PRACTICAL

ELECTRONICS

JUNE 1977 40p

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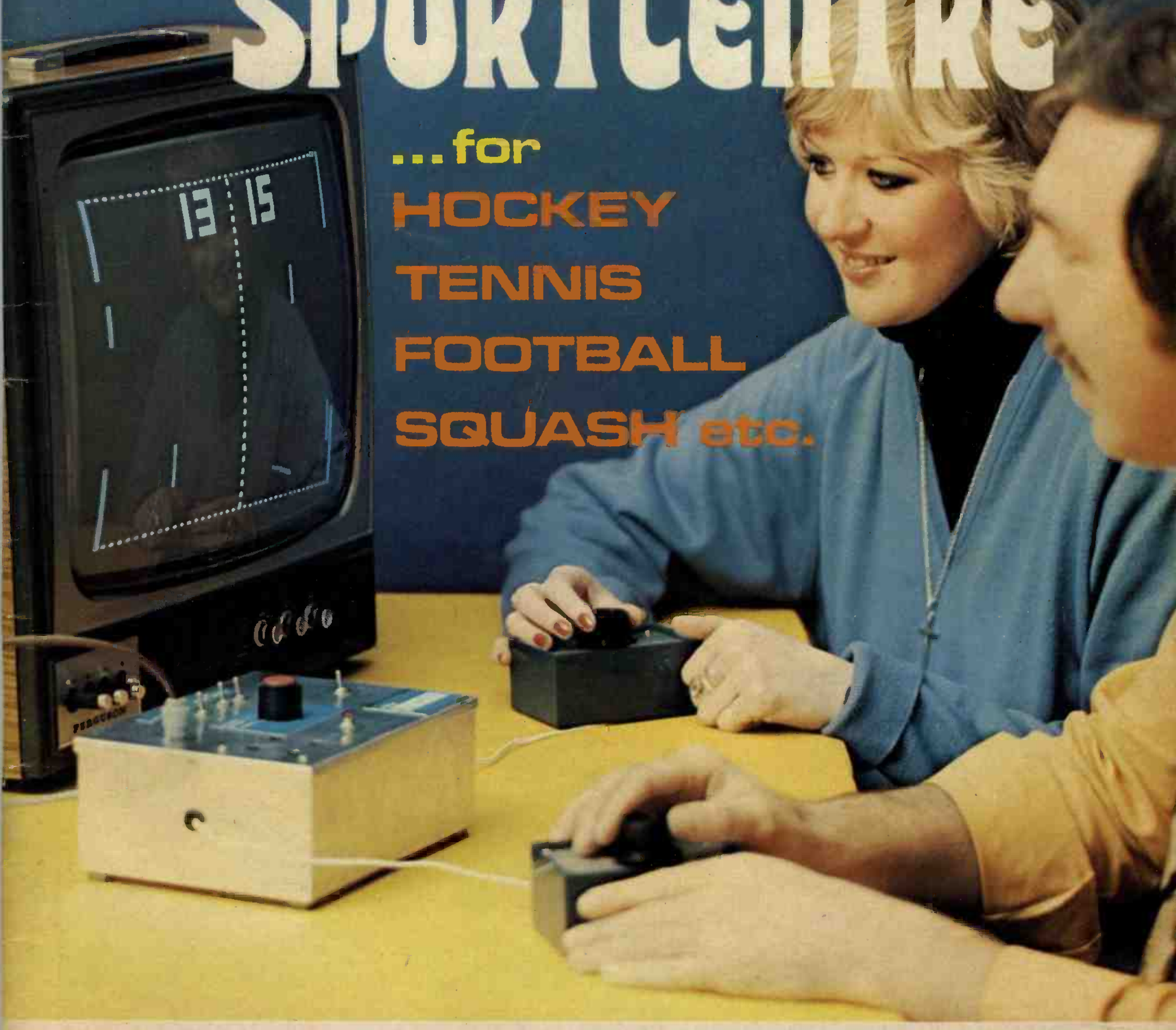

Also inside...

CAR LIGHTS REMINDER · SOUND to LIGHT CONVERTER

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 $9\frac{1}{2}$in × 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.

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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. 6·3V 4A C.T., 6·3V 2A £7·00
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 £4·60
1A 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·60
2A, 6, 8, 12, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7·00
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8·70
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11·25
5, 8, 10, 16V ½A £2. 6–0–6V 500mA £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. £3·75.
20-0-20V 1A £2. 30V 1½A £1·75. 20V 1A £1·80.
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.
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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 $10\frac{3}{4}$ × $8\frac{1}{4}$ × $\frac{1}{16}$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)

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With tweeter. And crossover. 10W. State 3 or 8 ohm. As illustrated. **£5·95** Post 45p

15W model £8·50 8 ohms. Post 65p

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BAKER MAJOR 12 £14·95

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. **£18·95**

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

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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. **£11·95** Post £1

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

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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. 50 watt model £49. **£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.

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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.

COLLARO GRAM MOTOR 120V GEAR BOX 5:1 95p. **75p**

PHILIPS GRAM MOTOR 6 VOLT A.C. £1·50

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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 $13\frac{1}{2}$ × $11\frac{1}{4}$in.
Above motor board $3\frac{3}{4}$in.
Below motor board $2\frac{1}{2}$in.
With STEREO/MONO CARTRIDGE. **£11·95**
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GARRARD MINICHANGER Size 12 × 8in £8·95
BSR P128 with Ceramic Cartridge £19·50

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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

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Sizes: 'A'—$14\frac{1}{2}$in × $12\frac{1}{2}$in × $4\frac{1}{4}$in, £2·50. 'B'—$20\frac{3}{4}$in × $12\frac{3}{4}$in × $4\frac{1}{2}$in, £3. 'C'—$17\frac{3}{8}$in × $13\frac{3}{8}$in × $3\frac{3}{4}$in, £3·25. 'D'—$16\frac{3}{4}$in × 14in × 4in, £3·50. 'E'—19in × $14\frac{3}{8}$in × $4\frac{1}{4}$in, £3·50.
Ideal for record decks, tape decks, etc. Post 75p.

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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.

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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 Discotheques.
Bass Resonance 35 c/s
Flux Density 15,000 gauss
Useful response 25–16,000 c/s
8 or 16 ohms models.

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PRACTICAL
ELECTRONICS

VOLUME 13 No. 6 JUNE 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our July issue will be on sale Friday, June 10, 1977
(for details of contents see page 425)

TRANSISTOR UNIVERSAL AMPLIFICATION Co. Ltd. PHONE 01-672 3137/672 9080

MANUFACTURERS OF
ELECTRONIC AND AMPLIFICATION EQUIPMENT

9 MONO DISCO MIXER
WITH AUTO FADE

Designed for the discerning D. J. of professional standard. Offering a vast variety of functions. Controls: Mic Vol; Tone, over-ride depth, auto/manual sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off sw. Max output 3V RMS.
Specification: Deck inputs—50mV into 1MΩ; Deck Tone Controls—treble total range 36dB at 15kHz—Bass total range 36dB at 50Hz. Mic input—200 ohms upwards 2mV into 22k. Mic Tone Control—Total range 40dB at 15kHz. Tape input—100mV into 200 ohms. Power requirements 20–50 volts d.c. at 50mA. R.I.A.A. comp mag inputs available 75p extra.
PANEL SIZE 18 × 4½in. DEPTH 3in. **£39·75**

12 STEREO DISCO MIXER. T/S SWITCHING, etc. £115·00

4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI 8

- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from ¼W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection
- Full wave control
- 13 easy connections

Patents applied for **£18·75**

Model 501 500W per channel as above without sound triggering £12·25

10 3 CHANNEL LIGHT MODULATOR

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections

£18·00

(Single Channel Version 1500 Watts £9·50)

3 ADD SEQUENCE CHASING AND DIMMING EFFECTS TO YOUR TUAC 3 CHANNEL LIGHT MODULATOR

- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel
- 9 easy connections

SEQUENCE DIMMER MODULE—3SDM1 **£13·00**

6 FUZZ LIGHTS RED GREEN BLUE AMBER £21·50

FRONT PANEL FOR LIGHTING EFFECT MODULES

(complete with switches, neons and knobs) as illustrated

▲ Size: 6¼" × 4¼"
For 4LSM1
£5·50

◄ For S1LMB
combined with 3SDM1
Size: 9" × 4¼"
£7·50

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has all the features! *ONLY* £10·95

● NEEDS NO CROSS-OVER NETWORK ● FREQUENCY RESPONSE 4,000–30,000Hz ±3dB ● PATENTED MOMENTUM DRIVE PRINCIPLE ● NO VOICE COILS OR MAGNETS ● HIGH INTERNAL IMPEDANCE ● ADAPTS TO ANY SYSTEM ● HIGH ACCOUSTIC OUTPUT ● MANY CAN BE CONNECTED IN SERIES TO FORM AN ARRAY—INCREASED OUTPUT ● POWER HANDLING CAPACITY 25 volts RMS—see chart

POWER HANDLING GUIDE

System Impedance	Capacity
2 ohms	312 watts
4 ohms	156 watts
8 ohms	78 watts
16 ohms	39 watts

COMPACT—
3¾ × 3¾ × 2¾in.

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7 TL30 D.C. COUPLED 5 × 5 × 1½in.
- 30 watt R.M.S. continuous sine wave output
- 8 transistors 4 diodes

£12·50

11 TL60 5 × 5 × 3in
- 60 watt R.M.S. continuous sine wave output
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- 2 R.C.A. 150 watt 15 amp transistors

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- 4 R.C.A. 150 watt 15 amp output transistors

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Really 3 shops—audio showroom, component bargains, modules, etc. Well worth a visit.

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- SS.110 10 watts r.m.s. using 24V and 4 ohm load £4·05
- SS.120 20 watts r.m.s. into 4 ohms, using 34V supply £4·61
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Combined pre-amp with active tone-control circuits. ±15dB at 10Khz treble and 30Hz bass. Stereo. Vol./balance/treble/bass controls. 200mV out for 50mV in. Operates from 10–16V £9·00

UNIT TWO
As Unit One, but for magnetic pick-ups. For inputs 1 to 5mV per channel. R.I.A.A. corrected. Adaptable to ceramic. Designed to genuine hi-fi standards. £12·43

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Your chance to lay the foundations of a really powerful disco or P.A. assembly at a marvellous price. This guaranteed Stirling Sound triumph is built for real hard work, so why pay more?

It's the SS.1100 100 watt R.M.S. amplifier (£10·45) together with SS.370 power unit (£14·63) plus full size heatsink for amp. (£1·39) yours for £24·25 —A saving of £2·20!

(Items bought separately come to £26·45)

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- SS.201 Front end tuner, two gang, slow geared drive. A.F.C. facility. Tunes 88–108MHz £5·90
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- SS.203 Phase Lock Loop Stereo Decoder for use with the above or any other standard type FM mono tuners. A LED may be fitted £4·19
- SS.203–1 Coil type Stereo Decoder Neg. earth with I.C. £3·06
- SS.203–2 Pos. earth, transistor £2·50

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Complete with mains transformers and low volt take-off points.

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SS.350	50V/2A	£10·38
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Fitted with Phase Lock-loop

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- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20–30v at 90 Ma max.

OUR PRICE ONLY

£20.45

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461.**
The S450 is supplied fully built, tested and aligned.
The unit is easily installed using the simple instructions supplied.

VAT ADD 12½%

STEREO PRE-AMPLIFIER PA 100

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response + 1dB 20Hz–20KHz.
Sensitivity of inputs:
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply 20-35V at 20mA. Dimensions—299mm × 89mm × 35mm.

£13.75 *p & p 45p*

MK60 AUDIO KIT:
Comprising: 2 x AL60's 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE** *£29·55 plus 62p postage.*
TEAK 60 AUDIO KIT:
Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE** *£10·70 plus 62p postage.*

AL 60

25 Watts (RMS)

● Max Heat Sink temp. 90C. ● Frequency response 20Hz. ● Distortion better than 0·1 at 1kHz. ● Supply voltage 15-50v. ● Thermal Feedback. ● Latest Design Improvements. ● Load—3,4,5, or 16ohms. ● Signal to noise ratio 80db. ● Overall size 63mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

ONLY £4.35

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1·5A at 35V. Size: 63mm, 105mm, 30mm. Incorporating short circuit protection.

INPUT VOLTAGE	33-40V. A.C.
OUTPUT VOLTAGE	33V. D.C. Nominal
OUTPUT CURRENT	10mA-1·5 amps
OVERLEAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

£3.75

TRANSFORMER BMT80 £2·60 + 62p. postage

STEREO 30 COMPLETE AUDIO CHASSIS

7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins.).

TRANSFORMER £2·45 plus 62p p & p

TEAK CASE £5·25 plus 62p p & p.

£16.25 *P & P 45p.*

15-240 WATTS!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropiate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation; low noise; low distortion; high overload; two simply combined for stereo.
APPLICATIONS: hi-fi; mixers; disco; guitar and organ; public address.
SPECIFICATION: Inputs–magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3–100mV; input impedance 47kΩ at 1kHz. Outputs—tape 100mV; main output 500mV R.M.S. Active Tone Controls—treble ±12dB at 10kHz; bass ±12dB at 100Hz. Distortion—0·1% at 1kHz; signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage—±16–50V.

Price £5·22 + 65p VAT. P. & P. free
HY5 mounting board B.1. 48p + 6p VAT. P. & P. free

HY30
15W into 8Ω

AVAILABLE EX STOCK

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion; short, open and thermal protection; easy to build.
APPLICATIONS: updating audio equipment; guitar practice amplifier; test amplifier; audio oscillator.
SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—0·1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz–16kHz −3dB.

Price £5·22 + 65p VAT. P. & P. free

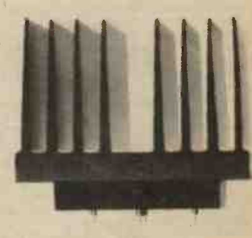
HY50
25W into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: low distortion; integral heatsink; only five connections; 7 amp output transistors; no external components.
APPLICATIONS: medium power hi-fi systems; low power disco; guitar amplifier.
SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±25V. Size—105 × 50 × 25mm.

Price £6·82 + 85p VAT. P. & P. free

HY120
60W into 8Ω



The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion; integral heatsink; load line protection; thermal protection; five connections; no external components.
APPLICATIONS: hi-fi; high quality disco; public address; monitor amplifier; guitar and organ.
SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±35V. Size—114 × 50 × 85mm.

Price £15·84 + £1·27 VAT. P. & P. free

HY200
120W into 8Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown; very low distortion; load line protection; integral heatsink; no external components.
APPLICATIONS: hi-fi; disco; monitor; power slave; industrial; public address.
SPECIFICATION: Input Sensitivity—500mV. Output Power—120W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±45V. Size—114 × 100 × 85mm

Price £23·32 + £1·87 VAT. P. & P. free

HY400
240W into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown; very low distortion; load line protection; no external components.
APPLICATIONS: public address; disco; power slave; industrial.
SPECIFICATION: Output Power—240W R.M.S. into 4Ω. Load Impedance—4–16Ω. Distortion—0·1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±45V. Input Sensitivity—500mV. Size—114 × 100 × 85mm.

Price £32·17 + £2·75 VAT. P. & P. free

POWER SUPPLIES: PSU36—suitable for two HY30s £5·22 + 65p VAT. P. & P. free. PSU50—suitable for two HY50s £6·82 + 85p VAT. P. & P. free. PSU70—suitable for two HY120s £13·75 + 1·10 VAT. P. & P. free. PSU90—suitable for one HY200 £12·65 + £1·01 VAT. P. & P. free. PSU180—suitable for two HY200s or one HY400 £23·10 + £1·85 VAT. P. & P. free.

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

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

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

The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists.
Set of basic component kits £83·03
Set of printed circuit boards £11·45
The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists.
Set of basic component kits £48·18
Set of printed circuit boards £7·66

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

ELEKTOR "FORMANT" SYNTHESISER (Elektor Magazine 1977)
Details of component kits and PCBs are in our lists.

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.
Component set with special foot operated switches £7·59
Alternative component set with panel mounting switches £4·96
Printed circuit board £1·43

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
Component set for above functions (excl. SWs) £7·84
Printed circuit board £1·81
Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.
Component set (incl. PCB) £2·88

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

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

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

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

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

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

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

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

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

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.
Component set using dual slider pot £8·86
Component set using dual rotary pot £6·20
Printed circuit board £1·62

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

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

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

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.
Component set (incl. PCB) £4·58

ENVELOPE SHAPERS
Both of the kits below have manual control over their Attack, Decay, Sustain and Release functions. Kits include PCB (VCA means Voltage Controlled Amplifier)
Envelope Shaper and VCA (P.E. Apr. 76) £6·68
Envelope shaper (without VCA) (P.E. Oct. 75) £4·66
Transient generator (P.E. Apr. 77) £6·34

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

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

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

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

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

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

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

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

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

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

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

MICROPHONE PRE-AMP (PE Apr. 77)
Component set (incl. PCB) £3·78

POST AND HANDLING

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

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PE

NOT TOTALLY BINDING

LARGE scale integration brings highly complex circuit systems within the ordinary constructor's reach. But at what cost to individual freedom and enterprise? The central LSI package rules the roost. It determines the overall pattern and personal designing is severely limited to a few peripheral trimmings, so far as the actual electronics is concerned. More scope is of course offered in the mechanical arrangement of the final working model for here personal preferences can be indulged in.

This somewhat pessimistic view is broadly true, although it does not apply totally in all cases. The general drift is at any rate discernible and is sufficient to suggest to some that the nature of project building is undergoing change, that a new era of "kit constructing" is dawning, an era reminiscent in many ways of the hey-day of the radio kits of the 20's and 30's. But the comparison is not quite fair since the present-day constructor has far more freedom of subject than the radio constructor of old who assembled kits strictly according to an unalterable plan. Today's electronics constructor has the advantage of the most advanced technology, in, moreover, a convenient miniaturised form. And not *all* LSI packages coming on the market are pre-ordained for some unique or exclusive electronic environment. Sometimes the options are open and true inventiveness has opportunity to shine outside the central star performer, the LSI chip.

Our Television Sportcentre is built around a well-known LSI chip and, naturally, individual initiative is rather restricted in this case. Even so, the opportunities are there, as a study of some of our contemporaries who have featured this same device will demonstrate. Each published design has its own individuality which shows through clearly. This provides good evidence that the construction of major projects based on the identical LSI chip need not necessarily become a drab uniform procedure, nor even just a kit assembly operation, as some might fear.

A greater danger to the hobby field comes from complete ready-made equipment. Television games again provide a good example at this very time. Maybe home constructed equipment of this kind will not be able to compete economically with the mass produced article, and TV games will join their honourable and distinguished predecessors the transistor radio, the pocket calculator, and the digital wristwatch as subjects generally abandoned after the initial experience in building one just for the sheer fun of the thing.

So this month's presentation of the Television Sportcentre may be a "one-appearance only". But who can really tell? Further innovations on the TV game theme are coming along from the i.c. manufacturers and it would be rash to predict any early closure of constructor activities in this particular field.

All users, commercial equipment makers and amateur constructors alike, have become dependent upon the device maker for the basic system design equally as for the actual device itself. Resourceful amateur designers will relish the challenge offered by every new LSI device that comes their way. Any successes in new adaptations for these devices will not go unmarked by the manufacturers and others on the professional side of the business, that is certain.

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SOUND to LIGHT CONVERTER

By M. Hadley

THE Sound to Light Converter described in this article was developed to provide a simple, cheap, but effective unit for use at parties. It provides good channel separation while avoiding the most common failing of other cheap sound to light units, namely generating mains interference which produces an irritating buzz in the record player or sound system in use. As this is produced by the fast switching of large currents, the silicon controlled rectifiers (s.c.r.s) in this unit are only switched when the mains voltage is at or near zero volts in each cycle.

FILTER SECTION

The three channels are split by active filters using 741 op. amps. (IC1–3 in Fig. 1). The bass and treble filters are standard 12dB per octave Sallen and Key circuits, in low pass and high pass configurations, with breakpoints at 370Hz and 1kHz. These give very good channel separation which is vital for an attractive display when three channels are used.

The midrange channel has 6dB per octave filters with the same breakpoints. Since this channel only covers one octave or so, the filter characteristics are quite suitable.

Each filter input is taken via its own 10 kilohm logarithmic level control from the secondary of isolating transformer T1. This can consist of the output and feedback windings of a valve audio output transformer. A suitable transformer can be wound using 28 s.w.g. wire. The primary is 210 turns and the secondary 280. The core should be from a valve audio output transformer.

R6 prevents damage to the amplifier in use if T1 should short out, and to the 741s if very high signal levels are applied when the sensitivity is turned fully up. Its value depends on the power of the amplifier in use and is between 100 ohms and 4·7 kilohms. A value of 470 ohms is suitable for most applications.

The three filter outputs are taken via 1·2 kilohm resistors to the gates of CSRs 1 to 3.

MAINS SWITCHING

S.c.r.s are used to run the lamps on alternate half-cycles of the mains waveform. This reduces the cost and complexity of the circuit considerably, while scarcely affecting the display. The only effect is a reduction in overall brightness, which is generally welcomed at parties.

Zero-voltage switching is used instead of the more conventional "phase control" dimming: this offers several advantages. First, mains-borne interference is almost entirely eliminated, and no high voltage capacitors or bulky chokes are needed to filter it out. This reduces overall cost, more than offsetting the cost of the zero crossing detector. Second, a more rapid, pulsating display is produced which most people find more pleasing than the slower effect. Finally, the dissipation in the s.c.r.s is reduced, cutting the size of the heatsinks needed.

The zero voltage switching circuit consists of TR1/2 and associated components. The mains voltage is attenuated by R1 and R2 and applied via C1 and R3 to the base of TR1. D1 removes negative half-cycles from the base, preventing reverse breakdown of the base emitter junction. The amplified pulses at the collector of TR1 hold TR2 off during positive half-cycles, except when the mains voltage is very low, holding the s.c.r. cathodes at about +9V. The gates are then reverse biased, and the s.c.r.s are held off. When TR2 is on, the s.c.r.s will turn on if the signal level at the filter output is above about 0·6V. Thus the s.c.r.s can only turn on when the mains voltage is passing through zero.

CONSTRUCTION AND POWER SUPPLIES

The prototype was built on 0·1in matrix Veroboard which carried all components except the transformers and level controls. The s.c.r.s used were 1A 400V types

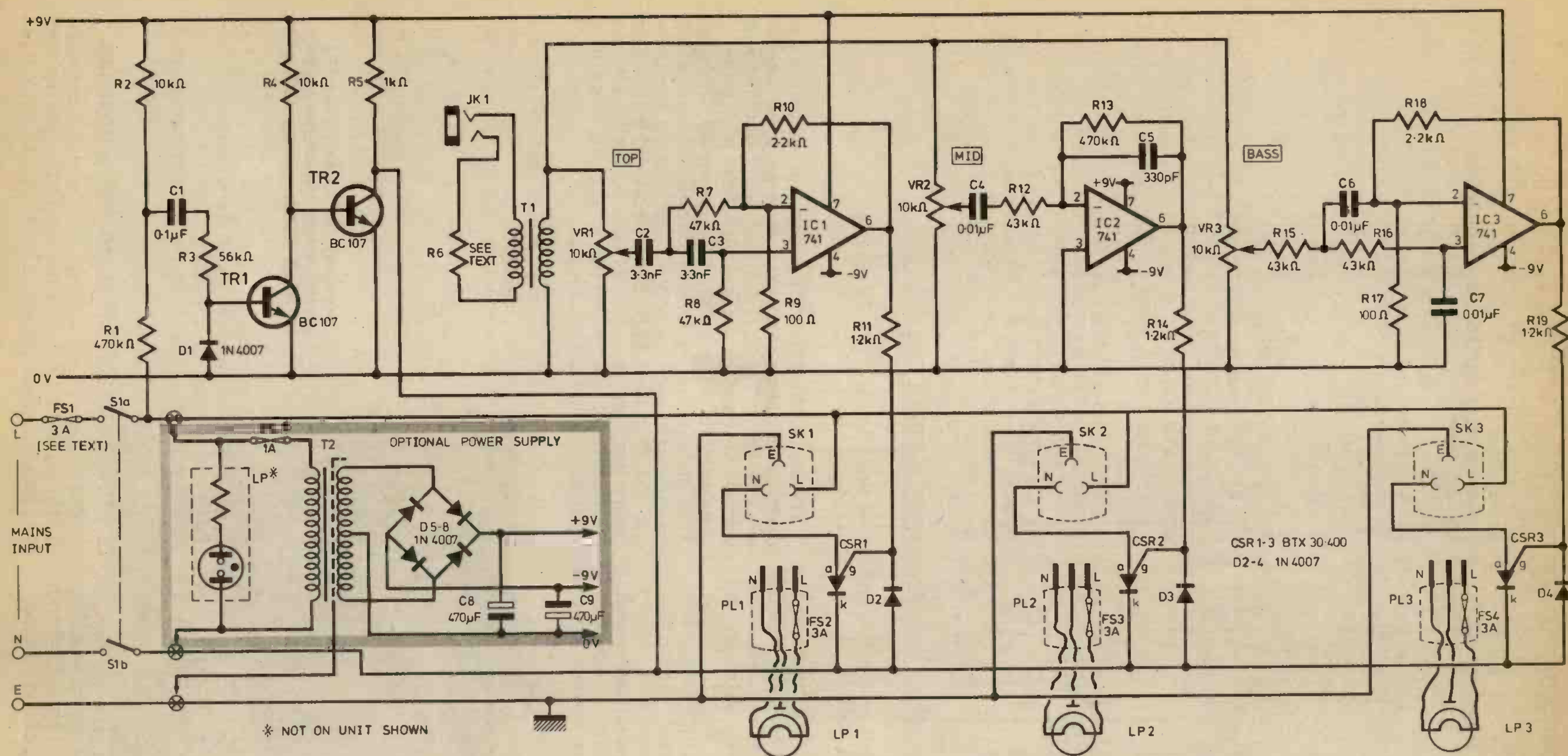


Fig. 1. Circuit of Sound to Light Converter. Each channel is suitable for lamps up to 150W

COMPONENTS . . .

