EVERYDAY ELECTRONICS and computer PROJECTS

SEPTEMBER 1985 £1·00

New Series... TRANSDUCERS

PERSONAL STEREO P.S.U

FRIDGE ALARM

ON SPEC · FUNTRONICS · ACTUALLY DOING IT · DOWN TO EARTH

Australia $1.75 New Zealand $1.95 Malaysia $4.95

SAVE EVEN MORE!

THE EVERYDAY ELECTRONICS FILM SERVICE

So many satisfied customers have been delighted with this award-winning film service that the economies made are now being passed on to you in the form of substantial price reductions. You can now save up to 75p on last year's prices. For 36 successful Superprints you pay only £2.95 inc. VAT. Compare this with last year's £3.70 and with the prices in the shops. Postage and packing is 30p extra as before. Here is the new price range—and remember, Superprints give you 30 per cent more picture area than standard prints at no extra charge.

No. of Superprints	Price (inc. VAT)	
12-15	£1.65	PLUS P/P 30p extra
24	£2.20	
36	£2.95	

RELIABILITY AND QUALITY

All our colour prints are made on Kodak Luxury Lustre paper. Prints have square corners and are borderless to give you maximum picture area. All prints are checked at every processing stage for accurate colour reproduction in a laboratory which is the winner of five recent successive Kodak Gold Awards for Quality. No other processing laboratory has been able to match this record. After allowing for postal and peak-period delays, you should normally expect your prints after seven to ten days.

ALL YOU HAVE TO DO

Send any make of colour print film together with your cheque or postal order inside the Freepost envelope enclosed with this Issue. Or fill in the coupon below and send together with your film and remittance in a strong envelope to: Everyday Electronics Film Service, FREEPOST, Watford WD1 8FP. Half-frame films are welcome, and these are charged at double the full-frame price.

PERSONALISED SERVICE

Readers know we care for their prints. If you have any queries, contact our service's ten-line switchboard: (01) 953 9911.

SPECIAL FILM OFFER

Films from the high-resolution emulsion 'ColorFast' range are available to all readers at highly competitive prices. And when you order three, you get another FREE.

110/24, 126/24, 135/24 £1.40 each OR 4 for price of 3—£4.20. Konica disc £1.60 OR 4 for price of 3—£4.80. 135/36 £1.80 OR 4 for price of 3—£5.40.

SPECIAL ALBUM OFFER

An attractive flip-type album, padded in black with gold embossing and holding 100 Supersize prints (in the shops £5.75) is offered to readers for only £3.99 inc. p&p.

All prices are correct at the time of going to press and are for UK readers only.

Approx. sizes of Superprints: 6"x4" (35mm) 5¼"x4" (110, Disc and 135 Half Frame) 4"x4" (126).

USE THIS LABEL IF YOU HAVE NO ENVELOPE, OR PASS TO A FRIEND.

To: Everyday Electronics Film Service, FREEPOST, Watford WD1 8FP.

From: Everyday Electronics Film Service, FREEPOST, Watford WD1 8FP.

Name__________

Address__________

____

Post Code__________

*Print my enclosed film ______

*Rush me_____of 110/24,_____of 126/24, _____of 135/24,_____of 135/36,_____of Disc/15 film______

*Rush me________album(s)

for which I enclose cheque/PO payable to Everyday Electronics' Film Service. £______

EES

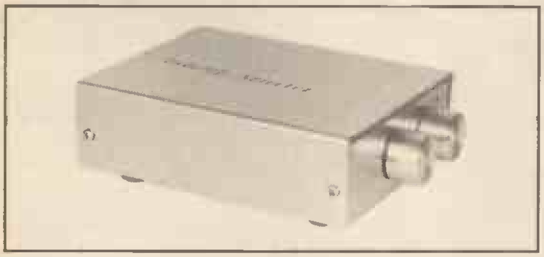
UNLESS YOU MAKE PRIOR ARRANGEMENTS WITH US we will only accept your film on the strict understanding that our liability in the case of loss or damage will not exceed the replacement cost of the unexposed film and the processing charges paid. NO CREDITS GIVEN FOR FAILURE PRINTS. This offer is limited to the U.K. Choice of materials at our discretion. The Everyday Electronics Film Service is operated in association with MFS Photographic Ltd., registered England 1835748. Registered Office: Stirling Way, Borehamwood, Herts. WD6 2AZ. Offer expires 31/3/86.

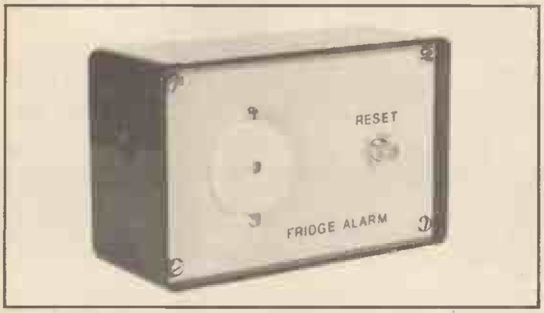
VOL 14 Nº9 SEPTEMBER '85

EVERYDAY ELECTRONICS and computer PROJECTS

ISSN 0262-3617

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





TEACH IN '86
Don't miss the start of this important new series—**See Pages 489 & 506**

PROJECTS

SERIES

FEATURES

Our October 1985 issue will be published on Friday, September 20. See page 489 for details.

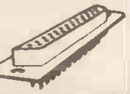
Rapid Electronics

MAIL ORDERS:
Unit 3, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	66p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solder lugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p



SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22 swg solder	100
0.5kg 22 swg solder	750

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2m lead 120p

MICRO

Brand new Micro products at lowest ever prices.
Take advantage of our volume discounts now!

Type	speed	manfr.	1+	10+	25+
2716	450nS	Hitachi	3.10	2.80	2.50
2764	220nS	Hitachi	4.10	3.80	3.60
27128	250nS	Hitachi	6.60	5.50	4.80
6116P3	150nS	Hitachi	3.10	2.90	2.60
6264P15	150nS	Hitachi	8.50	7.80	6.60
4164	150nS	Hitachi	3.00	2.70	2.40
41256	150nS	NEC	9.20	8.40	7.50
Z80ACPU	4MHZ	SGS	2.90	2.50	2.20

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 x 1	26
2.5 x 3.75	95
3.75 x 5	120
3.75 x 17	350
4.75 x 17	455
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	145
Pin insertion tool	185
Wiring pen	375
Spare spool 75p Combs	6

SWITCHES

Submin toggle.
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotery type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

MICRO

		27128-250	650				
		6116P3	310	6800	200	6522	330
		6264P15	850	6802	280	6532	520
		4164-15	300	6809	600	6551	540
2716	310	41256-15	920	6810	140	8085A	320
2532	380	4164-15	300	6821	140	8156	380
2732 one time programmable	280	41256-15	2850	6840	360	8251	350
		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
2732	430	Z80A CTC	320	6875	500	8259	400
2764-250	410	Z80A S10	880	6880	100	MC1488	70
2764-BBC	430	Z80A DMA	880	6502	370	MC1489	70

SOCKETS

	Low profile	Wire-wrap
8 pin	7p	28p
14 pin	8p	45p
16 pin	10p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

COMPONENT KITS

0 25W Resistor Kit Contains 1000 0.25W 5% resistors from 4.7 ohms thru to 10M Quantities depend upon popularity i.e. 10x10R, 30x470R, 30x10K, 25x470K. Just £7.90

Ceramic capacitor Kit. Total of 250 miniature ceramic capacitors from 22p to 0 1u. Just £6.90

Polyester capacitor Kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47u. Just £6 90

Preset Kit. Total of 110 miniature preset resistors from 100R to 1M. Horizontal mounting type. Just £6.90

Radial Electrolytic Capacitor Kit. A pack containing a total of 93 miniature caps from 1u to 2200u Just £7.50

Nut and Bolt Kit. Contains 800 assorted items. 100 each 6BA ¼in, ½in, nuts and wshrs, 4BA ¼in, ½in, nuts and wshrs. Just £3 20

CABLES

20 metre pack single core connecting cable ten different colours. 75p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit - 3p each.

Rectangular		TIL32	40
red	12	TIL111	60
green	12	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35

Seven segment displays
Com cathode. Com anode.
DL704 0 3" 95 DL707 0 3" 95
FND5000 5" 100 FND5070 5" 100
10 bar OIL LED display, red 180
5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips	8
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

Gold flashed contacts	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

NEW 1985 CATALOGUE

Our new fully illustrated 50 page detailed information on over 3000 product lines at the most competitive prices in the market. The catalogue costs just 70p including postage or free with orders over £20 in value. Send for your copy today!

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 . . . 150
SPECTRUM 2 x 28 way edge connector wire wrap. . 200
AMPHENOL PLUGS
24 way IEEE IDC . . . 450
36 way Centronix IDC . . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

Polyester, radial leads. 250v. C280 type; 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.

Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.

Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p

Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p;

Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.

Cer. disc. 22p-0.01u 50V, 3p each.

Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.

Polystyrene, 5% tol: 10p 1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.

Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 OIL 0.9A	
1A 400V	35	200V	50

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM1360C	110	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	130	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LM10C	325	LM733	70	ML928	210	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	265	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2¾ x 2"	95
71x46x22mm	50	6 x 4 x 2"	120
95x71x35mm	86	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80		
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90		

TRANSISTORS

				BC548	5	BFR40	23	2N1613	30	2N3906	10		
				BC549	10	BFR80	23	2N2218A	45	2N4037	45		
				BC557	10	BFR81	23	2N2219A	28	2N4058	10		
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25	2N4060	10	TIP35C	125
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20	2N4061	10	TIP36A	115
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25	2N4062	10	TIP36C	130
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18	40360	40	TIP41A	45
AC176	25	BC168C	10	BD115	55	BFX87	30	2N2484	27	40361	50	TIP42A	45
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60	40362	50	TIP120	60
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28	40408	50	TIP121	60
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28	2N5457	30	TIP122	60
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28	2N5458	30	TIP141	110
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28	2N5459	30	TIP142	120
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28	2n5485	35	TIP147	120
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28	2N5777	45	TIP2955	70
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24	2N697	20	TIP3055	60
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24	2N698	40	TIS43	40
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10	2N706A	20	TIS43	40
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28	2N708	25	TIS44	45
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55	2N918	35	TIS45	45
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50	TIP29	35	TI590	30
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TI591	30
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9	TIP29B	35	VN10KM	65
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10	TIP29C	35	VN46AF	94
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9	TIP30	35	VN66AF	110
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10	TIP30A	35	VN88AF	120
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP30B	35	ZTX107	11
BC117	22	BC237	7	BF197	12	MPF102	40	2N3707	10	TIP30C	40	ZTX108	11
BC119	35	BC238	7	BF198	15	MPF104	40	2N3708	10	TIP31A	35	ZTX109	11
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10	TIP31B	35	ZTX300	14
BC139	38	BC327	8	BF200	35	MPSA06	25	2N3772	170	TIP31C	40	ZTX301	16
BC140	29	BC328	8	BF244B	35	MPSA12	29	2N3773	195	TIP32A	35	ZTX302	16
BC141	30	BC337	8	BF245	35	MPSA55	30	2N3819	32	TIP32B	38	ZTX304	20
BC142	28	BC338	12	BF256B	45	MPSA56	30	2N3820	50	TIP32C	40	ZTX341	20
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65	TIP33A	65	ZTX500	13
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90	TIP33C	75	ZTX501	18
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10	TIP34A	70	ZTX502	18
BC149	10	BC517	30	BF337	35	MPSU56	56	2N3904	10	TIP34C	80	ZTX503	18
BC157	11	BC547	5	BFR40	35	2N118L	22	2N3905	10	TIP35A	105	ZTX504	25

CMOS

		4016	26	4034	145	4054	70	4081	'8	4502	50	4529	80
		4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18	4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18	4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18	4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65	4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18	4023	18	4044	50	4068	18	4095	70	4514	115	4555	50
4008	50	4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40	4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40	4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18	4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18	4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26	4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50	4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42	4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

		LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
		LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
		LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22	LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22	LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22	LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22	LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22	LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22	LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22	LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22	LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22	LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22	LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22	LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35	LS55	22	LS113	32	LS157	48	LS195	60	LS279	55		
LS14	45	LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
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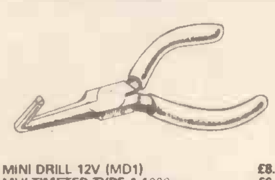

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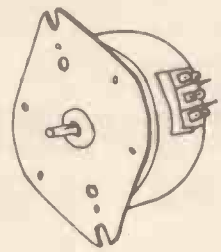

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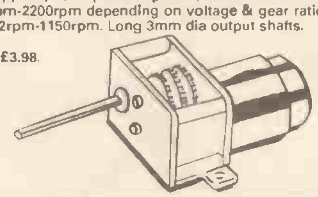

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VOL 14 No. 9 SEPT. '85

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ANOTHER ONE!

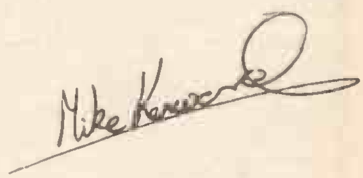
TEACH IN starts next month. That may not mean very much to our newer readers but to those that have taken EE for a few years it means another beginner's series in our highly rated manner. Teach In's started in the very first issue of EE (November 1971) and have been a part of the magazine every two years since that date. Many thousands of readers have used them to gain a basic understanding of electronics, to further their basic knowledge or to brush up on what might be getting a little outdated or simply forgotten.

Each Teach In has had its own style and presentation, each has employed a different method of practical demonstration, each in its own way has added to the general fund of data available. Many different and respected contributors have taken on the task of writing the series over the years—this year is no exception.

While EE readers may have seen the names of this year's Teach In contributors in our pages, one will be better known to them than the other. Mike Tooley now writes our regular *On Spec* feature and has produced some reviews of commercial products for us recently. David Whitfield has contributed to EE but at present is not a regular EE author. These two are however very well known to readers of our sister publication *Practical Electronics* where they have been regular contributors for many years. Writing as a team they have been responsible for many major constructional projects and a number of theoretical series and reviews. David Whitfield also writes the monthly *BBC Forum* page in PE.

They are both radio amateurs, regular constructors and authors. Mike is Principal Lecturer, Department of Technology at Brooklands Technical College and David is involved in computer software. Their experience and background admirably suit our needs and for *Teach In '86* we have the added advantage of back-up software for the BBC and Spectrum computers. Written by Mike and David, the software will help to reinforce the knowledge gained and keep a check on your understanding and progress.

Don't miss part one next month; copies will be in demand so place an order with your Newsagent now.



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UV EXPOSURE UNIT

C.J.BOWES

It is now possible for home constructors to buy all the materials needed to make professional quality printed circuit boards. One of the most useful techniques for manufacturing p.c.b.s is the photographic technique, by which prepared artwork is exposed onto sensitised glassfibre p.c.b. The major advantages of this technique are that the artwork is relatively easy to originate, and reasonably simple to correct if an error is detected. Once the master is proved to be correct, as many copies as are needed, can be simply produced rather than having to redraw the design directly onto the p.c.b. every time.

PCB PRODUCTION

Production of p.c.b.s by means of this technique require the sensitised boards to be exposed to ultra-violet (UV) light through the master artwork. This produces a latent image which is developed, either in a special proprietary developer or in sodium hydroxide solution. This produces a dye image on the board which is resistant to the etchant, usually ferric chloride solution, which is used to remove the unwanted copper from the board. This leaves the design originated on the artwork behind on the board. The process requires the use of a suitable light box in which the artwork and sensitised board are held in firm contact and exposed to the UV light.

The box should also screen the operator from the UV light, since prolonged exposure to the wavelengths suitable for exposing the sensitised board can cause irritation to the eyes. The process is also made easier if the light box is fitted with a timer to ensure acurate, and repeatable exposure times. Such light boxes are available from major component suppliers but they tend to be somewhat expensive.

SPECIFICATIONS

The unit described in this article is suitable for home construction and not only provides a suitable box in which to expose sensitised material but incorporates an electronic control system which allows any one of the six predetermined exposure times or a manual control to be selected. An audible warning device is incorporated which is triggered at the end of the preset exposure times, enabling the user to perform other tasks whilst waiting for the end of the exposure sequence to occur.

The construction of the outer case has been made as simple as possible, whilst giving easy access to the interior components for servicing.

CIRCUIT DESCRIPTION

The circuit diagram of the unit is shown in Fig. 1. The system consists of two control circuits, one a monostable timer circuit and the other a standard flip-flop circuit. These are both triggered by an anti-bounce circuit and connected, via a transistor current amplifier, to a relay, which is used to control the mains voltage to the ultra-violet emitting fluorescent tubes and associated control gear.

STARTING CIRCUIT

A single pole, momentary action, change-over switch (S2) is used both to start the automatic timing circuit and to toggle the manual control circuit. Because of the nature of the 4027 flip-flop i.c. used in the manual control circuit it is necessary to take steps to avoid the problem of contact bounce causing spurious pulses. Suppression of these spurious pulses is achieved by the anti-bounce circuit comprising R8, R9, IC2b and IC2c.

This circuit produces a single pulse output irrespective of how many times the switch contacts may bounce on closing.

The positive going (changing from logic 0 to logic 1) output from the starting circuit is taken directly from the output of IC2c to the clock input of the flip-flop. IC3. The negative going output of the anti-bounce circuit is taken from the output of IC2b and is a.c. coupled to the trigger input of the monostable circuit via C4. R10 and D1 are included in this circuit to give a reliable trigger pulse.

MONOSTABLE TIMING DEVICE

Preset exposure timing is obtained by using half of a CMOS 556 timer i.c. (IC1a) connected as a monostable circuit. In this mode the output of the i.c. swings from 0V to the power supply voltage for a time (T) found by applying the formula:

$$T = 1{\cdot}1 \times R \times C$$

(Where R = the resistor value in ohms and C = the capacitor value in Farrads.) In this case the capacitor value is that of C3 which is fixed at 100µ and the value of the resistance is selected by S1a from the network of resistors comprising R1 to R6 and VR1 to VR6. R1 to R6 are wired as a chain of resistors which in combination with C3, provide a time delay of slightly less than that required for each of the preset

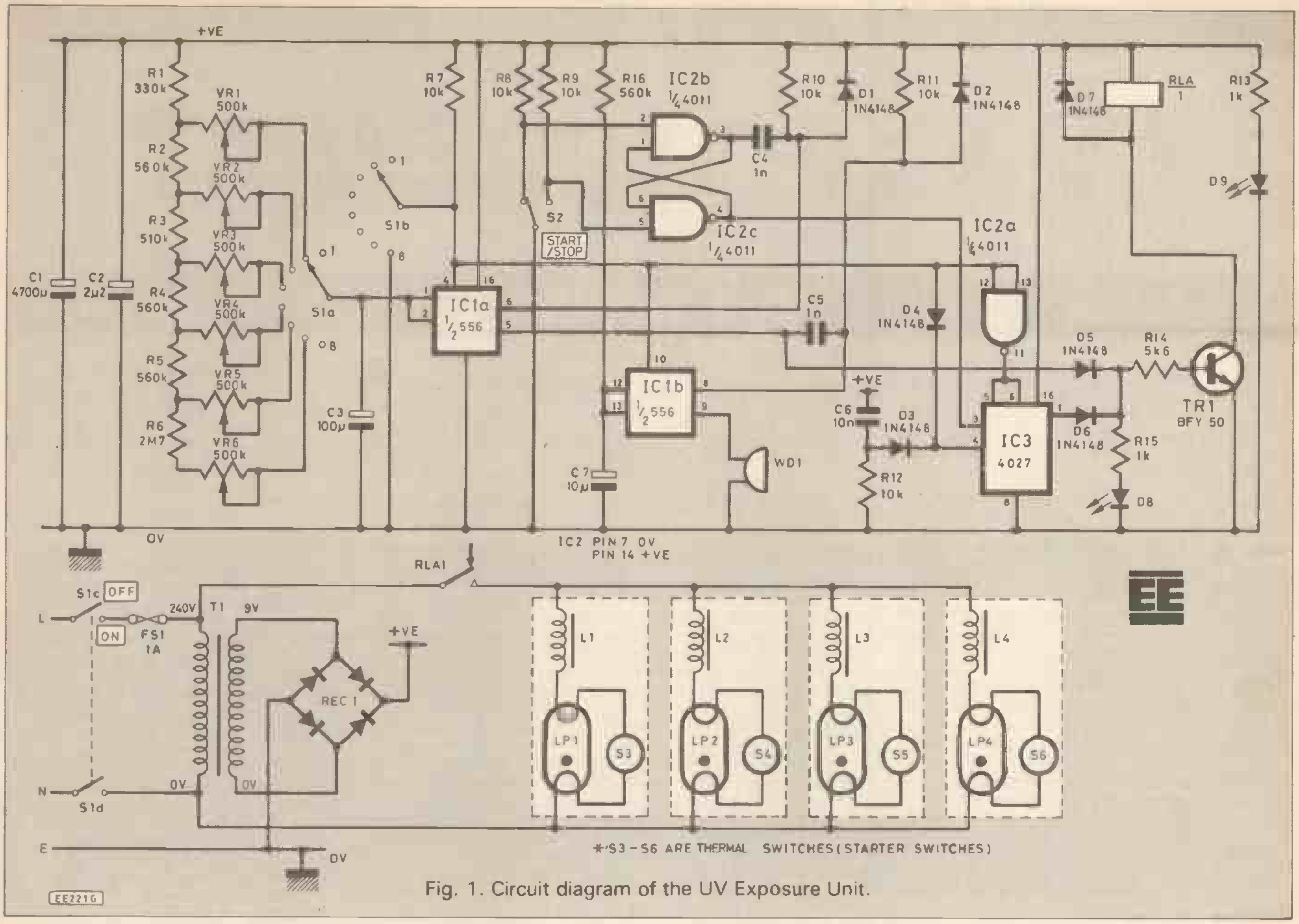


Fig. 1. Circuit diagram of the UV Exposure Unit.

timing intervals. S1a provides a means of adjusting the total value of resistance between V+ and C3. This enables the preset timings to be accurately set and overcomes the problems of tolerance within the timing components. The output from the monostable timer circuit is connected via D5 to the current amplifier which drives relay RLA.

