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ELECTRONICS

DECEMBER 1979

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AS SEEN IN
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The Compukit UK101 has everything a one board 'superboard' should have.

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★ 48 chars by 16 lines — 1K memory mapped video system providing high speed access to screen display enabling animated games and graphs.
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★ Standard KANSAS city tape interface providing high reliability program storage — use on any standard domestic tape or cassette recorder.
★ 4K user RAM expandable to 8K on board £49 extra.
★ 40 line expansion Interface socket on board for attachment of extender card containing 24K RAM and disk controller. (Ohio Scientific compatible).
★ 6502 machine code accessible through powerful 2K machine code monitor on board.
★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.
★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.

*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print.

COMMANDS

CONT	LIST	NEW	NULL	RUN	

STATEMENTS

CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF..GOTO	IF..THEN	INPUT	LET
NEXT	ON..GOTO	ON..GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

EXPRESSIONS

OPERATORS
+ - * / ↑ NOT.AND.OR. > < <> > = < = RANGE 10^{-32} to 10^{+32}

VARIABLES
A.B.C. .Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus $.e.g.A$

SPECIAL CHARACTERS
@ Erases line being typed, then provides carriage return, line feed.
← Erases last character typed.
CR Carriage Return — must be at the end of each line.
: Separates statements on a line.
CONTROL/C Execution or printing of a list is interrupted at the end of a line. "BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.
CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.
? Equivalent to PRINT

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FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

STRING FUNCTIONS

ASC(X$)	CHR$S(I)	FRE(X$)	LEFT$(XS.I)
RIGHT$(X$.I)		STR$(X)	
LEN(X$)	MID$(X$.I.J)		
VAL(X$)			

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video 100

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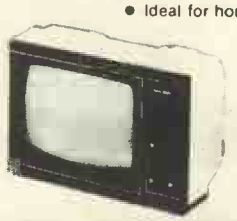

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- 12" diagonal video monitor
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- Compatible with many computer systems
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PRACTICAL
ELECTRONICS

VOLUME 15 No. 12 DECEMBER 1979

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GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR JANUARY ISSUE WILL BE ON SALE FRIDAY, 14 DECEMBER 1979
(for details of contents see page 33)

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- Smoother running
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
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- Extended energy storage

..in kit form

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The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R P M. Contact breaker burn is eliminated by reducing the current by 95% of the norm.

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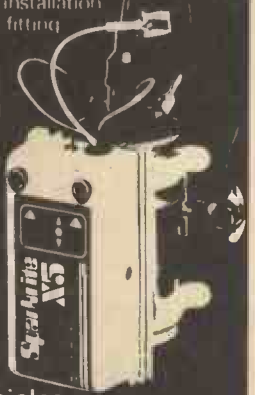

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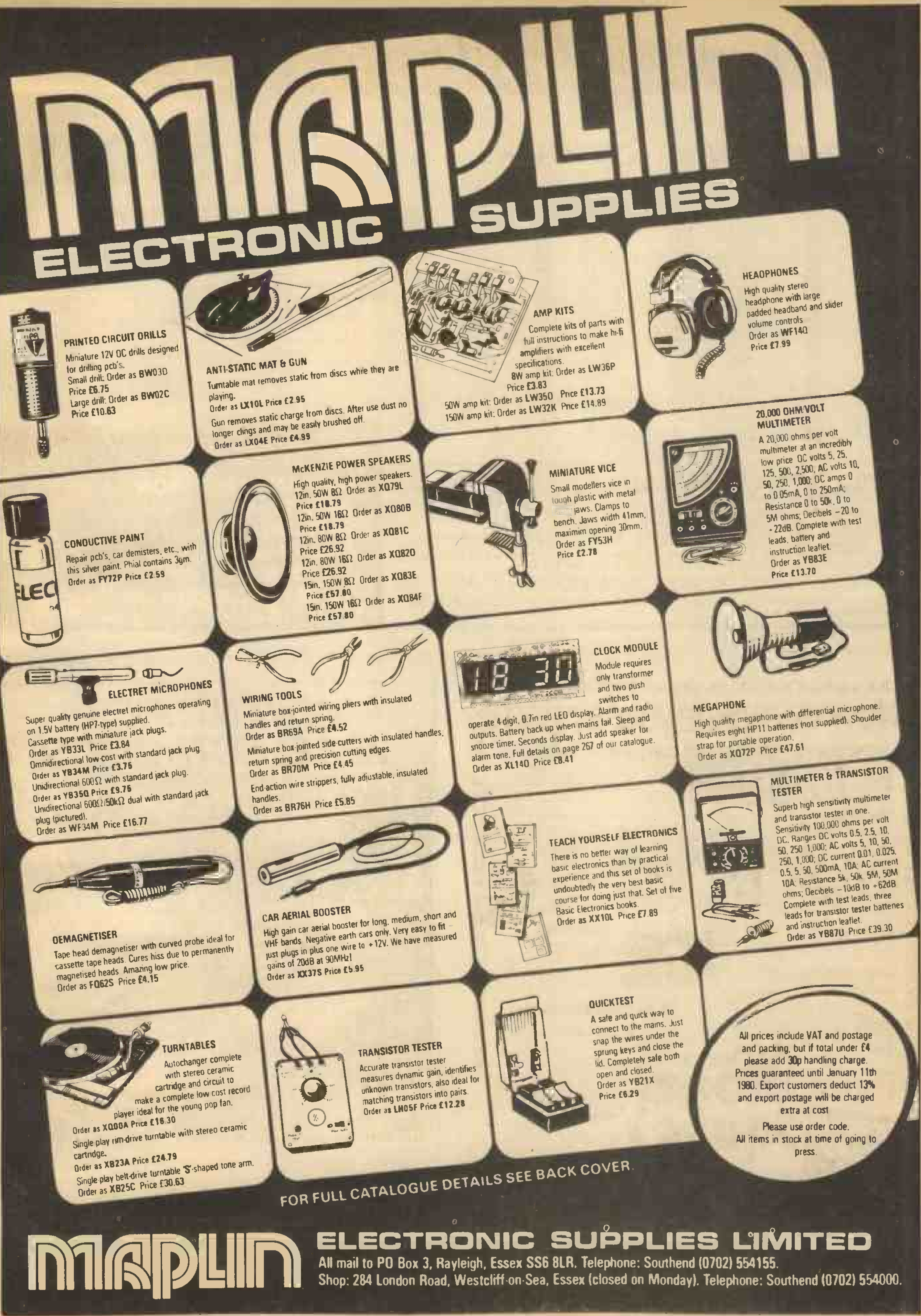

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30 x 30 WATT AMPLIFIER KIT

with BSR P200 belt drive deck and Shure M75 cartridge.

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Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max 8 ohm impedance.

£18.25 Per stereo pair £3.65 p&p

BSR P200

Belt drive chassis turntable unit semi-automatic, cueing device. **£25.50** p&p £2.60

A.D.C. QLM 30 Mk III Magnetic Cartridge to suit. **£7.95**

BSR

Manual single play record deck with auto return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r p m spindle adaptor ideally suited for home or disco use

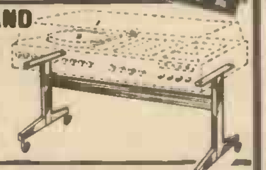
OUR PRICE **£11.25** p&p £2.75

GARRARD DECK MODEL CC 10A

Record changer with cueing device fitted with stereo ceramic cartridge ready to fit into your own plinth.

£8.15 p&p £2.05 Size 12" x 8½"

UNIT AUDIO STAND



Can be used with TV too! Finish in chrome with decorative wood spacer fitted with 4 Kenrick Mini Meteor castors

£3.95 £2.25 p&p

24" x 12½" x 11½" approx.

BARGAIN FOR PERSONAL SHOPPERS ONLY

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Features 8 watt total output. Full size BSR manual turntable with cueing and auto return. Socket for tape in and out and stereo headphones complete with speakers. **£35.75**

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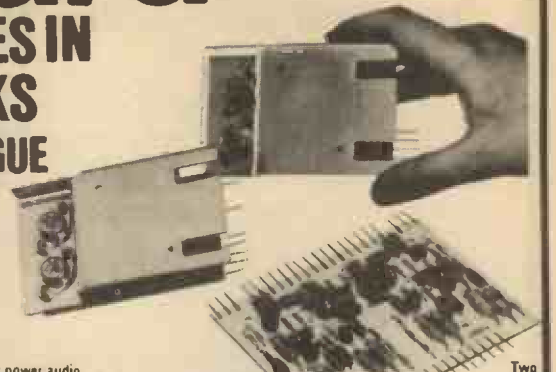

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1 PACK 1. 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input.
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illus. OUR PRICE p+p £1.00 **£7.65**

ACCESSORIES

Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance

£3.00 plus £1.50 p&p

Two Way Speaker Kit
Comprising of two 8" x 5" approx 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors **£4.05** per stereo pair plus £1.55 p&p

AVAILABLE ALSO TO PURCHASERS OF THE 10 + 10 AMPLIFIER KIT.

10 + 10 AMPLIFIER KIT

An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit.

Size approximately 9¼" x 8¾" x 4"

p&p £2.25 **£12.25**

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100 WATT MONO DISCO AMP

Size approx 14" x 4" x 10½"
Brushed aluminium fascia and rotary controls
Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2 or vice versa Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak

p&p £4.05 **£66.45**

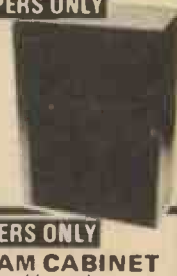
50 WATT MONO DISCO AMP

£30.60 p&p £2.70

Size approx. 13⅜" x 5¼" x 6¾"
50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

FOR PERSONAL SHOPPERS ONLY

DUO II SPEAKERS



Attractive teak finish, modern design, incorporating 2 speaker units—8" approx woofer and 2½" approx tweeter 45 to 1800 Hz. Impedance 8 ohms. Power 15 watts RMS
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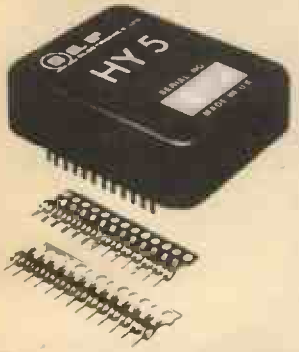

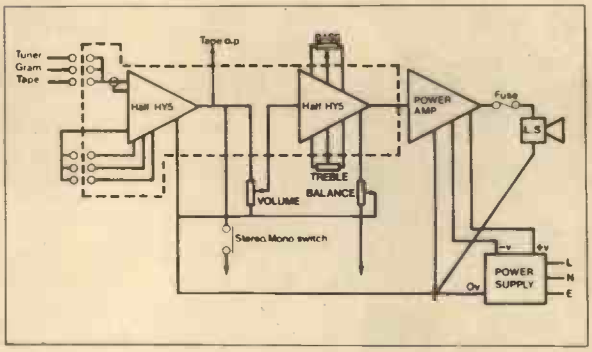

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

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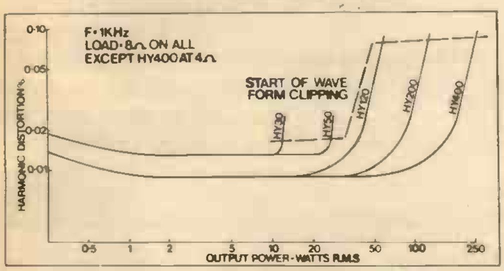
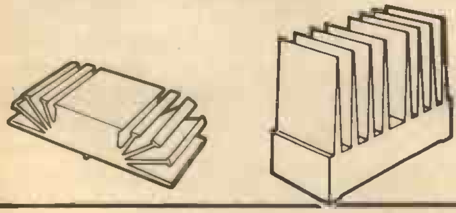
THE POWER AMPLIFIERS

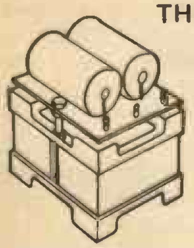




Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance — all models 4 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 1·00 KΩ
Frequency response — all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS



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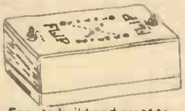

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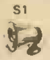

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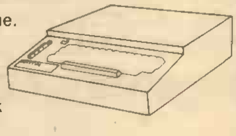

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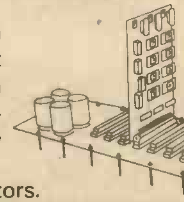

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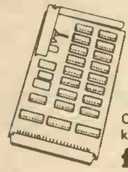

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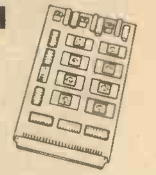

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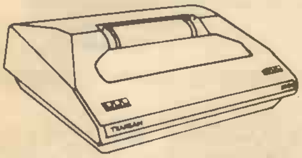

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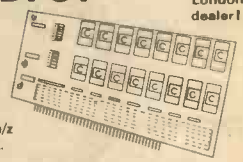

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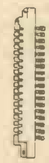

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TRITON DOCUMENTATION

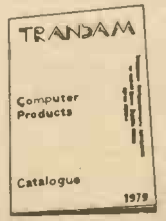
Available separately as follows — Prices include P&P

Triton manual. Detailed circuit description and constructional details and user documentation on level 4·1 monitor and basic	£5.70
L4·1 Listing listing of 1k monitor 2k tiny basic	£4.20
L5·1 User documentation on level 5·1 firmware	£1.20
L5·1 Listing listing of 1·5k monitor and 2·5k basic	£5.50
L6·1 User documentation on 7k basic interpreter	£1.80
Motherboard, 8k Ram and 8k Eprom constructional details	£5.00

User group newsletter subscription **£4** per annum. Triton software send SAE for list of programs available for Triton.

HOME COMPUTING CATALOGUE

If you're in town, visit our showroom in Chapel Street, next to Edgware Road tube station. We have Tritons on display plus a comprehensive range of components and accessories, specifically for personal computer users. Books, mags, tapes, data, cables plus much more. Showroom open 6 days a week. (Half day Thurs., from 1.30).



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40p +SAE
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TRANSAM — VAT ALL PRICES EXCLUDE VAT

**TRANSAM COMPONENTS LTD.
12 CHAPEL STREET
LONDON. NW1 TEL: 402 8137**

Quality audio modules and accessories for

S450

STEREO FM TUNER
Fitted with phase lock-loop

£26·73
+ 40p p&p

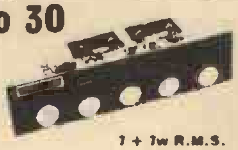
FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3 0 µV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

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, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

Stereo 30

COMPLETE AUDIO CHASSIS

£22·06
+ 66p p&p



7 + 7w R.M.S.

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than ·5% (Typically ·3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

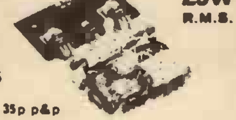
The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

25w R.M.S.

AUDIO AMPLIFIER MODULE 25 Watts RMS

£5·39 + 35p p&p



OUTPUT POWER	25 Watts RMS
SUPPLY	30-50 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0 1%.

AL80

35w R.M.S.

AUDIO AMPLIFIER MODULE

£8·54
+ 35p p&p

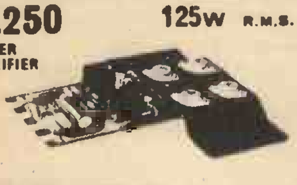
OUTPUT POWER	35 Watts RMS
SUPPLY	40-60 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%.

AL250

125w R.M.S.

POWER AMPLIFIER



£20·49 + 76p p&p

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80 V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION	
50 WATTS into 4 ohms	0·1%
50 WATTS into 8 ohms	0·06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

10w R.M.S.

AUDIO AMPLIFIER MODULES

£4·36 + 35p p&p

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than ·25%
LOAD IMPEDANCE	8-16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz-25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED POWER SUPPLY

£5·06 + 35p p&p

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

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO PRE-AMPLIFIER

£18·46
+ 45p p&p

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms } For an output 250 mV
2. RADIO TUNER	100 mV/100 K ohms
3. MAGNETIC P.U.	3·5 mV/50 K ohms
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10-20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 × 90 × 33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER

£3·43
+35p p&p

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3 5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

£8·95
+ 35p p&p

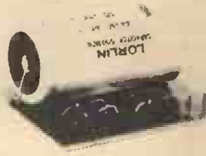
The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz-20 kHz (−3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	−60 dB
SIGNAL/NOISE RATIO	−65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450.etc.
Transformer T538.

Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 × 43 × 26mm.



£1·73
+ 35p p&p.

BP124 SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £4·03
+ 35p p&p. 5 WATTS —

STA15 STEREO AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The STA15 kit comprises the following Bi-kits modules, 2× AL60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab. power supply, 1 × BMT80 transf. giving 15 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £40·68 + 62p p&p.

STA15 ACCESSORY KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £21·94 + 86p p&p. Order No. 2240.

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·68 + 55p p&p.
T2050 For use with Stereo 30
Order No. 2050 Price: £3·74 + 55p p&p.
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £6·21 + £1.00 p&p.
BMT250 For use with AL250
Order No. 2035 Price: £7·30 + £1·10 p&p.
2040. For use with AL60
Order No. 2040 Price: £5·98 + 80p p&p.
2041. For use with AL80, AL120 and AL250
Order No. 2041. Price: £7·82 + 86p p&p.

CASES

TEAK 30, 32 × 23 × 8cm, designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. **£6·27.** p&p 70p.

TEAK 60, 42 × 29 × 9cm, for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve – has no front or back panel. o/n 140. **£8·63.** p&p 85p.

Just a little bit more... NASCOM-2

Compare its features:

*Z-80A 4MHZ. CPU: The most powerful 8-bit processor on the market.

*8K Basic: resident on board, MICROSOFT Basic, the industry standard, with extensions for on-screen editing, graphics, machine code interfacing. Optimised for speed (see benchmarks below).

*Full 57 Key Licon solid state keyboard: switch mechanisms are contactless, high reliability professional units for long trouble free life. Keyboard is mounted seperately to avoid straining main P.C.B.

*Total of 20K on-board memory: 2K monitor (Nas-Sys 1), 1K Video RAM, 1K Work space RAM, 8K Microsoft Basic, 8K user RAM.

*Kansas City cassette interface: for reliable storage of programs and data at 300 or 1200 baud, with full checksum error detection.

*Nas-sys monitor: A powerful 2K machine code monitor provides an ideal environment for learning about and developing machine code programs. Nas-sys uses a blinking non destructive cursor, with 22 commands. ASCII terminals are fully supported via the serial interface; users can add their own I/O drivers via the system I/O vector table to support other devices.

Nas-sys commands are:

A—Hex arithmetic	N—return to normal
B—set breakpoint	O—Output to P.I.O.
C—Copy	Q—Query input port
E—Execute	R—Read tape
G—Generate	S—Single step
H—Operate as half duplex, terminal.	T—Tabulate memory
I—Intelligent copy	U—activate user I/O drivers
J—Execute at FFA	V—Verify tape
K—set keyboard options	W—Write tape
L—load from tape	X—set external device
M—Memory modify	Z—execute at FFD

*On board P.I.O. — An uncommited P.I.O. (MK 3881) giving 16 programmable I/O lines with handshake.

*On board RS-232-Will interface directly into any standard teletype — allowing use of BASIC or Nas-sys from the teletype.

*Full on-screen editing: a complete screen editor with cursor movement (UP, DOWN, LEFT, RIGHT), insert and delete, backspace etc.

Screen display of 16 lines x 48 characters: Stable, clear display to British television standards. Full 128 ASCII character set; option for further 128 graphics characters.

*Fully buffered NASBUS compatible: Well defined bus structure with a range of expansion cards; including (shortly) a floppy disc system with CP/m — the industry standard operating system.

	Nett	Vat	Total
Nascom-2	295.00	44.25	339.25
Power supply	24.50	3.68	28.18
10 C15 cassettes	4.44	0.66	5.10
Z-80 Programming manual (Mostek)			4.50
Z-80 Microcomputer handbook			6.95
Practical microcomputer programming the Z-80			20.00
Sargon-8K Z-80 Chess program (book)			9.50

PERSONAL COMPUTER WORLD BENCHMARK TESTS

	APPLE II		RM. 380Z	PET
BM 1	1.5	1.1	1.4	1.7
BM 2	3.2	5.4	6.5	9.9
BM 3	7.3	11.1	13.2	18.4
BM 4	7.2	11.6	13.9	20.4
BM 5	8.9	12.6	15.0	21.7
BM 6	18.6	19.3	22.3	32.5
BM 7	28.2	27.6	31.6	50.9
BM 8		5.2	6.2	12.3

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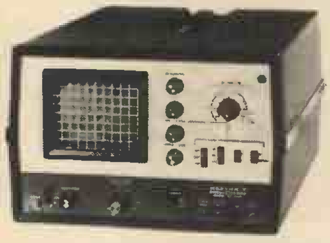
What's new from Heathkit?

IM 2212—Auto Ranging DMM



IO 4105—Single Beam 5 MHz Oscilloscope

IM 5217—Portable Multimeter

Plus

* GD 1290—VLF Metal Locator
* HX 1681—CW Transmitter
* IR 5201—XY Recorder
* CI 1525—Car Temperature Indicator

These brand new self-assembly kits are designed to the highest specification.

The step-by-step instructions make them easy to build at your leisure in your own home.

And first class quality makes them excellent value for money.

Details of the full Heathkit range are available in the Heathkit catalogue. Send for your copy now.

IM 2215—Hand-held DMM

There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (0452 29451).

To: Heath (Gloucester) Limited, Dept. (PE 12), Bristol Road, Gloucester, GL2 6EE.

Please send a copy of the Heathkit catalogue. I enclose 20p in stamps.

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Soldering iron offer FREE

When you receive your catalogue you will get details of this free offer.

HEATHKIT

PE VOLUME 15 No. 12 DECEMBER 1979

THE COUNTRY

EVEN in the face of a Government paper, which basically reports that the microprocessor revolution will create more employment in the foreseeable future, and the recent Labour Party commitment to microelectronics at its conference, some bodies are still spreading gloom over the electronics industry and the country. Even if there are sound arguments behind such pessimistic views, we are pleased to report that at last we are beginning to stop procrastinating and get on with the job in hand.

Many component distributors have been reporting an increase of up to 60 per cent in sales, this increase started back in August—normally a quiet month in the industry. The boom is generally attributed to the employment of m.p.u.s in new designs and equipment causing a market expansion, especially in demand for memories. The problem is that we are now years behind the Americans and our industry has been so slow to react to the new technology that a very high percentage of the newly developed equipments are being imported because, as yet, there are no British competitors.

It seems to us that, as a nation, we excel at the investigation and discussion of possible social problems and both management and workers—usually for very different reasons—are initially set against the speedy introduction of new techniques and technology. Both the lengthy strikes at *The Times* and ITV have had much to do with new technology. Unless our basic attitudes to progress change we will suffer a lower standard of living and new technology *will* cause unemployment—because we refuse to allow it to be used. We must all be prepared to change our views and retrain ourselves if necessary; if we do and if we move quickly we will ultimately all prosper.

THE HOBBYIST

Unfortunately the present buying spree by industry is creating component supply problems and once again we suspect the hobbyist is beginning to suffer. There has been a world shortage of ROMS and this has affected the supply of parts for home computers. Delivery dates are again lengthening and sometimes being broken by manufacturers, so have some sympathy with your component retailer if he is out of stock and says it could be a month or two before a certain device is again available—very often he can only pass on information from the manufacturer and that information has, in the past, sometimes proved to be unreliable.

These problems also have a bearing on the projects we bring you. Recently we have been investigating the possibility of publishing a constructional design for one of the latest devices, only to discover that no mask-programmed single chip processors, suitable for our purpose, were available in less than six months. Steps are now being taken to circumvent the problem with the use of a PROM—this alternative will cost slightly more but the six months gained will be worth it. However, the supply of PROMS and RAMS is now under some strain so we must also watch that position carefully. The time problem is not because we are small hobbyist buyers—we have been discussing a device costing about £6,000 to get into production with one of the world's largest suppliers.

Mike Kenward

Editorial Offices:
Practical Electronics,
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Dorset BH15 1JG
Phone: *Editorial* Poole 71191

We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £3·75 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

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

by Alan Turpin and David Shortland

HUNTRON TRACKER

The Huntron Tracker is a versatile instrument for trouble-shooting solid state circuits. The unit is capable of in-circuit testing of a number of descrete components: i.c.s, transistors, FETs, diodes, l.e.d.s, Zeners, UJT's, electrolytic capacitors and gate controlled devices.

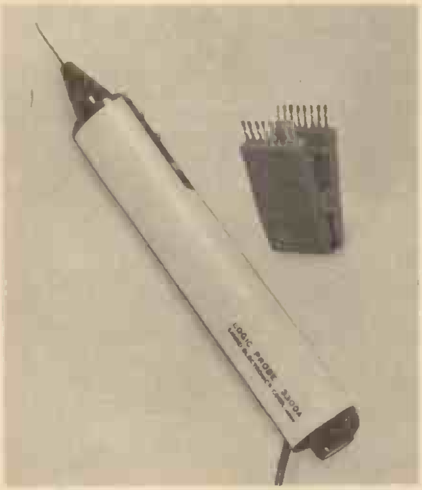
The Tracker uses a scope display, two non-polarised leads and three impedance ranges. The scope display show the condition of the device under test indicating "shorts", "opens" and "leaks". Both the forward and reverse response of the component can be displayed on the scope screen.

The price of the Tracker will be around £500. **MTL Microtesting Limited, 1-15 Butts Road, Alton, Hants. GU34 1EN (0420 88022).**

DTL/TTL, CMOS PROBE

The 3300A logic probe which has a 1 Megohm input impedance is supplied with two i.c. clips (a single pole and a 16 pole), carrying case and operating instructions.

The instrument operates on voltages from 5V to 18V d.c. and is protected against reverse p.s.u. connections and input over voltage.



Two l.e.d.s are used to detect high and low logic levels with the TTL threshold being 2·2V ± 0·2V for logic '1' and 0·6 ± 0·2V for logic '0'. The CMOS threshold is 70 per cent of the supply voltage ± 0·5V (logic '1') and 30 per cent of the supply voltage ± 1·0V (logic '0').

The price of the 3300A is £14·50 plus VAT and p&p. **Watford Electronics, 33/35 Cardiff Road, Watford, Herts. WD1 8ED (9023 40588).**

NEW CASES

Three new cases have been added to Vero Electronics range of moulded enclosures.

A desk top case (228 × 216mm) which is ideal for control equipment and keyboards is available in two versions, one with a raised top unit for digital readouts, encoders and other switches. Both have a base section moulded with an integral rear panel to accommodate connectors and plugs. Six mounting bosses are also provided in the base with holes to take self-tapping screws. Top and base sections screw together and the kit comes complete with aluminium front panels and fixing screws.

The other case, 150 × 85 × 45 mm high, has a front panel for identification and controls, which is protected by a raised edge all round. Assembly of components and connections to the front panel is simple as, with the case cover removed, components are accessible from all sides. The front panel is connected to the base by moulded posts and retained by the case cover. P.c.b. mounting pillars are moulded into the base, and a raised end surface is provided for cable grommets or components.

The price of the three cases are £9·50, £7·60 and £4·60 respectively.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants SO5 3ZR (042 15 69911).

DRILL AND DE-BURR

The step configuration of these Unibits allows drilling and simultaneous de-burring of a range of holes with one bit. Five bits cover holes from 4mm to 34mm in 1mm or 2mm

steps. Unibits are said to cope with sheet steel, brass, aluminium, copper, plastic and wood. Price from £7·38 inc. VAT, exc. p&p.

Toolrange Ltd., Upton Road, Reading RG3 4JA (0734 29446).

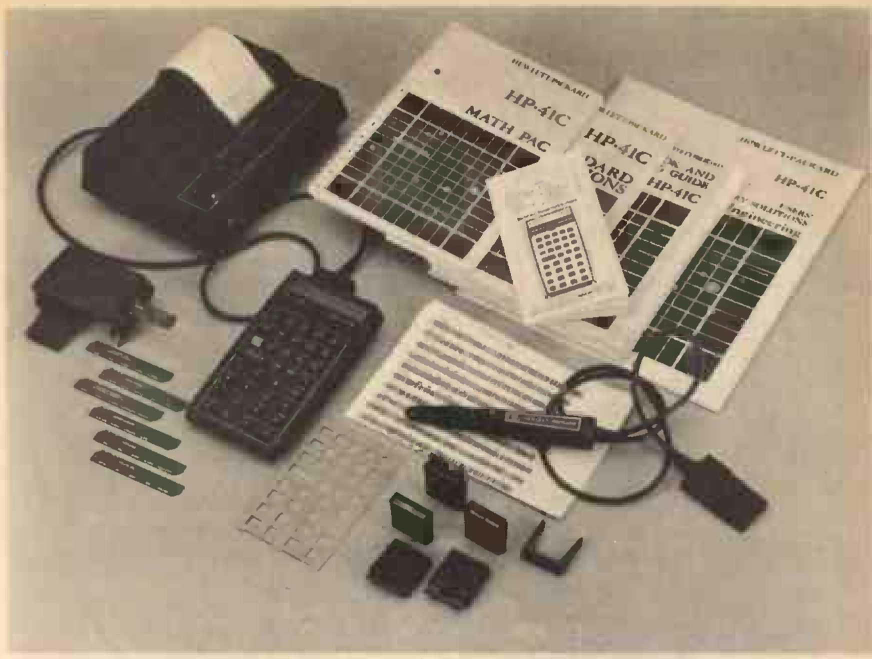
HP-41C

The latest programmable calculator from Hewlett Packard has a 12-character liquid crystal display, alpha-numeric keyboard and a memory which can retain data and programs after the calculator has been switched off. The type of memory can be selected from 448 bytes or 63 data storage registers or any blend of bytes and registers required.

The HP-41C has a total of 130 mathematical, scientific and statistical functions which are identified on the keyboard or can be used by either spelling the name of the function or assigning it to a particular key replacing a function which is not needed in the calculation. Two overlays are provided to enable users to re-label the keyboard with the functions they use most.

For problems in specialised areas such as engineering, aviation, finance, surveying etc. plug in modules are available together with handbooks. Any created programs should be assigned a name and then keyed in and whenever the program name is entered the program is automatically carried out.

Peripheral devices available for use with the HP-41C include: memory modules, magnetic card readers, plotting printer and an optical reader for bar codes. The card reader can be used to record programs which on replay become part of the calculator's memory. The programs on the card can also be instructed only to execute the program and not allow alterations. The thermal printer can print numbers, letters (upper and lower case), special characters, graphics and produce high resolution plots from data of programs.

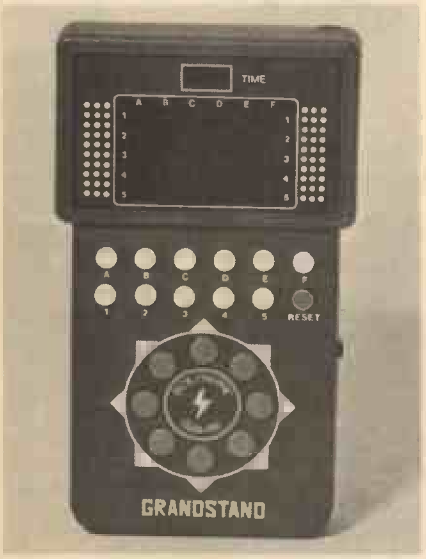


The price of the HP-41C is £190, the card reader £135 and the printer £260 plus VAT and p&p.

Hewlett-Packard Ltd., King Street Lane, Wokingham, Berks. (0734 784774)

US CRAZE

As one of the latest crazes in the US at the moment is hand held computer games you won't be surprised to hear that many manufacturers are predicting this Christmas



as the start of the "craze" period for these games over here. Tempus are offering a range of games which includes Digits, a variation of Mastermind or Codebreaker where the player must guess a hidden number in as few attempts as possible.

Amaze-A-Tron which is a maze game for two players who must find their way through a maze using coloured pegs on a 25 key matrix board. There are eight game variations and over one million different mazes available.

The U.F.O. Master Blaser Station is a game in which you shoot down as many U.F.O.s as possible before they reach your station. The U.F.O.s can change course, disappear or descend in pairs and you can increase the difficulty by increasing the speed of descent.

A hand held version of Solitaire is also available in which you must clear all the lights except one on the display panel by process of elimination. Each game is timed and two speeds are available.

The price of these games vary from £13·95 to £22·50 ex. VAT and p&p. **Tempus 19–21 Fitzroy Street, Cambridge CB1 1EH.**

PLUG-IN TIMERS

A new range of plug-in timers introduced by Adonis Instruments can be used to time intervals between 1 sec and 100 hours.

Both "delay on energise" or "interval delay" types are available and all types have the facility for "external start" from a remote signal. A range of voltage types are stocked, varying between 12V and 240V with each timer having 2-pole changeover contacts rated at 10A/250V.

Protection against mains transients and reverse polarity connection are built into the timers and the time period can be set either with the control on top of the case, or fixed and adjusted with an external control.

Each timer fits into standard octal or 1-pin bases and are compatible with many existing types. The price range of the timers is from £15·50 to £18·00 excluding VAT and p&p.

A.I., 70 Broomfield Road, Chelmsford, Essex CM1 1SW (0245 68459).

3½ DMM

The latest DMM from Lascar Electronics is claimed to be the first l.c.d. mulimeter with an indefinite "digital hold" facility.

The instrument which is housed in an ABS case with an adjustable carrying handle will give over 2000 hours life from a single battery.

The 0·5 l.c.d. has a built-in battery low indicator.

With a basic accuracy of 0·1 per cent the DMM features 10 voltage, 10 currents and 5 resistance ranges with resolutions of 0·1 mV, 0·1μA and 0·1 ohms. Inputs are via 4mm connectors which are protected against overloads and transients.

The multimeter is supplied complete with battery and operating instructions at a cost of £69·00 plus VAT and p&p.

Lascar Electronics Limited, Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex, SS13 1LH (0268 727383).

CRYSTAL SET

For anyone trying to find a Christmas present suitable for young children that will be both educational and interesting then the answer could be a crystal set. Many of us had our first introduction to electronics through such a set and Home Radio are hoping they will be able to addict youngsters to the hobby with their crystal set which is easy to build and requires no soldering. The price of the set is £2·50 including VAT and p&p. **Home Radio (Components) Ltd., 234–240 London Road, Mitcham, Surrey CR4 3HD (01-648 8422).**

BIMBOARD BUS-STRIP

To augment their existing range of 0·1in breadboards, Boss Industrial Mouldings have introduced a 2 line Bus-Strip for use where two existing integral rails of a Bimboard are

insufficient for a particular circuit design. The price of the bus is £1·92 excluding VAT and p&p. **Boss Industrial Mouldings Ltd., 2 Herne Hill Road, London SE24 0AU.**

OPTOELECTRONIC SHORTFORM

Optron, the US specialist manufacturer of optoelectronic devices whose products are handled exclusively in the UK by Norbain Electro-Optics Division has just brought out a new shortform catalogue giving details of its latest optoelectronic emitters and sensors. They range from phototransistors, infrared light emitting diodes, and matched emitting diodes and phototransistors to photodarlingtons and photodiodes.

Norbain, Electro-Optics Division, Norbain House, Arkwright Road, Reading, Berkshire RG2 0LT (0734 864411).

NEOSID

Neosid Limited have recently established a new outlet to cater for the amateur constructor.

A broad selection of the parent company's products are included in their new Small Order Catalogue, which covers a full range of ferrite components i.e. beads, screw cores, rods, E, I and U cores, also coil assemblies, plastics formers and trimming tools.

The catalogue is available free of charge from **Neosid Small Orders, P.O. Box 86, Welwyn Garden City, Herts, AL7 1AS.** (Please send stamped addressed envelope.)

PANEL TIME

Have you ever wanted an l.c.d. clock to mount on the front panel of a project, amateur transceiver, teletext control box?

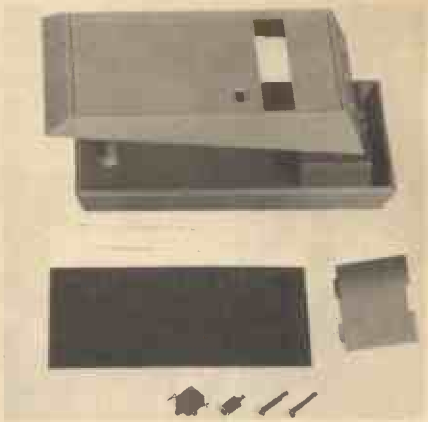
Ambit International are now stocking a miniature panel clock that can display time,

day and date. The unit is quartz controlled, has a back light, and an alarm function to drive a bleeper or other indicator. Running consumption is 6µA, accuracy is within ±2·5 minutes per year, and height of the characters is up to 0·5in. The display shown has a character height of 0·25in. Price is £10·60 inc. VAT and p&p.

Ambit International, 2 Gresham Road, Brentwood, Essex, CM14 4HN.

CSC CASE

The new hand-held case from CSC has been designed to house small, portable electronic systems such as calculators, counters, remote control units, communications devices and portable meters etc.



Measuring 76 × 152 × 38mm the case comes complete with assembly screws, antenna connector, red plastic front facia panel, subminiature jack connected to a battery snap connector and a battery compartment. There is sufficient room for keyboards, speakers, microphones or controls on the front panel.

The price of the case is £3·00 ex. VAT and p&p. **CSC, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.**

FREQUENCY SYNTHESISER

The FS-1B is a frequency synthesiser control unit module, comprising input prescalers, swallow counter, programmable divider, switchable filters and clock buffer.

It is programmed from a three line connection (clock/data/enable) with a 15 bit word that determines the reference frequency and output frequency of the VCO connected in the phase locked loop.

Frequencies in the range 20kHz to 200MHz may be programmed in conjunction with either discrete switch entry, hardwiring or simple computer control. A simple BASIC program exists to provide facilities for LF/MF/HF/VHF tuning options, so that owners of NASCOM, PET and similar systems may readily operate the module in conjunction with a voltage tuned radio having a buffered local oscillator output.