Resistors

R1	470 kΩ	R8	47kΩ	R15	43kΩ
R2	10kΩ	R9	100Ω	R16	43kΩ
R3	56kΩ	R10	2·2kΩ	R17	100Ω
R4	10kΩ	R11	1·2kΩ	R18	2·2kΩ
R5	1kΩ	R12	43kΩ	R19	1·2kΩ
R6	See text	R13	470kΩ		
R7	47kΩ	R14	1·2kΩ		

All ⅛W 10% except R1 which is ¼W 10% and R12, R15, R16 which are ⅛W 5%

Potentiometers
VR1–3 10kΩ log

Capacitors

C1	0·1µF	63V	C6	0·01µF	,,
C2	3·3nF	,,	C7	0·01µF	,,
C3	3·3nF	,,	C8	470µF	12V elect.
C4	0·01µF	,,	C9	470µF	,, elect.
C5	330pF	,,			

Semiconductors

TR1 & 2	BC107
D1–8	1N4007
IC1–3	741
CSR1–3	BTX30–400 400V 1A or C106D 400V 3A

Miscellaneous
T1 Valve audio output transformer (see text)
T2 240V primary, 6-0-6V 1A transformer Type CT1 (Electrovalue)
JK1 ¼in jack or DIN loudspeaker socket
FS1 3A (10A in high power version)
FS2–4 3A
S1 d.p.s.t. 13A mains toggle switch
Metal case 228 × 152 × 101mm (Home Radio) control knobs, mains cable, SK1–3 13A sockets, PL1–3 plugs to suit.

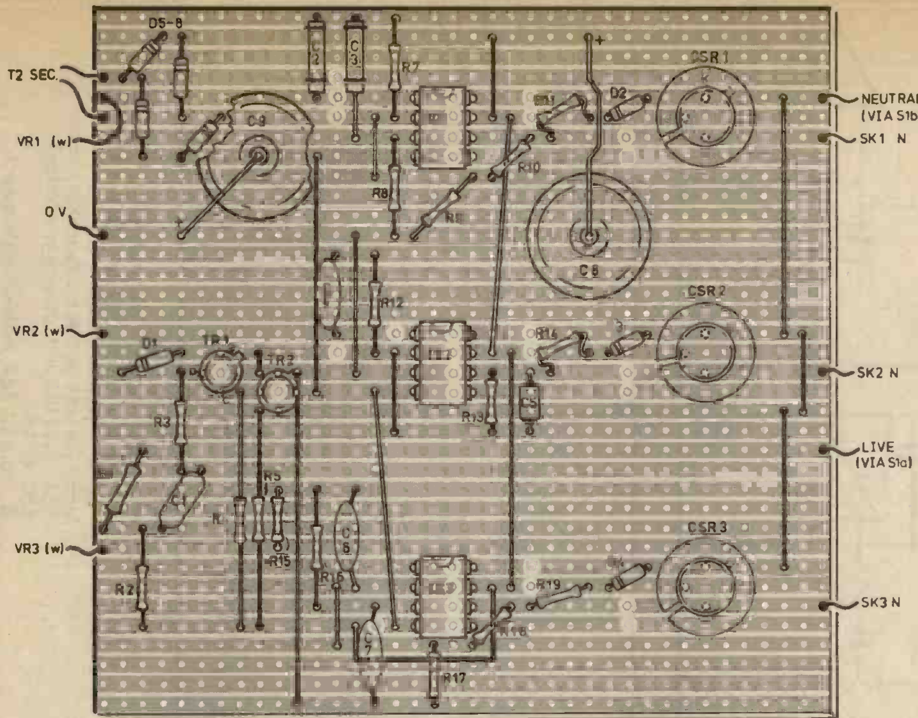


Fig. 2. Component and wiring details of main board. The 0V line is not connected to chassis

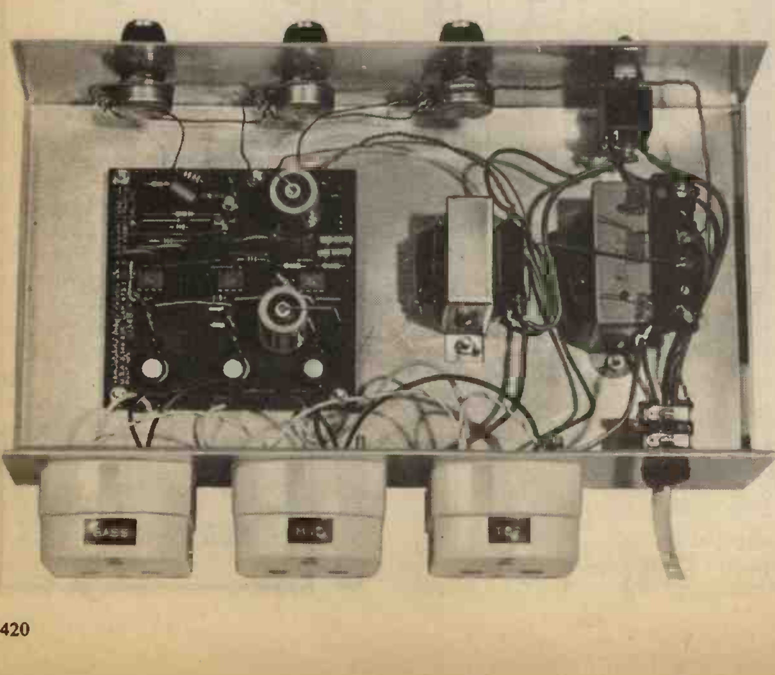
in TO5 cans which were mounted on the board and fitted with push-on "cog wheel" type heat sinks, which were found to be adequate, as they remained cool after several minutes running. A suitable Veroboard layout is shown in Fig. 2.

The unit was battery powered for simplicity and low cost, but for continuous use a power supply such as that shown in Fig. 1 is suitable.

The electronics is contained in a metal case which must be connected to mains earth. *It is, however, important that no part of the circuitry be earthed.*

The mains wiring should be done with standard p.v.c. mains cable, taking care that it does not chafe against any metal part. The level controls should be of the type with nylon shafts for the greatest safety.

A high standard of construction should be attempted when building any equipment which is to be connected directly to the mains supply, as mistakes can be expensive and dangerous. Particular care should be taken to ensure there are no solder bridges between tracks on the Veroboard, and that no part of the circuit board or heatsinks touches the metal case.



Showing the case assembly of the unit. Note the push fit heat sinks on the s.c.r.s

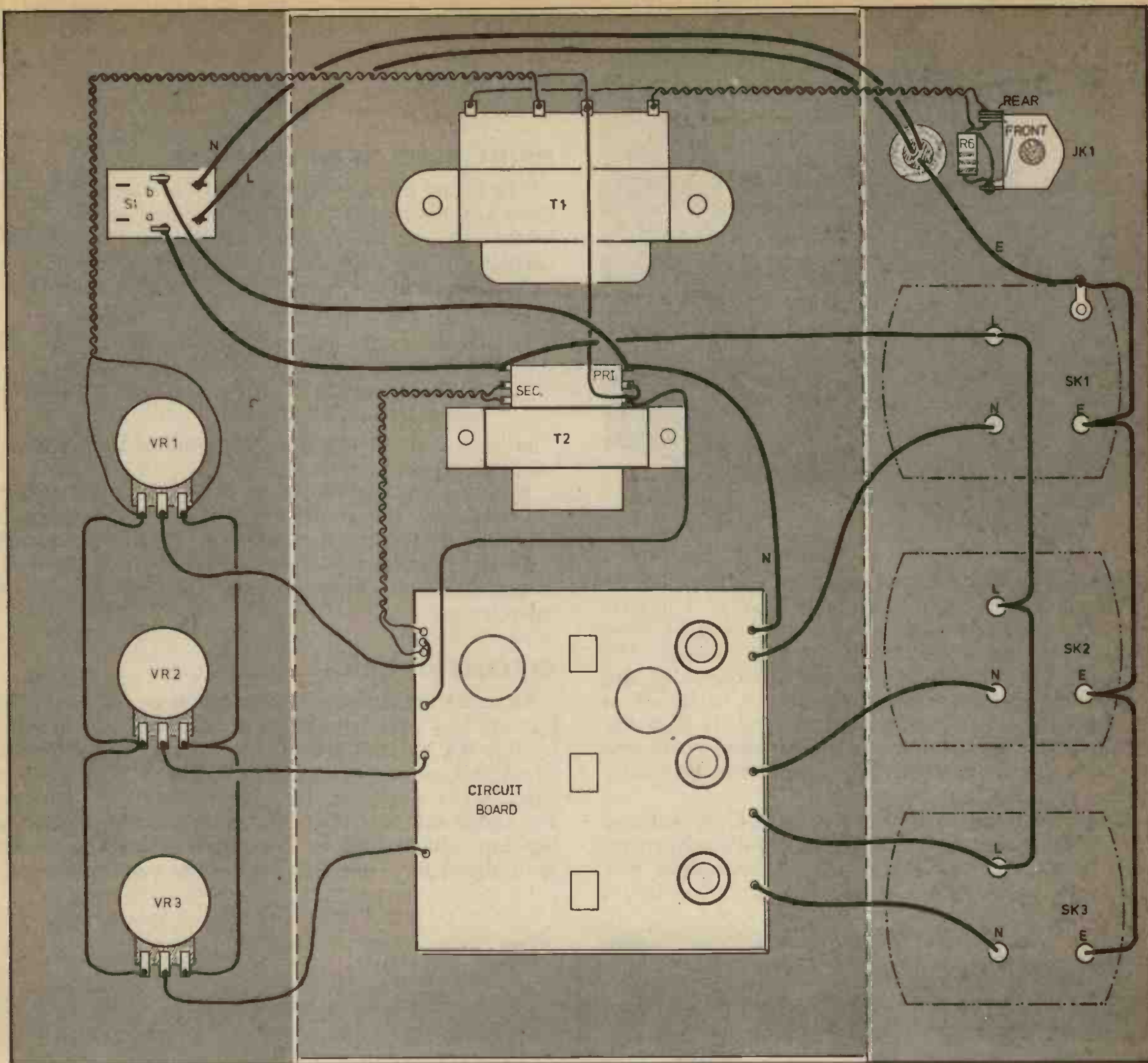


Fig. 3. Component interwiring to the board

The best form of lamp connector to use is the normal flat pin 13A socket, as this is both shuttered, for safety, and ensures that each lamp is fused. The sockets should be mounted on the rear of the unit and care taken to ensure that no "whiskers" of wire from the connecting cables touch each other or the case. These sockets are, however, expensive, and a suitable alternative is to build the lampholders into or onto the unit with the cables permanently wired in position.

The speaker input is isolated, and may be taken to a ¼in jack socket, or a DIN speaker socket. These sockets must also be kept insulated from the case.

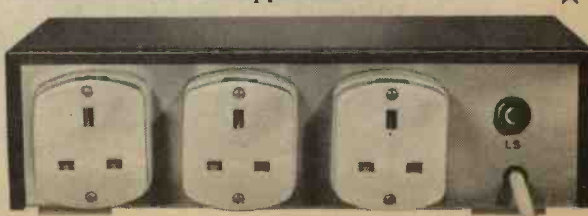
A professional finish can be given to the unit by labelling the controls with "Letraset" and finishing off with a coat of clear lacquer.

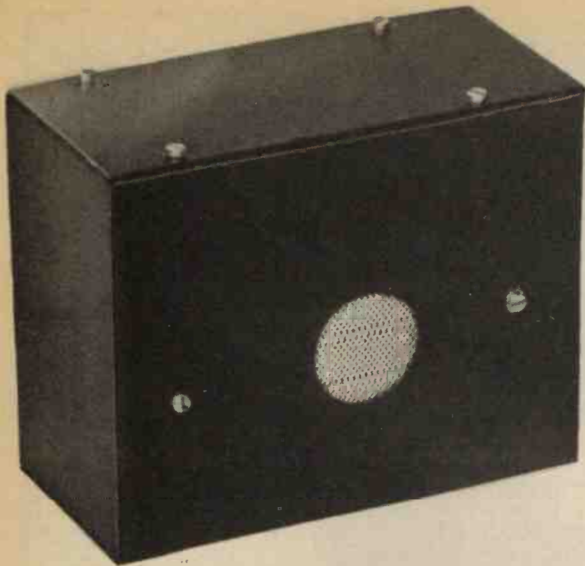
DISPLAYS

As it stands the unit is suitable for lamps of up to 150W per channel, which is about the most useful for a small private party. The circuit can be used without other modification for 3A s.c.r.s giving a power handling of about 500W per channel which is suitable for a larger party or small disco.

In use, the unit is connected across the speaker output of the amplifier used, and adjusted to give a pleasing display with the music at the desired level. The bulbs used can be small 15–60W bulbs for a very rapid, "flashy" effect, or larger 100 or 150W coloured spot bulbs for a slower effect.

As with the lamp connectors, this is an area where constructors can exercise their ingenuity to build a unit suitable for their own applications. ★





Now that the Government has introduced regulations requiring drivers to use dipped headlights in daytime when visibility is poor, it is very easy to leave lights on accidentally when finishing a journey. The result of this can vary between embarrassment and considerable expense. A simple answer is to fit a warning light on the dashboard in parallel with the sidelights, but this is not usually satisfactory as the light will either dazzle the driver at night or be hardly noticeable during the day.

A better solution is to employ an audible warning system. This cannot, of course, be connected permanently to the car's lighting circuit. Instead, a few logic gates are used to ensure that the warning is sounded only when required. The circuit shown is suitable for negative-earth vehicles: amendments for positive-earth vehicles are given at the end of the article.

PRINCIPLES OF OPERATION

The circuit of this device is shown in Fig. 1. Connections are made to both the lighting and ignition feeds in the car, and the operation of the logic controls an oscillator. The oscillator is normally inhibited, and only starts working when the following sequence of events occurs:

1. Ignition and lighting supplies both on (driving with lights on);
2. Ignition supply is then switched off (driver leaves car with lights on).

The output of the oscillator is amplified and fed to a small loudspeaker.

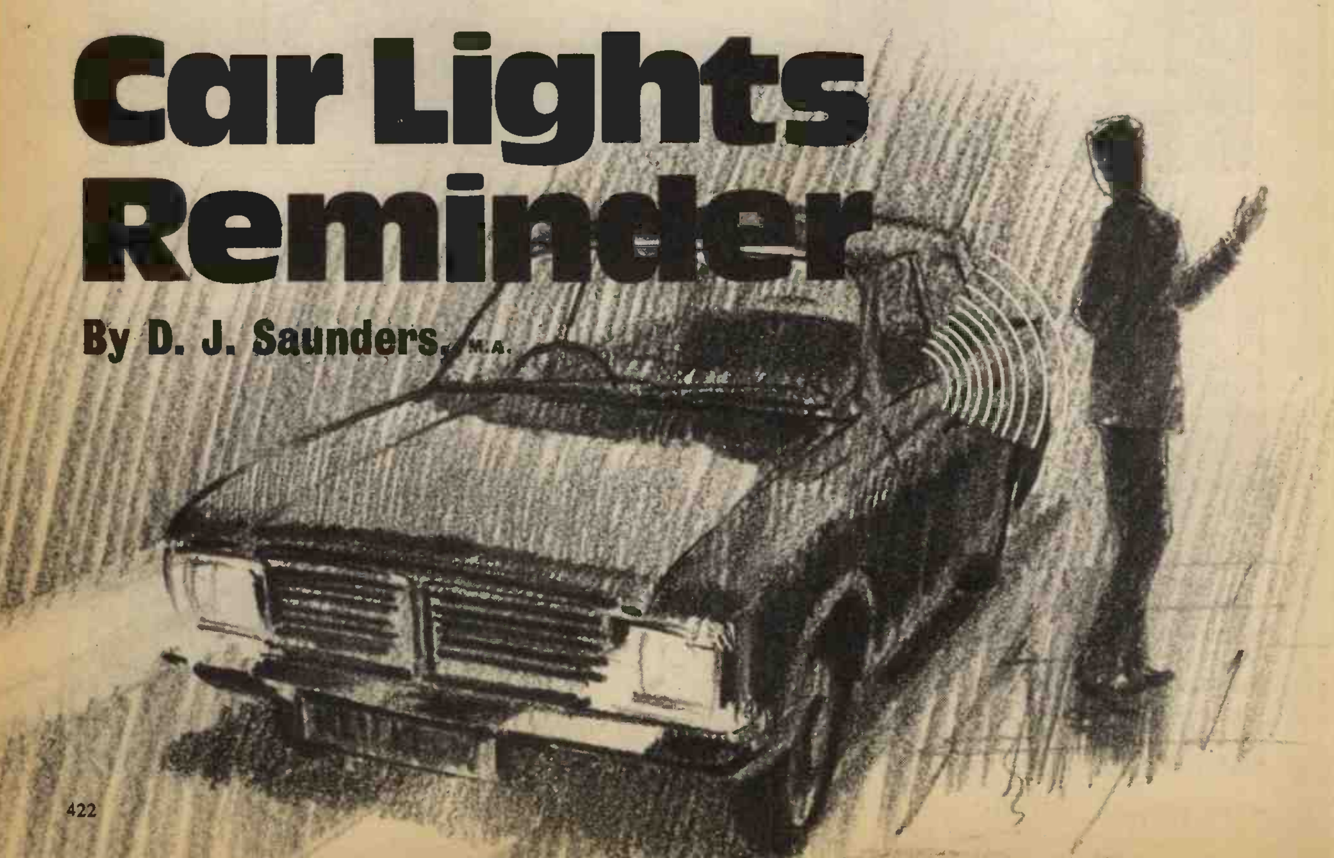
By using this method, a warning is sounded only if the lights are left on after stopping. The warning is cancelled by turning the lights off. Nothing happens if the lights are turned on with the car already parked, so the deliberate use of parking lights will not set off the warning.

CIRCUIT DETAILS

Detailed operation of the circuit is as follows. The ignition and lighting voltages are filtered and stabilised by R1, R4, C2, D4 and R2, R3, C1, D3 respectively. The stabilised outputs are fed to IC1a. This is a NAND gate, so its output is zero only when both ignition and lights are on. IC1b and IC1c are arranged as a flip-flop, which is set by the output of IC1a and reset by a signal from the lighting supply passing through

Car Lights Reminder

By D. J. Saunders, M.A.



COMPONENTS . . .

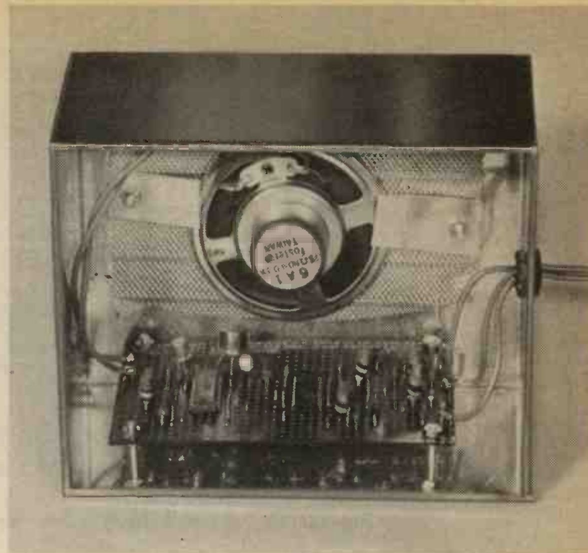
Resistors
R1, R2, R7 — 1kΩ
R3, R4 — 47kΩ
R5, R6 — 1MΩ
All 10% ¼W

Capacitors
C1, C2, C4–C6 — 0·01μF polyester (5 off)
C3 — 4·7μF 15V tantalum

Semiconductors
IC1 — CD4011AE
IC2 — CD4001AE
TR1 — BC108*
TR2 — BFY51*
D1, D2 — 1N4001
D3, D4, D6 — 10V 400mW Zener
D5 — 1N914

Miscellaneous
Loudspeaker, 75Ω miniature
Veroboard 0·1in pitch, 95 × 64mm
Aluminium box, nuts, bolts, etc.

*See text for types required for positive-earth version



Interior view of the prototype Car Lights Reminder

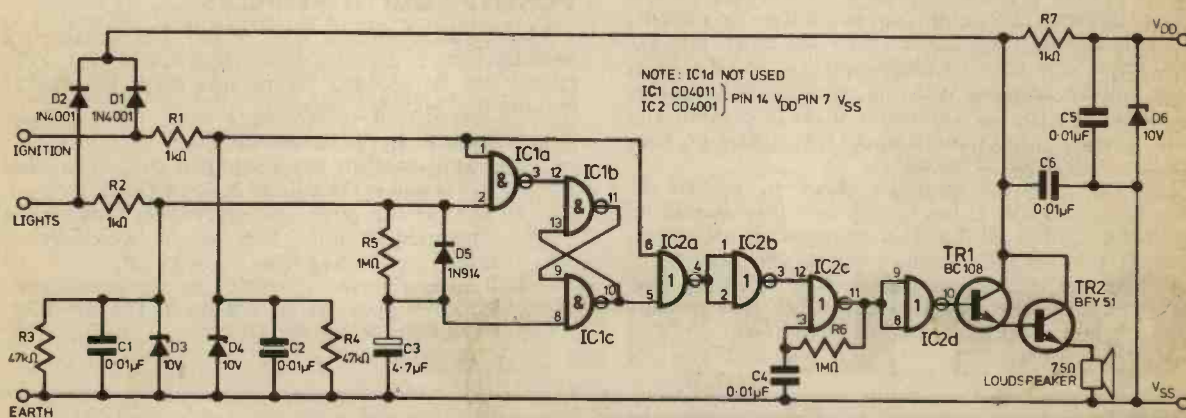


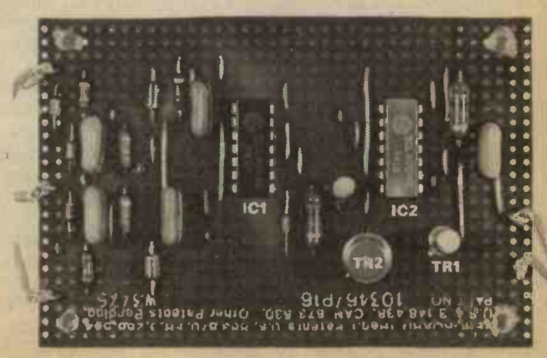
Fig. 1. Circuit diagram of the unit, negative earth version

the filter R5, D5, C3. The flip-flop "remembers" that the ignition and lights were both on together, and gives a zero output when this has occurred.