MANUAL CONTROL CIRCUIT

Manual control of exposure time, using the start/stop switch S2, is achieved by means of a 4027 J–K flip-flop (IC3). The clock pulses produced by the anti-bounce circuit are used to toggle the output (Q) of IC3.

In order to ensure that the output from IC3 is at logic 0 when the unit is switched on, C6 and R12 are arranged so as to cause a short logic 1 pulse to be applied to the clear direct input (pin 4) of IC3 every time that power is initially connected to the power supply rails. D3 is used to avoid interference between this pulse and the voltage present at pin 4 of IC1a. In order to ensure that the output of the flip-flop circuit will automatically go to logic 0 when switching from manual to automatic control the clear direct input is also connected, via D4, to the wiper connection of S1b. This is so arranged that whilst automatic control is selected, the clear direct input remains at logic 1, forcing the output (Q) to remain at logic 0. The J and K inputs are similarly connected, via the inverter formed by IC2a, to the wiper of S1b. This ensures that whilst the manual control option is not selected both the J and K inputs are at logic 0.

This inhibits the output of the i.c. from changing despite the presence of clock pulses at the input. Similarly S1b is used to short the end of R7 to ground. This is connected to the reset input (pin 4) of IC1a so that it is held at logic 0 whilst the manual control option is selected. This inhibits the output of a logic 1 signal by IC1a which would otherwise override the output from the manual control circuit.

The positive going pulses produced by the anti-bounce circuit are fed into the CK (clock) input (Pin 3) of IC3. When the manual control option is selected via S1 the J and K inputs are both a logic 1. Each pulse fed into the CK input causes the output (Q) to change stage to the opposite logic state to that at which it currently is. This output is fed to the current amplifier circuit via D6.

UV TUBE CONTROL CIRCUIT

The mains operated UV tubes are controlled through RLA1. Insufficient current is available from the two control circuits to directly drive the relay. So TR1 is used as a current amplifier to boost this current to a sufficient level to operate the relay. The two diodes D5 and D6 act as a simple OR-gate so that an output from either of the two i.c.s will be able to provide suitable bias current to cause TR1 to conduct through its collector-emitter junction. The relay is connected in series between the positive supply rail and the collector of TR1, thus the current flowing through the collector circuit also flows through the relay causing it to be energised. D8 is an l.e.d. which is illuminated by the output from the diode or gate to indicate that the fluorescent tubes are illuminated.

The unit uses four tubes, each of which is wired in series with a choke for power factor correction. Each fluorescent tube contains two heater filaments, one at each end. These are used to warm the tube up to the point at which electrons are emitted to produce a flow of charge through the gas inside the tube and cause the emission of light by electrons striking the coating inside the tube.

The heaters are initially connected in series until the charge flow is established, after which the circuit is broken to leave one of the filaments connected to Live through its choke and the other to Neutral. In order to achieve this control a Fluorescent Tube Starter is connected in series between the two filaments. The relay is connected so as to control the fluorescent tube circuits by completing the circuit between the mains power line and the chokes when it is energised.

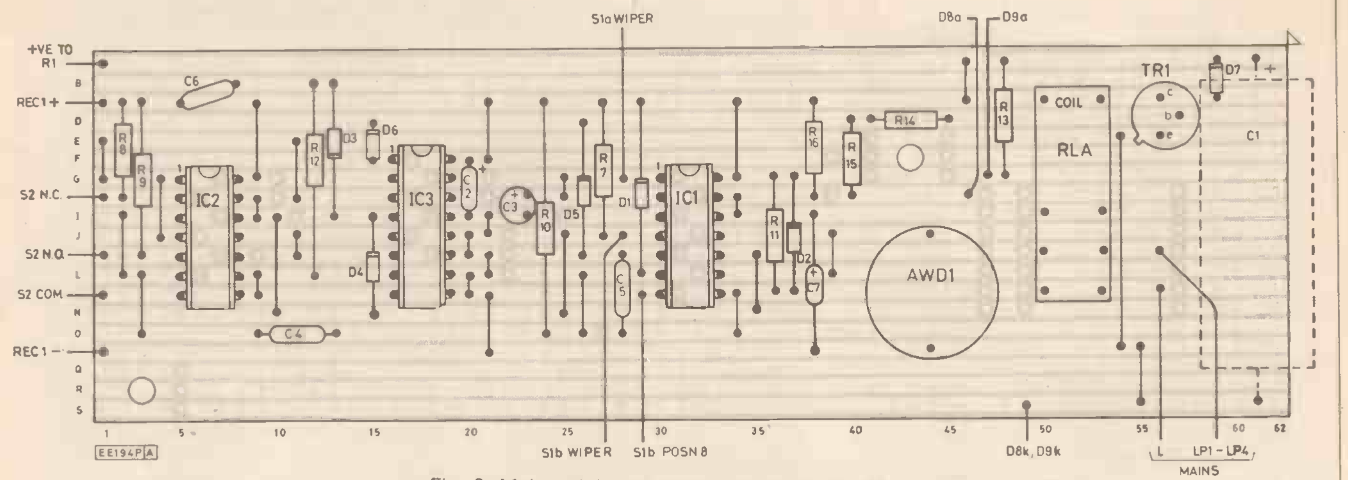
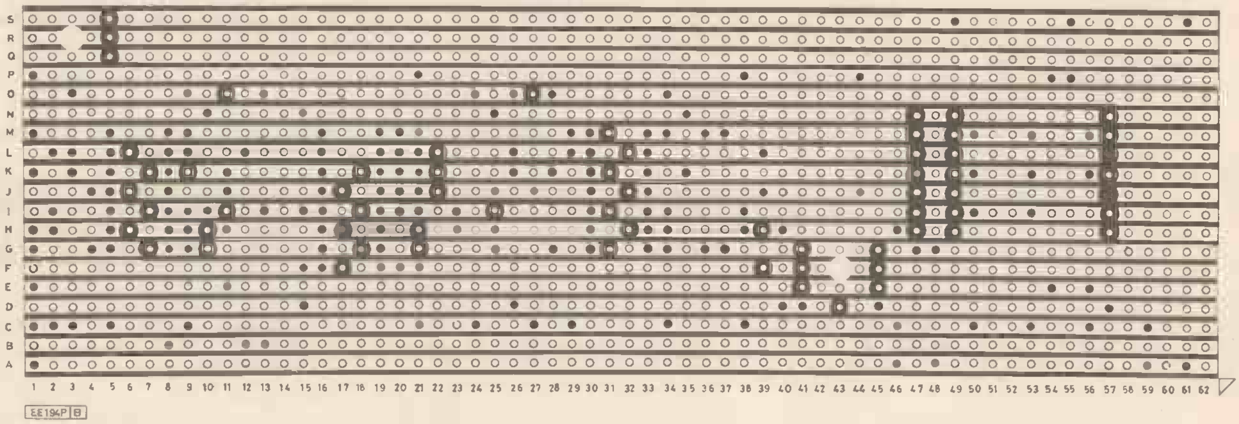


Fig. 2. Main stripboard layout and track details.



END OF EXPOSURE INDICATOR

An audible warning circuit is incorporated into the design to indicate the end of a preset timing period. The circuit uses the other half of the 556 timer i.c. connected as a monostable. The timing period for the circuit is set by means of R16 and C7 and, with the values given, produces an output of approximately six seconds duration. The circuit is triggered by being a.c. coupled to the output of IC1a. When the output of IC1a goes from the power supply rail voltage to 0 volts a short negative going pulse is produced by C5, D2 and R11. This is connected to the trigger input of IC1b and initiates the timing period. The reset input of this i.c., is connected to the wiper of S1b. This point is normally at logic 1 but the pull-up resistor, R7, is shorted out by S1b, giving a logic 0 state when the manual control option is selected. This inhibits the operation of the audible warning circuit when automatic timing is not selected. The output from IC1b is directly connected to WD1, which is a piezoelectric unit mounted directly onto the stripboard.

POWER SUPPLY

The power supply is conventional, consisting of a mains stepdown transformer, T1, which produces an output of 9V a.c. This is rectified by the diode bridge REC1 and smoothed by C1 to produce a 12V d.c. output, which is connected across the power supply rails. C2 is a small decoupling capacitor, mounted in the centre of the stripboard.

ELECTRONIC CONSTRUCTION

Construction of the electronics for this project is fairly straightforward, with most components mounted on the main stripboard as shown in Fig. 2. The stripboard should first be prepared by breaking the tracks with a stripboard cutter as shown in Fig. 2. The board should then be turned over and the components mounted in the correct places.

Construction will be helped at this stage if the smaller components and wire links are positioned first and then soldered. These are followed by the next larger components and so on until the relay is positioned last. Note that D7 is located underneath C1 and should obviously be positioned and soldered before C1 is installed. Care should be taken to ensure that all polarity sensitive components, such as diodes, capacitors, the transistor and the i.c.s are correctly positioned. The wire connections to the stripboard should be connected last. Although the board has been arranged so that ribbon cables can be used, single wires can also be used for this purpose. Identification of the correct connections will be aided if wires of different colours are used.

The fixed and variable resistors associated with S1 are mounted on a smaller piece of stripboard and connected to the switch wafer by cable. The layout and track breaks are shown in Fig. 3.

After wiring up the two stripboards they should both be carefully checked for solder bridges, dry joints and incorrectly positioned components. The power supply should then be constructed and used to test out the two stripboards before any attempt is made to install them in the case. It is, however, best to leave calibration of the automatic timing system until after installation is completed, since there is a good possibility of the settings being disturbed during installation.

CASE CONSTRUCTION

This project requires the construction of a more complex case than is usual for most electronic projects. This is because of the need to ensure that the p.c.b. material is held in positive contact with the artwork and that both are correctly positioned over the UV tubes during exposure, as well as the usual function of holding the components safely inside the unit. The prototype was constructed of wood and is in two parts, an inner section which houses all the electronic parts and UV tubes, and an outer case into which the inner section fits. This design has been chosen to aid installation and servicing. The sides and ends of the units are made of grooved timber which should be obtained as one piece. The groove must be wide enough to take the glass through which the exposure will be made. The sensitised board and artwork are held in position by means of a piece of foam plastics material glued to the underside of the lid. The case lid is hinged to the case and secured by means of two catches mounted on the opposite side of the case. (See photographs.)

INNER UNIT

The slide-in inner section is slightly more complex than the outer case and care must be taken in making it to ensure that it will be a secure fit within the outer case, whilst not requiring the use of excessive force when sliding it into position. The end piece and inner divider are made of the same timber as the outer case and sides and end, but the depth of these pieces is reduced by the thickness of the bases of both the outer case and the inner section. This is to ensure that the control panel slides into the grooves in the outer case when positioned in the grooves of the inner section's end and divider pieces. After these pieces have been cut accurately to size, the base of the inner section is positioned in the outer case and the position of the inner divider determined. This piece should be positioned so that the inner divider will be continuous with the edge of the lid when the latter is fitted. After marking the position of the divider on the base board the edge of the battens fixed to the outer case sides should also be marked before removing the inner base.

The holes through which the wires between the fluorescent tubes and the control circuits pass should be drilled and the divider can then be screwed and glued to the base. The end section can also be glued and screwed to the board at the same time. The support bearers for the UV tubes can also be positioned and glued to the base, care being taken to ensure that they do not protrude over the lines marked denoting the edge of the outer case bearers. Two screws, one each side, are required to hold the inner case in position in the outer case. The position of these can be marked and the holes drilled at this stage.

FINISHING

After the case has been completed it should be carefully checked to ensure that all the parts fit together. The case should then be sanded and painted. The inside of the light box section, including the part of the inner section divider which forms the fourth side of the light box, is painted matt white up to the level of the grooves into which the glass fits. The part of the inner section base which is not covered with the aluminium foil is also painted matt white. The lid, outside of the outer case, the edges and the inside of the case, down to the level of the grooves are painted to taste. Once the paint is dry foam plastic material can be glued to the inside of the lid and after the glue has dried the lid hinges can be fitted and the lid and its retaining catches can be fitted to the outside of the case.

COMPONENTS

Resistors

R1	330K
R2,R4,R5, R16,	560K (4 off)
R3	510K
R6	2M7
R7–12	10K (6 off)
R13–15	1K (2 off)
R14	5K6
VR1–VR6	500K $\frac{1}{4}$W min. preset. (6 off)

Resistors (All $\frac{1}{4}$ watt high stability unless otherwise stated)

See Shop Talk page 477

Capacitors

C1	4,700μ 16V electrolytic
C2	2μ2 16V, tantalum
C3	100μ 16V, electrolytic
C4,C5	1n disc (2 off)
C6	10n disc
C7	10μ 16V, electrolytic

Semidonductors

REC 1	1A, 50V chassis mounting bridge rectifier
D1–D7	1N4148
D8	red 0·2in. l.e.d.
D9	green 0·2in. l.e.d.
TR1	BFY50
IC1	556 dual CMOS timer
IC2	4011B, quad two-input Nand Gate
IC3	4027B, dual J K flip-flop

Miscellaneous

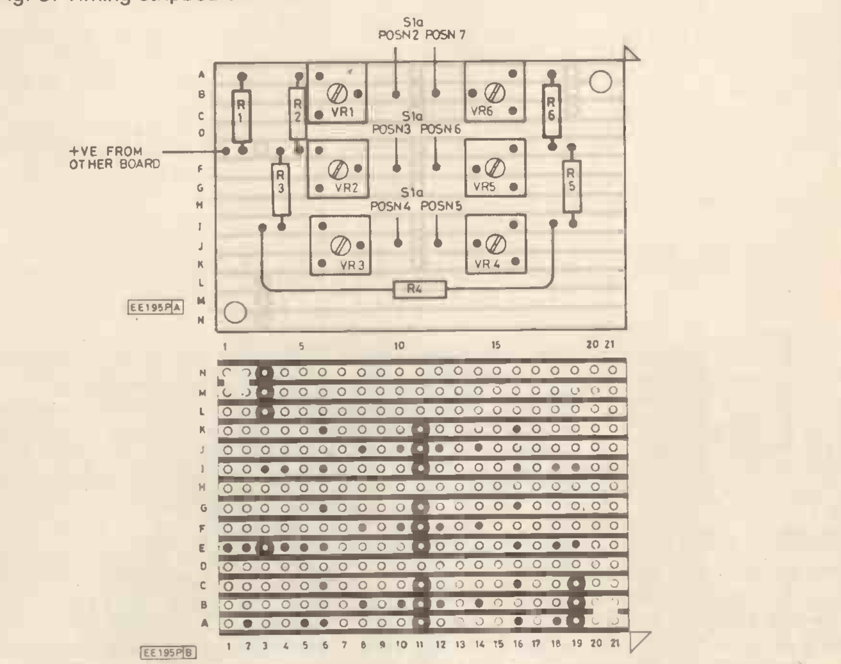
S1 2 pole, 8 way rotary switch with mains switch (use 12 pole, 2 way); S2 s.p.d.t. momentary action push switch; 28mm knob for S1; 15mm knob for S2; RLA 12V p.c.b. mounting relay with mains contacts; T1 240V primary, 9V, 6 VA secondary transformer; FS1 20mm, 1A fuse and holder; S3–6 fluorescent tube starters and holders (4 off); LP1–LP4 8W fluorescent tube chokes (4 off); L1–L4 8W UV fluorescent tubes (N.B. the "Blacklight" tubes sold by disco shops are not suitable, use the replacement tubes sold by component suppliers); Mains lead and plug; P clip to accept Mains cable; Stripboard 19 strips × 62 holes, Stripboard 14 strips × 21 holes; 14 way d.i.l. socket (2 off), 16 way d.i.l. socket, 12V, p.c.b. mounting audible warning device; Materials for case.

Approx. cost Guidance only £45

CONTROL PANEL

The main control panel of the unit is designed to fit into the four grooves which surround the electronics compartment. The panel can be manufactured from any material, or combination of materials, which have the same thickness as the glass. It can be painted, if necessary, and lettered with rub-down lettering secured by numerous coats of spray or clear varnish. Alternatively, the artwork can be transferred photographically, using the light box onto UV sensitive film which is then processed and stuck to the material of the panel.

Fig. 3. Timing stripboard and track details.



FINAL ASSEMBLY AND CALIBRATION

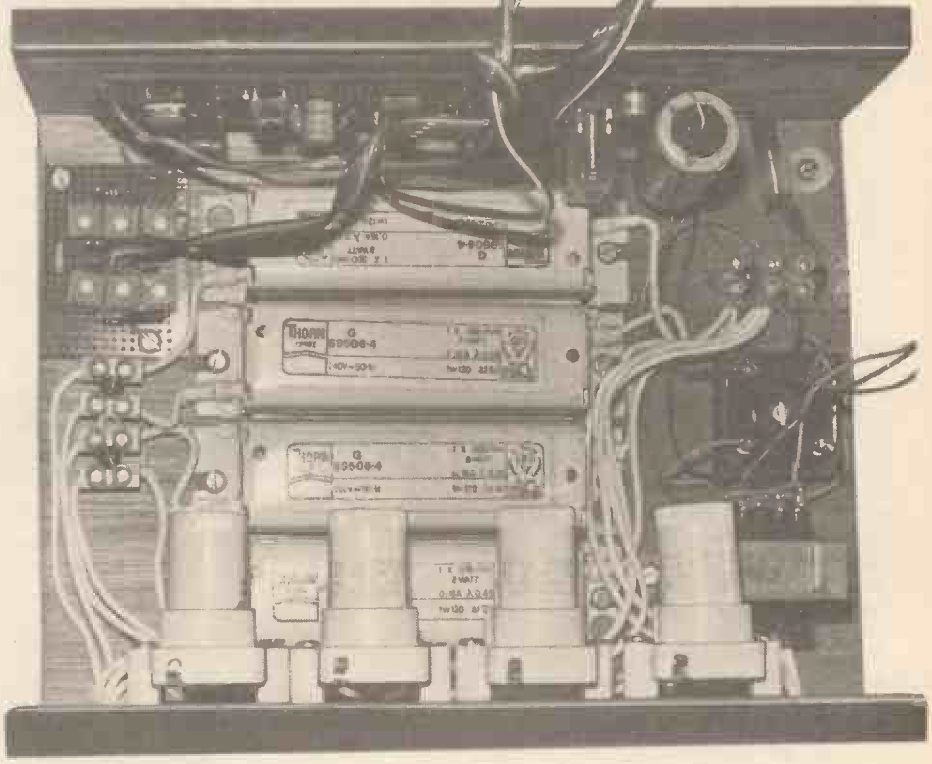
Once the box and the appropriate parts of the inner section have been completed the project can be assembled. All that is required to complete the case is to carefully slide the glass into the grooves. This should be done very gently with the hand pushing the glass wrapped securely in a thick towel. This is a vital safety precaution since the towel will protect the vulnerable arteries in the wrist from damage if the glass should fracture as a result of being pushed too hard.

The completion of the inner section consists of installing and connecting up the electronics. Firstly, the eight terry clips which are used to hold the UV tubes should be screwed to the bearers, so that the tubes will be evenly spaced.

The cables connecting the control circuitry to the ends of the fluorescent tubes farthest away from the electronics compartment should be glued to the base of the inner section with contact adhesive, care being taken to ensure that they lie flat on the base and pass neatly through the cut away undersides of the tube bearers. After the adhesive has dried the reflector, which is made from baking foil, should be cut to size and stuck to the base, over the top of the already installed cabling, with contact adhesive.

The stripboards, fluorescent tube control gear and power supply components are then installed as shown in the photographs and connected up to complete the circuit as shown in Fig. 1.

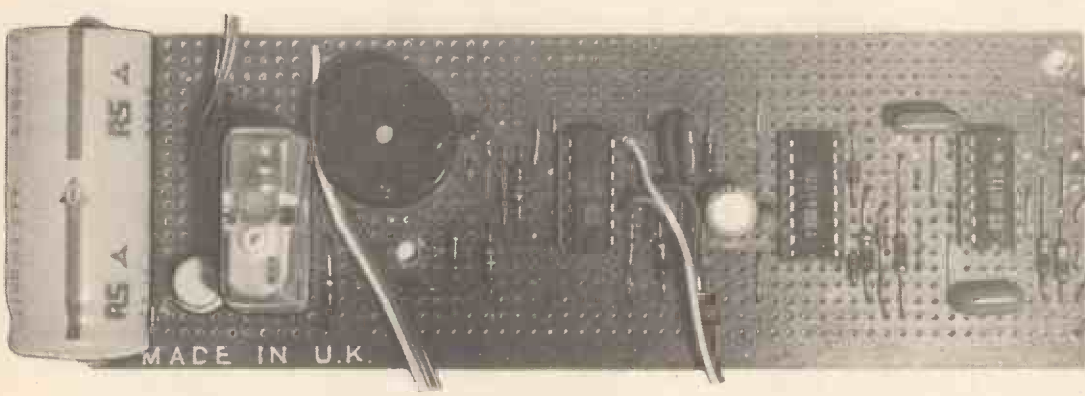
The fluorescent tubes should then be fitted into their terry clips, connected up and then tested by switching S1 to the manual position and operating S2. The four tubes should individually strike and commence emitting light. They should also switch off on a subsequent operation of S2. It is advisable at this point to test the operation of the circuit on the shortest automatic setting, to ensure that the striking of the tubes does not interfere with the timer circuit's operation.



Photographs illustrating the constructional details of the UV Exposure Unit.

The final task is to set the six presets (VR1 to VR6). This is best accomplished with all the fluorescent tubes except for that which strikes slowest, disconnected. The process is performed by selecting each of the auto time settings in turn with S1 and adjusting the appropriate preset until the correct duration between the striking of the tube and its being extinguished at the end of the timing period is accurately achieved. If the time is too short, the preset should be adjusted to increase the resistance and vice-versa if the tube remains lit for too long then the preset should be adjusted so that the value of resistance should be reduced.

