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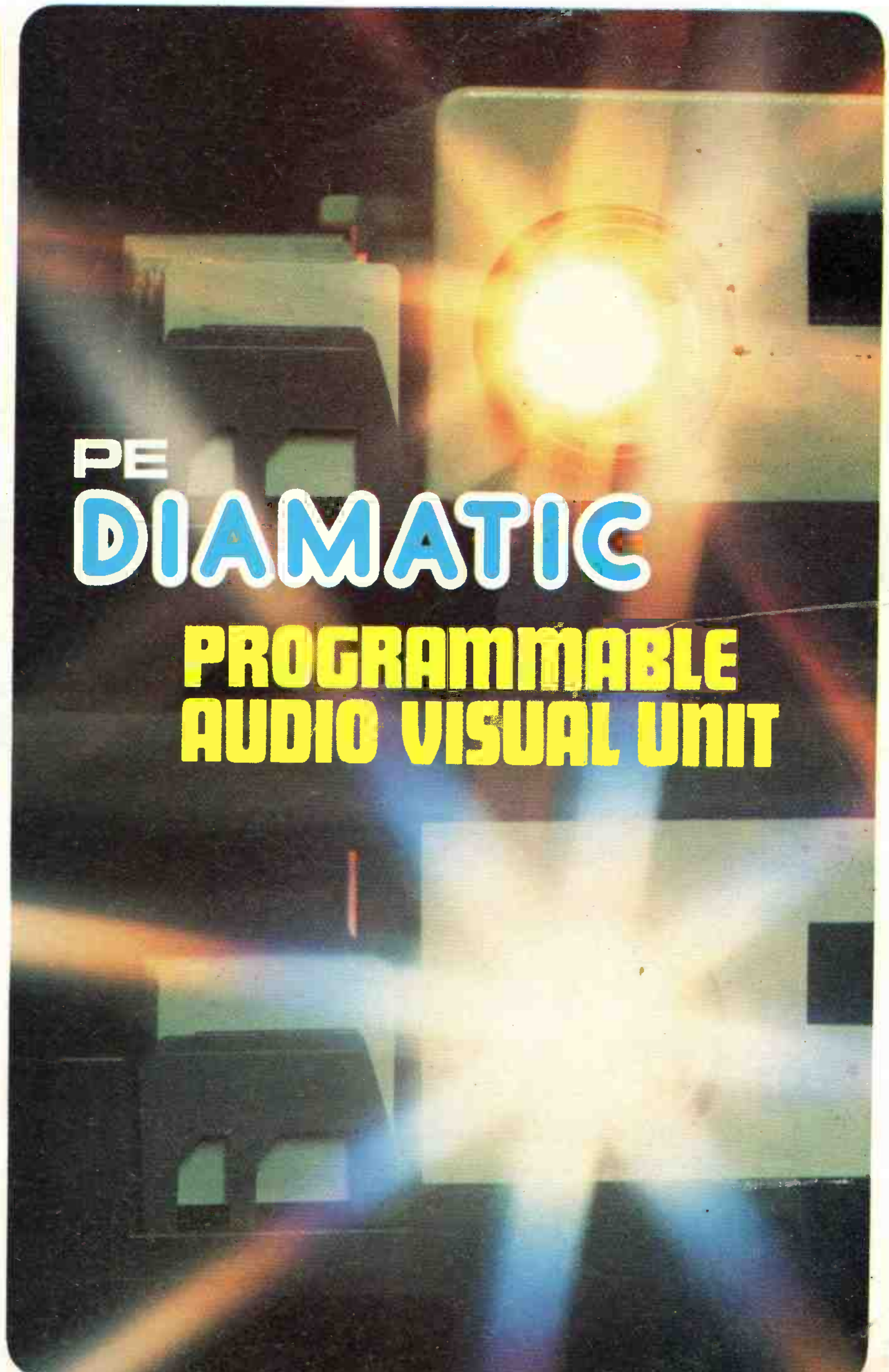

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Plus... SOLID STATE CAR INSTRUMENTS···No.2 REV. COUNTER

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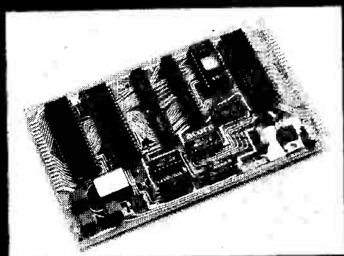
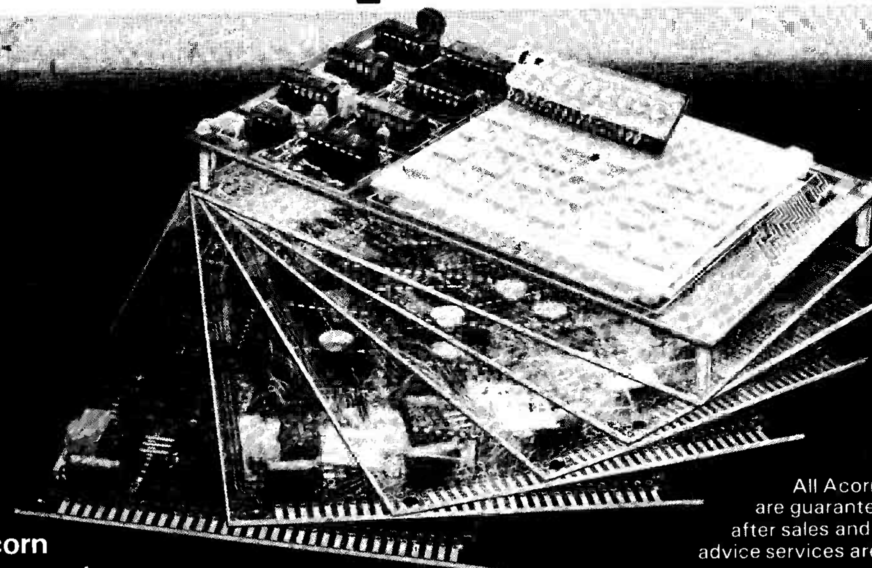


Acorn Controller

Designed as an industrial controller module, it is based on the 6502 CPU with 2K Eprom, 1.25K ram and 32 I/O lines. In eurocard format it is provided with an onboard monitor (2 × 74S571) giving comprehensive development and debugging facilities. Also available in minimum configuration for low cost OEM applications.

ACORN COMPUTERS LTD.
4A Market Hill, Cambridge, Cambs.

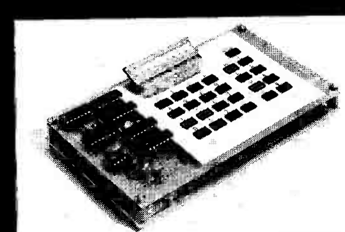


The Acorn Microcomputer

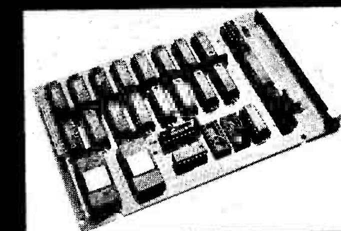
The Acorn controller module mounted beneath a matching eurocard with hex keyboard, 8 digit seven segment display and CUTS tape interface requires only a single unstabilised power supply to form the powerful Acorn microcomputer.

Although designed for expandability the Acorn Microcomputer is a complete development system for the Acorn controller and together with the Acorn Users Manual provides the perfect introduction to hex programming; the carefully optimised monitor has the following functions:

System Program
Set of sub-routines for use in programming
Powerful de-bugging facility displays all internal registers
Tape load and store

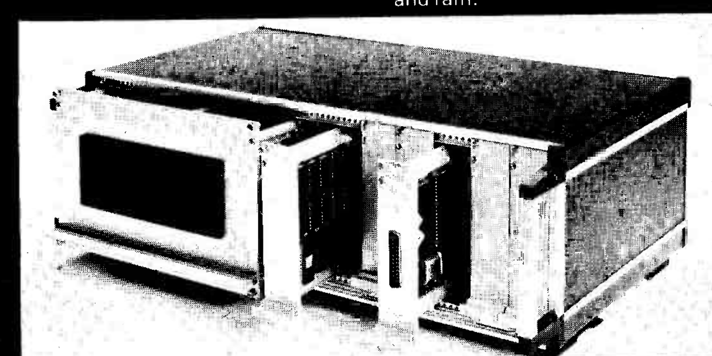


All Acorn modules are guaranteed and full after sales and technical advice services are available.



Acorn Memory

The first in our series of expansion cards is the Acorn 8K + 8K "state of the art" memory module. On a matching eurocard it provides 8K of ram (2114) and 8K of Eprom (2732) or 4K of Eprom (2716). It requires a single 5V rail, is designed for direct connection via a 32 way edge connector to the Acorn bus and is fully buffered for wiring into any system. Two onboard sockets provide independent positioning of Eprom and ram.



Software available soon includes 4K-Editor-Assembler-Disassembler, 4K Proprietary Fast Basic, Disc operating system with full file handling.
Although a standard strip of veroboard is all that is required for a full backplane, a racking system can be made available by Acorn Computers. The rack shown includes the VDU interface, two memory cards and dual floppy disc interface.

Order form

Send to: Acorn Computers Ltd. 4A Market Hill, Cambridge, Cambs.

☐ (qty) Acorn Microcomputer(s) in kit form at £65.00 plus £9.75 VAT

☐ (qty) Acorn Microcomputer(s) assembled and tested at £75.00 plus £11.25 VAT

☐ (qty) Acorn controller(s) (minimum configuration) at £35.00 plus £5.25 VAT

☐ (qty) Acorn Memory(s) assembled and tested at £95.00 plus £14.25 VAT
N.B. Price shown is for full 8K of ram, prices for smaller memory options and Eprom additions available on request.

I enclose a cheque for £........... made out to Acorn Computers Ltd.

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PE11

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ACORN COMPUTER

STOP PRESS: ACORN FULL COLOUR V.D.U. MODULE JUST RELEASED – PHONE OR SEND S.A.E. FOR DETAILS.

PRACTICAL
ELECTRONICS
VOLUME 15 No. 11 NOVEMBER 1979

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GENERAL FEATURES

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(for details of contents see page 65)

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DC Current	Range 2mA, 20mA, 200mA, 2amp. Accuracy 1% ± 1 digit, Resolution 1 Microamp Overload protection – 2 amp fuse and diodes
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Resistance	Range 20, 200, 2K, 200K, 2 Meg. 20 Meg. Accuracy 1% ± 1 digit, Resolution .01 ohms
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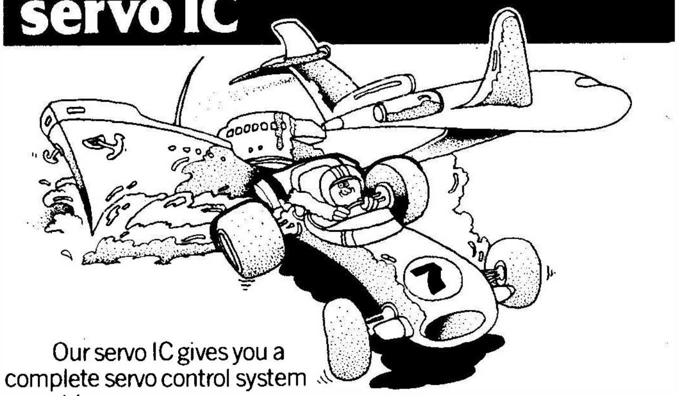

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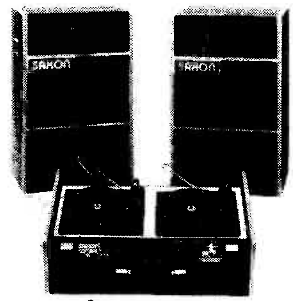

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JUST PLUG IN AND GO!!
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MONO SYSTEM WITH LOUDSPEAKERS
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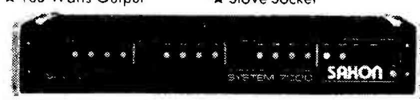

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Four Sirens in one package **£20.12** incl. of VAT
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Insert between mic & amp **£8.62**

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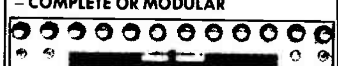

MONO OR STEREO WITH AUTOFADE

Available complete and ready to plug in or as an easy to connect module with all controls except monitor switch already fitted – full instructions supplied.

FEATURES INCLUDE:
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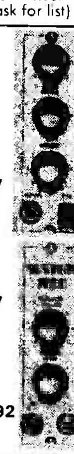

Make your own mixer Mono/Stereo up to 20 channels accept all inputs available as PCB only or complete on front panels

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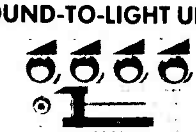

3 CHANNEL – 3kW **£33.92**
- ☐ Operates from 1W upwards
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+ £1 carr complete

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- ☐ Dimmer on each channel
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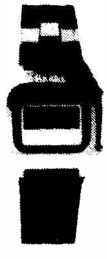

Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

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M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.,
Split and lap modes.
Back-light, auto calendar.
Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£10.65 Thousands sold!
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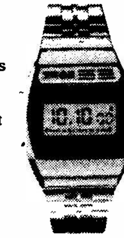
M3

QUARTZ LCD ALARM 7 Function



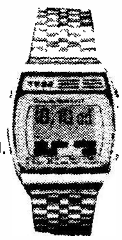
Hours, mins., secs., month, date, day.
6 digits, 3 flags plus continuous display of day and date or seconds. Back-light
Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions'

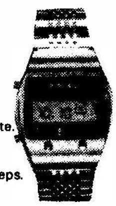


* Hours, mins., secs.
* Months, date, day.
* Basic alarm.
* Memory date alarm.
* Timer alarm with dual.
* Time and 10 country zone.
* Back-light.
* 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time



6 digits, 5 flags,
22 functions.
Constant display of hours and mins., plus optional seconds or date display.
AM/PM indication, month, date.
Continuous display of day.
Stop-watch to 12 hours 59·9 secs., in 1/10 second steps.
Split and lap timing modes.
Dual time zones.
Only 8mm thick.
Back-light. Fully adjustable open bracelet.
Guaranteed same day dispatch

£22.65

M6

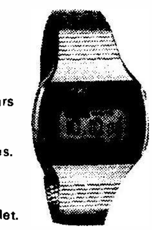
SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags.
22 functions.
Solar panel with battery back-up.
6 basic functions.
Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps.
Split and lap timing modes.
Dual time zones.
Alarm. 9mm thick. Back-light.
Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones



* 6 digits, 5 flags.
* 6 basic functions.
* 8 further time zones.
* Count-down alarm.
* Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
* Split and timing modes.
* Alarm.
* 9 mm thick.
* Back-light.
* Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up.
6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.
Split and lap modes.
Back-light, auto calendar. Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£13.65
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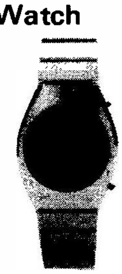
M9

QUARTZ LCD Ladies Day Watch



Only 25 × 20mm and 6mm thick.
Hours, minutes, seconds, day, date, backlight and auto calendar.
Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists.
State colour preference.

£9.95
Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

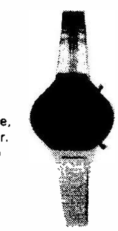
Elegant bracelet in bronze/gold finish or silver colour.
Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists.
State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch



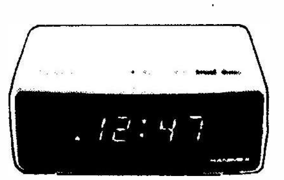
Highly functional watch which also suits those special occasions.
Beautifully designed with a very thin bracelet which retains strength as well as elegance.
Hours, mins, secs, day, date, backlight and autocalendar.
Bracelet fully adjustable to suit slim wrists.
State gold or silver finish.

£19.95

Guaranteed same day despatch

M18

HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on off control. Display flashing for power loss indication. Repeatable 9 minute snooze. Display bright/dim modes control. Size 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm)
Weight 1.43 lbs (0.65 kg) AC power 220V.

£10.20 Thousands sold!
Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

6 Functions plus Alarm:
Conference signal,
5 minute snooze alarm.
Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel.
Snooze sounds 5 mins., after main alarm and is always preceeded by the conference signal.

£14.95

M60

MACY QUARTZ ANALOGUE

Automatic Calendar
Day and Date
infinite bracelet.
This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

OUTSTANDING FEATURES

* **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
* **CALENDAR FUNCTIONS** include the date and day in each time zone.
* **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
* On command, stopwatch display freezes to show **intermediate (split/lap) time** while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
* **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch. **M16**

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

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Top value test equipment from TANDY

LCD DIGITAL MULTIMETER.

Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance.
Reading to ± 1999.

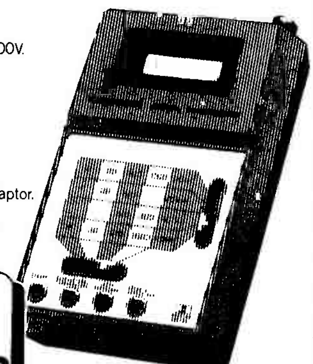
Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accuracte).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1μA to 200mA (1% ± 1 digit accurate).
Resistance: 1Ohm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
22–198

PRICE **53·19**

LOW—COST LCD MULTIMETER

A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 MOhm Input impedance.

Scales:
DC volts: 2–20–200–1000V.
AC volts: 200–500V.
DC current: 2–20–200MA.
Resistance: 2–20–200–2000 KOHM.
Power source: 9V battery or AC adaptor.
Size: 37 x 85 x 130 mm.
22–197



PRICE **39·93**

COMPONENTS AND PARTS

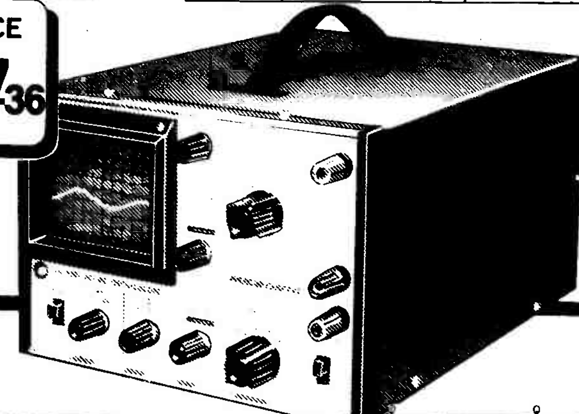
CAT. No.	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
276–9110	6 pin edge connector for 277–1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO–220 Heat Sink	60p
276–1364	TO–3 Heat Sink	81p

PRICE **137·36**

AC/DC 8 MHz OSCILLOSCOPE

A new approved 8MHz version of last years' winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

Specifications:
Horizontal axis: Deflection sensitivity better than 250mV/DIV. **Vertical axis:** Deflection sensitivity better than 10mV/DIV (1DIV–6mm). Bandwidth: 0.8MHz. **Input impedance:** 1MOhm parallel capacitance 35pF. **Time base: Sweep range:** 10Hz–100kHz (4 ranges). Synhronization: Internal (–) **Size:** 200 x 155 x 300 mm. Supply: 220/240V/50Hz. **22–9501.**



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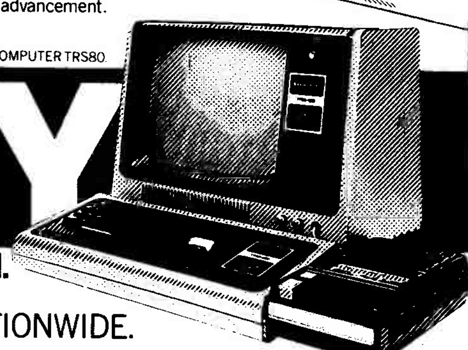

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BI-PAK SEMICONDUCTORS,

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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AC127	£0.21	BC149	£0.08	BC550	£0.16	BU105/02	£2.24	ZTX109	£0.11
AC128	£0.18	BC157	£0.12	BC556	£0.16	BU204	£1.61	ZTX300	£0.13
AC128K	£0.30	BC158	£0.12	BC557	£0.15	BU205	£1.61	ZTX500	£0.14
AC132	£0.23	BC159	£0.12	BC558	£0.14	BU208/02	£2.58	2N1613	£0.23
AC134	£0.23	BC167	£0.14	BC559	£0.16	MJE2955	£1.04	2N1711	£0.23
AC137	£0.23	BC168	£0.14	BD115	£0.58	MJE3055	£0.69	2N1889	£0.51
AC141	£0.25	BC169	£0.10	BD116	£0.92	MJE3440	£0.60	2N1890	£0.51
AC141K	£0.35	BC169C	£0.12	BD121	£0.75	MPF102	£0.32	2N1893	£0.35
AC142	£0.23	BC170	£0.10	BD124	£0.81	MPF104	£0.40	2N2147	£0.86
AC176	£0.21	BC171	£0.10	BD131	£0.40	MPF105	£0.40	2N2148	£0.81
AC176K	£0.30	BC172	£0.10	BD132	£0.40	MPSA05	£0.23	2N2160	£1.15
AC178	£0.29	BC173	£0.10	BD133	£0.46	MPSA06	£0.23	2N2192	£0.44
AC179	£0.29	BC177	£0.18	BD135	£0.44	MPSA55	£0.23	2N2193	£0.44
AC180	£0.23	BC178	£0.18	BD136	£0.40	MPSA56	£0.23	2N2194	£0.44
AC180K	£0.32	BC179	£0.18	BD137	£0.40	OC22	£1.73	2N2217	£0.25
AC181	£0.23	BC180	£0.29	BD138	£0.41	OC23	£1.73	2N2218	£0.25
AC181K	£0.32	BC181	£0.10	BD139	£0.41	OC24	£1.55	2N2218A	£0.23
AC187	£0.21	BC182L	£0.10	BD140	£0.41	OC25	£1.15	2N2219	£0.23
AC187K	£0.32	BC183	£0.10	BD155	£0.92	OC26	£1.15	2N2219A	£0.25
AC188	£0.21	BC183L	£0.10	BD175	£0.69	OC28	£0.92	2N2904	£0.23
AC188K	£0.32	BC184	£0.10	BD176	£0.69	OC29	£1.09	2N2904A	£0.24
AD140	£0.69	BC207	£0.13	BD177	£0.78	OC35	£1.03	2N2905	£0.20
AD142	£0.98	BC208	£0.13	BD178	£0.78	OC36	£1.03	2N2905A	£0.23
AD143	£0.86	BC209	£0.14	BD179	£0.86	OC70	£0.27	2N2906	£0.18
AD149	£0.69	BC212	£0.10	BD203	£0.92	OC71	£0.17	2N2906A	£0.21
AD161	£0.40	BC212L	£0.10	BD204	£0.92	TIC44	£0.33	2N2907	£0.23
AD162	£0.40	BC213	£0.10	BDY20	£0.92	TIC45	£0.40	2N2907A	£0.25
AD161/162MP	£0.81	BC213L	£0.10	BF457	£0.43	TIP29A	£0.46	2N2926G	£0.10
AF124	£0.35	BC214	£0.10	BF458	£0.43	TIP29B	£0.48	2N2926Y	£0.09
AF125	£0.35	BC214L	£0.10	BF459	£0.44	TIP29C	£0.51	2N2926O	£0.09
AF126	£0.35	BC227	£0.18	BF594	£0.35	TIP30A	£0.46	2N2926R	£0.09
AF127	£0.37	BC238	£0.18	BF596	£0.32	TIP30B	£0.48	2N2926B	£0.09
AF139	£0.40	BC251	£0.17	BFR39	£0.28	TIP30C	£0.50	2N3053	£0.18
AF186	£0.58	BC251A	£0.18	BFR40	£0.29	TIP31A	£0.46	2N3054	£0.46
AF239	£0.47	BC301	£0.32	BFR79	£0.32	TIP31B	£0.48	2N3055	£0.46
AL102	£1.38	BC302	£0.33	BFR80	£0.32	TIP31C	£0.50	2N3614	£1.15
AL103	£1.36	BC303	£0.32	BFX29	£0.25	TIP32A	£0.46	2N3615	£1.21
AU104	£1.61	BC304	£0.44	BFX30	£0.35	TIP32B	£0.48	2N3616	£1.21
AU110	£1.61	BC327	£0.18	BFX84	£0.25	TIP32C	£0.50	2N3646	£0.10
AU113	£1.61	BC328	£0.17	BFX85	£0.28	TIP41A	£0.50	2N3702	£0.09
BC107A	£0.09	BC337	£0.17	BFX86	£0.29	TIP41B	£0.52	2N3703	£0.09
BC107B	£0.10	BC338	£0.17	BFX87	£0.25	TIP41C	£0.55	2N3704	£0.08
BC107C	£0.12	BC440	£0.35	BFX88	£0.25	TIP42A	£0.50	2N3705	£0.08
BC108A	£0.09	BC441	£0.35	BFY50	£0.18	TIP42B	£0.52	2N3706	£0.09
BC108B	£0.11	BC460	£0.44	BFY51	£0.18	TIP42C	£0.55	2N3707	£0.09
BC108C	£0.12	BC461	£0.44	BFY52	£0.18	TIP2955	£0.69	2N3708	£0.08
BC109A	£0.09	BC477	£0.23	BIP19	£0.44	TIS43	£0.25	2N3709	£0.08
BC109B	£0.10	BC478	£0.23	BIP20	£0.44	TIS90	£0.20	2N3710	£0.08
BC109C	£0.12	BC479	£0.23	BIP19/20MP	£0.92	UT46	£0.23	2N3711	£0.08
BC147	£0.08	BC547	£0.12	BRY39	£0.51	ZTX107	£0.11	2N3819	£0.21
		BC548	£0.12					2N3820	£0.40

THYRISTORS

Volts No:	Price
1 amp TO 5 Case	
50 THY1A/500	£0.29
100 THY1A/100	£0.32
200 THY1A/200	£0.36
400 THY1A/400	£0.43
600 THY1A/600	£0.51
800 THY1A/800	£0.66
3 amp TO 66 Case	
50 THY3A/50	£0.32
100 THY3A/100	£0.34
200 THY3A/200	£0.37
400 THY3A/400	£0.48
600 THY3A/600	£0.57
800 THY3A/800	£0.74
5 amp TO 66 Case	
50 THY5A/50	£0.41
100 THY5A/100	£0.51
200 THY5A/200	£0.57
400 THY5A/400	£0.65
600 THY5A/600	£0.79
800 THY5A/800	£0.93
7 amp TO 48 Case	
50 THY7A/50	£0.55
100 THY7A/100	£0.58
200 THY7A/200	£0.65
400 THY7A/400	£0.71
600 THY7A/600	£0.89
800 THY7A/800	£1.05
10 amp TO 48 Case	
50 THY10A/50	£0.58
100 THY10A/100	£0.65
200 THY10A/200	£0.71
400 THY10A/400	£0.80
600 THY10A/600	£1.13
800 THY10A/800	£1.40
16 amp TO 48 Case	
50 THY16A/50	£0.62
100 THY16A/100	£0.66
200 THY16A/200	£0.71
400 THY16A/400	£0.88
600 THY16A/600	£1.03
800 THY16A/800	£1.59

SILICON RECTIFIERS

200mA	
IS920 50V	£0.07
IS921 100V	£0.08
IS922 150V	£0.09
IS923 200V	£0.10
IS924 300V	£0.11
1 Amp	
IN4001 50V	£0.05
IN4002 100V	£0.05
IN4003 200V	£0.07
IN4004 400V	£0.08
IN4005 600V	£0.09
IN4006 800V	£0.10
IN4007 1000V	£0.11
1.5 Amp	
IS015 50V	£0.10
IS020 100V	£0.11
IS021 200V	£0.12
IS023 400V	£0.14
IS025 600V	£0.16
IS027 800V	£0.18
IS029 1000V	£0.23
IS031 1200V	£0.28
3 Amp	
IN5400 50V	£0.16
IN5401 100V	£0.17
IN5402 200V	£0.18
IN5404 400V	£0.19
IN5406 600V	£0.24
IN5407 800V	£0.28
IN5408 1000V	£0.34
10 Amp	
IS10/50 50V	£0.21
IS10/100 100V	£0.24
IS10/200 200V	£0.26
IS10/400 400V	£0.40
IS10/600 600V	£0.48
IS10/800 800V	£0.58
IS10/1000 1000V	£0.69
IS10/1200 1200V	£0.79
30 Amp	
IS30/50 50V	£0.64
IS30/100 100V	£0.79
IS30/200 200V	£1.06
IS30/400 400V	£1.43
IS30/600 600V	£2.02
IS30/800 800V	£2.23
IS30/1000 1000V	£2.65
IS30/1200 1200V	£3.31
60 Amp	
IS70/50 50V	£0.86
IS70/100 100V	£0.96
IS70/200 200V	£1.38
IS70/400 400V	£2.01
IS70/600 600V	£2.58
IS70/800 800V	£2.87
IS70/1000 1000V	£3.45

OPTOELECTRONICS

LED'S (diffused)

O/no.	Type	Price
1501	Size ·125mm RED	£0.11
1502	Size ·125mm GREEN	£0.21
1503	Size ·125mm YELLOW	£0.21
1504	Size ·2mm RED	£0.11
1505	Size ·2mm GREEN	£0.21
1506	Size ·2mm YELLOW	£0.21
1509	Size ·2mm CLEAR	£0.12

SUPER 'Hi-Brite' Type

1521	Size ·3mm (·125) RED	£0.11
1522	Size ·5mm (·2) RED	£0.11
1514	ORP12 Light dependant resistor	£0.63
1520	OCP71 Photo transistor	£0.40

LED CLIPS

1508/·125 pack of 5 ·125 clips	£0.17
1508/·2 pack of 5 ·2 clips	£0.20

DISPLAYS

DL703 RED 7 segment D.P. left (·30" height) common anode single digit O/NO: 1523 **£0.80**

DL707 RED 7 segment D.P. left (0·3" height) common anode single digit O/NO: 1510 **£0.92**

DL527 RED 7 segment D.P. left (0·50" height) common anode Two-digit reflector O/NO: 1524 **£1.95**

DL727 RED **7 segment D.P. right (·510" height)** common anode Two-digit light pipe O/NO: 1521 **£2.53**

DL747 RED **7 segment D.P. left (·630" height)** common anode Single-digit light pipe O/NO: 1511 **£1.72**

OPTO-ISOLATORS

Isolation Breakdown – Voltage 1500 – continuous fwd current 100mA.

CIL74 Single-channel 6 pin DIP standard type – optically coupled pair with infra-red LED emitter and NPN silicon photo transistor O/NO: 1497 **£0.57**

CILD74 Multi-channel 8 pin DIP two isolated channels O/NO: 1498 **£1.15**

CILQ74 Multi-channel 16 pin DIP four isolated channels O/NO: 1499 **£2.53**

2nd GRADE LED PAK

A pack of 10 standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for amateurs who do not require the full spec. O/NO: 1507 **£1.04**

74 SERIES TTL ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7427	£0.27	7472	£0.23	74105	£0.43	74163	£0.71
7401	£0.12	7428	£0.29	7473	£0.28	74107	£0.27	74164	£0.78
7402	£0.12	7430	£0.12	7474	£0.28	74110	£0.41	74165	£0.78
7403	£0.12	7432	£0.25	7475	£0.33	74111	£0.66	74166	£0.89
7404	£0.12	7433	£0.25	7476	£0.28	74118	£0.92	74174	£0.74
7405	£0.12	7437	£0.25	7480	£0.50	74119	£1.35	74175	£0.71
7406	£0.25	7438	£0.24	7481	£0.97	74121	£0.27	74176	£0.66
7407	£0.25	7440	£0.13	7482	£0.78	74122	£0.44	74177	£0.66
7408	£0.14	7441	£0.57	7483	£0.66	74123	£0.46	74180	£1.72
7409	£0.14	7442	£0.46	7484	£1.01	74136	£0.59	74181	£0.66
7410	£0.12	7443	£0.80	7485	£0.78	74141	£0.63	74182	£0.80
7411	£0.19	7444	£0.80	7486	£0.25	74145	£0.63	74184	£0.80
7412	£0.17	7445	£0.74	7489	£1.95	74150	£0.78	74190	£0.78
7413	£0.27	7446	£0.69	7490	£0.36	74151	£0.55	74191	£0.71
7414	£0.57	7447	£0.55	7491	£0.73	74153	£0.55	74192	£0.69
7416	£0.26	7448	£0.64	7492	£0.40	74154	£0.94	74193	£0.66
7417	£0.26	7450	£0.12	7493	£0.34	74155	£0.57	74194	£0.71
7420	£0.12	7451	£0.12	7494	£0.86	74156	£0.57	74195	£0.69
7421	£0.23	7453	£0.12	7495	£0.57	74157	£0.57	74196	£1.20
7422	£0.18	7454	£0.12	7496	£0.57	74160	£0.66	74197	£1.20
7423	£0.24	7460	£0.12	74100	£0.97	74161	£0.71	74198	£2.12
7425	£0.21	7470	£0.28	74104	£0.44	74162	£0.71	74199	£2.12
7426	£0.26								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.16	CD4015	£0.87	CD4026	£1.38	CD4043	£1.01	CD4070	£0.19
CD4001	£0.17	CD4016	£0.48	CD4027	£0.57	CD4044	£0.94	CD4071	£0.19
CD4002	£0.18	CD4017	£0.86	CD4028	£0.78	CD4045	£1.61	CD4072	£0.19
CD4006	£1.05	CD4018	£0.97	CD4029	£0.97	CD4046	£1.49	CD4081	£0.19
CD4007	£0.19	CD4019	£0.48	CD4030	£0.55	CD4047	£1.00	CD4082	£0.20
CD4008	£1.05	CD4020	£1.03	CD4031	£2.30	CD4049	£0.48	CD4510	£1.13
CD4009	£0.51	CD4021	£0.94	CD4035	£1.15	CD4050	£0.48	CD4511	£1.09
CD4010	£0.55	CD4022	£0.94	CD4037	£1.09	CD4054	£1.26	CD4516	£1.15
CD4011	£0.17	CD4023	£0.17	CD4040	£1.01	CD4055	£1.15	CD4518	£1.15
CD4012	£0.18	CD4024	£0.74	CD4041	£0.87	CD4056	£1.55	CD4520	£1.15
CD4013	£0.48	CD4025	£0.17	CD4042	£0.82	CD4069	£0.19	CD4014	£0.92

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.92	CA3130	£1.06	MC1350	£1.38	UA710C	£0.46	SN76115	£2.18
CA3014	£1.55	CA3140	£0.80	MC1352	£1.61	72710	£0.34	SN76660	£0.86
CA3018	£0.74	LM301	£0.33	MC1469	£3.39	UA711C	£0.36	SL414A	£2.24
CA3020	£1.95	LM304	£1.84	MC1496	£1.03	72711	£0.36	TAA550B	£0.40
CA3028	£0.92	LM308	£1.15	NE536	£3.05	UA723C	£0.52	TAA621A	£2.30
CA3035	£1.61	LM309	£1.72	NE550	£1.09	72723	£0.52	TAA621B	£2.87
CA3036	£1.15	LM320-5V	£1.72	NE555	£0.27	UA741C	£0.27	TAA661	£1.72
CA3042	£1.72	LM320-12V	£1.72	NE556	£0.69	72741	£0.27	TAD100	£1.49
CA3043	£2.12	LM320-15V	£1.72	NE565	£1.38	741P	£0.23	TBA540	£2.41
CA3046	£0.80	LM320-24V	£1.72	NE566	£1.38	UA7447C	£0.69	TBA810S	£0.86
CA3052	£1.84	LM380	£0.97	NE567	£1.95	72747	£0.69	TBA810	£1.12
CA3054	£1.26	LM381	£1.66	UA702C	£0.52	UA748	£0.40	TBA820	£0.80
CA3075	£1.72	LM3900	£0.66	72702	£0.52	72748	£0.40	TBA9200	£2.87
CA3081	£1.72	MC1303L	£0.97	UA703	£0.28	748P	£0.40	TCA270S	£2.30
CA3089	£2.30	MC1304	£2.18	UA709	£0.28	SN76013N	£2.01	TBA800	£0.92
CA3090	£4.14	MC1310	£1.09	72709	£0.52	SN76023	£2.01		
CA3123	£2.18	MC1312	£2.18	709P	£0.28	SN76110	£1.72		

AUDIO MODULES

Amplifiers

AL20	5 watt amplifier module	£3.73
AL30A	7-10 watt amplifier module	£4.35
AL60	15-25 watt amplifier module	£5.39
AL80	35 watt amplifier module	£8.44
AL120	50 watt amplifier module	£13.74
AL250	125 watt amplifier module	£19.24

Pre-amplifiers

PA12	Stereo pre-amplifier module	£8.94
PA100	Stereo pre-amplifier module	£18.45
PA200	Stereo pre-amplifier module	£19.07

Power Supplies

PS12	Power supply (24 volts DC)	£1.72
SPM80	Stabilised power supply (33V)	£5.06
SPM120/45	Stabilised power supply (45V)	£6.67
SPM120/55	Stabilised power supply (55V)	£6.67
SPM120/65	Stabilised power supply (65V)	£6.67
SG30	Power supply for equaliser	£4.37

Miscellaneous

MPA30	Stereo magnetic cartridge pre-amp	£4.42
S.450	Stereo tuner	£26.72
Stereo 30	Complete 7 watt stereo amplifier board	£22.66
BP124	Siren alarm module 5 watts	£4.02
GE100MKII	10 channel mono graphic equaliser	£23.00

SOCKETS

1611	8 pin DIL	£0.09
1612	14 pin DIL	£0.11
1613	16 pin DIL	£0.12
1720	18 pin DIL	£0.18
1721	20 pin DIL	£0.20
1722	22 pin DIL	£0.22
1614	24 pin DIL	£0.24
1615	28 pin DIL	£0.26
1723	40 pin DIL	£0.34
1616	T018 transistor	£0.13
1617	T03 transistor	£0.37
16117	T05 transistor	£0.13
1726	14 pin DIL Wire wrap gold plated Cambion	£0.25

G.P. SWITCHING TRANSISTORS

T018 sim to 2N706/8 BSY27/28/95A ALL usable devices no open & shorts. ALSO available in PNP sim. to 2N290/BCY70. 20 for **57p** – 50 for **£1.15** – 100 for **£2.07** – 500 for **£9.20** – 1,000 for **£16.10** – when ordering state NPN/PNP.

SILICON DIODES G.P.

300mW 40PIV (min) sub min FULLY TESTED ideal for Organ builders. 30 for **57p** – 100 for **£1.72** – 500 for **£5.75** – 1,000 for **£10.35.**

METAL FOIL CAPACITOR PAK

Containing 50 metal foil capacitor – like Mullard C280 series – mixed values ranging for ·01uf-2·2uf. Complete with identification sheet O/NO: 16204 **£1.38.**

JUMBO PAK SEMICONDUCTOR

16222 – Transistors Germ and Silicon Rectifiers-Diodes-Triacs-Thyristors-ICs and Zeners ALL NEW & CODED. Approx. 100 pieces offering the amateur a fantastic bargain PAK and an enormous saving **£2.58.**

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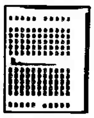
DEPT. PE11, PO BOX 6, WARE, HERTS. Tel: 0920-3182
Visit our NEW shop: 3 BALDOCK ST., WARE, HERTS. Telex: 817861

EXPERIMENTOR BREADBOARDS FROM CSC

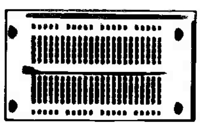
No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build breadboard of any size.

All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP.4B.

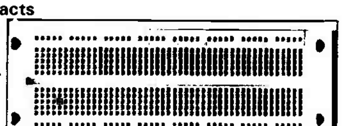
EXP.325. The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin IC's. **ONLY £1·70**



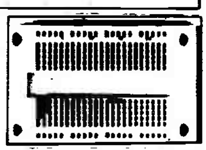
EXP.350. £3·73 270 contact points with two 20-point bus-bars.



