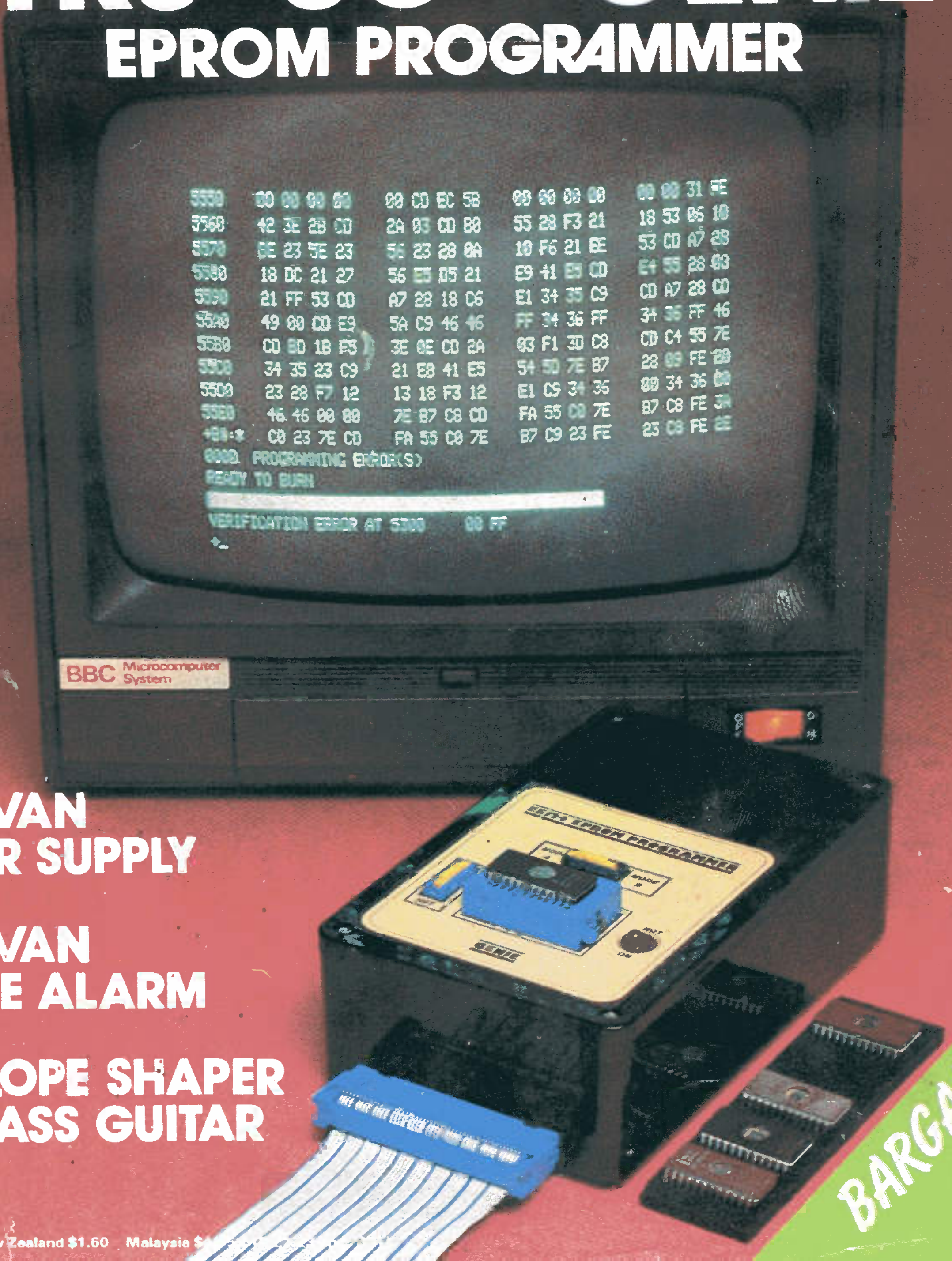
EVERYDAY ELECTRONICS and computer PROJECTS

JUNE 1983

85p

TRS-80 and GENIE EPROM PROGRAMMER



CARAVAN POWER SUPPLY

CARAVAN FRIDGE ALARM

ENVELOPE SHAPER FOR BASS GUITAR

BARGAIN OFFER SMOKE DETECTOR

Australia $1.50 New Zealand $1.60 Malaysia $

SAVE ON THE PRICE OF YOUR COLOUR PRINTS!

NOW ONLY 12p EACH

with the Everyday Electronics Colour Print Service

While prices go up elsewhere, Everyday Electronics makes a bargain offer in its Colour Print Service. Now you can have as many films printed as you like, including Giant Superprints, at only 12p a print. There is no developing charge and just 25p towards postage and packing.

At this new price, the magazine Colour Print Service, already used by hundreds of thousands of readers, is as fast and efficient as ever. Here's all you have to do to enjoy its advantages.

Send any make of colour print film, including disc film, inside the envelope enclosed with this issue. Or fill in the coupon below and send with your colour print film in a strong envelope to: **Everyday Electronics Colour Print Service, FREEPOST, READING RG1 1BR. No stamp is required.**

SEND NO MONEY

We are so confident in the reliability of our service and the quality of our prints (each one date-stamped with the month and year of developing) that you don't pay until you've seen them.

LUXURY COLOUR PRINTS

You will be amazed at the beautiful colours and sheen finish of these prints. They have elegant rounded corners and are borderless to give you maximum picture area. And with the Giant Superprints, you get 30 per cent more picture area than the standard enprints *at no extra cost!*

UNBEATABLE VALUE

All you pay for the Colour Print Service is 12p for each good print received plus 25p towards postage and packing. The most you would pay us for processing and printing a 24-exposure film for example is £3.13. Compare that with the price you would pay in the shops.

FREE ALBUM PAGES

With each film we process, you receive an album page voucher. Collect and return three vouchers, and you receive a set of FREE album pages to fit into our specially designed album for any size of print up to 4in. by 6in.

HOW YOU BENEFIT

You benefit in three ways. Firstly, you pay nothing for the actual processing—only for prints and postage and packing. Secondly, you enjoy a personal service with every care taken over each individual order. And thirdly, you pay only for what you get—with no credit vouchers as with many other companies. An invoice comes with your prints, so it is a straight business transaction.

48 HOURS IN-LAB SERVICE

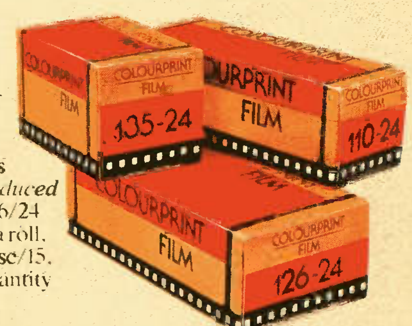
Your films will be processed within 48 hours* of receipt, but please allow for postal delays.

The price of this offer is limited to the U.K.

*C41 Process cassette and cartridge film only.

FILMS AT REDUCED PRICES

Always keep your camera action-ready. Order replacement films *at our specially reduced prices:* 110/24, 126/24 or 35/24 at £1.20 a roll, or three for £3; disc/15, £1.30 each (no quantity discount).



Offer excludes Black & White, transparency, sub-miniature, C22 & Agfa CNS film.
Superprints can only be produced from Kodacolour II, C41 cassette, cartridge and disc film not half frame. Prices correct at time of going to press.

If you have any queries, contact our Customer Service on Reading (0734) 597332.

Use this label if you have no envelope, or pass it to a friend. It is used to pack your prints.

To: Everyday Electronics Colour Print Service
FREEPOST, Reading RG1 1BR

● Please print my film Superprint size ☐
Standard Enprint size ☐

If film is being ordered ● Please send me ____
of 110/24 ☐ of 126/24 ☐ of 35/24 ☐ of disc/15 ☐

● Tick box(es) as required.

From: Everyday Electronics Colour Print Service
FREEPOST, READING RG1 1BR

Mr/Ms ____

Address ____

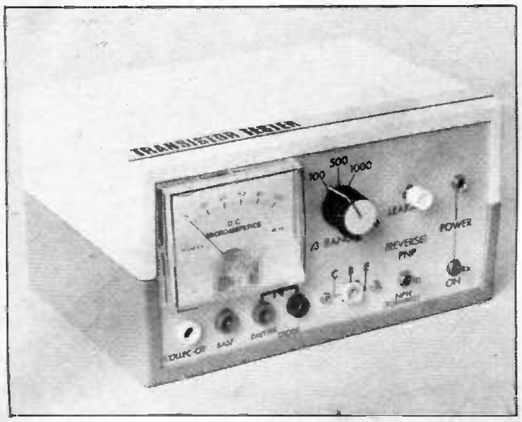
____

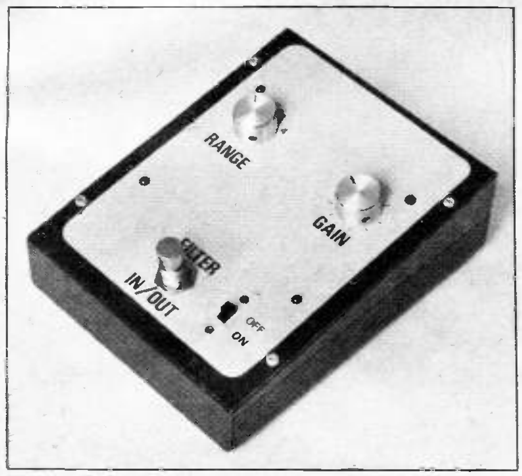
____ Postcode ____

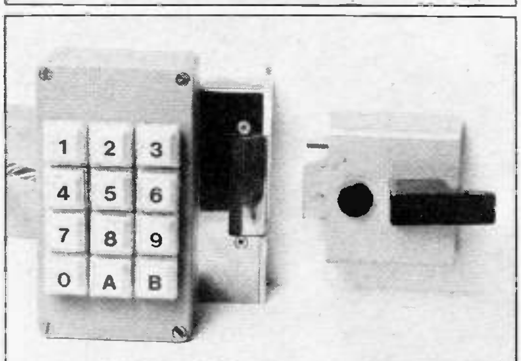
EVERYDAY
ELECTRONICS
and computer PROJECTS

VOL. 12 NO. 6 JUNE 1983

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







PROJECTS

SERIES

FEATURES

Our July 1983 issue will be published on Friday, June 17. See page 360 for details.

CRICKLEWOOD ELECTRONICS LTD.

40 Cricklewood Broadway, London NW2 3ET. Tel. 01-452 0161. Tlx. 914977.

Here's a selection from our vast stocks. Full price list free on request. Orders by 'phone quoting credit card no. or by mail order. Callers welcome. All products first grade franchised source. All in-stock items despatched same day. Official orders welcome from Govt. Depts. schools, etc. Please add 60p p&p + 15% VAT. Overseas orders no VAT but allow £2.00 min. p&p. Quantity discounts negotiable.

TRY US NOW – WE'VE GOT WHAT YOU NEED.

RESISTORS

CARBON FILM 5% HI STAR LOW NOISE
10Ω to 10MΩ
¼W E24 2p
½W E24 2½p
1W E12 6p
2W E12 12p

METAL FILM ULTRA STABLE 0.4 EXTRA LOW NOISE
10Ω to 1MΩ
2% E24 5p
1% E24 6p

LOW OHMIC GLAZE ½W
0.22Ω to 8.2Ω
E24 11p

WIREWOUND ON CERAMIC E12 SERIES
2 to 3 WATT 0.22Ω to 330Ω 28p
4 to 7 WATT 0.47Ω to 6k8 33p
10 to 11 WATT 1Ω to 33K 37p

POTS & PRESETS

ROTARY POTS LOW NOISE ¼" SPINDLES
E3 SERIES
4K7 to 2M LIN 32p
4K7 to 2M LOG 32p
As above with DP mains switch 79p
As above stereo (no switch) 89p

PRE-SETS PIHER (DUSTPROOF)
E3 100Ω to 10MΩ
Mini Vertical 15p
Mini Hzontal 15p
Standard Vert 18p
Standard Horiz 18p

CERMET 20 TURN PRECISION PRE-SETS
¾" E3 Series 50Ω to 500K 89p

CAPACITORS

CERAMIC 100V DISC (PLATE) E12 MICRO MINI
typically -5%
1pF to 10nF 7p

POLYCARB 5% SIEMENS 7.5mm MINI-BLOC E12 250V
1nF to 6n8 7p
8n2 to 47nF 8p
56nF to 150nF 10p
100V
100nF to 150nF 11p
180nF to 270nF 14p
330nF to 390nF 20p
470nF to 560nF 26p
680nF 30p
1µF (10mm) 35p

POLYESTER 250V RADIAL (C280)
10nF, 15nF, 22nF, 33nF, 47nF, 68nF 7p
100nF 7p
150nF, 220nF 10p
330nF, 470nF 13p
680nF 18p
1µF 22p
1µ5, 2µ2 39p

FEEDTHROUGH
1nF 500V 7p

HIGH VOLTAGE
Capacitors please enquire – many types in stock

TANT BEADS

.1	35V	14p
.22	35V	14p
.33	35V	14p
.47	35V	14p
.68	35V	14p
1.0	35V	14p
2.2	35V	14p
3.3	35V	18p
4.7	16V	18p
4.7	35V	20p
6.8	25V	20p
6.8	35V	21p
10	16V	18p
10	35V	27p
15	10V	22p
15	16V	30p
15	25V	32p
22	6.3V	26p
22	16V	29p
33	10V	30p
47	3V	14p
47	6.3V	34p
47	16V	39p
100	13V	32p
100	10V	55p

ELECTROLYTICS
Mainly Matsushita (Panasonic) & Siemens

AXIALS (Wires each end)

µFd	V	
47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p

µFd	V	
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end) Matsushita only

µFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

TRANSFORMERS
All 240V Primary
6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V 100mA 95p
1A 2.90
20-0-20V 1.25A £2.90
12-0-12 500VA 4.35
12-0-12 500VA 8.95
0-6-6-9-9 1.25A 4.25
These goods are heavy send extra p&p. We will credit any difference

VEROBOARD

0.1" COPPER TRACKS
2.5 × 3.75 80p
2.5 × 5 90p
3.75 × 3.75 90p
3.75 × 5 103p
2.5 × 17 280p
3.75 × 17 355p
4.79 × 17 466p
VQ Board 180p
Dip Board 3.50
Track Cutter 135p
100 Pins 49p
Veroblock 3.95
Vero Wiring
Pen + Spool 3.35
Spare Spool 75p
Combs 6p

PCB MATERIALS

FERRIC CHLORIDE
Quick dissolving pellets (mix with 1 litre water) 1.69

ETCH RESIST TRANSFERS
1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons
9. Mixture
Any sheet of above 35p

GRADE ONE GLASS PCB Single Sided
178 × 240mm 95p
420 × 195mm 130p
420 × 245mm 195p

DALO ETCH RESIST PEN 90p
spare nib

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spray ing. Expose to UV

Single sided
100 × 160 1.55
100 × 220 1.90
203 × 114 1.85
233 × 220 3.99
Double sided
100 × 160 1.65
100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
Developer for above (do not use Sodium Hydroxide) 500ml 2.50

WIRE & CABLE
Prices per Metre
Solid connecting wire 5p
Mains/Speaker Cable
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p
Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
Aerial Cable
50Ω RG58A 36p
75Ω UHF 36p
75Ω VHF 28p
300Ω Flat 14p
Rainbow Ribbon Cable
Prices per foot
8 Way 19p
10 Way 21p
16 Way 30p
20 Way 38p
24 Way 47p
30 Way 55p
32 Way 57p
40 Way 72p

RECHARGEABLE BATTERIES
Top quality. Don't throw these batteries way they charge up to 1,000 times!
HP2 (1.2AH) 2.10
HP2 (4AH) 4.75
HP7 (¼AH) 99p
HP11 (1.2AH) 2.29
PP3 4.95
Chargers
TYPE H
Adjustable to 6 of any HP type above £15.59
TYPE M
As above but charges 4AH batteries faster £25.95
TYPE P
PP3 £5.50
TYPE A
HP7 (Up to 4 at a time) £5.85

SOLDERING
ANTEX SOLDERING IRONS
C240 (15W) 4.59
X25 (25W) 4.99
Iron stand 1.65
C240 Element 1.99
X25 Element 2.05
Bits C240
No. 2 (Small) 65p
No. 3 (Med) 65p
No. 6 (Micro) 65p
Bits X25
No 50 (Small) 65p
No 51 (Med) 65p
No 52 (Lge) 65p
SOLDER 125gms
18 swg 2.95
22 swg 3.10

PLUGS & SOCKETS
'D' Connectors
25 Way Solder
Male 1.60
Female 2.09
PCB Wire Wrap
Male 1.60
Female 2.09
Covers £1.00
Phono Plugs
Blk, Red, Grn, Wht or Yellow 15p
Line Skts 15p
Chas. Skt 1 20p
Dual 30p
Quad 40p

TRANSISTORS
Britain's largest retail selection. A small sample of our vast stocks

2N930	20p
2N930A	30p
2N1893	30p
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	20p
2N2222A	24p
2N2223	25p
2N2368	2.60
2N2369	25p
2N2369A	19p
2N2904A	19p
2N2905	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3053	27p
2N3054	56p
2N3055	60p
2N3055H	120p
2N3250	36p
2N3251	36p
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442RCA	1.85
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3638	55p
2N3638A	67p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3773	1.99
2N3819	25p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3866	90p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4240	3.00
2N4347	2.26
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4870	80p
2N4871	55p
2N4888	92p
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5551	37p
2N5884	5.95
2N5884	5.95
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC2078	1.70
2SJ49	3.50
2SJ50	3.75
2SJ82	4.29
2SK134	3.50
2SK135	3.75
2SK226	4.29
3N128	1.12
3N140	2.37
3N200	6.93
3N201	2.98
40360	60p
40361	67p
40362	67p
40363	2.22
40406	1.39
40407	75p
40408	1.58
40410	1.80
40411	2.85
40412	90p
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC141K	28p
AC142K	28p
AC151	51p
AC152	45p
AC153	55p
AC153L	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
AF239	55p
AF240	1.00
AL102	3.49
AU110	2.20
AU113	3.67
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	12p
BC167B	13p
BC168	10p
BC168B	12p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	26p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC186	24p
BC187	24p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LA	13p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
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BC302	43p
BC303	47p
BC327	14p
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BC460	32p
BC461	33p
BC516	40p
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BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC558C	17p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BC650	45p
BC651	46p
BCY70	16p
BCY71	16p
BCY72	19p
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD237	98p
BD238	96p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD243C	85p
BD244A	82p
BD244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BD249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	30p
BF245B	51p
BF246	35p
BF246A	39p
BF246B	53p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	45p
BF256B	48p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF457	46p
BF458	56p
BF459	62p
BF469	85p
BF470	85p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.50
BFS98	1.70
BFX29	26p
BFX30	27p
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BSX19	24p
BSX20	24p
BSX21	40p
BU104	2.22
BU105	1.70
BU108	2.95
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU226	3.25
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU500	2.95
BUY18S	3.95
E430	5.95
J300	48p
J310	53p
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ4502	3.99
MJ15003	4.85
MJ15004	5.55
MJ15015	2.45
MJ15016	3.34
MJE340	53p
MJE350	1.50
MJE2955	99p
MJE3055	69p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
DC20	2.30
DC25	2.50
DC28	1.70
DC29	2.35
DC35	2.35
DC43	70p
DC44	82p
DC70	50p
DC71	50p
DC72	50p
DC82	50p
DC83	75p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.58
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP130	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1.04
TIP142	1.04
TIP145	1.15
TIP147	1.15
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS43	40p
TIS88A	60p
VN10KM	60p
VN46AF	86p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX450	39p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	8p
1N916	10p
1N4001	4p
1N4002	4½p
1N4003	5½p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5403	15p
1N5404	18p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1S44	10p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA155	15p
BA156	38p
BA157	25p
BA158	30p
BA159	32p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAX13	10p
BAX16	11p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
MZ2361	1.80
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p

SCRs, TRIACS, DIACS

THYRISTORS
4, 8 & 12 Amps Texas TO220
Suffix A – 100V
B – 200V
C – 300V
D – 400V
M – 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p
4A TIC106D	49p
TIC106M	68p
TIC116A	66p
TIC116B	68p
8A TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p
12A TIC126C	73p
TIC126D	77p
TIC126M	95p

TRIACS
Texas 400V
TO220 Case
TIC206D (4A) 66p
TIC225D (6A) 74p
TIC226D (8A) 88p
TIC236D (12A) 1.16
TIC246D (16A) 1.22
TIC253D (20A) 1.90
TIC263D (25A) 2.11

DIACS
BR100 40p
ST2 25p

ZENER DIODES
400 500mW E24 Series
2.4-47V 7p
1.3 Watt E24 Series
3.3-82V 14p

BRIDGE RECTIFIERS
(PIV shown in brackets)
1½ amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40

OPTO
LEDs
R Red
G Green
Y Yellow
Large diffused 1 – 50 –
R5D 9p 7p
G5D 15p 12p
Y5D 15p 12p
Small diffused
R2D 8p 6p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright high efficiency Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Rectangular Stackables LEDs
R6L 17p
G6L 18p
Y6L 19p

LINEAR ICs

AY1-5050	95p
AY3-8910	5.39
AY3-8912	5.59
CA3048	2.99
CA3059	2.80
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	95p
HA1366W	2.40
HA1388	2.54
ICL7106	7.50
ICL7107	9.75
ICL7611	97p
ICL7660	1.95
ICL8038	2.95
ICL7555	80p
ICL7556	1.50
LC7120	3.20
LC7130	3.20
LC7137	3.85
LF347	1.40
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF398	4.59
LM335Z	1.19
LM348N	62p
LM349N	1.16
LM350K	4.60
LM379S	4.50
LM380N14	75p
LM380N8	1.50
LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386	88p
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733	69p
LM741CH	96p
LM741CN	15p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1871	4.39
LM1872	4.38
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.60
LM2917N	1.89
LM2917N8	1.89
LM3900	49p
LM3911	1.20
LM3914	2.00
LM3915	2.00
LM3916	2.50
LM13600	1.10
OM335	7.20
NE531N	1.36
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534A	95p
PLL02A	4.95
PLL03A	12.75
RC4136	59p
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TCA910	2.19
TCA940	1.99
TDA1002	3.39
TDA1003	3.94
TDA1004	2.87
TDA1005	3.94
TDA1010A	2.25
TDA1022	4.95
TDA1024	1.19
TDA2610	3.90
TDA2611A	2.50
UAA170	1.59
UAA180	1.69
ULN2003	85p
UPC575C2	2.50
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	1.90
ZN1034	1.90
ZN1040	6.75

74 TTL

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	16p
7407	16p
7408	14p
7409	14p
7410	15p
7411	16p
7412	14p
7413	16p
7414	17p
7416	17p
7417	17p
7420	15p
7421	20p
7422	20p
7423	20p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	17p
7433	21p
7437	19p
7438	19p
7440	15p
7441	65p
7442	27p
7443	65p
7444	65p
7445	46p
7446	50p
7447	35p
7448	40p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	30p
7472	25p
7473	23p
7474	18p
7475	22p
7476	24p
7480	40p
7481	1.19
7482	63p
7483	38p
7484	63p
7485	60p
7486	18p
7489	1.70
7490	20p
7491	35p
7492	25p
7493	34p
7494	24p
7495	34p
7496	34p
7497	85p
74100	80p
74104	50p
74105	55p
74107	20p
74109	23p
74110	29p
74116	50p
74118	53p
74119	57p
74120	59p
74121	25p
74122	30p
74123	34p
74125	30p
74126	29p
74128	35p
74132	29p
74136	27p
74141	55p
74142	1.75
74143	1.95
74144	1.95
74145	49p
74147	89p
74148	55p
74150	49p
74151	35p
74153	35p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	40p
74165	40p
74166	48p
74170	1.17
74172	2.50
74173	48p
74174	54p
74175	49p
74176	39p
74177	45p
74178	68p
74180	40p
74181	1.15
74182	55p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	48p
74198	77p
74199	77p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	13p
74LS13	19p
74LS14	22p
74LS15	14p
74LS20	12p
74LS21	15p
74LS22	12p
74LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS40	12p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	18p
74LS76	18p
74LS78	18p
74LS80	1.20
74LS83	33p
74LS85	39p
74LS86	16p
74LS90	22p
74LS92	25p
74LS93	24p
74LS95	36p
74LS96	50p
74LS107	20p
74LS109	23p
74LS112	20p
74LS113	22p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	33p
74LS136	24p
74LS138	24p
74LS139	27p
74LS145	70p
74LS147	99p
74LS148	69p
74LS151	30p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	28p
74LS160	32p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	58p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	39p
74LS175	39p
74LS181	88p
74LS183	1.20
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	35p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	29p
74LS258	33p
74LS259	55p
74LS261	99p
74LS266	18p
74LS273	53p
74LS275	1.25
74LS279	30p
74LS280	95p
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	75p
74LS298	79p
74LS299	1.55
74LS323	1.55
74LS324	1.45
74LS325	2.96
74LS326	2.30
74LS327	2.30
74LS347	95p
74LS348	88p
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS383	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	1.60
74LS541	99p
74LS640	1.69
74LS641	1.69

CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	24p
4011	10p
4012	15p
4013	20p
4014	46p
4015	39p
4016	20p
4017	32p
4018	44p
4019	25p
4020	44p
4021	39p
4022	39p
4023	12p
4024	32p
4025	12p
4026	77p
4027	20p
4028	37p
4029	43p
4030	14p
4031	1.19
4032	80p
4033	1.20
4034	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4040	40p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	83p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.22
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	44p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.20
4093	20p
4094	69p
4095	75p
4096	70p
4097	2.88
4098	74p
4099	90p
4502	50p
4503	29p
4507	33p
4508	1.19
4510	45p
4511	48p
4512	39p
4514	1.10
4515	1.10
4516	50p
4518	39p
4519	29p
4520	48p
4521	90p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	65p
4553	2.25
4555	35p
4556	35p
4560	1.40
4566	1.40
4569	1.59
4584	39p
4585	79p

LOGIC

CPU's

1802	7.00
2650A	11.99
6502	3.47
6800	2.25
6802	2.45
6809	6.24
8035	3.49
8060	10.90
8080A	2.30
8085A	3.49
SCMP1	17.06
Z80A	2.95

MEMORIES

2114 (200ns)	93p
2532	3.60
2564	11.95
2764	7.75
2708	2.25
2716 (5V)	2.10
4116 (200ns)	77p
4118-3	3.25
4164	3.95
5101 (450ns)	1.89
5204	7.50
6116	3.85
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

MISC LOGIC ICs

ADC0804	3.95
ADC0816	14.90
ADC0817	10.06
AY5 2376	5.90
INS1671	20.80
INS1771	20.00
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
8T26	95p
8T28	1.20
8T95	85p
8T97	85p
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
8154	9.42
8155	3.50
8212	1.10
8216	99p
8224	1.05
8226	2.47
8228	2.20
Z80ACTC	2.60
Z80ADART	5.50
Z80ADMA	6.70
Z80APIO	2.69
ZN425E8	3.39

VOLTAGE REGS

– Positive – 100mA
78L05A 26p
78L12A 26p
78L15A 26p
78L24A 30p

1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p

– Negative – 100mA T092
79L05 59p
79L12 59p
79L15 59p

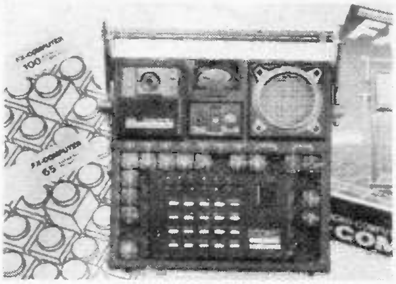
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZIF SOCKET
24 Pin 4.35

SWITCHES
Toggles (Mini)
SPST 49p
SPDT 55p
DPDT 69p
DPDT C off 85p
4PDT 2.75

ELECTRONI·KIT

FX-COMPUTER



Teach-Yourself Computer and Electronics Construction Kit

A complete introduction to the "How, Why and What" of Computers and Electronics in the most practical way ever devised

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7412	**17p**	7448	**43p**	7493	**24p**
7413	**17p**	7450	**14p**	7494	**33p**
7414	**23p**	7451	**14p**	7495	**33p**
7416	**19p**	7453	**14p**	7496	**38p**
7417	**19p**	7454	**14p**	7497	**86p**
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4008	**36p**	4025	**12p**	4048	**38p**
4009	**24p**	4026	**75p**	4049	**21p**
4010	**24p**	4027	**20p**	4050	**21p**
4011	**10p**	4028	**40p**	4051	**42p**
4012	**15p**	4029	**45p**	4052	**48p**
4013	**20p**	4030	**14p**	4053	**48p**
4014	**45p**	4031	**125p**	4054	**78p**
4015	**40p**	4034	**140p**	4055	**80p**
4016	**20p**	4036	**249p**	4059	**430p**
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Featured in April issue P.E. Reprint 50p. Free with kit.

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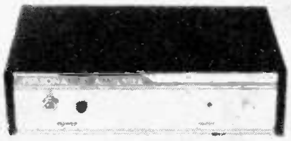
Amplifier for your personal stereo cassette player as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.



Parts: Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit, £1.95 + £1.50 p&p. Pair of 4½" eliptical speakers, £1.50 the pair, + £1.00 p&p. Input & output sockets & plugs, £1.50. Recommended case (for the power supply and amp only), £2.95 + 80p p&p.

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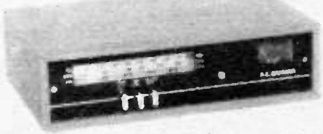
Supplied with all parts, circuit diagrams and instructions.

ACCESSORY: Stereo/mono mains power supply kit with transformer. £10.50 plus £2.00 p&p.

SPECIFICATIONS:
Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @ 100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

VHF STEREO TUNER KIT



This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to strict P.E. specification, Front scale size: 10½" x 2½" approx. Complete with diagram and instructions.

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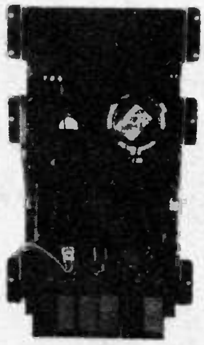

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EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 6 JUNE 1983

HOLIDAY TRAIL

THOUGHTS of summer and holidays to come have prompted two projects for caravan users and campers which are featured this month.

In the months ahead we can confidently expect car-caravan combinations to become increasingly commonplace on our roads as motorists and their families feel the urge to get away from it all and explore remote off-beat places. It is one of life's little oddities that such intrepid travellers usually like to bring along with them some of the amenities of civilised life. This is not difficult in fact, since there are many examples of portable electrical and electronic equipment suitable for such trips and capable of being powered from a 12-volt supply.

It is not wise of course to impose excessive additional load on the car battery and the best course is to use a separate car battery installed inside the caravan to power equipment such as interior lights, refrigerators, cassette players, radios, TV sets or personal computers during overnight stops. (This arrangement is not suitable for long stays at holiday sites.) The extra battery can be recharged from the car generator whilst travelling. Circuitry to permit this kind of operation without any harm to the car's normal electrical system is described in the article *Caravan Power Supply*.

Many caravanners as well as tent campers take with them a small absorption-type refrigerator powered from a gas cylinder. There is always the possibility of the gas supply becoming exhausted unexpectedly or some other fault developing with the resultant loss of foodstuff. A simple warning device powered by its own 9V battery will eliminate this danger. The *Caravan Fridge Alarm* may be built with either a visual or audible alarm and is operative when touring or at a fixed site.

Security is a matter for concern the whole year round, and electronic devices are being resorted to more and more in order to frustrate attempts at unauthorised entry. The *Push Button Combination Lock* described in this issue, when used with the recommended electrically operated lock release, will provide alternative means to unlock a cylinder-type lock whilst retaining the normal key operation. It will meet various needs, for example where a number of persons require access to premises but the issuing of keys to all individuals is not practical nor desirable. Being battery operated, the combination lock and associated release mechanism are immune from mains failures.

A word about next month's EVERYDAY ELECTRONICS. Our new series *Microcomputer Interfacing Techniques* will be a must for all computer enthusiasts. This important series will explain how to get the most from your computer by linking it to the outside world. Appropriate electronic hardware will be described in each part. As each part will be vital to the whole do make sure of your copy every month by placing an order with your newsagent.

Fred Bennett

EPROM PROGRAMMER TRS~80 & GENIE

A PORT-BASED SYSTEM DESIGNED FOR USE WITH A HOST COMPUTER TO PROGRAM +5V RAIL 1K, 2K AND 4K BYTE EPROMS

BY B.W.TERRELL B.S.c. & J.W.TERRELL M.S.c.

THE EE124 Eprom Programmer has been designed to be used with a host computer to program single supply rail EPROMS. Two versions are described in this article (i) for use with the TRS-80 Model 1 Level II microcomputer (ii) for use with the Video Genie, Genie I and II microcomputers. The construction of the units has been tailored to allow them to be easily connected to the computer using the system bus expansion cable. The prepared software is suitable only for these machines.

Although specifically designed for use with these models, the hardware may be used with other computers providing certain system signals are accessible and that suitable software is developed. It is expected that the only hardware modification needed for use with other Z80 based computers is to configure the finger sets, by means of an adaptor or a custom built cable/connector to align with the configuration of the system bus of the chosen computer. The signals that need to be accessible are: D0 to D7, A0 to A7, 0V, $\overline{IN}$, $\overline{OUT}$ for use with the TRS-80 version. If $\overline{IN}$ and $\overline{OUT}$ are not available, but $\overline{IORQ}$, $\overline{RD}$, $\overline{WR}$ are, then the Genie version can be used. Users will of course have to develop their own software.

The EE124 plus TRS-80 or Genie can program the EPROMS listed in Table 1 which also gives the required setting of the MODE switch.

The pinning details for the EPROMS in Table 1 are given in Fig. 1.

SYSTEM DESCRIPTION

The EE Eprom Programmer comprises:

(i) Programmer Logic Unit (PLU)
(ii) EE124 Software cassette (T004)

Programmer Logic Unit

Access to the PLU is through a double sided p.c.b. connector set projecting through a slot in the front panel. The 20 + 20 (TRS-80) and 25 + 25 (Genie) fingers allow direct connection to these computers using the system bus expansion cable.

The PLU is equipped with the following facilities:

(a) A 24-pin Zero Insertion Force socket. This allows an EPROM to be inserted or removed from the socket without applying any pressure to the pins. The EPROM should be placed in the socket with the lever in the vertical position. Moving the lever to the horizontal position causes the socket contacts to securely grip the EPROM pins and make good electrical contact with all pins. To remove an EPROM, return the lever to the vertical position. It may then be easily lifted out of the socket.

(b) An EPROM power supply isolating switch. This is labelled HOT-SAFE. When in the SAFE position the 0V, +5V and +25V supply lines to the socket are interrupted to allow the EPROM to be safely removed or inserted. If an EPROM is removed from, or inserted into, a HOT socket, it may become permanently damaged.

(c) A two position MODE switch. When programming or reading EPROMS, the MODE switch must be set to A or B according to the EPROM type, see Table 1.

SOFTWARE

The EE124 Software is written in Z80 machine code and is suitable for use on the TRS-80 Model 1 Level II and Video Genie, Genie I and II microcomputers. It has many powerful features. Editing is particularly easy, with 256-byte page display, single interpage keystroke and full cursor control. The software is compatible with EDTASM so that object code prepared by EDTASM can be loaded and programmed quickly.

The commands provided are:

BURN COPY EXIT FILL LOAD MEMORY
NEW PAGE READ SAVE TEST ZERO

PRINCIPLE OF OPERATION

A block diagram illustrating the principle of operation of the EE124 Eprom Programmer is shown in Fig. 2.

It can be seen that the system is port based and has three latched $\overline{\text{OUT}}$ ports (252, 253 and 254) and one $\overline{\text{IN}}$ port (253). Once the MODE has been manually selected, the system is completely under software control. The mode referred to above has no connection with the two EPROM modes of operation described below.

Read Mode

In the read mode, the address and control data are clocked into the appropriate latches via the host computer data bus. Latch 253 output is dis-enabled by a control line from latch 252.

When an $\overline{\text{IN}}$ signal is generated (active low), the IN port is enabled and the corresponding EPROM data read into the host computer. Successive EPROM locations are read until halted by software.

Program Mode

In the program mode, both the EPROM address and the data to be programmed reach the EE124 via the host computer data bus. The low order address, high order address plus control data, and program data are sequentially clocked into the port latches.

A number of control cycles are then executed in which control data is sequentially clocked into port latch 252 to produce the following order of events:

(1) +25V to V_{pp}
(2) PGM pin to appropriate program level
(3) maintain this level for 50ms
(4) return PGM pin to previous level
(5) remove +25V from V_{pp}
(6) read and verify

The above steps are repeated until either the last location is programmed or a verification error occurs, whereupon the system returns to command mode.

The assignment of the bits for each port are detailed in Table 2.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Programmer for use with the TRS-80 computer is shown in Fig. 3b. The signals from the computer expansion slot reach the circuitry via the 40-way expansion cable.

The TRS-80 (and Genie) employs the Z80 microprocessor. Besides being able to address up to 64K memory locations, the Z80 also produces control signals and addresses to service up to 256 8-bit wide I/O ports.