Once all the presets have been adjusted, the disconnected fluorescent tube leads, should be reconnected and the inner section slid into the outer case, taking care whilst so doing to carefully align the control panel in its grooves. The inner section is finally secured in place by screwing into position the two case fixing screws. ☐



Main stripboard layout showing the position of C1, the p.c.b. mounted relay and AWD1.

SHOP TALK

BY RICHARD BARRON

Catalogues Received

We have received the latest catalogue from **Greenweld** which replaces the 1984/85 edition (purple cover) and the winter supplement. It is priced at 70p but this can be recovered by making use of the discount vouchers on the back page of the catalogue. Up to £1 can be saved.

The catalogue contains a large and well illustrated range of components presented in alphabetic order. There is also a range of: kits, modules, test instruments and other miscellaneous items.

One section particularly worth a mention is the bargain list supplement which contains a good selection of very low-cost goodies such as: multimeters, power supplies and component packs.

More details are available from: **Greenweld Electronic Components, Dept. EE, 443, Millbank Rd., Southampton, SO1 0HX. ☎ (0703) 772501**.

Also this month, we received a late copy of the 1984/85 catalogue from **Marco Trading**. This contains a comprehensive list of components, audio products, cases, TV accessories, tools and electrical products.

Some of the product lines and prices in this catalogue may now be out of date but the 1985/86 catalogue will be available soon for around £1, and as usual will contain a bargain supplement.

For more details contact: **Marco Trading, Dept. EE, The Maltings, High St., Wem, Shropshire, SY4 5EN. ☎ (0903) 32763**.

The quarterly offering from RS is now available which covers their total product range for July to October. Unfortunately this catalogue is only available to trade customers. Despite this, some components for projects published in *EE* are specified as an RS part.

If you have trouble finding an equivalent then it is worth while getting in touch with a retail electronic components company who will often help; indeed they may even be able to supply the actual part you require.

Test Gear

Test gear is always of some interest to the hobbyist. We recently received the new short-form instruments catalogue from **Thandar**.

Some of the test instruments are a little expensive but there are a few oscilloscopes and multimeters which may be of interest. Further details about these are available from: **Thandar Electronics Ltd., Dept. EE, London Rd., St. Ives, Huntingdon, Cambs., PE17 4HJ.**

Robots

Maplin Electronics, well known to the electronics hobbyist, is now set to become the major European supplier of non-industrial robots.

In order to better handle their expanding robot marketing and sales, Maplin have established a new Robot division. Dave Snoad who heads the Maplin robotic operations, believes that robots could before long become as popular as the home video or computer. Meanwhile, with the role of robots in industry continuing to expand, there is a considerable demand for training robots such as the "HERO"—the world's number one best seller.

Maplin are now developing interfaces for their highly competitively priced range of robots to such popular microcomputers as the Sinclair ZX81 and Spectrum, Commodore C-64 and the Acorn BBC-B.

Robot kits from Maplins come in a range of prices starting around £79.95 for the ZERO 2.

More details are available from: **Maplin Electronic Supplies Ltd, Dept. EE, PO Box 3, Rayleigh, Essex, SS6 8LR. ☎ (0702) 552911**.

On Spec
For Spectrum Owners

If you are a Spectrum or Spectrum Plus owner, then our *On Spec* page is designed especially for you. It contains a host of useful tips and circuit ideas for making more use of your micro.

If you have any queries, or ideas which may be of interest to other Spectrum owners please write to:

Mike Tooley,
Department of Technology,
Brooklands Technical College,
Heath Road,
Weybridge,
Surrey KT13 8TT.

P.S. If you would like a copy of the latest "Spectrum Update" don't forget to include a stamped addressed envelope.

CONSTRUCTIONAL PROJECTS

Caravan Alarm

It is important to use the correct type of relay (RLA) for the *Caravan Alarm*, a suitable one being available from **Maplin Electronics**. The case used for the prototype of this project is also available from Maplin Electronic Supplies Ltd., Dept EE, PO Box 3, Rayleigh, Essex, SS6 8LR.

Fridge Alarm

The components for the *Fridge Alarm* project are readily available from many of the advertisers in *EE*. However, make sure that when you order the Quad 2-input CMOS NAND gate to specify the 4011UBE or the 4011BE as these are necessary to achieve very low quiescent current.

Personal Stereo PSU

The p.c.b. mounted transformer used on the prototype of the *Personal Stereo PSU* was supplied by **RS Components**. If there is any difficulty experienced in finding a similar transformer then a chassis mounted type may be used. Details of this are given in the article.

Resistance Thermometer (Transducers—1)

It is worth looking around at the various plugs and sockets available for the *Resistance Thermometer* as it may be worth using a cheaper alternative to the type used on the prototype. The platinum film probe for this project is available from **RS Components**, stock number 158-402.

RIAA Preamp/Input

The NE5534A i.c. specified for the *RIAA Preamp/Input* is a special low noise version but the LF351 or TL071 may be used as an alternative. The latter versions are cheaper but cause a loss of 10dB signal to noise ratio. The NE5534A is available from **Rapid Electronics, Dept. EE, Unit 3, Hill Farm Ind. Estate, Boxted, Colchester, Essex, CO4 5RD.**

Semiconductor Thermal Indicator (Transducers—1)

The programmable current source used in the *Semiconductor Thermal Indicator* is available from **Maplin Electronic Supplies**, order code WQ 32K.

UV Exposure Unit

The various "electrical" parts such as the starters and chokes for the *UV Exposure Unit* are available from many DIY electrical shops. The tubes may be a little harder to locate but are available from **RS** (stock no. 556-250). The other components are fairly common.

Voltage Regulator Unit (Building Blocks—2)

As was mentioned last month, the p.c.b. for this project is available from the **EE PCB Service** and is part of a set of four. This enables you to build four projects from one p.c.b. making each one very cheap.

ELECTRONIC BUILDING BLOCKS

PART TWO

RICHARD BARRON

BEFORE we continue this series, I must apologize for an error which appeared in Part One. The centre tap of the transformer should be connected to the 0V output track on the p.c.b. (Fig. 13) and not to C3 as shown.

Last month we took a close look at obtaining low voltage d.c. supplies derived from the mains. As we saw, that whilst being useful in some applications, an unregulated supply has many short-comings: only one voltage is available which is unstable when subjected to a wide range of load currents. Generally, as the current demand varies, the output voltage varies accordingly. Also, even with a constant load there will be a ripple content to the output voltage at a frequency of 100Hz (for full-wave rectified voltages derived from the mains. See Fig. 1).

The effect of this may be negligible for many loads such as d.c. motors or lamps, but it is almost certain to cause mis-operation of loads incorporating i.c.s., especially digital circuits. Now we must consider some new *building blocks* which can be used to improve upon the simple supply.

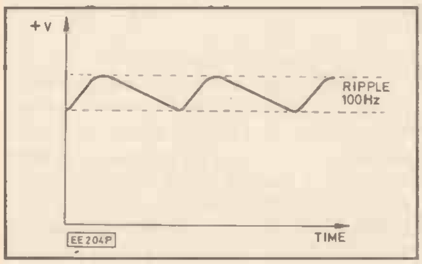


Fig. 1. 100Hz ripple.

CONSTANT VOLTAGE

The basic element of any regulated supply is a known voltage reference which can be relied on under a wide range of conditions. This reference usually relies on the characteristics of some form of semiconductor diode. We saw the basic characteristics of diodes in part one but now we must take a closer look at these devices which are used in many electronic circuits.

DIODES

The circuit symbol for the diode is shown in Fig. 2, together with a graph illustrating its general V-I characteristics. It can be seen that once the forward bias voltage threshold has been reached (usually around 0·6V for silicon diodes) the diode will pass a wide range of current with very little effect to the voltage across it. This characteristic can be utilised to provide a useful voltage reference.

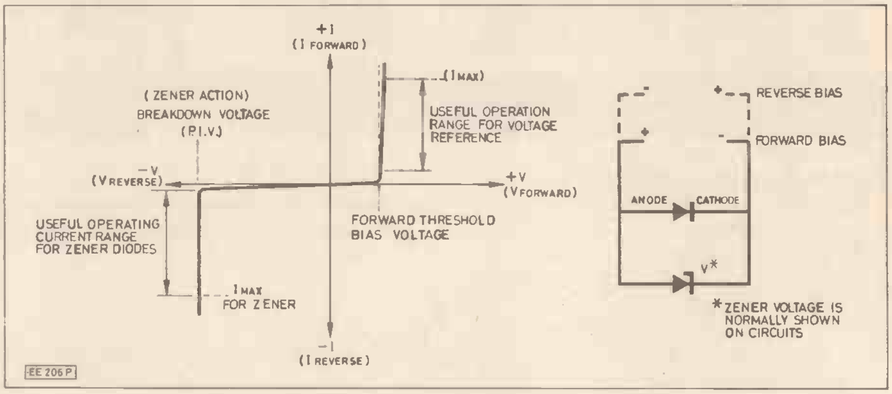


Fig. 2. Circuit symbols and diode characteristics.

Also shown in the graph is the diode reverse bias conditions. On ordinary diodes, once the peak inverse voltage has been exceeded, the diode will break down under the avalanche effect. If this occurs the diode is rendered useless. However there are certain diodes which can be used in the avalanche region, namely zener diodes.

ZENER DIODES

The action of the zener diode is similar to the standard diode except that providing the maximum reverse current is not exceeded, the diode will recover from the avalanche region. Since the zener diodes can be constructed to present different reverse voltage break-down levels, they provide very useful voltage references.

For our purposes, the characteristics outlined so far are the most important but it must be borne in mind that these parameters can be influenced by other factors, particularly temperature. Typical limits are usually specified for a given working temperature (often 25 degrees C). Temperature variations caused by power dissipation or environmental conditions may cause these voltage and current parameters to change. The effects of this can be minimised by operating diodes well within the working limits especially the current limits. Table 1 lists the basic specifications of some common diodes.

TYPE	If MAX	PIV
IN4148	85mA	75V
IN4001	IA	50V
IN4002	IA	100V
OA202	80mA	150V
IN5401	3A	100V

Table 1a. Some common diodes.

TYPE	VOLTAGE RANGE	POWER
BZY88 SERIES	2·7–15V	500mW
BZX85 SERIES	2·7–6·8V	1.3W
BZX88 SERIES	7·5–72V	1·3W

Table 1b. Some common zeners.

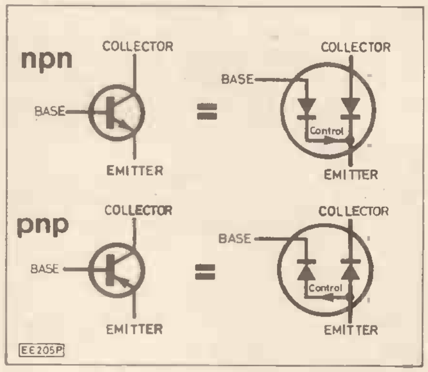


Fig. 3. Transistor action.

Another semiconductor device used in regulator circuits is the transistor. These devices have a variety of applications which will be described in a forthcoming article in this series. In the mean time we will take a look at the basic characteristics of two types of transistor and try to explain their operation in terms of diode action.

Fig. 3 illustrates the circuit symbol and schematic constructional details of the bipolar *npn* and *pnp* transistor. To make use of these devices it is not neccesary to have an in-depth understanding of their construction but merely to know their limits of operation.

For our purposes, transistors may be considered as two diodes connected anode-to-anode or cathode-to-cathode and these are called *pnp* and *npn* types respectively. This gives us three terminals: base, emitter and collector. If we consider the base-emitter diode as a control device for the collector-emitter diode then the operation should be fairly easy to grasp.

The base-emitter diode must be forward biased to allow the collector-emitter diode to pass current. Only a relatively small base current is required to allow a large collector current to flow. The relationship between these two currents is called the current gain (h_{fe}) of the transistor. In fact transistor characteristics are much more complicated than this but this explanation will do for now. Some typical transistor characteristics are shown in Table 2.

TYPE	CONSTRUCTION	Pt	Ic	Vce	Vcb	h_{fe}	Ft
BC107	*npn*	360mW	100mA	45V	50V	110–450	250MHz
BC108	*npn*	360mW	100mA	20V	30V	110–800	250MHz
BC109	*npn*	360mW	100mA	20V	30V	200–800	250MHz
BC212	*pnp*	300mW	−200mA	−50V	−60V	60–300	200MHz
BC213	*pnp*	300mW	−200mA	−30V	−45V	80–400	350MHz
BC478	*pnp*	360mW	−150mA	−40V	−40V	110–800	150MHz
BFY51	*npn*	800mW	1A	30V	60V	40	50MHz
2N3905	*pnp*	310mW	−200mA	−40V	−40V	50+	150MHz

Pt=Total power which may be dissipated by the transistor
Ic=Maximum collector current
Vce=Maximum potential across collector—emitter junction
Vcb=Maximum potential across collector—base junction
hfe=Typical range of current gain
Ft=Maximum frequency of operation (switching)

Table 2. Some common transistor characteristics.

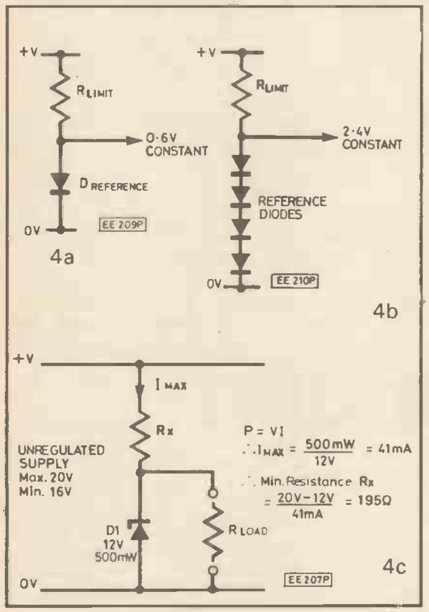


Fig. 4. Diode voltage references.

BUILDING

Now that some of the very basic concepts of semiconductors have been established we can now build on these to provide some practical designs for voltage reference *building blocks*.

Fig. 4 shows how diodes may be used to give us a fixed voltage which is tolerant to a wide range of supply voltages.

In Fig. 4a an ordinary diode is forward biassed via a currrent limiting resistor to give a potential of 0·6V with respect to 0V. (Remember most silicon diodes require around 0·6V to conduct.) The limiting resistor should limit the current to well below the maximum current specified for the diode. Suppose the supply voltage is likely to vary from 8V to 12V then we would expect the voltage across the limiting resistor to vary between (12V–0·6V) and (8V–0·6V). This gives us between 11·4V and 7·4V across the resistor. Now if the diode had a maximum forward current of say 200mA then the resistor should be greater than: 11·4V/0·2A = 57 ohms.

In Fig. 4b there are four diodes connected in series to provide a reference of around 2·4V. Any number of diodes may be connected this way to provide a range of references to suit. Obviously this may be impractical, but nevertheless useful to remember.

Fig. 4c shows a zener diode reverse biassed to provide a 12V reference from a 20V unregulated supply. The principle of the calculations required to work out an appropriate limiting resistor value are exactly the same as for the ordinary diode.

However, as can be seen from Table 1, zener diodes are usually specified as having maximum power dissipations rather than maximum currents. So suppose a zener is described as a 6·3V device with a max power rating of 500mW. Then since power (P) = VI watts, the maximum current is 500mW/6·3V = 70mA. Therefore the limiting resistor for a 12V supply should be greater than (12–6·3V)/0·07A = 81 ohms.

CONSIDERING THE LOAD

The basic voltage references we have discussed so far are limited in use. This is due to the variations in load which we expect to operate. If we consider the circuit of Fig. 4c where a simple zener circuit is used to provide a constant supply of 12V then it is easy to show its limitations.

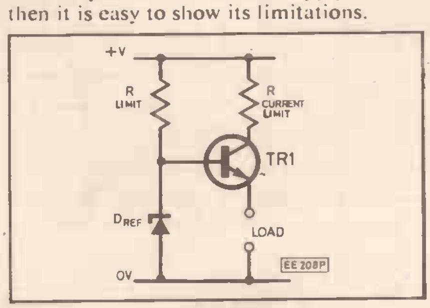


Fig. 5. Simple transistor regulator.

Suppose we have chosen a limiting resistor of 200 ohms and the load resistance requires a maximum current of 10mA at 12V. Now the limiting resistor has to pass current to keep the diode in its zener region plus 10mA to supply the load. In this case all is well as a current of 10mA through 200 ohms will only cause a voltage drop of 2V. Even under worst case situations when the supply to the circuit has dropped to 16V there is still enough current to keep the diode biassed to its zener region.

However, now let us consider the circuit has to supply a maximum current of 100mA. This will cause a drop across RX of 0·1 × 200 =20V. Obviously this is unacceptable as even under ideal conditions when the supply is at 20V the load cannot be operated.

INCREASING CURRENT CAPABILITY

To overcome the problem outlined above, a transistor can be introduced into the circuit which can supply the extra current and still maintain the correct voltage. The circuit of Fig. 5 shows how this may be achieved. A voltage reference is fed to the base of TR1 which causes the base-emitter junction to be forward biassed when a load is connected. The base current need only be very small to maintain this condition as the collector-emitter "diode" will supply the necessary currrent to operate the load.

When using circuits of this type, a high gain transistor should be used which is of the correct current and power rating. Table 3 shows how transistors are normally specified in data sheets, giving various current limits such as collector current Ic, and voltage ratings such as base-emitter voltage, Vbe. More of this will be explained when we look at our constructional project for this month.

INTEGRATED CIRCUITS

Although useful and indeed practical design ideas, the simple constant voltage regulators described so far are still less than adequate for supplying many circuits. Much more complicated configurations employing such techniques as spike rejection, overload protection and thermal compensation are available. In most cases however it is not necessary to design these types of circuits as they are available in integrated circuit form.

A few of the available voltage regulator i.c.s are listed in Table 3 and Fig. 6 shows their pin-out details together with some standard methods of utilising them. It should be noted that most regulator i.c.s. require a heat sink to enable them to be used to their full capacity.

FORMULAE

Electronics can be a very complicated subject to study, but by applying some basic rules you should be able to make your way round many circuits without too much difficulty. From what we have discussed so far, you should be able to design some basic power supplies using only some very simple formulas. These are summarised in Table 4.

When applying these simple rules and formulae, remember to always consider "worstcase" situations, ie when is the current greatest or when is the volt-drop greatest.

From Ohms Law:

$$V = IR :- I = \frac{V}{R} :- R = \frac{V}{I}$$

The power dissipated in a d.c. circuit is given by:

$$P = VI :- V = \frac{P}{I} :- I = \frac{P}{V}$$

Table 4. Formulae.

TYPE	OUTPUT VOLTAGE	O/P SHORT CIRCUIT CURRENT	I/P VOLTAGE RANGE
7805	+5V	750mA	7–25V
7812	+12V	350mA	14·5–30V
7815	+15V	230mA	17·5–30V
7824	+24V	150mA	27–38V
7905	–5V	750mA	–7–25V
7912	–12V	350mA	–14·5–30V
7915	–15V	230mA	–17·5–30V
7924	–24V	150mA	–27–38V

Table 3. Voltage regulator characteristics (78 and 79 series).

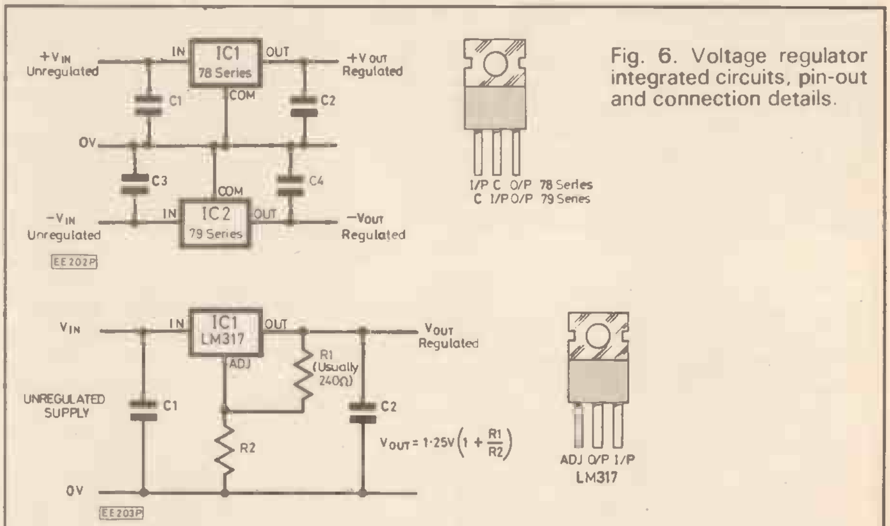


Fig. 6. Voltage regulator integrated circuits, pin-out and connection details.

VOLTAGE REGULATOR UNIT

This month's constructional project is a useful voltage regulator board which may be used in conjunction with last month's project to supply a range of voltages suitable for many other devices. Both discrete components and integrated circuits are used to give a variable plus and minus supply as well as a fixed 5V supply suitable for driving TTL and CMOS i.c.s.

CIRCUIT OPERATION

The circuit operation (Fig. 7) is fairly straightforward once the principles mentioned so far have been understood. The 5V supply uses a 7805 i.c. in its standard configuration and the positive variable supply uses a common LM317 i.c. The LM317 generates its own internal voltage reference which may be adjusted via a couple of external resistors. R1 and VR1.

The 7805, a fixed regulator, needs only a couple of external capacitors which help to provide added ripple protection and good regulation. Like the LM317 this i.c. is designed to provide internal overload, thermal and short circuit protection. These characteristics makes them both very easy and convenient to use. They are also both fairly inexpensive.

NEGATIVE SUPPLY

The negative voltage reference is obtained from a zenor diode connected between 0V and the negative rail of the unregulated supply. A variable resistor, VR2, is connected across the voltage reference and its centre tap is used to provide a variable reference of between 0 and 7·3V which is fed to the base of TR1. TR1 and TR2 are connected in the Darlington configuration which produces a high current gain.