EXP.300. 550 contacts with two 40-point bus-bars. **£6·13**



EXP.650 for Micro-processors. **£3·83**



EXP.4B. More bus-bars. **£2·45**

ALL EXP.300 Breadboards mix and match with 600 series.

ANTEX IRONS

1943	15 watt quality soldering iron with 3/32" bit	**£4·88**
1947	Replacement element for 1943	**£2·18**
1944	Iron coated bit 3/32" for 1943	**£0·53**
1945	Iron coated bit 1/8" for 1943	**£0·53**
1946	Iron coated bit 3/16" for 1943	**£0·53**
1948	18 watt iron with iron coated bit	**£4·59**
1952	Replacement element for 1948	**£2·18**
1949	Iron coated bit 3/32" for 1948	**£0·53**
1950	Iron coated bit 1/8" for 1948	**£0·53**
1951	Iron coated bit 3/16" for 1948	**£0·53**
1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	**£4·88**
1935	Replacement element for 1931	**£1·84**
1932	Iron coated bit 1/8" for 1931	**£0·57**
1933	Iron coated bit 2/16" for 1931	**£0·57**
1934	Iron coated bit 3/32" for 1931	**£0·57**
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder	**£6·38**
1939	ST3 iron stand made from high grade bakelite chrom plated steel spring, suit all models – includes accommodation for six bits and two sponges to keep the iron bits clean	**£1·86**
1724	Model MLX as X25 iron but 12 volts	**£5·29**

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0·09	BY100	£0·25	BYZ11	£0·52	OA90	£0·11
AA120	£0·09	BY101	£0·25	BYZ12	£0·46	OA91	£0·11
AA129	£0·09	BY105	£0·25	BYZ13	£	OA95	£0·11
AAY30	£0·10	BY114	£0·25	BYZ16	£0·47	OA182	£0·15
AAZ13	£0·17	BY124	£0·25	BYZ17	£0·41	OA200	£0·09
BA100	£0·11	BY126	£0·17	BYZ18	£0·41	OA202	£0·09
BA102	£0·37	BY127	£0·18	BYZ19	£0·41	SD10	£0·07
BA148	£0·17	BY128	£0·18	OA5	£0·69	SD19	£0·07
BA154	£0·14	BY130	£0·19	OA10	£0·40	IN34	£0·08
BA155	£0·16	BY133	£0.24	OA47	£0·09	IN34A	£0·08
BA173	£0·17	BY164	£0·58	OA70	£0·09	IN914	£0·07
BB104	£0·17	BY176	£0·86	OA79	£0·11	IN916	£0·07
BAX13	£0·08	BY206	£0·34	OA81	£0·11	IN4148	£0·07
BAX16	£0·09	BYZ10	£0.51	OA85	£0·11	IS44	£0·06
						IS920	£0·07

CASES AND BOXES

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

No.	Length	Width	Height	Price
155	8in	$5\frac{1}{2}$in	2in	£1·72
156	11in	6in	3in	£2·92
157	6in	$4\frac{3}{4}$in	$1\frac{3}{4}$in	£1·79
158	9in	$5\frac{1}{4}$in	$2\frac{1}{2}$in	£2·43

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

No.	Length	Width	Height	Price
159	$5\frac{1}{4}$in	$2\frac{1}{4}$in	$1\frac{1}{2}$in	£0·85
160	4in	4in	$1\frac{1}{2}$in	£0·85
161	4in	$2\frac{1}{4}$in	$1\frac{1}{2}$in	£0·85
162	$5\frac{1}{4}$in	4in	$1\frac{1}{2}$in	£0·97
163	4in	$2\frac{1}{2}$in	2in	£0·87
164	3in	2in	1in	£0·60
165	7in	5in	$2\frac{1}{2}$in	£1·43
166	8in	6in	3in	£1·82
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front – strong construction easily accessable.

169	$2\frac{1}{8}$in	$5\frac{3}{8}$in	$2\frac{3}{4}$in	12in	$3\frac{1}{2}$in	8in	£5·45
168	$2\frac{5}{8}$in	$7\frac{1}{4}$in	4in	16in	$4\frac{1}{2}$in	11in	£8·21

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·14
171	140mm	75mm	205mm	£4·62
172	140mm	110mm	205mm	£6·00

SPECIAL OFFERS

MINIDRILL 12v hand held battery-operated mini drill. 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No.1402. **£7·79**

TRANSFORMER 240v Primary 0-20v @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20v @ 2A is obtainable. Ideal for the experimenter. No.2042. **£1·50** + 86p. P & P

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with: $4\frac{1}{2}$ metres of 2-core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan. No.1724. **£5·29**

CARBON RESISTOR PAKS

These paks contain a range of Carbon Resistors assorted into the following groups.

16213	60 mixed 1/8w 100ohms-920ohms	£0·69
16214	60 mixed 1/8w 1Kohms-82Kohms	£0·69
16215	60 mixed 1/8w 10Kohms-83Kohms	£0·69
16216	60 mixed 1/8w 100Kohms-820Kohms	£0·69
16217	40 mixed 1/2w 100ohms-820ohms	£0·69
16218	40 mixed 1/2w 1Kohms-82Kohms	£0·69
16219	40 mixed 1/2w 10Kohms-82Kohms	£0·69
16220	40 mixed 1/2w 100Kohms-820Kohms	£0·69

CERAMIC PAKS

16160	24-3 or each value 22pf 27pf 33pf 39pf 47pf 68pf	£0·69
16161	24-3 of each value 100pf 120pf 150pf 180pf 220pf 270pf 330pf	£0·69
16162	24-3 of each value 470pf 560pf 680pf 1000pf 1500pf 2200pf 3300pf	£0·69
16163	24-3 of each value 4700pf 6800pf 01uf 015uf 022uf 033uf 047uf	£0·69

ELECTROLYTIC PAKS

16201	values from 47mfd – 10mfd	£0·69
16202	values from 10mfd – 100mfd	£0·69
16203	values from 100mfd – 680mfd	£0·69

COMPONENT PAKS

16164	200 resistors mixed value approx (count by weight)	£0·69
16165	150 capacitors mixed value approx (count by weight)	£0·69
16167	80 1/2w resistors mixed values	£0·69
16168	5 pieces assorted ferrite rods	£0·69
16169	2 tuning gangs MW LW VHF	£0·69
16170	1 pack wire 50 metres asssorted colours single strand	£0·69
16171	10 reed switches	£0·69
16172	3 micro switches	£0·69
16173	15 assorted pots	£0·69
16175	30 paper condensers – mixed values	£0·69
16176	20 electrolytics trans. types	£0·69
16177	1 pack assorted hardware – nuts, bolts gromets etc	£0·69

BOOKS BY BABANI

BP6	Engineers & Machinists Ref. Tables	40p†
BP14	2nd book Transistor Equivs & Subs	£1·10†
BP22	79 Electronic Novelty Circuits	75p†
BP24	52 Projects Using IC741 (or Equiv)	75p†
BP26	Radio Antenna Book Long Distance Reception & Transmission	85p†
BP27	Giant Chart of Radio Electronic Semiconductor & Logic Symbols	60p†
BP32	Build Metal & Treasure Locatore	85p†
BP34	Practical Repair/Renovation C/TV	95p†
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	95p†
BP36	50 Cicts use Germ/Sil/Zener Diodes	75p†
BP37	50 Projects Using Relays/SCR/Triacs	£1·10†
BP39	50 Field Effect Trans Projects	£1·25†
BP40	Digital IC Equivs & Pin Connection	£2·50†
BP41	Linear IC Equivs & Pin Connection	£2·75†
BP42	50 Simple LED Circuits	75p†
BP43	How to make Walki-Talkies	£1·25†
BP44	IC 555 Timer Projects	£1·45†
BP45	Projects on Opto-electronics	£1·25†
BP46	Radio Circuits Using IC's	£1·35†
BP47	Mobile Discotheque Handbook	£1·35†
BP48	Electronics Projects for Beginners	£1·35†
BP49	Popular Electronic Projects	£1·45†
BP50	IC LM3900 Projects	£1·35†
BP55	Radio Stations Guide	£1·45†
BP160	Coil Design & Construction Manual	85p†
BP202	Handbook of Integrated Circuits Equivalents & Substitutes	75p†
BP205	1st Book Hi-Fi Speaker Enclosures	75p†
BP213	Circuits for Model Railways	85p†
BP215	Shortwave Circuits & Gear for Experiments & Radio Hams	85p†
BP216	Electronic Gadgets & Games	85p†
BP217	Solid State Power Supply Handbook	85p†
BP221	28 Tested Transistor Projects	95p†
BP222	Short-wave Receivers for Beginners	95p†
BP223	50 Projects using IC CA3130	95p†
BP224	50 CMOS IC Projects	95p†
BP225	A Practical intro to Digital IC's	95p†
BP226	Build Advanced Short-wave Receivers	£1·20†
BP227	Beginners Guide to Building Electronic Projects	£1·25†

REGULATORS

Positive	Price
uA7805 TO220	£0·85
uA7812 TO220	£0·85
uA7815 TO220	£0·85
uA7824 TO220	£0·85
uA7818 TO220	£0·85

Negative	
uA7905 TO220	£0·92
uA7912 TO220	£0·92
uA7915 TO220	£0·92
uA7924 TO220	£0·92
uA7818 TO220	£0·92
72723 14 pin DN	£0·52
uA723C TO99	£0·52
LM309K TO3	£1·72

CASSETTES

o/no 3193	30 min lettertape	£0·38
o/no. 301	Dindy C60 tape	£0·41
o/no, 302	Dindy C90 tape	£0·52
o/no. 303	Dindy C120 tape	£0·75

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1/50	£0·23
100v RMS	BR1/100	£0·25
200v RMS	BR1/200	£0·29
400v RMS	BR1/400	£0·41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0·52
100v RMS	BR2/100	£0·56
200v RMS	BR2/200	£0·60
400v RMS	BR2/400	£0·67
1000v RMS	BR2/1000	£0·78

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1·50
200v RMS	BR10/200	£1·70

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£1·90
200v RMS	BR25/200	£2·20

TRIACS

2 amp **TO5 case**

volts	No	Price
100	TR12A/100	£0·36
200	TR12A/200	£0·59
400	TR12A/400	£0·82

10 amp

volts		
100	TR110A/100	£0·88
200	TR110A/200	£1·06
400	TR110A/400	£1·29

6 amp

volts		
100	TR16A/100	£0·59
200	TR16A/200	£0·70
400	TR16A/400	£0·88

10 amp

volts		
400	TR110A/400P	£1·29

DIACS

BR100 **£0·23** D32 **£0·23**

ZENER DIODES

400 mw (BzyBB) D007. Glass encapsulated range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. **No. Z4 10p**

1w-1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w Metal stud type SO10 case. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z10 44p**

METAL FOIL CAPACITOR PAKS

16204 – Containing 50 metal foil capacitor like Mullard C280 series – Mixed values ranging from 01uf – 2·2uf. Complete with identification sheet **£1·38**

JUST QUOTE YOUR ACCESS OR BARCLAYCARD NO.

BARCLAYCARD VISA

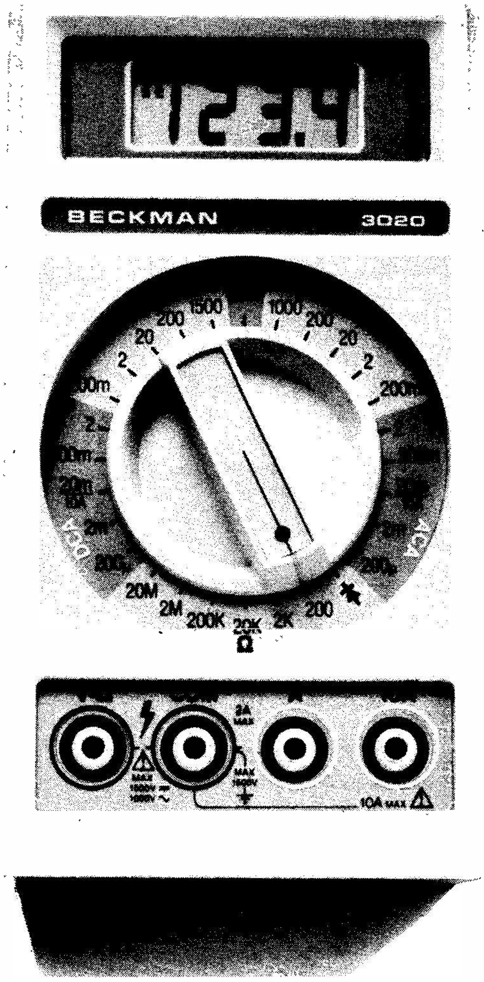
Beckman superiority is no fluke

We've been making precision instruments since 1935 and our sales are worldwide. We welcome competition, because it lets us show how good we are. So when we make a 3½ digit hand-held multimeter like the 3020, we make it better than anyone else.

Who else, for instance, can hold a candle to our 2,000 hours battery life?

Who else offers the time-slaughtering feature of Insta-Ohms,™ showing continuity in less than 100 milliseconds?

Make the comparison with our nearest competitor. You'll soon see what gives us such a superiority complex.



SPECIFICATIONS

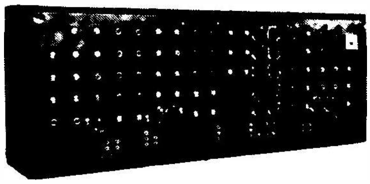
PARAMETER	BECKMAN 3020	FLUKE 8020A
DC Voltage		
Ranges	5,200mV–1500V	5,200mV–1000V
Accuracy	± (0.1% rdg + 1 digit)	± (0.25% rdg + 1 digit)
AC Voltage		
Ranges	5,200mV–1000V	5,200mV–750V
Accuracy 45Hz–2kHz	± (0.6% rdg + 3 digits)	± (0.75% rdg + 2 digits) to ± (1.5% rdg + 3 digits)
DC Current		
Ranges	6,200uA–10A	4,2mA–2A
Accuracy	± (0.35% rdg + 1 digit) (except 10A)	± (0.75% rdg + 1 digit)
AC Current		
Ranges	6,200uA–10A	4,2mA–2A
Accuracy 45Hz–2kHz	± (0.9% rdg + 3 digits) (except 10A)	± (1.5% rdg + 3 digits) to ± (2.0% rdg + 2 digits) (up to 1kHz)
Resistance		
Ranges	6,200Ω –20MΩ	6,200Ω –20MΩ
Accuracy	± (0.2% rdg + 1 digit)	± (0.2% rdg + 1 digit) to ± (2.0% rdg + 1 digit)
Battery Life	2000 hrs	200 hrs
Fast Continuity Check	Yes	No

Specifications obtained from published data.

BECKMAN

Beckman Instruments Ltd
Sales and Marketing Organisation
Queensway, Glenrothes, Fife, Scotland, KY7 5PU.
Telephone: (0592) 753811 Telex: 72135

KITS FOR SYNTHESISERS, SOUND EFFECTS



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

LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHONOSONICS

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

P.E. 128-NOTE PROGRAMMABLE SEQUENCER

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.

Set of basic component kits	KIT 76-5	**£28.92**
Set of PCBs & layout charts	KIT 76-6	**£5.66**
Set of text photocopies		**£1.36**

P.E. 16-NOTE PROGRAMMABLE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synthesisers.

Set of basic component kits	KIT 86-3	**£22.90**
Set of PCBs	KIT 86-4	**£5.09**
Set text photocopies		**£1.84**

P.E. STRING ENSEMBLE

A multivoiced string instrument synthesiser

Set of basic component kits	KIT 77-6	**£68.70**
Set of PCBs & layout charts	KIT 77-7	**£24.19**

P.E. JOANNA PLUS ORGAN VOICING

A modified version of the P.E. 5-octave piano that retains all the original facilities and also includes switchable organ voicing circuitry.

Set of basic component kits	KIT 71-5	**£89.87**
Set of PCBs & layout charts	KIT 71-6	**£29.51**
"Sound Design" booklet		**£1.00**

ELEKTOR ELECTRONIC PIANO

A touch-sensitive multiple-voicing piano using the latest integrated circuit techniques for the keying and envelope shaping, and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos.

5-octave set of basic components	KIT 80-6	**£100.64**
5-octave set of PCBs (as published)	KIT 80-7	**£26.02**
Additional 3-octave extension basic parts	KIT 80-5	**£40.98**
Additional 3-octave set of PCBs (as published)	KIT 80-8	**£9.45**
Set of text photocopies		**£1.81**

P.E. MINISONIC MK2 SYNTHESISER

A portable mains operated miniature sound synthesiser with keyboard circuits. Although having slightly fewer facilities than the large Formant and P.E. synthesisers the functions offered by this design give it great scope and versatility.

Set of basic component kits (excl. KBD R's & tuning pots – see list for options available	KIT 38-23	**£67.05**
Set of PCBs (incl. layout charts)	KIT 38-24	**£9.87**
"Sound Design" booklet		**£1.00**

P.E. SYNTHESISER

The well acclaimed and highly versatile large scale mains operated synthesiser. Other circuits in our lists may be used with it to good advantage.

Main Unit basic component kits	KIT 23-27	**£86.99**
Main Unit set of PCBs & layout charts	KIT 23-28	**£14.52**
Keyboard Unit basic component kits	KIT 23-29	**£52.07**
Keyboard Unit set of PCBs & layout charts	KIT 23-30	**£8.42**
Main Unit set of text photocopies		**£5.91**
Keyboard Unit set of text photocopies		**£2.30**

ELEKTOR FORMANT SYNTHESISER

A very sophisticated synthesiser for the advanced constructor who puts performance before price.

Set of basic component kits	KIT 66-12	**£193.68**
Set of PCBs (as published)	KIT 66-13	**£53.92**
Set of text photocopies		**£7.83**

P.E. GUITAR EFFECTS PEDAL

Modulates the attack, decay and filter characteristics of a signal from most audio sources, producing 8 different switchable effects that can be further modified by manual controls.

Basic parts with foot switches	KIT 42-1	**£8.45**
Basic parts with panel switches	KIT 42-2	**£5.55**
PCB & layout chart	PCB 43A	**£1.57**
Text photocopy		**28p**

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Main unit PCB (as published)	PCB 9913	**£3.69**
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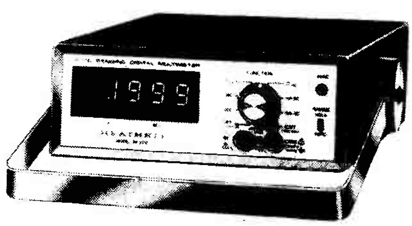

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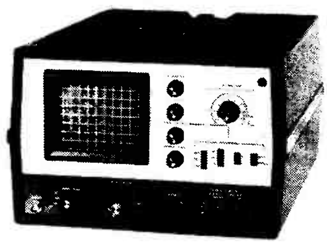

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HEATHKIT

PE VOLUME 15 No. 11 NOVEMBER 1979

OPPORTUNITIES ABOUND

"WE ARE all, nowadays, electronics conscious. Yes, even the layman, while not conversant with the technicalities involved, has a general appreciation of the vital part played by this young but exuberant branch of electrical engineering in the complex world of today . . . and this is but the beginning.

"As we step over the threshold into a new exciting technological age, our dependence upon electronics is all too apparent: terrestrial developments centre around automation, with electronics providing the brain and guiding hand for power-operated machinery; extraterrestrial exploration relies utterly upon electronics for remote control, communications and telemetering services.

"These grand scale developments have an impact on the entire field of electronics, for in their wake come new components, new circuits, new methods and, of course, new applications."

Some might query the terms "young" and "the beginning" when applied to electronics and these are the only clues to the fact that those words were the opening paragraphs of the PE editorial in Volume 1 No. 2—back in December 1964! Whilst looking back to see how far we have come over the past 15 years what is most apparent is that we are still part of a relatively young and most certainly exuberant industry.

NO BOUNDS

The introduction of the transistor—just making a significant impact on the hobbyist market back in '64—has led us into an electronics world which knows no bounds and, while progressing at breakneck speed five years ago is now going twice as fast.

That editorial continued in the following way:

"Without a doubt the amateur enthusiast will be eager to reap his share of these benefits of technological progress, as he has been indeed in the past. For it is true that amateurs have been conducting experiments and building electronic equipment since the earliest days of radio communication; even before the thermionic valve drove the crystal diode into (temporary) oblivion, and long before the very term 'electronics' entered into general use.

"But, in more recent times, the technical revolution triggered off by the invention of the crystal triode or transistor some 16 years ago has quite dramatically transformed the situation to the advantage of the home constructor."

The crystal triode! We wonder how many readers using microprocessors know how a triode works.

30 YEARS ON

Only about 30 years from the discovery of transistor action we are able to put about 100,000 semiconductor devices in the area originally required for one.

If that first 16 years progress "dramatically transformed the situation to the advantage of the home constructor" just think what the last 15 years have done. Far from putting us "out of business", as some intimated when i.c.s. became readily available, the hobby has grown in both numbers and complexity and now forms a significant market for the component industry.

We fully expect the next 15 years to be even more rewarding.

Mike Kenward

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SOLID STATE CAR INSTRUMENTS

No.2 REV. COUNTER

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

The second article in a series of car instrument constructionals using the LM3914 (discussed last month), and which produce an l.e.d. bar display

MEASURING the rate at which the engine turns over is something which on first thoughts might not appear to be of much practical interest to the average motorist. In fact it is a very useful facility in both engine tuning and everyday driving situations.

In order to obtain optimum performance, it is necessary to drive at an engine speed which produces the maximum torque for that particular engine (the torque produced by an engine tends to decrease at high and low revs). The average saloon car performs best at approximately 2,000–3,000 r.p.m. and driving at this rate will produce optimum fuel consumption and acceleration for that particular gear. Indeed, one of the reasons for the increasing popularity of the 5-speed gearbox is that it allows driving nearer to this optimum rev's while at higher road speeds.

Another point of interest is that the forces exerted on the engine unit vary with the square of the engine rev's, i.e. doubling the r.p.m. increases the forces on, say, the rocker gear by a factor of 4. Hence, it is important that the maximum r.p.m. rating for a particular engine is not exceeded, irrespective of road speed.

In engine tuning, it is often necessary that certain measurements (e.g. ignition timing advance) are carried out at known engine speeds. Also the "tickover" speed should be adjusted so that the engine does not waste fuel while idling, yet moves off smoothly when required.

MEASUREMENT OF RPM

Measuring the engine r.p.m. would seem to require some type of transducer which is connected to the engine crankshaft. A little thought, however, soon shows that there is usually one already fitted; the *distributor!* The distributor shaft in a 4-stroke engine rotates at exactly half of the engine speed, and is responsible for the opening and closing of the contact breaker points. The contact breaker causes a pulsed signal to be produced across the primary (LT) winding of the ignition coil. The number of pulses produced per minute will be:

$$\tfrac{1}{2} \times \text{r.p.m.} \times \text{number of cylinders}$$

All that is now required is a circuit to count these pulses and turn the result into an analogue signal which is suitable for driving the display module input, i.e. 0 to +5 volts for the required full scale.

Pulse counting by digital methods is one obvious way of determining contact breaker rate. This approach, however, requires a minimum of three to four i.c.s and also involves a stage of digital-to-analogue conversion, see Fig. 1a for details. A simple charge pump alternative (Fig. 1b) has the advantage of simplicity, but suffers the disadvantages of additional sensitivity to both pulse width and amplitude. These problems may be overcome by the incorporation of a monostable prior to the charge pump (Fig. 1c). With a monostable pulse width which is less than the periodic time of the input pulse train, the output of this new arrangement will now only depend on the input pulse frequency. The response time and full-scale values may then be set by a suitable choice of R and C, and of the monostable pulse width. A derivative of this approach is used in the integrated frequency-to-voltage converter produced by National Semiconductor and used in the r.p.m. counter to be described below.

FREQUENCY-TO-VOLTAGE CONVERTER

National Semiconductor's LM2917 is a linear monolithic i.c. which contains a frequency-to-voltage converter, together with a high gain op amp/comparator designed to operate a relay, lamp or other external load, up to 50mA. The tachometer section uses a charge pump technique and offers frequency doubling for low ripple, input protection, and an output which falls to ground level for a zero frequency input.

One of the main aims in the design of the LM2917 was ease of use. A single RC network provides the frequency doubling (see Fig. 2), and the output is simply related to the input frequency by the following formula:

$$V_{out} = F_{in} \times V_{ref} \times R_a \times C_a$$

The integral voltage regulator sets the value of Vref and ensures accurate, stable conversion performance.

The input stage is a differential amplifier driving a positive feedback flip-flop circuit. This arrangement allows the user to define the input switching level, while retaining the hysteresis around that level to ensure good noise rejection. Following the input stage there is a charge pump where the input frequency is converted to a d.c. voltage. This operation requires a timing capacitor (Ca), an output load resistor (Ra), and an integrating filter capacitor (Cb). The capacitor Cb determines the trade-off between output ripple voltage and response time of the circuit.

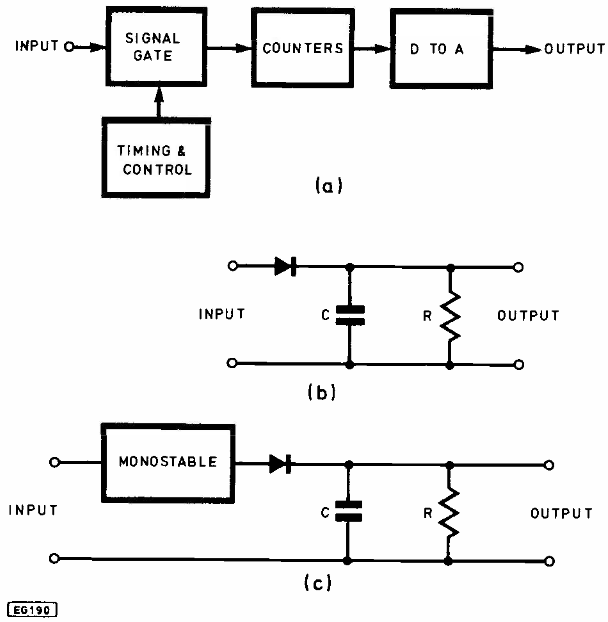


Fig. 1 (a) Measurement of r.p.m. (b) Basic diode pump (c) Frequency controlled diode pump

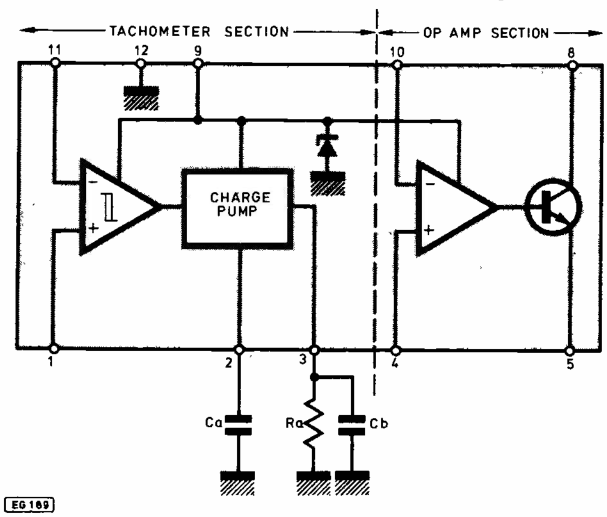


Fig. 2. The LM2917 frequency-to-voltage converter

TACHOMETER

The circuit diagram for the complete tachometer is shown in Fig. 3. The input is taken from across the ignition coil and applied to the input of the frequency-to-voltage converter, IC1, via the filter formed by R1, R2 and C1. The input switching level is set by R4 and D1, and consequently the input level must exceed approximately 0·6V before the signal will be recognised.

The output voltage varies depending on the input frequency and on the values of the frequency doubling capacitor, C2, and the composite load resistor, R3 and VR1. The values of these components are chosen such that the output of the circuit is 5·0V when the maximum r.p.m. is reached. This arrangement ensures that the circuit is compatible with the standard display module. Values are given in Table 1 for various maximum r.p.m. ranges and differing numbers of engine cylinders. VR1 may be omitted if desired and the load provided by a single fixed resistor R3.

The response time of the circuit is set by C3; increasing the value of C3 will increase the response time, and vice versa. The dropper resistor for the internal Zener regulator, R5, is chosen to minimise the reference voltage variation over a supply range of 9 to 16V. The remainder of the circuit is the standard display module.

CONSTRUCTIONAL NOTES

The overall construction of the tachometer closely follows the pattern of the battery condition indicator described last month. Once again only two examples of possible implementations are discussed in detail. A printed circuit design is shown in Fig. 4, and a component and connection diagram is shown in Fig. 5. A corresponding stripboard layout is shown in Fig. 6.

The display mode which appears most appropriate for a tachometer is the bar graph, and these are the connections shown in Figs. 5 and 6. Constructors may wish to colour code the individual l.e.d.s to suit their own taste and engine specifications, e.g. green for the first 8 l.e.d.s, orange for the 9th, and red for the last one. In cases where the l.e.d.s are to be mounted in a circular arc (possibly concentric with the speedometer), it may be desirable to increase the display to 20 or even 30 l.e.d.s by use of additional LM3914 devices. These techniques will be discussed in a later article.

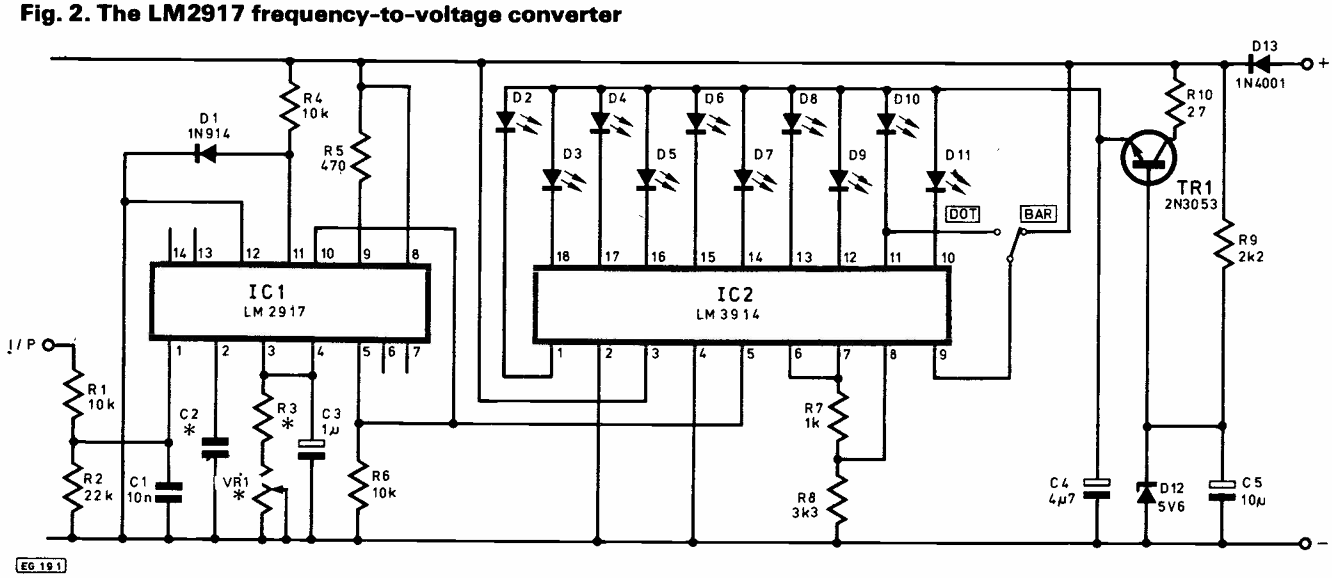


Fig. 3. Full circuit diagram of the Rev. Counter.

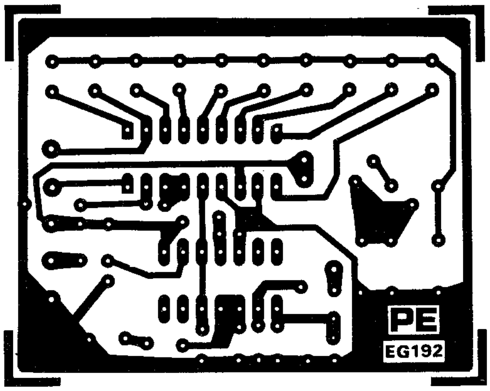
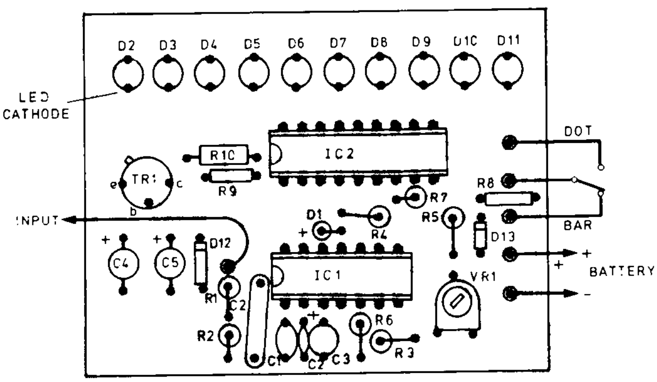


Fig. 4. Printed circuit layout (actual size)



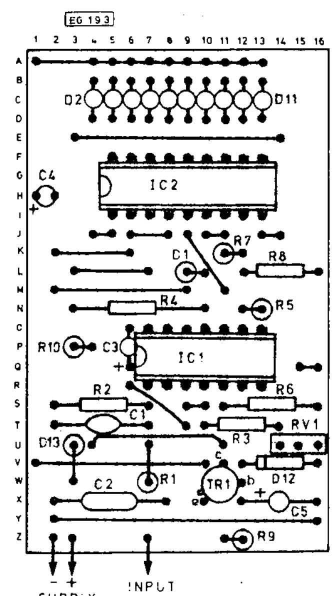
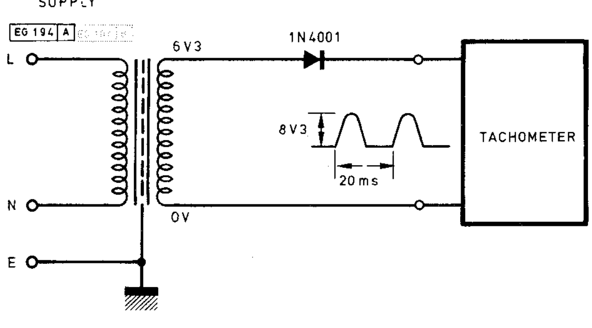


Fig. 5. (above). Component layout of p.c.b. for Rev. Counter

Fig. 6. (left). Alternative stripboard layout. Note that R9 goes to collector TR1 which will not affect operation

Fig. 7. (below). Method of calibration



In most applications the component values given in Table 1 should be enough to ensure adequate calibration of the tachometer. VR1 may be replaced by either a link or a suitable fixed resistor to make up the required total load resistance. However, in situations where a high degree of accuracy is required, some form of calibration procedure is necessary. The first step in such cases is to work out the pulse frequency which corresponds to the maximum indicated r.p.m. This may be found from the following equation for max pulse frequency:

$$\frac{\text{maximum indicated r.p.m.} \times \text{No. of cylinders}}{120}\ \text{Hz}$$

Table 1. Values of composite load resistance (R3 + VR1), all in kilohms

Maximum Indicated	C2 = 10nF			C2 = 22nF		
RPM	4 cyl	6 cyl	8 cyl	4 cyl	6 cyl	8 cyl
1000	1984	1323	992	902	601	451
2000	992	661	496	451	301	226
3000	661	441	331	301	200	150
4000	496	331	248	226	150	113
5000	397	265	198	180	120	90
6000	331	220	165	150	100	75
7000	283	189	142	129	86	64
8000	248	165	124	113	75	56

COMPONENTS . . .

Resistors

R1, R4, R6	10k (3 off)
R2	22k
R3	see text
R5	470
R7	1k
R8	3k3
R9	2k2
R10	27 $\frac{1}{2}$W

All resistors $\frac{1}{4}$W 5% except where stated

Potentiometers

VR1 See text for value. Hor. preset for p.c.b., vert. preset for stripboard

Capacitors

C1	10n ceramic
C2	see text
C3	1µ elect
C4	4µ7 elect
C5	10µ elect

Transistors and Diodes

D1	1N914
D2–D11	l.e.d.s to suit physical requirement
D12	BZY88C5V6 400mW Zener
D13	1N4001
TR1	2N3053

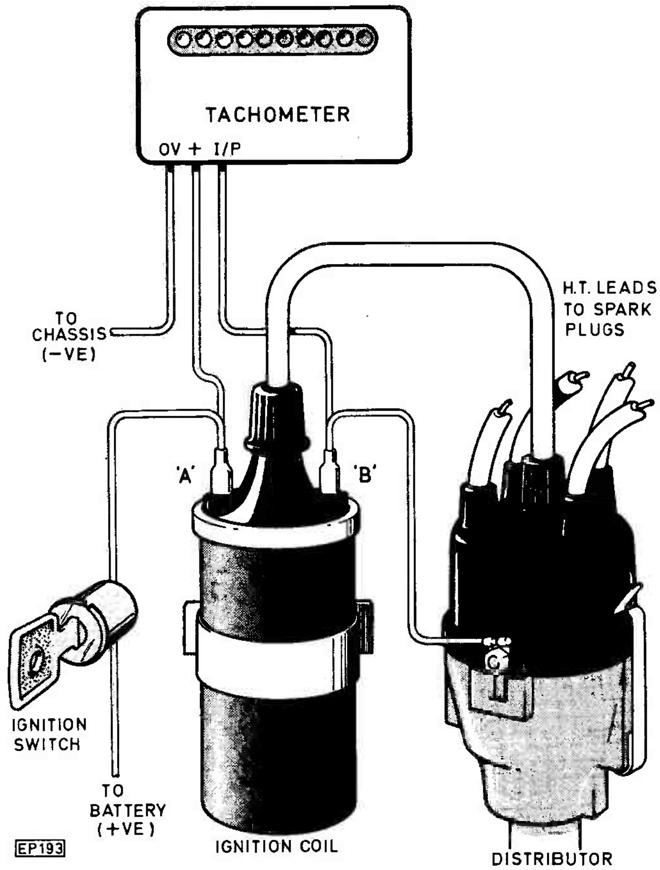
Integrated Circuits

IC1	LM2917
IC2	LM3914

Miscellaneous

Printed circuit board (or 0·1 inch stripboard: 70 x 45mm)
Suitable moulded case

This, for example, gives 200Hz for a 4-cylinder engine at 6,000 r.p.m. A direct method of calibration is then to use a pulse generator to apply a 200Hz square wave (greater than three volts amplitude) to the input, and then adjust VR1 to give 5·0V across R6. Should a pulse generator be unavailable, a suitable mains (filament-type) transformer may be used to generate a 50Hz signal, and VR1 is then adjusted to give an appropriate proportion of 5·0V across R6, e.g. 1·25V (i.e. fifty 200ths of 5·0V) in the case of a 6,000 r.p.m. 4-cylinder tachometer. See Fig. 7 for details.



INSTALLATION AND USE

Connecting the tachometer to the engine ignition system is a very simple operation. Fig. 8 shows how the supply (A) and measurement input (B) leads are connected across the ignition coil; the 0V connection being made to any convenient point on the vehicle chassis. In cases where the instrument is to be used as a piece of test equipment, switched values of load resistance may be provided for different ranges/numbers of cylinders, and connections brought out on flying leads with crocodile clips.

The tachometer has been successfully tried on a variety of British and foreign vehicles. Constructors should, however, be aware that for vehicles already fitted with a *current* pulse type of tachometer (e.g. *Smiths type RVC*), the readings obtained may tend to be rather misleading.