The output of the flip-flop and a signal from the ignition supply are both taken to IC2a. This is a NOR gate, so it gives a positive output only when both inputs are zero—that is, when the ignition is off and the flip-flop has remembered that both ignition and lights were previously on together.

The output of IC2a is inverted by IC2b and fed to IC2c, which is connected as a simple gated oscillator. The values shown for C4 and R6 produce a suitably unpleasant noise for the warning signal. Finally IC2d isolates the oscillator from the two transistors TR1 and TR2, which are connected as a Darlington pair for high current gain. The 75Ω miniature loudspeaker is connected in the emitter circuit of TR2.

Power for the device is obtained from whichever of the ignition or lighting circuits is on, by means of the two diodes D1 and D2. The supply is taken directly to the two transistors, but is stabilised before being used to power the integrated circuits.



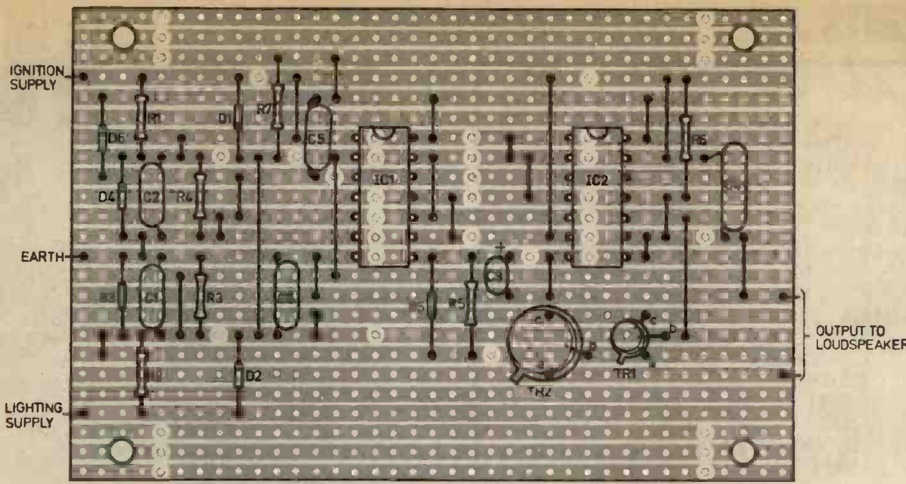


Fig. 2. Component layout on Veroboard, negative earth version

CONSTRUCTION

The unit may be built on a 95 × 64mm piece of 0·1in matrix Veroboard. The layout is not critical, and one possibility is shown in Fig. 2. A warning may be needed, however, concerning the two integrated circuits. These are CMOS types rather than the more familiar 7400 series, and they are electrically somewhat fragile. They will be supplied with the pins shorted together by aluminium foil or conductive foam to prevent any static charge from building up. They should be kept like this until required for use.

The i.c.s may be mounted either in sockets or directly on the board, but in any case they should be inserted last, after all the other components and wires. Insert IC1 before IC2. Avoid touching the pins, and if the integrated circuits are being soldered, ensure that the soldering iron is well earthed. If all these precautions are taken, there shouldn't be any trouble.

The completed board and the loudspeaker may be mounted in a small aluminium box and fixed at some convenient position inside the car.

POSITIVE-EARTH VEHICLES

The circuit shown in Figs. 1 and 2 is suitable for vehicles with a negative-earth electrical system. The circuit can be adapted for positive-earth vehicles by making the following changes:

1. Reverse all the diodes and C3.
2. Interchange the two integrated circuits (so that IC1 is now CD4001 and IC2 is CD4011).
3. Reverse the power supply connections to the integrated circuits. This can be accomplished simply by rotating them through 180°.
4. Replace the two transistors by *pnp* equivalents. Possible types are BC478 or BC158 for TR1, BC461 or 2N3134 for TR2. ★

NEWS BRIEFS

Bionic Voice

When Mr Charles Lacey of Berinsfield, Oxford, began to relate his invention to a member of PE, nothing at first seemed very remarkable, until it was revealed that Mr Lacey has no larynx, and was using his invention there and then—an electronic voice!

For those, who after surgery, are told they can never speak again, here lies hope. For with Mr Lacey's bionic voice, audible oscillations are introduced orally by a circuit small enough to fit to the upper dental plate, whereupon the natural speaking action of the mouth modulates the sound into recognisable speech, even retaining most of the former accent.

Isolation inflicted on the voiceless has been tackled before, with gadgets producing a weak "Dalek" type speech, which on demonstration seem comparatively primitive. But with Mr Lacey's invention, an acoustically controlled feedback system produces floating frequency and amplitude, giving rise to artificial intonation and automatic suppression when the mouth closes. However, with this and other of his aids for the handicapped, there are still obstacles to be overcome. The pioneering spirit of this self-taught electronics designer has so far been well supported and encouraged.

"Ideally", says Mr Lacey, "I should like to set up a viable but non-profit making workshop, producing aids to order. But for this I would need a sponsor." It would almost certainly be the first of its kind in the country!

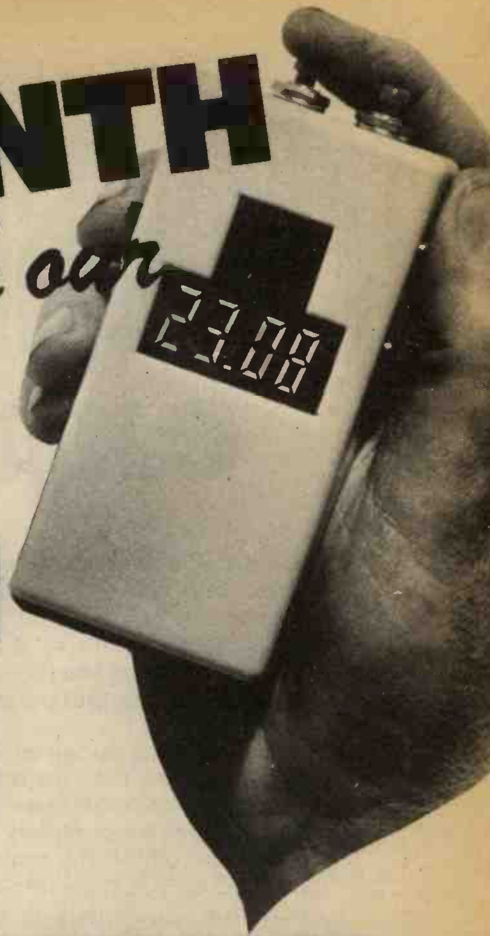
His latest target is to raise £60 for a VDU in order to provide one of his Portable Keyboard Writers for a Speech Therapy patient at the Charing Cross Hospital.

Let us hope that Mr Lacey can find the backing, to reach those whom his inventions would undoubtedly benefit.

New Secretary for IERE

Mr Graham D. Clifford, C.M.G., C.Eng., F.I.E.R.E., F.C.I.S., retired as the secretary of the Institution of Electronic and Radio Engineers on March 31st, 1977. The Council has appointed Air Vice-Marshal Sinclair M. Davidson, C.B.E., C.Eng., F.I.E.R.E., F.R.Ae.S., RAF, as secretary. Mr Clifford will continue as the Director of the Institution with special responsibilities for a further year.

Make NEXT MONTH EVENT*ful with our*



DIGITAL STOPWATCH

This high accuracy digital stopwatch is based on the Intersil ICM 7205 chip, giving normal start-stop-reset operation, plus Taylor mode lap timing and cumulative timing. Clocking up to one hour is possible on the large six digit display. Other features include automatic reset at switch-on and a rechargeable power source with advanced warning (about 15 minutes) of low battery condition.

Also...

EARTH LEAKAGE CIRCUIT BREAKER

The effects of electric shocks can kill, either directly or indirectly. In many cases these are caused by faulty insulation or earthing so that dangerous leakage currents pass with skin contact. The only safe way to operate mains equipment is to monitor these fault currents and this is what this unit does simply and reliably.

TWIN TRACE DOUBLER

Four trace display for a double beam 'scope

PRACTICAL
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OUR JULY ISSUE WILL BE ON SALE FRIDAY, JUNE 10, 1977

Part 4 — PERIPHERAL CHIPS: MEMORIES

MICROPROCESSORS explained

By R. W. Coles

Up to now in this series we have concentrated our attention on the microprocessor chip itself, learning how it works, and what it can be instructed to do. There can be no doubt that the MPU chip is the Prima Donna of any system, but it's not much use at all on its own, and has to be supported by a variety of peripheral chips like the all important program and data memories, and of course the input and output ports which provide communication channels to the outside world.

Using the analogy of Part 2, a microprocessor system which consists of nothing more than an MPU chip is like a building site foreman complete with calculator and notebook, but without any building plans or any workforce, and consequently completely useless!

It is becoming the trend to incorporate as many of the necessary peripheral circuits as possible into the MPU package, but this is not a trend which can continue indefinitely if microprocessors are to retain their general-purpose nature, since it would eventually reduce user options regarding optimum memory size and number of input/output lines. However, in the special case of microprocessors used in large quantities for consumer applications, like the Texas TMS1000, the one chip MPU based system is already a reality. *Our* main concern is the use of the microprocessor as a general purpose problem solving tool, and so our interest in the one chip "Shoe-horn" jobs is necessarily limited.

An ideal system as far as we are concerned would use a capable MPU chip with external provision for data and program storage which can be expanded as necessary. Communication requirements vary from application to application, and so we would like to either have versatile parallel input-output devices available, or be able to put these together as required, from general purpose logic such as the TTL or CMOS families.

This month we shall be looking at the range of memories available for our use, and how these devices are used in practice.

To the uninitiated, the range of memory devices available must seem a little confusing, or perhaps to those with a well developed sense of the ridiculous, quite hilarious! Without great effort one can recall RAMS, ROMS, PROMS, EAROMS and EPROMS, but there *are* more, and you can quite enjoy yourself building up a list of your own. When you have gone as far as you can, try listing the semiconductor technologies involved as well; you can put down NMOS, PMOS, CMOS, FAMOS, AIM, and Fusable-Link to get started, but you'll find plenty more.

If this memory game is not your cup of tea, and you want to ignore everything which does not get you further along the road to switching on your very own microprocessor system, then don't despair because what you *need* to know is really quite simple.

READ/WRITE MEMORY

Easy storage and retrieval of data in a microprocessor system is of vital importance, and the read and write operations must take place at high speed if the speed of the microprocessor chip is to be utilised properly.

In the recent past all computer stores which were designed for rapid access used a matrix of ferrite rings, or cores, which could be magnetised in one of two directions to indicate whether a logic 1 or logic 0 was stored. These stores could be accessed in microseconds and had the advantage of random access to the data stored, and non-volatility when power was removed. Their disadvantages included high cost, large size, and the fact that data was destroyed when read out, so that a write-after-read cycle was necessary.

Stores of this type are called "core-stores", and this title is still sometimes applied to any memory system which provides a random access read and write storage facility, even that used in microprocessor systems.

Recently the true core stores have been replaced in computer designs by semiconductor memory chips called RAMS for Random Access Memory, and it was the ready availability of this high speed, low cost memory technology which helped to make the microprocessor a practical proposition. Semiconductor RAMS work on a totally different principle to the magnetic core stores because they use a matrix of transistor storage elements fabricated on an LSI chip using the same range of bipolar or MOS technologies as other semiconductor logic. This makes them easy to use, easy to drive, and very compact.

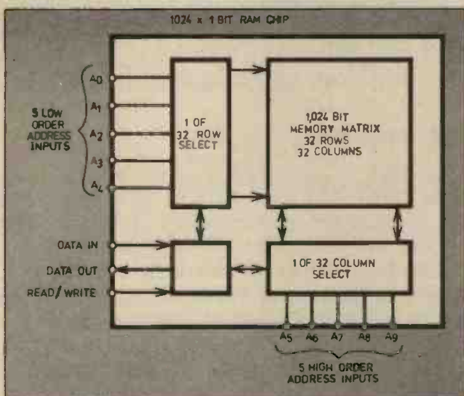


Fig. 4.1. Basic RAM organisation

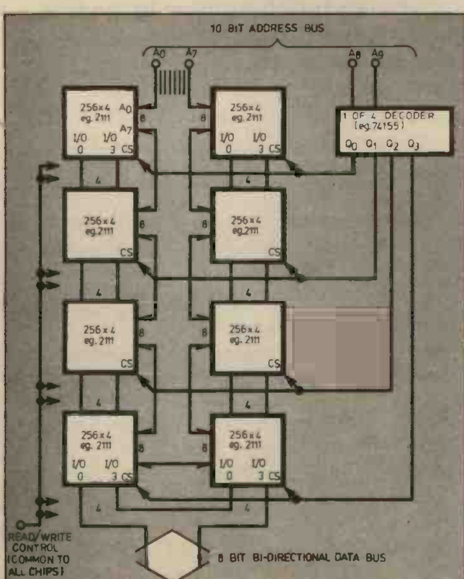


Fig. 4.2. Using the "Chip Select" inputs to build large memory arrays. This is a 1024 × 8 bit memory with Intel 2111 256 × 4 static RAMS

All microprocessor systems use read/write semiconductor RAM memory of one sort or another for data storage during calculations and stack operations. In some cases, it is used for program storage as well.

Semiconductor RAMS have the disadvantage that they are volatile, which means that their contents are destroyed when power is removed even if it only disappears briefly. This fact makes them unattractive for storing programs for dedicated systems, but in development systems, where programs are loaded and modified on a casual basis, they are used extensively for both data and program storage.

STATIC OR DYNAMIC?

Semiconductor RAMS can either be "static" or "dynamic" in operation and it is important to appreciate the trade-offs involved in choosing one or the other. Static RAMS use storage elements based on a conventional bistable flip-flop which can be set or reset by write operations, and which of course will *stay* set or reset until a new write operation takes place.

Information stored in a static RAM will remain inviolate providing power is applied, and the stored data does not have to be read or overwritten at any minimum rate to retain its integrity. Dynamic RAMS, on the other hand, do not use bistable flip-flops to store the data but rely on the storage of charge on the gate capacitor of an MOS transistor for their operation. The stored charge leaks away fairly quickly and this makes it necessary for the data to be "refreshed" at a regular rate to retain data integrity. This may sound a bit of a burden for the microprocessor system to bear, especially when one recalls that data must be refreshed about every 2 *milliseconds*, but you have to remember that many microprocessors can carry out several hundred program steps in that time and the use of dynamic RAMS does bring some useful advantages.

Because the storage element in a dynamic RAM consists of little more than a single MOSFET, larger numbers of these elements can be squeezed onto a given area of silicon, and power consumption is reduced into the bargain. Refreshing of the memory can be controlled by the microprocessor itself, or it can be carried out by external hardware which requires a few extra components but which makes the operation transparent to the programmer.

As far as amateur systems are concerned, for memory sizes up to 4K (4,096) words it is definitely better to use static RAMS, but beyond this size the cost-per-bit advantages of the dynamic types become increasingly attractive. At present, manufacturers are working on some giant dynamic RAMS with no less than 16K (16,384) bits in a 16-pin package!

RAM ORGANISATION

The typical RAM chip (static or dynamic) consists of a large array of storage elements, each of which will store a single binary bit. The chip can be "bit" or "word" organised, so that arrays of say 1,024 elements can be arranged as 1,024 separately addressable bits, or as 256 separately addressable words each of *four* bits.

The addressing of a particular bit or word inside the chip is achieved by the selection of a row and column line which intersect at the desired location(s) in the matrix. Since a 1K × 1 bit chip might have 32 rows and 32 columns in its matrix, some decoding of the necessary ten-bit binary address code is required to produce the row and column select signals, and this is supplied "on-chip" in all currently manufactured RAM devices. See Fig. 4.1. Addressing a location causes the current state of its bit(s) to become available on the "data out" line(s). Overwriting the stored data can be achieved by setting up new data on the "data-in" lines and taking the "read/write" control line to the write state momentarily.

Memory arrays of any size can be constructed by using more than one chip. An eight-bit MPU requires an eight-bit word organised store, and this could be built by using eight 1K × 1 bit chips in parallel (1K word store) or by using two 256 × 4 bit chips in parallel (256 word store). If a larger store is required you can either use chips with a greater capacity (up to 4K × 1 bit at present) or you can take advantage of the "chip select" inputs, which can be found on most RAM chips, to build stores of unlimited size. The "chip select" input must be present before any read or write operation can take place, and by using an external address decoder to drive these inputs it is possible to extend the address range to any number of bits. See Fig. 4·2.

RAM TIPS

Random access memories of a certain size can be obtained with various "access times" of between about 50 nanoseconds and 1 microsecond. When choosing a RAM for a particular MPU system make sure you choose one fast enough, but *don't* overdo it, speed is expensive in both cash terms and in power dissipation!

CMOS RAMS are now available in sizes up to 1K bit. These devices are quite fast and have the overwhelming attraction of extremely low current drain during standby. Using CMOS static RAMS you can build non-volatile memories which will retain data for months with the aid of a small battery supply which takes over when the main supply is removed, an extremely useful facility in some situations. The only problem is that CMOS devices cost about four times as much as NMOS devices of the same size.

READ ONLY MEMORY

Read only memory is much cheaper than read/write memory on a cost per bit basis, and has the overwhelming advantage of complete non-volatility in normal usage. Information can be stored in a ROM chip either during manufacture, or, in the special case of PROM devices, at some time after manufacture with the aid of special programming equipment.

Read only memory is ideal for the storage of programs in a microprocessor system, and for those systems performing *dedicated* tasks it is by far the dominant form of memory used. A dedicated system might have many thousands of words of ROM store, and probably less than 1K word of RAM used as a "Scratch-pad" or "Jotter". Even MPU development systems and general purpose MPU based computers which use a lot of RAM memory need fixed ROM programs to enable them to do basic "house-keeping" jobs as soon as power is applied. Consider the National Semiconductor SC/MP Introkit for example: it uses a 512 word ROM store for the KITBUG program which enables the user to load *his* program into the 256 word RAM and subsequently execute and debug it.

INSIDE THE ROM

To the microprocessor, a ROM memory looks pretty much the same as a RAM memory. The MPU sends the ROM an address and gets back the data stored at that address via the data bus. The ROM usually shares the same address space as system RAM and so, if a programmer gets his knickers in a twist, the MPU *can* try to write into ROM locations by mistake. Since the ROM does not have inputs connected to the data bus and, of course, does not have a read/write control input, this would be a rather fruitless exercise which would fortunately not harm the ROM data already resident!

Internally, the ROM has an address decoder and a storage matrix rather like that of a RAM but in this case the matrix does not need bistables or dynamic storage elements and can make do with a simple "diode matrix" type of element where a connection is either present for a logic 1 or logic 0 stored.

Glossary of Terms

AIM—Avalanche Induced Migration. A PROM technology which relies on the *making* of links during the programming process, rather than the *blowing* of links which is perhaps a more common procedure.

EAROM—Electrically Alterable Read Only Memory. This is a PROM technology which uses MNOS (Metal Nitride Oxide Silicon) to form a memory which can be electrically erased and rewritten. This technology is in competition with ultra violet erasable EPROM devices, but is more expensive and apparently less popular.

EPROM—Erasable and re-Programmable Read Only Memory. A general name which is usually used to refer specifically to ultra violet light erasable PROMS, like the popular 1702A which uses the FAMOS technology.

FAMOS—Floating gate Avalanche Metal Oxide Semiconductor. The ultra violet erasable PROM technology which is programmed by means of charge stored on the isolated poly silicon gate electrode of an MOS transistor via an avalanching junction. Erasure is achieved by neutralizing the charge with one of an opposite polarity produced by irradiation with ultra violet light.

PROM PROGRAMMER—A hardware facility for storing data or programs into PROM memory. The programming operation can involve "blowing" fuses, "making" links, or avalanching junctions with voltage or current pulses—the characteristics of which are specific to a particular device or family. Universal programmers are available which require the connection of a "personality" module to set up the system for a particular device type.

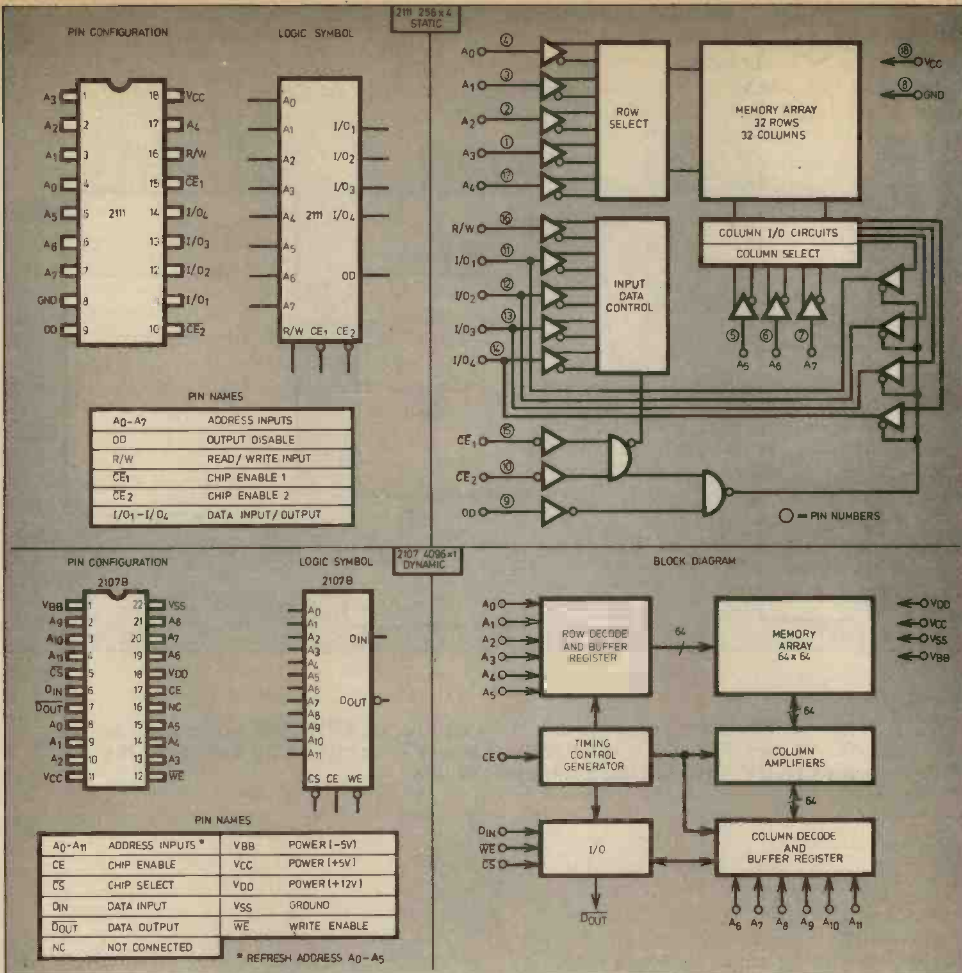


Fig. 4.3 Two useful NMOS RAMS suitable for MPU Systems. The 2111 is a 256 × 4 static device with common data in/out data lines controlled by the O.D. (Output Disable) Pin. The 2107 is a 4096 × 1 dynamic device with four times the capacity of the 2111

ROM TYPES

There are probably more variations on the read only memory theme than there are on the read/write memory theme, and this makes a basically simple device more difficult to get to grips with than should really be the case. For the purposes of this series we have chosen to look at ROMS from a less academic and more practical point of view, i.e. "What ROM types do we need to be familiar with to get our MPU systems operational?" To answer this question we need to consider just three types, the mask programmed ROM, the programmable ROM, or PROM, and the ERASEABLE AND RE-PROGRAMMABLE ROM or EPROM.

MASKED ROM

Mask programmed ROMS have their contents fixed by the final metallisation layer which is laid down on the semiconductor chip during the manufacturing process. This process yields the cheapest program store available, but *only* if several thousand ROMS with the *same* contents are ordered together so that the high mask charge can be recovered. This may not sound of much use to *us*, but remember that development systems and prototyping cards often come with a set of system software, and masked ROM is sometimes used to house it.