The four Z80 signals for providing these and other control signals are $\overline{\text{MREQ}}$ (memory request), $\overline{\text{IORQ}}$ (input/output request), $\overline{\text{RD}}$ (read) and $\overline{\text{WR}}$ (write). Only four combinations of these outputs are allowed:

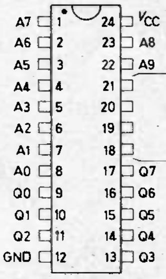
$\overline{\text{RD}}$, $\overline{\text{MREQ}}$, $\overline{\text{WR}}$ — $\overline{\textbf{READ}}$ from memory; $\overline{\textbf{WRITE}}$ to memory

$\overline{\text{RD}}$, $\overline{\text{IORQ}}$, $\overline{\text{WR}}$ — read from port $\overline{\textbf{IN}}$; write to port $\overline{\textbf{OUT}}$

It is the latter, $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ which are used in this design. In the TRS-80, these two signals are generated on board and made available at the expansion slot. These signals are active low (indicated by

Table 1. Eproms accommodated by the EE124 Eprom Programmer

Type No.	Manufacturer	Organisation	Mode
TMS2758–0	Texas	1K x 8	A
TMS2508	Texas		A
2758	Intel		A
TMS2516	Texas	2K x 8	A
2716	Intel		A
S4716	AMI		A
2716	AMD		A
MB8516	Fujitsu		A
HN462716	Hitachi		A
MK2716	Mostek		A
MCM2716	Motorola		A
MM2716	National		A
uPD2716	NEC		A
2716	Signetics		A
SY2716	Synertek		A
TMM323	Toshiba		A
M5L2716	Mitsubishi		A
TMS2532	Texas	4K x 8	A
TMS25L32	Texas		A
HN462532	Hitachi		A
MCM2532	Motorola		A
2732	Intel	4K x 8	B
HN462732	Hitachi		B
M5L2732	Mitsubishi		B
MB8532	Fujitsu		B



Pin	TEXAS 2508	TEXAS 2758*	TEXAS 2516	TEXAS 2532	INTEL 2758	INTEL 2716	INTEL 2732
21	V_{PP}	V_{PP}	V_{PP}	V_{PP}	V_{PP}	V_{PP}	A11
20	$\overline{CS}$	$\overline{CS}$	$\overline{CS}$	PD/$\overline{PGM}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}/V_{PP}$
19	NC	V_{IL}	A10	A10	V_{IL}	A10	A10
18	PD/PGM	PD/PGM	PD/PGM	A11	$\overline{CE}$	$\overline{CE}$	$\overline{CE}$
	MODE A						MODE B

*TMS2758-JLO ONLY

Fig. 1. Pinning details for the various EPROMS accommodated by the Programmer.

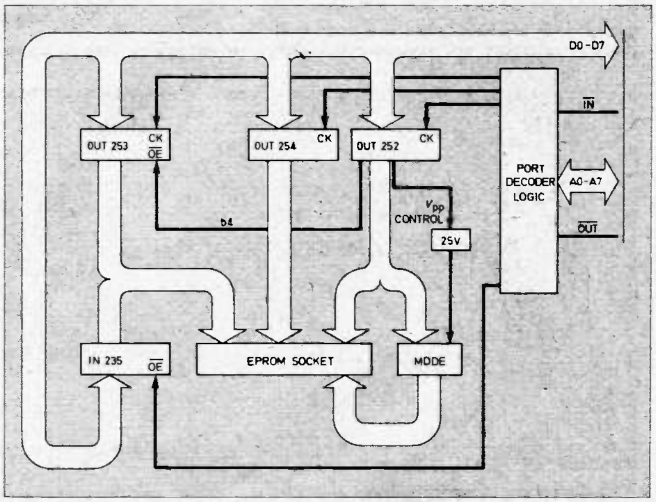


Fig. 2. Block diagram showing system operation.

Table 2. Selecting ports

Address bus during I/O cycle			Port Selected
A0	A1	A2 to A7	
0	0	All logic 1	252
0	1		253
1	0		254
1	1		255

Table 3. Truth table for 74LS139 (IC2)

Select inputs A	B	Output control ($\overline{OE}$)	$\overline{Q0}$	Outputs $\overline{Q1}$	$\overline{Q2}$	$\overline{Q3}$
X	X	1		Hi–Z		
0	0	0	0	1	1	1
0	1	0	1	0	1	1
1	0	0	1	1	0	1
1	1	0	1	1	1	0

X means don't care.

the "bar"), which means that when they are selected they are set to logic 0. Every time a port is selected, either $\overline{IN}$ or $\overline{OUT}$ goes to logic 0 (depending on direction of data transfer). At all other times they are at logic 1.

During an $\overline{IN}$ and $\overline{OUT}$, the port address is placed on the lower half of the address bus (A0 to A7) and data read from or written to the port via the data bus in the usual way.

The ports chosen for this design are 252, 253 and 254 which allows a very simple and unique decoding to be implemented, and these are of course not in use by the TRS-80 or Genie systems.

When ports 252 to 255 are addressed, bits A2 to A7 are at logic 1. These six signals reach the inputs of IC1, an 8-input NAND gate. Only when all inputs are at logic 1 does the output go to logic 0. For all other combinations the output remains at logic 1. IC1 output is used as a control signal for IC2.

The precise port being addressed in this range is determined by the levels on A0 and A1, see Table 2. These address lines reach the select inputs of IC2, a 2-to-4 line decoder. This chip has 3-state outputs: the two logic levels 1 and 0 and a third high impedance (Hi–Z) state which produces the same effect as physically disconnecting the outputs ($\overline{Q0}$ to $\overline{Q3}$) from the circuitry.

IC2 outputs are in the Hi–Z state when its $\overline{OE}$ control is at logic 1. Taking this pin to logic 0 allows the outputs to assume the logic levels selected by A0 and A1. The truth table for IC2 is given in Table 3. Port 255 ($\overline{Q3}$) is not used.

The three outputs from IC2 reach inputs of NOR gates (IC3); $\overline{IN}$ and $\overline{OUT}$ also reach the appropriate IC3 gates. The outputs from IC3 provide the control signals for the following latches and buffer (IC5 to IC7 and IC8).

IC5, 6 and 7 are octal D-type latches. The information reaching the eight inputs is transferred and latched into the eight outputs by a positive going (low-to-high) pulse edge to the clock (CK) input. All inputs receive information from the data bus.

Suppose for example the CPU is OUTputting to port 252. The port address appears on the lower half of the address bus with data to be sent out on the data bus. As A0 and A1 are at logic 0, output $\overline{Q0}$ is selected. A2 to A7 are all at logic 1 so IC1 output drops to logic 0 and this enables the outputs of IC2. $\overline{OUT}$ goes low later in the output cycle after time has been allowed for the data and address buses to stabilise. So initially a logic 0 reaches IC3a pin 12 and a logic 1 is on pin 11. Consequently the output of IC3a is at logic 0.

When $\overline{OUT}$ goes low, the output of IC3a then goes high. This reaches the CK input of IC5 and the data bus information is clocked through and latched into the outputs of IC5. IC6 and IC7 operate in a similar manner.

Port 253 is wired as a bi-directional port, that is to say the CPU is able to read from ($\overline{IN}$) and write to ($\overline{OUT}$) this port address. The $\overline{OUT}$ section is IC7 with decoded control, and IC8 provides the $\overline{IN}$. IC7 and IC8 are wired in anti-parallel.

Fig. 3a. Expansion bus contacts and additional circuitry (IC10) required by the Genie microcomputer.

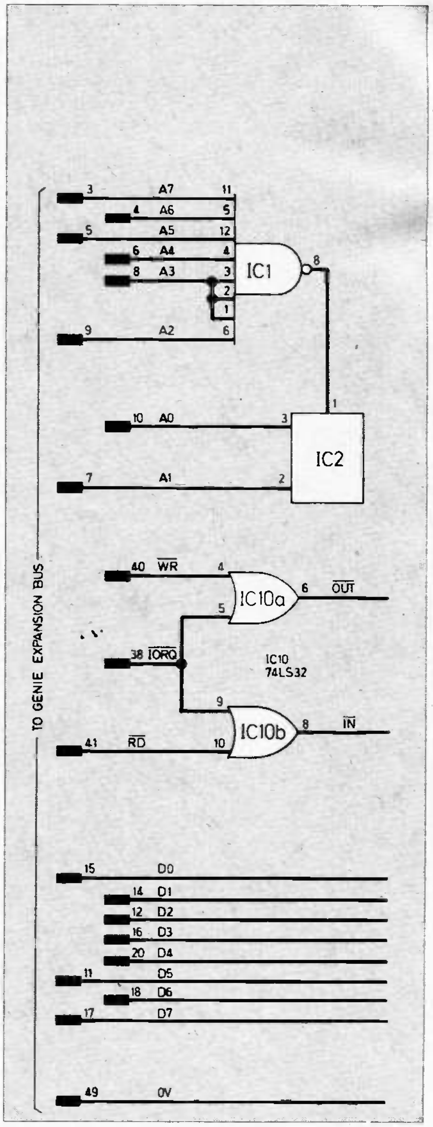


Table 4. Assignment of the ports

Host Computer Data Bus	Port 253 Data (IN & OUT)	Port 254 Low order address (OUT)	Port 252 (OUT) High order address and control: Mode A 1K × 8	Mode A 2K × 8	Mode A 4K × 8	Mode B 4K × 8
bit 0	D0 (9)	A0 (1)	A8 (23)	A8 (23)	A8 (23)	A8 (23)
bit 1	D1 (10)	A1 (2)	A9 (22)	A9 (22)	A9 (22)	A9 (22)
bit 2	D2 (11)	A2 (3)	VOL (19)	A10 (19)	A10 (19)	A10 (19)
bit 3	D3 (13)	A3 (4)	PGM (18)	PGM (18)	A11 (18)	A11 (21)
bit 4	D4 (14)	A4* (5)	———	———	———	———
bit 5	D5 (15)	A5** (6)	———	———	———	———
bit 6	D6 (16)	A6 (7)	$\overline{CS}$ (20)	$\overline{CS}$ (20)	$\overline{PGM}$ (20)	$\overline{CE}$ (18)
bit 7	D7 (17)	A7 (8)	V_{pp} (21)	V_{pp} (21)	V_{pp} (21)	V_{pp}/$\overline{OE}$ (20)
					Texas 2532	Intel 2732

Notes
Numbers in parentheses are EPROM socket pin positions.
** Not used * Controls $\overline{OE}$ of OUT PORT 253.
VOL represents logic 0.
PGM 50 millisecond high pulse, with V_{pp} on
$\overline{PGM}$ 50 millisecond low pulse, with V_{pp} on
V_{pp} 25V supply: 0 — off, 1 — on

IC8 is connected as an octal buffer with tri-state outputs. Its outputs are enabled by providing a logic 0 to its $\overline{OE}$ pins (1 and 19). Similar circuitry to the $\overline{OUT}$ ports is employed but here the decoded address signal and $\overline{IN}$ reach NOR gate IC3d. What is really required here is an OR gate to give a logic 0 to pins 1 and 19 when IN253 is requested. To make convenient use of the local "spare" NOR gate in the IC3 package, an inverter is used to follow IC3d to construct the required OR function. Thus when the decoded address control signal goes to logic 0 and $\overline{IN}$ falls to logic 0, IC8 is enabled and connects the EPROM data outputs to the computer data bus.

To program (burn) an EPROM location, the address of the location and the data to be burned must be presented to the appropriate EPROM address and data pins. Next +25V needs to be connected to the V_{pp} pin and then a 50 millisecond pulse of the correct polarity fed to the programming pin.

Bit 7 of port 252 controls the +25V supply line, a logic 1 turns it on, a logic 0 turns it off. The address is sent to the EPROM via IC6 (A0 to A7), and IC5 (A8 to A11). The data is sent via IC7. Control signals to present the 25V and programming pulse are sent via IC5 upper half.

The control signals for the EPROMS listed in Table 1 vary in several respects as can be seen in Fig. 1. To accommodate the different organisations and memory size it was found necessary to include a manually operated MODE switch, S1, in the design. The position of S1 in conjunction with software produces the required result.

To read an EPROM location, IC6 and IC5 provide the address and control information and IC8 provides the link to the data bus.

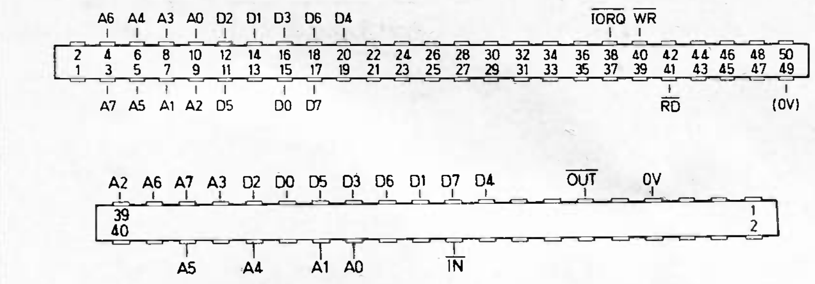
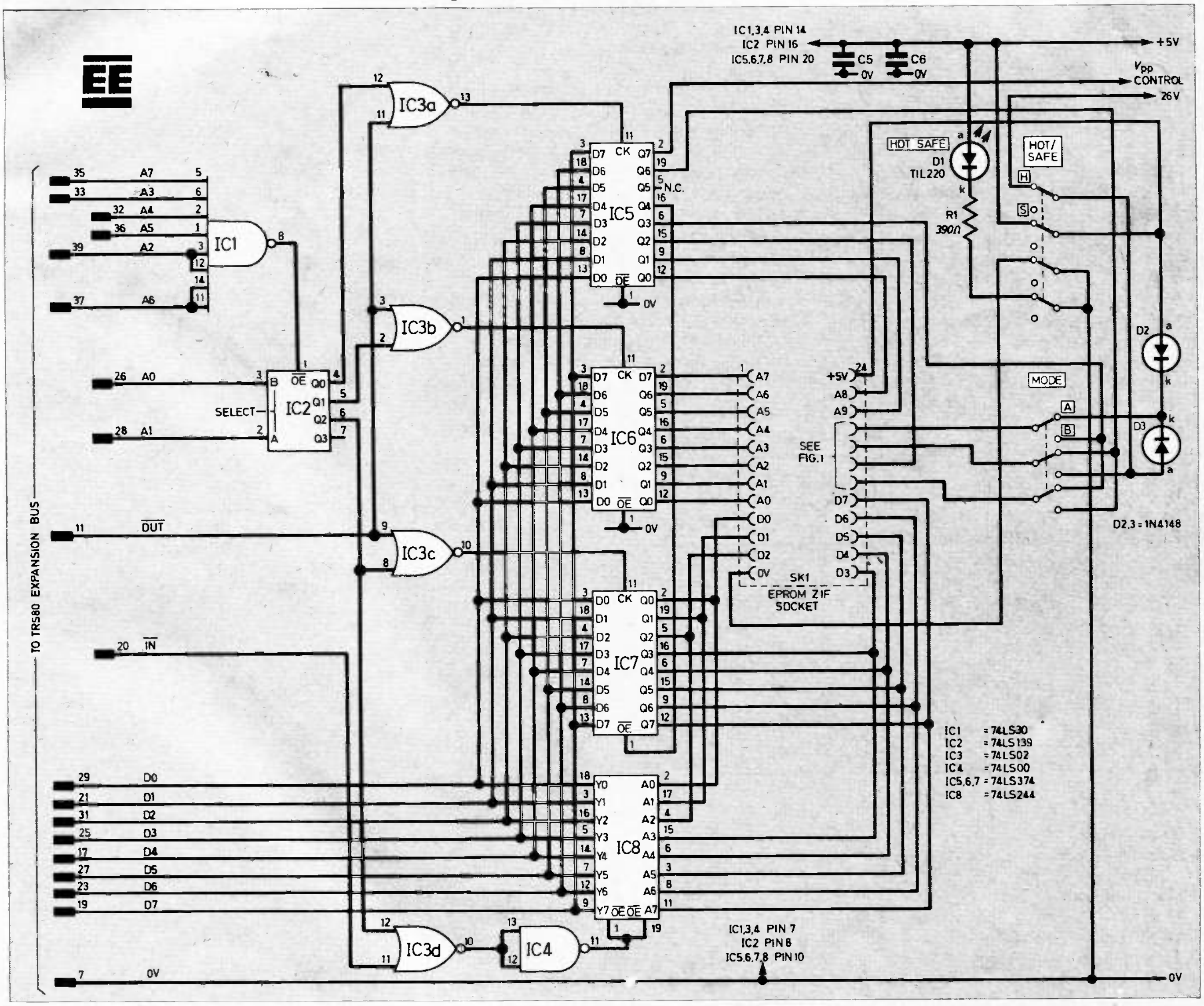
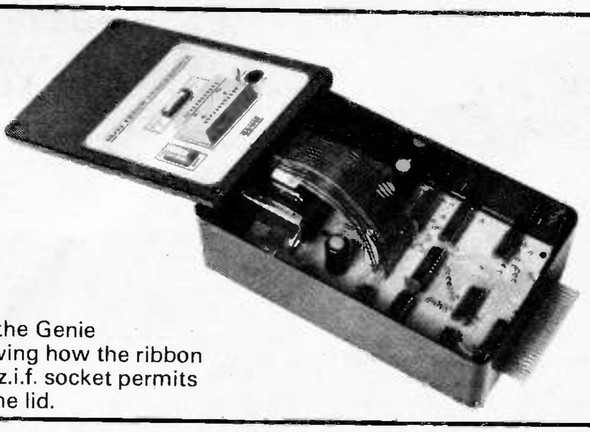


Fig. 4. Looking directly at the expansion slot on the Genie (upper) and TRS-80 (lower), viewed from the rear.

Fig. 3b. Circuit diagram of the TRS-80 version of the Programmer.





View inside the Genie version showing how the ribbon cable to the z.i.f. socket permits removal of the lid.

An EPROM should not be removed from or inserted into a powered up socket (hot socket). S2 functions as a HOT-SAFE switch. In the SAFE position the 0V, 5V and 25V supply lines to the socket are interrupted. Light emitting diode D3, lit when the socket is HOT, provides an immediate visual indication of the switch position.

The Genie microcomputers (Video Genie, Genie I and II) do not provide IN and OUT at their expansion slots. They do provide the CPU signals, IORQ, RD and WR which allows IN and OUT to be derived. The circuitry for doing this is given in Fig. 3a. The IN and OUT outputs are to connect to the IN and OUT inputs in the main circuit diagram, Fig. 3a, to produce the complete circuit diagram for use with the Genie microcomputers.

The edge contacts for the two computer types are given in Fig. 4.

POWER SUPPLY

The power supply section of the Programmer is shown in Fig. 5. It produces +5V and +26V and is mains powered.

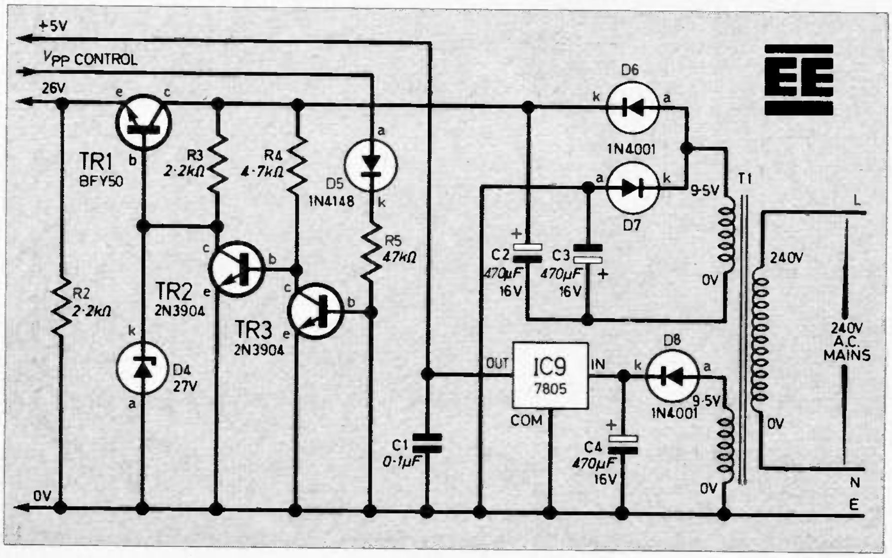
The 240V a.c. mains voltage enters the unit and appears across T1 primary. There are two secondary windings, each rated at 9·5V 320mA. One voltage winding is half-wave rectified by D8 and then smoothed by C5. This provides a raw d.c. input to monolithic voltage regulator, IC9. The output from this device is a stabilised +5V with in-built short circuit protection.

The other secondary winding feeds a voltage doubling and smoothing circuit composed of D6, D7, C3 and C4. This produces a raw d.c. level of about 30V at maximum V_{pp} load. This is applied to the collector of TR1 and feeds Zener diode D4 (27V) through its series resistor R3. The base emitter drops approximately 0·7V to give about 26V at its emitter. This is the supply to V_{pp} through S2 and S1.

This output stage is turned on (supplying 26V) or turned off (output is 0V) by the electronic switch composed of TR2 and TR3 and local components. The control signal for the switch comes from the software via bit 7 of IC5. A logic 1 to V_{pp} CONTROL turns on TR3 and its collector drops to near 0V. TR2 is therefore off and is effectively disconnected from D4.

If now a logic 0 is presented, then TR3 is turned off. TR2 is now free to turn on via base bias resistor R4 and TR2 collector falls to near 0V. D4 is thus shunted and TR1 is held off so there is no voltage at TR1 emitter. R2 straps TR1 emitter to 0V in this condition.

Fig. 5. Circuit diagram of the mains derived power supply of the Programmer.



HARDWARE

Both versions of the Programmer described here are constructed using two printed circuit boards. The larger board in each case is a double-sided type, that is to say, there is a track pattern on each side of the board. Interconnections are required between the two sides at numerous places. Track pins are made specially for such a connection and their use is strongly recommended for this project. These pins are tapered with heads. The board should be drilled 1mm diameter at these positions for the specified pin.

The through-the-board connections are at each of the pad positions seen on the board topside. Track pins are used in all but four places, where the component lead is used instead. These are the decoupling capacitors C1 and C2 which of course must be soldered on both sides of the board.

The p.c.b.s, supports and components have been tailored to suit the inexpensive but robust Vero General Purpose Plastic Box size 180 × 110 × 55mm.

The board is supported on snap-fixing 6mm long plastic stand-off pillars fitted to the base of the case. These require a 3·8mm diameter hole drilled in the board and a 5mm diameter hole drilled in the case.

A slot is required in the front end of the case to accommodate the protruding finger set. A shaped hole is needed in the rear end to allow the mains cable to pass to the board via a strain relief bush. This securely grips the cable and prevents any strain being exerted at the soldered connection to the board.

The second smaller p.c.b. is a single-sided board. It holds the two switches and the z.i.f. socket and local components and is screwed to the underside of the lid using four 6BA fixings. Three rectangular cut-outs are required in the lid to suit the z.i.f. socket and the switches. A hole is also required to accommodate the panel mounted l.e.d.

Begin construction by preparing the case. Full details are given in Figs. 6 to 8. The plastic is very easy to cut and file.

PRINTED CIRCUIT BOARDS

It is assumed that the drilled printed circuit boards have been obtained from the *EE Printed Circuit Board Service* with all holes drilled to suit the specified components.

Remove the two top corner cut-outs using a small hack-saw and then file smooth up to the border line so as to just remove it. Position the board (right-way up) on the underside of the case and use the four board fixing holes to drill pilot holes in the case for the corresponding base fixing holes. Enlarge the case holes to 5mm diameter. Slightly countersink both sides of these four holes.

Push the plastic pillars into the case holes and then check that the board fits onto the pillars and the finger set protrudes through and clears the slot. If all is well remove the board and make ready for assembly.

ASSEMBLY

All components are fitted to the board topside as can be seen in the layout diagrams, Fig. 9 (for TRS-80 version) and Fig. 10 (for Genie version). Begin by inserting all the track pins. You will find it easier to push these in from the topside as all topside pad positions are through-the-board interconnection points.

Remember to leave the four holes for C1 and C2, to be fitted later. Push the pins firmly into the board. Solder all pin topsides, turn over and solder all pin undersides. A small diameter bit is recommended for most of the soldering on this board, about 1·5mm diameter.

Next insert the i.c. sockets and solder. Check for solder bridges as you proceed. An eye glass will be especially useful for this purpose.

Now position and solder all other low profile components: resistors, diodes and IC9 followed by the transistors and decoupling capacitors, C1, C2 and C6. Remember to solder C1 and C2 to top and underside. The electrolytic capacitors may next be inserted paying attention to polarity and finally fit and solder in T1. Prepare a length of mains cable 3-core and connect to the board according to layout diagram.

POWER SUPPLY CHECK

The assembly should now be thoroughly inspected, checking for possible solder bridges, unsoldered pins, correct orientation of diodes, transistors and capacitors. When you are satisfied, the power supply section should be checked. It is a good idea while testing to sit the board in its case with finger set protruding through the slot. This lessens the possibility of inadvertently touching the p.c.b. underside tracks carrying mains voltage.

Plug in and switch on at the mains. Identify the 0V and +5V rails and check that the voltage is at or very close to +5V.

Attach a short length of fine wire to your voltmeter probes and check that there is 5V between each V_{cc} and GND pin position at each socket. Too stout a wire has been found to excessively open the socket contact such that it is unable to make contact with the i.c. pin when inserted.

You should measure about 30V or more between 0V and TR1 collector. There should be no output at TR1 emitter. A lead connected between the free

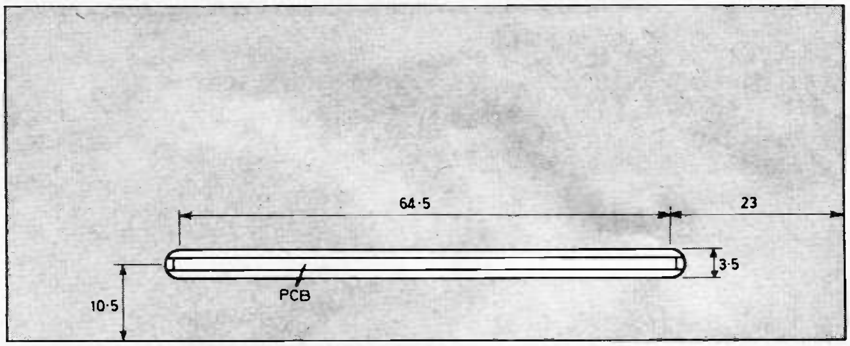


Fig. 6. Slot to be cut in the case front panel to suit the Genie version p.c.b. (830602).

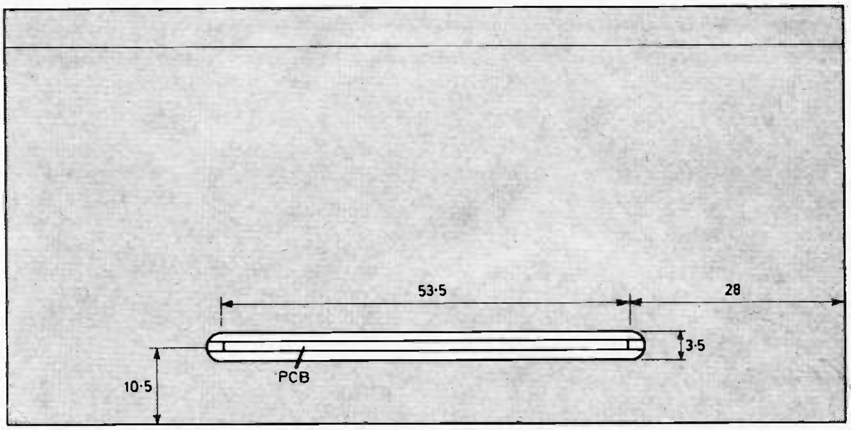


Fig. 7. Slot to be cut in the case front panel to suit the TRS-80 version p.c.b. (830601).

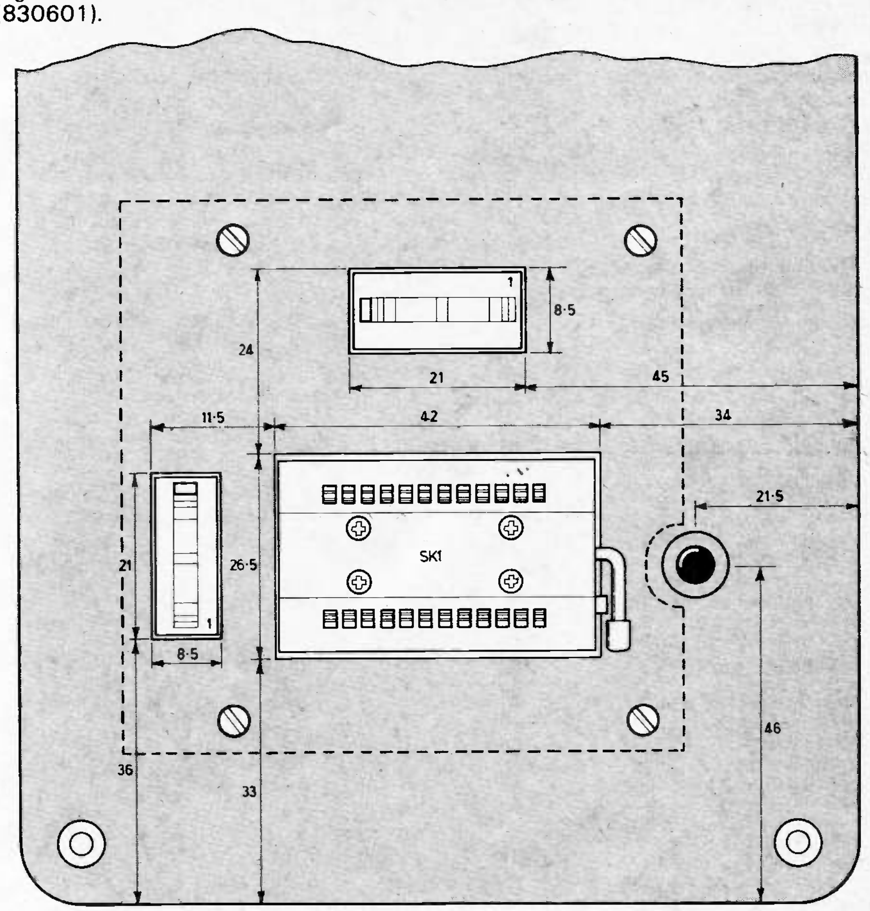
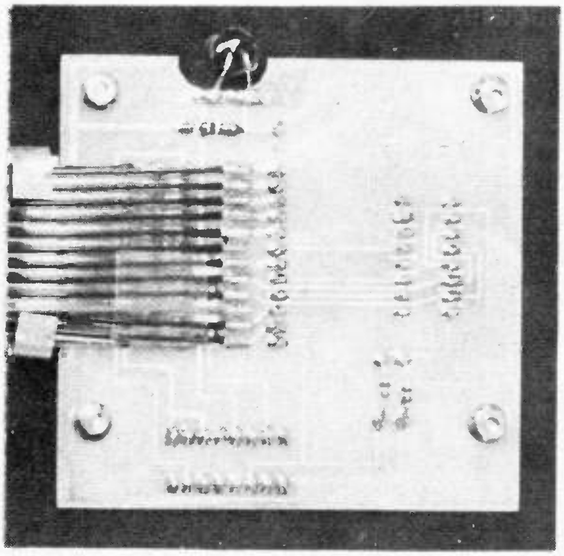


Fig. 8. Cut-out dimensions of the case lid to suit the p.c.b. (830603) and specified components. Note the orientation of the switches.

TRS~80
EPROM PROGRAMMER



The fitted top board fully populated showing ribbon cable running to lower board through a cable gripper.

COMPONENTS

Resistors

R1	390Ω
R2	2·2kΩ
R3	2·2kΩ $\frac{1}{2}$W
R4, R5	47kΩ (2 off)

All $\frac{1}{4}$W carbon ±5% except where stated otherwise

Capacitors

C1	0·01μF ceramic
C2–C4	470μF 16V elect. radial (3 off)
C5, C6	0·1μF plastic or ceramic (2 off)

Semiconductors

D1, D2	1N4148 small signal silicon (2 off)
D3	TIL220 red l.e.d.
D4	BZY88C27 27V 400mW Zener diode
D6–D8	1N4001 1A 50V rectifier (3 off)
D5	1N4148 small signal silicon
TR2, TR3	2N3904 silicon *npn* (2 off)
TR1	BFY50 silicon *npn*
IC1	74LS30 TTL 8-input NAND gate
IC2	74LS139 TTL Dual 2-to-4 line decoder (3-state)
IC3	74LS02 TTL Quad 2-input NOR gates
IC4	74LS00 TTL Quad 2-input NAND gates
IC5–IC7	74LS374 TTL Octal D-type flip-flops (3-state) (3 off)
IC8	74LS244 TTL Octal buffers (3-state)
IC9	7805 5V 1A monolithic voltage regulator TO-220 package
IC10	74LS32 TTL Quad 2-input OR gates (Genie only)

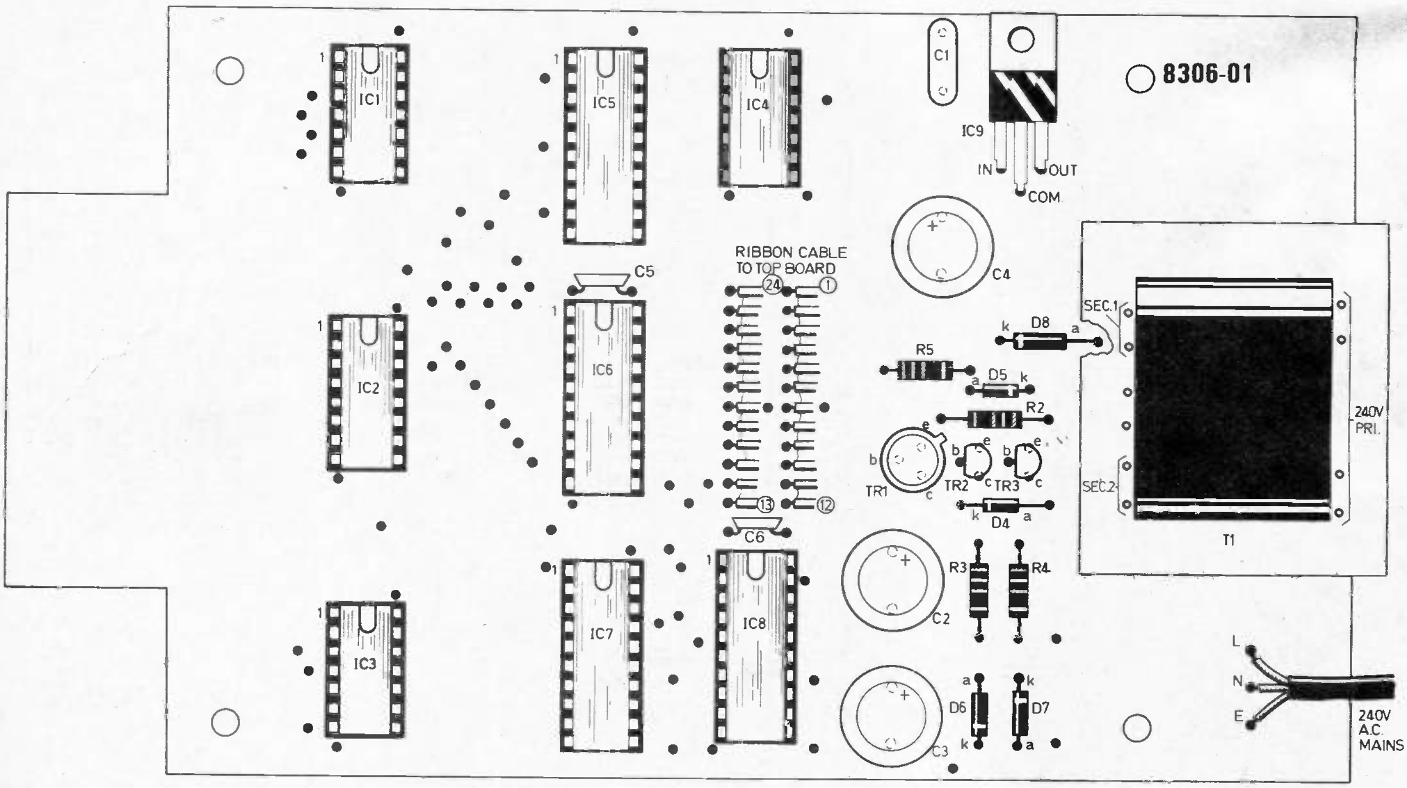


Fig. 9. Layout of the components of the topside of the TRS-80 version p.c.b. The black "dots" indicate the positions of the track pins to be soldered to both sides. Note that C5 and C6 are to be soldered top and underside.

Miscellaneous

S1, S2 — 4-pole 2-way d.i.l. switches (type DS16A 4–2) (2 off)
SK1 — 24-pin d.i.l. Zero Insertion Force Socket (type W3924–10)
T1 — Mains primary/0–9·5V, 0–9·5V 320mA secondaries (type P0609)

Printed circuit boards: double-sided size 180 × 104mm Order Code: 8306-01 (TRS-80), 8306-02 (Genie); single-sided size 89 × 89mm Order Code: 8306-03; d.i.l. sockets: 20-pin (4 off), 16-pin (1 off), 14-pin (3 off, TRS-80), (4 off, Genie); plastics case Vero type 202-21391A; 1mm track pins (66 off, TRS-80), (79 off, Genie); 6mm long plastic stand-off pillars (Verospeed type 226-22549H) (4 off); self-adhesive rubber feet (4 off); mains cable strain relief bush; 6BA countersunk screws and nuts, washers (4 sets); 3-core mains cable, 1m; 10-way flexible jumper link cable, 3 × 6 inch lengths (Verospeed type 226-22549H).

Software

T004 cassette: EE124 Eprom Programmer (TRS-80 & Genie)

COMPONENTS approximate cost £35 excluding software

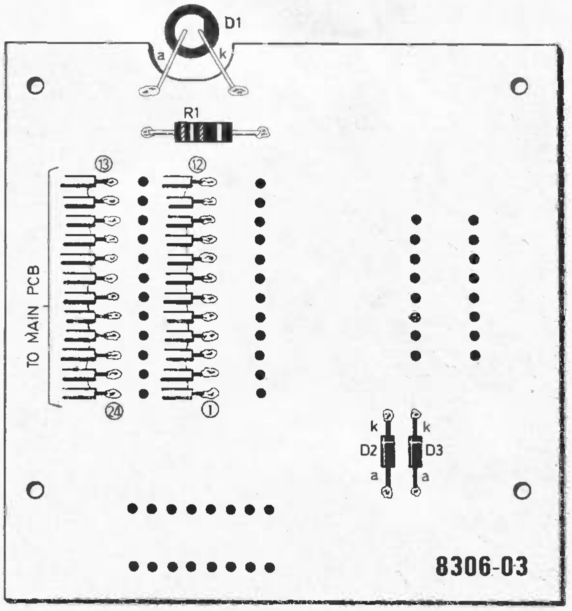


Fig. 11. Shows the components soldered to the "underside" of the top p.c.b. and ribbon cable connection points. For TRS-80 and Genie versions.