NEXT MONTH: Battery Current Indicator, Temperature Gauge, Dwell Indicator. All three car instruments form a special supplement with details on extending the displays and on providing extra warnings of high level readings

Market Place

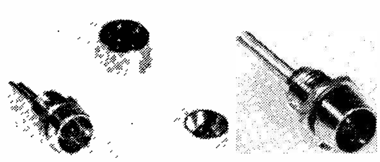
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

FULL FRONTAL

These BIMDICATORS were designed to satisfy applications requiring indicators with a restricted viewing angle, long operating life, and good aesthetic qualities.

Both devices utilise red, green or amber l.e.d.s which are set back from the front of the indicator and have low current, low voltage characteristics, fast switching times, and are fully i.c. compatible.



The BIM 33 l.e.d. (left) has a nickel plated brass body and is panel mounted in a 6mm dia. hole. The BIM 34 l.e.d. has a chromium plated brass body and is panel mounted in an 8mm dia. hole.

Prices inc. VAT and p&p, for either size are: Red—71p, Green or Yellow—81p.

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Toolrange supply tools and production aids for the electrical and electronic industries and their address is **Toolrange Ltd., Upton Road, Reading, Berks., RG3 4JA (0734 22245).**

CSC

A new 32 page catalogue from Continental Specialties Corporation features the company's ranges of breadboarding equipment, logic testing devices, and test instrumentation. Products featured include a wide range of solderless breadboards and breadboard assemblies, test clips, instrument cases, pulse and function generators, frequency counters and accessories, logic probes, logic monitors, the CSC digital pulser, test kits and probe kits.

The catalogue is available from **Continental Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ**

AEROSOLS FOR ELECTRONICS

Switch cleaning aerosols by Servisol are now available from Toolrange. Other aerosols in the range are anti-static cleaners, water proofing sprays, insulating varnish sprays and chemical circuit freezers. Prices average out at 70p per can.

Toolrange Ltd., Upton Road, Reading, Berks., RG3 4JA (0734 22245).

MICRO-KIT CONSTRUCTION

If you would like a microprocessor system but are daunted by the assembly then Logsign may be of interest.

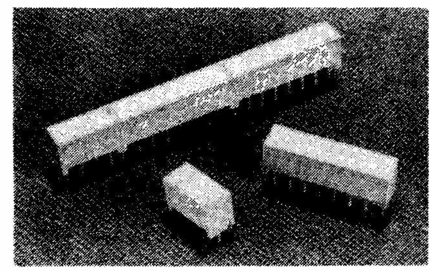
Logsign will obtain and build a kit: construct a kit supplied by a customer; even undertake to finish a kit which has proved problematical.

Charges start at around 10 per cent of system value for the most popular kits such as Nascom, Compukit, Newbear 77/68 etc., rising to around 25 per cent for large systems like Horizon.

Logsign Microcomputer Engineers, P.O. Box 33, Truro, Cornwall, TR3 6BZ. (0872 76205).

LIGHT BARS

For those of you who are intending to construct the "car devices" currently being published by us, this new range of modular l.e.d.s should be of interest.

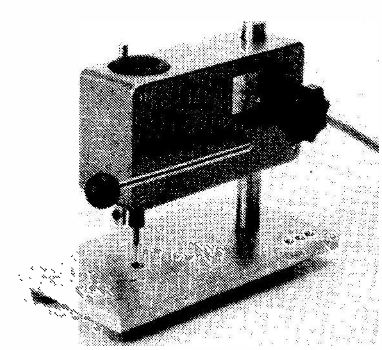


The HLMP 2300, 2400 and 2500 series of 9 to 19mm rectangular devices can be multiplexed and are X-Y stackable. Composed of two or four in-line l.e.d.s with the light from each l.e.d. optically scattered to form an evenly illuminated light emitting surface, these devices may be strobed at high peak currents or driven from d.c. supplies. Available in red, yellow and green the HLMP 2300, 2400, and 2500 are priced from 97p exc. VAT and p&p.

For further information contact **Hewlett Packard Ltd., Kings Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.**

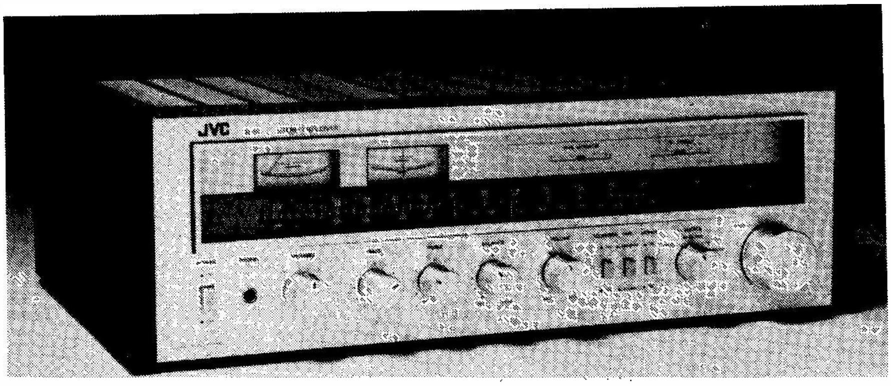
HIGH SPEED DRILL

A new high speed drilling machine which is ideal for use in p.c.b. prototype workshops had just been announced by Linton Laboratories. The Junior Drillmaster which is mains operated has a motor speed of 14000 r.p.m. with a drill capacity of 206mm dia.



The drill, which is supplied with a guard and four separate collets (0·5 to 3·2mm), is priced at £65 inc. p&p, plus VAT.

Linton Laboratories Limited, 4 Bartlow Road, Linton, Cambridge, CB1 6LY.



JVC STEREO RECEIVER

The photograph shows JVC's R-S7, an AM/FM receiver which delivers 50W per channel r.m.s. with both channels driven into 8 ohms, from 20Hz to 20kHz. The THD is no more than 0·03 per cent and a phono equaliser ensures a signal to noise ratio of 90dB.

The R-S7 has a protection circuit which prevents power on/off noise from reaching the speakers, disconnects the speakers electronically if an abnormal d.c. voltage appears at the terminals and protects the power transistors from short circuits, low speaker impedances, etc. Retail price is around £203 (inc. VAT).

AM/FM/CB RECEIVER

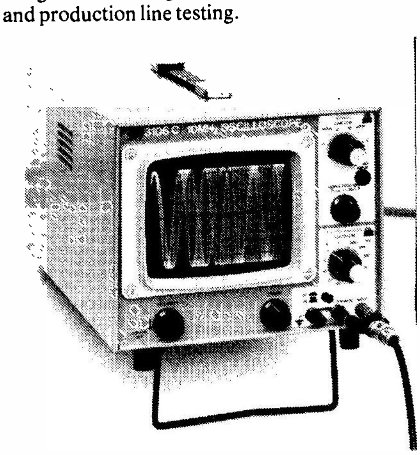
A Hong Kong manufactured receiver labelled Bristal has been under appraisal at the office recently. It is said to comply, as of date of manufacture, with FCC rules and regulations part 15 subpart C.

As well as receiving legal transmissions from the British Broadcasting Corporation it is rumoured that if you switch the Bristal to CB you might hear French, Spanish and Italian CBers as clear as next door, probably a combination of skip and spaghetti burners.

The set measures 185 x 90 x 50mm, has a telescopic aerial one metre long, and has been seen for sale at £18·95 plus VAT.

10MHz Scope

The 3106C oscilloscope is a general purpose single trace instrument which has been designed for college labs, service shop repair and production line testing.



The instrument features a 5in flat c.r.t., d.c. to 10MHz bandwidth, vertical amplifier with a sensitivity of 10mV to 50V/cm in 12 calibrated steps, 0·5µs to 0·01 sec/cm sweep range and a times five magnifier. The price of the 3106C is £159·95 including VAT, carriage is £2·50.

Kramer & Co., 9 October Place, Holders Hill Road, London NW4 1EJ (01-203 2473).

3rd HAND

The 3rd Hand is a rather aptly named p.c.b. holder which can be clamped on the edge of a bench, table or worktop. The p.c.b. is held in position by an open ended clamp which allows any size of board to be held. When in

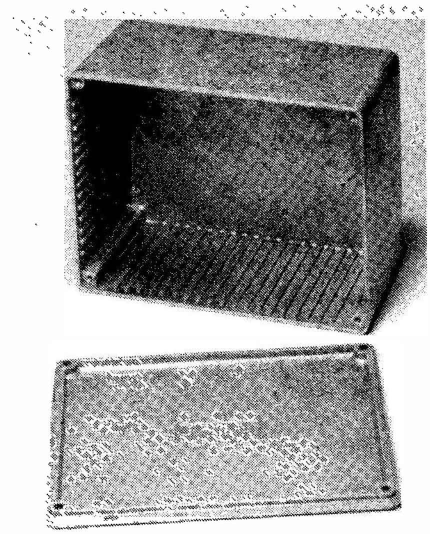
position the board can be flipped over to allow access for soldering and clipping.

The cost is £8·95 including VAT and p&p.

Para Sales, 1 Hook Road, Kingsclere, Newbury, Berks. RG15 8PD.

P.C.B.s ACCEPTED

This diecast aluminium box incorporates slots on all four sides for quick housing and removal of 1·8mm thick p.c.b.s. Dimensions of the box are 121 x 95 x 61mm. Grey hammertone is a shortly to be introduced optional finish.



BOSS Industrial Mouldings make a range of this type of box called BIMBOXES. This size is £3·45 inc. p&p and VAT.

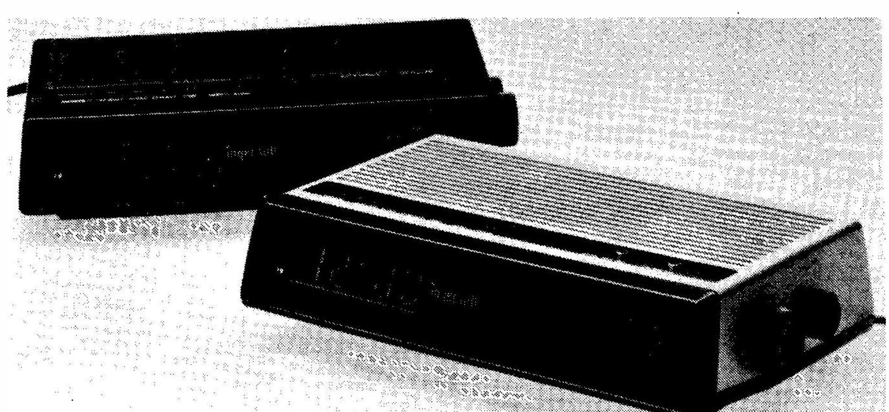
BOSS Industrial Mouldings Ltd., Higgs Ind. Est., 2 Herne Hill Road, London SE24 0AU (01-737 2383).

CRYSTALS MADE TO ORDER

Golledge Electronics stock a very good range of crystals for microprocessors, markers, clocks, marine VHF, radio control, etc. They can supply crystals made to order, normal delivery six weeks.

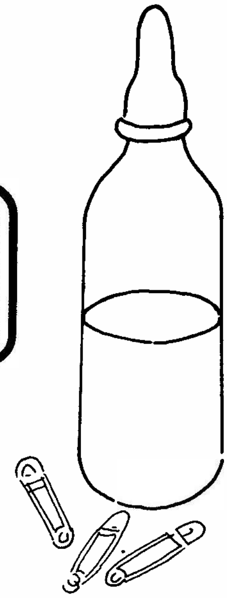
Golledge are also designers of a range of "building block" modules which require only simple external connections and can be made to work well by anyone with little or no experience of radio construction.

Leaflets on the crystals and the modules are available from **Golledge Electronics, G3EDW, Merriott, Somerset TA16 5NS (0460 73718).**



This is Ingersoll's latest clock radio waker upper. It has a 12 hour l.e.d. display and will wake you with the three band radio or a nine minute repeating buzzer. For the listener who falls off to sleep it has a 60 minute shut off timer. It is mains operated, has a power failure indicator, and is finished in either teak or satin silver. The price is £30·65 inc. VAT.

BABYCOM



O.N. BISHOP

BABYCOM is a two unit monitoring system for the nursery. It consists of a control unit with a microphone, which should be placed near the cot and an alarm unit which can be placed anywhere else in the house. The two units are joined together via a 3 core flex.

The alarm is triggered by sound, the microphone picks up the baby's cries and the control unit of the system which contains a 5-bit shift register records the noise as a "1". After 10 secs the contents of each register (A, B, C, D and E) are shifted along (A to B, B to C etc.) with any new noises being entered into register A whilst the information in register E is erased.

For the alarm to sound the baby must trigger it twice (two registers at 1) within a 50 sec. period. When triggered the alarm will sound for one period and then stop unless the baby makes any further noises in which case it will continue to sound until the baby settles down and one or less of the registers is at "1". When the alarm sounds you can listen in to the baby by pressing the switch S3 on the alarm unit.

CONTROL UNIT

The circuit diagram of the power supply and the control unit is shown in Fig. 1. The circuit is powered via transformer T1, rectifier diodes D1 and D2, smoothing capacitors C1 and C2 and a regulator circuit formed by TR1, R1 and Zener diode D3.

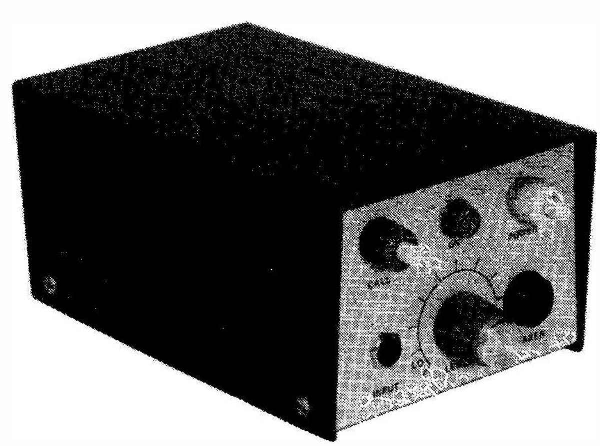
Any noise picked up by the microphone via JK1 is amplified by IC1 and then fed to the detector circuit of which TR2 and TR3 form a high gain amplifier. If the output of IC1 is above a certain level (when a loud enough sound is detected) the collector of TR3 is switched "high". The output level of IC1 at which this will occur is determined by the setting of VR1, the sensitivity control.

The two timers of IC2 are connected as two astable multivibrators. One timer runs at approximately 1Hz, with 2:1 mark-space ratio and the other runs at approximately 0·1Hz, its output waveform being "high" with very short clocking "lows" every 10 secs. The frequencies are nominal and the clocks can be set accurately enough by suitable choice of timing capacitors and resistors; there is no need for variable preset timing resistors. The logic circuit comprises the 7496 5-bit shift register and the 7425 dual 4-input NOR gate with a strobe input. The output from the detector circuit (collector TR3) is fed to the preset input of register A (IC3 pin 2). The common preset input (pin 8) is held high by Vcc so that the output of register A (pin 15) goes "high" immediately register A receives a "high" input. Preset inputs of the other registers (pins 3, 4, 6 and 7) are grounded, so that these registers have a "low" output at switch-on.

If any noise is detected during a 10 sec. period the output of register A goes "high" and remains high until the end of that period. Then the clock pulse steps the data through the registers.

The NOR function of IC4 operates only if the strobe input (pin 3) is "high". If the input is "low" the gate output is "low" whatever the state of its four inputs. The first NOR gate receives its strobe input from register A and its four inputs from registers B to E. If register A is low (no noise during the 10 sec. period), the gate output is low, irrespective of the other registers. But if register A goes "high" what happens next depends on the state of the other registers. If these are all "low" (no noise during previous four periods), the output remains "low" (no alarm). If any one or more of these are "high", the gate output goes "high", switching on TR4. At the end of the period TR4 is switched off as the output of register A goes low, unless of course baby makes further noises.

The second NOR gate of IC4 has its strobe input (pin 11) permanently wired to Vcc and is wired to function as an



The control unit

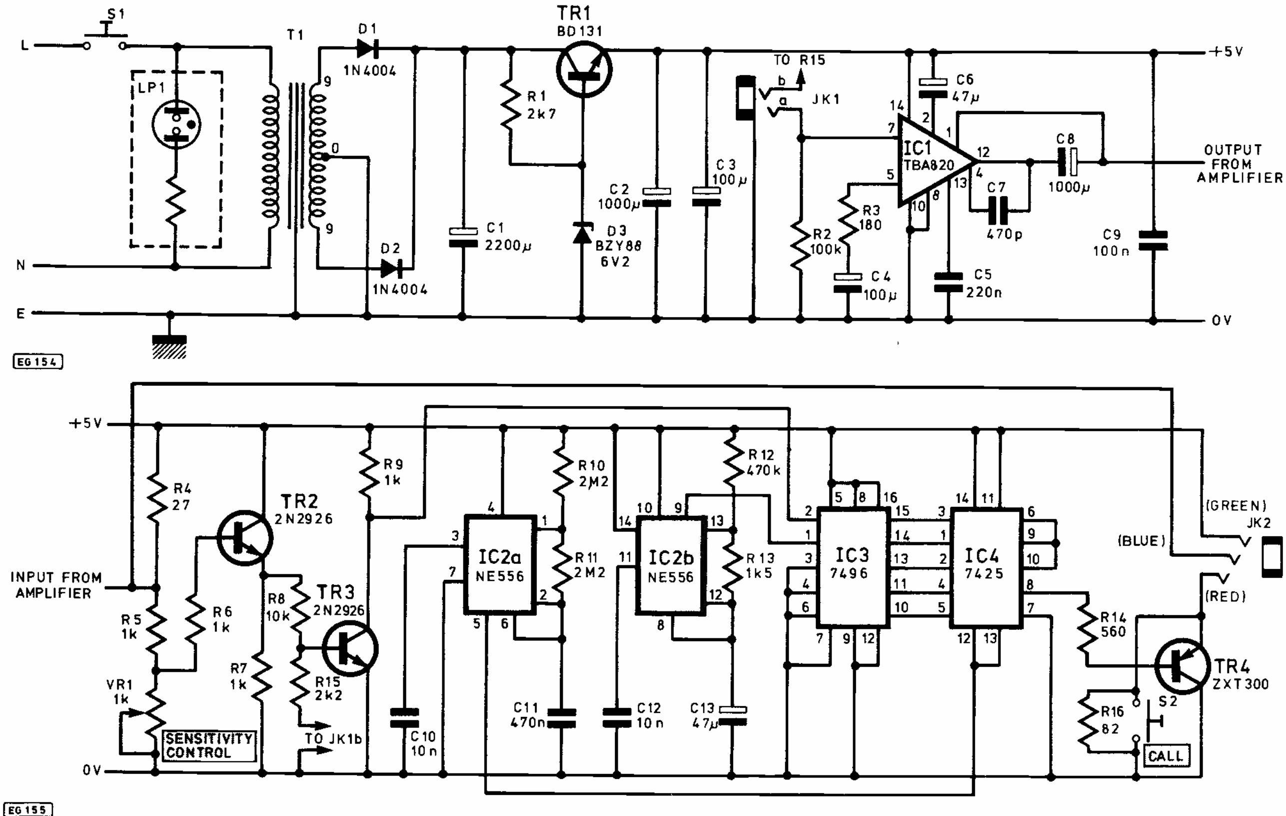


Fig. 1. Circuit diagram of the power supply and the control unit

ordinary 2-input NOR gate. This receives inputs from the first NOR gate ("high" = alarm) and from the 1Hz clock. In the "no alarm" state the output of this gate is continuously "low". In the alarm condition, the output of this gate is the inverse of the clock output. The output is used to turn TR4 on and off regularly.

ALARM UNIT

The alarm unit (Fig. 2) incorporates an oscillator and amplifier to produce the audio alarm tone. The frequency at which the oscillator operates can be varied by changing the value of C14. As TR4 is turned on the red lead of the alarm unit is connected to 0V switching on lamp LP2, the oscillator and therefore the alarm. Switching TR4 on and off via the second NOR gate of IC4 causes the lamp to flash and the alarm to bleep.

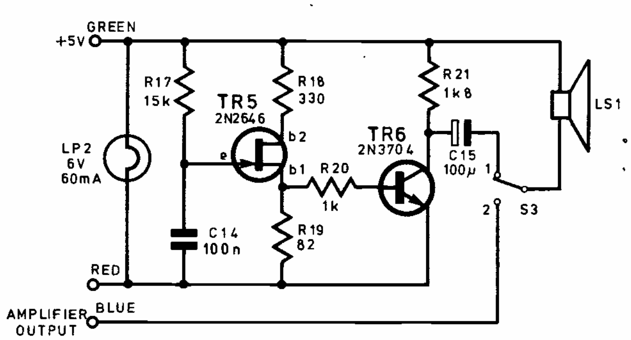


Fig. 2. Circuit diagram of the alarm unit

FAIL SAFE

The unit incorporates a number of features to ensure that "no alarm" really does mean "no noise" and is not the result of a failure in the system.

1) There is no volume on the alarm unit, so this cannot be turned down and then forgotten. Similarly, the lamp cannot be switched off.
2) In the "no alarm" condition a small current flows through R16, bypassing TR4. This current is insufficient to activate the AF oscillator but does cause LP2 to glow. If the unit is operating correctly the lamp should be either flashing brightly or glowing dimly.
3) One side of the microphone jack socket (JK1b) is used as switch 1 which is wired in series with R15 to TR3 so as to connect the base of TR3 to ground when the microphone jack is not in its socket. Thus if the microphone has not been plugged in, or its plug partly pulled out of the socket, TR3 is turned off, its collector potential goes "high" and a "high" will appear at register A triggering the alarm.

CONSTRUCTION

In the prototype, the control unit of the Babycom was housed in a 175 x 95 x 70mm case. The front panel should be drilled and the panel components mounted into position. The Veroboard layout shown in Fig. 3 should be soldered next and then carefully checked to ensure there are no solder bridges or incomplete track breaks to short out the board. After the board has been checked it can be fitted as close to the back and one side of the case as possible using 6BA screws and spacers. Note that only one Veroboard is needed instead of the two used in the prototype

Transformer T1, the smoothing capacitor C1 and the "L" shaped heat-sink for TR1 should be fitted alongside the Veroboard with the transformer at the back of the case. The rest of the power supply circuit should then be mounted on a piece of tagboard (Fig. 4) and fitted to the clip holding

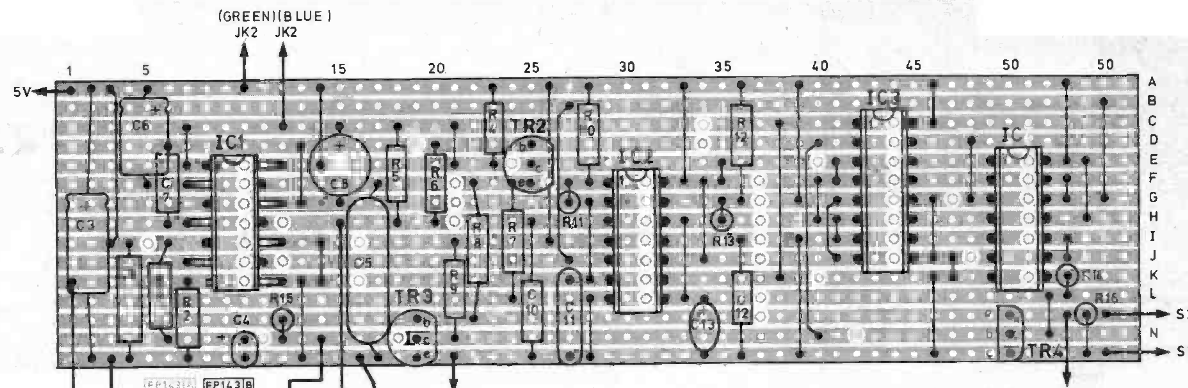


Fig. 3. Veroboard layout of the control unit

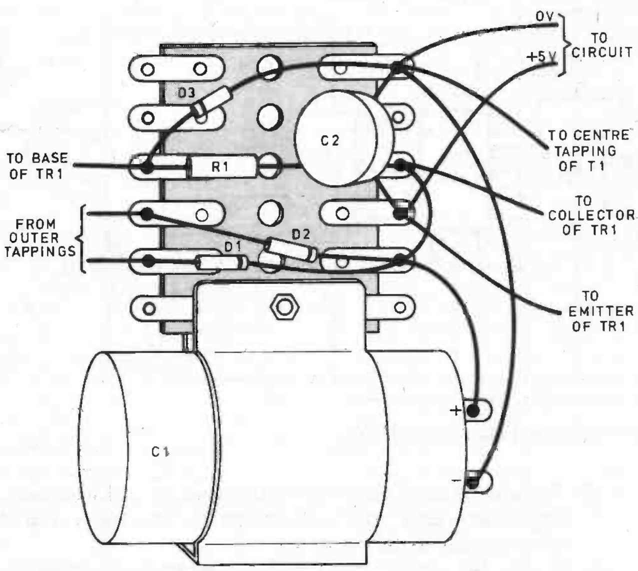
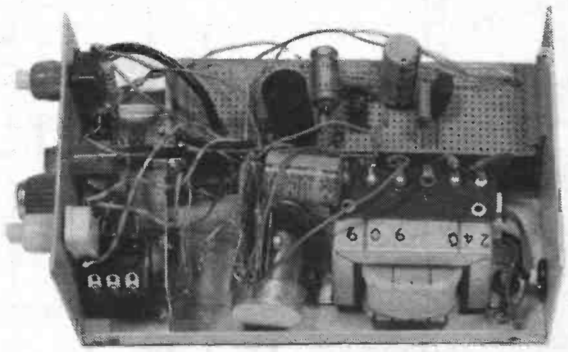


Fig. 4. Tagboard layout of the p.s.u.



Internal view of the control unit

capacitor C1. Care should be taken that the upper end of the tag strip does not touch against the top cover of the case.

After all the components have been fitted into the case the wiring between the components should be carried out. R16 is mounted between the terminals of S2 and a short length of co-ax cable should be used to link JK1 to the

COMPONENTS . . .

Resistors

R1	2k7
R2	100k
R3	180
R4	27 ½W
R5, R6, R7, R9, R20	1k (5 off)
R8	10k
R10, R11	2M2 (2 off)
R12	470k
R13	1k5
R14	560
R15	2k2
R16, R19	82 (2 off)
R17	15k
R18	330
R21	1k8

All resistors ¼W 5% unless otherwise stated

Potentiometers

VR1 1k linear

Capacitors

C1	2200μ 16V elect.
C2, C8	1000μ 10V elect. (2 off)
C3, C4, C15	100μ 10V elect. (3 off)
C5	220n polyester
C6	47μ 10V elect.
C7	470p ceramic
C9, C14	100n polyester (2 off)
C10	10n ceramic disc
C11	470n polyester
C12	10n ceramic disc
C13	47μ 16V tant

Semiconductors

D1, D2	1N4004 (2 off)
D3	BZY 88 6V2
TR1	BD131
TR2, TR3	2N2926 (2 off)
TR4	ZXT 300
TR5	2N2646
TR6	2N3704
IC1	TBA 820
IC2	NE 556
IC3	7496
IC4	7425

Miscellaneous

T1	9–0–9V secondary 100mA mains transformer
S1	Push button, push to make push to break
S2	Push button, push to make
S3	S.p.s.t. biased
LP1	240V neon
LP2	6V 60mA MES filament lamp
LS1	Miniature speaker 8Ω
JK1	Min jack socket
JK2	Stereo jack socket
MIC1	High impedance crystal microphone

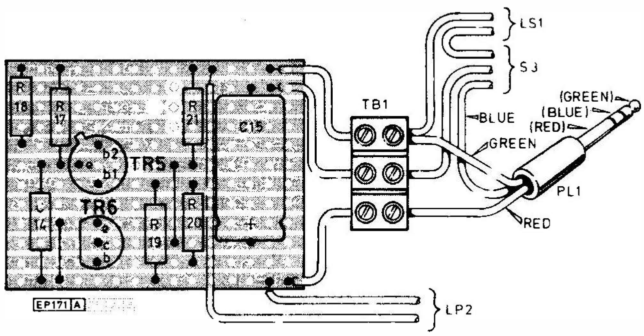
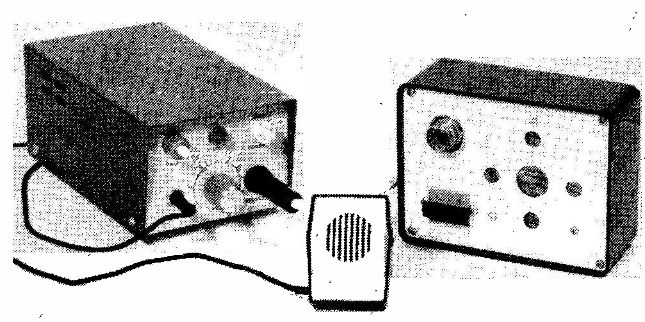


Fig. 5. Veroboard layout of the alarm unit



The complete Babycom system

amplifier on the Veroboard layout.

The prototype alarm unit of the Babycom was housed in a 130 × 100 × 50mm case. The Veroboard layout of the alarm circuit is shown in Fig. 5. After the board has been soldered and checked it should be fitted into the case with the loudspeaker, indicator lamp and switch S3 fitted into the front panel. The alarm unit is joined to the control unit via 3 core cable and PL1. ★

News Briefs

INTELLIGENCE PRINTS BACKWARDS

SOMETHING of a price breakthrough is the Trendcom 100 Intelligent Printer from Personal Computers Ltd. A high performance serial printer capable of 40 char's/sec, the Trendcom 100 has a 96 character set and is controlled by its own internal microprocessor.

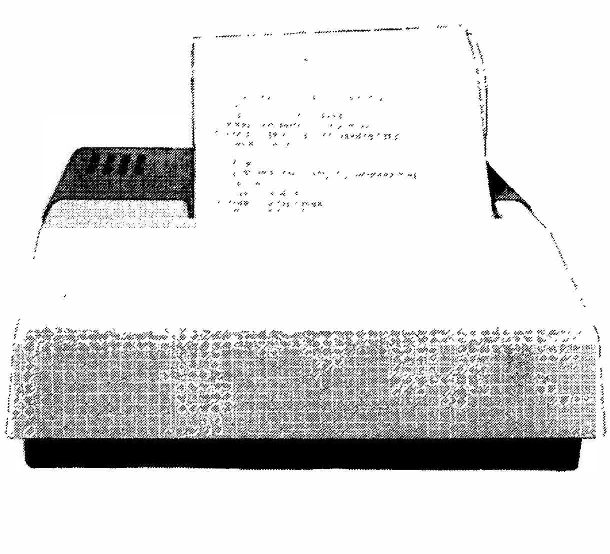
To speed things up, each line of characters is stored ready to be printed, and when summoned, may be printed from left-to-right or right-to-left, so that in effect the print head is quietly zig-zagging its way down the paper (known as bidirectional look-ahead printing).

Print-out is aesthetically pleasing (10 char's/inch) based on a 5×7 dot matrix onto low cost thermal paper. High reliability is inherent with only two d.c. stepping motors to control the print head and paper roller, and everything is powered from its own mains supply.

Interfacing to most microcomputers should be easy with TTL compatible inputs, and interface cards are available for PET, Apple II, TRS80 and RS232 ports. Signals available from Trendcom 100 are $\overline{\text{STROBE}}$ and BUSY. A Test input activates a self test message.

You may have seen printers with this kind of specification before, but here is the difference: Trendcom 100 costs £241.

Personal Computers Ltd., 194–200 Bishopsgate, London, EC2M 4NR.



ONE-CHIP COLOUR TV SYSTEM

MOTOROLA Semiconductors announce a European designed, multi-standard TV colour system, the TDA 3300, Chroma III, one-chip colour system.

This third generation system accepts a colour TV signal in the form of composite video and gives an output ready for application to the c.r.t. cathode, via a simple output stage.

Included on-chip are a number of features which, Motorola believes, will make the TDA 3300 one of the most sophisticated integrated TV systems yet available. Key features of the system are:

User Controls—The device includes a full range of user controls, saturation, contrast and brilliance, which have been designed with a high input impedance, in the order of 1MΩ, and an operating range of 0 to 5V. This makes them compatible with Motorola and other Remote Control systems via a simple RC network.

Beam Limiting—An on-chip beam limiter automatically adjusts the output drive to prevent blooming of the picture detail highlights.

Reference Generation—For simplicity the system uses the easily obtainable 4·43MHz crystal for the reference frequency generation. Further, the 90° phase shift is accomplished on-chip by an unique self correcting circuit which will keep phase errors down to a minimum.

Automatic Black Level Setup—By sampling the c.r.t. cathode current the system is able to adjust dynamically the tube black level throughout its life, thus eliminating three complex adjustments during the set manufacture.

Full Multi-standard Capability is available as PAL and NTSC, the latter being aimed at the video recorder user. However, this is extended to SECAM with the soon to be announced TDA 3030 SECAM decoder.

On-Screen-Display—In order to take full advantage of the range of facilities available to the current and coming generation of TV sets, Teletext, games, camera, etc., the TDA 3300 includes on-chip, RGB on-screen-display inputs and the associated fast blanking inputs.

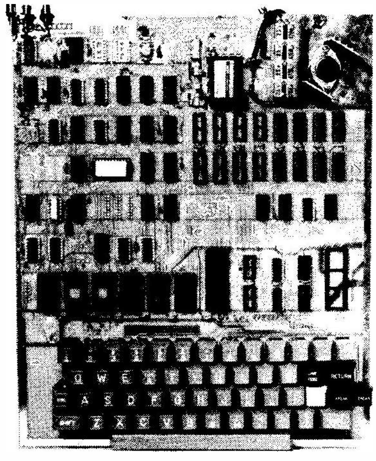
In spite of all these facilities the TDA 3300 requires a single 12V power supply and has low current drain of 50mA.

POINTS ARISING

AUTORANGING MULTIMETER
(April-May 1979)
The diodes D2 and D3 (BAV 47) may be replaced by BAV 45s which are available from **Ace Mailtronix Ltd. Tootal Street, Wakefield, West Yorkshire.**

CONSTANT DISPLAY FREQUENCY METER
(August 1978)
A link should be made between the centre pin of IC17 and C4—ve.

COMPUKIT UK 101
SINGLE BOARD COMPUTER



PART 4 A.A.BERK B.Sc. Ph.D.

CONCLUSION OF SERIES

AS INDICATED in the previous articles, the Compukit is hardware expandable in many ways. Expansions to the machine are in the process of being produced and include a Colour Graphics Board, and a large memory board which will bring the machine nearer to its maximum addressing ability in RAM and EPROM/ROM. By the time this article appears, these boards should be available.

Software expansions include a sophisticated Machine Code Monitor, disassembler and assembler which is included with the machine. Many programs, including games, already exist and it is hoped that others will become available in the near future from those software houses which have shown interest in the machine.

The hobbyist who wishes to expand the hardware of the machine himself may be interested in two useful and important methods of doing so. These are described below. Firstly, it is essential to bear in mind a picture of the machine's memory map:

When expanding the system or adding I/O ports, certain addresses are used for specific functions and must not be overlapped. It is also important to allow for future expansions by keeping clear of memory space which may eventually house extra RAM. In general, later expansion boards will add memory consecutively with the 8K of on-board RAM, so that the BASIC interpreter will find it during the usual memory test when C is pressed after Reset.

To decide on suitable addresses, the Address Map shown in Table 4.1 should be consulted. The addresses given are in hexadecimal notation and, as can be seen, BASIC workspace can be as large as 40,191 bytes (0300 to 9FFF) before overlapping with the BASIC ROMs. There is plenty of space from C000 to CFFF (4096 bytes), and from D400 up to F7FF, apart from the keyboard and ACIA. It is in this last portion that parallel or serial I/O ports can be neatly added with less danger of interfering with later additions.

Table 4.1. Memory map.

Address	Function
0130	NMI vector
01C0	IRQ vector
0000–02FF	Scratchpad RAM for operating system
0300	Start of BASIC workspace
1FFF	End of on-board RAM (8K)
A000–BFFF	BASIC interpreter
D000–D3FF	Video RAM
DF00	Polled keyboard
F000, F001	ACIA serial port
F800–FFFF	MONITOR ROM

In order to expand the Compukit, therefore, a certain amount of address decoding is necessary to locate any peripherals at the right place in the machine's memory. There are two main ways in which this may be achieved. The top 1K of the 8K of RAM (ICs 38 and 52) may be left unused and its address decoded output (RS7) supplied to the expansion as an $\overline{\text{ENABLE}}$ signal. A more general method is to add an expansion board to the system containing its own address decoding. Both of these are described.

PARALLEL I/O PORTS

Suppose we wish to add 16 I/O ports to the machine in the most straightforward manner possible for some control purpose. A 6820 or 6821 (with greater drive) is most suitable for the job. This chip is the famous PIA or Peripheral Interface Adapter containing a number of I/O drivers and latches as well as several control lines.

A couple of d.i.l. plugs will allow the circuit in Fig. 4.1 to be connected to the Compukit with minimum effort to control almost anything. The circuit shown includes some lights and switches—just imagine the l.e.d.s to be relays and the switches to be sensors of some kind.

To use Fig. 4.1 and appreciate the circuit's full potential, the data sheet for the device must be obtained and studied. This is a very useful chip and each of its sixteen I/O lines (PB0-PB7 and PA0-PA7) may act as either input or output. There are four external control lines for various purposes (CB1, CB2, CA1, CA2), and interrupts, via IRQ, may be generated by external devices. In order to use the chip, which looks life four memory locations (here decoded as 1C00, 1, 2, 3) internal registers must be set to a pattern of bits which informs the device of those lines which are to be inputs, and which are outputs. Data to be written to outputs is sent to the appropriate location within the PIA which subsequently clocks it through to the output latches. Similarly, incoming information is stored in a register and may be retrieved by reading the correct memory location in the PIA at the program's convenience. The Interrupt structure may be used to force the MPU to "look" at the PIA when an external device sends its information through.

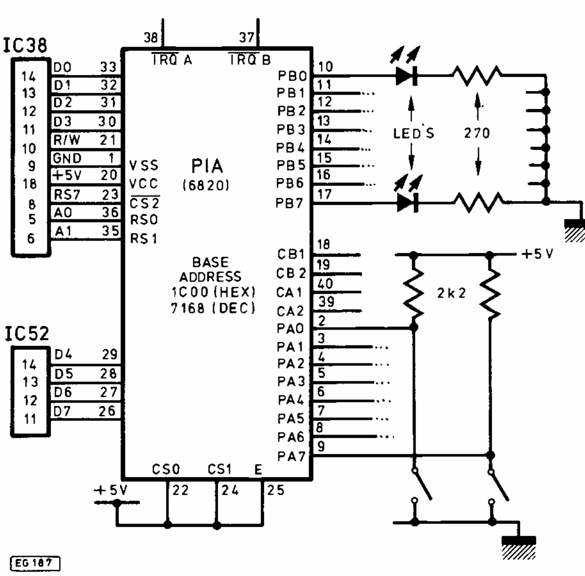


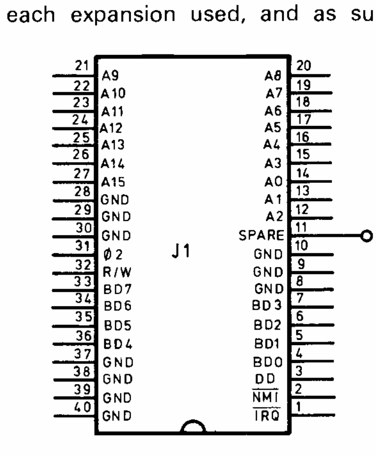
Fig. 4.1. Switches and lamps interface

An interesting feature of such a device is that the time taken to change an input line to an output is similar to the instruction speed of the MPU system driving it. This allows the possibility of swopping between input and output very fast to make any given line (or lines) appear to the operator as if it is performing both functions simultaneously. Handshaking between microcomputers can be arranged in this way, and parallel processing by a set of machines may be envisaged.