Various reference frequencies are available, both in conjunction with an on-board selection in the data control, and the use of different frequency crystals.

Priced at £24·95 in one-off quantities, the FS-1B is available from **Ambit International, 2 Gresham Road, Brentwood, Essex CM14 4HN (0277 227050).**

PE AT BREADBOARD '79

DECEMBER 4th–8th AT ROYAL HORTICULTURAL HALLS, ELVERTON ST., WESTMINSTER

We will be exhibiting a range of projects and hope to include: Ultrasonic Alarm; Solid State Car Instruments; EPROM Programmer; Ultrasonic Cleaner; Teletext; Digital Frequency Meter; Compukit UK101 with peripherals; Short Range Communication Transmitter and Receiver; Modem; Pushbutton Car Radio; PE Diamatic and perhaps a few more forthcoming attractions. Interested? Then come along and see for yourself.

A computer range from £500

The number one micro-computer in Britain today, selling more than 1,000 per month!

The Commodore Pet computer range is versatile and affordable. Programs can be written in Basic, the easiest computer language to learn. There is also machine language accessibility for professionals.

The Pet is a fully expandable system, peripherals being available for many specialist applications, (peripherals such as dual drive floppy discs and printers).

There are already over 300 standard programs, tested and in use in commercial, scientific, educational and many other applications throughout Britain. The Pet is a portable and professional computer that operates by plugging into a normal 13 amp mains. Service and advice is readily available through the nationwide network of dealer outlets.

For a demonstration contact your local dealer – some of whom are shown here. In case of difficulty contact Consumer Information Dept (PE2), Commodore Systems, 360 Euston Road, London NW1.

commodore

We made small computers big business.

Associated Commodore dealers:

BIRMINGHAM
Camden Electronics 021-773 8240
CPS (Data Systems) 021-707 3866
Taylor Wilson Systems Knowle 6192
BOLTON
B & B Consultants 0204-26644
BOURNEMOUTH
Stage One Computers 0202-23570
BRADFORD
Ackroyd Typewriter & Adding Machine Co 0274-31835
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Sigma Systems 0222-21515
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DERBY
Davidson Richards 0332-366803
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Dyson Instruments 0385-66937
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Micro Centre 031-225 2022
EXETER
A.C. Systems 0392-71718
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Allen Computers 0472-40568
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Sumlock Bondain 01-253 2447
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Micro Computation 01-882 5104
LONDON NW4
Da Vinci Computers 01-202 9630
LONDON SW14
Micro Computer Centre 01-876 6609
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Adda Computers 01-579 5845
LONDON WC1
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MATLOCK
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Preston Computer Ctre 0772-57684
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P.P.M. Brookwood 80111
Petalect 04862-69032
YEOVIL
Computerbits 0935-26522
NORTH SCOTLAND
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NORTHERN IRELAND
Medical & Scientific Lisburn 77533

Semiconductor UPDATE...

FEATURING Z8000 7110 AY-3-1350

R. W. Coles

CAPTAIN ZILOG

Zilog would like to draw your attention to their brand new microprocessor, the 16 bit Z8000.

Interesting electronics engineers or hobbyists in yet another new microprocessor will probably be difficult, and the fact that a comparable device from Intel, the 8086, has been around for several months won't make things any easier.

Technically, the Zilog Z8000 is a big leap forward, with the power of a minicomputer and an address range of up to 8 megabytes. It is probably more powerful than the Intel competition, but it seems that it will soon itself be upstaged by an even more powerful device from Motorola, the 68000. All this has put Zilog in the awkward position of not being the first and not being the best either, a situation which called for an expensive publicity campaign to broadcast the news about the Z8000 before all those sockets are gobbled up by other 16 bit devices.

Now, one way to tackle the publicity task would be to commission some technical articles and advertisements extolling the virtues of the Z8000 architecture, but Zilog wanted to get all electronics engineers interested and there's only one way to do that, isn't there? Yes of course, they gave the Z8000 its very own comic book! Enter Captain Zilog, alias systems designer Nick Stacey, who is given the gift of "Zilog power" by an extra terrestrial being who hauls him bodily through his VDU screen.

Moulded in the fine tradition of Superman and Captain America, Captain Zilog hurls himself into adventures such as "The doom of Doctor D" and "Battle beneath the architecture" in a desperate (and of course successful) attempt to foil the dastardly plans of Doctor Diabolicus who intends to conquer Earth with the aid of his super main-frame computer. Liberally laced with comments such as: "Stick it in your Index Register Diabolicus" or "Dancin' data" and "Leapin' logic", the new Zilog comic book is a must, if you can get one!

This is certainly a novel way to publicise a new device, being less distracting than the "sex" alternative, and much less boring than a ten page sheet! I found after reading the comic book that I knew quite a lot about the Z8000.

BIG BUBBLE

The future bulk memory requirements of the Zilog Z8000 and all the other fourth generation microprocessors will probably not be satisfied by present floppy disc systems because their electro-mechanical technology is bulky, fragile, and likely to get more expensive rather than less as time goes by. The advantages of solid-state memory are self evident, and the bulk memory requirement will soon be satisfied by magnetic bubble memory chips which are compact and have no moving parts.

Bubble memories rely on the non-volatile storage and propagation of magnetic domains within a synthetic garnet substrate, and are thus quite different in their operation to conventional semiconductor RAM devices. Despite the differences in operation, bubble memories are made using the same basic techniques which have been developed for the other LSI technologies, and this has attracted many of the biggest semiconductor manufacturers including Intel, Texas Instruments, Rockwell, and Plessey in the UK.

Bubble memories are essentially serial in operation (like shift registers) rather than parallel (like RAM devices) and the speed at which the bit domains can be moved is limited to a few tens of kilohertz. Together, these factors make the access time to a particular location very much larger than the few hundred nanoseconds of today's RAM chips, but this is more than made up for by the huge amounts of data which can be stored by a single device. One of the latest bubble memory chips, the 7110 from Intel, stores 1 megabit, or looked at another way, 128 kilobytes, just think how many RAM chips you would need to handle that!

To speed up the access to any particular location, the 7110 is organised internally as 4096 separate shift registers, each of 256 bits. Two registers are used together to form a 512 bit page and on-chip processing treats each page as 64 8 bit bytes to achieve an average random access time of 40 milliseconds. That may be a lot slower than a conventional RAM but it's faster than a floppy disc and a lot more compact and reliable. A single 7110 could replace a complete mini-floppy drive in many applications.

RING-A-DING-DONG

A new single-chip tunes synthesiser, which can be programmed to generate up to 28 different tunes, has been introduced by General Instrument Microelectronics Limited.

Designated the AY-3-1350, the 28-lead NMOS device operates from a single 5V power supply, and is suitable for use in toys, musical boxes, doorchimes and other "novelty" products.

The standard circuit is pre-programmed with 25 short tunes plus 3 simple chimes, but this may be altered to suit the application. It is possible for instance, to program just a single tune consisting of up to 251 notes. The chip does offer great flexibility to designers, as it can also generate tunes from data held in external PROMs.

In addition to its programming options, the AY-3-1350 may operate in a number of different modes, making it suitable for a wide variety of different applications. In a doorchime for instance, it can be connected to play any one of 25 pre-selected tunes from the front door bell push, with one of 5 tunes from the back door. In addition a third bell push can be wired to play a simple chime. All the tunes would be selected by switches or matrix board inside the chime cabinet.

A further possibility is to connect the circuit to a number of different bell pushes on each door. This might be useful for telling which different tradesmen are calling, or which member of the family is required at the door. Mother, father, brothers and sisters could each have their own particular "call" tune. In addition further variations could be made for back door, side door, or even a bell push for alarm purposes in an apartment used by an elderly relation.

Applications exist in low cost paging systems, where key personnel are each allocated one tune. A brief tune played over loudspeakers in a noisy factory would be much easier to recognise than a spoken name.

The circuitry may be connected so that there is virtually no power consumption when in the stand-by condition. When any bell push is activated the circuit plays a tune and then automatically powers down again to conserve batteries—even if the visitor keeps his finger on the bell push. Releasing the button and repressing would cause either the same tune to play again, or the next tune to be selected, depending on the precise operational mode of the device. Alternatively, the circuit may be wired to replay tunes over again until the button is released.

With the addition of an external ROM or PROM the standard AY-3-1350 will play almost any tune or tunes desired. These could be 28 tunes averaging 8 notes each or one tune of up to 251 notes. This would provide about 1–2 minutes worth of music.

The pitch, tone and speed of tunes played may be independently set by simple external components. These may be either preset or brought out as potentiometers as a user control. Either switch closures may be used to trigger the device or a capacitive touch switch using a few external interface components.

EPROM PROGRAMMER
PART 1

A.A. BERK B.Sc. Ph.D.

THE EPROM programmer is a memory-mapped peripheral for the 2708 family of Erasable Programmable Read Only Memories (EPROM's) and programs at about the maximum possible speed (around 2 minutes). The p.c.b. contains its own power supply giving +12V, −5V, +27V, and only requires +5V and a 9–0–9 volt transformer. On board, there is 1K of RAM for storing information to be transferred to the EPROM. The EPROM may be read before or after programming for verification, and used *in-situ* as a normal 1K block of Read Only Memory. The programmer thus effectively expands the host system by 2K of memory (1K of EPROM and 1K of RAM), with the added facility of being able to reprogram the EPROM section. Connection of the machine is simple and almost identical to the *PE* VDU connections.

Eleven Address Bus Lines (A0–A10), eight Data Bus Lines (D0–D7), a Read/Write line and some address decoding logic is all that is required. Interface to the COMPUKIT UK 101 and many other machines requires just a couple of d.i.l. plugs. The COMPUKIT would allow the necessary routines to be written in BASIC. A minimal MPU system containing the machine is shown in Fig. 1.

Use of the programmer is restricted to writing the desired target program or data into the 1K of on-board RAM, running and checking it, and then switching on the programmer which then takes around two minutes to copy the RAM contents onto EPROM. The machine automatically hands EPROM and RAM back to the MPU system.

EPROM THEORY

Each individual cell within the 2708 contains a "floating gate", which is able to collect a charge from a "pumping" pulse-train produced by a programmer. When sufficient charge has been accumulated within this completely insulated storage element, the cell, initially showing a "one", will return a "zero" along its data line when read.

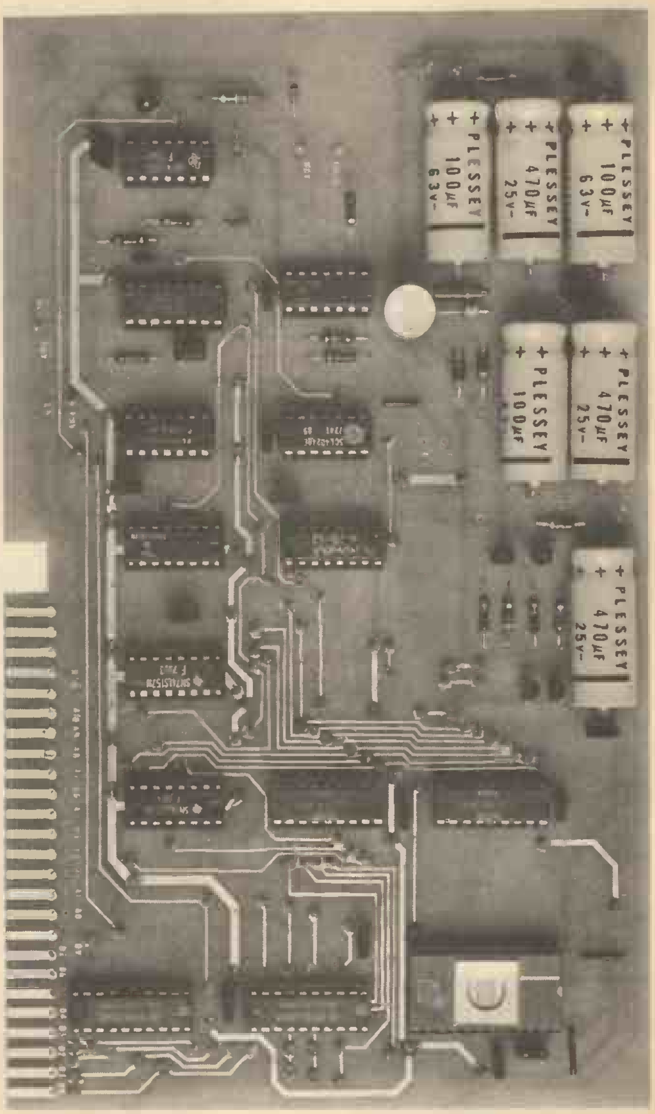
The 2708 family members have a quartz window in the upper surfaces of their packages. Through this, a strong ultra-violet light may penetrate to knock the electrons in the storage elements out of their shallow energy levels and allow them to leak away via the substrate.

This clears the cell back to a "one". The organisation of the 2708 causes 8 cells (one byte) to be read and programmed at a time, hence requiring normal Address and Data lines.

To program the EPROM, the programmer produces a succession of addresses along A0–A9, and, for each, presents the data to be programmed along D0–D7. The EPROM thus starts, after erasure, with FF (8 "ones") in each location.

The requirements of the 2708 family demand that *all* locations be presented with data a large number of times during the programming sequence. The number of such complete addressing cycles is determined by the speed of operation.

The Block and Connections diagram shows a typical Read Only Memory device with the addition of a Programming pin. This pin is pulsed up to +27 volts during programming.



The $\overline{CS}$/WE pin is a normal chip select except when programming, when it is held at +12 volts. The timing Diagram (Fig. 3), shows the signals necessary to program the 2708. It should be emphasised that the programming cycle consists of cycling through all 1024 memory locations N times and presenting the data to be stored over and over again. The sequence is as follows. $\overline{CS}$/WE is switched to +12V, the first address and data are presented and >10µS later, pin 18 is pulsed up to +27V. These conditions are held for 0·1 to 1ms (0·5ms is chosen for the machine presented here) and then pin 18 drops to zero and the next address and data loaded. The cycle from address 0 to address 1023 thus takes a little more than half a second.

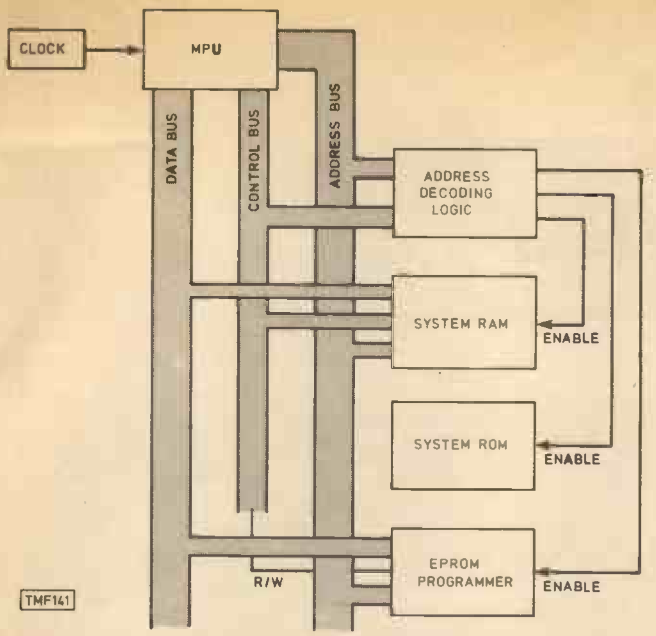
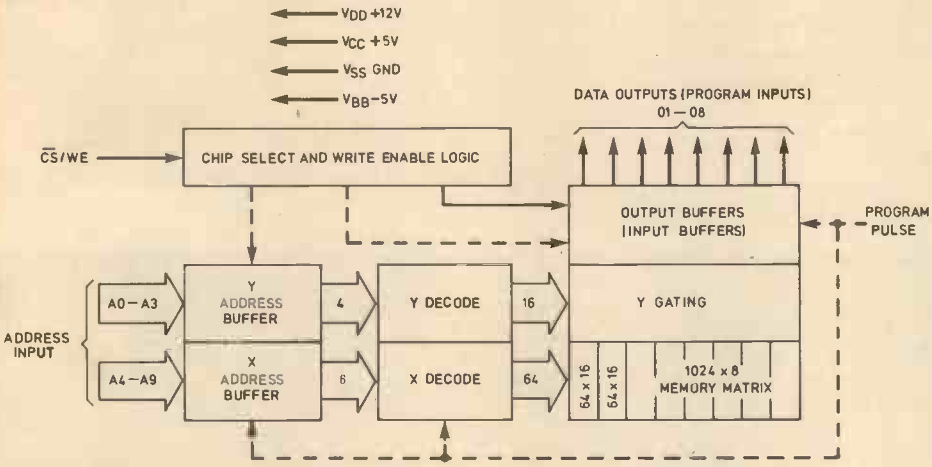


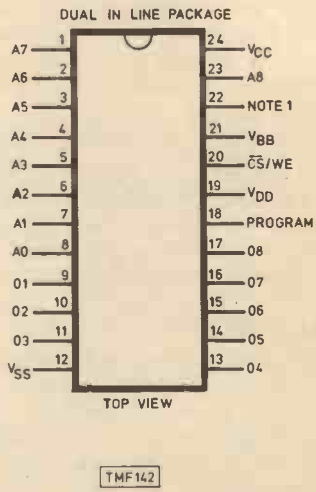
Fig. 1. Minimal system containing EPROM Programmer

This entire sequence is then repeated a number of times. The total number, N, of such loops is between 100 and 1000 (possibly more) depending upon the width (tp) of the program pulse (+27 volts). The formula for determining N is: $N \times tp > 100ms$. Thus, for 0·5ms, N is a minimum of 200. The total programming time for this number is slightly over 100 seconds.

The EPROM starts with its locations containing FF, thus if the programmer presents just FFs to the EPROM, it will retain its "erased" state. Even though each memory location must be accessed during programming (many times in fact), those presented with FF will remain untouched. Thus, a block of the EPROM may be programmed selectively without affecting the rest of the device. In fact, this is true of an EPROM already containing any other block of information. Contents of that block, whatever they may be, remain unaffected by the programming procedure as long as FF is presented to each of its locations during the cycles.

Indeed, a single bit in any given location can be set to zero selectively by presenting 1's everywhere else during programming.





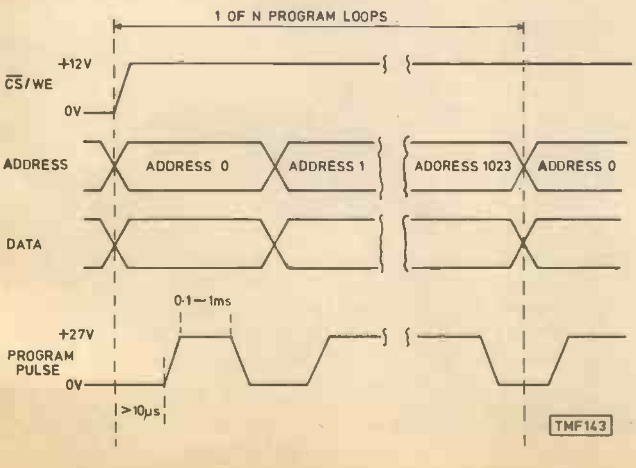
PIN CONNECTION DURING READ OR PROGRAM

MODE	PIN NUMBER 9–11, 13–17	12	18	19	20	21	24
READ	D_{OUT}	V_{SS}	V_{SS}	V_{DD}	0V	V_{BB}	V_{CC}
PROGRAM	D_{IN}	V_{SS}	PULSED 27V	V_{DD}	V_{DD}	V_{BB}	V_{CC}

PIN DESCRIPTION
A0–A9 ADDRESS INPUTS
01–08 DATA OUTPUTS
$\overline{CS}$/WE CHIP SELECT/WRITE ENABLE INPUT

Fig. 2. The 2708 EPROM

Fig. 3. Program timing diagram



It should be noted that the machine described here is *not* suited to the *single supply* 2716, nor types of EPROM other than 2704, 2708 and the multi-supply 2716. The reason for this is that the cycle-timing diagram requirements are quite unique to this family.

Fig. 4 shows the hardware set-up of the programmer. The heart of the device is in the timing control block. It is here that the cycles of sequentially presented addresses are produced, as well as the correct repetition rate and number of complete loops necessary.

The counter-produced addresses are switched over to the RAM and EPROM by the Address Bus switch after a Program Request signal is received. A Ready line, and l.e.d. on the p.c.b., signals when the programming cycle is in progress.

The RAM is held in the READ state, and the Counter addresses RAM and EPROM sequentially. The RAM (which holds the desired program) places the data on the Data Bus and hence onto the input pins of the EPROM. The timing control then waits a few microseconds and switches the 27 volt level on to the Program pin of the EPROM for 0·5ms.

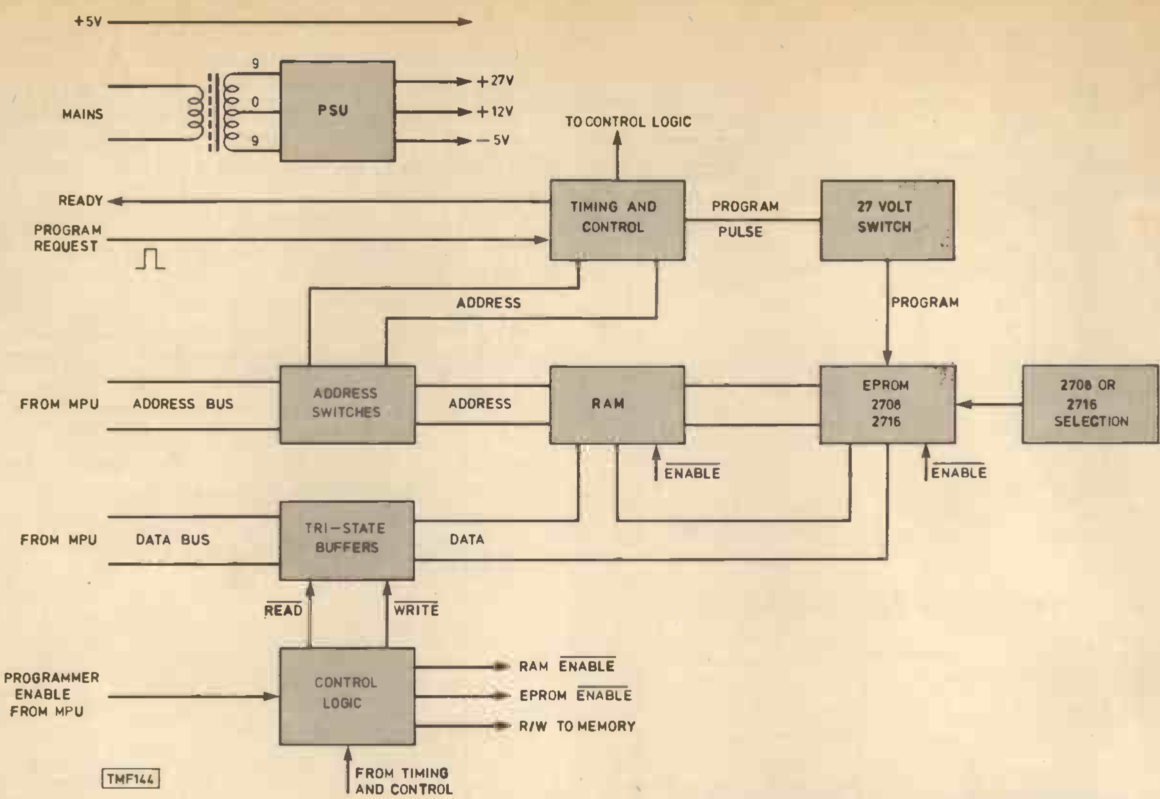


Fig. 4. Block diagram of EPROM Programmer

COMPONENTS . . .

Resistors

R1	1k ½W
R2	1k
R3	47
R4	150
R5	100
R6, R9	2k2 (2 off)
R7	15k
R8	8k2
R10, R12	10k (2 off)
R11	33k

All resistors ¼W 5% unless othewwise stated.

Capacitors

C1, C2,C4	470μF/25V elect (3 off)
C3, C5, C6	100μF/63V elect (3 off)
C7	1n ceramic
C8	100n ceramic
C9	10n ceramic
C10	33μ elect
C11 upwards	100n Supply decoupling

Transistors and Diodes

D1–D4	1N4004 (4 off)
D5, D6	1N914 (2 off)
D7	27V/1W Zener
D8	Any l.e.d.
TR1, TR3	BC549 (2 off)
TR2	BC559

Integrated Circuits

IC1	7474
IC2	4024
IC3	4040
IC4	2708 or 2716 EPROM
IC5, IC6	2114 (2 off)
IC7, IC14	74LS244 (2 off)
IC8, IC13	7400 (2 off)
IC9	74123
IC10–IC12	74LS157 (3 off)
IC13	79L05
IC14	78L12

Sockets

14 pin	4 off
16 pin	5 off
18 pin	2 off
20 pin	2 off
24 pin	1 off

Miscellaneous

T1 Mains transformer. Sec. 9–0–9V at 1A
S1 Double pole single throw
Pins for through-board connection
Double sided 0·156in. pitch 50-way edge socket
Printed circuit board

Constructor's Note

Kit of parts, including double-sided, drilled and tinned p.c.b. (not plated-through), is available from: **Modus Systems Ltd., Dept. EP, 29a East Cheap, Letchworth, Herts. SG6 3DA. £37·30 VAT + p.p. inc. P.cb. £8·45 inc.**

The kit excludes T1, S1, IC4 and edge socket, but sockets are included for all i.c.s.

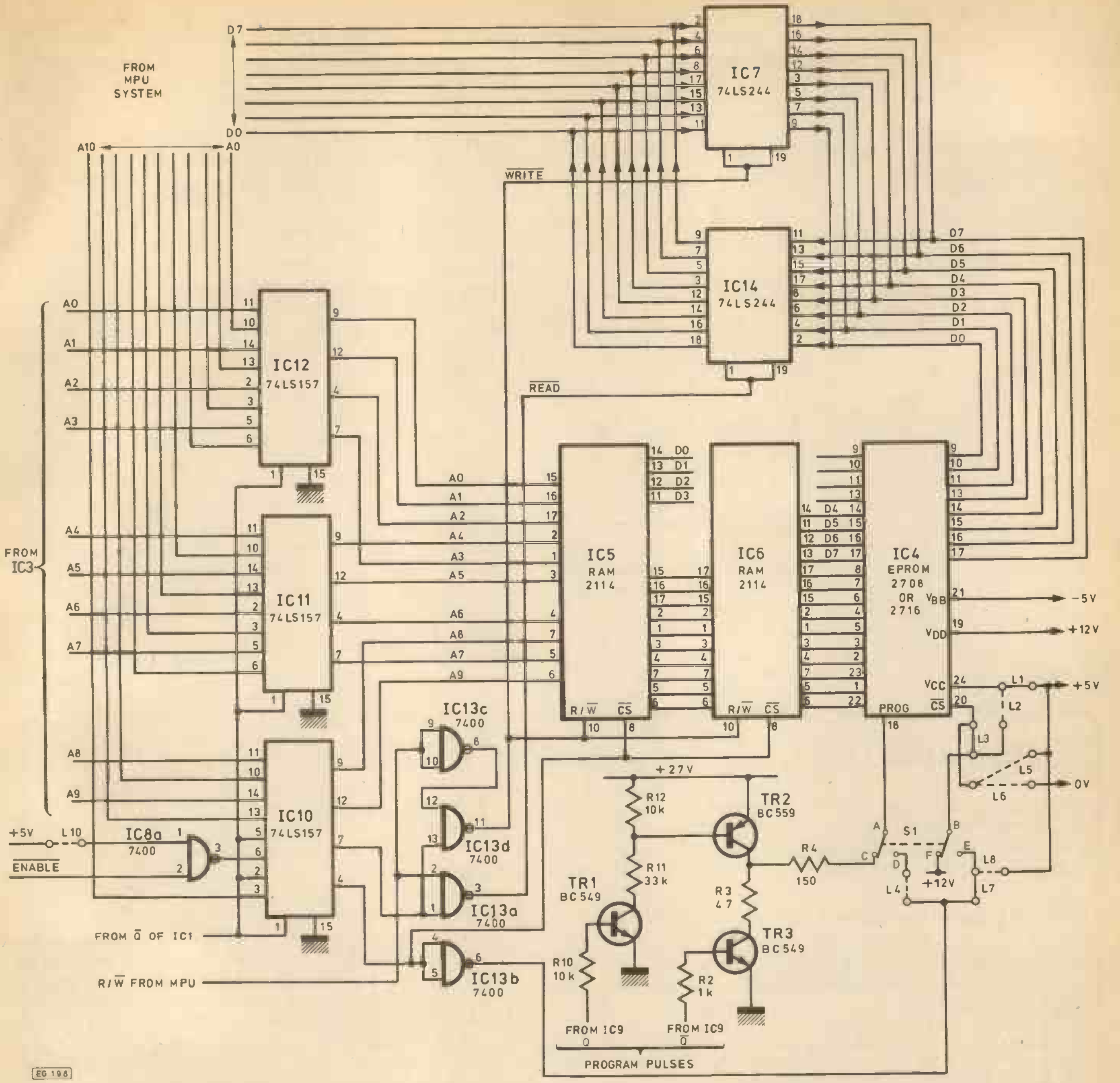


Fig. 5. Memory and switching of the Programmer. S1 is in the "Program" position. Links are shown connected for 2708

The cycles continue until complete and the EPROM and RAM are then handed back to the MPU system for normal use.

It should be clear then, that the role of the MPU system hosting the process is to provide for the RAM, programs or data to be "burned" into EPROM. To this effect, the RAM should be filled with FFs beforehand, so that any unused RAM space does not affect the EPROM.

The RAM and EPROM form a normal part of the MPU's address map, such that programs and data may be stored in either or both for running and use *in-situ*. The only time the memory is not available to the MPU is *during* programming. When the tri-state buffers are switched off, the data Bus of the MPU system is disconnected from the machine.

Last month, in the final part of the COMPUKIT UK 101 article, "plug-in" methods of expanding the machine utilising the upper part of the 2114 memory were described. This is the most convenient method of attaching a programmer and is described next month.

POWER SUPPLY

The Power Supply Unit (Fig. 6) gives all necessary power levels except for the +5V which is usually available from the MPU system. An external transformer with a secondary of 9–0–9 volts at 1 Amp is necessary for the PSU and may be purchased from Modus Systems Ltd., who can also supply the p.c.b. and full kit.

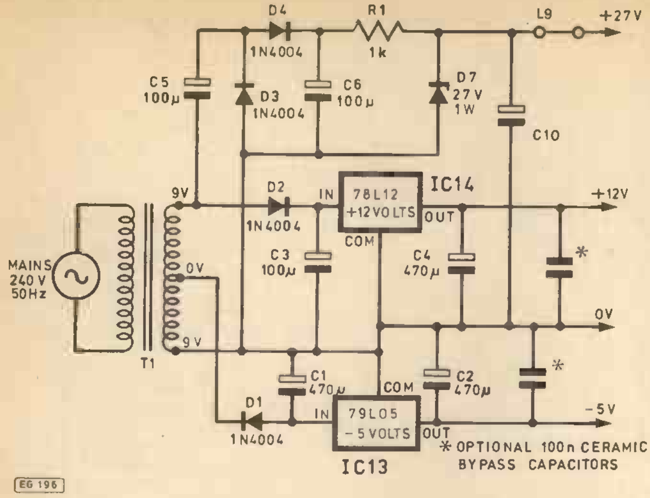


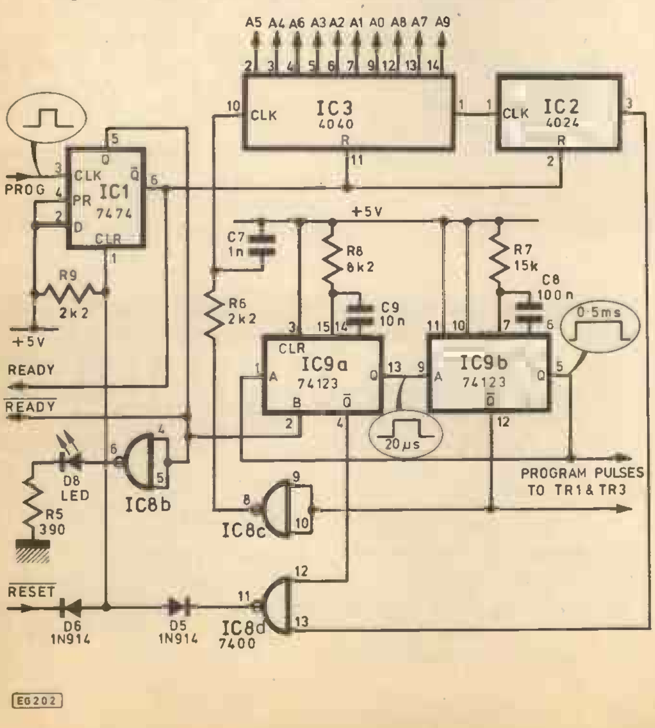
Fig. 6. Power supply

The full 18 volts is halfwave rectified to supply a regulator for the 12 volt level, and a 9 volt winding is used for the −5 volt regulator. Plenty of power supply bypassing is included on the p.c.b. and little rippling was detected on the prototype.

The 27 volt supply is formed by voltage doubling the 18 volts via D3 and C5. The unregulated voltage developed across C6 is held at 27 volts by a Zener diode.

A note of caution is applicable here. For safety, the link L9 should only be connected for programming, since the voltage is quite sufficient to destroy all the i.c.s on the board if accidentally bridged to nearby tracks. In addition, power-up could place the programmer in the program mode, and this would destroy the contents of an EPROM if in place. A reset line is provided to stop the programming cycle at any time, and a power-up reset could be automatically applied by a capacitor and resistor in series if required. +5V, −5V and +12V are all necessary for normal operation of the EPROM and none should be applied to the EPROM for any length of time without the others.

Fig. 7. Program timing and control of the programmer



The 27 volt pulse, in particular, must *never* be applied unless the others are present exactly as required in the timing diagram, and certainly should never be applied for more than 1ms continuously.

PROGRAM TIMING AND CONTROL

The circuit diagram of Fig. 7 shows the program timing and address counter elements. The user (or his MPU system) switches the Program Input (pin 3 of IC1) to a "one". This latches IC1 on, until its Clear (pin 1) is set to Zero.

Q and $\overline{Q}$ of IC1 are set to "1" and "0" respectively, removing the reset level from IC2 and 3 and starting IC9a timing. 20μs later, Q of IC9a falls and starts IC9b timing via its "A" input, which is sensitive to falling edges. Program pulses are sent out via Q and $\overline{Q}$ to Q1 and Q3 which are part of the 27 volt switch. The 27 volt program pulse then holds for 0·5ms.

Throughout the process so far, the outputs of IC3 have remained in their reset state of all zeros. This address is presented to the RAM and EPROM to Program Address 0 in the EPROM. When the 0·5ms ends, a falling edge triggers off IC9a again via its A input and a short time later, via IC8c, R6 and C7, the CLOCK input of IC3 receives its first high-to-low transition. This causes an advance. The delay allows the EPROM to settle fully out of the "program" state. This new address is then allowed to settle before IC9a's Q output falls and programming of the next address occurs.

IC3 is a 12-bit counter and pin 1 is its twelfth bit. Thus, the addresses are cycled through four times before pin 1 suffers a high-to-low transition which advances IC2 by one count. This chip is a 7-bit counter and pin 3 is its seventh bit. Thus the addresses are cycled through $4 \times 2^6 = 256$ times before pin 3 goes high which sets IC8d pin 13 to a "1". As soon as IC9a has finished timing, pin 12 of IC8d is set to a "1", clearing IC1, and the system returns to its quiescent state. The theoretical time, assuming accurate pulse lengths, is thus $(520\mu s) \times 2^{12} \times 2^6 = 136$ seconds.

A certain amount of leeway in timing has been included to offset variations in programmer components and EPROM manufacture.

USE OF THE MACHINE

The software to run the programmer should be in the machine already. Any MPU system must have routines for accepting information from the user, usually via a keyboard, and placing it in any memory location desired. By this means, the RAM block may be filled with the necessary data by hand. The only software necessary will be a small routine to fill the RAM with FFs if the whole EPROM is not programmed. Verification of EPROM contents is, again, performed via the computer's normal system of reading out data from any selected memory location, by simply reading through the appropriate EPROM addresses, as with any block of memory in your machine.

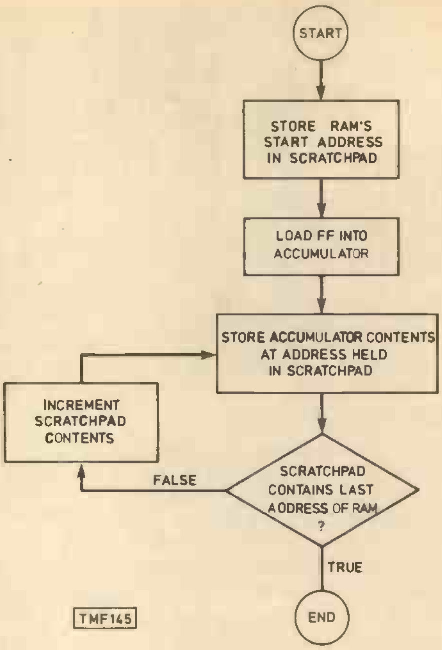
A short flow-chart to fill the RAM with FFs is presented in Fig. 8. This can be written for any simple machine-code based system and requires either one testable 16-bit register for scratchpad, or two 8-bit locations to store an address.

The flow-chart will code into instructions more easily on some machines than others. For instance, 6800 and Z80 both contain 16-bit registers and may be used with ease to discover when the last address in RAM has been set. SC/MP and 6502 do not have this facility and checking sixteen bits of information is a more involved job. However, any machine is capable of performing the routine, and provided there is a bus-structure available, interfacing in hardware and software will be quite straightforward.