PROM

Programmable ROMS have the great advantage that people like us can use them to store our programs *even* if our programs are only one-off. To program a PROM a PROGRAMMER is required, and you can pay over £1,000 for a really good one. Fortunately, there are a number of circuits around for simple programming that require little more than a few TTL monostables, some voltage regulator chips, and a row or two of toggle switches. Programming a PROM using a simple manual programmer of this sort is certainly a bit tedious for the larger PROMS, because data has to be entered in binary

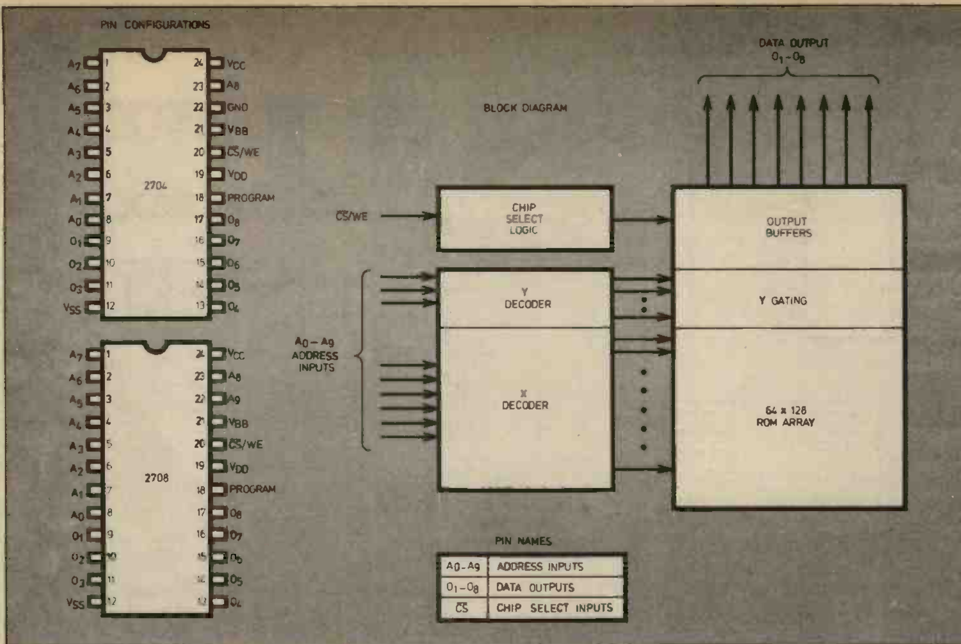


Fig. 4.4 The 2704 and 2708 are state of the art EPROMS organised as 512 × 8 and 1024 × 8 respectively. Erasure is achieved by exposing the chips to UV light via their transparent lids

form, but the tedium can be eased to some extent by thinking about all the money you are saving!

The PROM principle is implemented in a variety of different ways by different manufacturers, and each of them produce devices which require different programming voltages and currents so that it is not possible to build a low cost universal programmer. This means that you have to choose a PROM family and stick with it, even though, for our purposes, which family you choose is immaterial.

Most PROMS are fusible link devices which consist of arrays of nichrome or poly-crystalline silicon fuses which are "blown" during the programming operation. An alternative technique called AIM (Avalanche Induced Migration) relies on *making* links rather than breaking them.

Whatever type of PROM you use, there *is* one major drawback, and that of course is that *you have to get it right first time* unless you don't mind throwing away expensive PROMS and starting again!

EPROM

Everyone makes mistakes when writing programs, and during development work there is a need for a PROM which can be erased and reprogrammed over and over again. If that sounds like a RAM description to you, remember that *this* device must behave in circuit just like a mask programmed ROM except that at the end of the day it can be unplugged, erased, and reprogrammed. A range of devices which provide this useful facility are available, and of all the ROM family, it is these which are of must use to the small microprocessor user.

The EPROMS we refer to are programmed with the aid of a PROGRAMMER which causes charge from an avalanching junction to be stored on the electrically isolated gate of a MOSFET device. Thanks to the high order of insulation provided for the floating gate electrode, the stored charge would take hundreds of years to leak away naturally but erasure is easily achieved by neutralising the stored charge with one of an opposite sign produced by irradiation with ultraviolet light. The chip is mounted in a standard 24-pin d.i.l. package with a glass window to permit erasure to be achieved. The ultra-violet light used has to be of short wavelength (2,537 Angstroms) which can be harmful to us humans, although simple and safe erasure boxes are easy to build. The EPROM chips are insensitive to daylight and any other type of light to which they might naturally be exposed during normal use, but erasure takes only about 15 minutes when light of the correct wavelength and intensity is used.

These devices are a bit more expensive than standard PROMS but they are very cost effective for most applications because of their reusability.

Three sizes are available, the 1702A 256 × 8 which was the first practical version on the market, the 2704 512 × 8 and the 2708 1K × 8 which are more recent and use an improved technology. See Fig. 4.4.

NEXT MONTH: Input/Output devices and Interrupts.

Unique full-function 8-digit wrist calculator... available only as a kit.

A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes – take your jacket off, and you're lost!

But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

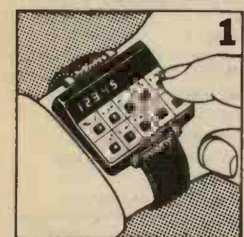
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable £9.95 (plus 8% VAT, P&P). And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, $1/x$, x^2; plus a full *5-function memory.*

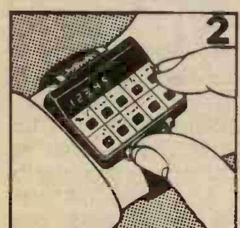
All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.

1



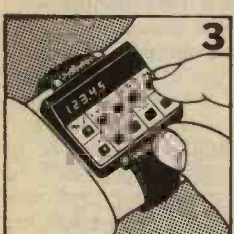
1. The switch in its normal, central position. With the switch centred, numbers – which make up the vast majority of key-strokes – are tapped in the normal way

2



2. Hold the switch to the left to use the functions to the left above the keys...

3



3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Dimensions:
1¹³⁄₁₆" (46 mm) wide,
1⁷⁄₁₆" (37 mm) deep.
Weight:
less than 1 oz (28 g).

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free:* we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Contents
Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and is accompanied by full instructions. The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10-day money-back undertaking.

Send the coupon today.

KIT ONLY £9.95 PLUS VAT, P&P

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* Please send me . . . (qty) Sinclair Instrument wrist-calculator kits at £9.95 plus 80p VAT plus 25p P&P (Total £11).

* I enclose cheque/PO/money order for £....................

* Complete as applicable.

Name ____________________

Address ____________________

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(Please print)
I understand that you will refund my money in full if I return the kit undamaged within 10 days of receipt. PE/6

BY FRANK W. HYDE

SHUTTLE TRIALS

It is fifteen years since John Glenn circled the Earth in an epic four and a half hour mission. A milestone in American history made possible by the insistence of a young American President. In that period of half a generation the advance of science and technology has exceeded all expectations.

The advent of the Shuttle is also a landmark in the progress of technology, for the concept of the re-usable vehicle is a radical departure from the expendable units and a final capsule return to Earth. The shuttle which after much testing for the validity of its aerodynamic design has successfully been through five unmanned test runs.

Space matters have moved at such a pace that even this new concept has its full recognition only among those with a special interest in the future. Just as the successive missions in space became commonplace news, often with but a passing reference by the media.

As has often happened in this sphere of activity time schedules have been improved so that the first vehicle *Orbiter 101* was available for tests in February. By March five test flights had proved that the Boeing 747–*OV101* ferry combination was successful. The drop tests were unmanned in this instance. *Orbiter 101* was rather different from the *OV 102* and the succeeding vehicles.

Since the tests did not require all the facilities of the final units the aerodynamics were settled in what could be described as a mock-up. One modification became necessary in the form of an airscoop above the crew cabin in order to supply air if the life support systems fail. Already a tail cone had been added to reduce the buffetting of the tail section of the Boeing 747.

The *OV 102* tests will be with the final equipment and six manned flights due to be started in late May will be operative but no drops will be made. The first of the drop tests will begin in July.

The vehicle is 11m long, 6·7m high and 7·7m wide. There are three rocket engines in the tail section, two manoeuvring engines and forty-four attitude thrusters. The body will have heat resisting tiles over part of the surface with carbon/carbon-felt insulation for certain other parts. The final vehicle without crew and payload will be about 2,616kg.

BY JOVE, LIFE!

The possibility of life on Jupiter was presented in a paper by Carl Sagan and E. E. Salpeter. The paper points out quite boldly that the gaseous condition of the atmosphere of Jupiter is similar in structure to that of the Earth.

From the knowledge available about the chemistry of the atmosphere they are suggesting that the colours, especially the red tint, are the result of the activity of living organisms.

The two men believe that there are conditions which produce large floating organisms which could be visible to the cameras of the *Mariner 10* and *11* probes on the flyby mission later in the year. They suggest that an entry probe would be able to detect, with a mass spectrometer, such organisms. While this cannot be done on the mission scheduled for this year it will be possible to do this with the entry mission planned for 1982.

Sagan and Salpeter have compared the ecology of Jupiter's atmosphere. They say that the seas on Earth which have plankton at near surface levels on which the fish can feed is comparable with a condition on Jupiter where they suggest there are *creatures?* which they call floaters, sinkers and hunters. They are seen as gas bags, the hunters being up to many kilometres across. This would be within the limits of resolution of the *Mariner* space probe cameras.

Nothing like this was seen on the previous flypast. It is also salutary to remember that speculations of life on Mars had a somewhat similar direction of thought which, however, was not verified by the landers.

URANUS RINGS

It has been noted that Uranus, the planet which has an exceptional tilted axis, about 98° to the main plane of the Solar system, has rings around the equator. Observations of the occultation of the star SAO 158657 by Uranus, revealed that there were a series of occultations when the star was well clear of the planet itself.

This indicated that there were other obstructions to the light by some other bodies. The length of time that the star disappeared from sight is a measure of the size of the objects. From the observations it would seem that some of the bodies will be at least 100km across. If this is indeed the case then there could have been a satellite at about 20,000 km above the planet's surface.

There is a limit for the distance of a satellite from the centre of its parent which is critical. It is called the Roche limit. In the case of Uranus this limit is around 59,500km. The objects observed were between 44,000 km and 51,000km from the centre of the planet.

This is consistent with a disrupted satellite. However, the size of the parts is exceptionally large. This adds a new dimension to the odd planet that has many peculiarities. It lies almost on its side which means that the satellites move in a vertical direction with respect to the plane of the orbit. Undoubtedly more will be heard about this discovery.

It is not often that three independent groups observe the phenomenon together. The three groups were the observers in Kuiper Airborne Observatory, three astronomers at Perth, Australia, and two in the Indian Institute of Astrophysics.

THE BLACK CLOUD

Fred Hoyle wrote a science fiction story about a cloud that enveloped the Sun and appeared to have intelligence. Now this has become a point in his new excursion with Wickramsinghe into speculation that life exists between the stars.

These two outstanding men have now suggested that interstellar dust grains have accumulated skins of polymer and that evolution may already have begun. They take this idea a stage further and say that it is possible that proteins and even genes and the cells necessary for life on Earth may have formed on this medium. The idea was "sparked off" by the observation of an organic extract from a meteorite.

There is an ultra-violet spectral line which hitherto has not been identified and this new observation coincides with the position required. There is a broad absorption peak at a wavelength of 2,200 Angstroms. The line is about 300 Angstroms wide and is characteristic of such organic compounds. This is their story at the moment. It jumps ahead of all the other speculations now in vogue. They say "that they have a Darwinian type of evolution of a primitive gene as well as a primordial cell in interstellar space".

TV SPORTCENTRE

By A. M. MARSHALL

Mains-powered: no expensive batteries to replace!

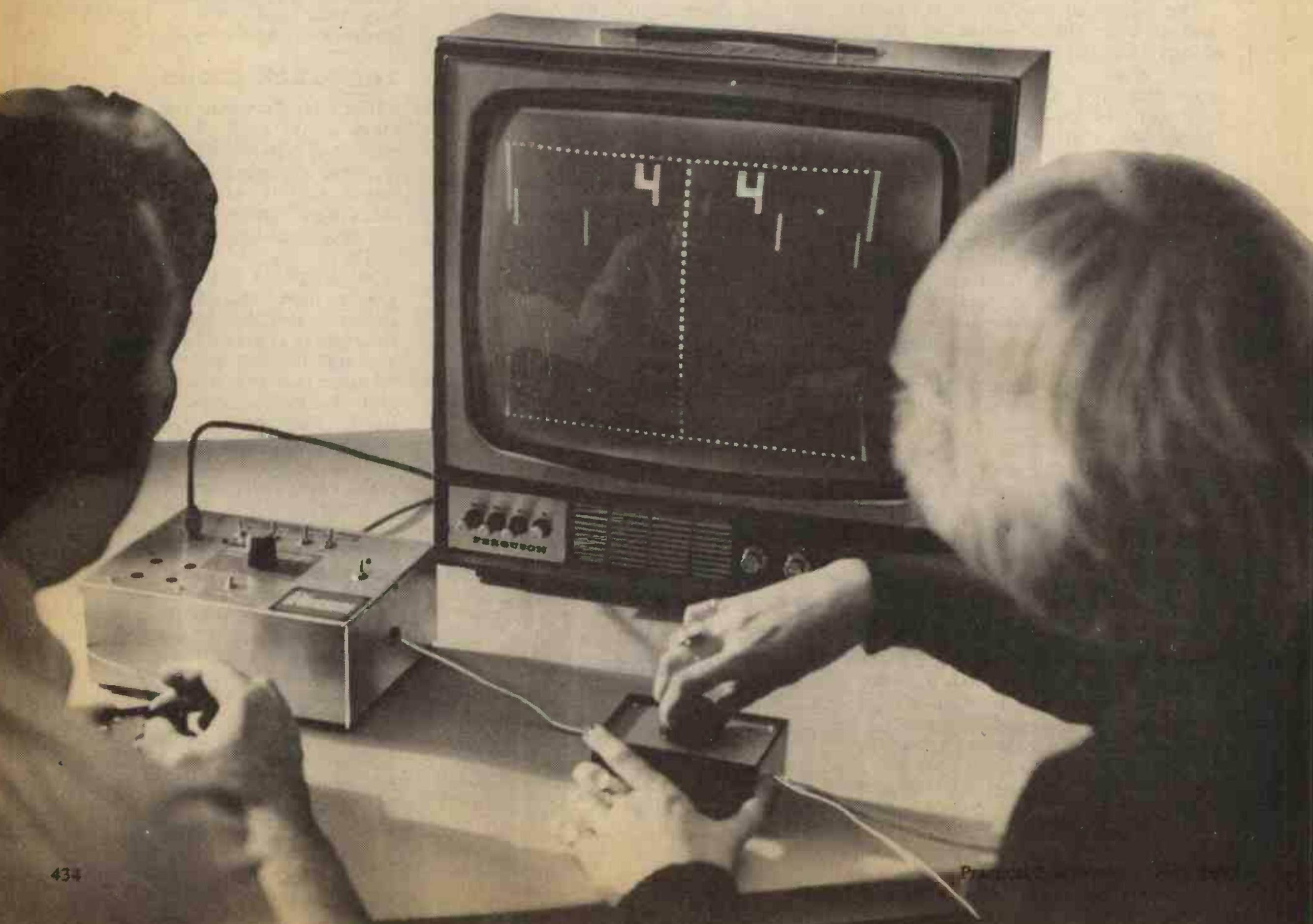
THE TV SPORTCENTRE is based on the AY-3-8500 integrated circuit manufactured by General Instrument Microelectronics. This i.c. provides four basic games, plus two optional extras, with selectable bat size, and selectable ball angles and speed. Automatic scoring and on-screen display of scores are featured, while sound effects add realism to all the games, which are:

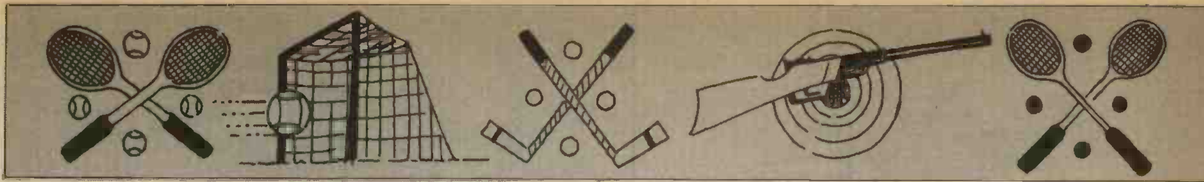
● *Tennis*—The picture on the television screen is as shown in Fig. 1 with a centre net, top and bottom boundaries and one bat per side. The scores for each side are counted up from 0–15 and displayed continuously.

After the RESET button has been pressed, the scores will be 0, 0 and the ball will serve arbitrarily from one side of the centre line at one of the angles. If the ball hits the top or bottom boundary it will be reflected and continue in play. The participant receiving service must move his bat to try to intercept the ball.

When a "hit" is detected by the logic, the ball will rebound at an angle determined solely by which part of the bat made the hit. Each bat is divided into four sections of equal length. When using the four-angle option, four different rebound angles are used, as the name implies. When using the two-angle option, the top and bottom pairs of sections are each summed together and only the two shallower angles are used.

The ball will traverse towards the other bat, reflecting from the top or bottom boundary as necessary. The action will repeat until one or other bat misses the ball, whereupon the logic detects a "score". The appropriate score counter is incremented and the new score displayed on the screen. The ball will then serve automatically from the centre line towards the side which had just missed. This sequence is repeated until one score reaches 15, whereupon the game stops. The ball will continue to bounce around the screen but no further hits or scores can be made. Pressing the RESET button zeroes the score counters and restarts the game.





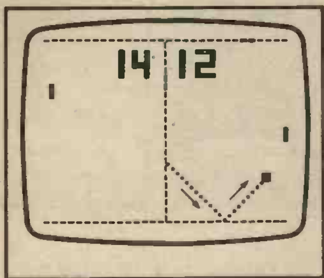


Fig. 1

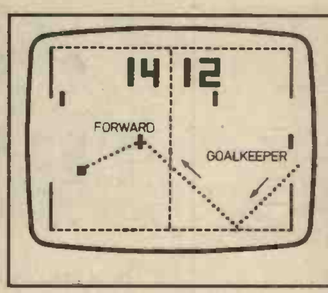


Fig. 2

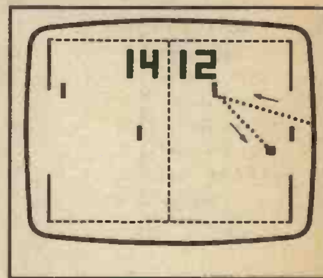


Fig. 3

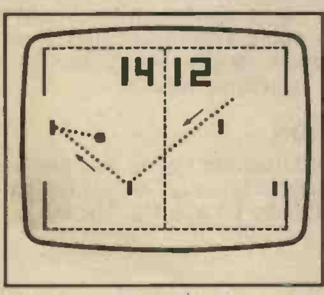


Fig. 4

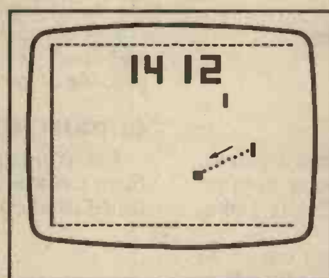


Fig. 5

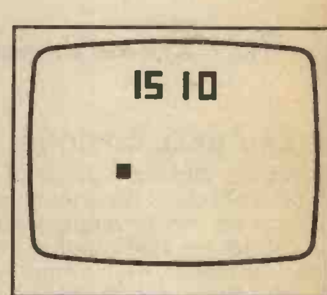


Fig. 6

While the game is in progress, three audio tones are produced to signify top and bottom reflections, bat hits and scores.

● *Soccer/Hockey*—The appearance of the game is shown in Fig. 2, where it will be seen that each participant has two players, a "goalkeeper" and a "forward". The goalkeeper is in his normal position and the forward is in the opponent's half.

When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball he can "shoot" it back towards the goal (Fig. 3). If the ball is missed it will travel to the other half of the field where the first team's forward can try to intercept the ball and redirect it forward at an angle determined by the player section used (Fig. 4). The players are subdivided in the same way as the bats in the tennis game. If the ball is reflected from the end boundary or "saved" by the goalkeeper, the same forward can intercept the outcoming ball and divert it back towards the goal.

A score is registered when the ball passes through one of the goal-mouths. Scoring and game control are similar to those of the tennis game, and the same sound effects are used.

● *Squash*—This game is illustrated in Fig. 5. There are two players who alternately hit the ball into the court. The proper sequence of play is assured by enabling each player alternately, first the right-hand and then the left-hand.

● *Solo/Practice*—This game is similar to squash, except that there is only one player.

● *Rifle Shooting 1*—In this game (Fig. 6) a large target bounces randomly about the screen. A special rifle containing a lens and photocell is aimed at the target.

When the trigger is pulled, the shot counter is incremented. If the rifle is correctly aimed so that light from the target is reaching the photocell at that instant, the hit counter will be incremented and a hit sound generated. The target will then be blanked for a while. After 15 shots the score appears but the game can still continue.

● *Rifle Shooting 2*—This game is similar to the first shooting game except that the target traverses the screen from left to right under control of the manual serve switch.

RIFLE

As mentioned above, a special rifle is required to play the two shooting games. Such a rifle is presently under development, and we plan to publish full details in a future issue.

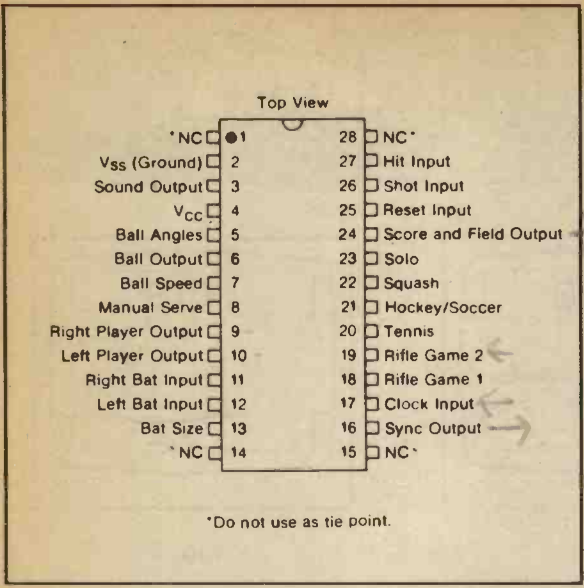
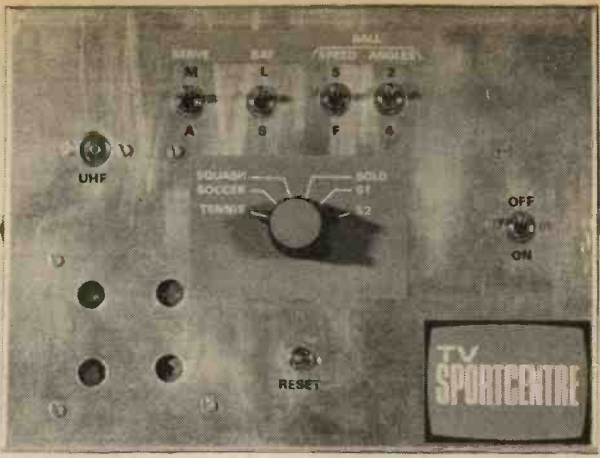


Fig. 7. AY-3-8500 pin configuration



BAT AND BALL OPTIONS

Apart from offering a choice of six different games, the AY-3-8500 chip allows the user to select a number of different options to vary the difficulty of any game. These are (see pin configuration Fig. 7):

● ***Bat Size (pin 13)***—This input is left open circuit to select large bats and connected to 0V by S5 to select small bats. On a 19 in TV screen, large bats are 1·9 in high and small bats are 0·95 in high.

● ***Ball Angles (pin 5)***—This input is left open circuit to select two rebound angles and connected by S2 to 0 V to select four rebound angles. When two angles are selected they are ±20°, when four angles are selected they are ±20° and ±40°.

● ***Ball Speeds (pin 7)***—This pin is left open circuit to select low speed (1·3 seconds for the ball to traverse the screen). When connected by S3 to 0V, high ball speed is selected (0·65 seconds for the ball to traverse the screen).

● ***Manual Serve (pin 8)***—When this pin is left open circuit, the game stops after each score. The next serve is achieved by momentarily connecting the pin to 0V via S4. Leaving this pin connected to 0V gives automatic serving. The most convenient form for S4 is that of a push-to-break momentary switch. Alternatively a push-to-make switch can be connected in parallel with S4.

● ***Sound Output (pin 3)***—Audio signals of three different frequencies appear on this pin. These are 976Hz for a hit, 488Hz for a boundary reflection and 1950Hz for a score.