The interface in Fig. 4.1 may, of course, be adapted to run many other devices including UARTs, USARTs or just tristate buffers and TTL latches. In fact, by using the lower ten address lines from IC38 and IC52, any 1K (or less) memory mapped device may be attached to the Compukit. So far, the author has successfully driven the PE VDU and the coming EPROM Programmer. The advantages of using BASIC to control these devices are enormous. Tasks which appear most daunting when a machine code microcomputer is used, become almost trivial in the high level language.

Several extra terminals may be added to the basic machine in this way, adding considerably to the system's viability in small business applications.

However, the above expansion method, though quick and easy to implement, does tie up 1K of on-board RAM for each expansion used, and as such may be regarded as



DD	DATA-BUS DIRECTION
0	MPU READS FROM EXTERNAL DEVICES
1	MPU WRITES FROM EXTERNAL DEVICES

Fig. 4.2. Expansion connector

wasteful in the long run. This should lead the user to attach his peripherals to the machine via the 40-pin d.i.l. socket J1. The specifications for this socket are given in Fig. 4.2. All bus lines are brought out to the socket, and they allow external memory mapped devices to communicate with the MPU directly. The BD lines are buffered data lines, with direction controlled by the DD signal which selects Read or Write through ICs 6 and 7 as shown in Fig. 4.2.

All sixteen address lines are present, as is R/W, IRQ, NMI and Ø2. For correct memory timing this last signal should be fed to an *active high* enable line from all external devices. There is also one spare line not connected to anything, but brought out to a pad next to the socket. The rest of the pins are Ground connections.

To use this socket, each external device must generate its own address decoding, the details of which depend upon the amount of memory each expansion takes up. Any such device should occupy a unique address position and hence each address line must be involved in its "fetching".

For devices taking up 8 bytes of memory, for instance, Fig. 4.3 gives a straightforward method of decoding. Here, the 8 bytes are arranged to lie at F400 to F407.

This particular circuit is, of course, purely a functional *suggestion* to highlight the fact that NAND gates decode 1's and NOR gates decode 0's, and that all address lines play some part in decoding the base address of F400.

Thus, small memory requirements are easily catered for using the simplest logic devices. It is usually a good idea to use CMOS or LS i.c.s to reduce bus loading.

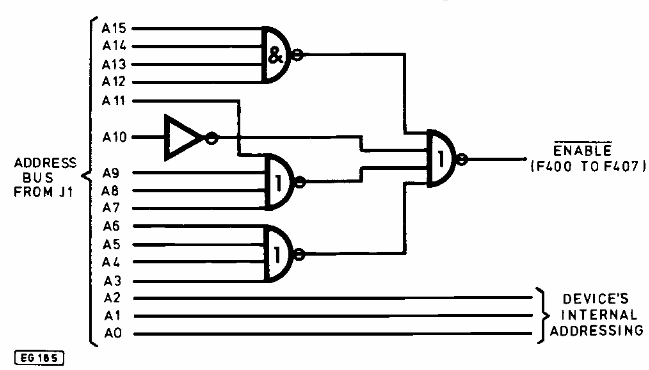


Fig. 4.3. Address decoder for 8 bytes

For large memory requirements, the n to 2^n line decoders such as 74LS138,9 and 74154 are extremely useful. A 24K memory board, for instance, will need its own internal page-select logic to enable different banks of memory i.c.s, just as the Compukit itself does, via some of the above decoders.

For general hardware control purposes, the Compukit may be operated in either BASIC or machine code. The latter can be considerably faster as it deals fundamentally with *electrical* steps. From BASIC, an I/O port can be controlled by the WAIT statement or using PEEK and POKE. This has the advantage of extreme ease of programming. Imagine controlling a home-security system. The program could continually PEEK a number of I/O ports (PIA perhaps) connected to remote sensors. When a change occurs, an IF statement would decide whether to act, and a few subroutines would decide which action to take. Some other sensors could be PEEKed nearby and, in a short time, an alarm could be sounded or a stream of appropriate invective produced via a speech synthesis unit!

Extremely complex programs with feedback and analysis could be constructed using the powerful BASIC involved, which, though not as fast as machine code, would act many orders faster than any human activity involved.

The speed problem becomes important, for example, in controlling high speed machines or processes. Then, a hybrid program using the USR function could swop back and forth between BASIC and machine code for *instant* response to requirements.

As the IRQ and NMI interrupts are fully available to the user, an even more sophisticated system is possible whereby the external process takes control of the computer, when needed, via an interrupt.

The potential is exciting and to some extent already being exploited. Anyone interested could do worse than construct an "l.e.d. and Switch" I/O expansion as in Fig. 4.1 and learn to use it! The next step would be to add a D/A or A/D converter and learn to control and receive analogue data in real time.

SPECIAL KEYBOARD FUNCTIONS

Referring to the keyboard matrix circuit diagram and hardware description, it has already been stated that the keyboard is polled in software for key closures except during program execution (unless waiting for an INPUT).

There are two important routines associated with the polling sequence. One determines which key has been pressed, and the other is a routine for detecting CONTROL C. The latter is not in general disabled during program execution, and may be used to BREAK a program for examining variables, etc. The routine involved may, however, be disabled or enabled by the user via the following statements:

POKE 530,1 disables
POKE 530,0 enables

The first of these may be placed before a part of the program whose execution it is important not to be able to interrupt. If the second statement is placed at the end of the protected region, then CONTROL C will never intrude on that region if pressed.

Table 4.2.

COLUMN	ROW	CA/RA
C0	R0	254
C1	R1	253
C2	R2	251
C3	R3	247
C4	R4	239
C5	R5	223
C6	R6	191
C7	R7	127

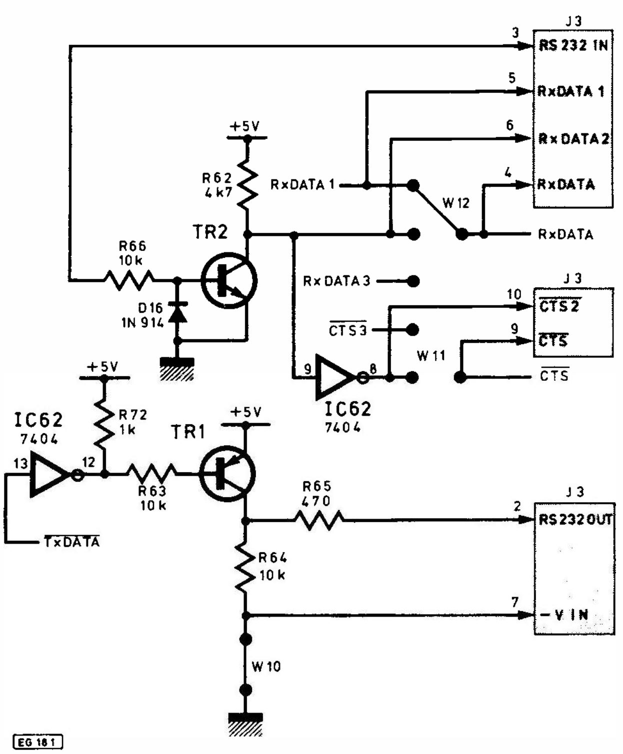
The keyboard matrix may be used in special applications during the execution of a program, by treating it as an ordinary read/write memory location (57088 decimal or DF00 hexadecimal). To do this, it is often important to disable the CONTROL C routine to prevent it from interfering.

An example of the keyboard's use for special functions could be to allow the keys to be reprogrammed to return graphics characters. A program would be written to allow, say, all the "block" characters to be called from a section of the keyboard when SHIFT LOCK is up.

To perform any special programming of the keyboard, the following statements are used:

POKE 57088, RA
IF PEEK(57088) = CA THEN (statement)

RA is the *address* of the row being tested for key-closures according to Table 4.2. This POKE statement may be thought of as "setting" the appropriate row to the "on" condition. CA, column address, is the value which location 57088 takes on when a key in the row RA is pressed. Thus if 57088 is POKEd to have value 254, and 57088 is then read (via PEEK) and found to have value 254 then the program knows that SHIFT LOCK is down (see the keyboard matrix diagram).



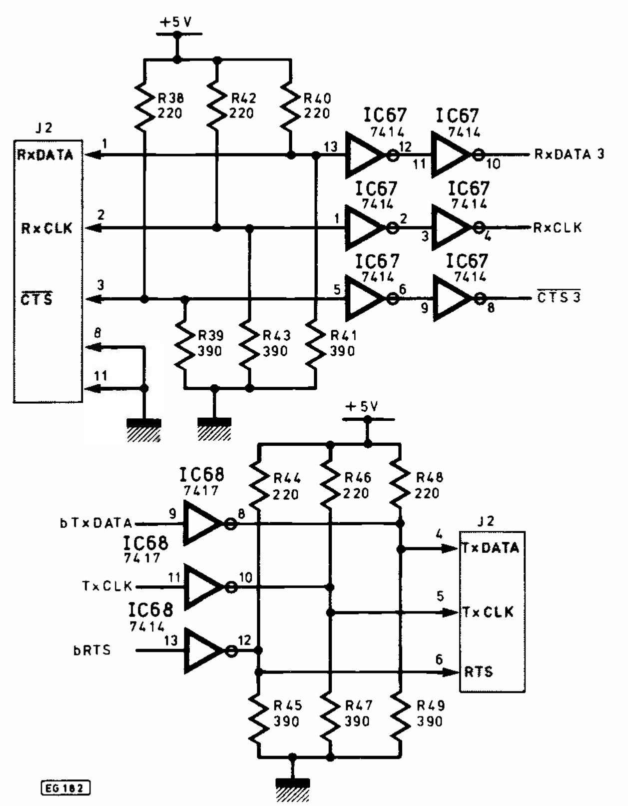


Fig. 4.4. (left) Asynchronous I/O and RS232. (right) Serial data buffers

The following program changes the keys 1 to 7 to graphic characters when SHIFT LOCK is up. When down, the words SHIFT LOCK roll up the screen until SHIFT LOCK is pressed. Then the keys 1 to 7 are active and each gives a different character until 7 is pressed when the program terminates.

```
10 POKE 530,1
20 POKE 57088,254
30 IF PEEK(57088) = 254 THEN PRINT "SHIFT-
LOCK DOWN": GOTO 20
40 POKE 57088,127
50 IF PEEK(57088)=255 THEN 40
60 PRINT CHR$( PEEK(57088) );
70 IF PEEK(57088)=253 THEN END
80 GOTO 10
```

The program, though rather simple, is meant to illustrate how information can be gathered from the keyboard and used to control execution. Note that in line 50 the keyboard location is assumed to have value 255 unless a key is pressed, as R1–R8 pull up the inputs to IC4 and IC5 and force them to "see" 1's until an active key is pressed.

The applications of the above are manifold, not least in the execution of games or simulation exercises; two areas which in many ways are very similar!

In order to use this keyboard polling easily, it is a good idea to label the keyboard matrix diagram, published in Part 1, with the CA and RA addresses corresponding to the columns and rows. For instance, C0 and R0 should be labelled 254, C1 and R1 253, etc.

This concludes the description of the Compukit UK 101. By the time this article appears, many readers will have had the opportunity of operating the basic machine. The applications are enormous and stretch across the full gamut of endeavour. It is hoped that through the pages of *Practical Electronics*, future developments can be described as they occur and thus keep readers up to date with a machine considered to be ahead of its time.

It only remains for us to wish you all good luck with the project. ★

COMPUKIT CIRCUIT DIAGRAMS

Fig. No.	
2	Block diagram
3	Keyboard matrix and interface
4	Power supply
2·1	Component layout
2·2	VDU interface
2·3	Cassette interface
2·4	The uP and expansion socket
2·5	Clocks
3·1	BASIC ROMs
3·2	Monitor ROM
3·4	8K RAM
3·5	Address decoding
4·2	J1 pin-outs
4·4	Serial interface

MORE!
Next month we will publish Part 1 of an EPROM programmer designed to plug into Compukit—it will also function with other computers. We also expect to be able to publish another exciting computer peripheral in the near future—we do not believe this has previously been published as a hobby design—more details in future issues.

Countdown

Satellite Communications (conference)—Oct. 30, 31, London Press Centre. Will "tele conferencing" replace business travel? Who will finance this expanding technology, and how should outer space be shared between the nations? Details Online Conferences Ltd. ✆ Uxbridge (0895) 39262.
Personal Computer World Show—Nov. 1–3, West Centre Hotel, London.
Compec—Nov. 6–8. Grand Hall, Olympia, London. Details: Iliffe Promotions Ltd. ✆ 01-261 8437/8.
Professional Viewdata Exhibition '79—Nov. 7 & 8. West Centre Hotel, London.
Technical Innovation In The Service Of The Elderly and Disabled—Markets And Needs (symposium)—Nov. 19–21. Berlin. Details: H. S. Wolff, Clinical Research Centre, Watford Road, Harrow, Middlesex.
Integrated Telecommunications For The 80s—Nov. 20, 21. Carlton Tower, London. Details: Online.
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.
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.
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, London. ✆ 0799-22612.
The Mersey Micro Show—April 30, May 1, 2, 1980. Adelphi Hotel, Liverpool. Exhibition and seminars, with the co-operation 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.

INTRODUCTION of the slide dissolve unit has been a most exciting development for the enthusiast in colour slide photography. Two projectors are used with the slides stored alternately in each and smooth dissolves from one picture to the next are made by dimming one bulb whilst brightening the other. Not only does this technique stop that annoying sudden darkness between slides but it also gives a new freedom to the photographer to produce creative sequences of images which suit the changing moods of an accompanying soundtrack. Photographic clubs all over the world have established specialist groups for audio-visual work and some outstanding work has been shown at exhibitions and competitions.

But not all work has to be at this level; even the most ordinary collection of holiday snapshots will benefit from the professional touch given by pictures which automatically dissolve from one to the next in synchronism with a recording of music or commentary. Equipment to operate two projectors and to record the control and soundtrack signals on tape is available commercially but a basic unit will cost over £150 and advanced systems can cost far more.

This series of articles describes a dissolve control unit which is easy to build and adjust yet costs in the region of £40 to make putting it well within the reach of many amateur photographers. Cross-fading between the two projectors is controlled by a knob which allows the user to fade at any speed to suit the mood of the occasion. To change the slide a single button is pressed which automatically changes the slide in the dark projector—very useful in the heat of the moment when it is all too easy to press the wrong button and upset the whole sequence. Two additional buttons provide "twinkle" (rapid switching between two projectors) and automatic superimposition of two images—features not always found on commercial machines. Operation of the controls produces an audio signal which can be recorded on one track of any domestic cassette or reel-to-reel tape recorder and subsequently replayed to reproduce exactly the sequence of fades and changes that were originally recorded.

The control is designed to handle two remote-control projectors having 24V 150W lamps although it is easily modified to handle 250 watt lamps. Each projector needs a simple modification to interrupt the wires carrying current to the bulb and to bring them out at a socket for connection to the control box. Additional connections to each projector operate the slide change mechanism and provide the power to drive the electronics so that no separate connection to the mains is needed.

PE

DIAMATIC

Programmable Audio Visual Unit

J.R.W. AMES

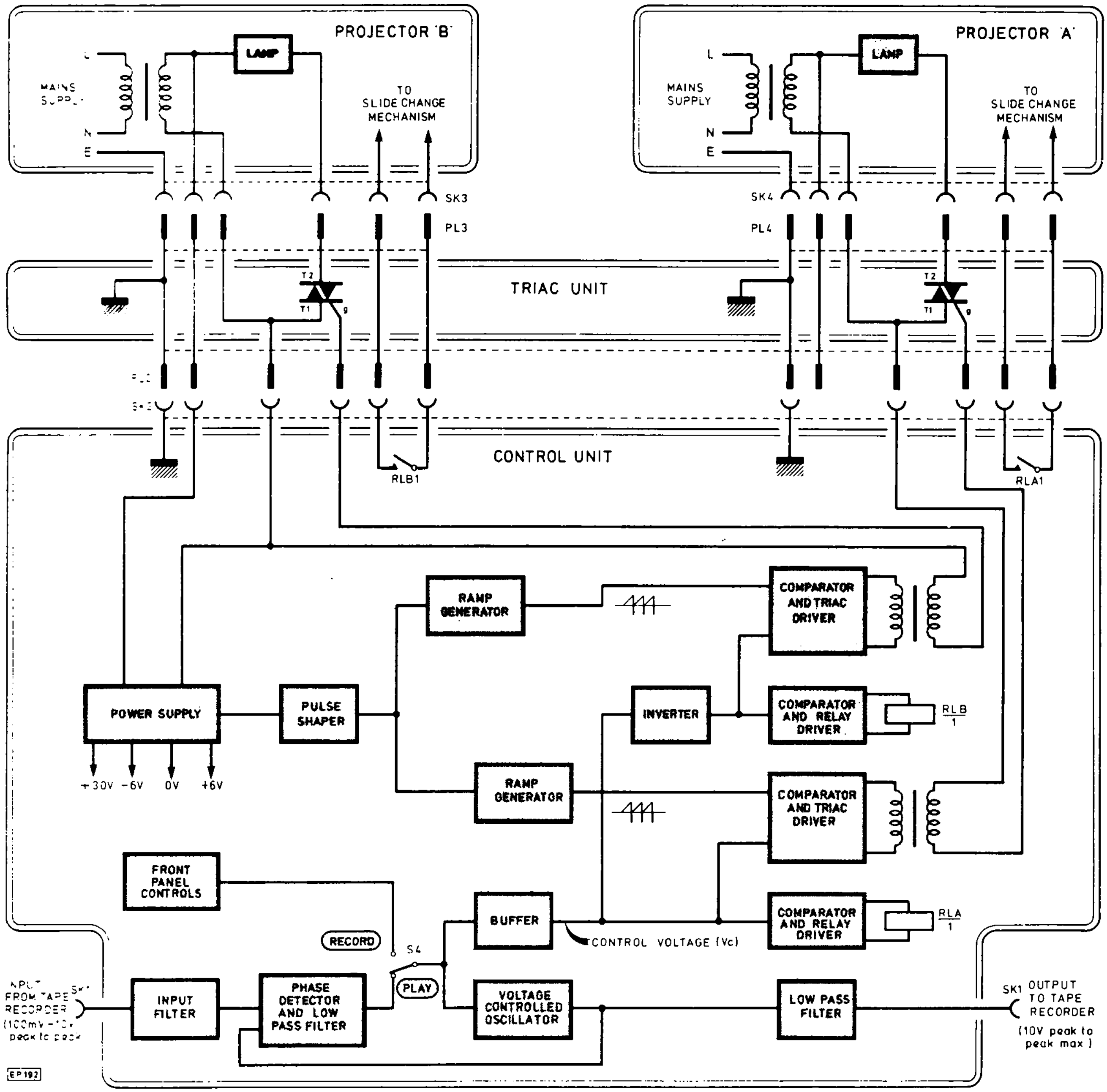


Fig. 1. Block diagram

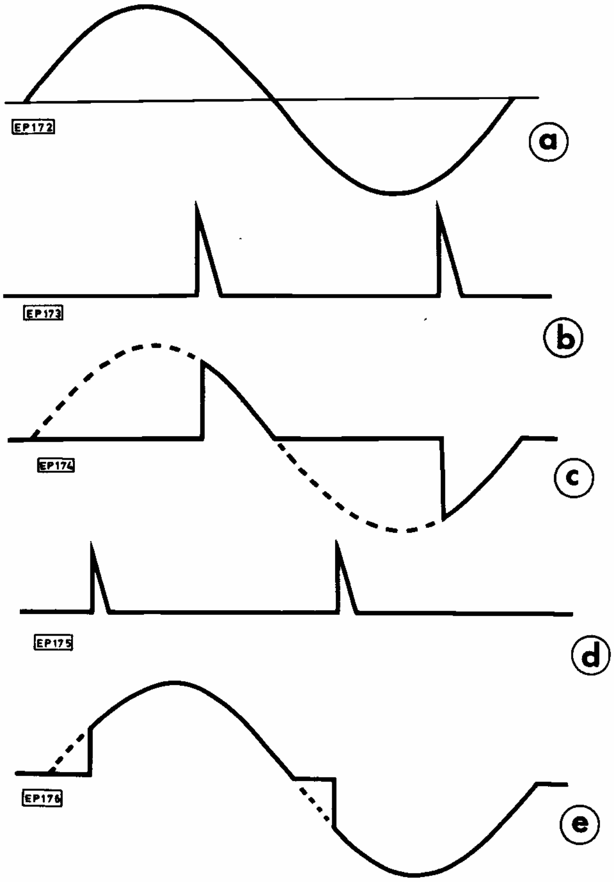


Fig. 2. (a) Mains input (b) late trigger pulses (c) small voltage across load (d) early trigger pulses (e) large voltage across load

BRIGHTNESS CONTROL

A triac is used to control the brightness of each projector lamp. When the device is connected in series with a circuit it behaves like a switch which is turned on by the brief application of a pulse to its trigger contact. Provided that the current through the triac stays above a certain sustaining level it will remain conducting, but it will turn off as soon as the current falls below this critical level. These features make the triac a useful device for regulating the power applied to a load which is driven from an alternating current supply.

The block diagram of the unit (Fig. 1) shows that a triac is connected in series with the lamp circuit of each projector and Fig. 2 shows how the circuit works. In (c) the triac is turned on late in every half cycle and turns off automatically as the alternating current reverses in direction producing a small average voltage across the lamp. More light is produced in (e) where the triac conducts for the larger part of each half cycle causing almost the full rated current to flow in the lamp. Trigger pulses are applied to each triac via a pulse transformer which isolates the driving electronics from the alternating voltage applied to the load.

In order to exercise precise control over the current flowing in the lamp we need to be able to vary the position of the trigger pulses within each mains half-cycle smoothly and accurately.

SAWTOOTH

As the block diagram shows a 100Hz sawtooth signal derived from the full-wave rectified mains frequency is compared in a high gain comparator circuit with a d.c. control voltage, producing the results shown in Fig. 3. Increasing the control voltage (b) causes the comparator positive-going transition (c) to occur later and later in the mains half-cycle. This transition is differentiated to form the triac trigger pulse so the triac conducts for a shorter period and the average current in the load therefore decreases. Finally the control voltage exceeds the peak of the sawtooth, no trigger pulses are produced, and the light remains off.

As the control voltage is reduced (d) the trigger pulse occurs earlier in each half-cycle so increasing the lamp brightness. Notice the negative-going pulses that are added to the sawtooth at the end of each period. If these pulses are not added to the sawtooth no trigger pulses are produced when the control voltage falls below the lowest point of the waveform and the lamp abruptly changes from full-on to off. With the pulses added the control voltage can fall well below the base of the sawtooth while still producing a narrow trigger pulse at the beginning of each half-cycle to keep the lamp on.

The control voltage is connected directly to one comparator (projector A) and to the second via an inverter (projector B). As the input voltage to comparator A rises the input to comparator B falls and vice-versa producing a smooth cross-fade (dissolve) between the two projectors.

SLIDE CHANGE

The slide in a projector is only changed when its lamp is dark. At this time the control voltage for that projector is very close to the peak of the sawtooth and slide change is

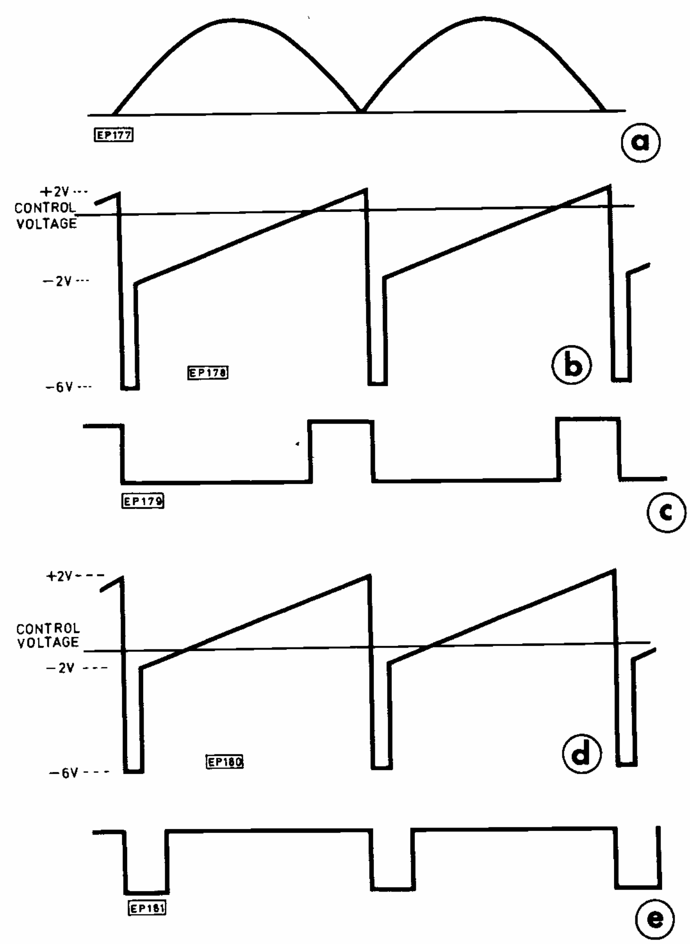


Fig. 3. Comparator waveforms (a) full wave rectified signal (b) sawtooth (c) comparator output (dim) (d) sawtooth (e) comparator output (bright)

initiated by momentarily increasing the voltage to cross a further threshold just above the peak level. This momentary increase is detected by the comparator and relay driver (see the block diagram) and the relay operates, closing a pair of contacts which are connected to the projector slide change solenoid in parallel with the normal remote control contacts.

As the control voltage for the dark projector rises to cross the slide change threshold the control voltage for the bright projector falls below the lowest point of its sawtooth comparison signal. If it were not for the negative-going pulses added to the sawtooth (Fig. 3) the bright projector would turn off momentarily each time a slide is changed.

Fig. 4 summarises the relationship between the control voltage levels and the actions of the two projectors.

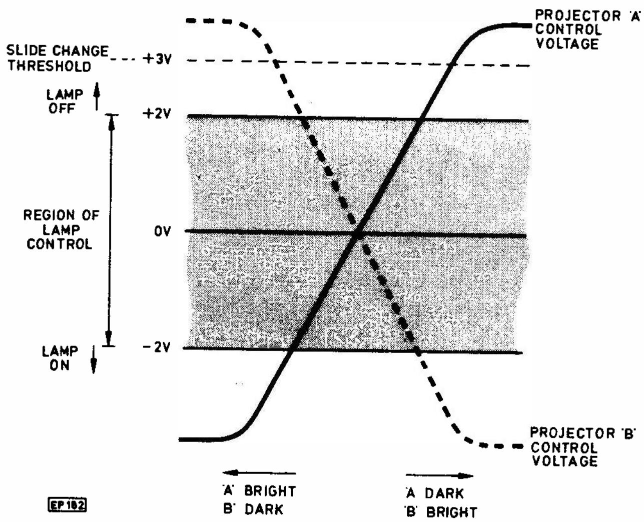


Fig. 4. Control voltage relationship

RECORD AND REPLAY

When recording a sequence of dissolves, switch S4 (Fig. 1) is placed in the "record" position placing the projectors under manual control. The voltage derived from the front panel controls is also used to vary the frequency of a voltage controlled oscillator (VCO) whose output varies in the band 1kHz to 3kHz as the projectors are cross-faded and makes a jump to either 500Hz or 4kHz when the slide in the dark projector is changed. This varying frequency is sent to the tape recorder after filtering to remove unwanted higher harmonics from the square wave signal.

On replay S4 is moved to the "play" position to form a phase-locked loop whose input signal is derived, after buffering, from the tape recorder. The output of the phase detector and low pass filter now copies the control voltage that was derived from the front panel controls during recording and the original sequence of events is reproduced exactly.

A special signal loss detector in the input buffer stage ensures that the projectors behave predictably when the replay signal is lost during tape editing. Both projectors illuminate at half brightness until the signal returns when the sequence continues from where it was interrupted.

CONNECTIONS TO THE PROJECTORS

The electrical connections to the projectors are shown in Fig. 1. A triac is connected in series with the bulb circuit and trigger pulses are applied to the gate via a pulse transformer which isolates the projector circuits from the remainder of the electronics. Currents of up to 7A will flow in the lamp circuit so the connections to the triac must be

made with stout wire and the triac itself must be in firm contact with a good heatsink—more about this in the construction information.

Both sides of the low voltage secondary winding of the mains transformer are brought out from the projector to provide power for the unit so that a separate mains connection to the unit is avoided. The slide change button of each projector remote control is duplicated by a relay contact in the unit which closes momentarily to set the slide change mechanism in motion.

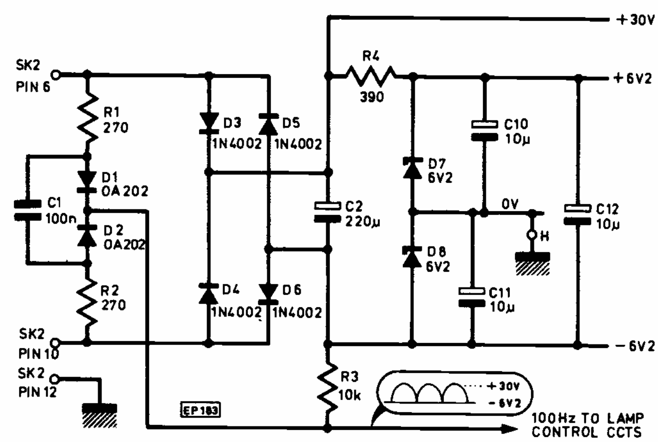


Fig. 5. Power supply

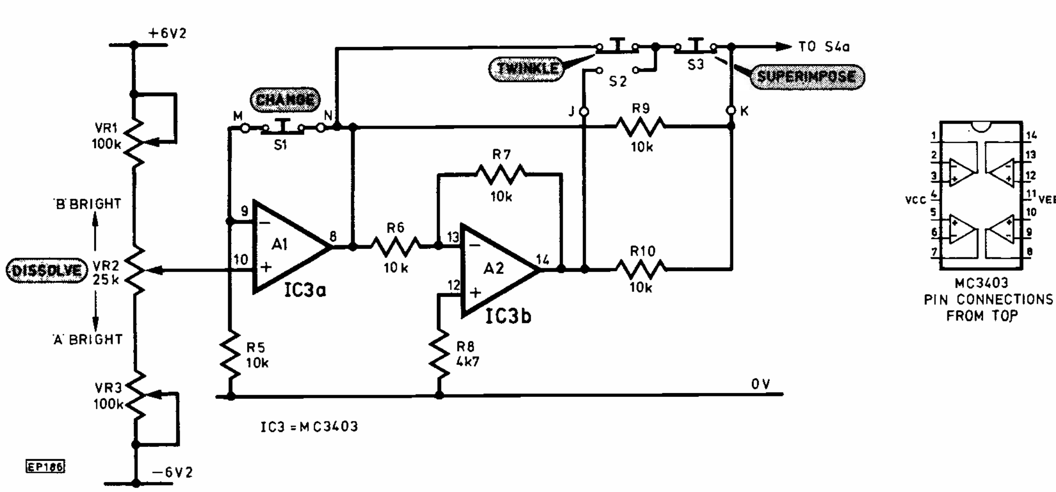
POWER SUPPLY

D3–D6 together with C2 (Fig. 5) form a conventional full-wave bridge rectifier which is fed from the mains transformer of one of the projectors and provides a smoothed output of about 36V. The rectifier output is connected via a dropper resistor to the pair of Zener diodes to generate stabilised supplies of $\pm 6{\cdot}2$V and a 0V rail which power the electronics. The unstabilised output is available to operate the three relays in the unit. A separate unsmoothed full-wave rectified supply to drive the triac trigger control circuits is provided by D1, 2 and R3. R1, 2 and C1 form a low pass filter which prevents transients caused by the switching of the projector triac from disturbing the control circuits.

FRONT PANEL CONTROLS

In Fig. 6 a resistive divider chain derives the voltage to control the brightness of the projector lamps during a cross-fade. VR2, the fader potentiometer, produces a control voltage which varies between limits of approximately ± 2V, set by presets VR1, 3 when making the initial adjustments. Careful selection of VR2 is important. The component specified was chosen because it behaves in a linear fashion immediately the spindle moves away from either end stop.

Fig. 6. Circuitry associated with front panel controls



Many potentiometers that were tested (both carbon track and wire-wound) showed little or no change in resistance during the first 20°–30° of rotation giving an unpleasant feel to the control as no change in lamp brightness occurred over this range.

Amplifier A1 serves a dual purpose. S1 is normally closed making A1 a non-inverting high impedance buffer but when S1 is opened it becomes a comparator with threshold at 0V and its output then jumps to the supply rail towards which it is already offset. When VR2 is at either end of its range one of the projectors is dark and operation of S1 causes the control voltage to cross the slide-change threshold (set at about +3V) for this projector. In this way the dark slide is automatically selected for change and only one change button is needed.

A1 is one of four operational amplifiers with internal compensation that are housed in a single package—the MC3403. The amplifiers in this package have sufficient slewing rate to give full output for signals of up to 4kHz and they are used in this unit wherever an amplifier or comparator is needed. In all eleven amplifiers are used so three MC3403 packages are required. Because of the relatively low accuracy required of the d.c. amplifiers in this circuit it has not been necessary to use more expensive amplifiers with very high input impedance and low offset currents.

From A1 the output is normally connected via S2 to the lamp control and recording circuit at the record/replay switch. When S2 is operated, however, an inverted version of the control voltage (derived by A2, R6, 7, 8) is produced, inverting the states of the projectors to produce a "twinkle" effect. Operation of S2 allows rapid alternation between two slides and can be used to produce an animation effect.

S3, the superimpose button, breaks the output from S2 allowing R9, 10 to sum the control voltage (from A1) and its inverse (from A2). The opposing voltages add to give 0V making both of the projectors light up equally and superimposing their images on the screen. R9, 10 also make sure that the control voltage waits respectably at 0V during changeover if S2 is of the break-before-make variety.

INTERFACE TO RECORDER

With S4 in the "record" position (Fig. 7) the control voltage derived from Fig. 6 is connected to the buffer, A5, and then to an inverter formed by A6, R22–24. The resulting pair of voltages, one of which is the inverse of the other, is used to control the two projectors, A and B.

While making a recording the control voltage is also connected to the input of a voltage controlled oscillator (VCO) which is part of IC1, an integrated phase-locked-loop circuit type MC14046. As the voltage changes the frequency

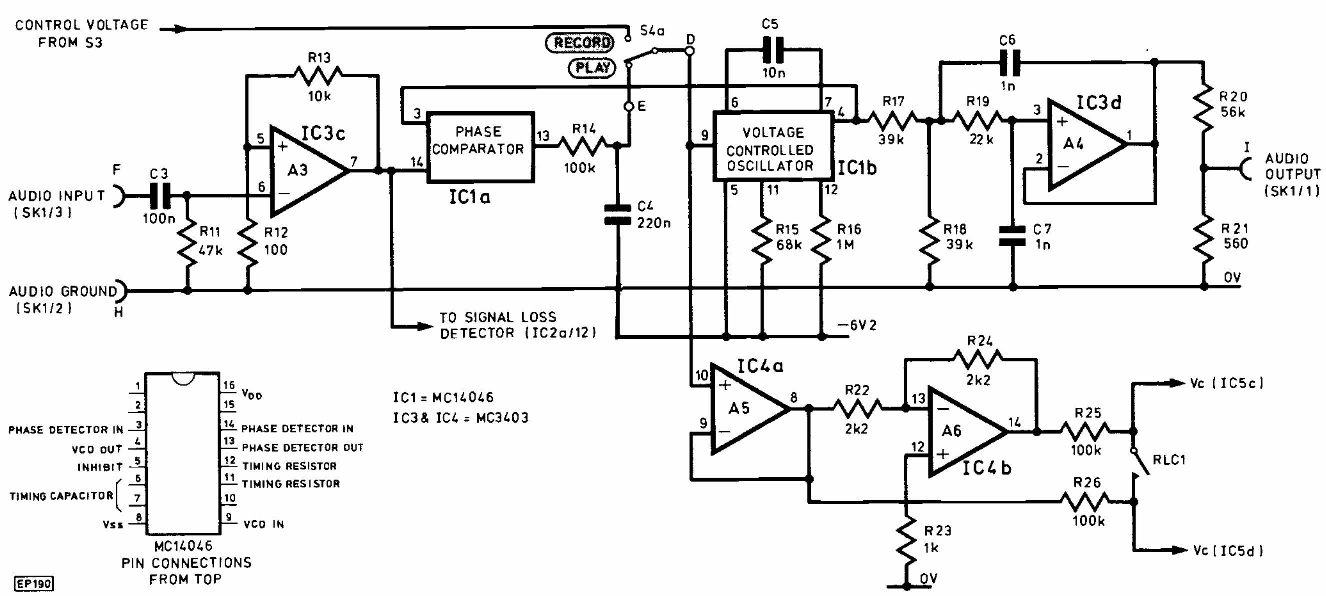


Fig. 7. Record/Replay circuits

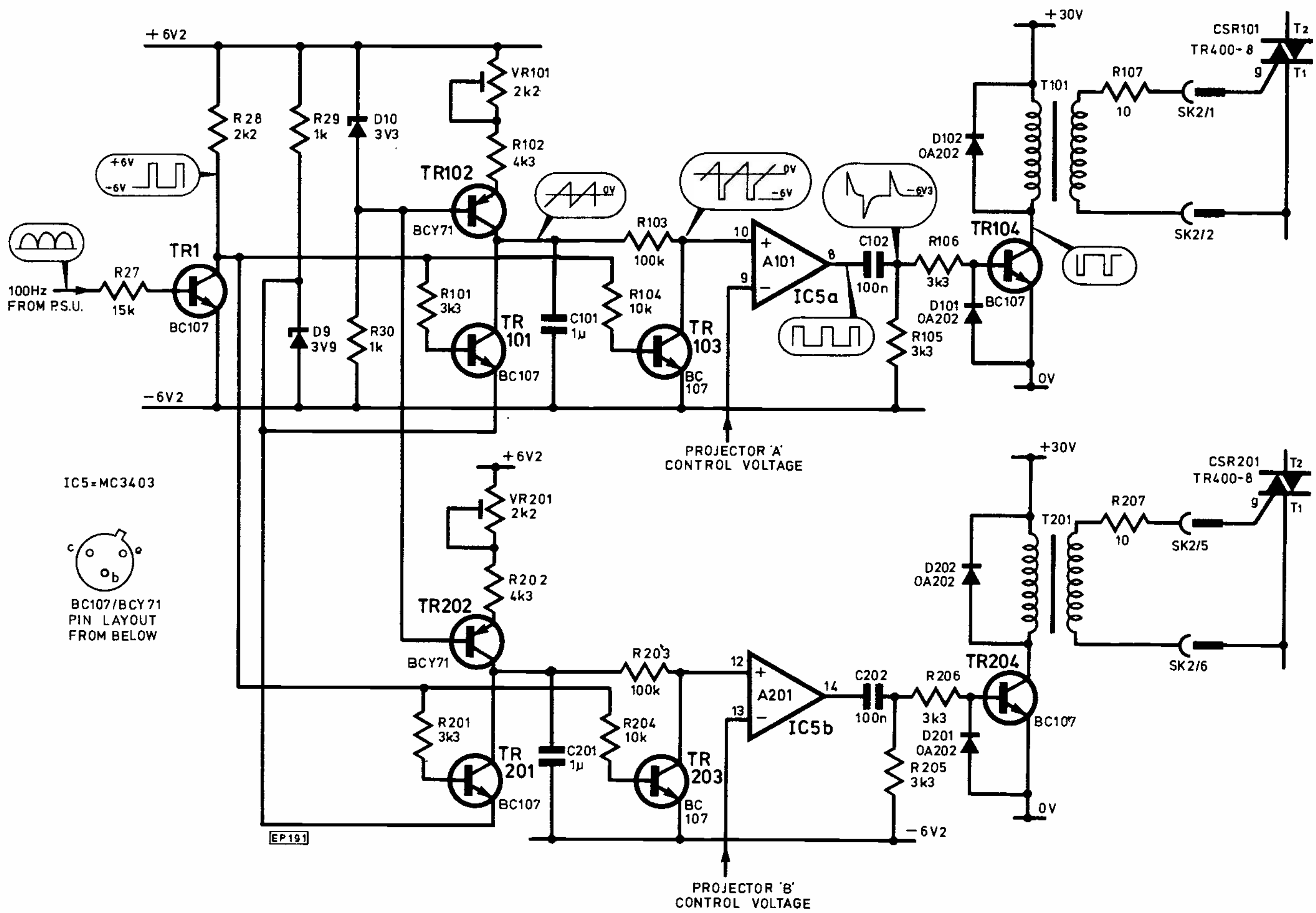


Fig. 8. Lamp control circuits

of the oscillator varies between 500Hz and 4kHz. This varying frequency is filtered by a second order low pass Sallen and Key filter (A4, R17-19, C6, 7) whose break point is set at 4kHz to remove undesirable higher harmonics from the square wave output of the VCO. The filtered tone, whose amplitude is approximately 10V peak-to-peak, is attenuated by R20, 21 before being connected to the input of the tape recorder. The values given for the attenuator resistors result in an output signal of 100mV peak-to-peak but the constructor can choose any suitable value by varying the resistor ratio.