If a load is connected the emitter-collector junctions of the two transistors become forward biassed and are able to supply sufficient current to drive the load. At all times the voltage at the emitter of TR2 remains constant as it is controlled by the volt drop across the base-emitter junctions of TR1 and TR2. In this case the output voltage will always be 1·2 (0·6 × 2) volts more positive than the voltage at the centre tap of VR2. R3 provides some degree of over current or short circuit protection.

DEVICE CONSIDERATION

IC1 and IC2 were chosen because of their proven reliability and ease of use. Both devices can safely supply an output current in excess of 500mA but under these conditions would require a heat sink due to the large power dissipation. Since this regulator board is only expected to supply around 300mA, heat sinks are not necessary.

In the variable output configuration used here the output voltage of the LM317 is given by:

$$V_{out} = 1{\cdot}25V\,(1+R2/R1) + I_{adj}\,R2$$

Using the values of R1 and R2 as shown, this would give an output voltage up to about 13V. However using the power supply from Part One limits this to around 8·5V in practice.

COMPONENTS

Resistors

R1	270
R2	100
R3	15 1 Watt

Capacitors

C1–C3	1μ tant. bead (3 off)
C4	10μ tant. bead

Semiconductors

D1	7V3 200mW zener
TR1	BC179
TR2	2N3905
IC1	LM 317 voltage reg.
IC2	7805 voltage reg.

Miscellaneous

VR1	2k5 p.c.b. mounted pot.
VR2	10k p.c.b. mounted pot.

4mm sockets (4 off); wire; solder, etc.

Approx. cost Guidance only **£4.50**

If this board is going to be used with other power supplies to provide a greater voltage and current range, then a heat sink may be required. In this case it is necessary to know the power likely to be dissipated by the regulator. This can be found by the formula:

Power dissipation (P) = (Vin – Vout) × Iout.

POWER DISSIPATION

The zener diode used in this circuit is specified as being a 200mW, 7·3V device. Since the input to the regulator circuit is about 9V max, the voltage across R2 will be 1·7V max. This gives us a current of 17mA, therefore the power dissipated by D1 will be (7·3V × 17mA) 124mW maximum which is well within limits.

The output current from the zener reference will be small as it flows through a resistance of 10 kilohms (VR2). Although some current flows into the base of TR1 it can be ignored as it is negligible.

TR1 and TR2 are connected in the Darlington configuration to provide a large current gain (TR1 gain × TR2 gain). Whatever current is provided by this transistor pair, the output voltage remains the same, between 0V and 6·5V.

Most of the current to the output is supplied by TR2 which means that most of the power in this part of the circuit is dissipated by TR2. R3 is included to give some protection against over current conditions. It can be seen that if the output is say 6V then there will be about 2V dropped across R3. This will give a maximum current of (2V/15Ω) 133mA. If the circuit draws more current, the voltage drop across R3 will increase thus protecting the output transistor from being overheated.

The voltage and currents specified for TR2 are well within the limits of this circuit but a heat sink may be required.

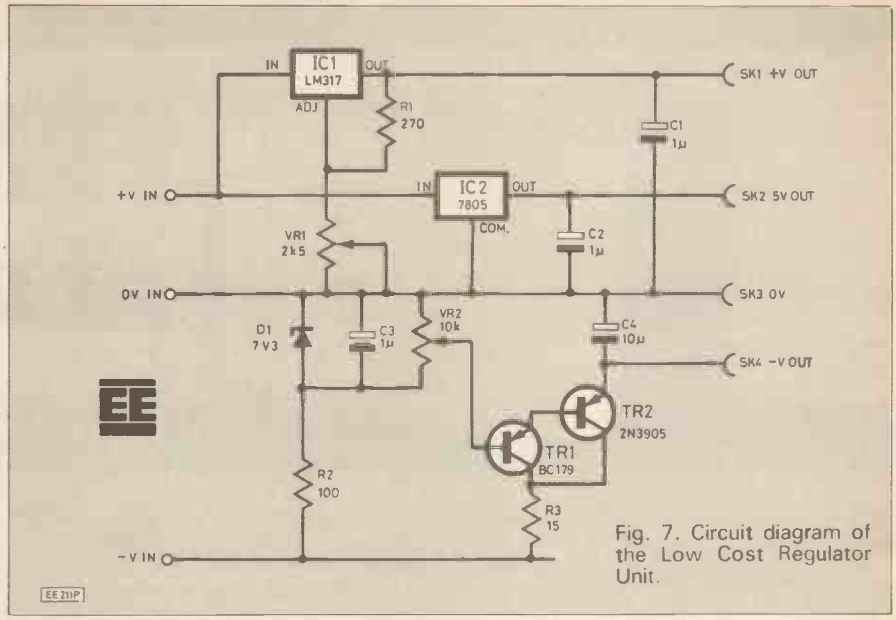


Fig. 7. Circuit diagram of the Low Cost Regulator Unit.

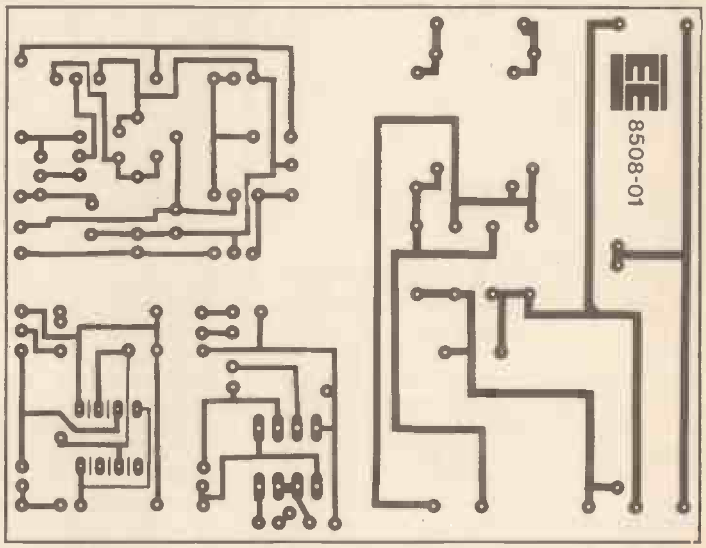


Fig. 8. P.c.b. design for four separate projects.

CONSTRUCTION

All of the components for this circuit are mounted on a small p.c.b. which is shown in Fig. 9. This p.c.b. is obtainable from the EE p.c.b. service and is part of a single board (Fig. 8) containing four different circuits. All you have to do is carefully cut off the board you require. This idea means that the p.c.b. for each project in this series is very cheap.

As with all p.c.b construction it is best to mount the smallest components first. The integrated circuits and transistors should be fitted last. All the input and output wires should be connected to p.c.b. pins to make a neater job. The outputs are terminated on 4mm sockets and should be labelled, 0V, 5V +V and –V.

VR1 and VR2 are p.c.b. mounted devices which makes it very easy to mount the circuit in a suitable box. If you are using it in conjunction with the project from Part One there is plenty of room in the case for this and other circuits which will be described in other parts.

See Shop Talk page 477

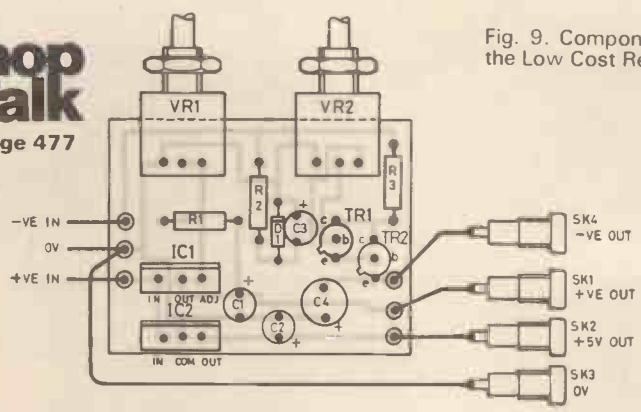


Fig. 9. Component layout of the Low Cost Regulator Unit.

Photo illustrating the Low Cost Regulator Unit p.c.b. assembly which may easily be added to the PSU of Part One.

NEXT MONTH: We shall take a look at one of the most common building blocks used in electronics, the oscillator. The constructional project will be a simple audio signal generator.

FRIDGE ALARM

R.A.PENFOLD

MOST refrigerators have a form of door latch which usually fully closes the door once it is almost closed, but this does not always happen, and the door can sometimes be left slightly ajar. This results in wasted power as the refrigeration mechanism tries to cool the flow of air into the refigerator, and of more importance, it can result in the interior temperature rising well above its normal level if the refrigeration mechanism is unable to cope with this inflow of air. This is not necessarily a disastrous situation, but it is certainly an undesirable one, especially if a long time passes before it is noticed and rectified.

This alarm is designed to prevent the door of a refrigerator from being accidentally left open for more than a minute or so. It is a form of light operated switch which is completely self contained and is merely placed in any convenient position inside the refrigerator. With the door closed the unit is in darkness and goes into its inactive state. In this mode the current consumption is extremely low, being typically only about one microamp. This is very important as the unit must operate continuously in a low temperature from a battery supply, and a negligible current consumption is essential if a reasonably long battery life is to be obtained. The battery should, in fact, have virtually its shelf life, and should only need to be replaced about two or three times a year.

The unit is activated by even quite low light levels. Many refrigerators have an internal light which is operated by a microswitch and is automatically switched on when the door is open. This should provide considerably more than an adequate light level to activate the alarm, and the precise position of the unit within the refrigerator should not be too critical. Not all refrigerators have an automatic light, and with those that do not the positioning of the alarm is somewhat more critical since there is only light entering the fridge through the partially open door to activate the unit. However, the high sensitivity of the light detector circuit helps to avoid having things excessively critical in this respect.

A straightforward light activated alarm would be usable, but it would have the disadvantage of triggering every time the refrigerator door was opened. This is avoided by incorporating a delay circuit which prevents the alarm from being sounded for around 1·5 minutes after the unit is activated. If the door is closed within this time the delay circuit is reset over a period of a minute or so, so that the full delay is obtained next time the door is opened. It might occasionally happen that the door will be intentionally left open for more than the delay period, and the alarm will obviously then be operated. The alarm can either be ignored and allowed to reset itself once the door is closed again, or to save on battery consumption (and one's nerves) the unit can be manually reset using the reset button. The alarm sound is a simple audio tone generated by a ceramic resonator, which should be perfectly satisfactory for this application.

SYSTEM OPERATION

The basic manner in which the unit functions is quite easy to understand, and the block diagram of Fig. 1 should help to explain the way in which it operates.

Obviously the first stage of the unit is a light detector, and as explained previously this must offer high sensitivity. One consequence of this high sensitivity is a high output impedance with inadequate drive current to operate the delay circuit properly. This is overcome by incorporating a buffer stage which gives a high level of current gain and enables the delay circuit to be driven properly even under quite low light levels. The delay circuit itself is just a CR type. This is used to operate an audio oscillator when the charge voltage exceeds a certain level. In order to ensure reliable gating of the oscillator a high gain amplifier is used to give a "sharper" control signal to the oscillator.

The oscillator does not have a high drive current available, and could not drive a normal loudspeaker properly (even a high impedance type). It is used to drive a ceramic resonator which generates a reasonably loud tone from the limited available drive current of only about two milliamps.

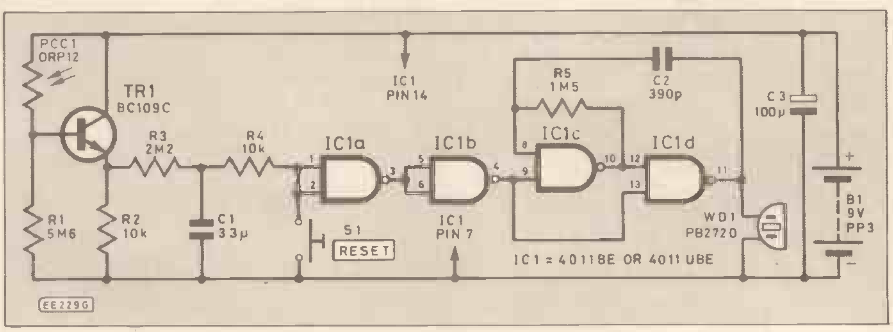


Fig. 2. Complete circuit diagram.

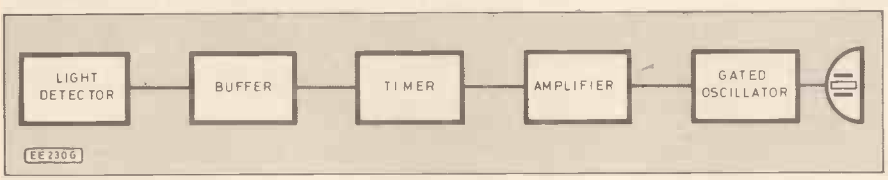


Fig. 1. Block diagram of the Fridge Alarm.

CIRCUIT OPERATION

The full circuit diagram of the unit is shown in Fig. 2; this is based on a CMOS 4011 quad two input NAND gate. Both the 4011BE (buffered) and 4011UBE (unbuffered) versions are suitable for this circuit.

Starting with the light detector circuit, a cadmium sulphide photoresistor PCC1 is connected to R1 to form a potential divider circuit. Under dark conditions PCC1 exhibits a resistance of many megohms, giving a very low output voltage from the potential divider circuit. The resistance of PCC1 falls in response to an increasing light level, and under a reasonable light level it will have a resistance of one megohm or less, giving an output voltage from the divider circuit which is something approaching the full supply potential. Resistor R1 has been given a high value in order to give the circuit good sensitivity.

The buffer amplifier consists of emitter follower TR1 and its load resistor R2. With PCC1 in darkness the input voltage to the base of TR1 will be so low that this device will be cut off, and only minute leakage currents will flow through it. This is an important point as it ensures that the buffer amplifier provides an insignificant contribution to the circuit's current consumption under stand-by conditions. The very high resistance through PCC1 and R1 results in the light detector circuit also having an insignificant current consumption of only about one microamp.

Resistor R3 and C1 form the CR delay circuit. When the output from TR1 switches to the high state, C1 starts to charge via R3. The voltage across C1 rises exponentially rather than in a linear manner. In other words, as the voltage across C1 rises, the voltage across R1 decreases, giving a lower charge current and a slower rise in voltage.

It takes 5CR seconds for the charge voltage to reach more than 99 per cent of the input voltage, but only about 1CR seconds for it to reach approximately two thirds of the input voltage. In this case the charge voltage must reach typically a little under two thirds of the supply voltage in order to activate the alarm. With the specified values this results in a delay of about one minute or so, but in practice the precise delay obtained will vary somewhat from one unit to another due to component tolerances. Obviously the exact delay is not too important in this application, but if necessary it can be altered by using a different value for R3. The length of the delay is proportional to the value of this component.

It is necessary to use a tantalum bead capacitor for C1 as this type generally has a much lower leakage level than an ordinary electrolytic of the same value. A low leakage current is essential in this case as the charge current is very low. Anything other than a very low leakage level would result in all the charge current leaking away and a charge potential equal to the trigger voltage would never be reached.

Two gates of IC1 (IC1a and IC1b) connected in series are used as the amplifier.

Both gates have their two inputs connected together so that they function as simple inverters. The output of IC1b is normally low, but when the charge on C1 reaches the transition voltage of the inverters (about half to two thirds of the supply voltage) the output of IC1b changes from the low state to the high one in just a fraction of a second. The high combined gain of IC1a and IC1b of around 2500 times ensures that a fast transition is obtained despite the very slow rate of change at the input. Resistor R4 is a protection resistor for the input of IC1a, and S1 is the reset switch. When operated, the latter discharges C1 by way of R4 which then protects S1 against an excessive current flow and contact sparking.

The oscillator is built around IC1c and IC1d, and this is virtually a conventional CMOS astable circuit. It differs from the standard configuration only in that a control signal is applied to one input of each gate, while the other input of each device is used to give an inverter action. The output of a NAND gate is low when both inputs are high, but is high if one or both of the inputs are low. This means that taking one input of each gate low ensures that the outputs must go high, and operation of the oscillator is blocked. However, when the contol inputs are taken high, the output state of each gate is controlled by the other input, and oscillation is enabled. Thus the alarm sounds when the output of IC1b goes high.

The PB2720 ceramic resonator is a piezoelectric device which offers high efficiency at frequencies of around 2kHz to 4kHz. The alarm sound should be sufficiently loud for this application, but if desired the value of C2 can be altered to obtain the frequency which gives optimum efficiency and volume from WD1.

The choice of a CMOS device as the basis of this circuit was not an arbitrary one, CMOS devices have the advantage of a very low quiescent current consumption. In fact, the quiescent current drain of the 4011 is negligible. The current consumption will rise substantially when the refrigerator door is opened and the photocell circuit is activated, and it will rise further if the alarm switches on, but the current drain never exceeds more than about four milliamps.

CONSTRUCTION

Start construction by cutting out a 0·1in.

COMPONENTS

Resistors

R1	5M6
R2,4	10k (2 off)
R3	2M2
R5	1M5

All ¼W 5% carbon film

Capacitors

C1	33µ 10V tantalum bead
C2	390p ceramic
C3	100µ10V axial elect.

Semiconductors

IC1	4011UBE or 4011BE CMOS quad 2 input NAND gate
TR1	BC109C

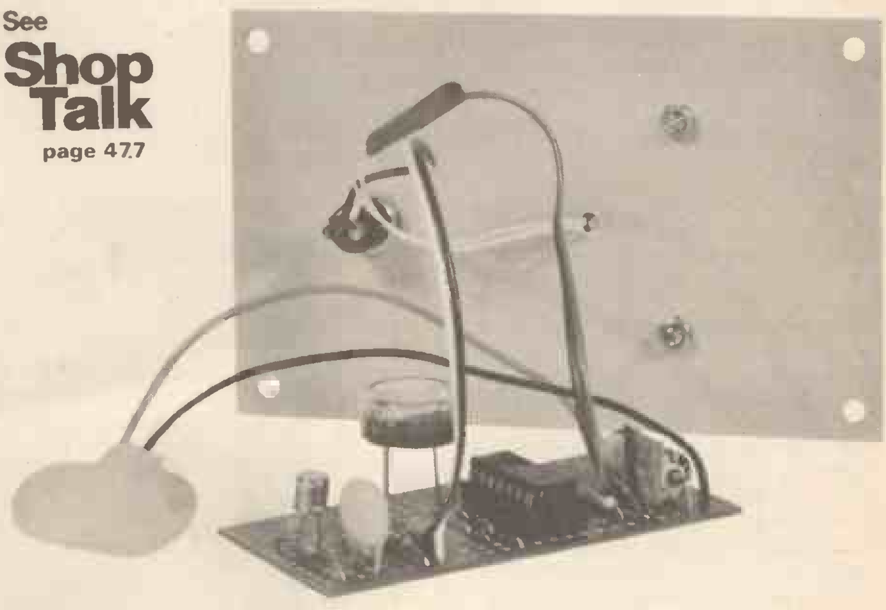
Miscellaneous

PCC1	ORP12 light dependent resistor
WD1	PB2720 ceramic resonator—available from Cirkit, 43-27203
B1	9 volt battery (PP3 size)
S1	Push to make/release to break switch

0·1 inch matrix stripboard, 26 holes by 13 copper strips; case about 107 by 66 by 39mm; battery connector; 14 pin d.i.l. i.c. holder; wire; solder; fixings; etc.

Approx. cost Guidance only **£7.50**

See **Shop Talk** page 477



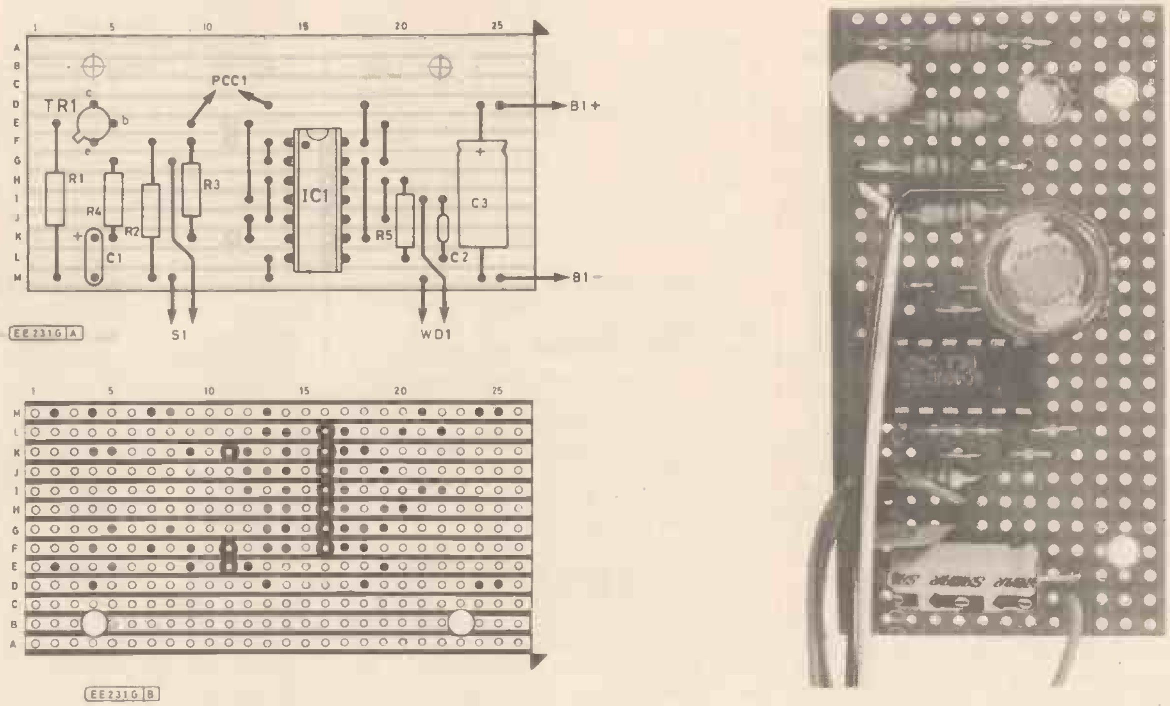


Fig. 3. Veroboard layout and wiring for the Fridge Alarm.

pitch stripboard having 26 holes by 13 copper strips. File any rough edges to a smooth finish and then make the cuts in the copper strips, as detailed in Fig. 3. The cuts can be made using either a special tool or a small hand-held drill bit. If the unit is not to be housed in the specified case the two 3·2 millimetre diameter mounting holes should also be drilled at this stage. These holes are not required if the board is fitted in the specified case.

