PRACTICAL

ELECTRONICS

AUGUST 1977

40p

Can you beat it?

MIND V MACHINE

PE Mastermind

Also inside...

CAPACITANCE/RESISTANCE METER · CLOCK AUTO DIMMER

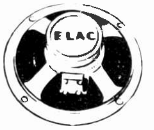
RETURN OF POST MAIL ORDER SERVICE

R.C.S. 10 WATT AMPLIFIER KIT

This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s, input 100M.V. high imp Size 9¼in × 3in × 2in. A/C mains operated.

Mono kit **£11·25** Stereo kit **£18** post 45p

Easy to build. Full instructions supplied.



ELAC 10 inch

Ribbed cone. Large ceramic magnet. 50–16,000 c/s Bass resonance 55 c/s. 10W. 15 ohm impedance. **£4·50**

MAINS TRANSFORMERS

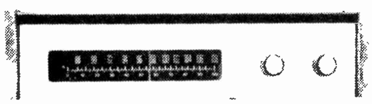
ALL POST 50p each.

250–0–250V 70mA, 6·3, 2A **£2·95**
250–0–250 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A **£4·60**
350–0–350 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A **£5·80**
300–0–300 120mA 2×6·3V 2A C.T., 6·3V 2A **£8·50**
220V 45mA, 6·3V 2A **£1·75p**
HEATER TRANS, 6·3V 3A, **£1·45** ½ amp. **95p**
GENERAL PURPOSE LOW VOLTAGE
Tapped outputs at 2A 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V **£5·30**
1A 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£5·30**
2A 6, 8, 12, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£8·50**
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£11·00**
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£14·50**
5, 8, 10, 16V ½A **£2** 12V 100mA **£1**. 9V 1A **£1**
12V 300mA **£1**. 12V 500mA **£1**. 12V 750mA **£1**.
40V 2A tapped 10V or 30V **£2·95** 20V 3A **£2**.
40V 2A **£2·95** 30V 5A + 34V 2A ct. **£3·45**.
20-0-20V 1A **£2·95**. 30V 1½A **£2·75**. 20V 1A **£2·20**.
60V, 40V, 20V or 20-0-20V, 1A **£3·50**.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W **£5**; 250W **£6**; 400W **£7**; 500W **£8**.
CHARGER TRANSFORMERS. Input 200/250V for 6 or 12V 1½A **£2·75**; 4A **£4·60**.
FULL WAVE BRIDGE CHARGER RECTIFIERS. 6 or 12V outputs 1½A **40p**; 2A **55p**; 4A **85p**.

R.C.S. STABILISED POWER PACK KIT

All parts including printed circuit and instructions to build this unit. Voltages available: 6V, 7·5V, 9V, 12V. Up to 100mA output. Please state voltage required. **£2·95** Post 45p.

R.C.S. STEREO FM TUNER



This completely cased mains powered Hi-Fi Tuner with brushed aluminium facia is British made using the latest circuitry. Bargain. **£27·50** Post 45p

Kuba Stereo Tuner/Amplifier Chassis. Brand new £33·50.

BARGAIN 3W AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. **£3·95**

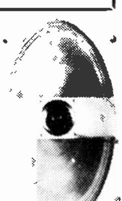
WAFER THIN HEATING ELEMENTS

Size 10¾ × 8¼ × $\frac{1}{16}$in. Operating voltage 200/250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos.

ONLY **40p** EACH (FOUR FOR **£1·50**)

ALL POST PAID—Discounts for quantity.

E.M.I. 13½ × 8in SPEAKER SALE!



With tweeter. And crossover. 10W. State 3 or 8 ohm. As illustrated. **£6·50** Post 45p

15W model **£8·50**
8 ohms. Post 65p

20W model **£9·50**
4 or 8 or 15 ohms. Post 65p

BAKER MAJOR 12 £15

Post £1·00

30–14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 4 or 8 or 16 ohms must be stated.

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. As illustrated. **£19**

Please state 4 or 8 or 16 ohms. Post £1·60

"BIG SOUND" BAKER SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups and discos. Useful response 30–13,000 c/s. Bass Resonance 55 c/s.

GROUP "25" 12in 30W 4, 8 or 16 ohms **£12** Post £1

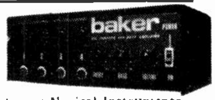
GROUP "35" 12in 40W 4, 8 or 16 ohms. **£14** Post £1

GROUP 50/12in 60W 4, 8 or 16 ohms with aluminium presence dome **£21** Post £1·60

GROUP "50" 15in 75W 8 or 16 ohms **£26** Post £1·60

Disco, Group + PA Cabinets in stock. Send for Leaflet. Cabinet Fittings, Handles, Corners, Feet, Covering Material all in stock.

BAKER 150 WATT ALL PURPOSE TRANSISTOR MIXER AMPLIFIER



Ideal for Groups, Disco, P.A and Musical Instruments. 4 inputs speech and music 4 way mixing. Output 4/8/16 ohm. a.c. Mains. Separate treble and bass controls. **£68** Carr. £1·50

NEW 'DISCO 100 WATT' £52

ALL TRANSISTOR AMPLIFIER CHASSIS 2 inputs. 4 outputs separate volume treble and bass controls. Ideal disco or slave amplifier chassis. Carr. £1
BLACK CARRYING CABINET AVAILABLE £9.

PW SOUND TO LIGHT DISPLAY

Complete kit of parts with R.C.S. printed circuit. Three 1,000W channels. As featured in Practical Wireless. **£14·00** CABINET extra £3.

GOODMANS CONE TWEETER

18,000 c/s. 25W 8 ohm. Price **£3·25**
E.M.I. 5in. mid range 25W **£4·95**.
E.M.I. 13 × 8 in. 25W Bass Unit **£8·50**

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS

Professional model. Four inputs. Treble, Bass, Master Volume Controls. Ideal disco, P.A. or groups. S.A.E. for details. 5 speaker outputs. 3 or 8 or 15 ohm. 100V line to order. Suitable carrying case **£16·50**. **£85** plus £2·50 carr

LOW VOLTAGE ELECTROLYTICS

1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.**
500mF 12V **15p**; 25V **20p**; 50V **30p.**
1000mF 12V **17p**; 25V **35p**; 50V **47p**; 100V **70p.**
2000mF 6V **25p**; 25V **42p**; 50V **57p.**
2500mF 50V **62p**; 3000mF 25V **47p**; 50V **65p.**
3900mF 100V **£1·60.** 4700mF 63V **£1·20.**
5000mF 6V **25p**; 12V **42p**; 25V **75p**; 35V **85p.**

RCS STEREO PRE-AMP KIT

Complete kit includes all components, volume control and P.C. board. High, medium and low inputs per channel can be ganged to make Multiway Mixers **£2·95**.

BSR HI-FI AUTOCHANGER

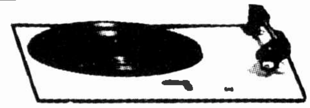
Plays 12in, 10in or 7in records Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.c. 200/250V. Size 13½ × 11¼in. Above motor board 3¼in. Below motor board 2¼in. With STEREO/MONO CARTRIDGE. **£11·95**

Single Player version £13·50. All Post 75p
DE-LUXE AUTOCHANGER Balanced Arm **£17·50**
GARRARD MINICHANGER Size 12 × 8in **£8·95**
BSR P128 with Magnetic Cartridge **£24·50**

PORTABLE PLAYER CABINET £4·50

Post 50p.

Modern design. Size 16in × 15in × 7in rexine covered. Large front grille. Hinged lid. Chrome fittings. Motor board cut for Garrard or BSR deck.



R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop, stereo/compat. cartridge. Baseplate. Size 11in × 8¼in. Turntable. Size 7in diameter. A.c. mains. 220/250V.

3 speeds plays all size records. **£6·95** Post 45p

Two for £13. Post 75p.

HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Silver grey finish. **£6·50**
Model "A". Size 12½ × 14¾ × 7½in. Post **£1·30**
Model "B". Size 16 × 13¾ × 7in. **£7·50.**
Extra Large Model. Teak finish. For transcription decks. Size 20 × 17½ × 9in. uncut board. Callers only **£18·50.**

TINTED PLASTIC COVERS ONLY

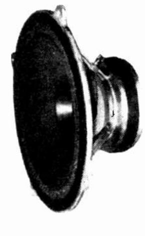
Sizes: 'A'—14¾in × 12½in × 4¼in, **£3**. 'B'—14¼in × 13⅞in × 3in, **£3·25**. 'C'—17⅜in × 13⅜in × 3¾in, **£3·75**. 'D'—16¼in × 14in × 4in, **£4**.
'E'—19in × 14⅜in × 4¼in, **£4.** 15in × 13½in × 3in **£3·50.**
Ideal for record decks, tape decks, etc. Post 75p.

BAKER HI-FI SPEAKERS

HIGH QUALITY—BRITISH MADE

SUPERB

12in 25 watts

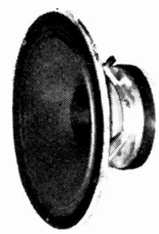


A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.
Bass Resonance 25 c/s
Flux Density 16,500 gauss
Useful response 20–17,000 c/s
8 or 16 ohms models.

£22 Post £1·60

AUDITORIUM

12in 35 watts



A full range reproducer for high power. Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Disco-theques.
Bass Resonance 35 c/s
Flux Density 15,000 gauss
Useful response 25–16,000 c/s
8 or 16 ohms models.

£21 Post £1·60

15in model 45 watts £26. Post £1·60

BLANK ALUMINIUM CHASSIS, 18 s.w.g. 2½in sides, 6in × 4in, **70p**; 8in × 6in, **90p**; 10in × 7in, **£1·15**; 14in × 9in, **£1·50**; 16in × 6in, **£1·45**; 12in × 3in, **87p**; 16in × 10in, **£1·70**. 12in × 8in, **£1·35**.

ALUMINIUM PANELS, 18 s.w.g. 6in × 4in, **15p**; 8in × 6in, **25p**; 10in × 7in, **30p**; 12in × 5in, **30p**; 12in × 8in, **40p**; 16in × 6in, **45p**; 14in × 9in, **50p**; 12in × 12in, **55p**; 16in × 10in, **75p.**

ALUMINIUM ANGLE BRACKET, 6in × ¾in × ¾in, **15p.**
ALUMINIUM BOXES, MANY SIZES IN STOCK.

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PRACTICAL
ELECTRONICS

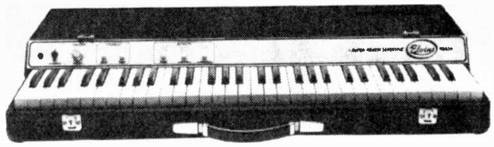
VOLUME 13 No. 8 AUGUST 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our September issue will be on sale Friday, 12 August, 1977
(for details of contents see page 569)



SUPER TOUCH—SENSITIVE PIANO

We have shown our special brand of skill and expertise in designing this piano featuring:—
Wide range of touch-sensitive response ESU design.
Free from breakthrough noise.
Choice of keyboard C-C or F-F Transpose control.
Two models are available. Model TS50 is a touch-sensitive piano only. Model TS53 has extra effects of Honky-tonk, Harpsichord with fast and slow tremolo.

KIT SECTION PRICE LIST
ESU5 + 5 Keyer Units **£11·95** each, 5 required.
ESU5 + 6 Keyer Unit **£13·95**, 1 required.
Power Supply **£9·50**
Keyboard and Switches **£29·00**
Toneforming, Headphone and Voltage Regulator **£14·50**
Loud and Soft Pedal **£7·95**
Master Tone Generator **£15·00**
Tremolo Unit **£3·75**
Cabinet switches, etc. **£32·50**
Please add VAT at 12½%

Can you afford £750 for an electronic piano? If the answer is NO why not visit our showroom and try our electronic pianos, discuss the technicalities in detail without obligation.
WE GUARANTEE TO SAVE YOU MONEY. IT IS SIMPLE ONCE YOU KNOW HOW.

ELVINS ELECTRONIC MUSICAL INSTRUMENTS,
Showroom: 12 Brett Road, Hackney, London E8 1JP. Tel. 01-986 8455.
Component shop: 40a Dalston Lane, Dalston Junction, E8 2AZ. Tel. 01-249 5624.

Parts for organ builders	
4-Octave C-C keyboard	£26·00
5-Octave C-C keyboard	£28·00
5-Octave F-F keyboard	£28·95
5-Octave F-F piano keyboard	£30·00
13 note pedal board	£25·00
25 note pedal board	£55·00
stop switches	75p
Tone Generator Units	
GD500/5 with 73 outputs	£39·95
GD500/6 with 85 outputs	£48·50
GD500/7 with 96 outputs	£52·50
Diode Gate Sustain and Distribution Units	
4-Octave with 3 pitches	£32·00
4-Octave with 4 pitches	£38·00
5-Octave with 3 pitches	£33·00
5-Octave with 5 pitches	£60·00
5-Octave with 6 pitches	£65·00
4-Octave with 9 pitches	£88·00
5-Octave with 9 pitches	£96·00
Toneforming Units	
3 pitches with 10 voices	£24·00
4 pitches with 10 voices	£26·00
4 pitches with 15 voices	£27·50
5 pitches with 10 voices	£38·40
6 pitches with 19 voices	£65·95
9 pitches with 10 voices	£40·50
Rotating Speaker Units	
Bass unit	£68·00
Mid Range	£75·00
Hi-Fi Horn	£89·00

Other useful components in stock for organ work. Send S.A.E. for lists.

ELECTRONIC MUSICAL INSTRUMENTS
12 Brett Road, Hackney, London, E8 1JP. 01-986 8455

VALVE BARGAINS

Any 5-64p, 10-£1·20, 50-£5·00. Your choice from the list below.

ECC82, EF80, EF183, EF184, EH90, PCF80, PCF802, PCL82, PCL84, PCL85, PCL86, PCL805, PL504, PY81/800, PY88, 30PL-14, 6F28, PFL200.

Colour Valves—PL508, PL509, PL519, PY500/A. All tested. **35p each.**

Aerial Splitters—2 way, 75 OHMS, Inside Type, £1·50

AERIAL BOOSTERS

Aerial boosters can produce remarkable improvements on the picture and sound, in fringe or difficult areas.

B11—For TH stereo and standard VHF/FM radio.
B12—For the older VHF television—Please state channel numbers.
B45—For Mono or colour this covers the complete UHF Television band.

All boosters are complete with battery with Co-ax plugs and sockets. Next to the set fitting.
£4·20

250,000 Capacitor Clearance Sale

ALL MULLARD C280 AND C281 RANGE OF POLYESTER FILM CAPACITORS 250 AND 400 VOLTS WORKING. VERY GOOD MIXED SELECTION OF VALUES FROM ·01µ TO 1·5µf.

PRICE 100 - £1·50, 500 - £7·00, 1000 - £12·00

ALL PRICES INCLUDE VAT. P&P 30p PER ORDER. PLEASE SEND UNCROSSED P.O. OR CHEQUES FOR RETURNING IF WE ARE OUT OF STOCK OF CAPACITOR BARGAIN PACKS. EXPORTS WELCOME AT COST.

ELECTRONIC MAILORDER LTD.
62 BRIDGE STREET, RAMSBOTTOM, BURY, LANCS.
Telephone: RAMS (070 682) 3036

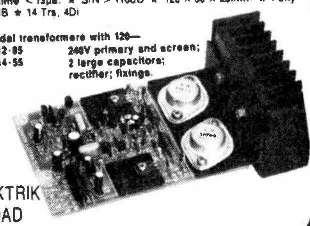
Crimson Elektrik

AUDIBLY SUPERIOR POWER AMPLIFIER MODULES

A power amp. built with CE modules will be audibly comparable to the very best amps. commercially available, but at a much reduced cost. T.h.d. is typically 0·01% by the use of output triples and moderate feedback, while t.i.d. is no worry with a slew-rate limit of 16V/µs (only 9V/µs is required for the power bandwidth of CE 1008). Settling time <15µs ★ S/N > 110dB ★ 120 × 80 × 25mm ★ Fully protected ★ 775mV/56kΩ ★ 12Hz-35kHz, −3dB ★ 14 Trs, 4Di

Power Supplies: Featuring high quality Toroidal transformers with 120—240V primary and screen; 2 large capacitors; rectifier; fixings.
CPS1 For 2 × CE608 or 1 × CE1004 £12·85
CPS2 For 2 × CE1004 or 2 of 4 × CE608 £14·55
CPS3 For 2 × CE1008 £15·85

Power amp. modules:
CE608 60W r.m.s./8Ω, ±35V £16·30
CE1004 100W r.m.s./4Ω, ±35V £19·22
CE1008 100W r.m.s./8Ω, ±45V £23·22
H/sinks 50mm 90p; H/duty 100mm £1·60



CE1008 + Domestic heatsink (50mm)

All prices inclusive
S.A.E. for full details
Tel. (9–5) 0533-386211

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74 STATION ROAD
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Our easy to use FREE CATALOGUE gives circuit diagrams and contains full information on our

Counter Kits	Clock Kits
PCB Sets	Display PCBs
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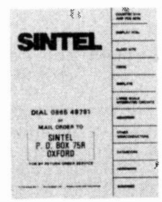

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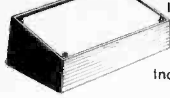
MINI CONSOLES



Ideal for small desk control panels and consoles. Moulded in orange, blue, black and grey ABS. Incorporates slots for holding 1.5mm thick pcb's. Aluminium panel sits recessed into front of console and held by screws running into integral brass bushes.

MC 161 x 96 x 58mm	£1.53	(1-9)	£1.50	(10+)
MC 215 x 130 x 75mm	£2.20	(1-9)	£2.17	(10+)

Add 25p per £1 order value for Post & Packing

ECONOMY QUALITY LED's

50 for only £5 — 100 for only £9
Mixed bags, all sizes, various colours

FULL SPECIFICATION LED's

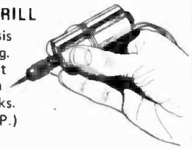
Red (specify size) 75p per pack
Green, Yellow, Orange (specify size) £1.20 per pack
(Each pack contains 5 LED's, Mounting Clips and Data)

TYPE A NEON INDICATORS

Supplied with resistor for 240 Volts operation
Held in 8mm hole by plastic bezel
150mm wire leads

Red, Amber, Clear, Opal 19p each
Green 28p each

12 VOLTS MINI HAND DRILL

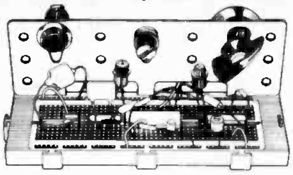


Ideal for drilling pcb, chassis etc as well as model making. Supplied with 2 collets that accept tools and drills with 3/32" and .050" dia. shanks.
£7.56 (Includes VAT & P.P.)

Stop wasting time soldering

The NEW MW BREADBOARD accepts

Transistors, LED's, Diodes, Resistors, Capacitors and all DIL packages with 6 to 40 pins



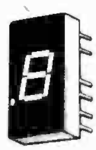
Includes slot-in Component Support Bracket and has over 400 individual sockets, plus Vcc and Ground Bus Strips
Price £9.72 (includes VAT & P.P.)

TYPE MP NEON INDICATOR

Supplied with resistor for 240 Volts operation
150mm leads, held in 6.4mm hole by nut

Red, Amber, Clear, Opal 20p each

SEVEN SEGMENT DISPLAYS



Economy Quality
Common Anode — 0.3" — Left Decimal
Red, Yellow and Green @ 45p each

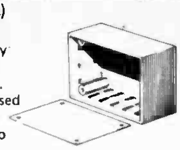
Full Specification
Common Anode — 0.3" - Left Decimal
Red @ 98p each
Green and Yellow @ £1.35 each
(Data supplied with Full Spec. displays only)

Quantity quotations on request

P.P. Note Unless included in price add 25p Post & Packing for orders totalling under £10. All prices include VAT and are valid in UK only for 2 months from journal issue date

Michael Williams Electronics
47 Vicarage Av. Cheadle Hulme, Cheshire SK8 7JP

SC BOXES (square corners)

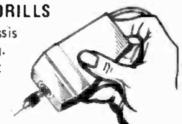


Easily drilled or punched, orange, blue, black and grey ABS. Incorporate slots for holding 1.5mm thick pcb's. Aluminium panel sits recessed into front of the box and held by screws running into integral brass bushes.

SC 85 x 56 x 35mm	80p	(1-9)	77p	(10+)
SC 111 x 71 x 48mm	£1.07	(1-9)	£1.04	(10+)
SC 161 x 96 x 59mm	£1.49	(1-9)	£1.46	(10+)

Add 25p per £1 order value for Post & Packing

240 VOLTS MINI HAND DRILLS



Ideal for drilling pcb's, chassis etc as well as model making. Supplied with 3 collets that accept tools and drills with 1mm, 2mm and 1/8" dia shanks.
£9.72 (includes VAT & P.P.)
Accessory tools... 5 Burrs, 1mm, 2mm, 1/8th Drills, 3/32" Collet Price £1.75 (Includes VAT & P.P.)

RC BOXES (round corners)

Easily drilled or punched, orange, blue, black and grey ABS. Incorporate slots for holding 1.5mm thick pcb's. Close fitting flanged lids held by screws running into integral brass bushes.

RC 100 x 50 x 25mm	51p	(1-9)	49p	(10+)
RC 112 x 62 x 31mm	59p	(1-9)	52p	(10+)
RC 120 x 65 x 40mm	68p	(1-9)	62p	(10+)
RC 150 x 80 x 50mm	77p	(1-9)	74p	(10+)
RC 190 x 110 x 60mm	£1.33	(1-9)	£1.30	(10+)

Polystyrene version
in grey only with no slots, no integral brass bushes

RC(P) 112 x 61 x 31mm	35p	(1-9)	32p	(10+)

Add 25p per £1 order value for Post & Packing

INTERNATIONAL ELECTRONICS UNLIMITED

SPECIAL SALE

DIGITAL		LINEAR	
7400	06	301 mDIP	16
7410	09	311 mDIP	
7438	12	or 14 pin	49
7453	10	340T 6V	75
74181	1-35	723 DIP	34
74123	34	741 mDIP	17
74153	49	1458 mDIP	37
74154	68	75453 mDIP	18
74C00	08		

LED

RED LED .190"	07
WHITE LED (RED EMIT.) RL2-03 .160"	10
DL 702 RED C.C. .30" LHD	68

SHIFT REGISTERS

2511	1-02
2527	1-35
2532	1-58

LINEAR

301	21	324	1-23	560	2-23
302	49	339	1-06	562	2-23
304	56	340K	1-48	565	1-38
305	60	370	92	566	1-38
307	44	372	51	567	1-38
308	69	373	35	709	31
309K	1-25	376	38	710	24
310	75	380	93	711	51
311	67	380-8	1-02	739	75
319	82	381	1-13	741	29
320T	1-12	382	1-13	747	51
320K	1-32	531	2-07	748	31
322	69	540	1-38	75491	58
		556A	1-02	75492	63

IC SOCKETS
Solder tail - low profile

8 pin	£-11	24 pin	£-25
14 pin	-12	28 pin	-36
16 pin	-13	40 pin	-42
18 pin	-19		

wire wrap - gold plate
14 pin £-30

SPECIAL DEVICES

372	AF-IF Strip Detector DIP	£2-08
546	AM Radio Receiver Subsystem DIP	-53
1310	FM Stereo Demodulator DIP	2-05
1496	Balanced Modulator-Demodulator	-70
1800	Stereo multiplexer DIP	1-76
ULN2208	FM Gain Block 34db (typ) mDIP	-84
ULN2209	FM Gain Block 48db (typ) mDIP	-86
2513	Character Generator 64x8x5 DIP-24	7-24
3046	Transistor Array DIP-14	-52
8038	Volt. controlled osc.	2-95

DISCRETE LED's

ME4	INFRARED CLEAR DOME .170"	21
MV10B	CLEAR DOME .170"	-15
MV50	CLEAR — AXIAL .09"	-08
MV50	RED — AXIAL .09"	
NSL100	RED .19"	10
RL209	RED DIFF. SUBMINIATURE .12"	10
RLT-T1-03	WHITE DIFF. SUBMINIATURE NO FLANGE .124"	12
RLC-200	RED DIFF. CURRENT REG. .190" CONST. BRIGHTNESS 4.5-12.5V	-16
RL-4403	RED DIFF. FULL FLOOD .190"	-09
GREEN	SPOT .190"	12
CLEAR	POINT .190"	10

MM 5330
4½ DIGIT DVM LOGIC **£5-00**

LH 0070
BCD BUFFERED REF **5-00**

LF 13300D
DUAL SLOPE A/D **6 95**
ANALOG BUILDING BLOCK

MM 5616
QUAD BI-LATERAL SWITCH **75**

Data sheets on request. Add 20p ea. if item is priced below 50p each.

SHIPMENT MADE VIA AIR-POSTAGE PAID 3 DAYS FROM RECEIPT OF ORDER

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1 x 8K EROM

74S200 £2-95
256 BIT RAM TRI-STATE

LED DISPLAYS

DL10A	RED CA .27" LHD	£1-15
DL 707	RED CA .30" RHD	1-03
DL 507	RED CA .50" RHD	[illegible]
FND 359	RED CC .375" RHD	-59
DL 702	RED CC .30" LHD	[illegible]
HSN 74R	RED CC .30" RHD	
DL 500	RED CC .50" RHD	-89
MAN5	GREEN CA .27" LHD	-89
MAN8	YELLOW CA .27" LHD	-89
MAN82	YELLOW CA .3" LHD	1-29
MAN66	RED CA .6" LHD	1-49
DL747	RED CA .6" LHD	1-50

MEMORIES

1101	256 bit static RAM	-89
1103	1024 bit dynamic RAM	-79
2102	1024 bit static RAM	1-50
5261	1024 bit dynamic RAM	-79
F93410	256 bit bi-polar RAM	1-19
2513	ROM — character generator	7-00
82S23	256 bit PROM	2-50

2102 £-89
1024 bit static RAM 16 pin

1702A £5-00
2048 bit static PROM elect. prog. UV eras. 24 pin

UART AY51013A **£4-50**

CENTRAL PROCESSING UNIT

8008	£12-95
8080A	£12-95

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HSN 33	3 DIGIT RED .12" CC FITS 14 PIN SOCKET	£ 60
DL 33 B	3 DIGIT RED .12" CC MAG. LENS FITS 14 PIN SOCKET	63
DL 33 B—	SAME AS DL33B EXCEPT — & 2 DIGITS	38
HP 5082-7414	4 DIGIT RED .11" CC RHD MAG LENS FITS 14 PIN SOCKET	-89
HP 5082-SERIES	5 DIGIT RED .11 CC LHD MAG. LENS FITS 14 PIN SOCKET	-98

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Add 50p to cover shipping and handling if order is less than £5.

The above prices do not include any taxes leviable by a purchasers country of residence.

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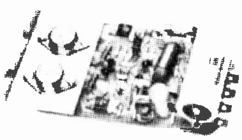
MODULES AND INDIVIDUAL UNITS **SYSTEM 7000** COMPLETE & READY-FOR-USE EQUIPMENT

POWER AMPLIFIER MODULES 30—240 WATTS



- Fully tested & guaranteed.
- Full RMS Sine Wave output.
- Distortion typically 0·2%
- 10 Transistors, 4 Diodes.
- Response 30HZ–30KHZ
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- Sensitivity suits most mixers.
- Built-in surge suppression & compensation
- Twin D.C. & output fuses.
- Top-grade components throughout.

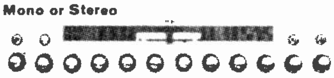
30 Watts rms	60 Watts rms		120 Watts rms		240W rms
SA308 30W rms/ 8 ohms £9·50	SA604 60W rms/ 4 ohms £12·50	SA608 60W rms/ 8 ohms £13·50	SA1204 120W rms/ 4 ohms £14·50	SA1208 120W rms/ 8 ohms £21·00	SA2404 240W rms/ 4 ohms £25·50

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

PM301 For 1/2 SA308 £9·90	PM601/4 For 1/2 SA604 £12·50	PM601/8 For 1/2 SA608 £12·50	PM1201/4 For 1 SA1204 £12·50	PM1201/8 For 1 SA1208 £12·50	PM1202/4 For 2 SA1204 £19·50	PM1202/8 For 2 SA1208 £19·50	PM2404/1 For 1 SA2404 £19·50

SYSTEM 7000 COMPLETE DISCO MIXERS (With Autofade)

Mono or Stereo



- Ready to plug in & use
- Automatic Mic override
- Two tone panel
- Twin deck & mic & tape inputs
- Left/Right deck fader
- 20Mz–20kHz Noise —77 dB

The choice of the professional D.J.
Controls: Mic volume, Bass, Treble, A/Fade Depth, Tape, L/Deck, R/Deck volumes, Bass, Treble, Master, Headphone volume, Selector & On/Off.