As a final note on the above, it is possible to perform the setting of RAM to FF by hardware. All the facilities for stepping through memory exist on the programmer, and it is just a question of keeping the EPROM disabled, the RAM in the write-state, the Bus buffers tri-state and all Data lines to a logic "one". This will fill the RAM with 1s as IC3 cycles through once.

Next month, the final part covers the rest of the hardware, p.c.b. layout, construction and hardware interfacing to your system.

Fig. 8. Flow diagram to fill the RAM with FFs



The EPROM Programmer may be run from the UK101

Countdown

Organisers: Please send details of exhibitions, club open days and other events to Mike Abbott at least six weeks in advance. Inclusion will be subject to space etc.

Electronics 79—Nov. 20-23. Olympia, London. ✆ 021 705 6707.
Video Rights 79 (conference)—Nov. 26, 27. Cafe Royal, London. Details: Nord Media ✆ 01-629 9381.
Breadboard 79—Dec. 4–8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. ✆ 0822 4671.
IBM Hardware Selection—Dec. 5, 6. Skyline Hotel, London Airport. Details: Online.
BEX (Business Equipment Exhibition)—Feb. 6–7. Queens Hall, Leeds. Details: Douglas Temple Studios. ✆ 0202-20533.
BEX—Feb. 20–21. The Pavilion, Bournemouth. Details: Douglas Temple Studios.
IEA/Electrex—Feb. 25–29, 1980. National Exhibition Centre, Birmingham. Details: Industrial and Trade Fairs Ltd. ✆ 021-705 6707.
Viewdata '80—March 26–28. Wembley Conference Centre, London. Conference and exhibition. Details: Online Conferences Ltd. ✆ Uxbridge (0895) 39262.
Computer-Aided Design (conference and exhibition)—March 31–April 2, 1980. Metropole, Brighton. Details: Organisers, CAD 80. ✆ 0483 31261.
Seminex—April 14–18. Dept. Physics, Imperial College, London.
Communications '80—April 14–18. National Exhibition Centre, Birmingham. Details: ITF Exhibitions. ✆ 021-705 6707.
Electronic Test and Measuring Instrumentation—April 22–24, 1980. Wythenshaw Forum, Manchester. Details: Trident.
International Conference On The Electronic Office—April 22–25, 1980. London Penta Hotel. Organised principally by the Institute of Electronic and Radio Engineers. 99 Gower St., London WC1E 6AZ.
All-Electronics Show (1980)—April 29–May 1, Grosvenor House, Liverpool. Exhibition and seminars, with the co-operation of Liverpool.
The Mersey Micro Show—April 30, May 1, 2, 1980. Adelphi Hotel, Liverpool. Exhibition and seminars, with the cooperation of Liverpool University. Details: Online.
The 1980 Microcomputer Show—July 10–12. Royal Lancaster Hotel, London. Details: Online.
IBC 80—Sept. 20-24. Metropole Centre, Brighton. Details: Secretariat, IEE, Savoy Place, London WC2R 0BL.

POINTS ARISING

SIX CHANNEL MIXER *(September 1979)*

Switch S3b, terminal 4, should be connected to terminal 4 of switch S3a and not to 0V.

DIGITAL TEMPERATURE CONTROLLER *(October 1979)*

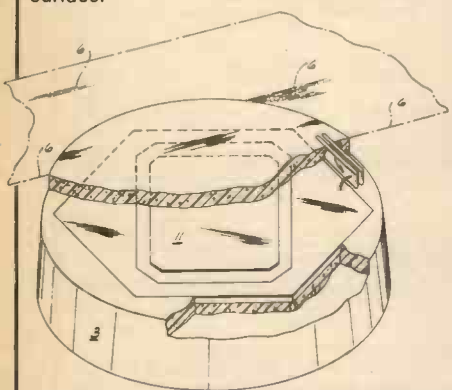
The values for C8 and C9 should be transposed in the circuit and components list.

PATENTS REVIEW...

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

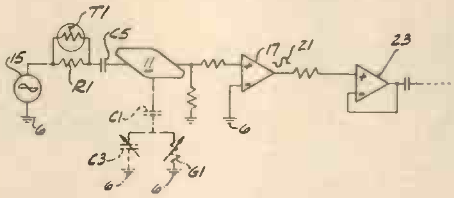
PRECIPITATION SENSOR

British patent application 2 010 486 from Surface Systems Inc. of Missouri, USA (applied for under the new laws and dating back to December 1977) describes a module for automatically sensing wet and icy conditions on a road or airport runway surface.



The module can trigger a visible or audible alarm, for instance light up a danger sign, when a surface becomes slippery and dangerous; or a series of sensors can provide air traffic control with a continuous readout of airport runway conditions.

A block 3 of epoxy resin material, with silica glass or sand filler for strength and resistance to wear, is embedded in the surface 6 to be monitored. A square electrode 11 of metallic foil is encapsulated in the block thereby providing both capacitance and conductance paths to surface 6.



In the circuit diagram the capacitance path is represented by phantom capacitors C1 and C3, and the conductance path by phantom resistor G1. A constant-voltage oscillator 15 and capacitor C5 supply electrode 11 with a sine wave signal at a frequency of around 5kHz. The signal is applied via resistor R1 and thermistor T1 to compensate for any small change in the value of capacitor C1 caused by temperature. Because a relatively low frequency sine signal is used, oscillator 15 can be placed up to 500 feet from sensor electrode 11 without significant loss.

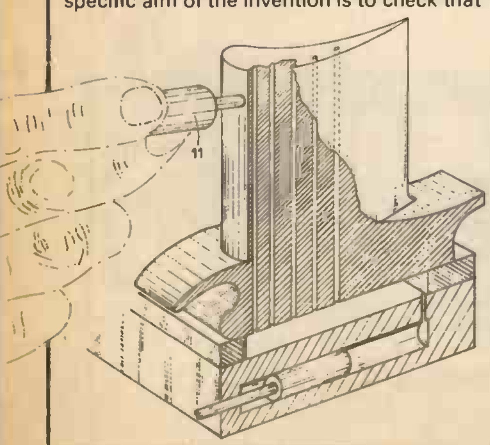
Whenever there is water or ice precipitation the sensor surface is connected capacitively and conductively to the surface 6. This causes a significant loss of current from electrode 11 to surface 6. The amplitude of the signal appearing at the input of amplifier 17 is thus a function of the change in the capacitance and conductance between sensor electrode 11 and surface 6. The output of amplifier 17 therefore decreases as precipitation accumulates on the sensor. Precipitation circuit 23 provides an indicator or alarm trigger signal when the output signal 21 of amplifier 17 falls to a predetermined level.

In one modification of the invention a delay circuit is incorporated to ensure that the temporary removal of ice or water from the sensor block by passing vehicles does not affect the overall reading.

LIQUID MAGNET

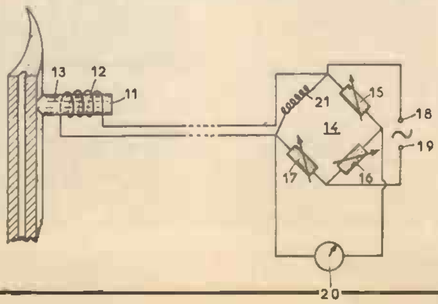
British patent application 2 009 414 from the French company Societe Nationale D'etude et de Construction de Moteurs D'aviation was filed under the new patent laws and dates back to November 1977.

Although the invention is concerned primarily with a magnetic means of measuring the thickness of passageways inside gas turbine blades, it is clear that the principle described has much wider applications. The specific aim of the invention is to check that the cooling passages inside a turbine blade are accurately formed, with adequately thick walls. To achieve this the passages are temporarily filled with ferro-magnetic fluid.



This material, which was developed (like so many others) for use in space, is a suspension of magnetic particles in liquid which behaves like a fluid magnet. Because ferro-magnetic fluid is expensive, it is introduced into the passageways and withdrawn after use by a simple piston and cylinder arrangement.

A probe 11, like a metallic pencil, is wound with a coil 12 on a core 13. This coil forms one branch of an a.c. bridge 14, of which the other branches are formed by potentiometers 15, 16 and 17. The bridge is supplied at a first diagonal by a.c. from generator supply 18, 19 and a measuring apparatus 20, for instance a meter, is connected across a second diagonal to read any dis-equilibrium of the bridge. Compensation winding 21 is identical to, and in parallel, with the winding 12, but wound in the opposite direction.



Equilibrium of the bridge is achieved with the probe against the part to be measured. When the probe is subsequently moved over the part, any irregularities in the passages containing the fluid cause a visible change at the meter 20 because the fluid governs the impedance of winding 12.

It is interesting to note in passing that the American firm Teledyne Acoustic Research already has what appears to be a master patent on use of ferro-magnetic fluid to fill the gap between the voice coil and magnet of a loudspeaker. Indeed many Acoustic Research loudspeakers now have fluid filled gaps of this type. The claimed advantage is that the fluid helps conduct heat away from the voice coil to the magnet pole piece in the manner of a heat sink and provides friction-free radial support for the coil former.

The Acoustic Research patent was granted under the old British laws (BP 1 542 266) and cites US patents 3 612 630 and 3 734 578 as describing basic forms of ferro-magnetic fluid *per se*.

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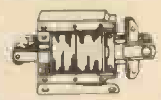

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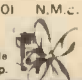

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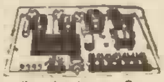

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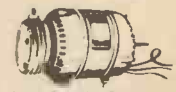

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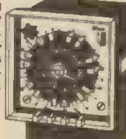

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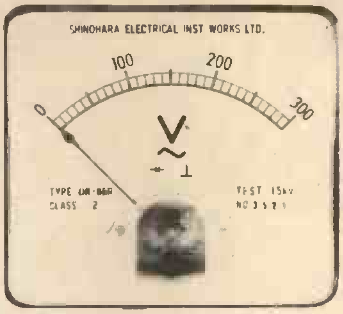

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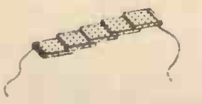

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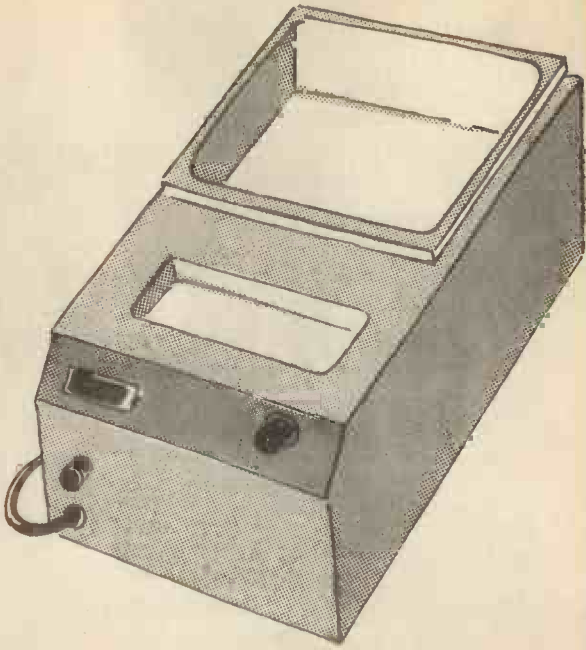

ULTRASONIC CLEANER

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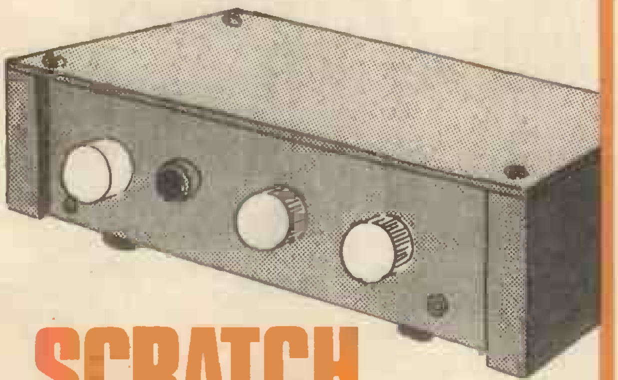

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SOFTY *Review*

Softy is a general development tool for MPUs and next month our contributor, Dr. A. A. Berk, reviews this new line in the micro scene.

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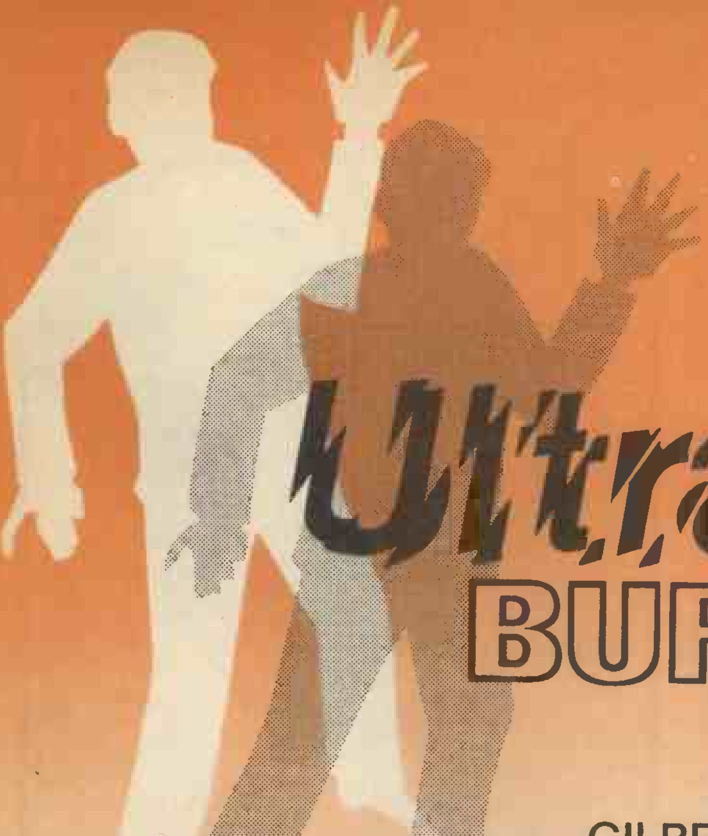


Ultrasonic BURGLAR ALARM

GILBERT DAVIES

THIS ultrasonic burglar alarm is a two unit system: a Movement Detector and a Control Unit. The Movement Detector, which contains the ultrasonic transmitter (X1) and receiver (X2), will detect movement within a room and then send an alarm signal to the control board. The Control Unit contains the keyswitch for on/off control of the system, the delay circuits, and the relay for controlling the alarm as well as the battery back up circuit in case of mains failure.

CIRCUIT OPERATION

When the burglar alarm is switched on a 40kHz signal is transmitted from the ultrasonic transducer (X1) which is detected by the receiving transducer X2. This sets up an ultrasonic pattern within the protected room. If an object moves within this field a frequency shift occurs (due to the Doppler effect) to the waves which are reflected from the moving object. The transducer X2 will therefore receive two different frequencies (40kHz and the shifted frequency which can be higher or lower than 40kHz); these will combine to produce a beat note. The frequency of this audio or sub-audio beat note will be the difference between the two ultrasonic frequencies. This beat frequency is then amplified, filtered and used to operate the alarm.

MOVEMENT DETECTOR

The circuit diagram of the Movement Detector is shown in Fig. 1. If constructors wish to use the Detector Unit on its own the relay RLA and D15 (shown in the shaded area) should be fitted and the value of C13 increased to 22 micro farads. If both units are to be used the two wire links shown on the Movement Detector board should be fitted. The 18V output from the transformer (T1) is fed to the bridge rectifier formed by D11 to D14, smoothing capacitor C15 and the voltage regulator (IC2) to obtain a stabilised 12V supply.

The 555 timer (IC3) is connected as a variable square wave generator the output of which (pin 3) is fed to the ultrasonic transmitter (X1). The transmitted signal from X1 is

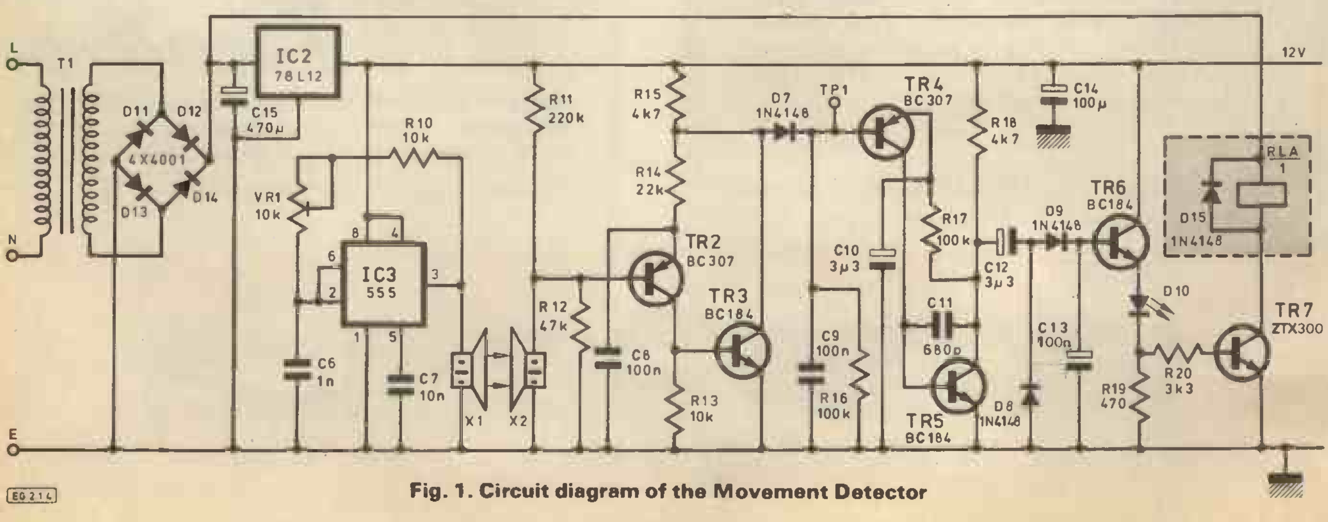
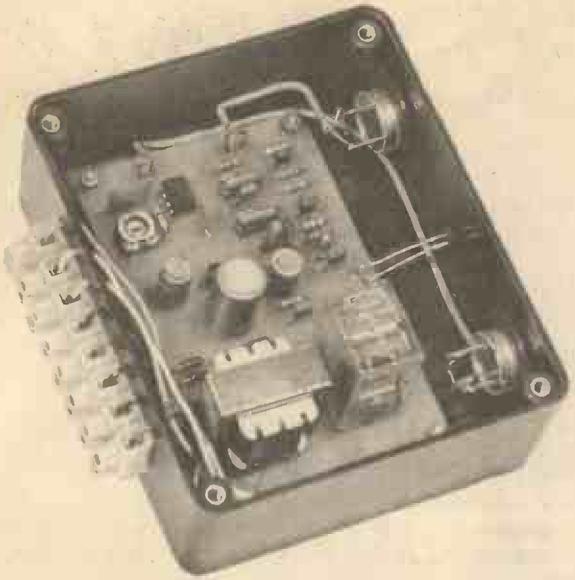


Fig. 1. Circuit diagram of the Movement Detector

picked up by the receiver X2 and amplified by TR2 and TR3 with resistor R14 providing 100 per cent feedback making this stage very stable. The a.c. gain of the stage is determined by C8 which shunts the high frequency signals in the feedback path therefore increasing the gain of the stage($\simeq$ 50 times the input voltage at 40kHz).

As only the positive going signal is required at the output of this stage the bias is offset from the normal half supply rail to provide a better operating working voltage for the diode detector as well as a greater overload margin for the input stage.



Internal view of the Movement Detector. Note that the relay RLA has been included

The output from TR3 collector passes through the envelope detector D7 and the CR network C9, R16 which removes the 40kHz signal. The signal from TR3 collector varies the d.c. level across C9 and provides both the bias and the signal for the next stage. This stage is basically the same as the first stage with the exclusion of the load resistor for TR4 collector.

SPECIFICATION

0·5 sec alarm function test at switch on.
2 sec delay to suppress invalid movement.
20 sec delay at switch on — to prevent alarm operation on leaving room.
20 sec delay on entry — to allow the alarm to be cancelled.
2 min alarm before cancelling (alarm is pulsed at 2 Hz).
Quiescent current 25µA at 12V d.c.
18V battery back up in the event of a mains failure.

The capacitor C11 limits the HF response by applying negative feedback to TR5 so that the ultrasonic component of the signal is not amplified. R17 and C10 were chosen to provide a suitable bandwidth for Doppler shift frequencies.

The output from TR5 is fed to the diode pump network (D8, D9) via C12 which rectifies the signal and charges C13 to convert the beat note to a steady voltage. When the voltage across C13 reaches 2·6V, TR6 turns on and the l.e.d. (D10) is illuminated. TR7 is also turned on via R20 and the collector voltage of TR7 falls to zero. This fall in collector voltage is passed to the control unit via the wire link and the common output of RLA on the Movement Detector Board.

However if the relay RLA is used the falling collector voltage of TR7 is used to energise the relay from the unstabilised 18V supply, whilst D15 suppresses any spikes generated by the relay coil. The collector of TR7 remains low until C13 discharges through TR6 turning off both TR6 and TR7 and switching the collector voltage of TR7 high.

COMPONENTS . . .

Resistors

R1, R3, R7, R14	22k (4 off)
R2, R11	220k (2 off)
R4, R5	2M2 (2 off)
R6	10M
R9, R10, R13	10k (3 off)
R8	470k
R12	47k
R15, R18	4k7 (2 off)
R16, R17	100k (2 off)
R19	470
R20	3k3

All resistors ¼W 10% carbon

Potentiometers

VR1	10k min. hor.

Capacitors

C1, C4	4µ7 25V tant (2 off)
C2, C3, C5	10µ 25V tant (3 off)
C6	1n ceramic
C7	10n ceramic
C8, C9	100n polyester (3 off)
C10, C12	3µ3 16V tant (2 off)
* C13	100n or 22µ 16V elect
C11	680p ceramic
C14	100µ 16V elect
C15	470µ 25V elect

Semiconductors

D1 to D6, D7 to D9, D15	1N4148 (10 off)
D11 to D14	1N4001 (4 off)
D10	TIL 209
TR1, TR7	ZTX300 (2 off)
TR2, TR4	BC307 (2 off)
TR3, TR5, TR6	BC184 (3 off)
IC1	4093
IC2	78L12
IC3	NE555

Miscellaneous

X1	Transmitter MA 40 LIS
X2	Receiver MA 40 LIR
T1	Transformer 18V 75 mA
* RLA	Varley VP2 700 ohms
RLB	12V 1640Ω open type (RS 349 — 131)
B1, B2	Battery PP9 (2 off)
S1	Keyswitch
P.c.b.s.	(2 off)
Battery clips	(2 off)
ABS case 115 x 95 x 45mm	(2 off)
Grommets	
Terminal block	
Keyswitch	
* Piezoelectric transducer	1TT U2 — 50 RHA

* See text

Constructor's Note

Printed circuit boards and other components are available from **G.J.D. Electronics, 105 Harper Fold Road, Radcliffe, Manchester.**

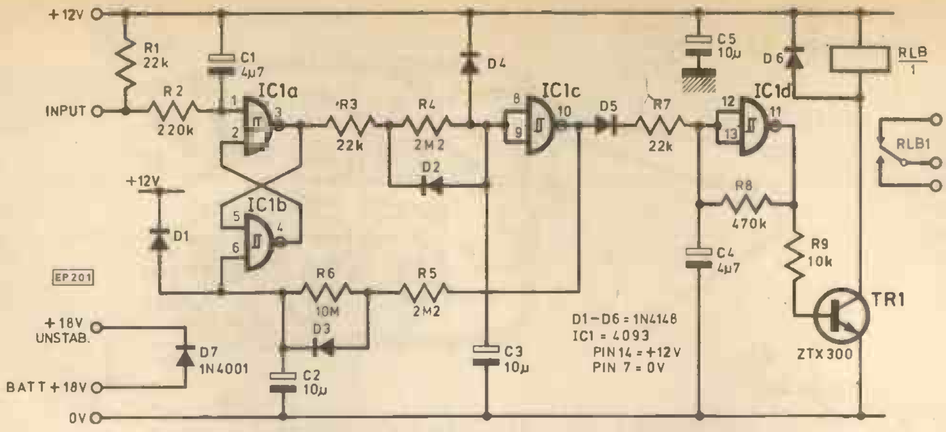


Fig. 2. Circuit diagram of the Control Unit

CONTROL BOARD

The circuit diagram of the control board is shown in Fig. 2. R1 forms the collector load for TR7 (on the detector board) and when the collector voltage is switched low there is a two second delay caused by R2 and C1 before the voltage on pin 1 (IC1a) goes low. This delay prevents invalid movements from triggering the alarm. Gates "a" and "b" of IC1 form a bistable which is reset at switch on by C2 and takes 20 secs to charge, this allows the house to be left without triggering the alarm. If no movement is present the output of gate "a" is low and C3 is discharged.

The output of gate "c" is high which holds the input of gate "d" high and its output, which holds TR1 off and the relay de-energised, is low. At switch on the relay energises

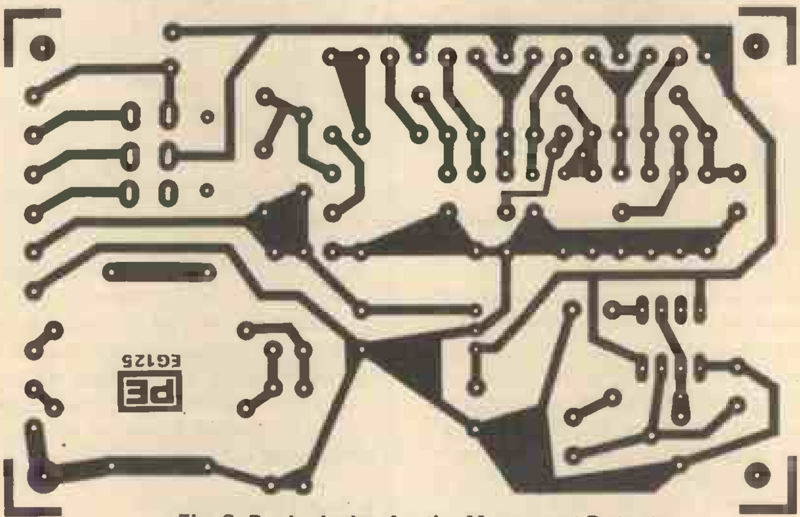


Fig. 3. P.c.b. design for the Movement Detector

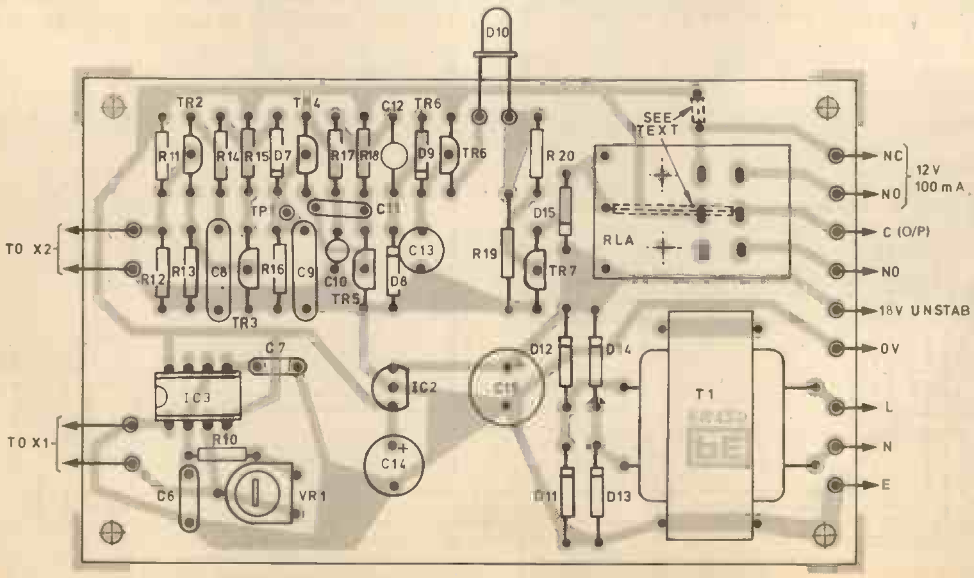


Fig. 4. Component layout of the Movement Detector

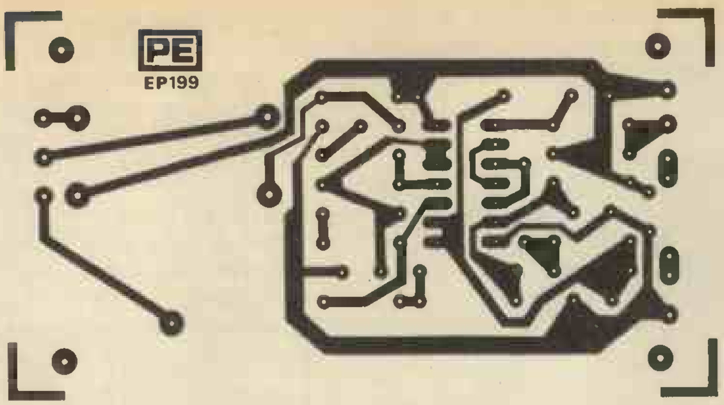


Fig. 5. P.c.b. design for the Control Unit

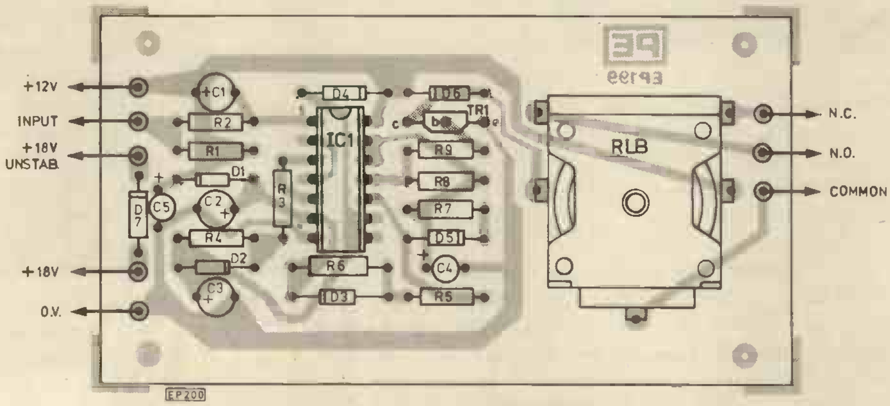


Fig. 6. Component layout of the Control Unit

for 0·5 sec to provide an alarm test every time the system is switched on.

When movement is present for more than 2 secs the input of gate "a" goes low setting the bistable with the output of gate "a" going high charging C3 through R3, R4. This allows the input to gate "c" to go high and its output low releasing the input of gate "d". Gate "d" forms a 2Hz Schmitt oscillator, the frequency being determined R8, C4. The output from gate "d" passes through R9 driving TR1 and energising RLB. D6 suppresses the back e.m.f. from the relay coil.

The output of gate "c" also discharges C2 which after 2 mins resets the bistable and cancels the alarm. D1 and D4 discharge C2 and C3 at switch off.

Diode D7 has the battery voltage connected to its anode and the unstabilised 18V to its cathode. Because the unstabilised voltage will be higher the diode is turned off. When the main voltage falls the diode will conduct and the battery voltage will be applied to the system. When the main supply is re-established the diode D7 automatically switches off the battery voltage.

CONSTRUCTION

In the prototype system the movement detector and the control unit were mounted into two separate ABS boxes.

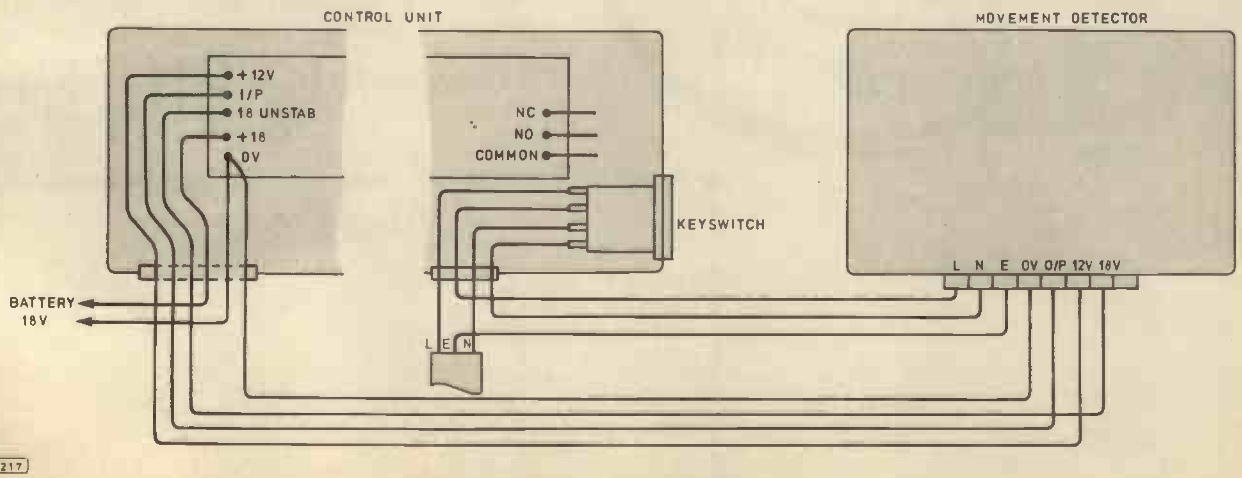
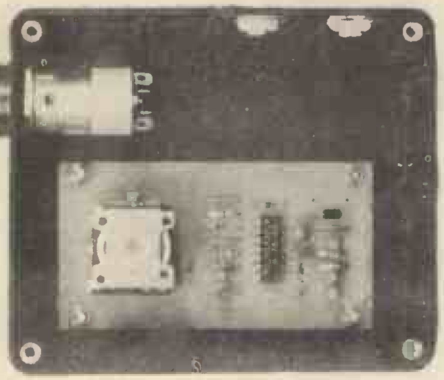


Fig. 7. Wiring interconnections for the two units

The transducers are mounted inside grommets on the front panel with the indicator l.e.d. mounted mid way between them. If the l.e.d. is not required on the front panel it can be placed inside on the p.c.b.



Internal layout of the Control Unit

The p.c.b. design for the Movement Detector is shown in Fig. 3 with the component layout in Fig. 4. After the board has been soldered and checked it can be mounted into the case and connected to the terminal block. The transducers should be soldered to the board using screened leads.

The p.c.b. design and component layout for the Control Unit are shown in Figs. 5 and 6. After soldering and checking, the p.c.b. should be mounted into the case together with the keyswitch. The two PP9 batteries were mounted outside the case on the prototype although if a larger case is used they could be mounted inside. The two units should be wired together as shown in Fig. 7.

ALARM OPTIONS

The system can be fitted with an external piezo electric transducer which can directly replace RLB and D6, driven from the collector of TR1.

If an external alarm is used it can be connected via the contacts of RLB and either a mains or 12V d.c. buzzer used.

INSTALLATION

The detector is prone to both vibration and air currents therefore the points shown in Table 1 should be observed to avoid false triggering of the alarm.

TABLE 1

a) Do not place the unit on a vibrating surface.
b) Close doors and windows.
c) Do not point the unit at a wall with a radiator or convector heater.
d) Objects should not be placed within 5 feet of the unit as this will limit its sensitivity.
e) The external alarm should be far enough away from the unit so as not to produce vibration.
f) Cats, dogs and other household pets should be taken into consideration.
g) If more than one unit is used care should be taken to ensure the two ultrasonic "fields" do not interact the alarm to trigger.

SETTING UP

The varible resistor VR1 should be adjusted for the maximum d.c. level at TP1. The sensitivity of the unit can be checked by moving in front of the ultrasonic transmitter and receiver and noticing the l.e.d. movement indicator. Finely adjust VR1 until the maximum sensitivity is obtained ★

FRANK W. HYDE

THE LARGEST INFRA RED TELESCOPE

A triumph of engineering skill has added a fourth member to a group of telescopes on the summit of Mauna Kea on the big island of Hawaii. The United Kingdom Infra Red Telescope (UKIRT) was inaugurated by His Royal Highness the Duke of Gloucester on the 10th of October.

In recent years there has been a very considerable expansion of activity in the field of Infra Red Astronomy, indeed it could now be said that it has paralleled advances made in other areas of the spectrum. New sources of radiation have been recorded and new mechanisms have been posed to account for physical processes that are taking place in remote regions of the Universe. For example it has been discovered that the nuclei of galaxies radiate an unexpectedly large amount of infra red energy. As yet the extent of the power involved is unknown.

There are massive clouds of interstellar dust and gases which appear to be the site of galaxy and star formation. These cradles of creation may hold the clues relating to the origin of the Universe. Solid matter in these areas provide the surfaces needed for hydrogen and other molecules to form. Of the different types of molecule identified, more than 50, all have specific emission or absorption at the infra red and radio frequencies. The extent of the complexity involved in the molecular processes was unsuspected a decade ago.

It may be possible now to set up a galactic distance scale using techniques involving magnitudes and measured velocity dispersions. At millimetre wavelengths the infra red telescope is the only means of studying the cosmic background radiation at 2·7 degrees. This is the temperature at which there should be remanent radiation from the processes that were in operation at the formation of the Universe.

Two British firms were involved in the development and construction of the 3·8 metre UKIRT. They are Grubb Parsons who have had so much experience in the design and development of telescopes over many decades and are now a unit of Northern Engineering Industries, together with Hadfields Ltd., famous for their original work on the 250ft diameter radio telescope at Jodrell Bank, Hadfields are now part of the Lonrho Group.

The UKIRT was commissioned by the Science Research Council in 1975. The contract went to the Special Projects Division of Hadfields Limited. Work commenced in the spring of 1975.

