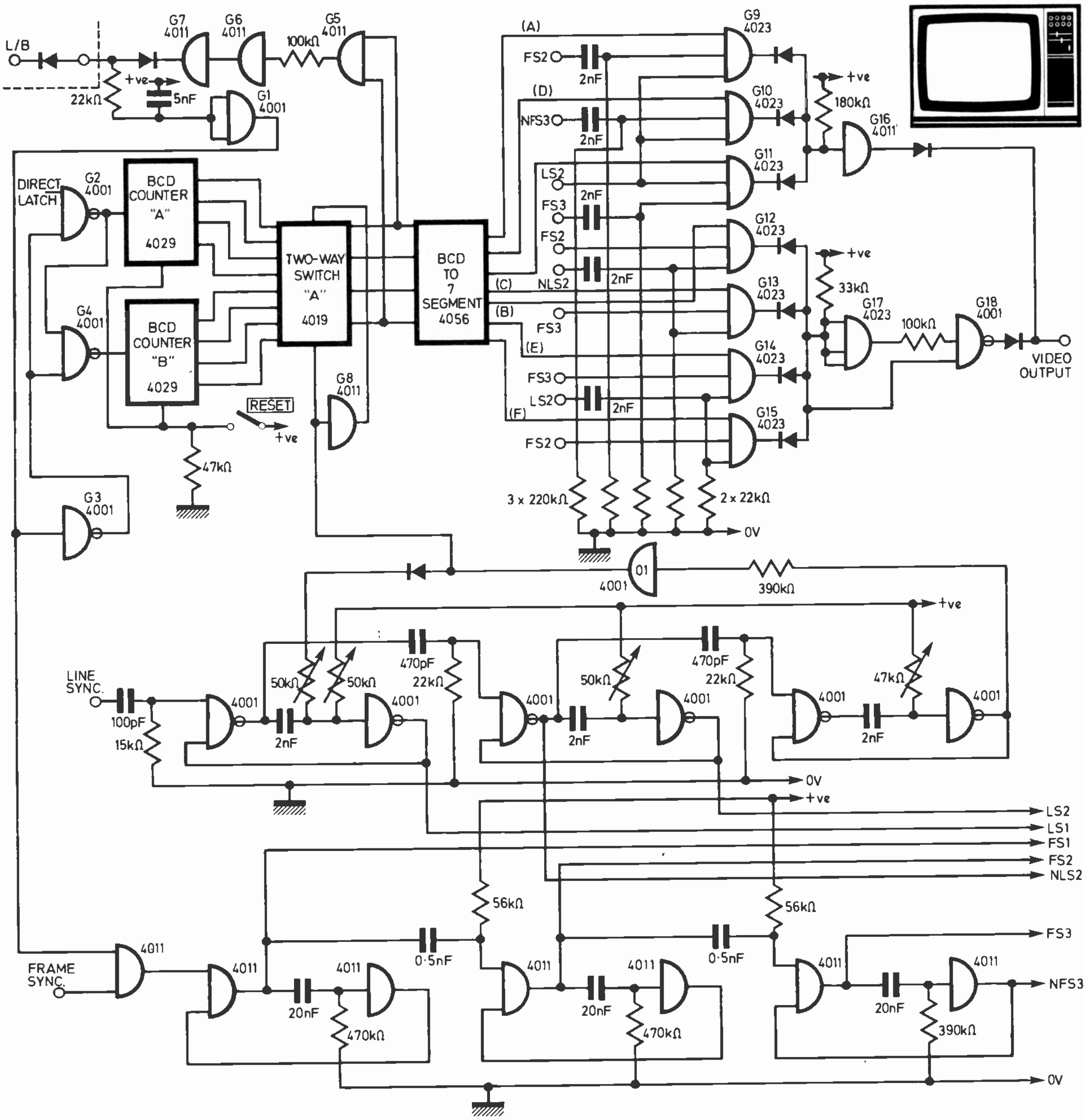


Fig. 1b

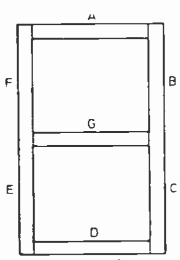


Fig. 2a

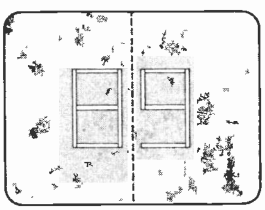


Fig. 2b

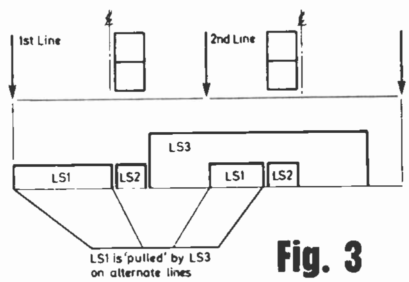
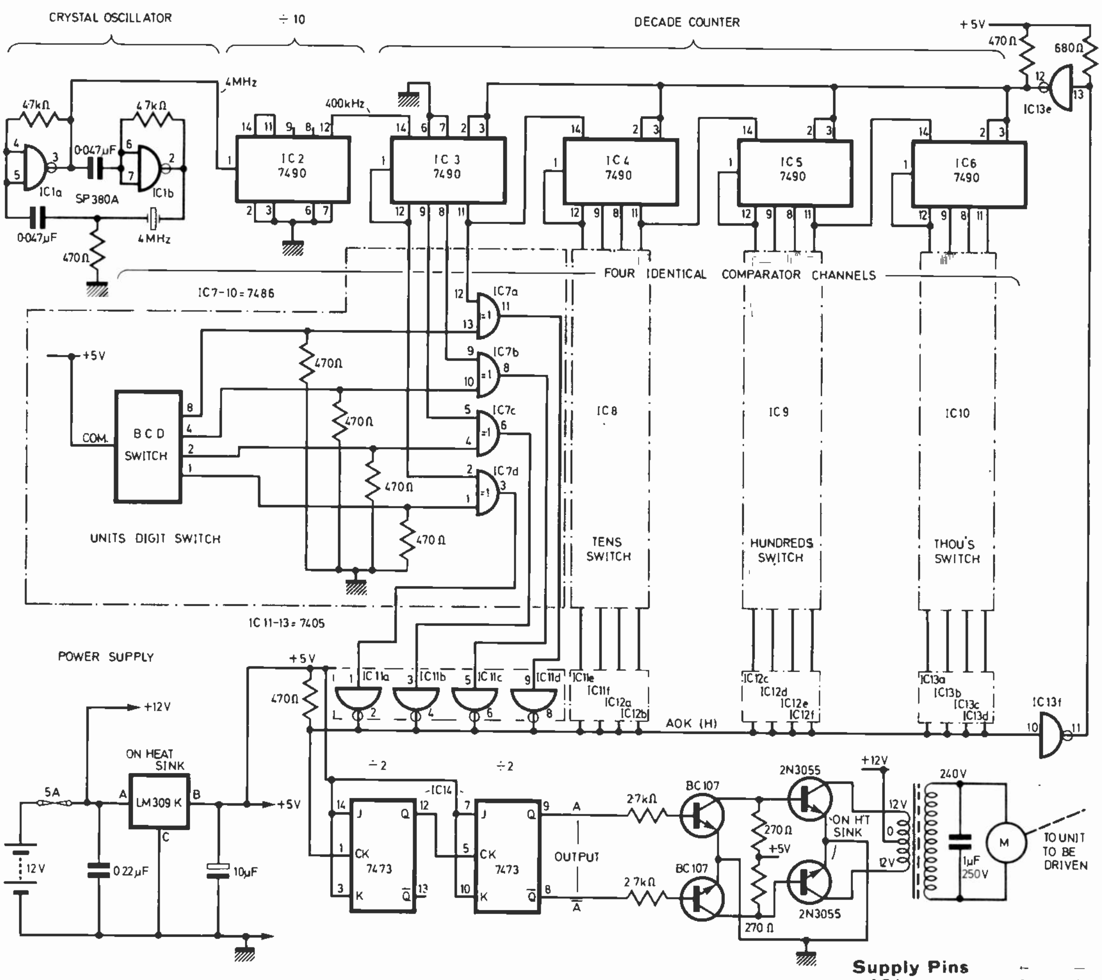


Fig. 3

MOTOR DRIVER



Supply Pins	+	—
IC1	8	1
IC2–6	5	10
IC7–13	14	7
IC14	4	11

Fig. 1

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, parity 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,
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200V	0·64	0·64	0·75	0·75	0·87	0·87	0·97	1·01	1·17	1·17
400V	0·77	0·78	0·80	0·83	0·97	1·01	1·13	1·19	1·70	1·74
600V	0·96	0·99	1·01	1·10	1·21	1·26	1·42	1·50	2·11	2·17

N.B. Column (a) without internal trigger, (b) with internal trigger.

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7405	0·18	7491AN	0·65
7408	0·18	7492	0·57
7409	0·18	7493	0·45
7410	0·16	7494	0·85
7412	0·25	7495	0·67
7413	0·40	7496	0·82
7414	0·72	74100	1·07
7417	0·43	74107	0·35
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7425	0·30	74122	0·47
7427	0·30	74123	0·65
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7432	0·28	74145	0·68
7437	0·30	74154	1·30
7441AN	0·76	74164	0·93
7442	0·65	74165	0·93
7445	0·90	74174	1·40
7447AN	0·81	74175	0·94
7448	0·81	74180	1·06
7470	0·32	74181	2·70
7472	0·26	74191	1·33
7473	0·30	74192	1·20
7474	0·32	74193	1·35
7475	0·47	74194	1·20
7476	0·36	74196	1·64