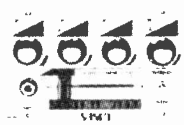
Mono 18v **£37·50** Mains **£43·50** Stereo 18v **£53·50** Mains **59·50**

IN MODULAR FORM— All you require is front panel (see below) knobs & sockets etc. All electronics are assembled & tested.

- Specification as for complete mixer
- All Potentiometers supplied & fitted
- Low cost do it yourself with step by step easy to follow instructions.

Mono **£19·50** Stereo **£29·50** Panel **£3·50** Supply unit **£8·50**

SYSTEM 7000 LIGHTING CONTROL UNIT MK II (Four channel)



Has your light unit got?

- 4,000 W handling
- Sequence facility
- Smart 2 tone panel
- Advanced IC circuitry
- Top grade components
- Integral dimmers
- Automatic audio level

OURS HAS!

All your needs in one superbly designed unit

ONLY **£42·50**

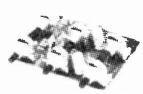
IN MODULAR FORM—THE QUADRAFECT £29·50 (Panel £2·50)

As with the mixers the Mk II L.C. unit may be purchased in module form with all controls, requiring only a panel, case & knobs etc. There are 13 simple connections

- 1-240w Audio
- 8A RCA triacs
- 0·5-20Hz Sequence
- Fully suppressed

CUSTOM MIXER MODULES (Complete or in printed circuit form only)

Make your own mixer, mono or stereo, up to 2 channels, with full monitoring facilities, and provision for echosend/return etc.



- Inputs for low and high 2 mic, ceramic & magnetic cartridge etc.
- Up to 20 input modules per single mixing module
- Feed most types of amplifier—accepts all inputs
- Professional low noise circuitry 20 Hz-30kHz
- Infinitely adaptable—Extremely economical

COMPLETE MODULES With facia panel, Knobs & sockets, Monitor buttons, Ready wired & tested

- 0·5W headphone circuit
- Full range bass/treble controls
- Noise—80dB

Mono Input **£8·50** Mono mixing stage **£8·50**
Stereo Input **£12·00** Stereo mixing stage **£12·00**

PRINTED CIRCUIT MODULES With controls fitted, requires only sockets, facia & knobs

Mono Input **£5·50** Mono mixing stage **£5·50**
Stereo Input **£9·00** Stereo mixing stage **£9·00**

Power supply for up to 20 channels—PPM18—£8·50.

SYSTEM 7000 SOUND—LITE (3-CHANNEL)

IN COMPLETE OR MODULAR FORM
(Modular form illustrated)

- Complete unit similar to Mk II unit above
- Long established & proven design
- 3 Channels—100W per channel
- RCA 8A Triacs—individual channel fuses
- 1-240 W Input—master audio level plus Bass/Middle/Treble

COMPLETE UNIT—Fully cased with rear terminations—just plug in & go! **£24·75**

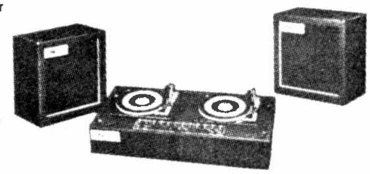
MODULAR FORM Facia & knobs etc. Needs only 11 simple connections **£16·50** (Panel £2·50)

CENTAUR—THE 100W RMS STEREO DISCO

COMPLETE WITH SOUND-TO-LIGHT SEQUENCER & LIGHTS

ONLY **£225** (+ £4·50 carr) or Low interest terms Deposit £27·86 12 months at £21·18 or 24 months at £12·01

- 100W RMS stereo output
- Twin heavy duty loudspeaker
- Four channel sound lite—sequencer complete with display
- Separate mic., music bass & treble controls
- Sturdy vynide cabinets with all leads
- Twin BSR decks with lift arm



NEW

NOW AVAILABLE

SUPER CENTAUR

200W Stereo output—other details as above **£275** (carr. 4·50)
or Deposit £31·06 12 months at £25·03 or 24 months at £14·20
Cut-price condenser mic & headphones £15·00 (only with complete discos)

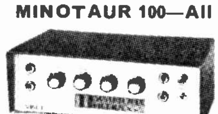
SAXON MINI-DISCO 50W RMS £139·50 100W RMS £159·50 (carr. £2·50)

- C/W Heavy duty loudspeaker
- 100W version has twin speakers
- Includes mic input & headphone monitor circuit
- Twin BSR decks with liftarm
- Tremendous value—just plug in & go
- Wide range bass & treble controls

Cut-price condenser mic & headphones £15·00 (only with complete discos)

10% DEPOSIT. LOW INTEREST CREDIT ON ORDERS OVER £150

SYSTEM 7000 MINOTAUR 100—All Purpose Wide Range Amplifier



- 100W rms — 1dB
- Standard 8 ohm output
- Twin mixed inputs accept a wide range of signals
- 30HZ–30KHZ ±2dB
- 23dB bass/treble

A four input, high power amplifier which will deliver up to 150 watts output. An absolute must where multiple mixing & power are required

- Four individually mixed inputs
- Wide range bass/treble+master

An extremely compact and versatile amplifier with full protection and a clean, attractive appearance. Ideal for all groups, disco's & clubs

£49·50

- Vynide covered case
- Fully short proof
- Superb value for money

SAXON 150 HEAVY DUTY AMPLIFIER £59·00

STROBES & PROJECTORS (We stock the full Pluto range) Send for details

SUPERSTROBE £19·75

- 2–3 Joules
- 80W Tube for long life
- Compact 4" × 4" × 4"

PRO-STROBE £32·50

- 6–8 Joules
- External trigger
- Long Life tube timer circuit

150 WATT LIQUID WHEEL PROJECTOR

- Accepts all accessories
- C/w with wheel & motor plate
- Sturdy steel construction

Remarkable value—Sold elsewhere at £39·50. Our price is only: **£33·00**

ACCESSORIES Condenser mics ECM77 600 ohm £13·50 ECM 81 Dual impedance £14·95 Crown headphones £6·75 Heavy duty boomstand £14·50

All prices subject to VAT @ 8% except SA308/PM301, mics. & headphones (12½%)
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SEMICONDUCTORS—COMPONENTS

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA129	£0·08	BY100	£0·22	BYZ11	£0·45	OA91	£0·07
AAY30	£0·09	BY107	£0·22	BYZ12	£0·45	OA95	£0·07
AAZ13	£0·15	BY105	£0·22	BYZ13	£0·40	OA182	£0·13
AAZ17	£0·15	BY114	£0·22	BYZ16	£0·41	OA200	£0·08
BA100	£0·10	BY124	*£0·22	BYZ17	£0·36	OA202	£0·08
BA102	£0·32	BY126	*£0·15	BYZ18	£0·36	SD10	£0·06
BA148	£0·15	BY127	*£0·16	BYZ19	£0·36	SD19	£0·06
BA154	£0·12	BY128	£0·16	OA10	£0·35	IN34	£0·07
BA155	£0·14	BY130	*£0·17	OA47	£0·08	IN34A	£0·07
BA156	£0·14	BY133	*£0·21	OA70	£0·08	IN914	£0·06
BA173	£0·15	BY164	£0·51	OA79	£0·13	IN916	£0·06
BB104	£0·15	BY176	*£0·75	OA81	£0·13	IN4148	£0·06
BAX13	£0·07	BY206	£0·30	OA85	£0·13	IS44	£0·05
BAX16	£0·08	BYZ10	£0·45	OA90	£0·07	IS920	£0·06

SILICON RECTIFIERS

Type	Price	Type	Price	Type	Price	Type	Price
IS920	£0·06	IN4003	£0·08	IS020	£0·10	IN5400	£0·14
IS921	£0·07	IN4004	£0·09	IS021	£0·11	IN5401	£0·15
IS922	£0·08	IN4005	£0·10	IS023	£0·13	IN5402	£0·16
IS923	£0·09	IN4006	£0·11	IS025	£0·14	IN5404	£0·17
IS924	£0·10	IN4007	£0·12	IS027	£0·16	IN5406	£0·21
IN4001	£0·05½	IS015	£0·09	IS029	£0·20	IN5407	£0·25
IN4002	£0·07			IS031	£0·25	IN5408	£0·30

TRIACS

2 AMP TO5 CASE

Volts	No.	Price
100	TR12A/100	£0·31
200	TR12A/200	£0·51
400	TR12A/400	£0·71

10 AMP TO48 CASE

Volts	No.	Price
100	TR110A/100	£0·77
200	TR110A/200	£0·92
400	TR110A/400	£1·12

6 AMP TO66 CASE

Volts	No.	Price
100	TR16A/100	£0·51
200	TR16A/200	£0·61
400	TR16A/400	£0·77

10 AMP TO220 CASE

Volts	No.	Price
400	TR110A/400P	£1·12

DIACS

BR100 £0·23 D32 £0·23

THYRISTORS

600mA TO18 CASE

Volts	No	Price
10	THY600/10	£0·15
20	THY600/20	£0·16
30	THY600/30	£0·20
50	THY600/50	£0·22
100	THY600/100	£0·25
200	THY600/200	£0·38
400	THY600/400	£0·45

7 AMP TO48 CASE

Volts	No.	Price
50	THY7A/50	£0·48
100	THY7A/100	£0·51
200	THY7A/200	£0·57
400	THY7A/400	£0·62
600	THY7A/600	£0·78
800	THY7A/800	£0·92

1 AMP TO5 CASE

Volts	No.	Price
50	THY1A/50	£0·26
100	THY1A/100	£0·28
200	THY1A/200	£0·32
400	THY1A/400	£0·38
600	THY1A/600	£0·45
800	THY1A/800	£0·58

10 AMP TO48 CASE

Volts	No.	Price
50	THY10A/50	£0·51
100	THY10A/100	£0·57
200	THY10A/200	£0·62
400	THY10A/400	£0·71
600	THY10A/600	£0·99
800	THY10A/800	£1·22

3 AMP TO66 CASE

Volts	No	Price
50	THY3A/50	£0·28
100	THY3A/100	£0·30
200	THY3A/200	£0·33
400	THY3A/400	£0·42
600	THY3A/600	£0·50
800	THY3A/800	£0·65

16 AMP TO48 CASE

Volts	No.	Price
50	THY16A/50	£0·54
100	THY16A/100	£0·58
200	THY16A/200	£0·62
400	THY16A/400	£0·77
600	THY16A/600	£0·90
800	THY16A/800	£1·39

5 AMP TO66 CASE

Volts	No.	Price
50	THY5A/50	£0·36
100	THY5A/100	£0·46
200	THY5A/200	£0·50
400	THY5A/400	£0·57
600	THY5A/600	£0·69
800	THY5A/800	£0·81

30 AMP TO94 CASE

Volts	No.	Price
50	THY30A/50	£1·18
100	THY30A/100	£1·4[illegible]
200	THY30A/200	£1·63
400	THY30A/400	£1·79
600	THY30A/600	£3·50

5 AMP TO220 CASE

Volts	No.	Price
400	THY5A/400P	£0·57
600	THY5A/600P	£0·69
800	THY5A/800P	£0·81

No.	Price
BT101/500R	£0·80
BT102/500R	£0·80
BT106	£1·25
BT107	£0·93
BT108	£0·98
2N3228	£0·70
2N3525	£0·77
BTX30/50L	£0·33
BTX30/400L	£0·46
C106/4	£0·60

SUPER UNTESTED PAKS

Pak No.	Qty		Order No.	Price
U50	100	Germ. gold bonded OA47 diode	16130	£0·60
U51	150	Germ. OA70/81 diode	16131	£0·60
U52	100	Silicon diodes 200mA OA200	16132	£0·60
U53	150	Diodes 75mA 1N4148	16133	£0·60
U54	50	Sil rect top hat 750mA	16134	£0·60
U55	20	Sil rect stud type 3 amp	16135	£0·60
U56	50	400mW zeners DO7 case	16136	£0·60
U57	30	NPN trans BC107/8 plastic	16137	*£0·60
U58	30	PNP trans BC177/178 plastic	16138	*£0·60
U59	25	NPN TO39 2N697/2N1711 silicon	16139	£0·60
U60	25	PNP TO59 2N2905 silicon	16140	£0·60
U61	30	NPN TO18 2N706 silicon	16141	£0·60
U62	25	NPN BFY50/51	16142	£0·60
U63	30	NPN plastic 2N3906 silicon	16143	*£0·60
U64	30	PNP plastic 2N3905 silicon	16144	*£0·60
U65	30	Germ. 0071 PNP	16145	£0·60
U66	15	Plastic power 2N3055 NPN	16146	£1·20
U67	10	TO3 metal 2N3055 NPN	16147	£1·20
U68	20	Unijunction trans TIS43	16148	£0·60
U69	10	1 amp SCR TO39	16149	£1·20
U70	8	3 amp SCR TO66 case	16150	£1·20

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PAKS

Pak No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx (count by weight)	16164	*£0·60
C2	150	Capacitors mixed value approx. (count by weight)	16165	*£0·60
C3	50	Precision resistors. Mixed values	16166	£0·60
C4	80	⅛W resistors mixed preferred values	16167	*£0·60
C5	5	Pieces assorted ferrite rods	16168	*£0·60
C6	2	Tuning gangs. MW/1W VHF	16169	*£0·60
C7	1	Pack wire 50 metres assorted colours single strand	16170	£0·60
C8	10	Reed switches	16171	*£0·60
C9	3	Micro switches	16172	*£0·60
C10	15	Assorted pots	16173	*£0·60
C11	5	Metal jack sockets 3 × 3·5mm 2 × standard switch types	16174	*£0·60
C12	30	Paper capacitors preferred types mixed values	16175	*£0·60
C13	20	Electrolytics trans. types	16176	*£0·60
C14	1	Pak assorted hardware—nuts/bolts, gromets, etc.	16177	£0·60
C15	5	Mains slide switches ass.	16178	*£0·60
C16	20	Assorted tag strips and panels	16179	£0·60
C17	15	Assorted control knobs	16180	*£0·60
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4012	20	7409	25	7484	93	74158	154
4013	51	7410	17	7485	117	74159	198
4014	107	7411	26	7484	33	74160	108
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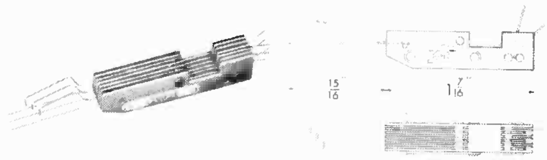

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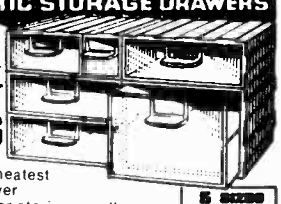

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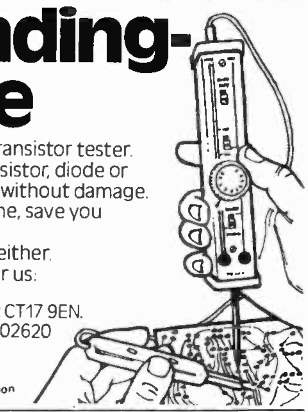

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PE

A GAME WITH ASSOCIATIONS

An electronic version of the popular game *Mastermind* was inevitable. The basis of the game is code-breaking. Cryptography, the writing of secret or concealed messages, has been practised from the earliest civilisations onwards, and the art or science of cryptanalysis (code-breaking) is of equal antiquity. The unravelling of the puzzle, the decoding of the secret message or sign, has always been an irresistible challenge. In its highest form of development as conducted by governments and their agencies, it becomes a matter of vital importance for national security and the most brilliant mathematicians, renowned chess exponents, and other intellectual giants are brought into the battle of wits where logic in its purest form provides the chief weapons.

The electronic connection with code-breaking is very definite and real. From official revelations made in recent years concerning British intelligence activities during the 1939–1945 war, we now know that valve circuits were pressed into service to perform the formidable number of computing operations necessary in the attempt to break down enemy messages. From this original application of electronic switching circuits in the field of cryptanalysis, it would appear that Britain has just claim to fathering the electronic computer: for this embryo computing machine (known as "Colossus") hastily designed and built during the last war, antedated by a few years the American ENIAC which is generally recognised as the world's first electronic digital computer.

In any event code-breaking, under the supreme exigencies of war, certainly laid the seeds for future electronic developments. Thus for those who like to delve into such matters our latest electronic game brings to mind interesting historic associations: with the ageless human pursuit of code-breaking, and also with the (by comparison) very young roots of electronic technology.

The *Practical Electronics Mastermind—Super Mastermind* is really a better title, since our design can be modified to extend to a four-from-ten colour game—uses TTL techniques. At this moment this is the cheapest way to achieve an electronic simulation of the game. The number of i.c.s involved is quite large, around 50 devices. Yet such are the economics of TTL packages that the total cost is likely to be less than £15. This fact alone should provide a convincing answer to those who may ask why not use a microprocessor?

Without doubt microprocessors are a natural for a game such as *Mastermind*. Programmes have been written for playing this game and other games on microprocessor based minicomputers and evaluation systems. But no one is likely to devote an equipment costing £150 and upwards solely to this particular amusement. Dedicated microprocessor versions of the game will come along in due course, that is certain, but the price of these devices needs to fall considerably before they can offer a viable alternative to the TTL based version.

What is true of *Mastermind* in this respect must be equally true of other applications in general. So even as we enter the microprocessor era it will be wise to recognise those real advantages still offered by the logic approach based on standard inexpensive i.c.s.

F.E.B.

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Can you beat it?

THIS series of articles will serve to present an electronic version of the very popular game using coloured pegs and secret codes; Mastermind. Unlike the vast majority of electronic games, however, Electronic Mastermind may be played by a single player with the machine acting as an opponent. Gone therefore is the frustration of having an expensive item of electronic gear lying around with nobody to be your human opponent just when you want to play. Of course, there is absolutely no reason why a group of willing competitors should not take turns to play a game with the machine. Indeed, it is the contrasting techniques of play adopted by different players which can produce considerable additional excitement.

PE Mastermind

By P. F. TURNEY

THE GAME EXPLAINED

For the benefit of those readers unfamiliar with the basic game, a summary will now be given. Mastermind is conventionally played by two players, one of whom selects four colours chosen from a set of six colours in any combination unknown to the second player. The second player must then deduce this secret combination using his own intuition and logical reasoning. He does this by selecting what he thinks to be the combination and placing this as a set of coloured pegs on a board before the first player, who then has to present clues indicating the correctness of the selection.

The original electronic prototype offered the very comprehensive facilities of not only being able to generate a secret combination of colours for the player to deduce, but also of being able to deduce a set of colours thought of by the player. A memory and display to store and present the results of all deductions was also incorporated.

However, due to reasons of economy the machine to be described here takes over the role in the game of inventing the secret combination of four colours, and the player then proceeds to deduce these using clues that are presented to him by the machine. The primary objective in Mastermind is thus to duplicate the hidden sequence of colours randomly generated by the machine, in the minimum number of moves.

BULK COMPONENTS LIST

Integrated Circuits

7400N	4	7454	5
7402	4	7473	7
7404	2	7474	1
7408	3	7482	2
7410	3	7486	2
7413	1	7490	4
7420	5	7496	2
7427	1	74118	1
7447	2		

Resistors
1kΩ 10
330Ω 16

Capacitors
0·1μF 14 plastic or ceramic
100μF 1 10V elect
3,500μF 1 10V elect

Switches
D.P.C.O. 6 (Bulgin types)
D.P.C.O. 1 (Radiospares)
Single Pole push-to-break 1 (Radiospares)

Displays
DL727 1 (Litronix)

Veroboard
95 × 432mm (3¾in by 17in) 1
95 × 100mm (3¾in by 4in) 1
(0·1in matrix, coppered)

Miscellaneous
19 Veropins, single core wire, Mastermind coloured pegs
Additional components for "4 from 10 colour" facility
7400N (1 off). 7407 (1 off). 7454 (1 off). Four pole, two way, change-over switch. Double pole change-over switches (4 off). Small Veroboard.

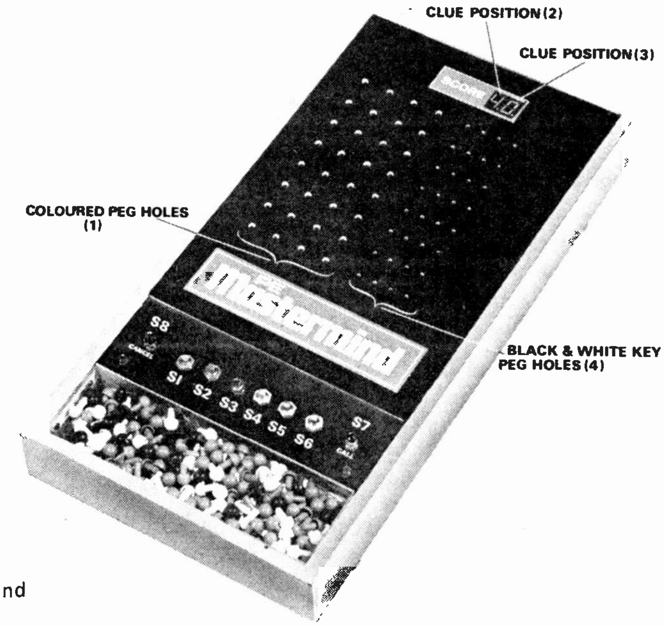


Fig. 1.1. Layout of the basic "four from six" colour game

The basic game offers a choice of four colours chosen from six, but a series of simple modifications are to be described for a switchable "four from ten colour" alternative. Since this facility is not included in the prototype, the mainline of the text is to concentrate on the basic "four from six colour" game.

As an item of electronic hardware the equipment is quite complex, utilising some 49 TTL integrated circuits. We are including an overall list of components in this issue, so that the prospective constructor may judge for himself the likely cost and complexity of the project before embarking on any actual construction.

With careful shopping the total cost of TTL for the game is approximately £13, including an additional three i.c.s for the "four from ten" colour game.

In this article, we shall describe the use and general principles of the machine, together with the physical features and the power supply. The construction of a well regulated power unit early on in the project will facilitate the comprehensive checking of the circuitry to be described in forthcoming issues.

PRESENTATION

The layout of the basic game is shown in Fig. 1.1. To commence play, the "Call" button S7 is pressed, setting up internally a random choice of colours and simultaneously clearing the logical circuits. The player then makes an initial choice of any four coloured pegs and places these in the first row of peg holes (1). These colours must then be sequentially entered into the machine, in a left to right order, using the appropriate push-buttons S1-6. After the fourth colour has been entered the machine returns information in clue positions (2) and (3), indicating the comparative correctness of the entered colours with the internal ones. The player then records these clues by entering the appropriate number of black and white key pegs into the first row of key peg holes (4).

Using this information, the player deduces a further combination of four colours, placing the appropriate coloured pegs in the second row of peg holes, and then proceeding to enter the colours using the push-buttons as before. The clues are this time recorded in the second row of key peg holes; and so on until the internal code is deduced.

A maximum of eight opportunities are provided to do this, although a good player may average between four and five deductions.

THE CLUES

Two pieces of information are given for each deduction. Firstly, in clue position (2) a numerical indication of the coloured pegs which are correct for both colour and position is given (for convenience, we shall call this the "P" result). Secondly, an indication of the number of pegs correct for colour but incorrect for position is presented in clue position (3) (called the "I" result). Thus, as an example, the game terminates when the score is four in position (2) and zero in position (3).

Two further examples illustrating the scoring principles are shown below, the second demonstrates the convention adopted when dealing with repeated colours. Scoring is identical to that in the commercial game.

(i)	*Internal unknown code*	Red Green Blue Yellow
	Deduction of player	Green Red Blue White
		Score: 1 ("P"), 2 ("I")
(ii)	*Internal unknown code*	Red Red Red Black
	Deduction of player	Red Black Black Red
		Score: 1 ("P"), 2 ("I")

Conventionally, black key pegs are used to record the "P" results and white key pegs to record the "I" results.

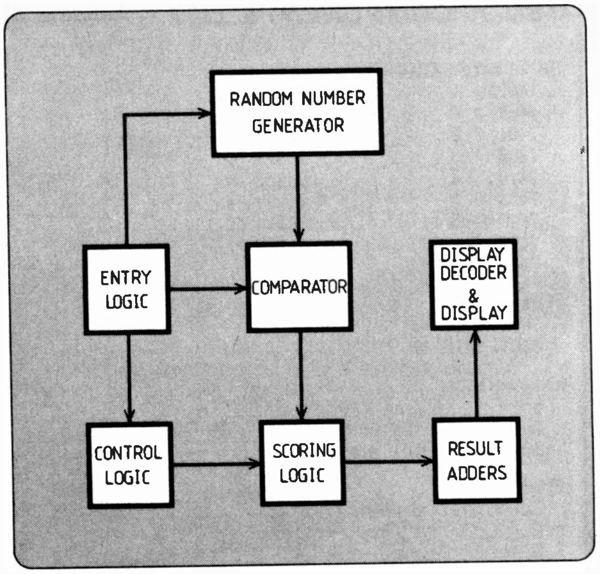


Fig. 1.2. Block schematic diagram of game

PRINCIPLES OF OPERATION

In the schematic diagram of Fig. 1.2, a random number generator (RNG) is used to produce the secret code. This simply comprises four modulo ("length") six counters, with the colours represented by four, three bit, binary codes. At the start of play, the depression of the "Call" button randomly programmes these counters, so that they then contain the codes to be deduced.

As the player sequentially enters the four colours forming a deduction, the codes generated by the RNG are called up for comparison with each of these entries as they appear. Note the necessity for each entry to be compared with all four internal codes, so that a total of 16 comparisons are made for each deduction entered.

The machine does not await the entry of all four colours of a particular deduction before computing the score, but instead computes this as each colour is entered. Thus the score is updated as further colours are entered, with the final result being available for display following the entry of the fourth colour of the deduction. Mastermind thus has a serial mode of operation.

As each colour is entered the results of the comparisons then performed are operated on in accordance with the scoring rules of the game discussed earlier. This function is performed by the scoring logic, the operation of which is the most complex section of the machine to understand.

The entry section of the logic debounces the contacts of the coloured push-buttons, and also transforms the debounced signal so obtained into binary machine code.

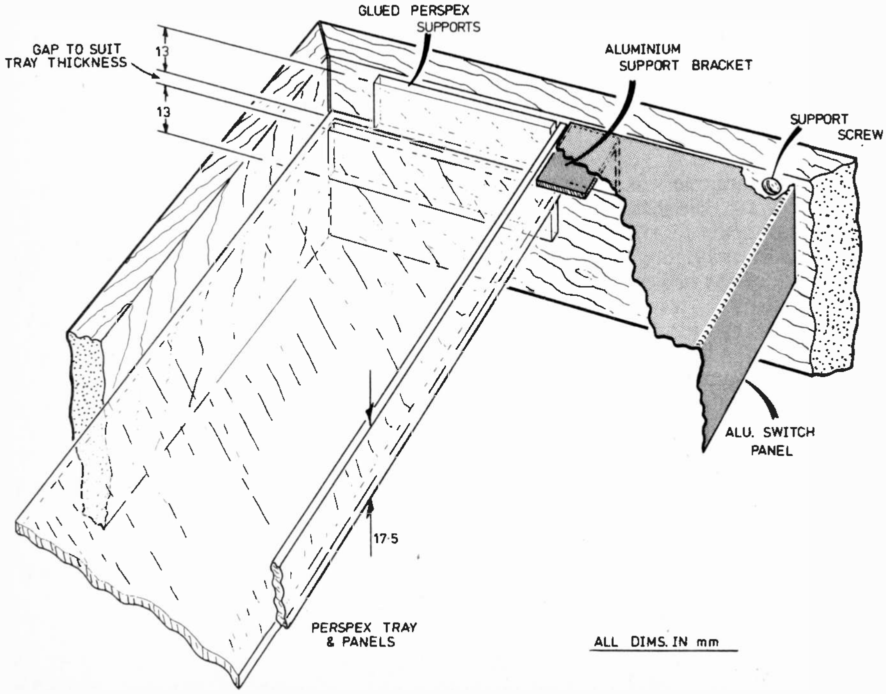


Fig. 1.3. Showing peg box and switch panel assembly. No switch drilling details are given as this will depend on game options

Finally, the control, or, as it is sometimes called, the "Orchestrating Logic" serves to conduct the electronics and achieve the correct temporal balance in the machine's hierarchy of logical operations.