On replay the output from the tape recorder is buffered and amplified by A3. This ampifier has hysteresis (determined by R12, 13) of ±50mV to ensure that no residual noise at the input is recognised as a false signal when the input is removed. If a very large input signal is available the hysteresis can be increased to give added protection by increasing R12. Reducing the hysteresis is not recommended and the input sensitivity of the unit is therefore determined by this figure. Input impedance of the amplifier is 47k fixed by R11.

The buffered tone is fed to one input of the phase comparator (also part of IC1), the other input of which has the VCO output signal applied to it.

With S4 in the "play" position a phase locked loop is formed using R14/C4 as the low pass filter with the result that the VCO locks exactly to the frequency of the input tone. The VCO, however, is the one that was initially used to make the recording so when its frequency corresponds with that of the incoming tone the voltage at its input is exactly equal to the control voltage that was originally applied. The recovered voltage is connected to A5 and used to control the projectors as described above.

If the received signal is lost, or if the unit is switched to "play" before the tape recorder is started, the output of the phase comparator will drop to −6V. A control voltage of this value will turn one projector full on and the other off as well as changing its slide. To avoid this problem a loss of signal detector (described later) monitors the output of A3 and operates RLC if the signal is lost during replay. Contact RLC1 adds together the opposing voltages generated by A5, 6 producing an output to both projector brightness controllers of about 0V which turns both projectors half on—a useful feature when initially aligning their images on the screen.

LAMP CONTROL CIRCUITS

Apart from common bias components this part of the circuit (Fig. 8) is split into two identical parts, one for each projector. To avoid repetition only the components for one half will be mentioned which are numbered 101 upwards. Components for the other half are numbered 201 upwards with the same second and third digits.

The unsmoothed rectified mains voltage from the power supply circuit is used to saturate TR1, allowing it to turn off only during the short periods when the signal is close to −6·2V. As a result narrow positive-going spikes occur at the collector coincident with the zero-crossings of the a.c. mains waveform.

COMPONENTS . . .

Resistors

R1	270
R2	270
R3	10k
R4	390 5W
R5	10k
R6	10k
R7	10k
R8	4k7
R9	10k
R10	10k
R11	47k
R12	100
R13	10k
R14	100k
R15	68k
R16	1M
R17	39k
R18	39k
R19	22k
R20	56k
R21	560
R22	2k2
R23	1k
R24	2k2
R25	100k
R26	100k
R27	15k
R28	2k2
R29	1k
R30	1k
R31	3k3
R32	10k
R33	150k
R34	100k
R35	100k
R36	100k
R37	100k
R38	10k
R101, 201	3k3
R102, 202	4k3
R103, 203	100k
R104, 204	10k
R105, 205	3k3
R106, 206	3k3
R107, 207	10
R108, 208	10k

Resistors all $\frac{1}{4}$W except where stated.

Semiconductors

IC1	MC14046 Phase locked loop
IC2	MC14528 Dual re-triggerable monostable
IC3	MC3403 Quad op-amp
IC4	MC3403 Quad op-amp
IC5	MC3403 Quad op-amp
TR1	BC107
TR2	BC107
TR101, 201	BC107
TR102, 202	BCY71
TR103, 203	BC107
TR104, 204	BC107
TR105, 205	BC107
D1	OA202
D2	OA202
D3	1N4002
D4	1N4002
D5	1N4002
D6	1N4002
D101, 201	OA202
D102, 202	OA202
D103, 203	OA202
D7	6·2V 1·3W BZX85 series
D8	6·2V 1·3W BZX85 series
D9	3·9V 400mW BZY88 series
D10	3·3V 400mW BZY88 series
D11	OA202
CSR101, 201	TR1 400-8 (R/S 261–801)

For 250W lamp use 2N5574 (R/S 261–558)—stud mounting

Relays

RLA	Single pole make 24V 740
RLB	Single pole make 24V 740
RLC	Single pole make 30V 3k

Potentiometers

VR1	100k	Cermet skeleton preset
VR2	25k	Linear wirewound
VR3	100k	Cermet skeleton preset
VR101, 201	2k2	Cermet skeleton preset

Capacitors

C1	0·1µ 250V Polyester
C2	220µ 63V Electrolytic
C3	0·1µ 250V Polyester
C4	0·22µ 250V Polyester
C5	10n 250V Polystyrene
C6	1n 160 V Polystyrene
C7	1n 160V Polystyrene
C8	0·1µ 250V Polyester
C9	10µ 25V Tantalum
C10	10µ 25V Tantalum
C11	10µ 25V Tantalum
C12	10µ 25V Tantalum
C101, 201	1µ 100V Polycarbonate
C102, 202	0·1µ 250V Polyester

Switches

S1	Single pole push to break
S2	Single pole push to changeover
S3	Single pole push to break
S4	2 pole changeover toggle

Plugs and Sockets

PL1	5 pin DIN
PL2	15 way D-type
PL3	15 way D-type
PL4	15 way D-type
SK1	5 pin DIN
SK2	15 way D-type
SK3	15 way D-type
SK4	15 way D-type

Covers for PL2, 3, 4
Shorting links
(2 off 15 way D-type)

Transformers

T101, 201 Transformer assembly

Core	FX2238 (Mullard) 2 off per assembly
Bobbin	DT2281 (Mullard) 1 off per assembly
Ring	DT2356 (Mullard) 1 off per assembly
Clip	DT2357 (Mullard) 4 off per assembly
Board	DT2359 (Mullard) 1 off per assembly

28 swg enamelled copper wire
36 swg enamelled copper wire

Miscellaneous

Control box	220mm x 156mm x 100mm (R.S. 509-276)
Triac housing	Aluminium diecast box 171mm x 121mm x 55mm
Rubber feet	8 off
I.c. socket 16 pin	2 off
I.c. socket 14 pin	3 off

Control knob
15 way screened cable
1mm Veropins
13A mains cable (3 core)

TR1 and all the other transistors in this unit are type BC107 or its complement, the BCY71. Constructors should beware of substituting near equivalents without first checking the maximum collector to emitter voltage that the device will tolerate. In several places in the circuit the transistors have collector voltages of 30V or more which is sufficient to damage BC108/9 devices and their equivalents.

TR102 together with R102, VR101 and the common bias supply formed by R30/D10 forms a constant current source which charges C101 causing the voltage across it to rise linearly with time. At each mains zero-crossing C101 is discharged by TR101 to −2·2V determined by the common bias network R29/D9. The peak voltage which the ramp across C101 reaches before the discharge is determined by the charging current and can be varied between +1·5V and +2·5V by VR101. This adjustment, made during initial setting up, determines the value of control voltage which just extinguishes the projector lamp.

The ramp voltage is fed via R103 to the comparator A101. At the comparator input TR103 clamps the ramp signal to −6·3V during each mains zero-crossing to produce the waveform with negative-going spikes as shown in the figure.

To the other input of the comparator is applied the projector control voltage derived from the manual controls or from the tape recorded signal. When the ramp voltage rises above the control voltage the output of the comparator makes an abrupt positive-going transition of about 10V which is differentiated by C102/R105 and applied to the base of TR104. D101 prevents breakdown of the base-emitter junction of TR104 during the negative-going edge of the comparator output which occurs at the mains zero-crossing when C101 is discharged. TR104 collector produces narrow 30V pulses at the trigger instants which are coupled via the 10:1 step-down transformer T101 to the gate of the triac. R107 limits the triac gate current and prevents damage to TR104 in the event of a short circuit. D102 suppresses overshoot caused by the primary inductance of T101 when the triac is disconnected from the secondary circuit which might otherwise break down the driver transistor.

The emitter of TR104 is returned to 0V rather than to −6·2V for a particular purpose. Differentiation of the comparator output produces a steep rising edge followed by an exponential decay to −6·2V as sketched on the circuit diagram. If the emitter were returned to −6·2V the point at which the transistor turned off (about 0·6V above the emitter voltage) would be on the shallow part of the exponential decay producing an ill-defined switching point and output pulse width. Furthermore, the slowly changing voltage may result in the slow turn-off of TR104 which may begin to dissipate excessive power whilst in the linear region of operation. Returning the emitter to 0V ensures that both turn-on and turn-off occur at rapidly changing points on the differentiated waveform.

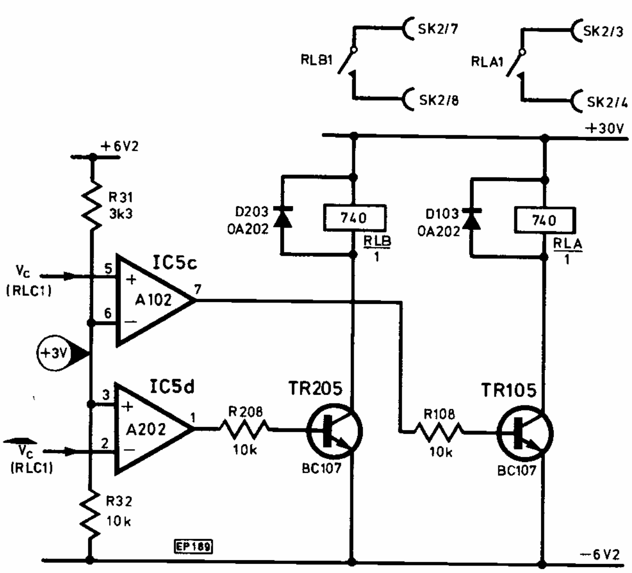


Fig. 9. Slide change relay drivers

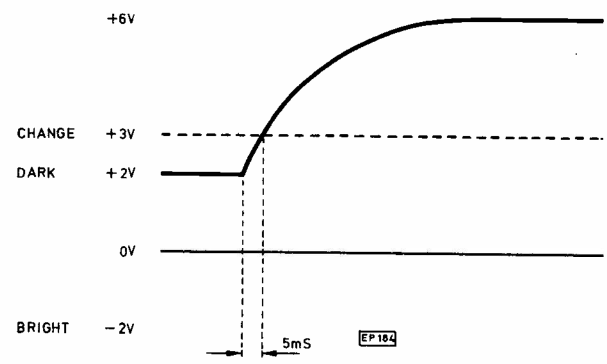


Fig. 10. Signal loss

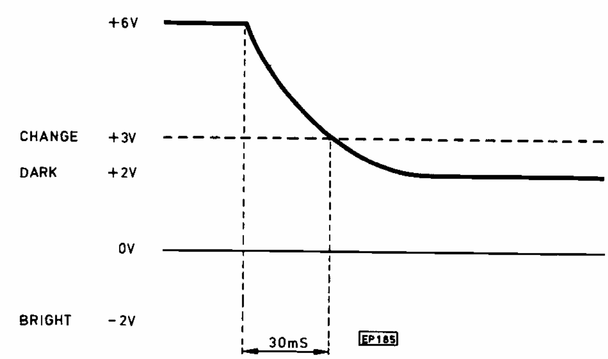


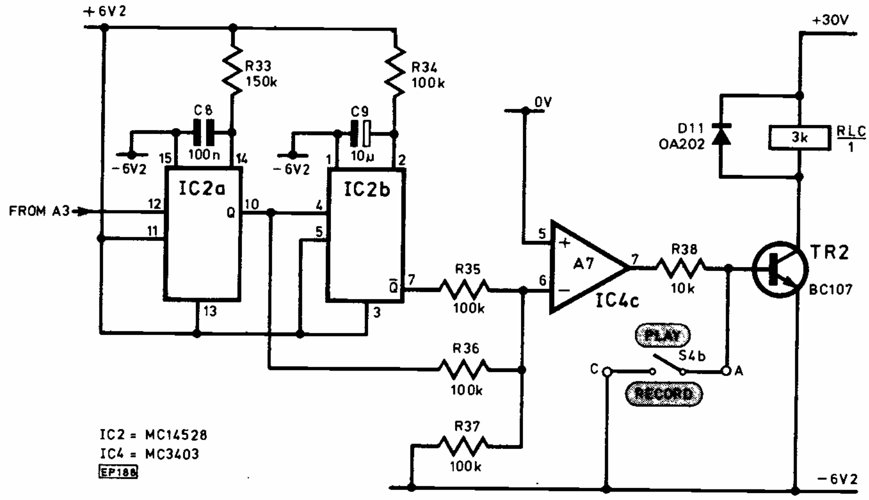
Fig. 11. Signal regained

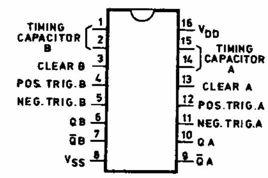
SLIDE CHANGE RELAY DRIVERS

The projector control voltage is compared with a common threshold of +3V (generated by R31, 32) in A102 as shown in Fig. 9. When the slide change button is depressed the control voltage of the dark projector jumps from approx +2V to cross the +3V threshold, turning on TR105 as a result. Relay RLA then operates completing the slide change circuit to the projector. D103 prevents damage to TR105 caused by overshoot across RLA when the transistor turns off.

SIGNAL LOSS DETECTOR

If the signal from the tape recorder is lost during replay (when making an edit, for example) the output of the phase detector falls to −6·2V at a rate determined by the low pass filter R14/C4. Fig. 10 shows what happens to the control voltage of projector B (after inversion by A6) assuming that it is dark (the worst case) when the input signal is lost. We see that the projector lamp goes out and about 5ms after the signal is lost the voltage crosses and stays across the slide change threshold. This will cause some projectors to change once, others will change repeatedly, while some will even change backwards—all undesirable effects!





MC14528
PIN CONNECTIONS
FROM TOP

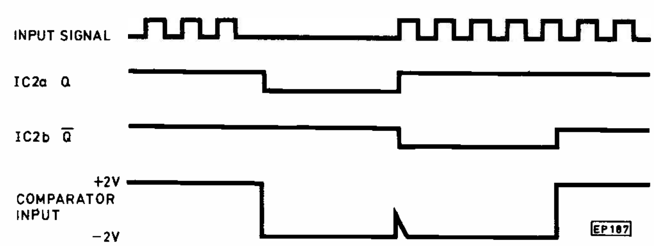


Fig. 12 (above). Signal loss detector circuit. Fig. 13 (right). Showing operational waveforms of signal loss detector

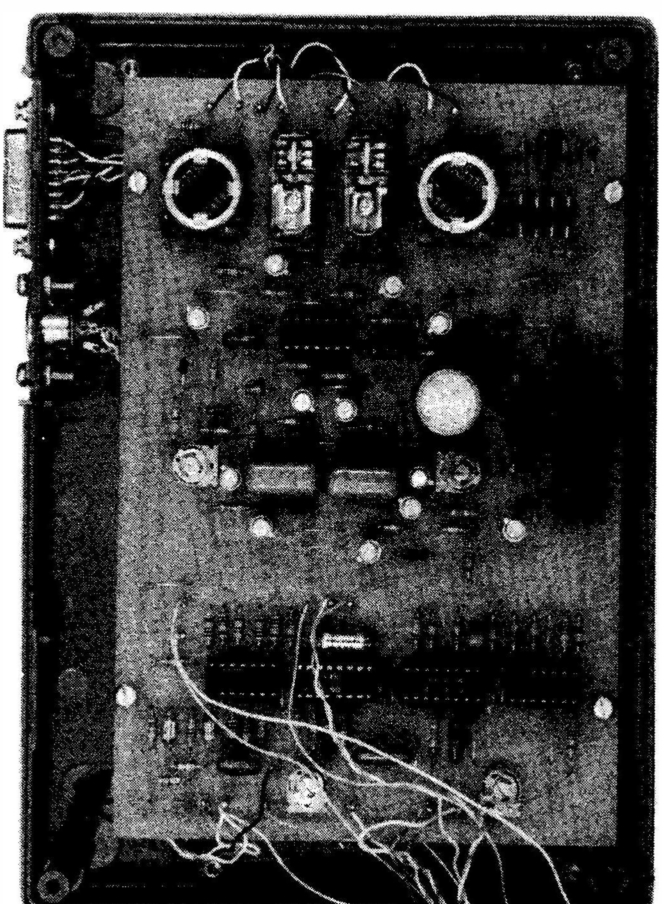


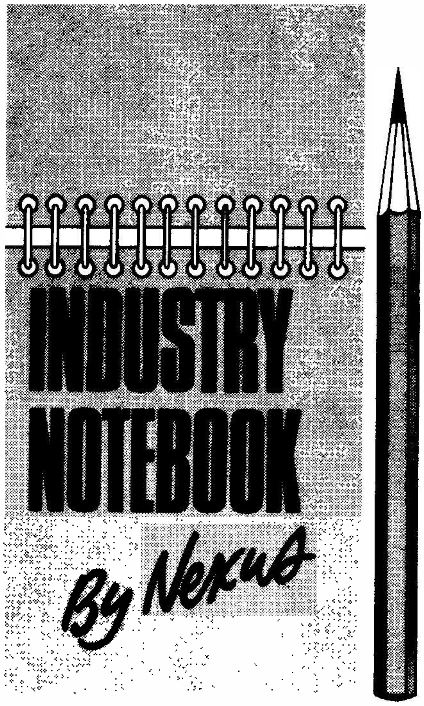
Fig. 11 shows what happens when the input signal returns—it takes about 30ms for the control voltage to stop changing the slide and to return to its correct level.

To prevent this effect it is necessary to clamp the control voltage to a value within the lamp control range before the output of the phase detector crosses the change threshold and to release the control voltage only after the phase detector output comes within this range again. This is done by means of a fast-operate slow-release signal loss detector formed by two CMOS monostables IC2a, b (Fig. 12) which is connected to the output of the signal buffer A3. CMOS devices will work over a wide range of supply voltages enabling IC1 and IC2 to be operated from the $\pm 6{\cdot}2$V rails so that a separate power supply is not needed. Fig. 13 shows the waveforms that result from the operation of the circuit.

Shortly after the signal is lost (the time being determined by R33/C8) the Q output of the retriggerable monostable IC2a falls making the inverting input of comparator A7 fall below the 0V threshold. The comparator output rises, operating RLC via TR2, and contact RLC1 in the tape recorder interface circuit closes turning both projectors on at half power. S4b prevents RLC from clamping the control voltage when making a recording as no signal is then present at the input terminal.

On recovery of the signal the Q output of IC2a rises immediately triggering IC2b whose $\overline{Q}$ output falls, keeping the comparator input below 0V for a period determined by R34/C9. In this way the attack and decay characteristics of the signal loss detector can be individually adjusted to prevent mis-operation of the slide change relay of projector B during tape edits or before the show begins when the tape recorder is not running.

NEXT MONTH: Construction and setting up



A Matter of Degree

There now seems to be general acceptance that both our primary and secondary educational systems have failed in respect of generating large numbers of employable people, whatever other qualities they may possess. Especially so in mathematics, physics and even English. My own contacts in industry are constantly telling me how hard it is to find good keen youngsters who can do simple arithmetic or write a sensible paragraph.

To a lesser extent but still serious is the university graduate who needs further training before being able to do any useful work in industry.

Now GEC-Marconi and Bath University have got together with a new $4\frac{1}{2}$ year degree course for electrical and electronic engineers. British educational standards, savaged over the years by trendy educationists, have been thrown overboard. Instead the new standard is proudly announced as equivalent to the French Grandes Ecoles and the German Technische Hoch Schulen which, judging by results in those countries, is far more effective. I can testify, again from experience, that French and German graduates from their respective educational systems are just as 'rounded' and 'human' and 'socially responsible' as our own product. Frequently more so, as well as being better qualified and self-disciplined.

The new Bath course, which also enjoys a support grant from the Engineering Industries Training Board, is to be a sandwich course with a difference. The difference is that individual students will be sponsored by individual GEC-Marconi companies to which they will return periodically for their industrial training sections of the course, eventually joining that company.

Emphasis is to be on real-life engineering, especially the systems approach to problem solving and design. Students will not only learn engineering fundamentals but will get thrown in at the deep end in case studies, seminars and role-playing, reminiscent of Harvard Business School management training.

I can only spot one fault in the scheme. It doesn't start until September 1980. Anyway, this gives plenty of time for prospective Masters of Engineering to apply to the School of Electrical Engineering, Bath University.

End of Term

Company annual reports can be compulsive reading. Often for what they leave out or the neat way that difficulties are glossed over. They are obliged to give the facts and figures of performance but beyond the balance sheet there is plenty of scope for originality in keeping the existing shareholders contented and attracting new ones. They are sometimes like end-of-term reports and none more so than that of Teradyne Inc, the Boston-based ATE manufacturer.

Their latest 'theme' company report features seventeen of their top salesmen round the world. Punchy profiles of their backgrounds, their wives, hobbies and business philosophy. And, of course, how well they are doing for Teradyne and its shareholders.

After allowing for the publicity gloss, all are clearly dedicated to their company and to personal achievement. And all are constantly on the move. Champion traveller is Tim Chan, based in Taiwan and looking after his own country, Korea, Hong Kong, Singapore, Malaysia, Thailand and Indonesia. He needs two dozen visas in his passport to get around his vast territory. Stan Fuller, based in Phoenix, pilots his own Cessna 210. Rene Verhaegen covers Benelux in his Audi, clocking up 65,000km a year. And so one could go on.

This is a highly-motivated team with good products, high-priced, and sold worldwide. And the company is growing fast, now turning over $100 million a year. Since founded it has never had a strike and has no collective bargaining contracts with its 2,000 workforce. Vice-President, sales, who heads up the global marketing is, for the record, not a high-powered tough American entrepreneur but a tough, high-powered Briton, Dennis P. O'Connell.

Racal Breakthrough

Racal Communications Inc in the USA and Racal (Canada) Ltd were established many years ago in the hope of breaking through the 'Buy American' act which operated so unfairly against non-American-owned companies in military procurement. Patience has now been rewarded but only with exceptional products which won the day in fierce competition. The US Air Force is initially buying $11 million worth of a new Racal receiver, the RA 6790/GM, and the Canadian Armed Forces the RA 6778C to the tune of $5·5 million Canadian.

The significance of the US Air Force contract is that it is the start of a replacement programme for the ageing R-390 communications receiver of which there are an estimated 40,000-plus in service round the world. The RA 6790 is a joint Racal UK/US development. With a different front panel it made its European debut at the Racalex 79 exhibition in London as the RA 1792. It features a new frequency synthesiser based on a special LSI chip designed by Racal Microelectronics Ltd and has a 100-frequency built-in memory for instant tuning to pre-selected channels.

Black Chips

Oil-rich Nigeria might be the first black African country to produce microcircuits. According to reports, the University of Ife has been purchasing production equipment and Nigeria could be in the business by the early or mid-1980s.

Naval Missile

British Aerospace Dynamics Group has received a £300 million shot-in-the-arm to develop a new sea-skimming anti-ship air-launched guided weapon. Provisionally known as the P3T, the weapon is of the fire-and-forget type, pre-programmed by fire control computer just before launch with the on-board homing head and computer finding the target and moving in for the kill. It appears to be a further development of the Anglo-French Martel currently in service with the Royal Air Force. The only electronic subcontractor so far named is Marconi Space and Defence Systems for the active radar target seeker and homing head.

BA Dynamic Group is also looking at in-house costs. At Stevenage a computer-aided draughting and design system has been installed which is said to multiply draughtsman productivity by a factor of four. Of the 12,000 drawings a year currently produced, some 2,500 are expected to be handled by the automated system, leading to greater accuracy and consistent standards and cutting out much of the tedium of repetitive manual work. But apart from the benefits, BA Dynamics say, like others, that there is a shortage of suitably qualified design staff.

Micro-min Laser

The latest in sophisticated micro-min is the world's smallest hand-held laser rangefinder, a little larger than a packet of 20 cigarettes and weighing, including battery, 1·2lb. An infantryman can easily carry it in his pocket and then has instant personal ranging up to 4,000 metres with an accuracy of ±3 metres. The pulse output is a third of a megawatt and the manufacturer, International Laser Supplies Inc., expect the cost to be as 'little' as $2,500 each in 1,000-off quantities.

Talking Calculator

And the latest in calculators is Sharp's desk-top development that repeats calculations with a synthesised voice as you key them in or demand the answer. This feature seems of doubtful value—but then I haven't seen the full specification. Anyway, it appears that you can choose your own language, English, French, Spanish, German or Japanese.

Learn Basic THIS WAY ...and enjoy it!

R. FERGUSON

THIS article is directed towards those electronics enthusiasts who have sufficient hardware experience but possess little or no knowledge of programming. According to a recent survey conducted by The Amateur Computer Club, 70 per cent of computer faithfuls are in this category and they will find that few books suit their particular needs. Having your own computer, or at least access to one, means that you can learn at the keyboard and at your own speed. The choice of BASIC as the language is inevitable. It is the most readily available for the home computerist, which is due in turn to the fact that it is easy to learn, to understand and to apply. It is also surprisingly versatile.

INPUT AND OUTPUT

From here on it will be assumed that you are sitting comfortably at the keyboard, ready to 'converse' with the computer. We will ignore, at least to start with, the usual formal classifications of 'assignments', 'declarations' etc. and jump straight in at the deep end with the first essential in any communication system, INPUT and OUTPUT. This is done with statements which may be used directly, as if we were 'commanding' the computer. At this stage we will regard all such statements as 'instructions' and refer to them in this way. On entering BASIC, the computer will respond with the usual prompt, # ■ flashing etc. which indicates that you are in command and may proceed with your first (or next) entry.

In order to embark on a new program however, we must erase all traces of previous entries and initialise all variables. This is done by typing NEW at the terminal. Remember to do this every time a fresh program is started. There is one other entry which must be made each time an instruction is completed. This is the typing of the CR (carriage return) key, which indicates to the computer the end of that particular instruction set. Remember then, to press the RETURN key at the end of each instruction statement: and now we are ready to start. Type,

NEW (+ RETURN key)

and on the next line, type the following

```
PRINT 25 – (19 – 7) * 2 + 50
(+ RETURN)
```

The printer will respond with the result of this calculation, which is 51. This illustrates two features:

1. The instruction 'PRINT' means, in effect, "Evaluate this expression and PRINT the result".
2. The calculation follows the usual arithmetical sequence: brackets; powers; multiplication and division; addition and subtraction: and where two operations are in the same category, the calculation is effected from left to right. This is more clearly shown in the next example. Try it.

```
PRINT 25 – 2 * 3 + (6/2) ↑ 2    (+ RETURN)
```

The order here would be,

(1.) 6/2 (=3) (/ signifies DIVIDE)
(2.) 3 ↑ 2 (=9) (↑ signifies TO THE POWER)
(3.) 2*3 (=6) (* signifies MULTIPLY)

This leaves 25 – 6 + 9 to be evaluated, so the last two steps would be,

4. 25 – 6 (=19)
5. 19 + 9 (=28)

which will have been printed on the next line. This, of course, is no more than any calculator can do, but it's a start. To move one step beyond the calculator stage, try this:

PRINT "A, B; C: D." (+ RETURN) (note the quotes, " ")

SPACING

You will have found that whatever appeared between the quotes, including spaces, was reproduced exactly as entered. Combining these features, we have simple control over our output. For example, try the following:

```
PRINT "THE SUM OF 5 AND 4 = ";5 + 4    (+ RETURN)
```

which produces,

```
THE SUM OF 5 AND 4 = 9
```

Note the semicolon after the second quotes. This controls the spacing before the result of 5 + 4 is printed. Try the same line again using a comma instead of a semicolon. This time a space of about 7 characters will be left before the 9 is printed. The line is automatically divided into printing zones of 14 positions (this may vary slightly in different versions of BASIC) and the comma is used to effect this separation.

Next, try

```
PRINT "LENGTH", "BREADTH", "AREA"
```

which will print these headings, suitably spaced out at 14 unit intervals, ready for the print-out of a table of dimensions as follows:

```
LENGTH        BREADTH       AREA
```

Now experiment with various combinations of text, expressions and spacing, using both the semicolon and the comma.

Since each PRINT instruction produces a carriage return and line feed at the end of the statement, a PRINT used alone in a program will have the effect of skipping a line. You will have

noticed by now that spaces are ignored by BASIC (except when they appear between quotes).
The computer sees no difference between

PRINT 4+5 /3 and . . . . . PRINT 4+5/ 3

If memory space is short, quite a bit can be saved by omitting all spaces, but it will not do your sanity any good when you have to search for errors!
To summarise so far with an example,

```
PRINT "LENGTH = ";5, BREADTH = ";7,
AREA = "; 5 * 7
```

which will produce,

```
LENGTH = 5 BREADTH = 7 AREA = 35
```

Note that in the print statement a space is left after each equals sign (=), before the quotes are closed, so that the values 5, 7 and 35 are suitably spaced away from the equality sign.

TAB FUNCTION

There is one more convenient output control available in BASIC, the TAB function. This gives precise positioning for any part of a print-out, which you will now discover if you type the instructions,

```
PRINT TAB(10);"BASIC IS BEAUTIFUL"
```

You will find that the first word is started in the tenth printing position. Note that the value 10 must be in parenthesis and that this in turn must be followed by a semicolon before opening the quotes. The value in brackets may be any expression, with or without variables, so the printing position can be made dependant on an earlier program routine and in the final evaluation, incorporated in the PRINT statement: all of which helps to make graph plotting much simpler.
Finally try,

```
PRINT TAB(5);"RESISTANCE = "; 25; TAB(25);
"VOLTAGE = "; 5; TAB(40);"CURRENT = "; 5/25
```

This gives,

```
RESISTANCE = 25    VOLTAGE = 5    CURRENT = 0·2
```

. . . which shows that the TAB function may be used more than once in any one PRINT statement, so we have effective control over our print-out. (If the printer encounters a TAB value *less* than its present position, it will continue *from* its present position . . . it can hardly go backwards!)

PROGRAM CONSTRUCTION

Having learned to control print-out we can now move on to program construction. The first noticeable difference is that when a program is entered, there will be no response from the computer at the end of each line, as happened previously when in the command mode. Each line should be numbered to indicate that a program is being entered, and this also determines the logical order in which the steps will be executed. The numbered steps or statements may however be *entered* in any order, since the computer will, under BASIC control, execute them in the correct numerical (i.e. logical) order.

Line numbers are in multiples of five or ten. By leaving gaps between, additional lines can be sandwiched in; and the need to add, delete or in other ways alter a program after apparent completion is the rule rather than the exception.

The first example for you to try follows:

```
NEW
10 LET A = 5       (let the value 5 be entered in store A)
20 LET B = 12      (let the value 12 be entered in store B)
30 LET C = A+B     (add the contents of A and B and
                   place in C)
40 LET D = A–B     (subtract B from A and place the result
                   in store D)
50 PRINT "A + B = ";C, "A – B = ";D
60 END
```

The full program has now been entered and resides in memory, waiting for an instruction to start operating. The command in BASIC for this is RUN, so now type,

RUN (+ RETURN) . . . . . and the immediate response will be,

```
A + B = 17     A – B = –7
```

The explanations on each line are hardly necessary, which is the beauty of BASIC; it is almost self-explanatory! Note that in some versions, the word LET is optional when in program mode, so line 30, for example, would be acceptable as,

```
30 C = A+B
```

VARIABLES

This program also demonstrates the use of letters as variables. In fact any letter from A to Z may be used, either alone or with a digit (0 to 9) as a suffix. For example A, A0, A1, A2, B2, Z2 are all acceptable as variables in the same program.

You will no doubt have realised that the above program can be simplified, since the PRINT instruction will deal with more than one calculation in the same line. Enter the following,

```
NEW
10 LET A = 5
20 LET B = 12
30 PRINT "A + B = "; A + B, "A – B = "; A – B
40 END
```

which will produce exactly the same output as before.

There is one more output control. Enter the following:

```
NEW
10 PRINT "ALL THIS TEXT ";
20 PRINT "WILL APPEAR ";
30 PRINT "ON THE SAME LINE"
40 END
```

As stated, the entire print-out will be on the one line, due to the effect of the semicolon at the end of lines 10 and 20, which is to suppress the carriage return and line feed normally following a PRINT statement. Notice the space left before the quotes were closed in lines 10 and 20, which prevents a 'cramming' of the words from the end of one line to the beginning of the next. One more similar example:

```
10 LET S = 1+2+3+4+5
20 PRINT "MEAN OF THE FIRST FIVE ";
30 PRINT "NATURAL NUMBERS = "; S/5
40 END
RUN
```

This will give,

```
MEAN OF THE FIRST FIVE NATURAL NUMBERS = 3
```

This completes the list of all output instructions and practice should provide proficiency; and now with this repertoire, plus the skeleton of a program to work on, we can proceed to INPUT.

INPUT

Up to now, all data has been written into the program, but where the same program is used for different sets of values, it may be necessary to enter the data separately each time the program asks for a new set.

This can be done using the statement 'INPUT', which causes the program to stop and wait for the appropriate entries at the keyboard, each value separated from the next by a comma.

When the program stops because of an INPUT instruction, a 'question mark (?)' will be printed to indicate to the user that data is requested. Here is a simple example to start with:

```
NEW
10 INPUT A, B, C
20 PRINT A*A; B*B; C*C
30 END
RUN
```

After line 10, the program stops, prints a question mark '?' and expects three values (separated by a comma) to be entered. When this is done (and followed in the usual way by RETURN), the three values are placed in stores A, B and C *in that order* and the rest of the program is implemented. In this way, by again entering RUN, a new set of data can be typed in and this can be continued as long as there is data available for evaluation.

Note that the order of entry of data must correspond to the order in which it has to be applied to the variables. If in the above example, we had entered 5, 7, 24 after the question mark '?', the print-out would have been,

```
25   49   576
```

Now try this complete program, using your own values for L, B and H.

```
NEW
10 INPUT L,B,H
20 PRINT
30 PRINT "LENGTH", "BREADTH", "HEIGHT",
   "VOLUME"
40 PRINT
50 PRINT L, B, H, L*B*H
60 END
RUN
```

The effect of this will firstly be a question mark '?', after which your values for L, B and H must be entered, followed by RETURN as usual. On receiving this input from the keyboard (remember the comma between), the next output will be, (using 5, 4, 3 for the data),

```
LENGTH    BREADTH    HEIGHT    VOLUME

5         4          3         60
```

The double spacing is effected by the PRINT statement in line 40 and the horizontal spacing is obtained by the use of commas in lines 30 and 50.

GOTO

One disadvantage of the above program is that if we again type RUN in order to repeat for another set of data, the print-out will still include the headings LENGTH, BREADTH etc. To avoid this and to allow tabulation of further data under the original headings, it is necessary to introduce a new instruction, GOTO, which directs the program to a specific statement number from where it will continue execution in the usual numerical (logical) sequence. To effect these improvements there is no need to re-enter the whole program. Any line may be deleted by typing the line number followed by RETURN; and a line may be altered by retyping the whole line (including the line number) correctly, when the new line will replace the old one. Just make the following additional entries:

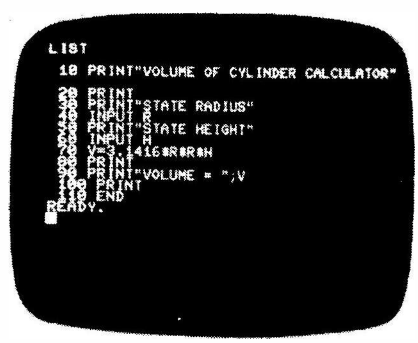
```
20 GOTO 50
60 GOTO 10
70 END
```

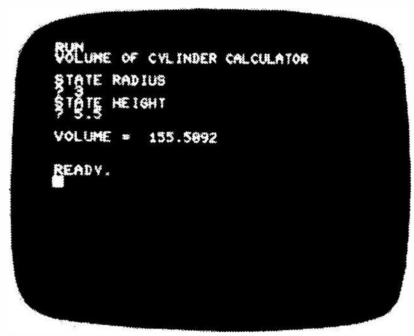
Now type RUN, when the question mark will appear as usual, but after receiving the next set of values the program will jump to line 50, missing the 'print headings' line and so continue to print out these values and result, tabulated as before. At line 60 the instruction is now 'GOTO 10', so the program returns to the start and requests the next set of data. While all this may satisfy our present requirements, it firstly introduces an undesirable element and secondly presents a problem. The unwanted part of the output, you will already have noticed, is the question mark followed by the data, which intrudes on the continuous tabulation of the print-out. A remedy for the latter will be explained later.

LOOP PROBLEMS

Since the program returns to line 10 at the end of each routine, the END statement is never reached and we are 'stuck in a loop', a well known nightmare in programming. Although it does not interfere with the execution of this particular program, it will certainly cause you trouble sooner or later and this is as good a time to deal with it as any.To escape from such a dilema, the 'panic button' is used. This may vary in different versions of BASIC, sometimes a single key labelled 'ESC' (escape), or the combination of two keys, one a control key and the other a suitable character such as 'X' (exit), 'O' (out), 'C' (cancel) etc. For our purpose we will call it the ESC key, but refer to your own version to find the appropriate replacement. It may be necessary to press the ESC key repeatedly, depending on what sequence of operations the computer is engaged in, before you succeed in interupting the loop. The ESC key can also be used to halt the execution of a program at any time, if you want to return to the 'command' status, where the keyboard is again in control. Now try a variety of tabulation programs such as,

1. Volume of a cylinder (V), given the radius (R) and height (H). (V = 3·1416 * R * R * H)
2. Tax (T) payable, given rate of tax (R%), gross income (I) and total allowances (A). (T = (I—A) * R/100)
3. Value of resistance (R), given three resistances (R1, R2, R3) in parallel. (R = 1/(1/R1 + 1/R2 + 1/R3))





The listing for program one and its execution is shown above. If your machine has π in memory, only the actual symbol need be included. As the sign for raise to the power is ↑, statement 70 can be reduced to π • R ↑2 • H.