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NE566	1·50*
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BA158	0·22	OA85	0·12
BA159	0·25	OA90	0·08
BY206	0·15	OA91	0·08
BY207	0·20*	OA200	0·09
BYX36-300	0·12	IN914	0·04*
BYX36-600	0·15	IN4001	0·04*
BYX36-900	0·18	IN4002	0·05*
BYX36-1200	0·21	IN4003	0·06*
BYX38-300	0·50	IN4004	0·07*
BYX38-600	0·55	IN4005	0·08*
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AC127	0·16	BC119	0·25	BC237	0·16*	BD137	0·40*	BF200	0·40	BSX78	0·35	TIP32A	0·64	2N3133	0·30
AC128	0·16	BC125	0·18*	BC238	0·16*	BD138	0·48*	BF218	0·30	BSY52	0·28	TIP41A	0·68	2N3134	0·30
AC128K	0·25	BC126	0·20*	BC300	0·34	BD139	0·58*	BF219	0·30	BSY53	0·39	TIP42A	0·72	2N3137	1·10
AC141	0·22	BC140	0·32	BC301	0·32	BD144	2·20	BF220	0·28	BSY54	0·33	2N404	0·40	2N3440	0·56
AC141K	0·34	BC141	0·28	BC302	0·40	BD157	0·60	BF224J	0·18*	BSY55	0·74	2N696	0·20	2N3442	1·20
AC142	0·18	BC142	0·23	BC303	0·46	BD181	0·86	BF244	0·17*	BSY65	0·35	2N697	0·20	2N3570	3·60
AC142K	0·32	BC143	0·23	BC307	0·15*	BD182	0·92	BF257	0·30	BSY76	0·20	2N706	0·15	2N3702	0·10*
AC176	0·16	BC144	0·30	BC308	0·16*	BD183	0·97	BF258	0·35	BSY78	0·75	2N718	0·22	2N3703	0·10*
AC176K	0·32	BC147	0·09*	BC309	0·18*	BD184	1·20	BF259	0·48	BSY95A	0·16	2N929	0·18	2N3704	0·10*
AC187	0·18	BC148	0·09*	BC310	0·20*	BD232	0·60	BF336	0·35*	BU105	1·80*	2N1131	0·15	2N3705	0·10*
AC187K	0·36	BC149	0·09*	BC317	0·12*	BD233	0·48	BF337	0·32*	BU105/02	1·90*	2N1132	0·16	2N3706	0·10*
AC188	0·18	BC152	0·25*	BC319	0·13*	BD237	0·55	BF338	0·45*	BU108	3·00*	2N1302	0·40	2N3707	0·10*
AC188K	0·32	BC153	0·18*	BC320	0·18*	BD238	0·60	BFW30	1·25	BU109	2·50*	2N1303	0·40	2N3708	0·09*
AD149	0·45	BC157	0·09*	BC321	0·18*	BD410	0·60	BFW59	0·30	BU126	1·60*	2N1304	0·45	2N3709	0·09*
AD161	0·35	BC158	0·09*	BC323	1·16*	BDX32	2·30	BFW60	0·36	BU133	1·60*	2N1305	0·45	2N3710	0·10*
AD162	0·35	BC159	0·09*	BC327	0·18*	BDY10	1·50	BFX29	0·26	BU204	1·60*	2N1306	0·50	2N3711	0·10*
AF114	0·20	BC160	0·32	BC328	0·16*	BDY11	2·00	BFX30	0·30	BU205	1·90*	2N1307	0·50	2N3715	1·70
AF115	0·20	BC161	0·38	BC337	0·17*	BDY20	0·80	BFX84	0·23	BU206	2·40*	2N1308	0·60	2N3716	1·80
AF116	0·20	BC168	0·09*	BC338	0·17*	BDY38	0·60	BFX85	0·25	BU208	2·60*	2N1309	0·60	2N3771	1·60
AF117	0·20	BC169	0·12*	BC407	0·22*	BDY60	1·70	BFX86	0·25	MJ480	0·80	2N1711	0·24	2N3772	1·90
AF118	0·50	BC169C	0·14*	BC408	0·22*	BDY61	1·55	BFX87	0·20	MJ481	1·05	2N2102	0·44	2N3773	2·10
AF124	0·25	BC170B	0·12*	BCY30	0·55	BDY62	1·15	BFX88	0·20	MJ490	0·90	2N2217	0·30	2N3819	0·28*
AF125	0·25	BC171	0·12*	BCY31	0·55	BDY95	2·14	BFX89	0·90	MJ491	1·15	2N2369	0·14	2N3904	0·16*
AF126	0·25	BC172B	0·12*	BCY32	0·60	BF121	0·50	BFY11	1·10	MJE340	0·40*	2N2369A	0·14	2N3906	0·11*
AF139	0·35	BC182	0·11*	BCY33	0·55	BF123	0·50	BFY18	0·50	MJE520	0·45	2N2483	0·20	2N4123	0·14*
AF239	0·37	BC182L	0·12*	BCY34	0·55	BF127	0·50	BFY40	0·50	MJE521	0·55	2N2484	0·16	2N4124	0·14*
AL102	1·45	BC183	0·10*	BCY38	0·50	BF157	0·50	BFY41	0·60	OC43	0·95	2N2646	0·50	2N4290	0·14*
AL103	1·30	BC183L	0·10*	BCY39	1·15	BF177	0·25	BFY50	0·20	OC44	0·32	2N2711	0·20	2N4291	0·14*
AU107	3·30*	BC184	0·11*	BCY40	0·75	BF178	0·30	BFY51	0·18	OC45	0·32	2N2712	0·15	2N4292	0·14*
AU110	1·75*	BC184L	0·12*	BCY42	0·30	BF179	0·30	BFY52	0·19	OC46	0·20	2N2904A	0·20	2N4347	1·10
AU113	1·60*	BC186	0·20*	BCY54	1·60	BF180	0·30	BFY53	0·25	OC70	0·30	2N2905	0·18	2N4348	1·20
BC107	0·09	BC187	0·24*	BCY70	0·12	BF181	0·30	BFY64	0·35	OC71	0·35	2N2905A	0·22	2N4870	0·35*
BC107B	0·09	BC207B	0·12*	BCY71	0·18	BF182	0·30	BFY90	0·90	OC72	0·22	2N2906	0·18	2N4871	0·35*
BC108	0·09	BC212	0·11*	BCY72	0·12	BF183	0·30	BLY15A	0000	OC84	0·40	2N2925	0·14*	2N4918	0·60*
BC108B	0·09	BC212L	0·12*	BD115	0·15	BF184	0·20	BSX19	0·16	OC139	1·30	2N2926O	0·09*	2N4919	0·70*
BC109	0·09	BC213	0·12*	BD131	0·36	BF185	0·20	BSX20	0·18	OC140	1·30	2N2926R	0·10*	2N4920	0·50*
BC109B	0·09	BC213L	0·14*	BD132	0·40	BF194	0·10*	BSX21	0·20	OC170	0·23	2N2926Y	0·09*	2N4922	0·58*
BC109C	0·12	BC214	0·14*	BD135	0·36*	BF196	0·12*	BSX76	0·30	TIP29A	0·44*	2N2926G	0·10*	2N4923	0·46*

PRINTED CIRCUIT KIT £3·65
Make your own printed circuits. Contains etching dish, 100 sq.in of pc board, 1lb ferric chloride, etch resist pen, drill bit and instructions.

JC12 AMPLIFIER
6W IC audio amp with free data and printed circuit.
£1·95

DELUXE KIT FOR JC12
Contains extra parts except JC12 needed to complete the amp including balance, volume, bass and treble controls. Mono £2·19. Stereo £5·04.

JC12 POWER KIT
Supplies 25V 1A £3·65.

JC12 PREAMP KITS
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SINCLAIR IC20
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VP20 Volume, tone-control and preamp kit £8·55.

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New integrated circuit 20W amplifier kit complete with chip, printed circuit and data £3·95.

FERRANTI ZN414
IC radio chip £1·44. Extra parts and pcb for radio £3·85. Case £1. Send S.A.E. for free data.

BATTERY ELIMINATOR BARGAINS

RADIO MODELS
50mA with press-stud battery connectors. 9V £3·45. 6V £3·45. 9V+9V £5·45. 6V+6V £5·45. 4½V+4½V £5·45.

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Transistor stabilized 8-way type for low hum. 3/4½/6/7½/9/12/15/18V. 100mA £3·20. 1A £6·50.
Heavy duty 13-way types 4½/6/7/8½/11/13/14/17/21/25/28/34/42V. 1A model £4·95. 2A model £7·95.
Car convertor kit Input 12V d.c. Output 6/7½/9V d.c. 1A transistor stabilized £1·95.

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PZ5 £4·95. Z40 £5·75. Project 805Q £20·95.

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S450 tuner £20·95. AL60 £4·60. PA100 £14·95. MK60 audio kit £31·95. Teak 60 £12·95. Stereo 30 £16·95. SPM80 £3·95. BMT80 £3·62. Send S.A.E. for free data.