As IC1 is a CMOS device it requires the normal antistatic handling precautions. It should be fitted in a 14 pin d.i.l. integrated circuit holder, but it should not be plugged into the holder until all the other components and the link wires have been soldered into place. It should be left in the antistatic packaging until then, and handled as little as possible when it is being plugged into the holder. Do not overlook any of the link wires—there are nine in all. Light dependent resistor PCC1 should be left with long leadout wires (about 20 millimetres long).

It is advisable to use the specified case for this project as it has printed circuit guide rails into which the component panel will slide. The case is a plastic type with a metal front panel and approximate outside dimensions of 107 by 66 by 39 millimetres. The component panel fits into the second set of vertical guide rails counting from the left hand end of the case. The component side of the board faces towards the left hand end of the case, and a hole about 10 to 12 millimetres in diameter is drilled adjacent to PCC1 to enable light to pass through to it. If a different case is used the component panel must be bolted in place using M3 or 6BA fixings. The board should be positioned so that PCC1 is close to the "window" drilled in the case.

Switch S1 and WD1 are mounted on the front panel, WD1 requires two short 8BA mounting bolts plus fixing nuts. Apart from the holes for these, a third small hole is needed in the front panel to enable the leadout wires of WD1 to pass through to the interior of the case. Alternatively, WD1 can be mounted behind the front panel, but this is a more difficult way of doing things as a large (30 millimetre diameter) cut out is then needed to accommodate the front plate of WD1.

The unit is completed by wiring S1, WD1, and the battery clip to the component panel, as shown in Fig. 3. It is likely that the leadout wires of WD1 will prove to be slightly too short, and extension leads must then be fitted. However, use some insulation tape or pieces of sleeving over the connections to make quite certain that they do not accidentally short circuit.

TESTING

As an initial test the unit can simply be left in dimly lit room, and the alarm should operate after very roughly one minute. Placing the unit in darkness should result in the alarm cutting off again. Check the reset button by bringing the unit back into the light and pressing S1 once the alarm starts operating again.

It is a good idea to check that the quiescent current consumption of the unit (i.e. the current consumption with PCC1 in darkness) is no more than a few microamps. In the unlikely event of the current consumption being rather on the high side a cure should be effected by reducing the value of R1 to 1 megohm. This should only be done if an excessive stand-by current consumption is detected as it would otherwise unnecessarily reduce the sensitivity of the unit.

There should be no difficulty in finding a suitable position for the unit inside the refrigerator. In the case of one which does not have an interior light PCC1 must obviously be aimed towards the door opening. □

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components.
Price per parcel is £1.00, but if you order 12 you get one extra free, except those marked 's.h'

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 25 13 amp fuses for ring mains
4 – 5 surface mounting switches suitable insulated for mains voltage
5 – 3 flush electrical switches intermediate type, will also replace 1 or 2 way switches
6 – 5 in flex line switches
7 – 4 in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6v 1a secondaries
10 – 2 mains transformers with 12v ½a secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
15 – 25 assorted germanium transistors OC45 etc
16 – 4 tape heads, 2 record, 2 erase
17 – 2 ultra sonic transmitters and 2 ditto receivers
18 – 2 15000 mfd computer grade electrolitics
19 – 2 light dependent resistors similar ORP12
20 – 5 diff micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units
23 – 1 40 watt 3 way crossover unit
24 – 250 various screws and self tappers
25 – 1 of each wafer switches – 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC in flight stereo unit (second hand)
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of ICI Dry Lubricant
34 – 96 x 1 metre lengths colour-coded connecting wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 x 465 KC IF transformers
41 – 8 Rocker Switches 10 amp Mains SPST
42 – 6 Rocker Switches 10 amp Mains SPOT
43 – 5 Rocker Switches 10 amp SPOT Centre Off
44 – 4 Rocker Switches 10 amp DPOT
45 – 1 24 hour time switch mains operated – (s.h.)
46 – 1 6 hour clockwork timeswitch
47 – 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12v OC or 24V AC 4CO relays
51 – 1 x 12v 2C O very sensitive relay
52 – 1 x 12v 4C O relay
53 – 2 mains operated relays 3 x 8 amp changeovers (secondhand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism with 2 keys)
56 – Miniature Uniselector with circuit for electric jigsaw puzzle
57 – 5 Dolls' House switches
58 – 2 telephone hand sets incorporating ear piece and mike (s.h)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 ohm earpieces
63 – 1 Mullard Thyristor trigger and modules
64 – 10 assorted knobs ¼ spindles
65 – 5 different thermostats, mainly bi-metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
68 – Heavy duty 4 pole contactor – 24v coil
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 4 wire wound pots – 18, 33, 50, and 100 ohm
72 – 1 1250 watt dimmer Ultra ref SE20
73 – 4 3 watt wire wound pots 50 ohm
74 – 50 1/3 watt carbon film resistors good spread 10 values
75 – 20 2 watt carbon resistors 10 values
76 – 30 1 watt carbon resistors 15 diff values
77 – 1 time reminder adjustable 1-60 mins
78 – 5.5 amp stud rectifiers 400V
79 – 4 2a bridge rectifiers 400V
80 – 2 10a bridge rectifiers 30V
81 – 2 30a panel mounting slydlok fuses
82 – 4 porcelain fuse holders and fuses
83 – 1 fluorescent choke – your choice – 15, 20, 30, 40 or 65w watt
84 – 10 - .1 mains voltage suppressor condensors
85 – 1 mains shaded ple motor ¾" stack – ¼ shaft
86 – 2 5" ali fan blades fit ¼" shaft
87 – 2 3" plastic fan blades fit ¼" shaft
88 – Mains motor suitable for above blades
89 – 1 mains motor with gear box 1 rev per 24 hours
90 – 1 mains motor with gear box 1 rev per 12 hours
91 – 2 mains motor with gear box 16 rpm
92 – 4 fluorescent starters suit 4 – 80 w tubes
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
97 – 1 infra red fire element 1000 watts
98 – 1 motorised stud switch (SH)
99 – 5 assorted ferrite shapes
100 – 3 ferrite magnets
101 – 1 2½ hours delay switch
102 – 1 9v mains power supply unit
103 – 1 6v mains power supply unit
104 – 1 4½v mains power supply unit
105 – 1 5 pin flex plug and panel socket
106 – 1 12v vibrating reed bleepers
107 – 5" speaker size radio cabinet with handle
108 – 5 different multi way push switches
109 – 10 ¼" spindle type volume controls
110 – 10 slider type volume controls
111 – 2 musical boxes (less keys)
112 – 1 heating pad 200 watts
113 – 1 fm front end with tuning condensor and data
114 – 1 1w amplifier Mullard 1172
115 – Wall mounting thermostat 24v
116 – 3 pairs small 2prs. medium croc clips
117 – 4 pairs large (car size) crocodile clips
118 – Teak effect extension 5" speaker cabinet
119 – 1 log & 1 coal fibreglass fire fronts
120 – p.c.b. with 2 amp full wave and and 7 other recs.
121 – 2 – 13 amp flush switched sockets
122 – 10 mtrs twin screened flex white p.v.c. outer
123 – 100 plastic with hardened pin flex clips
124 – 10 assorted slide switches

SOUND TO LIGHT UNIT

Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

CAR STARTER/CHARGER KIT Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00. post paid.

4/5A BATTERY CHARGER Transformer and rectifier £3.95 & £1 post, 3 kits £12.

WALL MOUNTING ROOM THERMOSTAT

By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 – 30 c – 13 amp 250v contacts. Price £4.60. – 10 for £40.

EX-G.P.O. TELEPHONES

Black heavy type	£5.50
Lightweight 746 type	£7.50
Ex-G.P.O. plug	£1.00
Ex-G.P.O. socket	£1.00

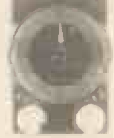
PRESTEL UNITS

These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input)

By LAMOA (USA) Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% load regulation 1% from no load to full load or full load to no load. Complete in heavy duty case Models available 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER



Learn in your sleep: Have radio playing and kettle boiling as you wake switch on lights to ward off intruders have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING

if you use our disco switch ONLY £6.90

These have 12 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc. etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost.

COMPUTER DESKS

Again available Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only £9.50 – you must collect – hundreds supplied to schools.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

- 1 Framco motor with gear box
- 1 manual reversing & on/off switch
- 1 push to start switch
- 2 limit stop switches
- 1 circuit diag. of connections

£19.50 plus postage £2.50

J. BULL (Electrical) Ltd.

(Dept. EE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU. Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote. Shop open 9.00 – 5.30, Mon to Fri, not Saturday.

VENNER TIME SWITCH

Ex-Electricity Board. Guaranteed 12 months.

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. without case, metal case - £2.95, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

EXTRACTOR FANS – MAINS OPERATED

Woods extractor.
5" – £5.75, Post £1.25.
6" – £6.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 3Kw £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £2

Still available: £4.95 + £1.50 post. or have 3 for £16 post paid

ROCKER SWITCHES Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each – 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT 15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

THE AMSTRAD STEREO TUNER

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

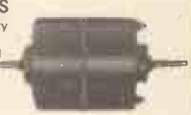
Some of the features are: long wave band 115 – 170 KHz, medium wave band 525 – 1650 KHz, FM band 87 – 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board

Offered at a fraction of its cost: only £5.75 + £1.50 post + insurance

MINIATURE WAFER SWITCHES

2 pole, 2 way – 4 pole, 2 way – 3 pole, 3 way – 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole, 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS



Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle –
1/10 hp £3.45
1/8 hp £5.75 1/6 hp £7.50

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.

£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

R C Bridge Kit	£9.95
3 Channel Sound to Light – with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch – fools friends and enemies alike	£1.95
3 – 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Radio stethoscope – fault finding aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit – for surveillance or normal F M	£3.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – hifi 20hz – 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50

CONSUMER ELECTRONICS SHOW *Chicago...*

Rik Hooper takes a look behind the scenes at one of America's foremost exhibitions.

THE 1985 International Summer Consumer Electronics Show, held in Chicago from 2–5 June was the most heavily attended event in CES history. The summer show, like its winter counterpart in Las Vegas, is sponsored, produced and managed by the Electronic Industries Association's Consumer Electronics Group.

Over 1,300 exhibitors occupied more than 750,000 net square feet of floor space at McCormick Place, McCormick West, and the McCormick Center, Americana Congress and Blackstone Hotels. Exhibiting companies represented the full range of electronic categories; including audio equipment; video hardware, blank tape and prerecorded video; personal computer hardware and software for the home; telephones; satellite earth stations; accessories, and personal electronics items such as calculators and watches.

Attendance at the show was around 115,000 which eclipsed the 98,271 recorded last summer. Approximately two-thirds of these visitors were retailers who visited the giant exhibition to view the latest available technology, and make buying commitments for the remainder of the year.

PERSONAL CHOICE

As with past Consumer Electronics Shows, the computer companies were launching their latest products into the marketplace, and in particular computers for the 128K market.

On the opening day of the show Amstrad Consumer Electronics introduced its new 128K personal computer, which Chairman Alan Sugar predicted "will revitalise the home/office segment of the lagging personal computer market in the US, by offering true PC power and capability at a price the public can afford.

"Amstrad's CPC6128 has all the power of an Apple II, at as little as half the price," asserted Sugar, who was named as 1984 "Young Businessman of the Year" in the UK.

"Considering its power and low price, the CPC6128 fills a unique niche. It is the first personal computer with the capabilities for business, home, educational and entertainment use, at a price that makes sense to the consumer."

Amstrad brought out its first computer, the CPC464 in June 1984. Some 200,000 of these 64K machines were sold worldwide by the year's end, paving the way for the CPC664 introduced last April, and the powerful new 128K model. According to Amstrad US, the 128K model will be released into the UK market in the early part of next year.

The CPC6128 comes in two package configurations. Both include 128K RAM memory, CP/M and AMDOS operating systems, Basic and Logo operating languages, a built-in 3-inch disc drive, and a bundled monitor—one system includes a high resolution 640 × 200 full colour RGB monitor, operating software, Amstrad's word processor, and entertainment software. The alternative system includes an 80-column monochrome green monitor with operating software and Wordstar word processor.

Commodore International displayed its full range of computer products and services now being marketed in dozens of countries around the globe. Commodore Business Machines, the US company, was showing the Commodore 128 personal computer, which it began shipping at the end of last month (July).

The 128 PC is a sophisticated system forecast to sell at £260. In addition, the 128 is fully compatible with peripherals and software

① ***The Model Ku/C-6000 ten channel satellite receiver from Panasonic.***

② ***The Sony WatchCam home security monitor system.***

③ ***The new Amstrad CPC6128 128K personal computer, with built-in disc drive.***

④ ⑤ ***Latest audio/video amplifier, SA-V1160, and digital synthesiser audio/video receiver SX-V500, from Pioneer.***

⑥ ***The Fisher ICS713S features a dual cassette deck and five band equaliser.***

⑦ ***The 128K Commodore 128 PC is expandable to 512K and is shown here with separate disc drive, colour monitor and two-button mouse.***

⑧ ***Home video system from Polaroid uses 8mm Supercolor video cassettes.***

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developed for the top selling Commodore 64, which is now owned by more than 4·5 million people worldwide.

The 128 PC incorporates two microprocessors, allowing it to run software in the 64 and 128K modes, in addition to the many programs written in CP/M language. This capability combined with 128's memory, expandable to 512K, allows the user to generate integrated business programs.

The contemporary styling of the Commodore 128 features a 92-key typewriter keyboard with a 14-key numeric pad for fast accurate number crunching. For added user friendliness, the 128 offers eight programmable function keys, six individual cursor keys for graphics and text manipulation, and a 'help' key that lists programming errors in reverse field.

AUDIO/VIDEO ROUND-UP

There was a strong showing by the audio/video manufacturers—spearheaded by Pioneer which introduced more than 60 new products. "This is by far the most exciting year ever for Pioneer," explained Jack Doyle, Pioneer's Chairman of the Board. "The scope and range of our new offerings demonstrate our commitment to providing the consumer with high-quality, high-value products that reflect the real needs of people today".

Two integrated amplifiers were unveiled by Pioneer, the high-end SA-V1160 and SA-960, rated at 100 and 70 watts per channel, respectively. The SA-V1160 is a Type 11, non-switching, low distortion amplifier featuring Pioneer's dynamic power supply. It has two video inputs, video dubbing capability, two r.f. inputs/outputs, two tape monitors and what is claimed to be a unique dynamic expansion circuit.

Matching the amplifiers are two new digital tuners, the state-of-the-art TX-V1160 featuring a.m., f.m., and TV tuning sections. It offers 24 a.m./f.m. and 12 station presets, multichannel TV sound, separate audio program and remote control capability.

Reinforcing its leadership position in the compact disc revolution, Pioneer introduced four new players, three of which offer wireless remote control. Heading the line-up is the PD-5010, which incorporates Pioneer's linear servo system for error free tracking, 27-track programmability, 2-speed audible scanning and track search.

Fisher, the Californian audio equipment manufacturer presented a totally re-styled integrated component system line-up. Three models make-up the new line, the ICS-705, 713 and 735.

The ICS-705 features an a.m./f.m. stereo tuner, 3-band equaliser, turntable, cassette player/recorder and shelf size speakers. The ICS-713 adds a dual cassette deck with Dolby noise reduction, and a 5-band equaliser. The ICS-735 features a 15 watt per channel amplifier, a dual-deck with synchronous dubbing, sequential play, auto search function and Dolby. The Quartz PLL digital synthesiser tuner offers eight a.m./f.m. presets.

Toshiba America presented a complete range of electronic consumer goods including 12 new format colour television sets, a wide variety of hi-fi systems, compact disc players, radios, tape recorders, telephone answering machines, programmable coffee makers, and microwave ovens with numerous cooking features.

The company's main exhibit was the M-5400 VHS format video cassette recorder. This model, uses Toshiba's own integrated-circuit chips, is a 117-channel cable compatible VCR with four heads, 16-function wireless remote control and four event/seven day programmable timer.

Polaroid announced a Supercolor high grade hi-fi video cassette, formulated for optimal video and audio reproduction. Manufactured to strict specifications, the new tape meets the high standards required for true high-fidelity audio, recording and playback.

SATELLITE LAUNCHES

The satellite companies, once again, gave a strong showing of their products, with dish antennas mounted outside the main exhibition hall. At least 40 earth station manufacturers attended the show, including the more well known companies such as Houston Satellite Systems, Interstat, Luxor, Panasonic and Uniden.

The Panasonic Industrial Company, a leading supplier of advanced electronics to the business and industrial marketplace, introduced a satellite receiver capable of receiving both Ku-band and C-band signals. The rugged Ku/C-band has ten channel capacity and features front panel push buttons for instant selection of channels.

Houston Satellite Systems introduced the Tracker System V—an antenna positioner that features u.h.f. wireless remote control and a Z-80 microprocessor system that memorizes satellite position, skew, and polarization. The user never has to manually change polarity when selecting various channels or moving from one satellite to another.

Channel selection is virtually instantaneous, and is performed by simply pressing the desired numbers or stepping up/down through the stations. The positioner has selective channel and satellite lockout capabilities where one may designate which channels can be viewed on any and all satellites. A particularly interesting feature is the satellite scan mode to rapidly move to the next programmed satellite without specifying the satellite name, and also a channel scan mode for initial system programming.

SHOW STOPPERS

Once again Sony Consumer Products Company produced the more novel and exciting products including Sony's first digital Trinitron XBR monitor receiver incorporating a digital memory which Sony calls the Home Management Helper System; and the Mini-8 ultra compact camcorder—the size of a paperback book—which promises to open up a whole new world to amateur movie makers with easy operation and two-hour recording capabilities.

Polaroid demonstrated their latest 8mm home video system including a lightweight, easy-to-operate, video camcorder, playback deck and pocket-sized 8mm video cassettes capable of 90 minutes or recording and playback on a home TV set.

The user simply inserts a Polaroid Supercolor 8mm video cassette in the camcorder (a combined camera and video recorder), tapes the action, then "docks" the camcorder in the playback machine for instant replay.

Probably one of the most original of all the products on display was the Sony WatchCam—a home security monitor system utilising the four-inch black and white flat picture tube of its popular Watchman personal TV series. In addition to a four-inch monitor, the system includes an ultra-compact B/W surveillance camera, a camera mount for easy installation in a standard door peephole, and a 67-foot connector cable.

The camera incorporates an ultra-sensitive saticon pickup tube capable of reproducing images in lowlight conditions. Weighing only six-ounces, it can easily be mounted on any standard door peephole to allow the user to see a visitor by simply switching on the monitor.

ISSUES AND ANSWERS

More than 150 of the year's most innovative products—selected by a panel of consumer electronics editors—were on display at the 10th annual *CES Design & Engineering Exhibition*, which was held on the Lobby level of McCormick Place. The products were judged on the basis of engineering and design superiority, and were selected from a field of more than 400 entries.

Over 35 hours of information conferences and workshop sessions were offered in four major product categories; video, audio, computer, and telephones and telecommunications. Each product category featured a focal conference called "Issues and Answers"; specialised, practical workshops; and informative business and retail operations seminars.

All conferences were videotaped and shown on large-screen TVs via "CES TV News", daily throughout the show and via cable in 15 major hotels. □

OCTOBER FEATURES...

NEW SIZE

Understand Electronics

TEACH IN '86

A new series in nine parts, designed to give a comprehensive background to modern electronics. The emphasis is on the *practical* rather than the theoretical. Many interesting exercises will be dealt with, giving the participant an excellent grounding in all aspects of our field, with the minimum of soldering. This course—with optional software—will be of interest to the complete newcomer as well as to those with some previous experience. A useful related project will also be featured every month (below).

PROJECT 1

Safe Power Supply Unit

This is a +9V/−9V d.c. unit designed for use with the *Teach-In '86* series (see above). It is the first of nine related projects, each relevant to that month's Teach-In notes. This unit is not essential for Teach-In participants (batteries can be used) but it will nevertheless always be a useful tool in its own right.

Soldering Buyer's Guide

Soldering is a vastly underrated business in the world of the electronics enthusiast, and its true importance cannot be too highly stressed. It is in reality a simple task 'when you know how' and the combination of a good soldering iron and capable hands will minimise dry joint problems and ensure a much higher rate of 'first time working projects'. This guide shows you how—it also features a wide range of currently available irons and equipment.

EVERYDAY ELECTRONICS and computer PROJECTS

OCTOBER 1985 ISSUE ON SALE FRIDAY, SEPTEMBER 20

ORDER YOUR COPY NOW—SEE PAGE 506

PERSONAL STEREO PSU

T.R.de Vaux Balbirnie

PERSONAL stereo systems may be seen everywhere—in streets, parks, buses and trains. Young people use them for pop music. Others play learning tapes—to help with a foreign language, for example. Since they use headphones rather than a loudspeaker, they are truly personal and do not disturb others who may not share the listener's tastes.