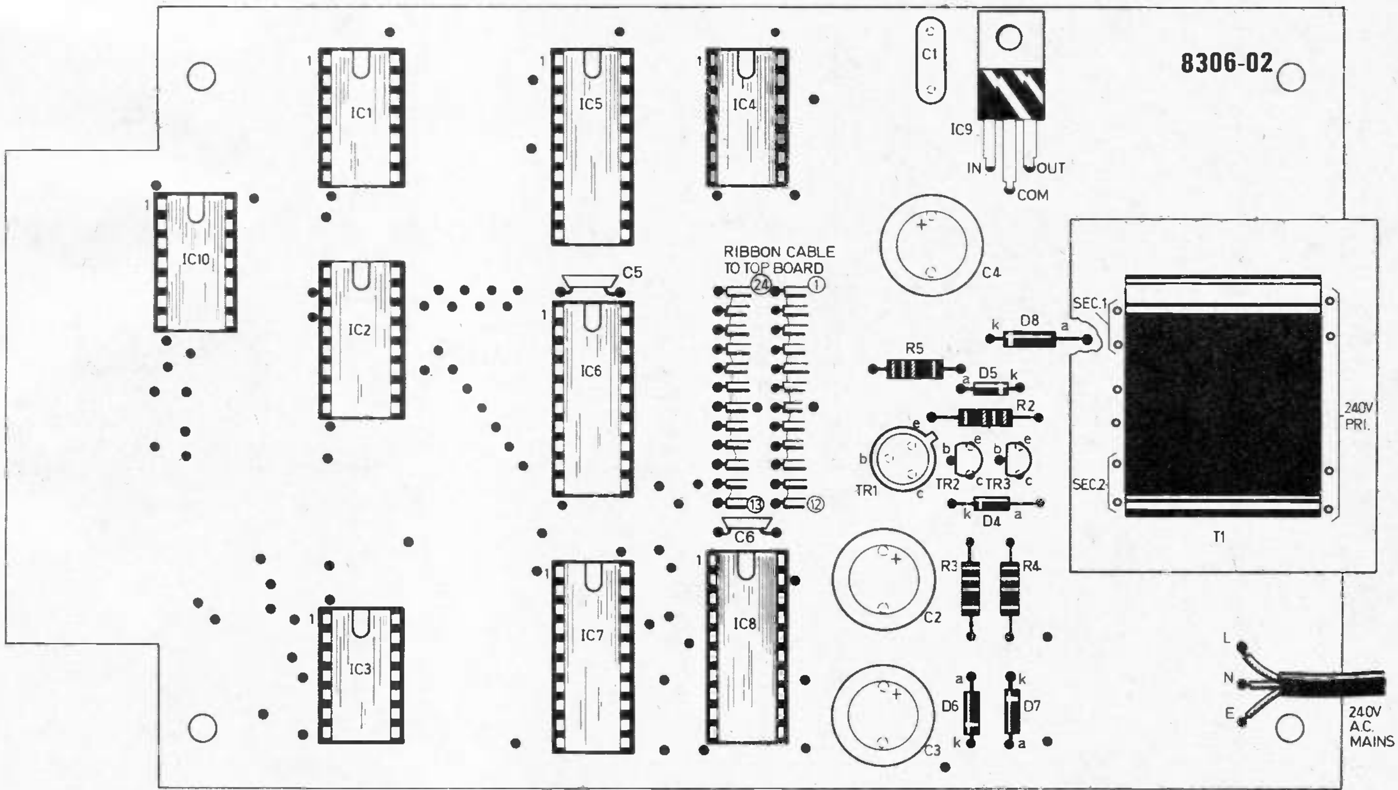


Fig. 10. Layout of the components on the topside of the Genie version p.c.b. The black "dots" indicate the positions of the track pins to be soldered to both sides. Note that C5 and C6 are to be soldered top and underside.

end of R5 and +5V should cause TR1 emitter voltage to become about 26V. If the above results are not obtained, switch off, investigate and remedy before proceeding.

If all is satisfactory, unplug the unit from the mains and connect the inter-board wiring cable. In the prototype, webbed 0·1 inch pitch ready-stripped and tinned cable was used. This is normally available in 10-wide lengths, and is very flexible. The two additional pairs were cut from a third length. Trim off excess from board underside.

The i.c.s may now be inserted. They all face the same way. Fit rubber feet at each corner of the case and push the board firmly onto its supports. Feed the mains cable through its exit hole, but do not fit the strain relief bush yet.

Prepare the case lid to accept the top panel components, see Fig. 8. Use a round file to remove the section of the board to clear the l.e.d. when fitted.

Components are to be mounted on both sides of the upper board. Fit S1, S2 and the z.i.f. socket on the top (uncoppered) side. Position the board so that the components fit into their apertures and then use the board fixing holes as a template to drill the fixing holes in the lid. Countersink the lid holes.

Use countersunk screws, nuts and washers to fix the board secure. A dab of paint on the thread of the screw will prevent the fixing working loose in use. A label to identify the functions may now be attached. This will also conceal the fixing screws. Fit the l.e.d. clip. Insert the l.e.d. and bend its leads carefully using a pair of pliers so that the leads make contact with the rectangular pads on the p.c.b. (Fig. 11). Check polarity before soldering.

Solder D1, D2 and R1 to the board, feeding the shortened leads into the pad holes. Attach the self-adhesive flat cable gripper to the lid immediately in front of the board as seen in the photograph.

It only remains for the 2 × 12-way flat cables to be soldered to the appropriate rectangular pads adjacent to the z.i.f. pins. Trim the tinned leads to about 3mm before soldering. Double-sided tape will be found useful when carrying out this. Stick a short length of the tape onto the board immediately in front of each line of pads. Press each 12-wide cable in turn and solder. Ensure that there are no "shorts". A small screwdriver blade was used to hold the wire in contact with its pad during soldering to give a good joint. A third hand would be useful at this stage. When both cables have been soldered close the cable-gripper arms to hold secure.

Manipulate the cables to run away from the transformer and screw down the lid.

TESTING

Plug into the mains. The panel l.e.d. should be lit when S2 is in the HOT position and go out when set to SAFE. Set in HOT position. Check that the voltage between pin 12 of the socket (GND) and pin 24 (V_{cc}) is +5V. With S1 set to MODE A, pin 21 (V_{pp}) will read either 4·5V or about 25V depending on whether IC5 bit 7 has initialised at turn on to logic 1 or logic 0. In MODE B V_{pp} will read about 26V or 0V depending on bit 7 state. This unknown state of bit 7 (IC5) clearly illustrates the danger of powering up the Programmer with an EPROM in the socket. When certain conditions exist with 25V applied to V_{pp} the EPROM will be destroyed.

In normal use, this condition will not exist since the software correctly initialises the system before instructing the user to insert the EPROM. Full details later.

Connect the Programmer to the computer using the appropriate expansion cable. Do not apply power to the Programmer. Turn on the computer. It should function normally. Turn off the computer. Turn on the Programmer and then the computer. Again the computer should function normally. If not turn off both units, investigate and remedy.

If results are satisfactory, run through the "Setting-Up Procedure" but do not insert an EPROM when instructed to. Set to MODE A and type 4 in response to the prompt at instruction No. 9. You are now at No. 12.

Type P# <ENTER>
Move the cursor to 00F0 and type in AA
Press <BREAK>
Type B0000:00FF <ENTER>

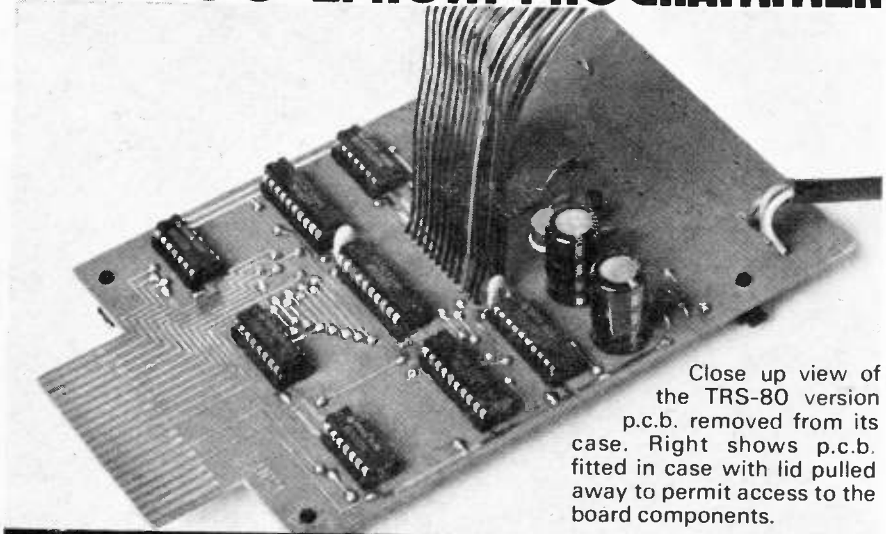
Check that the voltage at pin 21 is approximately 5V. Set your voltmeter to read 30V d.c. f.s.d. and connect across pin 12 and 21. Observe the meter and type <ENTER>. The needle should deflect to 25V for about 12 seconds and then fall back to its previous reading.

Check now that:

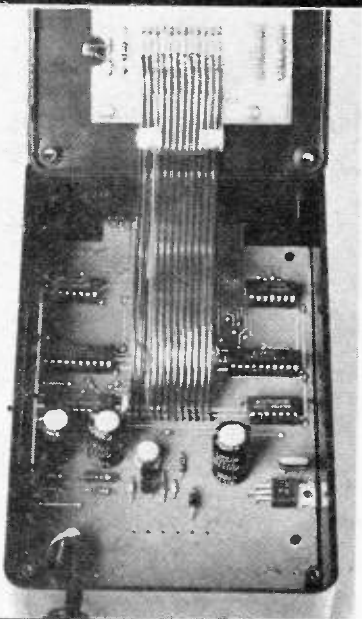
A0 to A3, A8 to A11, read logic 0
A4 to A7, read logic 1
D0, D2, D4, D6, read logic 0
D1, D3, D5, D7, read logic 1

Repeat the whole of this test procedure but this time set MODE B. V_{pp} is now on pin 20. Before a "burn" takes place, this

TRS~80 EPROM PROGRAMMER



Close up view of the TRS-80 version p.c.b. removed from its case. Right shows p.c.b. fitted in case with lid pulled away to permit access to the board components.



pin should read 0V, and during the burn it should read 26V approx. and return to 0V after about 12 seconds. Check all data and address pins to read the same logic levels as before. If so the unit is functioning normally and is ready for use.

SETTING-UP PROCEDURE

Users are advised to read all of this section before attempting to use the system.

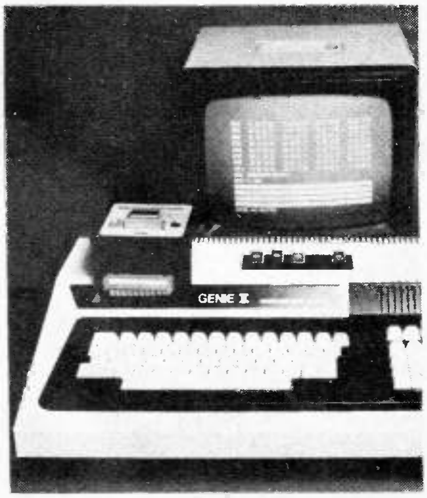
The EPROM socket should be empty and all equipment should be "off" before commencing the setting-up procedure which should then be carried out in the following sequence.

1. Connect the PLU to the computer using the system bus expansion cable.
2. Set the HOT-SAFE switch to SAFE.
3. Connect the PLU to a 240V a.c. mains supply and switch on.
4. Switch on the TRS-80/Genie and enter BASIC in the usual way by pressing the <ENTER> key.
5. EE124 is a machine code program which can only be loaded via the SYSTEM command. Type
   SYSTEM <ENTER>
   and the SYSTEM prompt `*?_` will be displayed.
6. Depress the play button on the cassette recorder and check that the volume control is set between 5 and 6. Type the filename
   EE124 <ENTER>
   The cassette motor will start and the program will load in the usual way.
7. Once the load is complete, the SYSTEM command prompt will again be displayed. This time type
   /<ENTER>
   The following message will be displayed

   ```
   EE124 SOFTWARE 1·1
   COPYRIGHT EVERYDAY
   ELECTRONICS 1983

   SELECT MODE SWITCH_
   ```

8. Refer to Table 1 and identify the MODE (A or B) for the EPROM which is to be programmed. Set the MODE switch accordingly and type
   <ENTER>
   The following message will be displayed
   `SELECT 1, 2 OR 4 ?_`
9. The same EPROM socket is used to program three different sizes of EPROM. They are 1K × 8, 2K × 8 and 4K × 8. Thus, type
   1 <ENTER> for 1K × 8
   2 <ENTER> for 2K × 8
   4 <ENTER> for 4K × 8
   The following message will be displayed
   `INSERT EPROM_`
10. Move the socket lever to the vertical position and insert the EPROM paying particular attention to polarity. Lock the EPROM into position.
11. Set the HOT-SAFE switch to HOT.
12. Type
    <ENTER>
    and the system is ready for use. The command prompt `+` will be displayed and any of the commands on page 348 will be accepted.



The Eprom Programmer in use with the Genie II microcomputer. The screen shows that a 4K-byte EPROM has just been successfully "burned".

To remove an EPROM from a powered up Programmer

A. Set the HOT-SAFE switch to SAFE.

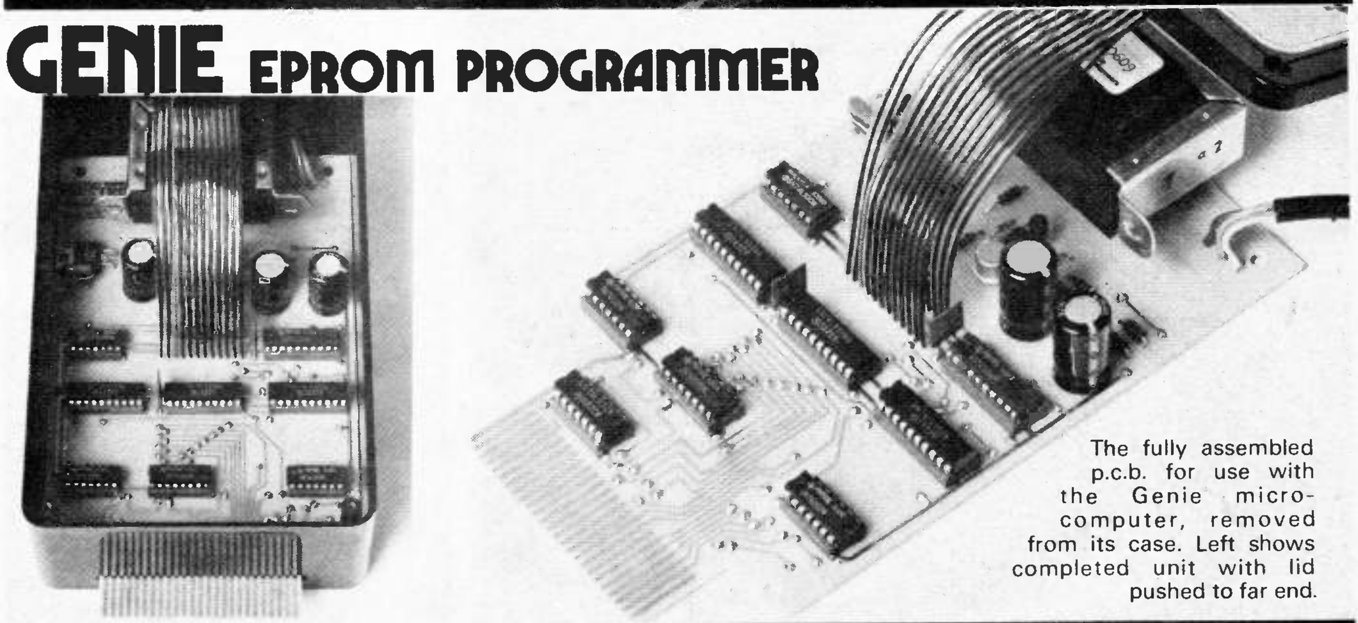
B. Move the socket lever to the vertical position and lift out the EPROM.

At the end of a programming session, do not turn off any mains supply without having first removed the EPROM. Follow steps A and B with:

C. Switch off Programmer.

D. Switch off computer.

GENIE EPROM PROGRAMMER



The fully assembled p.c.b. for use with the Genie microcomputer, removed from its case. Left shows completed unit with lid pushed to far end.

COMMANDS

All items appearing in ruled boxes are automatically displayed on the screen.

All commands are vetted by the syntax analyser. This is a routine which checks the structure of commands. If the structure of a command is incorrect, a SYNTAX ERROR message will be displayed.

Commands are of a particularly simple form and are checked against the following production rules:

```
<Command>          <Command letter> <Parameters>
<Command letter>   B|C|F|L|M|N|P|R|S|T|X|Z
<Parameters>       <Address>|<Address>:<Address>|
                                       <Null string>
<Address>          #|*|.|<HHHH>
<H>                0|1|2|3|4|5|6|7|8|9|A|B|C|D|E|F
```

\# * and . are shorthand notations for first, last and current address, respectively. Spaces are ignored by the syntax analyser.

Example

(a) #:* (b) * (c) . (d) 2410:* (e) .:* (f) 2410:2490

The above parameters are not considered by the analyser to be syntactically incorrect but may be described as BAD PARAMETERS when used with certain commands. The following *are* considered to be syntactically incorrect:

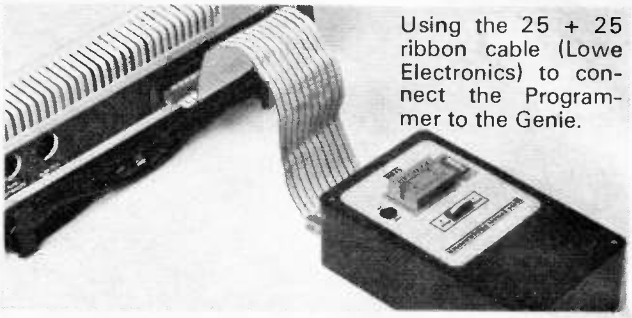
(a) #* (b) 2410.2490 (c) :2490 (d) 2410. (e) .:

All commands must start with a bona fide command letter otherwise an ILLEGAL COMMAND message will be displayed. If the syntax of a command is correct, the legality of any parameters will be determined by the nature of the command.

A complete explanation of the commands and examples of their use will accompany the T004 software cassette available from the EE Software Service.

Table 5. Summary of commands

Command	Description
B	*Burns* bytes from the buffer to the EPROM
C	*Copies* bytes from the EPROM to the buffer
F	*Fills* buffer locations with FF
L	*Loads* SYSTEM tape into the buffer
M	*Memory* sets origin
N	*New* executes a cold restart
P	*Page* displays 256 bytes from the buffer
R	*Read* displays 256 bytes from the EPROM
S	*Saves* contents of buffer locations
T	*Tests* EPROM locations for FF
X	*Exits* to Basic
Z	*Zeros* buffer locations



Using the 25 + 25 ribbon cable (Lowe Electronics) to connect the Programmer to the Genie.

ENHANCING THE SOFTWARE

The authors feel that the set of 12 commands is sufficient for most needs but that there may be some users who wish to enhance the software by adding extra commands. This can easily be done.

The command table is situated from 5318 to 533B; each command cell of 3 bytes consists of

COMMAND LETTER	LSB	MSB

Space for four extra commands has been left from 533C to 5347. Simply type in the three elements of a new command cell. The syntax of the new command will automatically be checked and on jumping to the command address, the top of the stack will hold the BAD PARAMETER(S) address.

CALL 58DO — returns HL, DE with command parameters.

CALL 5A1C — returns HL, DE with buffer addresses, i.e. command addresses which have been adjusted for origin of EPROM and position of buffer. (4300≤HL & DL≤52FF.)

COPYING SYSTEM TAPES

SYSTEM tapes can be easily *copied*, *edited* and *created* using the M, L, P and S commands. However, it must be remembered that although programs appear to be in main memory, they are actually stored in the buffer. They can only be run by first saving them onto cassette using the S command and then by loading them into main store from Basic using the SYSTEM command. □

JACK PLUG & FAMILY...

BY DOUG BAKER

Logic Symbols

YOU will have noticed this month that we are using a different set of symbols in circuit diagrams to represent logic gates. These changes have been made to agree with those symbols found in manufacturers logic i.c. data books and application notes, as well as logic and microprocessor books (especially those titles from America) and other journals.

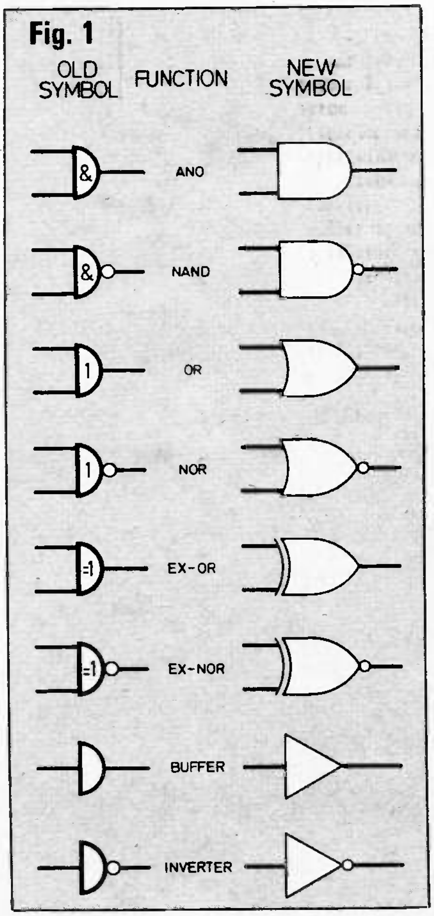
The symbols for the gates need no qualifying letter inside the symbol outline, it is the shape of the symbol which conveys its logic function. In Fig. 1 you can see the "old" symbol followed by its logic description and the "new" symbol for each of the different types of gate. These apply to both TTL and CMOS families.

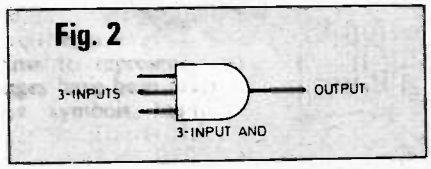
All gates with the exception of the Buffer and Inverter types, are shown as 2-input gates. For example, the first one in the list is fully described as a 2-input AND gate. AND gates with more inputs would be represented by drawing the elongated "D" with a number of lines equal to the number of inputs, into the flat of the "D"; Fig. 2 shows a 3-input AND gate. Other 3-input gate types are drawn similarly.

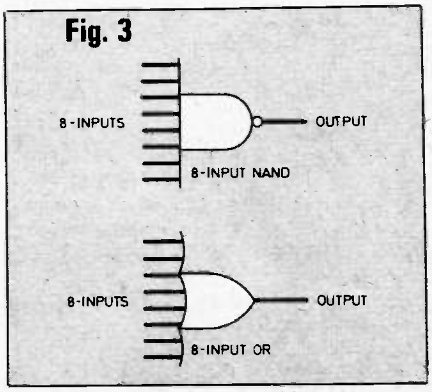
For a large number of inputs, the symbol is not made larger, but its input face is, see Fig. 3, which shows an 8-input NAND gate and an 8-input OR gate.

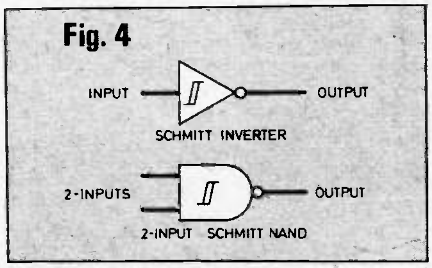
The difference between AND and NAND, and OR and NOR symbols is the small circle at the output. This is a negating sign. A logic 1 produced on the gate-side of the circle becomes a logic 0 at the other side. Similarly a logic 0 becomes logic 1. This can be seen in the truth tables.

Fast acting "Schmitt" versions of the NAND and INVERTING gates are also available and these are identified by a "hysterisis loop" symbol. Fig. 4 shows a Schmitt INVERTER and NAND gate. They obey the truth tables for the INVERTER and NAND gates, respectively.









TRUTH TABLES

AND

Inputs		Output
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

OR

Inputs		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

EX-OR

Inputs		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

NAND

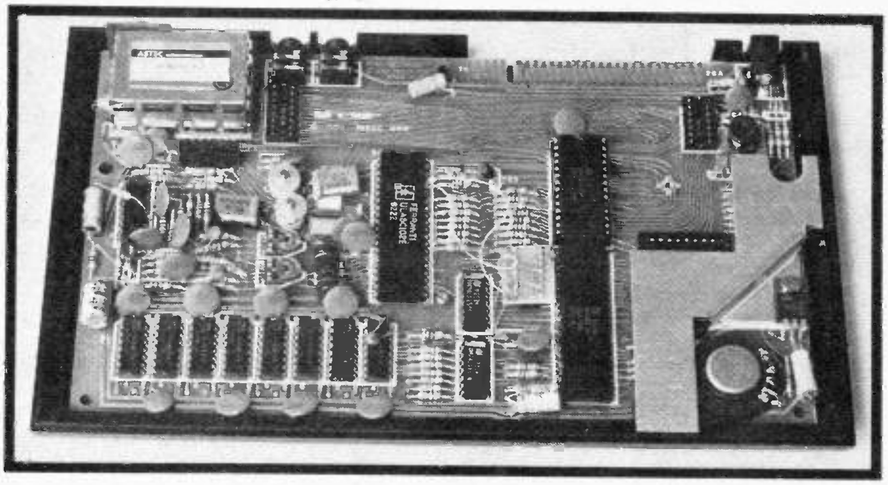
Inputs		Output
A	B	C
0	0	1
0	1	1
1	0	1
2	1	0

NOR

Inputs		Output
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

EX-NOR

Inputs		Output
A	B	C
0	0	1
0	1	0
1	0	0
1	1	1



(Top) The Sinclair ZX Spectrum is supplied complete with 1·2A mains adaptor, manual, and all the necessary leads to connect it to a TV and cassette player. (Above) The printed circuit board assembly showing the edge finger set at the rear which provides access to the control, data and address buses for expansion purposes.

THE ZX Spectrum package comprises the computer, a 1·2A mains adaptor, a TV aerial lead, two cassette recorder leads, an introductory booklet and a comprehensive user's manual.

The computer is housed in an attractive plastic case, slightly longer than the ZX81 and measures 233mm wide by 144mm deep by 30mm high. A 29-way double-sided finger set is situated at the back from which full data, address and control busses can be accessed, and the system is controlled by the Z80A microprocessor, a faster version of the well-known Z80μP.

The mains adaptor connects to the Spectrum via a female cassette power connector, which is an improvement on the male miniature jack plug used on the ZX81. The adaptor is sufficiently powerful to run the ZX printer, unlike the standard 0·7A adaptor which accompanies the ZX81. However, the printer also comes with a 1·2A adaptor, and ZX Spectrum owners who buy the printer will have paid for a spare 1·2A adaptor!

KEYBOARD

The keyboard is made up of 40 "moving" keys with full upper and lower case, and is a significant improvement on the ZX81's touch-sensitive keyboard. All keys are at normal typewriter pitch, but the keyboard is not suitable for touch typing. For a non-ZX81 user who is used to single character entry on a full-size QWERTY keyboard, the Spectrum keyboard will take some getting used to.

There are many good points, however. All keys have auto-repeat which makes input and editing so much easier than the ZX81. If the cursor is positioned at the end of a long program line, for example, it can quickly and painlessly be moved back to the beginning of the line simply by holding down the CAPS SHIFT and ⇦ key. Every time a key is pressed, a click (albeit barely audible) can be heard from the internal loudspeaker.

All BASIC words can be obtained by pressing a single key, as with the ZX81. However, accessing the set below the keys requires practice. For example, to access the keyword CIRCLE, both shift keys, CAPS SHIFT and SYMBOL SHIFT, need to be pressed to change the K cursor to the E cursor. Then the SYMBOL SHIFT and the H key need to be

SPECIAL REPORT
SINCLAIR ZX

pressed for the word CIRCLE to appear. This sounds a rather long and complicated process, and indeed the number of keystrokes required to access some words is more than the number of characters in the word itself! Nevertheless, this is something that can be easily mastered.

DISPLAY

Users with black and white only TV's could be excused at times from thinking that the ZX Spectrum is just a ZX81 in a different case, for the screen format is identical to the ZX81. The main display, excluding the border which is unused on the ZX81, is split up into 24 rows of 32 columns. The bottom two rows (at least) are reserved for all program and run-time input. While this is fine for the beginner, it can be a limitation and a source of irritation to the more advanced programmer.

The main display of 22 lines of 32 characters is made up of 176 by 256 dots (called pixels), each of which can be controlled individually. The trade off between resolution and memory is a difficult one but one which the Spectrum designers seem to have got right.

Eight colours are available and are good on the whole, although certain combinations of colours in adjacent character positions give rise to blurring and instability along vertical boundaries. The colours have been sensibly arranged so that users with black and white televisions see ordered shades of grey ranging from white (colour code 0) to black (colour code 7). Pixels within each character position (and there are 64 of them arranged on an 8-by-8 grid) can only be one of two of the eight available colours and are aptly named PAPER (background) and INK (foreground). This could be considered a limitation, but is another instance where extra memory would be required to store the colour attributes of the pixels if more than two colours per character position were allowed. Again, they have got it right.

Furthermore, each character position can be set to flash and/or to be extra bright using the FLASH and BRIGHT commands. Together with BORDER, which sets the border colour, INVERSE which gives inverse video (that is PAPER colour becomes INK colour and vice-versa) and OVER which superimposes any printing or plotting that is already on the screen, these all add up to a comprehensive and impressive range of colour graphics.

BASIC

The Spectrum uses what is essentially a super-set of ZX81 BASIC. The interpreter and operating system are stored in 16K of ROM and the system runs at the speed of the ZX81 in FAST mode with the steady non-flicker display of the '81 in SLOW mode.

The instruction words READ and DATA, which were missing from the ZX81, have been included together with the very useful RESTORE n, which restores the data pointer to program line n. Dummy reads of data are no longer necessary to reposition the data pointer.

The instruction IN and OUT are very useful additions so that port boards and other devices can be controlled directly from BASIC without recourse to machine code. A powerful feature of the Spectrum BASIC is the ability for users to define their own functions using the DEF FN instruction.

For example, DEF FN L$(a£,n) = a$(TO n) returns the first n characters of a$ so that L$("PUTTY",3) = "PUT". Those of you familiar with Microsoft BASIC will recognise that this function is equivalent to LEFT£. Functions may use up to 26 numeric and 26 string arguments and can be mixed, as in the above.

Another powerful and unusual feature of Spectrum BASIC is the full expression evaluator which is called during program execution whenever an expression, constant or variable, is encountered.

Graphics commands are comprehensive. PLOT controls the INK of a pixel and DRAW draws lines as well as parts of circles if an additional parameter is supplied.

SOUND

Tucked away inside the bottom right-hand corner of the Spectrum is a small loudspeaker. Under command of the instruction BEEP, notes of varying pitch and duration can be generated. Unfortunately, the sound is barely audible, which is a pity. BEEP also ties up the CPU for the duration of the tone and it is not possible to break into the system at this time. [An amplifier to increase the volume of BEEP and other sounds was featured in the April '83 issue of EE. Full constructional details were given.]

TAPE STORAGE

The ZX81 cassette interface, as many users will know, is very unreliable. How many times have users waited for several minutes to load a long program only to find at the end, for some unexplained reason, that the data has not been accepted? These problems are well-known to ZX81 users, and so it comes as no surprise to find that a new cassette interface has been designed for the Spectrum. It is very reliable and fast. The Baud rate (number of bits transferred per second) has been increased six-fold to 1500 and a 16K program now takes only 100 seconds to load.

Not only is the system more reliable, but a VERIFY command has also been included so that a saved program can be compared with what the computer intended to be saved. Also, two programs, one stored in memory and the other on tape, can be combined using MERGE.

There are a number of other features which enable data files, other than programs, to be stored on tape. Blocks of machine code can be saved and loaded from BASIC and arrays can be transferred and merged individually. The contents of the entire screen can be stored using a single command and loading is equally as simple.

CONCLUSIONS

The 16K version is priced at £125 and the 48K version at £175. Undeniably, both represent superb value for money. Each microdrive will sell for under £50 and the RS232 for about £20.

Readers seriously considering buying a computer for the first time would not go far wrong it they bought the ZX Spectrum. The machine is not only a good one but it is well supported by software houses and add-on manufacturers, which is a very important point for a potential buyer to consider.

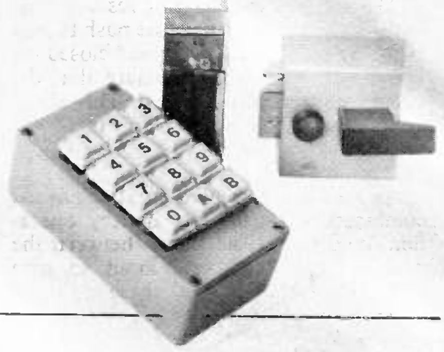
Early supply and production difficulties brought Sinclair Research much criticism from the computing press, but these problems are now behind them and the ZX Spectrum looks set to be an even bigger winner than the ZX81. □

X SPECTRUM

BY J.W. TERRELL M.Sc.

PUSH BUTTON COMBINATION LOCK

BY J. HADLEY



THE Push Button Combination Lock provides a convenient alternative to a key operated lock, especially when a number of people use the same door. This system is designed to use a lock release mechanism which can easily be fitted in place of the door frame mounted part of a cylinder lock, and which allows the lock to be used with a key, if required.

The circuit is battery powered, making for simpler installation and allowing operation during mains failure. Provision is made in the design to cater for the situation when the battery voltage eventually falls to a level at which the lock release fails to operate.

PRINCIPLE OF OPERATION

A number of designs for push button locks have been published which rely on relatively complex digital circuitry. The design to be described here makes use of the principle of transferred charge using the basic concept shown in Fig. 1.

When switch S1 is momentarily closed, capacitor C1 is charged to the supply voltage. When switch S2 is momentarily closed, the charge on C1 is shared between C1 and C2. Similarly switch S3 transfers charge to C3; this stored charge is used to operate the lock release circuit by momentarily closing switch S4.

Switches S1, S2, S3, and S4 are selected from a keyboard of twelve or sixteen keys to provide the sequence of numbers required. Unused switches are connected through a common line, such that, if any incorrect key is pressed all charged capacitors are discharged via diodes D1, D2, and D3, and the sequence will then have to be restarted.

The simple arrangement of Fig. 1 has two disadvantages. The first is that the voltage falls at each transfer. If the values of the capacitors are equal the voltage is halved at each transfer and the voltage on C3 is only a quarter of the supply voltage. Secondly, the switching arrangement precludes the use of commercially available keyboards which usually have a common connection to one side of the switches.

THE CIRCUIT

The circuit shown in Fig. 2 overcomes these disadvantages by using CMOS NAND gates, as buffer stages, between each capacitor. This allows almost the full supply voltage to be transferred between each capacitor.

The operation of the circuit is as follows: when switch S1 is closed, C1 is charged through R1 and when released the voltage on C1 decays exponentially. Providing that this voltage is still greater than half the supply voltage, closing switch S2 will cause the output of gate IC1a to go low, which in turn causes the output of gate IC1b to go high.

C2 then charges through D3 and R4. The second pair of NAND gates (IC1c and IC1d) perform the same function by charging C3 when switch S3 is closed. The lock release is operated when switch S4 is closed, causing the output of gate IC2a to go low, switching on transistor TR3 which provides sufficient base current to cause TR4 to go into saturation.

LOCK RELEASE

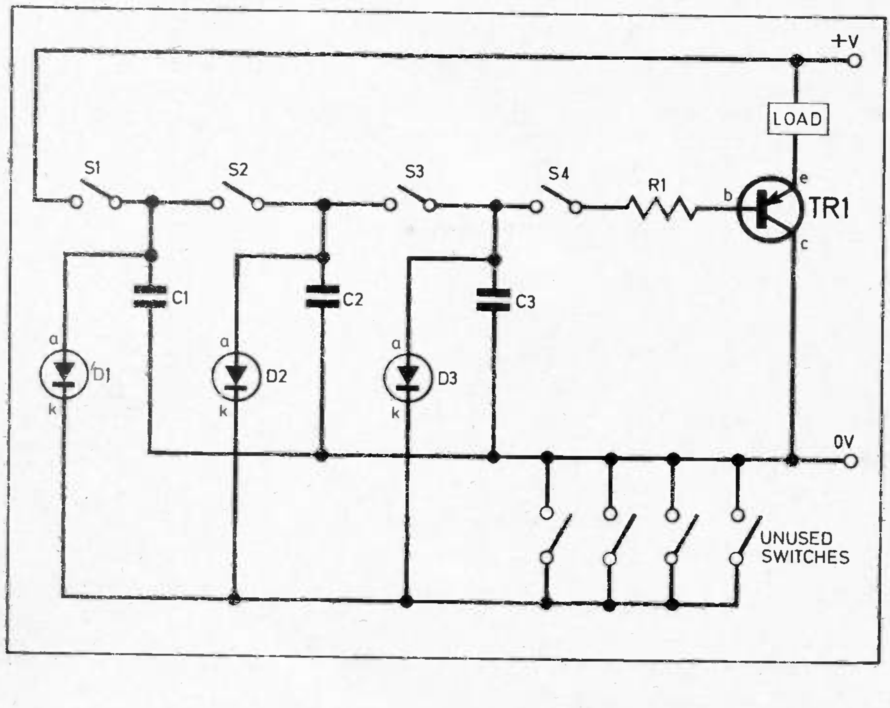
The lock release coil is connected between the positive supply and the collector of TR4 via a 2·2 ohm resistor. This resistor limits the coil current when the battery voltage is high.