SAXON ENTERTAINMENTS MODULES
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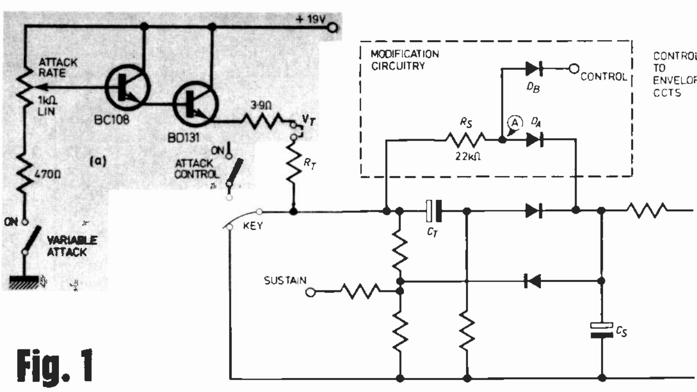


Fig. 1

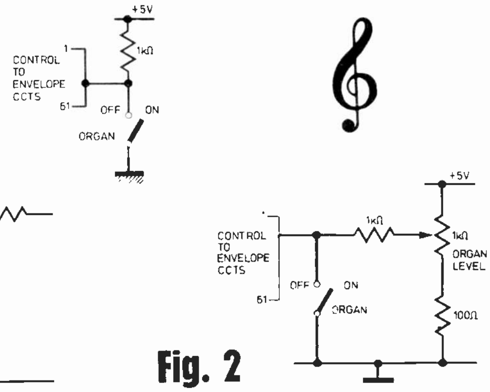


Fig. 2

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. One 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 busbar, 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 busbar 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.

Pitch	Point E	Point F
2′	0	0
4′	0	1
8′	1	0
16′	1	1

Pitch Selector control inputs

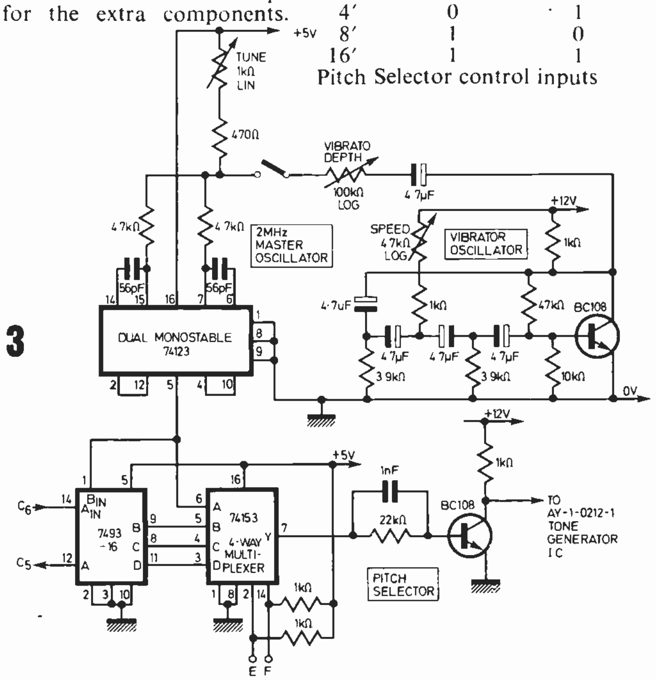


Fig. 3

PROGRAMMABLE MELODY GENERATOR

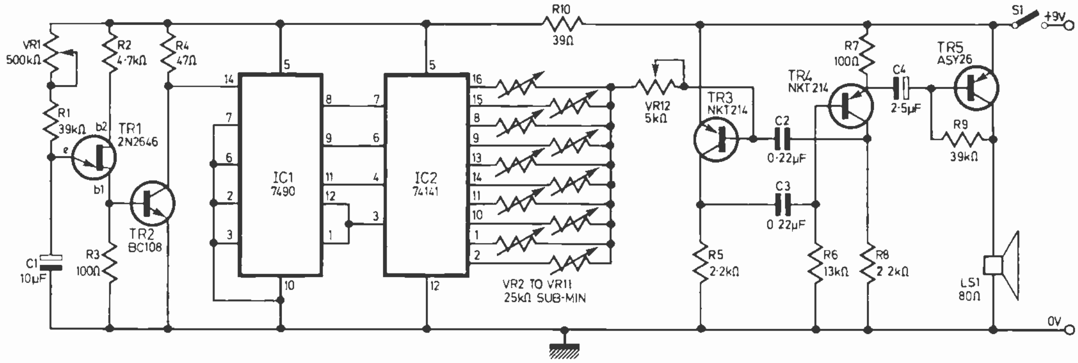


Fig. 1

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 IC1 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.c. 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 so 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 ever 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.

POINTS ARISING

DIGITAL VOLTMETER (*April 1977*)

In the specification table, the figure for accuracy should read 0·1mV per °C.

PE SUPPLEMENT "PUTTING IT TOGETHER" (*April 1977*)

In the section on Wiring Pens, it was stated that only one colour of wire was available. This is incorrect. The Verowire system offers four different colours.

SOLAR HEATING CONTROLLER (*February 1977*)

The relay contact RLA1, connected across R5, should be a normally closed contact, shorting out R5 until the relay has operated.

The value of R5 may need to be reduced, depending upon the type of relay used. In some cases, a value as low as 22Ω has been found necessary to ensure reliable operation.

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.

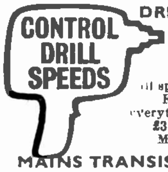
This may be overcome by inserting a diode in series with the live supply feed to S1 in Fig. 1, with polarity appropriate to the car's electrical system (anode to supply for negative earth systems, and vice versa). A 10A device is required, such as the RS Components 261–019, mounted on a suitable heat-sink 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.



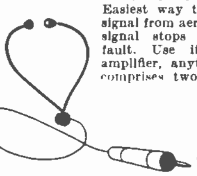
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45** including post & VAT. Made up model **£1·00** extra.

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: main transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1·50** VAT & Postage 50p.

RADIO STETHOSCOPE



Easiest way to fault find, traces signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Complete kit comprises two special transistors and all parts including probe tube and crystal ear-piece, **£2·95**, twin stetho-set instead of earpiece. £1·00 VAT and postage incl.