HOME USE

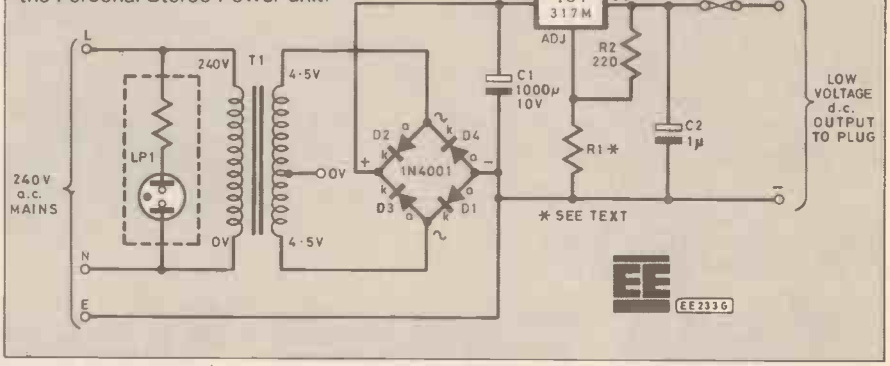
Personal stereos have sufficiently high quality to enjoy at home but prolonged use soon runs down the batteries. This project is a miniature mains power unit specially designed for these radios and cassette players—operating cost are then negligible. It seems that most models use either two or four AA type batteries for 3V or 6V operation. This unit will deliver up to 130mA at either voltage. This is sufficient for radios and most cassette players. The current requirement is sometimes overstated in the instructions so, if necessary, check with a multitester. Be sure to fit new batteries before doing this. If more than 130mA is needed don't despair—read on! Check also that the equipment is fitted with a d.c. input socket of known polarity.

The output voltage is internally preset by a single resistor which may easily be replaced should the need for the alternative voltage arise. Although there are some mains connections to make, anyone competent with a soldering iron should, with care, be able to make a safe job.

CIRCUIT DESCRIPTION

The circuit for the Personal Stereo Power Unit is shown in Fig. 1. T1 is a transformer which reduces the mains input to a suitable low working voltage. Diodes D1 to D4 are connected as a full-wave rectifier and the resulting d.c. is smoothed by C1 and regulated by IC1. The output voltage is determined by R1 and R2. In this circuit, R2 is fixed in value and R1 chosen to provide the correct output—in fact, the voltages are made slightly low as a safety precaution. FS1 is a fuse in the positive output lead and LP1 is a neon (mains-on) indicator.

Fig. 1. Complete circuit diagram of the Personal Stereo Power unit.



CONSTRUCTION

Refer to Fig. 2 and Fig. 3 for details of the circuit panel. This is based on a piece of 0·1in. matrix stripboard, 13 strips by 29 holes. The panel should be cut slightly large then filed to fit the runners of the plastic box securely. Make the breaks in the copper strips and connect the single link wire as indicated. Follow with soldered on-board components. When mounting R1, keep it clear of the circuit panel so that it is more easily replaced should the need arise.

Attach the Veropin for mains earth connection. Note that with the circuit panel in position in the case, T1 rests on the base. Make a careful check on the double row of broken copper strips between the primary and secondary connections to T1. These must be broken completely to isolate the mains from the low-voltage section. Make a heat sink for IC1 using thin sheet alumin-

COMPONENTS

Resistors
R1* 270 for 3V output
820 for 6V output
R2 220
All resistors 0·4W ± 1%

Capacitors
C1 1000μ 10V electrolytic
C2 1μ 100V electrolytic

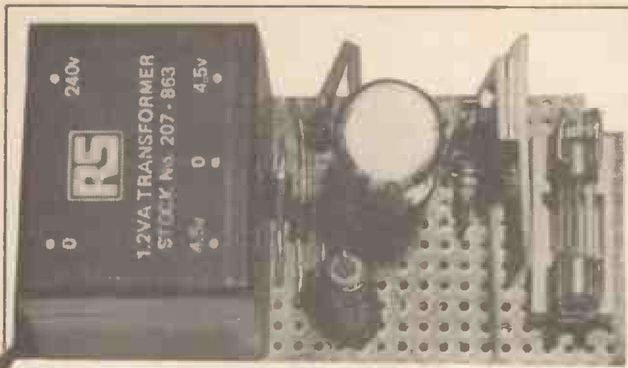
Semiconductors
D1–D4 1N4001 (4 off)
IC1 317M variable voltage regulator

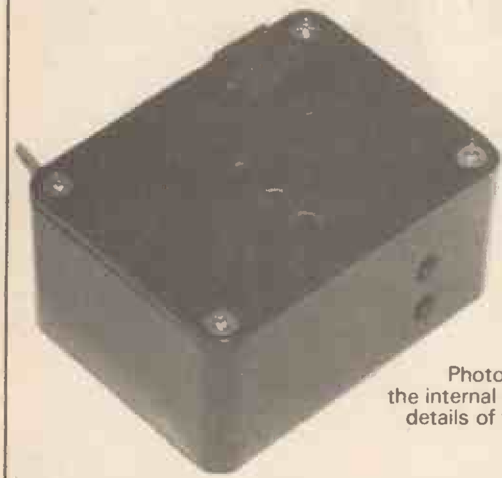
See Shop Talk page 477

Miscellaneous
Plastic box; 0·1in. matrix stripboard; 13 strips × 29 holes (for high-current circuit the board may be smaller); 20mm fuseholder and fuse; Veropin; 3A 3-way terminal block (for high-current only); solder tag (high current only); Small panel-mounting mains neon indicator; heatsink; 4·5–0–4·5V fully-encapsulated p.c.b. mounting mains transformer (R.S. stock no: 207-863).

* see text

Approx. cost Guidance only **£9**





Photos illustrating the internal and external details of the Personal Stereo PSU.

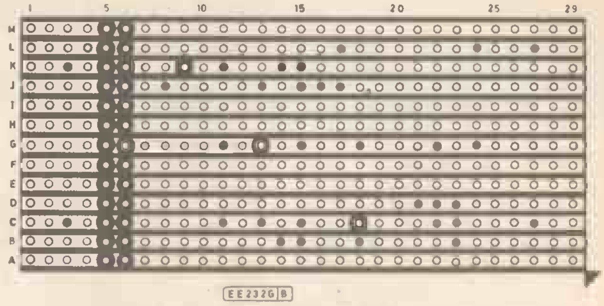


Fig. 2. Details of the stripboard layout including track cutting details.

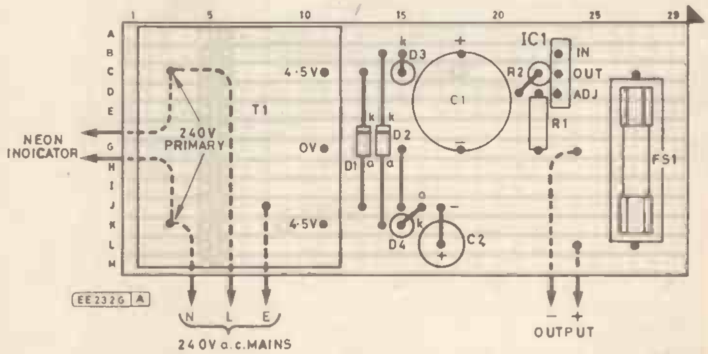


Fig. 3. Component layout of the Personal Stereo PSU.

ium, size 32 × 16mm. Drill a small hole in the corner and attach it to the i.c. noting that with the circuit panel in position, the heat sink rests in one of the slots in the box.

If currents in excess of 130mA are required then some modification to the above instructions is needed. Obtain an uprated chassis-mounting transformer appropriate to the current loading. This will determine the size of the case required. Construct the circuit panel from hole 10 onwards omitting the on-board transformer (Fig. 4.) Note that IC1 is suitable for loads up to 500mA.

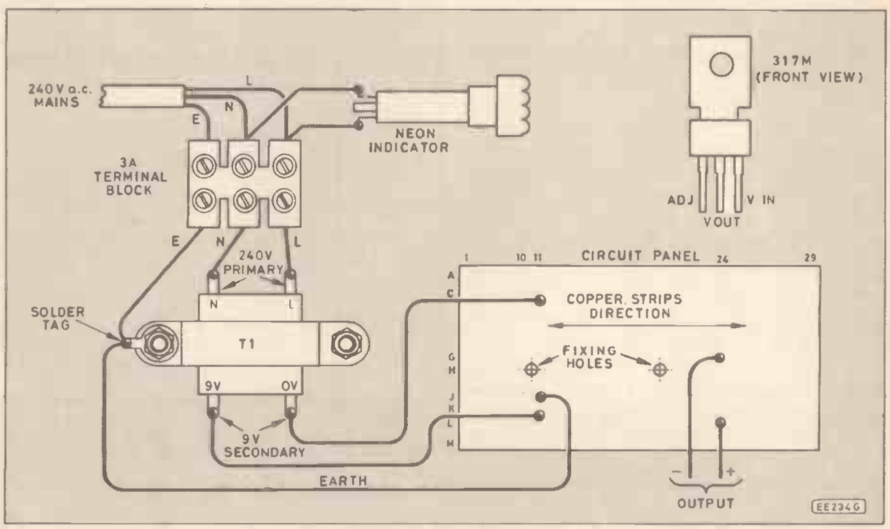


Fig. 4. Alternative transformer wiring details for the Personal Stereo PSU. The same stripboard is used.

PREPARING THE CASE

Begin by drilling the holes in the rear for the mains and low-voltage output leads. Drill the ventilation holes near T1 and a hole for LP1 as shown in the photograph. The position of the latter is critical and care must be taken to ensure that LP1 connections cannot touch the copper strips of the circuit panel. Use an insulating sleeve for added protection.

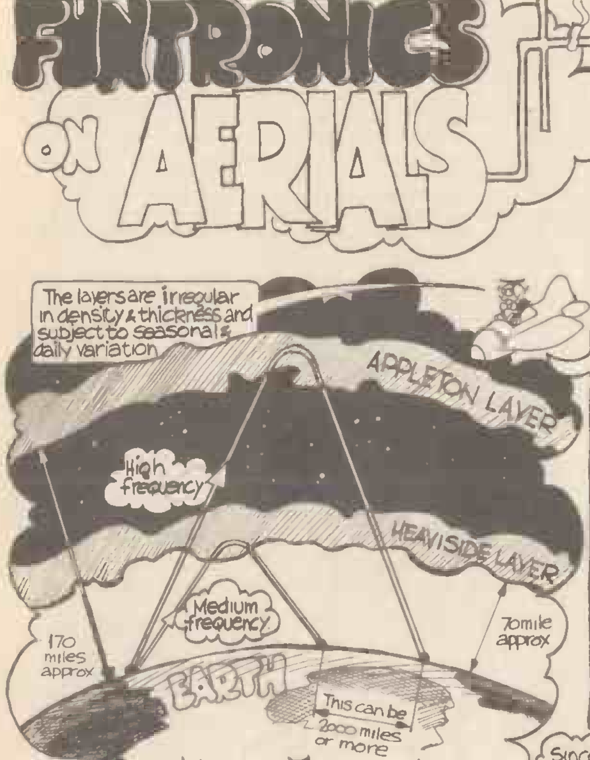
Measure pieces of 3A 3-core mains wire and light-duty twin wire for the output. Connect them to the underside of the circuit panel as indicated in Fig. 3. Connect the neon indicator. Fit both leads with strain relief bushes inside the case so that they cannot break free from the panel should they be pulled accidentally. Fit self-adhesive feet to the case, insert the fuse and attach the lid.

For the higher current circuit, mount T1 and the 3-way terminal block on the base of the box. Include a solder tag beneath one T1 fixing. Mount the circuit panel nearby using two small fixings in strip H. Place small plastic stand-off insulators on the bolt shanks to hold the panel clear of the base of the box. Refer to Fig. 4 and complete the wiring. Note the mains earth connection to the T1 solder tag and from there to the negative supply line at the circuit panel. Double the area (at least) of the heat sink on the regulator, IC1.

TESTING

Attach the correct type of plug to the output lead making certain that the polarity has been correctly observed—interchanging positive and negative connections may damage the equipment. Fit the mains plug with a 3A fuse. Note that it is normal for T1 and IC1 to become quite hot in use and the case will therefore become warm in prolonged operation. □

FINTRONICS ON AERIALS



Let's take a much closer look at the IONIZED layers. yes, there's actually two, the APPLETON and KENNELLY–HEAVISIDE LAYER.
The electro-magnetic radiation consists of two parts - the GROUND WAVE and SKY WAVE. The GROUND WAVE (low frequency) tends to follow the earths curvature to an extent. The Sky wave reaches the ionized layers. The effect of these depends, of course, upon the angle at which the wave meets and on its frequency (NOTE)

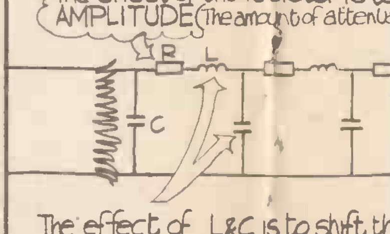
Since the layers are about 70 to 170 miles high & the EARTH is 8K dia, all sketchs are Not To Scale.

PROF

TRANSMISSION LINE

The t... of a c... high frequency sig... nt to understand ... varies from its INPU... and phase. To understand how t... consider the cable to consist o... of Resistors, inductors, and cap... the transmission line as show...

The effect of the resistor is to ... AMPLITUDE (The amount of attenua...



The effect of L&C is to shift th...

In short the transmission line rep... incoming signals the value of wh... as well as length of cable.

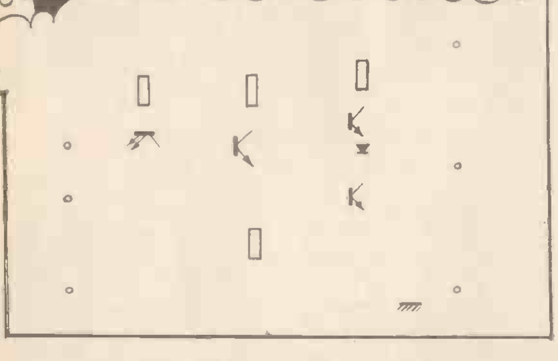
NB At RADIO FREQUENCY a transmis... as a RESONANT circ...

"Strange, we received your signals"

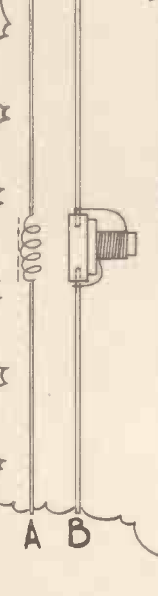
TRANSISTOR TEASER

Join-up the components below to form a familiar circuit

Solutions on page 513



the LOADED AERIAL

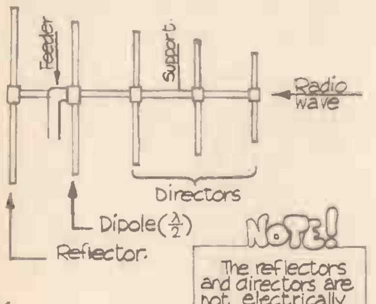


To match an aerial to a l.f. wave length particularly in a portable situation becomes impractical. Shorter aerials can be used by increasing the electrical length of the aerial by loading with a coil.

The coil in 'A' would double the field strength reading of say a 1 metre long aerial.

Sketch 'B' shows how this coil would be fitted. The coil would have about 30 turns of 28swg enamelled wire on a 7mm dia former.

UNDIRECTION AERIALS



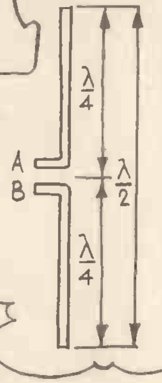
Transmission and reception are improved when 'director' and reflectors are added to the dipole.
For transmitting aerials they have the effect of concentrating the radiation in one direction.
For receiving aerials they have the effect of increasing the strength of the received signal.

The function of the directors is very simple, they direct the radiation in the vicinity of the dipole and the function of the reflector is to reflect radio waves back to the dipole.

NOTE! The reflectors and directors are not electrically connected to the dipole.

HALF WAVELENGTH DIPOLE

The principle operation of a receiving aerial is that of a conductor. If the conductor (ie aerial) is placed in the path of electromagnetic radiation current is induced in the conductor.



For maximum radiated and received energy, the aerial has to be a optimum length equal to half the wave length of the signal.

A & B connections are for the transmitter or receiver.

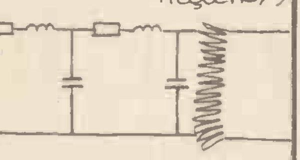
There is a very simple formula used to arrive at the optimum length.

$\lambda = \frac{c}{f}$

λ = wavelength
c = speed of light (3×10^8 m/s)
f = frequency

ransmission line in the form
cable is used to carry
nals. Now, it's very importa-
that its OUTPUT signal
UT signal in both amplitude
his comes about we must
f a very large number
acitors distributed along
wn below.

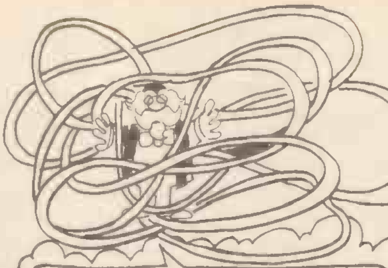
o attenuate the
ation is the same regardless of frequency)



he phase at h.f., only

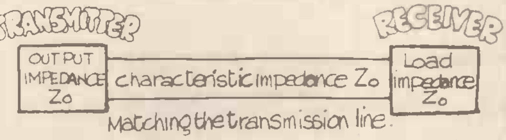
resents an IMPEDANCE to
ich depends on frequency

sionline may be used
uit



Let's consider a transmission line of infinite length. Looking at the transmitting end the line represents an impedance known as the characteristic impedance Zo. The value of Zo depends on the size of the conductor, the spacing, and insulation between live and earth.

But of course a transmission line cannot be of infinite length so let's look at the real world

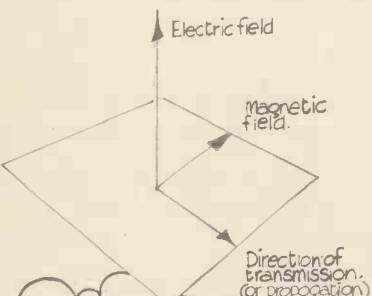


Matching the transmission line.

Let's consider a short line terminated by an impedance other than the characteristic impedance

The energy absorbed by the load (Receiver) will be low because some energy is reflected by the terminating impedance and a STANDING WAVE is formed along the line. However, if we terminated the line with its characteristic impedance Zo, the transmitting energy wave sees an infinitely long line and reflection ceases. All the energy is thus absorbed by the load and the energy or power is transferred from the transmitter to load at a maximum. This is known as: MATCHING THE TRANSMISSION LINE

You may be wondering what transmission line have to do with AERIALS well not much but its worth covering this method of transmitting a signal. As you will see both methods have their advantages & disadvantages

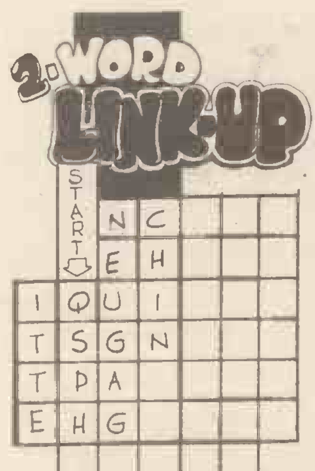


A vertical aerial creates a VERTICAL electric field and the radiation is said to be vertically polarized.

The electric field is at right angles to the magnetic field with the direction of propogation at right angles to both.

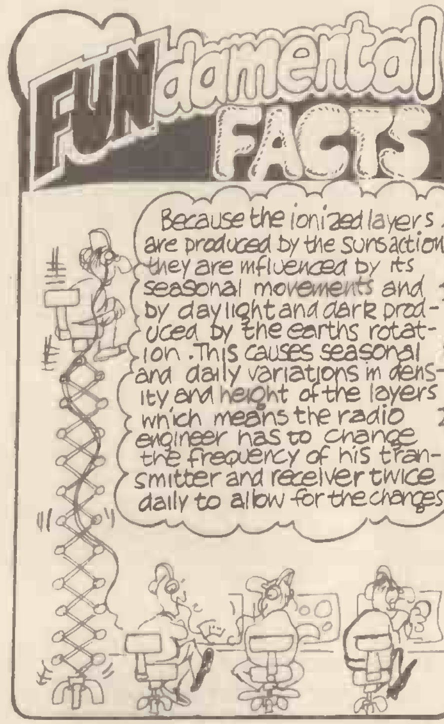
NOTE And, of course, the Horizontal aerial creates a HORIZONTAL electric field.

2-WORD LINK-UP



Make a chain of 2-words related to ELECTRONICS by joining the above letters

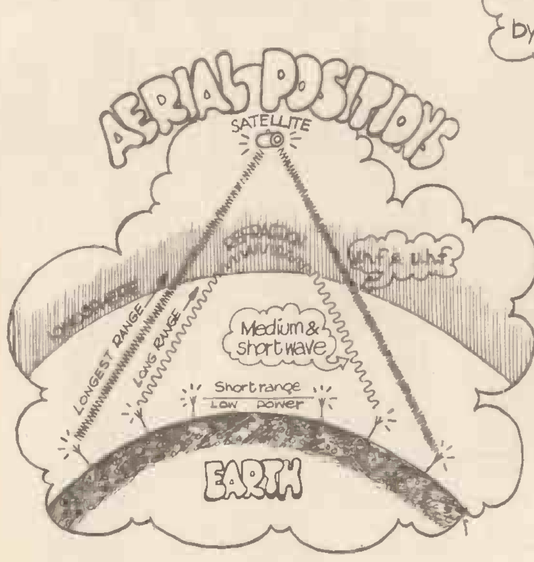
FUNdamental FACTS



Because the ionized layers are produced by the suns action, they are influenced by its seasonal movements and by daylight and dark produced by the earths rotation. This causes seasonal and daily variations in density and height of the layers which means the radio engineer has to change the frequency of his transmitter and receiver twice daily to allow for the changes

"Alright, who told our new operator he had to physically follow the ionosphere?"