READ AND DATA

The input of data using the INPUT instruction (which is the only method available on minimum versions of BASIC) has obvious limitations, as you have already discovered. A second method which can be used requires two statements, READ and DATA, which must be programmed as a pair. The READ statement inputs data sequentially and finds its data in the corresponding order following the DATA statement. Type out the following,

```
 5 READ A, B, C, D
10 DATA 2,3,4,5
15 PRINT (A+B)*(C+D)
20 STOP
```

. . . which produces the output, 45

Several things to note here:

1. The values 2, 3, 4 and 5 will be read into stores A, B, C and D *in that order*. Care must be taken therefore, that the values following DATA are entered in the correct sequence to correspond to that of the variables.
2. The DATA statement (or statements) may appear anywhere in the program, provided that if there is more than one, they are still kept in the proper order.
3. The above example could have been written as,

   ```
   10 DATA 2,3
   16 DATA 4,5
   ```

   . . . with exactly the same result, since the READ statement will search for the required data sequentially, wherever it appears in the program.
4. Instead of the usual END as the last entry, STOP has been substituted which, though also halting execution, transfers control to the keyboard to allow investigation of that part of the program before the next part is implemented. Provided that no changes are made to the program at this point, typing CONT will direct the computer to continue from where it received the STOP instruction.

Now enter the following:

```
 5 READ A, B, C, D, E, F
10 DATA 6,8,9,21,3,13 . . . (or any six integers you care to
   use)
15 LET T = A+B+C+D+E+F
20 PRINT "MEAN = "; T/6
25 STOP
```

which will print,
MEAN = 10 . . . then the program will stop and wait for further commands. By retyping line 10 with a fresh set of values, followed by GOTO 5 (no line number, since this is a command after a STOP), the program will return to the start and operate on the new data.

FOR . . . NEXT LOOP

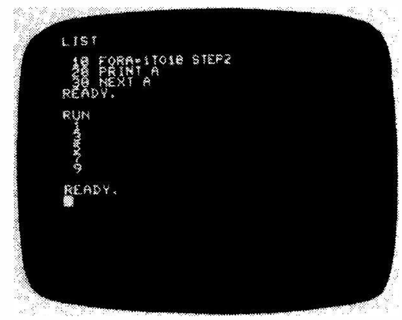
Attempt to find the mean of several hundred numbers by this method and there will obviously be trouble! Fortunately, the problem is easily solved by the use of a FOR . . . NEXT loop. Enter this program and see what happens.

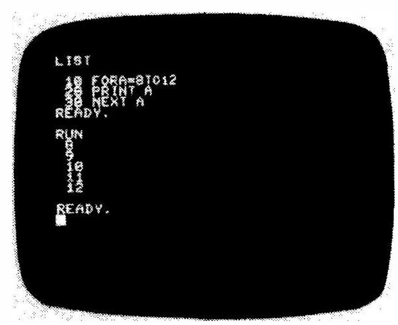
```
 5 FOR I = 1 TO 6
10 READ N
15 PRINT N*N;
20 NEXT I
25 DATA 1,2,3,4,5,6
30 STOP
```

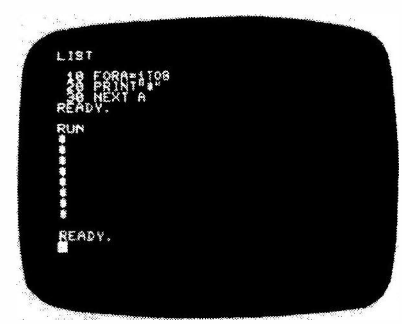
The print-out will be,
1 4 9 16 25 36

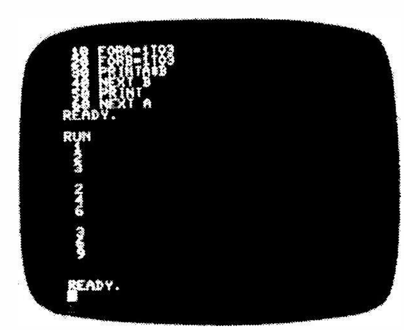
The FOR . . . NEXT loop operates in this way: the variable I (any letter may be used) takes on successive values from 1 to 6 and for each one, that part of the program which lies between lines 5 and 20 is executed. As each new value of I is reached, a test is made to see if it has exceeded the 'TO' value (6 in this case), when the loop terminates and the rest of the program is completed. In effect, then, 'NEXT I' means, "Repeat this routine for the next value of I".

By changing line 5 to have a larger terminating value for I, and by entering the appropriate amount of data, a large number









Typical FOR . . . NEXT loop listings

of values can be accommodated. Try this method now on the earlier program to find the mean of six numbers, but this time make it sixteen—or sixty.

Then try this program, which shows how part of the loop can depend on the value of I itself, and how the incremental step need not be unity. (The latter requires the addition of 'STEP N', where N may be any value, positive or negative, integer or decimal). Can you visualise what the print-out will look like?

```
 5 FOR I = 1 TO 9
10 PRINT TAB(4*I); I;
15 NEXT I
20 PRINT
25 FOR H = 18 TO 2 STEP -2
30 PRINT TAB(2*H); H/2
35 NEXT H
40 STOP
```

It is sometimes helpful, when writing out your program, to offset that part which lies within the FOR . . . NEXT loop; on large programs this serves as a check on the start and finish of each loop. Some versions of BASIC will automatically produce such a print-out. This has been done in the last program at lines 10 and 30.

Before continuing with further examples of the FOR . . . NEXT loop, it will be helpful to introduce a few more controls and to be more specific about the use of numbers.

Except in the minimum versions of BASIC, where only integers are acceptable, any real number may be entered, to at least eight significant figures, the range varying for different versions, but usually from $\pm 10^{-99}$ to $\pm (10^{100} - 1)$. Numbers may be entered normally as integers or decimals, or in exponent form; (for example, 176, 49·75, or 314159E-5, the latter representing $314159 * 10^{-5}$. The E stands for exponent).

You will no doubt have typed a few errors by now and will have found retyping the whole line exasperating. This can be avoided by the use of two devices, the BACKSPACE control and the DELETE . The former will cancel the last character to be entered and the latter will erase the whole line. Refer to the manual for your particular version, since these controls vary, the most likely ones for a BACKSPACE being a CONTROL C (for CANCEL), or a CONTROL⟵.

REM AND LIST

Finally, two facilities which will prove invaluable when 'debugging' a program, the REM (remark) statement and the LIST command.

The REM statement allows comments or explanations to be attached at intervals throughout a long program, without interfering with its operation. Anything following REM on the same line will be ignored by the program but will be printed out in any listing. This brings us to the use of LIST which, as a command, will cause the whole program, as then held in memory, to be printed in correct order; which allows an examination and check of the present state of the program. Further, by typing, for example, 'LIST 35', only line 35 will be listed; and by entering 'LIST 20, 70', all lines from 20 to 70 inclusive will be printed.

Combining some of these new facilities and using the FOR . . . NEXT loop, type out this program exactly as shown.

```
 5 REM TO FIND THE MEAN OF ANY NUMBER OF
   VALUES
10 PRINT "HOW MANN ⟵ Y NUMBERS ARE
   THERE?
15 INPUT N
20 FOR I = 1 TO N
25 READ X
30 LET T = T+X
35 NEXT I
 8 LET T = O
40 PRINT "TOTAL = "; T
45 PRINT "MEAN = "; T/N
50 STOP
40 (+ RETURN)
38 DATA 7, 12, 5·8, 2·9E2, 99·4E-1, . . . (select your
   own data)
LIST
```

In line 10, an error was typed, so the backspace (CANCEL) character, control '⟵', was entered following the extra 'N', which corrected the word 'MANY'. (Check that your version uses '⟵'; it may be different). After line 35 was entered it was realised that the totalling store, T, would have to be set to zero for the first and each subsequent set of values. Line 8 was then typed in to accomplish this. It was also decided at this point that a print-out of the actual total was not required, so line 40 was erased by entering 40 followed by RETURN. It was now discovered, as sometimes happens, that the data itself had been forgotten and this was then entered as line 38. Because of these changes, a listing was requested by typing LIST (and RETURN), when the following output was obtained.

```
 5 REM TO FIND THE MEAN OF ANY NUMBER OF
   VALUES
 8 LET T = O
10 PRINT "HOW MANY NUMBERS ARE THERE ?"
15 INPUT N
20 FOR I = 1 TO N
25 READ X
30 LET T = T+X
35 NEXT I
38 DATA 7,12,5·8,2·9E2,99·4E-1, . . .
45 PRINT "MEAN = "; T/N
50 STOP
```

If the program is now run, the value of the mean will be printed; and if a re-run is required for a new set of values, enter line 38 again with the new data, then type
GOTO 8 . . . which will return control to the program at line 8, repeating the whole process.

This example also demonstrates how the terminating value, N, in the FOR . . . TO statement (line 20) can itself be a variable and therefore alterable for each new set of data.

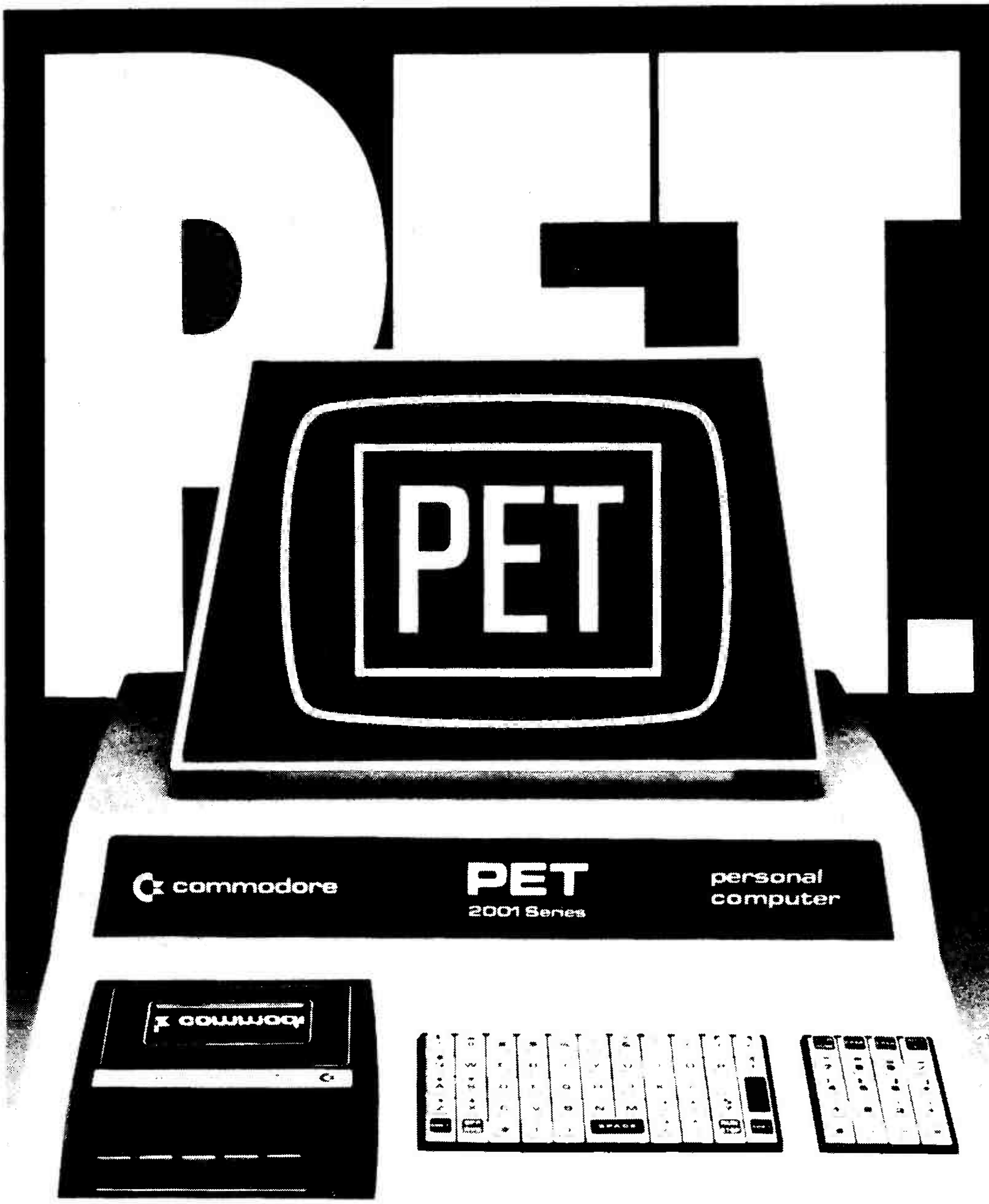
IF . . . THEN

Most versions of BASIC offer a number of functions such as ABS(X), INT(X), RND(X) and SQR(X), which will find the absolute value of X, the largest integer not greater than X, a random number derived from X and the square root of X respectively. The latter will almost certainly be obtained from a simple sub-routine which uses a process of iteration to obtain the square root; and this will form an ideal example with which to introduce the IF . . . THEN statement. This is the decision-making facility in BASIC, where an expression of relativity appears between IF and THEN.
For example,

IF A > B THEN 50 . . . will cause the program to branch to line 50 if the relation A > B is true. Otherwise it will continue to the next line in the sequence. Here is the program, expanded slightly, in order to make its operation easier to follow.

```
 5 REM SQUARE ROOT
10 LET E1 = 2
15 PRINT "ENTER NUMBER"
20 INPUT N
25 LET Q = N/E1
30 LET E2 = (Q+E1)/2
35 IF ABS(E1-E2) < 0·0001 THEN 50
40 LET E1 = E2
45 GOTO 25
50 PRINT "SQUARE ROOT = "; E2
55 STOP
```

In line 10, the first estimate, E1, is given any reasonable value, in this case, 2. Line 25 divides the number, N, by E1 and puts the quotient, Q, in store Q. Since the root of N will lie between Q and E1, the average of these two values is calculated in line 30 and placed in store E2. Line 35 tests to see if the absolute difference between this new improved estimate and the previous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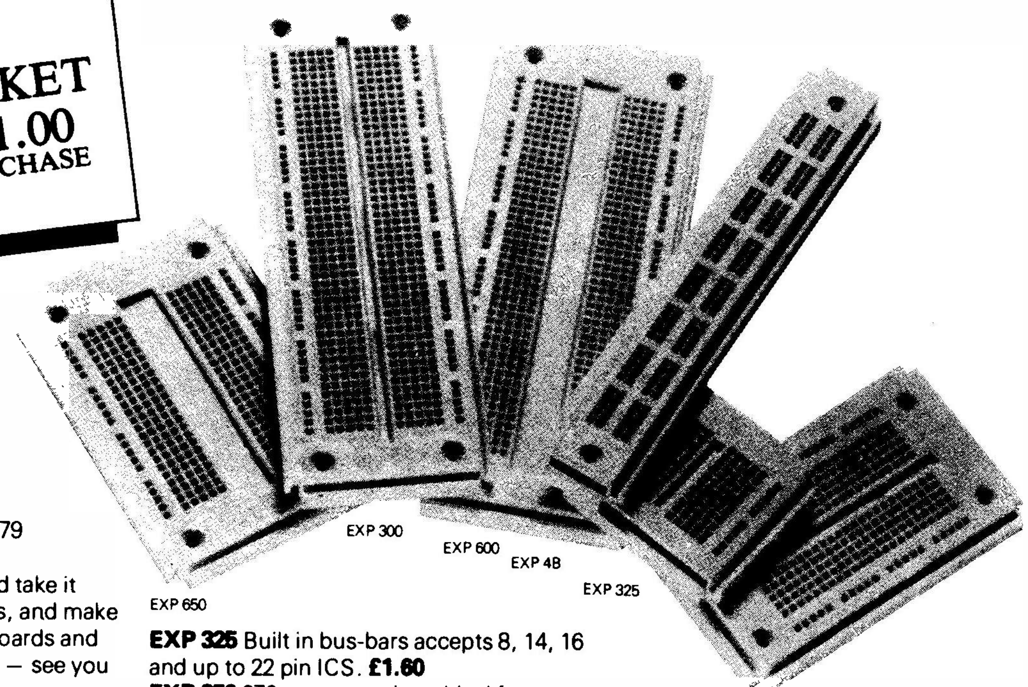

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one is significant (you may choose your own degree of accuracy here): if not, the last calculated estimate, E2, is printed. If the absolute difference is still too great, E1 takes on the value of E2 (line 40) and a return is made to line 25 to repeat the loop. A calculation of this type, which may have to be undertaken frequently in a longer program, can be tucked away in a corner as a sub-routine, to be called into use when required. This is effected in BASIC by the statements GOSUB and (to get back to the main program at the exit point), RETURN. An example of this occurs in the following program, which finds the roots of a quadratic equation, $Ax^2 + Bx + C = O$, given the values of the co-efficients, A, B and C.

```
 5 PRINT "ENTER CO-EFFICIENTS"
10 INPUT A,B,C
15 LET D = B*B-4*A*C
20 IF D < O THEN 80
25 GOSUB 50
30 LET X1 = (R-B)/2/A
35 LET X2 = -(R+B)/2/A
40 PRINT "ROOTS ARE "; X1; X2
45 GOTO 85
50 LET E = 2
55 LET R = (D/E+E)/2
60 IF ABS(R-E) < 0·0001 THEN 75
65 LET E = R
70 GOTO 55
75 RETURN
80 PRINT "NO REAL ROOTS"
85 STOP
```

Line 20 tests to see if D is negative and if so, causes a branch to line 80, which declares that there is no real solution and the program stops. If D is not negative, it proceeds to line 25 which in turn directs operations to the sub-routine at line 50. Having obtained the square root of D (held in store R) to the required accuracy, line 75 returns the sequence to line 30, where we left the main program. Finally, line 45 directs operations past the sub-routine to the STOP statement. If required, a 'GOTO 10' command will return everything to the start for the next equation.

ON . . . GOSUB, ON . . . GOTO

To complete this topic, there are two more useful statements which are used in conjunction with GOSUB and GOTO; they are ON . . . GOSUB and ON . . . GOTO. Try to assess the effect of the following program before typing RUN.

```
10 PRINT "TYPE 1, 2 OR 3"
15 INPUT X
20 ON X GOTO 25, 35, 45,
25 PRINT "YOU ENTERED 1"
30 GOTO 50
35 PRINT "YOU ENTERED 2"
40 GOTO 50
45 PRINT "YOU ENTERED 3"
50 END
RUN
```

You will have discovered that line 20 effects a branch to either lines 25, 35 or 45, depending on the value of X, which may be any value or expression, greater than zero. For $X = 1$ the program is directed to line 25, $X = 2$ sends it to line 35 and $X = 3$ to line 45. If $X < 1$ or $X \geqslant 4$, an error message will be printed and if X is not an integer, it will first be truncated to an integer value. The statement ON . . . GOTO could be replaced by ON . . . GOSUB with a similar effect, the branch going to some sub-routine within the program.

DIM

A set of numbers arranged in a row or column, or an array of numbers held in matrix or table form can be manipulated very easily using the DIM statement in BASIC. This defines the dimension of an array, when named in the program, using any letter of the alphabet. For example, DIM Y(100) allocates memory space sufficient to deal with 100 values and reserves it for the array named Y. For a two-dimension matrix, the statement becomes DIM Z(A,B), where A and B define the number of elements in the row and column respectively of matrix Z. A table of values consisting of 20 rows and 15 columns would therefore be entered as DIM T(20,15). There is a limit set to the size of A and B, which will vary from one version to another, but usually at least 255 elements are allowed. Although an array having less than ten elements (or ten by ten in two dimensions) need not be defined by the DIM statement, it is advisable, in order to save memory space, to do this anyway. It is usually necessary to use a FOR . . . NEXT loop to read into or print from an array, the following program illustrating this for a one dimension set.

```
 5 REM PRIME NUMBERS LESS THAN 1000
10 DIM A(1000)
15 FOR H = 2 TO 1000
20 IF A(H) < O THEN 50
25 PRINT H;
30 IF H > SQR(1000) THEN 50
35 FOR I = H to 1000 STEP H
40 LET A(I) = -1
45 NEXT I
50 NEXT H
55 END
```

Line 10 reserves space for the one-dimension array named A. This will usually set all elements to zero, but in some versions it may be necessary to do this in the program first, for example:

```
60 FOR K = 1 TO 1000
70 LET A(K) = 0
80 NEXT K
```

NESTED LOOPS

Above is the first program which has used nested loops (a loop within a loop) and this will also be required when dealing with a two-dimension array. At line 15, the outer loop is started for the first value of H, which is then printed, line 25. The second, inner loop starts at line 35 and is repeated for all defined values of I by the statement in line 45. Line 50 now returns the program to the start of the outer loop for the next round. Note that all the circuits of loop I are undertaken before the next round of loop H begins. For a two-dimension array, a similar arrangement is necessary. To illustrate, the following program reads in the 20 elements of a 5 by 4 table, replacing all odd values by zero, then printing the revised table.

```
 5 DIM T(5,4)
10 FOR I = 1 TO 5
15 FOR H = 1 TO 4
20 READ T(I,H)
25 IF T(I,H)/2 = INT( T(I,H)/2 ) THEN 35
30 LET T(I,H) = 0
35 NEXT H
40 NEXT I
45 DATA
   3,14,12,5,20,18,7,14,19,30,25,25,16,4,7,11,21,30,24,6
50 REM PRINT REVISED TABLE
55 FOR J = 1 TO 5
60 FOR K = 1 TO 4
65 PRINT T(J,K)
70 NEXT K
```

```
75 PRINT
80 NEXT J
85 END
```

The print-out from this will be,

0	14	12	0
20	18	0	14
0	30	0	0
16	4	0	0
0	30	24	6

A few points to note from this last program:

1. Since the outer loop is from 1 to 5, the values will be read in as 5 rows, the inner loop expecting 4 elements for each row. The data therefore, must be entered similarly in order, row by row. While the table may, if preferred, be read in columns, it cannot be printed this way and of course it is necessary to have the same arrangement for both the READ and PRINT statements.
2. If an odd number is divided by two the result cannot be an integer, so line 25 uses the INT(X) function to test each element for even status. Note also the use of 'nested' brackets in this line.
3. If line 35 is now changed to . . . 35 PRINT T(I,H), . . . , line 36 becomes . . . 36 NEXT H . . . and a PRINT inserted at . . . 38 PRINT . . . , lines 50 to 80 will not be required, as the print-out will be processed while the loops are being cycled.

This by no means exhausts all the commands, functions and statements available in BASIC, but with further practice and experience it should be easy to learn the others from a BASIC manual.

E24 PARASCAN

To assist understanding of how BASIC commands work *together*, the following program is explained step by step.

Should you have need of an odd value resistance, E24 Parascan will compare every possible combination of twin parallel resistors, and display those which meet your requirements.

The computer asks for the resistance you require (assumed to be in Ohms), and then asks for the acceptable tolerance (just enter figure).

```
20  DATA 1, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2, 2.2, 2.4,
    2.7, 3
30  DATA 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8,
    7.5, 8.2, 9.1
40  DIM R(24) : FOR A = 1 TO 24 : READ
    R(A) : NEXT A
100 X=1 : Y=1 : INPUT"RESISTANCE ";R
105 IF R>4550000 THEN PRINT"OUT OF
    RANGE " : GOTO 100
110 INPUT"% TOLERANCE ";T
120 L=R-(T/100)*R : U=R+(T/100)*R
130 PRINT"FROM ";L;" TO ";U;" OHMS" :
    PRINT
200 FOR Z = 1 TO 7
230 FOR M = 1 TO 24 : IF R(M)*X<R THEN
    275
233 FOR W = 1 TO 7
235 FOR N = M TO 24 : IF R(N)*Y<R THEN
    270
240 P=R(M)*X*R(N)*Y/((R(M)*X)+(R(N)*Y))
250 IF P<L OR P>U THEN 270
255 T1=((100*P/R)-100)*1000 : T1 =
    INT(T1)/1000
256 R1=R(M)*X : K$="" : K1$=""
257 IF X>100 THEN R1=R1/1000 : K$="K"
258 IF X>100000 THEN R1=R1/1000 : K$="M"
262 R2=R(N)*Y : IF Y>100 THEN
    R2=R2/1000 : K1$="K"
263 IF Y>100000 THEN
    R2=R2/1000 : K1$="M"
265 PRINT R1; K$; TAB(6)"||"; R2; K1$;
    TAB(14);"="; P; TAB(28);T1; "%"
270 NEXT N : Y=Y*10 : NEXT W : Y=1
275 NEXT M : X=X*10
280 NEXT Z
```

DATA statements containing the fundamental decade of the E24 range

A variable R is chosen, subscripted (n), to identify the above DATA. To cope, n must be from 1 to 24, so R(n) is DIMensioned thus.
A FOR-NEXT loop is used to READ-in the data, where A plays the part of n

Variables to be used later are preset. Then the machine is programmmed to ask for the required resistance, and designates it R. The computer will not confuse this with R(n)

The highest resistors this program will compare are: 9M1 || 9M1, so that nothing greater than 4M55Ω can be found. Only when the IF condition is true will the PRINT and GOTO statements be executed

Requests % tolerance required, designated T

Algorithm calculates upper and lower (U and L) limits allowable

These limits are printed for user reference. The null PRINT statement creates a line space on the screen

Specifies instructions 230 to 275 to be executed 7 times (the number of E24 multiples to be considered for one arm of the parallel pair), eg. 4·7, 47, 470, 4k7, 47k, 470k, and 4M7

Specifies instructions 230 to 270 to be executed 24 times (the number of E24 values to be considered for one arm of the parallel pair)
The IF statement will successively bypass to NEXT M until the sampled resistor is at least as high as the requested one. This avoidance of unnecessary processing considerably speeds up the action

Specifies instructions 235 to 270 to be executed 7 times (same as line 200, but for other arm)

Specifies instructions 235 to 270 to be executed up to 24 times (same as line 230, but for other arm). N is sampled from M to 24 to avoid repeat sampling of that which occurred in the M loop. eg. 4k7 || 8k2 and 8k2 || 4k7 is avoided

Each time this main algorithm is executed, P becomes the parallel value of the resistors being tested. The "product-over-sum" equation is used on resistors R(M) and R(N), with X and Y as their respective multipliers

Checks that P falls within U and L, IF not, THEN jumps to next value

T1 becomes the percentage error of P to requested R. The first statement deliberately over-calculates T1 by a factor of 1000, so that the INT statement can round-down to a manageable 3 decimal places, by dividing by 1000

Converts R(M) and R(N) to R1 and R2 ready for PRINT statement. The purpose of this block of instructions is to convert print-out to Ω, kΩ, and MΩ, to save screen space

The output PRINT instruction (bypassed by out-of-range parallel R combinations). R1 and R2 are the resistor values; K$ and K1$ state the units. Quotes contain the parallel symbol "||" and "%" symbol

These specify that the NEXT value of N, or M, should be tried. Although two NEXTs may share the same line, NEXT W, for example, will not be selected until all the Ns from M to 24 have been tried (see, line 235). In this example, the multiplier Y will be raised to the power of ten in the process

Without graphic embellishments this program is fairly portable (will work on most machines) but the UK101 requires that READ statements *precede* DATA statements. The E24 resistors are assumed to be zero tolerance.

Semiconductor UPDATE...

FEATURING: ULA 2U000 AD7525 NE586/7

R. W. Coles

THE EVERYTHING CHIP

My first offering this month is not something that hobbyists can easily rush out and buy, but I do feel that it will interest most PE readers for two reasons: (a) It is British to the core, and (b) It is a novel device with almost unlimited potential which is sure to crop up in "hobby sockets" before long.

The device in question is the Ferranti **ULA 2U000,** where the ULA part stands for Uncommitted Logic Array. There isn't anything new about the ULA concept itself, Ferranti have been selling versions based on their unique Collector Diffusion Isolation (CDI) technology for several years, but their latest offering really does look a winner in a truly internationl sense. But first, a word about the ULA philosophy.

In these days of Large Scale Integration (LSI), anyone can get a complex logic system integrated as a single chip—providing they are prepared to order at least 10,000 to make it cost effective! Anyone who can't afford those sort of quantities has to make do with random logic chosen from the TTL or CMOS families for example, or perhaps a microprocessor with its attendant memory and peripheral chips. Those are the main options, and for many applications none of them fit very well. It is in these "awkward" applications where the great British ULA compromise can come to the rescue.

The ULA is an LSI chip which consists of an array of standard logic gates without interconnections. The uncommitted semiconductor chips are mass produced with all the economics of scale which that brings, and then stockpiled (unpackaged) as a standard product. When Joe Bloggs & Co. want a washing machine controller chip, or John Smith & Co. need a controller for an electronic camera, they draw up a logic diagram with all the necessary gates, counters, flip-flops and drivers shown, and Ferranti produce a final metallisation mask which interconnects the gates on a ULA to do the job. The fact that only the final mask is "special" means that design time is short and the resulting devices are much cheaper than a discrete logic, or microprocessor, approach.

The 2U000 seems to be the ultimate device in a logical progression of ULAs from Ferranti, and in this case it can do *more* than the custom MOS LSI competition because it has linear circuitry on chip as well as the normal ULA logic gates. With the 2U000 it is possible to build complete systems with gates, flip-flops, counters, Schmitt triggers, l.e.d. drivers, comparators, oscillators, and amplifiers, all on one chip with any number of package pins from 14 to 40! The new chip can be battery powered too, sipping only about one milliamp from a one volt supply despite the 256 logic cells (each of which can be connected as two two-input gates) *and* the forty linear or interface cells which are arranged around the chip periphery.

You still can't get your hands on goodies like this in one-off or even ten-off quantities of course, but you don't have to order ten thousand either! If there is any justice in this world, this chip should be a real winner for Ferranti *and* for Britain.

DIGI-POT

If you need an accurately set potentiometer with good resolution for an instrumentation application say, the old way to do it is to use a bulky, wire wound, helical pot with a turns counting dial. It would be expensive, the pot would wear out eventually, and reading the dial wouldn't be too easy, but it would work, and with luck you might get 1:1000 usable resolution. Soon you'll be able to do it the digital way—thanks to Analog Devices and their Multiplying Digital to Analogue Converters (MDACs).

Now I suppose everyone knows roughly what a DAC is (parallel binary in—proportional analogue signal out at the other end) but I for one always expected to see a precision d.c. reference supply used with every DAC, and that's where the M comes in, to prove me wrong. A *multiplying* DAC can be used with any signal on its "reference" pin—even an a.c. waveform which swings above and below ground. So, instead of binary in and analogue out with the scaling set by a precision d.c. reference, we get a.c. signal in and a.c. signal out with the output related to the input by a scaling factor determined by the binary input. In effect the a.c. input is multiplied by the binary input, with the largest multiplier being unity.

Now, I have been talking about an a.c. signal input, just to show the change in emphasis in MDAC applications, but actually it can be any sort of signal, a.c., d.c. or precision reference. A classic application for an MDAC might be the control of gain or "level" in an audio channel by means of a computer or microprocessor, but there are many other occasions when an analogue signal has to be kept under precise, digital control.

So much for MDACs but how about Analog Devices and digital pots? Analog devices have a whole family of MDACs available already, but newly added is the **AD7525** which has the distinction of having b.c.d. (binary coded decimal) rather than straight binary inputs. B.c.d. is of course great for interfacing with *people* as every calculator knows, because it is easy to convert to and from decimal (or denary for the purists!). Team up the AD7525 with a $3\frac{1}{2}$ digit thumbwheel switch, which can be set from 0000 to 1999 and you have got yourself the simplest, most reliable, precision potentiometer money can buy. You can use it anywhere you need a precision pot—power supply O/P voltage setting, amplifier gain setting, time delay setting and so on. It will work for a.c. and d.c. signals and you can put it right in the signal path with only the non-critical b.c.d. connections brought to the front panel.

IMPROVED DECODER

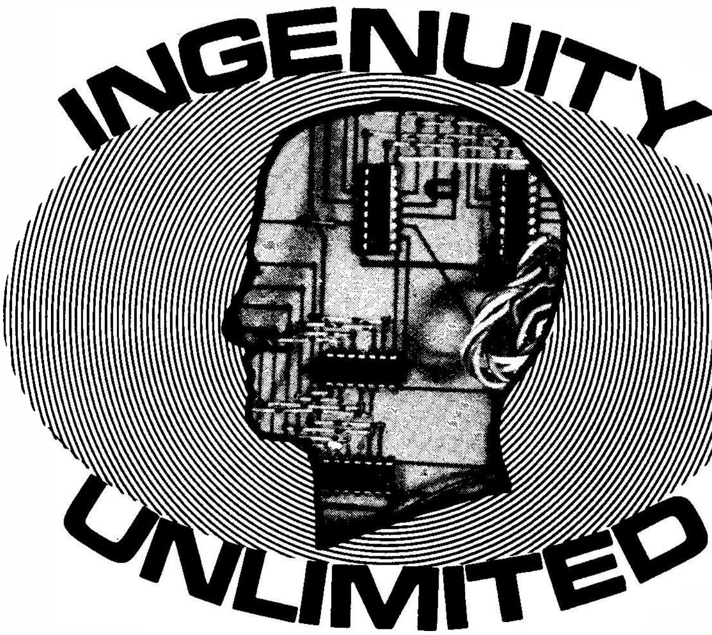
When the 7447 seven segment decoder joined the TTL family it was one of the most complex devices then available, and all those goodies like leading zero suppression and intensity modulation capability made it and its attendant filament or l.e.d. displays very attractive compared with the traditional high voltage "Nixie" tubes previously used for number indication. Time marches on however, and the 7447 has now got competition. Most of the competition up to now has had a limited area of application, but a pair of new devices from Signetics/Mullard look ready to oust the 7447 from its industry-standard position.

The devices, coded **NE586** and **NE587** do all that the 7447 does, including leading zero suppression and intensity modulation, but in addition they both feature an input latch and constant current output drivers which remove the usual need for a collection of current limiting resistors. The input latches make interfacing with microprocessors and other systems, like counters, where data is available only in a dynamic form, very easy. The NE586 has a fixed O/P drive current of 25mA per segment which is suitable for a range of seven segment l.e.d. digits. The NE587 has an extra pin which allows single resistor programming of the output current up to a 50mA maximum, making display multiplexing easier and the choice of l.e.d. digit even wider.

Ferranti Ltd., Gem Mill, Chadderton, Oldham, Lancs. OL9 8NP.

Analog Devices Ltd., Central Avenue, East Molesey, Surrey KT8 0SN.

Signetics/Mullard Ltd., Mullard House, Torrington Place, London WC1E 7HD.



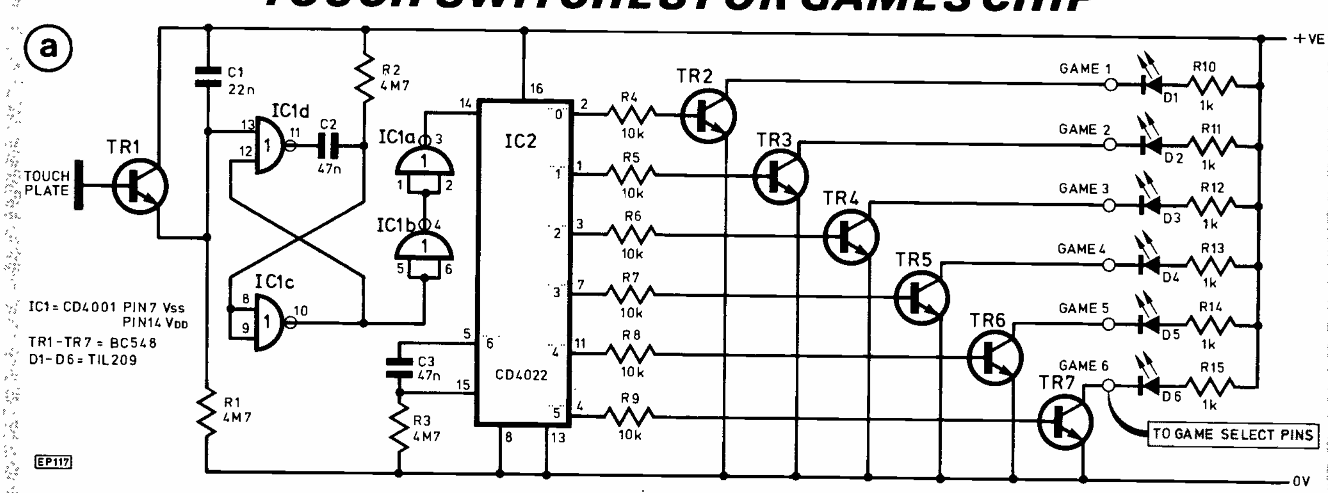
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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.

TOUCH SWITCHES FOR GAMES CHIP



I HAVE made some electronic units to suit the AY-3-8500 TV-game. Instead of using usual switches I have constructed some touch switches.

(a) A touch switch to select one of the six games—this was built around the CD4022 which is made to count from '0' to '5' via R3 and C3. At count '6' pin 5 goes high and thus resets the counter to '0'. Pin 15 is usually held logic 0 by R3.

IC1a and IC1d of the CD4001 form a monostable which is triggered by TR1 by placing a finger on its base. The output of the monostable is fed to IC1b and then to IC1a to give a good pulse to the input of CD4022, pin 14.

The outputs will randomly go high making TR2–TR7 conduct, and by connecting the game selector pins of the AY-3-8500, a touch at the base of TR1 will change game. You may also connect six l.e.d.s and six resistors to the collectors and the positive supply line.

Instead of using TR2–TR7 it may be possible to use the hex inverter buffer CD 4049.

(b) A touch switch to select angles and/or ball speed and/or bat size—a CD4001 is used to trigger CD4022 (or 4017, see Fig. 5) in the same way as before. The outputs of CD4022 are connected via twelve diodes to the bases of TR2–TR4 and the collectors are randomly high/low, which is seen from the l.e.d.s. There are eight different stages, which will be seen from the table below.