Modern telescopes and other instruments in use for astronomical purposes are now very much concerned with electronics. Control systems abound and astronomy cannot be seen now as an isolated activity for it is, by reason of the space industry involved, not only in the scientific experiments but in all systems involving navigation and the practical guidance of space vehicles. The infra red telescope by its very nature covers a wide field of technology. The mechanics are concerned with the elements such as control of a surface which is so sensitive that just tilting on its axis can set the mirror in a condition of distortion. Such conditions not only affect the performance of individual tasks but have long term possibilities in ageing and deterioration of the materials used. This is primarily where the control system depends on electronics.

The mirror was to be 3·8 metres in diameter and 29 centimetres in thickness. Now apart from the very critical parameters involved in the manufacture of such a mirror, its performance at all angles is prodigious. The final result must be such that distortion must be held to an almost impossible low level. The contours of the surface of the primary mirror is held by a special support of three rings with a total of eighty pneumatic cylinders. These are electronically controlled. The result has been to achieve subiarc second performance under all normal operating conditions.

The material of the mirror is a glass ceramic called Cer-Vit. Normal glass would not be suitable for a mirror of this size and nor would it be able to resist thermal distortion which is one of the great hazards with large mirrors. Cer-Vit is not subject to this defect and indeed is almost unaffected by thermal changes. It should be noted here that even a minute distortion of the surface can result in a confused image at the focus and thereby nullify measurements.

The rest of the optical system consists of smaller mirrors all made of Cer-Vit. One of them is a plane mirror used in the Coudé beam. This has a major axis of 1·5 metres and a thickness of 3 centimetres. The mirror blanks were purchased from Owen's of Illinois and figured by Grubb Parsons.

The principle of operation is in a number of modes. Two of these will be described.

The primary mirror is at the "bottom" of the main structure. This receives the radiation from the sky and directs it on to a secondary mirror at the "top" of the structure. The radiation is then again returned toward the primary mirror. Different secondaries may be used. In one case the radiation passes from the secondary mirror through a hole in the centre of the primary mirror to a point about one metre behind the primary. This is the Cassagrainian focus. At this point the radiation is recorded by instruments mounted on the frame of the telescope. Thus all instruments in a similar mode have to be mounted on the telescope since it traverses the sky and the instruments must follow. The amount of such instrumentation has a limiting factor. To overcome this, where the equipment for examining the radiation is large, another mode is adopted. By the use of plane mirrors another focus independent of the position of the main axis of the telescope is achieved. This is called the Coudé focus. By means of plane mirrors the beam from the system can be diverted so that it remains independent of the motion of the telescope itself. This enables large and bulky apparatus to be accommodated in a basement below the telescope.

The remainder of the telescope apart from the optical systems was designed and constructed by Hadfields of Sheffield. The whole completed telescope was built, tested, dismantled and conveyed to the final site there to be erected and put into operation by that Company under the guidance of the Royal Observatory Edinburgh.

COMPUTER CONTROL

Many of the mechanical and control systems are new concepts in control. A high proportion of this innovative design is found in the unique electronic control systems and computer control. The control computer is physically coupled systems employing the European CAMAC standard interface which provides almost unlimited expansion facilities. The control computer is of unique design due to Hadfields and provides time dependent data for telescope motions without frequency synthesis. This technique has been developed into an advanced form by software engineers from Imperial College, London and the Royal Observatory of Edinburgh.

In operation the telescope has a special device not used on ordinary optical telescopes. To be effective an infra red device must be able to separate the radiation from the body or area under study from the background radiation. This is provided by a special "rocking" secondary mirror. This allows the telescope to "see" the sky and the object alternately. The mirror is rocked at a rate of up to 30 cycles per second. The detector is therefore presented with a varying signal which the electronics record. Any British astronomer may apply for time to use the telescope. Application must be made to the Royal Observatory, Edinburgh who are responsible for the administration of their project.

SHUTTLE SCHEDULE

The first space shuttle schedule shows that between 1981 and 1984 all thirty-eight flights are already fully booked.

The customers are US business enterprises, foreign Governments, many departments of the US Government in which no less than 12 spacelabs are required each having many experiments aboard.

PE

DIAMATIC

Programmable Audio Visual Unit

PART 2 — J.R.W. Ames B.Sc. W.L.Blyth B.Sc.

IN this final part board construction together with interwiring and final setting up will be detailed.

CONSTRUCTION

The authors' projectors are made largely of plastic with a metal lamp house which gets very hot so there is no suitable heatsink surface for the triacs. To get round this problem the prototype system, shown in the photographs, was built in two boxes. One houses the majority of the electronics while the other, which also doubles as a heatsink, is for the triacs. Two boxes were used so that the high current connections to the triacs could be kept short whilst leaving the control box free to be positioned in a convenient positon when making a recording. Connection to each projector is via a short length (approx. 400mm) of heavy duty mains cable while a screened multi-core cable connects the triac drivers to the control box. Other constructors may have projectors with exposed cool metal surfaces in which case the triac housing can be eliminated and the projectors connected directly to the control box.

The price of the multi-way connectors used in this arrangement amounts to nearly £18—one third of the cost of the whole unit. Many constructors may therefore prefer to mount a heatsink on the side of their plastic bodied projectors thereby eliminating the need for expensive connectors. The connection from each projector to the control unit then comprises 5 light current signal leads plus earth so a DIN audio connector can be used, reducing the cost of connectors to no more than £2.

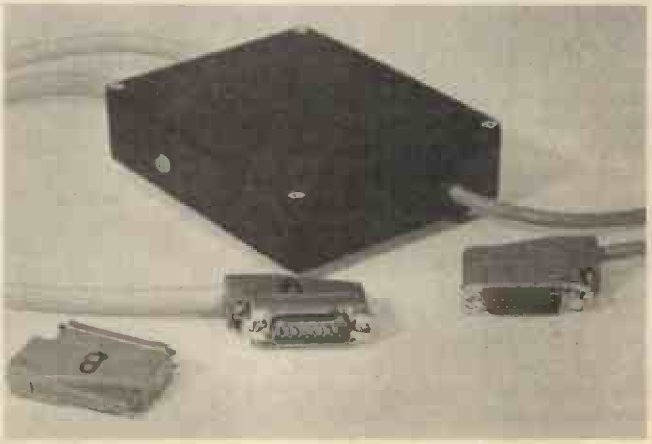
TRIAC HOUSING

Fig. 1 shows the circuit that is contained within this housing. Straight-through connections are provided for the slide change and power supply connections to each projector while additional inputs from the main control box trigger each triac. The connections to the control box carry only small currents and are made by a multi-core screened cable (to reduce radiation from the triac trigger pulses) terminated by a 15-way D-type plug and socket (PL2, SK2). D-type plugs and sockets are also used for the connections to the projectors. Each way of these connectors can carry a maximum of 5A and in this arrangement four pins are connected in parallel for each of the two load carrying connections.

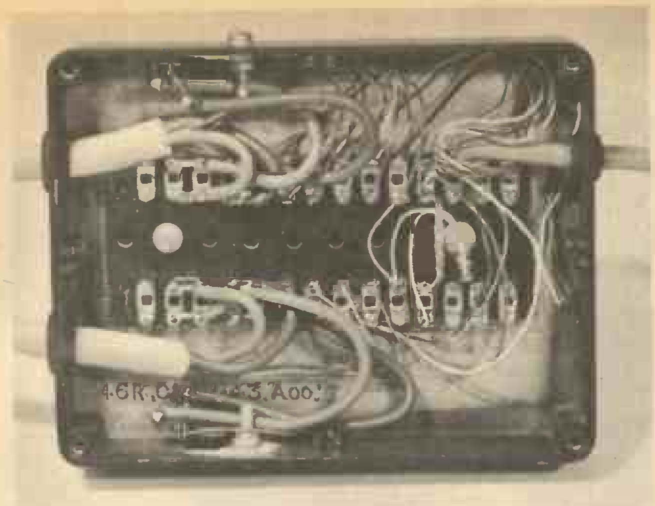
The circuit is housed in an aluminium die-cast box which should be painted with matt black spray paint after drilling. Before mounting the triacs on the inside of the box make sure that all paint is removed from the area and apply a thin film of heatsink compound to the mating surfaces. The specified triac has a mounting tab which is electrically isolated from all of its terminals. When using a substitute device without an insulated tab it will be necessary to mount it by means of a nylon nut and bolt and to use a mica insulating washer.

Fig. 14 shows the layout inside the box and the details of the connections to the plugs, shown from the solder side of each plug. It will be necessary to shorten the specified group-boards a little before they will fit in the box. About 400mm of 3 core 13A mains cable is used to connect the housing to each projector plug. The third core of the cable can be pulled out leaving a hole large enough to take the four 0·4mm dia. wires that connect to the slide change mechanism, the power supply and earth. Inside the box the conductors from each composite cable are connected to tags on the group-board. From the group-board stout wires are connected to the T_1 and T_2 connections of each triac while the cores of the multi-way connection to the control box are also terminated on the appropriate tags. Make sure that the earth wire from each of the projectors is connected through to the chassis tag and that the screen of the multi-core cable is connected to this tag also.

It is not easy to solder the thick conductors of the load carrying cable to the pins of the projector plugs and it may be helpful to make the parallel connections between pins first using a piece of stiff wire (a resistor lead, for example). The heavy duty cable cores are then stripped back for only a short distance (approx. 4mm) and fanned out a little before



Triac housing



Interior wiring

being butt jointed to the stiff wire link which provides a large enough area to form a good soldered joint.

MAIN CONTROL CIRCUIT

The whole of the electronics is mounted on a single printed wiring board whose layout and component overlay are shown in Figs. 19 and 15. As a result the circuit is very easy to assemble even for the beginner or for someone whose main interest lies in photography! Installing a few components at a time work from one side of the board inserting the components and bending back their leads so that they do not drop out when the board is inverted. When a group of components have been fixed in this way invert the board and solder carefully using a clean miniature iron and miniature resin-cored solder. Apply only the minimum amount of solder to make a sound joint and then cut off the component leads before repeating the operation. Continue in this way mounting all the wire-ended discrete components before others are inserted. R4, the power supply dropper resistor, gets fairly hot and should be stood away from the board by putting a U-bend in its leads.

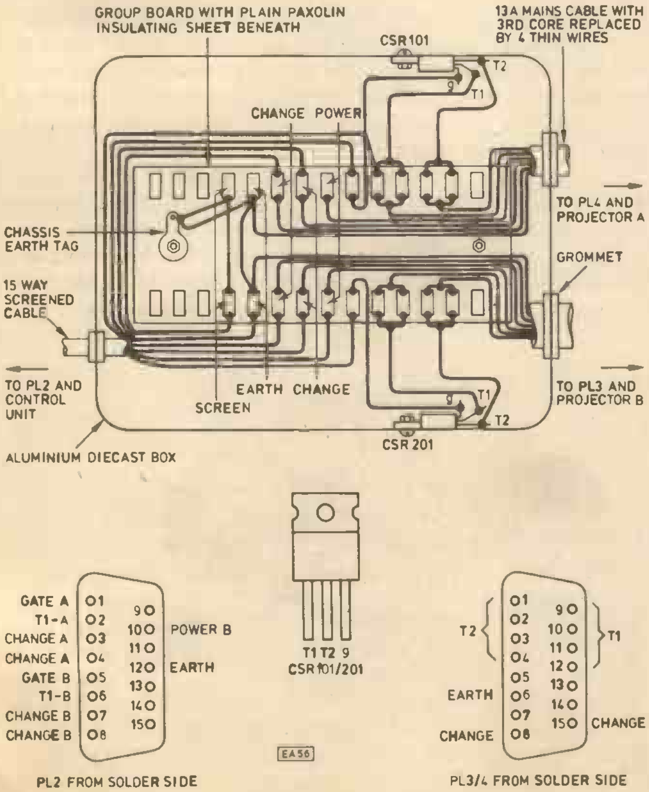


Fig. 14. Layout and plug connection

Mount the skeleton preset potentiometers and sockets for the integrated circuits making sure that they are held securely home whilst soldering.

The specified cermet preset potentiometers should not be replaced by the cheaper s.r.b.p.-based types which have inferior mechanical and electrical characteristics. Use of sockets for the i.c.s is not a luxury—it is very difficult indeed to unsolder all 14 or 16 leads of a suspect "chip" without damaging the device or the board (or both), and it is very discouraging to undertake the task only to discover that it was not the i.c. that was causing the problem. Sockets allow easy substitution tests as well as ensuring that the devices are not damaged by excessive heat during soldering.

Finally, insert pins from the copper side of the board into the holes provided for off-board connections and push them firmly home using a hot soldering iron before fixing them with a small quantity of solder. In the same way that i.c. sockets are not essential to the project these pins can be omitted, but they make it much easier to make connections to the board without causing damage, and they make it possible to attach and remove external wires once the board is firmly mounted in the box.

TRANSFORMER

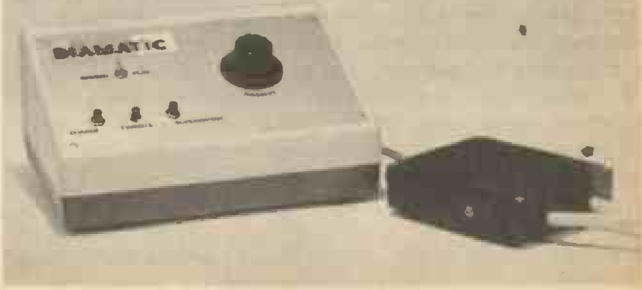
The pulse transformers, T101 and T102, are very easy to make and should not deter anyone from undertaking the project. Wind 100 turns of 38 swg wire on to one half of the sectionalised bobbin and twist the free ends of the wire together for a short distance to prevent them from unwinding. Repeat the operation for the secondary winding using 10 turns of 28 swg wire in the other half of the bobbin.

Now put the bobbin into one half of the pot core, line the other half of the core up on top and clip the whole assembly to the mounting board with the ring and clips as shown in Fig. 18. Solder the protruding wire ends to the pins on the base according to the layout in Fig. 15—the sense of the windings is not important as the triac will turn on with either positive or negative pulses applied to its gate. To prevent vibration and noise from the transformer when in use dip the whole assembly into household polyurethane varnish, giving it a good shake to remove surplus fluid on removal, and leave it to dry for 24 hours. Finally give the windings a check for d.c. continuity and insert the transformer into the printed wiring board before carefully soldering it into place.

THE BOX

First mount the two sockets SK1 and SK2 at the back of the box after carefully making the cut-outs.

The DIN socket SK1 is used to interconnect with the



Relative sizes of Diamatic pair

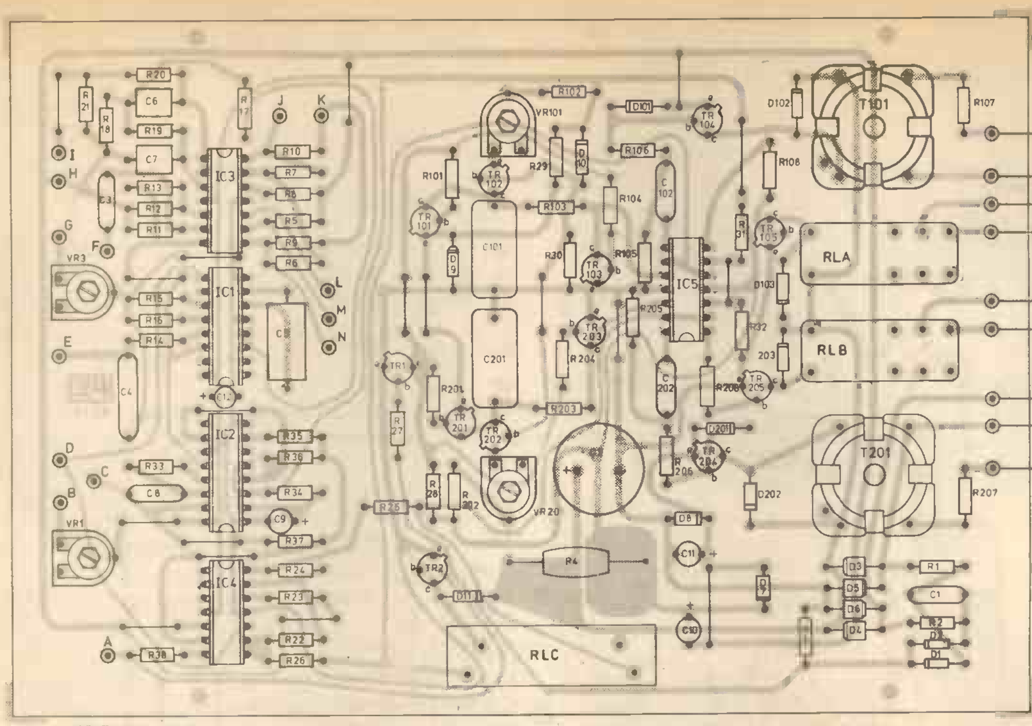


Fig. 15. Board component layout

tape recorder while the multi-way D-type socket, SK2, carries the connections to the triac housing. Fig. 20 shows the numbering of the socket connections from the interior of the box to assist in wiring. Solder leads of suitable lengths to the socket pins before mounting the printed wiring board in the box using four 3mm holes drilled to align with the mounting holes on the board. Group the wires neatly together and solder them to the appropriate pins on the board making sure that you leave enough wire to allow the board to be removed from the box to assist with later fault finding and debugging.

Fig. 16 shows the drilling details for the front panel. Mount the components where shown being careful not to damage the front surface of the panel and wire up the controls as shown in Fig. 17.

Group the wires from the front panel together remembering to leave enough wire to allow the panel to be removed for access.

When all the soldering is complete insert IC1-5 in their sockets noting that they do not all lie the same way round. It is very easy to insert an i.c. the wrong way round or to trap a pin underneath it so check carefully to avoid some tricky fault finding later.

AUDIO LEADS

The correct terminations for the DIN plug connection to the tape recorder are shown in Fig. 20 in which the left hand channel of the stereo pair has been chosen to carry the dissolve control tone. The connections to the plugs at both ends of the lead are identical. For right hand channel operation wire up the plug using pins 4 and 5 in place of 1 and 3 respectively. If phono connections to the tape recorder are required wire up one DIN plug as shown and terminate the two free wires at the other end with standard phono plugs.

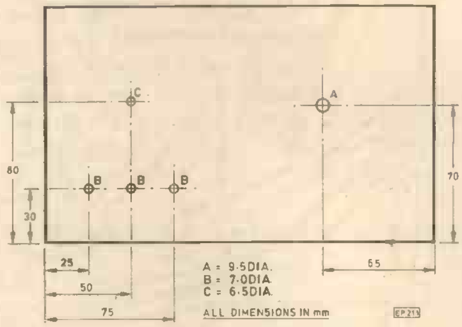


Fig. 16 Drilling detail of control panel

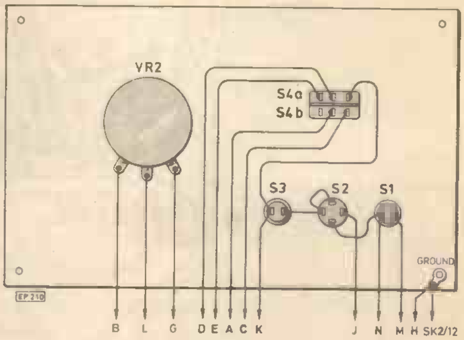


Fig. 17 Component wiring for control panel

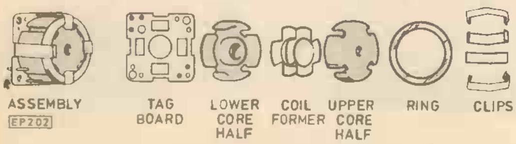


Fig. 18. Exploded detail of pulse transformer

MODIFYING THE PROJECTORS

There are probably as many variations on the basic electrical circuit of a projector as there are manufacturers of this type of equipment so it is not possible to give modification instructions in great detail. We show in Fig. 21 the circuit diagram of a typical projector together with the modifications needed to enable it to work under control from the slide dissolve unit.

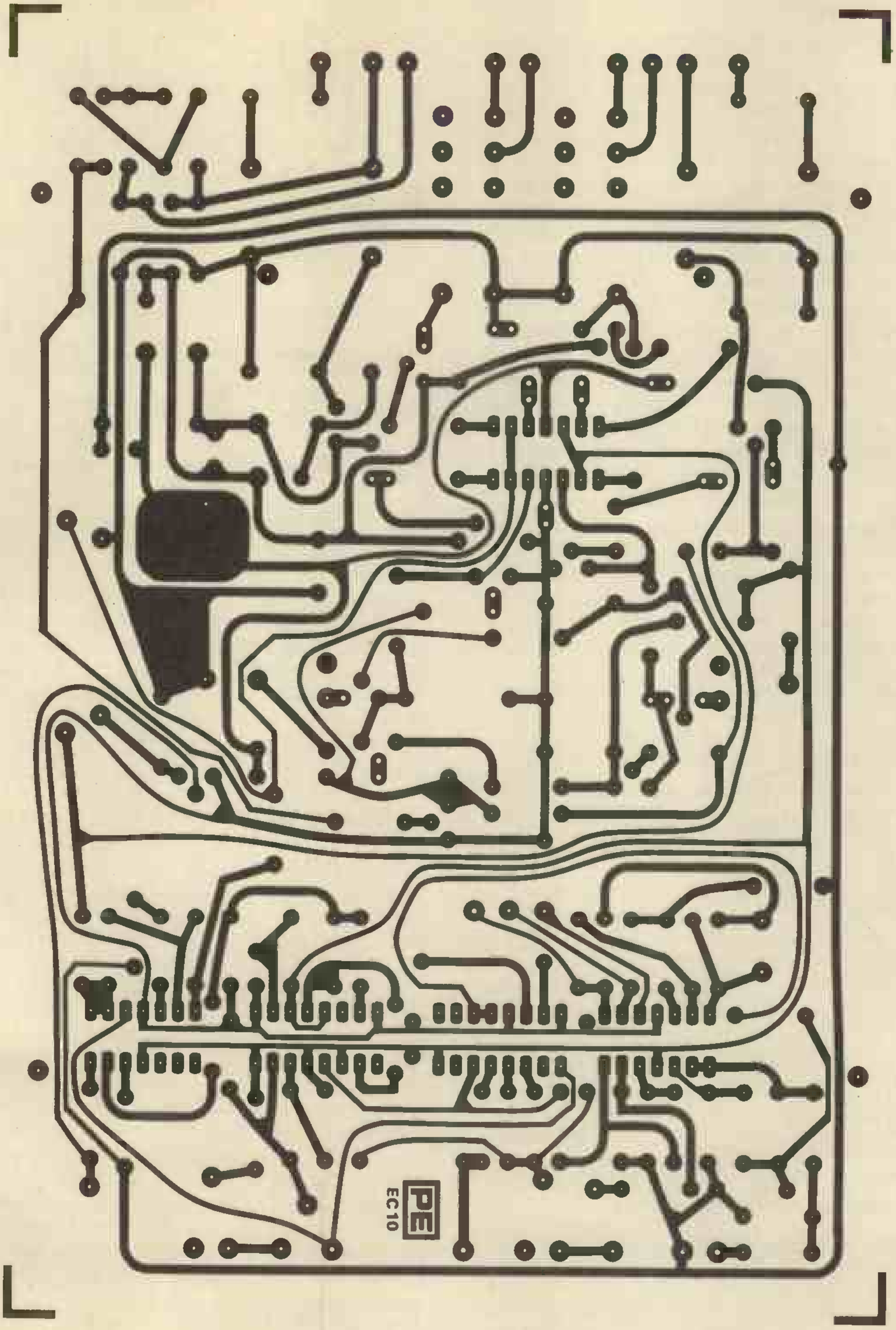


Fig. 19. Printed circuit board for Diamatic

The first and most obvious of the modifications involves interrupting the lamp circuit and bringing it out to a suitably placed D-type socket for connection to the triac housing. Also brought out to the socket is a connection in parallel with the slide change switch and a connection to the transformer secondary which completes the power supply circuit for the control electronics.

Not so obvious are the suppression components shown connected across the two solenoids. The change solenoid (SOL1) operates every time the change relay contacts make in the control unit and the slide direction solenoid (SOL2) will also operate if the direction switch on the projector remote control is set to "reverse". On release of the change relay the back e.m.f. across both of the solenoids causes arcing across the relay contacts which can interfere with the audio channel and disturb the operation of the control circuit. Suppression components are fitted across the coils of both the solenoids to prevent this problem.

First it is necessary to establish whether the solenoids involved (in many projectors there will be only one) are powered from an a.c. or d.c. supply. In the example shown (which is of a real projector) SOL1 is d.c. operated while SOL2 is powered by unrectified a.c. Across the d.c. solenoid we may connect a normally reverse biased rectifier diode that will conduct during the reverse swing of the back e.m.f. thereby preventing an arc from developing. This treatment is not possible for an a.c. solenoid so in this case a series combination of R/C is used to damp the back e.m.f. and reduce the intensity of the arc.

For operation as a normal projector without the dissolve control unit in circuit a dummy plug which shorts together the interrupted lamp connections is inserted in the multi-way socket and slide change is controlled in the usual way from the projector remote control.

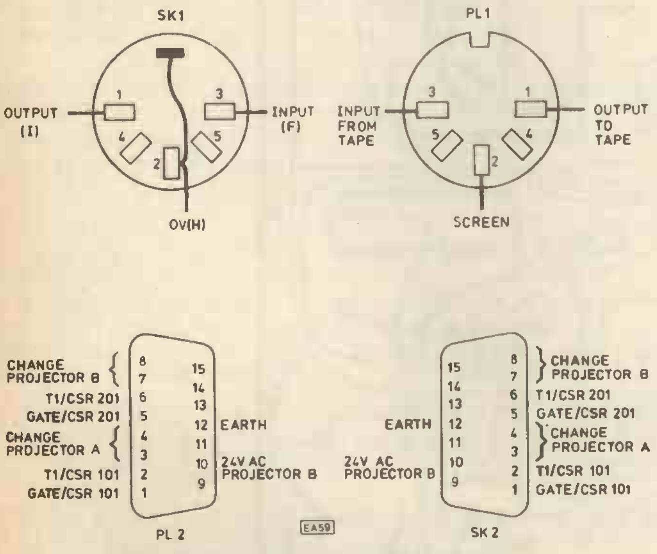


Fig. 20. Plug and socket connections

Constructors who build the triac into their projectors can revert to normal operation by connecting a resistor in series with a switch between T_2 and gate of the triac. With the switch open operation of the lamp circuit is controlled by the triac trigger pulses but when the switch is closed the triac is held in its conducting state and the lamp remains at full brightness.

SAFETY

An earth connection is shown in the circuit diagrams which connects the 0V rail and all metalwork to mains earth via the projectors. It is important that this connection is

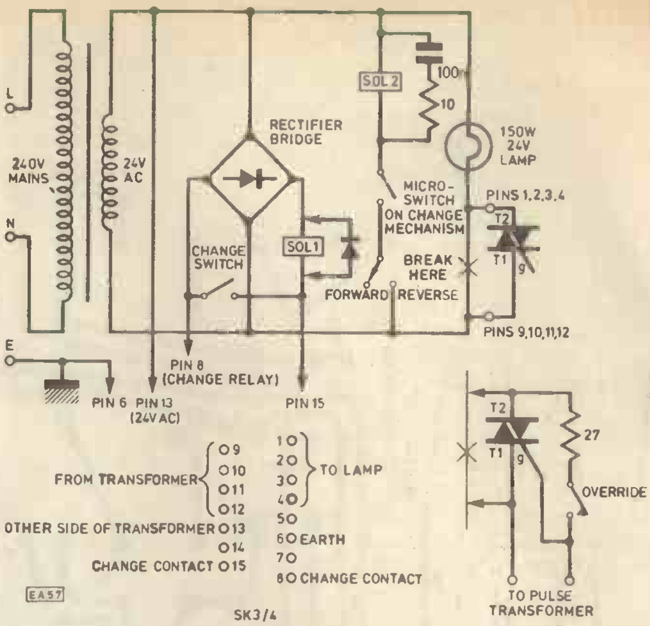


Fig. 21. Circuit diagram of projector with mods

made even if the projectors are double-insulated and do not have a ground connection because the control circuits and hardware are not protected by the double-insulation and could therefore become live in the event of a fault in either projector. If a two-core mains lead is fitted to either or both of the projectors replace it with a three-core 3A cable and connect the earth lead through to the control equipment via the multi-way connector as shown in the diagrams.

Do not rely on an earth connection made via audio equipment—if a hum loop results when separately earthed audio equipment is used remove the connection between the board (pin H) and the DIN connector (SK1, pin 2) to alleviate the problem but remember to replace it if isolated equipment is used at a later date.

ADJUSTMENTS

Only four adjustments are needed before the unit can be used. The object is to adjust the control circuit of each projector so that the lamp is just extinguished at one extreme of the range of the dissolve control knob and just at maximum brilliance at the other. This ensures that there is no "dead space" at either end of the control and that maximum brightness is achieved with no annoying residual image on the screen at the other extreme. Referring back to Fig. 3 we see that a projector is at maximum brilliance when its control voltage just reaches the bottom of the ramp signal (approximately −2V). The lower extreme of the ramp is fixed for both projectors by the common bias (set by R29/D9) to which C101 is discharged. Because this level is fixed it is necessary to adjust the control voltage at each end of its range to make certain that the bright projector is just at its brightest point. This adjustment is made with VR1 and VR3 which set the voltage seen by the wiper of VR2 at each end of its travel (Fig. 6).

Having set up the bright end of the range for each projector it is necessary to ensure that they just turn off at the other extreme of their range. A projector lamp is just extinguished when its maximum control voltage just exceeds the positive tip of the ramp. As we have already fixed the two extreme values of the voltage we must now adjust the peak value of the ramp at the dark end of the range for each projector. The adjustment is made by VR101 (VR102) which varies the current generated by the source which charges C101 (C201) and therefore affects the slope of the ramp.

SETTING UP

The setting up procedure is as follows. First connect the two projectors to the triac housing via the heavy duty cables. It does not matter which projector is connected to each of the two cables as, although power is drawn from only one of the two projectors, both are wired up to supply power when connected to the appropriate lead. Next plug the multi-core connection from the triac housing into the control box, which should be switched to record with all preset adjustments set to mid range, and switch on the projectors. Check that operation of the dissolve control fades from one projector to the other although the adjustment of the lamps at each end of the range will almost certainly be wrong. With the control to the extreme of its travel at which projector A should be bright adjust the preset VR3 anti-clockwise until the projector will go no brighter and then reduce its setting until the lamp dims just perceptibly. Now increase the setting a little to reach maximum brightness. Set the dissolve control to its other extreme (B bright) and repeat the procedure using VR1 for the other projector. The adjustments of VR1 and VR3 interact so it will be necessary to repeat this sequence of events with the control set alternately at each end of its travel three of four times until no perceptible difference is found from one adjustment to the next.

When the bright end of the range is correct set the dissolve control to make A dark and adjust the current source preset VR101 until A is just extinguished. The best way of making this adjustment is to project a slide onto a screen in a darkened room and to adjust the preset until the image can just no longer be seen. When the setting is made in this way the projector lamp will be left with a dull orange glow which keeps it warm and speeds its response to rapid changes. Repeat the adjustment for projector B using VR201; the current source presets do not interact so it is only necessary to make one adjustment for each projector at opposite extremes of the dissolve control.

When the adjustments are complete check that the slide change control works at both ends of the dissolve control range, that the "twinkle" control swaps over the states of the two projectors and that the "superimpose" button forces them both to illuminate at half power. Finally, with the dissolve control set to either end of its range and with no audio input switch to play and check that the signal loss detector operates forcing both the projectors to switch on as if the "superimpose" button had been pressed.

You are now ready to make your first slide dissolve programme.

FREQUENCY SETTING

The adjustments already described are all that are required if the same unit is to be used both to record and to play your audio-visual presentations. Because the same VCO is used both during recording and during playback no adjustment of the VCO output frequency is needed. If, as may happen in a club for instance, different units are used for recording and playing back it is necessary to ensure that all the VCOs have the same brightness/frequency characteristic.

R15 and R16 control the frequency of the VCO at the upper and lower extremes of its control range. In order to make several units compatible with one-another it will be necessary to replace these resistors with pre-set potentiometers, possibly mounted so as to be accessible through the rear of the box.

In order to set up a group of units they should first be adjusted individually in the manner described in the previous section. One of the units is then nominated as "master" and its variable R15 and R16 set to mid-range. The output of this unit is then connected to each of the "slave" units in turn so as to carry out the adjustment of their VCO frequencies. With the "master" set to record and the "slave" set to play the master control potentiometer is set to the end of its range at which projector A is bright. R16 of the "slave" is then adjusted until its A projector is just at full brightness. R15 is next adjusted to set the brightness of "slave" projector B with the "master" control at the other extreme. The whole procedure must be repeated three or four times until no variation between successive adjustments is detected as the frequency setting controls will interact with one-another.

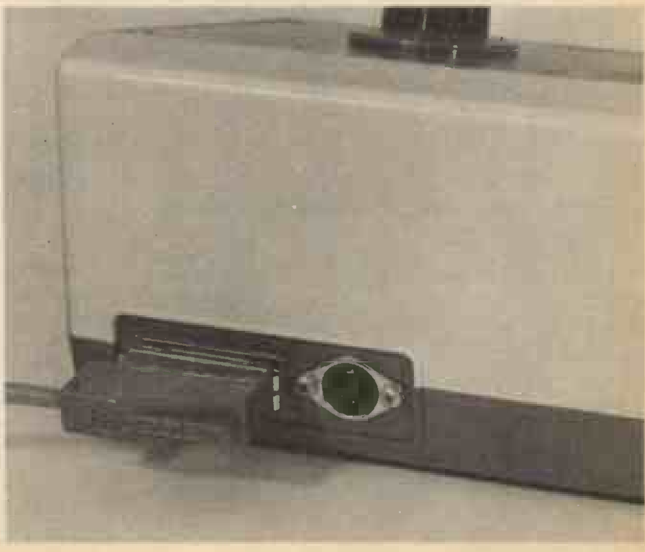
MAKING A RECORDING

The best recording technique to use will depend on the type of tape recorder involved. The output from the dissolve unit occupies one complete track of an audio tape recorder so those readers who, like the authors, do not possess a multi-track machine, will have to use one track of their stereo tape deck and record only mono sound. This is a limitation of course but the impact of a fully synchronised dissolve programme more than makes up for a lack of accompanying stereo sound.

Using a two-head machine (many cassette recorders are of this type) it will be necessary to record both the sound and the slide control tone simultaneously. The sound will first be assembled on an auxilliary tape machine if a number of sources (e.g. disc, tape, microphone) are to be mixed together and then played into the master recorder while the slide sequence controls are operated. With a relatively simple sound programme (e.g. disc only) it is possible to record sound and vision directly without the need for an extra tape recorder.

Three-head machines often allow you to play the contents of one track whilst recording on the other. In this case the sound programme can first be built up on one track, from a number of sources if required, and the visual control signal can later be added to the other track whilst listening to the sound.

Before making a recording it is vital to draw up a script indicating exactly how the intended sequence of dissolves, twinkles, etc. relates to the sound track. It is also helpful to practice by running through the programme several times



to check on timings and to learn to anticipate the operation of the controls.

To make a recording arrange the projectors so that their images are superimposed and load the slides alternately into each magazine with a black slide as the first in each set so that the screen is dark whichever projector is illuminated. With the black slide in each projector gate switch to record and adjust the dissolve control so that the projector that will show the first slide is *dark*, the other fully illuminated. Now switch on the tape recorder at least 30s before the first slide is due to appear and after about 15s press the slide change button to remove the black slide from the gate and replace it with the first one to be projected. When the slide is to appear fade it in with the dissolve control and as soon as it is fully illuminated press the change button to bring the second slide into the gate of the dark projector. Continue in this way alternately operating the dissolve control and the change button until the sequence is completed. It will probably be necessary to insert a black slide as the last in each projector so that the screen remains dark at the end of the presentation.

REPLAY

A smooth, efficient and unruffled beginning to a show adds greatly to the overall effect that it has on even the most uncritical of audiences so fumbling with projectors, wires and controls is best done before the viewers arrive.

The signal loss detector helps by allowing you to superimpose the images from the two projectors at half power simply by switching to "play" without an audio input applied. When the images are set correctly load the slides into the two projectors (making very sure that the right magazine has been loaded into each projector) and bring the first (black) slide into the gate of each. Wind the tape to a position just after the beginning of the slide control tone and connect the output of the recorder to the control unit which is switched to "play".

When the moment arrives switch on the projectors and turn off the room lights. Now start the tape recorder and enjoy the show which will begin by first bringing a slide into the gate of the dark projector and then fading it up on to the screen.

We apologise for the omission of joint authorship and qualifications in Part 1. ★

INDUSTRY NOTEBOOK

By Nexus

Energy Saving

Among all the claims and counterclaims for energy saving systems, sane or crazy, it is refreshing to find a few hard facts and figures based on actual field experience.

The Italian company Telettra has recently published some details of a 2,000 mile national route network of microwave links they have engineered in co-operation with the New Guinea PTT Administration. The first links went in seven years ago and, taking advantage of the newest technology which allowed an extremely low power consumption of only 30W, the equipment was originally powered from dry cells needing replacement every six months. There was therefore no need for mains supply power lines or expensive diesel generation and, as New Guinea has a benign climate, no air conditioning was required. Despite the low power consumption of the repeater stations the capacity is 960 telephone channels plus TV.

Later expansion of the system also brought an up-date and the repeaters are now powered from solar cells with a secondary cell float. The system still demands a visit from a technician every six months to service the secondary cells and clean the solar panels, but over a five year period the cost of ten replacement sets of dry batteries is saved.

Drawing on this experience together with the falling cost of solar cells Telettra now say that the capital cost of a solar powered system breaks even with a diesel generator installation for local power up to 100W. In service the savings come from a nil fuel bill and no maintenance costs for diesel equipment. One of the great advantages of independent local power is that the equipment cabins can be sited anywhere. No approach roads are needed as would be the case for regular delivery to the site of diesel fuel, or the provision of overhead power lines or both.