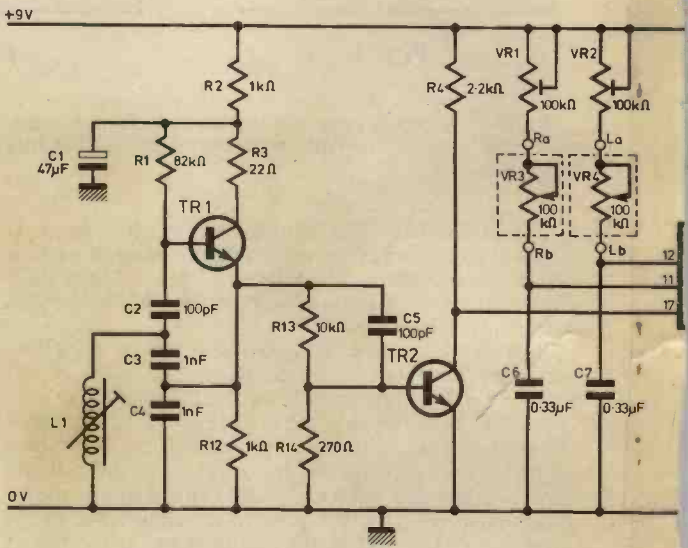
BLOCK DIAGRAM

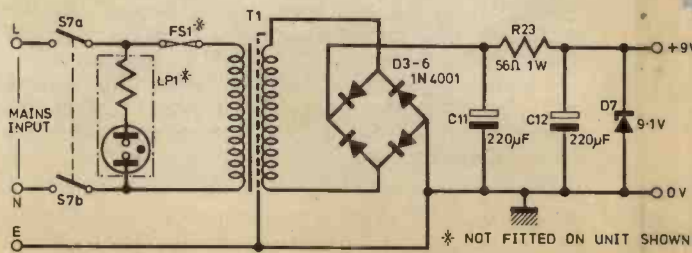
The block diagram Fig. 8 shows the input, output and control requirements of the AY-3-8500 games integrated circuit. The master oscillator provides the clock signal for the i.c., from which its internal dividers produce the line and field sync pulses as well as the horizontal and vertical components of the video signals of the game. These are combined in the video/sync mixer, the output of which modulates a simple u.h.f. oscillator.

The modulated signal is suitable for feeding into the aerial socket of a standard 625-line receiver tuned to around channel 50. A single transistor buffer enables the audio signals from the i.c. to drive a small moving coil loudspeaker. The whole system operates from a stabilised 9V d.c. power supply which should be capable of providing a current of 100mA.

CIRCUIT OPERATION

Referring to the circuit diagram Fig. 9, TR1 and TR2 form the master oscillator. TR1 is a Colpitts oscillator tuned to about 2·097MHz by L1 and C2. The output is





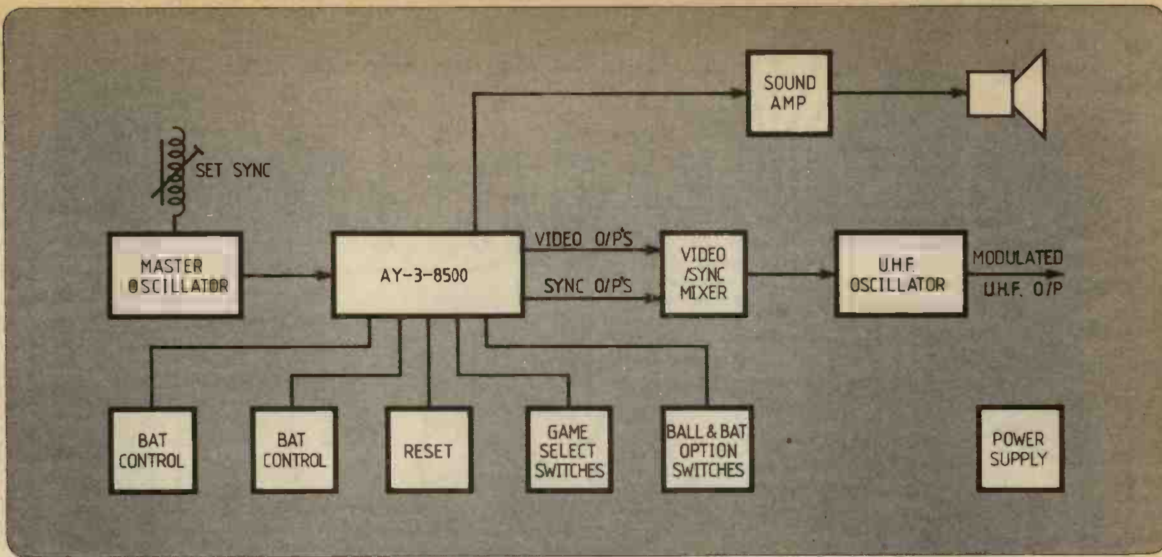


Fig. 8. Sportcentre block diagram

buffered by TR2 and feeds the clock pin of IC1. Variable resistors VR3 and VR4 are player controls for changing the bat positions. It was not found necessary to use screened lead to operate them remotely in the prototype. A 3m length of lightweight twin flex was used for each control. Preset controls VR1 and VR2 are for adjusting the bat displacement to cover the full height of the screen.

Transistor TR3 forms the video/sync mixer. The resistors connected to its base ensure that the video and sync levels are in the correct ratio. The composite video output is applied to the emitter of the u.h.f. oscillator TR5 to modulate it. The stripline inductors L2, L3 and L4 are part of the copper track of the printed circuit board. The frequency of the oscillator is set by C8.

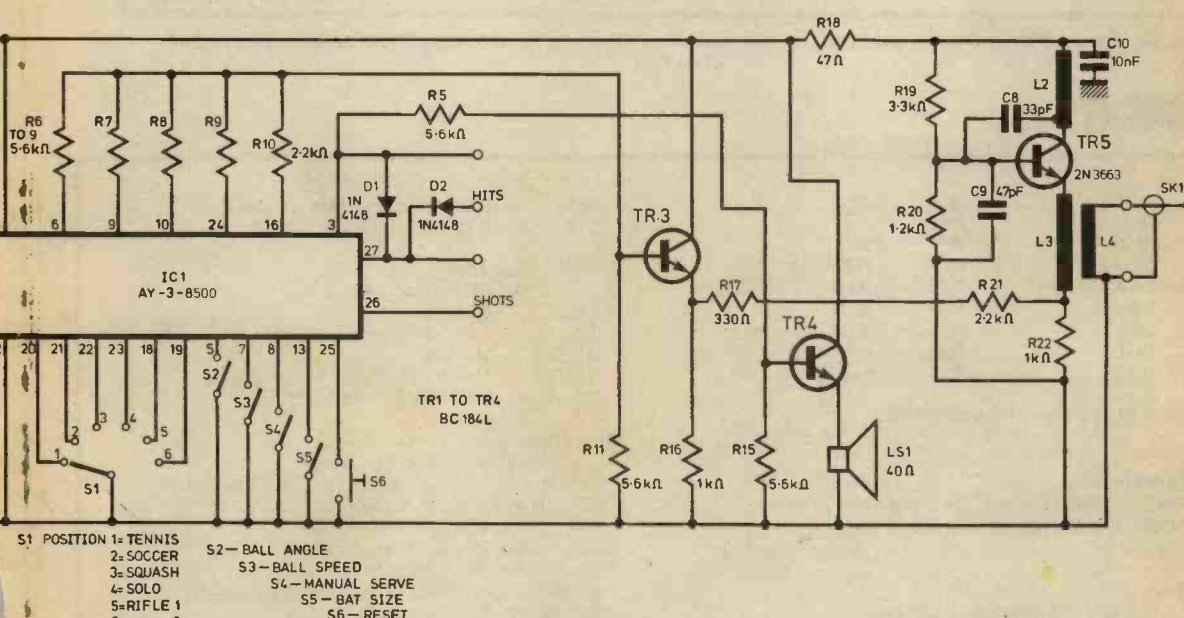


Fig. 9. Circuit diagram of the Sportcentre

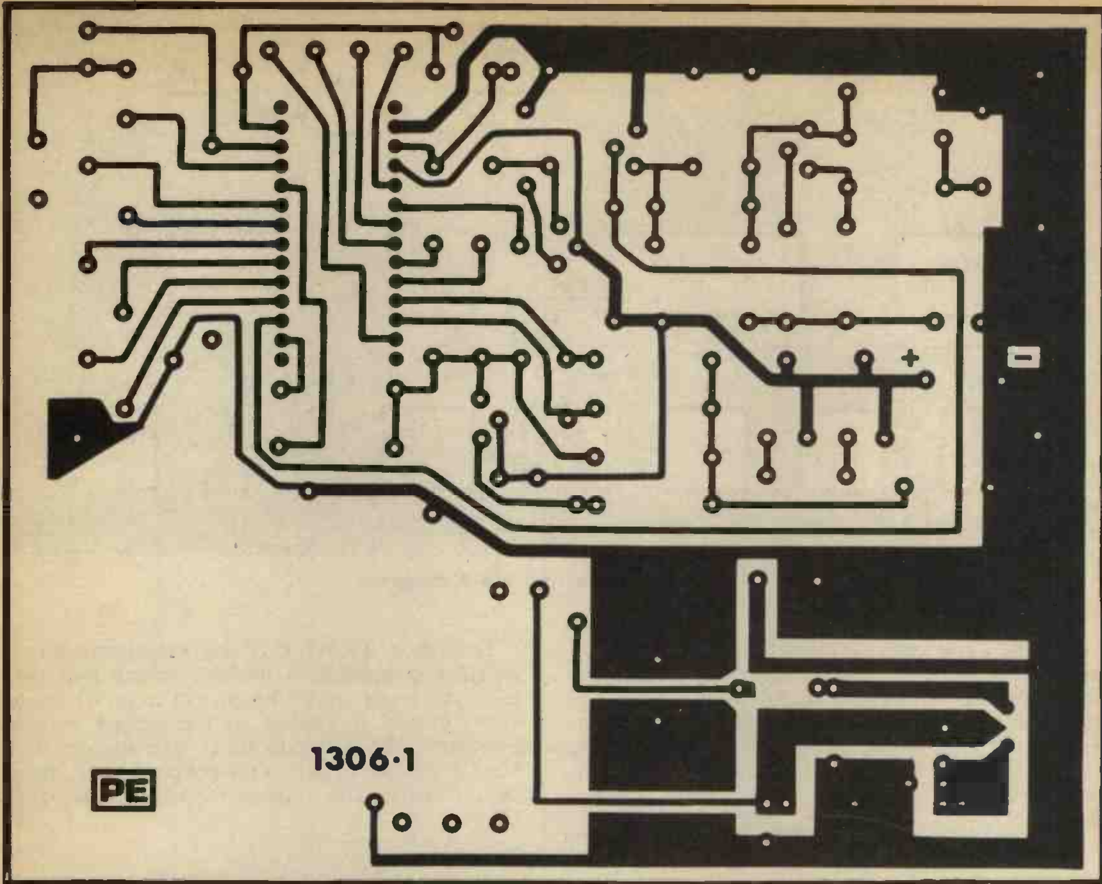


Fig. 10. Printed board track pattern, shown full size. Blank area at bottom left is reserved for rifle circuitry

COMPONENTS . . .

Resistors

R1	82kΩ	R15	5·6kΩ
R2	1kΩ	R16	1kΩ
R3	22Ω	R17	330Ω
R4	2·2kΩ	R18	47Ω
R5–R9	5·6kΩ (5 off)	R19	3·3kΩ
R10	2·2kΩ	R20	1·2kΩ
R11	5·6kΩ	R21	2·2kΩ
R12	1kΩ	R22	1kΩ
R13	10kΩ	R23	56Ω 1W
R14	270Ω		

All ¼ watt 5% carbon film except R23

Potentiometers

VR1, VR2	100kΩ miniature horizontal presets
VR3, VR4	100kΩ linear moulded track

Capacitors

C1	47μF 16V	Tantalum bead type
C2	100pF	Polystyrene
C3	1nF	,,
C4	1nF	,,
C5	100pF	,,
C6	0·33μF	MKM polycarbonate
C7	0·33μF	MKM polycarbonate
C8	33pF	sub-miniature plate ceramic
C9	47pF	sub-miniature plate ceramic
C10	10nF	disc ceramic
C11	220μF 25V	tubular electrolytic
C12	220μF 25V	tubular electrolytic

Semiconductors

TR1–TR4	BC184L (4 off)
TR5	2N3663
IC1	AY-3-8500 (GIM)
D1, D2	1N4148
D3–D6	1N4001 (4 off) or silicon bridge
D7	9·1V 400mW Zener diode

Miscellaneous

LS1 35/40Ω 2·5in loudspeaker
T1 Min. mains transformer, 12V 6VA sec.
LP1 Neon indicator 240V a.c.
FS1 200mA 20mm with holder
S1 1-pole, 6-way rotary switch
S2–S5 S.P.D.T. min. toggle switch (4 off)*
S6 Min. push-to-make push-button switch
S7 D.P.S.T. min. toggle switch
Printed circuit board. Aluminium box 200 ×150 × 75mm.
Plastic moulded boxes 110 × 71 × 50mm (2 off).
Coil former, 6mm diameter, with tuning slug. 36s.w.g. enamelled copper wire. Knobs. Coaxial socket.
Miniature group board.
*See text regarding S4

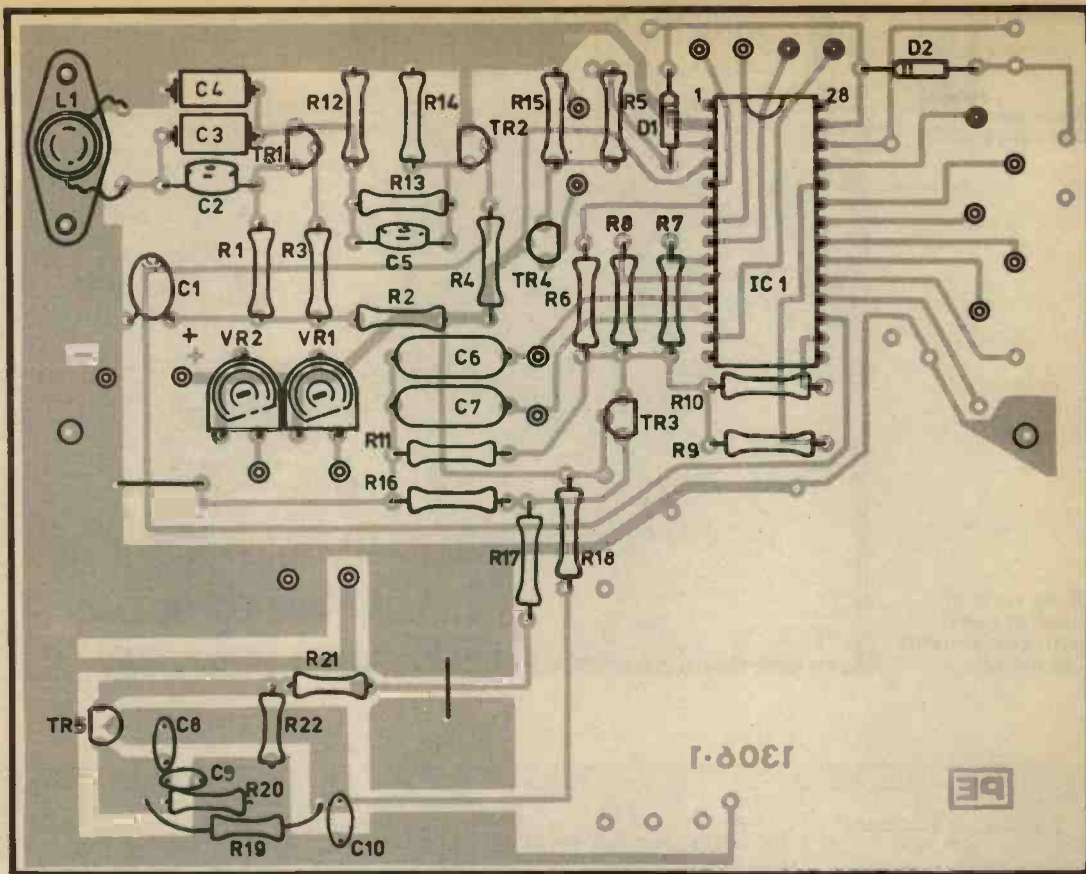
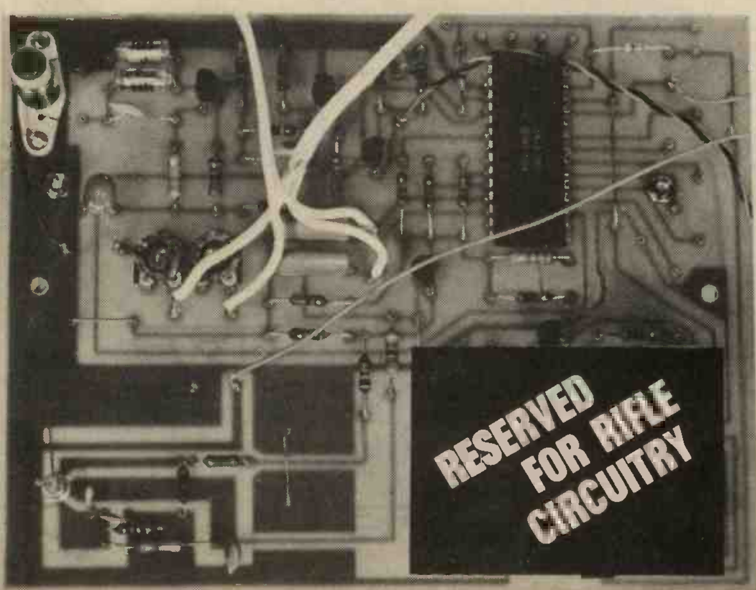
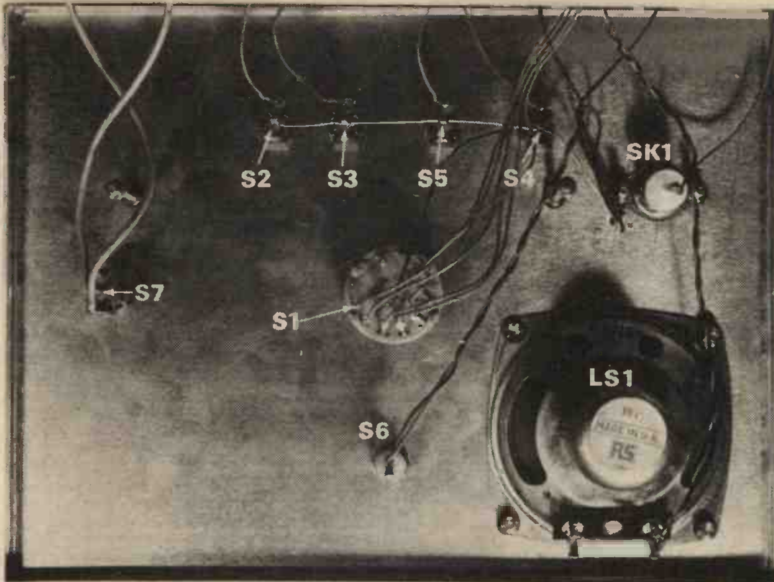


Fig. 11. Printed board component layout



Prototype printed circuit board



Rear view of control panel with components identified

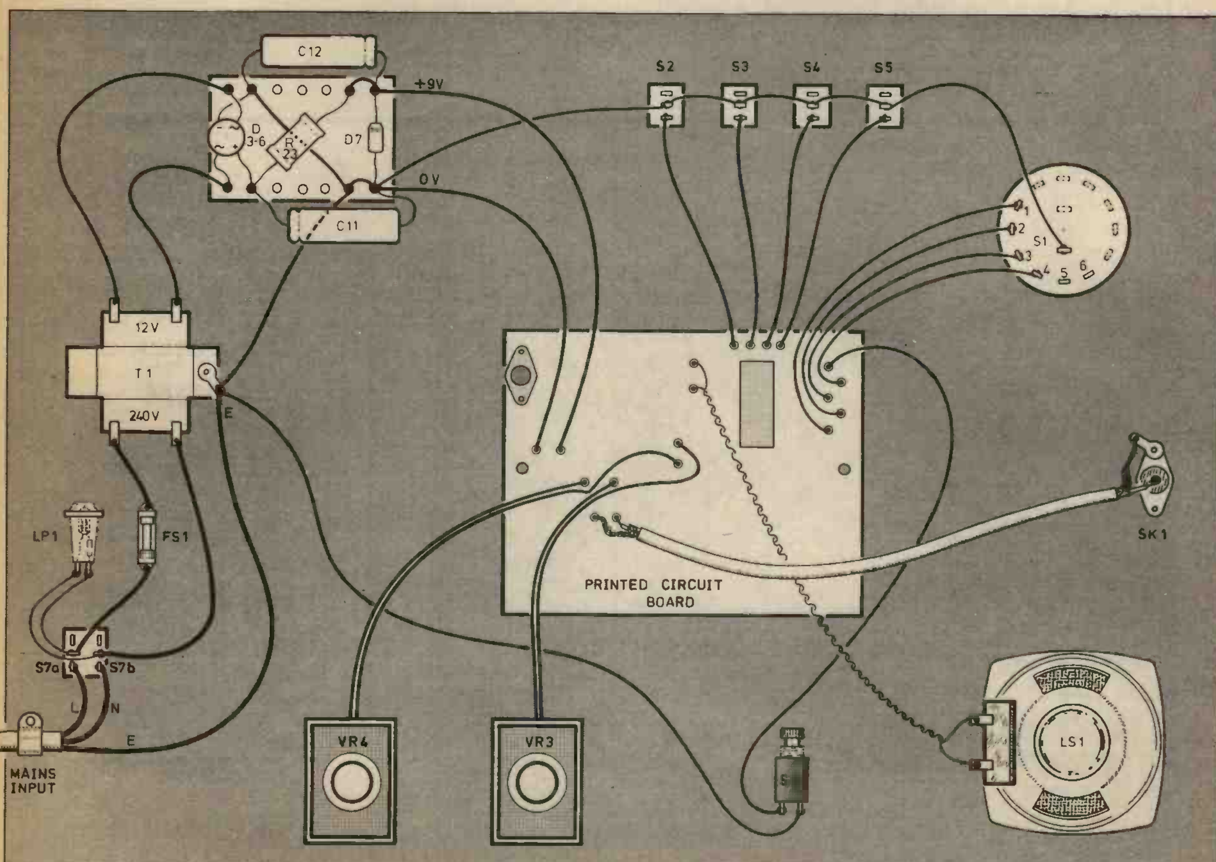
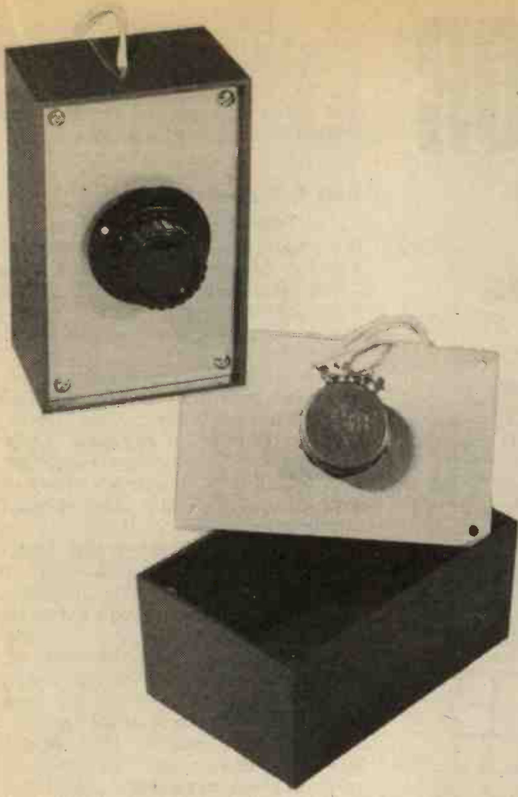
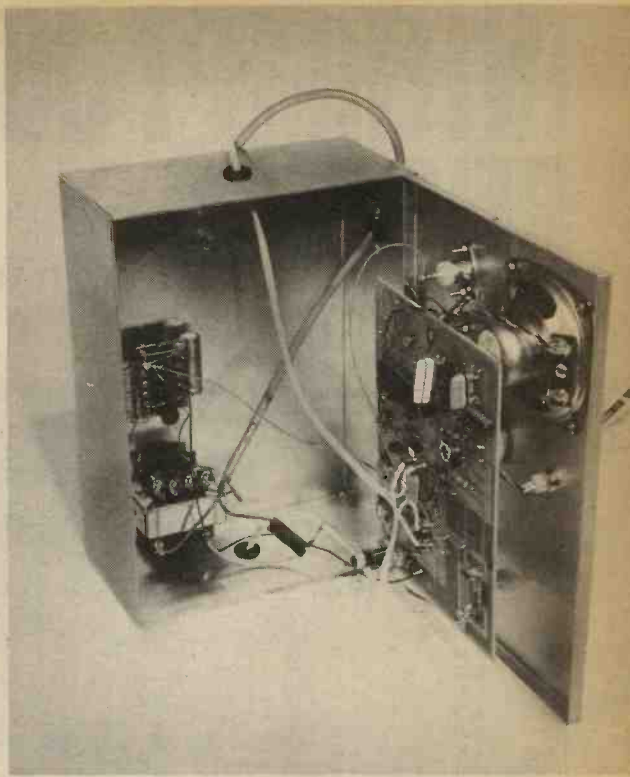


Fig. 12. Wiring diagram including power supply



Remote controls



Interior view of prototype

CONSTRUCTION

The inductor L1 consists of 55 turns of 36 s.w.g. enamelled copper wire close wound on a 6mm (0·25in) diameter former. Two small holes (1mm dia.) should first be drilled in each side of the base of the former for anchoring the ends of the winding. A small amount of quick-setting adhesive should finally be applied to fix the turns of the coil.