PHYSICAL FEATURES

The majority of the logical circuitry is wired up on a single sheet of Veroboard, and you may, quite rightly, consider this to be a somewhat unusual format for a construction involving so many i.c.s. Admittedly, it is unusual and requires slightly more care regarding the routing of power supply lines and the provision of adequate decoupling for the circuits than for, say, a p.c. board system. There are, however, several advantages; for example, with only a single board there are obviously no interboard connections of noise sensitive logic signals. It is also cheaper.

CONSTRUCTION OF THE CASING

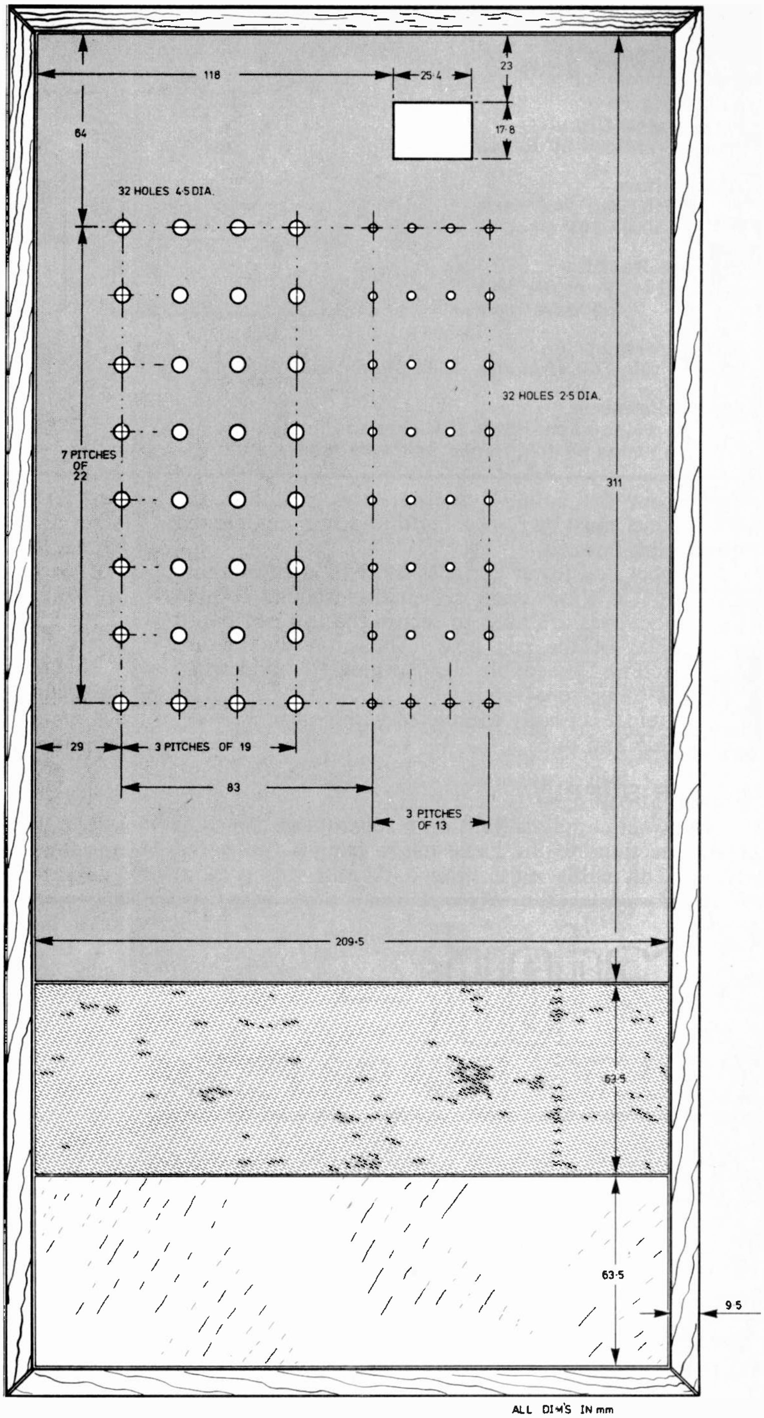
In the prototype the casing was made from softwood, with dimensions as shown in Fig. 1.4. The power supply unit is not housed within this, and the 5V supply lines enter via a two pin socket. It is advisable that you obtain such a socket prior to making the cut-out to accommodate it, so that the hole can then be made precisely to the dimensions of your particular socket.

When cutting the joints, work to the internal dimensions of the box, taking care to orientate the joints correctly. The wood should then be finished with a fine sandpaper before fixing the pieces together with wood adhesive.

The bottom of the casing is formed from light hardboard, suitably perforated to facilitate ventilation. The removable back of an old valve wireless set would be ideal for this purpose! This is fastened using four small wood screws passed through four rubber cabinet feet.

The top surface is in three parts: (a) the peg board, (b) the switch panel, and (c) the peg box. The peg board has dimensions as shown in Fig. 1.4. This board is supported by four Perspex batons (or batons of a similar material) screwed to the woodwork.

The aluminium switch panel for the switches is detailed in Fig. 1.3, also showing the peg box. In the prototype, the latter is constructed using transparent Perspex. If the



CUTTING LIST

Casing
Total length of softwood 1,448 × 44·5 × 9·5mm.
Perspex peg board 311 × 209·5 × 3mm (opaque).
Aluminium switch panel. 63·5 × 209·5 × 1·5m.
Perspex peg box top 63·5 × 209·5 × 3mm (transparent). 3mm perforated base hardboard 438 × 209·5

Fig. 1.4. Casing assembly details with cutting list

COMPONENTS . . .

POWER SUPPLY UNIT

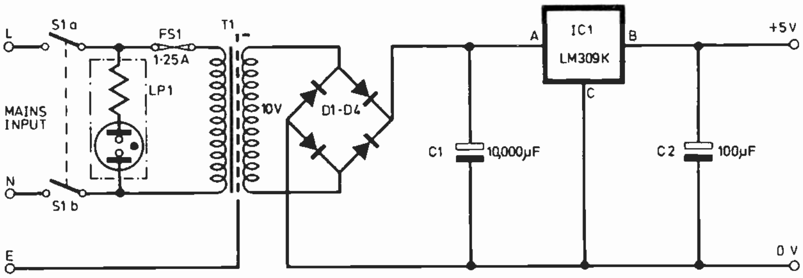
Integrated Circuit
IC1 LM309K 5V Regulator

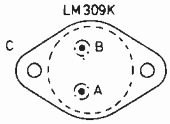
Capacitors
C1 10,000µF 20V elect.
C2 100µF 10V elect.

Bridge Rectifier
D1–D4 2A or 4A 500V full wave type

Transformer
T1 10V, 2A secondary—240V primary with screen

Miscellaneous
LP1 mains neon, FS1–1·25A fuse and holder, two pole mains switch, tinned heat sink, chassis etc.





"four from ten colour" alternative is required, the switch panel must be re-organised to accommodate ten colour push-buttons.

All upper and lower surfaces must be easily removable, and for this reason six small fasteners formed from solder tags are used to secure the top peg board and the lid of the peg box. Those on the lid are loosely screwed to enable easy turning by hand when the lid is to be removed.

The cabinet is finally completed with a coat of paint, both inside and out.

POWER SUPPLY

The power supply is built on a separate chassis with the connections to the game made using a two cored cable. This cable must have a current rating of at least 5A in order to avoid any significant voltage drop along it. It is also for this reason that its length must not exceed 2 metres.

A current of approximately 1·1A at 5V is required for the game and this is obtained from a regulator chip of the LM309K variety, as shown in the circuit diagram above.

This regulator must be mounted on a heat sink and the secondary voltage of the mains transformer should not exceed 10V in order that heat generation by the regulator be kept to a minimum.

No assembly details are given for this as construction is straightforward.

NEXT MONTH: Entry section of logic is described together with master clock and random colour generator.

Readout—
A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

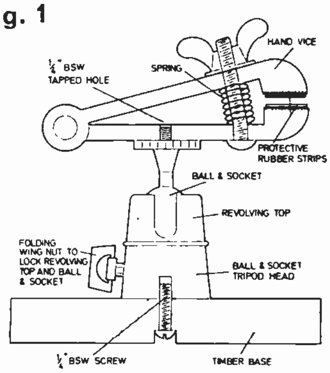
ADJUSTABLE VICE

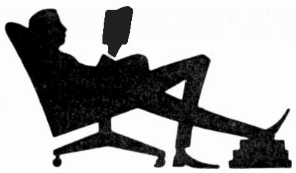
There are on the market, miniature vices which can be set to grip at any angle. Obviously this is very useful when working on p.c.b.s, as the components are inserted from one side, and the board is then rotated to allow soldering.

I have designed a similar device (Fig. 1) which only cost me about three pounds to make. A hand vice (from any good tool shop), has one of its limbs drilled and tapped to ¼ inch BSW; a local garage might do this at negligible cost if you do not have the tools, but a photographer should find it worthwhile to purchase them as ¼ BSW is the standard tripod thread. The vice can now be mounted on a ball and socket head, which is available at most photographic dealers. The tripod head is finally mounted on a substantial piece of timber, which in turn can be clamped to the work bench. The rotating ball and socket allows movement in any direction.

R. M. Henderson,
Newcastle upon Tyne.

Fig. 1





BOOK REVIEWS

50 CMOS IC PROJECTS
By R. A. Penfold
Published by Bernards (Publishers) Ltd.
102 pages, 108×180mm. Price £0.95

AFTER an introduction covering the more important characteristics of CMOS devices, the chapters march soberly but thoroughly through monostable, bistable and astable multivibrators, amplifiers, oscillators, and Schmitt triggers, finalising with "Special Devices" featuring i.c.s of a range *considered by the author* to be less useful to the typical constructor.

A good introduction to CMOS at a practical level, but watch out for confusing mistakes such as page 32, where a BC179 is shown as a *npn* transistor. M.A.

HAM RADIO
By Kenneth Ullyett
Published by David and Charles
163 pages, 216 × 136mm. Price £4·50

INTENDED as an introduction to amateur radio for the layman, or to give the experienced amateur a useful and up to date resume of his hobby, this book claims to be the first to cover the subject without the use of mathematics, circuits, block diagrams or formulae.

Subjects covered include the various communication modes, getting a transmitting licence, learning the Morse code, antennas (aerials), and equipment.

Unfortunately, the book is marred throughout by numerous inaccuracies, which will be as misleading for the newcomer as they are annoying for the experienced.

G.C.A.

ROOMS FOR RECREATION
By Euan Barty
Published by the Design Council
69 pages, 197×208mm. Price £1.95

ONE of a series of Design Centre publications, this book deals with a total of sixteen hobbies, among which electronics is conspicuous by its absence!

However, it contains a wealth of general information which will be of use to the electronics enthusiast. Subjects covered include workshop planning, furniture and fittings, lighting, heating, ventilation, wall and floor finishes, noise and safety. G.C.A.

BEGINNER'S GUIDE TO AUDIO
By I. R. Sinclair
Published by Newnes Technical Books
184 pages, 119×186mm. Price £2.75

THIS book brushes on most aspects of audio, starting with the nature of sound, how it is picked up, amplified, recorded and reproduced, and gives a quick splash of room acoustics.

Being only a guide it is non mathematical where possible, and almost vague in places, but goes into detail you can get your teeth into when dealing with the "neat" electronics such as tone controls and output stages.

This would not be a bad starting point for the complete novice because of the book's broad base, although a little supplementary study might be required on the circuit theory chapters.

Up to date methods are not neglected, and descriptions of current dumping, quad, pseudo quad, and electrostatic techniques are given. M.A.

A CATALOG OF OPERATIONAL TRANSFER FUNCTIONS
By Don Watts
Published by Garland Publishing, Inc.
545 Madison Avenue, New York, N.Y. 10022
224 pages, 150 × 222mm. Price $26

THIS book is a complete single-source catalogue of electronic operational transfer functions giving s-plane pole and zero locations, gain and phase Bode plots, sketches of impulse and stop functions, responses (where applicable to linear circuits), actual circuit or block diagrams with reference designators, and pertinent design equations for each function. Sections are included on: Linear, amplitude, and frequency independent; non-linear amplitude dependent; linear single pole; linear single zero; linear double zero; linear one pole/one zero; linear one pole/two zero; linear two pole; linear one zero/two pole; linear two pole/two zero; and multiple order functions. This format makes possible the selection of one of several possible solutions to the same function, which is the design engineer's job, and at the same time allows additional realisations to be added to the appropriate section if and when they become available.

An introductory chapter explains how the book may be used by practising engineers, scientists, and students. As an aid to the uninitiated, each modern function is preceded (at the section start) by the classical R-L-C filter function before the introduction of realisations using only resistors and capacitors with integrated circuit operational amplifiers. Thus, the student can quickly learn the features of modern audio filter design, the latest outgrowth of analogue computer technology.

FUNDAMENTAL ELECTRICAL TECHNOLOGY
By Marvin H. Klayton
Published by Addison-Wesley Publishing Co.
710 pages, 242 × 160mm. Price £13.60

THIS is another book of American origin which provides a basic course in electrical engineering. Whilst it does not avowedly fulfil any set syllabus the content should adequately encompass the first two years of any UK electrical engineering course.

The chapters cover basic electrical concepts, simple circuits, network solving, magnets and electromagnetism, a.c. circuits, polyphase circuits, transformers, resonance, special application networks, electrical signals and measurements and instruments.

The units and symbols are SI and there is a copious appendix so that one does not need to go outside the book for reference in studying.

Each chapter is backed with problems with solutions which makes it a good choice for self study, more so as it has an excellent 11 page index.

The review copy sent was in hard back.

ELECTRONICS AND THE PHOTOGRAPHER
By T. D. Towers
Published by Focal Press
316 pages, 216×137mm. Price £6.50

A VERY comprehensive book, covering just about the entire field of applications of electronics (and, to some extent, simple electrics) to photography.

Subjects covered include: Batteries, Mains Power Supplies, Light Measurement, Exposure Meters, Semi- and Fully-automatic Cameras, Electronic Shutters, Electronic Focusing, Artificial Lighting—embracing Mains-driven Lighting, Expendable Flash Bulbs, and Electronic Flash, Remote Control, Electronic Timers, Print Exposure Control, Electronics in the Darkroom, Photographing TV and Oscilloscope Screens, Adding Sound to Photographs. Other chapters cover electronic fundamentals, and the history and future of electronics in photography.

Basically, this is a "how-it-works", rather than a "how-to-do-it" book. There are some circuits for the electronics enthusiast to play with in the later chapters, but these are very definitely not suitable for the novice. G.C.A

SEMICONDUCTOR UPDATE... By R.W. COLES

TL 497
TBM 0101
CD 40107 BE

SWITCHER

Standard series voltage regulators are a real blessing but one thing they cannot claim to be is *efficient* because they must, by their very design dissipate a substantial amount of power, especially if the input/output voltage differential is large.

It has long been recognised that a more efficient regulator design can be produced by employing the "switching" technique which relies not on controlling the effective resistance of a series regulator but on varying the pulse width or frequency of a "chopped-up" version of the input voltage which is then converted into an equivalent smoothed d.c. output with the aid of a simple LC filter. A switching regulator is efficient because the series pass transistor is always turned hard-on or hard-off and these of course are both low dissipation states. In the past, switching regulators have only been used where their high efficiency is particularly advantageous (generating 5V from a 28V battery supply for example) because they tended to be rather expensive to put together using discrete components.

Thanks to Texas Instruments, the switching regulator can come in out of the cold and be used wherever its special characteristics are required, without worries about cost now that the **TL 497** is available. This new device brings together in a tiddly fourteen pin d.i.l. all the active components required to build a variety of switching regulator circuits with 60 per cent or greater efficiencies, adjustable output voltages, and current limiting.

The TL 497 contains a 500mA switching transistor, a control oscillator, current limiter, sense amplifier, 1·2V reference and a commutating diode, and will operate over a range of frequencies from 10kHz to above 50kHz.

When you switch to "switchers" you don't only gain efficiency either. After being chopped up by the switching transistor the output is essentially an a.c. signal and so can be used to provide voltage step-up or inversion with the aid of the inductor section of the l.c. filter.

BUBBLE MEMORY

Microprocessors and also larger computers usually require two different kinds of read/write memory for efficient operation. First and foremost of course, they need a RAM array which can be accessed very rapidly (less than 1 microsecond) and which is used for the storage of programs and data required for immediate use.

This kind of memory, while being the most versatile, is relatively expensive to provide and can be physically bulky. This creates a need for a second kind of memory which can store very large quantities of data in a cheaper and more compact form such as magnetic tape or discs. When this kind of storage is available data can be transferred back and forth between it and the RAM so that the processor itself "sees" only high speed random access storage which apparently has a limitless capacity for data.

Due to their inherently sequential operation magnetic tape and disc systems have average access times considerably in excess of those exhibited by semiconductor RAM, but their cheapness and non-volatility still make them very attractive whenever bulk storage is required. Ever conscious of this requirement for cheap sequential access memory systems the semiconductor giants have long dreamed of producing a solid state equivalent which would remove the dependence on unreliable mechanical tape and disc drives, and on the face of it, Texas Instruments appear to be close to making these dreams come true with the **TBM 0101 device.**

The TBM 0101 is a "Bubble Memory" device which packs no fewer than 92 kilobits of data into a fourteen pin d.i.l. module which consumes less than 700mW in continuous operation while providing an average access time of about 4ms.

"Bubble" technology is unusual in that it marries the economy of magnetic storage with the high density of semiconductor fabrication techniques by building on to a semiconductor chip a sort of magnetic track along which tiny individual magnetic domains (only 5μm in diameter) are constrained to propagate.

Control functions such as "transfer", "replicate" and "annihilate" are implemented by providing current pulses through appropriate control elements on the chip which cause local alterations in the magnetic field. To detect the presence or absence of "bubbles" as the domains are called, two magneto-resistive elements are provided which can drive an external "sense" amplifier to produce TTL compatible data.

The TBM 0101 is a first step into this intriguing new technology, and no doubt further development will reduce the amount of external drive circuitry currently required. Who knows, perhaps one day we will see all solid state audio "tape recorders" using devices like these!

BEEFY CMOS

The trouble with CMOS is that it can seem a bit puny when you want to use it to talk to the outside world where all the relays, lamps, and l.e.d.s live. If you have ever become a bit peeved about having to parallel umpteen CMOS gates together to get the sink current you needed you'll be pleased to hear about the **CD 40107 BE** from RCA which while being a fully paid up CMOS member can sink (wait for it!) no less than one hundred and twenty milliamps!

The CD 40107 BE contains two independent two-input NAND buffers with open drain *n-channel* output transistors, which means, of course, that it only sinks current and doesn't source it like standard CMOS. The bulging biceps of this new device are squeezed into an 8 pin Mini—d.i.p. package which has, I'm told, a built in hairy chest!

Next Month!

Meet the CHAMP

PE MICROPROCESSOR DEVELOPMENT SYSTEM

A design which allows the small user and the home constructor to design and develop practical microprocessor based hardware and software for a very small outlay. Comprising three units, Development System, Programmer and UV Eraser, the overall component cost is around £200. The microprocessor used is the Intel 4040, and features include calculator-based hexadecimal keyboard and display, battery-powered CMOS RAM store, and a programmable input/output array.

Also in this issue...

FREQUENCY COUNTER TIMER

Using a 1MHz crystal as the frequency standard, this instrument can count at up to 25MHz, giving an accurate readout on a 5-digit display. The four mode settings include TIME in milliseconds and COUNT PULSES.

C.R.O. LOGIC MONITOR GENERATOR

A simple unit which allows a conventional d.c.-coupled oscilloscope to be used to display the state of eight logic channels.

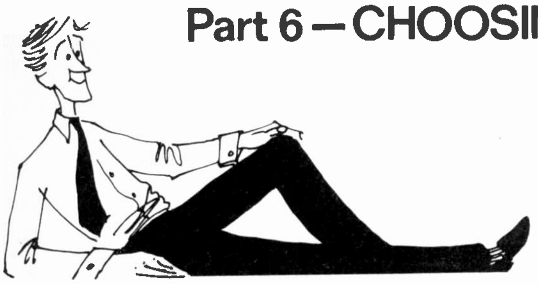
BIGGER PAGES!

Starting next month the page size of PE is going up, giving more room for the growing technologies without neglecting simpler projects.

Plus... FREE DORAM CATALOGUE with each SEPTEMBER issue!

PRACTICAL
ELECTRONICS

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, AUGUST 12, 1977



Part 6—CHOOSING A MICROPROCESSOR

MICROPROCESSORS explained

By R. W. Coles

Microprocessors do not just represent a new "ball game" for electronics enthusiasts, they make up a whole new "Olympiad", so full of new "events" that we need not blame ourselves for wondering, "Which shall we enter first?"

At one end of the arena we can expect to find simple dedicated applications which employ a small handful of chips in a low cost answer to an existing problem. At the other end we can already see the exciting prospect of truly **useful** *home digital computers with language compilers, cassette storage, VDU displays and several kilobytes of RAM memory. This latter use of microprocessors will have the interesting effect of bringing new entrants into our hobby from the ranks of the "software-people" in rather the same way that our ranks are swelled by ever increasing numbers of "music lovers"!*

If you are still sitting in the stands, wishing that you were down on the track, and wondering how on earth to get started, this concluding part of "Microprocessors Explained" is for you. The idea is to help you decide just what part of the arena **you** *want to enter, and having sorted that out, to help you decide just what to spend your hard earned cash on. Oh—and if you are interested in gold medals, microprocessors may not be for you, all we can offer is a great deal of "toil, tears and sweat", and a lot of fun!*

WHAT do *you* want to do with microprocessors? If they are a new and bewildering subject to you (and if you haven't had any association with digital computers in general, they probably are) you may answer that question by pointing out that you find the *concept* exciting but that you really don't feel ready to take a positive move towards any specific microprocessor-system until you have had time to learn a lot more about the subject.

If this *is* your reaction don't just say, "One of these days I'll get a book from the library." There has been enough meat in this series to get you out of the novice class and on to the nursery slopes, so dig out those back numbers and be advised that when you feel *au fait* with input/output ports, stacks, accumulators and hex code, you will be ready to put the L plates up and start the exciting business of building and/or operating a microprocessor system of your own!

Of course you *could* end up hating the sight of a hexadecimal keyboard, or even having ceremonial software-bonfires on your front lawn, so obviously you don't want to fork out a lot of money on your first cautious contact with this alien world. Fortunately, the microprocessor manufacturers are aware of your problems (well, some are!) and it should be possible to find a system to suit your needs and your pocket, with the aid of Table 6.1. This "Consumer Guide" attempts to set down the salient features of the Evaluation Kits and Tutorial Systems now available.

LOW COST INTRODUCTORY SYSTEMS

What manufacturers do to produce these low cost introductory systems is to put together on a p.c.b. a basic self-contained microprocessor system with clock facilities, a modicum of RAM, and a ROM full of "System

TABLE 6.1: BASIC MICROPROCESSOR SYSTEMS

Name	Maker	Build yourself	Ready built	MPU chip	Word length	RAM memory supplied (words)	Built in I/O device	External I/O device reqd.	Firmware provided	Tutorial system rating	Development system rating	'Home computer' system rating	Price range	Name
Scrumpi	Bywood	√		SC/MP	8 bits	256	SWS/LEDS	None	None	★★	★	★	£50	Scrumpi
Introkit	National	√		SC/MP	8 bits	256	None	TTY or KBDKIT	System monitor	★★	★★	★	↓	Introkit
Champ	P.E. Project	√		Intel 4040	4 bits	512	HEX KBD/ DISP	None	"	★★	★★★	★		Champ
F8 Kit	Fairchild & Mostek	√		F8	8 bits	1K	None	TTY	"	★★	★★	★		F8 Kit
MEK 6800 D2	Motorola	√		M6800	8 bits	256	HEX KBD/ DISP	None	"	★★★	★★	★		MEK 6800 D2
CDP 18S020	RCA	√		CDP 1802	8 bits	256	LED Bus Monitor	TTY	"	★★	★★	★★		CDP 18S020
SDK 80	Intel	√		Intel 8080	8 bits	256	None	TTY	"	★★	★★	★★		SDK 80
Intercept Jnr	Intersil		√	IM6100	12 bits	256	OCTAL KBD/DISP	TTY Optional	"	★★★	★★	★★		Intercept Jnr
KIM-1	MOS Technology		√	6502	8 bits	1K	"	"	"	★★★	★	★★		KIM-1
PC 1001	Signetics		√	2650	8 bits	1K	None	TTY	"	★★	★★	★★		PC 1001
Cramerkit M6800	Cramer	√		M6800	8 bits	1K	SWS/LEDS	TTY Optional	"	★★	★★	★★		Cramerkit M6800
MPT 8080	Limrose		√	Intel 8080	8 bits	1K	SWS/LEDS	TTY Optional	None	★★★	★	★	↓	MPT 8080
MEK 6800B	Motorola		√	M6800	8 bits	384	None	TTY	"	★★	★★	★★	£300	MEK 6800B
LCDS	National		√	SC/MP	8 bits	256	HEX KBD/ DISP	TTY Optional	"	★★	★★★	★★	↓	LCDS
Polyvalent Dev System	Motorola		√	M6800	8 bits	512	VDU/ ASCII KBD	Printer Optional	"	★★	★★★	★★★		Polyvalent Dev System
Micro Designer MD-0	E. L. Instruments	√	√	Intel 8080	8 bits	2K	LEDS/SWS	TTY	"	★★★	★★	★★	↓	Micro Designer MD-0
Prompt 80	Intel		√	Intel 8080	8 bits	1K	HEX KBD/ DISP	TTY Optional	System monitor	★★	★★★	★★	£1,000	Prompt 80

NOTES: Microprocessor systems are listed in *approximate* order of cost. For more detailed price information contact manufacturers
Star ratings are offered as a rough guide only, and *are* arguable
The term 'system monitor' covers a wide range of program capability. What it *excludes* are assemblers and high level language compilers

Monitor" programs. In general, no cabinets, power supplies or input/output terminals are provided, and all these are necessary to a greater or lesser degree. The System Monitor programs usually expect to speak to an ASCII coded, 10 character-a-second terminal, such as a Teletype ASR33, although in some cases a simple hex keyboard/display may be used, or may even be provided as part of the deal.

The idea is that the user can cook up small programs and enter these into his system's RAM memory via an input device, and then run them and debug them using system-monitor commands. If you are asking "What kind of programs" then the answer must be "very simple ones" because (a) there won't be a lot of program space in the RAM and (b) the input/output arrangements will be a limiting factor.

To start with, these basic systems act as **tutorial systems,** allowing the user to become familiar with the operation of a particular MPU chip and to develop his programming skills. As confidence is gained they take on the usefulness of **development systems,** where sections of a program can be checked out before they are transferred to a "homebrew" hardware system.

EXPANSION

Very often the basic system can be expanded by adding extra memory and interface facilities, though in most cases the method of expansion is left very much to the user, and a good knowledge of system operation is required before this can be attempted.

HARDWARE ORIENTATED

All this fussing about "evaluation" and "tutorials" may turn some of you off. You probably cut your teeth on a 7400 gate, back in the frontier days of logic. Since then you have dabbled with those cissy CMOS gates and rode roughshod through board after board of "Manufacturers' TTL fall-outs", blazing a trail littered with pseudo-random lawn sprinklers, psychedelic door bells, and a host of other less well-known achievements. Now along come these microprocessors. They look as though they have some potential, particularly since you have just calculated that to build your latest U.F.O. detector you will need 428·25 TTL packages which according to rule-of-thumb estimates will have the interesting effect of dimming the lights for miles around when switched on. Maybe, just maybe, it would be worth running your eye over a microprocessor workshop manual (it's only logic after all), putting a new point on your soldering iron, and sending off for a few Jiffy-bags full of MPU chips.