Fine! But how about locations where temperature variations are such that the equipment needs an air conditioned environment? Conventional air-conditioning burns up more power than the equipment itself. Telettra says the answer lies in a new form of shelter exploiting the thermal characteristics of the materials from which it is constructed and the few watts of heat dissipation in the equipment itself. There are no moving parts and by changing the materials a passively conditioned shelter can be made to iron out temperature fluctuations in either tropical or arctic environments. For large installations the conditioning can be enhanced by natural circulation of fluids in a closed circuit.

Note the three-pronged systems approach. First, getting the power needs lower for a given function, second the development of a non-energy consuming conditioned shelter, third the timely application of solar cells as soon as the cost became economical. Telettra see a huge market for this type of equipment all over the world but especially in the vast undeveloped areas.

Augustine's Law

Norman R. Augustine, vice president technical operations, Martin Marietta Aerospace Corporation, following the example of Professor Parkinson, has established his own set of Laws. Augustine's are based on observation of trends in his own industry and projecting them into the future. The US defence budget increases yearly but so does the cost of tactical aircraft, the latter at a much greater rate. Extrapolating the figures Augustine suggests that by the year 2054 the total defence budget of the United States will buy only one tactical aircraft. Similarly, that before the tricentennial the US Government will employ more government workers than there are workers. Nonsense, of course, but with just that little grain of truth which makes you sit up and think.

Augustine ruefully reflects that in World War 2 all the technology was developed, built and applied and the war was won in just half the time it takes to develop a new military system today.

How Big?

GEC may be Britain's largest private employer (about 184,000 employees) as well as one of the best managed and consistently profitable. And annual turnover is now a healthy £2,500 million. But, as GEC management point out to their staff, there are much bigger fish in the sea. US General Electric (no connection) has nearly four times the turnover and Siemens of West Germany over three times. Matsushita and Toshiba of Japan are both much larger in turnover than GEC while French Thomson-Brandt and Brown Boveri of Switzerland and Germany are nudging from behind only barely short of GEC's sales performance.

Direct comparisons are, however, difficult because such conglomerates (including GEC) have different interests. GEC, for example, unlike US GE, does not make aero engines or own coal mines. A more valid comparison is to try to separate out the various activities. Yet when we do this there is another shock. The whole of GEC's activities in electronics, automation and telecommunications accounts for only one fifth of group turnover. Take out the business in traffic lights, telephone exchanges and industrial automation and you might guess that in 'pure' electronics GEC is about level on turnover with Racal whose business is almost totally in professional electronics.

This is not to disparage GEC, clearly a powerful force in electronics world-wide, but it does impress on us the problem of comparability and that, after all, from this perspective some of the smaller British firms are relatively larger than we imagined.

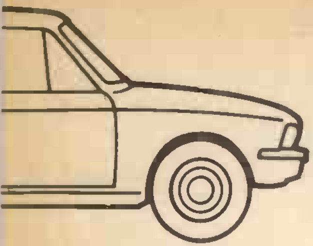
It is now ten years since GEC swallowed up English Electric and AEI. Turnover was then less than £900 million. Today's £2,500 million turnover is achieved with 50,000 fewer employees, reflecting a mix of factory productivity gains and price inflation. Annual salary per employee is now averaging nearly £4,000, not far short of four times the 1970 figure which worked out, by present standards, at a lowly £21·80 per week—but you got more for your money in those days.

BPO Split

Apart from predictable adverse comment from union spokesmen on the postal side of the business, the Government's decision to split the present BPO into two corporations was generally welcomed. PO telecommunications can now romp ahead doing their own thing, and doing it well. Most people, users only of the domestic network, are unaware of the international aspects of the business, or of the immense capital sums involved.

Two recently announced projects are examples. TAT 7, due in service by 1983, will provide another 4,200 submarine cable channels between the UK and the USA. Britain has a 22 per cent share of the £100 million cost and ST&C will manufacture in the UK 2,700 miles of the cable at a cost of £30 million. Another £100 million project is INMARSAT providing by the mid-80s marine satellite communications for shipping. The BPO has an 11 per cent share in the project which will have its HQ in London. Yet another dish aerial is to be constructed at the Goonhilly complex to accommodate the new service. The BPO of course also has a major share in INTELSAT and is pressing ahead with international sales of the Prestel viewdata service.

Under the new arrangement, home and business subscribers will be able to use terminal equipment of their own choice provided it has no adverse technical effect on the public network. With the BPO monopoly of supply broken, there will be intense competition for the business providing a real challenge for home producers to exercise initiative. They have about two years in which to prepare. Failure means handing the bulk of the business to the Far East.



SPECIAL SUPPLEMENT

SOLID STATE CAR INSTRUMENTS

Ammeter · Engine Temperature Dwell Meter

Michael Tooley B.A. David Whitfield B.A. M.Sc.

No.3 AMMETER

No. 1 *Battery Voltage Indicator*, including a description of the LM3914, and No. 2 *Rev' Counter* appeared in *October* and *November*. This supplement incorporates the remaining three, plus details of warning and cascading.

CONVENTIONAL moving iron ammeters usually offer poor calibration, whilst transient response is severely impaired due to the damping needed to prevent overshoot. These ammeters are often difficult to install since they require heavy duty leads (30A or more) from the battery.

The instrument described overcomes these limitations and provides linear response over a range of typically ±25A. Furthermore, the displayed current range is adjustable, thus permitting the user to preselect the actual range of indication to suit his particular needs. The module is basically a voltage measuring device with a high input impedance.

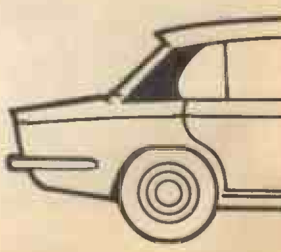
PRINCIPLE OF OPERATION

The usual arrangement of connections to a vehicle battery is shown in Fig.1(a). A heavy duty copper braid links the negative terminal of the battery to the vehicle chassis. This earth strap has a very low resistance, typically 0·002Ω or less. The equivalent circuit of the battery connection, showing the earth strap resistance, is given in Fig. 1(b). The voltage drop developed across the earth strap resistance, R, is directly proportional to the current flowing in it. Furthermore, the polarity of this voltage will change according to whether the battery is being charged or discharged. The obvious disadvantages are that the resistance of the earth strap will vary from car to car, and the voltage developed is very small, typically 20mV for a current of 10A. Hence, in order to interface with the standard LM3914 display circuit, additional amplification is required, and the gain must be made variable to allow for variation in earth strap resistance from one vehicle to the next.

The obvious solution is to use a simple operational amplifier arrangement. There is, however, a problem associated with the fact that the input voltage (developed across the earth strap) varies in polarity about 0V (chassis potential). This is overcome by using a FET as a common source amplifier. See Fig. 2. The output voltage developed across the drain load resistor, R_D, depends upon the drain current, I_D, and Fig. 3 shows how the drain current varies with the gate-source voltage, V_{GS}. By suitable choice of source resistor, R_S, the drain current will increase and decrease about a steady value according to whether the battery is being charged or discharged. Again, by appropriate choice of values, the drain voltage is made to be approximately half the supply voltage, and thus it will interface correctly with the operational amplifier stage which follows. The effects of supply voltage and temperature variations are reduced by using a balanced differential arrangement as shown in Fig. 4. An input protection circuit is necessary in the event of the earth strap ever becoming disconnected, since the excessive gate-source voltage would damage TR1. VR1 allows the circuit to be balanced and compensates for any difference in FET characteristics.

The complete circuit of the Ammeter is shown in Fig. 5. Input protection is provided by R3 and D1–D2. This ensures that the maximum input voltage excursion at the gate of TR1 is 600mV in either polarity. R5 and D13 provide a regulated supply for the differential stage and VR2 sets the voltage gain of the operational amplifier stage. D14 is used to remove the d.c. level from the output of the operational amplifier and allows correct interfacing with the display driver, which requires a 0 to 5V input signal. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible signal at the input of IC2 over the desired current range.

NO HEAVY GAUGE WIRES
FAST RESPONSE
CLOSER CALIBRATION



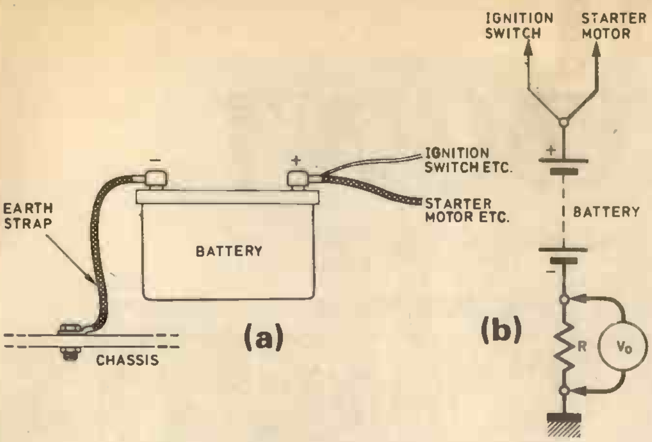


Fig. 1. (a) Conventional car battery connections; (b) Equivalent circuit of the battery earth strap

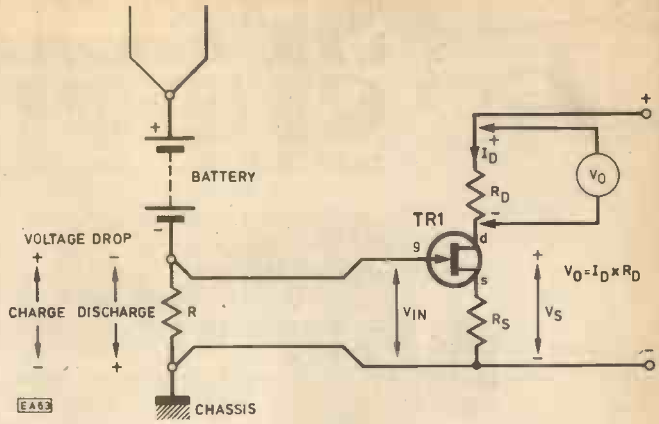


Fig. 2. Simple common source amplifier using an n. channel FET

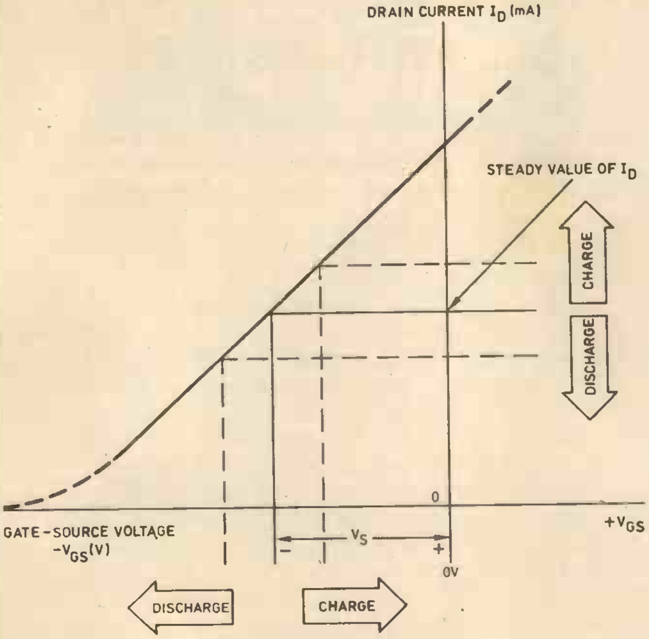


Fig. 3. Mutual characteristics $I_D/(V_{GS})$ of an n. channel depletion mode FET

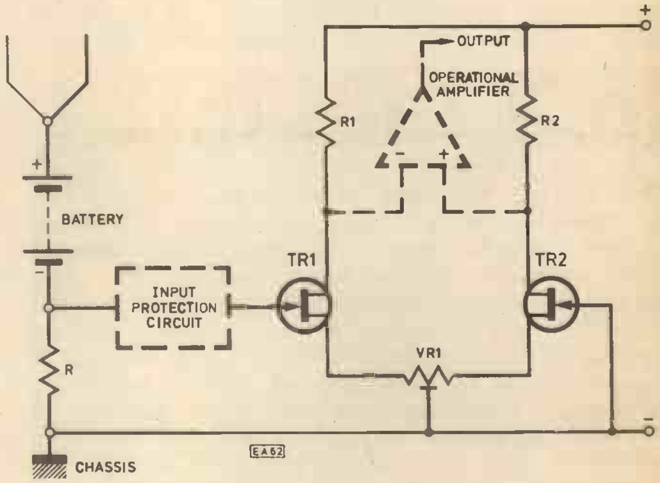
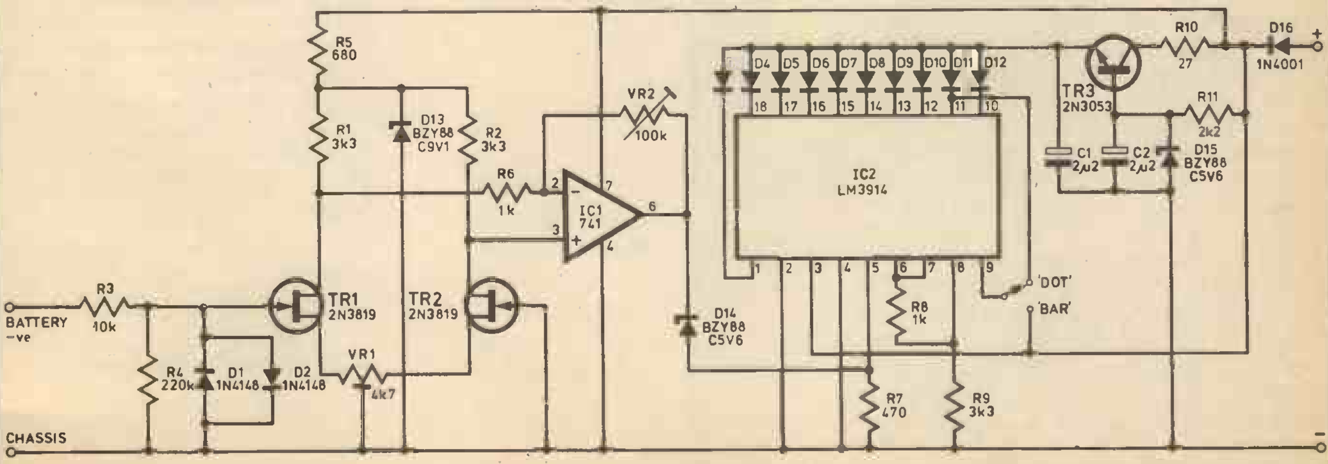


Fig. 4. Practical realisation of Fig. 2

Fig. 5. Circuit diagram of the Ammeter



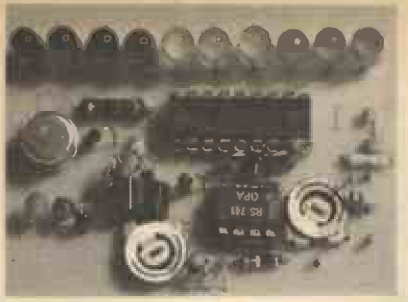
CONSTRUCTION

Two constructional examples are described. Individual constructors will most likely exercise their own preference as to the mechanical assembly of the instrument. The p.c.b. pattern is shown in Fig. 6 with the corresponding component layout given in Fig. 7. The printed circuit board is recommended for use when the instrument is for dashboard mounting in a rectangular "instrument pod". An alternative layout which uses 0·1 inch matrix stripboard is shown in Fig. 8. This method of construction is more appropriate when the instrument is to be of the hand-held type.

The pod mounted version uses standard 0·2 inch l.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The MODE link in both layouts has been shown in the recommended DOT display position. The l.e.d.s may be colour coded to suit the constructor's preference and suggested colours are red for the five left-hand diodes (indicating discharge) and green for the five right-hand diodes (indicating charge).

TESTING AND CALIBRATION

Before installation it is recommended that the instrument is "bench checked" using the circuit in Fig. 9. This provides a variable input voltage of up to 100mV of either polarity. It thus simulates the approximate range of voltages that will appear across the earth strap, and constructors can check



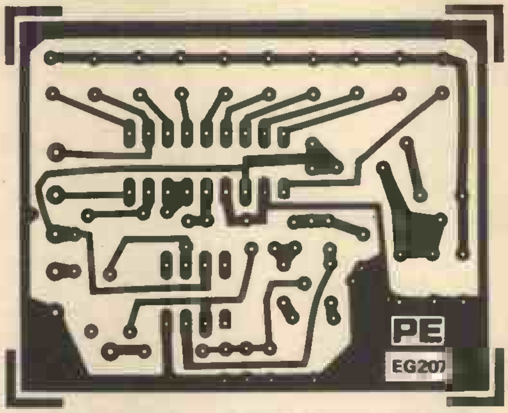


Fig. 6. Printed circuit layout (actual size)

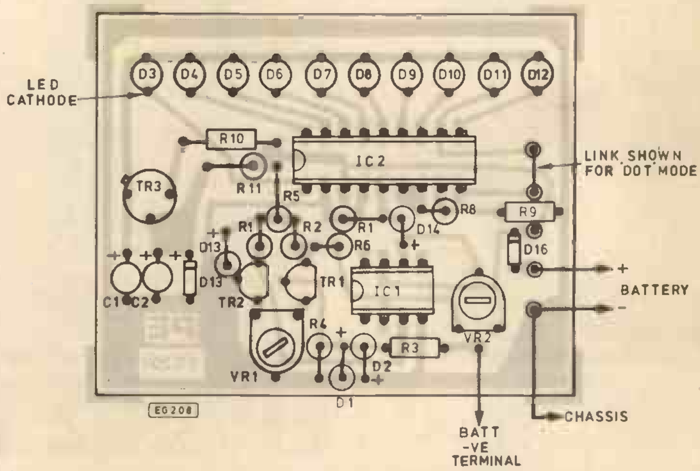


Fig. 7. Component layout

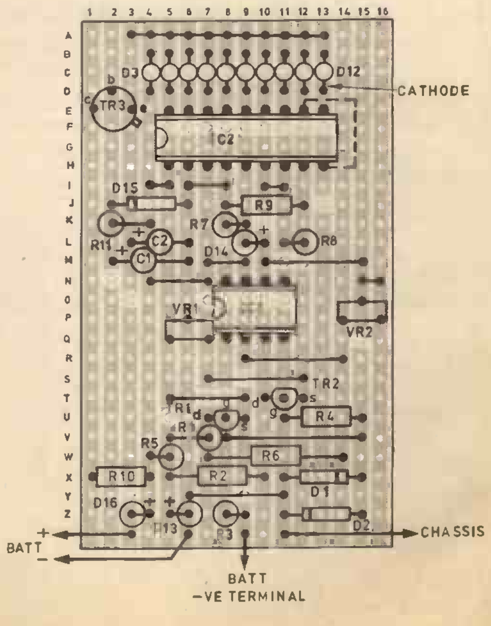


Fig. 8. Alternative stripboard layout

COMPONENTS . . .

Resistors

R1, R2, R9	3k3 (3 off)
R3	10k
R4	220k
R5	680
R6, R8	1k (2 off)
R7	470
R10	27 $\frac{1}{2}$W 5%
R11	2k2

All resistors $\frac{1}{4}$W 5% unless otherwise stated

Potentiometers

VR1	4k7 miniature skeleton pre-set
VR2	100k miniature skeleton pre-set

(Use horizontal pre-sets for PCB mounting, vertical for Veroboard mounting.)

Capacitors

C1, C2	2μ2 25V tantalum (2 off)

Transistors and Diodes

TR1, TR2	2N3819 (2 off)
TR3	2N3053
D1, D2	1N4148 (2 off)
D3–D12	10 off l.e.d.s—size and colour to suit
D13	BZY88 C9V1
D14, D15	BZY88 C5V6 (2 off)
D16	1N4001

Integrated Circuits

IC1	741
IC2	LM3914

Miscellaneous

Printed circuit board or stripboard
Moulded case as appropriate

that the circuit functions correctly before wiring to the vehicle. With the 1k variable resistor set to mid-position, VR1 should be adjusted so that D7 just extinguishes and D8 just becomes illuminated. Moving the variable in one direction should cause the green l.e.d.s (D8 to D12) to illuminate successively and in the other direction the red l.e.d.s (D3 to D7) should illuminate successively. VR2 should be adjusted so that the whole range is covered.

The instrument can now be fitted to the vehicle. Care should be taken to connect the input leads correctly (otherwise a reverse indication will result) using a length of two core cable which terminates at either end of the earth strap. Calibration in the vehicle can then follow, but it will first be necessary to know the power or current requirements of one or more items connected to the vehicle's electrical system.

With no electrical accessories operating and the ignition off, VR1 should be adjusted for centre zero indication as before. Now assume, for example, that two headlamps, each rated at 60W, are illuminated together with side lights and rear lights accounting for a further 60W. The total power from the battery (assuming that the engine is not running and no other accessories are connected) will be 180W which corresponds to a current of 180/12 or 15A. (In the example we have assumed that the battery is man enough to stand up to this load—in practice the terminal voltage of the battery would probably fall a little from the nominal 12V.) It is now merely a question of adjusting VR2 so that the third

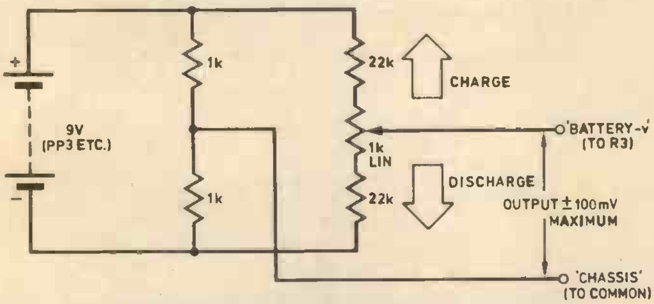


Fig. 9. Circuit for bench-checking the Ammeter

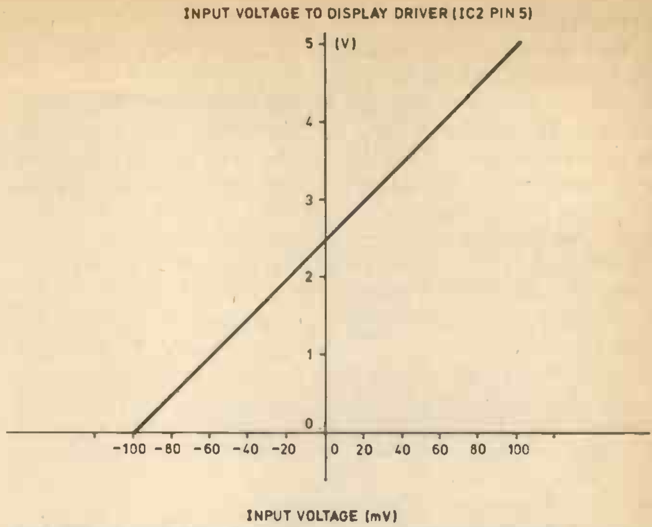


Fig. 10. Earth strap voltage versus display module input voltage — typical

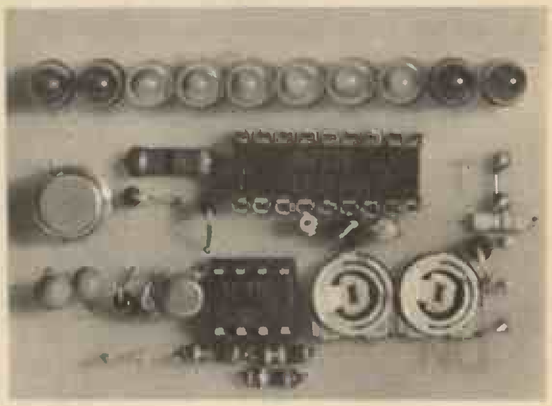
red l.e.d. from the centre, D5, is illuminated (assuming calibration is 5A/LED or ±25A). If a different calibration is required it is simply a matter of adjusting VR2 accordingly. The setting of VR1 should now be checked once again and the car started. A momentary full scale discharge indication will be given as the starter motor is engaged. The charging indication should be checked. On most cars this will be between 5 and 15A. The following table gives a *rough* guide of the current consumption of various items:

Sidelights	3A
Rear stoplamps	5A
Rear screen heater	10A
Radio/cassette	less than 1A
Fan	3A
Interior light	½A

★

No. 4 ENGINE TEMPERATURE

THE instrument described overcomes the accuracy limitations of conventional temperature gauges, and provides a linear response over a range of typically 0°C to 100°C. In addition, the response time is faster than with conventional gauges, and the displayed temperature range is adjustable, thus permitting the user to select a range of indication to suit his particular needs.



PRINCIPLE OF OPERATION

The transducer used is a general purpose silicon transistor. The base-emitter junction voltage, V_{BE}, which although normally quoted as approximately 600mV, varies with the junction temperature. Although the voltage change produced is rather small, it is a linear function of temperature and lies in the range from –2·0 to –2·5 mV/°C (ie, V_{BE} falls as the temperature increases). Over the desired 100°C temperature range the total change in V_{BE} will be approximately 225mV and, since the display module requires an input voltage of 0 to 5V, some additional amplification is necessary.

The basic temperature sensing arrangement is shown in Fig. 1. The base-collector voltage is fixed; a resistor is included in the emitter lead and, provided that the supply and bias voltages remain constant, V_{BE} gives an indication of the temperature of the transistor junction. An improved arrangement is shown in Fig. 2 where two transistors are connected in a differential configuration. This is important in reducing the effects of supply voltage variation which in a vehicle can be as much as 25%. If the circuit is exactly balanced, with R1 equal to R2 and identical transistors, the output voltage will be zero, provided that the two transistors are at the same temperature. Any difference in temperature will cause an imbalance in the circuit and a corresponding output voltage. Ideally TR2 should be closely maintained at a constant temperature, however in practice the interior temperature of a vehicle is usually regulated to a comfortable and fairly constant level (between 20 and 25°C) by the driver. The temperature sensor, TR1, is mounted at some convenient point on the engine block and thus is kept at the working temperature of the engine.

Fig. 3 shows the practical realisation of Fig. 2. A Zener diode is used to stabilise the base-collector voltages of TR1 and TR2. The emitters of TR1 and TR2 are connected to the differential inputs of an operational amplifier. This responds to the difference in the two base-emitter voltages. The operational amplifier also provides the additional voltage gain necessary for interfacing with the display module. VR1 provides a means of balancing the circuit and compensating for any mismatch in transistor characteristics.

The complete circuit of the engine temperature indicator is shown in Fig. 4. The gain of the operational amplifier stage is made adjustable by means of VR2 and, since the output of the stage is at about half-supply potential (approximately 5V), a Zener diode, D2, is used to remove the d.c. level before the signal is applied to the display driver, IC2. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible 0 to 5V signal at the input of IC2 over the desired temperature range.

CONSTRUCTION

As with the other instruments in this series, two constructional examples are described. Fig. 5 shows the printed circuit track pattern and Fig. 6 the corresponding component layout recommended for use in a dashboard instrument for mounting in a rectangular instrument pod. The alternative layout using 0·1 inch matrix stripboard which is suitable for a hand-held instrument is shown in Fig. 7. The pod mounted version uses standard 0·2 inch l.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The wire MODE link in both layouts has been shown in the recommended Dot display mode. The l.e.d.s. may be colour coded,

Fig. 1. Base-emitter voltage varies with temperature of transistor junction

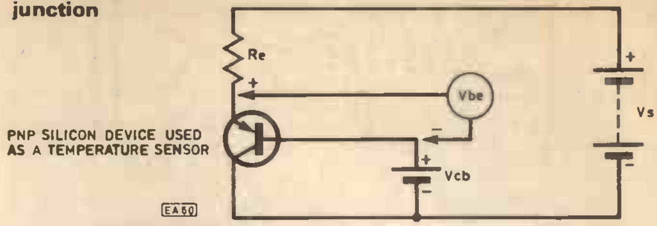


Fig. 2. Differential configuration to reduce the effects of supply and bias voltage variations

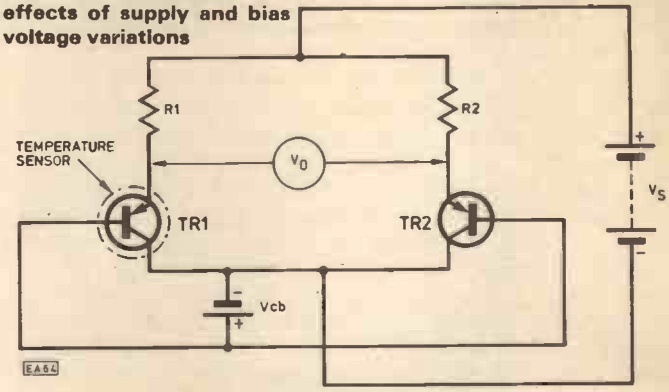


Fig. 3. Practical realisation of Fig. 2

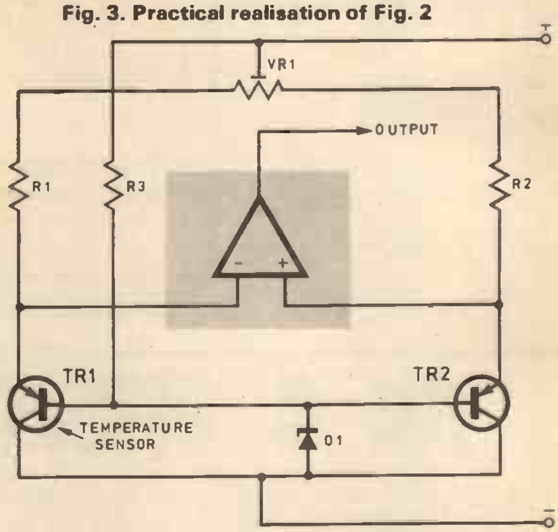
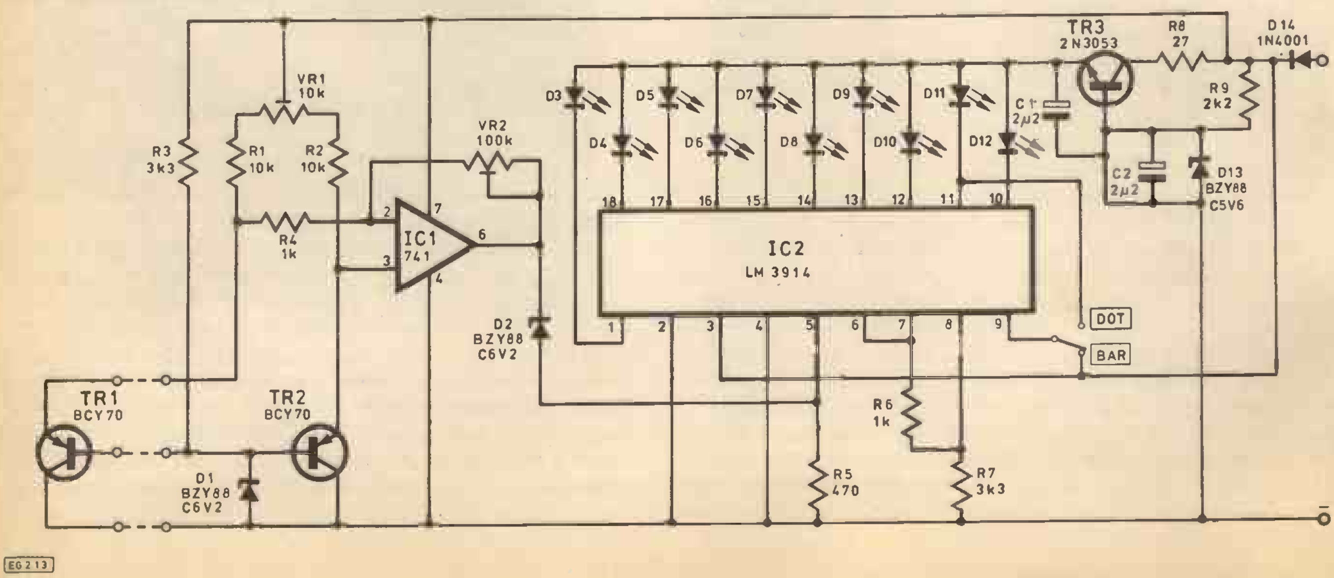


Fig. 4. Circuit diagram of Engine Temperature Gauge. Note: D2 should be BZY88 C4V7



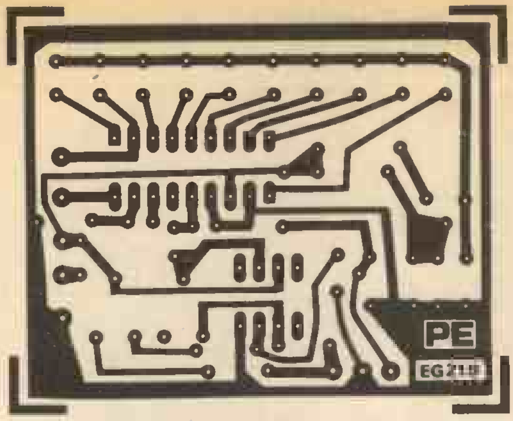


Fig. 5. Printed circuit layout (actual size)

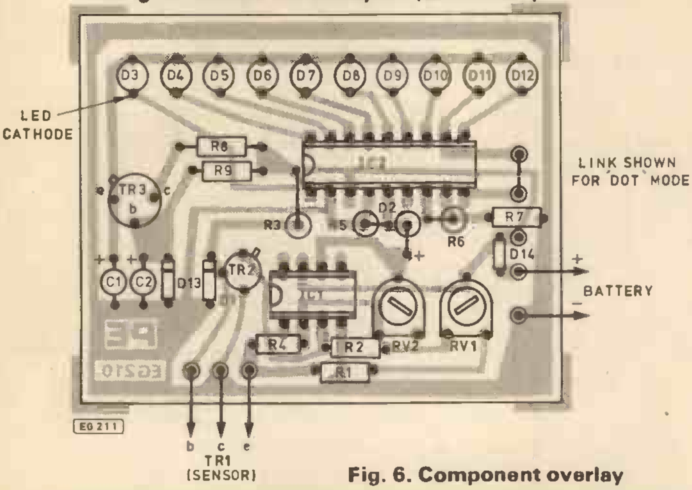
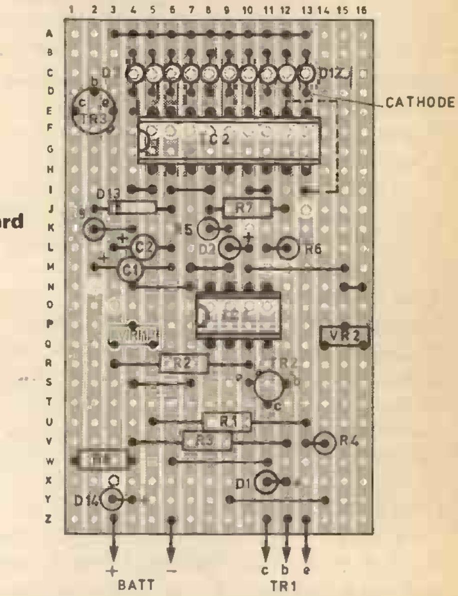


Fig. 6. Component overlay

Fig. 7. Stripboard layout



COMPONENTS . . .

Resistors

R1, R2	10k (2 off)	
R3, R7	3k3 (2 off)	
R4, R6	1k (2 off)	
R5	470	
R8	27 ½W	
R9	2k2	

All resistors ¼W 5% except where stated

Potentiometers

VR1	10k	min. skel. pre-set
VR2	100k	min. skel. pre-set

(Use hor. pre-sets for p.c.b. mounting, vert. for stripboard mounting.)

Capacitors

C1, C2 2μ2 25V tantalum

Transistors and Diodes

TR1, TR2	BCY70
TR3	2N3053
D1	BZY88 C6V2
D2	BZY88 C4V7
D3–D12	l.e.d.s to suit (10 off)
D13	BZY88 C5V6
D14	1N4001

Integrated Circuits

IC1	741
IC2	LM3914

Miscellaneous

Printed circuit board or 63 x 40mm of 0·1 inch stripboard

Moulded case as appropriate

and suggested colours are red for the two l.e.d.s on either extreme and yellow for the others. Hence a red "warning indication" will be given when the engine temperature is outside the range 20°C to 80°C.

CALIBRATION

Calibration is quite simple and, if necessary, can be carried out without the aid of a thermometer. VR1 should be used to set the low temperature indication of the display and VR2 to adjust the range of display. An approximate calibration temperature of 0°C can be obtained using a cupful of crushed ice which is just on the point of melting. The temperature sensor, TR1, should be placed in the ice taking care not to immerse the leads. VR1 is then adjusted until the extreme left hand l.e.d., D3, just extinguishes (leaving the rest of the display blank). TR1 should then be placed in a cupful of water that has just been boiling, again taking care not to immerse the leads. This will produce a temperature of around 90 to 95°C. (Do not use a kettle since the steam produced can cause condensation around the transistor leads.) VR2 is then adjusted so that the extreme right hand l.e.d., D12, is illuminated. The procedure should be repeated, again adjusting VR1 at one end of the range and VR2 at the other. The calibration can, of course, be checked using an accurate thermometer if available. Having completed the calibration, the instrument is ready for fitting to the vehicle.

CONNECTION TO THE VEHICLE

The temperature sensor, TR1, should be either bonded to the engine block using epoxy adhesive or held in place by a small metal clamp. The metal case of the transistor is connected to the collector and may thus safely be earthed to the chassis of the vehicle. Care should be taken to insulate the transistor leads and ensure a sound mechanical termination. A short length of three-core cable should be used to connect the temperature sensor to the instrument pod. Alternatively a length of two-core screened cable may be used in which case the earth/collector connection is the screen itself. ★

No. 5 DWELL METER

THE dwell angle of the contact breaker cam is of great importance to engine performance, particularly at higher rev's. The dwell angle is the angle through which the cam turns while the contact breaker points remain closed and depends upon the angular separation of the cam lobes on the distributor shaft, and the maximum gap between the points. It must be sufficiently large to enable the soft iron core of the ignition coil to become magnetically saturated to provide a good spark, yet not so large as to cause over-dissipation. Too small a dwell angle will result in a low spark voltage, and poor combustion. This may be caused by:

(a) The contact breaker gap being too large.
(b) The cam being excessively worn.
(c) The cam and shaft bearings being excessively worn.