When the battery voltage has fallen to a level where the lock release fails to operate, the 2·2 ohm resistor can be bypassed by closing switch S5 at the same time as S4 is closed. The output of gate IC2d goes low when S5 is closed and this switches on TR1 and TR2. Since the collector of TR2 is connected directly to the coil, the full supply voltage, less the saturation voltage of TR2, appears across the coil.

The normal sequence of operation is to momentarily close S1, then S2, then S3 and finally S4 to operate the lock release. When the lock fails to operate, because the battery voltage is too low, the sequence is repeated but S4 and S5 are closed simultaneously.

This will allow the door to be opened in spite of the low battery voltage, but is also an indication that the batteries should be replaced before their voltage falls to a level at which the lock release

Fig. 1. Circuit of the transfer charge principle used in the Push Button Combination Lock.



will fail to operate even when the override switch is used.

The value of the charging resistor used in the circuit requires that the push button switches S1, S2 and S3 are held closed for about half a second to ensure that the capacitors are fully charged. This slows down the maximum keying rate and provides added security against random keying.

Any switch not used in the selected combination, or for low battery operation, is connected as shown between the positive supply and the input to gate IC2b. Operating any of these switches causes the output of IC2b to go low and as the door is opened. As can be seen from the graph in Fig. 3, the battery voltage on load has fallen to 6·2V after 4000 operations and that a further 200 operations are possible using the override switch, before the battery voltage has fallen to 5·2V.

Knowing the average daily use will enable the battery life to be estimated. Over an extended period there will be an additional loss of capacity due to storage effect which can amount to about 10 per cent per annum. For this reason it is not economical to use the higher powered HP2 cells, which have twice the capacity of HP11s, unless justified by frequent use.

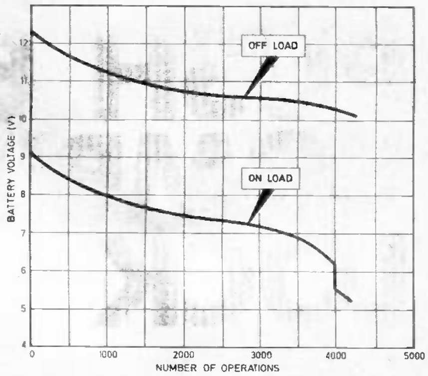


Fig. 3. Battery deterioration graph of voltage against number of operations.

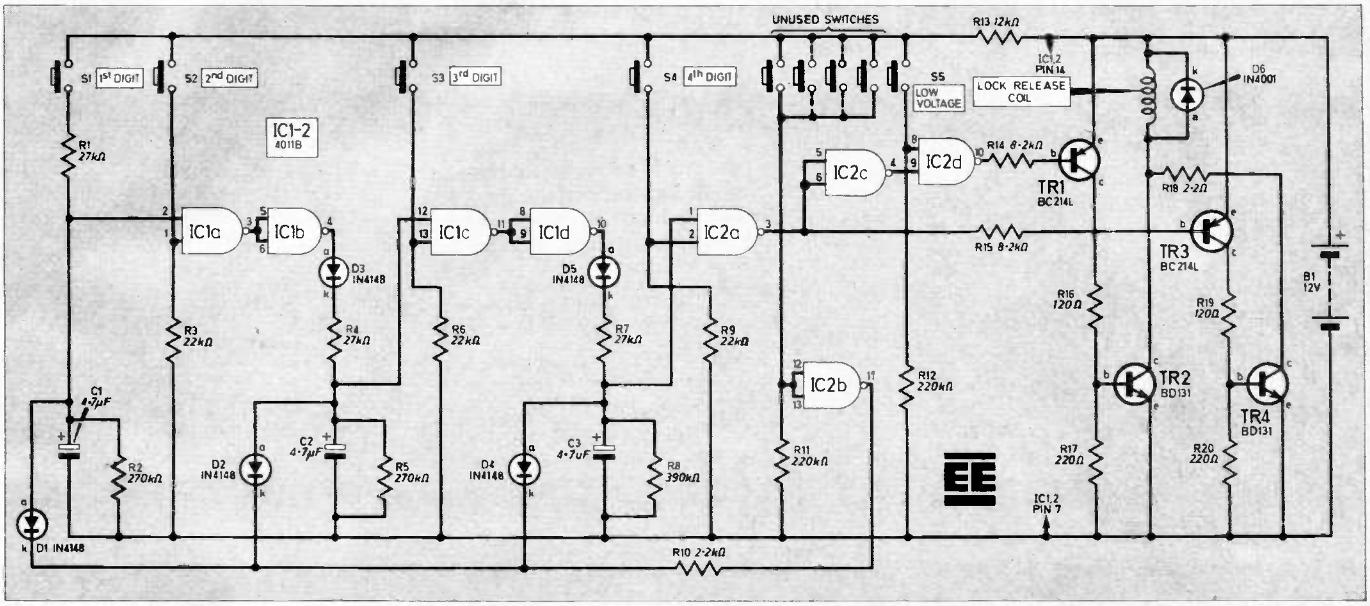


Fig. 2. Complete circuit diagram for the Push Button Combination Lock. The push switches S1 to S5 and the unused switches make up the keyboard and are housed in a separate case.

this discharges any of the capacitors (C1, C2 and C3) which have a charge. Pushing any wrong button therefore requires the correct sequence to be restarted at S1.

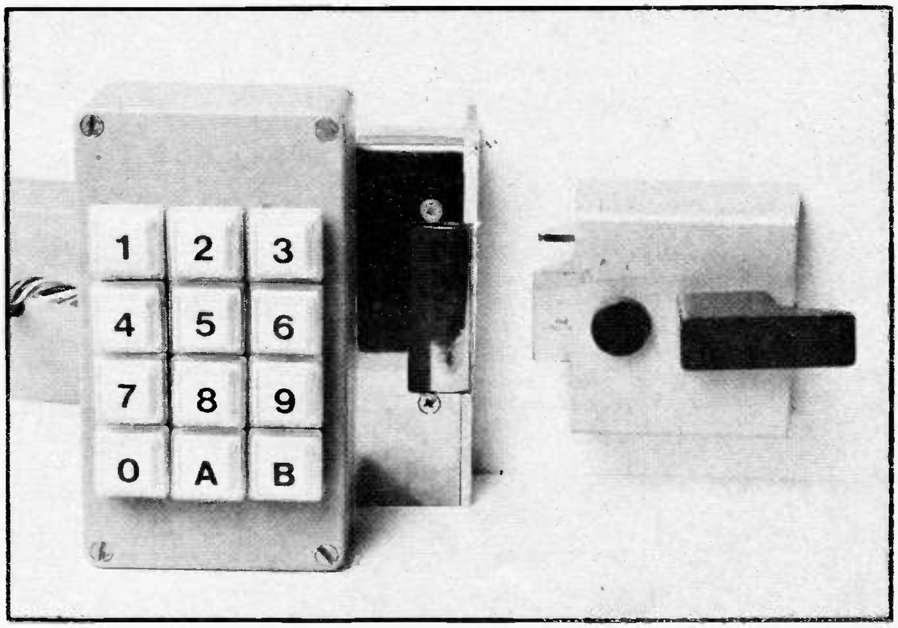
CHOICE OF BATTERIES

The lock release is designed to operate on a nominal 12V, but will operate down to about 4V, providing that pressure is not applied to the release, by pushing against the door, until the lock release has been activated.

With the 2·2 ohm resistor, the circuit and lock release will operate down to 6V or less. Using eight $1\frac{1}{2}$V cells to provide an initial voltage of 12V allows a long battery life to be realised. Current drain is negligible on standby and 800mA when the lock is operated. HP11 batteries are capable of supplying this current and to check that a reasonable life can be expected, the manufacturers data has been supplemented by an accelerated life test.

The test used a time switch to operate the circuit for two seconds every 15 minutes. Two seconds is typical of the time for which the peak current is drawn

Foreground shows the keyboard housing, lock release mechanism and a typical cylinder lock. The control unit is partially obscured by the keyboard case.



COMPONENTS

See **Shop Talk** page 369

Resistors

R1,4,7	27kΩ (3 off)
R2,5	270kΩ (2 off)
R3,6,9	22kΩ (2 off)
R8	390kΩ
R10	2·2kΩ
R11,12	220kΩ (2 off)
R13	12kΩ
R14,15	8·2kΩ (2 off)
R16,19	120Ω (2 off)
R17,20	220Ω (2 off)
R18	2·2Ω 3W wire wound ±5%

All ¼W carbon film ±5% unless otherwise stated

Capacitors

C1,2,3	4·7μF 25V tantalum (3 off)

Semiconductors

D1–5	1N4148 silicon (5 off)
D6	1N4001 silicon
TR1,3	BC214L *npn* silicon (2 off)
TR2,4	BD131 *npn* silicon (2 off)
IC1,2	4011B CMOS quad 2-input NAND gate

Miscellaneous

S1–12	12-way (or 16-way) keyboard with common connection (not matrix type)
B1–8	HP11 1·5V battery (8 off)

Diecast or plastic case, 112 × 62 × 31mm (for main circuit); plastic case 190 × 110 × 60mm (for batteries); 0·1in matrix stripboard, 19 strips by 41 holes; surface mounted electric lock release; battery holder for 4 × HP11 (2 off); 14-pin i.c. holder; Veropins; 7/0·2mm wire; 2-core mains cable; mounting hardware.

Approx. cost Guidance only £10 excluding lock & cases.

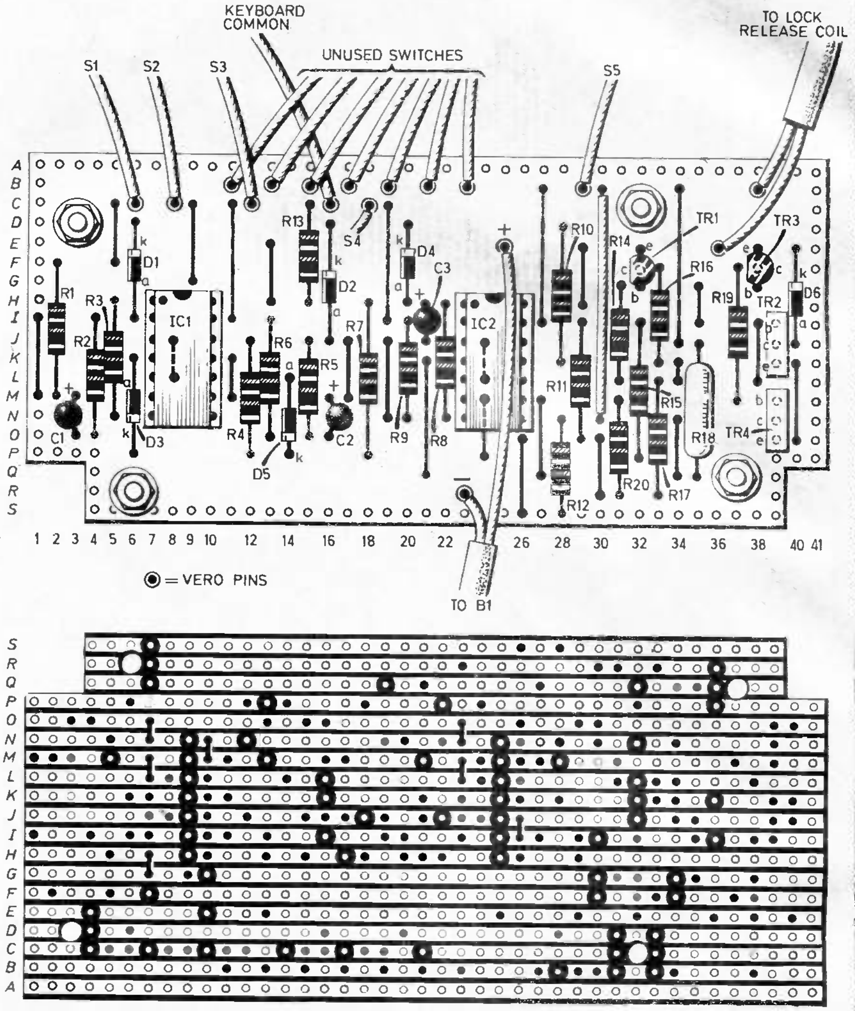


Fig. 4. Component layout, underside showing breaks in the copper and interwiring cables of the main lock control board. Pay special attention to the small links on the underside of the board.

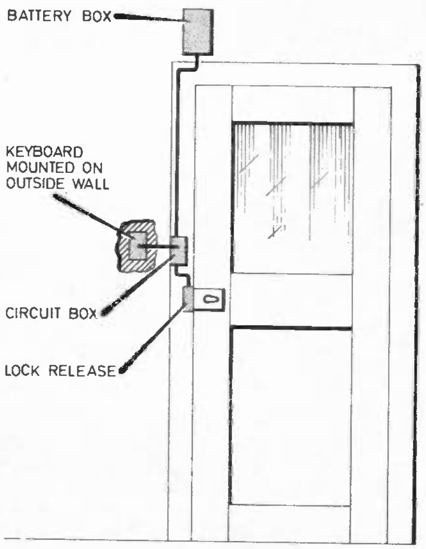
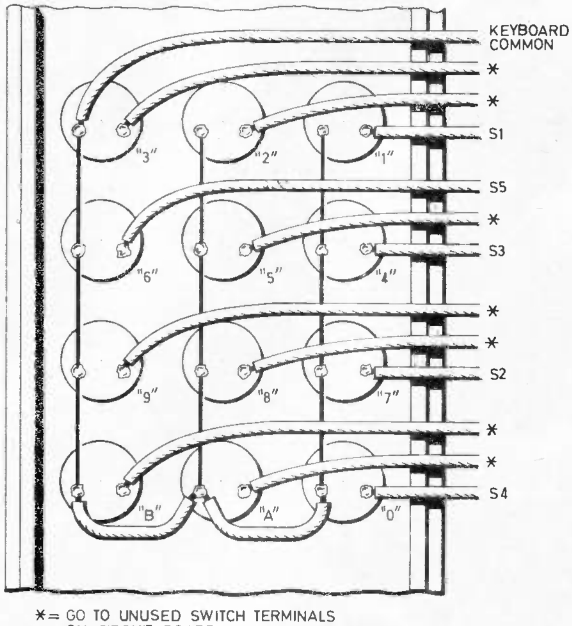
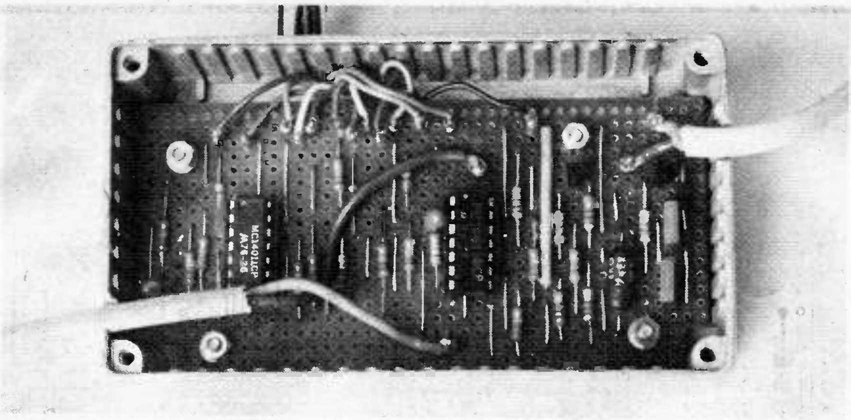


Fig. 6 (Left). Suggested mounting arrangement of the various units around the door and door frame.

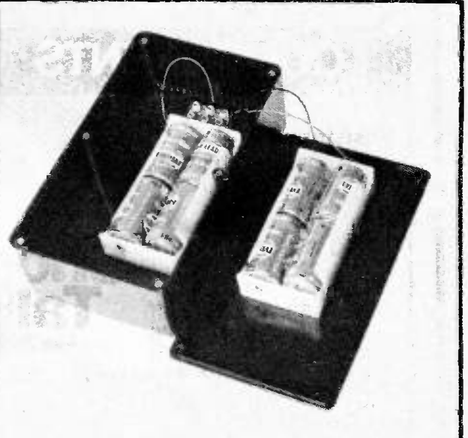


*= GO TO UNUSED SWITCH TERMINALS ON CIRCUIT BOARD

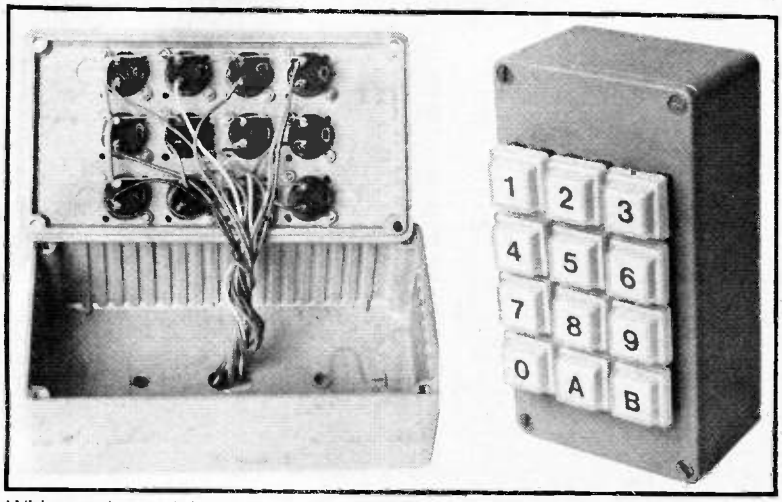
Fig. 5 (Right). Wiring to the individual push-switches which make up a 12-way keyboard unit. The combination shown is 1740 with 6 as the low voltage key.



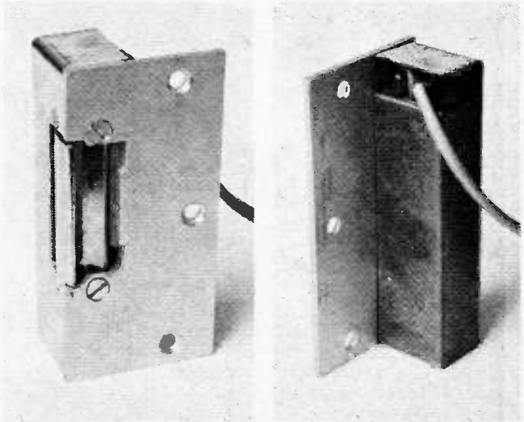
The main lock circuit board mounted in the control unit.



The two 4-way battery holders mounted in the battery housing box.



Wiring to the push button combination switches and the exterior of the keyboard box showing "coding" of the push switches.



Front and rear views of the lock mechanism. The lock "solenoid" coil is shown on the right.

KEYBOARD

Keyboards are available commercially with 12 or 16 buttons and the single pole, not the matrix version, is required in this application. Alternatively, one can be made up from the wide selection of momentary action push button switches available from suppliers.

The circuit does not allow the use of repeated numbers so that the sequence 8593, for example, can be used but 8595 cannot. Because one button is used for low battery voltage, a 12-way keyboard will have 11 × 10 × 9 × 8 combinations and a 16-way keyboard will have 15 × 14 × 13 × 12 combinations.

These are equal to 7920 and 32,760, respectively. To anyone trying to operate the lock by pushing buttons at random, the chance of success at the first attempt is 1 in 20,736 (that is 1 in 12^4) for the 12-way keyboard, and 1 in 65,536 (1 in 16^4) for the 16-way keyboard.

CIRCUIT BOARD

The main lock circuit was built on a piece of 0·1in matrix stripboard, 19 strips by 41 holes and this is shown in Fig. 4. All wired connections to the keyboard must be made to Veropins as this facilitates the changing of the combination at a later date.

The usual care should be taken when inserting polarised components (tantalum capacitors and diodes) and to note the orientation of the semiconductors.

The layout requires a number of links, some of which are beneath the i.c. holders and also on the trackside of the board. These latter links are shown on the trackside view in Fig. 4.

The finished board is housed in a plastic or diecast box, 112 × 62 × 31mm.

The wiring of a keyboard made from individual switches (a 12-way is shown) is given in Fig. 5. This is made from 12 momentary action key switches in a plastic or diecast box, 120 × 65 × 40mm. Alternatively, a proprietary keypad can be used and this will have one side of the switches already commoned up.

INSTALLATION

The actual positioning of the units around the door will be determined by the available space. It is probably more convenient to install the batteries in a separate box and one arrangement is shown in Fig. 6.

An alternative would be to fit the keyboard and circuit box on the door and feed the lock release with a cable to the hinge side of the door and around the door frame.

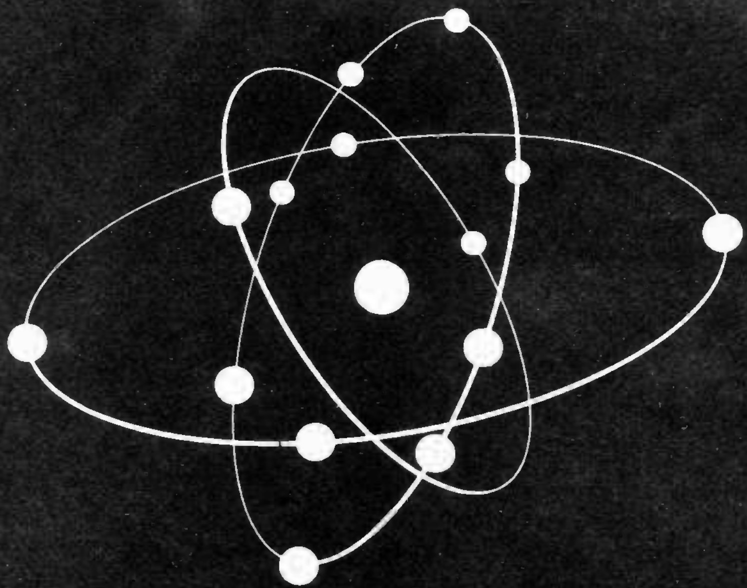
The HP11 batteries are housed in a plastic case, size 190 × 110 × 60mm, using two, 4-way battery holders, one screwed to the base and the other to the lid of the box. Connections from the batteries and to the lock release should be made with 2-way mains cable.

SETTING THE COMBINATION

A wire from each switch, together with the common switch connection, is brought through the wall or door to the circuit box. The required sequence of digits is selected from the 12 or 16 switches of the keyboard and the wire from the first switch is wired to the pin marked S1. Similarly the second, third and fourth selected switches are wired to the pins marked S2, S3 and S4.

A fifth switch is selected to function as the low battery voltage switch and this is connected to the pin marked S5 on the circuit board layout. All switches not used in the sequence are connected to the row of pins marked. There are sufficient pins shown for a 12-way keyboard. If a 16-way keyboard is used four more pins can be added or two wires can be connected to a single pin. Finally the common lead is connected to the pin shown. □

ELECTRONICS and the ELECTRON



Part 2 CONDUCTION IN VARIOUS MATERIALS

BY J.B. DANCE

CONDUCTION is the flow of an electric current through a material; it can occur in solids, liquids and gases. Indeed, an electric current can even flow through a vacuum.

CURRENT FLOW

The flow of an electric current involves the movement of electric charge. The charges which move may be positive charges, negative charges or both types, depending on the material through which the current is flowing. The term "electric charge" signifies the amount of electricity present or the amount flowing per unit time.

In order to understand electric currents, we must look at matter on the atomic scale. We then find that the flow of an electric current consists of the flow of extremely minute charged particles. In a metal these charged particles are electrons, but in liquids and gases positive ions can also contribute to the flow of current. If all the charged particles in a material are held firmly in position, no current can flow.

Charged particles are known as ions. Electrons are a rather special form of charged particle and one does not usually apply the term ion to an electron. If a neutral atom containing a positive nucleus and a number of electrons loses one of these electrons, we have a positive ion. Similarly if a neutral atom gains an electron, it becomes a negative ion.

In order to cause a steady electric current to flow through a material an electric voltage or e.m.f. (electromotive force) must be applied across the material concerned. In general the greater this voltage, the greater the current which will flow through a given piece of the material.

The voltage may be regarded as the driving force which causes the current to flow through the material. It may be compared with the water pressure between two points in a water system which causes water to flow through the system.

OHM'S LAW

Ohm's Law states that the voltage across a conductor is directly proportional to the current passing through it. That is:

$$V \propto I$$

In general we do not like proportional signs, so we change the proportional sign to an equals sign and introduce a constant, R:

$$V = IR$$

This quantity R is the resistance of the material through which the current is flowing in ohms.

Most metals obey Ohm's Law; that is, the voltage across a given piece of the metal is proportional to the current flowing through it. However, there are many materials which do not obey this law. For example, in many semiconductor devices the current is not proportional to the voltage across the device.

Instead of saying that such materials do not obey Ohm's Law, one can say that the resistance of the material varies with the applied voltage.

CONVENTIONAL CURRENT

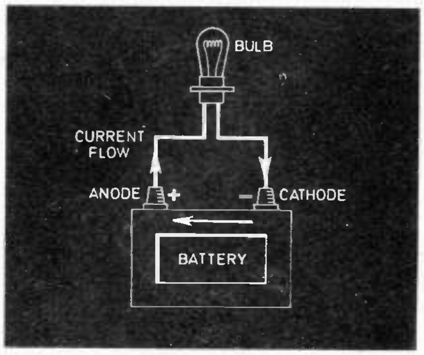
If one connects a battery to a small lamp, as in Fig. 2.1, current is said to flow from the positive terminal of the battery (which is known as the anode) through the bulb to the negative terminal (which is known as the cathode). In any external circuit which a battery feeds, current is said to flow from the positive to the negative electrode.

However, inside the battery the current must flow from the cathode to the anode in order to be able to continue flowing around the circuit. This matter concerning the direction of current flow can be quite confusing, so inexperienced readers should always be careful to give it an adequate amount of thought.

When the battery is being charged (Fig. 2.2), however, the current flows from the positive connection of the charger into the battery and through the battery to the cathode from where it returns to the charger. Thus it flows through the battery in the opposite direction to that shown in Fig. 2.1.

The battery charger in Fig. 2.2 must provide a voltage which exceeds the battery voltage by a small amount so that it can force the current through the battery against the e.m.f. of the battery.

Fig. 2.1. The direction of the conventional current flow from a battery through a lamp bulb.



The direction of current flow to which we have been referring is known as the conventional current, since it is the direction of current flow accepted by most people. In actual fact the particles which carry the electric charge in any metallic wire are electrons. Electrons carry a negative charge and therefore flow from the negative to the positive electrode in the circuit external to the battery. It can be seen from Fig. 2.3 that the direction of the electron flow is opposite to that of the conventional current flow.

AN HISTORICAL MATTER

If the flow of electrons is from the negative to the positive electrode, why do we have a conventional current flowing in the opposite direction? This is essentially an historical matter.

When the terms "positive" and "negative" were given to the two types of electric charge and voltage a very long time ago, there was no particular reason why these terms should be allocated in one of the two possible ways and very little was known about electricity at the time. The electron had not been discovered.

It so happens that the anode of a battery was allocated the "positive" sign and the cathode the "negative" sign. When, much later, electrons were discovered, it followed that they had a negative charge on this convention. Hence these negatively charged particles flow towards a part of the circuit which is at a more positive potential, whilst current was assumed to flow from the positive through the external circuit to the negative connection of the battery.

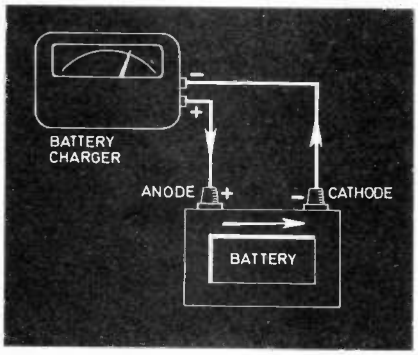


Fig. 2.2. The current flow from a charger through a battery; note that the current flows in the opposite direction through the battery to the current in Fig. 2.1.

From time to time authorities have suggested that we change the direction in which we consider a conventional current to flow so that it would become the same as the direction of the electron flow. However, if this change were made now, it would cause enormous confusion; for example, the arrow in all circuit diagrams containing diode or transistor symbols would have to be reversed in direction. When using a circuit one would have to think whether it had been published before or after the change.

In any case, positive ions flow in the same direction as our present conventional current. If we changed the conventional direction of current flow, we should meet the same problem with positive ion movement as we now have with electrons. One may note that the flow of current in the "metal" of antimatter, if it exists, is in the same direction as our conventional current, since charge carriers are positive positrons (the antiparticles of the electron).

Thus it appears we shall continue to regard conventional current as flowing from positive to negative electrodes in the external circuit of a battery.

MATERIALS

In some substances, such as metals, only a small voltage is required across a length of the material to produce a substantial current in it. Such materials are known as "good conductors".

In other materials, such as glass, the application of even a very high voltage across a thin layer of the material will produce only a very small current. Bad conductors are known as insulators.

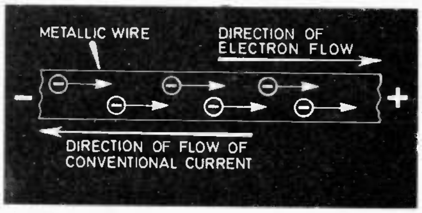
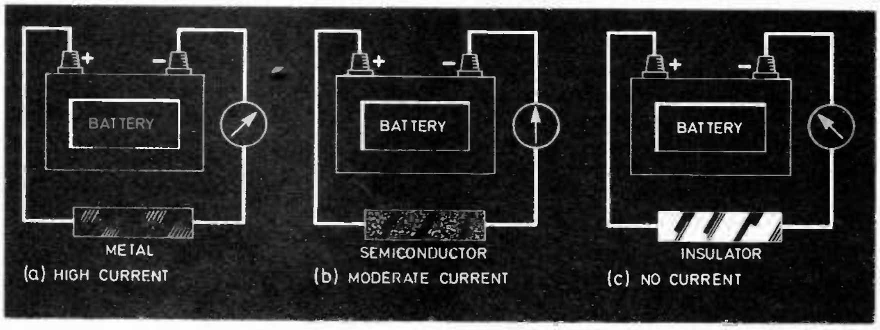


Fig. 2.3 (above). In a metallic wire the current is carried by the minute electrons which move towards the positive side. However, the conventionally accepted direction of current flow is opposite to movement of the electrons.

Fig. 2.4 (below). A battery will produce (a) a high current in a metal bar (b) a moderate current in a bar of a semiconductor and (c) no detectable current in an insulating bar.



In addition to the good conductors and insulators, there is a third class of materials known as "semi-conductors" which pass only a small current when a moderate voltage is applied across a thin slice of the material. It is this class of materials which makes modern electronics possible, since the flow of current through the material can be controlled by small input signals.

For completeness we will mention that a fourth class of materials can exist at very low temperatures which are known as "super-conductors". The resistance in a superconductor is almost zero, but the property of super-conduction disappears as the material is warmed only by a relatively small amount above the absolute zero of temperature.

METALLIC CONDUCTION

An atom consists of a central positively charged nucleus with electrons situated near to it. In a metal the inner electrons (those near to the nucleus) are fixed firmly in position, since the attraction between their negative charge and the positively charged nucleus prevents them from breaking away from the latter.

However, the outer electrons in a metal are free to move anywhere within that piece of metal. If a voltage is applied across the metal, electrons will flow towards the positive side and other electrons will enter the metal at the negative side. The battery which drives the electrons through the metal can be regarded as a pump which pumps electrons out of its cathode and receives a corresponding number back at its anode.

Thus it is the availability of huge numbers of electrons which are free to move in the metal which renders it a good conductor.

INSULATORS

In the case of insulators, the electrons are all fixed in positions by the electrical forces. The chemical bonds which hold electrons in position are electrical forces. A relatively large amount of energy is required to enable one of these electrons to break free and this amount of energy is not normally available for any one electron at room temperature. Thus there is nothing in an insulator which can carry an electric charge and any flow of current is extremely small.

In all solid materials the positively charged nuclei are held firmly in position by electrical forces and cannot contribute to conduction. It is only the movement of electrons which can make an appreciable contribution to the conductivity of any solid.

It is interesting to note that insulators will become conductors if their temperature is raised by an adequate amount. For example, if one applies a potential of about 200V across a glass rod about 20cm long by winding copper wires around each end and then heats the centre of the rod, a large current will pass when the temperature approaches red heat and this current will be adequate to maintain the temperature of the rod.

The increase of conductivity is partly due to the heat energy enabling electrons in the glass to escape from the atoms to which they are normally fixed and partly due to the high temperature softening the glass so that ions can start to move as one approaches the liquid state.

SEMICONDUCTORS

In semiconductor materials there are a limited number of free electrons able to move in the material. This number is extremely small when compared with the number of free electrons in a metal. Thus the current which flows when a small voltage is applied across a semiconductor material is very much smaller than that which flows when a similar potential is applied across a piece of metal of similar dimensions.

A semiconductor material is rather like an insulator, but the amount of energy required to release some of the electrons is far smaller. A few of the electrons acquire enough energy from the heat in the material for them to break away from the atoms to which they are normally attached and they can then contribute to conduction.

If the temperature of a semiconductor material is raised, the extra heat energy enables a much greater proportion of the electrons in the material to move. Thus the conductivity of a semiconductor material increases greatly with increasing temperature. The silicon semiconductor material used in most modern semiconductor devices cannot be used as a semiconductor above a temperature of about 200 degrees C, since the number of mobile electrons is then too great for it to be regarded as a semiconductor material.

Modern semiconductor devices are made using extremely pure silicon to which certain elements have been added, but the early transistors were made using germanium. Silicon and germanium are elements, but certain compounds are also semiconductors; for example, cadmium sulphide is used in photoconductive cells, gallium phosphide in light emitting diodes and gallium arsenide in infra-red detectors and lasers.

Semiconductor products are often known as "solid-state devices" since the materials in them are solids, unlike the earlier radio valves in which electrons flow in an evacuated enclosure.

Next month we shall continue our discussion on conduction in various materials.

CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised.

Payment is made for all circuits published in this feature.

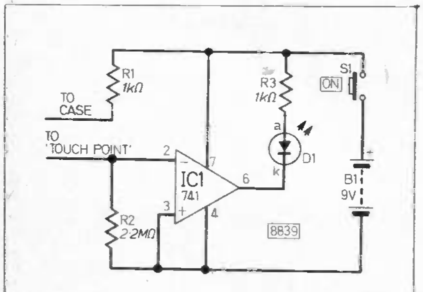
Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

PROBELESS CONTINUITY TESTER

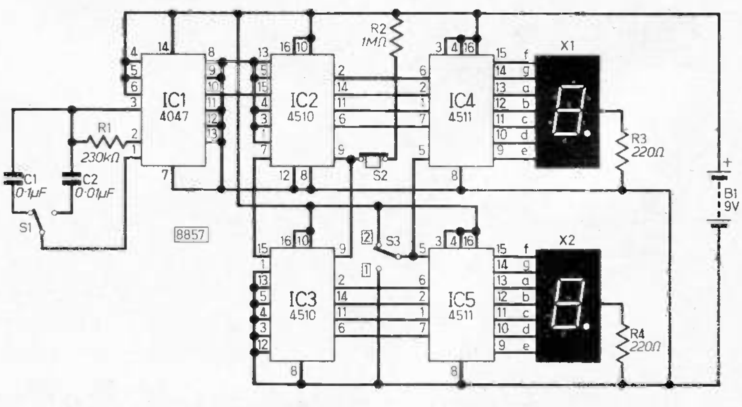
Continuity testers usually have two test probes. But in the present model, there is only one "touch point" instead of the probes. The device to be tested is held by one of its leads in one hand and the tester is held in the other. The other lead of the device is touched against the "touch point" (some metallic object about the size of a coin or even smaller. This is fixed on an insulated panel to isolate it from the tester case which is metallic.) The current flows from the metal body of the tester, through your body, the device and into the "touch point". This current is detected by the IC1 lighting up D1.

The "touch point" can be the head of a drawing pin. It should be insulated from the metal case, while mounting

J. Sreekumar,
Cochin,
India.



SIMPLE REACTION METER



This is based on the 4047B multivibrator IC1 connected as an astable. S1 controls the frequency. When S1 is switched to C1 (0·1μF) the frequency is 10Hz. At C2 (0·01μF) the frequency is100Hz. Resistor R1 is 230k (220k and 10k in series). This value is required in order to obtain fair accuracy. The pulse is fed into the 4510B BCD counter. This feeds binary into the 4511B which decodes it to drive a seven-segment common cathode display. The first 4510B (IC2) feeds a pulse which has been divided by 10 into the second counter stage IC3, IC5, which operates in the same way. S2 is push-to-break and resets both digits to 0.

S3 is the latch which when in position 1 (connected to negative) allows the 4511B to display the pulses being counted. When S3 is positive (position 2) the 4511B displays the number which was being counted at the exact moment the switch was turned to positive.

How to time a person's speed: The subject undergoing test holds S3 (which is in positon 1). Another person holds S2 pressed so the digits are at 0. As soon as S2 is released the digits start counting the pulses, and when the person being timed sees the digits counting, he switches S3 to position 2, this latches the 4511B so the time is displayed. To reset, S3 is returned to position 1 and S2 pressed. Timing can be accurate to 1/10 of a second or 1/100 of a second depending on what range S1 is set to.