AERIAL POSITIONS



"FANTASTIC PICTURE! THAT LAST BIT OF FINE TUNING DID THE TRICK!"

by Thakery

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THE QUESTION most often asked by readers of this column is: "Where can I get further information on Spectrum hardware and interfacing?" I shall, therefore, start this month's instalment of *On Spec* with a short "Recommended Reading List" for Spectrum hardware enthusiasts. The list is not exhaustive, being merely confined to those books which I have personally found useful.

Useful Reading

Almost certainly the cheapest of all publications covering Spectrum interfacing is Owen Bishop's "Easy Add-on Projects for Spectrum, ZX81 & Ace" (Pub. Bernard Babani ISBN 0-85934-099-6). This very modestly priced book describes a number of simple and often ingenious projects which are designed to operate in conjunction with a simple address-decoder module. This latter device can be put together from readily available components or can be purchased in kit form from Kelan Engineering (see August *EE*).

The "Spectrum Hardware Manual" by Adrian Dickens (Pub. Melbourne House, ISBN 0-86161-1115-2) describes the internal operation of the Spectrum and is liberally illustrated with useful photographs. It does, however, only cover Issues 1 and 2 of the Spectrum (there can't be very many Issue 1 Spectrums still going, can there?).

Several interface projects are described and these include a breadboard system (the photograph of this needs to be seen to be believed!), a reset switch, adding a Z80 PIO, a joystick/keyboard interface, and an eight channel analogue-to-digital converter. There is also a hand-drawn circuit diagram of an Issue 2 Spectrum which, unfortunately, contains several errors!

Graham Bishop's "Spectrum Interfacing and Projects" (Pub. McGraw-Hill, ISBN 0-07-084702-9) contains a number of well-thought-out projects and interface designs, including analogue-to-digital and digital-to-analogue converters. The book also contains some fairly basic information on the Spectrum hardware configuration together with a brief introduction to machine code.

The "ZX Spectrum User's Handbook" by R. J. Simpson and T. J. Terrell (Pub. Newnes Microcomputer Books, ISBN 0-408-01323-0) deals with both hardware and software. The chapters on hardware and programming in machine code are particularly useful. A simple one-byte memory-mapped I/O interface is described but no constructional details are provided. This book is very comprehensive and contains all of the information that most Spectrum owners will ever require.

Now on to the project, which this month is a simple DAC, based on a standard and widely-available converter chip.

Digital-To-Analogue Converter

In simple control applications one often needs to provide an analogue, rather than digital, output. Whilst this can be achieved by networks of discrete "binary weighted" resistors (see Fig. 1) or by an R-2R ladder network (see Fig. 2), several semiconductor manufacturers have come to our aid with integrated circuits which will accept a digitally encoded input and provide a corresponding analogue output. Such devices contain the precision resistors matched to an accuracy which would be impossible to achieve using discrete component technology.

The complete circuit diagram of the digital-to-analogue converter is shown in Fig. 3. The circuit is based on the popular Ferranti ZN428E. This device is a monolithic 8-bit digital-to-analogue converter i.c. which uses an "R-2R" network and contains an 8-bit data input latch to facilitate byte up-dating from an 8-bit data bus. The chip also contains its own internal 2·5V reference.

Address decoding is provided by IC3. This provides a logic 0 output whenever all eight address lines go high (corresponding to a decimal address of 255). The output of IC3 is gated with $\overline{IORQ}$ and $\overline{WR}$ lines within IC4a and then inverted by IC4b in order to provide an active-low enable signal which allows data to be latched into IC1.

Depending upon other external hardware fitted, some readers may wish to change the port address. This can be achieved quite easily using the unused gate, IC4c. As an example, Fig. 4 shows the modification required for changing the port address to 191 decimal (i.e. avoiding the use of address line A6).

The analogue output appearing at pin 5 of IC1 is passed to an adjustable gain non-inverting buffer formed by the operational

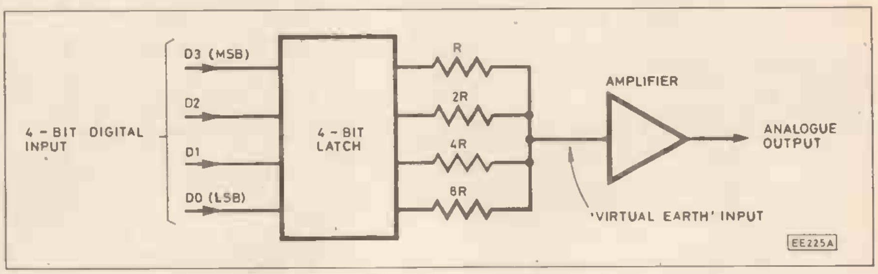


Fig. 1. Binary-weighted resistor network for D-to-A conversion.

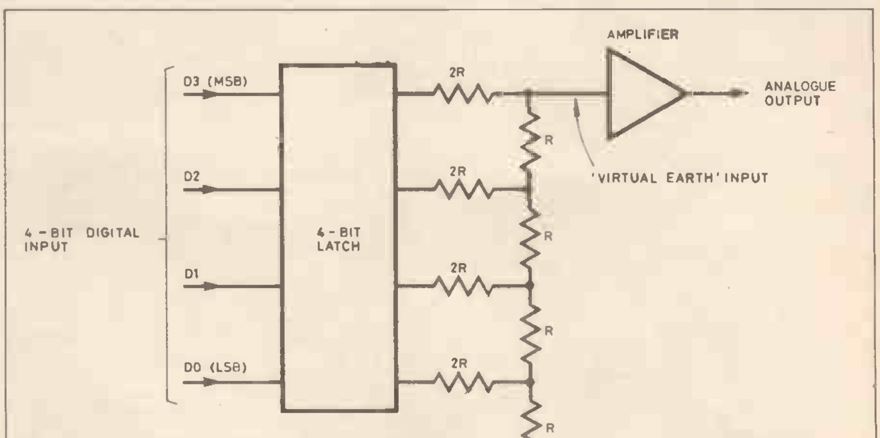


Fig. 2. An "R-2R" ladder network for digital-to-analogue conversion.

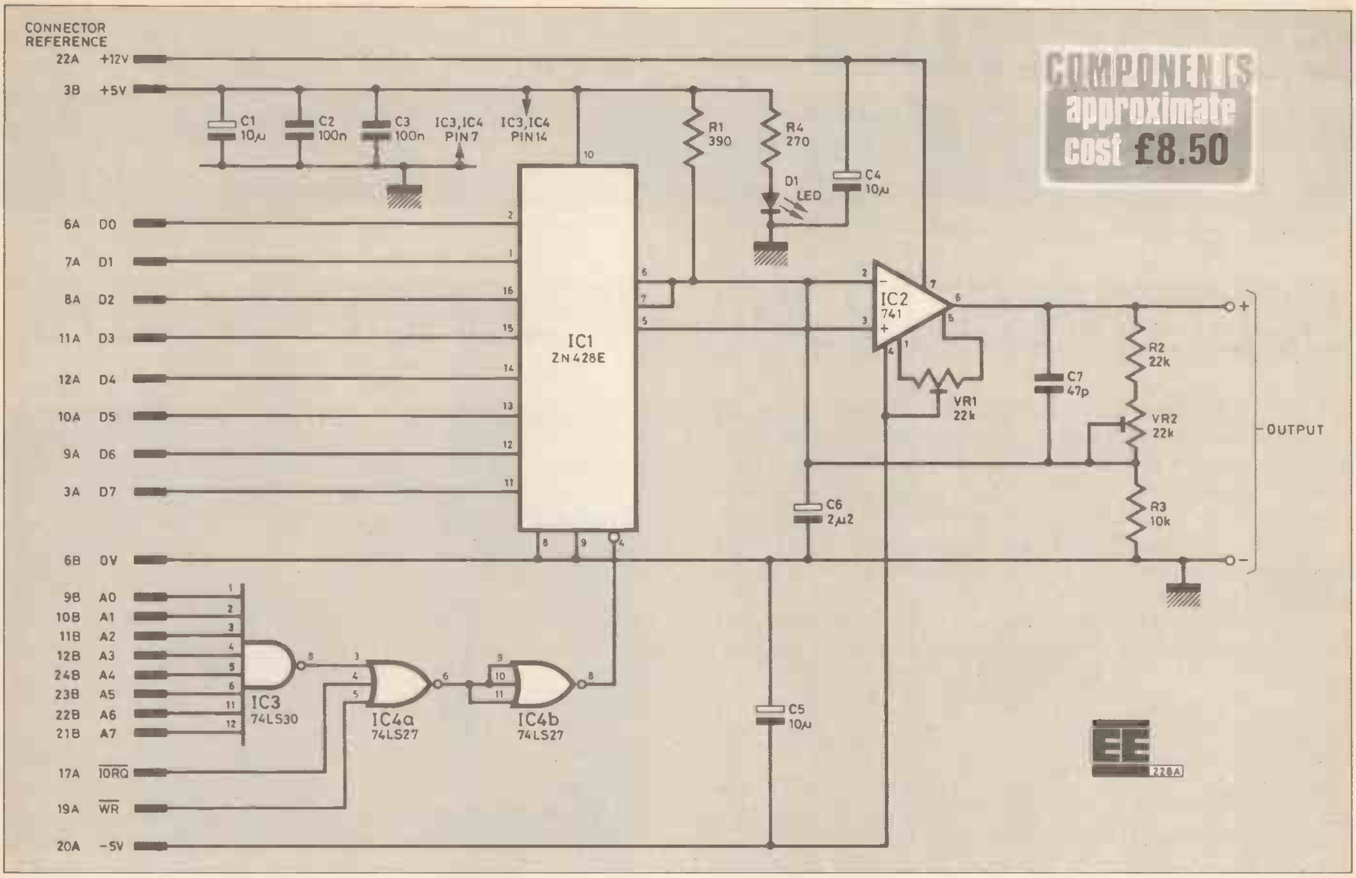


Fig. 3. Complete circuit diagram for the converter, using address 255 decimal.

amplifier, IC2. This stage provides a relatively low-impedance output which is substantially linear over the range 0V to 10V.

Construction

The digital-to-analogue converter is assembled on a piece of Veroboard measuring approximately 80mm × 100mm. As with previous projects, the precise dimensions of the board are not critical; however, it must have a minimum of 28 tracks aligned in the vertical plane so that a 28-way double-sided edge connector can be mounted along the bottom edge of the board.

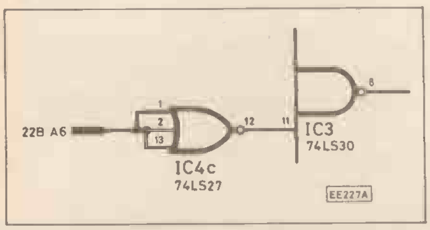


Fig. 4. Example of circuitry for decoding for port address 191 decimal.

This connector requires approximately five rows of holes across the full width of the stripboard and is arranged so that the board stands vertically when the connector is mated with the Spectrum.

Before soldering any of the components it is important to allow some clearance for the rear "overhang" of the case. For the Spectrum this gap should correspond to 8 rows of holes (20mm approx.) whilst for the Spectrum Plus the gap should be increased to 12 rows of holes (30mm approx.).

Links on the underside of the board should make use of appropriate lengths of miniature insulated wire (of the type normally used for wire wrapping). Readers requiring further information on the connector should refer to March *On Spec* or send for our latest "Spectrum Up-Date".

When the stripboard wiring has been completed, the integrated circuits should be inserted into their sockets (taking care to ensure correct orientation) and the entire board should be carefully checked before connecting to the Spectrum. Note that the Spectrum should ***always*** be disconnected from its supply before either connecting or disconnecting any interface module. If all is well, when power is re-applied, the normal copyright message should appear. If not, disconnect the power, remove the interface and check again.

In October's *EE*, we shall deal with the DAC at greater length. In the meantime, please don't forget to let me have any comments for inclusion in *On Spec*.

NEXT MONTH: We shall deal with setting-up and practical applications of the converter, and some simple software for driving it.

COMPONENTS

See Shop Talk page 477

Resistors

R1	390
R2	22k
R3	10k
R4	270

All ¼W ±5%

Potentiometers

VR1,VR2 22k (2 off)

Capacitors

C1,C4,C5	10µ 16V electrolytic (3 off)
C2,C3	100n polyester (2 off)
C6	2µ2 25V tantalum bead
C7	47p ceramic

Semiconductors

D1	Red l.e.d.
IC1	ZN428E
IC2	741
IC3	74LS30
IC4	74LS27

Miscellaneous

14-pin d.i.l. sockets (2 off); 16-pin d.i.l. socket; 2-pin 2·54mm pitch p.c. mounting connector; 28-way open end double-sided 2·54mm pitch connector (e.g. Vero part number 838-24826A); 2·54mm hole pitch stripboard measuring approx. 80mm × 100mm (minimum 28 strips).

YOUNG ELECTRONIC DESIGNER AWARDS

THE final 37 aspiring young electronic designers, making up the teams in this year's *Young Electronic Designer Awards,* gathered anxiously in the Great Hall at the Westminster School, London (end of May), to see if all their hard work was to be rewarded with one of the top prizes.

This year the prize winners were announced by Miss Petula Clark and presented by His Royal Highness The Duke of Edinburgh.

The competition was divided into two age categories, senior (14 to 19) and junior (under 14). The prizes offered by the sponsors, Cirkit Holdings plc, were cash amounts of £500, £250, £100 and £50 in each age group. Also a special prize of a Texas Instruments Professional Computer was donated by Texas to the winning school in the senior section.

Of the original entries received the final was reduced to just eighteen projects divided across the two sections. Entries ranged from a "Granny" Buzzer to a Sequence Timer for Offshore Beacons and a Washday Alarm to a Interface Unit for the BBC Micro.

First place junior winner, Daniel Rodenhurst is pictured demonstrating his Egg Dipping Control Device project to HRH The Duke of Edinburgh, Miss Petula Clark, Alistair McDonald (3rd right) Chairman of Cirkit Holdings plc and Daniel's teacher Mr D. Morgan.

The judging panel for the grand finals was made up of the following: Professor John Eggleston, Chairman of the Department of Education, University of Warwick; Sir Robert Telford, President, The Marconi Co.; Sir Alec Morris, Divisional Executive—Equipment, British Aerospace Dynamics Group; Peter Van Cuylenburg, Managing Director, Texas Instruments Ltd.; Jonathan Burchell, Cirkit Holdings plc.

Final Results

After the opening ceremonies and speeches welcoming the distinguished guests, contestants, teachers and parents, the big moment arrived and the judges' final decisions were revealed.

HRH The Duke of Edinburgh is pictured examining Jonathan Kempster's Audible Spirit Level which won first prize in the senior section of the Young Electronic Designer Awards *competition.*

WINNING DESIGNS

Senior	Junior
1st Ashcombe—£500	1st Maelor–£500
2nd Cavendish—£250	2nd Millfield High—£250
3rd Bishopshalt—£100	3rd Falmer High—£100
4th Bosworth College—£50	4th Bryn Offa—£50

The Audible Spirit Level, designed and built by Jonathan Kempster won the first prize of £500 in the senior section. His school Ashcombe School, Dorking are now the possessors of a Texas Professional Computer.

Second prize of £250 in this section was awarded to Paul Metcalf of the Cavendish School for his Pelican Crossing Model, a teaching aid for schools. An Infra-red Remote Control for use by the disabled to control equipment in the home won third prize of £100 for Russell Vowles of Bishopshalt School, Hillingdon.

Junior Winners

The £500 first prize in the junior section went to Daniel Rodenhurst of Maelor School, Wrexham for his Egg Dipping Device. Second prize (£250) was won by Paul Dunlow, Stephen Jenkins, Colin Knowles, Lee Taylor and Sean Taylor of Millfield High School, Cleveleys for their Caravan Reversing Aid. Third prize of £100 was awarded to Joanne Weeks, Angela Banfield and Rachel Sennett of Falmer High School, Brighton for their Washday Alarm.

All the participating finalists received consolation prizes of Texas TI-30 Galaxy Scientific calculators and packs of components.

First for TWA

First Computer has secured a major order for a combination of hardware, software and consultancy from the International division of TransWorld Airlines, one of the world's leading operators.

The order is to supply IBM XT business micro-computers for TWA's twelve international sites at major airport terminals in Europe, the Middle East and India. First Computer is also to provide a mix of "off the shelf" and custom written software. The systems will be used for TWA's personnel records, financial management and word processing needs at its international centres.

Mr Keith Riggs, TWA's Director of International Budgets and Controls said, *"The factor that decided which company ultimately received the contract was the level of software development support that was available. First Computer are able to provide just the service TWA require."*

TOP GIRL

IF SHE did but know it, somewhere out there in industry is the 1985 Girl Technician of the Year busily getting on with her career in electrical or electronic engineering. The search is now on to find her.

Sponsored by The Caroline Haslett Memorial Trust and the Institution of Electronics Incorporated Engineers, *The Girl Technician Engineer of the Year Award* is intended to focus attention on electrical and electronic engineering as a worthwhile professional career for women. By selecting the most outstanding girl Technician Engineer it is hoped that she will, by her example, encourage more young girls to enter the electrical and electronic engineering profession.

Nominations for the 1985 Award, with its £250 prize, and for the newly announced Mary George Memorial Prize (£100), awarded to the most promising younger entrant, must be received by 8 October 1985.

For further details and copies of nomination forms, apply to: **The Secretary, IEEIE, Dept EE, Savoy Hill House, Savoy Hill, London, WC2R 0BS.**

The Radar Division of Thorn EMI Electronics has recently been awarded a £6M contract by the Ministry of Defence to develop and supply a colour display for the Searchwater ASW radars installed on RAF Nimrod MRS aircraft.

The new display is scheduled to enter service in 1987.

The Inland Revenue has ordered two performance and capacity management/modelling programs from BGS Systems for use in its computer centre at Worthing.

UNIVERSITY VENTURE

British Petroleum has committed £130,000 under its Venture Research ("Blue Skies") Programme to back the work of a three man team at Edinburgh University's Department of Computer Science. The expanding and unique Blue Skies Programme—currently running at £1·5 million per annum—exists to inject BP funding into challenging ideas drawn from across the whole range of experimental and theoretical research at universities and comparable institutions at home and abroad, in the belief that some of these could generate completely new types of industrial opportunity.

The £130,000 investment at Edinburgh goes to Professor Robin Milner and Dr Gordon Plotkin working in liason with Professor Rod Burstall—all of the University's Department of Computer Science.

Just the Ticket

Equipment to modernise fare and ticket collection procedures on London's underground is to be supplied and installed by Westinghouse Cubic under a contract worth £45 million awarded by London Underground Ltd. Westinghouse Cubic is the automatic fare collection and revenue systems specialist.

Passenger-operated ticket machines, booking office machinery and supervisory computers are to be supplied by the company, following the successful trials of new-style, passenger-operated ticket machines at Vauxhall station during 1983. The system will speed up ticket issue and reduce queueing by passengers. It will also provide the means of reducing the possibility of passenger fraud.

They will supply approximately 900 self-service ticket machines of two types, which will issue new credit card-sized tickets including travelcards and season tickets. Coins of most denominations will be accepted by the machines and change will be given, while one machine type will also accept and give change from a £5 note.

Two types of machine are to be Installed: "Few-fare" machines will be located at all but the quietest stations, issuing tickets to regular passengers aware of the correct fare to the ten most popular fare sectors from each station. "Multi-fare" machines will issue a complete range of tickets to all underground stations and selected BR stations by pressing a destination button.

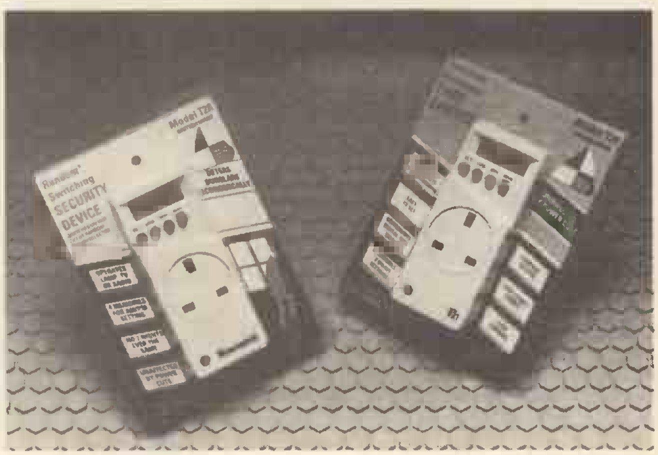
Each station will have its own supervisory computer linked to the centralised computers at the Underground's control centre.

DESIGN SELECTION

CAMBRIDGE based TEK Marketing have just had two of their plug-in timer modules accepted by the Design Council for inclusion in the Design Centre Selection.

The TR31 is a precision electronic timeswitch which can be programmed for up to three on/off cycles during a 24 hour period. The T2R is a derivative of the T31 aimed exclusively at home security. It will switch a lamp or other appliance at random intervals during two user programmed periods.

Designed by TEK in 1983, it is claimed that they were the first products to enable the consumer to purchase a programmable electronic timeswitch, with battery back-up, suitable for plugging into a 13A mains socket.



FOR YOUR ENTERTAINMENT

BY BARRY FOX

No call for DIY

More and more shops are now selling DIY telephone wiring kits. You get some telephone wire, a standard BT socket and instructions on how to string it in parallel with an existing BT socket. Specialist shops, for instance in London's Edgeware Road, sell the sockets on their own. Sometimes these have screw terminals, to make fitting easy.

Professional engineers don't like screws because they tend to work loose. They prefer friction-grip sockets which strip the insulation and bite into the metal as the wire is pushed in. The public can now buy the special tools needed to make a clean join with a friction socket.

Obviously, BT is not pleased about the sale of these sockets or kits: *"They are not approved for connection to the public telephone network, only to a PBX private exchange. They should not be on sale to DIY installers.*

"We don't approve of people adding extra sockets. The only thing we permit is the replacement of standard sockets with decorative ones. You can buy them, but they should still be installed by BT engineers."

With good reason, BT is getting worried. If DIY phone installers do not understand what they are doing, all kinds of odd things can happen. BT here is partly to blame. It has not publicized the technical pitfalls, so people just think BT is complaining out of commercial pique. Amateurs have a go at fitting by trial and error.