Large dwell angles will result in overloading of the capacitor and burning of the contact breaker points at low speeds. Too large a dwell angle is usually due to the gap of the contact breaker being set too small.

The correct dwell angle for a particular vehicle will be found in the workshop manual. Generally, the dwell angle is usually slightly less than two-thirds of the angle between the cam lobes. In a 6-cylinder distributor, for example, the cam lobe separation is 60 deg and the dwell angle is about 36 deg (comparable figures for a 4-cylinder unit are 90 deg and 52 deg, respectively).

MEASUREMENT OF DWELL ANGLE

Measurement of the contact breaker dwell angle is most easily accomplished by observation of the voltage waveform across the contact breaker points. An idealised representation of this waveform is shown in Fig. 1(a).

A straightforward method of measuring dwell angle requires only a moving coil d.c. voltmeter and a calculator. The mean value of the waveform in Fig. 1(a) is given by:

$$V_{mean} = V_s \times \frac{\text{Angle between cam lobes} - \text{Dwell angle}}{\text{Angle between cam lobes}}$$

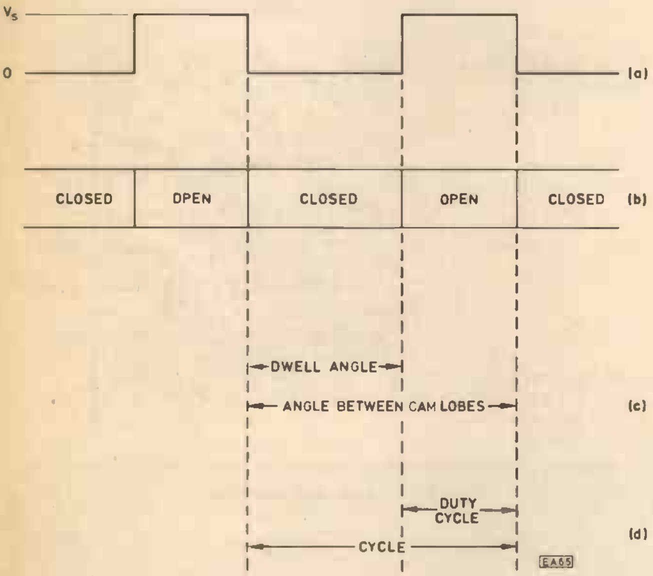
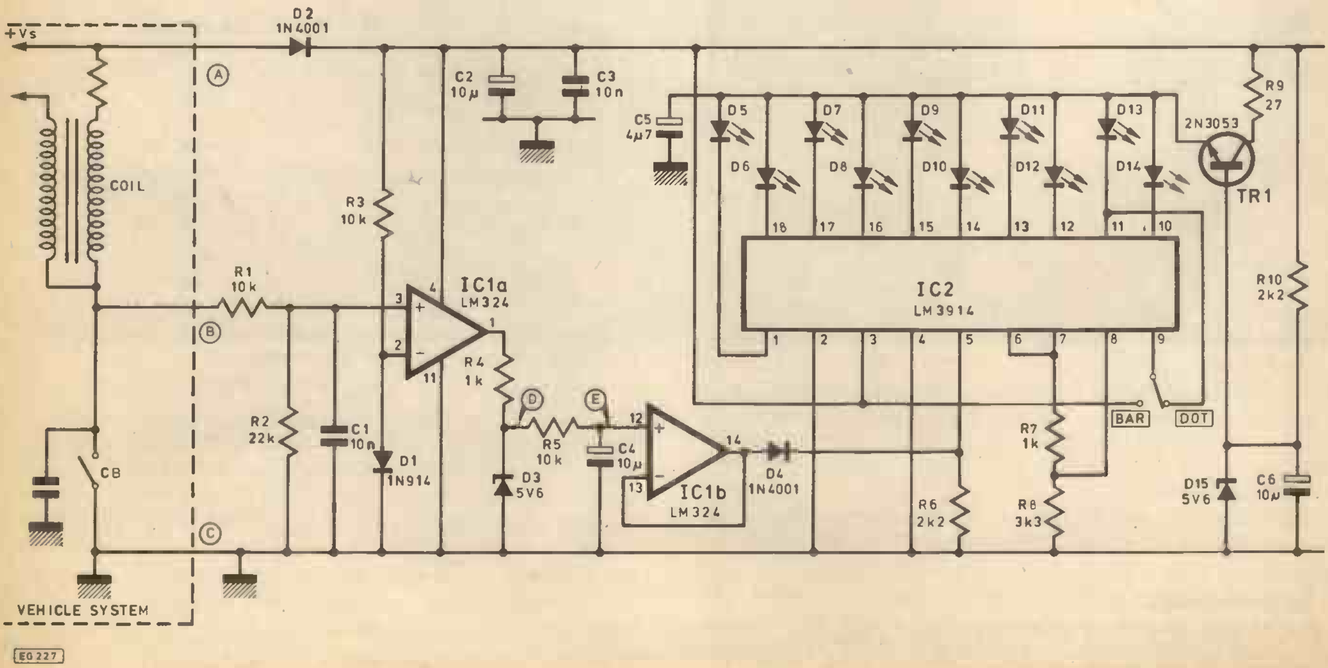


Fig. 1. (a) Breaker points voltage waveform. (b) Points condition; (c) Timing angles; (d) Duty cycle

Fig. 2. Circuit diagram



The values of V_{mean} and V_s may be measured at the two ends of the ignition coil primary winding. The moving coil movement will average the waveform and the dwell angle may then be found from:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{V_s - V_{mean}}{V_s}$$

This technique is tedious when repeated measurements are required.

Ideally, dependance upon the variable value of V_s should be eliminated, allowing a simple scaled meter to be used, whereby the *duty cycle* of the waveform, rather than the *voltage* is measured. The dwell angle is then:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{100\%\text{–Duty cycle}}{100\%}$$

The calibration now depends only upon the angle between the cam lobes. This meter works on duty cycle and displays dwell on a scale which may be calibrated to 90 deg, 60 deg or 45 deg for distributors with 4, 6 or 8 cam lobes, respectively.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 2. The contact breaker voltage waveform is sampled at point "B", and then filtered by R1, C1 and R2. The filtered signal is applied to the non-inverting input of op. amp. IC1a, which is arranged as a voltage comparator. The combination of R3 and D1 sets the switching threshold such that the voltage at point "B" must exceed approximately 1 volt to cause the output of the comparator to go "high".

COMPONENTS ...

Resistors

R1, R3, R5	10k (3 off)
R2	22k
R4, R7	1k (2 off)
R6, R10	2k2 (2 off)
R8	3k3
R9	27 $\frac{1}{2}$W

All $\frac{1}{4}$W 5% unless otherwise stated

Capacitors

C1, C3	10n ceramic (2 off)
C2, C4, C6	10μ/16V elect (3 off)
C5	4μ7/10V elect

Transistors and Diodes

D1	1N914 or similar
D2, D4	1N4001 (2 off)
D3, D15	BZY88 C5V6 Zener (2 off)
D5–D14	L.e.d.s to suit physical requirements (10 off)
TR1	2N3053, BFY50 or similar

Integrated Circuits

IC1	LM324
IC2	LM3914

Miscellaneous

Stripboard or p.c.b. Moulded case

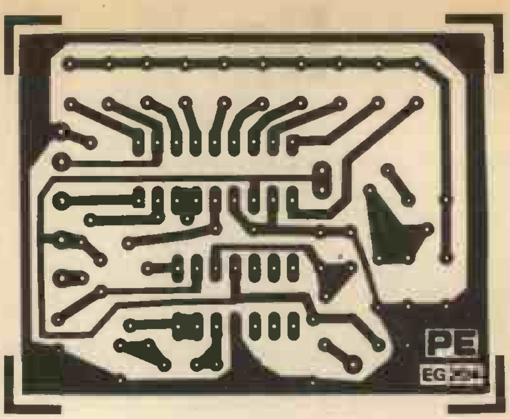


Fig. 3. Printed circuit layout (actual size)

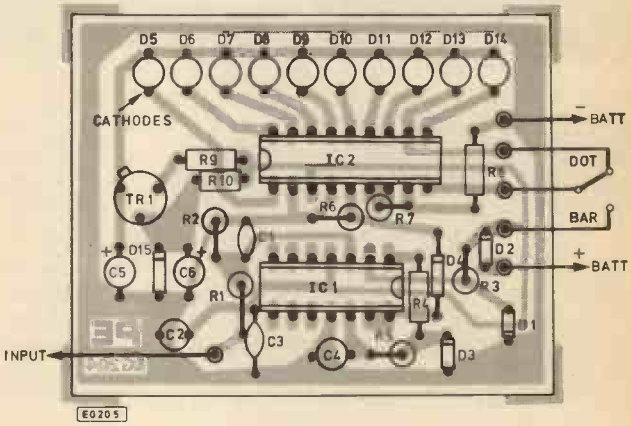


Fig. 4. Component overlay

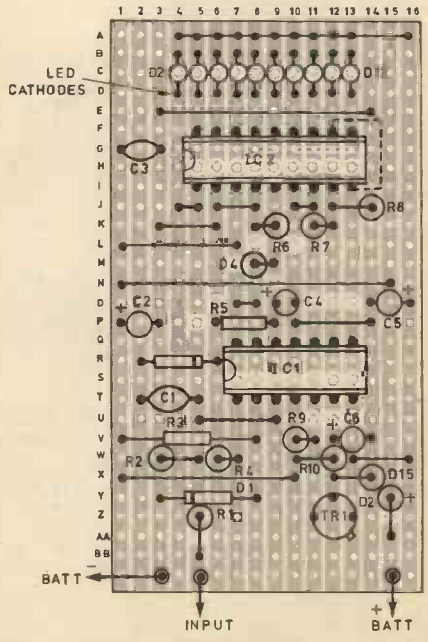


Fig. 5. Alternative stripboard layout

The comparator output is a rectangular waveform limited to the output saturation levels of the op. amp., which in this application are approximately 600mV and (V_{supply}—1·2) volts for the "low" and "high" states respectively. The dependence of the "high" level on the supply voltage is eliminated by the clipper circuit, R4 and D3, and the result is a signal between the levels of 600mV and 5·6 volts.

The average value of the signal at point "D" varies linearly between 600mV and 5·6 volts as the duty cycle varies between 0 and 100%. This average value is developed at point "E" by the integrator formed by R5 and C4, and is subsequently buffered by IC1d to minimise loading effects. The 600mV d.c. offset is removed by D4, and the voltage across R6 varies from 0 to 5V as the duty cycle at the input varies from 0 to 100 per cent to correspond to dwell angles from maximum (angle between the cam lobes) to zero, respectively.

The time constant of the display response is determined by the integrator circuit of R5 and C4. The remainder of the circuit comprises the standard display module.

PRACTICAL DETAILS

The constructional details for the dwell meter closely follow those outlined for the earlier instruments in the series. A p.c.b. design is shown in Fig. 3, with a corresponding component layout in Fig. 4. A stripboard layout for a hand-held test instrument is shown in Fig. 5.

Both instrument variants are shown wired for dot mode display. The display scale should be calibrated 90°–0°, 60°–0°, 45°–0° for 4, 6, 8-cylinder distribution units respectively. The connections for use are the same as those for the tachometer (November), and are summarised again in Fig. 2. A higher resolution display of the dwell angle may be obtained by the use of additional display driver devices, described later. ★

HAZARD WARNING & CASCADING...

THERE are many occasions when it is imperative that the driver receives an immediate warning that all is not well under the bonnet. The two techniques described below illustrate methods of producing hazard warnings in sharp contrast to the normal indication given by the instrument concerned. The examples provided should enable constructors to modify any of the instruments previously described in the series for added hazard warning indications. The enthusiastic constructor will doubtless wish to further exploit the many features of the LM3914 and, in this case, the suggestions given will merely provide a starting point.

MODE SWITCHING

An obvious method of attracting the driver's attention to an instrument operating in Dot mode is to change the display to Bar mode whenever a pre-determined level is exceeded. In practical terms this involes switching the display mode input (pin 9 of the LM3914) electronically, and since the particular l.e.d. illuminated relates to the input level, it is possible to sense the voltage across the l.e.d. concerned and use this to activate an electronic changeover switch. If the voltage at the input of the standard display module (pin 5 of the LM3914) were to be increased slowly from 0 to 5V, and the last l.e.d. used for setting the display into Bar mode, then the display would operate in the normal Dot mode until the last l.e.d. became illuminated, at which level the display would change to Bar mode. In practice any one of the l.e.d.s could be used for determining the changeover point. For most applications it is suggested that either l.e.d. No. 8 or l.e.d. No. 9 is used to provide the changeover (corresponding respectively to 80% and 90% of full range).

Fig. 1 shows a simple practical arrangement which may be used in conjunction with the standard display module. The display mode is changed from Dot to 'bar' whenever D8 is illuminated. A reference voltage is provided by means of R3 and D9. This sets the potential at the emitter of TR1. When D8 is extinguished the voltage at pin 12 of the LM3914 is "high" and base current flows through R1, effectively saturating TR1 and thereby reducing the collector voltage and the mode input voltage at pin 9 of the i.c. to a low value. The display then operates in Dot mode. When D8 is illuminated the voltage at pin 12 of the LM3914 is low (approximately 3V), and thus the base-emitter junction of TR1 is no longer forward biased. TR1 is therefore held off and the voltage at its collector rises to be almost equal to the supply (12V). Hence the mode input is made approximately equal to the supply voltage and the display operates in Bar mode. It is important to note that, if the display indication falls back below the hazard threshold determined by the particular l.e.d. selected, the display then reverts to the normal Dot mode of operation.

TR1 can be almost any n.p.n. silicon transistor having a current gain of 100 or more. A 3·3V Zener diode of at least 250mW rating should be used for D9. The additional components can readily be mounted on a small piece of stripboard and wired to the existing circuitry.

FLASHING BAR DISPLAY

Where a Bar mode display is used (as would normally be the case with a rev. counter, for example) an alternative technique for gaining the driver's attention must be used. In this case, probably the most dramatic method is to make the entire display flash on and off whenever a safe level is exceeded. Since the current drawn from the reference output (pin 7 of the LM3914) determines the brightness of the l.e.d.s in the display it is possible to turn off the display by reducing this current to zero. The circuit of Fig. 2 shows a simple arrangement for flashing the display whenever D8 is illuminated. The falling potential at the cathode of D8 when it first becomes illuminated is applied, by means of C1 and R2, to the reference output of the display driver. R3 is included to ensure that D8 becomes extinguished along with the other l.e.d.s in the display when the display is momentarily turned off. The LM3914 is programmed to produce a constant current in each of its l.e.d. loads and hence the additional resistor in series with D8 does not affect its brilliance. With the component values given the circuit operates at a rate of approximately 90 flashes per minute with a duty cycle of around 30%. It is important to note that, because the reference output is used to modulate the display, the top end of the resistive divider chain which feeds the non-inverting inputs of the ten comparators within the LM3914, must be supplied from a separate regulated supply. This can conveniently be derived from the supply rail which feeds the l.e.d.s (nominally 5V) however, since Bar

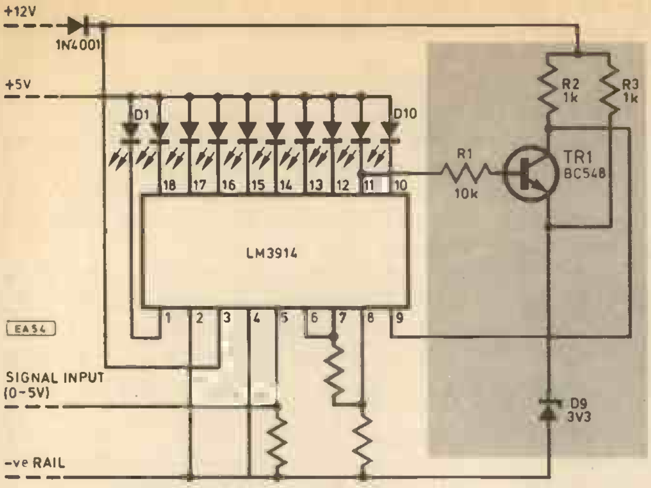


Fig. 1. Circuit to provide Dot-to-Bar mode changeover triggered by l.e.d. 8

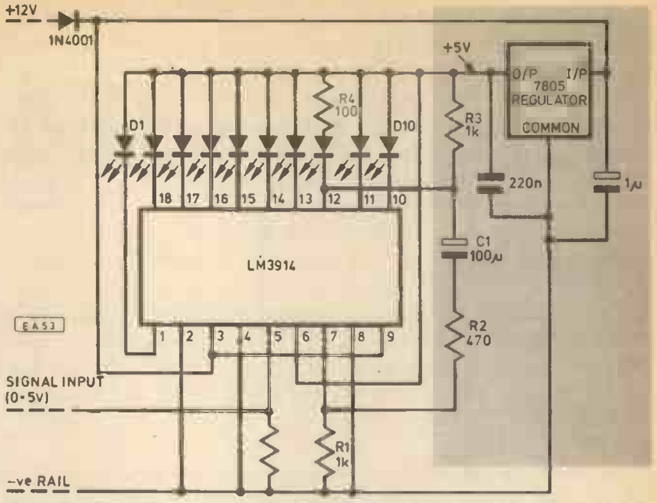


Fig. 2. Circuit to provide flashing bar display triggered by l.e.d. 8

mode is employed and a relatively high current is drawn from this rail, it is recommended that the simple discrete component series transistor regulator used with the standard display module be replaced with a conventional 5V integrated circuit regulator.

Where the flashing circuit is to be fitted to an existing circuit board it is recommended that the extra components are assembled using a small piece of stripboard. The regulator should be fitted with a suitable heatsink (19°C/W should be adequate) and capacitors C2 and C3 should be fitted as close as possible to the pins of the regulator. The existing transistor series regulator arrangement should be disabled by removing the transistor and associated components from the board. It will also be necessary to modify the board wiring around pins 6 and 7 of the LM3914. R1 and R4 can conveniently be incorporated on the existing board and five connecting wires will be necessary.

DISPLAY RESOLUTION ENHANCEMENT

The basic display module described in this series makes use of a display consisting of 10 l.e.d.s. It is often desirable, however, to know the value of the measured parameter to finer limits than can be read from the basic display module. This means that a greater number of l.e.d.s must be used, for example, to display 0-6000 r.p.m. in steps of 200 r.p.m. requires 30 l.e.d.s.

The design of the LM3914 integrated circuit means that the display is conveniently increased in multiples of 10

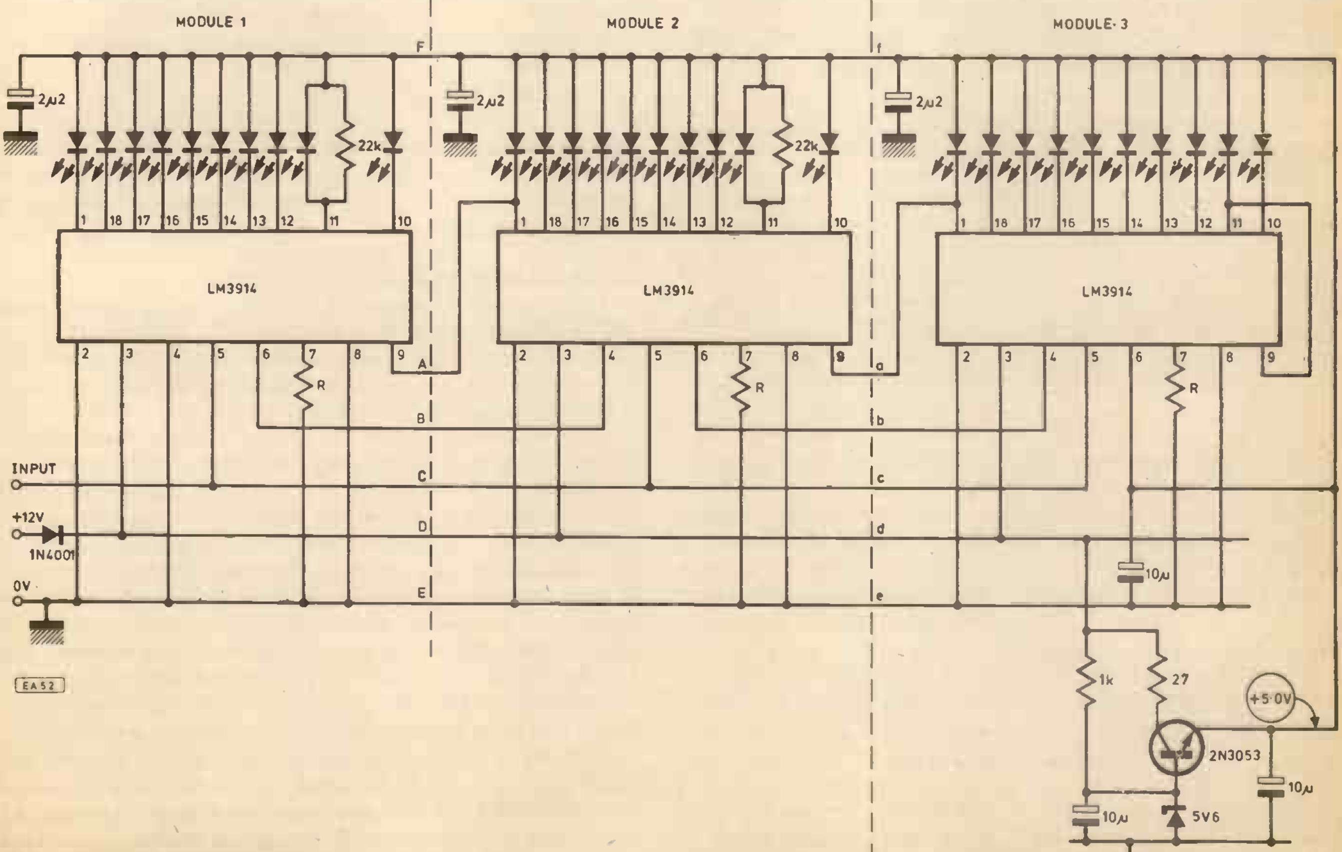


Fig. 3. Extended Dot mode display

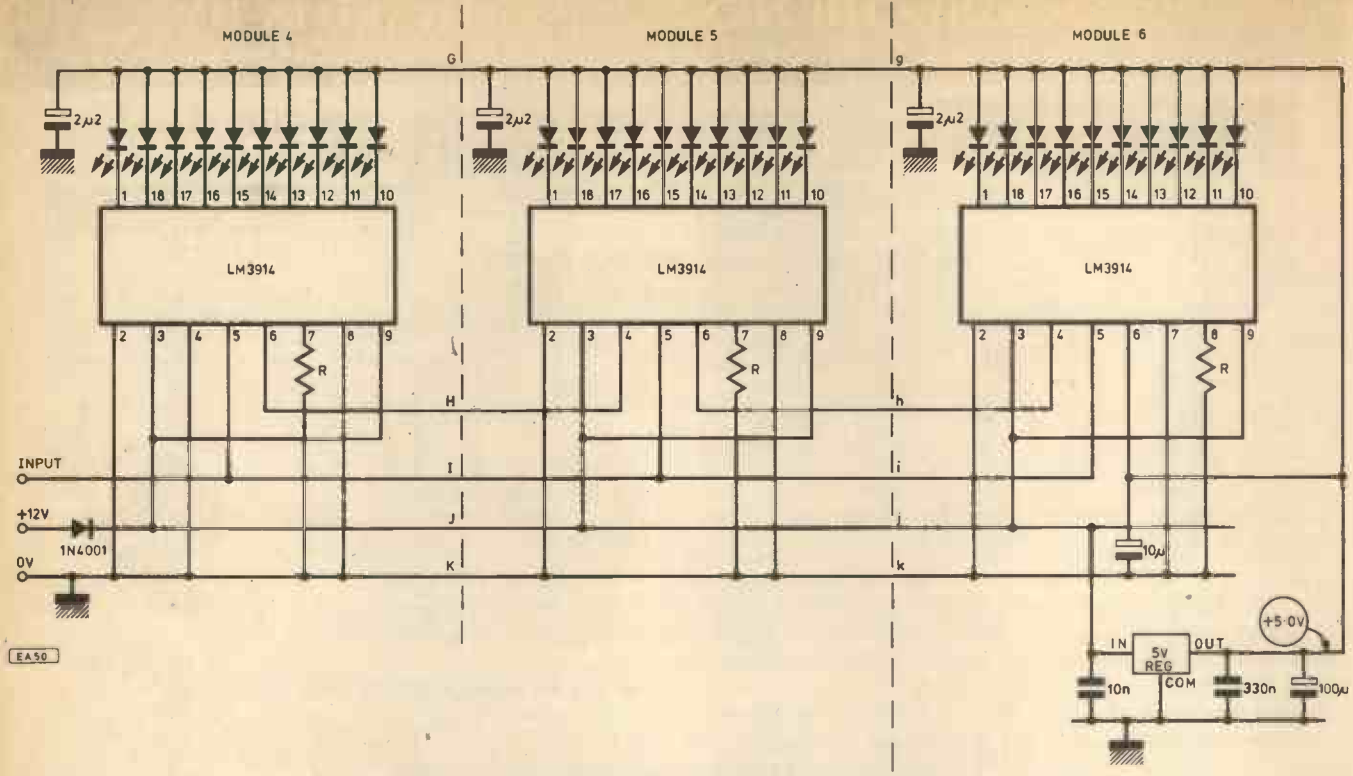


Fig. 4. Extended Bar mode display

l.e.d.s, with the precise circuit details varying slightly depending upon the choice of Dot or Bar mode for the display format. In this way the display may be extended up to 100 l.e.d.s.

EXTENDED DOT MODE DISPLAYS

The "chaining" of display devices to provide an extended Dot mode display employs some as yet unused characteristics of the Mode Select Amplifier in the LM3914. The Mode Select Amplifier looks at three inputs to decide whether to show a Dot display, a Bar display, or a Dot display using multiple LM3914 devices. The three inputs to the Mode Select Amplifier are from pin 9 (mode), pin 3 (V+), and from pin 11 (D9); the last two being connected internally.

Holding the mode pin to within 20mV of the voltage at pin 3 will cause a bar graph to be displayed. A dot mode display will appear if pin 9 is 200mV or more below the voltage at pin 3. If the mode pin is 900mV below the voltage at the anodes of the l.e.d.s, D10 will be turned off. This last feature is exploited in the extended dot mode displays to be discussed and is used to turn the last l.e.d. of one LM3914 *off* when the first l.e.d. of the next device up the chain is turned *on.*

The circuit diagram for a 30-l.e.d. dot mode display module is shown in Fig. 3. The l.e.d. current is set by the value of the resistors R, to a value given by:

$$I \simeq \frac{12\cdot5}{R} \text{ (R is typically 1 k}\Omega\text{)}$$

The full-scale calibration of the display module shown depends on the exact value of the 5 volt rail, i.e. the full-scale value is set by the voltage at pin 6 of the LM3914 in module 3. A 22k resistor is also required in parallel with D9 in modules 1 and 2 to ensure correct operation of the Mode Select Amplifiers.

A 20-l.e.d. display may be constructed by omitting module 2 from the circuit of Fig. 3, and making direct connections A-a, B-b, C-c, D-d, E-e, and F-f. Alternatively, the display may be extended beyond 30 l.e.d.s by breaking the links at A, B, C, D, E, and F, and inserting additional modules of type 2 as required.

EXTENDED BAR MODE DISPLAYS

Bar graph displays of 20 or more l.e.d.s are relatively simple to build. All that is required is that the mode pin of each LM3914 is connected to pin 3 of the same LM3914. The circuit diagram for a 30-l.e.d. bar graph display module is shown in Fig. 4.

As with the extended dot mode display, the full-scale input voltage for the module is set by the voltage at pin 6 of the LM3914 in module 6. The power dissipation of the regulator for the anode supply to the l.e.d.s requires careful consideration. A stable 5·0 volt output is required, with the regulator capable of dissipating the surplus power associated with a full-scale display. For example, a 100-l.e.d. display with R = 1k would involve a regulator dissipation of 8·75 watts when operated from 12V supply, (the individual l.e.d. current would be 12·5mA). It is recommended, therefore, that an integrated circuit regulator be used as shown in Fig. 4, and that adequate heat-sinking arrangements be made.

Displays of 20 l.e.d.s should omit module 5 from the circuit given in Fig. 4, and links should be inserted at G-g, H-h, I-i, J-j and K-k. For displays of more than 30 l.e.d.s, the links should be broken at G, H, I, J, and K, and additional modules of type 5 inserted as required. ★

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Compukit

Sir—Some time ago I think you asked for reader comments and I would like to say that in my view *PE* has improved very considerably over the years and particularly in recent times.

But I have a moan! The Compukit articles, who are they aimed at, the expert or the amateur? Right at the start the writer lists the amateur as a potential user, but the articles are written using computer jargon (the writer says as much in one place) which is pretty well unintelligible to the beginner in the computer world, however expert he may be in general electronics. In saying this I am not referring to the BASIC dialect but to words such as "string function" (on page 43 of the pull-out, it is stated that a string can be 0 characters long which seems to have no meaning, and whence 255?), "the memory defaults", "arrays", "truncated integers", etc., and does the average amateur know his Boolean algebra?

With reference to the pull-out itself, does this refer particularly to the Compukit or to BASIC in general?

May I refer to the "Microprocessor Evaluation System" article in the May issue of *PE* in which the writer states several times that 377 octal is 255 binary, but 377 octal is equivalent to 255 decimal, there are no 2s and 5s in the binary system. As the writer makes the statement several times he presumably means something by it, but what? Lastly, to the beginner in the computing world (and that includes me) the charts on pages 20, 21 of the same article, are unintelligible in the form given.

The small booklet that you issued in May 1978 is not much use with reference to the above points, what about a reissue?

I was initially filled with enthusiasm for the Compukit but this is rapidly turning to frustration. Is there any chance of a short glossary being published as an addendum to the last article of the series?

A. Bray,
Potters Bar.

Thank you for your comments. This is a difficult area for PE because we have to optimise between encumbering every computer based article with the same mass of fundamental explanations, or keeping to the point but losing the beginner. This is why, in the Compukit article, we refer the reader to our Learn BASIC article which, we hope, will put the newcomer in the picture.

However, to briefly answer your questions: A string ($) is a string of alphabetic characters. i.e. You may state A = 123 but not A = CAT, for this must be a string A$ = "CAT". A string of no characters is a null string, i.e. A = " ". The maximum of 255 char's is governed by the highest number 8 binary bits may record.

When the machine is said to default to something, it is assuming a preset value in the absence of information to the contrary.

An array is a subscripted variable i.e. A(1) to A(10) is a dimensioned array with ten possible values.

Truncated integer. This is to round-down, i.e. 2·76 becomes 2 etc.

To revise Boolean algebra is a prerequisite for any amateur embarking on computer work, and the pull-out describes the BASIC which Compukit *is capable of only.*

With reference to the binary and octal numbers in the Microprocessor Evaluation System article, the statement is technically incorrect. The number 255 represents the individual digits of the b.c.d. equivalent, not the strict binary equivalent—Ed.

Schottky

Sir,—In "Semiconductor Update" in September's issue of Practical Electronics, R. W. Coles states "There will be other new TTL families from manufacturers such as Fairchild . . ."

A few months ago Texas Instruments announced their AS and ALS range of advance TTL families. To date, only one part is obtainable, the 74ALS74.

One year ago, Fairchild announced fast: "Fairchild Advanced Schottky TTL". This range was not only announced several months before competing products: it is also considerably easier to obtain. Already the simple SSI building blocks are available, and MSI multiplexers, registers, counters and bus drivers are either available or will shortly be announced.

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A technical description of fast technology has already been published in *Electronics*, March 1979, pp. 111.

J. Summers,
Fairchild.

Recompense!

Sir—Re. your correspondence page in October issue and the article on CB. There is no doubt in my mind that most, if not all of this, is triggered off by people who wish to flog 27MHz imports. I have had a life-long interest in radio and have made no concerted effort to study, and yet recently I saw a paper used at the May RAE exam and could have passed it. This would give me access to equipment designed for 144MHz costing less than the £260 quoted in Mark Sawicki's article. Study Morse for a few weeks and I can transmit world-wide! Much more interesting and just as useful in emergencies as CB probably is. In the States, I am told, it (CB) is abused more than used.

I suppose that the Government will eventually give in, they usually do, but if they take the soft option, 27MHz, then they are morally bound to recompense modellers financially, who have to change their equipment. I am not, by the way, an RC modeller.

T. D. Ray,
Derby.

Champ

Sir,—In the conclusion of the CHAMP series you mentioned possible further articles on programming or hardware designs, but nothing has been printed yet.

There must be many PE readers who have constructed CHAMP and have information to exchange.

I would be glad to exchange with any CHAMP enthusiasts hardware ideas, problems and even the occasional program.

J. Coyne,
BFPO 17.

CHAMP has been rather overtaken by new technology but it is not our intention to neglect those who have built it and we would welcome small programmes and hardware ideas for publication and for exchange to other CHAMP users—Ed.

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	470	470Ω
	2Ω2	2·2Ω
Capacitance	680µ	680µF
	4µ7	4·7µF
	470n	0·47µF
	47n	0·47µF
	4p7	4·7pF
Inductance	3H4	3·4H
	800m	800mH
	2m6	2·6mH
	1m	1mH

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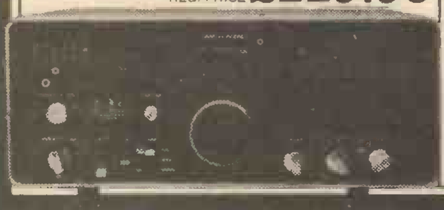

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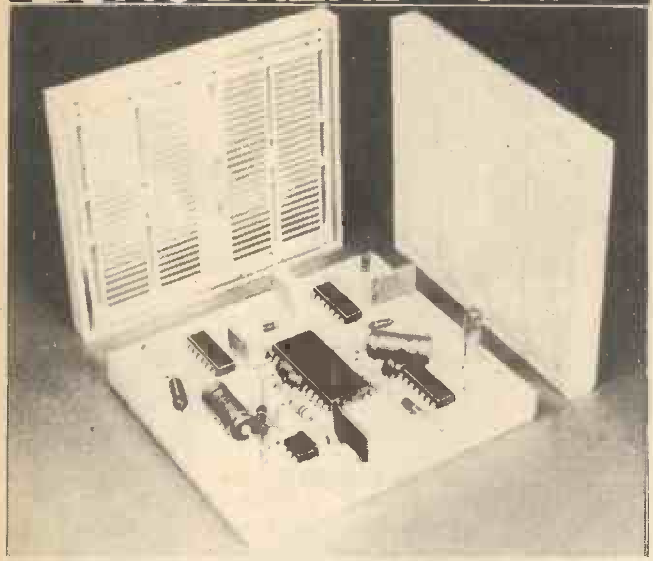

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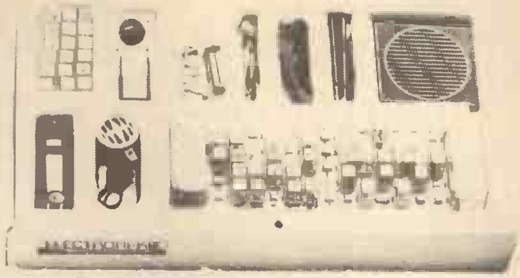

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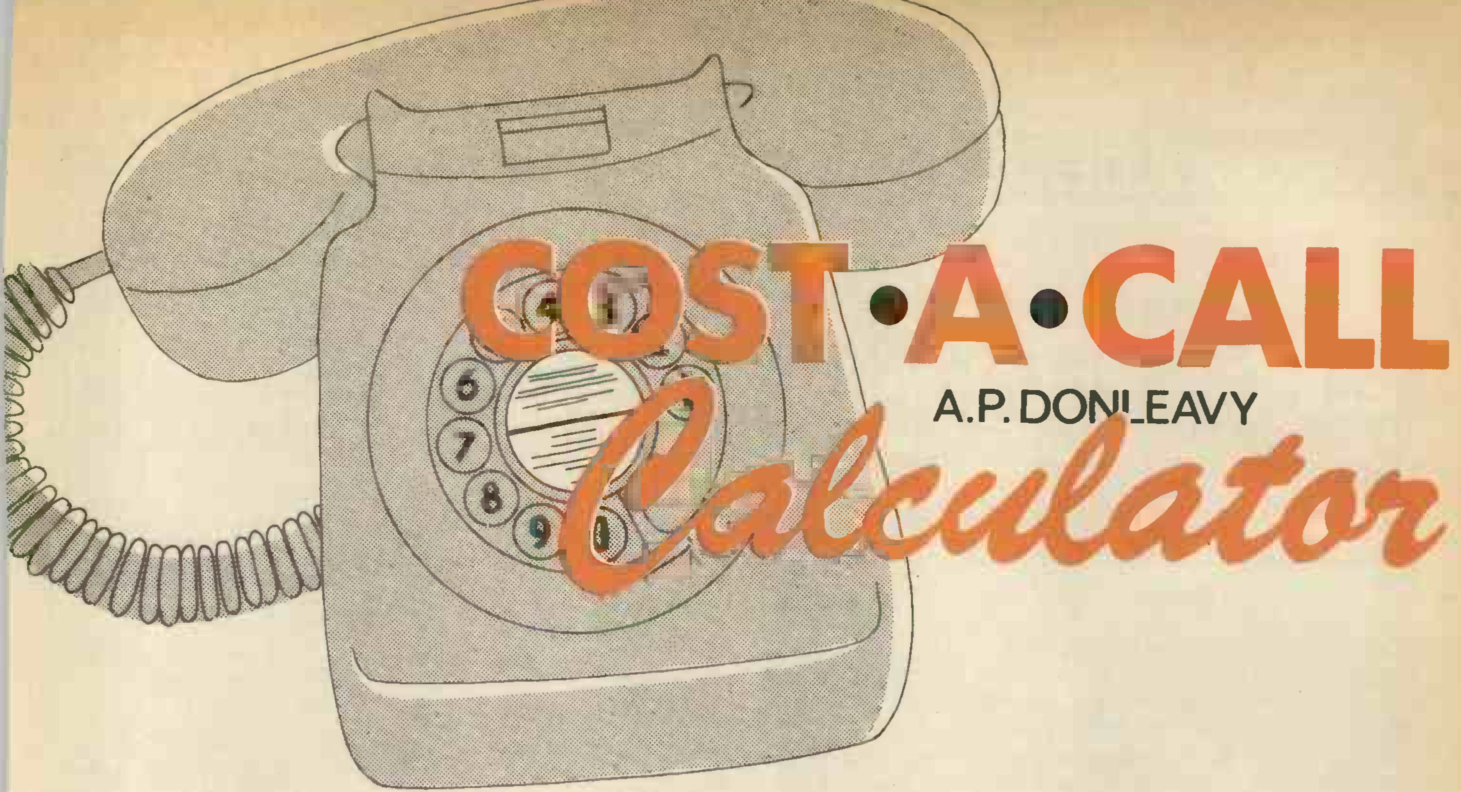

COST•A•CALL Calculator

A.P. DONLEAVY

Can be used to cost several calls

THE unit to be described will display directly the cost of a telephone call, taking into account the time of day, distance called, and length of time of a call. The unit can also be used to total the cost of several calls.