Exaggeration? Well, maybe a little, but you know the sort of hardware-orientated fanatics we are talking about, and with a maverick spirit like theirs they *will* get to grips with microprocessors in the end, never fear, even without our help! If anyone reading this identifies with them, and is casting his flinty gaze in the direction of microprocessors ("A man's gotta do . . . etc.") we would point out that their interest is very close to our hearts; we too like to think of microprocessors doing something *practical*.

All we urge is that the hardware enthusiasts recognise that using these devices does require an investment in acquiring some new skills, and so a good place to start is with Table 6.1 so that a minimal system (let's call it a development system!) can be selected to start them on their way. (No doubt before they even get their system unpacked these guys will be thinking about expanding

TABLE 6.2: HOME COMPUTERS

System	Manufacturer	MPU Chip	Description	Available peripherals
8800	Altair	8080	The ALTAIR 8800 is a ready built cabinet mounted computer system which uses a versatile bus structure for easy plug-in expansion up to 16 boards. System monitor, resident assembler and BASIC interpreter are all available on paper tape or cassette.	TTY, VDU, Line printer. Floppy disc drive.
MP68	Computer Workshop	M6800	The MP68 is a cabinet mounted computer system which is available either as a kit or ready built. The basic system arrives with 2K of RAM but this is expandable to 24K by plugging in extra boards. Software available includes an assembler/editor, two versions of BASIC and a floating point math package.	VDU, Printer, Audio cassette interface, Graphics system.
PET	CBM	6500	The PET is a futuristically styled self contained home computer which *includes* a VDU, an ASCII keyboard, a cassette deck and 4K of RAM. Software is based on a powerful BASIC interpreter in ROM and memory expansion is possible up to 32K. Plans are afoot to sell pre-recorded programs covering accounting and educational applications. (PET will be available in the Autumn.)	(Future) Printer, Modem. Floppy disc drive.

TABLE 6.3 MPU CHIPS

Chip	Manfs.	Technology	Word length	On chip clock	Interrupt lines	Basic addressing range	Subroutine nesting levels	No. of instructions	Power supplies	'Learner' rating	'Practical' rating	'Home computer' rating	Chip
4004	Intel National	PMOS	4 bits	No	None	4K	Three	46	+5V −10V	★	★★	★	4004
4040	Intel	PMOS	,,	No	One	8K	Seven	60	+5V −10V	★★	★★★	★	4040
2650	Signetics	NMOS	8 bits	No	One	32K	Eight	75	+5V	★★	★★★	★★	2650
6500 (Family)	MOS Technology	NMOS	,,	Yes	Two	65K	Unlimited	56	+5V	★★	★★	★★	6500 (Family)
8080	Intel, Texas AMD National	NMOS	,,	No	One	65K	Unlimited	74	+5V +12V −5V	★★	★★	★★★	8080
CDP1802	RCA	CMOS	,,		One	65K	Unlimited	91	+3V to +12V	★★	★★	★★	CDP1802
F8	Fairchild Mostek	NMOS	,,	Yes	System depen-dent	65K	System dependent	62	+5V +12V	★★	★★★	★	F8
LP8000	General Instrument	PMOS	,,	No	None	16K	Unlimited	48	+5V −10V	★	★★	★	LP8000
M6800	Motorola AMI	NMOS	,,	No	Two	65K	Unlimited	72	+5V	★★	★★★	★★★	M6800
SC/MP	National	PMOS	,,	Yes	One	4K	Zero (software expand-able	46	+5V −7V	★★	★★★	★★	SC/MP
Z80	Zilog Mostek	NMOS	,,	No	Two	65K	Unlimited	158	+5V	★	★★★	★★★	Z80
IM6100	Intersil Harris	CMOS	12 bits	Yes	Two	4K	Unlimited	Microcoded	+5V to +10V	★★	★	★★★	IM6100
CP1600	General Instrument	NMOS	16 bits	No	One	65K	Unlimited	87	+5V +12V −3V	★	★	★★★	CP1600
F100L	Ferranti	CDI	,,	No	One	32K	Unlimited	29 (BASIC)	+5V	★	★	★★★	F100L
PACE	National	NMOS	,,	No	One	65K	Unlimited	45	+5V +8V −12V	★	★	★★★	PACE
TMS9900	Texas	NMOS	,,	No	One	65K	Unlimited	69	+5V +12V −5V	★	★	★★★	TMS9900

NOTES: Star ratings here are based on the question 'I want to make a system tomorrow, which chip should I choose?' Obviously these ratings are arguable. Where subroutine nesting is stated as 'unlimited' it is of course limited by the available RAM in a given system.

what they have bought; extra memory, twin carburettors, U.F.O. field sensor peripherals, etc.!)

SOFTWARE ORIENTATED

The next category of potential MPU user may not even read this magazine at all, or if they do, it's on microfiche which they absorb at 2.4 pages per second. These people wear hair shirts, and no shoes, and spend all their time thinking about normed vector spaces, transcendental equations and black holes. Normally they don't have to touch soldering irons, the required I.B.M. computers and graphics displays being pressed into their eager hands by a grateful public who feel they are getting good value for money.

These potential entrants into the microprocessor arena have their eyes fixed on the misty horizon (they have never grasped the concept of hard cash!)

Don't get us wrong, we *need* these fundamental research workers. They want Fortran compilers, floppy discs, 32-bit arithmetic and a VDU terminal. And after someone has got up a collection, they will show us *all* the way ahead.

If any of these boffin types are reading this, they *can* get help from the tables because although a mini-evaluation card may not interest them, the "Home Computer" market is starting to take off, particularly in the States and there are a few systems available on the UK market already, as shown in Table 6.2.

HARD FACTS

We have painted a lurid picture of some potential "microprocessor-people" to emphasise the differences between these extremes, but of course in between lie all the shades of grey and we have no doubt that *you* won't fall immediately into one of our extreme categories. It is a fair bet however, that your main interest in microprocessors can be summed up in one of three basic ways:

(a) You want to learn all about these revolutionary devices.
(b) You want to do "practical" things like control your model train layout, your car ignition system, or your central heating.
(c) You want to build a "Home Computer" with extensive software and bulk storage facilities to crunch numbers and act as an intellectual challenge.

Our tables have been drawn up accordingly, with star ratings for each of these possible uses.

CHOOSING A CHIP

You may have been surprised by the fact that we have put the choice of "system" before the choice of MPU "chip". Certainly the professionals would look hard at the choice of chips to start with, and worry about development systems and so on, later. In our case, however, the availability of an off-the-shelf get-you-started system, or even just a design for one, is an important prerequisite to choosing a chip to do a job.

As an example, the Zilog Z80 is an extremely attractive eight-bit MPU chip with lots of Rolls-Royce features, but if you want to use it you will have to start from scratch because there is no low cost "basic system" to help you. In our book this rules it out for the present.

By way of contrast, the Intel 4040 is not the latest and the greatest microprocessor chip on the market, but starting next month in these pages there will be a project covering the construction and use of a low cost development system based on this chip and this makes it a very attractive choice for amateur projects.

Even though the availability of hardware and software support (in our price range!) has a powerful influence on the MPU chip we eventually choose, there is bound to be a need for an objective chip comparison, and we have provided this in Table 6.3 which covers the more prominent MPU chips currently available. This comparison does not include the faster bipolar microprocessors because in our opinion they are out of our market and rather specialised in their application at present.

CHOOSING A PERIPHERAL

The choice of an input/output device for use with general purpose microprocessor systems is a very difficult one for home constructors. Many "basic systems" cards expect to talk to a Teletype ASR33 terminal or similar, as mentioned earlier, and with prices starting at about £500 this is clearly out of the question for most of us.

Some manufacturers have recognised this problem and have come up with ingenious solutions. Simplest of all is a rewrite of system software to allow it to control a simple hexadecimal keyboard and seven-segment display via a few input/output ports. Hexadecimal peripherals of this sort can be made from small calculators and are consequently of low cost, but the problem is that unless you modify the system software yourself (not an easy job if you are a beginner) these devices are not compatible with most "ASCII-speak" systems.

A compromise between the Teletype and the hex keyboard, which overcomes the software compatibility problem of the latter, is possible if a system is built which "imitates" a Teletype in some way. You can patch up simple imitations with the help of a UART chip and some LEDS and switches; however G.R. Electronics actually make a Teletype imitation which lives in a calculator case and does most things that a Teletype does at a fraction of the price! Needless to say, at the heart of this neat innovation is a microprocessor which has been programmed to believe it's a terminal!

VIDEO DISPLAY UNIT

One *very* attractive way to talk to your microprocessor is via a VDU (Video Display Unit) which uses a TV screen as an output medium and is usually twinned with a full ASCII keyboard for input. VDUs can be made fully compatible with existing system software and need not be as expensive as they sound if you can use an existing TV and can buy a ready-made, surplus ASCII keyboard.

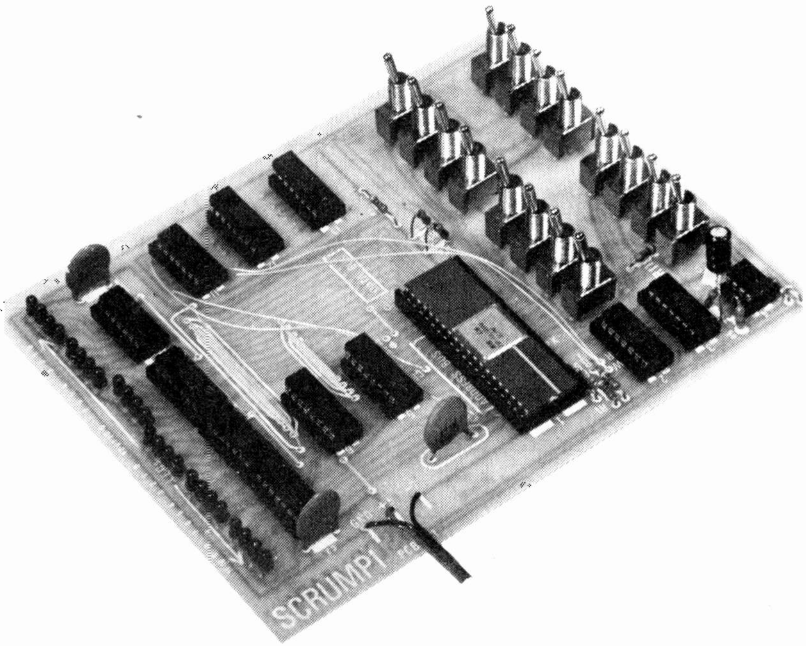
If you are interested in the "Home Computer" side of microprocessors then a VDU is a natural choice, but if you want to build dedicated systems then a simple hex keyboard will be sufficient if your chosen system will drive it.

THE END OF THE BEGINNING

That brings us to the end of this introductory series. Next month sees the start of an exciting microprocessor constructional project which will enable those readers who have developed all the symptoms of the microprocessor-bug to indulge themselves further! ★

SCRUMPI KIT REVIEWED

By D.B. JOHNSON-DAVIES



All the components are mounted on the single-sided fibreglass printed-circuit board; twenty wire links are needed to complete the connections. A double-sided board would add little to the cost and it is difficult to see why one was not used. Apart from this inconvenience construction was straightforward. All the parts were supplied and sockets were provided for all the i.c.s. The switches are soldered to the board by their terminals, but the whole board could be mounted behind a suitably drilled panel to make a more robust unit. The circuit needs a power supply of +5V and −7V and these can be derived from a single 12V supply with a 5V Zener diode.

WITH all the articles on microprocessors that have been appearing recently there must be a number of readers who feel that they will never really understand micros until they have actually used and programmed one, and who are therefore wondering how they can get their hands on a system as cheaply as possible. Bywood's "Scrumpi" kit may be the answer as it provides a self-contained development system using the minimum of parts, and at £55·56 costs less than most other solutions.

DESIGN CENTRE

It is designed around National Semiconductor's SC/MP, an 8-bit low cost micro which has a simplified instruction set and architecture in aid of economy. Its lack of sophistication means that most programs require more steps to achieve the same as a micro with a greater variety of instructions, registers, and addressing modes. On the other hand the chip provides a good selection of control inputs and outputs eliminating the need for I/O devices in simple applications: three outputs, flags F0 -1, and -2, are controlled by bits in the status register and two inputs, SENSE-A and -B, set bits in the status register. In addition, SENSE-A can optionally cause an interrupt. Serial I/O can be performed via the SIN and SOUT pins using the extension register.

In "Scrumpi" the states of the twelve address lines and the eight data lines are displayed in binary form on l.e.d.s driven by CMOS buffers. The data lines can be taken to ground by eight programming switches. The memory consists of two 256 × 4 bit memory chips, providing 256 words of read/write memory. Two four-bit latches act as an eight-bit I/O port in which each set of four can be wired as either inputs or outputs. They are enabled by the highest address line, A11, so that all addresses in the range X'800 to X'FFF (where the X' signifies hexadecimal notation) are mapped on to the one I/O port.

FUNCTIONS

The various functions of the kit are controlled by a flip/flop, a 555 timer and some NAND gates, and are selected by a further eight toggle switches. These are: RESET, SLOW, STEP, RUN/HALT, PROTECT, SENSE-A, SENSE-B, and LOAD. The circuit of the kit is shown in simplified form in Fig. 1.

HOW IT WORKS

"Scrumpi" gets away without the need for any monitor program in ROM by making cunning use of the control signals provided by the MPU. The memory is programmed by a primitive form of DMA (direct memory access) by automatically stopping the MPU during each instruction cycle. All the instructions consist of at least one read cycle—the "instruction fetch" which gets the op-code from memory. For example, SR (shift right) has only one cycle. For the two-word instructions there is a second read cycle to fetch the displacement or data; for example, LDI (load immediate) has a second read cycle to get the data from the next location. Store instructions obviously have an additional write cycle, and the two longest instructions ILD (increment and load) and DLD (decrement and load) consist of three read cycles and one write cycle.

The MPU is stopped by taking the NHOLD input low during the input or output cycle, and this extends the cycle indefinitely until NHOLD is

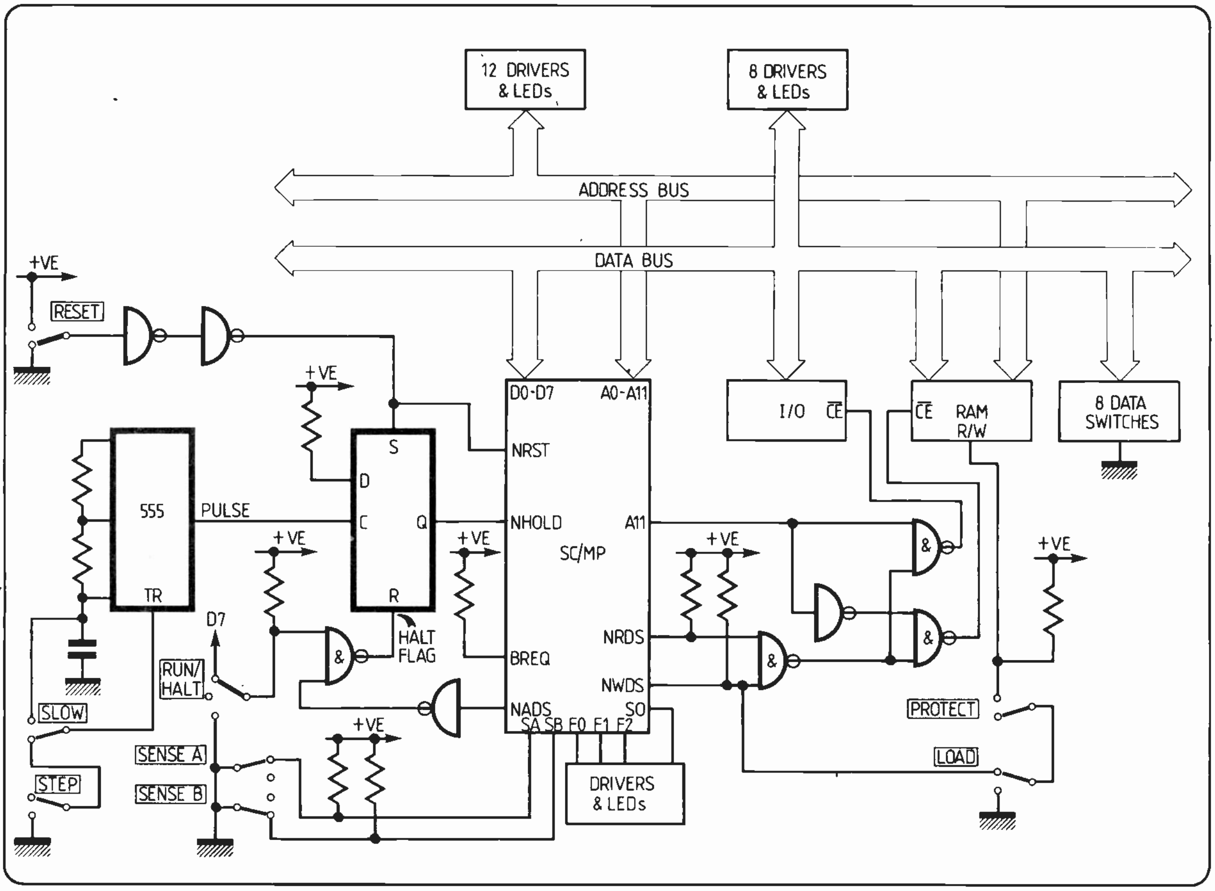


Fig. 1. Simplified circuit diagram of "Scrumpi". The eight function switches control the various modes of operation of the kit

returned high. In "Scrumpi" the NHOLD input is controlled by a D-type flip/flop, which is reset by the pulse on the NADS (address strobe) output occurring at the start of each input/output cycle; see Fig. 2. This puts NHOLD low extending the cycle until the flip/flop is clocked by a pulse from the output of the 555 timer; the MPU is then released to run until the next NADS pulse at the start of the next cycle.

In a read cycle the MPU is stopped with NRDS (read strobe) low which is used to enable the memory in write mode, causing the data in memory at the location addressed by the MPU to be put on to the data bus. In a write cycle the MPU is stopped with NWDS (write strobe) low which enables the memory to read data put on to the data bus by the MPU.

"Scrumpi" is programmed by stepping or running the MPU to the required address, putting the eight data switches to the required eight-bit binary value, and then operating the LOAD switch. This switch puts the memory chips into read mode and so loads the value on the data bus into the memory location. Programming can only be done during a read cycle since in a write cycle the MPU is putting data on to the data bus too.

ENTERING A PROGRAM

To make this operation clear consider how one would enter the following program which uses the instruction ILD (increment and load) to increment the contents of location X'032 using program-counter-relative addressing. The program follows:

Address:	Data:	
001	A8	ILD
002	30	disp.
003	next instruction	
.	.	.
.	.	.
032	04	data

First all memory locations are set to X'00 by running the MPU while loading with the data switches set to 0. Operating RESET now starts the MPU at address X'001 (Fig. 2 (a)). The required value, X'A8, is set on the data switches (as 10101000) and LOAD operated to store this to memory. The STEP switch will now cause the 555 timer to deliver a pulse, releasing the MPU from hold state to execute the instruction. Since the ILD instruction is four cycles long (see Fig. 2) a further three operations of the STEP switch are needed to complete execution of it.

The second cycle fetches the displacement (X'30); see Fig. 2 (b). This added to the program counter gives the effective address of the data: X'032. The third cycle fetches the data from this location. Finally the fourth cycle writes the incremented value back to the same location (Fig. 2 (d)).

The kit could thus be said to provide a hardware trace facility by making use of the SC/MP's control signals; "Scrumpi" makes an asset out of economy and provides a graphic demonstration of how each instruction behaves in action.

BREAKPOINTS

"Scrumpi" also provides a hardware breakpoint facility. The code X'00 is interpreted by the MPU as a HALT instruction; in fact execution of it will pulse the H-flag which is put out on line D7 when NADS is

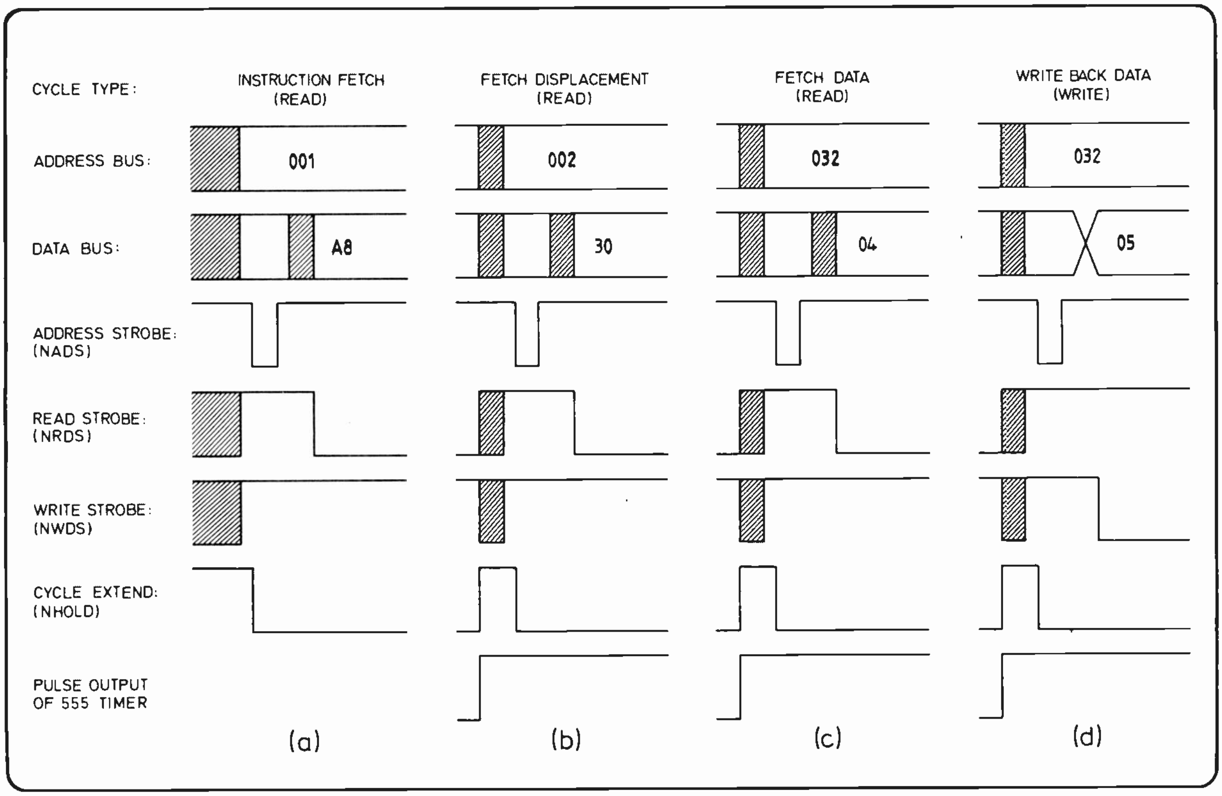


Fig. 2. Timing diagram showing how the control input NHOLD is used to stop the MPU after each of the read/write cycles of the four-cycle instruction ILD (increment and load). The shading indicates that the outputs concerned are in high-impedance state

low. With the RUN/HALT switch in the correct position D7 is taken to the flip/flop, gated by NADS. A HALT instruction placed anywhere in a program will then act as a breakpoint; executing it will rest the flip/flop and put the MPU into hold state.

It should be obvious from the foregoing description that programming is a tedious business; the data switches must be set for each instruction to be entered and although the conversion from hexadecimal to binary becomes automatic after a time, the process is error-prone and slow which discourages attempts at large programs; added to which is the knowledge that the program will evaporate on switching off the power.

JUMP TO SUBROUTINE

A fair amount of ingenuity is needed to get some programs into memory, especially if they contain conditional jumps, as the only access to a location is by executing instructions which lead to it. It might therefore be prudent to leave the first seven locations free so they can be loaded with the following "jump to subroutine":

Address:	Data:		
001	C4	LDI	load P3 with X′0123
002	01	X′01	
003	37	XPAH P3	
004	C4	LDI	
005	23	X′23	
006	33	XPAL P3	
007	3F	XPPC P3	

Execution of this will cause a jump to X′0124. Any location can be reached by loading the correct address in X′002 and X′005.

KIT DESIGN

One worrying aspect in the design of this kit is the way programming is achieved by using the data switches to ground the data lines linking the MPU and memory. Suppose that X′FF is to be altered to X′00 at a certain location. In this case all eight outputs from the memory devices are, until the LOAD switch is operated, driving into a short-circuit. The "on" resistance of the outputs is about 30 ohms so dissipation under these conditions could reach 3 watts; the maximum recommended dissipation is 1 watt. This is one reason for the instruction to load the memory with X′00 before programming.

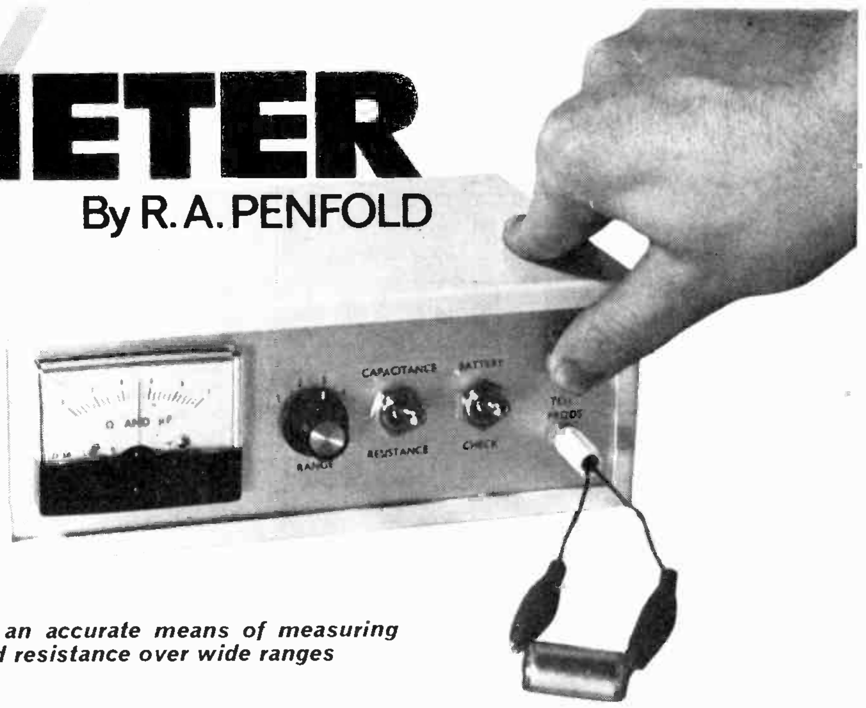
Operation of the LOAD switch was also somewhat erratic; it is surprising that the spare flip/flop was not used to eliminate contact-bounce. Mr. Miller-Kirkpatrick of Bywood is currently involved in designing a new version of the kit which may overcome these problems.

CONCLUSION

Aspiring computer programmers who want to forget about the hardware the moment "Scrumpi" is working would be well advised not to spend their money on this kit; it is just not a practical proposition to write more than the simplest of programs on the system. To quote from the manual: "You will very soon realise that "Scrumpi" is very limited as it stands because it does no more than light up l.e.ds." The constructor who is more interested in hardware than software, however, could use "Scrumpi" to form the base from which to build a more extensive microprocessor system.

C/R METER

By R. A. PENFOLD



Fulfils the need for an accurate means of measuring capacitance and resistance over wide ranges

ONE of the most frustrating problems that the electronics enthusiast can encounter is to be faced with a capacitor of unknown value or a capacitor that is suspected of being faulty, without having available the appropriate test gear to perform the required measurement. Although a capacitance meter is likely to be required less often than the more important items of test gear, it can prove to be very useful and much used in the long term.

Problems can also arise when one wishes to make accurate resistance measurements, as many multimeters have only a couple of resistance ranges, and a logarithmic resistance scale that reads from right to left. Apart from being inconvenient to read, the accuracy on the resistance ranges of most multimeters is less than that obtained on the other ranges.