MICRO SWITCH BARGAINS

Rated at 5 amps 250 volts, ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for **£1·00**, VAT and post paid.

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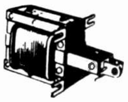

Model TT2—small but powerful 1in. pull—approx. size 1¼ × 1¼ × 1½in., **£1·00**
Model 4001/—½in. pull. Size 2¾ × 2 × 14in. **£1·50**
Model TT10—1½in. pull. Size 3 × 2½ × 2in. **£3·50**
Prices include VAT & postage.

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Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£7·95** plus **95p** VAT & Postage

RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined in series or parallel thus relay will operate off voltages between 5 and 30 volts DC. Price **44p** each, 10 for **£4** post and VAT paid.

MULTISPEED MOTORS

Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼ in. diameter and approximately 1 in long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia × 5 in. long. Price **£2·00** including Post & VAT.

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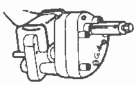
So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in **£2·33**. Post & VAT 60p.
13in × 10in **£1·85**. Post & VAT 50p.

SPIT MOTOR WITH CARTER GEAR BOX



Probably one of the best spit motors made. Originally intended to be used in very high priced cookers however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact, there are no ends to its uses. Normal mains operation. **£3·25** including POST & VAT.

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Famous Satchwell, elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month **£2·50**, post and VAT paid.

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied

Model 1153 500mW power output **£1·50** including Post & VAT.
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NEED A SPECIAL SWITCH

Double lead contact. Very slight pressure, closes both contacts **12p** each. Plastic pushrod supplied for operating. **10p** each. 10 for **68p.**

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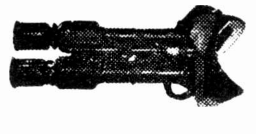
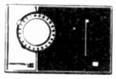


Made for military purposes during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (5KV approx.) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra red cell, technical data on which is available. The binoculars are unused, believed to be in good order. In fact they were never issued, but since they were made a long time ago they can hardly be called new. Sold without guarantee. Price **£17·50** per set. Post & VAT £2·50.

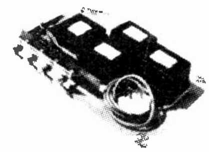
SMITHS CENTRAL HEATING CONTROLLER

Push button gives 10 variations as follows (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off.



A handsome looking unit with 24-hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over **£15**—we offer these, while stocks last at **£7·50** each including VAT and postage.

MULLARD UNILEX

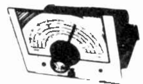


A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Goodmans speakers this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£14·00** including VAT and postage.

250 WATT TRANSFORMER

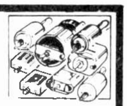
Heavy duty power transformer which can be used for many purposes. Rated at 250 watts it is very well built with frames for upright mounting and is varnish impregnated. Its primary is for 230/240 volts 50 cycles, it has four secondaries each 10v very high current windings. Just a few of the circuits it can power are 10-0-10v at up to 12 amps, 20-0-20v at up to 6 amps; single 10v at 25 amps; single 20v at 12½ amps; single 30v at 9 amps, single 40v at 6·5 amps. The transformer can be used for power circuits (charging, etc.) or for amplifiers, there being an earth screen between primary and secondaries. A transformer like this today would cost at least **£15** from the makers, however, we are making a special offer at **£5·95**. Post & VAT Paid. Grab some while you can our stock may not last long.

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis front panel and all the parts **£1·90**—crystal earphone **55p** including VAT and postage.

8 POWERFUL BATTERY MOTORS

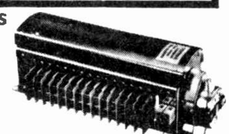


For models, Meccano's, drills, remote control planes, boats, etc., etc. **£2·00.**

ROTARY PUMP

Self priming, portable fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertilizer, chemicals, anything liquid. Hose connectors each end. **£2·00** Post Paid.

MOTORISED DISCO SWITCHES



With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 2000w's can be controlled and this would provide a magnificent display. For mains operating **£4·25** post & VAT Paid. Ditto 9 switch **£4·95** Post & VAT Paid. **DITTO BUT 12 SWITCH £5·75 POST & VAT PAID.**

MAINS RELAYS

With triple 10 amp changeover contacts operating coil wound for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment **60p** each, 10 for **£5** post and VAT paid.

TWIN OUTPUT POWER PACKS

These have two separately R.C. smoothed outputs so can operate two battery radios or a stereo amp without cross modulation (they will of course operate one radio/tape cassette/calculator, in fact any battery appliance, and will save their cost in a few months). Specs: Full wave rectification, double insulated mains transformer—total enclosed in a hard P.V.C. case—three core mains lead—terminal output—when ordering please state output voltage 4½v, 6v, 7½v, 9v, 12v or 24v.
Price **£3·95**. Post and VAT included.

CAR STARTER

Most drivers who use their car around town find that on a very cold morning they have difficulty in starting because the battery has not any charge left in it. This always seems to happen on the morning when you are in a particular hurry so a charger/starter is well worth having. Our kit for this comprises: a heavy duty 250w transformer and full wave rectifier which for short periods will deliver 20 amps. This is usually enough to get the car started, directly it has started of course it can be disconnected from the battery as the car's internal charger will take over. Special offer price of this is **£6·50p** including post and VAT.

TERMS: Where order is under £6 please add 50p surcharge to offset packing expenses

J. BULL (ELECTRICAL) LTD.

(Dept. P.E.), 103 TAMWORTH ROAD, CROYDON CR9 1SG.

ITS FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and its free—just send S.A.E. Below are a few of the Bargains still available from a recent list.

100 watt Mains Transformer. 240v 50hz primary wound in separate halves, primary screen. This has three secondries 24-0-24v, 0-49v and 0-88v tapped to 80v. Any one of these secondries may be loaded up to the 100 watts or the load can of course be spread over to all the secondries. Upright mounting, impregnated and varnished. Size 4" × 3½" × 3". Price **£3·50** + **28p.** Post 80p + 6p.