At the time of writing, the Post Office charges three pence for each unit of time of the duration of a telephone call. For a long distance call (over 56km) at peak rate, each ten seconds will cost three pence. A local call at peak rate costs three pence for two minutes. Table 1 gives the current rates (cost codes) presently charged by the Post Office.

For example with the instrument set to cost code (a) it will add three pence to the display every ten seconds.

CIRCUIT

Fig. 1 gives a block diagram of the system used. The period timer is a monostable with a timing period set for the appropriate cost code—10s, 15s, etc. The negative edge of the output pulse is fed to both the unit timer, which is also a monostable, and, in turn, the cost oscillator. The timing pulse of this is used to gate the cost oscillator.

The duration of this pulse and the frequency of the oscillator are chosen such that only thirty oscillations occur before the gating pulse stops the oscillator. These thirty pulses are fed to the counter/display system, and cause a 3 to be displayed. The unit timer pulse is also fed back to retrigger the period timer, and start again the sequence of events.

IC1 contains two monstable oscillators (Fig. 2). IC1a is used to provide the period timing pulse. The length of this depends on which resistor R3—R11 is switched into the circuit and on the value of C3. VR1 is used to provide a control voltage to pin 3 which is used to make a fine adjustment to the timing pulse period. The length of this pulse is altered by VR2.

The output pulse is then fed to pin 12 of IC2. This is a four NAND gate CMOS chip. Three of these gates are connected as an oscillator. The oscillations are fed to pin 9, and only emerge at pin 11 of the gate if pin 12 is at logical 1, which is for the duration of the unit timer pulse.

Table 1: Cost Codes
Time in secs. for 3p. Costcode is in brackets

	Peak Rate	Standard	Cheap
Local	120 (f)	180 (g)	480 (h)
Up to 56km	30 (c)	45 (d)	180 (g)
Over 56km	10 (a)	15 (b)	60 (e)

The negative edge of the pulse is fed back via C5 to retrigger IC1a. C4, R13 and C5, R12 are used to provide short input triggering pulses, since these must be of shorter duration than the output pulse, which would not be the case if the pulses were fed directly to the inputs.

S2 is a double pole switch arranged such that S2a is on when S2b is off. In this mode pin 4, the reset of IC1 is grounded and the output pin 5 is low. Switching S2b on immediately gives a negative pulse to pin 8 IC1b which triggers the monostable so that the instrument immediately displays the first unit of cost, and then proceeds to cost the rest of the call.

TIMING PERIODS

The values of C3 and R3–R11 are chosen to give a timing period of 10 seconds per 100k (using VR1 for a final calibration). Therefore to obtain the timing periods 10, 15, 30, 45, 60, 120 and 180 seconds, resistors of 100k, 150k, 300k, 450k, 600k, 1·2M and 1·8M, respectively are required.

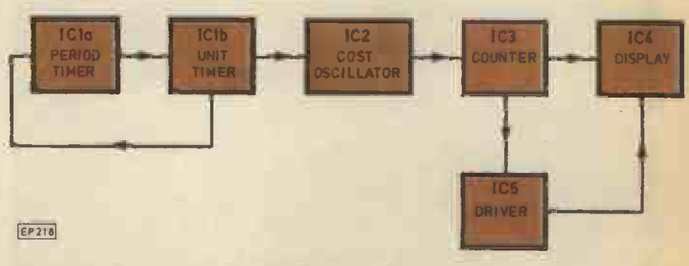

Fig.1. Block diagram

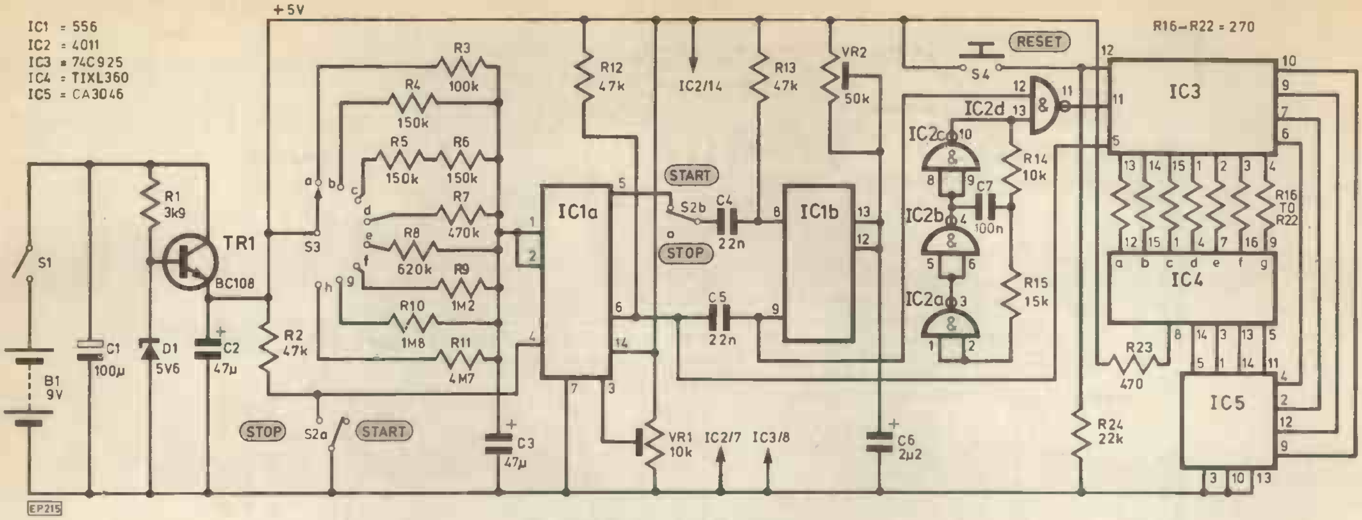

Fig. 2. Circuit diagram

300k resistor is obtained by two 150k in series and a 470k resistor is used instead of a 450k resistor, leading to a 5 per cent error in this timing interval. However, for domestic use this is not significant. Also R8 will need to be 620k. Varying VR1 changes all timing periods by the same percentage.

In the event of changes in telephone charges VR2 will recalibrate the unit cost of a call. Any changes in this period costing may be done with VR1, or else resistor changes may be required. This however is a simple job.

IC3 is a National CMOS MM 74C925 four digit counter/latch/driver, internally multiplexed. IC5 is a CA3046 chip containing five identical transistors, four of which are used to drive the display digits. The display is a TIXL306 calculator display with either four or six digits. Only four are used in this project.

The pulses from the oscillator are clocked into pin 11 of IC3 where they are then counted and displayed on IC4. S4 is depressed to zero the reading on the display.

COMPONENTS . . .

Semiconductors

D1	BZY88-5·6 Zener 400mW
TR1	BC108
IC1	556
IC2	4011
IC3	74C925
IC4	TIXL360
IC5	CA3046

Capacitors

C1	100μ elect 25V
C2	47μ tantalum
C3	47μ tantalum
C4	22n
C5	22n
C6	2·2μ tantalum
C7	100n

Switches

S1	On-off toggle
S2	Double pole double throw
S3	Single pole eight way rotary
S4	Press switch

Variable resistors

VR1	10k linear
VR2	50k multiturn trimpot

Resistors

R1	3·9k
R2	47k
R3	100k
R4	150k
R5	150k
R6	150k
R7	470k
R8	620k
R9	1M2
R10	1M8
R11	4M7
R12	47k
R13	47k
R14	10k
R15	15k
R16–22	270
R23	470
R24	22k

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Miscellaneous

Verobox 153 × 84 × 39·5mm

The power supply regulation circuit is fairly simple and straightforward giving a line voltage of about five volts.

COMPONENTS

IC5 may be substituted by an LM3086, which is a pin for pin equivalent. IC4 may be substituted by any display if the appropriate adjustments are made to the printed circuit board. All that is required is that the segments a–g and digits be connected to IC3 as shown. Individual 0·3 in. displays may be used also. Again the constructor will need to make his own modifcations.

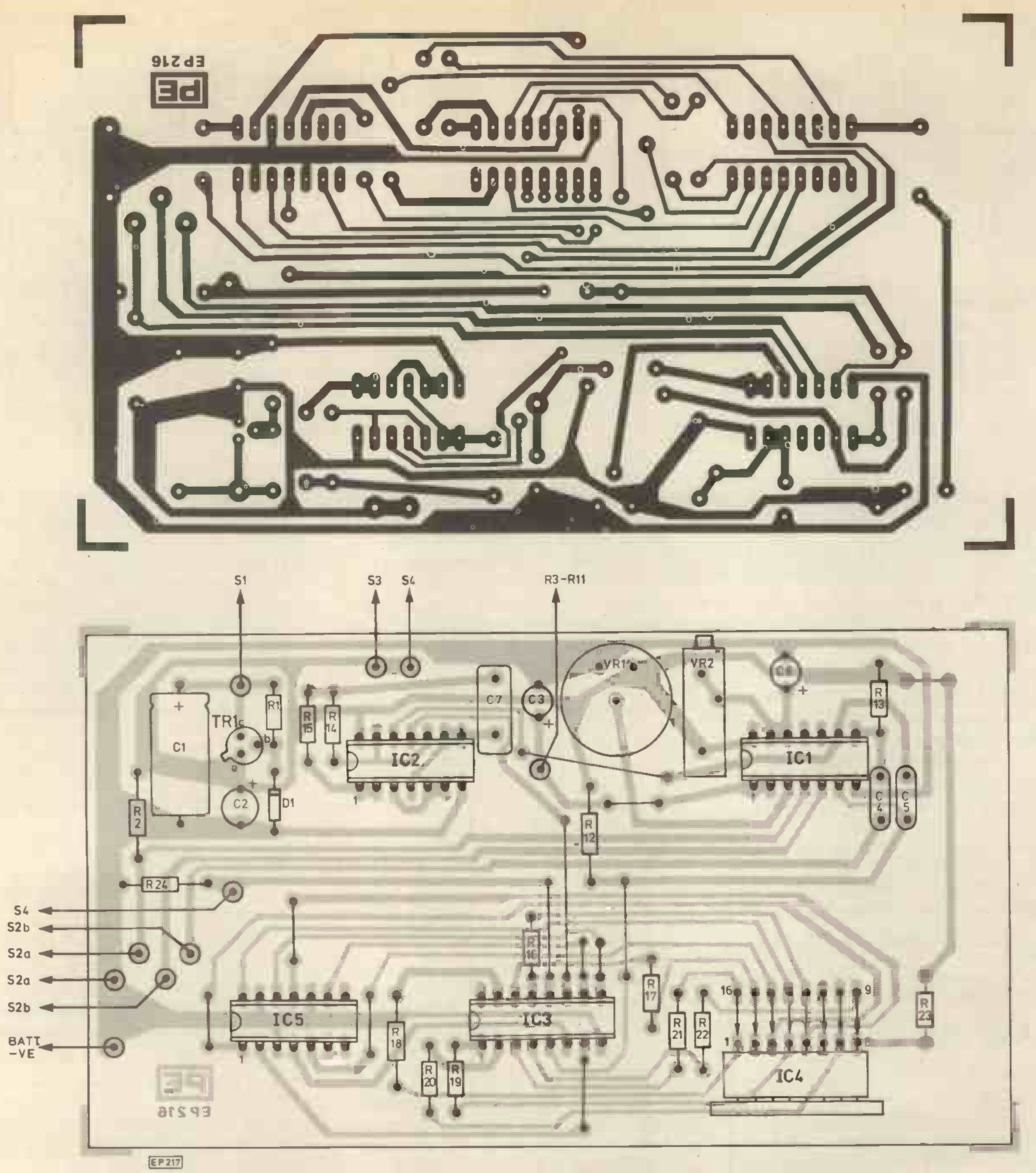
The specified display fits into a 16 pin DIL socket making the mounting simple. It is recommended that DIL sockets be used for all the i.c.s, especially for the 74C925. Being CMOS it can be easily damaged by static electricity.

CONSTRUCTION

Figs. 3 and 4 give the printed circuit board and component layout. The display is mounted in a DIL 16 pin socket arranged on its edge, such that the display is perpendicular to the board. Bend the socket pins round 90° and solder them into the holes drilled in the board. Stiff wire is used to connect the remaining pins of the display to the board.

Drill the front panel of the case to take the switches. Cut a window in this panel suitable for viewing the display. Red clear plastic can be used as a filter. This can be glued to the inside of the panel.

S3 is mounted on the lid of the box. R3–R11 are soldered directly onto the terminals of this switch. The battery, if used, is stuck on the underside of the lid using a double sided sticky mounting tab. The printed circuit is held to the base using two screws into the mounting studs. The lettering on the box can be done using Letraset. To avoid extra circuitry for controlling the decimal points, the unwanted decimals are blanked off using a felt tipped pen.



Figs. 3 and 4. P.c.b. and component layout. Arrows refer to display pin connections. For these see circuit

CALIBRATION

VR2 must first be adjusted so that the display increments by thirty each time. Switching S2 from stop to start will increment the display and speed up the calibration process.

Switch to cost code a, and adjust VR2 until the counter increments every 10 seconds. This roughly calibrates the period timer. Then switch to position g, and readjust VR2 so that the counter increments every three minutes. The unit is now calibrated.

TROUBLE SHOOTING

If the unit doesn't work on switching on, check power supply voltage and wiring. Also check the i.c.s are inserted the right way round.

If the four digits of the display light and S4 will zero any random number displayed when the instrument is turned on, then IC3, IC4, IC5 will be functioning. Attention can then be turned to the remaining circuitry. Remove IC1 and the display should count continuously. Switching on/off may be necessary to start the oscillations. If the oscillator is working, attention can then be turned on IC1. Make sure that VR1 is not set to either end of its travel, and check the voltages on the various pins of the i.c.

USING THE INSTRUMENT

Switch on, set cost code. Put S1 to stop, press S4, then put S1 to start when the call starts. At the end of the call put S2 to stop.

The cost will then be displayed. If another call is to be made do not turn off the instrument. Press to start and the cost of this call will be added to the last call. The instrument could be permanently left on if required to total the cost of all calls (up to a limit of £9·99). However, a mains adaptor would be imperative in this case. ★

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

MANY of the letters sent to Micro-Bus are from owners of a Science of Cambridge Mk14, the low-cost microcomputer system based on the SC/MP micro, and six of this month's seven topics were submitted by readers who own such a system.

OSCILLOSCOPE DISPLAY

The following ingenious video display makes it possible to display text or graphics on an ordinary oscilloscope. It was designed for use with a SC/MP micro, but is equally suitable for use with other micros. The circuit and program were submitted by *Adrian Dickens of Leicester*, and what follows is based on his description:

"The idea for the display is not revolutionary, but because the hardware costs under £1, it will enable anyone with a suitable microcomputer and an oscilloscope to experiment with a video display. In the prototype, 2048 bits of data stored in RAM are displayed as a matrix of 64 x 32 dots. Although the quality of the display leaves something to be desired, it is possible to display four lines of eight or nine legible characters each.

DISPLAY OPERATION

"The complete circuit of the cheap video display uses only two CMOS integrated circuits and a few resistors; see Fig. 1. The program of Fig. 2 drives the oscilloscope display, outputting data from the extra RAM space in the Mk14 microcomputer, locations 0B00–0BFF, as a stream of bits to the display circuit. Data from each memory location is output from the extension register using the serial input/output instruction 'SIO'. If the extra RAM is not present, the 1024 bits stored in 0F80–0FFF can be displayed instead. In this case the oscilloscope should be triggered by the Q9 output from IC1, and the program will have to be modified slightly.

When the program has been loaded into the Mk14, and the user is about to press 'GO', flag 1 will be low so the reset on the counter sets all the Q outputs low. If the program is now set in motion the counter is incremented for each bit output, and whenever a '1' appears at the serial output from the Mk14 the resistor chain is pulled low via IC2a. This in turn causes a dot to appear in the relevant position on the oscilloscope display. When all of the 2048 bits have been displayed the necessary trigger pulse appears at the Q10 output.

One improvement available to readers who own an oscilloscope with an X input would be to build another resistor chain using Q5 to Q10 and use this to deflect the beam from left to right, instead of relying on the internal timebase of the oscilloscope to do this."

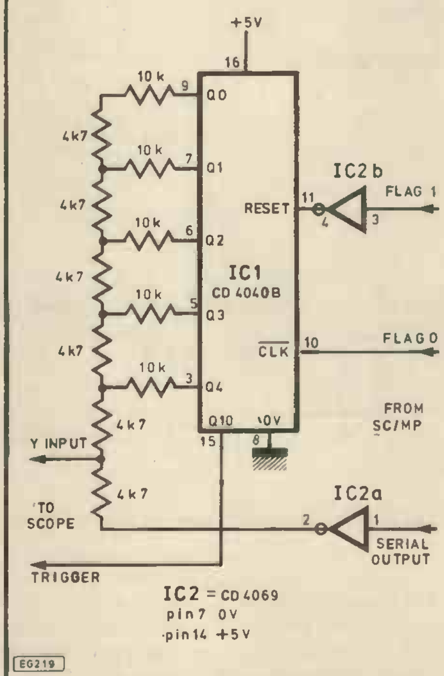


Fig. 1. Circuit for memory-mapped oscilloscope display

```
                ; MEMORY-MAPPED OSCILLOSCOPE DISPLAY
                ;
          0B00  MEMORY   =         0B00
     0000                .=0F20
     0F20 C40F  BEGIN:   LDI       H(COUNT)
     0F22 36             XPAH      2
     0F23 C43F           LDI       L(COUNT)
     0F25 32             XPAL      2
     0F26 C400           LDI       L(MEMORY)
     0F28 31             XPAL      1
     0F29 C40B  BACK:    LDI       H(MEMORY)
     0F2B 35             XPAH      1
     0F2C C501           LDI       @1(1)          ;LOAD DATA
     0F2E 01             XAE
     0F2F C409           LDI       09
     0F31 CA00           ST        (2)            ;COUNTER
     0F33 BA00  LOOP:    DLD       (2)
     0F35 98F2           JZ        BACK           ;DONE?
     0F37 19             SIO                      ;OUTPUT DATA
     0F38 C406           LDI       06
     0F3A 07             CAS                      ;CLOCK PULSE
     0F3B 1E             RR
     0F3C 07             CAS
     0F3D 90F4           JMP       LOOP
                ;
     0F3F       COUNT:   .=.+1                    ;FOR COUNTER
          0000           .END
```

Fig. 2. SC/MP program outputs data from memory to the oscilloscope display circuit

```
                ; DISPLAY A 9-LETTER MESSAGE
                ;
          0D00  DISP     =         0D00           ;DISPLAY ADDRESS
     0000                .=0F20
     0F20 C40F  START:   LDI       H(MESG)
     0F22 36             XPAH      2
     0F23 C43B           LDI       L(MESG)
     0F25 32             XPAL      2              ;P2 = MESG
     0F26 C40D           LDI       H(DISP)
     0F28 35             XPAH      1
     0F29 C400           LDI       L(DISP)
     0F2B 31             XPAL      1              ;P1 = DISP
     0F2C C408  RETURN:  LDI       8
     0F2E 01    SCAN:    XAE
     0F2F C280           LD        -128(2)        ;E AS OFFSET
     0F31 C980           ST        -128(1)        ;E AS OFFSET
     0F33 C4FF           LDI       -1
     0F35 02             CCL
     0F36 70             ADE                      ;DECREMENT E
     0F37 94F5           JP        SCAN
     0F39 9CF1           JNZ       RETURN         ;LOOP FOR EVER
                ;
     0F3B 6D    MESG:    .BYTE     06D,01C,07C,040,05C,050
     0F41 58             .BYTE     058,010,037
                ;
          0000           .END
```

Fig. 3. Program displays a message on the Mk14

EXTRA DISPLAY DIGIT FOR Mk14

The Science of Cambridge Mk14 microprocessor kit is supplied with a nine-digit display, but only eight of them are connected. The following simple modification, discovered by Mr R. G. Aucote, makes it possible to use the ninth digit:

"Only two wires are needed; one on the back of the printed-circuit board from pin 10, IC13 (DM7445) to the second of the two spare holes under the left-hand side of the display when viewed from the component side. The other wire links the same point on the board to terminal number 2 on the display (numbered left to right); this connection may already be present on later Mk14s.

The pattern of segments displayed by the monitor on the ninth digit will be determined by the contents of location 0F08, and since the monitor does not use this location a random pattern will be displayed at switch-on; to blank the digit, enter '00' into this location. When using the extra digit in a program it is simply addressed as 0D08, so when setting up a loop counter to multiplex the display use '08' instead of '07'."

DISPLAY ROUTINE

The program shown in Fig. 3 illustrates

how the Mk14s display can be multiplexed from a user program. It displays a nine-letter message, making use of the ninth digit wired up as described above. The routine works by repeatedly copying the nine segment codes for the message to the addresses for the nine display digits; P1 points to the display and P2 to the message bytes, and the extension register is used as an offset. The routine formed part of a cassette interface system, submitted by *Colin C. Tredwell of London,* which displayed a file name after a program was loaded from tape; unfortunately there is not space to publish the whole program here.

AUTOMATIC OFFSET CALCULATOR

As anyone who has programmed a SC/MP micro will know, the hardest part of "hand assembling" programs is calculating the offsets for program-counter relative jumps and addressing operations. The "offset calculator" program of Fig. 4, submitted by *Mr D. Love of Swansea,* eliminates the need to make these calculations by hand.

"The 'offset calculator' makes all the calculations automatically in one pass, thus speeding up writing programs and making them more likely to be free of errors. To use the offset calculator, programs are written as usual except that where instructions require a displacement, the low byte of the destination address is inserted as the second byte of the instruction instead of the displacement. The offset calculator makes the calculation when it passes over the program.

```
0F1F          COUNTER
0F20   B81F   LOOP:  DLD COUNTER
0F22   9020          JMP LOOP
0F24   A0     STOP CHARACTER
              FOR OFFSET
              CALCULATOR
```

In the example of a program which loops around, decrementing a counter the address of the program to be processed (0F20 in this example) is put in 0FF9, 0FFA so that the monitor will set up P1 for us. Then the offset calculator program is run from 'ENTER', and will stop when it encounters 'A0'. It will have altered the program to:

```
0F20  B8FE
0F22  90FC
```

and the program is now ready to run."

PROGRAM OPERATION

"The SC/MP instruction set can be divided into three basic types:
1) Single byte instructions
2) Double-byte immediate or indexed instructions
3) Double-byte instructions with displacement. The offset calculator is only concerned with the third category, so it must differentiate between them. All single-byte instructions are positive and so are easily identified, and double-byte displacement instructions end in either '0' or '8', the only exceptions being 'JP' (94) and 'JZ' (9C). Note that jumps and memory-reference instructions require different offsets, as illustrated by the example given above, and this is dealt with at 'INC' by incrementing the displacement for memory-reference instructions. Displacements must be in the range −128 to 127 since the program does not check for this."

```
              ; OFFSET CALCULATOR FOR SC/MP
              ;
0000                   .=0FBA
0FBA C501  ALTER:  LD     @1(1)      ;SKIP 2-BYTE INSTRUCTION
0FBC C501  ENTER:  LD     @1(1)      ;START EXECUTION HERE
0FBE 94FC          JP     ENTER      ;NO CALCULATION
0FC0 D40F          ANI    0F
0FC2 981E          JZ     ND0        ;ENDS IN ZERO
0FC4 C1FF          LD     -1(1)
0FC6 D40F          ANI    0F
0FC8 E408          XRI    08
0FCA 9821          JZ     ND8        ;ENDS IN EIGHT
0FCC C1FF          LD     -1(1)
0FCE E494          XRI    094        ;JP?
0FD0 9804          JZ     JUMP
0FD2 E408          XRI    08
0FD4 9CE4          JNZ    ALTER      ;NOT JNZ.
0FD6 31    JUMP:   XPAL   1
0FD7 01            XAE
0FD8 40            LDE
0FD9 31            XPAL   1          ;RESTORE P1
0FDA C501          LD     @1(1)      ;GET SECOND BYTE
0FDC 02            CCL
0FDD 78            CAE
0FDE C9FF          ST     -1(1)      ;STORE DISPLACEMENT
0FE0 90DA          JMP    ENTER      ;CONTINUE
0FE2 C1FF  ND0:    LD     -1(1)
0FE4 E490          XRI    090
0FE6 98EE          JZ     JUMP       ;JMP?
0FE8 E430          XRI    030        ;0A0?
0FEA 9C07          JNZ    INC
0FEC 3F            XPPC   3          ;STOP AT A0 BYTE.
0FED C1FF  ND8:    LD     -1(1)
0FEF E198          XRI    098
0FF1 98E3          JZ     JUMP       ;JZ?
0FF3 A900  INC:    ILD    (1)        :MEMORY REFERENCE
0FF5 90DF          JMP    JUMP       ;DO CALCULATION
              ;
     0000              .END
```

Fig. 4. SC/MP program automatically calculates offsets for program-counter relative instructions

EXTRA OUTPUTS FOR SC/MP

The basic SC/MP micro has three "flag" outputs which can be controlled from programs. The circuit of Fig. 5, sent in by *Steve Stamps of Avon,* shows a simple way of extending the number of outputs by using a CMOS decade counter, clocked by one of the flags, to select one of ten outputs. The AND gates provide control of the selected output.

"A small subroutine, Fig. 6, is run to address any particular output. Once addressed, the output can then be controlled on and off by the operation of flag 1. The contents of 0F27 determine which output will be enabled. If the addressed output is changed the original output will be disabled, but if necessary latches could be added to store the states of the outputs. The circuit was originally developed to connect a small robot to an Mk14."

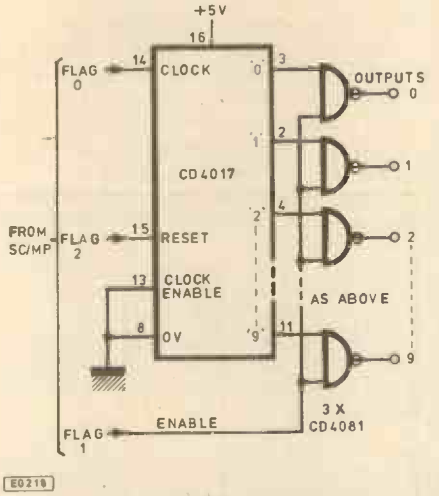


Fig. 5. Circuit uses a decade counter to add ten outputs to a SC/MP micro

```
              ; OUTPUT ADDRESSING ROUTINE
              ;
     0006  OUTPUT   =      6          ;OUTPUT 1 TO 10
              ;
0000                .=0F1F            ;
0F1F       COUNT:   .=.+1
0F20 C404  BEGIN:   LDI    04         ;PULSE RESET
0F22 07             CAS
0F23 C400           LDI    00
0F25 07             CAS
0F26 C406           LDI    OUTPUT     ;WHICH OUTPUT?
0F28 C8F6           ST     COUNT
0F2A C401  LOOP:    LDI    01         ;PULSE CLOCK
0F2C 07             CAS
0F2D C400           LDI    00
0F2F 07             CAS
0F30 B8EE           DLD    COUNT      ;FLAG PULSED
0F32 9CF6           JNZ    LOOP       ;  'OUTPUT' TIMES?
0F34 C402           LDI    02         ;ENABLE OUTPUTS
0F36 07             CAS
0F38 3F             XPPC   3          ;RETURN
              ;
     0000           .END
```

Fig. 6. Routine which selects an output—in this case 6—with Fig. 5

SC/MP SUBROUTINE STACKER

"One of the problems of programming with SC/MP is how best to use the three 16-bit pointer registers. These can be used as stacks, subroutine addresses, or to address data, etc. but when you need to switch from one use to another it is easy to get into a mess."

So writes *Mr N. E. H. Feilden of Suffolk,* and to remedy the situation he has written a routine for SC/MP to simulate the JSR and RTS instructions of other micros such as the 6502; see Fig. 7.

"A list of the subroutine addresses is stored in memory pointed to by P2. The appropriate one is selected by the value received in the accumulator by the stacker routine. Thus the calling program contains: 'LDI n, XPPC 3' (C4 nn 3F) as the equivalent of 'jump to subroutine'. The subroutine address is taken from locations P2+n (high byte) and P2+n+1 (low byte). The calling address is saved in a stack using P1, which should initially point to the top of a free area of RAM. Return is achieved using 'JMP 17(3)' (93 17) which causes a jump to the stacker routine at 'ENTRY 2'.

Pointer P3 should be set to the address 'EXIT' (0B00 in this case) before use. The routine is fully relocatable, so it can be put anywhere convenient in memory without modification. This version is fairly simple; it does

```
              ; SC/MP SUBROUTINE STACKER
              ;
0000                .=0B00
0B00 3F    EXIT:    XPPC   3
0B01 01    ENTRY:   XAE
0B02 C9FD           ST     -3(1)      ;STORE ENTRY VALUE OF E
0B04 C280           LD     E(2)       ;GET SUBROUTINE ADDS. HIGH
0B06 37             XPAH   3
0B07 CDFF           ST     @-1(1)     ;RETURN ADDS. HIGH TO STACK
0B09 02             CCL               ;INCREMENT E:
0B0A C401           LDI    1
0B0C 70             ADE
0B0D 01             XAE
0B0E C280           LD     E(2)       ;SAME FOR LOW ADDS. BYTE
0B10 33             XPAL   3
0B11 CDFF           ST     @-1(1)
0B13 C1FF           LD     -1(1)      ;RESTORE ORIGINAL E VALUE
0B15 01             XAE
0B16 90E8           JMP    EXIT
0B18 C501  ENTRY2:  LD     @+1(1)     ;RETURN ADDS. LOW
0B1A 33             XPAL   3
0B1B C501           LD     @+1(1)     ;RETURN ADDS. HIGH
0B1D 37             XPAH   3
0B1E 90E0           JMP    EXIT
              ;
     0000           .END
```

Fig. 7. Program implements a stack to simplify the use of subroutines

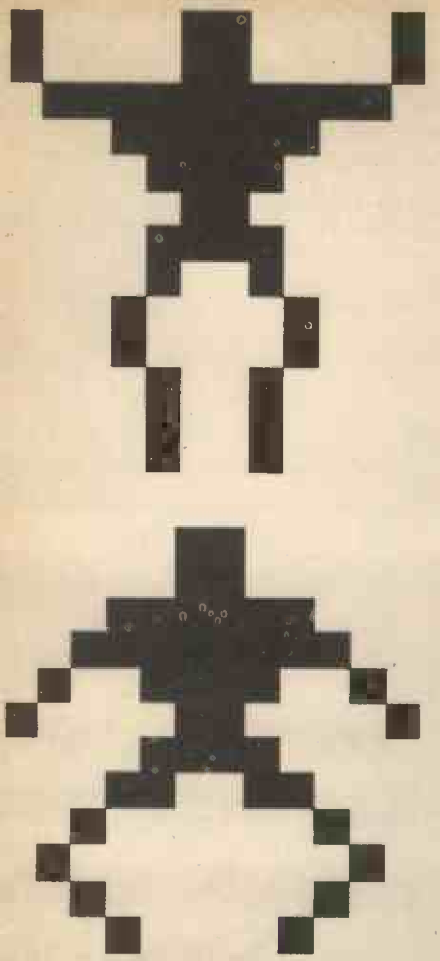


Fig. 8. Graphics generated by the falling-man program

```
                ; FALLING MAN DISPLAY
                ;
       0F00     RAM      =       0F00        ;FOR VARIABLES
       0B00     DISP     =       0B00        ;DISPLAY MEMORY
                ; RAM OFFSETS:
       0002     COL      =       2           ;COLUMN
       0003     CNT      =       3           ;COUNTER
       0004     ROW      =       4           ;ROW COUNT
                ;
0000                     .=0F20
0F20 C40F     ENTER:   LDI     H(RAM)
0F22 37                XPAH    3
0F23 C400              LDI     L(RAM)
0F25 33                XPAL    3           ;P3 TO VARIABLES
0F26 C40B     BEGIN:   LDI     H(DISP)
0F28 35                XPAH    1
0F29 C406     LOOP:    LDI     6
0F2B CB02              ST      COL(3)
0F2D 31       NEWMAN:  XPAL    1           ;BEGIN NEW MAN
0F2E C40F              LDI     H(MAN)
0F30 36                XPAH    2
0F31 C470              LDI     L(MAN)
0F33 32                XPAL    2           ;P2 TO MAN PATTERN
0F34 C413              LDI     19
0F36 CB03              ST      CNT(3)
0F38 C40F     COPY:    LDI     15          ;ROWS PER PICTURE
0F3A CB04              ST      ROW(3)
0F3C C601     NEWROW:  LD      @1(2)
0F3E CD01              ST      @1(1)
0F40 C601              LD      @1(2)
0F42 CD07              ST      @7(1)       ;POINT TO NEXT ROW
0F44 BB04              DLD     ROW(3)      ;PICTURE DONE?
0F46 9CF4              JNZ     NEWROW
0F48 C6E2              LD      @-30(2)     ;RESET P2
0F4A C590              LD      @-112(1)    ;RESET P1 1 ROW DOWN
0F4C 8F40              DLY     040         ;WAIT...
0F4E BB03              DLD     CNT(3)
0F50 E404              XRI     4           ;4 SWEEPS TO GO?
0F52 9818              JZ      LAND        ;YES - CHANGE PICTURE
0F54 E404              XRI     4           ;RESTORE CNT
0F56 9CE0              JNZ     COPY        ;FRESH SWEEP?
0F58 8FFF              DLY     0FF         ;LEAVE MAN STANDING
0F5A BB02              DLD     COL(3)      ;NEXT MAN:
0F5C BB02              DLD     COL(3)      ;SUBTRACT 2
0F5E 94CD              JP      NEWMAN      ;ALL DONE?
0F60 C400              LDI     0
0F62 31       CLEAR:   XPAL    1           ;CLEAR SCREEN
0F63 C400              LDI     0           ;BLANK
0F65 CD01              ST      @1(1)
0F67 31                XPAL    1
0F68 9CF8              JNZ     CLEAR       ;MORE TO DO
0F6A 90BA              JMP     START       ;REPEAT FOR EVER.
0F6C C61C     LAND:    LD      @+28(2)     ;P2 TO STANDING MAN
0F6E 90C8              JMP     COPY        ;CONTINUE.

                ; BIT-PATTERNS FOR FALLING MAN
     0F70 0000  MAN:      .DBYTE  X'0000,X'4308,X'4308
     0F76 3FF0            .DBYTE  X'3FF0,X'0FC0,X'0780
     0F7C 0300            .DBYTE  X'0300,X'0780,X'0480
     0F82 0840            .DBYTE  X'0840,X'0840,X'0480
     0F88 0480            .DBYTE  X'0480,X'0480,X'0000
                ;
                ; BIT-PATTERNS FOR STANDING MAN
     0F8E 0300            .DBYTE  X'0300,X'0300,X'0FC0
     0F94 1FE0            .DBYTE  X'1FE0,X'2790,X'4308
     0F9A 0780            .DBYTE  X'0780,X'0CC0,X'1020
     0FA0 2010            .DBYTE  X'2010,X'1020,X'0840
     0FA6 0000            .DBYTE  X'0000,X'0000
                ;
          0000            .END
```

Fig. 9. Animation program for use with a Science of Cambridge VDU module

preserve the E register, but not the S. It could be adapted to handle interrupts since an 'XPPC 3' will always go to the stacker from anywhere outside the stacker. More complex schemes with two levels of indirection may be used to perform multiple tasks, for instance, in controllers."

FALLING MAN DISPLAY

The last in this month's series of applications for the Mk14 is a program donated by *Nick Toop*, designer of the Science of Cambridge VDU Module, to demonstrate some of the graphics possible with this VDU. The program generates a display of a man falling through space with his arms raised, and then landing with his arms lowered; see Fig. 8. He is then joined by three similar men, and the cycle repeats indefinitely. The animation is generated in half of the screen, 32 of the 64 possible rows, and uses the Mk14's extra RAM at OB00 for the display area. This memory is mapped to the display in rows of 64 dots, 8 bytes per row.