The device that forms the subject of this article has been designed to fill the need for a convenient and accurate way of measuring capacitance and resistance at low cost. Furthermore, it requires no external components for calibration, and the calibration process merely consists of adjusting four preset resistors (one for each range) for f.s.d. of the panel meter.

RANGES

The circuit does not merely consist of separate resistance and capacitance measuring circuits with the same meter being used to indicate the measured value, but achieves maximum economy by using the same basic circuit for both types of test.

Eight ranges are covered, four of resistance and four of capacitance. These are as follows:

Range	Resistance	Capacitance
1	0–10MΩ	0–1nF
2	0–1MΩ	0–10nF
3	0–100kΩ	0–100nF
4	0–10kΩ	0–1µF

These ranges permit the measurement of resistance between a few hundred ohms and 10 megohms, and capacitance between a few tens of picofarads and one

COMPONENTS . . .

Resistors

R1	10kΩ	R9	1 MΩ
R2	120kΩ	R10	100kΩ
R3	680Ω	R11	10kΩ
R4	5·6kΩ	VR12	4·7kΩ preset
R5	1kΩ	VR13	4·7kΩ preset
R6	4·7kΩ	VR14	4·7kΩ preset
R7	560Ω	VR15	4·7kΩ preset
R8	10MΩ (see text)		

All metal oxide 1 or 2% except presets

Capacitors

C1 100µF 10V elect.
C2 220nF type C280
C3 470nF type C280
C4 1µF
C5 100nF
C6 10nF
C7 1nF

Semiconductors

IC1 NE555V
IC2 NE555V
TR1 BC109

Switches

S1 D.p.d.t. toggle switch
S2 D.p.d.t. toggle switch (used as s.p.d.t.)
S3 4-way 3-pole standard wafer rotary switch
S4 Push-to-make release-to-break push button switch

Meter

ME1 1mA f.s.d. moving coil panel meter

Miscellaneous

Case about 205 × 140 × 75mm (Verobox type 75-1411D or similar). 3·5mm jack plug and socket, two crocodile clips or probe clips, materials to produce the p.c.b. PP7 battery and clips to suit, control knob, hardware.

microfarad. It thus covers by far the majority of values the amateur is likely to need to measure.

All ranges have a forward reading linear scale.

OPERATION

The circuit is based on two NE555V timer i.c.s. Fig. 1 shows the complete circuit diagram of the unit.

IC1 is used in the astable mode, and C2 is continually being charged via R2 and discharged through R3. As R3 has a much lower value than R2, the discharge time is considerably shorter than the charge time.

The output of IC1 is developed across R4, and the voltage at pin 3 of IC1 is high while C2 is charging, and low while it is discharging. A series of very brief negative pulses are thus produced by IC1 and fed via C3 to the input of IC2. The astable operates at the fairly low frequency of about 50Hz.

The meter circuit is not fed direct from the output of IC2, as the peak output voltage of this varies with fluctuations in the supply voltage. It is important in the interest of accuracy that the average output voltage across the meter is dependent upon the monostable pulse length, so R5, R6, R7, and TR1 are used to form a shunt regulation circuit, and they clip the output pulses at approximately +4V. TR1 is used as an amplified diode, and this gives a much higher degree of stabilisation than using a low voltage Zener diode.

Varying the supply voltage from a little over 9V to 7·5V (the approximate range covered by a 9V battery during its useful lifetime) was found to have a slight but insignificant effect upon the accuracy of the unit.

CAPACITANCE MEASUREMENT

In the capacitance measuring role, S1 connects a reference resistor into circuit and connects the test

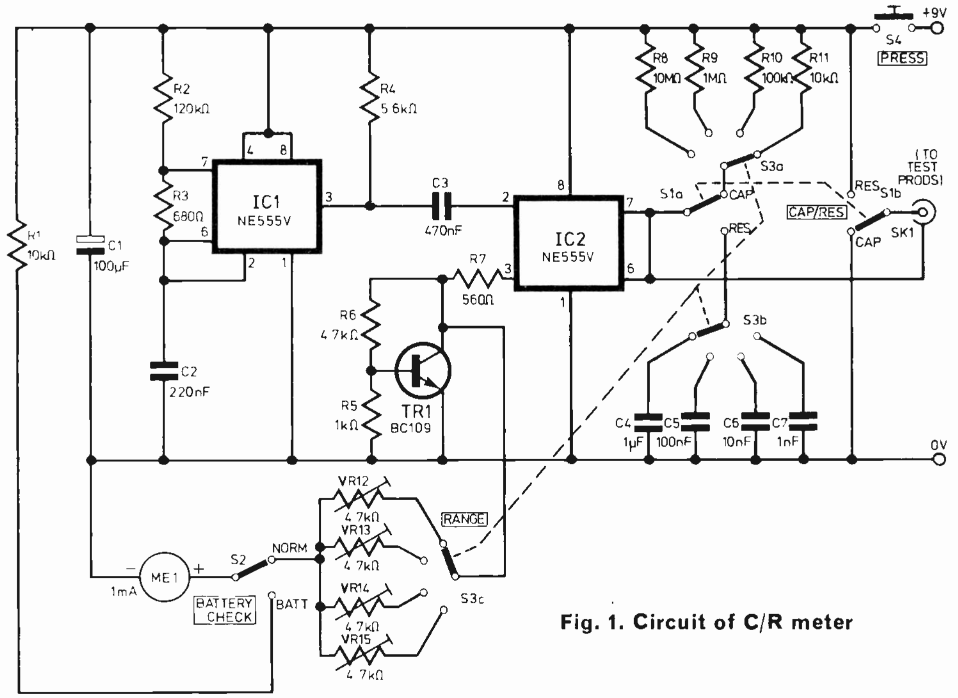


Fig. 1. Circuit of C/R meter

IC2 is used in the monostable mode. Here the device produces a positive output pulse at pin 3 after a negative trigger pulse has been received at pin 2. The length of the pulse is determined by the values given to the timing resistor and capacitor. When the circuit is in the capacitance measuring mode the timing capacitor is the capacitor under test, and the timing resistor is an internal component of the device. When used to measure resistance the opposite is true.

OUTPUT STABILISATION

There is a linear relationship between the length of the output pulse and the values of the timing components. The output of the meter circuit is fed to a meter which responds to the average output voltage of the monostable.

prods between the negative supply rail and pins 6–7 of IC2. There are actually four reference resistors (R8 to R11) giving four capacitance ranges, S3 being used to switch in the resistor for the desired range.

With S3 in the position shown, R11 is switched into circuit and the unit has a range of 0–1 microfarad. With a 1 microfarad capacitor connected across the test terminals each output pulse from the monostable ends shortly before the next pulse from the astable is received. This gives the astable and monostable output waveforms shown in Figs. 2(a) and 2(b) respectively. The meter circuit sensitivity is adjusted using VR12 to give f.s.d. of the meter with a 1 microfarad capacitor in circuit.

If a lower value capacitor, say 0·5 microfarad is now connected, the length of monostable output pulses will be halved. This gives the output waveform shown in Fig. 2(c). The meter reads the average output voltage which will obviously be half its previous level.

It will be apparent from this that the meter reading is linearly proportional to the value of the test capacitance. Each time S3a is moved a position to the right the reference resistance is raised by a factor of ten times, and so only one tenth of the capacitance is required across the test terminals to provide f.s.d. of the meter. The unit thus obtains its four capacitance ranges of 0–1nF, 10nF, 100nF, and 1µF.

RESISTANCE RANGES

When used in the resistance mode the circuit operates in the same basic manner, except it is now the timing resistor that is the test component and the timing capacitor that is an internal part of the unit. S1 switches the reference resistors out of circuit and the reference capacitors into circuit, and switches one test prod from the negative to the positive supply.

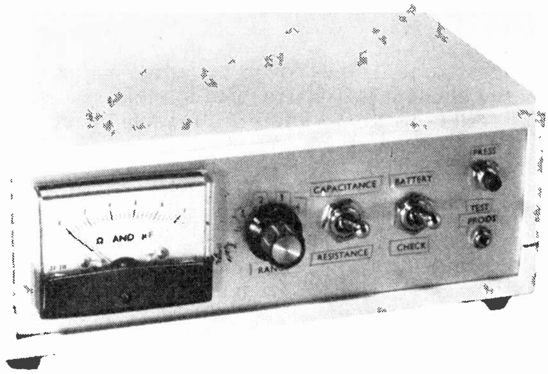
As we have already seen, with a microfarad timing capacitor in circuit a timing resistance of 10 kilohm produces f.s.d. of the meter. Lowering the resistance across the test terminals reduces the monostable pulse length proportionately, and gives a lower reading on the meter. Again there is a linear relationship between the value of the test component and the meter reading, and of course the scale is forward reading. The same basic circuit can thus be used for the measurement of both resistance and capacitance. Four switched reference capacitors (C4 to C7) provide four resistance ranges.

The power is not supplied to the circuit until S4 is depressed. A normal on/off switch is not used as when S1 is in the "Resistance" position and no resistor is connected across the test prods, the meter would be deflected beyond f.s.d. if the power was connected. This problem is solved by using a pushbutton for the on/off switch, as this is not closed until the component under test has been connected to the test prods.

BATTERY CHECK

Current consumption is about 10 milliamps, but as power is only drawn while a reading is being taken, an ordinary 9V radio type battery (PP7, etc.) can be used to power the unit and will have virtually its shelf life.

When the battery voltage does drop due to ageing, misleading results could be obtained and there is the danger of the battery leaking and damaging the unit. A



battery check circuit has therefore been included. This uses S2 and R1, and with S2 in the "Check" position the meter is connected across the supply rails via R1. The meter then has a f.s.d. sensitivity of about 10V, and can be used to check that the loaded supply voltage is satisfactory.

CONSTRUCTION

Many of the components are mounted on a printed circuit board that measures 86 × 56mm. Details of this are shown in Fig. 3.

There is quite a large amount of point to point wiring to the components on the front panel. When this has been completed the p.c.b. is mounted on the base of the cabinet behind S1, S2 and S3 using three 6BA or M3 bolts, and spacers to hold it a little way clear of the bottom of the case.

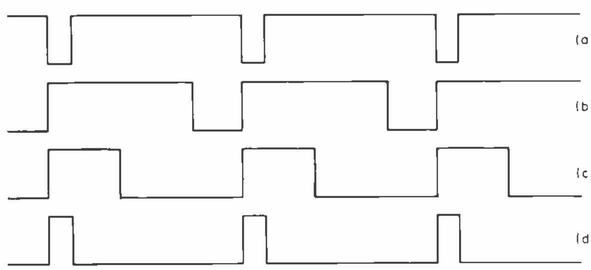


Fig. 2. (a) Output from the astable circuit, brief negative pulses to trigger the monostable (b) the waveform across the meter at f.s.d. (c) the waveform across the meter at half f.s.d. (d) the waveform across the meter at $\frac{1}{10}$th f.s.d.

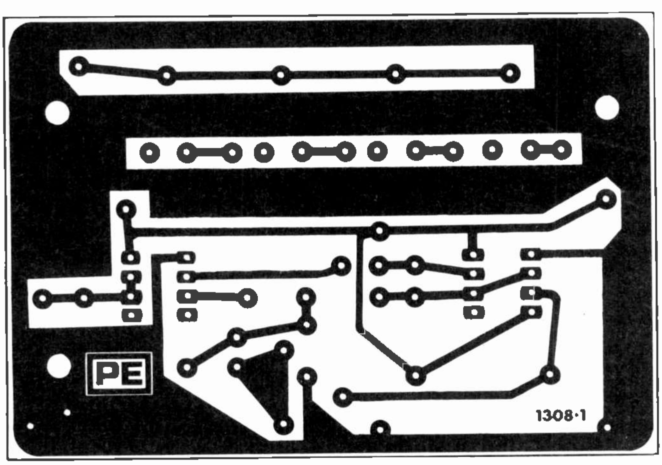


Fig. 3. Printed board track pattern shown full size

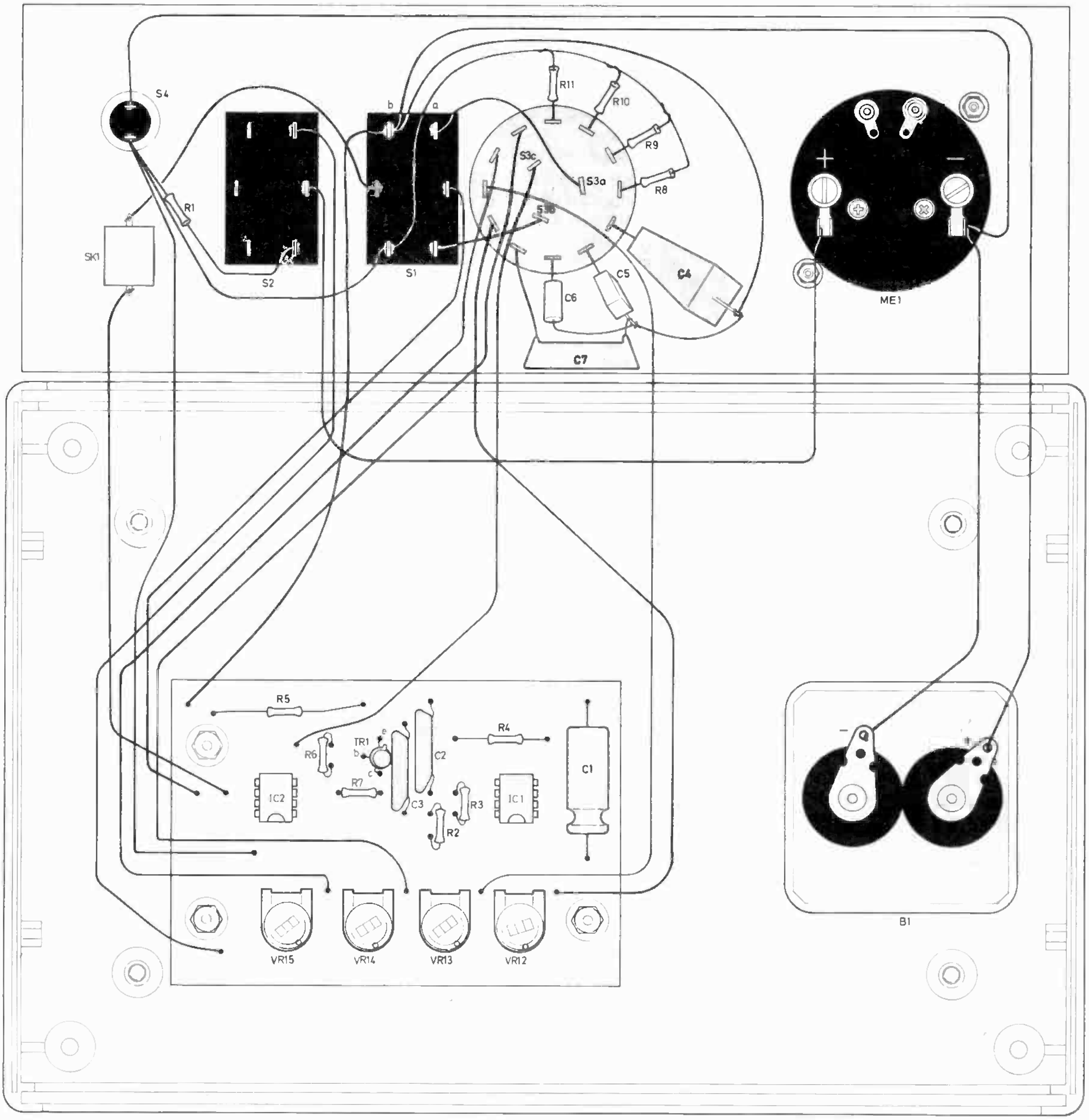


Fig. 4. Board assembly and complete interwiring details for unit

ADJUSTMENT AND USE

A set of test leads are required, and these consist of a couple of 100mm lengths of insulated wire each terminated in a 3·5mm jack plug at one end and a crocodile clip at the other.

At the outset VR12–VR15 are all adjusted to insert maximum resistance into circuit (fully clockwise). Temporarily connect the centre tags of S3a and S3b together. Mechanically zero the meter, turn the unit on, and set S3 to position 1. The meter should give a large positive indication and then VR15 is adjusted to give precisely f.s.d. of the meter. Then switch S3 to the other three switch positions, and use the appropriate preset resistor to produce f.s.d. of the meter in each switch position.

COMPONENTS

This method of calibration uses the internal timing components as the calibration standards. It is therefore important that these components have close tolerances as it is the precision of their values that largely determines the accuracy of the finished unit.

The resistors should have tolerances of 1 or 2 per cent, and the capacitors tolerances of between 1 and 5 per cent, according to availability. The smaller the tolerance of these components the better.

R8 can be a 5 per cent type as this is the closest tolerance in which this value would seem to be available. Alternatively it can be made up from several 1 or 2 per cent types connected in series to provide the required value of 10 megohms. ★

INDUSTRY NOTEBOOK

By Nexus

HIGH FLYING

At the end of his year of office as President of the Electronic Engineering Association. Peter Bates needs no excuses for pointing out how well the industry had performed in 1976 against a background of world recession, high interest rates, inflation and all other problems which affect us.

As I recorded month by month in this column last year the various successes in order intake, in deliveries, in exports, I remained optimistic while fellow commentators on other industries were almost universally full of gloom.

My optimism was apparently justified. The 1976 figures now available show that the capital goods sector of the electronics industry increased its total output of £1,400 million, a gain of 28 per cent, and of the total 42 per cent was directly exported. There was a positive trade balance in Britain's favour of £206 million, an improvement of nearly 40 per cent over 1975.

If we exclude computers, where our imports are traditionally greater than our exports, the trade balance looks even better. This does not mean, however, that our own computer industry is in the doldrums. Total sales in 1976 were £565 million, a gain of 26 per cent, and 55 per cent went for export.

Well, these are just the bare bones of a mass of statistics which confirm the trend towards even greater achievement. But the difficulties remain immense, not least being the handicap of a weak government which, while paying lip service to the need for incentives to greater efforts does precious little to provide them.

The successor as President to the EEA is Ronald Newham, an old hand at EMI (he has 40 years' service) and Director responsible for engineering and marketing at EMI Electronics. Among the pressing problems he is now facing is forging a new relationship with the Society of British Aerospace Companies (SBAC) now that the major airframe manufacturers, including the guided missile sectors which have strong direct electronic interests, have been nationalised.

Even today few people fully realise that one person out of every three of the working population is employed in the public sector. Think about it. Seven million people. The whole of the manufacturing sector of British industry, the wealth producing sector, only employs $7\frac{1}{2}$ million.

HAND-OUT?

As forecast in this column in our February issue, the Post Office had £100 million surplus and, under pressure, has agreed to return £7 per line to each telephone subscriber. My figures were exactly right but I was wrong in suggesting that the Post Office would not pay out. But they have done so grudgingly, with ill grace, and are clearly determined to claw it all back in an as yet unspecified manner.

But the Post Office still wins. £100 million invested at a modest 10 per cent over six months still yields £5 million in interest, a handsome sum which, as it rightly belongs to the public, might well be used to buy 20 badly needed EMI Scanners for the Health Service.

Not content with piling up the profits in telecommunications, I note the postal side has been doing nicely with Jubilee stamps. The collectors' presentation pack of four stamps (face value $42\frac{1}{2}$p) with 16 page booklet costs £1·20. Without the booklet they are $52\frac{1}{2}$p, only 10p more than buying them loose. And none will be used to post a letter. There's maximising profits for you.

THREAT FROM THE EAST?

With a thousand square kilometres of land and a population barely more than half of Greater London, Hong Kong now has 700 electronics factories, 70,000 workers in the business and a total output of over £500 million a year, nearly all in consumer electronics. Add to this Japan with its population of twice that of the UK and equally frantic activity in consumer electronics and it's enough to send a shiver down the spine. Not to mention increasing production in places like Korea, Taiwan and Singapore.

Not content with domestic production, leading Japanese companies are busy setting up plants in other areas, including the UK where, at the time of writing, Hitachi is trying to follow the example of Sony and Matsushita. Naturally enough, British manufacturers of domestic TV are regarding the Japanese invasion with distaste but the government view is that if such companies are coming to Europe they may as well come to Britain with their investment and their jobs, especially if they establish themselves in areas of high unemployment.

The Hitachi affair is interesting because that company has recently helped establish a TV picture tube manufacturing plant in Finland and hope to source tubes from there for their proposed TV assembly plant in the UK. But the British would be happier if they used the Mullard 20AX tube made in Durham. Unfortunately the Hitachi tube is of their own design and to switch to 20AX would mean a re-design of the TV set. The bargaining is still going on.

INSTRUMENTS IMPROVE

Instrument manufacturers are doing a lot better than of late according to a survey by ICC Business Ratios. Covering 60 leading companies, the survey shows a 50 per cent growth over the past three years, export sales at 32 per cent of the total and an improvement on return on capital.

HIGH TECHNOLOGY

Few people outside the industry appreciate the level of complexity of high technology products. When the Americans decided to buy the European designed Roland all-weather short range air defence missile system they found they had to translate into English 90,000 engineering documents and, almost as confusing, the 25,000 drawings were in metric measure whereas the Americans, so forward in many areas, still work in inches.

The initial phase of US production, through to prototypes and some test firings, is costing 265 million dollars. But if the Americans wanted to develop such a system themselves the cost would have been a billion dollars according to the Brigadier General who is managing the project for US Army Missile Command.

Readout—
A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

A Hot Point

Sir—With reference to the letter from Mr Aylen Baker and Mr Wilkinson (June 1977), I wish to make a few points concerning solar heating systems as applied to domestic hot water systems.

Firstly, referring to Mr Aylen-Baker's point on polystyrene insulation, the temperature of solar heating systems rarely exceeds 60°C, due to the high heat losses at these high temperatures, and the fact that with the systems used in this country, the quantity of water in the system is too much to be heated over 60°C in one day, even if no heat was extracted from the system to heat domestic water, etc. In fact, it is undesirable to raise the temperature too high, because weighed against the extra heat gain are the heavy losses. Thus polystyrene insulation for collectors is a cheap and effective way of cutting down heat losses.

The most efficient way of running a system is to have a fairly high flow rate through the collectors. This way the temperature rise across the collector is kept low and so are the heat losses from it. I would therefore recommend the pump to be switched on for long periods continuously, instead of short bursts as Mr Aylen-Baker suggests. This would lead to water lying in the collector, and being heated to ridiculously high temperatures, leading to heavy heat losses.

On the other subject of angle of incidence, I confirm Mr Williams figures of 35–40° as being the optimum for collection to be maximum all year round.

M. K. Berry,
Ramsgate.

Bad Move?

Sir—I note with some disappointment that PRACTICAL ELECTRONICS is "following the crowd" in changing to a larger format.

In my opinion, to change the size *at all* is a bad move, but to make the change *part way through a volume* is ridiculous beyond words, and shows little consideration for your readers, especially those who have kept bound copies over the years.

What argument can be used in favour of enlarging the page size escapes me. The magazine is presently of a convenient size, and the argument of using International paper sizes (e.g. A4) does not hold water, since the present page-size is so very close to the I.S.O. size B5 (see British Standard 3176). I can only suppose that someone "on high" has decided that "bigger" equals "better", and has issued his "fiat" accordingly. We poor down-to-earth readers are (as usual) not consulted, and just have to "lump it".

R. C. Fuller,
Middlesex.

It has for long been our intention to increase the page size of PE. We believe this to be in the interest of readers and likely to be generally welcomed.

This change involves the use of larger rolls of paper by our printers. Unfortunately, reordering of bulk paper supplies does not coincide with the beginning of the year (or volume), but has to be made in the autumn.—Editor.

Cross-hatch Generator

Sir,—Constructors building the "Cross-hatch Generator", PRACTICAL ELECTRONICS, September 1976, may be interested in a modification to the generator which facilitates colour television receiver purity adjustment. The modification may also quite easily be incorporated into an existing unit, as it requires only minimal disturbance to the circuitry.

For colour television purity adjustments, an all white raster is required. This may be achieved simply by the addition of one single-pole, single-throw switch, wired between V_{DD} (+9V) and pin 8 of IC6a (see Fig. 2 on page 710). With the switch open, the unit generates the cross-hatch pattern as before. When the switch is closed, the passage of video pulses through NOR gate IC6a is inhibited. Pin 10 of IC6a is therefore held at zero volts, which is the required logic level to set the video component of the waveform at IC6d output to logic 1. Blanking pulses through IC6d remain unaltered. The resultant waveform generates an all white raster.

A. A. Birch,
Penrith, Cumbria.

L.E.D. CLOCK AUTO-DIMMER

By E. B. EVES

SOME integrated circuits for the construction of digital clocks are fitted with the facility to dim the display in the dark. The circuit in Fig. 1 allows this facility to be added to most other clocks, or indeed any circuits using l.e.d. displays. With some modification it can also be used to provide two brightness levels in filament lamps, as for instance in driving lights for use in fog.

THE CIRCUIT

The circuit uses a light dependent resistor as the detector, connected in series with a fixed resistor. The voltage across the l.d.r. depends upon the current through it, which in turn depends upon the level of incident light.

The voltage is applied to the inverting input of IC1, while the non-inverting input is connected to the slider of Trimpot VR1.

The operational amplifier works as a saturation switch which controls the base of TR1. At normal daytime light levels the output of the amplifier is low, and TR1 is held off. The voltage at point X, therefore, is the sum of the two Zener voltages, and the output from the circuit is approximately 0·6V below this. As the light level falls, the voltage at the inverting input of the amplifier falls and eventually "crosses over" the voltage of the non-inverting input. The amplifier switches, and saturates TR1, shorting out D1. The voltage at point X is now approximately 0·6V + D2 voltage. Simultaneously the voltage at the output will be 0·6V less than this (V_{BE} TR2), or D2 voltage.

In order to prevent too high a current through the diodes, R4 should be large, and drop a large proportion of the supply volts, so that in both states the current in the diodes is within the correct operating range. For this reason the supply voltage needs to be high compared with the required display supply, even in daylight conditions. In the clock to which the prototype was fitted, the CT7001 clock chip was used, which requires a supply of 17V. After some experimentation it was found that supply levels of 10·9 volts and 2·7 volts to the l.e.d.s via suitable dropping resistances gave acceptable day and night brightness levels, hence 5·5 volts and 13·7 volts were dropped across R4 in the two states. The maximum current rating for continuous

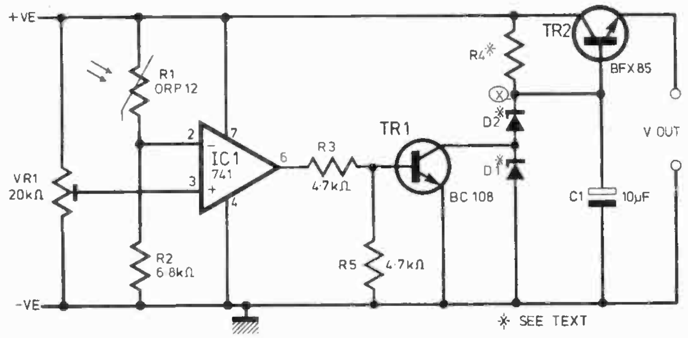


Fig. 1. Basic voltage control circuit

COMPONENTS . . .

Resistors
R1 ORP12 (light dependent resistor)
R2 6·8kΩ
R3 4·7kΩ
R4 *
R5 4·7kΩ
All ¼ Watt 10% carbon

Potentiometer
VR1 20kΩ 20 turn Trimpot

Capacitors
C1 10µF 16V elect.