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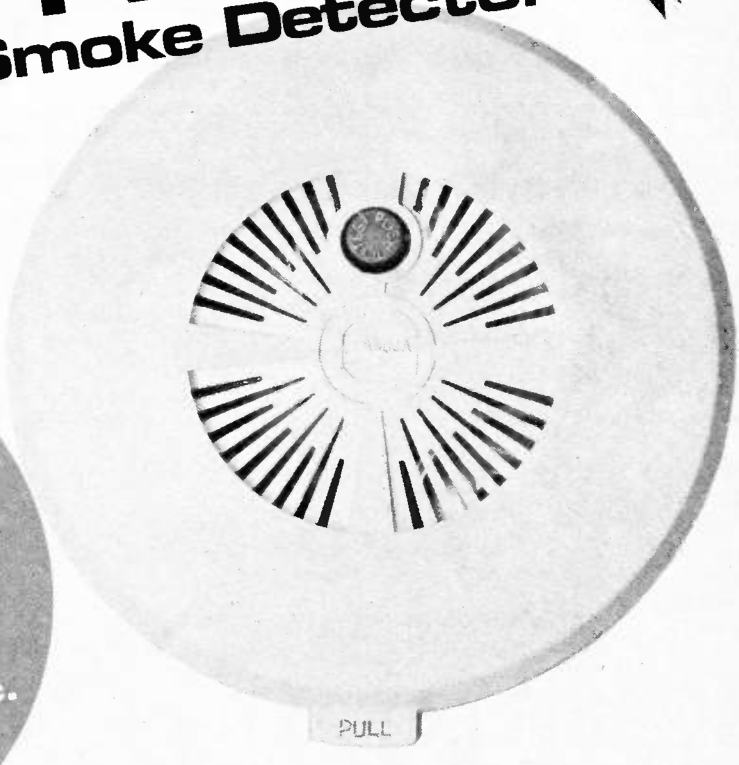

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JULY ISSUE

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JULY 1983 ISSUE ON SALE FRIDAY, JUNE 17

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Computer Forecast

I've been doing some long overdue donkey work on computing. I wonder how many readers are in the same boat as I am? Too busy earning a living at work that doesn't involve computers to spend the time necessary to get to grips with computing.

With this in mind I'll make a public bet. I bet that within a couple of years there are word processors, and computer filing systems, on the market that require absolutely no knowledge of computing. You'll use them as easily as you use a typewriter. The software program will be in a dedicated chip inside the keyboard so that it's ready for action the moment you switch it on.

I'll also bet that the machines that make a killing on this market come from Japan. It will be the video boom all over again. While Western companies are still trying to sell equipment that requires the proud purchaser to make all manner of compromises, the Japanese will have quietly designed a range of computer equipment that is tailor-made for people who don't want to know anything about computers. Mark my words!

Medical Cure

Meanwhile, anyone who wants to use a computer as a working tool (for instance, I wanted to use one for indexing my files on audio and video topics) has got no choice. They have to learn a bit about computing or do without.

As a mixed blessing I ended up in hospital and convalescing for a couple of weeks. So I spent the time learning something about computers.

I'm not recommending that people who need to learn the rudiments get themselves into hospital, but if you are in the same unfortunate position I strongly suggest that you turn it to your advantage. Even if you aren't very interested in computing, it's better than watching someone else's choice of TV programme on the ward set.

To my surprise I found that modern hospitals now have mains power points by each bed. If you get on the right side of the ward nursing staff, they will let you bring in a small computing system, like a Sinclair, and run it on the bedside table.

I was lucky in finding a couple of doctors on the ward round who were both computer buffs. They encouraged me to bring in a computer and the ward sister said: "All right, provided it doesn't make any noise".

Other hospitals, and other wards, may have a different policy. But all is not lost. Your answer here is to use a pocket computer, like the Sharp PC 1211. The same model is also sold by Tandy.

The cost is well under £100 and although these units look like calculators, they are in fact full-blown computers, albeit with fairly limited memory. With a cassette interface you can write programs, dump them onto tape and load them again the next day.

The instruction book that comes with the Sharp is pretty clumsily written, and the Tandy version is much better. But with either, and some hard work, you can do some very useful ground work on basic computing and BASIC program language.

Bear this in mind if you have advance warning that you are likely to be laid up, in hospital or in bed, for a couple of weeks. It's a good opportunity to turn a stroke of bad luck to your advantage.

Hospital Radio

Here's another tip for anyone facing a stint in hospital. Unless you are very ill, you'll soon get bored. Even if you are learning computing, you'll want to listen to the radio as well. But the radio systems in even modern hospitals leave a lot to be desired.

They use acoustic stethoscopes, like those in long-haul airlines, and you can only listen to a limited choice of channels piped through to your bed by the hospital distribution system. It's also likely to be in mono only.

The answer is to take along a personal stereo cassette player, or radio with headphones. However, do check that a tape player produces good sound while it is being shaken around, as well as while it is laying stationary on a shop counter.

Some of the cheaper models produce awful wow and flutter as soon as you use them on the move. It won't matter in hospital, but it will drive you crazy if you later try and use the player while you are walking or jogging.

By the way, if you are visiting someone in hospital and you can afford an expensive present, a personal cassette player or radio will probably be far more welcome than flowers or fruit.

Video In A Spin

The video games boom is levelling off. Atari in America has laid off a quarter of its workforce.

Personally, I'm not surprised, and I'm certainly not sorry, that the public is fast growing tired of blasting blips off a TV screen. The games manufacturers are trying to counter the loss of interest with ever more exotic cartridges.

One trend is to sell games that are "spin-offs" from feature films, like *Tron, Star Wars* and *Raiders of the Lost Ark.* Another trend is towards semi-sadistic games, like guiding chickens across a busy road. And in America, there are now pornographic games, from strip poker to all manner of unmentionables

All the signs are that all these are the desperate efforts of a dying industry. But there is growth in games programs for micros. Businessmen and householders are buying small computers because they think they ought to use them for accounting, calculation or word processing. As often as not the only programs they end up running are games programs.

Joystick

Accessory firms are also making money out of video games. For a little over £10 each you can buy exotic joystick controls to replace those that come as standard with TV games.

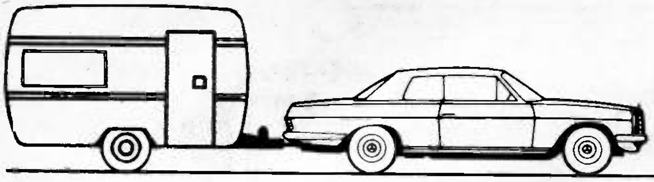
Most hand controllers for home TV games use a separate joystick and firing button to steer and blast blips on the screen. Usually, only one shot is fired for each press of the button.

New add-on controls from American manufacturers Spectravision and DiscWasher do better than that. They come with a standard 9-pin D-plug which fits straight into the control socket of an Atari game or Commodore computer. The firing button is on top of the joystick, under the player's thumb.

The makers reckon that this brings consistently higher scores. It also means that right and left handed users can for the first time compete on equal terms.

For really high scores you have to pay an extra £8 and plug in a DiscWasher Constant Fire adaptor between the joystick plug and circuit. This contains an integrated circuit which is powered by spare d.c. from the games unit and generates a constant pulse fire cycle every time the thumb button is pressed. So on the screen there is a machine-gun effect.

Gadgets like these are selling well, partly because people just love to buy extra add-on gadgets. But it's also partly because the hand controllers with TV games get very hard use, wear out and need replacing with new ones fairly frequently.



CARAVAN POWER SUPPLY

BY T. R. de Vaux-Balbirnie

THE author is one who believes that caravanning can be made more pleasurable by the benefits of electronics. Fluorescent lights, electric water pumps, extractor fans and cooker hoods are convenient, while cassette recorders, television and, perhaps, a video game or personal computer, can be useful on wet days and in making a true home-from-home.

POWER SUPPLY

The battery in the towing vehicle may be used to power any 12V equipment but this ties up the car since it must be parked nearby. Some members of the family might wish to use it leaving the others behind. So there is much to be said in favour of a separate battery for the caravan. This is useful, even at home, since the interior light may be used without having to couple up the car.

It will be noted that an auxiliary battery is only used for the interior equipment, the exterior lights on the caravan receive their power from the car system in the usual way.

CHARGER

Assuming the auxiliary battery to be fully charged before setting out on a trip, it could only be expected to give a short period of service without being recharged. The present system has been designed to keep the battery topped up with charge, at a rate of about 2A on touring holidays. It is not designed for use on long-stay holidays at a fixed location. Since charging is effected by the generator in the car, the project is best where stops are for a few days at a time, followed by periods of towing.

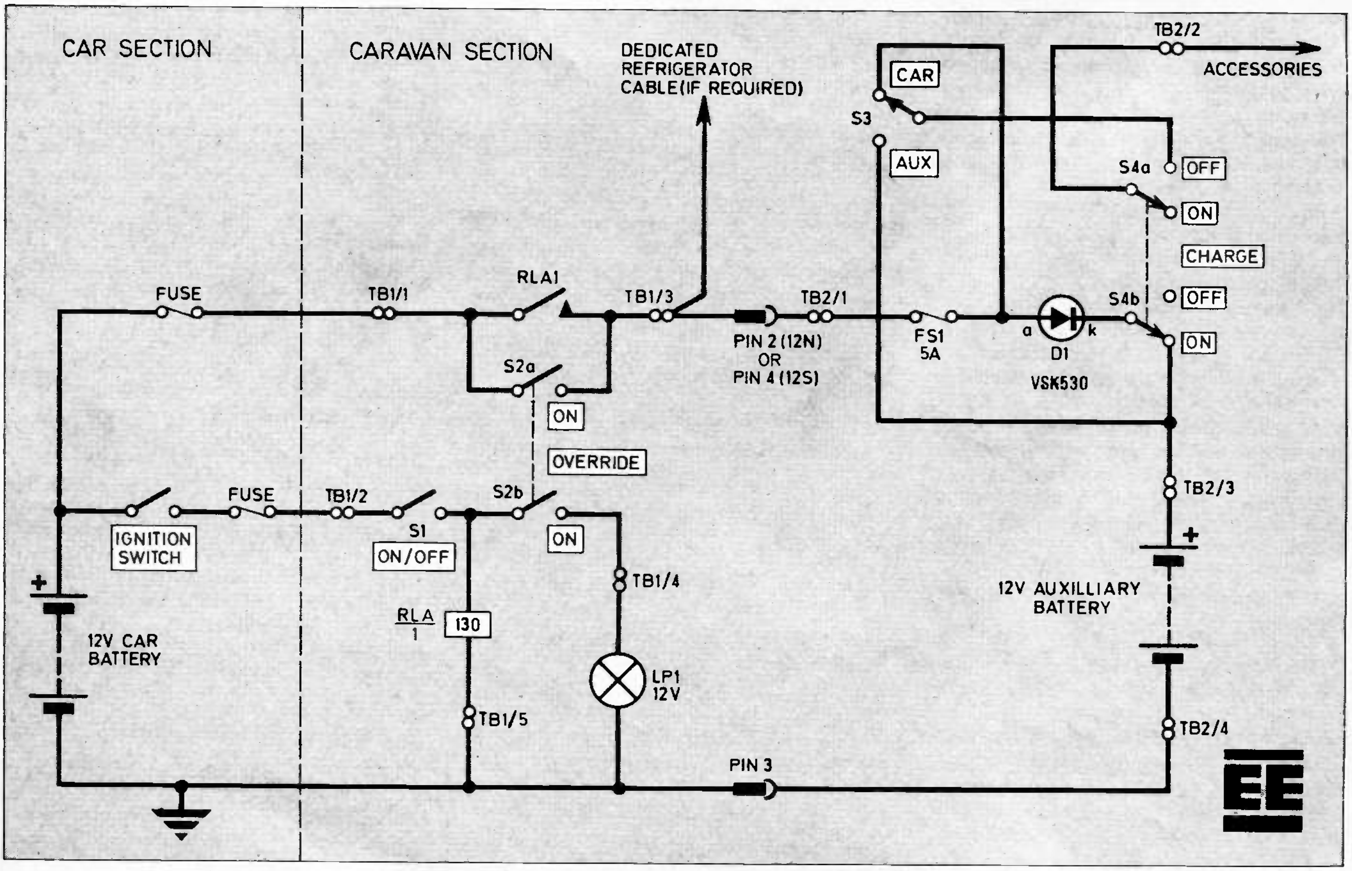
Readers wishing to keep a battery charged on fixed-site holidays would be advised to buy a commercial unit offering mains facilities and to choose a site with mains outlets.

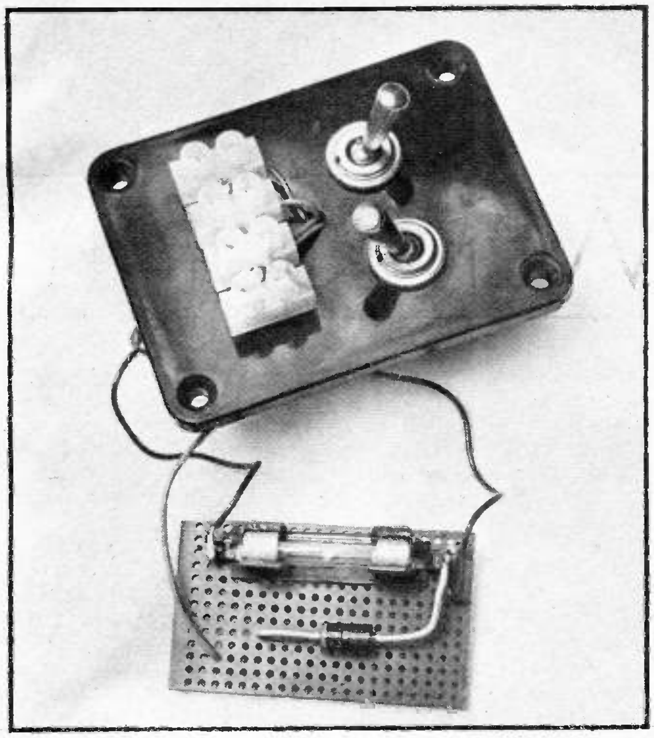
The project described is for a *negative-earth* car. It is equally suitable for *positive-earth* systems and the simple modifications required are described later.

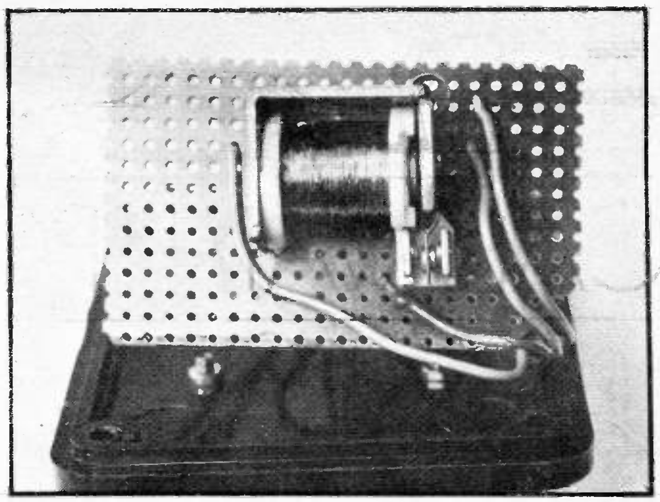
RESISTANCE

When driving along there will normally be about 14V available from the car charging system. This will exist at the accessory pin on the drawbar socket. From here, current is directed through existing wiring to the caravan and used to charge the auxiliary battery.

Fig. 1. Complete circuit diagram of the Caravan Power Supply.







Above—The matrix board mounted relay in the car section. The two switches and 5-way terminal block (not shown in this view) are mounted on the lid.

Left—The caravan mounted section of the Power Supply, showing the diode and fuse constructed on a piece of plain matrix board. Switches and terminal block are again assembled on the case lid.

Since the caravan battery is nominally 12V, there will only be about 2V available to drive current through the circuit. For charging at 2A, using Ohm's law, we get:

$$R = \frac{V}{I} = \frac{2}{2} = 1 \text{ ohm}$$

From this it is clear that the resistance of all wiring must be kept low or a poor charge rate is to be expected. If a refrigerator is powered through the accessory cable, there is likely to be an excessive voltage drop due to the high current flowing. It is always much better to supply a refrigerator through a *dedicated* run of cable. This is difficult where the car is fitted with a single socket (the 12N (Normal) system), because there is no spare connection.

On recent outfits (both cars and caravans manufactured since October 1979) there is a second socket fitted to the drawbar, the 12S (Supplementary) socket. The 12S socket has pin 6 reserved for refrigerators. When a refrigerator is fitted in an older outfit, it would still be wise to fit a 12S socket. This is available from caravan accessory shops.

An alternative to fitting a 12S socket would be to tape a supplementary wire to the 7-core cable and use a weatherproof connector for powering the refrigerator.

HOUSING

The Caravan Power Supply is built into two similar plastic boxes, each fitted with two switches. One part is located in the boot of the towing car and the other in a front locker of the caravan adjacent to the auxiliary battery. The circuit diagram of the entire system is shown in Fig. 1.

The car mounted case contains a relay, RLA1. This permits charging of the caravan battery only whilst the ignition of the car is on. This is necessary as there will be no chance of a well-charged car battery draining into a poorly-charged auxiliary battery.

The first switch, S1, switches off the system. This is useful to avoid mechanical wear on the relay during long non-towing periods. The second switch, S2, over-rides the relay for a reason to be explained later. When over-ridden, a warning light illuminates on the dashboard when the ignition is next switched on.

CARAVAN SECTION

The caravan section of the project carries a fuse, FS1, and diode D1. The diode directs current to the caravan system and, under no circumstances, the other way. An ordinary *p-n* junction diode would lead to a voltage drop of up to 1V and a poor rate of charge. Instead, a *Schottky barrier* diode is used. This is more expensive than the conventional type but gives a more acceptable voltage drop of about 0·2V.

Switch S4 on the caravan section selects either ON CHARGE (when driving along) or OFF CHARGE (when parked). When OFF CHARGE the caravan equipment may be used. S3 is labelled CAR/AUX. This selects the battery from which current is to be drawn. When the car is available there seems no point in draining the auxiliary battery.

To enable the car battery to power accessories it will be necessary to set S2 to OVER-RIDE, hence the purpose of this switch.

CONSTRUCTION

COMPONENT BOARD

The circuits for each panel are illustrated in Fig. 2 and Fig. 3. The diagrams should make the connections clear. Note that the specified relay is fitted with change-over contacts but only the "energise-to-make" (or normally open) contacts are used. The diode is secured by passing its negative connection through a hole in the panel and bending it. The polarity of the diode is important and the white band shows the cathode.

COMPONENTS

See Shop Talk page 369

Semiconductors

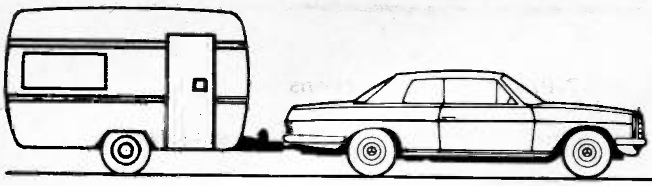
D1 VSK530 5A Schottky barrier rectifier

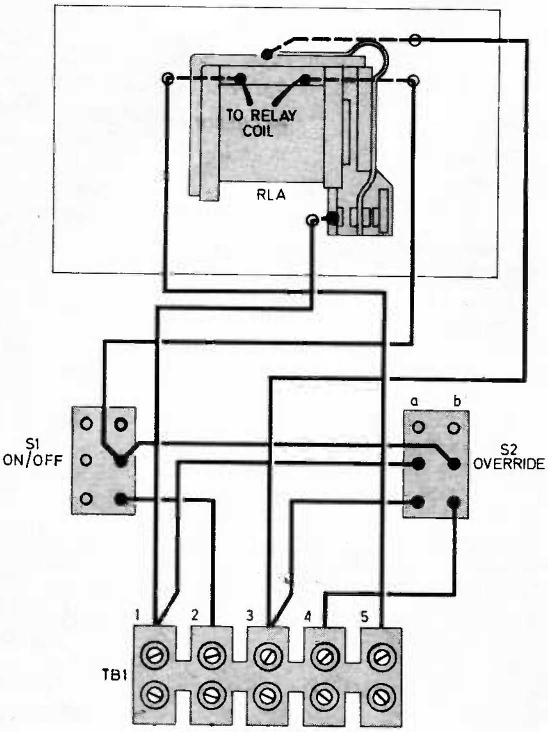
Miscellaneous

S1,2,3,4	d.p.d.t. toggle (4 off)
RLA	miniature relay, 12V, 130Ω coil with 30A rated contacts
LP1	12V, 2·2W panel lamp
FS1	5A fuse

0·1 inch plain matrix board, 12 strips by 21 holes (2 off); plastic case, 76 × 56 × 35mm (ABS case type MB1) (2 off); terminal block 6-way (2 off).

Approx. cost Guidance only £12





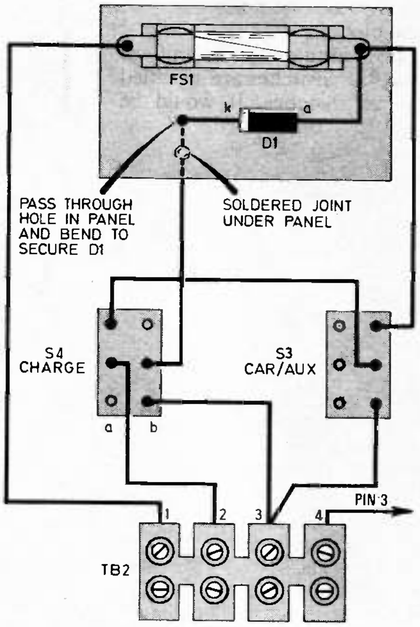


Fig. 2 (left). Diagram showing wiring details of the car section, consisting of a relay RLA1 and switches, S1 and S2.

Fig. 3 (above). Wiring details of switches, S3 and S4 in the caravan section, showing diode and fuse connections.

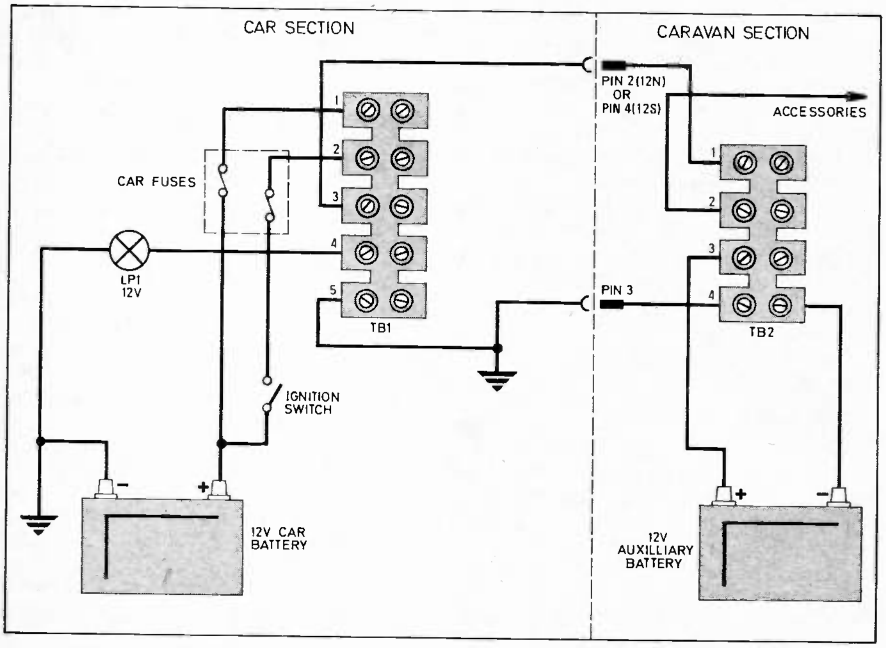


Fig. 4. Interwiring details for the car and caravan sections, note that the connections between the two sections are made via the 7-pin (12N or 12S) socket. See Table 1.

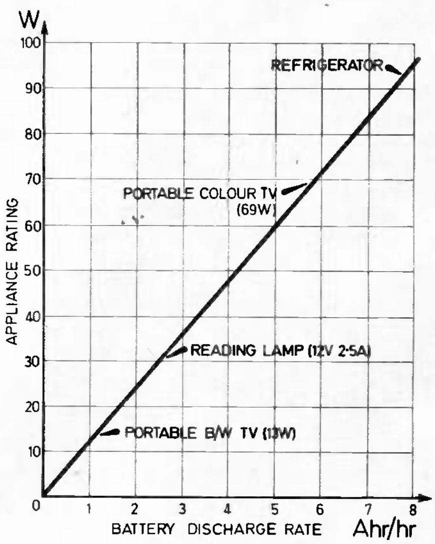


Fig. 5. Graph showing the typical discharge rate for the caravan auxiliary battery, for various electrical appliances.

Solder 100mm long wires to the components as indicated in the diagrams for connection to the terminal blocks. Drill the boxes for the switches and terminal strip fixings. Drill a small hole near each terminal strip to accept the wires from the circuit panels. Attach the switches and terminal blocks. Insert the circuit panels, pass the wires through the holes and wire up the terminal blocks.

For ease of ordering and uniformity of appearance, all four switches are specified as d.p.d.t. toggle switches. It would be possible, although hardly worthwhile, to make a small saving by using simpler switches for S1, S2 and S3. The switches must be of at least 3A rating. Small brackets may be attached to the boxes to enable them to be fitted in position.

TABLE 1
7-Pin Socket Connections

Pin No	12N (Normal)	12S (Supplementary)
1	Left indicator	Reversing light and catch if fitted
2	Foglight (accessories if no 12S fitted)	Battery charging
3	Earth	Earth
4	Right indicator	Accessories
5	Right sidelights and number plate	Warning lights
6	Stop lights	Refrigerator
7	Left-hand sidelights/ number plate	Spare

Looking at sockets from the plug side, pins are numbered clockwise *with No. 1 at the top. Pin 7 is in the centre.*

INTERWIRING

Refer to Fig. 4 for wiring details. Choose a convenient place in the rear for the car section. This should be close to the existing wiring to the 7-pin drawbar socket. Remember that access is required to operate the switches.

Locate the wire which leads to the accessory pin on the drawbar socket. (See Table 1.) Break this wire and extend the free ends using "bullet" connectors. The end leading to the 7-pin socket should be connected to TB1/3 and the other end to TB1/1. Two runs of light-duty auto-type wire should be made to TB1/2 and TB1/4. The former connects to a fuse which is live only when the ignition is switched on and the latter to one terminal of the warning light positioned on the dashboard of the car. The remaining connection, TB1/5 is earthed by being connected to the metal body of the car. The unused terminal of the warning light is also earthed.

The caravan section may now be wired up. The locker chosen for the box and auxiliary battery should be as close as possible to the inlet connections from the 7-pin plug. These are often located in the locker itself or under the caravan. The wire leading to the accessories should be found, removed from its terminal, and connected to TB2/2.

The free terminal should be connected through a short length of wire to TB2/1. TB2/3 and TB2/4 are respectively the positive and negative connection for the auxiliary battery. TB2/4 is earthed by connecting it to the wire which leads to pin 3 on the 7-pin plug. Proper connectors should be used for the auxiliary battery, do not rely on crocodile clips or other make-shift methods. (Note previous comment about refrigerators.) On no account may one be powered through the caravan section of the unit.

POSITIVE EARTH

For *positive-earth* cars, reverse the connections to the diode and the auxiliary battery.

TESTING

Note that all tests must be made with the caravan stationary as the law does not permit riding in a caravan. Satisfactory testing can only be carried out using a 0–5A ammeter. First switch off all accessories and disconnect the wire from the positive terminal of the auxiliary battery. Connect the positive terminal of the meter to the free wire and the negative terminal to the battery terminal. Now set the switches in the following way:

Car Section:

S1 (ON-OFF switch)	ON
S2 (OVER-RIDE switch)	OFF

Caravan Section:

S3 (CAR/AUX switch)	TO EITHER POSITION
S4 (CHARGE switch)	ON

The ammeter should give no reading. Switch the ignition on but do not start the engine yet. A click may be heard as the relay operates and a small reading may be observed on the ammeter. Run the engine at a fast idle. The ammeter should indicate a current depending on the state of charge of the auxiliary battery. It may be expected to be 2A or so and higher for a very poorly charged battery.

Now check the circuit in the discharge mode. Remove the ammeter and reconnect the battery wire. Set the switches as follows and switch a caravan light on:

Car Section:

S1 (ON-OFF switch)	ON
S2 (OVER-RIDE switch)	ON

Caravan Section:

S3 (CAR/AUX switch)	AUX
S4 (CHARGE switch)	OFF

Assuming the auxiliary battery is charged, then the caravan light should be on. Now set the CAR/AUX switch to CAR. The caravan light should stay on. This time it receives current from the car battery. Remember that the relay must be over-ridden, using S2, before the car battery can supply current. Test by switching S2 OFF—the interior light should now go off. Test the warning light by setting the OVER-RIDE switch to ON with the ignition on.

AUXILIARY BATTERY

Any 12V car battery will serve for the auxiliary supply. It is always wise to choose a battery of the same size and having the same fittings as the car battery. It may then be used as a spare battery in an emergency. Budget batteries are quite suitable and will have a long life since the auxiliary supply is only intended for light-duty use. Even a battery from a breaker's yard may be satisfactory but reject one if it shows signs of neglect or if it has been left in a discharged state for a long time.

During long periods of non-use the battery should be charged periodically to keep it in good condition. Alternatively it may be exchanged with the car battery from time to time. Always keep the terminals clean and tight and remember to charge it fully before setting out on holiday.

SWITCH FUNCTIONS

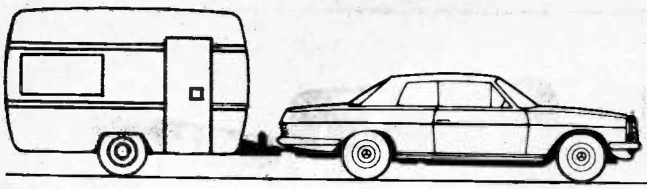
S1 To cancel the system for the winter months. When ON, the relay operates each time the ignition is switched on whether towing or not. This is not harmful but causes unnecessary mechanical wear.

S2 To over-ride the relay. This is only needed when parked and the car battery is required to power caravan accessories.

S3 CAR/AUX—with S4 OFF set S3 to AUX to operate equipment from the caravan supply. Set to CAR (with S2 ON) to operate equipment from car battery.

S4 CHARGE switch. Set to ON when driving along to keep auxiliary battery charged. Set to OFF when parked. When S4 is ON, S3 may be set in either position.

The warning light comes on if S2 is left at OVER-RIDE and the ignition is switched on. It would be bad practice to leave it this way. □



CARAVAN FRIDGE ALARM

BY T. R. de Vaux-Balbirnie

A REFRIGERATOR is regarded as an essential piece of caravanning equipment and can certainly simplify a holiday. Tent campers are also seeing the benefit of a well-stocked fridge. Unfortunately, refrigerators are prone to failure for the simplest reasons, a gas bottle running out or a poor electrical connection and this causes great inconvenience unless discovered in time.

This project is an alarm which will provide early warning of fridge failure. It gives a signal by means of either a lamp or a buzzer. The audible signal is useful when at a fixed site. The visible signal is more appropriate when towing.

In this case, the unit is placed in the front window of the caravan and the lamp observed through a car rear-view mirror. It would be a simple matter to construct the project for buzzer-only warning if preferred.

PLASTIC BOX

The project appears as a small plastic box with two switches mounted on top. The first is simply an on-off switch. The second is used to select either lamp or buzzer warning. A terminal block is used to connect the unit to the sensor on the fridge.

The box contains its own battery. One reason for this is because the most common cause of failure while towing is failure of the electrical supply. The alarm would also fail to work if it received current from the same source as the fridge.

Although the internal 9V battery is small, excellent service may be expected even where the unit is switched on continuously for long periods. This is because the standby current requirement of the circuit is extremely low, about 15 microamps. When the alarm is actually operating the current rises to about 15mA (buzzer) or 60mA (lamp).

The Caravan Fridge Alarm was designed for use with *absorption* fridges of the type used in caravans and for camping. It may be used with certain *compressor* fridges of the household type but readers would need to make their own tests to find out if this is possible.

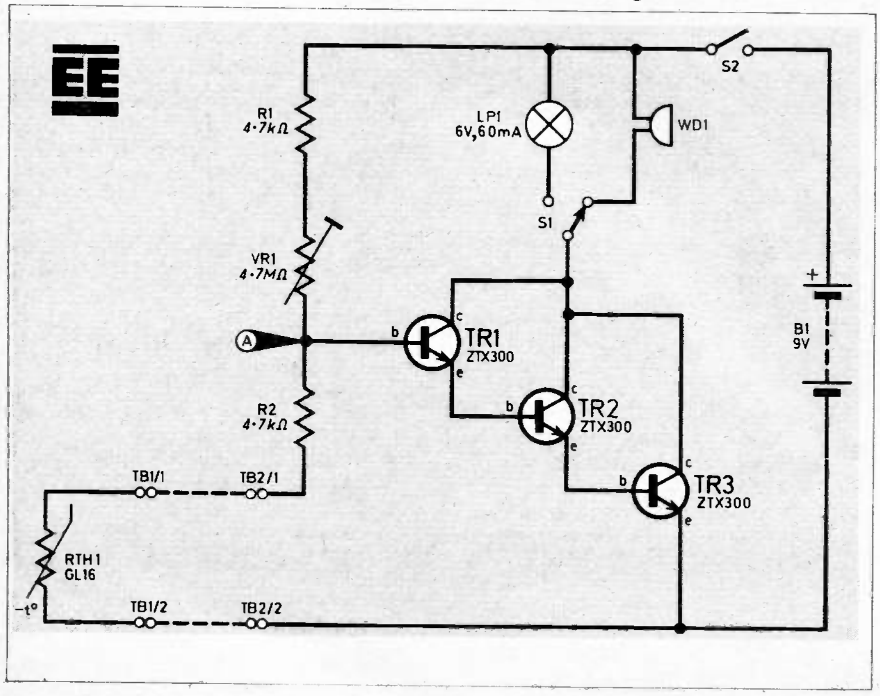
OPERATION

Previous designs have relied on the rise in temperature inside the fridge when it fails. Unfortunately, there may be difficulty inserting the sensor into the cabinet without disturbing the thermal insulation. This project, by contrast, works by sensing the fall in temperature of an easily-accessible part behind the fridge.

A small boiler is an essential component of an absorption fridge. This is maintained at a high temperature by means of either a gas flame or an electric heater. The sensor is applied close to this and if the electric or gas supply fails then the boiler will cool and the alarm trigger. An adjustment on the circuit panels allows this to happen at a suitable preset temperature.

Although nearly fool-proof, this method of detecting failure is not quite so. If the refrigerant itself were to fail then the boiler would stay hot but the fridge would not work. Circumstances like this are thought very unlikely.

Fig. 1. Main circuit diagram of the Caravan Fridge Alarm.



CIRCUIT DESCRIPTION

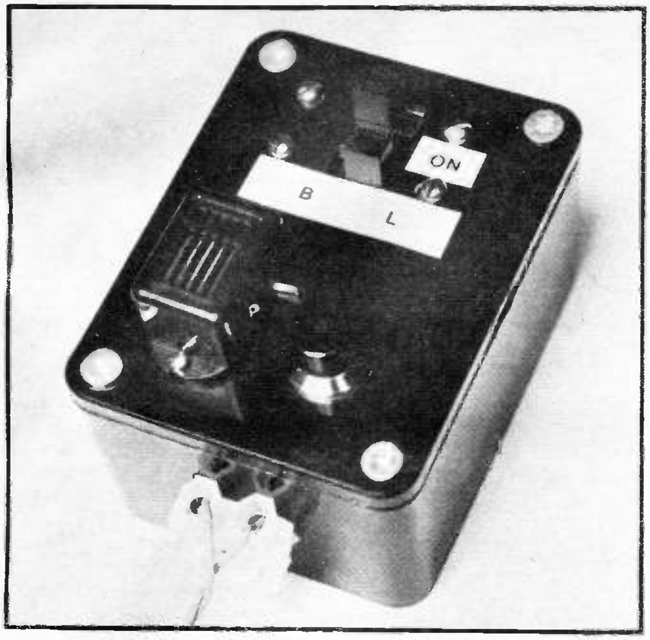
The circuit for the Caravan Fridge Alarm is shown in Fig. 1. The sensor detecting the fall in temperature is a suitably protected bead thermistor, RTH1. VR1, R1, RTH1 and R2 form a potential divider across the battery. When the unit is switched on at S2, a small current will flow continuously. This is too low to cause serious battery drain on account of the very high resistance involved.

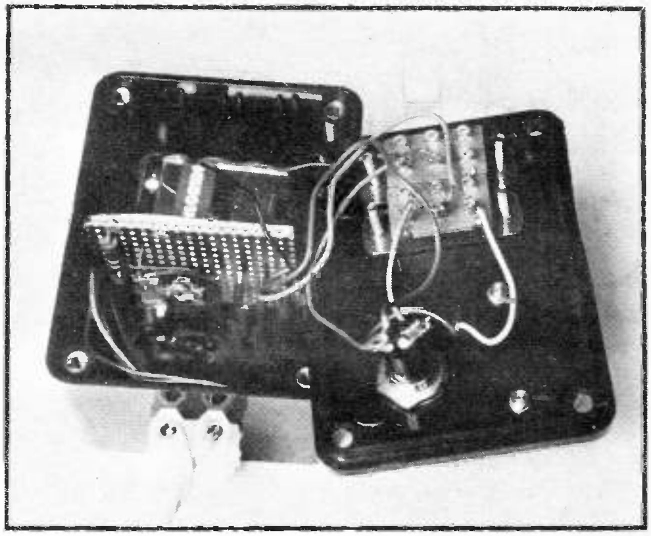
When RTH1 is hot and the refrigerator operating normally, its resistance will be comparatively low and the voltage at point *A* less than the 0·7V needed to turn on TR1. When RTH1 cools, its resistance rises and the voltage at point *A* will rise above 0·7V so TR1, TR2 and TR3 will turn on.

These three transistors are connected in a very high gain arrangement called a "Darlington triple". The base current entering TR1 in order to operate the alarm at the end of the chain is exceptionally low. This leads to a very sharp response. The two-way switch, S1, allows current to flow to either the lamp, LP1, or the buzzer, WD1.