The board (Figs. 10 & 11) can be assembled by fitting and soldering the links (tinned copper wire), resistors, diodes, capacitors, transistors, presets and coil. Carefully check the orientation of the transistors, diodes and electrolytics. The last component to be inserted is the integrated circuit, which should be retained in its packaging until required. This is an MOS i.c. and is thus susceptible to damage from static electricity until it has been soldered into the p.c.b. A properly earthed soldering iron must be used. If this precaution is observed it is not necessary to use a 28-pin i.c. socket, or Soldercon sockets.

The board is mounted behind the lid of the box, spaced off on long 6BA screws and nuts. Before attaching it, wires must be soldered to it for the switches, loudspeaker and power supply. The connection from the modulator to the coaxial socket can be made with a short length of screened lead.

The internal layout of the unit is shown in Fig. 12. The power supply components are mounted on a miniature group board which is fixed to the bottom of the main box by two 6BA screws and spacers. For D3–D6 use either four separate diodes or a bridge as preferred.

TESTING AND SETTING UP

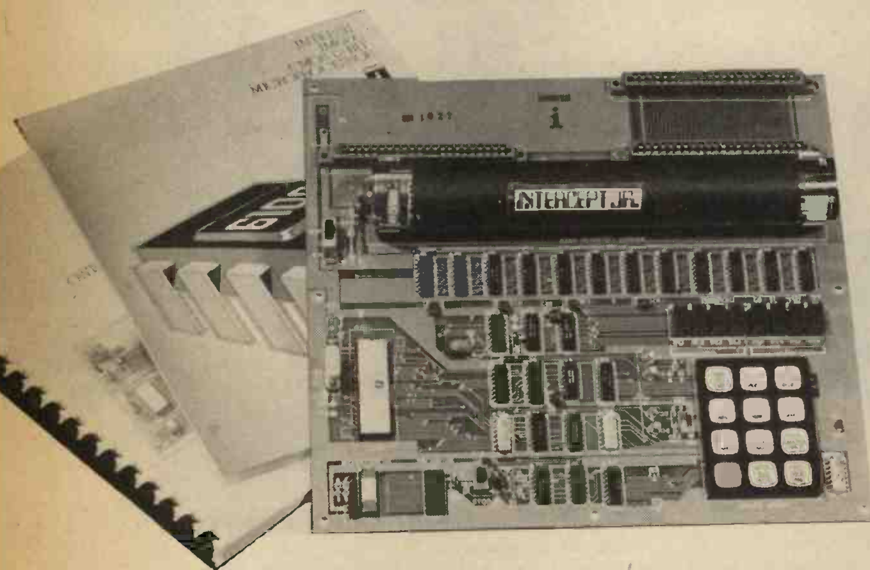
Before switching on, carefully check the polarity of the connections to the power supply. Set the game selector switch to TENNIS and the serve switch to AUTOMATIC. After switching on, the tones for boundary reflections and scoring should be heard coming from the loudspeaker.

Connect a coaxial lead from the games unit to the aerial socket of a television receiver. A signal should be received at around channel 50. The core of L1 should now be adjusted for proper locking of the pattern. Fine adjustment of this core should stop any slow undulations in the pattern.

The capacitor C8 in the u.h.f. oscillator may have to be increased or decreased in value by 5 or 10pF if the signal does not tune in conveniently. Finally, the presets VR1 and VR2 should be adjusted so that the bats traverse the full height of the screen. ★

INTERCEPT JUNIOR REVIEWED

By R.W. COLES



THE Intercept Junior is a "stripped down" microprocessor development and tutorial system which features the unique Intersil IM6100 CMOS microprocessor chip in a versatile and expandable "no frills" design.

The system is based on its big brother, Intercept itself, which is a cabinet mounted development and prototyping system with mains power supply, a comprehensive range of facilities, and needless to say, a price tag to match! Intercept Junior brings the undoubted power of the 12-bit IM6100 chip within the reach of the computer hobbyist and small industrial user.

COMPACT LAYOUT

As can be seen from the photograph, a very compact layout has been achieved where MPU, RAM, ROM chips, keyboard display and battery power source coexist on a single glass fibre printed circuit board measuring 28cm by 25cm, without appearing at all cramped. To keep the "Junior" as economical as possible, no case is provided, the rear of the board being protected by a hardboard cover with attached rubber feet.

The attractive component layout is laid bare to the probing oscilloscope or multimeter, as is the fashion with this type of system. At the rear of the circuit board are three edge connector sockets which can be used for system expansion using either the RAM, PROM, and INPUT/OUTPUT cards available from Intersil, or suitable custom built alternatives which would be fairly simple to construct and probably cheaper.

THE IM6100 MICROPROCESSOR

Before delving further into the pros and cons of the Intercept Junior system it is as well to consider the chip which makes it all possible, the IM6100 itself. The feature which makes the IM6100 unique is the fact that it is configured to recognise the instruction set of the most popular range of minicomputers ever built, namely the PDP8E's from Digital Equipment Corporation which are in use around the world in their tens of thousands controlling industrial plant, laboratory experiments, and almost anything else you care to name.

The PDP8 minicomputer has been around since the middle sixties, and not surprisingly, a comprehensive library of software routines has been established both by D.E.C. themselves, and by their customers, most of which could be run on systems using IM6100 microprocessors.

It's not just the availability of software which will guarantee success for the IM6100 though, the simple fact is that there are more engineers in the business familiar with the PDP8E than with any other computer, and for these people, putting the IM6100 to work will be child's play.

CMOS TECHNOLOGY

The PDP8E connection is certainly the *biggest* gun in the Intersil arsenal, but the fact that the IM6100 uses CMOS technology which takes a mere 2·5mA from a five volt supply is a pretty potent sales weapon in its own right.

A silicon gate CMOS process is used and operation is fully static so that the system clock can be slowed, or even stopped, if required. Three versions of the chip are produced, the basic IM6100 which is characterised for operation at 5 volts at clock frequencies of up to 4MHz, the IM 6100A which is a high-speed selection operating at up to 8MHz at 10 volts, and the economy IM6100C, which is a little slower with a 3·3MHz maximum clock rate at 5 volts. Intercept Junior uses the IM6100C which is adequate for the job; using the IM6100A at 10 volts can increase consumption to 10mA at 8MHz.

The chip is housed in a 40-pin ceramic package and includes an on-chip clock oscillator so that the external component count is minimised. At 5 volts, TTL compatability is assured, though it seems more logical to use 4000 series or 74C series CMOS to save power.

A full complement of peripheral and support chips are supplied by Intersil (and others, incidentally) including CMOS RAMs and ROMs, a CMOS UART and a capable "Peripheral Interface Element" or PIE. One omission from the list is a CMOS PROM, but this I believe is in the pipeline, and, anyway, with a bunch of CMOS RAMs maintained for months by a couple of pen cells, who needs PROMs?

ARCHITECTURE

The IM6100, like its progenitor the PDP8E, employs 12-bit parallel-transfer operation, two's complement arithmetic, and single address instructions. The chip has six 12-bit registers, (Fig. 1) but only three of these are program accessible, namely the accumulator, the M.Q. register, and the program counter. When compared with other current microprocessors, the amount of on-chip storage provided seems limited, but against this must be set the fact that the first 128 words of RAM storage can be directly addressed and may be used as index registers, stack pointers and temporary data storage in the same way that on-chip registers are used in other designs.

Communication with memory and input/output ports etc. takes place on a single-bit bidirectional parallel bus which carries address information, data inputs, and data outputs in time-multiplexed sequence.

This time-multiplexing means that the address outputs have to be latched externally, but this is not always a problem since the standard 6508 CMOS RAM has the necessary latches on chip. If other memory components are used, even standard bipolar PROMs for example, latches such as the SN74174 must be employed to store address information for use during memory read and write cycles.

The 12-bit address word gives a basic address range of 4096 locations, called a "field", and with extra external logic, up to eight fields can be accommodated. Each field is divided into 32 pages, with 128 words per page.

GROUP 1 MICROINSTRUCTION OPTIONS. A LARGE NUMBER OF BIT PERMUTATIONS ARE POSSIBLE.

BITS—	0	1	2	3	4	5	6	7	8	9	10	11
	1	1	1	0	CLA	CLL	CMA	CML	RAR / RTR	RAL / RTL	BSW	IAC

MICROCODE BITS (bits 4–11)

MNEMONIC	OPERATION
CLA	CLEAR ACCUMULATOR
CLL	CLEAR CARRY LINK
CMA	COMPLEMENT ACCUMULATOR
CML	COMPLEMENT CARRY LINK
RAR	ROTATE ACCUMULATOR RIGHT
RTR	ROTATE ACCUMULATOR TWO PLACES RIGHT
RAL	ROTATE ACCUMULATOR LEFT
RTL	ROTATE ACCUMULATOR TWO PLACES LEFT
BSW	SWOP RIGHT HAND 6 BITS WITH LEFT HAND 6 BITS
IAC	INCREMENT ACCUMULATOR

Fig. 2. An example of the IM6100 microcode format

MICROINSTRUCTIONS

The IM6100 has the interesting distinction of a microcoded instruction capability, again like the PDP8. Microcoded instructions are instructions which may be designed by the programmer using combinations of simpler instructions (Microinstructions), in a single instruction word by setting appropriate word bits to a "One" or a "Zero" (See Fig. 2).

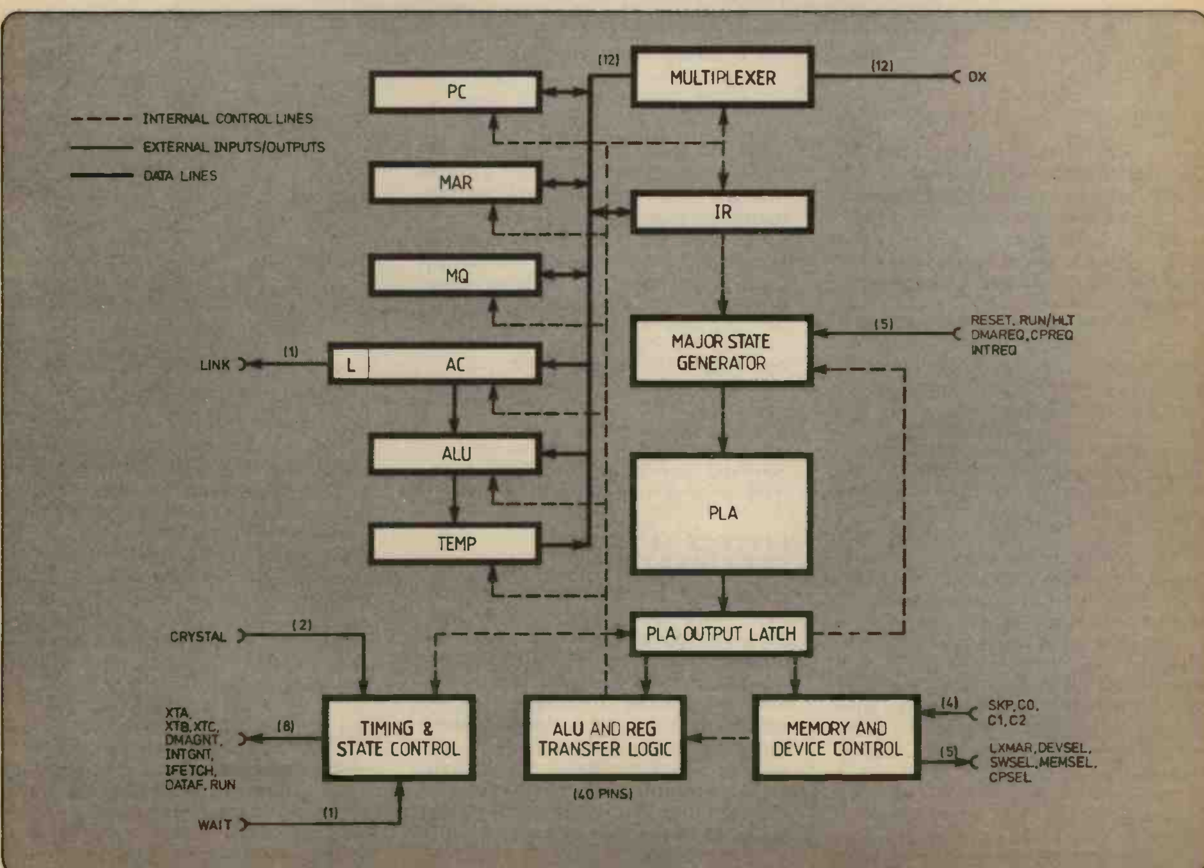
In practice, only certain combinations are normally used, and so lists of these "Popular" combinations are published in the IM6100 manuals in much the same way that other microprocessor instruction sets are laid out.

There is no doubt that a microcoding capability can add flexibility to a microprocessor, and the Intercept Junior makes full use of this as we shall see.

PROBLEMS

Subroutines can be a bit of a headache with the IM6100 if programs are stored in ROMs or PROMS, because a JMS (*JUMP TO SUBROUTINE*) instruction stores the

Fig. 1. Inside the IM6100 chip



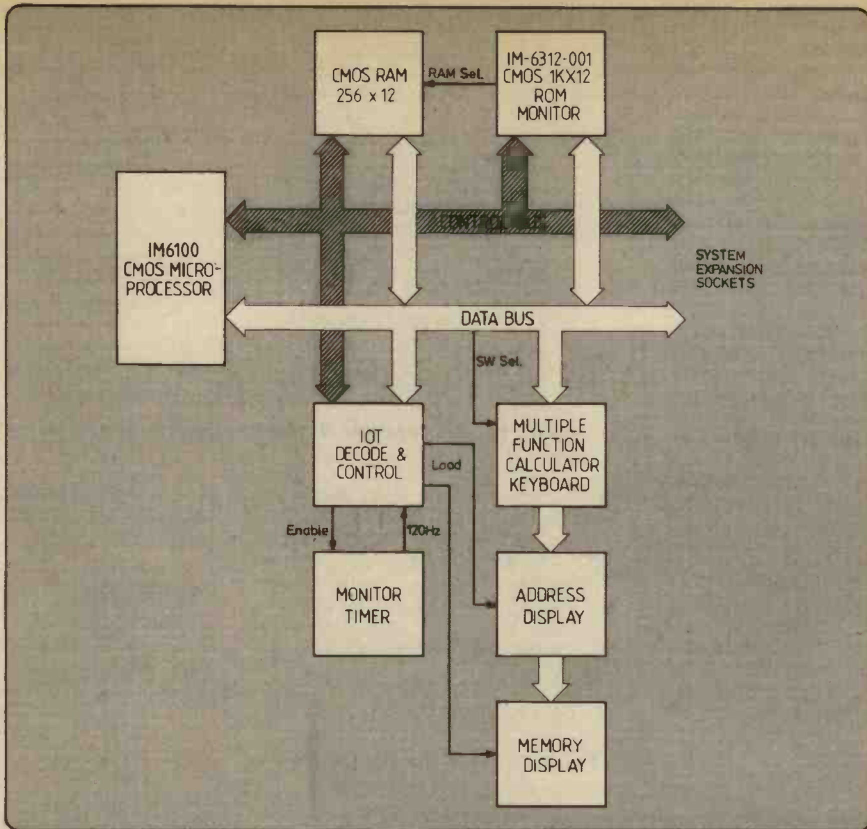


Fig. 3. The Intercept Junior system components

current contents of the program counter in the first *subroutine* address instead of using a separate stack area. If the subroutine is in, say, a ROM it is impossible to write the return address into what is, after all, a *read only* memory, and so we have a problem.

There is of course a way out, but it requires providing an entry point for each subroutine in RAM memory, and the contents of these entry points have to be "Initialised" at power-on by a part of the main program so as to load them with appropriate unconditional jump instructions. This is a programming anomaly which the IM6100 inherits from the PDP8 which would itself normally be used only with "Writeable" program memory, and for the sake of that all important compatibility, it is something users will have to live with.

The only other complaint I think is worth voicing here is about the lack of BCD arithmetic instructions, though it could be argued that with a 12-bit machine there is every incentive to do all number-crunching in binary anyway.

CONTROL PANEL

A unique and very attractive feature of the IM6100 chip is the provision for a dedicated and independent control panel which can utilise a completely separate memory to house test routines, loaders etc. This means that control panel functions such as those required by a general purpose microprocessor or development system can be provided on *any* IM6100 system without disturbing the main memory and its contents.

If appropriate, the control panel, complete with memory, can be a portable device which is plugged into dedicated systems only when it is required, for program loading, modifications, or debugging purposes.

INTERCEPT JUNIOR ORGANISATION

Intercept Junior has 256 words of RAM and 1,024 words of pre-programmed ROM, with a socket for another 1,024 words of ROM also on the main board (Fig. 3). Interaction with the system is achieved via the colourful multi-function keyboard and the eight-digit, seven-segment l.e.d. display which indicates the current program counter (P.C.) contents, and the contents of the address to which it points (E.A.). The binary contents of the P.C. and the E.A. are displayed in octal, using the character set 0 to 7 to represent a group of three binary bits, so that each bit word uses four characters.

The octal system for representing binary numbers is also used for keyboard entries, so that only the digits 0 to 7 appear on the keys. Those used to hexadecimal coding will probably not like having to use octal, but this is another inheritance from the PDP8 and in fact makes the Intercept Junior easier to use for those who are familiar with the D.E.C. machines.

The ROM supplied is a mask-programmed device which contains all the control panel monitor routines to provide keyboard encoding and debouncing, display driving, register saving and control of a teletype or tape reader when the appropriate interface card is fitted. The ROM occupies pages 24 to 31 at the high end of the 4096 word main memory area, while the RAM occupies the two lower pages, 0 and 1.

OPERATION

After switching on, the Intercept Junior can be loaded with user programs via the keyboard, although long programs would require the addition of extra memory, since half the 256 word RAM supplied is used by the monitor routines, and this restricts user programs to only 128 steps in the basic system.

Program steps are entered not by looking up instructions in the manual and keying in their hex, or octal, equivalent as is usually the case with other systems, but by using the microcode mnemonics which appear directly on the keys. This means that after a little familiarity with the system, it is possible to enter program instructions directly through the keyboard without constant reference to coding lists.

With the basic system, the types of programs you can run are restricted to those which use the l.e.d. display for output, and the keyboard for input. Since the display is of the "deooded" type with no access via the program to individual segments, display is restricted to the 0–7 octal or 0–9 decimal set with no possibility of alphanumerics.

To take advantage of the D.E.C. PDP8E software such as the PAL III assembler, the 23-bit floating point math package, F.P.P., or the FOCAL 8 calculator package, it would be necessary to add an extra 4K of RAM memory and a teletype interface card. In principle at least, this is quite possible, although slots only exist for 1K of extra RAM if you use standard Intersil expansion cards.

HANDBOOK

One aspect of the Intercept Junior which deserves special mention is the excellent Owner's Handbook which comes with each system. We found this book easy to read and a mine of information on both the hardware and the software aspects of Intercept Junior.

Included as appendices are two very useful sections, one an introduction to logic, and the other a comprehensive and concise glossary of all those microprocessor buzz-words like "Indirect Address" and "Data Break".

The book is written rather like a programmed learning course so that those with little or no knowledge of microprocessor techniques need not feel, (as is often the case) that they have been dumped in at the deep end. Programming is introduced by means of thirteen examples with easy to follow commentaries, and after working through these, most people would be ready to try some simple routines of their own. Full circuit details of the Intercept Junior and the optional plug-in cards are provided, and by studying these it should be possible to expand the system hardware without too much head-scratching.

VERDICT

Any assessment of the Intercept Junior must necessarily take account of the IM6100 microprocessor which is such an essential part of it. We feel that for anyone with PDP8E experience or better still, access to PDP8E software, the IM6100 and the Intercept Junior are a very attractive proposition.

For people without either of these things, the Intercept Junior makes an excellent tutorial system which is reasonably priced if one considers that easy expansion is assured because of the on-board sockets.

The IM6100 is, of course, a powerful microprocessor and hardly the sort of thing you would want to invest in for the "low end" application such as, say, train set control. If, however, you long for the day when you can hook up your VDU and low-cost floppy-disc to a microprocessor-based home computer which will handle Master-Mind and Chess programs, you may still have a couple of years to wait, but meanwhile the IM6100 and the Intercept Junior make a promising starting point!

POINTS ARISING

RANDOM NUMBER GAMES MACHINE *(December 1976)*

In Fig. 3, page 971, the TO-220 plastic package should have pins 2 and 3 transposed. In Fig. 4, page 973, pin 8 of IC6 should go to the 0V rail. There is an apparent discrepancy between circuit diagram and wiring diagram in the connections between the two counters IC3 and IC4 and IC9a/b. In fact both are correct as they are electrically equivalent.

The designation R5 and R6 in Fig. 4 should be transposed. Also, the point "T" (IC5 pin 6) should be linked to IC3 pin 11.

AUTOWAH *(March 1977)*

Note that the orientation of TR1 shown in Fig. 3, page 207, can be misleading. The correct leadout of the f.e.t. is shown above:

LOW COST RADIO CONTROL SYSTEM *(January/February 1977)*

In Fig. 3, page 105, two additional links are required on the printed board pattern. These are between R20/TR4 collector and C3/R21, and between the junction of R6/R9/R12/R24 and the 0V rail.

PUBLISHERS ANNOUNCEMENT

The current 1977 Binders will now only hold 8 issues as the September 1977 issue format will be increased in size.

A larger Binder to accommodate 16 issues from September 1977 to December 1978 will be introduced.

Remittances with overseas orders for binders: please add 60p to cover dispatch and postage.

ELECTRONIC DIE

By G. Jones

THIS circuit illuminates l.e.d.s in the familiar die pattern, representing a number chosen at random on each "throw". Whilst the concept of such a device is not new, this design uses a novel counter which may be of interest.

The completed unit

OPERATION

The circuit shown in Fig. 1 consists of a gated clock driving a six-state counter which is stopped in a state chosen at random; this is then converted into a displayed pattern. The period for which the clock is operating is controlled by the length of time for which a finger bridges the strips of a touch plate. C3 charges through the skin resistance, saturating TR2 and sending the output of IC1a high. IC1b then acts as a simple multivibrator providing clock pulses to the counter.

When the touchplate is released, C3 discharges through TR2 allowing IC1a output to go low and

COMPONENTS . . .

Resistors

R1	100Ω
R2	1kΩ
R3–9	270Ω (7 off)
R10	390Ω
R11	120Ω
All ¼W carbon	

Capacitors

C1	0·33μF metal foil
C2	22μF 16V elect.
C3	10μF 16V elect.