Semiconductors
IC1 µA741
TR1 BC108, BC548 etc.
TR2 BFX85
D1–D2 BZY88*

Miscellaneous
Veroboard, 8 pin d.i.l. integrated circuit holder, connecting wire.
* see text

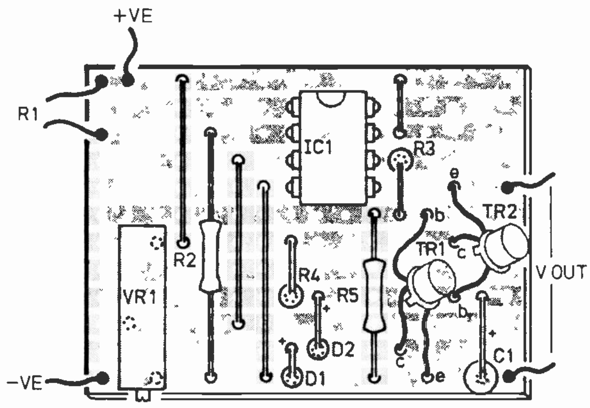


Fig. 2. Component layout on 0.1in Veroboard

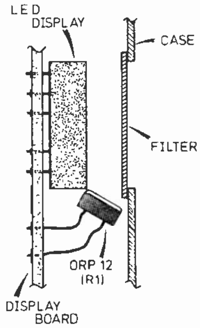
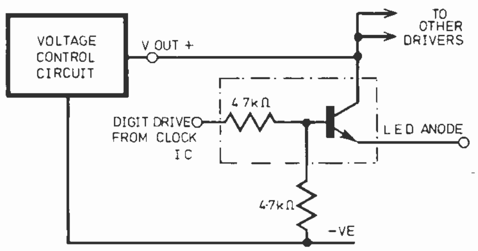


Fig. 3. Photocell location at display window



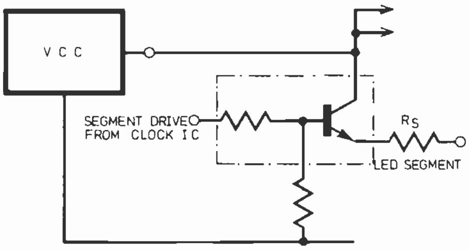


Fig. 4. (a) Common anode drive arrangement, such as DL707, etc. The existing display cathode resistors set the segment current. (b) Common cathode drive arrangement, such as DL704, DL33, etc. Here Rs sets the segment current

operation of the diodes used was 50mA. A resistor of 1·2kΩ kept the current within this limit, allowing a current of 5mA in the "daylight" state, which was sufficient to operate the diode satisfactorily, and approximately 15mA in the "dark" state.

The large difference in supply volts, especially when it is remembered that the l.e.d. typically drops 2·1 volts is due to the great change in sensitivity of the eye. The actual relative levels are a matter of personal preference, but care must be taken to stay within the current limits of the type of l.e.d. display used.

CONSTRUCTION

The layout of the circuit will depend on whether it is constructed as a separate unit as shown in Fig. 2, or it may be incorporated as part of the clock control boards. If a suitable voltage is available from the clock supply this may be done, if not, a higher tapping on the transformer, and a simple rectifier and smoothing circuit must be used.

The l.d.r. must be mounted to receive light falling ON the display, but not light FROM the display. If a filter is used, setting the display back from it improves visibility in daylight, and leaves room for the l.d.r. to be mounted as shown in Fig. 3.

Potentiometer VR1 should be positioned so that it can be adjusted through a hole in the back or the bottom of the box. It was found preferable to use a 20-turn Trimpot, as this gave greater ease of adjustment than a normal skeleton preset. The connections to common anode and common cathode l.e.d.s are shown in Figs. 4a and 4b.

TESTING AND SETTING UP

When the circuit has been assembled, before connecting to the display, a 10kΩ resistor should be placed across the output, and the voltage across this measured in full daylight. The display "window" should then be covered. After a short delay caused by C1 (which prevents transient light flashes or shadows switching the circuit), the voltage should fall. If it fails to switch, VR1 is probably set too low and should be adjusted until switching occurs at the required light level.

In order to assess the voltages required to give satisfactory outputs, D1 and D2 may initially be replaced with a variable resistor, connecting the centre tap to TR1 collector.

The setting up described above may be carried out in this way, then the l.e.d. displays connected and the clock started. The variable resistor can now be adjusted to give the required brightness initially in the dark, and then in daylight. It should be remembered to allow the eye to adapt for several minutes to the dark before deciding finally on the output level.

The voltage at point X can now either be measured or calculated for both states, and the correct values of Zener diodes put in place of the resistors. It is not advisable to use resistors permanently, because it was found that fluctuations in the current drawn by the display caused noticeable variation in intensity at night.

This circuit has been used successfully on a l.e.d. display digital clock. For other types of display this circuit may be suitable, although some modification of the output may be required, and certainly some experimentation to find the right voltage levels.

This circuit could be used to control the filament current in a phosphor diode display, and with a suitable output transistor it could also be used with incandescent lamps. ★

NEWS BRIEFS

Microprocessor Symposium

READERS involved in the application of microprocessors will be interested to learn of a forthcoming residential symposium organised by the Society of Electronic and Radio Technicians. Entitled "Microprocessor Systems and Software", it will be held at the University of Kent at Canterbury from September 26–29.

This symposium comes just twelve months after the very successful "Microprocessors at Work". In the intervening period many more working systems have been built and much practical experience gained.

This year's symposium is intended to take delegates from basic principles through surveys of current devices, development systems, system testing and software documentation. Further sessions will describe actual working applications, including greenhouse monitoring, control of heating and ventilating systems, medical applications and graphics terminals.

Further details can be obtained from the Symposium Secretary (MPU), S.E.R.T., 8–10 Charing Cross Road, London WC2H 0HP, telephone 01-240 1152.

Build Your Own Computer

THIS one-day conference, the first of its kind in the UK, attracted some 400 delegates on a sunny Saturday in May. In fact, it proved so popular that people were being turned away at the door!

Following an introductory teach-in on digital circuitry and microprocessors, a fascinating address by Manfred Peschke, publisher of the American small computer systems magazine *Byte*, gave a picture of personal computing developments in the USA. Applications including colour displays, synthesised speech and music, and speech analysis were described, and finally some results from a sample readers' survey conducted by *Byte* were given.

These revealed that some 35 per cent of readers owned an operating home computer system, while 74 per cent had qualifications at least equivalent to a Bachelor's degree. The median salary of the sample was $20,000, and most of them expected to spend about $2,000 per annum on their hobby! It would be interesting to see results of a similar survey in the UK.

Others speakers described the various items of hardware and software of interest to the personal computing enthusiast, with special reference to input/output devices. Several users recounted their experiences in building and using small computers in various fields, including video synthesis and education. The final speaker indulged in a little crystal gazing on the future of the computer in the home, from appliance control to complete home information systems.

Twelve firms had stands in an associated exhibition, displaying a wide range of hardware and literature. One of these, Computer Workshop, announced at the conference a new, complete four-terminal, multi-user computer system running time-sharing BASIC (a simple high-level language) and priced at under £3,000 including a printer. Previously, a system offering such facilities would probably have cost over ten times this amount.

Online Conferences Ltd., who organised the conference, plan to run a similar event next year. They can be contacted at Cleveland Road, Uxbridge UB8 2DD.

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.

TOUCH CONTROL KITS

Touch activated switching can now be employed by the hobbyist or evaluated by product designers with a new kit offered by **AMI Microsystems.**

Designated the TCK100, the kit includes the first microcircuit available off-the-shelf for operation of touch activated (capacitance) control panels. Up to 16 touch switches can be operated with a single integrated circuit which can be interfaced, using the AMI kit, with virtually any electrically operated product or apparatus.

Included in the kit is a prewired control panel, an AMI S9263 integrated circuit and an instruction package. With the addition of a few readily available standard components such as l.e.d.s, a transformer, etc. the unit will conveniently demonstrate the many advantages of AMI's touch control switching, which has already been used in similar form in electronic cookers introduced in the United States by Frigidaire.

As well as offering greater reliability than conventional electromechanical switches, touch control switching panels are mechanically safe, since there are no protruding knobs, electrically safe because of the insulator layer separating the circuitry from the touch surface, and more easily cleaned, a feature of particular significance in the design of domestic appliances.

This form of switching can be used in computer control, television equipment, domestic appliances, power tools, games, industrial equipment, keyboards of all types, and many other consumer and industrial products.

Full technical details and further information on the AMI TCK100 Touch Control Kit can be obtained from **AMI Microsystems Ltd., 108A Commercial Road, Swindon, Wilts.**

PROGRAMMABLE CALCULATORS

Claiming a major technological advance in handheld programmable calculators featuring pre-written solid state software libraries **Texas Instruments** have just announced their TI-58 and 59 models.

Both can use interchangeable prerecorded program libraries which range in content from applied statistics and surveying to aviation and marine navigation.

The module programs can be addressed repeatedly from the keyboard or be inserted as subroutines in other programs developed by the user. Module contents cannot be altered although users of the TI-59 can record up to 960 steps of any new program on two magnetic cards. (A module and an inserted card can be seen in the photograph.)

So that users can put their machines to work more quickly and obtain maximum benefits of programming, TI has developed new instructional material in a "personal programming" book form to replace the traditional owner's manual. This learning guide comes with either calculator.

In step-by-step fashion, users can learn simple programming techniques in the book's first chapter. Then they can move on through a self-paced course in programming. A comprehensive selection of examples from a number of disciplines permit users to apply programming power to a particular personal, professional, or occupational interest.

Included with each calculator is a master library module and manual covering 25 pre-written programs in engineering, mathematics, statistics and finance.

Backed by a one-year warranty the TI-58 will sell for £99·95 and the 59 for £249·95.

Lower priced at £49·95 is the TI-57 which should have special appeal for users wanting to learn programming fundamentals, like the 58 and 59 it has features to make it easy for users to edit or correct errors in programs. These include single-step and back-step keys to review programs and insert and delete keys so instructions can be added or removed at any time.

Besides its programming features the calculator has the normal facility for higher mathematical problem solutions.

The TI-57 comes with a charger, carrying case, owner's manual and program record forms. The same warranty as before applies.

PRINTED CIRCUIT KIT

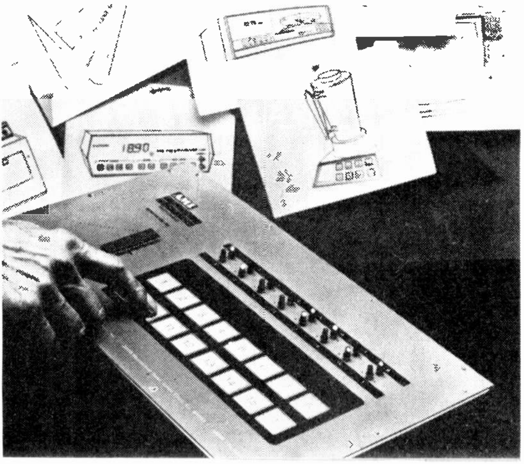
Amongst the many new items in the latest edition of **Verospeed** components catalogue is a complete copper etching kit that is claimed to be both clean and safe to use.

The Seno-GS system comes in a special pack and the chemicals/powders are kept in sealed bags. One of the bags is used to "seal-in" the prepared board during the etching process. This is accomplished by using two slide-on clamps. Designed for quick production of prototype printed circuits from copper-clad blanks, the kit will remove the copper from up to 10 Eurocard-size boards.

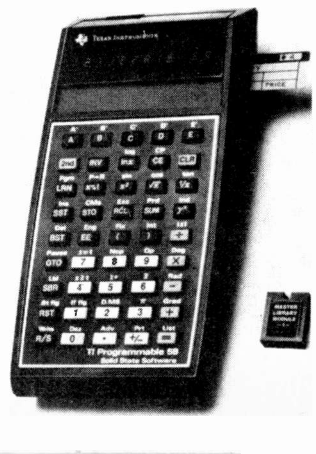
Also contained in the kit is an etch resist pen, transfers and a copper cleaning block. Finally, a special neutraliser is included which ensures environmentally safe disposal once the kit is exhausted.

Further details and price of the Etching Kit are contained in the Verospeed Catalogue available from **Verospeed Service, Unit 10, Barton Park Industrial Estate, Eastleigh, Hants, SO5 5RR.**

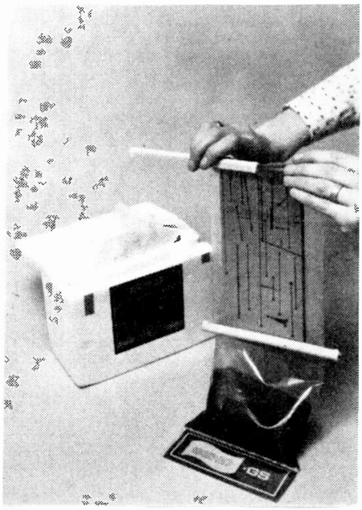
The TCK100 kit from AMI Microsystems



Texas TI-59 Calculator



Seno-GS p.c.b. kit from Verospeed



pelican CROSSING MODEL

By D. EDWARDS

Do not toy with the idea of road safety for children. Build this educational working model; for it's definitely no toy, but indeed could be a life-saver!

PRACTICAL demonstration is one of the most effective methods of teaching. Another, is learning by your mistakes; but there are occasions when the price of a mistake is too high! In these situations the written word gives way to the instructional model, where research has shown that practical demonstration of techniques and procedures eases assimilation of information, which might otherwise be highly indigestible.

It was this philosophy which resulted in the design of a small scale working model of a Pelican Crossing, primarily intended as a teaching aid for children and old people, but found in practice to capture the attention of other age groups from all walks of life.

The model had particular novelty value for children, who took delight in its operation, whilst being blissfully unaware that they were learning at the same time. Questioned afterwards, the children showed that they had grasped the essentials of using a Pelican Crossing, and their parents expressed greater peace of mind as a result.

The beneficial value of taking on a constructional project such as this for a local school or old people's home is considerable, but even at home in the lounge, the model makes an interesting conversation piece, and by its constant reminder to children, could one day save their lives.

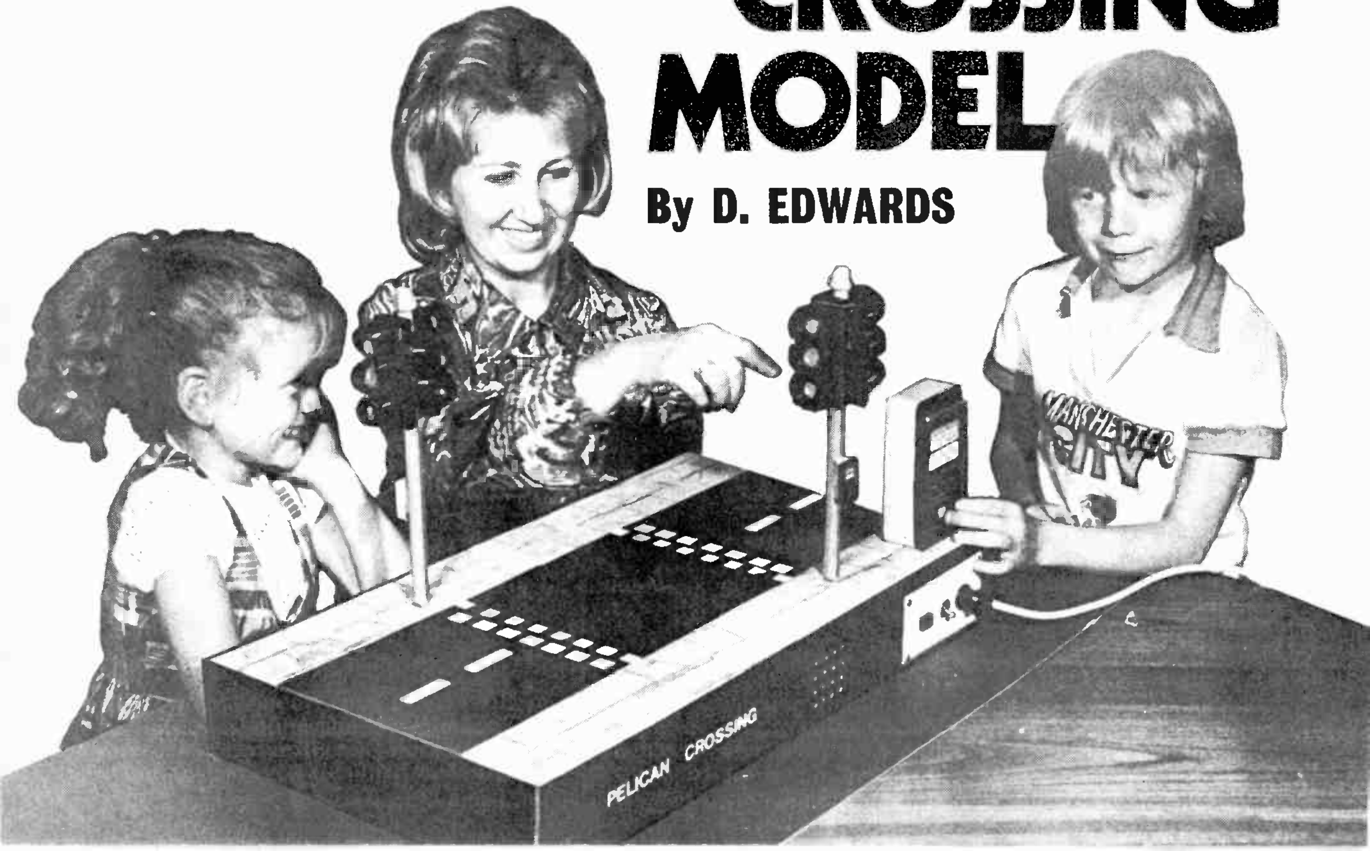
THE CIRCUIT

The circuit is shown in Fig. 1, and when push button S1 is pressed the monostable IC1 is triggered into operation, which applies a voltage to the circuit comprising TR1 and TR2. These form a multivibrator giving fast switching edges suitable for driving TTL logic, even with a long time constant. The output pulses are fed to input A of IC2 (decade counter). The BCD output of IC2 is then fed to the input of the 74145 (IC3), which is a BCD to decimal decoder/driver. Pushing S1 therefore, will cause IC3 to count through, operating RLA to RLE in turn. These relays are used for the various switching operations on the pelican crossing.

Steering diodes D7 to D18 ensure that only the correct lights operate. As well as triggering IC1, S1 also resets the decade counter IC2 to zero. The bleep is generated by IC5 modulated by IC4, the latter being a slow running multivibrator. The output from IC5 drives the loudspeaker via C8. Another slow running multivibrator is formed by IC6, which operates relay RLF. This in turn operates the flashing amber and green-man lights.

Various outputs of the 74145 have been strapped together to enable the timing cycle ratios of the lights necessary for realism. For instance, when S1 is pressed, the wait sign is illuminated, but the 74145 is allowed to count two pulses before the traffic lights change to amber.

A smooth 6·3 volt supply powers IC4, IC5 and IC6. This prevents buzzing in the loudspeaker, and relay "chatter" due to ripple. The other i.c.s are fed from a 5 volt stabilised supply, provided by IC7 and its associated components. The power supply circuits are shown in Fig. 2.



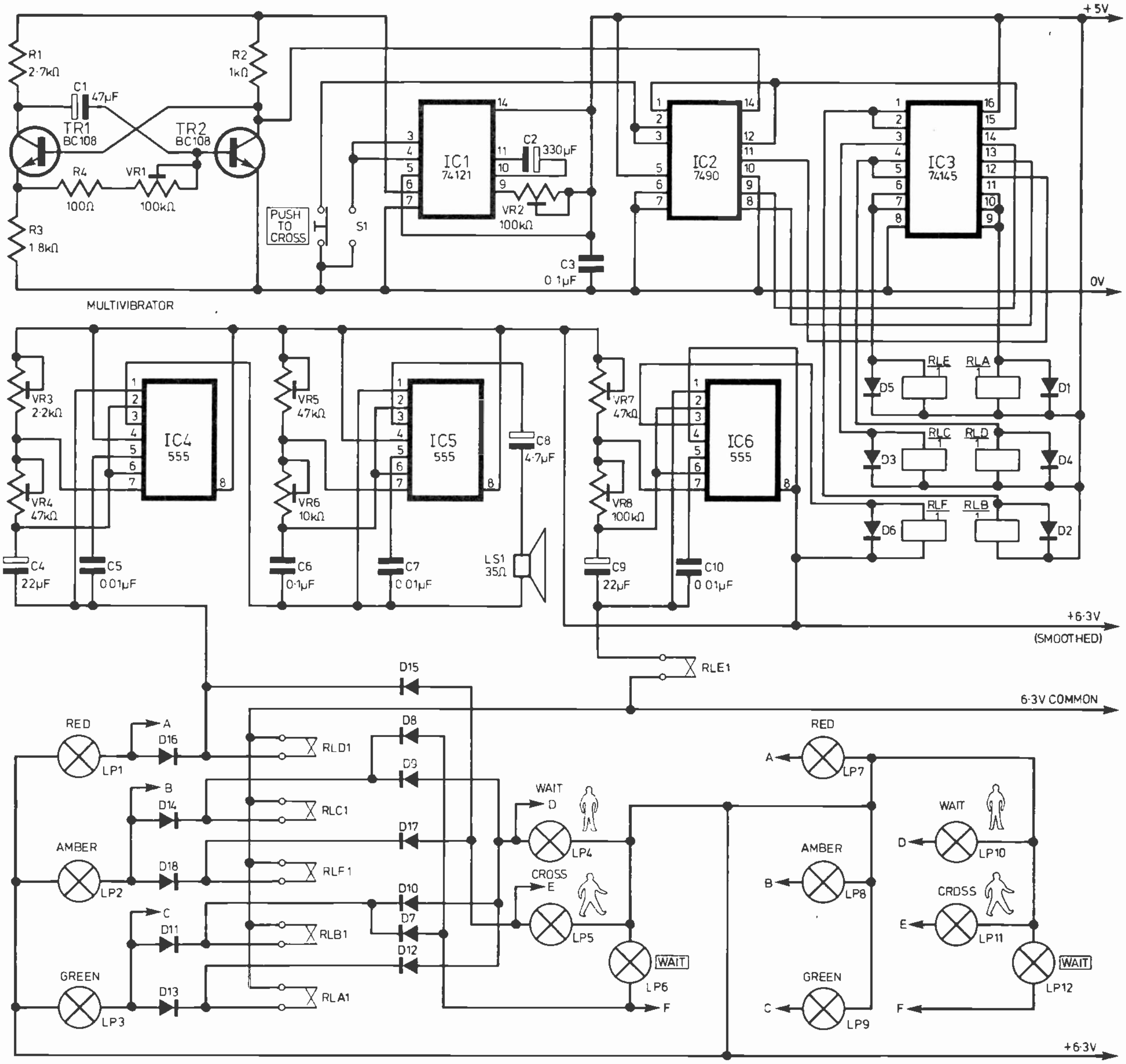


Fig. 1. Pelican ▲ circuit diagram

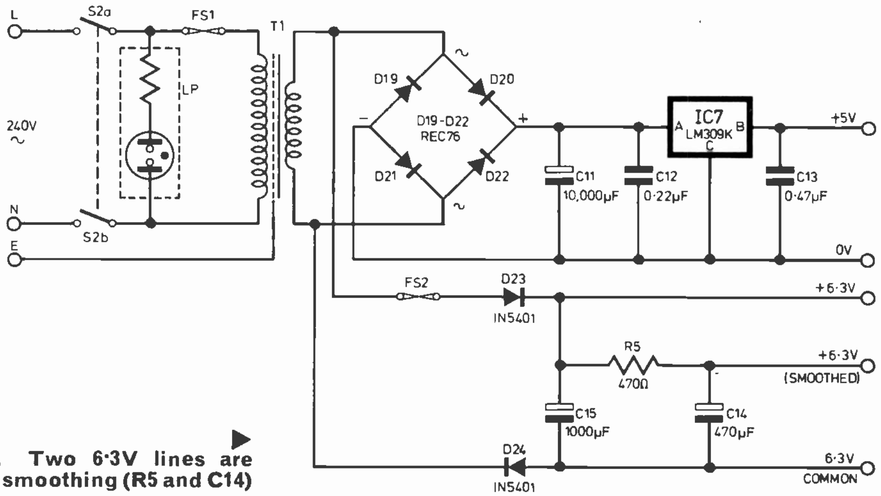
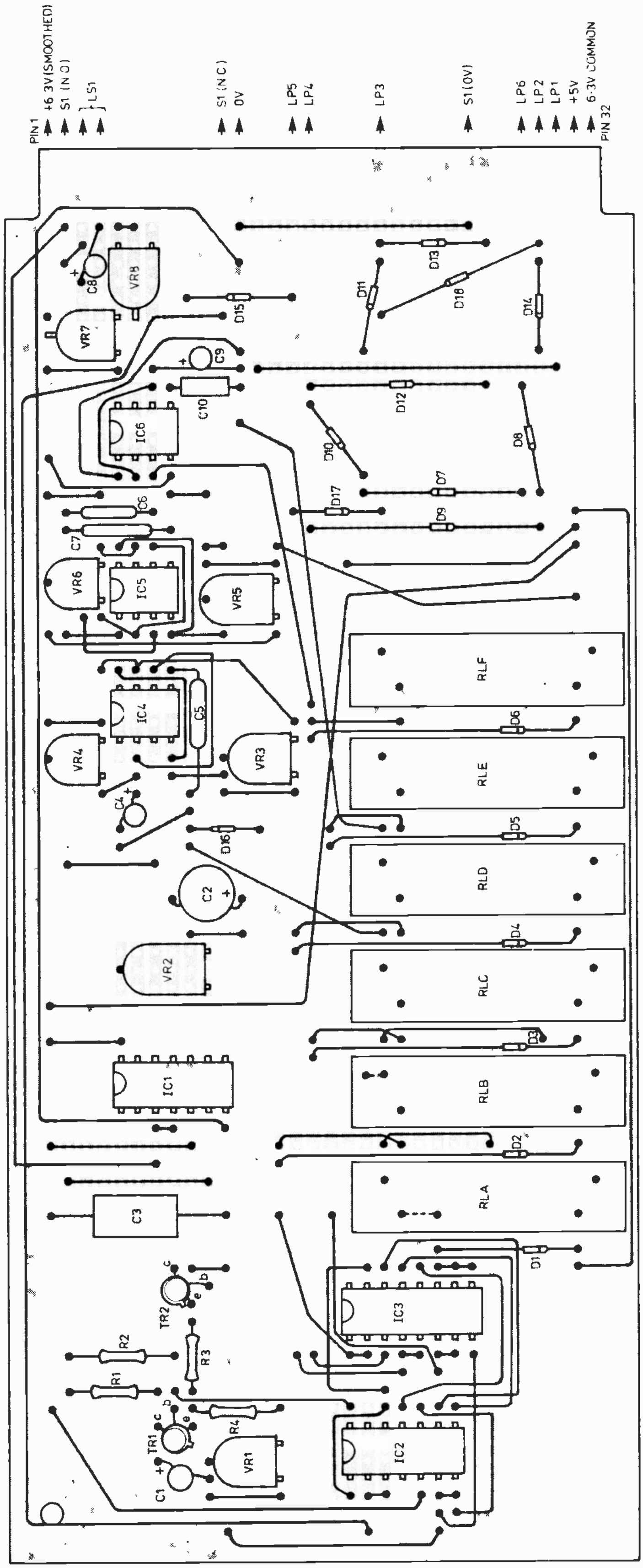


Fig. 2. Power supply unit. Two 6·3V lines are generated, one with additional smoothing (R5 and C14) ▶



COMPONENTS . . .