Switches S1 and S2 are specified as d.p.d.t. types since these are readily available. It would be possible to use a s.p.d.t. for S1 and a s.p.s.t. for S2 with a slight saving in cost.

VR1 is the adjustment whereby the alarm operates at a preset temperature within its range.





(Above). Prototype with the lid removed showing the internal layout and use of moulded guides to mount the circuit board.

(Left). The completed prototype Caravan Fridge Alarm showing the case mounted components.

CONSTRUCTION

COMPONENT BOARD

The circuit panel is constructed on a piece of 0·1 inch matrix stripboard 12 strips by 21 holes in size. Refer to Fig. 2 and solder all components into position. Any breaks in the stripboard should be made prior to inserting components. Check carefully that no solder bridges have been left between adjacent copper tracks. End by soldering connecting leads to Veropins as shown in Fig. 2.

COMPONENTS

Resistors

R1,2	4·7kΩ (2 off)

Semiconductors

TR1,2,3	ZTX300 *npn* silicon (3 off)

Miscellaneous

S1,2	d.p.d.t. slide (2 off)
VR1	4·7MΩ horizontal skeleton preset
RTH1	GL16 glass bead thermistor
B1	9V PP3
WD1	6V buzzer
LP1	6V, 60mA indicating lamp

0·1 inch matrix stripboard, 12 strips by 21 holes; plastic case, 76 × 56 × 35mm (ABS case type MB1); terminal block 2-way (2 off); metal spring clip.

Approx. cost Guidance only £9.00

TESTING

A test may now be made on the circuit panel before fitting it into its case. Set VR1 to about mid-position and connect the thermistor as shown in Fig. 2. Connect the 6V bulb and then connect up the battery terminals. The lamp will probably light.

With the help of an assistant, warm RTH1 by holding a lighted match 50mm below it for a few seconds. The lamp should go off and re-light when the thermistor cools. If this does not happen then some adjustment to VR1 is required. The final setting for VR1 can only be found at the end when the sensor is in position on the fridge.

CASE

Prepare the case by drilling holes for the switches, lampholder, the buzzer and terminal block fixings. A suitable layout is shown in the photograph. Drill a small hole next to the terminal block position for the wires which will pass through from the component panel. Drill a similar hole for the buzzer wires to pass through. Attach all remaining components and complete the wiring (Fig.3).

SENSOR

It is essential to use a thermistor of the same type as specified in the components list. Suggested positions for the sensor are shown in the photographs, these cover the

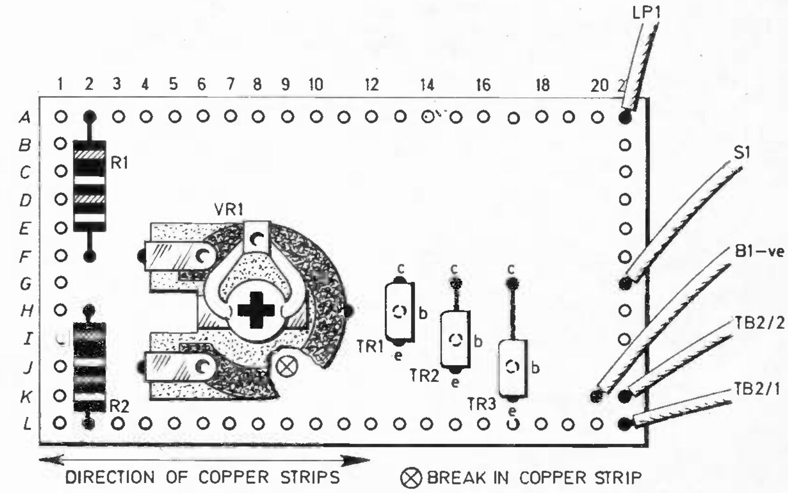
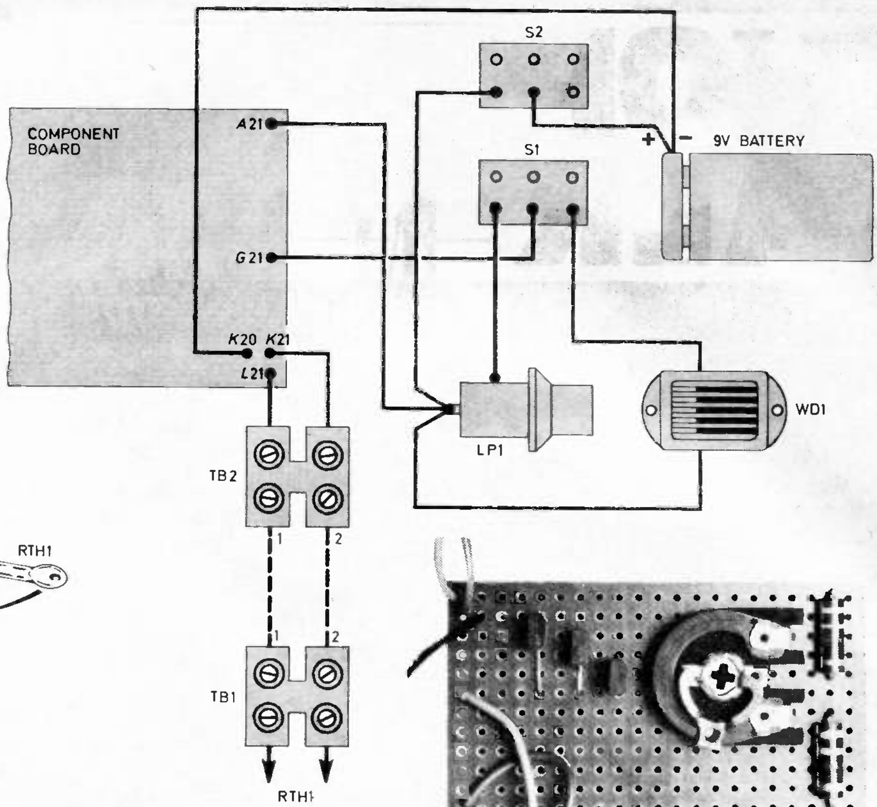
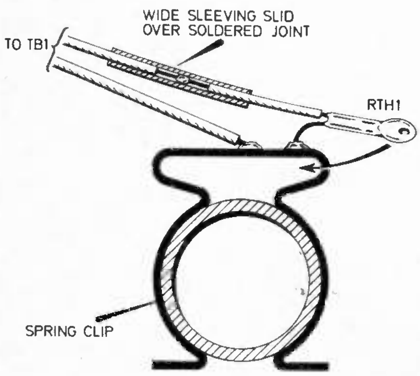


Fig. 2. Component layout of the Fridge Alarm. Note the track break beneath VR1.

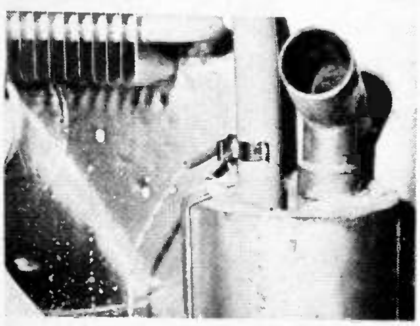
Fig. 3 (right). Diagram showing offboard wiring details. Note that TB1 and RTH1 are remotely mounted via a twin covered cable on a suitably positioned pipe (see text and photographs).

Fig. 4 (below). Diagram showing mounting details for the temperature sensor. Note that when soldering to a plated spring clip, the plating must be removed and the use of an additional flux may be required. To make good thermal contact ensure that the bead is located in the bend of the clip using epoxy resin.

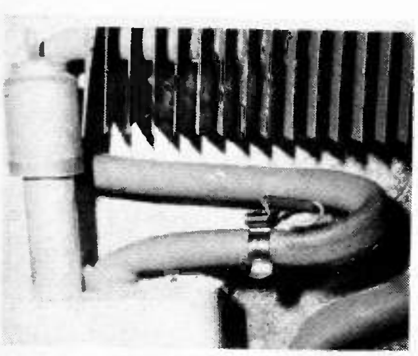




Completed component board.



Temperature sensor shown mounted on the Electrolux Fridge.



Temperature sensor shown mounted on the Camping Gaz Fridge.

Electrolux and Camping Gaz type refrigerators. Readers with other fridges should have no difficulty finding a suitable place.

The chosen position must feel very hot when the unit is at full operating temperature but warm enough to hold comfortably by hand about 15 minutes after switching off. On no account may the sensor be placed where it could disturb thermal insulation or interfere with the combustion of gas (inside the flue, for example).

The thermistor is very delicate and some protection is required. The method tried with the prototype is shown in Fig. 4. Alternatively, the thermistor may be secured to a small piece of thin sheet copper and this wired into position. Whatever method is used, it is essential that the sensor makes good thermal contact with the refrigerator.

Make sure that the thermistor leads cannot short circuit or the project will not work. The two thermistor leads are extended to reach TB1 which is attached to a convenient mounting point behind the fridge. Make certain that the wires are kept clear of all hot parts.

SETTING UP

Link TB1 at the refrigerator to TB2 at the unit using light-duty twin stranded wire. Run the fridge to operating temperature. Switch the unit on at S2 and set S1 to LAMP. If the lamp comes on, adjust VR1 until it goes off. Allow the fridge to cool down. If the lamp comes on, re-adjust VR1 to keep it off. When the sensor feels just warm rather than hot, adjust VR1 so that the lamp is just on.

Check that the system works with the buzzer as well as the lamp. If the alarm operates continuously, suspect a break in the wire between the sensor and the unit. Note that it is normal for the warning, whether by lamp or buzzer, to begin gradually rather than suddenly.

When in position, the battery could cause short circuits to the copper strips of the circuit panel. To prevent this, place a piece of cardboard between the battery and panel. Use a little foam plastic to prevent the battery from moving around inside the case.

It is most important to allow for as large a drop in temperature as convenient to trigger the alarm. If this precaution is not observed the standby current consumption of the circuit will be higher than need be and the life of the battery reduced.

If a multimeter is available then this current may be checked with the sensor at full operating temperature. It should be about 15–20 microamps. When doing this, it is essential not to allow the alarm to operate since the increased current would damage the meter. □

SHOP TALK

BY DAVE BARRINGTON

Catalogues

We have received just two catalogues this month. The first is the lavishly printed 48-page "Instruments for Testing and Design" from **Global Specialties Corporation.**

This catalogue covers digital logic probes and meters to function generators and a new oscilloscope multiplexer. The new 8-channel scope multiplexer, type 8001, extends the versatility of any single or dual channel scope by permitting viewing and comparison of eight channel analog or digital display.

For the constructor, there is a range of solderless breadboarding systems.

Copies of the "Instruments for Testing and Design" catalogue may be obtained from: **Global Specialties Corporation, Dept EE, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.**

For the Sinclair ZX81 and Spectrum home computer users, **Redditch Electronics** have just re-issued their accessories pamphlet.

This 16-page pamphlet lists such items as a add-on keyboard, input/output port boards and a music board. Also listed are a range of multi-pin connectors and a small range of books and tapes covering programming and using ZX81 and Spectrum machines.

Copies of the Redditch ZX81 and Spectrum Accessories pamphlet may be obtained from: **Redditch Electronics, Dept EE, 21 Ferney Hill Avenue, Redditch, Worcs. B97 4RU.**

Self-Service Multimeter

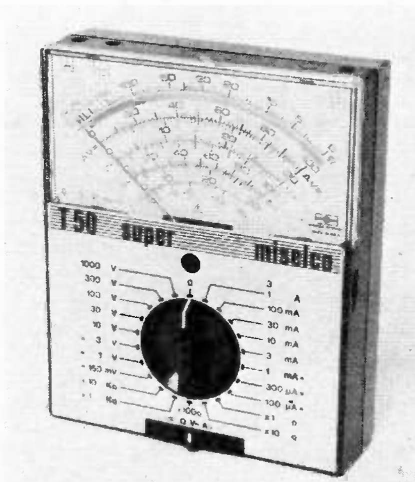
The latest addition to the range of multimeters and component test equipment stocked by **Alcon Instruments** is the Miselco T50 Super Multimeter. It has an input sensitivity of 50kΩ/V, large mirrored scale, switched ranges (39 in all) to measure resistance, d.c. and a.c. voltages and current, dB range and is fully protected against overload.

The p.c.b. and meter movement are factory calibrated such that any board will match any movement and maintain calibration. In this way the user is relieved of the worries of any repair or re-calibration problems.

The overall accuracy of the T50 Super is 2·5 per cent on all d.c. ranges and 3 per cent on a.c. The 16μA 100 degree movement incorporates an anti-parallax mirror.

The T50 SUPER Multimeter, housed in a two-tone brown plastics case, costs £52.35 plus VAT, without batteries. Included with the meter are a set of test probes/leads, instructions, circuit diagram and spare fuse.

Further information of the complete range of test meters may be obtained from: **Alcon Instruments Ltd., Dept EE, 19 Mulberry Walk, London SW3 6DZ.**



CONSTRUCTIONAL PROJECTS

Caravan Power Supply & Fridge Alarm

The heavy duty relay used in the *Caravan Power Supply* should be rated at least 3A contacts. The type used in the author's model was a 12V d.c. 30A automobile type. This is stocked by Maplin and listed as: YX99H (12V 30A Relay).

The 5A Schottky barrier diode D1, type VSK 530, should be ordered through a RS Components supplier. This carries the RS code 262-466.

The thermistor GL16 used in the *Caravan Fridge Alarm* is sometimes listed as G16 and TH-B11 types. These devices have a resistance of 1MΩ at 20°C.

The wiring for both models should be rated at approximately 5A.

Combination Lock

The only source for the lock release mechanism for the Combination Lock we have been able to locate is: Altype Security Systems, Dept EE, 310 High Street, Watford, Herts. This is known as type 203 and costs £11 (including postage) plus VAT. If any readers know of a similar device we would be pleased to hear from them.

We do not envisage any component purchasing problems for the *Transistor Tester* or the *Envelope Shaper for Bass Guitar*.

Eprom Programmer

The Eprom Programmer p.c.b. has been designed to accept the P0609 (and C0609) transformer from Ambit. The top board (8306-03) has been laid-out to accept the Erg D16A4-2 d.i.l. switches; these are stocked by RS Components (337-510). The z.i.f. socket is manufactured by Wimslow and is also stocked by RS (402-232). RS Components only supply to account customers and not to the general public. You will have to order through your local electrical/electronic dealer. Verospeed supply the "webbed" ribbon cable (226-22549H).

EE PRINTED CIRCUIT BOARD SERVICE

The printed circuit boards (drilled and roller tinned) for the Eprom Programmer may be obtained from Everyday Electronics: 8306-01 (TRS-80 version) £6.95; 8306-02 (Genie version) £6.95; 8306-03 £1.50. All prices include VAT and postage and packing. Remittances should be sent to Everyday Electronics PCB Service, Everyday Electronics, Editorial Offices, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

Printed Circuit Master Copies

For those constructors who wish to make their own Eprom Programmer p.c.b.s, photostat copies of the printed circuit masters may be obtained by sending a stamped SAE (A4 size) to the address above.

EVERYDAY ELECTRONICS SOFTWARE SERVICE

The EE Software Service provides an easy and reliable means of program entry for our computer-based projects. All programs have been tested by us and consist of two good quality copies of the working program on cassette tape. Certain program listings are also available.

All prices include VAT, postage and packing. Remittances should be sent to Everyday Electronics Software Service, Editorial Offices, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

PROJECT TITLE	CASSETTE CODE	CASSETTE COST	LISTING CODE	LISTING COST
ZX81 SPEED COMPUTING SYSTEM (Feb 83)	T001	£2.95	L001	£2.95
REAL-TIME CLOCK (Apple) (May 83)	T002	£2.95	L002	£2.95
REAL-TIME CLOCK (BBC) (May 83)	T003	£2.95	L003	£2.95
EPROM PROGRAMMER (TRS-80 & GENIE) (June 83)*	T004	£3.95	N/A	—

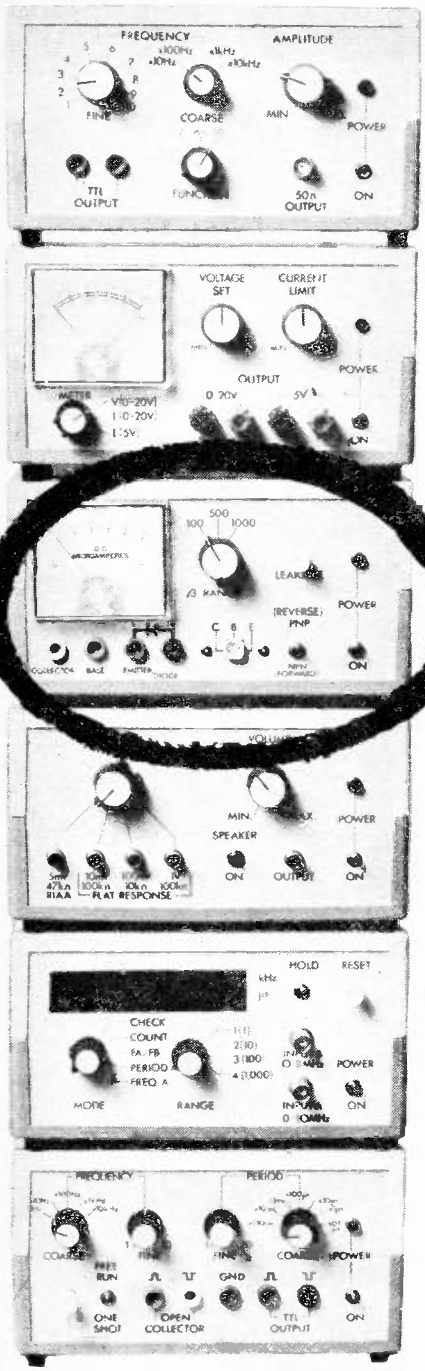
* Includes Command List with examples.

TEST GEAR 83 TRANSISTOR TESTER

UNIT FOUR

BY J. R.W. BARNES

THE TEST GEAR 83 SERIES CONSISTS OF:
DUAL POWER SUPPLY • FUNCTION GENERATOR • TRANSISTOR TESTER
PULSE GENERATOR • LABORATORY AMPLIFIER • FREQUENCY METER



THE ADVENT of solderless breadboard systems has made it possible to re-use electronic components many times. The circuit can be breadboarded and the final version is built with the same components.

It is inevitable, however, that some transistors may be destroyed by incorrect connections or a design error. So some form of quickly testing transistors (and diodes) is desirable to ensure that the final circuit functions as the prototype did.

SPECIFICATIONS

A second reason for making a Transistor Tester a useful piece of laboratory equipment is to check the specification of a particular device against that given in the transistor data book.

The current gain (h_{fe}) of a transistor is usually given as a typical value or specified as being between an upper and a lower limit. As this parameter is one of the most important design considerations, an accurate reading is desirable.

Bargain packs are a useful source of cheap transistors and the Transistor Tester will sort them into good/bad, *npn*/*pnp* and identify the leads of unknown types.

TRANSISTOR PRINCIPLES

Transistors have two major roles in electronic circuits; as switches (digital applications) and amplifiers (analogue electronics). In both of these spheres, the transistor is a current controlled and current controlling device. The voltages in a circuit are determined by resistors using the Ohms law relationship.

The most frequently used connection for a transistor is the common emitter configuration, and it is this method of connection that is used by the Transistor Tester. (See Fig. 1a and 1b.)

The collector current (I_C) of the transistor is given by:

$$I_C = h_{FE} \times I_B$$

where I_B is the base current and h_{FE} is the large signal (or static) current gain. In order to distinguish between the large signal current gain and the small signal (or dynamic) current gain, the former uses capital letters for the "FE" suffix on the notation.

The small signal current gain, h_{fe} (note the use of lower-case letters for "fe"), is given by:

$$h_{fe} = \frac{\text{change in collector current}}{\text{change in base current}}$$

$$h_{fe} = \frac{\delta i_c}{\delta i_b} \text{ (}\delta\text{ meaning "change in")}$$

As this is a ratio of two currents, it has no units. It is sometimes known as the forward current transfer ratio. Note also the use of lower-case letters indicating that i_c and i_b are small signal values.

CHARACTERISTIC CURVES

The transistor characteristics can be plotted graphically as shown in Fig. 2. If the base current (I_B) is fixed and the collector-emitter voltage (V_{CE}) is varied, the collector current (I_C) can be measured

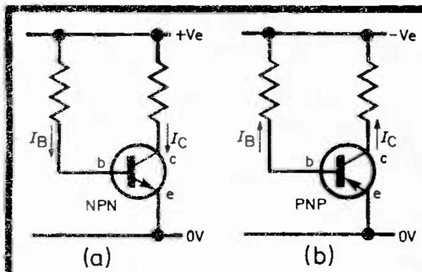


Fig. 1. The common emitter circuit configuration for (a) an *npn* transistor and (b) a *pnp* transistor.

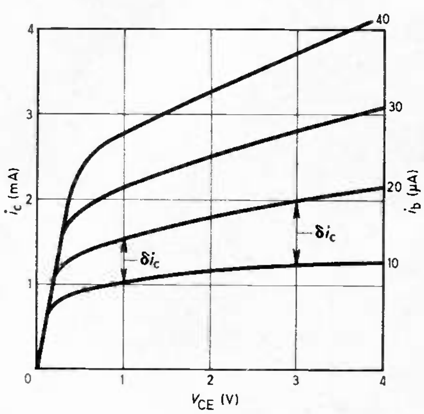
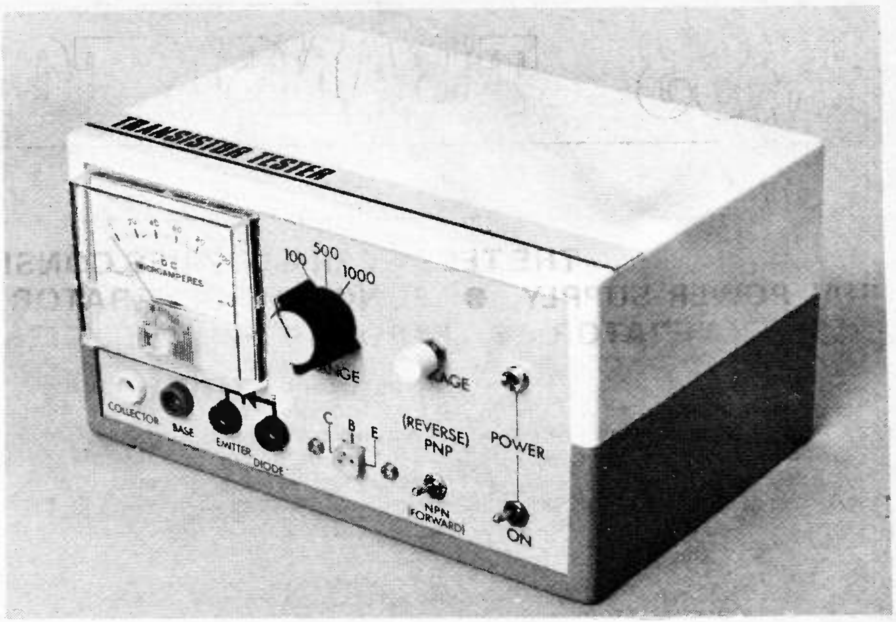


Fig. 2 (right). The common emitter characteristic curves for a typical *npn* transistor. Note that the change in i_c increases as V_{CE} increases for the same change in i_b.

SPECIFICATIONS

Functions:	measures the current gain (h_{FE}) of *npn* and *pnp* transistors. Tests diodes. Determines leakage current.
Gain ranges:	0–100 0–500 0–1000
Conditions:	$V_{CE} = 3{\cdot}5V$ $I_b = 100\mu A, 20\mu A, 10\mu A$ respectively
Leakage:	0–100µA
Power:	9V PP6 battery



The Test Gear 83 Transistor Tester unit.

and plotted as in the diagram. This is done for a number of values of I_B to produce a series of curves.

It can be seen that the change in I_C compared with the change in I_B varies slightly as V_{CE} increases. Therefore the gain is not constant throughout and this implies that h_{FE} is not equal to h_{fe} (as h_{FE} is constant).

However, for most purposes, this difference is too small to be of any consequence and in most applications they can be assumed to be equal. The Transistor Tester measures gain by fixing the base current and measuring the collector current.

CIRCUIT DESCRIPTION

Unlike all other units in the *Test Gear 83* series, the Transistor Tester is battery powered since the current consumption is low and its use intermittent.

The actual current consumption is about 5mA with no transistor connected and rises to around 15mA dependent upon the gain of the transistor under test.

The use of an l.e.d. continually on to indicate power would be wasteful as the current consumption of the l.e.d. would be greater than that of the Tester!

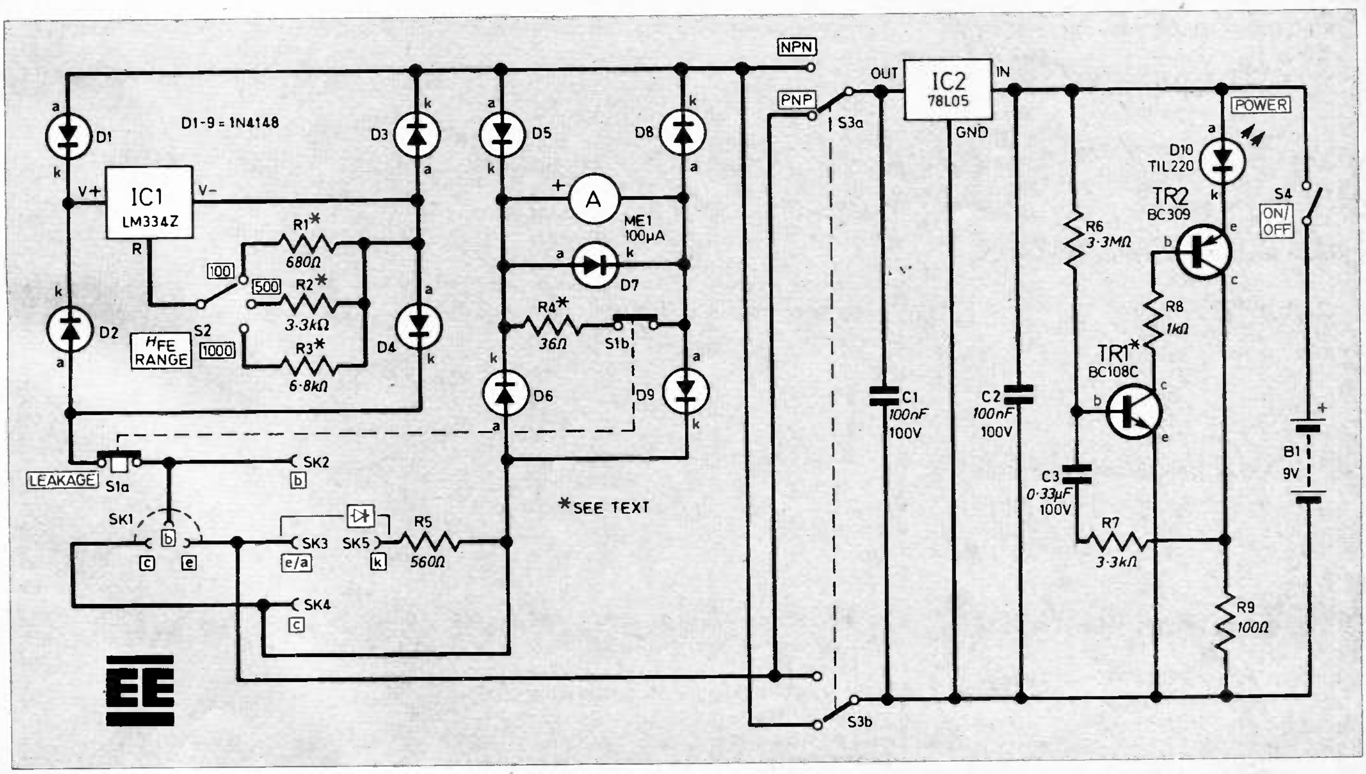
Therefore, a small relaxation oscillator built around TR1 and TR2 pulses the l.e.d. about 90 times a minute thus reducing the average consumption to 0·9mA. This was found to be particularly effective in indicating that the unit was on.

The constructor may replace the battery with a mains power supply unit in which case the flasher circuit would not be required. For this modification, it is recommended that R9 is increased to 820 ohms and TR1, TR2, R6, R7, R8 and C3 are omitted. The collector and emitter pads of TR2 will need to be linked if the original p.c.b. layout is retained.

REGULATOR

The voltage regulator, IC2, provides a current limited supply of 5V. The low

Fig. 3. The complete circuit diagram for the Test Gear 83 Transistor Tester.



voltage will prevent damage to the transistor under test if the polarity switch (NPN/PNP) is incorrectly set. The current being limited to 100mA will protect the meter in the event of a short circuited transistor being placed in the test socket.

The capacitors C1 and C2 ensure the high frequency stability of the supply.

The polarity of the transistor under test is set by S3. This simply reverses the polarity of the power supply. In order to keep this switching arrangement uncomplicated, two bridge rectifiers are employed. The first, D1 to D4, ensures that the constant current generator (IC1) is always connected to the correct polarity power supply.

The second bridge, D5, D7, D8 and D9, avoids the necessity of having to switch the polarity of the meter, ME1.

Resistors R1, R2 and R3 are used to set the base current (I_B) of the transistor under test. R4 is a meter shunt resistor to set the meter sensitivity to 10mA full-scale deflection.

For the purposes of measuring leakage current, the base current is removed and the shunt resistor (R4) open circuited to return the meter sensitivity to 100μA f.s.d. This is done by depressing switch S2.

Note that most silicon transistors, including power types, should register very little leakage current and anything over 10μA should be regarded with suspicion. Germanium transistors will have a slightly higher leakage current.

CIRCUIT OPTIONS

Depending on the degree of accuracy the constructor requires, there are two options for the values of resistors R1 to R4. Should the high accuracy be chosen, then a fixed value resistor is used in series with a preset (in parallel with a preset in the case of R4). The values are shown in Table 1.

TABLE 1

	High accuracy	Low accuracy
T1	620Ω in series with 100Ω preset.	680Ω ±2%
R2	3kΩ in series with 470Ω preset.	3·3kΩ ±2%
R3	6·2kΩ in series with 1kΩ preset.	6·8kΩ ±2%
R4	39Ω in parallel with 1kΩ preset.	36Ω ±2%

Provision is made on the p.c.b. layout for the presets. If however, an accuracy of around 10 per cent (worst case) is sufficient, then the fixed value resistors also listed in Table 1 can be used without the presets. Three links will be required on the p.c.b.

If the high accuracy version is selected, then a digital multimeter with a 200μA range will be needed to calibrate the base current.

COMPONENTS

Resistors

(High accuracy version)

R1	620Ω
R2	3kΩ
R3	6·2kΩ
R4	39Ω

All metal film ±2%

VR1	100Ω miniature horizontal preset
VR2	470Ω miniature horizontal preset
VR3	1kΩ miniature horizontal preset
VR4	1kΩ miniature horizontal preset

(Low accuracy version)

R1	680Ω
R2	3·3kΩ
R3	6·8kΩ
R4	36Ω

All metal film ±2%

(All versions)

R5	560Ω
R6	3·3MΩ
R7	3·3kΩ
R8	1kΩ
R9	100Ω

All carbon film ±5%

Capacitors

C1,2	100nF, 100V Siemens type polyester (2 off)
C3	0·33μF, 100V Siemens type polyester

Semiconductors

D1–9	1N4148 silicon (9 off)
D10	TIL220 0·2in red l.e.d.
TR1	BC108C *npn* silicon
TR2	BC309B *pnp* silicon
IC1	LM334Z adjustable current source
IC2	78L05 5V, 100mA regulator

Miscellaneous

S1	d.p.d.t. non-latching push button
S2	1-pole, 12-way midget rotary (with stop set at 3-ways)
S3	d.p.d.t. miniature toggle
S4	s.p.s.t. miniature toggle
SK1	T05 pin circle transistor socket
SK2–5	4mm banana socket (4 off) colours to suit
ME1	100μA f.s.d. panel meter with 1·4kΩ coil (type ML52)
B1	9V PP6 battery

Verocase type 202–21036C; single-sided p.c.b. 155 × 57mm; battery clip; chrome l.e.d. mounting bezel; control knob; 7/0·2mm wire; Veropins.

See Shop Talk page 369

COMPONENTS approximate cost £21

CONSTRUCTION

CIRCUIT BOARD

A single p.c.b. is used, and it is designed to be attached to the terminals on the back of the panel meter. If a different meter is used, the spacing of the mounting holes may need to be modified. It is wise to check this before etching the p.c.b.

Alternatively, the p.c.b. assembly can be mounted on the base of the Verocase.

The layout and full-size track artwork are given in Fig. 4. Solder all components to the board in the normal order, taking all usual precautions with the polarity of the diodes and the orientation of the semiconductors. Veropins should always be used for the flying leads.

If the preset resistors are not used, the wire links drawn as dotted lines on Fig. 4 must be fitted adjacent to R1, R2 and R3. Note that R4 does not require a link to be fitted in place of the preset as this is in parallel with R4.

FRONT PANEL

The front panel is drilled to suit the controls and meter as shown in Fig. 5. The large hole for the meter can be made by drilling a series of small holes and cutting out the connecting pieces. The rough edge is then finished with a half-round file.

The dimensions of this cut-out and all mounting holes should ideally be checked against the actual components to be used as some variation does occur between different manufacturers.

The transistor socket, SK1 (T05 pin circle), is first mounted onto a piece of plastic or p.c.b. material and then fixed to the front panel from the reverse side with two screws.

Constructors may wish to fit other types of transistor sockets but in practice, the T05 type is suitable for most popular transistors.

The four 4mm sockets are for use in testing diodes and larger transistors via flying leads.

The wiring is carried out with a flexible 7/0·2mm equipment wire and the recommended length for each is about 150mm.

TRANSISTOR TESTER

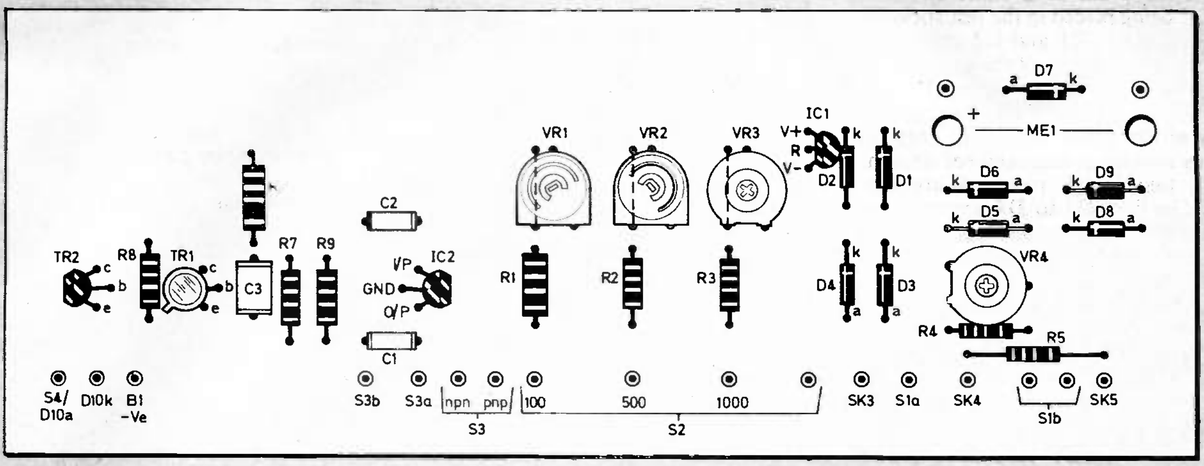
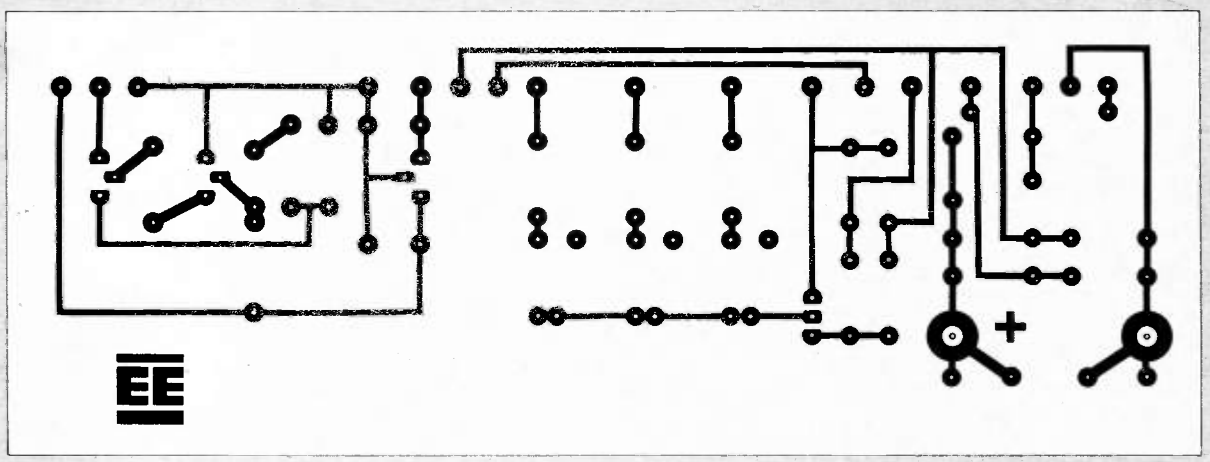
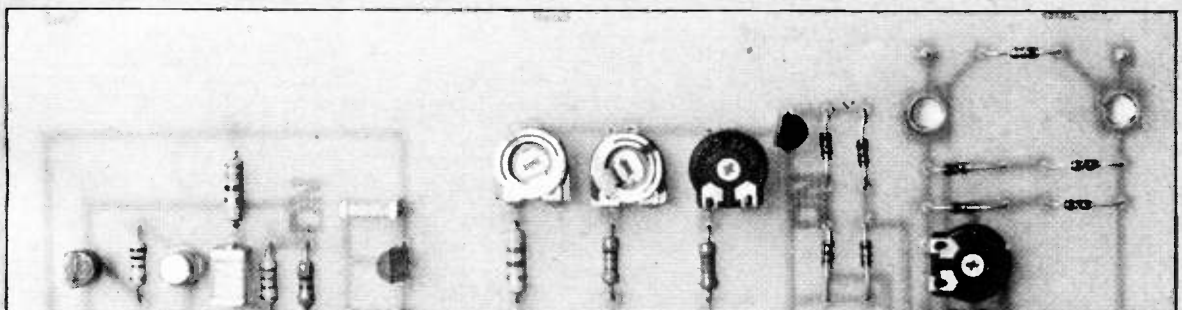


Fig. 4. Full-size p.c.b. artwork and component layout. Note that the three wire links shown as dotted lines below VR1, VR2 and VR3 are only required if the low accuracy version is built and the presets are omitted. No link is required in place of VR4. The board is mounted directly onto the meter terminals and it is advisable to check the pitch of these terminals before etching and drilling.