PROGRAM OPERATION

The falling-man program, Fig. 9, makes clever use of auto-indexing to keep it as short as possible. The bit patterns for the two positions of the man are stored after the program at "MAN". Each row of the man consists of 16 dots, specified by two bytes, and the whole man comprises 15 rows. The program writes the man to the display a total of 19 times, each time shifting the man down by one row to give the appearance of falling. For the first 15 sweeps of the man the picture of the falling man is used, and for the last 4 sweeps the standing man is used.

The resulting animation is pleasingly realistic, and should inspire owners of suitable systems to attempt more ambitious displays, such as a man walking across the screen.

EIGHT EIGHTS WINNERS

The winners of the Eight Eights competition, presented in the August Micro-Bus, were:

Mr D. Caballero of Ramsgate, Mr J. M. Brinton of Cheltenham and Mr E. Vyncke of Alleur, Belgium.

News Briefs

PRESTEL TESTING THE INTERNATIONAL MARKET

BUSINESSMEN in seven countries will soon be able to take part in an international trial of Prestel. the British Post Office's world-leading viewdata system which gives users access to computer information banks by means of a simple TV type display terminal.

Invented at the Post Office Research Centre this system has already put Britain ahead of any other country in the mass marketing of electronic information. Now following the start of the world's first public viewdata service in London on March 27 Britain will score another world first when it begins experiments with an international viewdata service later this year.

The trial is designed to identify the kind of information today's globe-trotting businessman, or government official, needs to know but which is often difficult to get quickly. With a Prestel international service it will be instantly available, literally at the user's fingertips.

The trial will be open to selected users in the UK and up to six countries—Australia, German Federal Republic. the Netherlands, Sweden, Switzerland, and the United States. It will offer a wide variety of up-to-the-minute business information drawn from many parts of the world—prices in the world's premier stock markets, currency exchange rates, schedules for the world's major airlines, the latest shipping news, as well as a variety of specialist information such as commodity prices, economic analyses and company management information.

The decision to go ahead with the trial follows a six-month evaluation of the potential market for such a service carried out for the Post Office by Logica Limited. This firm has now been commissioned to assist in implementing the trial which is expected to last one year. During the trial, a decision will be taken regarding a full-scale service.

Already discussions are under way with firms who might provide information needed for an international databank, part of which could be multi-lingual. Parallel talks are due to start soon with TV set manufacturers about supplying the few hundred terminals needed for the trial. The telecommunications authorities of the other countries involved are being invited to discuss the Post Office's plans.

The trial service will be using a dedicated Prestel computer in London which will become available after the full public service goes live in London.

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4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
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7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
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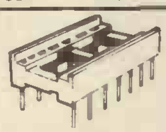

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BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
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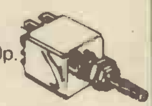

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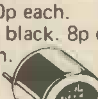

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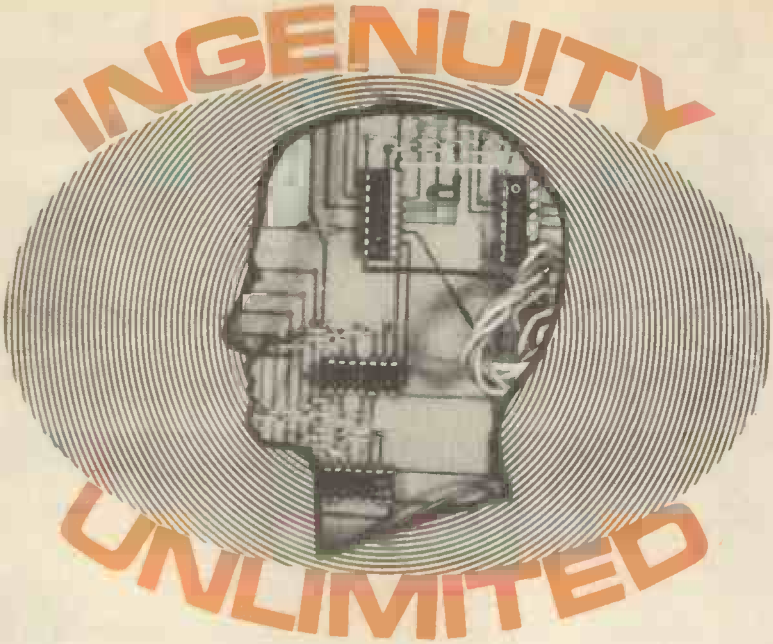


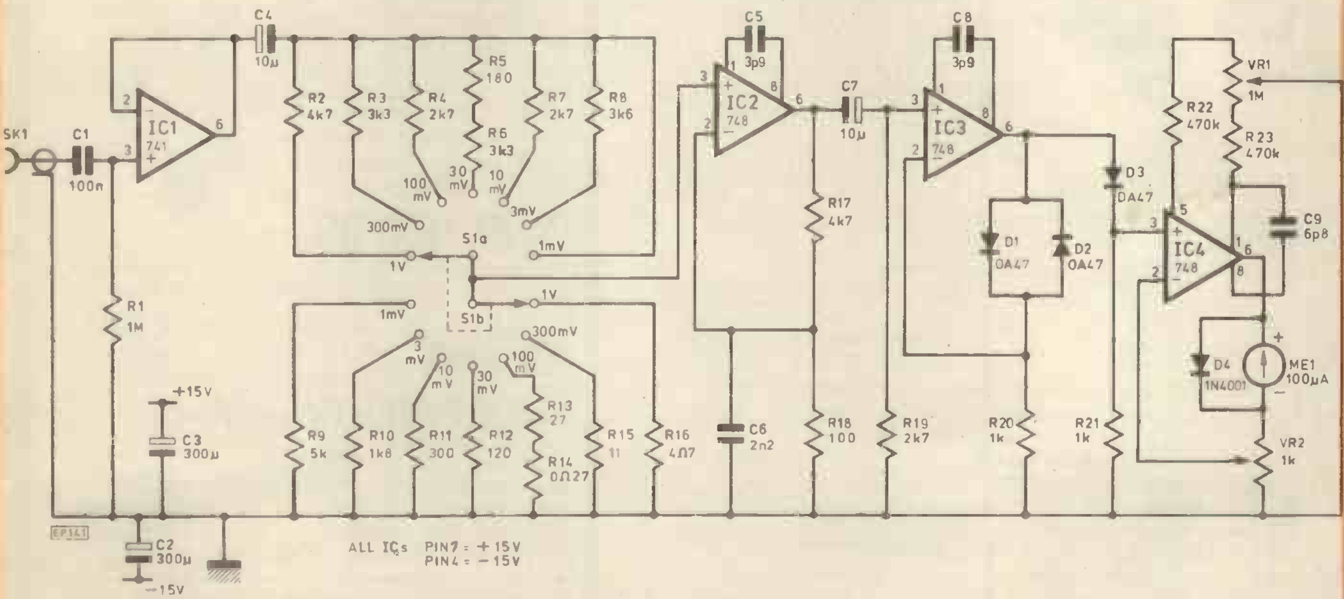
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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.

AUDIO-MILLIVOLTMETER



HAVING constructed the audio-millivoltmeter featured in the June '76 edition of *PE*, I discovered that circuit noise and main's hum caused a permanent deflection on the meter that was unacceptably large on the lowest range. To cure this I devised this circuit.

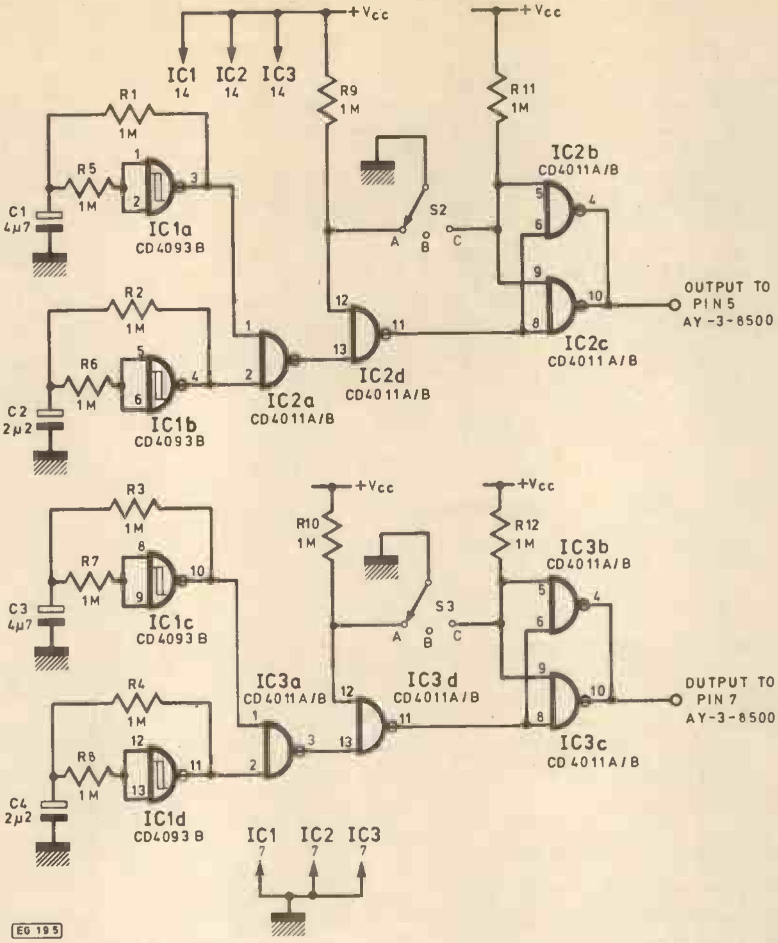
IC1 has unity gain and acts as a buffer amplifier for the input signal across R1. The signal is then fed through one of the voltage-dividers to IC2, which amplifies it and provides frequency compensation. The signal then passes to IC3 which duplicates it across R4 and so produces a low-distortion half-wave rectified signal across R5 (it is important that R20 = R21 and that D1, D2 and D3 are identical). The rectified signal is d.c. and is amplified by IC4 to drive the meter. The gain of this stage is varied by VR2, allowing calibration, and the meter is zeroed by VR1. D4 protects it from damage.

The input impedance of the circuit is governed by R1, one megohm was found to be satisfactory. The frequency response is virtually flat up to and beyond 100kHz, depending on the value of C2 which affects the frequency compensation of IC2. The circuit measures a.c. signals from 1mV to 1V in seven ranges using a 100µA f.s.d. meter with 0–3 and 0–10 scales.

The circuit is very sensitive and care should be taken in its construction and housing; all signal carrying leads, the selector switch, the input socket, and any sources of main's hum should be properly screened.

Kevin Cameron,
Melrose,
Roxburghshire.

TELE-GAMES MOD



THE introduction of the General Instruments, AY-3-8500 i.c. has produced a large number of almost identical tele-games circuits. It was while seeking some degree of variation from these circuits, while still maintaining the use of the AY-3-8500, that the following circuit was evolved, to introduce a certain amount of randomness to the game. In this way differences in ground texture (ball speed variation) and slight mis-hitting (angle at which the ball leaves the bat is uncertain) can be represented.

The circuit operation is very simple; consider the top section used for ball speed variation. Two slow oscillators are built around two NAND Schmitt triggers operated in the inverting mode. The speed of the oscillators is 0·3Hz and 1Hz using the quoted values. The resistor in series with the gate is to help protect the gate from switch on surges. The two oscillators are then gated via IC2a to produce random pulses.

A SPDT centre off switch (S2) replaces the S2 in the original game. It can be seen that with S2 in position A the output of IC2c will be high, thus IC2bd will be low, giving a high ball speed. Similarly, with S2 in position C, IC2bd will be high, and so the ball speed will be low. However, with S2 in position B, both IC2c and IC2bd are enabled thus giving the random transitions at the output of IC2bd. The AY-3-8500 uses 100 kilohm pull up resistors, and although one gate drive will cope with the current drain, two may be used in parallel to ensure adequate speed.

An identical circuit is used to change the rebound options between 2 and 4 angles.

The circuit may be much simplified, by using only one oscillator and one drive gate, the circuit could then be built around one quad NAND Schmitt, but the full random nature is not available. It should also be possible to obtain speed changes every time a rebound occurs by using a monostable and latch on the sound output to alter the speed.

The connection to pins 5 and 7 of the AY-3-3500 may be made at the original switch points.

The oscillator gates must be Schmitt to ensure oscillation and the capacitors should be Tantalum types.

I. C. Lare,
Northwich,
Cheshire.

DC/DC VOLTAGE MULTIPLIER

SHOWN is an astable, symmetrical multivibrator working at about 1,000Hz. It has the special feature, that the ordinary collector resistors are replaced by *p.n.p.* silicon transistors. Even using small transistors, the output has a low impedance. When using supply voltages lower than 5–6 volts the base protection diodes may be omitted. It is advisable to use transistors with a nominal I_c maximum two or three times the input current; they need not match exactly.

The multivibrator has been tested with small power transistors BC328 as TR1–TR2; and BC338 as TR3–TR4. The base diodes are ordinary small signal silicon types.

The circuit works well with power transistors too: *p.n.p.* 2N2955, *n.p.n.* 2N3055 and base diodes 1N4001. With these it is necessary to decrease the base resistors and to keep the frequency, increase the capacitors proportionally.

It might seem unusual to use this type of converter instead of the popular transformer coupled type, which has somewhat higher efficiency, but this needs less space and is light weight. Thanks to the present cheap, high quality semiconductors, the total result is better than one might expect.

The circuits are interesting to the experimenter, and could certainly be improved.

The examples in the tables tell the rest of the story.

P. Poulsen,
Odense,
Denmark.

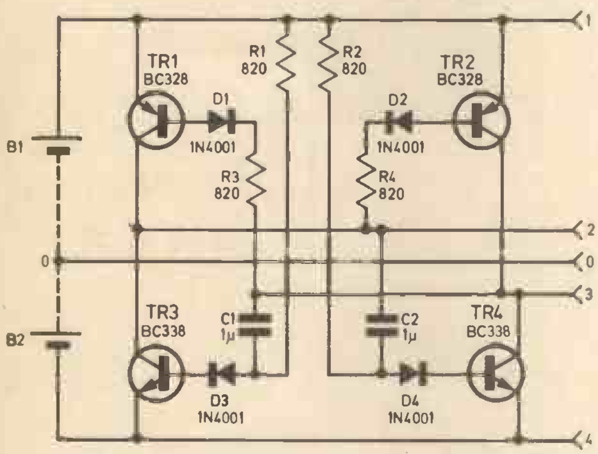
Circuit 1 + 2

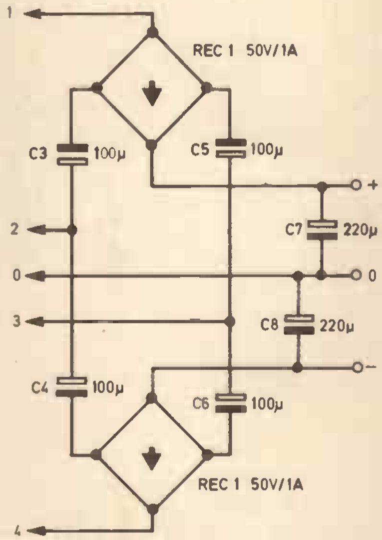
	Input			Output	
Input:	1·5V	14mA	Output:	2·25V	2mA
	3·0V	50mA		3–0–3V	10mA
	6·0V	80mA		9–0–9V	20mA
	12·0V	250mA		16–0–16V	50mA

Circuit 1 + 3

	Input			Output	
Input:	3V	130mA	Output:	6–0–6V	15mA
	6V	100mA		23–0–23V	10mA
	6V	160mA		16–0–16V	15mA
	6V	280mA		15–0–15V	30mA
	6V	340mA		12–0–12V	50mA
	12V	680mA		28–0–28V	60mA
	12V	750mA		25–0–25V	80mA

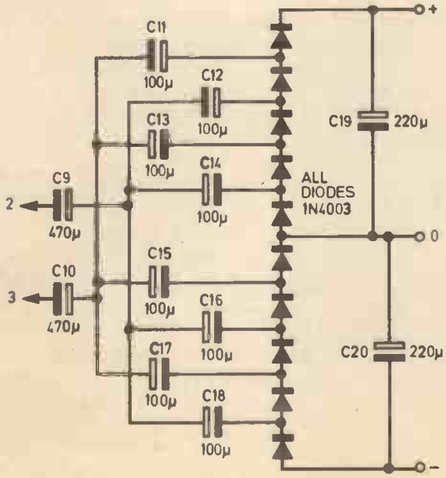
1





2

3



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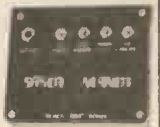

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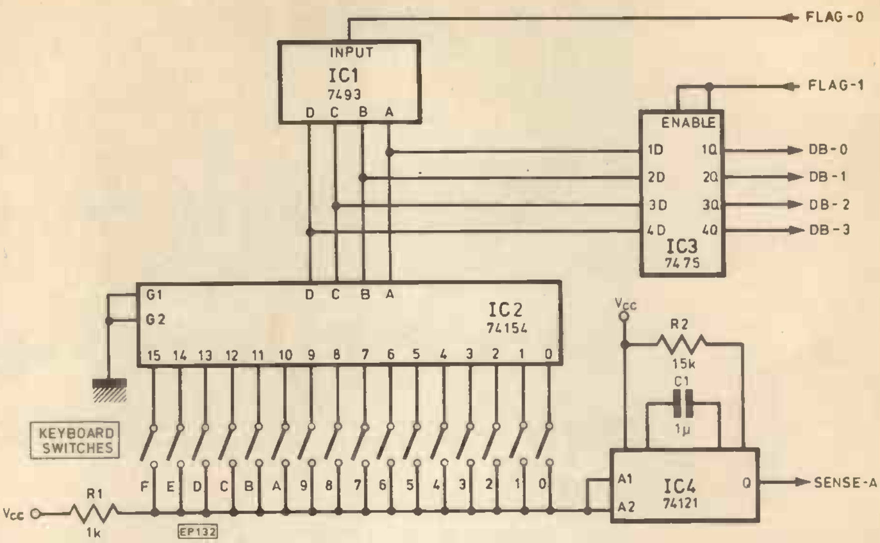

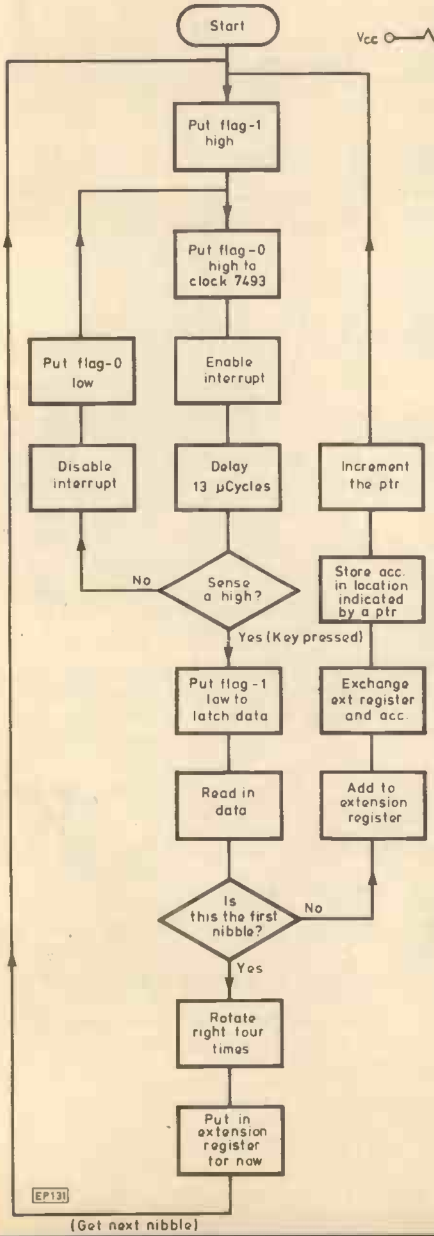

THIS circuit is for an experimental hexadecimal keyboard for use with National Semiconductor's SC/MP microprocessor. Using four popular TTL i.c.s it represents an interesting example of the hardware/software trade-off in MPU systems. If built with one of the surplus calculator-style keyboards advertised regularly in *P.E.*, total cost should be under £5. Use of 74LS series TTL is recommended.

It comprises a 7493 4-bit counter clocked by Flag-O of SC/MP, feeding a 74154 4-16 line decoder. Outputs from this decoder go to the 16 keys of the keyboard, whose common line is debounced via a 74121 monostable.

SC/MP increments the counter by putting Flag-O high. One of the 16 decoded lines corresponding to the resultant 7493 binary output now goes low. Suppose the key on that line is now depressed, causing the output of the 74121 to go high and an interrupt on the SC/MP. The MPU responds by halting the counting sequence, and by putting Flag-1 low to latch the 4-bit (hexadecimal) code using a 7475. Outputs of the 7475 are connected to the four least significant bits of SC/MP's data bus, which it now reads and stores after rotating right four times. The sequence is now repeated to get another hexadecimal character, which is added to the first to produce a singel 8-bit byte. This can now be stored in a memory location pointed to by a Pointer Register; the Pointer Register is now incremented and the whole process is repeated to obtain the next byte.

A greater understanding of the above process may be obtained by studying the flowchart 2 shown left.

N. Rushton,
Northwood,
Kirkby.

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JANUARY 1979 TO DECEMBER 1979

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7406	.24
7407	.24
7408	.14
7409	.15
7410	.13
7411	.20
7412	.15
7413	.22
7414	.48
7416	.22
7417	.29
7420	.12
7423	.21
7425	.21
7426	.21
7427	.29
7428	.33
7430	.12
7432	.21
7437	.22
7438	.22
7440	.18
7441	.53
7442	.40
7445	.84
7446	.84
7447A	.48
7448	.56
7450	.12
7451	.12
7453	.12
7454	.14
7460	.12
7470	.22
7472	.20
7473	.27
7474	.23
7475	.29
7476	.20
7482	.60
7485	1.04
7486	.18
7489	1.50
7490	.28
7491	.62
7492	.33
7493	.28
7495	.40
7496	.48
74107	.22
74109	.36
74121	.23
74122	.33
74123	.52
74125	.45
74126	.45
74132	.82
74141	.46
74145	.44
74147	1.36
74148	.99
74150	.58
74151	.48
74153	.43
74154	.68
74155	.46
74156	.43
74157	.40
74160	.67
74161	.56
74162	.57
74163	.48
74164	.80
74165	.56
74166	.99
74170	1.50
74173	1.21
74174	.58
74175	.58
74176	.73
74177	.73
74180	.43
74181	1.44
74182	.87
74184	1.14
74185	1.21
74188	3.16
74189	2.50
74190	.52
74191	.49
74192	.50
74193	.51
74194	.44
74195	.70
74196	.79
74197	.75
74198	.99
74199	1.30
74221	1.06
74247	1.35
74251	.81
74273	1.27
74283	1.13
74365	.57
74366	.57
74367	.57
74368	.57
74390	.88

74LS

74LS00	.17
74LS01	.17
74LS02	.17
74LS03	.17
74LS04	.18
74LS05	.22
74LS08	.21
74LS09	.21
74LS10	.21
74LS11	.21
74LS12	.21
74LS13	.43
74LS14	.75
74LS15	.21
74LS20	.21
74LS21	.21
74LS22	.21
74LS26	.21
74LS27	.21
74LS28	.22
74LS30	.21
74LS32	.30
74LS33	.30
74LS37	.26
74LS38	.26
74LS40	.21
74LS42	.75
74LS47	.93
74LS48	.93
74LS49	.93
74LS51	.21
74LS54	.21
74LS55	.21
74LS73	.38
74LS74	.31
74LS75	.48
74LS76	.31
74LS78	.31
74LS83	.90
74LS85	
74LS86	.31
74LS90	.66
74LS91	1.12
74LS92	.79
74LS93	.89
74LS95	.93
74LS96	1.33
74LS107	.37
74LS109	.37
74LS112	.37
74LS113	.37
74LS114	.37
74LS122	.79
74LS123	.83
74LS124	1.60
74LS125	.41
74LS126	.41
74LS132	.69
74LS133	.46
74LS136	.41
74LS138	.67
74LS139	.67
74LS145	1.12
74LS151	.93
74LS153	.80
74LS154	1.50
74LS155	.83
74LS156	.83
74LS157	.65
74LS158	.65
74LS160	1.25
74LS161	.80
74LS162	1.33
74LS163	.80
74LS164	1.22
74LS165	.83
74LS166	1.90
74LS168	1.97
74LS169	1.97
74LS170	1.98
74LS173	.93
74LS174	1.12
74LS175	1.12
74LS181	3.19
74LS188	.51
74LS189	2.39
74LS190	.99
74LS191	.99
74LS192	1.20
74LS193	1.20
74LS194	.99
74LS195	1.12
74LS196	1.12
74LS197	1.12
74LS221	1.06
74LS240	2.39
74LS241	2.39
74LS242	2.39
74LS243	2.39
74LS245	
74LS247	1.25
74LS248	1.25
74LS249	1.25
74LS251	1.10
74LS253	1.06
74LS257	1.06
74LS258	1.06
74LS259	1.60
74LS261	
74LS266	.43
74LS273	1.95
74LS279	.65
74LS283	1.25
74LS289	
74LS290	1.05
74LS293	1.05
74LS295	1.50
74LS298	1.33
74LS348	1.80
74LS352	1.20
74LS353	1.06
74LS365	.54
74LS366	.54
74LS367	.54
74LS368	.54
74LS386	.41
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4001	.17
4002	.15
4006	.78
4007	.15
4008	.62
4009	.35
4010	.30
4011	.20
4012	.16
4013	.40
4014	.67
4015	.71
4016	.32
4017	.65
4018	.67
4019	.55
4020	.72
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4030	.60
4032	.95
4034	1.30
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4049	.35
4050	.35
4051	.52
4052	.52
4053	.52
4054	1.27
4056	1.65
4059	5.34
4060	1.20
4066	.35
4068	.18
4069	.17
4070	.17
4071	.17
4072	.17
4075	.17
4077	.17
4081	.17
4082	.17
4085	.82
4086	.82
4093	.51
4099	1.50
4502	.77
4508	1.95
4510	.70
4511	.75
4514	2.50
4515	2.88
4516	.60
4517	4.19
4518	.65
4521	1.87
4522	1.25
4526	.83
4528	.65
4534	5.50
4536	3.48
4543	1.56
4553	4.45
4566	1.61
4583	.83
4585	1.14

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710 14 pin	.42
710 T099	.69
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741 8 pin	.23
741 14 pin	.42
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LM301AH	.51
LM307N	.51
LM307H	.89
LM308N	.75
LM308H	1.15
LM318N	2.35
LM319H	2.30
LM324N	65
LM339N	60
LM348N	95
LM370N	3.27
LM371H	2.61
LM373N	3.50
LM374N	3.50
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LM379S	4.46
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LM382N	1.36
LM386N	.87
LM387N	1.12
LM389N	1.06
LM725CN	2.96
LM1303N	1.18
LM1808N	2.22
LM1812N	6.49
LM1820N	1.17
LM3065N	1.23
LM3900N	.55
LM3905N	1.22
LM3909N	.75
LM3911N	1.28
M252-81-AA	8.87
M253-81-AA	9.20
MC1310P	1.26
MC1312P	2.25
MC1314P	3.47
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MC1350P	1.23
MC1351P	1.32
MC1352P	.92
MC1456CG	2.32
MC1458CP1	.56
MC1495L	5.31
MC1496P	.87
MC3302P	.71
MFC6030A	2.25
NE555N	.30
NE556N	69
NE560N	3.50
NE561N	3.50
NE562N	3.50
NE565N	1.29
NE566N	1.39
NE567N	1.81
SL414A	1.94
SAA1024	3.95
SAA1025	5.82
SD6000V	3.46
SN76001N	.95
SN76003N	2.32
SN76008K	1.25
SN76013N	1.55
SN76013ND	1.36
SN76018K	1.25
SN76023ND	1.40
SN76033N	2.32
SN76532N	1.73
SN76544N	1.42
SN76660N	.65
SN76666N	.78
TAA320A	.60
TAA350A	2.70
TBA120B	.79
TBA231	.98
TBA5200	2.88
TBA651	2.05
TBA800	.92
TBA810AS	.99
TBA820	.82
TBA9900	2.65
TCA730	4.25
TCA740	4.50
TCA940	1.79
TDA1054	1.38
TDA2020	3.58
UAA170	2.29
UAA180	2.29
ZN414	.75
ZN404	.59
ZN423T	1.16
ZN424E	1.30
ZN425E	4.10
ZN459CT	3.82
ZN1034E	2.16
ZN1040E	8.98
ZNA118E	7.19
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4116(250ns)	7.75
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4050(350ns)	2.70
4060(300ns)	2.75

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2102A-2(250ns)	1.33
211A-1(500ns)	1.85
2112A-2(250ns)	2.11
21L02(350ns)	1.33
MM5257	7.97
MM2114	5.95
MC6810	3.48
4035(1000ns)	1.23
4045(250ns)	7.07

ROMS

2513(UC)	7.18
2513(LC)	7.18
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8T95	1.80
8T96	1.80
8T97	1.80
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8212	2.31
8216	2.39
8224	3.19
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8251	5.75
8253	7.97
8255	5 84

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MM5303	5.79

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24v	7824	89	7924	.98

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5v	L005T1	1.36	L129	.85
12v	L036T1	1.35	L130	.85
15v	L037T1	1.36	L131	.85

500mA +ve T0220			—ve T0220	
5v	78M05	.64	79M05	.78
6v	78M06	64	79M06	.78
8v	78M08	.64	79M08	.78
12v	78M12	64	79M12	.78
15v	78M15	64	79M15	.78
18v	78M18	64	79M18	.78
24v	78M24	64	79M24	.78
			723(01L)	.43
			723(T099)	.79

100mA T092				
			LM304H	2.55
5v	78L05	.32	LM323K	6.66
6v	78L06	.32	LM325N	2.77
8v	78L08	.32	LM326N	2.77
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10·0Mhz	3.45
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MAN72	1.62
MAN82	2.50
MAN3620	2.31
·5"	
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DL727	2.50
·6"	
DL746	2.54
DL747	2.54
DL750	2.54
·8"	
DL846	1.82
DL847	1.82
DL850	1.82
C.A.± 1 ·3"	
DL701	1.50
MAN53	2.50
MAN73	1.62
MAN83	2.50
MAN3630	2.31
C.C. R/H ·3"	
DL704	1.26
MAN54	2.50
MAN74	1.62
MAN84	2.50
MAN3640	2.31

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TIL232 Gr.	.20
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TIL234	.22

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6800 D2

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		BC107	.10	BCY72	.17	MPF102	.40	TIS91	.25	2N2925	.10
		BC108	.10	BD131	.44	MPF103	.41	ZTX107	.13	2N2926G	.12
		BC109	.10	BD132	.44	MPF104	.41	ZTX108	.13	2N2926O	.12
		BC147	.08	BD135	.43	MPF105	.41	ZTX109	.13	2N3053	.23
		BC148	.08	BD136	.43	MPF106	.58	ZTX300	.15	2N3054	.56
		BC149	.09	BD139	.43	MPSA05	.28	ZTX301	.18	2N3055	.51
		BC157	.09	BD140	.43	MPSA06	.28	ZTX302	.21	2N3442	1.67
		BC158	.09	BD239C	.36	MPSA55	.28	ZTX303	.20	2N3702	.12
		BC159	.09	BF160	.35	MPSA56	.28	ZTX304	.20	2N3703	.12
		BC168	.14	BF167	.32	MPSU05	.55	ZTX311	.20	2N3704	.12
		BC169C	.12	BF177	.28	MPSU06	.82	ZTX312	.20	2N3705	.12
		BC177	.16	BF178	.29	MPSU55	.80	ZTX341	.20	2N3706	.12
		BC178	.16	BF179	.35	MPSU56	.64	ZTX500	.15	2N3707	.12
		BC179	.16	BF180	.23	OC28	1.79	ZTX501	.16	2N3709	.12
		BC182L	.12	BF181	.32	OC35	.92	ZTX502	.22	2N3710	.12
		BC183L	.12	BF184	.24	OC36	1.14	ZTX503	.17	2N3711	.12
		BC184L	.12	BF185	.24	OC44	.36	ZTX504	.21	2N3772	1.94
		BC187	.32	BF194	.10	OC45	.28	ZTX531	.25	2N3773	3.31
		BC212L	.12	BF195	.10	OC71	29	ZTX550	.25	2N3819	.28
AC126	.22	BC213L	.12	BF196	.10	OC72	.35	2N914	.36	2N3904	.15
AC127	.22	BC214L	.12	BF197	.10	OC81	.31	2N1304	.58	2N3906	.15
AC128	.22	BC327	.12	BF200	.32	ORP12	2.11	2N1308	.53	2N4248	.91
AC176	.22	BC441	.35	BF244B	.35	TIP29C	.58	2N1309	.58	2N5447	.16
AC187	.22	BC461	.35	BF272	1.29	TIP30C	.65	2N1711	.23	2N5449	.20
AC188	.22	BC477	.25	BFX88	.28	TIP31A	.51	2N1893	.35	2N5777	.72
AD149	.81	BC478	.25	BFY50	.23	TIP31C	.72	2N2218	.36	2N6111	.79
AD161	.48	BC479	.25	BFY51	.23	TIP32A	.56	2N2219	.23	2N8288	.79
AD162	.48	BC547	.14	BFY52	.27	TIP32C	.81	2N2220	.30	3N141	1.23
AF114	.35	BC548	.14	BRY39	.74	TIP41A	.72	2N2221	.26	40673	.81
AF115	.35	BC549	.14	BSX20	.21	TIP41C	.90	2N2222A	.22		
AF116	.35	BC557	.14	MJ481	2.14	TIP42A	.74	2N2646	.55		
AF117	.35	BC558	.14	MJ2955	1.14	TIP42C	.89	2N2904	.25		
AF139	.40	BC559	.14	MJE340	.69	TIP2955	.72	2N2905	.23		
AF239	.48	BCY70	.17	MJE2955	1.17	TIP3055	.66	2N2906	.21		
ASY26	.46	BCY71	.17	MJE3055	.92	TIS43	.41	2N2907	.23		

DIODES

AA129	.10
BA100	.17
BA102	.31
BA115	.25
BA145	.21
BA148	.21
BA154	.15
BAX16	.13
BB105B	.38
BR100	.36
0A47	.13
0A79	.13
0A90	.09
0A91	.09
0A200	.09
0A202	.10
IN914	.05
IN4148	.06

ZENERS

BZY88 1.3v to 33v	.09
BZX61 3.3v to 100v	.15

SOCKETS

	DIL	W/W
8 pin	.10	.24
14 pin	.13	.38
16 pin	.14	.39
18 pin	.20	.46
20 pin	.22	.59
22 pin	.25	—
24 pin	.28	.84
28 pin	.32	.59
40 pin	.47	1.12

RECT's

IN4001/2	.05
IN4003/4	.06
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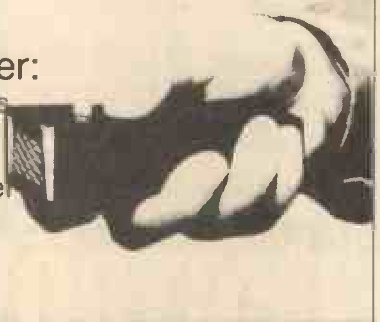

The Transmitter: is light and cordless and housing the battery. Simply, point the transmitter at the receiver to turn on or off

Now available in the U.K. the 'Kontite' Remote Control unit switches electrical appliances and equipment on or off safely from distances of up to 35 feet.

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BC172	0.12	BY100	0.52	T1P31A	0.51	2N3772	2.30	74157	0.86
BC173	0.14	BY126	0.16	T1P32A	0.55	2N3773	3.45	74159	2.42
BC177	0.17	BY127	0.19	T1P33A	0.79	2N3819	0.41	74170	2.65
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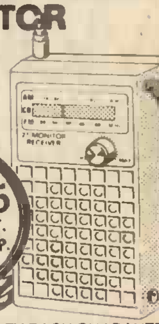

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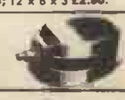

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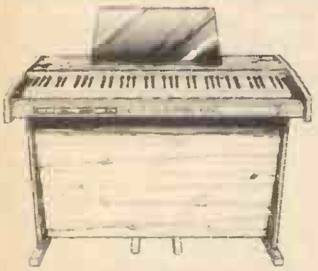

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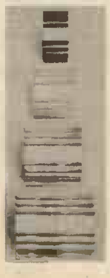

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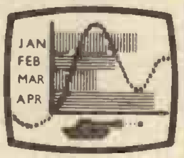

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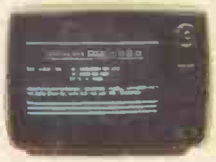

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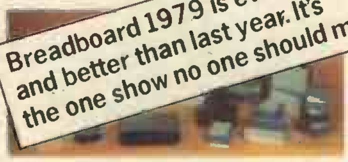

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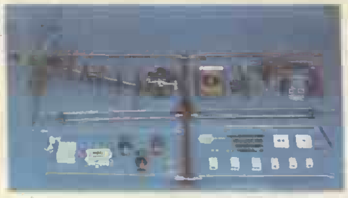

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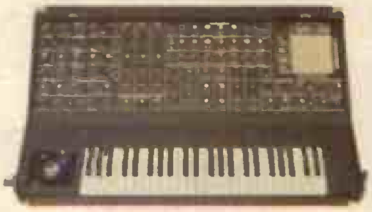

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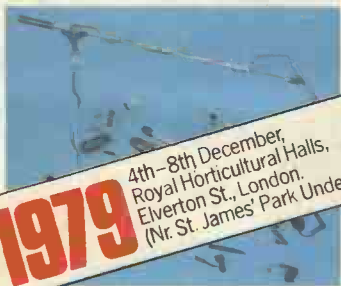

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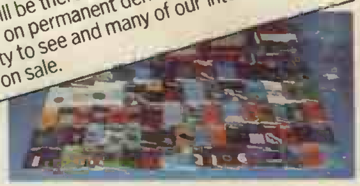

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