Integrated Circuits

IC1	SN7413
1C2–3	SN7473 (2 off)
IC4	SN7400

Transistors

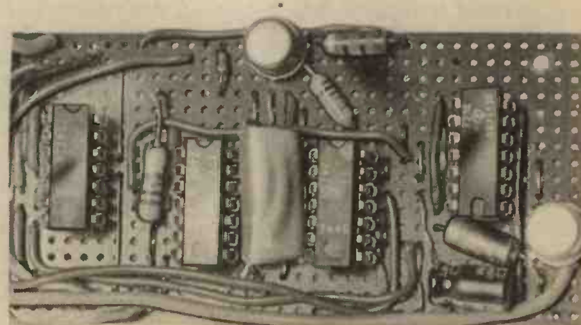
TR1	BFX88
TR2	BC107 or similar

Diodes

D1–7	TIL209 or similar
D8	1N914

Miscellaneous

6V supply/battery, Case, Veroboard, 1·8in × 3·5in (2 off) and off-cuts



Circuit board component layout

turning on TR1. Then if any of points A, B, C, D are taken to ground (through the counter circuit) the appropriate l.e.d.s (D1–7) are lit. Thus the display is only on when the counter is stationary.

COUNTER

Previous designs have employed a three stage binary counter, forced into a short (6-state) cycle, and gate circuitry to decode the output into a form suitable for display. This type of circuit generally leaves a flip-flop unused as they are most conveniently available in pairs in the SN7473 i.c. By considering the face of a die it will be seen that only four independent display controls are necessary, labelled A–D in Fig. 1 and Fig. 2a.

As the counter uses four bistable elements, its state at any time can be represented by a four bit binary word DCBA; for example 0001 represents output A low, outputs B, C, D, all high. There are 2^4, (16) of these states and on receipt of a clock pulse the counter will move from its present state into a new one, for example, from 0001, after one clock pulse, into 0111. This is represented by Fig. 2(b), where it will be seen that there are six states in a central "cycle".

No matter what the initial state of the counter, after one clock pulse it will rest in one of these states and after further clock pulses the counter will have moved into one of the six states. These six states are therefore chosen to represent the six states of the die and the number of spots illuminated is shown again each state thus: "4" is 0110 for example.

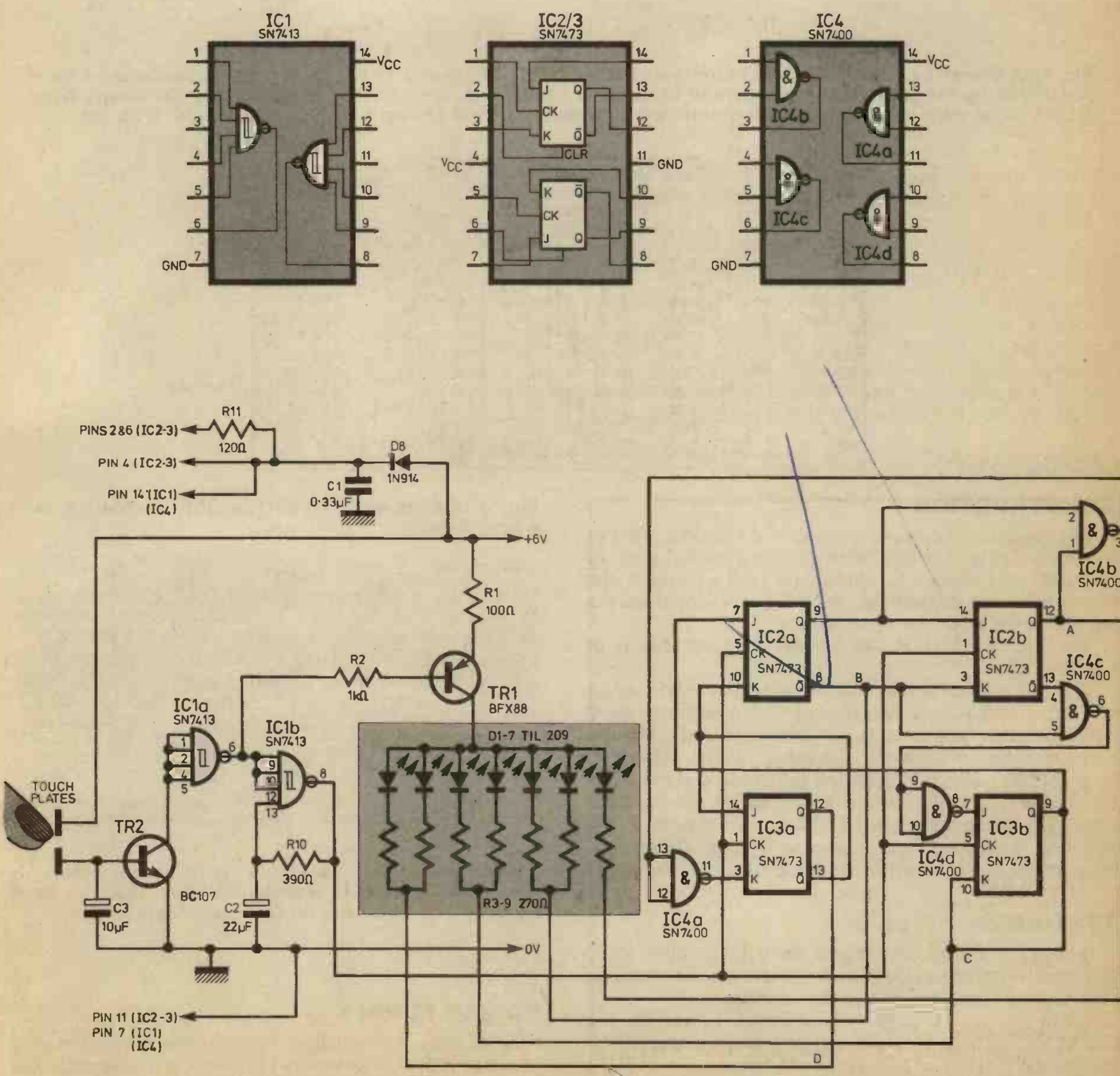


Fig. 1. Circuit of die and i.c. leadouts

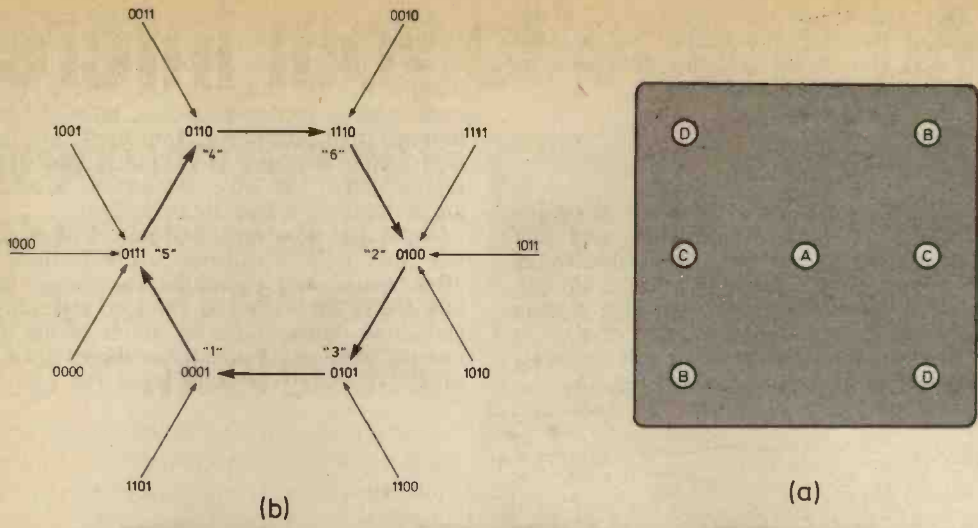


Fig. 2(a). Seven l.e.d.s are required to indicate the six states of the die. There are sixteen possible conditions presented by the four binary counters to the l.e.d.s. Each condition can be represented by the binary word DCBA. The words that relate to die 'number' configurations are shown in the central 'cycle' (Fig. 2b)

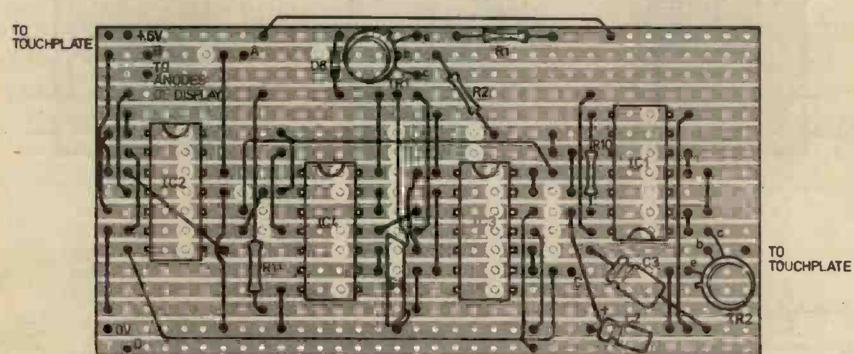


Fig. 3. Component layout for the Veroboard with wiring details

CONSTRUCTION

The majority of components are laid out on a piece of Veroboard (Fig. 3) with the display on a second piece of board. It was chosen to mount the l.e.d.s through the board from the copper side with R3–9 soldered on the copper strips from the same side.

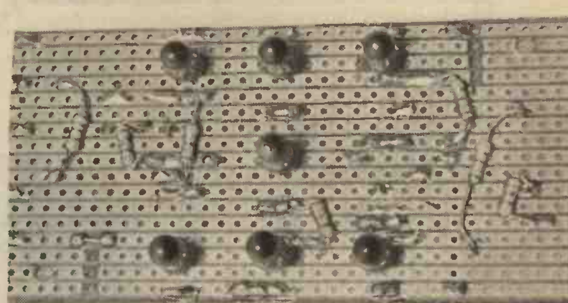
The diodes are laid out in the manner shown in Fig. 2(a).

The touchplates in the prototype was constructed of two small offcuts of Veroboard (0·6in square) glued back-to-back (copper strips showing and running perpendicular to those on the other offcut). Alternate strips of the top board are then soldered by short wires to two strips on the bottom board which are the contacts. The plate can then be glued over a hole in the die case (insulated from the case if it is metal) and leadouts taken from within the case, through the hole.

TESTING

It may be found convenient initially to omit R10; IC1 will not then oscillate and the die can be made to step around the cycle to test the counter.

Clock pulses are provided at about 100Hz by the circuit shown, and this rate can be greatly increased by lowering the value of C2. However, the fan out of IC1a is exceeded in this circuit and reliable operation may not be obtained if too low a value is selected.



The seven l.e.d. assembly with its resistors is mounted on its own Veroboard. The board is fixed by pushing the l.e.d.s through mounting clips

POWER SUPPLY

A 6V supply is specified because this is conveniently obtainable from batteries. However, as it exceeds the maximum safe V_{cc} for TTL i.c.s, D8 is included to lower V_{cc} by about 0·8V. ★

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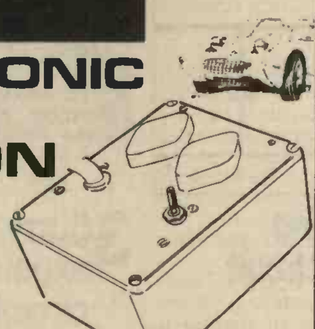

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Solar Heating

Sir—With reference to the article "Electronic Control Unit for Solar Heating Systems" by G. I. Williams (PRACTICAL ELECTRONICS, February 1977), there are a number of points which I would like to make.

1. Under no circumstances use expanded polystyrene insulation in the collector. It will either melt or burst into flames, as temperatures inside a properly built collector can exceed 100°C.

2. Under no circumstances use a polythene cover, which will degrade due to the action of ultra-violet within about two months. Also, it will stretch when hot, touch the metal collector and melt. Planning permission is required for solar panels, and this will not be granted for sub-standard designs. If too many such designs appear, much of the hard work put in by manufacturers in overcoming the opposition of planning authorities will be undone.

3. In the arrangement of Fig. 1, an expansion tank should be included on the solar circuit.

4. In practice it is better to have a pump running time of seconds rather than minutes. Consider for example early morning; the collector heats up just enough to operate the pump, but the water in the pipework is usually very cold and will chill the collector, in theory sufficiently to switch off the pump.

However, on a nine-minute cycle, warm water will be drawn from the solar tank, passed through the collector where it will most likely be cooled by radiation to the sky, and returned to the tank to chill the water.

5. The thermal mass of the thermistors embedded in Araldite and copper tube will be so high that the response time will be very poor. I have found it to be very effective to Araldite the thermistors directly onto the back of the collector and tank.

D. D. Aylen-Baker,
Slough.

Sir—In his article on Solar Heating Controls, Mr. G. I. Williams states that the collector should be installed at an angle of 30° to the horizontal.

None of the other books on the subject which I have read agree with each other as to any precise angle, but all seem to favour one at least twice that recommended by Mr. Williams.

To quote just one reference, *McLaughlin House of the Future* (*TV Publications*), "Taking the average elevation of the sun at different seasons and times of the day, the absorption of heat is most efficient if the collector is set up at an angle of L + 13½° to the horizontal, where L is the latitude in degrees of the site." This gives an angle of 65½° to the horizontal for Bedford, for example.

K. J. Wilkinson,
Farnborough,
Hants.

The Author replies

Mr. Aylen-Baker is quite right to point out that polystyrene is a fire hazard. However, it is very debatable whether a hazard exists in this application. As far as I can ascertain it will not spontaneously ignite, though it will soften at around 104°C. Readers, if worried, may like to use alternative insulation.

I agree that glass is preferable to polythene. Some experimenters prefer glass with a low iron content, which is claimed to improve collector efficiency by about 10 per cent. A further improvement can be achieved by the use of a special black paint on the collectors, though this does not seem to be available on the retail market.

The position with regard to planning permission is confused. Some local authorities seem to require it, others I am told do not.

Readers who construct the control unit may wish to make R4 variable as suggested in the final paragraph, allowing the operate time to be shortened. Greater relay contact wear will result if the operate time is in seconds rather than minutes as Mr. Aylen-Baker suggests. Solid-state switching could be used instead of the relay, but this would make the unit less versatile.

The measured response time of the completed thermistor probes (0–100 per cent, in water) is 15 seconds for a 4°C change in temperature, the thermal conductivity of copper and Araldite being quite good.

In reply to Mr. Wilkinson, the optimum angle of the solar collector depends upon the time of year and time of day at which one wishes the collector to be most efficient. In *The Survival Handbook by Michael Allenby (Pan Books)*, an angle of 30°–35° to the horizontal is quoted as being optimal for the six weeks of summer sun. I am of the opinion that October – March collection would be improved by a further 5° of inclination, without drastically degrading the summer performance.

Bright Ideas

Sir—Two small simple constructional tips which may be of interest to your readers.

A "third hand" of a limited but convenient sort can be devised for use when soldering circuit boards by wrapping a broad elastic band several times round the workpiece. This acts as a "tyre" which holds the work to the table or bench by limiting the tendency for the work to skate around.

Cork tiles may be epoxied to metal chassis sides to provide an attractive finish, or to the bottom of a chassis in place of commercially available feet.

R. T. Third,
Aberdeenshire.

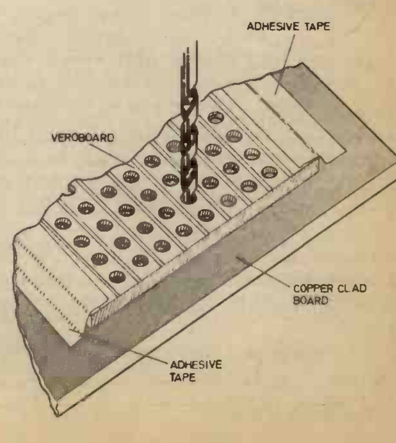
Simple Drilling

Sir—When designing my own printed circuit boards, in particular those which include integrated circuits, I always found it very difficult to drill holes at exactly 0·1in spacing and to keep the holes in a straight line.

However, I came up with this solution. By Sellotaping a piece of 0·1in Veroboard to the circuit board the holes in the Veroboard become an excellent guide for the drill, resulting in perfectly spaced holes.

It is a simple idea, but a very effective one.

J. M. Hayes,
Cononley.



Handling

CMOS Devices

By L. J. Gallace & H. L. Pujol*

ALL metal-oxide semiconductor devices are susceptible to damage by electrostatic discharge of energy between any two pins. The gate input, for example, is equivalent to a small very low leakage capacitor which can be charged to a high voltage. The dielectric breakdown voltage is normally of the order of 80V, therefore, any discharge above this level could damage the gate oxide and result in a high leakage input.

Fig. 1 shows the standard RCA protection network incorporated in all CD4000A-series and some CD4000B-series COS/MOS integrated circuits. Diode D1 is a distributed resistor-diode network made up of *p*+ to *n*− substrate material and having a voltage breakdown in the range of 30–50V. Diode D2 is a separate built-in diode of *n*+ to *p*− well material and having breakdown in the range of 30–40V. This network can protect the gate oxide against electrostatic discharges of up to 1kV (worst case).

Fig. 2 shows an improved protection network used on new RCA COS/MOS devices which increases the worst-case protection to 4kV.

Fig. 3 shows the equivalent "body discharge" circuit used at RCA during all static test measurements. Improved protection can be obtained by adding series resistors or RC networks at the CMOS device inputs. In addition, Zener diodes at the output pins can clamp the voltage to safe levels. The Zener value should be above the expected maximum regulation excursion, but should not exceed 15V.

Operation above maximum ratings can force CMOS devices into a *p-n-p-n* s.c.r. "latch up" mechanism which can be destructive. Care should be taken to suppress any transients and avoid any large loads during operation near the maximum rating.

"Latch-up" is considered to be the creation of a low-resistance path between the power supply and earth on a circuit during an electrical pulse, which then remains a low-resistance path after the pulse. In CMOS circuits, several parasitic bipolar transistors exist, as shown in Fig. 4.

The *p-n-p* transistor is a wide-base lateral structure whose β is a function of device geometry, and is normally less than 0·2. The conditions for s.c.r. turn-on are as follows:

(1) β *n-p-n* × β *p-n-p* $\gg 1$
(2) The lateral *p-n-p* and vertical *n-p-n* base emitter junctions are forward biased.
(3) The bias circuit which applies power to V_{DD} and to the input must be capable of supplying current equal to the holding current of potential s.c.r.s.

Fig. 5 shows the equivalent circuit for the s.c.r. structure present in CMOS circuits. Fig. 6 shows a curve of I_{DD} as a function of V_{DD}, which illustrates the effect of secondary breakdown and s.c.r. latch-up.

Table 1 shows typical values of breakdown voltage and sustaining voltage and current for COS/MOS A-series and B-series devices. The table shows that B-series devices are much harder to latch than A-series types because of the higher breakdown voltage.

Table 1

	A Series	B Series
$V_{BKDNmin}$	17V	25V
V_{sus}	15V	22V
I_{sus}	Type-Dependent 2–40mA	50–100mA

Observation of the following operating rules will enhance the life of any CMOS system:

(1) When CMOS devices interface with external signal sources, the CMOS power supply should be turned on before the inputs are turned on. Similarly, the input should be turned off before the CMOS power supply is turned off. (In other words, $V_{SS} \leqslant V_{IN} \leqslant V_{DD}$.) This rule will avoid input-diode damage.

(2) In the case of CD4009A and CD4010A devices, the diode between V_{CC} (pin 1) and V_{DD} (pin 16) should not be forward-biased. V_{DD} should always be greater than V_{CC}. This rule is especially important during power sequencing.

(3) When series resistors are used on power supplies, it is wise to avoid biasing inputs to

*RCA Solid State

the non-limited side of the supply. This action will eliminate the potential hazard of forward biasing the input diodes.

(4) The power-supply polarity should not be reversed (i.e. $V_{DD} - V_{SS} > -0{\cdot}5V$). Such reversal could over-dissipate the substrate diode.

(5) All inputs should be terminated. A floating input can force the CMOS inverter into a linear mode and cause faulty operation as a result of the large current.

(6) When CMOS devices are interfaced in printed circuit cards, a pull-up or pull-down resistor should always be used if there is a possibility of an input becoming open.

(7) CMOS outputs should not be "wire-OR-ed". Instead 3-state outputs or transmission gates should be used.

(8) Output loads should not be returned to voltages greater than V_{DD} nor less than V_{SS}, otherwise the output diodes will be turned on. ★

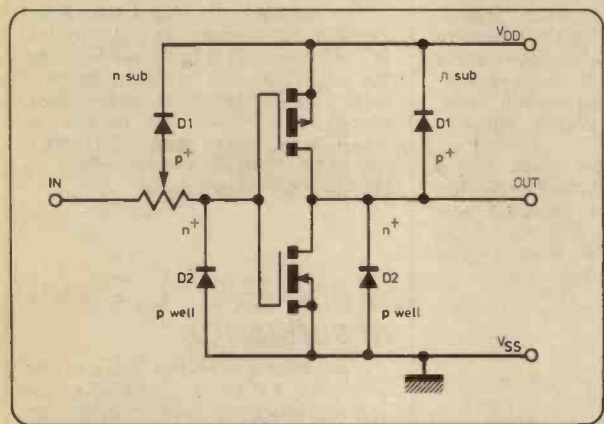


Fig. 1. Standard RCA protection network; used on all CD4000A and some CD4000B series devices

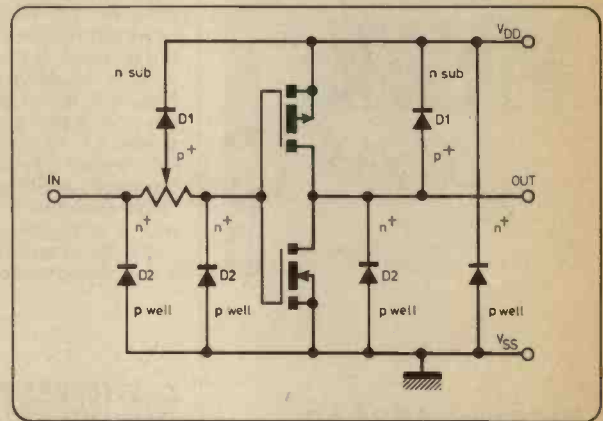


Fig. 2. Improved protection network used on new RCA COS/MOS devices

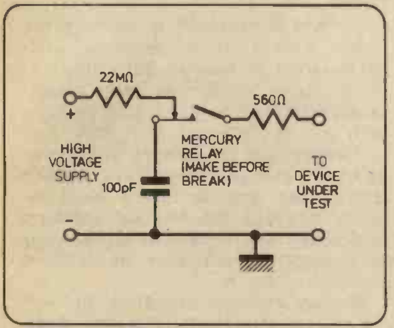


Fig. 3. Equivalent "body discharge" circuit used at RCA during all static test measurements

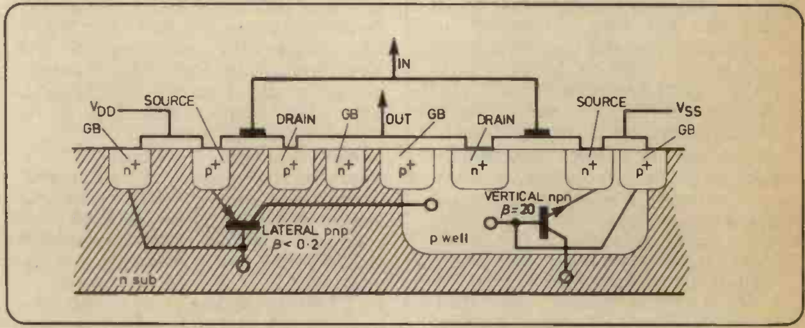


Fig. 4. Parasitic bipolar transistors in CMOS circuits

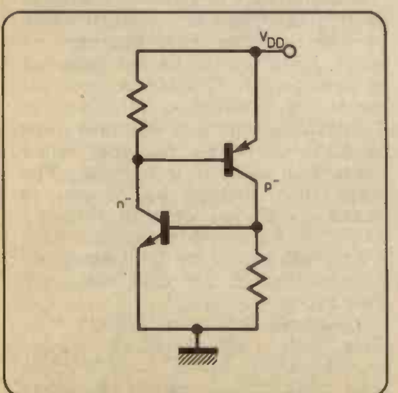


Fig. 5. Equivalent circuit for the s.c.r. structure present in CMOS circuits

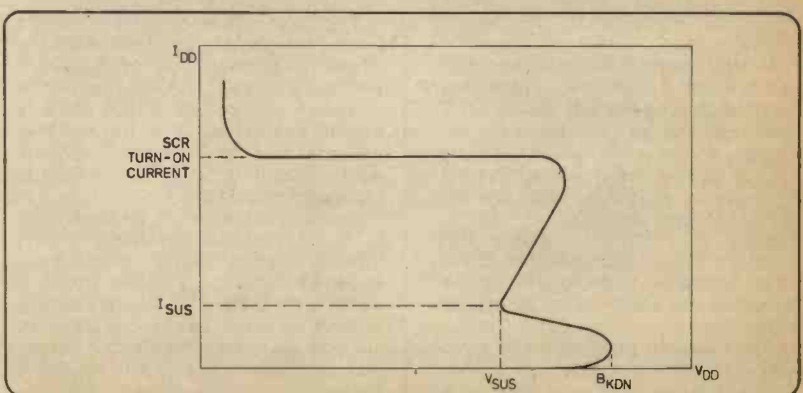


Fig. 6. Curve illustrating effect of secondary breakdown and s.c.r. latch-up

INDUSTRY NOTEBOOK

By Nexus

LOOKING ABROAD

Unstoppable Racal, after three months of cliff-hanging negotiations, finally won the battle for control of the Milgo Corporation. This single move has not only immensely increased Racal's stake in data communications with its great growth prospects but has also considerably strengthened Racal's status as a budding multinational organisation.