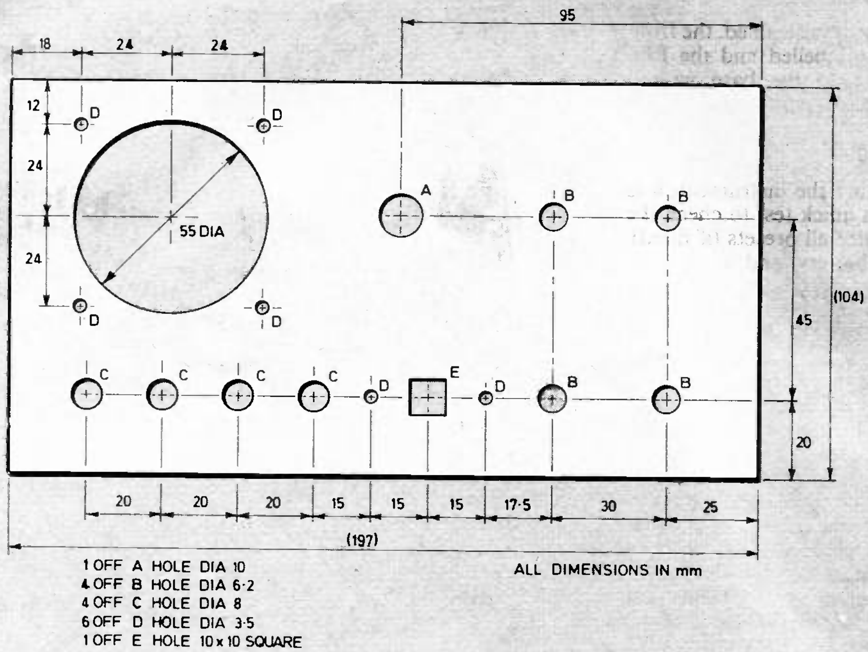


Fig. 5. Front panel drilling details. Note that the meter cut-out may vary for different panel meters.

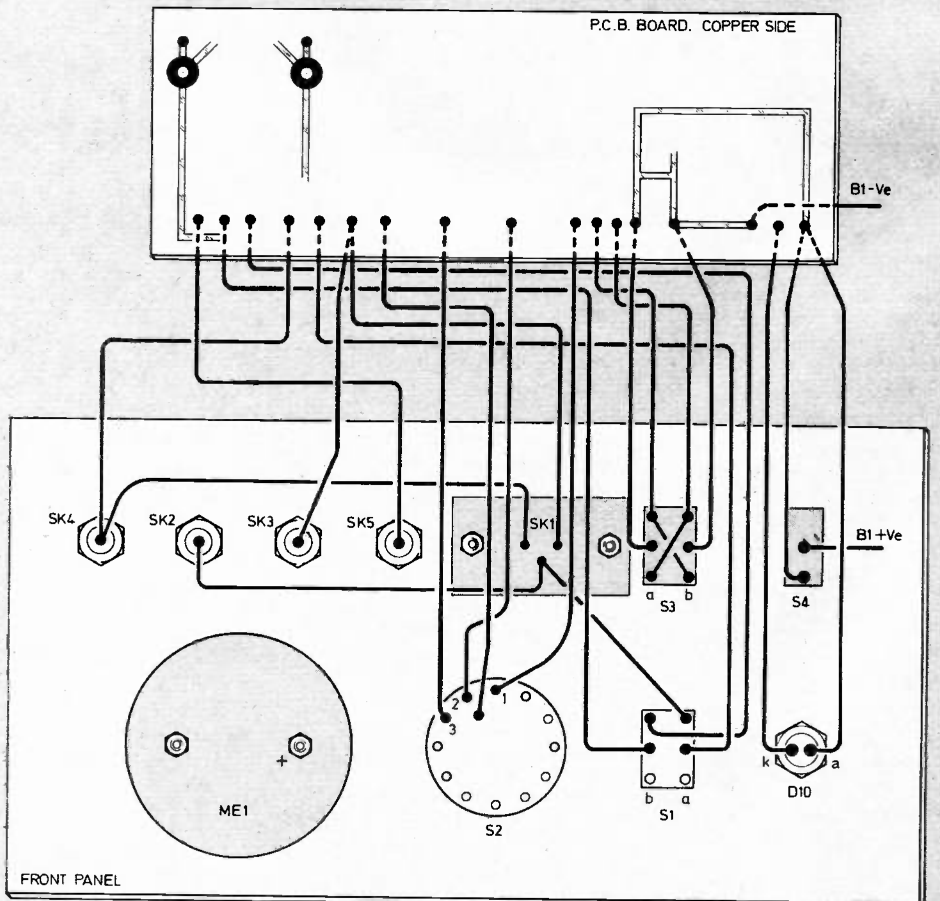


Fig. 6. Interwiring diagram with the p.c.b. shown from the trackside and folded down. All connections to the board are made on the component side.

The wiring diagram in Fig. 6 shows all interconnections but note that the p.c.b. is shown removed from the meter terminals for clarity.

Finally, the case is assembled, the front panel controls are labelled and the PP6 battery is secured to the base with a double-sided adhesive tab.

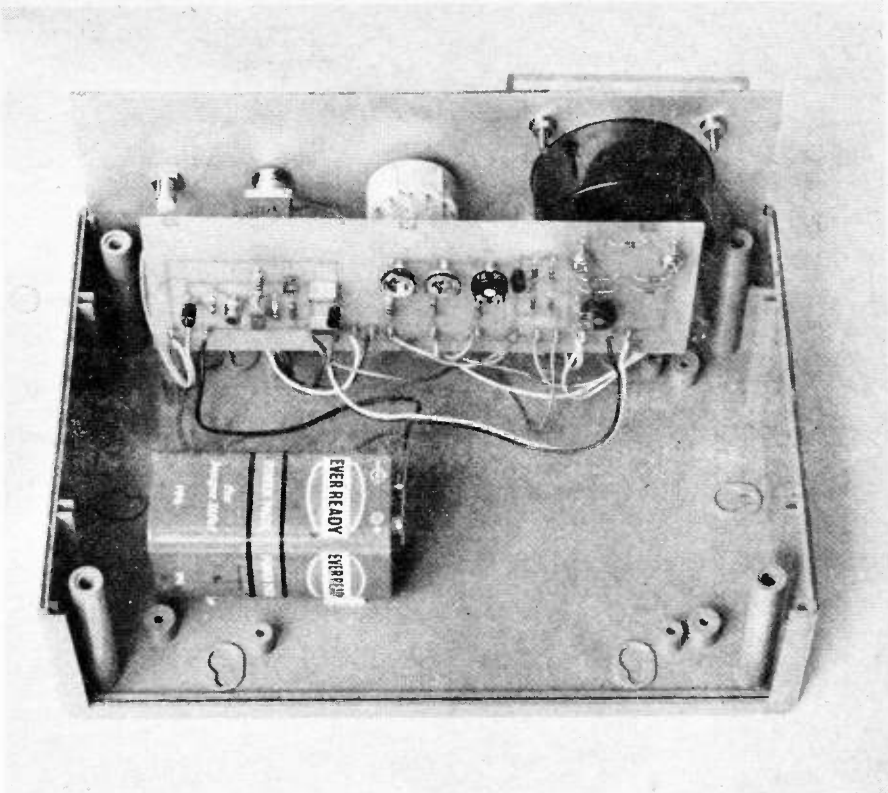
CALIBRATION

Before calibrating the instrument, it is advisable to run a quick test to check the basic circuit. Centre all presets (if fitted), connect the 9V battery and switch on. The l.e.d. should flash about 90 times a minute (three times in two seconds).

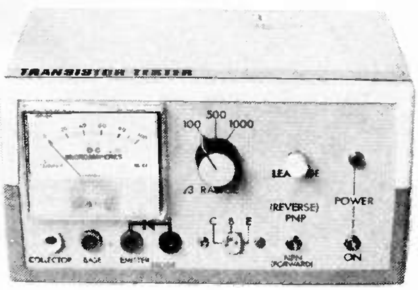
The voltage across C1 should be 5V. If so, a transistor of known polarity can be inserted into the test socket and the polarity switch set to the correct position. The meter should register a reading indicating that the circuit is functioning.

To set the base current, a digital microammeter is connected between the base and emitter sockets on the Transistor Tester, the positive lead to the base socket with the polarity switch set to NPN.

The RANGE switch is set to the first position, labelled 100 on the front panel, and the preset resistor in series with R1



The front panel assembly viewed from the rear with the top and back panel removed. The battery is secured with double-sided adhesive foam tabs.



Front view of the prototype model showing the control labelling. Note that the meter full-scale deflection reading depends upon the position of the Range switch.

(marked VR1 on Fig. 4) is adjusted to read 100μA on the microammeter.

The RANGE switch is then set to the second position, labelled 500 on the front panel, and the preset in series with R2 (marked VR2 on Fig. 4) is adjusted to read 20μA on the microammeter.

With the RANGE switch in the third position, labelled 1000 on the front panel, the preset in series with R3 (marked VR3 on Fig. 4) is adjusted to read 10μA on the microammeter.

The fourth and final calibration is to set the full-scale deflection of the panel meter, ME1, to 10mA by adjusting the shunt resistor, R4. A one kilohm potentiometer is required and this is connected in series with a digital milliammeter between the collector and emitter sockets of the Tester. The positive probe to the collector with the polarity switch in the NPN position.

Adjust the one kilohm potentiometer for a reading of 10mA on the milliammeter and then adjust the preset in parallel with R4 (marked VR4 on Fig. 4) until the panel meter, ME1, reads full-scale deflection. Calibration is complete.

Using the Transistor Tester to measure the gain of a transistor is fairly straightforward. The device is inserted into the test socket and the polarity switch set to the correct setting (if known).

The meter will give a reading of static gain (h_{FE}). According to the position of the range switch, S2, the meter reading is multiplied by 1 (for the 100 setting), 5 (for 500) and 10 (for 1000).

The leakage current of a transistor is measured by depressing the LEAKAGE switch, S1, and the meter will give a reading in microamps (μA).

Diodes are connected as indicated on the front panel, that is anode (a) to the diode socket and cathode (k) to the emitter socket, and a meter reading should register with the polarity switch in the NPN (FOWARD) position. The reading is unimportant, it just shows that a current is flowing.

When the polarity switch is changed to the PNP (REVERSE) position, all current flow should cease, indicated by no movement of the panel meter. Any other result indicates a faulty diode.

To ascertain the reverse biased leakage current of a diode, the LEAKAGE switch, S1, is depressed and the meter will give a reading in microamps (μA). □

BOOK REVIEWS

TOWERS' INTERNATIONAL DIGITAL I.C. SELECTOR

Author	T. D. Towers, MBE, MA, BSc, C.Eng, MIERE
Price	£9.95 limp edition
Size	248 × 174mm. 256 pages
Publisher	W. Foulsham & Co Ltd
ISBN	0-572-01179-2

For those readers unfamiliar with Towers' previous semiconductor guides, including Transistors, Linear i.c.s and Microprocessors, they are comprehensive and painstakingly researched data tables listing all currently available type numbers. The Digital Integrated Circuit Selector is no different and gives electrical and mechanical data on over 13,000 American, European, British and Japanese devices.

The data is listed under type numbers in alphanumerical order and gives details on logic family (CMOS, TTL and so on), application, description, packaging, some important specifications and a suitable substitute (should one exist). Perhaps the most useful information for day-to-day use is the pin-out diagrams for the dual-in-line versions of all the digital i.c.s listed.

As digital electronics is becoming increasingly important with the advent of the cheap microprocessor, a guide of this nature is invaluable to the hobbyist, teacher, engineer and buyer alike and in many cases will invalidate the need for numerous manufacturers' data books.

G.P.H.

ELECTRONICS POCKET BOOK

Author	E. A. Parr, BSc, C.Eng, MIEE
Price	£6.40 limp edition
Size	185 × 120mm. 350 pages
Publisher	Butterworth & Co Ltd
ISBN	0-408-00481-9

Not a new book as the first edition was published twenty years ago, but still as useful today. Now in its fourth edition, the completely new Electronics Pocket Book has been fully updated and now includes sections on digital techniques, computers, opto-devices and all the usual branches of electronic design.

For the student and hobbyist, this handy reference work is an ideal source of readily available, and perhaps more importantly understandable, information.

G.P.H.

HOW TO USE OP-AMPS

Author	E. A. Parr, BSc, C.Eng, MIEE
Price	£2.25 limp edition
Size	175 × 110mm. 154 pages
Publisher	Bernard Babani Ltd
ISBN	0-85934-063-5

One part of my technical education that was sadly lacking was that of the use of the op-amp. These eight-legged little creatures had always eluded me so it was a pleasant surprise to find this book most readable and obviously written by a man who has a great deal of respect for what is probably the most versatile i.c. available to the engineer.

The text starts with first principles and continues in as non-mathematical fashion as is possible to explain design techniques using op-amps in applications as diversified as audio circuits and industrial control.

As an op-amp i.c. can now be purchased for little more than the price of a simple transistor and yet still give high gain and predictable performance, an understanding of their function is essential for cost-effective design.

G.P.H.

COUNTER INTELLIGENCE

BY PAUL YOUNG

Changing Times

A short while ago, I read about an American, he was driving over the Hudson when he noticed that his watch had stopped. He opened his window, tossed it into the river and took a new one out of the glove pocket. In the USA electronic watches can be purchased for about three dollars, at that price it is not even worthwhile changing the battery!

I recently made a purchase which makes me think we may have already reached that stage in this country. My wife's watch stopped and our local horologist having closed down, I decided to buy her a digital one to tide her over. I bought her a dainty wristwatch, quartz controlled with the time and date functions. It was elegant to look at had a stainless steel bracelet and a twelve month's guarantee. All fairly routine, but the price, believe it or not was £2.95 including VAT!

This set me thinking. If you take off the VAT and assume that it must have passed through at least one pair of hands before it reaches the shop, what does the actual manufacturer receive for it, and equally important, what is the worker who assembles it paid?

The Government of the day is always urging manufacturers to be more competitive, but how do they compete with that? Robots? Yes, possibly, but there is one big drawback to replacing your workforce with Robots. Robots don't have wage packets, and taken to its ultimate conclusion, the manufacturer finishes up with no customers.

Fascinating Gift

I believe it was Einstein who came up with the theory, "That when sitting on a red hot stove, a few seconds would seem like half an hour, and conversely, when sitting next to a beautiful girl, half an hour would seem like a few seconds". Naturally whimsical Young wants to know how the time would compare between sitting next to a beautiful stove and sitting on a hot girl?

While pondering on these profound theories, I came up with one which is equally true, and which in the fullness of time you will be able to test out for yourself. It is this, as you get older, you will find that time passes more quickly. When you reach the status of senior citizen you will find it is whizzing by.

All of which brings me to a case in point. Earlier in the year I had been sent an amusing Christmas story by my brother, which I fully intended to pass on to you. Before I could sort it out and type it, we have arrived at the June issue. Here is his story, later than planned but blame it on Anno Domini (see above).

"Are children starting earlier these days? I am old enough to remember when little girls (that is under 10 years old) asked Father Christmas for things like dolls and prams. Apparently all that is changing. My boss's daughter just five years old and already getting to grips with computer programming decided she would like an electronic construction kit for Christmas.

We found a kit comprising of 150 different projects with a well produced 200-page construction manual. At £12 it was excellent value, but the real point was this.

On getting the kit home, my boss who is a top flight electronic and computer boffin, decided to try out some of the experiments (after the children were packed off to bed). He admitted next day, that he found making up the circuits with discrete components, so fascinating that he was up 'till the small hours experimenting, I gather that the kit has proved so successful it has actually stopped young Hannah from chattering for hours on end. Almost a miracle I understand."

Well I don't know if any moral can be drawn, but at least it is a useful tip to Mums and Dads as to what to buy their children—of either sex.

ENVELOPE SHAPER for BASS GUITAR

BY A. NIEMIRO

THE Envelope Shaper is not the most common of guitar effect pedals, but nonetheless produces a distinctive and useful sound. Operating by varying the tone of the instrument in sympathy with the signal level, the shaper produces a sound reminiscent of a "Wah-Wah" unit, but does away with the need for a mechanical pedal, so leaving the musician free to concentrate on playing his instrument.

The prototype was designed specifically for use with electric bass guitar which, when used with the shaper, gives a colourful and prominent sound especially appropriate in Soul and Funk music. However, the addition of a range switch increases the versatility considerably and allows the unit to be used equally well with lead and rhythm guitar and electric piano.

The unit is built into a small case and foot-operated so that the musician may switch the effect in and out whilst playing.

FILTER DESIGN

The actual sound effect is obtained by feeding the instrument signal through a bandpass or resonant filter. Such filters give a frequency response as shown in Fig. 1.

It was decided to achieve this response by employing a multiple feedback circuit; the basic form of which is shown in Fig. 2. If R_{IN} is much greater than R_A then the centre or resonant frequency of the filter is given by:

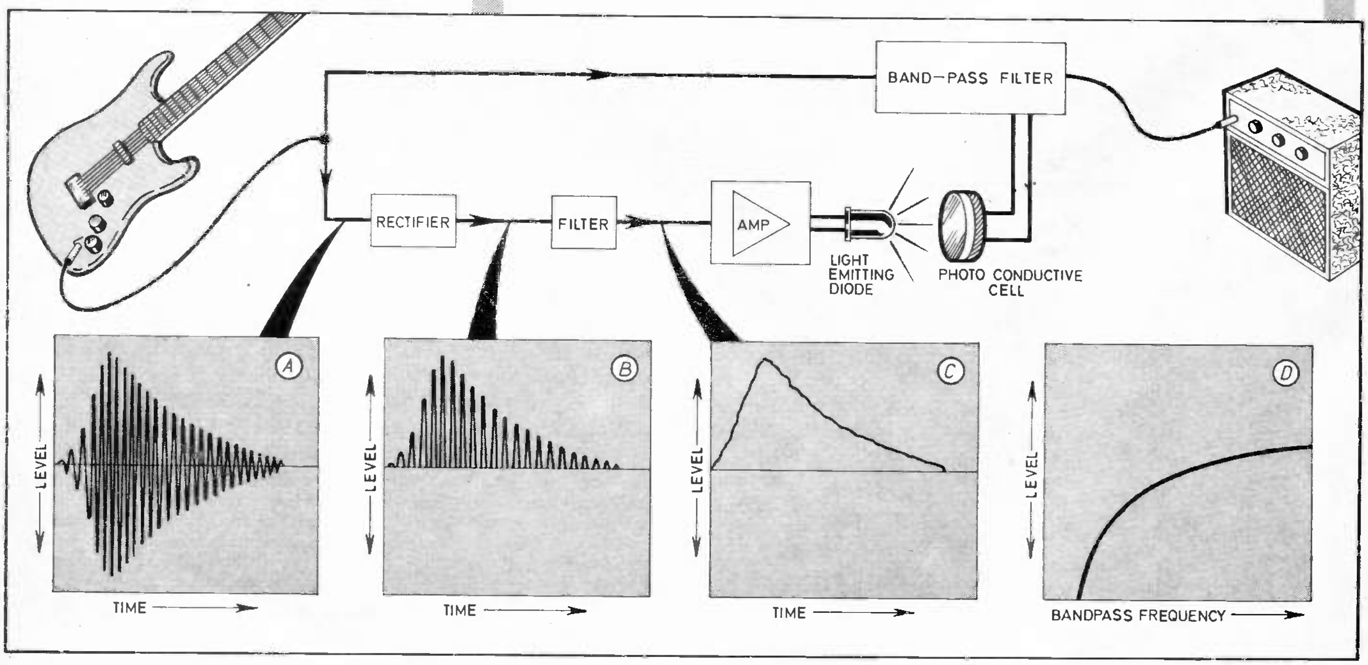
$$f_0 = \frac{1}{2\pi \times C \times \sqrt{R_A \times R_B}}$$

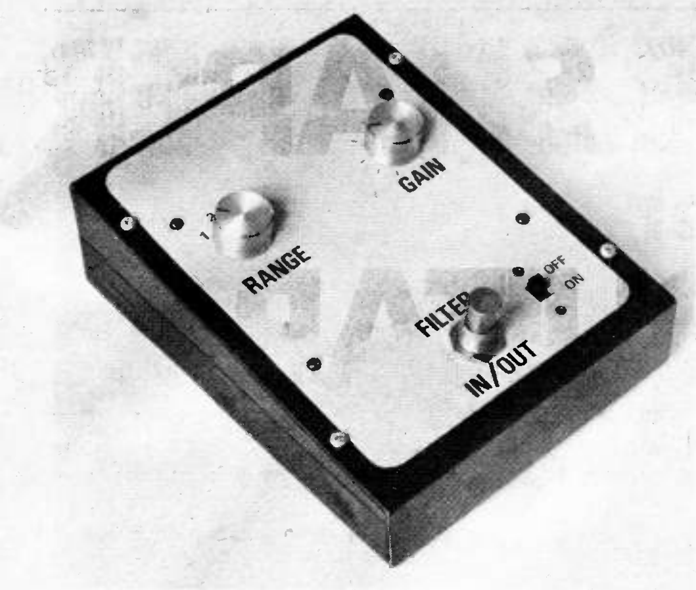
HOW IT WORKS

The input signal from an electric musical instrument is split up and fed through two separate paths in the Envelope Shaper.

The control signal passes through an active rectifier which converts the a.c. input signal (*A*) into a chopped d.c. signal as shown in *B*. This is then smoothed and filtered by a resistor-capacitor network which removes the high-frequency components to give a d.c. voltage that is the envelope or "outline" of the original signal (*C*). This voltage is then amplified to a suitable level to drive an l.e.d. The brightness of this l.e.d. is, therefore, dependent only upon the amplitude of the input signal.

The input signal also passes through a band-pass filter. This section only allows through a narrow band of frequencies close to the filter's resonant frequency which is determined by the resistance of the photocell. Since the photocell is placed opposite the l.e.d. the resonant peak of the filter varies in sympathy with the changing signal level (*D*).





The completed sound effects pedal showing the layout of the front panel.

Fig. 1. Frequency response of a resonant filter.

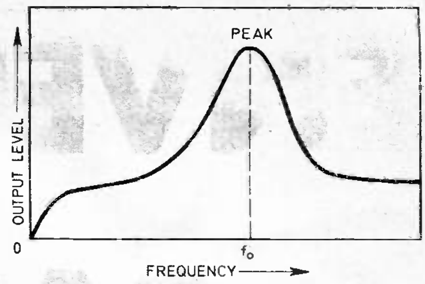
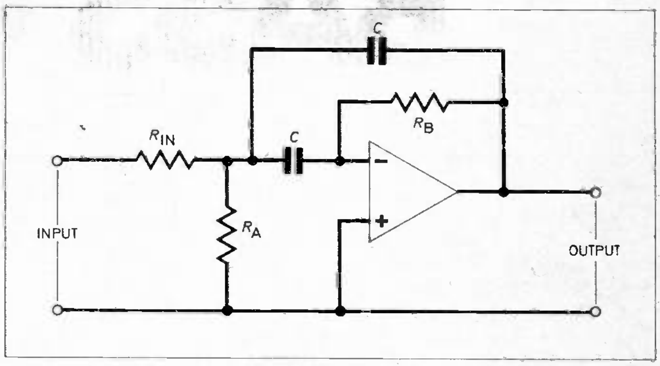


Fig. 2 (below). Diagram showing basic multiple feedback circuit.



Therefore, by varying R_A, the centre frequency can be swept across the audio spectrum. In the final design, R_A is replaced by a light dependent resistor illuminated by an l.e.d. placed next to it.

Since f_o is also inversely proportional to C we can alter the frequency range swept by allowing different values of capacitance to be switched in. This not only changes the frequency but also affects the sharpness or Q (magnification factor) of the peak, thus allowing a greater variety of sounds to be produced.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Envelope Shaper is given in Fig. 3. From the d.c. blocking capacitor C1, the signal is split and fed to IC1a and IC2 via R1 and R4, respectively.

IC1a gives some gain and also performs a half-wave rectification. Placing the rectifying elements D1 and D2, in the feedback path of IC1a allows rectification of very small signals well below the diode's normal forward voltage of 600mV.

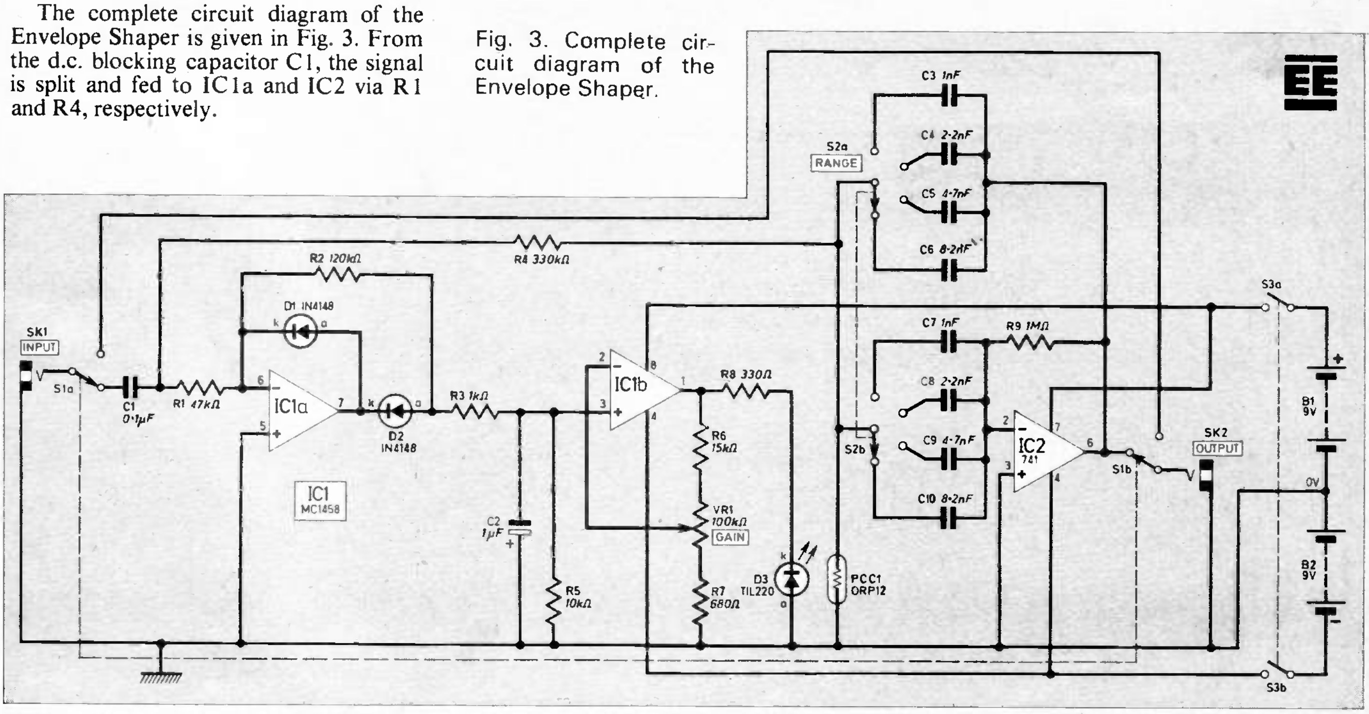
Capacitor C2 is charged via R3 to the instantaneous peak negative voltage at the input and this is amplified by IC1b. VR1 controls the unit's sensitivity by varying the gain of IC1b.

The l.e.d. D3 is driven from the output of IC1b via current-limiting resistor R8. It is seen that the brightness of this l.e.d. varies with the envelope of the input.

The input signal is also taken, by R4, to IC2. The band-pass filter is built around IC2 which is wired in a multiple feedback configuration. Light dependent resistor PCC1 determines the filter's resonant frequency and is arranged so that it is only illuminated by the light from D3.

Switch S2 selects the value of capacitance in the feedback path of IC2 and thus alters the frequency range swept.

Fig. 3. Complete circuit diagram of the Envelope Shaper.



ENVELOPE SHAPER for BASS GUITAR

COMPONENTS

Resistors

R1	47kΩ
R2	120kΩ
R3	1kΩ
R4	330kΩ
R5	10kΩ
R6	15kΩ
R7	680Ω
R8	330Ω
R9	1MΩ

All $\frac{1}{4}$W carbon ±5%

Capacitors

C1	0·1μF polyester
C2	1μF polyester
C3,7	1nF polycarbonate (2 off)
C4,8	2·2nF polycarbonate (2 off)
C5,9	4·7nF polycarbonate (2 off)
C6,10	8·2nF polycarbonate (2 off)

Semiconductors

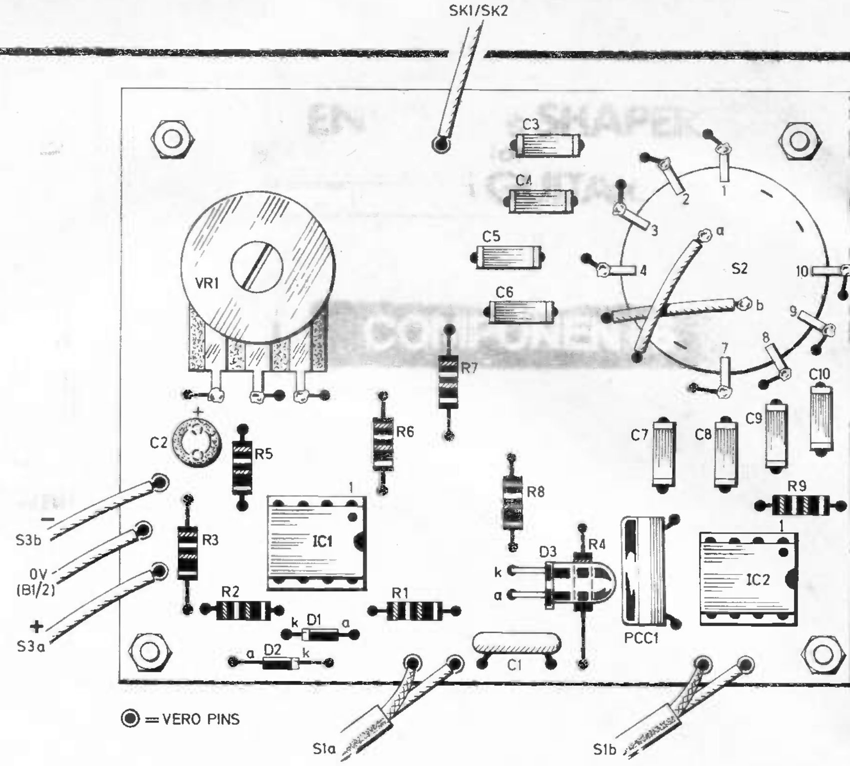
D1,2	1N4148 silicon (2 off)
D3	TIL220 0·2in red l.e.d.
IC1	MC1458 dual op-amp
IC2	741 op-amp

Miscellaneous

VR1	100kΩ lin carbon potentiometer
PCC1	ORP12 light dependent resistor
S1	d.p.d.t. foot switch
S2	2-pole, 6-way rotary
S3	d.p.d.t. miniature slide
SK1,2	0·25in mono jack (2 off)
B1,2	9V PP3 (2 off)

Single-sided printed circuit board, 95 x 78mm; aluminium case 150 x 120 x 50mm; 6BA fixings; 8-pin d.i.l. socket (2 off); rubber feet.

Approx. cost Guidance only £10.00



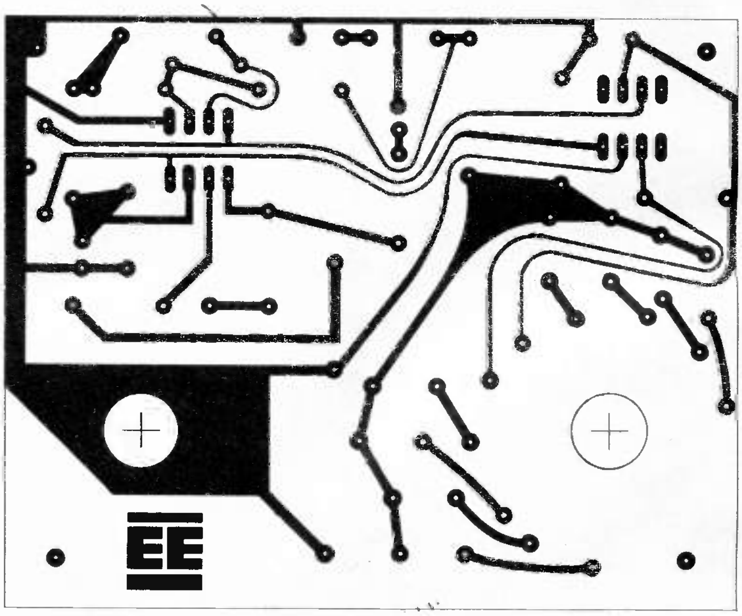
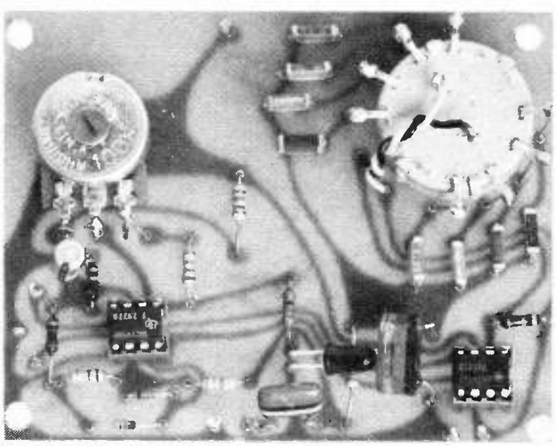
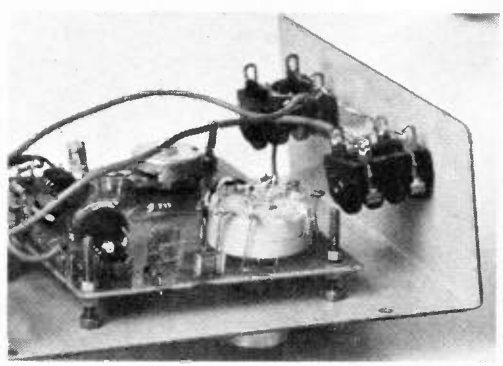


Fig. 4. Component layout and full size printed circuit board master for the Envelope Shaper.



(Left). Picture showing the components mounted on the printed circuit board.



(Right). Wiring details of front panel mounted components.

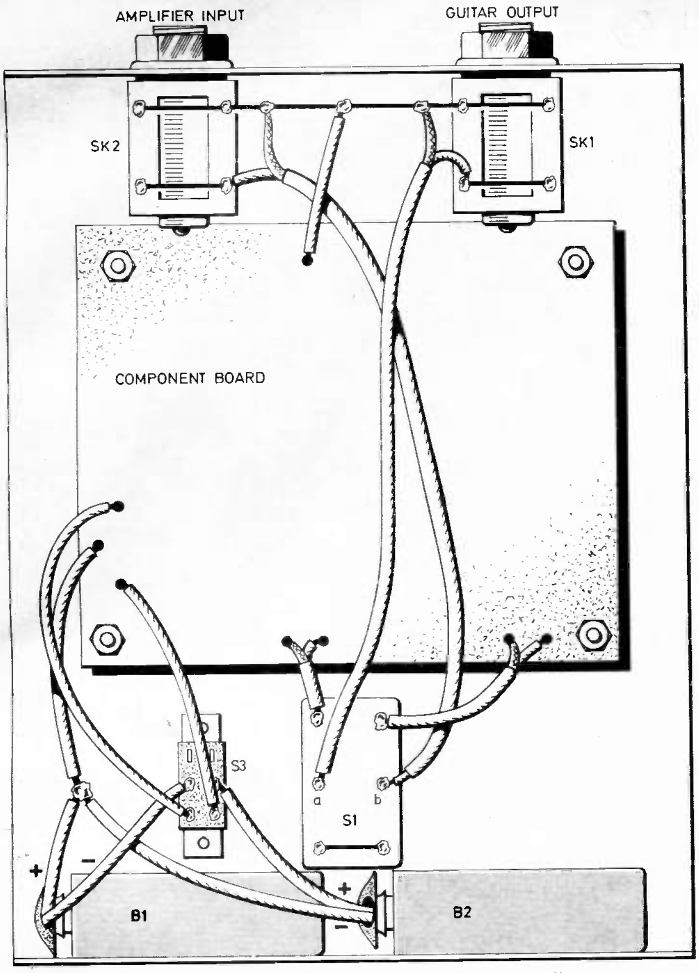
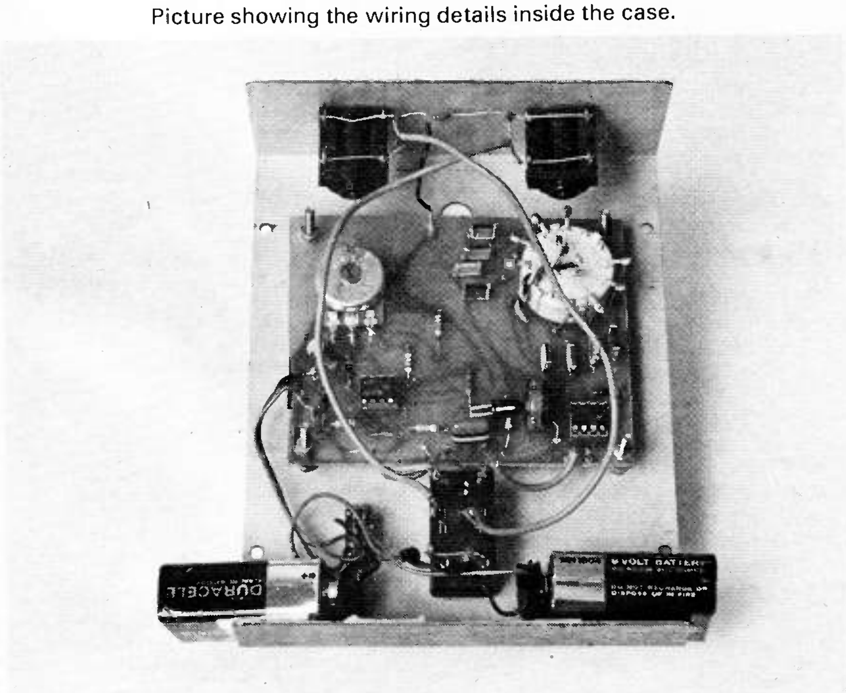


Fig. 5. Complete offboard interwiring details.