Connector Strip for Push on tags. 7 pole, each pole accepting 6 push on tags on strong plastic base with fixing holes. Price **45p** + **4p.**

Stereo Flex twin screen fig. 8 type. PVC insulated overall. 10 metres for **£1** + **8p.**

Latching Relay by Guardian Electric, mains operated it is in fact two relays mounted on a metal base plate. The relays being mounted in such a way to ensure that when one closes the other opens and vice versa thus when closed relay A would remain locked until manually released or electrically released by energising relay B. Each relay has 2 sets of 10 amp change-over contacts. Ahould be ideal for burglar alarms and similar applications. Price **£1·95** + **16p.**

Connecting Wire. 7 Stranded PVC insulated on 500 metre drums, 6 different colours available, price **£4** per 500 metres + **32p.** Post £1 + 8p. Please give alternative colours when ordering.

Mains Motor—double ended with normal mounting feet, ideal for small fan heater, etc. Price **75p** + **6p.** Post 30p + 3p.

Magnetic Clutch xerox ref. nos. 121 5494 and PN 866-10. This is a two part device, the main section with the coil fits to the spindle of the machine and the break plate only has to be mounted close to the main section. Price **£3·00** + **24p.** Post 30p + 3p.

Photo Multiplier Tube. American RCA, their type no. 4555. These tubes have a gain of a million or more, regular price over £20 but we offer these brand new at **£4·50** + **36p.**

Push Button Double Changeover Switch. Honeywell type No. 14 DMG. Contact rated at 10 amps 250 volts, a tough spring return switch definitely strong enough to be used as a foot switch. Price **50p** + **4p.**

Clockwork Time Switch for delaying switch for up to 12 hours. Being clockwork this is independent of the mains and is therefore ideal for remote places, worked by batteries. Front dial, which is calibrated in hours, is turned through the required degrees together with preset time up to 12 hours. Double pole switch rated 15 amps 30 volts. Price **£3·00** + **24p.**

Delay Switch electrically operated—will give delay of up to 2 hours—contact suitable for 2 × 10 amp appliances. Price **75p** + **6p.**

Open Type Relay with 10 amp Changeover contacts. Mains operated coil. ex-equipment but perfect. Price **50p** + **4p.**

Portable Radio Case. size 11" × 8" × 3½", mounting studs for standard 5" speaker and panel to take the normal three controls. Price **£1·50** + **19p.** Post £1 + 12p.

Tuning Dial, fits normal slow motion type condenser suitable for above cabinet. Price **50p** + **6p.** Self adhesive scale L & M, price 25p + 3p.

Disco Black Light Lamp. We have just received a new delivery of these 175w ultra violet lamps but regret to say that the price has increased and the new price is now **£6·75** + **86p.** Post £1·00 + 12p.

For the benefit of of our readers not knowing this lamp we wish to point out that it is probably the most useful ultra violet lamp available especially for disco work as it does not require choke or starter. It can simply be plugged into the nearest lamp holder. It is a true black light and has proper "Woods" filter glass.

Ferric Chloride Crystals for etching copper, making printed circuit boards, etc. Special purchase enables us to offer this in 1lb bags at **50p** + **4p** + 20p + 2p.

7 Digit Counter. Another special purchase enables us to offer this mains operated counter for only about a quarter of its proper price. It works off 240v 50hz mains and requires no step down. There is only one point about this that is it counts in even numbers only, 2, 4, 6, 8, 10, etc. If you want to count single you must divide the final figure by 2. Price **50p** + **4p.** Post 10p + 1p.

2kw Heater Assembly. Spiral elements in metal frame, size 6¼" × 2¼" elements centre tapped so can be used for 1kw or 2kw. Unusual shape, looking at it sideways the frame looks rather like a ship's ventilator. Probably made for some well known fan heater. Price **£1** + **8p.** Post 30p + 3p.

Stereogram Cabinet. Long low modern teak veneered cabinet size approximately 4' 2" × 15' × 5' probable cost to make today over £20. We have a few of these, they are slightly second, at prices ranging from **£5** each, depending on condition—sorry but these are for callers only.

Digital Display Unit (Digivisor). A precision made instrument which is basically a moving coil voltmeter. Instead of having a pointer, however, the scale is punched out with numerals, 0, 1, 2, 3, 4 and so on. When you apply a voltage for instance 8 volts—fig. 8 comes in front of a lamp and is focussed on to the screen. This device which must have cost a small fortune to develop and make can also be used for a variety of other purposes. Voltage regulation by making beam of light trigger a photocell, etc., etc. price £5 + **40p.**

Valves—send for your requirements, most types in stock.

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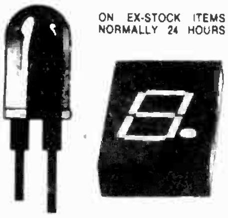

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DL704 COM CATH. 0.3" £1*
DL747 0.6" JUMBO CA £1.25*

DIGITAL CLOCK IC 51224 £4*
ZENON STROBE TUBES £4 & £7*

RED LEDS 10P.

RED LEDS 209 STYLE 0.125"
OR 0.2" DIA. NO CLIP 10p*

TIL209 RED LED & CLIP 12p*
BIG 0.2" RED LED & " 14p*
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747 DUAL 741	69p*	MFC6030	£1
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BC157/8/9	11p	2N706/8	14p*
BC167/8/9	12p	2N2646 UJT	40p*
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BC182/3/4*a*/*l*	10p	2N2926 ory	7p*
BC212/3/4*a*/*l*	12p	2N3053	17p*
BCY70/1/2	15p*	2N3055 90W	33p*
BD131/132ea	36p*	2N3055 115w	45p*
BFY50/51	15p*	2N3614 T03	£1*
BFY52/53	16p*	2N3702/3/4	10p
BSX 19/20/21	*19p**	2N3705/6/7	9p
BZY88 ZENER	10p	2N3708/9	9p
C106D SCR	54p*	2N3710/11	15p
MJ2955 T03	99p*	2N3819 &23e	17p
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MJE3055	65p*	2N3904/5/6	15p
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EDGEWISE 200μA CENTRE ZERO METERS, 90p each.
CRYSTALS, 5mHz 10X type, **50p;** 600kHz 10XAJ type, **50p.**
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800V 2A PLASTIC TO3 NPN TRANSISTOR, 50p; 3 for **£1·10.**
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BOOKS "Practical Test Equipment", **75p;** "Simple Short Wave Receivers", **60p;** "Practical Electronic Projects", **75p.** The three for **£1·60.**
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DUAL GATE MOS FETS LIKE 40673, 33p; 4 for **£1·10.**

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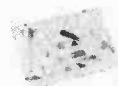
The famous DEC System of Solderless Breadboarding is ideal for both the young and more mature students of Electronic Engineering as it enables circuits to be tried and tested without the use of soldering and because of the specially designed contacts allows components to be used over and over again. It is also extremely useful for the Circuit Designer who wishes to experiment with and perfect his circuit quickly yet economically.