Resistors

R1	2·7kΩ	R4	100Ω
R2	1kΩ	R5	470Ω 1W
R3	1·8kΩ		

All resistors ¼W 5% unless otherwise stated

Potentiometers

VR1 100kΩ
VR2 100kΩ
VR3 2·2kΩ
VR4 47kΩ
VR5 47kΩ
VR6 10kΩ
VR7 47kΩ
VR8 100kΩ
All min horizontal skeleton presets

Capacitors

C1 47μF tantalum bead type
C2 330μF elect
C3 0·1μF paper
C4 22μF tantalum bead type
C5 0·01μF paper
C6 0·1μF paper
C7 0·01μF paper
C8 4·7μF tantalum bead type
C9 22μF tantalum bead type
C10 0·01μF paper
C11 10,000μF elect
C12 0·22μF paper
C13 0·47μF paper
C14 470μF elect
C15 1,000μF elect

Semiconductors

D1–D6	1N4001 1A 50V (6 off)
D7–D18	1N5401 3A 100V (12 off)
D19–D22	REC 76 2A 200V (1 off)
D23–D24	1N5401 (2 off)
TR1	BC108
TR2	BC108
IC1	74121
IC2	7490
IC3	74145
IC4–6	NE555 (3 off)
IC7	LM309K 5V regulator

Miscellaneous

6 off reed relays (6–9 volt, 700Ω coil)
2 off SPDT push-buttons
Mains on/off switch
2 off 14 pin d.i.l. i.c. socket
3 off 8 pin d.i.l. socket
1 off 16 pin d.i.l. socket
Strip-board 91 by 204mm (0·1 inch matrix)
Strip-board 95·5 by 50mm (0·1 inch), for power supply.
Miniature loudspeaker 35Ω
Mains transformer 6·3V 5A
Fuse (1 amp) and holder
Instrument type mains plug and socket
Mains neon lamp
Aluminium front plate
32 way edge connector
Up to 17 bulbs (6 volt 0·04 amp)
Tinplate for traffic lights
Coloured gel for lenses
Aluminium tubing
Con-Tact or Fablon

◀ Fig. 3. Board layout. Diode leads should be sleeved, and links shown beneath the relays should be made on the conductor side. Veropins may be used instead of a 32 way connector, and are used where several wires terminate at one hole

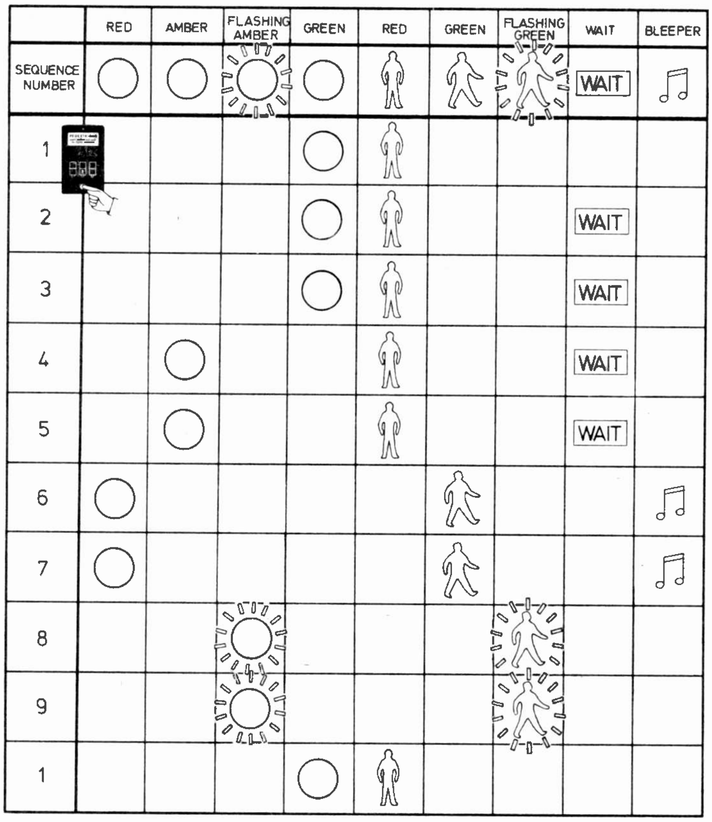


Fig. 4. Sequence of events at Pelican Crossings

CONTROLS

(1) Adjustment of the transistor **multivibrator pulse rate** is made by **VR1.**

(2) The **period** of IC1 is controlled by **VR2.** Presets VR1 and VR2 need to be adjusted together to produce a full sequence of events.

(3) Adjustment of the **bleep rate** is set by **VR3** and **VR4.**

(4) The actual **bleep pitch** is governed by **VR5** and **VR6.**

(5) The **amber light** and **green-man flashing rate** can be set by **VR7** and **VR8.**

The dormant state of the Pelican Crossing is when the pedestrian lights are at red, and the traffic lights are at green (see Fig. 4). When the PUSH TO CROSS button is pressed, the crossing system goes through five steps, starting with the WAIT signal illuminating, and finishing with the crossing back at the dormant state. The period of IC1 should be set by VR2, for the overall time taken by the crossing to complete its cycle of events. Then the multivibrator rate should be adjusted by VR1 to provide enough pulses during that period to drive the crossing system through the complete number of operations.

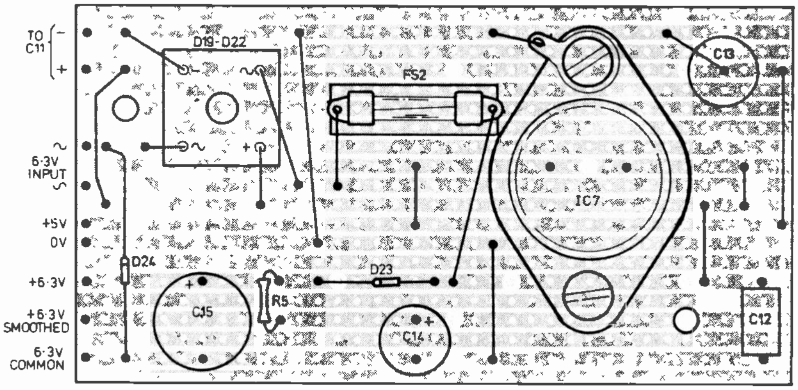


Fig. 5. Power supply board layout. Nylon nuts and bolts should be used for mounting

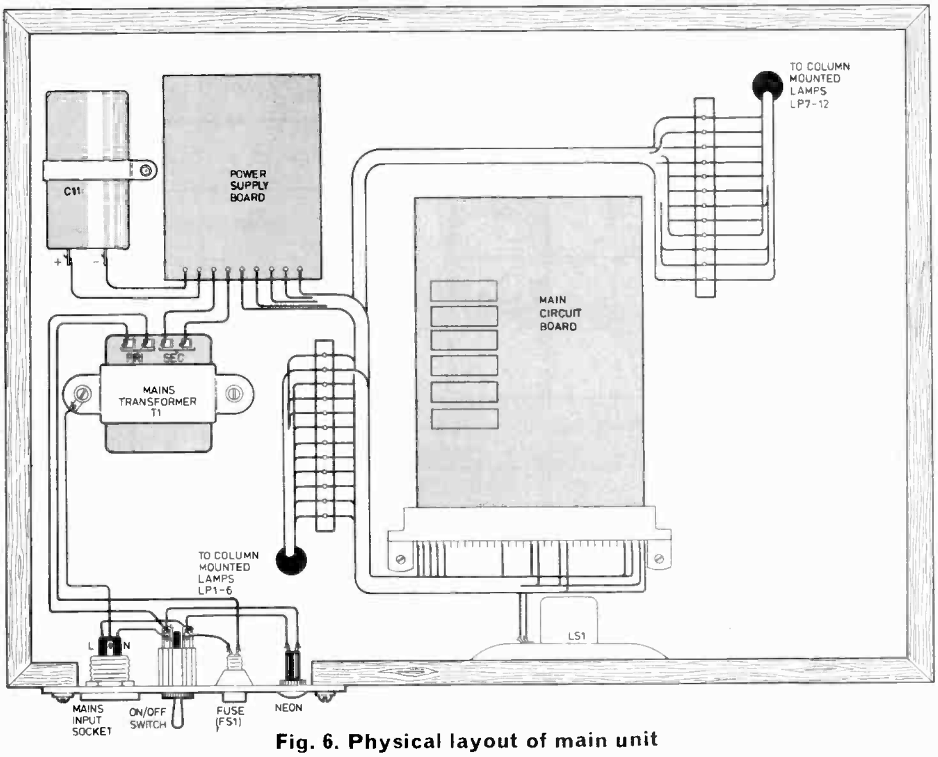


Fig. 6. Physical layout of main unit

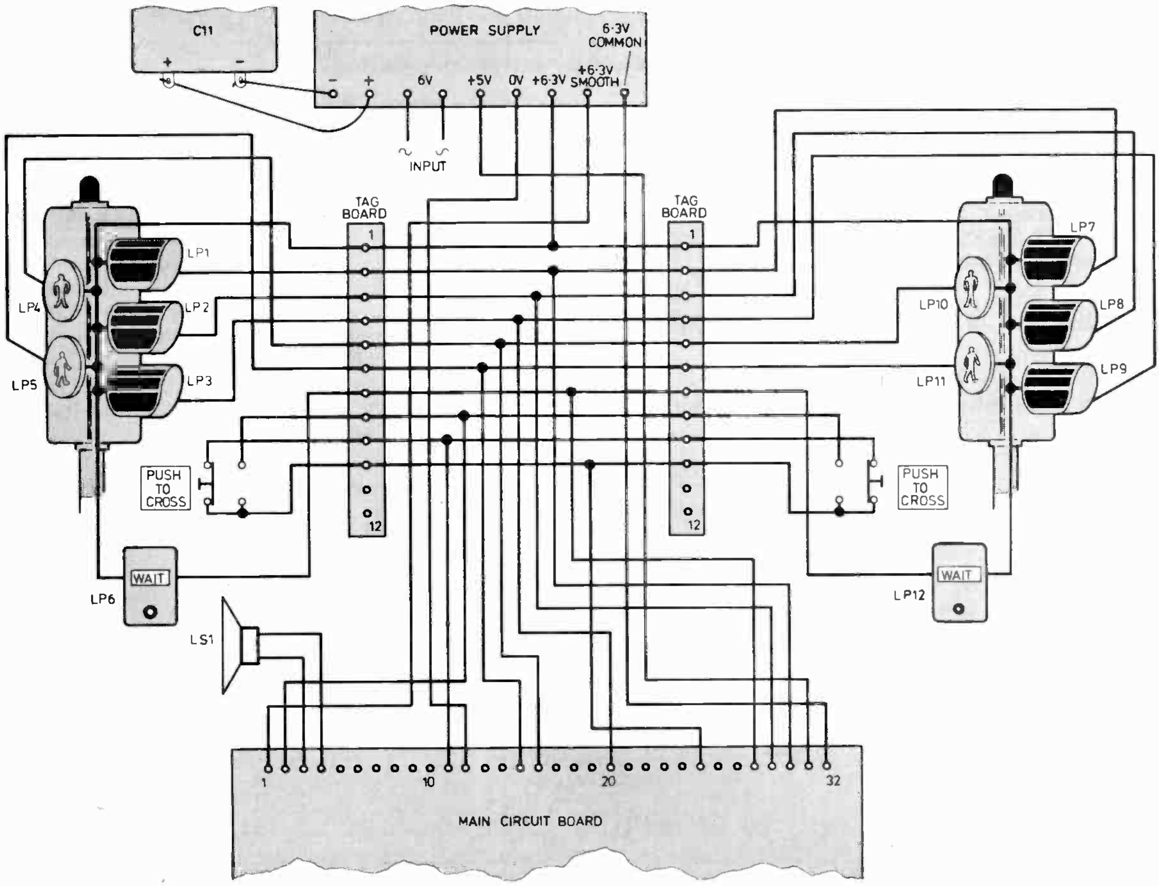


Fig. 7. Complete wiring arrangement

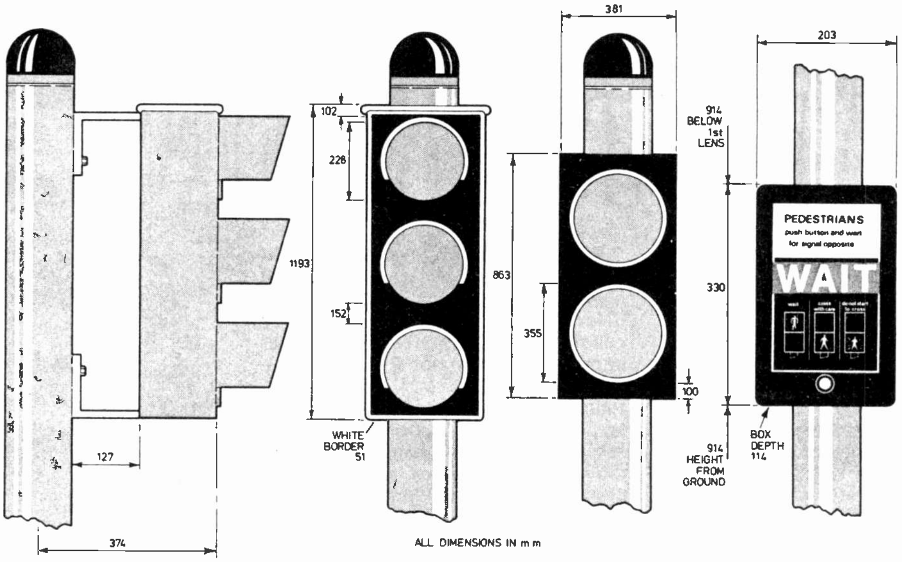


Fig. 8. Real life dimensions of traffic and pedestrian lights, and control box (drawings not to scale)

CONSTRUCTION

The main circuit is built on stripboard, the layout of which is illustrated in Fig. 3. A 32 way edge connector links this board to the rest of the circuit, including the separate power supply board of Fig. 5. The general layout of the whole unit is shown in Fig. 6.

The mains input socket, ON/OFF switch, mains neon and fuse, are all mounted on a small aluminium front panel. Also, the transformer and C1 are mounted separately, connected by a wiring loom (Fig. 7).

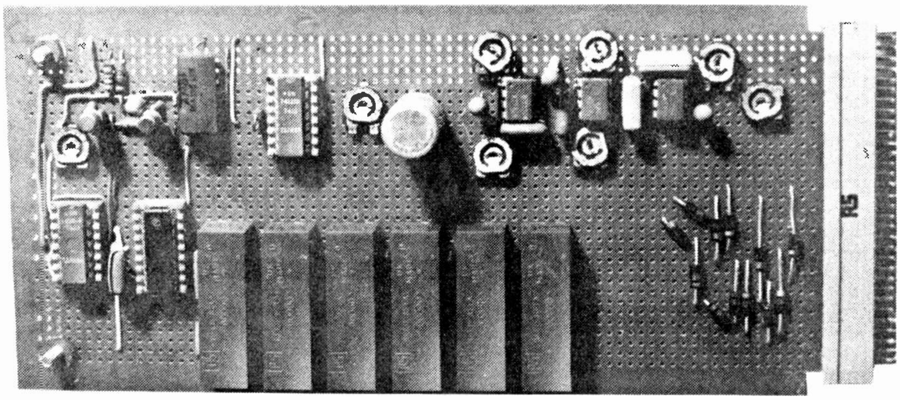
Various *full size* dimensions of the traffic and pedestrian lights and control box are shown in Fig. 8. The dimensions are in millimetres and must be scaled down, dependent upon the required size of the model. The control box which would have contained the PUSH TO CROSS button for maximum realism, was found to be too small on the prototype, and so a separate box on a larger scale was mounted on the side of the model. To alleviate detailed drawing and lettering on this larger control box, a photograph of the real thing was reduced to postcard size and mounted on the box facia.

The traffic light heads were built from thin tinplate suitably bent to shape, solder being used to fix the pieces together. Aluminium tubing was used to fabricate the traffic light columns. The lenses were constructed by placing red, amber or green gelatine over the light bulbs. In the case of the red-man and green-man, black Con-Tact was placed over the gelatine, and then cut out with a sharp knife, to give the outline of a man. The road itself is black Con-Tact, and the white lines are pieces of white Con-Tact.

The push buttons may have to be wired using screened cable due to the length of the looms, and the fact that TTL circuitry is susceptible to noise pick-up. It may also help to put suppressor capacitors across the push button contacts.

The loudspeaker is mounted on the side of the case, with small holes to allow for sound propagation.

The circuit does not show the push button on the other side of the road. However, the additional button is simply wired in parallel with S1. Likewise, all bulbs are not illustrated, and the extra repeater bulbs are wired parallel to the ones shown. ★



The prototype circuit board featured in the photograph differs from the diagrams, where the layouts were rearranged to accommodate point to point wiring on the component side

PATENTS REVIEW...

COIN DETECTIVE

An improved coin-operated timer capable of detecting fraud and suitable for a wide variety of uses, including parking meters and other pay-by-the-hour facilities, is claimed by Veritronics in BP 1 464 371.

The signal generator shown in the block diagram, Fig. 1, generates a 100kHz waveform, which is applied to one plate of a capacitor, C1, through which an inserted coin passes. The current amplifier, connected to the other plate of the capacitor, amplifies the square wave of current induced to flow by the resultant voltage waveform, and the rectifier produces a proportional d.c. signal.

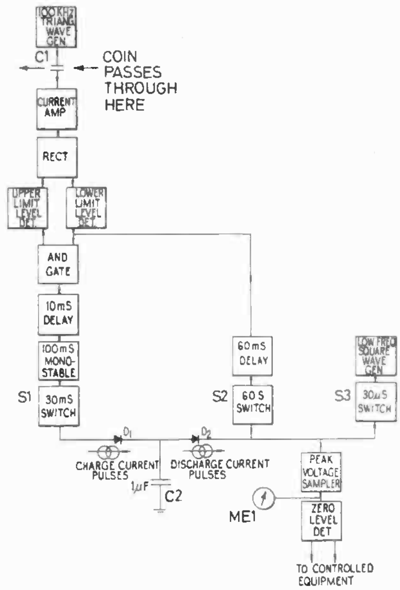
The rectifier output is fed to the "upper limit" and "lower limit" detectors. If both give a satisfactory output when the coin drops through the capacitor, an AND gate is activated to transmit a signal to a 10ms delay which gives an output only if the capacitance remains within the required limits for the 10ms as the coin falls. This prevents the apparatus being operated by unauthorised large objects.

The delay output is fed to the monostable, which when triggered gives a delay of 100ms. During this delay the circuitry is primed by causing diodes D1, D2 to conduct and at the same time a fixed voltage is applied to D1. At the end of the 100ms delay, S1 stays on for 30ms, to allow a controlled charge to flow into the timing capacitor C2 via diode D1. Thus for each genuine coin detected the timing capacitor voltage is raised by a fixed amount.

Meanwhile, a low frequency oscillator drives the 30 microsecond switch S3, which removes a controlled amount of charge from capacitor C2 every 1·5 seconds. When not being charged or discharged the capacitor is presented with the high reverse impedance of diodes D1, D2.

The meter ME1 is connected to a peak voltage sampler for capacitor C2 and indicates time paid which has not been used up. The zero level detector detects the end of time and switches off the equipment (such as games and appliances).

If the device is tampered with, the 60ms delay operates, to indicate that a coin or other object has been in the chute for too long; a 60 second switch S2 then operates, to discharge the timing capacitor C2.



The obvious advantage of the invention is that it is purely electrical, and contains no mechanical or moving parts, except for the coin itself.

FEEDBACK KILLER

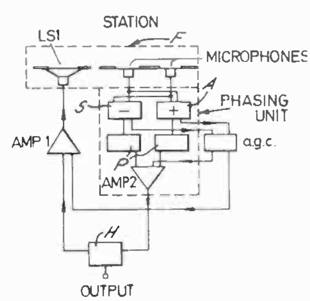
In BP 1 458 663, A.R.D. Anstalt, of Liechtenstein, proposes an apparently novel idea for killing acoustic feedback between the microphone and loudspeaker of a two-way communications system. The object is to reduce feedback risk, without recourse to voice-operated switching, even where the microphone and loudspeaker lie closely adjacent at each station.

The diagram Fig. 1 shows the circuit adopted at a station *F*, with a single loudspeaker and two microphones. The outputs from the two microphones are applied to an additive circuit *A* and a subtractive circuit *S*, each circuit being generally a transformer or amplifier.

The additive and subtractive outputs are passed through phase and amplitude adjustment circuitry *P* and summed in amplifier 2. This feeds the output line to remote stations and the loudspeaker LS1 of home station F, via hybrid H and home amplifier 1. Automatic gain control (a.g.c.) is also incorporated in the circuit.

When a speaker talks directly into the two microphones this "wanted" sound produces effectively equal outputs from each. But each microphone output also inevitably contains a component due to "unwanted" sound emanating from the adjacent loudspeaker LS1. However, because LS1 is laterally offset with respect to the microphones by what is inevitably a different distance from each, the unwanted sound components in the microphone outputs will differ in phase from each other and from the wanted component.

BP 1 458 663



It is interesting to note that the American pop group, "The Grateful Dead", have experimented with a similar system to kill feedback from their stage PA system.

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

BY FRANK W. HYDE

SPECIAL SATELLITE

As part of the special research programme of the International Magnetospheric Study (IMS), two major satellite missions may be regarded as the heart of this project. Scheduled to run for the period 1976–1979, IMS is set to make a detailed study of the various mechanisms that have appeared as a result of the substantial data now available.

There are a number of important reasons for using the magnetosphere as a sort of laboratory. It provides an opportunity to study in a small scale the activities in the universe. A very large proportion of the matter in the universe consists of plasma interacting with a magnetic field. The process by which magnetic field energy is transferred to ionised particles becomes a matter of major significance.

Since this process occurs in the magnetosphere it is possible to study, on a small scale, the behaviour of matter in the universe. There are vital rewards from this for not only can it help to solve some of the meteorological problems (particularly the prediction of the weather) but also provide clues toward a better knowledge of the pulsar and nuclear fusion.

THE TRAGEDY OF *GEOS*

The special satellite *GEOS* was designed to carry scientific equipment into a stationary orbit. This is the first satellite to be devoted to such a mission and it carried the hopes of many scientific groups. Unfortunately the launch was a partial failure. The full details of the failure are not yet known but the consequence is that *GEOS* will not reach its planned stationary position of 36,000km above the equator. An emergency decision at the time of the rocket motor failure put the *GEOS* into a highly elliptical orbit with a 12 hour period. This means two things: the first, only half the useful time each day will be available and the second that the satellite will pass through certain levels of the radiation belt which may so damage the basic electronics that its life may be limited to six months. The net result is that only a few per cent of the target hopes will be reached.

This is a salutary warning that in such important missions there should be a back-up system. The cost of the launcher is small when compared to the total cost. The tragedy is that all the costs of the launch have to be borne by ESA. Though some useful data will result it is a high cost, for more than 100 million dollars have been spent so far on *GEOS*.

THE PLANNED MISSION

The satellite would have been stationary at 36,000km above the equator. This position covers the region of the magnetosphere where disturbances take place due to dynamic processes. *GEOS* was to have been so positioned that the field lines joining the auroral zones would be observed both from the satellite and the ground stations. Thus the passage of particles back and forth along the field lines could be studied in great detail.

The satellite would have been in permanent view from a tracking station at Darmstadt in West Germany. One of the special problems with satellite experiments is the modification of local environments by the satellite. On some missions the spacecraft itself masks special phenomena. One of these is spacecraft charging and this can reach levels of 10kV. To this end *GEOS* has been given an all metallic skin so that there is equipotential distribution. There are eight booms on which are mounted sensitive detectors. The booms carry these detectors some 20 metres away from the body of the satellite. It is an ambitious attempt to isolate the effects not only of the satellite itself but also the equipment within it. This very long boom system is unique and it is hoped that the sensitivity will remain unimpaired. One of these sensors is a detector set to react to a variation of the magnetic field as low as a thousand millionth of the Earth's field.

The experiments involve a number of very sensitive parameters. This is necessary for a proper understanding of the interactions of a wave-particle nature. Four of the experiments will measure particle flux and the variations with direction and energy, over a wide range of thermal levels. There are also three experiments which will measure the effect of electromagnetic waves. A frequency of a range from zero to 77kHz will be used for the electric fields and a frequency of zero to 20kHz for the magnetic fields. Some of the experiments will be in duplicate to safeguard data.

The combined venture of NASA and the European Space Agency, which is the other major half of IMS, involves three satellites with a code name of International Sun Earth Explorer.

CHANGE OF NAME

The *Mariner* spacecraft designated for the second flypast of Jupiter and the other outer planets have a new name. They are now to be called *Voyager 1* and *2*. They will start their journey with at least one new addition to the mission. It will be an opportunity to check at close quarters the new discovery of possible rings round Uranus. These rings would appear to contain lumps of dense material, probably rocks of the order of 100km in diameter. This is something very exciting and susceptible to direct observation. The discovery was made a few weeks ago when an occulted star was found to have been eclipsed a number of times. This was witnessed by three independent teams of observers. It is possible that this confirmation may be available in about 1986.

It is interesting that Herschel who discovered Uranus did in fact note that there appeared to be a flattening of the poles. He wrote that there appeared to be double opposite points which might be rings! He gave this information to the Royal Society in 1796 and the details appear in the Philosophical Transactions of 1798. Later he decided that there were no rings. All this points to something peculiar about an already somewhat strange planet. However, considering the amount of observations over the 180 years that have elapsed since then it is surprising that no other references appear in the literature. It is of course possible that there is another explanation which may involve refractive layers round the planet. The correlation of three distinct and separated observing teams make a *prima facie* case for the solid or nearly solid occulting medium. Though it must also be said that for the occulted star to have appeared precisely in position on *each side* of the planet calls for very close observations.

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.

GUITAR FREQUENCY DOUBLER

The circuit of Fig. 1 gives an output frequency which is twice that of the input. This is done quite simply by full-wave rectification. In rectifying the input signal, however, a good deal of distortion is produced at the output.

However, there are very few guitarists who do not thrive on distortion in some form and anyway the introduction of harmonics makes for a more interesting sound.

In Fig. 1 IC2 takes the negative half of the input sinewave via D1 and inverts it to produce a positive output. The positive sinewave input via D2 is not inverted so that the end product is effectively frequency doubling.

IC1 is required to produce an amplified version of the guitar output, as normally this would not be sufficient to cause conduction in the diodes.

The preset VR1 should be adjusted to provide 4V r.m.s. at point A with either a guitar or audio generator, set at around 50mV, connected to the input. This set-up should give around 180mV at pin 6 of IC2 which in turn is reduced by the potential divider R6 and VR2 to give a maximum output of about 80mV.

If desired it is possible to get rid of a lot of the upper harmonics which contribute to the distortion by strapping a 0·022μF capacitor across VR2.

P. G. Ludgate,
High Wycombe,
Bucks.

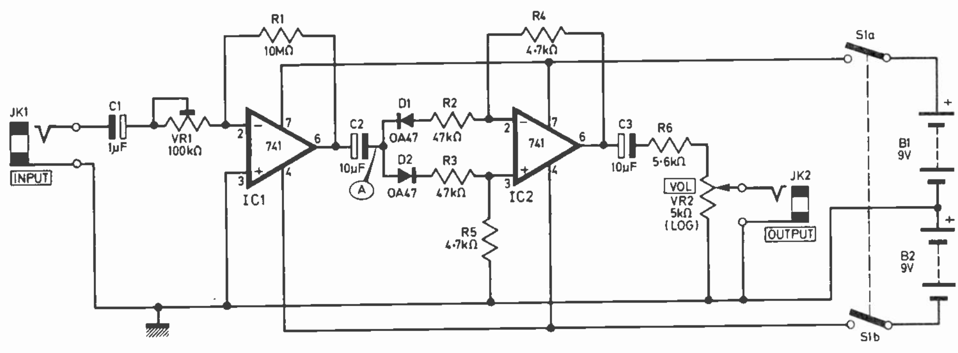


Fig. 1

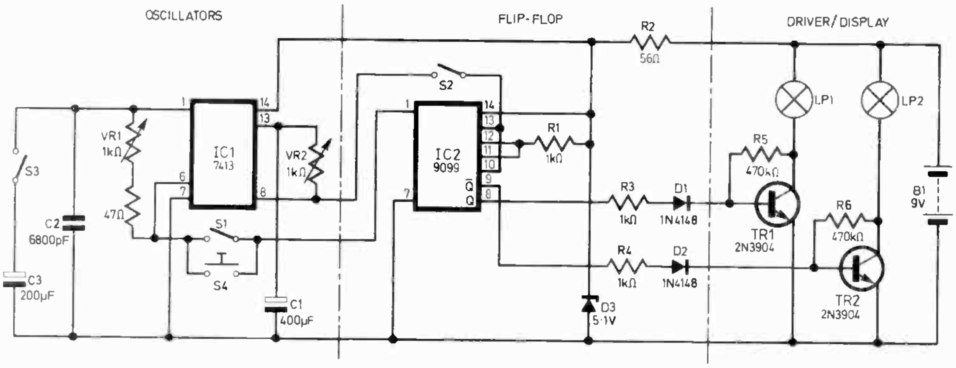


Fig. 1

RANDOM LIGHT DISPLAY

PULSES from one half of the 7413 in Fig. 1 (dual Schmitt trigger used as oscillators), are fed to the clock pin of IC2 (JK flip-flop) via S4. The flip-flop is wired with the J and K inputs at logic 1, thus each clock pulse causes the outputs Q and Q to swop states. The clock frequency is controlled by the value of VR1 and associated capacitor. Values of 200μF and 6,000pF were chosen to give slow and fast clocking frequencies, selectable by S3. The flip-flop outputs are used to drive lamps, via TR1 and TR2. Releasing the push-button leaves one lamp or the other alight, providing a simple heads or tails circuit.