Picture showing the wiring details inside the case.



CASE

The selection of a case to house the Envelope Shaper is largely a matter of personal choice, but a metal case is preferable as this will prevent excessive hum pickup. Any case which measures about 150 × 120 × 50mm should be suitable. Whatever housing is selected it must be completely light-proof or the circuit will not function properly.

COMPONENT BOARD

Construction is quite straightforward as most of the components are mounted directly on the printed circuit board. Etch and drill this in the normal way and then use the board as a template to mark out the mounting and control holes in the case (see accompanying photographs).

Next, solder the components to the board, paying particular attention to the orientation of the diodes, i.c.s, and electrolytic capacitor. VR1 and S2 should be mounted last as shown in Fig. 4. Note that D3 and PCC1 are mounted so that the l.e.d. shines directly on the sensitive face of the photoresistor.

Remember also, that the use of i.c. sockets lessens the risk of damaging the devices through overheating during soldering. The use of Veropins is recommended for connection to the p.c.b. since they ensure a reliable contact. Crop the leads on the back (solder side) of the p.c.b. as short as possible to prevent them shorting out to the case.

Finally, mount the switches and jack sockets in the case and finish the wiring between them as shown in Fig. 5. Note that the screened lead used for these interconnections need only be earthed at one end. The batteries should now be clipped in place and the case assembled leaving the unit ready for use.

IN USE

In operation, best results are obtained with the guitar bass, treble, and volume controls, all set at maximum. The range switch setting should be chosen by experimentation; noting that each range requires a different sensitivity. The optimum sensitivity is found by turning the control clockwise from minimum until the most pleasing effect is achieved.

Note that at some settings it will be necessary to turn down the guitar volume when the effect is switched out.

Since the quiescent and peak currents are quite high it is recommended that high-power batteries are used and the unit is always switched off when not in use. Alternatively, any mains power pack supplying between ±7V and ±15V may be substituted. □

RADIO WORLD

BY PAT HAWKER G3VA

Short-Wave Broadcasting

For more than 50 years, most major countries have broadcast radio programmes on short-waves (h.f.) originally directed at expatriate audiences but more recently in the hope of influencing foreign citizens, either by crude propaganda or more subtly by presenting a favourable view of the local way-of-life. Such operations are not cheap—the British Government's "Grant-in-aid" to the BBC is heading towards £80 million per annum. The USSR not only spends money on external broadcasting but also incurs the expense of its large network of "jamming" stations.

There is little doubt that some of the overseas m.f. relays serve large audiences, and that in some parts of the world listeners still depend on h.f. But in countries such as the UK the number of listeners who seriously listen to *programmes* on h.f. (excluding the DX enthusiasts who seek to log rare or distant transmitters) must be very small indeed.

It is sometimes said the h.f. broadcasting is really "governments speaking to governments". One notes that the BBC is currently seeking £13-million to add some new satellite "ears" to its Government-paid-for listening post at Caversham Park near Reading.

I recall industry's efforts to interest British listeners in "all-wave" sets back in the 1930s. Even today, from time to time, one reads of new receiver designs that will bring a boom in short-wave listening. But it never happens.

There are a number of reasons why listening to h.f. broadcasting continues to be a tiny, minority taste. Receivers that are easy to tune to a given frequency are available, but inevitably cost a lot more than medium and long-wave sets.

But the main deterrent is never likely to be overcome: the need for the listener to have access to a large amount of data on transmission schedules and frequencies and to understand the many variables that determine whether a given station will be heard at a given time in a given month on a given frequency. The h.f. broadcasters, including the BBC, do their best to advise listeners, through publications or programmes such as the World Service "Waveguide", which replaced the long-running "World Radio Club" a couple of years ago.

It is usually only the DX enthusiast, or those interested in amateur radio as a hobby, who are prepared to absorb all the information needed to achieve consistent reception of a daily or weekly programme. This is assuming that they have a set that can be tuned to a given frequency, and they know the frequency they want.

The logical answer to world broadcasting is not h.f. but space satellites in the form of Direct Satellite Broadcasting (DBS), though so far all attempts to establish DBS radio services on 26MHz or on microwaves during the past 15 years have floundered. The multi-channel digital sound systems to be used with television DBS are not a solution, as these will have "footprints" too limited for true intercontinental world coverage.

So it looks as though vast amounts of money will continue to be spent to broadcast, with limited success, on the 3·9, 6, 7, 9·5, 11·8, 15·3, 17·8 and 21·5MHz bands. And listeners will still need an up-to-date copy of *World Radio TV Handbook* to make sense of it all!

Teletext 10

With some one-million television sets containing teletext decoders installed in British homes, the Oracle and Ceefax services are now accepted as useful and well-established additions to television broadcasting.

It is surprising, even to those of us who were involved with the system in its early, experimental and "struggling" days, to recall that it is now over ten years since the first transmissions were made during broadcast hours, with "live" computer editing. These were based on the original Oracle system, and went out from the IBA's Crystal Palace transmitter to one or two prototype receivers!

The system, like the original Ceefax system, was indeed crude when compared to what became in 1974 the unified British teletext standard with its much higher data rate and far greater number of "pages". It was not until the beginning of 1977 that the first decoders reached the market in the form of a Labgear adaptor costing almost £400.

Teletext was basically what is called an engineer-led rather than a market-led development and it proved difficult for several years to interest the public in this new form of broadcasting cum information technology. Yet recent BREMA figures show that deliveries of teletext sets during 1982 reached 571,000 compared with 213,000 in 1981, about 80,000 in 1980, about 28,000 in 1979 and just 7,000 in 1978—an impressive growth rate for a British developed technology.

But, the most impressive industry figures are still those for video recorders, over 2·2 million deliveries in 1982 and 1 million in 1981. More videos sold or rented in the UK than even in the USA.

Sporting Ploy?

The use of two-way radio communications for sporting events is becoming ever more sophisticated and devious. This Year's British challenger for the America's Cup yachting event is even adopting military techniques to reduce the chances of giving away useful information to its American rivals.

The 12-metre yacht "Victory 83" and possibly other British entries will carry Racal-Tacticom's Clansman-type military equipment rather than standard marine equipment. Clansman is a frequency-synthesised system that can operate on virtually any frequency, and radio operators with military experience will be aboard.

However, they do not disclose whether high-speed "burst" data transmissions will be used to further confound eavesdroppers, nor whether the equipment will be authorised to use non-standard marine frequencies! But the Royal Burnham Yacht Club's "Victory Syndicate" are convinced that last summer their transmissions were constantly monitored by their rivals, who succeeded in obtaining vital performance intelligence.

Technology For Change

The progress of telecommunications from its earliest days of the pre-Morse electric telegraph, line telegraphy and telephony to the later development of radio communications, broadcasting and television and the latest data transmission and optical fibre systems already spans some 150 years. A new permanent exhibition at the Science Museum in South Kensington, London, opened on March 15, 1983 by Prince Charles, emphasises that this is "a technology for change" and successfully brings together in lively displays an absorbing selection of "historic" components, equipments, publications.

In this case "historic" does not exclude many items that will be familiar to most readers and some which are likely to recall vivid personal memories. For instance, it even includes a display of current amateur radio and citizens' band transceivers, though my eye was caught more by one of the wartime National HRO communications receivers on which I spent many hours listening and the firm's National One-Ten receiver which was a pioneering super-regenerative design with plug-in coils covering 1 to 10 metres (30 to 300MHz), popular in the 1930s with amateurs using the old 56MHz and 112MHz bands.

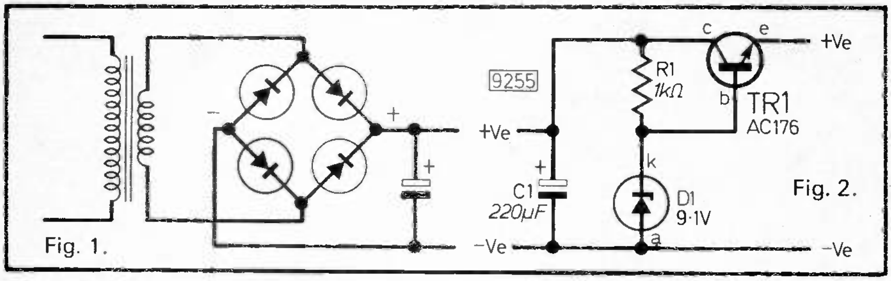
Substantial financial support for the new gallery has come from STC, a firm which this year marks the centenary of the setting up in London of the first office of Western Electric, the original parent company of STC, in 1883. But this does not imply that many of the exhibits are STC company-oriented—in fact they are drawn from many British and foreign firms.

Any reader of Everyday Electronics should regard a visit to the new gallery as a must if they live near or visit London. It is by no means "dead" history. There are buttons to press and even a chance to test your Morse-copying ability at speeds from very slow to very fast. And some fascinating photographs of the early days of the telephone with all those thousands of overhead wires converging on the first telephone exchanges.

CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

STABILISER FOR USE WITH LOW COST BATTERY ELIMINATORS



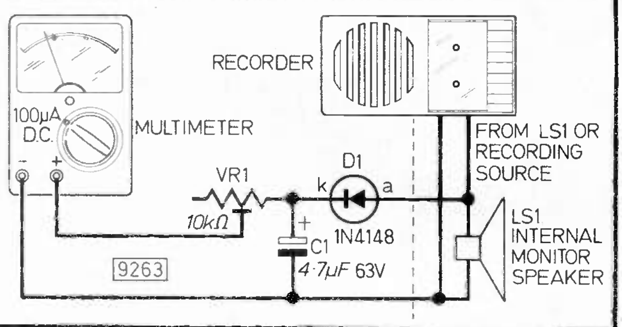
MAINS 9V battery eliminators are on sale for use with a wide range of electronic equipment. Although these devices are described as "9 volts" they are unstabilised usually consisting of simply a mains transformer, rectifiers and electrolytic smoothing capacitor as shown in Fig. 1. With a simple circuit such as this the voltage varies with current drawn, at low currents the voltage can rise to 12 volts.

The circuit described and shown in Fig. 2 can be used between the power supply and a 9V circuit. It was designed for use with circuits normally powered by a PP3 size battery. The transistor AC176 is a low cost germanium *npn* type (a BFY51 could be substituted).

If working with experimental circuits a 100 ohm resistor should be connected between the output of the stabiliser and the circuit to limit the current in the event of a short circuit. The stabiliser is suitable for low current only.

R. Soar,
Denaby Main,
Doncaster,
Yorkshire.

CONVERTING A MULTIMETER TO A 'VU' METER



IN more expensive audio devices, there may be a VU meter included in the unit. This can be very useful for recording to tell whether there is any overload.

In most portable, mono cassette recorders there is no such meter and as a simple alternative you can use your multimeter, set at the 100μA (d.c.) range for recording. The diagram shows how it is set up, using just one diode, capacitor and potentiometer. The latter is adjusted to give f.s.d. at just below distortion.

Alex Clark,
Lichfield, Staffs.

STRENGTH METER

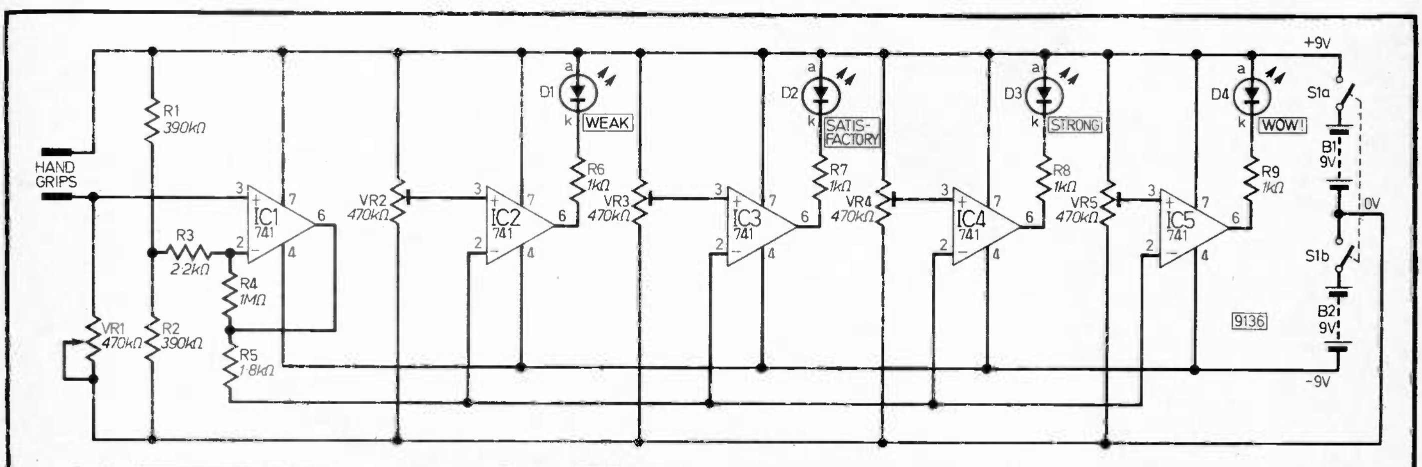
THE circuit to be described can be used for comparing the strength of different persons; or rather as a "strength meter". Two hand grips (metallic rods) are held in the contestant's hands. As he squeezes the hand grips the l.e.d.s light up in sequence. The strength of the contestant is measured by the maximum number of l.e.d.s he can light up this way.

The hand grips are made of brass or aluminium tubes; 10cm long and 2cm diameter.

VR1 is adjusted with the hand grips gently placed in the contestant's hands until D1 is just "off". The strength at which each l.e.d. is lit up can be individually controlled using VR2, VR3, VR4 and VR5. These preset potentiometers should be adjusted so that D1 is the first to light and D4 the last.

The circuit connections for IC2 through to IC5 are similar and more stages can be added in a similar manner. Although the i.c.s are marked 741 in the circuit, IC2, IC3, IC4 and IC5 can be replaced by a quad-op-amp i.c.

J. Sreekumar,
Cochin,
India.



NEW · NEW · NEW · NEW PRODUCTS NEW · NEW · NEW · NEW

VHS RE-RECORD TABS

With the increasing sales of video cassettes **Bib Audio/Video Products** have developed re-record tabs for use on VHS cassettes.

Some readers may not be aware that each video cassette has a safety tab, positioned at the rear of the cassette, which can be snapped out to avoid further recordings being made. This is a useful facility, particularly when precious recordings might be lent to friends, who may inadvertently erase the recording.

The Bib re-record tab enables further recordings to be made by taking up the space where the original tab was positioned. The new tab is re-usable and is removed by the use of a small screwdriver, or similar instrument.

The tabs are supplied in packs of 20, with fitting details printed on the pack. The recommended retail price of the Bib VHS Cassette Re-Record Tabs is £1.47, including VAT.

Bib Audio/Video Products Ltd.,
Dept EE, Kelsey House,
Wood Lane End,
Hemel Hempstead,
Herts HP2 4RQ.

PACKAGE DEAL

A new pack is being manufactured by **Cartados Packaging,** which has been specially designed to give protection to a wide range of electronic components during transit.

The pack consists of a white corrugated-board hinged carton, with profile foam on the inside of the lid and base. When the lid is closed and fastened into position, the foam sandwiches and holds the component firmly and accommodates all shapes and sizes of components.

This makes the cartons ideal for use as postal packs.

For more details and prices contact:

Cartados Packaging Ltd.,
Dept EE, King's Lane,
Englefield Green,
Surrey TW20 0TZ.

AUTORANGING CAPACITANCE METER

A hand-held autoranging capacitance meter which features a degree of precision, range and flexibility normally associated with benchtop instruments, is now being marketed by **Global Specialties.**

The new meter, type Model 3002, which incorporates a $3\frac{1}{2}$-digit liquid-crystal display and measures only 193 × 95 × 44mm, provides direct readings of capacitance from 1pF to 19,990µF. Eight automatically selected ranges remove the need for manual switching, and a dual-threshold measuring technique ensures a claimed accuracy within 0·2 per cent (± one count) from 1pF to 199µF and 1 per cent (± one count) between 200µF and 19·99mF.

The dual-threshold measurement technique is claimed to eliminate reading errors caused by dielectric absorption, and the use of d.c. charging characteristics to determine true capacitance means that the instrument can be used for measurements on cables, switches and other components as well as on capacitors.

The Model 3002 operates from six AA nickel-cadmium or alkaline batteries, and the maximum current consumption of 75mA ensures a long battery life. An optional a.c. adaptor/charger can also be used.

Global Specialties Corporation,
Dept EE, Shire Hill Industrial Estate, Saffron Walden,
Essex CB11 3AQ.

TALKING BOOKS

The company that first put speech into learning aids with "Speak and Spell" have just introduced books that talk. Called the **Texas** "Magic Wand Speaking Reader" the system uses bar codes coupled with speech synthesis microchips to produce an audible commentary.

Aimed at 4 year-olds and upwards, it's a true learning aid, adding excitement to a child's early attempts at reading. It guides the child's reading asking and answering questions prompted by coloured picture books.

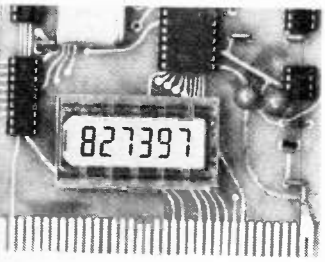
As well as a story, books containing puzzles with multiple choice answers, simple spelling tests and early arithmetic are available. Sound effects and simple tunes are also included in the books.

A bar code reader or "wand" is connected to a lightweight "talking computer" by means of a coiled flexi-cable. The wand is simply scanned across the bar codes and the computer proceeds to tell the story or ask questions.

The Texas Instruments "Magic Wand Speaking Reader" is expected to sell in the UK at around £39.95, books about £7.95 each, and more details can be obtained from:

Texas Instruments Ltd.,
Dept EE, Manton Lane,
Bedford, MK41 7PA.

DIGITAL COUNTER



To meet the need of designers for a counter which can be mounted in a confined space, **Eurovector** have marketed the Sub-Cub digital counter.

The Sub-Cub comprises a 6-digit (500kHz) l.s.i. counter chip, oscillator, Schmitt trigger and l.c.d. readout in a single dual-in-line type package that can be directly mounted on a printed circuit board. A supply voltage of 2 to 6V d.c. is required to power the unit, with supply current typically 15μA at a counting rate of 10kHz.

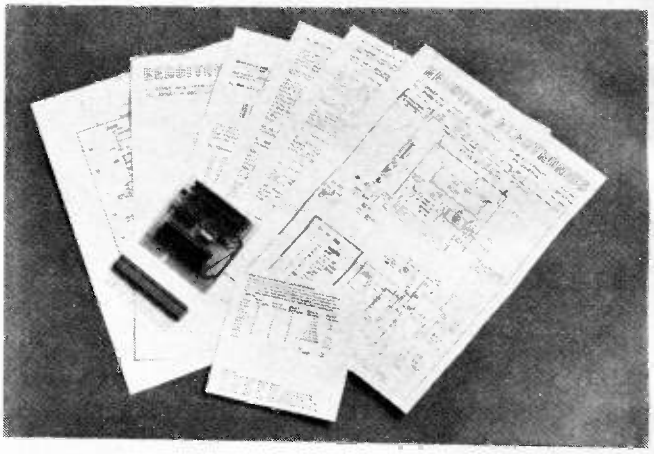
The display can be frozen at any time whilst the counter continues accumulating counts or is reset to zero in preparation for a new counting cycle. This allows it to be used as a frequency meter, tachometer and for period and pulse-width measurement.

Two modules are currently available; Sub-Cub I with 5mm high digits and Sub-Cub II with 9mm digits. An optional bezel kit provides for panel mounting if required.

For further information contact:

Eurovector Ltd., Dept EE, Wessex House, Silchester Road, Tadley, Basingstoke, RG26 6PX.

ZX81 INPUT/OUTPUT PORT BOARD KIT

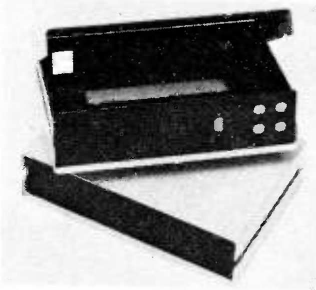


THE RE98 I/O Port designed and available from **Redditch Electronics** provides bi-directional access for the ZX81 to the outside world. It thus provides a facility for monitoring and control of external equipment under software/keyboard control.

The unit is available in kit form and comes with full step-by-step assembly instructions, test procedures and software test routines. Ideas for interfacing are also provided, such as using opto-isolators to receive information, filament lamp and relay driver circuitry and others. We are presently building the unit and plan to publish a technical report and suggest some application circuit ideas. For further information contact:

Redditch Electronics, Dept. EE, 21 Ferney Hill Avenue, Redditch, Worcs. B97 4RU.

INSTRUMENT CASE



THE range of all metal instrument cases produced by **Boss Industrial Mouldings** has been increased with the introduction of another size model in their Bim 3000 Series.

Available in two sizes of 250 × 167·5 × 68·5mm high and 250 × 187·5 × 78·5mm high, they incorporate a rigid matt black stove enamelled 18 s.w.g. chassis to which red, grey or orange stove enamelled 14 s.w.g. top and bottom covers are independently attached.

The chassis design includes integral brackets for supporting components, p.c.b.s and other assemblies and can be supplied with special ventilation slots, cut-outs and punchings to individual customer requirements.

For more details and prices enquiries should be made to:

Boss Industrial Mouldings Ltd., Dept EE, James Carter Road, Mildenhall, Suffolk IP28 7DE.

F227 SMOKE DETECTOR FIRE ALARM

THE F227 Ionisation Smoke Detector Fire Alarm is a highly sensitive instrument designed to sense the visible and invisible combustion of a fire. This type of detector gives the earliest possible warning of a fire, responding to the initial stages of combustion; and thus before visible-smoke or heat detectors. The extra seconds gained can be vital in allowing persons to escape from a developing fire.

The sensor utilises a tiny, harmless amount of radioactive material of 0·7μCi which complies to international standards. The detector is powered by a single 9V alkaline battery which can last for more than a year. When the battery runs low, the detector will emit a bleeping signal to indicate that the battery needs replacing. A test button is provided. Actuation of this button will cause the alarm to sound, thus checking all electronic circuitry, the sensor, the horn and the battery. A weekly test is recommended by N.F.P.A.

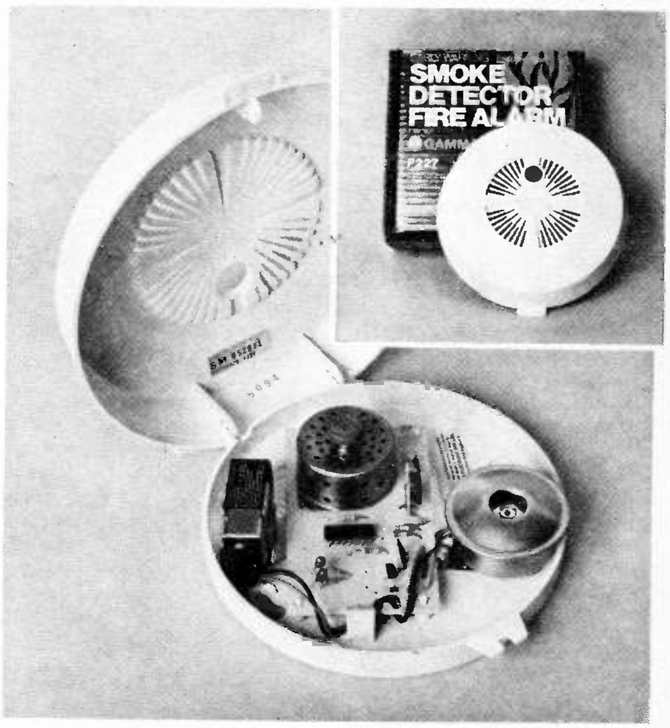
The detector is housed in a circular white plastic case. The cover is hinged and can be easily released, giving access to all parts, also to the keyhole slots provided for the fixing screws. Since heat rises, the aerosol products of combustions are always carried towards the ceiling. The detector should therefore be located on the ceiling as close to the centre of the room or hallway as possible.

Advice concerning the location of one or more smoke detectors in domestic premises is included in the owner's manual supplied with each instrument.

The F227 Smoke Detector Fire Alarm is manufactured by Gamma Electronic PTe. Ltd., Singapore, and is available (UK only) from:

R.T.V.C. Ltd., Dept EE, 21A High Street, Acton, London W3 6NG.

See Bargain Offer to EE readers on page 359 of this issue.



LETTERS

Pen Pal

Sir—I am thirteen years old, I am interested in electronics and computing and I collect electronic valves, and I am looking for a penfriend. My address is:

Shaun Gander,
6 Delaware Road,
Winterbourne,
Lewes,
Sussex
BN7 1LD.

Test Gear 83

Sir—I am building all the *Test Gear '83* projects in EVERYDAY ELECTRONICS. Unfortunately I cannot get hold of some of the components for the Power Supply. Please could you tell me where I can get them and how much they will cost?

The components are: KBL02 4A, 200V bridge rectifier (2 off); 0·47Ω, 3W wirewound resistor (2 off); 470Ω, 3W wirewound resistor (1 off); 0·1μF, 160V Siemens type capacitor (3 off; 2-pole, 6-way midget rotary with adjustable stop and the 1mA f.s.d. panel meter with 120Ω coil type ML52.

P. Greenfield,
Taverham,
Norwich.

*In reverse order, the ML52 panel meter is available from **Ambit International** for £5.98 and the stock number is* 37 00521. *They can also supply the midget rotary switch (stock number* 53 21025*) for 54p and the 0·1μF Siemens capacitors (stock number* 04 10407*) at 13p each. Prices are exclusive of VAT and please add 60p for postage.*

***Maplin** also stock a suitable panel meter, order reference* RW94C (2in Pan Meter 1mA)*, for £6.45 but this meter will require a slightly different cut-out in the front panel. The Maplin order reference for the switch is* FF74R (Rotary Sw6B) *at 70p, and the capacitors are ordered as* WW41U (Carbonate 0·1μF) *for 11p each. They also stock the 3W wirewound resistors as* W0·47Ω (W/W Min 0·47Ω) *and* W470Ω (W/W Min 470Ω) *at 29p each.*

These prices are inclusive of VAT and orders over £5 are postage free. Orders under £5 require an additional 50p for postage.

*The KBL02 bridge rectifier has been a little harder to locate. **RS Components** stock a suitable 4A, 200V "in-line" device which is equivalent to the KBL02 and the stock number is 262–113. However, RS do not sell directly to the public as they only supply to account customers. But most component shops will have an account with RS and can obtain this item on your behalf if you quote the stock number and the price should be in the region of £2 again.*

Ambit International are at 200 North Service Road, Brentwood, Essex CM14 4SG (telephone 0277 230909) and Maplin Electronic Supplies Ltd address is P.O. Box 3, Rayleigh, Essex SS6 8LR (telephone 0702 552911).

Pin Function Generator

Sir—Your help please! Could you advise me of the pin-out of a 14-pin d.i.l. LM318N (IC3, *Function Generator,* April 1983).

The major suppliers do not seem to stock the LM318 and although the circuit simply specifies an LM318, I am advised that there is an "H" and "N" version.

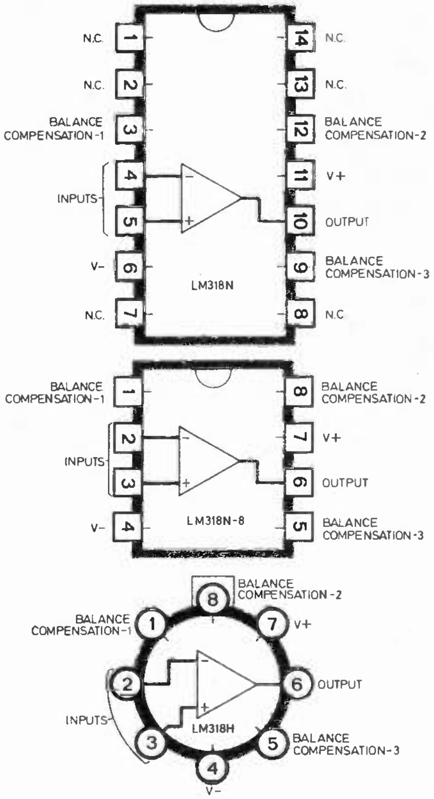
I was told that the N version was the correct one, but when supplied, turns out to be a 14-pin d.i.l. I have searched literally hundreds of other circuits and magazines but cannot find a single design that uses an LM318 (98 per cent use the 741) and suppliers seem reluctant to answer such queries by telephone, hence the request.

Please note that Fig. 6 (calibration scale) is also missing from the article. I still hope to finish this unit and eventually the future units in the *Test Gear 83* series.

R. S. Bareham,
Tunbridge Wells,
Kent.

Dealing with your last point first, Fig. 6, the calibration scale, was omitted from the text due to a lack of space and unfortunately the reference to it was left in. However, from the photographs showing the front of the Function Generator *unit it can be seen that the scale runs from 1 to 10 around the travel of the potentiometer in an almost linear fashion.*

It is not truly linear as the points are closer together at the beginning and end of the scale than they are in the middle but as it was not deemed to be important to achieve very accurate calibration, an estimation based on the photographs of the prototype model will be sufficient. We hope this has not inconvenienced any readers.



*As far as the LM318 goes, it is available in many versions. The **LM318N** is the 14-pin d.i.l. plastic packaged type (a "J" in place of the "N" indicates that it is a 14-pin ceramic pack) and the **LM318H** is an 8-pin TO5 metal can. The 8-pin d.i.l. variant is denoted the **LM318N–8** (again, a J signifies ceramic package). This suffix "8" was inadvertently omitted from the components' list.*

The pin-out diagrams given below show the pin functions of the three basic package types. Note that if pins 1, 2, 7, 8, 13 and 14 are ignored on the 14-pin version, the relative positions of all functions are identical to those on the 8-pin d.i.l. type.

It can also be seen that the pin numbers for both the 8-pin d.i.l. device and the 8-pin metal can are identical so that the LM318H could be preformed to the d.i.l. format to fit the p.c.b. layout.

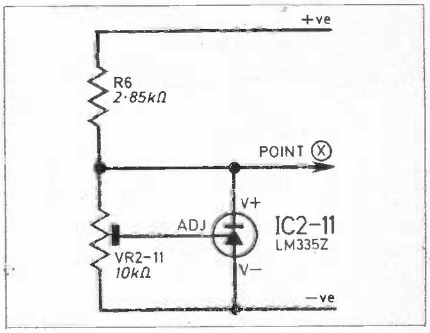
Greenhouse Monitor

Sir—The article on the *Beehive Temperature Meter* (February '83) prompted me to make up the project and adapt it to monitor my greenhouse, frames, compost heap and solar heater. The *Shop Talk* feature suggested Maplin for the parts, but the Digitron meter (ME1) is not in their catalogue and nor can I find a local (Glasgow) supplier.

I made up the project on a breadboard and have got it working in the meantime with a digital multimeter in place of ME1. I had some bother as the millivolt readings were too high and I found the current through the LM335Z temperature sensor also too high until I altered the circuit more in line with the drawing given in the Maplin catalogue. This meant putting a 2·85 kilohm resistor between the positive supply rail and the positive terminal of the LM335Z. The schematic diagram (see also Fig. 2, page 83) of this modification is shown below.

If you can get me the address of the manufacturer of the Digitron meter I should be most grateful. I have taken your paper now for some five years.

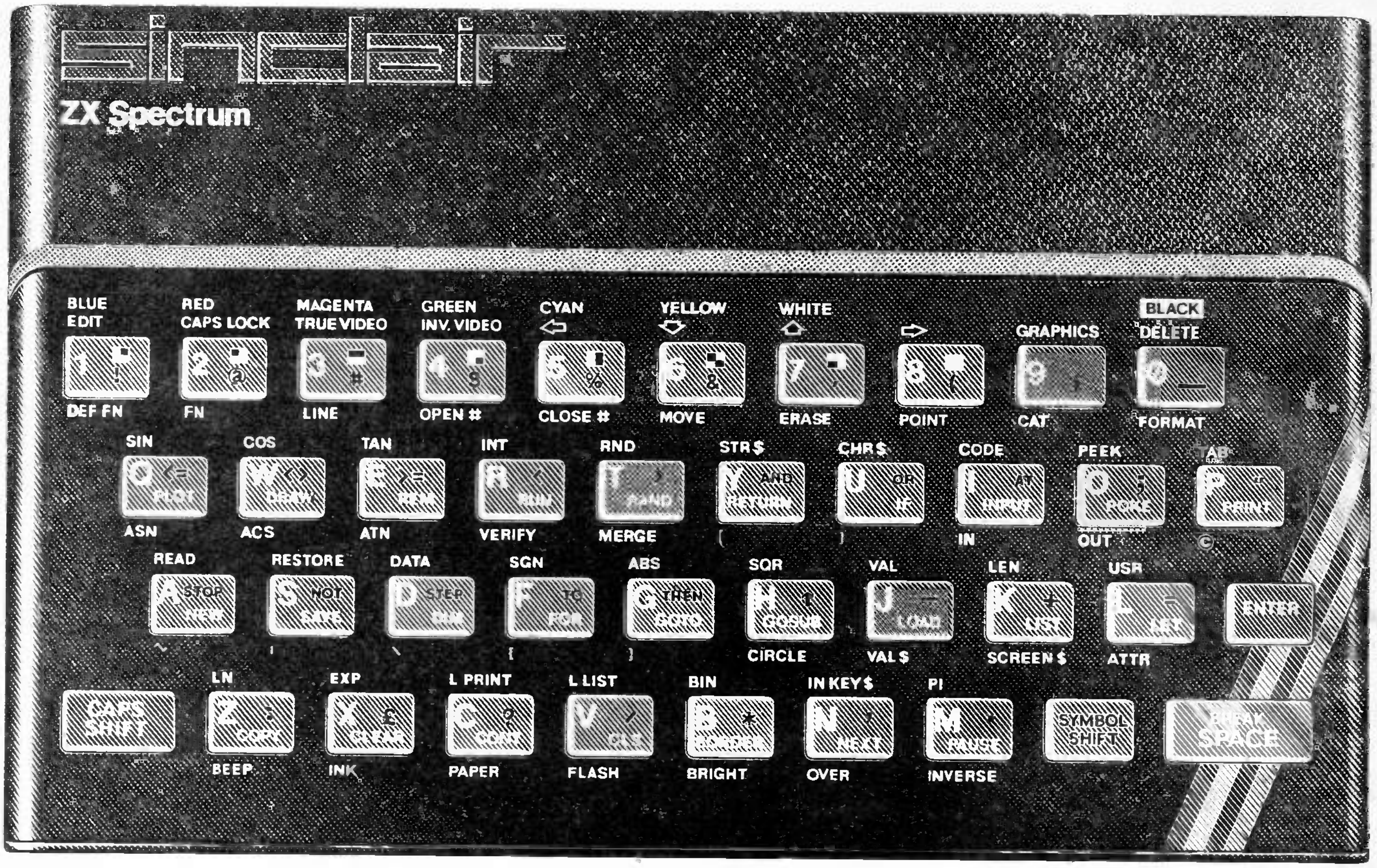
G. S. Wilton,
Clarkston,
Glasgow.



*The Digitron 8000 meter is manufactured by **Digitron Instruments Ltd., Merchant Drive, Mead Lane Industrial Estate, Hertford SG13 7BH.** They can supply the meter used on the prototype* Beehive Temperature Meter *for £34.25 plus VAT plus £3.50 postage and packing (total £42.90). Please supply payment with order and specify that it is the Digitron 8000-01 digital voltmeter with 999mV full scale deflection that is required.*

However, as this is an expensive component, a suitable alternative is to fit a pair of sockets in place of the meter and use a portable digital multimeter when measurements are required. The 2V range found on most d.v.m.s is ideal, remembering that 10mV is equivalent to one degree Celsius. Therefore a reading of 270mV (or 0·27V) is equal to a temperature of 27°C.

Sinclair ZX Spect



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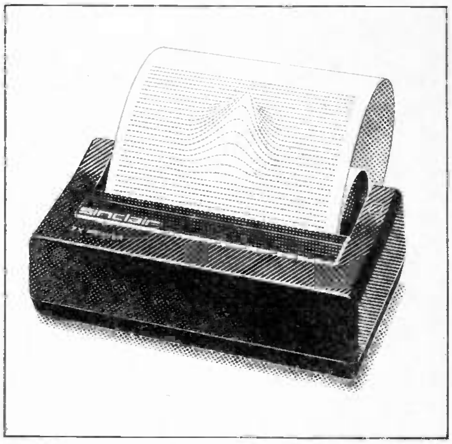

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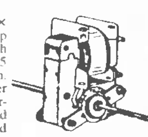

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