S-DEC (Model PB11)



This, the most popular Board, is designed solely for the use of discrete components and is particularly useful for basic educational purposes.
(No. of Contacts: 70)
1 off £1·98
5 off £1·76

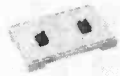
T-DEC (Model PB21)

This Board allows 2 TO5 or 1 DIL IC Station to be used and so is primarily intended for discrete work or for linear IC application where considerable numbers of discrete components may be required.
(No. of Contacts: 208)
1 off £3·62
5 off £3·21

μ-DEC 'A' (Model PB31)

The μ-DEC 'A' is specially designed for ease of use with IC's and allows 2 DIL or 4 TO5 stations to be used but will accommodate discrete components with equal facility.
(No. of Contacts: 208)
1 off £3·97
5 off £3·53

μ-DEC 'B' (Model PB41)



The μ-DEC 'B' is for similar uses as μ-DEC 'A', but has two 16 lead IC sockets as part of the Board.
(No. of Contacts: 208)
1 off £6·97
5 off £6·19

DEC ACCESSORIES

16 DIL adaptor (with socket) PB062	£1·92
10 TO5 adaptor (with socket) PB072	£1·80
Single ended leads (set of ten) PB101	£0·90
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All prices include 8% VAT. P. & P. 25p.

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INDUSTRY NOTEBOOK

By Nexus

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.

. . . AND RATIONALISING

With 15,000 semiconductor devices in the product catalogue Motorola has decided to call a halt, at least in Europe. After conducting an analysis of all applications and who uses what for which purpose, Motorola's back room boys in Geneva have concluded that Europe ought to be able to manage with only 4,000 devices to choose from. These have now been grouped in a new catalogue "The European Selection" expected to cover at least 90 per cent of European requirements.

The other 11,000 devices will still be available but may be harder to obtain as distributors may no longer stock them, and prices may go up to discourage their use. On the other hand, distribution costs will go down on the preferred range of devices and although there is no mention of price reduction the move clearly will help keep Motorola in a strongly competitive position, delaying price rises that otherwise might be needed.

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 deeply 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 re-forming 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 1976) has risen dramatically. The category of airborne radio, navigation and radar aids exported 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 System 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 in lots of 1–10. But you do get titanium/platinum/gold metallising thrown in.

PATENTS REVIEW...

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 fed direct to a pacemaker, which actuates 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 sense. 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 2·2 : 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.

BP 1 454 894

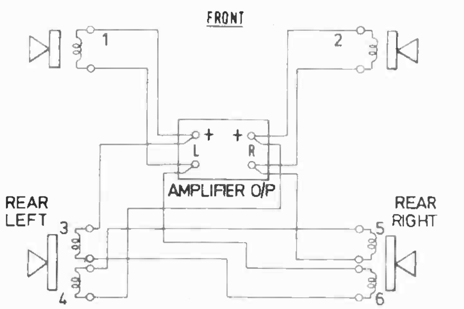

Fig. 1

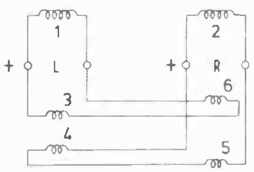

Fig. 2

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.

Copies of Patents can be obtained from the Patent Office Sales, St Mary Cray, Orpington, Kent Price 95p each

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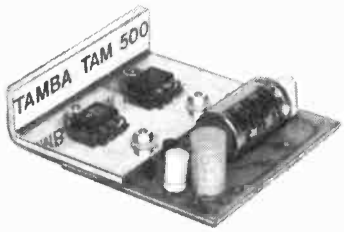

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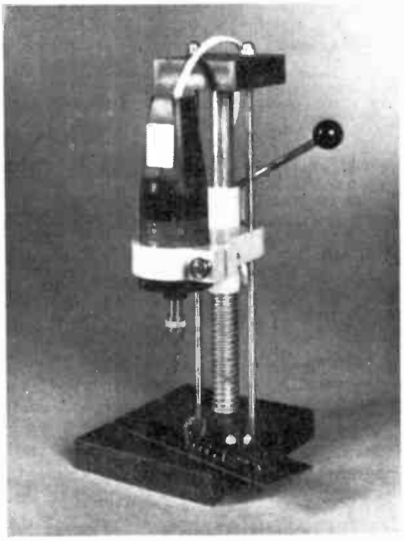

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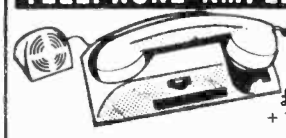

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2N708	0·21	2N3709	0·18	40408	0·65	BC169	0·12	BD137	0·35	BFY52	0·36
2N709	0·50	2N3710	0·16	40409	0·65	BC170	0·16	BD138	0·38	BFY53	0·34
2N718	0·27	2N3711	0·18	40410	0·65	BC171	0·14	BD139	0·40	BFY90	1·37
2N718A	0·30	2N3712	1·20	40411	2·85	BC172	0·12	BD140	0·40	BRY39	0·50
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2N3702	0·17	2N6123	0·43	BC157	0·12	BCY72	0·24	BFX29	0·38	TIS43	0·30