An added refinement to this circuit has been incorporated to widen the scope of its use. Here, the other half of the 7413, also connected as an oscillator, produces clock pulses which are fed to the SD and CD inputs of the flip-flop. These latter pulses take precedence over the pulses at the clock pin, consequently the output depends upon the pulses to the direct inputs together with the clock input. When the direct inputs are at logic 1, a complement output is obtained. Setting the direct inputs to logic 0 results in Q and Q being in the same state (logic 1). Thus by controlling the frequency of both oscillators, one may obtain an interesting variety of lighting effects from the lamps. The switches S1 and S2 may be closed, if it is desired to operate the circuit in some kind of permanent display. The number of lamps may be doubled by using the other half of the flip-flop, as it shares a common clock pulse with the first half.

P. R. G. Reynolds,
Benfleet,
Essex.

WARNING SYSTEM

THE circuit shown in Fig. 1, when wired up to the direction indicator system of a car or motor-cycle, will give an audible warning "bleep" whenever the indicators are activated.

Unijunction TR1, together with R1 and C1, forms an audio oscillator whose output is amplified by TR2 and applied to a low impedance miniature loudspeaker or earpiece. Diodes D1 and D2 maintain isolation between right- and left-hand indicator circuits.

The unit is specially suited for motor-cycles, where the indicator units are not self-cancelling and visual indications are not sufficient reminder.

Z. Najam,
Bedford.

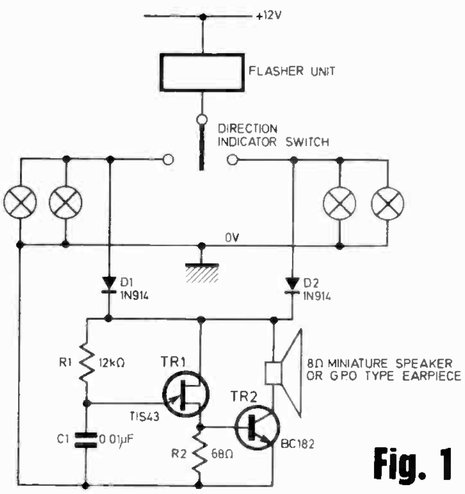


Fig. 1

GUITAR TUNING REFERENCE

THE heart of the circuit in Fig. 1 is the popular 555 timer, which is utilised in the astable mode of operation to produce a reference note for tuning guitars.

The frequency produced is determined by the formula:

$$f = \frac{1{\cdot}44}{(VR1 + 2VR2)C1}$$

$$\text{Or} \quad C1 = \frac{1{\cdot}44}{(VR1 + 2VR2)f}$$

where f = 164·81Hz for bottom E, and 659·78Hz for top E.

Top E may be a better choice, as the harmonics would be out of the ear's range.

Taking the nominal value 30kΩ for VR1 and VR2 to roughly give a centre setting, the value for C1 would be 24·2nF for top E, and 97nF for bottom E, using the above formula.

The unit is fairly stable, and will operate from a supply voltage ranging from 4 to 15 volts. With the timing controlled by VR1 and VR2, the unit can be calibrated using an oscilloscope or frequency counter looking across the terminals of LS1.

W. P. Bond,
Cheltenham.

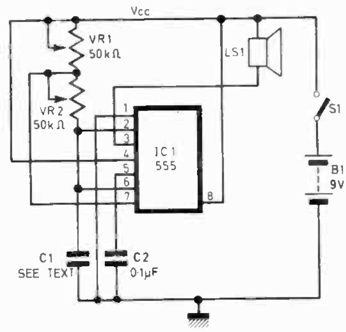


Fig. 1

LIGHT-CONTROL SYSTEM

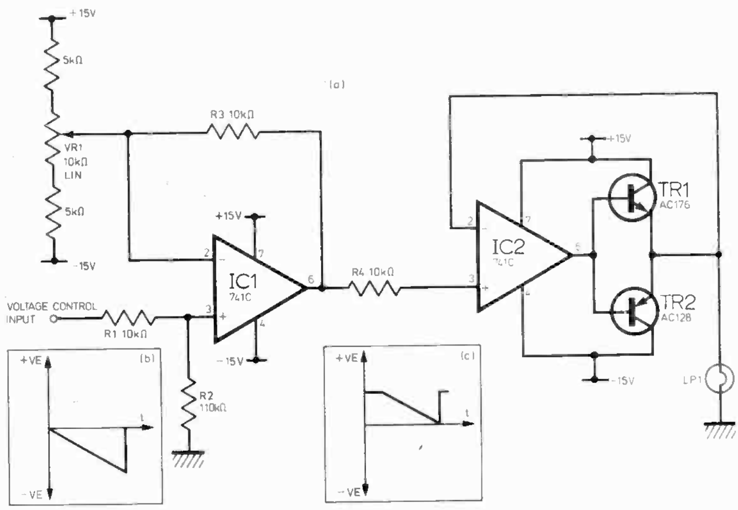


Fig. 1

ON adding the phasing unit (PE Sept 1973) to my PE Synthesiser, it was decided that the circuit should be voltage controlled to be in keeping with the rest of the synthesiser.

The circuit in Fig. 1a was developed for this purpose, and uses a bulb to control light sensitive resistors, which replace the dual-gang potentiometer of the phasing circuit.

With VR1 in its mid position, a negative going ramp (Fig. 1b) applied to the voltage control input, would cause the outputs of IC1 and IC2 to swing negative, causing TR2 to switch on, and light the bulb in accordance with the magnitude of the input voltage.

If, however, the wiper of the bias control VR1 is set negative, the output of IC1 now sits positive (Fig. 1c), this switching TR2 off, and TR1 on, causing the bulb to remain alight, and gradually dim on each ramp, returning suddenly to bright again.

The circuit has proved to be very versatile, in that with the adjustment of just one control (VR1) it is capable of accepting both positive and negative control signals, and is able to reverse their growth if required.

A further use found for the circuit was to operate a waa-waa unit, and some interesting results can be obtained when used in conjunction with either a sample and hold, or an envelope shaper.

M. Whyte,
Merseyside.

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2N697	0·30	2N3704	0·15	40361	0·45	BC159	0·14	BD116	1·20	BFX87	0·40
2N698	0·62	2N3705	0·15	40362	0·48	BC160	0·50	BD131	0·51	BFX88	0·40
2N699	0·55	2N3706	0·16	40363	1·20	BC161	0·50	BD132	0·54	BFX89	1·25
2N706	0·24	2N3707	0·18	40406	0·58	BC167	0·12	BD135	0·37	BFY50	0·34
2N706A	0·12	2N3708	0·16	40407	0·45	BC168	0·12	BD136	0·37	BFY51	0·38
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
2N720A	0·80	2N3713	2·30	40594	0·75	BC177	0·20	BD239	0·40	BSX20	0·31
2N914	0·35	2N3714	2·45	40595	0·85	BC178	0·20	BD240	0·45	BSX21	0·32
2N916	0·30	2N3715	2·55	40673	0·73	BC179	0·23	BD241	0·45	BU105	1·50
2N918	0·38	2N3716	2·80	AC126	0·37	BC182	0·11	BD242	0·47	BU205	2·20
2N929	0·25	2N3771	1·85	AC127	0·44	BC182L	0·14	BD243	0·60	MEO402	0·20
2N930	0·26	2N3772	2·00	AC128	0·37	BC183	0·11	BD244	0·62	MEO404	0·15
2N1131	0·60	2N3773	2·90	AC151V	0·35	BC183L	0·14	BD245	0·65	MEO412	0·20
2N1132	0·60	2N3789	2·90	AC152V	0·50	BC184	0·12	BD246	0·66	ME4102	0·10
2N1613	0·35	2N3790	3·10	AC153	0·49	BC184L	0·14	BD529	0·42	ME4104	0·10
2N1711	0·37	2N3791	3·10	AC153K	0·35	BC207	0·12	BD530	0·47	MJ480	1·35
2N1893	0·38	2N3792	3·50	AC176	0·40	BC208	0·11	BDY20	1·13	MJ481	1·55
2N2102	0·60	2N3794	0·20	AC176K	0·60	BC212	0·14	BF115	0·38	MJ490	1·35
2N2218	0·33	2N3819	0·36	AC187K	0·55	BC212L	0·17	BF117	0·70	MJ491	1·85
2N2218A	0·37	2N3820	0·38	AC188K	0·55	BC213	0·14	BF121	0·55	MJ2955	1·25
2N2219	0·30	2N3823	0·75	AD161	0·85	BC213L	0·16	BF123	0·55	MJE340	0·58
2N2219A	0·32	2N3904	0·21	AD162	0·85	BC214	0·16	BF152	0·25	MJE370	0·58
2N2220	0·35	2N3906	0·22	AF106	0·55	BC214L	0·17	BF153	0·25	MJE371	0·60
2N2221	0·22	2N4036	0·67	AF109	0·75	BC237	0·17	BF154	0·25	MJE520	0·45
2N2221A	0·26	2N4037	0·55	AF124	0·65	BC238	0·12	BF159	0·35	MJE521	0·65
2N2222	0·25	2N4058	0·20	AF125	0·65	BC239	0·16	BF160	0·30	MJE2955	1·40
2N2222A	0·25	2N4059	0·20	AF126	0·65	BC251	0·15	BF161	0·60	MJE3055	0·85
2N2368	0·25	2N4060	0·20	AF127	0·65	BC253	0·22	BF166	0·40	MP8111	0·35
2N2369	0·25	2N4061	0·17	AF139	0·69	BC257A	0·17	BF167	0·38	MP8112	0·40
2N2369A	0·29	2N4062	0·18	AF186	0·50	BC258A	0·17	BF173	0·38	MP8113	0·45
2N2646	0·75	2N4126	0·17	AF200	0·70	BC259B	0·18	BF177	0·30	MPF102	0·30
2N2647	1·40	2N4289	0·20	AF239	0·74	BC261A	0·21	BF178	0·35	MPSA05	0·23
2N2904	0·36	2N4919	0·65	AF240	0·98	BC262B	0·19	BF179	0·35	MPSA06	0·24
2N2904A	0·37	2N4920	0·70	AF279	0·80	BC263C	0·30	BF180	0·40	MPSA12	0·35
2N2905	0·37	2N4921	0·50	AF280	0·85	BC300	0·45	BF181	0·40	MPSA55	0·24
2N2905A	0·38	2N4922	0·53	BC107	0·15	BC301	0·45	BF182	0·45	MPSA56	0·24
2N2906	0·28	2N4923	0·70	BC108	0·15	BC303	0·60	BF183	0·45	MPSU05	0·50
2N2906A	0·25	2N5190	0·60	BC109	0·15	BC307	0·20	BF184	0·38	MPSU06	0·56
2N2907	0·21	2N5191	0·70	BC113	0·17	BC308	0·18	BF185	0·30	MPSU55	0·55
2N2907A	0·22	2N5192	0·75	BC115	0·19	BC309C	0·25	BF194	0·14	MPSU56	0·60
2N2924	0·15	2N5195	0·90	BC116	0·19	BC317	0·14	BF195	0·13	TIP29A	0·45
2N2925	0·17	2N5245	0·35	BC116A	0·20	BC318	0·13	BF196	0·14	TIP29C	0·60
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2N3392	0·16	2N5457	0·32	BC136	0·19	BCY30	1·03	BF254	0·24	TIP33C	1·10
2N3393	0·15	2N5458	0·33	BC137	0·14	BCY31	1·06	BF255	0·24	TIP34A	0·90
2N3394	0·15	2N5459	0·29	BC140	0·40	BCY32	1·70	BF257	0·37	TIP34C	1·20
2N3439	0·88	2N5484	0·34	BC141	0·45	BCY33	1·00	BF258	0·45	TIP35A	2·50
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2N3638A	0·16	2N6109	0·42	BC149	0·13	BCY59	0·25	BFS28	1·04	TIP42C	0·95
2N3639	0·30	2N6121	0·38	BC153	0·27	BCY70	0·25	BFS61	0·30	TIP2955	0·65
2N3641	0·20	2N6122	0·41	BC154	0·27	BCY71	0·26	BFS98	0·27	TIP3055	0·55
2N3702	0·17	2N6123	0·43	BC157	0·12	BCY72	0·24	BFX29	0·38	TIS43	0·30

INTEGRATED CIRCUITS

CA3020	1·78	LM1808	1·92	TAA550	0·60
CA3020A	2·29	LM1828	1·75	TAA560	1·60
CA3028B	1·01	LM3301N	0·85	TAA570	2·30
CA3028A	1·29	LM3302N	1·40	TAA611B	1·85
CA3030	1·24	LM3401	0·70	TAA621	2·15
CA3030A	1·89	LM3900	0·75	TAA661A	1·32
CA3045	1·40	LM3905	1·60	TAA661B	1·32
CA3046	0·89	LM3909	0·68	TAA700	3·91
CA3048	2·23	MC1035	1·75	TAA930A	1·00
CA3049	1·66	MC1303	1·47	TAA930B	1·05
CA3052	1·62	MC1304	1·85	TAD100	1·95
CA3053	0·60	MC1305	1·85	TBA120	0·65
CA3080	0·68	MC1306	1·00	TBA400	1·50
CA3080A	1·88	MC1310	1·91	TBA500	2·21
CA3086	0·51	MC1312	1·98	TBA500Q	2·30
CA3088	1·59	MC1327	1·54	TBA510	2·21
CA3089	2·52	MC1330	0·92	TBA510Q	2·30
CA3090	3·80	MC1350	0·75	TBA520	2·21
CA3130	0·94	MC1351	1·20	TBA520Q	2·30
LM301A	0·65	MC1352	0·97	TBA530	1·98
LM301N	0·44	MC1357	1·45	TBA530Q	2·07
LM304	2·45	MC1458	0·91	TBA540	2·21
LM307N	0·65	NE555	0·53	TBA540Q	2·30
LM308C	1·82	NE556	1·05	TBA550	3·13
LM308N	1·17	NE565	1·30	TBA550Q	3·22
LM309K	2·10	NE566	1·65	TBA560Q	3·22
LM317K	3·00	NE567	1·80	TBA570	1·29
LM318N	2·25	SAS560	2·50	TBA570Q	1·38
LM323K	6·40	SAS570	2·50	TBA641B	2·50
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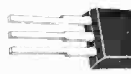

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7408	0·29	7427	0·39	7450	0·29	7481	1·10	7496	1·03	74153	1·11	74175	1·35	74196	1·17
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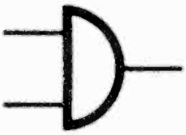


SIMPLE LOGIC PROBE

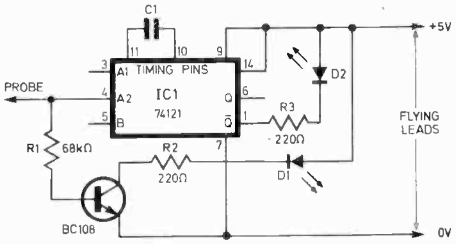
The circuit of Fig. 1 is a simple logic probe which can detect low, high and floating logic levels and also single short pulses and pulse trains. When the probe is connected to logic 0 then TR1 is turned off and the light emitting diode D1 does not glow. When the probe is at logic 1, TR1 is turned hard on and D1 glows brightly. However, when the probe, or logic signal, is floating then a small current flowing out of the monostable input A2 turns TR1 on slightly, causing D1 to glow dimly.

The second light emitting diode, D2, is on only when the monostable is triggered, which occurs on every 1 to 0 transition of the input signal. For a single pulse there is only one such edge and so D2 flashes once. For a pulse train at the input, the monostable is constantly being retriggered and so D2 glows brightly. Note that the brighter the glow from D2, the higher the frequency of the input signal.

The logic probe has a loading effect of slightly more than one standard input. The unused inputs to IC1 may be left unconnected. None of the component values is critical, but the value of R1 must be adjusted so that D1 glows dimly when the input is floating, also C1 must be sufficiently large that a single pulse produces a visible flash.

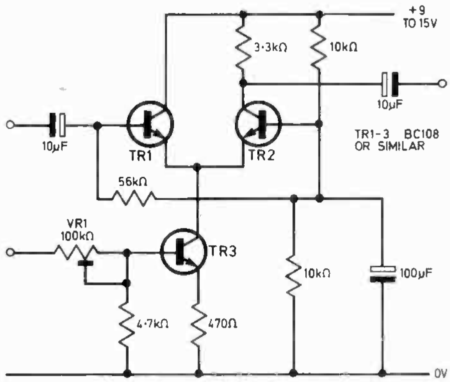
S. G. Bailey,
Guildford.

Fig. 1



LOW COST V.C.A.

Fig. 1



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TR1 and TR2 form a differential pair with the current through them determined by the current source TR3. This current is controlled by the voltage applied to the base in the usual exponential manner. The signal is applied to TR1 base and extracted from TR2 collector. VR1 sets the voltage attenuation ratio of the circuit and is, in effect, the control input.

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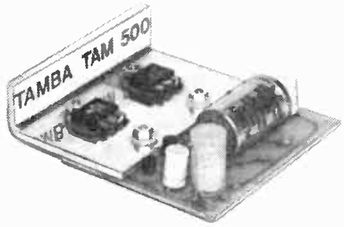

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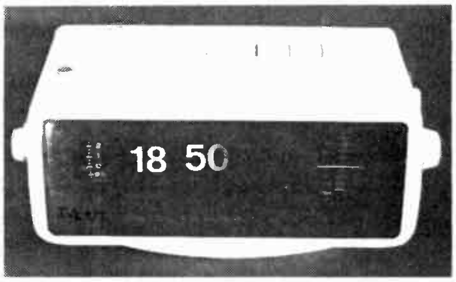

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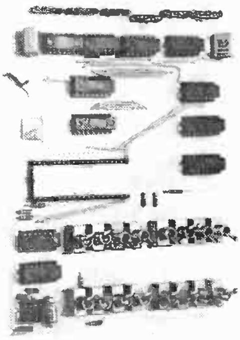

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These KITS replace conventional light switches and control 300W of lighting. No mains re-wiring required. Insulated Touch Plates. All with easy to follow instructions.

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ELECTRONIC DEVICES and semiconductors. Components for this month's projects. S.A.E. Lists. XKM, Box 65, Seaside, Eastbourne, Sussex. Telephone 32921.

BURGLAR ALARM Reeds 4 wire, with magnets plastic flush **75p** surface **75p**. Pressure mats 4 wire 20in × 30in **£1·80.** Bell covers plastic coated steel **£6.** Bells 6in 12V underdome type **£6.** Prices inc. VAT. Add 30p P. & P. Send for full price list, or CWO to: DOMESTIC SECURITY SYSTEMS, 241 Liverpool Road South, Burscough, Lancs, L40 7RE. Tel. 0704 893864.

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Police Headquarters
Avon and Somerset Constabulary
P.O. Box 188
BRISTOL

Closing date: 13th August 1977

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SITUATIONS VACANT

RADIO TECHNICIANS

Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over.

Standards required call for a sound knowledge of the principles of electricity and radio, together with 2 years experience of using and maintaining radio and electronic test gear.

Duties cover highly skilled telecommunications/electronic work, including the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer and analytic machinery.

Qualifications: Candidates must hold either the City and Guilds Telecommunications Part I (Intermediate) Certificate or equivalent HM Forces qualifications.

Salary scale from **£2,230** at 19 to **£2,905** at 25 (highest pay on entry) rising to **£3,385** with opportunity for advancement to higher grades up to **£3,780** with a few posts carrying still higher salaries. Pay supplement of **£313·20** per annum.

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Opportunities for service overseas.

Candidates must be UK residents.

Further particulars and application forms available from:
Recruitment Officer, Government Communications Headquarters
Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ
Tel.: Cheltenham (0242) 21491 (Ext. 2270)

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Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine.

INDEX TO ADVERTISERS

RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

RELAYS. WIDE RANGE OF A.C. and D.C. RELAYS AVAILABLE from stock, phone or write in your enquiries.

FT3 NEON FLASH TUBE

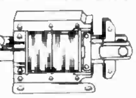
High intensity multi turn, high voltage, neon glow, discharge flash tube. Design for ignition timing, etc. **£1·50.** P. & P. 25p. 3 for **£3·00.** P. & P. 50p.

NI-CAD BATTERIES

	Height (mm)	Width (mm)	Length (mm)
16AH 1·2V Metal **£3**	163	55	27
23AH 1·2V Plastic Case **£4**	214	79	27
35AH 1·2V Metal **£6·50**	219	75	29
40AH 1·2V Plastic Case **£8**	275	80	35

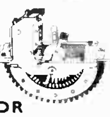
21 WAY SELECTOR SWITCH WITH RESET COIL. The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil. 230/240V a.c. operation. Unit is mounted on strong chassis, complete with cover. Price **£5·50.** P. & P. 75p.

NEW HEAVY DUTY SOLENOID. mfg. by Magnetic Devices. 240V a.c. operation approx. 20lb pull at 1·25in. Price **£7.** P. & P. 75p. Similar to above approx. 10lb pull **£3·50** P. & P. 60p.



UNISELECTOR SWITCHES

4 bank, 25 way 75 ohm. Coil, 36–48V d.c. operation. Ex. **New** equipment **£4·25.** P. & P. 75p. Total price inc. VAT **£5·40.**



MINIATURE UNISELECTOR

12 volt 11-way, 4 bank (3 non-bridging, 1 homing), **£2·50,** p.p. 35p.

RODENE UNISET TYPE 71 TIMER

0–60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6** P. & P. 60p.

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Sub miniature Burgess Button Type V.4.T.1. 10 for **£2·50.** 50 for **£10.** Post paid. Sub min Honeywell roller m/s type 3115m 906t, 10 for **£2·50** post paid. BF LEVER OPERATED 20 amp. C/O. Mfg. by Unimax USA, 10 for **£4,** P. & P. 50p (min. order 10).

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Dynamically balanced totally enclosed 9in rotor with max. air delivery of 1·5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular apertures fitted to base of unit. Powerful continuously rated 115V a.c. motor mounted on alloy base with fixing facilities. Dimensions: length 22cm × width 25cm × height 25cm. These units are ex equipment but have had minimum use. Fully tested prior to despatch. Price **£12** + £1·50 P. & P.

Suitable transformer for 230/240V a.c. **£6** + £1 P. & P.

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Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **500V,** 500 megohms, **£40.** Post 80p. 1,000V, 1,000MΩ, **£46.** Post 80p.

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Phone 01-995 1560
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INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types
SHROUDED TYPE

200 watt (1 amp) inc. AC voltmeter **£11·50**
0·5 KVA (2½ amp) (MAX) **£14·00**
1 KVA (5 amp) (MAX) **£18·00**
2 KVA (10 amp) (MAX) **£30·00**
3 KVA (15 amp) (MAX) **£38·00**
4 KVA (20 amp) (MAX) **£60·00**
CARRIAGE AND PACKING EXTRA

L.T. TRANSFORMERS

0–12V/24V at 1 amp, **£2·50** (P. & P. 50p).
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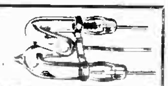
0–12V/24V 10 amp, **£12·35** (P. & P. £1·50).
0–4V/6V/24V/32V at 12 amp, **£13** (P. & P. £1·50).
0–12V at 20 amp or 0–24V at 10 amp, **£12·40** (P. & P. £1·50).
0–6V/12V/17V/18V/20V at 20 amp, **£14** (P. & P. £1·50).
0–6V/12V at 20 amp, **£11·85** (P. & P. £1).
Other types in stock—phone your enquiries.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT MK IV

Latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/240V a.c. operation.
Designed for larger rooms, halls, etc. Speed adjustable 1–20 f.p.s. Light output greater than many (so called 4 Joule) strobes **£18.** Post 75p. Specially designed case and reflector for Hy-Light **£8·25.** P. & P. £1.

XENON FLASHGUN TUBES



Range available from stock. S.A.E. for details.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt, £7·00 (callers only).
2ft 20 watt, £5·00. Post 60p. (For use in standard bi-pin). MINI. **12in 8 watt, £1·75.** Post 25p. **9in 6 watt, £1·40.** Post 25p. **6in 4 watt, £1·40.** Post 25p. Complete ballast unit and holders for 6in, 9in and 12in tube, **£3·50.** Post 40p. Also available for 12V d.c. operation, **£3·50** plus P. & P. 40p.

GALVANOMETER

50 micro mirror galvo. Calibrated 50–0–50 and 0–100. Mfg. by Griffin & George Ltd. Offered at a fraction of maker's price, in original ministry packing. **£12.** P. & P. 60p.

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

S.A.E. (Foolscap) for details.

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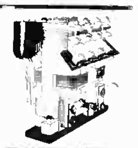
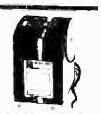


mfg by Hendrey Relays type C2839 220/250 AC ops. Contact 4C/O at 20 amp at 440 volts AC price **£6.00.** P. & P. 75p.

RESET COUNTER



230 volt AC 3 digits mfg Veeder Root type LL/1441 **£1·75.** P. & P. 25p.

BIG INCH

Tiny precision built 3RPM USA motor size only 1 × 1 100 volt AC op supplied with resistor for 230 volt AC price **£2·00.** P. & P. 20p. 4 for **£5·00** post paid.

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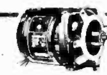
100 r.p.m. 115 lb. in. 110V, 50Hz. 2·8A, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled in-line gearbox. Length 250 mm. Dia. 135 mm. Spindle dia. 15·5 mm. Length 145 mm. Ex-equipment tested **£12.** Post £1·50. Suitable transformer 230/240V operation **£8.** Post 75p.

CITENCO

FHP motor type C 7333/15 220/240 volts AC 19RPM reversible motor, torque 14·5 kg gear ratio 144–1 brand new incl. capacitor, our price **£14·25.** P. & P. £1·25.

BODINE TYPE N.C.I.

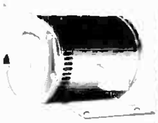


(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. 50Hz.
The above precision made U.S.A. motor is offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type **£6·25.** Post 75p or less transformer **£3·75.** Post 65p.
(Type 3) 71 r.p.m. 4 lb.ins. 230V a.c. Continuously rated. Reversible. **£6·50.** Post 75p.

15 R.P.M.

Type 5D48 80 lb. in. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. drive shaft 16 mm. Weight 8·5 Kilos. BRAND NEW. Price **£10.** Carr. £1.
Suitable transformer for use on 220/240 volt A.C. **£3·85.** Post 50p.

A.E.G. WATER PUMP



200/240V A.C. motor. 2,850 r.p.m. 480W approx. ⅔ h.p. Driving a centrifugal pump with 1½ inlet and outlet delivering approx. 40 gallons per min. at 10 ft. head. Ideal for pumping or circulating any non corrosive light viscosity liquid. Dozens of uses in industrial labs, etc. Note this pump is not self priming. Price **£15·00.** Post 75p.

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230V operation a.c. 15 or 20 r.p.m.
6 cam model **£5.** Post 60p.
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Also available for **50V** operation. Prices as above.

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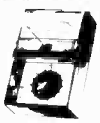
WHY PAY MORE?!



MULTI RANGE METER. A.C. volts 2·5–500. D.C. volts 2·5–500 (Sensitivity 2000Ω/V D.C. and A.C.) D.C. current 0·1/10/100 mA. Ohms range. Sturdy compact moving coil instrument with 21 ranges, dimensions 120 × 80 × 44 mm. Weight 0·32 kg. SERVICE TRADING CO. Price **£5·50.** Incl. leads and battery. Post 50p. (Total price incl. VAT and Post **£6·48**).

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Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k ohm. £1·90. Post 20p.
50 WATT 100/250/500/1k ohm. **£2·40.** Post 25p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£3·70.** Post 35p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

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Phone 01-437 0576

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