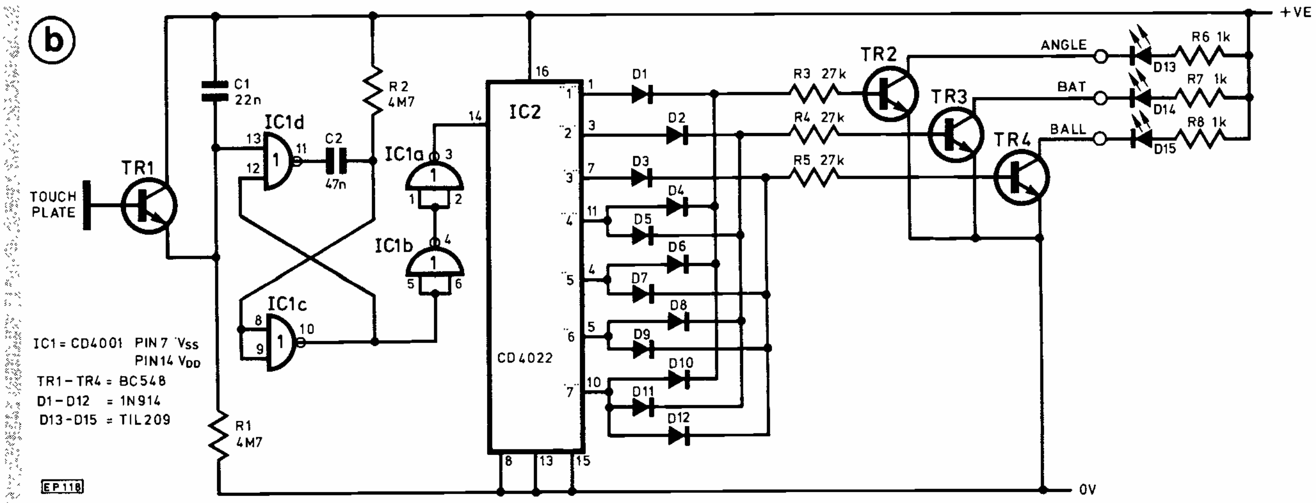
CD4022 *Pin*	*o/p*	**Angles** *TR2*	**Bat size** *TR3*	**Ball speed** *TR4*
2	0	1	1	1
1	1	1	1	0
3	2	1	0	1
7	3	0	1	1
11	4	1	0	0
4	5	0	1	0
5	6	0	0	0
10	7	0	0	0
		To Pin 5	Pin 13	Pin 7

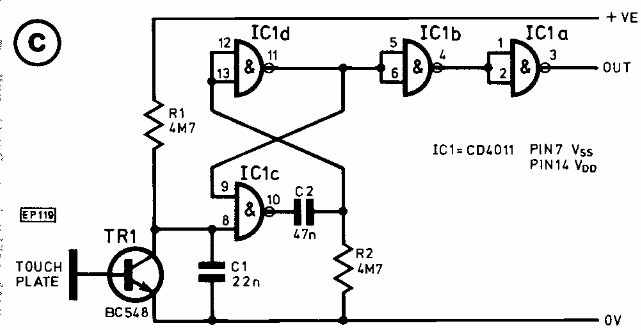
Which are pins of AY-3-8500

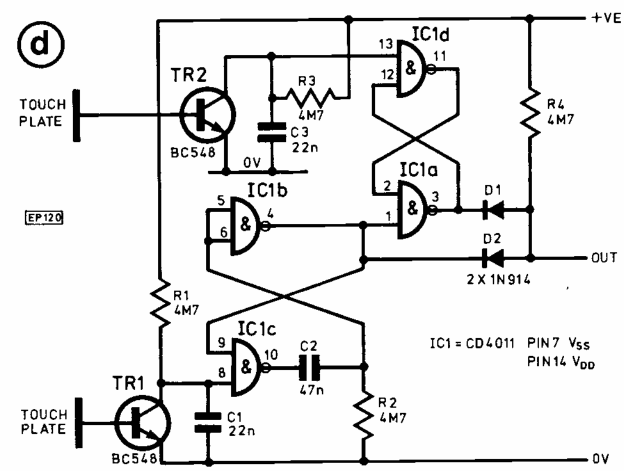
(c) A reset touch switch for the AY-3-8500—here are used the four gates of a CD4011. Gates IC1c and IC1d form a monostable and the output of gate IC1a goes logic 0 for a short time when touching the base of TR1.

(d) Automatic/manual serve of the TV-game—gates IC1b and IC1c form a monostable and the output goes logic 0 for a short time, by touching the base of TR1, this is the manual serve. Gates IC1a and IC1d form a bistable. The output of gate IC1a is logic 1 always after a touch at TR1 but change to logic 0 by touching the base of TR2 and thus remains logic 0—and this is necessary for the auto-serve.

Olav Foldoy,
Tananger,
Norway.







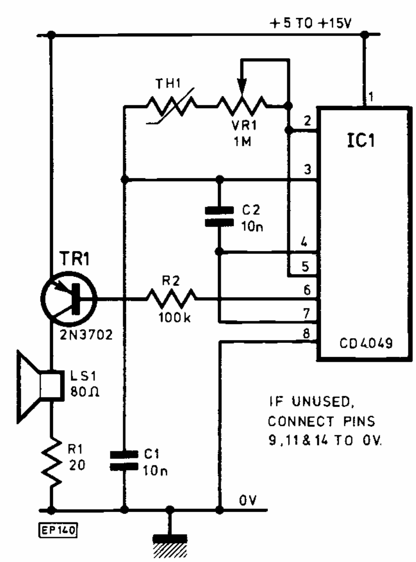
TRANSDUCER OSCILLATOR

This circuit uses three of the inverter buffers contained in the CD 4049 integrated circuit. A thermistor (or l.d.r.) and a preset together with two capacitors, comprise the oscillatory part of the circuit. The output is fed to a simple driver circuit and thence to a speaker. When power is supplied to the circuit, both capacitors charge through the combination of VR1 and TH1. The output from pin 6 oscillates from high to low at a frequency inversely proportional to the combined resistance of VR1 and TH1. Thus the frequency is controlled by the resistance of the thermistor and hence the temperature, once the order of frequency is set by VR1.

In operation, the frequency will increase with increasing temperature. The audio output gives a qualitative indication of temperature change. Coupled to a frequency meter and calibrated, it becomes a quantitative measurement.

If desired, the circuit may be duplicated, substituting an l.d.r. for the thermistor using the second half of the chip. A switching arrangement would enable either circuit to be coupled to the driver circuit. Thus giving an economical temperature/light oscillator.

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



SOUND-TO-LIGHT SEQUENCER

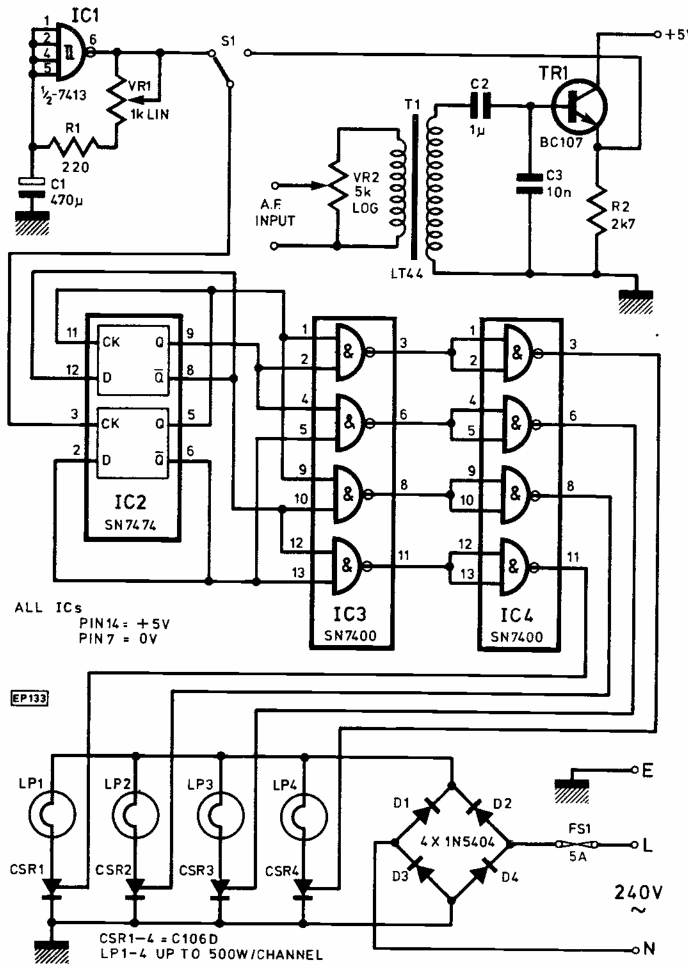
THE circuit shows a four channel sound-light sequencer utilising full wave control.

Clock pulses are drived from half of a 7413. This is connected as an oscillator with a fast edge and a frequency which is variable between about 0·5 to 20Hz. This clocks one half of the 7474 flip-flop organised as a divide by four counter which in turn is coupled to a decoder which interprets these four states and whose output sequences a low state at the outputs of the NAND gates. These outputs are inverted by IC4 and then are taken directly to the gates of the thyristors.

When any output of IC4 goes high, a logic 5V is applied to the gate of the corresponding thyristor, thus triggering it into conduction. When, however, this voltage is removed, as it is on triggering by the following clock pulse, so as soon as the full wave rectified mains supply to the thyristor falls to zero, the thyristor is turned off and so the cycle repeats, turning on each thyristor in turn.

The input of the low frequency amplifier, is connected across a speaker and so can be used to sequence the lights in time to the beat of music. One point to note, is that, as the ground connection is *not* at earth potential, but at 240V, the 0V rail on the logic supply *must not be earthed.*

R. Scott,
Stakeford,
Northumberland.



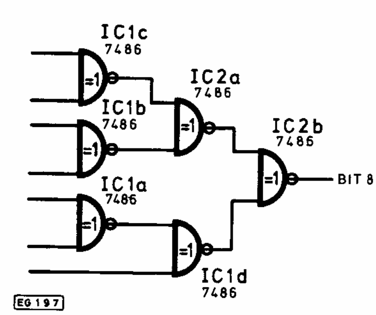
PARITY FOR ASCII

PARITY bits are provided for computers to enable a check for errors to be made. This is done by counting the number of 0s and 1s, and if an odd number is counted an error has occurred.

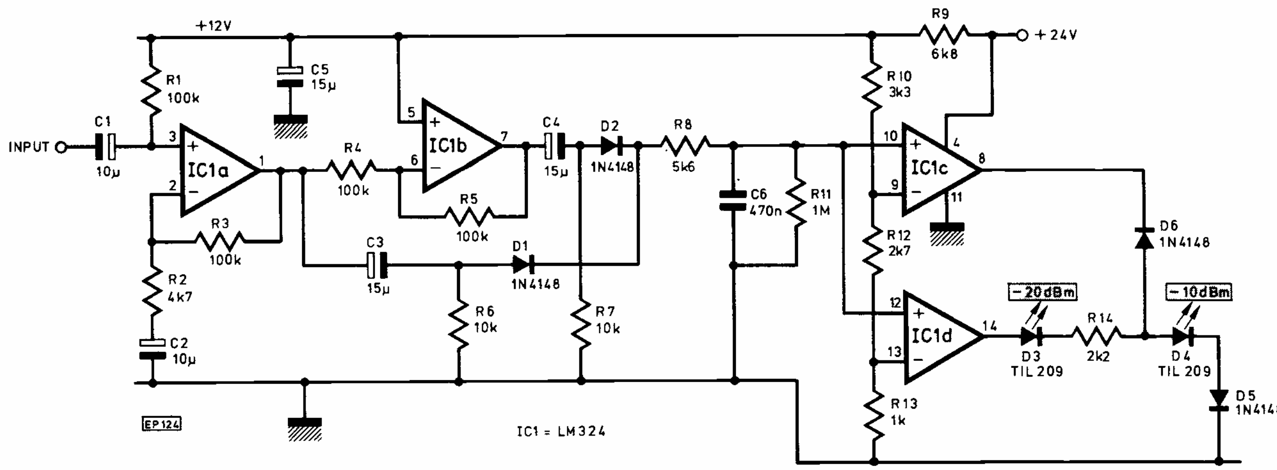
This circuit effectively counts the 1s, and adds a parity bit if the total is odd. The circuit is self-explanatory. The output of each EXCLUSIVE-OR gate is high only if one input is low and one high, i.e. a check for odd or even.

This means the gate IC2b is high only if the first seven bits have an odd number of 1s. This output is used a the eighth bit.

M. Williams,
Hornchurch,
Essex.



A PEAK PROGRAM INDICATOR



THIS circuit uses a single quad op-amp package to provide two stages of peak signal level indication, on a fast-attack. slow-decay basis. Full-wave rectification is used so that both positive and negative peaks are taken into account, and a special output configuration allows the power drawn from the supply to be no greater than that required for one l.e.d. indicator only.

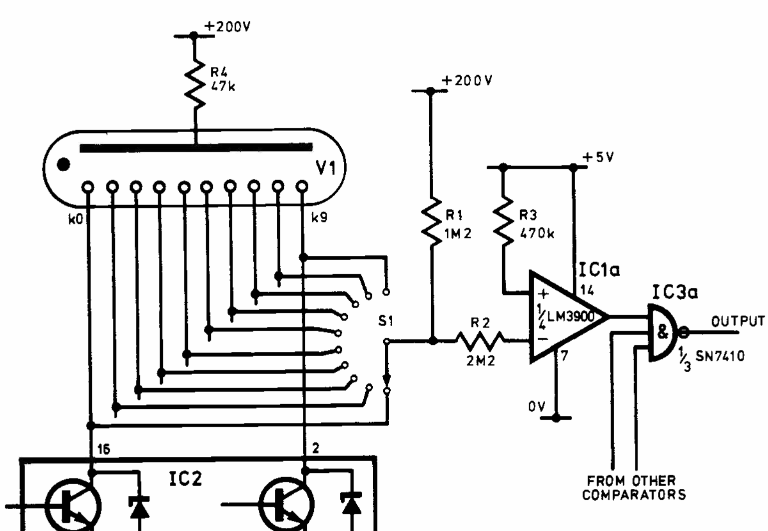
IC1a is a high input-impedance amplifier; the sensitivity of the indicator is defined by R2, which sets the gain of this stage. IC1b acts as a unity gain inverter, and so one of the diode rectifier networks acts on positive peaks, and the other on negative peaks, phase-inverted by this stage. Both peak rectifiers charge a common storage capacitor C6 through R8, which defines the attack time. R11 allows C6 to discharge between peaks, and sets the decay time.

IC1c and IC1d act as comparators, their trip points set by the voltages on their inverting inputs, derived from the resistor ladder-network that also generates the mid-rail voltage for biasing the linear stages. IC1d, which receives the lower voltage, switches to indicate the −20dBm level, its output going high and causing current to flow through D3. Since the output of IC1c is still low, it sinks this current through D6, and prevents D4 illuminating; D5 prevents any residual glow. At the −10dBm level, IC1c output also goes high, reverse-biasing D6, and D4 is also allowed to illuminate. It is this series connection of l.e.d.s which halves the worst-case current consumption.

With the component values shown, the attack time-constant is 3ms, and decay constant 470ms.

D. R. G. Self,
Walthamstow,
London.

DISPLAY TUBE/TTL INTERFACE



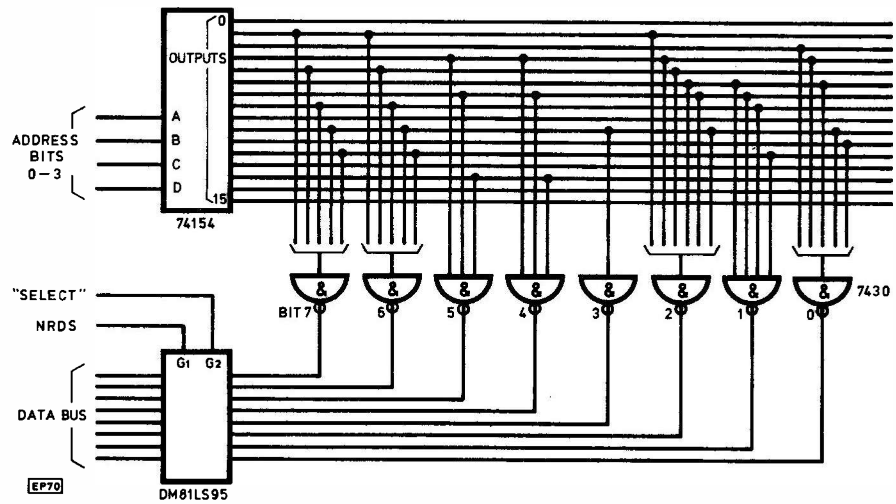
THIS circuit was used to interface the high voltage indicator tubes of a counter to TTL circuitry to detect when a particular count had been reached. It shows a worthwhile economy over a system using presettable down counters and thumbwheel switches, or BCD equivalence gates.

Each cathode of the display tube is wired to a ten way one pole switch (S1). The cathodes are usually held at about 55V by Zener diodes in the 74141 decoder/drivers when the numbers are off.

The number is illuminated when the output transistor turns on, taking the cathode to almost zero volts. The required count is selected by connecting that cathode to the op-amp. The resistor ratios are such that the output voltage goes high when the cathode voltage drops below 25V. The inverting input resistor is high enough to limit the current to a safe value even if the cathode goes up to the supply voltage, due to an internal short, for example. R1 is a bias resistor to maintain a small current through the Zener diode to prevent proximity effects when nearby cathodes pulse.

A. Langton,
Aberdeen.

SIMPLE TTL READ ONLY MEMORY



ONE of the problems facing the amateur user of microprocessors is that of loading programs into memory for testing. One can purchase a manufacturer-supplied ROM, which then restricts one to the manufacturer's methods of programming, or one can program one's own ROM, which is expensive. This approach presents an alternative method using a TTL ROM which is both flexible and economical for small programs. The program is designed for a system based around National's SC/MP, but the principle is applicable to any microprocessor system.

The "bootstrap" program is as follows:

Location	Instruction	Bit Configuration
0	None	0000 0000
1/2	LDI 1	1100 0100
		0000 0001
3	XPAH P1	0011 0101
4/5	LDI 7	1100 0100
		0000 0111
6	XPAH P2	0011 0110
7/8	LD 0(P2)	1100 0010
		0000 0000
9/10	ST @1(P1)	1100 1101
		0000 0001
11/12	LD 0(P2)	1100 0010
		0000 0000
13	XPAL P0	0011 0000

In this system the RAM memory is mapped from location 100 (hex) to 1FF (hex), and location 700 (hex) is an "input" register whose contents can be set externally by switches, using the SC/MP "hold" facility.

The first four instructions load pointer registers P1 and P2 with, respectively, the addresses of the start of RAM and of the "input" register. At location 7 the contents of the "input" register are loaded into the accumulator. This represents the first data byte to be stored in RAM. At location 9, this is stored and the contents of pointer register P1 incremented. At location 11 a further data byte is input. This should be set as follows:

00(hex) = more data to be loaded
FF(hex) = execute the program just input

This input byte is then exchanged with P0, the program counter, thus effecting a jump to either location 001 to load further information into RAM, or to location 100, the start of RAM, to execute the program just loaded.

The circuit to implement this program is shown. A 74154 decodes the low order four bits of the address to sixteen word lines. On those words where a 1 bit is required in a given location, the word line is wired to the input of an appropriate NAND gate. The outputs of the eight NAND gates are taken to the inputs of a DM81LS95 tri-state buffer. This is gated by the SC/MP Read Data Strobe, NRDS, and a "select" input which corresponds to the "chip select" of a conventional ROM or RAM. Fortuitously, bits 4 and 5 and bits 6 and 7 of this program are identical and can thus share the same NAND gates, although this economy will cause a considerable loss of flexibility should it be necessary to alter the program. This is a simple matter of rewiring the NAND inputs.

Thus a small ROM can be constructed using standard TTL for around five pounds. For large ROMs the method is uneconomic, but for programs similar to the above it is cost-effective.

J. E. Geary,
Sunningwell,
Oxon.

FRANK W. HYDE

RECORD FOR RUSSIA

This is the eleventh month of the year and it is fitting that what must be one of the most exciting years in space history should be recorded as such. On the threshold of the Shuttle era, where the techniques of the hardware have been undertaken by the United States with co-operation from space agencies round the world, the other side of the interface, mankind, has been developed by the Soviet Union. They turned their attention to the study of the biological problems of survival in space.

The longest stay in space and weightless conditions was concluded in August by Soviet cosmonauts Vladimir Lyakhov and Valeri Ryumin. They had been 175 days in space proving that this is also the province of mankind. The record of this year alone is unique for there were many misgivings, some are still vociferously apparent, yet once again the direct approach to a solution has proved the point.

MAN-MACHINE INTERFACE

In some quarters a great play is made about the so-called difficulties on return to gravity. It is right that these matters should be thoroughly investigated. They have been, and it is clear that provided the exercises prescribed by the medical experts are followed no harm results. Of course in these early stages it is necessary for biological measurements to take place as soon as cosmonauts return. Therefore the maximum information must come from allowing the cosmonauts to land in the 'heavy end'. The speed of their recovery is quite amazing when it is remembered that after several weeks in bed some considerable difficulties are experienced by ordinary people on Earth when they try to walk. Other biological problems have had much special attention in those countries interested. In the United States all the data is available. The Soviet Union has been able to supply the men required. So the space frontiers are making the new world and it is gratifying that all the nations are co-operating in these activities.

The special attention that Russia has given to the testing of facilites and the direct effect of the man-machine interface has resulted in a major contribution to the space age. The other cosmonauts who showed progressive extensions of time in space have all contributed. The immediately past record holders were preceded by two other Russians, Vladimir Kovalenko and Alexander Ivanchenkov. They too carried out tasks with the ferries as well as the special activities with the Kristall furnace and the Splav (alloy) electrical smelting installation.

CRYSTALS

Salyut-6 space station saw the active investigation of crystals synthesized from elements of the third and fifth groups of the periodic table such as gallium arsenide and indium antimonide.

Of special interest was the production of crystals of cadmium and mercury tellurides. This particular crystal is the basis of a thermovisor. This is an infra-red device which can yield valuable information on the internal condition of the human body. It is indispensible for certain medical specialists.

Experiments in melting extremely pure optical glass were very successful. Zero gravity is essential for the production of high quality crystals. The natural vacuum of space will no doubt enable crystals of the second generation to exceed the present 100,000 elements per square centimetre. Indeed it is already being forecast that by the late 1980's a million elements will be possible. This again will reduce the size of equipment.

CIRCUMTERRESTRIAL SPACE

There is no doubt that the feeling is growing that space exploration is associated with the application to the use of circumterrestrial space. It is to this end that the Soviet Union has spent so much time with the Salyut-6. The weight of this station is 19 tons. Its length is 15 metres. With two docked cargo ships it grows to 30 metres and 32 tons. The building up of stations by the simple process of joining up successive units, each a vehicle in its own right, seems to the Russians to be an efficient and safe way of dealing with the tasks of the future.

During the two years that the space station has been in orbit much work has been done. One interesting point that emerged from the working conditions in weightlessness was that as time went on the cosmonauts increased their efficiency in performing their allotted tasks. After the return of the last two cosmonauts the station continues orbiting automatically. During the period of its activity seven freight transport ships have made the journey to and from the Salyut-6.

Lyakhov and Ryumin began their record breaking trip in a Soyuz-32 spaceship on February 25 this year. On the 26 of February they commenced work aboard the Salyut-6. Materials and equipment were brought up by Progress-5, Progress-6 and Progress-7 ships. In addition the unmanned Soyuz-34 brought materials and equipment to the station. On June 13th the Soyuz-32 which brought the crew to the station returned with records and the two cosmonauts Kovalenko and Ivanchenkov.

TELESCOPES

The freight ship Progress-7 had brought up the radio telescope KRT-10. This was assembled in the intermediate chamber of the space station. Progress-7 was undocked and moved away. It was planned to use the Progress-7 as an observation point so that flight control could observe and control the telescope. The telescope was then moved out into position and the 10 metre parabola opened out. As it happened the unit did not quite get clear and the last task of Lyakhov and Ryumin before returning to earth was to execute a space walk to correct the fault.

The telescope was used in conjunction with the new 70 metre parabola at the long range radio communication centre in the Crimea. The distance between the two telescopes, one on Earth and the other in orbit, forming an interferometer. The base line was varied by the movement of the space station unit so that it was possible for this to range from 400km apart to 10,000km during the synchronous radio sessions. The effective aperture was the equivalent of a telescope the size of the Earth itself.

This opens up the possibilities for very large telescopes in space. A 10 metre parabola on Earth would weigh several tons but the space situated units would be a small fraction of this. It is therefore being planned by Russia to set up telescopes of up to 200 metres in diameter. A series of these will first be assembled in low earth orbit by a small team and then taken to a solar orbit. The total size of each unit would be from one to ten kilometres across. It would be possible in one combination to have one unit in near Earth orbit and the other at say Saturn. This would be a distance of about 1,500km.

This would have tremendous resolving power and might well be the means of detecting as yet unknown sources of energy and even perhaps discovering whether there were any planets round stars which might have civilisations. Also it would make it possible to set up a three dimensional picture of the universe directly.

THREE FOR ONE

Comsat are seeking to reduce the number of antennae in use for satellite communications. The new proposal called the torus antenna will enable three satellites to be in use with one antenna station. Normally there has to be a separate antenna for each satellite, each a parabola focussed at a particular point. In the new proposal, provided the satellites are grouped to a band not more than 30 degrees apart from each other it takes the form of a line focus. The reflector appears almost flat but is in fact shaped. It looks very much like three parallel linear parabolic channels. Within the 30 degree requirements three satellites can be interrogated with one station. The economics are sound for the station costs only 1·1 million dollars against 0·8 million dollars each for the single version.

QUIZMASTER

I.J. NICOLLE

Fair adjudication for quiz contests

THIS article describes a monitor set which can be used by a referee or quizmaster to adjudicate fairly the result of a contest between individuals or teams and as such should prove popular in clubs or fund raising activities such as charity functions

Each team is provided with a button or buttons to press when an answer to a question is to be submitted. The first to reply actuates a lamp and buzzer simultaneously alerting the referee to the station answering and disabling all other contestants' units.

A competition state of readiness is resumed by the referee pressing his button, after adjudication, when all units revert to their stand-by state in readiness for the next question or throwing open the question to the other contestants in the event of a wrong answer.

This system was designed for three competitors or teams; however, there is no reason why it cannot be extended to as many contestants as required.

CIRCUIT

In the off state the anodes of the three thyristors are at a positive potential biasing off D3 to D8. When one of the contestants' buttons is pressed it turns on the respective thyristor dropping its anode voltage to around zero volts; this in turn forward biases the other thyristors. The question master then notes which buzzer is sounding and cancels it by pressing his button removing the voltage from the circuit thus reducing the current through the thyristor below its holding level turning it off.

The type of thyristor used is not critical and any type should function perfectly as any variation in gate current is adjusted by the three presets to suit the manufacturer's data.

To adjust these presets connect an ammeter across the press switch contacts and adjust the wipers to get the right gate current (200mA on the thyristor specified). Do not adjust for gate voltage as this can be very misleading.

If triggering should become a problem use 0A47s as these have a lower forward voltage drop although they are more expensive.

The circuit around TR1 forms a simple voltage regulator with the base held at the Zener voltage thus holding the collector of TR1 at the Zener voltage less the forward voltage drop of the transistor junction, approximately 700mV.

The quiz-master's button shorts out the Zener diode, grounding the base of TR1, effectively removing all the voltage from the output. The Zener voltage is not critical and may be any voltage between 7-15V although the lights will be brighter and buzzers will be louder if the Zener voltage is towards the upper limit.

The regulator circuit may be discarded if a press to open push switch is available or even a toggle switch, but if this is done the output to the thyristors will not be stabilised and will rise to something like 22V causing the bulbs to have a shortened life and making it necessary to have higher working voltage capacitors.

Also the lamps may be dispensed with but if this is done the thyristors will not latch as the buzzers take an intermittent current, so some other load will have to be provided to keep the holding current above the threshold level.

Diodes D3 to D8 are needed to stop interaction between the thyristors. It will be noticed that these are all mounted in the centre enclosure instead of their respective boxes. Wiring up in this way enables the use of four core cable, otherwise six core cable would be necessary (Fig. 1).

COMPONENTS . . .

Resistors

R1	470
R2–R4	1k (3 off)
All $\frac{1}{4}$W carbon	

Capacitors

C1	1,000µ elect 25V
C2–C4	220µ elect 16V (3 off)

Potentiometers

VR1–VR3	10k (3 off)

Semiconductors

D1	1N4001
D2	BZY88 10V 400mW
D3–D8	1N914 (6 off)
CSR1–CSR3	C103YY (6 off) (R.S. 261–873) (3 off)
TR1	2N3053

Buzzers

BZ1–BZ3	12V single tone (R.S. 248-808) (3 off)

Miscellaneous

S1 Mains on/off toggle, S2–S5 push button switches, 4 boxes Astros Grey (AST578)—West Hyde, 40 feet four core cable. Transformer—6-0-6V 0·5A mains (R.S. 196–296). Lampholder—22mm dia. Bulbs—12V 2·2W, Mains neon, FS1—50mA

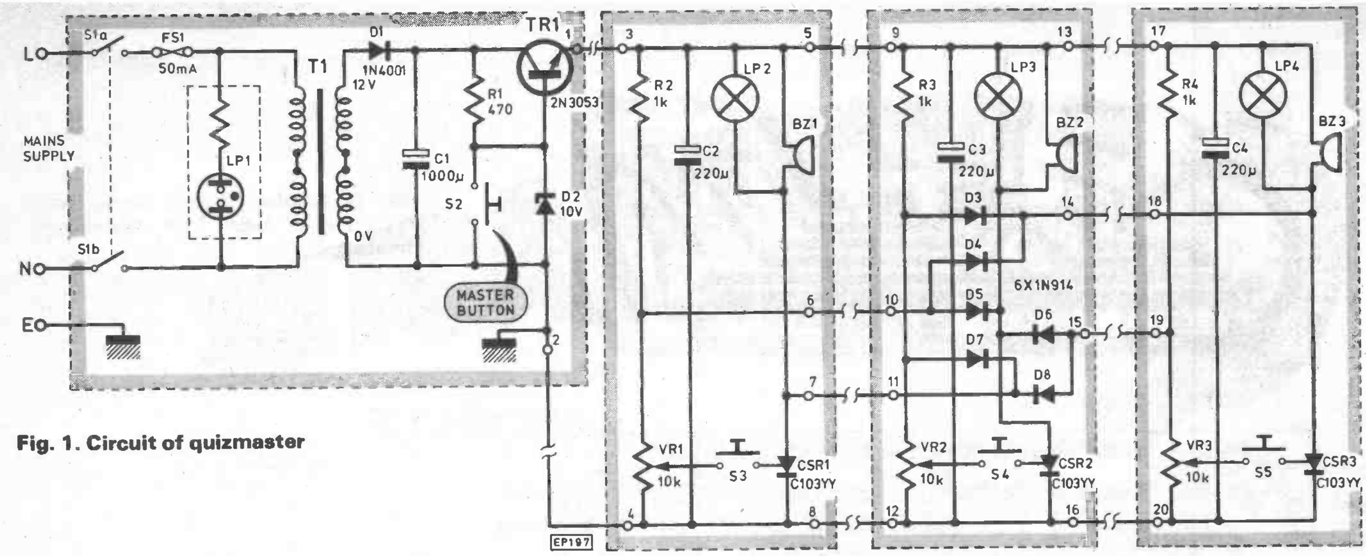


Fig. 1. Circuit of quizmaster

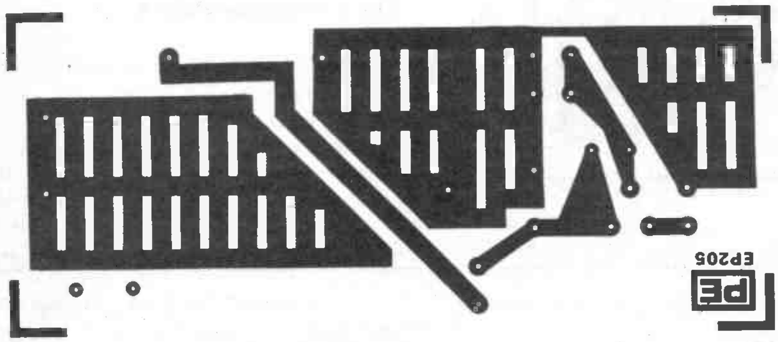


Fig. 2. Printed circuit board for p.s.u.

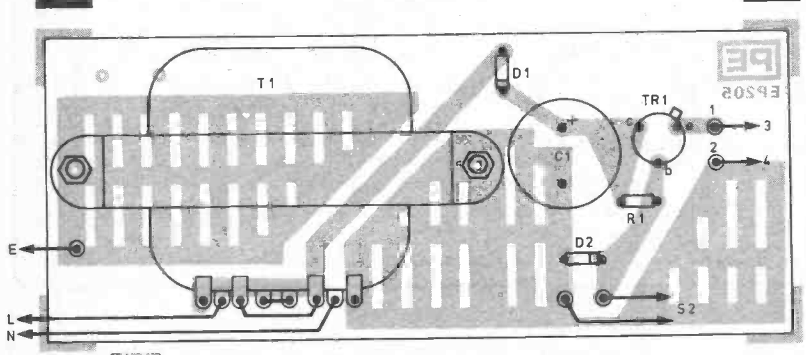


Fig. 3. Component layout

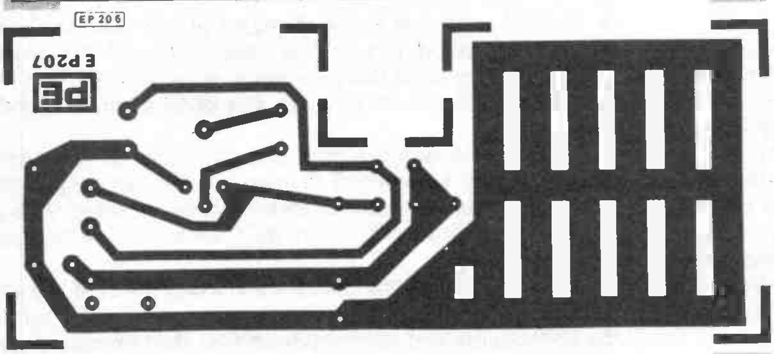


Fig. 4. Printed circuit board for individual or team boxes. Two are required

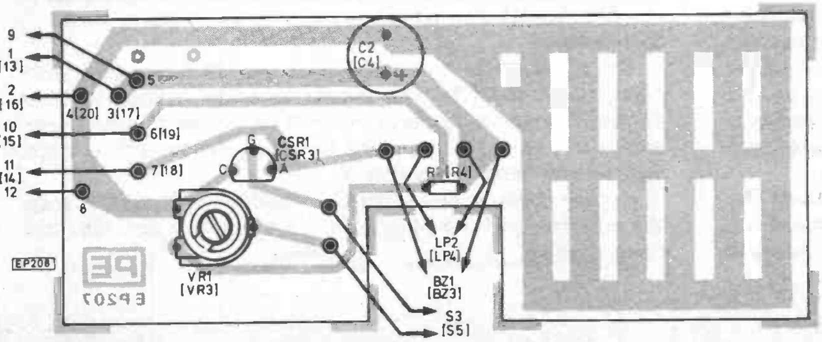


Fig. 5. Component layout. Pins and components for the duplicate box are shown bracketed

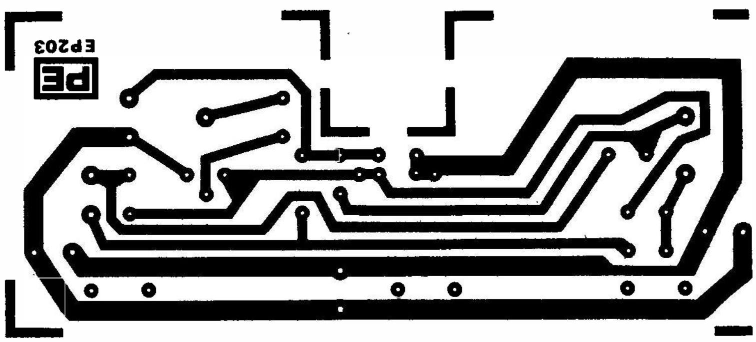


Fig. 6. Printed circuit board for individual or team box containing isolating diodes

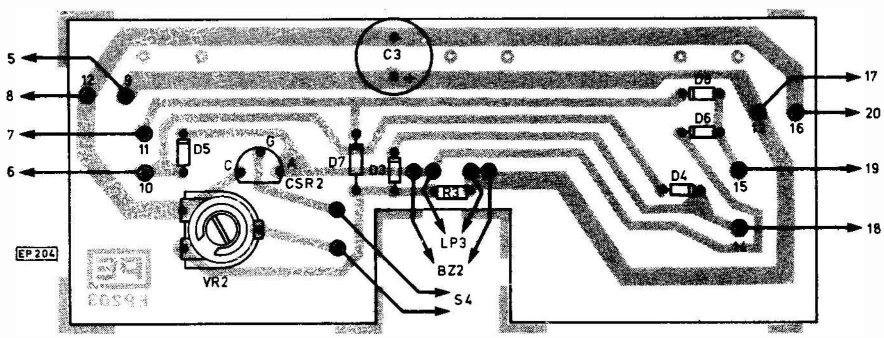


Fig. 7. Component layout

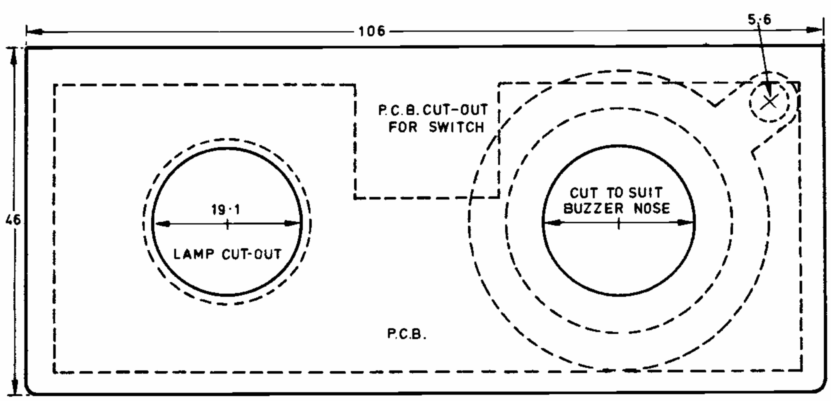


Fig. 8. Panel cut-outs for lamp and buzzer in contestants' boxes

EG 203

CONSTRUCTION

Construction is perfectly straight forward. The printed circuit boards are fitted upright in the slots moulded into the ends of the boxes. These slots are tapered down to the bottom of the box by approximately 1mm each side and seeing as the printed circuit board is also used for strain relief on the cable, some care is needed in fitting them to ensure that they are a fairly firm fit. Four core cable passes through the hole in the side of the box and then through two holes in the printed circuit board, supplying strain relief of the soldered joints. DIN plugs and sockets could be used to join up the separate units but as the cost was of prime importance on the prototypes, these were not used.

If when fitting the buzzers the hole through which they protrude is made a tight fit, the only other means needed to support them is double sided sticky tape top and bottom of the large diameter end, this being held fast by the lid when this is screwed down. Failing this a nylon nut and bolt and spacer must be used to bolt the buzzer to the printed circuit board.

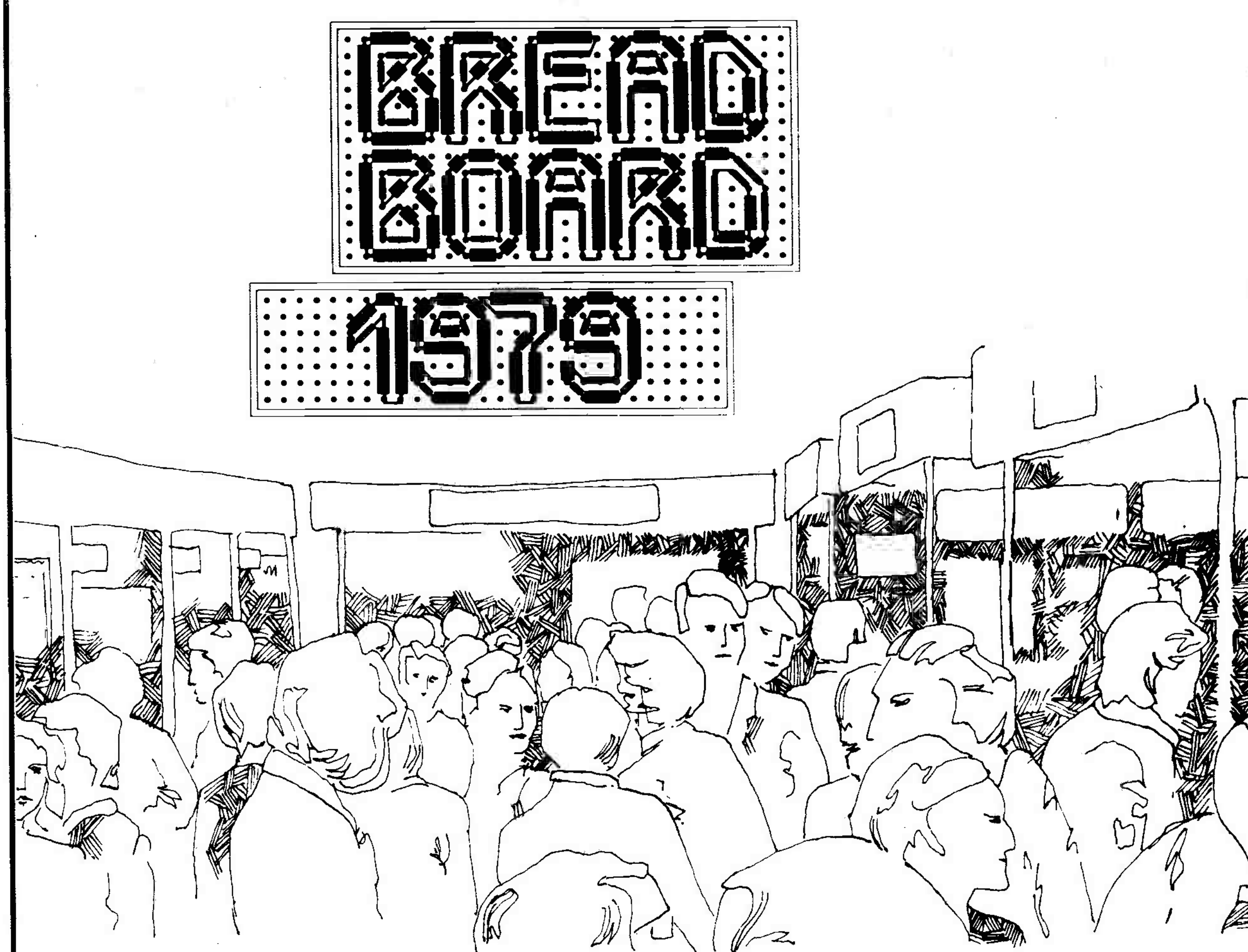
To make the holes for the panel light and buzzer the following procedure may be adopted. Mark the centre of the hole to be made with a punch, then using a pair of compasses or dividers mark the outer diameter of the hole, then drill out the centre as big as you can, filing out the plastic carefully to the outer diameter mark using, if possible, a half round file to finish off with, as this gives a much rounder hole.