Bracknell-based Racal and Miami-based Milgo have had a long relationship through Racal-Milgo owned 50/50 whereby Racal-Milgo had marketing rights throughout the world except North America for Milgo products. Now Racal has full control of Milgo manufacturing as well. Previously Racal had only one manufacturing plant in the USA, that of the wholly-owned subsidiary Racal Communications Inc. at Rockville, Maryland, which makes top level communications receivers mainly used for surveillance by the US Government.

With stronger direct presence in the USA, Racal is now bidding for a share in re-equipping the US forces with a new generation of tactical field radios, a product in which Racal has proved successful in 130 armies with a range of products from low-cost simple-to-operate manpacks for the armies of emergent nations right through to the sophisticated Clansman equipment designed for the British Army and now in full production.

The US Army programme for which Racal is making a bid goes beyond anything Racal or anyone else has so far achieved in technology. But Racal could win in competition with US and other British suppliers like Plessey and Marconi who are also expected to compete. For this programme the US authorities have waived the "Buy American" clause and will accept bids from the UK on equal terms.

Racal has teamed up with RCA Government Communications Systems at Camden, New Jersey, as a support company adding expertise on electronic counter-measures to Racal's proven performance on design, manufacture and delivery-on-time of tactical manpacks. Racal, however, will be the lead company of the two and, if the design contract is won, it could lead to huge manufacturing follow-on which will dwarf any of Racal's previous success stories.

It seems likely that Racal would have been bidding whether or not the Milgo deal had materialised but now with a strengthened American base and a tie-in with RCA, Racal clearly has a strengthened position.

DISHONESTY DIVIDENDS

The dividends coming to the electronics industry through criminal activities continue to increase as crime itself increases. And the dividends come not only from trying to counter the activities of the hardened wrong-doer. The "honest" citizen is not averse to a little fiddling, especially against authority, if he thinks he can get away with it.

A £1·8 million development contract for a prototype automated ticket inspection and barrier control system for British Rail has just been awarded to EMI Electronics with GEC-Elliott Automation as sub-contractors. The idea is dressed up as a help to passengers, saving time queuing up at ticket offices and at platform entrances and "allowing staff to provide a better service". Actually it is to plug the leak of £6 million a year estimated to be lost through dishonest commuters.

The pilot scheme will have trials for six months at five stations on the Waterloo–Staines line of Southern Region. If successful it is planned to establish the system at 600 stations on the busiest parts of the national network and the contract will be worth about £20 million. Further contracts could follow.

The system appears to be similar to that used on London's underground system using magnetically encoded tickets. I only hope it works a lot better. If you are carrying parcels in both hands the barriers are difficult to negotiate and it seems that an enormous staff of ticket collectors is still there, whether necessary or not is difficult to judge.

Petty pilfering is always a problem but one case recently reported was not so petty. Perhaps it could only have happened in America but WOR, one of New York's broadcast stations, suffered the loss of 20,000 ft of above-ground copper wire earth radials from the aerial system. It seems incredible that such a quantity could be lifted without attracting attention and one wonders whether the thieves (there surely must have been more than one) sold it as having "fallen off the back of a lorry".

The dividend in this case didn't come to the electronics industry but to the ironmongery business because the whole lot was replaced by best quality galvanised steel barbed wire, much more difficult to handle by would-be pilferers and, apparently, without noticeably adverse effect on radiation efficiency.

RESURGENCE

After what seems like years in the doldrums, TV sales are showing an upturn, much to the delight of dealers, set manufacturers and the big component suppliers. Colour TV deliveries last January were up 30 per cent on the January 1976 figure.

Mullard is currently promoting the 20AX colour tube, already well-established in Europe but comparatively new to British set manufacturers. It is a fast warm-up tube with an in-line gun assembly and vertical striped phosphors which give superior colour registration. Major British set manufacturers have already adopted the Mullard solution and tubes and neckwear are already in quantity production at Mullard plants in the UK.

Mullard is also pressing on with Teletext components including dedicated i.c.s and remote control i.c.s for TV receivers. Samples of the i.c.s, all in the LSI class, are already with set manufacturers.

Mackintosh Consultants are forecasting 12 million UK Teletext users by 1985 so this new business is worth going for. Mullard is reported as having spent £350,000 on development and production facilities for Teletext i.c.s and this will have risen to £0·5 million by mid-year when production will start in earnest. The Mackintosh forecast, by the way, is based on 85 per cent of Britain's 20 million households having colour TV by 1985 and of the CTV-equipped households, 75 per cent will have Teletext.

Viewdata, accessed through P.O. lines, will have a much slower growth rate because, says Mackintosh, of the rising cost of telephone calls. No further comment is required from me, although I am sorely tempted.

PATENTS REVIEW...

TV AERIAL

In BP 1 458 006, Maxview Aerials Limited, of King's Lynn, Norfolk, discloses and claims the fine details of some improvements in aerial construction for TV reception.

The patent recapitulates on the standard techniques adopted, e.g. whereby a folded dipole is placed close to a linear-passive resonator to make the combined assembly resonant over a wider range of frequencies. The dipole-resonator combination is of course usually located between a reflector and sequence of directors.

The new patent claims are two-fold. First, it is proposed that the folded dipole be formed as an isosceles triangle (Fig. 1) with a base formed from the two end sections of the folded rod conductor, merging into two equal sides. This triangular dipole is arranged in a plane parallel to the plane of a resonator member, and within the angle defined between two reflectors.

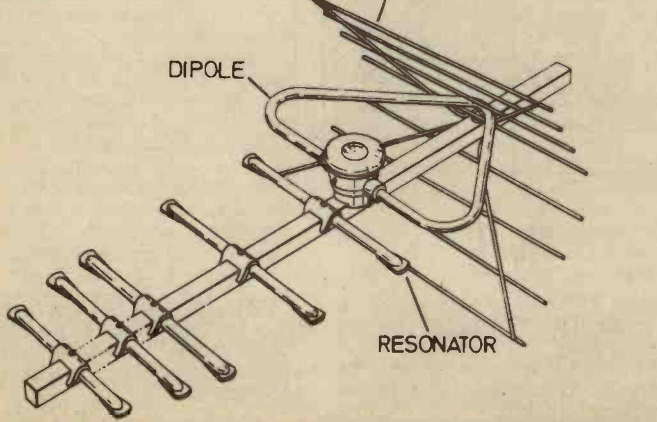
The base of the isosceles triangle is approximately equal to half the wavelength of the signal to be received, and the included angle between the equal sides is about 90°.

The second aspect of the invention constitutes detailed data on the size and spacing to be adopted for two forward passive members immediately ahead of the resonator, and twenty director elements mounted in a series ahead of the three members.

Size and spacing details are given for three specific types of aerial: one for reception in Group A (channels 21–34); one for reception in Group B (39–51) and one for reception in Groups C/D 49–68). It is claimed that the use of the isosceles triangle dipole in combination with passive members constructed and spaced exactly as described provides a useful increase in gain or bandwidth or both, in comparison to a similar aerial using a conventional folded dipole.

Also claimed is flatter impedance of the dipole over a wider band width.

BP 1 458 006



MAGNETS — BP 1 457 145

In BP 1 457 145, Hitachi of Tokyo list most of the known permanent magnet alloys consisting of rare earth elements. Also discussed are their advantages (ability to produce an intense magnetic field from a light-weight, small-sized magnet) and their disadvantages (tendency of the magnetic characteristics to change with temperature).

They now claim to have improved the temperature-dependent characteristics of a powerful permanent magnet alloy by substituting part of the light rare earth elements in the alloy with heavy rare earth elements. The light rare earth element exhibiting the best permanent magnetic properties is samarium, which is often alloyed with cobalt.

According to the invention, it is beneficial if some of the samarium is substituted by the heavy rare earth elements, Ho, Er, Dy and Tb. Following such substitution, the reversible magnetisation temperature coefficient becomes lower than 0·03% in the temperature range from −50°C to +100°C. Other substitutions, for instance by Ce or Ce mischmetall, provide similarly beneficial results, at less cost. Indeed, good results are claimed up to 200°C.

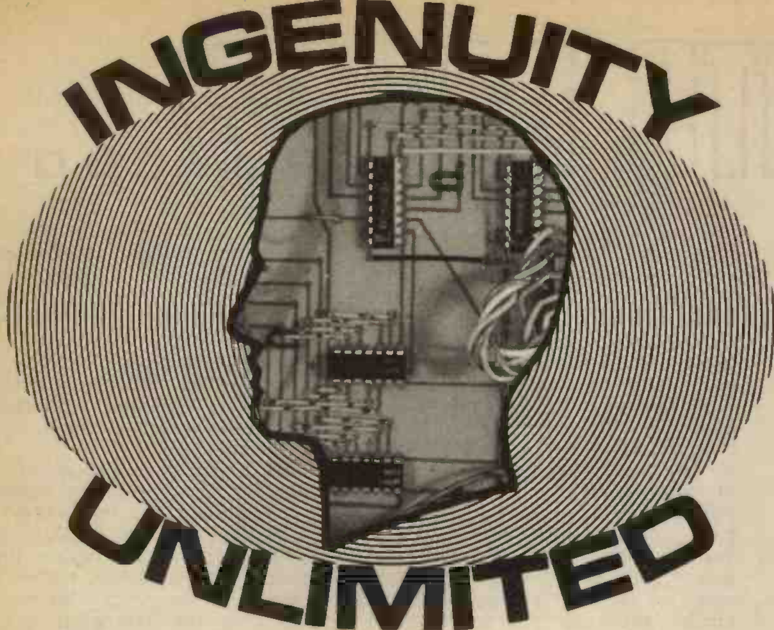
Chemical details for the preparation of various specific magnetic mixes are given. For instance, a useful alloy consisting of 32·75% Sm, 3·99% Ho and 63·26% Co is prepared by arc melting and crushing to a fine powder under a pressure of 10 tons/centimetre^3 in an intense magnetic field. Further sintering and cooling produces a magnetic material with impressive characteristics and resistance to temperature effects.

IN BRIEF

BP 1 459 235—Matsushita Electric Industrial Co Ltd: *Switching Circuit*. Contains full circuit details for a touch switch giving mains control. Touching the switch alters the amplitude (rather than the frequency) of an oscillator output. The amplitude changes are detected and used as trigger pulses to govern the main control switch.

BP 1 460 003—EMI Ltd: *Television Game Apparatus*. A modification of the now familiar TV game. In a race, there is penalty override of the operator manual control. For instance, a blip on the screen depicting a car has its movement slowed down beyond the operator's control if it leaves an area depicting a race track.

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



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.

NIGHT LIGHT LATCH

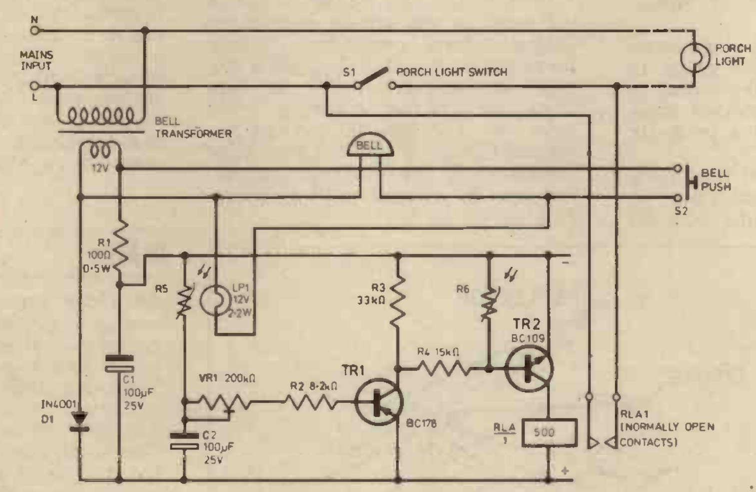


Fig. 1

THIS is a design for lighting a porch light from outside by using the bell push. This is particularly useful for when one is trying to find the keyhole in the dark. After a preset time the light switches off.

The porch light is lit from outside by pressing S2 which also rings the bell and LP1 lights lowering the resistance of the l.d.r. R5 which in turn causes TR1/TR2 to turn on and hence the relay.

With RLA1 contacts closed the porch light comes on for a period determined by C2.

R6 acts as an effective short to TR2 b/e during the day so preventing the porch light being switched on.

VR1 varies the holding time of the relay between about 0·25—2 minutes.

LP1 and R5 should be juxtaposed and contained in a sealed, opaque plastic tube.

R. N. Johnson,
Coulsdon,
Surrey.

FLUORESCENT LIGHT INVERTOR

THE Fluorescent Light Invertor of P.E. July, 1976, incorporates no forward biasing for the transistors. I found this circuit reluctant to oscillate, and so produced an invertor with forward biasing, which oscillated readily (see Fig. 1), the circuit being a variant of the invertor of the P.E. Scorpio electronic ignition system.

The transformer primary is bifilar wound on a television e.h.t. transformer core, as in the original Fluorescent Light Invertor. The two 8 turn coils are wound first, and then covered by a layer of insulating tape. Next, the feedback coils are wound on top, and covered with tape. The beginning of each winding in Fig. 1 is indicated by a spot.

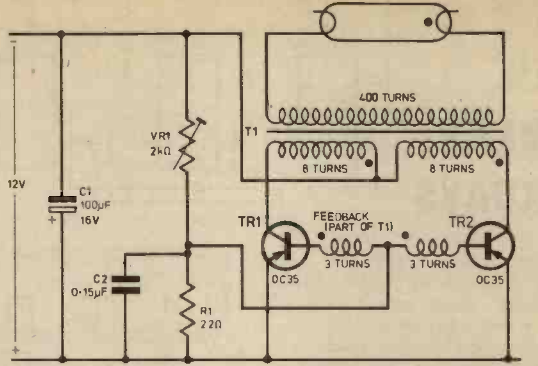


Fig. 1

Potentiometer VR1 determines the output power. This circuit can accommodate *npn* or *pnp* transistors simply by changing the polarity of the supply and capacitor C1.

I. P. Kemp, Cowley, Oxford.

"TRIMPHONE" WARBLER

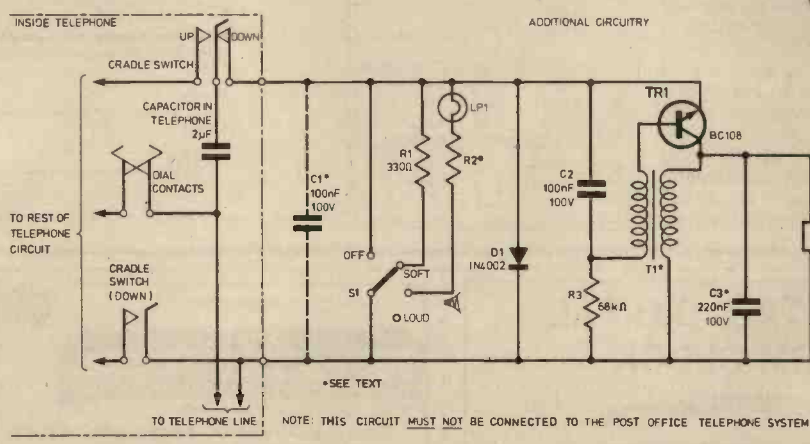


Fig. 1

MANY of the surplus telephones available through the second-hand market are sold without bells. The circuit in Fig. 1 will produce a "warbling ring" rather like a Trimphone, and can directly replace a conventional telephone bell, therefore being suitable for both these phones, and for situations where a different ringing sound is required to differentiate between an internal or Post Office telephone system.

The bell ringing current which alternates at about 17–25Hz, is halfwave rectified by D1 and then supplied to a simple oscillator formed by TR1, C2, C3, R3 and T1. This in turn drives a telephone earpiece (not the same one as in the handset). The oscillator is thus modulated at the ringing current frequency, producing the warbling tone. The oscillator circuit will also work on a d.c. supply, but of course the warbling effect will be lost.

To alter the volume, a shunt is placed across the oscillator; the individual shunts being selected by switch S1. If the shunt selected is LP1 with R2, the bulb will take a few seconds to warm up, and so its resistance will slowly rise, giving a crescendo effect. The component values are not very critical, but some experimentation may be needed for optimum results.

The following points may be useful: T1 is a transistor radio type output transformer, tuned by C3, and so the frequency of oscillation may be adjusted by altering the value of C3. A frequency of around 2kHz is most suitable, as both the earpiece and ear are most sensitive at about this frequency. The connections to one side of the transformer may need reversing to produce oscillation. The combined resistance of R2 and LP1 should be around 200 ohms when cold, rising to about 500 ohms after approximately 10–20 seconds.

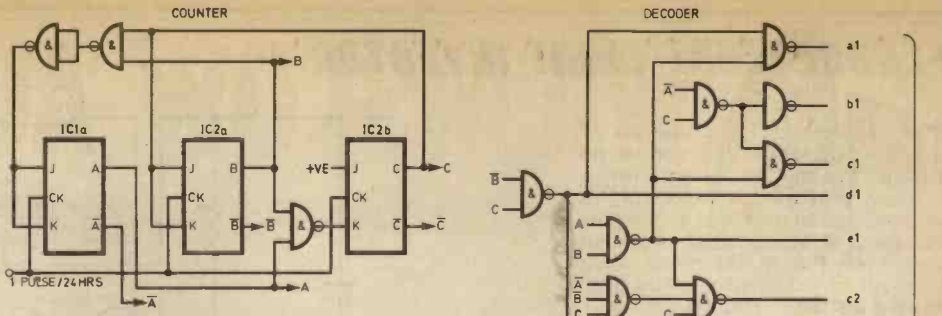
If an extension warbler is required, it will probably be necessary to include C1, and possibly also add series or parallel resistors to the circuit, so that both ring equally loud. Extension bells are usually connected in series to overcome this problem.

The changeover cradle switch can be replaced by a "make only" switch, with the ringer permanently connected across the line, provided that the line polarity during speech is always such as to bias the oscillator off. In this case the diode D1 must be omitted, and if d.c. is used for ringing a polarity reversal will turn the ringer off.

This circuit may not be connected to the Post Office telephone network, and should only be used on private systems.

A. J. V. and J. M. Yeomans, Banstead, Surrey.

SEVEN SEGMENT WEEKDAYS



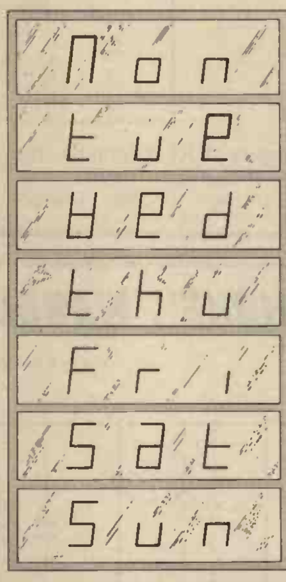
The circuit in Fig. 1 provides a day of the week reading for digital clocks using three seven segment displays, and minimal circuitry. Although seven segment displays do not lend themselves to alphabetic display, the symbols produced are readable.

The circuit requires one pulse per 24 hours, but if one pulse per hour only is available, this can be divided down using a 7492 (divide by twelve), and the unused half of the second 7473 (divide by two).

The first half of the circuit consists of three JK flip-flops, being a counter which counts from 1 to 7, resetting to 1 again. This is decoded for the seven segment displays by the second part of the circuit. In order to keep costs low, only NAND and INVERT gates are used.

The actual type of display and associated drive circuitry will depend upon the existing design of the clock.

H. Pyman, Romford, Essex.



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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	0·18	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
2N3019	0·55	2N5294	0·40	BC117	0·22	BC327	0·20	BF197	0·17	TIP30A	0·49
2N3053	0·30	2N5295	0·40	BC118	0·16	BC328	0·19	BF198	0·18	TIP30C	0·65
2N3054	0·60	2N5296	0·40	BC119	0·30	BC337	0·19	BF200	0·35	TIP31A	0·50
2N3055	0·70	2N5298	0·40	BC121	0·45	BC338	0·21	BF225J	0·25	TIP31C	0·66
2N3390	0·25	2N5447	0·15	BC132	0·30	BC547	0·12	BF244	0·35	TIP32A	0·50
2N3391	0·25	2N5448	0·15	BC134	0·15	BC548	0·12	BF245	0·34	TIP32C	0·75
2N3391A	0·25	2N5449	0·19	BC135	0·15	BC549	0·13	BF246	0·75	TIP33A	0·80
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
2N3440	0·64	2N5486	0·38	BC142	0·30	BCY34	1·20	BF259	0·49	TIP36A	3·35
2N3441	0·85	2N6027	0·53	BC143	0·30	BCY38	2·00	BF459	0·45	TIP41A	0·70
2N3442	1·35	2N6101	0·65	BC147	0·12	BCY42	0·60	BFR39	0·28	TIP41C	0·85
2N3638	0·16	2N6107	0·42	BC148	0·12	BCY58	0·25	BFS21A	2·60	TIP42A	0·80
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	1·65	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
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LM308N	1·17	NE565	1·30	TBA550Q	3·22
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7402	0·21	7414	1·80	7441	1·03	7472	0·38	7490	0·61	74121	0·49	74162	1·41	74188	2·00
7403	0·21	7416	0·61	7442	0·78	7473	0·43	7491	0·98	74122	0·45	74163	1·41	74189	3·99
7404	0·26	7417	0·61	7445	1·35	7474	0·43	7492	0·81	74123	0·58	74164	1·23	74190	1·91
7405	0·26	7420	0·21	7446	1·23	7475	0·58	7493	0·61	74141	1·03	74165	1·23	74191	1·91
7406	0·74	7423	0·39	7447	1·17	7476	0·51	7494	0·74	74145	1·06	74167	3·70	74192	1·62
7407	0·74	7425	0·39	7448	1·17	7480	0·45	7495	0·78	74151	1·11	74174	1·52	74193	1·62
7408	0·29	7427	0·39	7450	0·29	7481	1·10	7496	1·03	74153	1·11	74175	1·35	74196	1·17
7409	0·29	7430	0·21	7451	0·21	7482	0·67	7497	4·60	74154	1·85	74176	1·23	74197	1·17
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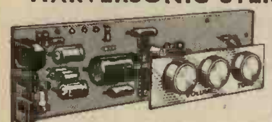

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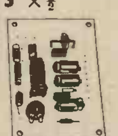

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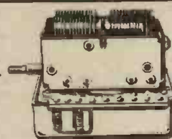

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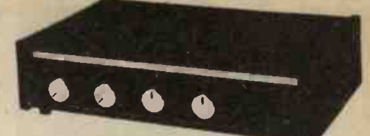

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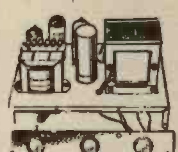

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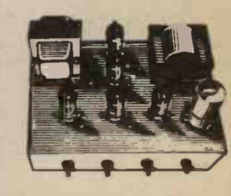

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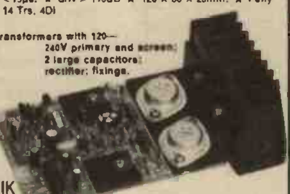
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