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LM308C	1·82	NE556	1·05	TBA550	3·13
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LM371N	2·25	76013N	1·70	TBA750	1·98
LM372N	2·15	76013ND	1·57	TBA750Q	2·07
LM373N	2·25	76018K	2·50	TBA800	1·20
LM374N	2·25	76023N	1·70	TBA810	1·16
LM377N	1·75	76023ND	1·57	TBA820	1·03
LM378N	2·25	76033N	2·55	TBA920	1·79
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LM380-8	0·90	76115N	1·87	TBA940	1·62
LM380N	0·98	76116N	2·06	TCA160C	1·85
LM381A	2·45	76131N	1·30	TCA160B	1·61
LM381N	1·60	76226N	1·94	TCA270	2·25
LM382N	1·25	76227N	1·51	TCA280A	1·30
LM384N	1·45	76228N	1·75	TCA290A	3·13
LM386N	0·80	76530N	0·91	TCA420A	1·84
LM387N	1·05	76532N	1·50	TCA730	3·22
LM388N	1·00	76533N	1·30	TCA740	2·76
LM389N	1·00	76544N	1·44	TCA750	2·30
LM702C	0·75	76545N	2·09	TCA760	1·38
LM709C	0·65	76546N	1·44	TCA800	3·13
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LM710N	0·60	76570N	2·08		
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LM723N	0·75	76650N	1·10		
LM741C	0·65	76660N	0·60		
LM741N	0·50	76666N	0·92		
LM741-8	0·40	TAA310A	1·50		
LM747N	0·90	TAA320A	1·15		
LM748-8	0·50	TAA350A	2·48		
LM748N	0·50	TAA521	1·00		
LM1800	1·76	TAA522	1·90		

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8 PIN	0·15
14 PIN	0·16
16 PIN	0·18
22 PIN	0·30
24 PIN	0·35
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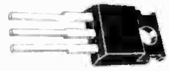
BR100 48p



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CD4001	0·20	CD4019	1·10	CD4043	1·00
CD4002	0·20	CD4020	1·12	CD4044	0·94
CD4006	1·16	CD4021	1·01	CD4045	1·43
CD4007	0·20	CD4022	0·97	CD4046	1·32
CD4008	0·97	CD4023	0·20	CD4047	1·15
CD4009	0·57	CD4024	0·79	CD4049	0·56
CD4010	0·57	CD4025	0·20	CD4050	0·56
CD4011	0·20	CD4027	0·56	CD4510	1·54
CD4012	0·20	CD4028	0·91	CD4511	1·54
CD4013	0·57	CD4029	1·17	CD4516	1·40
CD4014	1·01	CD4030	0·57	CD4518	1·25
CD4015	1·01	CD4031	2·26	CD4520	1·25
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SN7401	0·21	SN7413	0·51	SN7440	0·21	SN7470	0·35	SN7485	1·48	SN74118	0·99	SN74161	1·20	SN74192	1·27
SN7402	0·21	SN7416	0·46	SN7441	0·80	SN7472	0·29	SN7486	0·32	SN74119	2·02	SN74162	1·20	SN74193	1·27
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SN7406	0·59	SN7425	0·30	SN7448	0·89	SN7476	0·39	SN7493	0·49	SN74141	0·80	SN74167	4·20	SN74199	2·28
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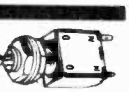
SN7410	0·21	SN7437	0·43	SN7454	0·21	SN7483	1·04	SN74100	1·23	SN74153	0·85	SN74180	2·96	SN76033N	2·50

SWITCHES



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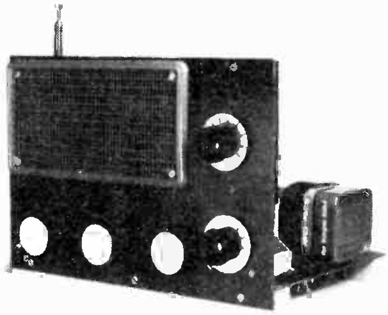

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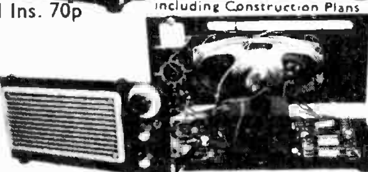

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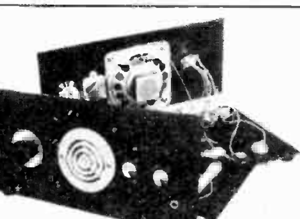
EDU-KIT JUNIOR



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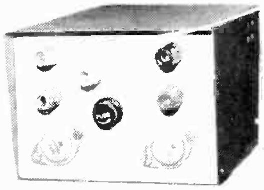

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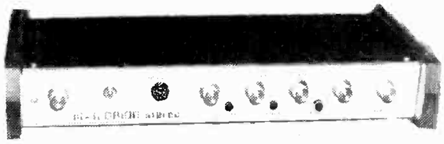

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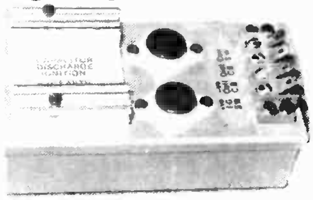

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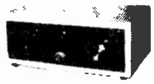

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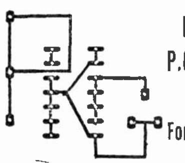

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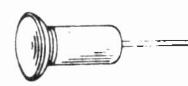

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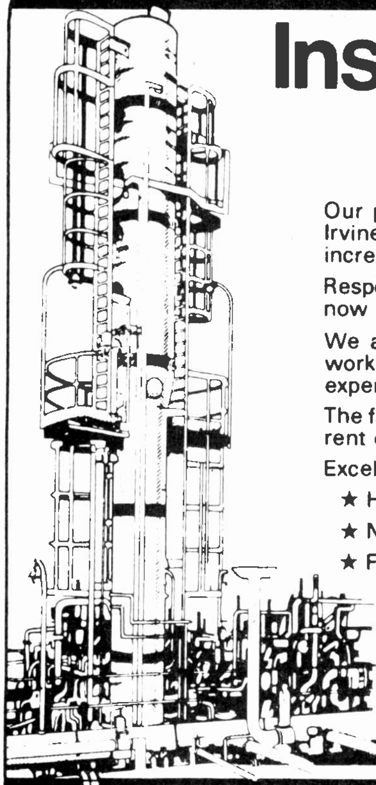

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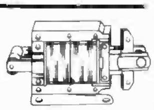

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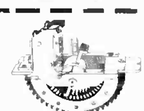

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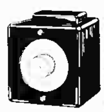

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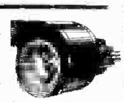

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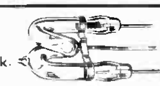

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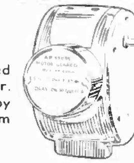

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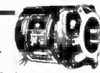

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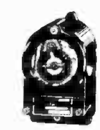

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