A word here about marks and scratches on the boxes. These may be cleaned off (if they are not too deep) using the type of cleaner that is advertised as cleaning without scratching, such as Jiff, but many other brands of the same type may be used.

The wires joining the boxes were brought out of the side and front of the boxes and are thus kept out of the way of the contestants and quizmaster so that their hands can rest comfortably on the tables while they are waiting to push their buttons.

The West Hyde boxes specified can be purchased with plastic or metal lids. The plastic type are needed for this application or the buzzers will not fit in the boxes. These enclosures are used because they have a smooth bottom with no moulding marks visible.

Rubber stick-on feet were also used on the boxes to stop the scratching of the polished table tops; they also hide the fixing screws. ★


BREAD
BOARD
1979

CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
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
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
4017	47p	4046	90p	4520	60p
4018	55p	4049	25p	4528	60p

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		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
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
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

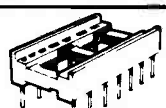
OPTO

LED's	0.125in	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

SKTS



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8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
16pin	11p	22pin	17p	40pin	32p

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2.5 x 5	54p	54p	Pin insertion tool 108p
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3.75 x 17	205p	185p	
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709	35p	LM339	45p	SN76477	230p
741	16p	LM378•	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

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				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
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
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
BC214	10p				
BC214L	10p				
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	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

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3pin	11p	9p	14p
5pin 180°	11p	10p	14p
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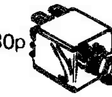

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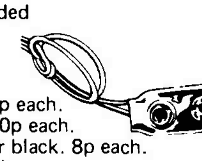

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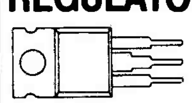

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78L12	30p	7812	60p	7912	80p
78L15	30p	7815	60p	7915	80p

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PRACTICAL
ELECTRONICS

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DIGITAL DARKROOM TIMER

R.J. MORRIS

WITH the development of simple chemistry processes for colour film printing, more and more amateurs are trying their hand at producing their own colour prints in the home darkroom.

Once you get into colour processing you quickly realise that the good old days where the enlarger button was held down for a count of ten are gone, due to the higher timing accuracy required.

This project describes a simple enlarger timer, the accuracy of which is not affected by fluctuations in the mains voltage, and which fulfils the need for simple operation, as of course the unit is used in total darkness. No indicators or displays have been incorporated as even the red light from such displays is not "safe" for use with colour photography.

RANGE

The range of the unit is from 1 to 99 seconds in one second steps but if required the timer can be modified to give a second range of 0·1 to 9·9 seconds in 0·1 second steps.

CIRCUIT DESCRIPTION

The circuit diagram of the Darkroom Timer is shown in Fig. 1. The power supply uses a standard 7805 regulator to provide +5V. It also provides a 9V a.c. line which is divided by R1 and R2 and clipped by the Zener diode D2 to provide an approximately square 50Hz input to IC2 (pin 1).

IC2 and IC3 are connected in cascade to divide the 50Hz input by 50 to produce a 1Hz standard timing pulse.

This 1Hz pulse is now fed to the input of the b.c.d. counters IC4 and IC5 which will count up the pulses from 0 to 9.

As the counters are cascaded the total count available is 99. The b.c.d. outputs from these counters are fed to the 4 to 10 line decoders IC6 and IC7. The outputs of these decoders will remain normally high and an output will go low when the particular code for that output is presented to the i.c.

Thus by using S3 and S4 any number from 0 to 99 can be selected by feeding one of the outputs from the decoders IC6 and IC7 to a NOR gate IC8a, i.e. if the number 56 is selected S3 will look at the 6 output of IC6 and S4 will look at the 5 output of IC7, thus at the number 56 the output from S3 and S4 will be low causing the output of the NOR gate to go high.

The timing sequence is started by closing S2 which resets the counters IC4 and IC5 to zero and also sets the latch formed by the two NOR gates IC8b and IC8c. Once the

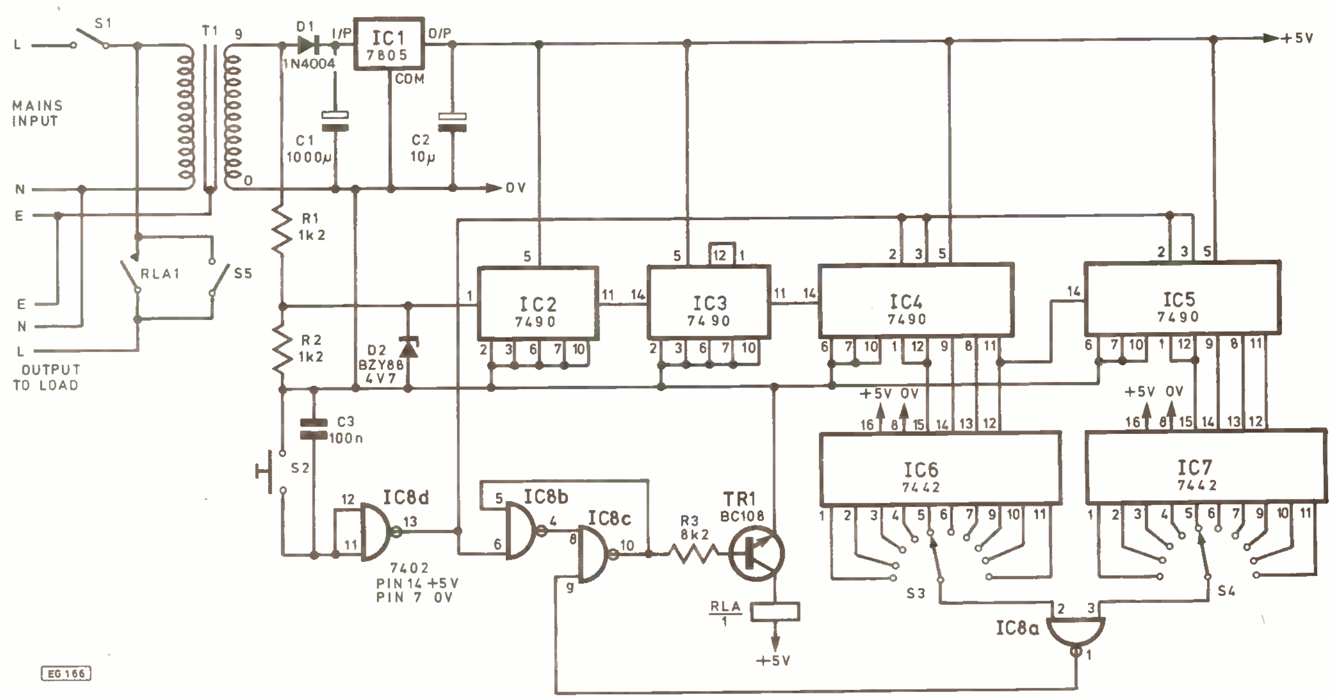


Fig. 1. Circuit diagram of the Darkroom Timer

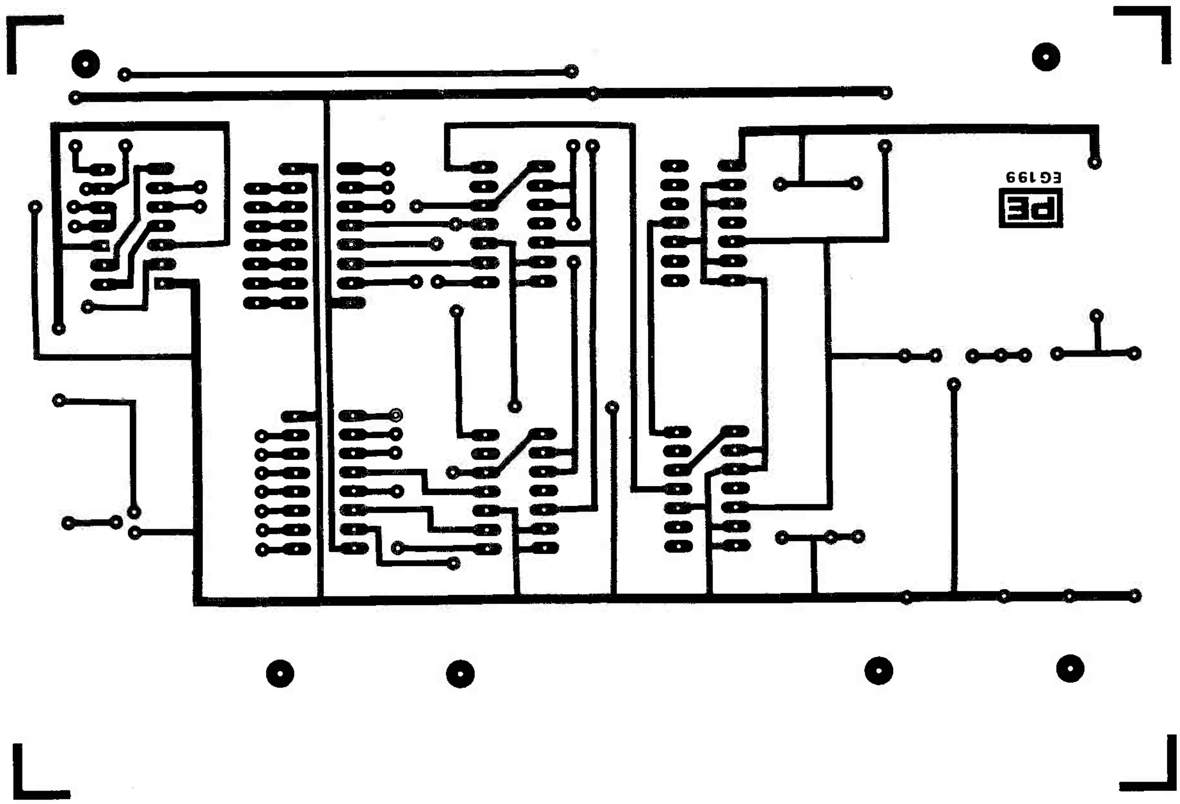


Fig. 2. Printed circuit board design

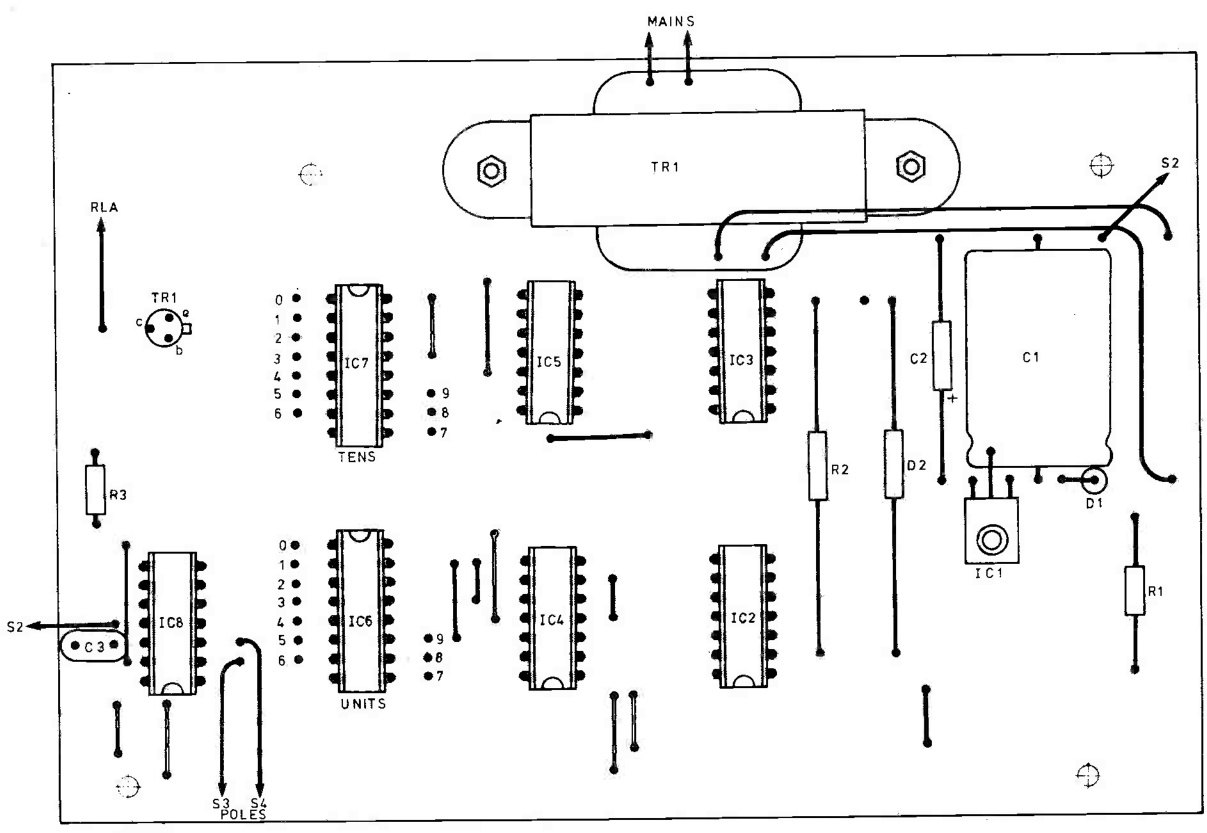


Fig. 3. Component overlay for p.c.b.

COMPONENTS . . .

Resistors

R1, R2	1k2 (2 off)
R3	8k2
All 5% $\frac{1}{4}$W carbon	

Capacitors

C1	1,000µ 25V elect
C2	10µ 10V elect
C3	100n polyester

Semiconductors

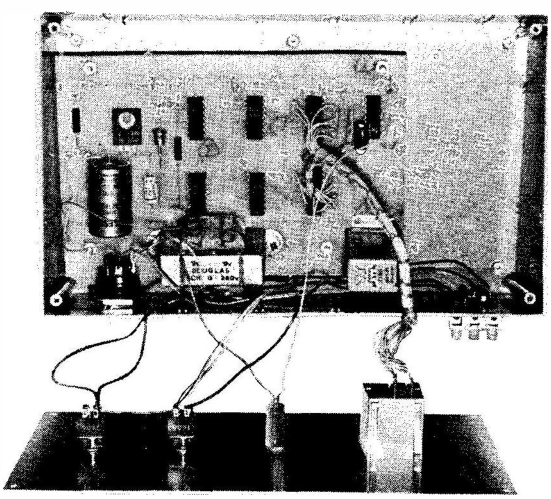
D1	1N4004
D2	4V7 BZY88 Zener
TR1	BC108
IC1	7805
IC2, IC3, IC4, IC5	7490 (4 off)
IC6, IC7	7442 (2 off)
IC8	7402

Miscellaneous

T1	9V 500mA min mains transformer
S1, S5	Single pole toggle
S2	Single pole push to make
S3, S4	Thumbwheel switches or two 1 pole 10 way wafer switches
SK1	Min. 3 way mains socket
PL1	Min. 3 way mains plug
Case	200 x 80 x 130mm
P.c.b.	EG 199
Terminal block	3 way

latch has been set the output turns on TR1 which operates the relay RLA switching on the enlarger lamp.

When the set count is reached the output of IC8a will go high, resetting the latch and switching off the enlarger lamp.



Internal view of the Darkroom Timer

CONSTRUCTION

The prototype was constructed on a printed circuit board the design of which is shown in Fig. 2 with the component layout shown in Fig. 3. After the p.c.b. has been soldered and checked the board should be mounted into the case and the switches and sockets fitted.

Thumbwheel switches were used for the time selector as they give a quick and easy method of selecting the exposure period and provide an indication of the set time. Alternatively, standard rotary wafer switches could be used to reduce the cost of the unit.

The relay used had a 6V 700 ohm coil but any relay with a coil voltage of about 4 to 6 volts and a coil resistance of over 200 ohms may be used, provided that the contacts are rated for the load.

CASE

The unit was housed in a plastic case with an aluminium front panel measuring about 200 × 80 × 130mm with all the controls mounted on the front panel and a mains input socket and a three way terminal block for the timer output mounted on the back of the case.

USE

To use the timer once it has been connected up, all that is necessary is to set up the desired time for exposure on the thumbwheel switch and press the "expose" button. The enlarger will then switch on and after the time set has elapsed, switch off.

Resetting is not necessary as the timer is reset when the "expose" button is pressed.

If it is desired to switch on the timer for focusing purposes a "focus" switch (S5) has been provided which by-passes the timer causing the enlarger lamp to stay on indefinitely.

ADDING A RANGE

A second range of 0·1 to 9·9 seconds in 0·1 second steps could be added by making the modifications shown in Fig. 4.

First, a single pole switch (changeover) is added to facilitate range switching. This switch will select either the output of IC2 (pin 11) or the output of IC3 (pin 11) and switch it to the input of IC4 (pin 14), thus feeding the counter with either 1Hz or 10Hz timing pulses.

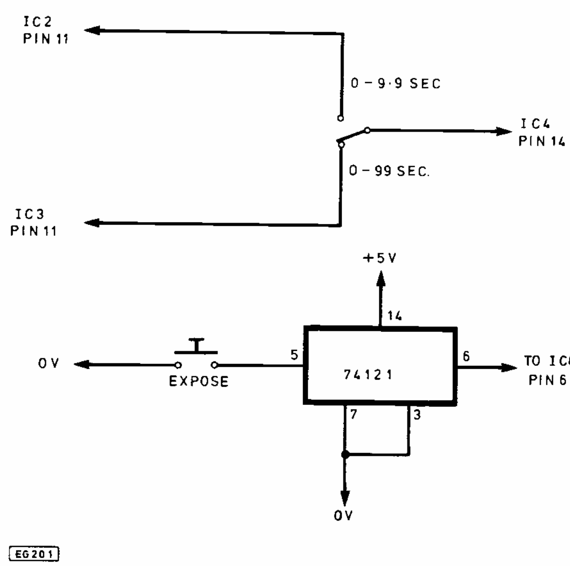


Fig. 4. Modification for adding a second range

Next, a monostable has to be added in the start circuit to give a narrow pulse when the "expose" switch is closed.

The reason for this is that when the "expose" switch is operated the latch sets immediately, switching on the enlarger lamp, but the counters do not start to count until the button has been released. Thus if the start switch is held down for 0·3 sec, there would be a timing error of 0·3 sec.

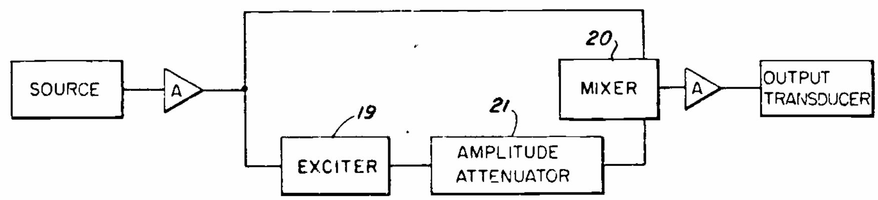
It is of course necessary to break the existing connections between pin 11 on IC3 and pin 14 on IC4.

A suitable monostable circuit is shown using a 74121 integrated circuit. ★

PATENTS REVIEW...

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

THE APHEX SOUND



British patent application 10848/77 in the name of Curt Knoppel was filed in the UK in 1977 under the old patent laws and will thus remain secret until accepted, granted and published by the British Patent Office. This will probably not be for a year or so.

The corresponding USA patent 4 150 253 was, however, recently published in the joint names of Curt Knoppel and Inter Technology Exchange Ltd., both of Los Angeles. This patent will be very interesting to anyone who has puzzled over the circuitry which is contained in the Aphex System as used by pop groups to make instrumental sounds, and the human voice, stand out and seem louder without any actual change in amplitude level.

"The formula by which the Aphex device selectively processes the audio signal has been arrived at after considerable research into the mechanisms of the ear", proclaim the Aphex ads. But so far there has been little hard fact available on how Aphex actually works. The US patent includes block schematics and circuit diagrams with component values, for both valve and transistor designs.

The block diagram shows the source signal amplified and split into two channels. The split signal passes unaffected through one channel to a mixer 20 and in the other channel is fed to an exciter 19 and attenuator 21. The output signal is thus a controllable combination of excited and unexcited signal.

Despite the advertisement claim quoted above, the patent wording admits that "it cannot be said with absolute certainty which specific elements in the exciter circuit 19 perform which function". But empirical tests and the comparison of input and output waveforms have shown that the exciter functions as a high pass filter, and generates low order, odd and even, phase shifted and amplitude dependent harmonics of the frequencies passed. A linear frequency dependent phase shift of about 360° is produced over the audio bandwidth with the point of zero phase shift at around 2kHz. In many respects therefore, the Aphex circuit is controllably producing exactly those audio effects which circuit designers normally strive to eradicate.

(Although the British Patent Office does not publish copies of US patent specifications, the foreign branch of the Patents Library attached to the Chancery Lane Patent Office holds a copy of all US specifications and will sell a photocopy at reasonable cost.)

REAR-VIEW RADAR

Recent UK patent application 2 004 418 (filed under the new laws) discloses ideas from the Nissan Motor Company of Japan for equipping motor cars with radar sensors to warn the driver of an impending collision. The aim is to offer sensing of danger from either behind or the side or both, for instance when a car is changing lane on a motorway.

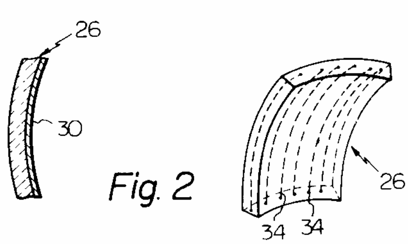


Fig. 2

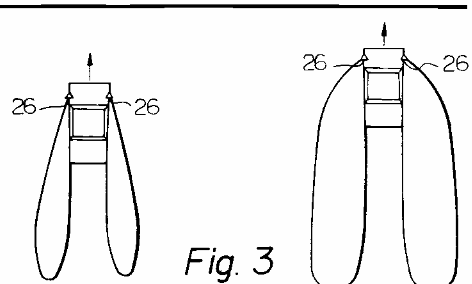


Fig. 3

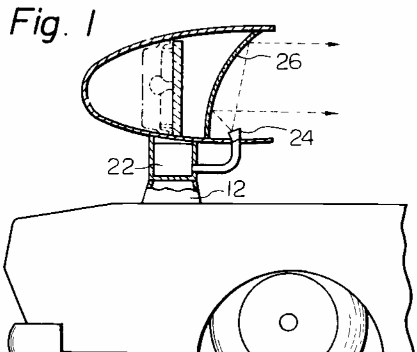


Fig. 1

The optimum position for providing rear and side radar lookout is that already occupied by the rear-view wing mirrors, so Nissan propose that the mirrors should be combined with micro-wave reflectors operating in the range 10GHz to 80GHz.

As shown in Fig. 1 a conventional micro-wave transmitter unit 22, including an oscillator such as a Gunn diode and modulator, is installed in the wing mirror post 12 and a wave guide connected to a feeder horn 24. This horn sits at the focal point of parabolic reflector 26. The reflector 26 is positioned in front of an ordinary wing mirror but the mirror is visible to the motorist because the parabolic reflector is light-transmissive.

Fig. 2 shows constructions for a light transmissive micro-wave reflector 26. One side of a curved plate of glass can be coated with a thin (few microns thick) film 30 of metal or of transparent and conductive oxide such as tin oxide. Coating is by vacuum evaporation. Alternatively a matrix of fine metal wires 34 are embedded in a curved plate of transparent glass or plastics.

Fig. 3 shows how the resultant radar lobes cover both the rear and side of the car for lane changing. Presumably Nissan intend incorporating an alarm system which will sound or light up if the driver attempts to change lanes when another vehicle is inside the radar lobes.

readout

... a selection from our postbag

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G3FYQ

Sir—I would like to take this opportunity of writing to you to give you details of the recently reformed "Pontefract & District Radio Society".

The club was re-formed in May and the Home Office have re-issued the callsign G3FYQ. The meetings are held fortnightly at Knottingley Town Hall starting at 7.30 pm.

The programme of future meetings is:—

Oct. 18th. Slow Scan Television by G41BN/G4FBA.

Nov. 1st. Film Night.

Nov. 15th. Oscar Satellite Operating by Jack Ward, G4JJ.

Nov. 29th. David Tong, of Datong Electronics on the Up/Down Convertor.

Dec. 13th. Social Evening—venue to be announced.

Further details can be obtained from address below or telephone Pontefract 71071. All new members will be most welcome.

Phil N. Butterfield, G4AAQ,
R.S.G.B. Area Representative,
Club Chairman,
43, Lynwood Crescent,
Pontefract
WF8 3QT,
West Yorkshire.

VLF Signals

Sir—I was very interested to read the article 'VLF Signals and the Magnetosphere' by C. R. Francis in your September, 1979 edition. I have been interested in this particular part of the electromagnetic spectrum for some time now, as a project with my sixth formers and we have amassed quite a lot of practical experience, much of the time using simple receiving equipment.

We would be very pleased if, through your columns, we could ask for other schools or individuals interested in VLF work and especially in Whistlers, to write to me at the address below, preferably enclosing a stamped addressed envelope. We could then share our knowledge, and even better, make simultaneous recordings of VLF phenomena. There is considerable scientific value in such co-operative work. Such co-operators need not have any prior experience.

You may be interested to know that we at Mayfield are supported in our work by the Royal Society, who have special arrangements for giving financial grants to schools doing research, and such help would be considered very favourably for any schools willing to join our investigations.

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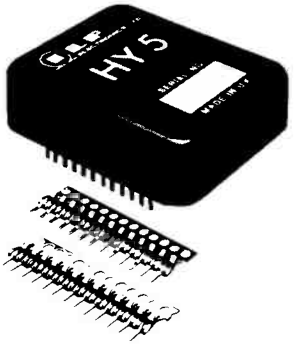

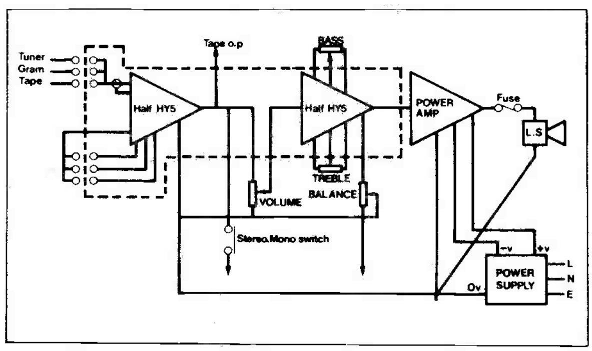

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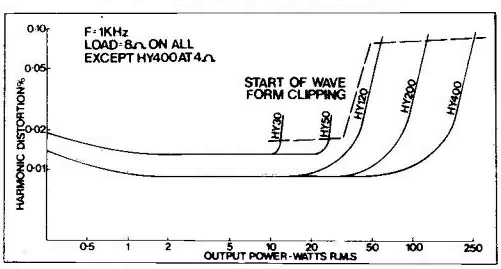

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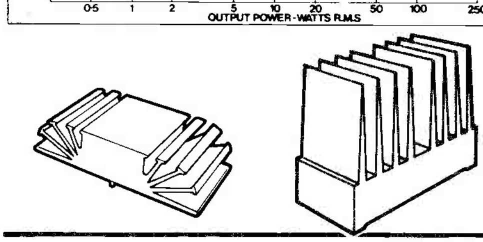

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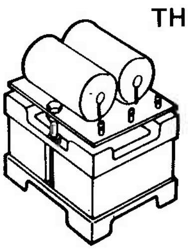

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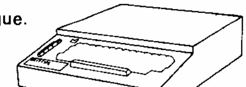

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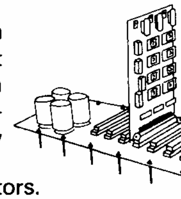

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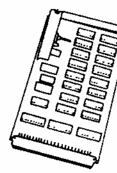

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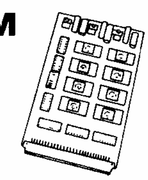

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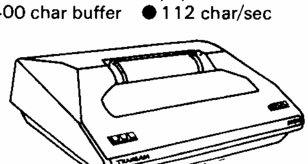

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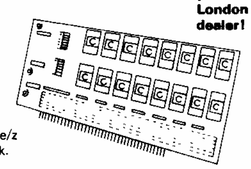

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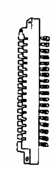

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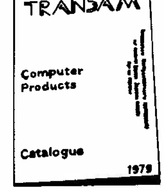

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1S921	0·08
2G301	1·15
2G302	1·15
2G306	1·27
2N404	1·15
2N696	0·29
2N697	0·29
2N698	0·35
2N705	1·38
2N706	0·17
2N708	0·23
2N930	0·23
2N1131	0·30
2N1132	0·30
2N1302	0·40
2N1303	0·40
2N1304	0·52
2N1305	0·52
2N1306	0·58
2N1307	0·58
2N1308	0·63
2N1309	0·63
2N1613	0·29
2N1671	1·73
2N1893	0·29
2N2147	2·02
2N2148	1·89
2N2218	0·29
2N2219	0·28
2N2220	0·21
2N2221	0·21
2N2222	0·21
2N2223	3·16
2N2368	0·20
2N2369A	0·24
2N2484	0·23
2N2646	0·63
2N2904	0·29
2N2905	0·29
2N2906	0·24
2N2907	0·24
2N2924	0·24
2N2925	0·25
2N2926	0·16
2N3053	0·29
2N3054	0·58
2N3055	0·81
2N3440	0·69
2N3441	0·92
2N3442	1·26
2N3614	1·73
2N3702	0·13
2N3703	0·15
2N3704	0·15
2N3705	0·15
2N3706	0·15
2N3707	0·15
2N3708	0·12
2N3709	0·15
2N3710	0·12
2N3711	0·12
2N3771	2·02
2N3772	2·30
2N3773	3·45
2N3819	0·41
2N3820	0·52
2N3823	0·63
2N3866	0·83
2N3904	0·15
2N3905	0·15
2N3906	0·15
2N4058	0·16
2N4059	0·12
2N4060	0·14
2N4061	0·14
2N4062	0·15
2N4124	0·17
2N4126	0·17
2N4286	0·23
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2N5458	0·40
2N5459	0·40
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7407	0·46
7408	0·23
7409	0·23
7410	0·18
7412	0·30
7413	0·37
7416	0·37
7417	0·37
7420	0·20
7422	0·23
7423	0·37
7425	0·35
7427	0·35
7428	0·49
7430	0·20
7432	0·35
7433	0·41
7437	0·37
7438	0·37
7440	0·21
7441AN	0·97
7442	0·83
7447AN	1·04
7450	0·21
7451	0·21
7453	0·21
7454	0·21
7460	0·21
7470	0·40
7472	0·38
7473	0·41
7474	0·46
7475	0·62
7476	0·46
7480	0·63
7482	0·86
7483	1·04
7484	1·15
7486	0·40
7490	0·60
7491AN	0·92
7492	0·69
7493	0·69
7494	0·92
7495	0·83
7496	0·92
7494	3·45
74100	1·73
74107	0·52
74109	0·81
74110	0·58
74111	0·81
74116	2·02
74118	1·15
74119	1·73
74120	0·95
74121	0·46
74122	0·69
74123	1·15
74125	0·63
74126	0·63
74128	0·69
74132	0·81
74136	0·63
74141	0·92
74142	2·65
74143	2·88
74144	2·88
74145	1·04
74147	2·30
74148	2·02
74150	1·84
74151	0·97
74154	2·02
74155	0·97
74156	0·97
74157	0·86
74159	2·42
74170	2·65
74172	5·06
74173	1·61
74174	1·73
74175	1·04
74176	1·26
74178	1·44
74179	1·44
74180	1·32
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21	4·0	**8·79**	1·31
51	5·0	**10·86**	1·52
117	6·0	**12·29**	1·67
88	8·0	**16·45**	1·89
89	10·0	**18·89**	1·89
90	12·0	**21·09**	2·24
91	15·0	**24·18**	2·39
92	20·0	**32·40**	O.A.

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Ref	Amps	Price	P & P
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103	1·0	**4·57**	1·10
104	2·0	**7·88**	1·31
105	3·0	**9·42**	1·52
106	4·0	**12·82**	1·73
107	6·0	**16·37**	1·89
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151	200	**12·28**	1·31
152	250	**14·61**	1·73
153	350	**18·07**	2·12
154	500	**22·52**	2·47
155	750	**32·03**	O.A.
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250	**12·55**	1·67	69W
500	**20·13**	1·89	67W
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1500	**33·02**	O.A.	93W
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Ref	12V Amps	24V Amps	Price	P&P
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213	1·0	0·5	**2·90**	0·90
71	2	1	**3·86**	0·90
18	4	2	**4·46**	1·10
85	5	2·5	**6·16**	1·10
70	6	3	**6·99**	1·10
108	8	4	**8·16**	1·31
72	10	5	**8·93**	1·31
116	12	6	**9·89**	1·52
17	16	8	**11·79**	1·52
115	20	10	**15·38**	2·39
187	30	15	**19·72**	2·39
226	60	30	**40·41**	O.A.

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Ref	VA	(Watts)	£	P&P
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64	75	0-115-210-240	4·41	1·10
4	150	0-115-200-220-240	5·70	1·10
67	500	0-115-200-220-240	12·08	1·91
84	1000	0-115-200-220-240	20·64	2·39
93	1500	0-115-200-220-240	25·61	O.A.
95	2000	0-115-200-220-240	38·31	O.A.
73	3000	0-115-200-220-240	85·13	O.A.
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235	330, 330	0-9, 0-9	**2·19**	0·44
207	500, 500	0-8-9, 0-8-9	**3·05**	0·85
208	1A, 1A	0-8-9, 0-8-9	**3·88**	0·90
236	200, 200	0-15, 0-15	**2·19**	0·44
214	300, 300	0-20, 0-20	**3·08**	0·90
221	700(DC)	20-12-0-12-20	**3·75**	0·90
206	1A, 1A	0-15-20-0-15-20	**5·09**	1·10
203	500, 500	0-15-27-0-15-27	**4·39**	1·10
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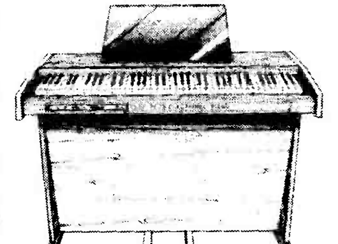

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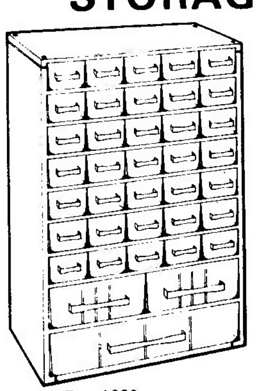

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100FE30	30-0-30	3A	6.05	138p
100FE36	36-0-36	3A	6.05	138p
150FE15	15-0-15	7A	7.47	150p
150FE26	26-0-26	5A	7.47	150p
150FE30	30-0-30	4A	7.47	150p
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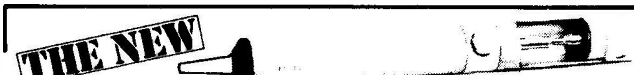

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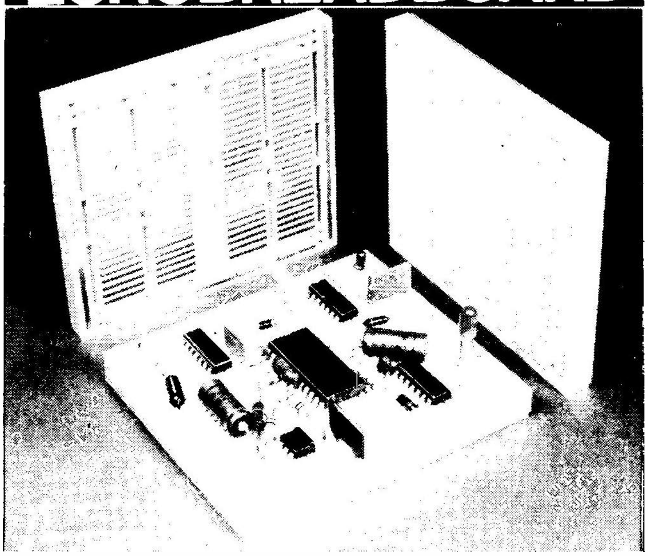

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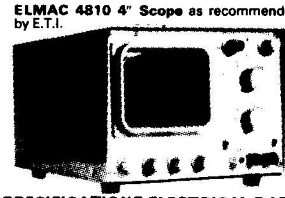

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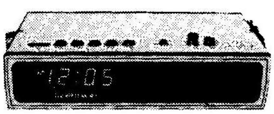

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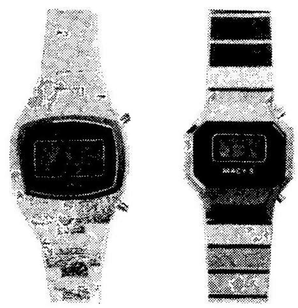

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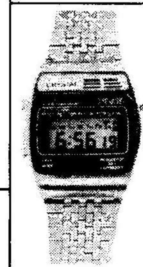

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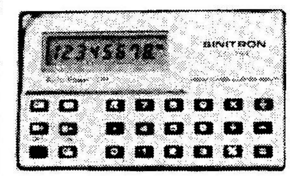

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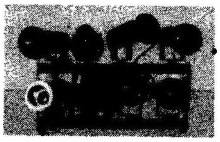

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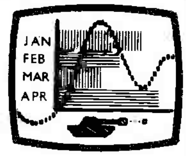

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15V	7815	70p	7915	75p
18V	7818	70p	7918	75p
24V	7824	70p	7924	75p
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5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

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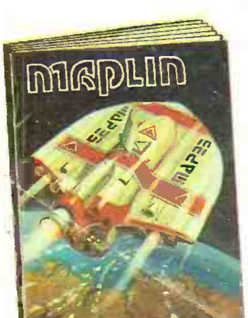

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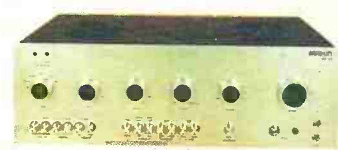

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