A recent booklet published by the government Office of Telecommunications, OFTEL, looked hopeful. It's entitled "Telecommunications Wiring in Business Premises and Homes." But it is only a rundown on the law and rules, written in the most awful civil service lingo. There is no technical meat. What the public needs is a booklet which spells out the electrical facts. It could well deter the bodgers who are worrying BT.

Electrically speaking, there is no limit on the number of sockets you can hang on a telephone line. The master socket contains a capacitor, but all the extension sockets are electrically inert.

Two wires *(A,B)* come into the house from the street. At the master socket a third wire, the bell wire, is added. The capacitor goes between the *B* wire and bell wire to let through the a.c. ringing signal, but block the d.c. speech and off-the-hook signalling current to the exchange.

There is an electrical limit on the number of phones you can plug in at any one time. It is the equivalent of four "standard" ringers or bells.

Every piece of authorised telephone equipment is marked with an REN, which is the Ringer Equivalent Number for the circuit. A ringer impedance of 4,000 ohms has an REN of one or unity. If it has a lower impedance, and is current hungry, then its REN is higher than one. Unfortunately, the REN is often marked only on the box or booklet which few people read and most will throw away.

The theoretical limit for extension phones is 4 REN units. So you can safely connect four phones each with an REN of one. You could only connect three if they each had an REN of 1·33, and so on. Most phones now are unity, however. In practice, you can sometimes get away with a combination of phones that puts the REN at greater than 4, but don't rely on it.

Cross lines

Odd things can happen when you get over 4 REN. One phone may ring, but none of the rest. Or none of the phones may ring. Or they ring weakly. But the person calling hears a normal ringing tone.

The result can depend on the exchange. The ringing current originates locally, from your own exchange, but there may be several different ringing machines. City ringers may be better able to cope with odd loads, than rural systems.

Bear in mind, also, that although a computer modem does not put any impedance across the line (unless it is of the auto answer type) an answering machine has a REN just like a telephone. So plugging in or switching on an answering machine can upset the system balance.

Although approved phones all meet (or should meet) the 4,000 ohm REN specification, electronic phones with warble ringers may not have the same electrical characteristic as those with an electromechanical bell. Their impedance is a complicated mix of capacitance, inductance and resistance which gets even more complicated when several electronic phones are used in parallel.

It's just like hi-fi, where a loudspeaker rated at 8 ohms may well dip in impedance to only a couple of ohms when reproducing some music frequencies. This can upset an amplifier. Four electronic phones, each with an REN of one, may not ring reliably when all plugged in together, even though the REN total is on paper still only 4.

There can also be intermittent problems caused by dampness on the p.c.b.s inside the socket boxes. When the weather is wet, or the atmosphere humid, there may be tracking which lowers the d.c. isolation between the *A* and *B* wires. This can again stop the bells ringing.

For my money, the biggest single problem is lack of information. I know of no attempts by officialdom to explain the REN guidelines fully and in simple terms. The OFTEL booklet is a non-starter. BT feels unable to publish anything because it would be seen to encourage the DIY fitting which BT wants to stop.

If subscribers call out BT engineers and the trouble is a DIY socket, BT will disconnect it and charge £15 plus VAT for the visit. So people have an added incentive to bodge.

I checked a couple of phones recently (both approved) and neither had a clear REN marking. Under the circumstances, is it any wonder that people are running into technical troubles?

Nightmare

As regular readers will know, I am certainly no computer buff. I have this quaint old-fashioned notion that computers should do a useful job, and save me time and money, not soak up time and money like a sponge while I learn to use them.

I have written about the miseries I suffered with the ACT Apricot, not because there is anything wrong with the machine, but because the instruction manuals (especially for the Xi hard disc version) are such a nightmare of jumbled jargon. After failing to stir the company into any real action through private correspondence I went into print and was immediately rewarded with a letter from a reader who said he was thrilled to find that he was not alone in being lost.

"The machine seems to have tremendous potential" he wrote "but there is little exaggeration in saying that the manuals explain nothing properly". He then threw up one of those nuggets of golden truth that describe a complicated situation in a few words. "The manuals are of the kind that you can only understand when you no longer need them."—I wish I'd thought of those words!

If you think we are exaggerating, try these simple tests. The Apricot Xi hard disc machine comes with all programs already stored on a Winchester. The instruction books tell you that you need to make safety backups. See if you can find where it tells you how to copy all the program tracks, and then the system tracks.

The Xi also offers path control so that it automatically searches out programs and files stored in sub directories. Try learning how to set a path from the instruction books. Also, try to create a simple command file, using Edlin. You would think, for instance, that it would make sense to start the description with the advice that you need to key "I" for insert, end with "E" for end and then "Q" for quit. You might think so, but you would be wrong.

Dixons and Tottenham Court Road shops are now selling Apricots at cut price alongside music centres and cameras. If you have a little spare time, try asking the sales staff about back-ups, Path and Edlin.

Every time I struggle with manuals like these I am left longing to get my hands on the man who wrote them so that I can shake him until he apologises for making simple logical things so infernally hard to comprehend. I also understand why the computer boom has crashed.

TRANSDUCERS

PART 1 GENERAL PRINCIPLES and TEMPERATURE MEASUREMENT... MIKE FEATHER BSc

WHAT IS a transducer? Scientists and engineers are constantly involved with the task of measuring the sizes of physical quantities in the world around them. Common examples of such quantities might include temperature, pressure, or magnetic flux density.

GENERAL PRINCIPLES

Clearly, these measurements need to be accurate if they are to be of value and an equally important factor in the specification of a measuring instrument for them is that it should be easy to use.

Electrical quantities such as currents and voltage can be measured to a considerable degree of accuracy with relative ease by using, for example, a digital multimeter. More sophisticated systems might employ an analogue-to-digital converter to give a digital representation of the analogue electrical signal produced. This can then be processed by a microcomputer.

Most physical quantities are not, however, electrical in nature, and if we want to use the convenience of an electrical measurement technique to determine the size of such variables, it is first necessary to derive from them an electrical signal which is a representation of the size of the quantity. This is the function of the transducer.

Fig. 1.1 and Fig. 1.2 show typical arrangements of transducers and associated measuring techniques.

Many transducers produce an electrical signal which is proportional to the size of the quantity being measured. This a generally desirable, but by no means essential, feature of a transducer.

Circuitry for non-linear transducers can be designed to produce an output which does vary linearly with the size of the parameter being measured: such circuits are often called "linearisers".

TRANSDUCERS FOR TEMPERATURE MEASUREMENT

The change in temperature of a material causes corresponding changes in a number of parameters associated with it. If these changes can be measured, we have the basis for a system of temperature measurement.

As an example, the expansion in volume of a small quantity of mercury with rise in temperature is used in the common mercury thermometer.

Table 1.1: Measuring temperature change electronically

SYSTEM	ELECTRICAL QUANTITY	APPLICATION
Metallic conductor	Change in resistance	Platinum resistance thermometer
Semiconductor	Change in resistance	Thermistors and LM334
Thermocouple	Change in thermo e.m.f.	Thermocouples

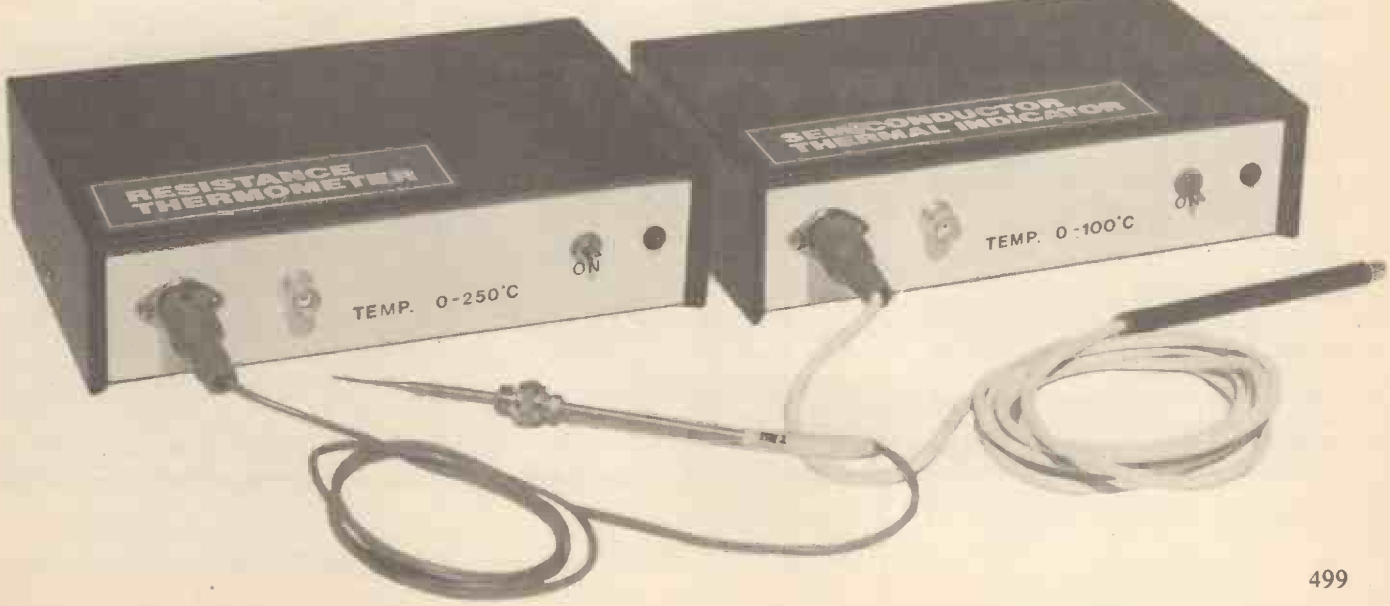
For our purposes, we are interested in systems in which a change of temperature produces a corresponding change in some electrical quantity associated with the system. Some examples of these are given in Table 1.1.

In this article, we shall discuss the theory and the construction of two practical temperature measuring systems. Although originally intended for use with the microprocessor data acquisition system described in the December 1983 issue of *EE*, the completed units can be used with a digital or analogue voltmeter.

TEMPERATURE MEASUREMENT USING RESISTANCE THERMOMETERS

The resistivity—or specific resistance—of a metallic conductor, unlike that of a semiconductor, shows an increase as the temperature of the conductor rises. For a particular length and diameter of wire then, the resistance will increase as its temperature rises.

The increase in resistance per K rise in temperature expressed as a fraction of the wire's resistance at 0°C varies according to the material of which the wire is made: this quantity is known as the *temperature coefficient of resistance* of the material. Its value does not differ very much for pure metals, but special alloy wires such as Constantan, or Eureka are specifically manufactured so as to possess small temperature coefficients. This means that the resistance of a length of such wire does



not vary much with its temperature, thus rendering the wire useful for the manufacture of standard and very high stability resistors.

Platinum, being a pure metal, possesses a relatively high temperature coefficient, which means that the resistance of a particular wire made of platinum will show an appreciable variation with its temperature: this forms the basis of resistance thermometry—a temperature measurement technique which is capable of high precision over a wide range.

A typical platinum resistance thermometer can measure temperatures in the range −50°C to +250°C with an accuracy of 0·1%.

The sensing element itself originally consisted of a fine platinum wire grid arrangement, but in modern devices, this has been replaced by a platinum track deposited on to an insulating substrate.

Temperature sensing elements of this type are available in an unsheathed form and, if these are used, care should be taken when handling them as the arrangement is rather delicate. A more robust sensor is available in which the platinum sensing element is housed in a stainless steel probe and provided with suitable connecting leads—see Fig. 1.4.

Determination of the resistance of the sensor generally utilises a bridge technique, with the sensor forming one arm of the bridge. Various bridge configurations exist, but the simple "quarter-bridge" circuit shown in Fig. 1.3 is adequate for many applications. When correctly adjusted, this circuit will produce an output voltage very close to 1mV/°C.

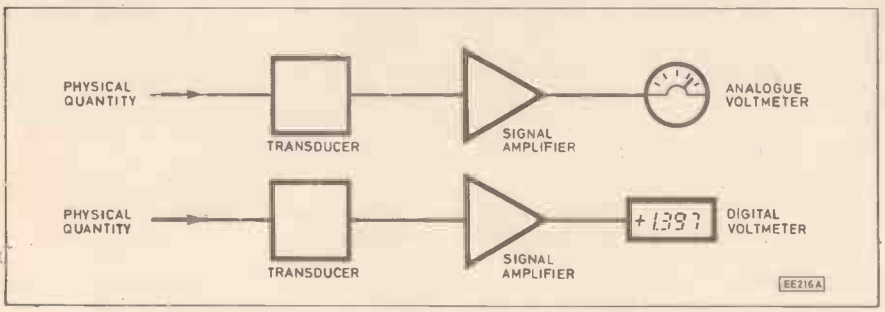


Fig. 1.1. Block diagrams for analogue and digital readouts.

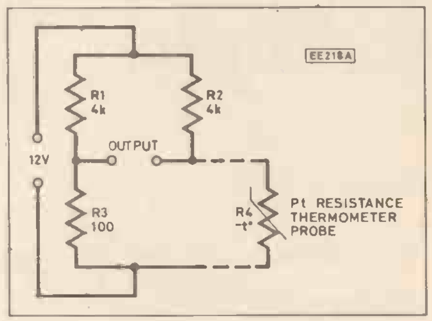


Fig. 1.3. Circuit diagram for a quarter bridge arrangement.

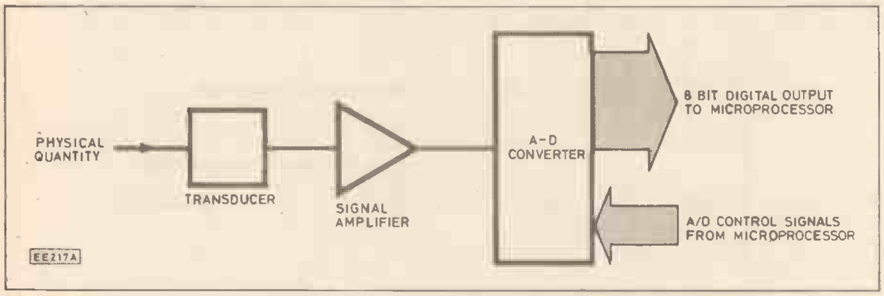


Fig. 1.2. Microprocessor interfacing using a A to D converter.

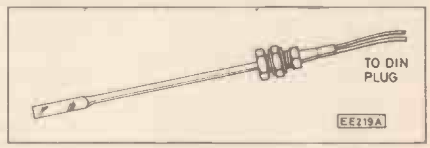


Fig. 1.4. Typical stainless steel probe housing the platinum sensing element.

Resistance Thermometer

THE PRACTICAL CIRCUIT

The practical circuit of the resistance thermometer is shown in Fig. 1.5. R1 and R2 form part of the ratio arm section of the bridge; VR1 completes this and provides a balance set facility.

All resistors should ideally be precision 0·1% types, but these are expensive and for many purposes, 1% types can be used. The bridge requires a stable voltage supply and the circuit includes the variable voltage regulator IC1 to provide this. The actual output voltage per unit change in the probe temperature depends on the bridge supply voltage and VR2 enables this to be varied for calibration purposes.

CONSTRUCTION

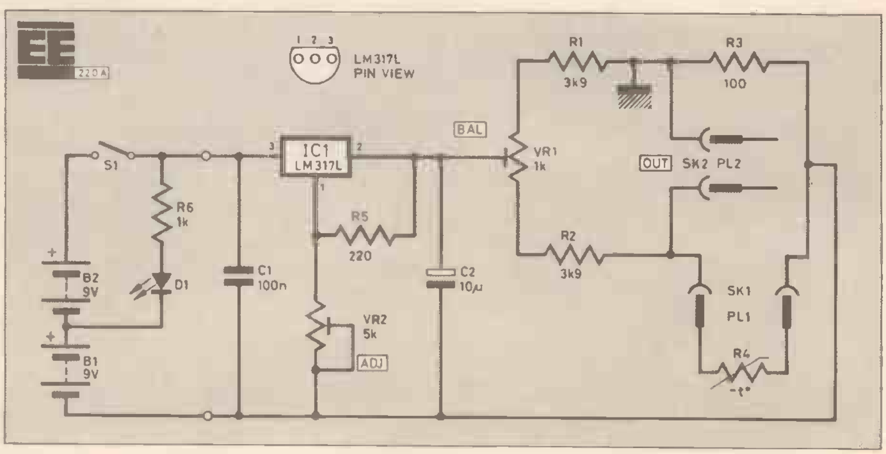
The construction of the circuit should present little difficulty, particularly if the p.c.b. pattern is used. See Fig. 1.6. Care should be exercised, however, when inserting and soldering in the fixed resistors. Their leads should not be bent too sharply at the ends as this can result in mechanical stress and cracking of the resistive film. They should not be mounted in contact with the p.c.b., but two or three mm above it.

TESTING AND CALIBRATION

For acceptable accuracy, a digital voltmeter (3½ digits) is almost essential for calibrating the completed module. If a resistance decade box of range 0 to 199 ohms and a resolution of 0·1Ω is available, then this should be used and the following procedure adopted:

(a) connect the DVM to the output of the bridge network and set it to its 200mV range

Fig. 1.5. Complete circuit diagram for the Resistance Thermometer.



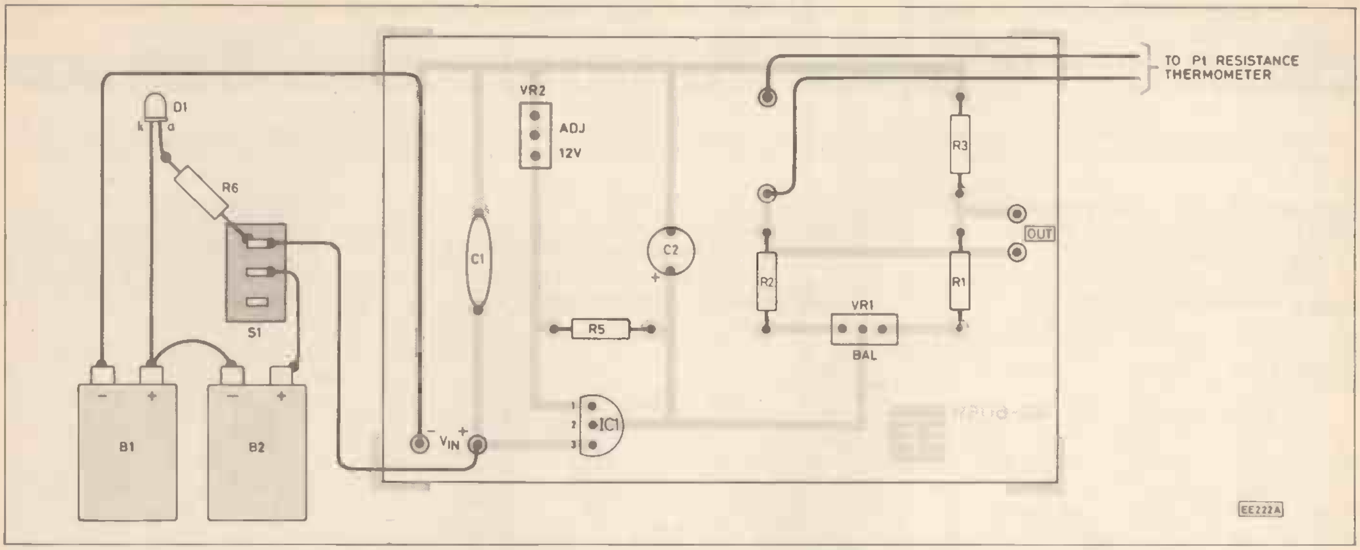


Fig. 1.6. Component layout and interwiring for the Resistance Thermometer.

COMPONENTS

See Shop Talk page 477

RESISTANCE THERMOMETER

Resistors

R1,R2	3k9 (2 off)
R3	100
R4	Platinum film probe
R5	220
R6	1k

All $\frac{1}{2}$W 1% metal film (except R4—see text)

Potentiometers

VR1	1k, $\frac{3}{8}$in. square. 25-turn cermet trimmer
VR2	5k, $\frac{3}{8}$in. square. 25-turn cermet trimmer

Capacitors

C1	100n polyester
C2	10µ elect., radial leads

Semiconductors

D1	green l.e.d.
IC1	LM317L voltage regulator

Miscellaneous

B1,B2	9V PP3 batteries (2 off)
PL1	5 pin DIN plug
PL2	BNC plug
S1	single-pole, sub-min. changeover switch
SK1	5 pin DIN socket
SK2	BNC socket

Case—203 × 127 × 51mm; printed circuit board, available from the *EE PCB Service,* order code 8509-03; stand-off mounting bushes for p.c.b.; battery connector clips; adhesive pads for batteries; adhesive feet for case.

Approx. cost Guidance only £32

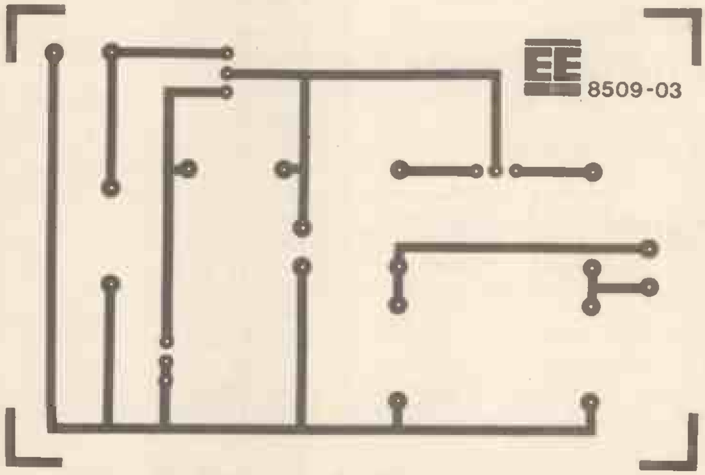


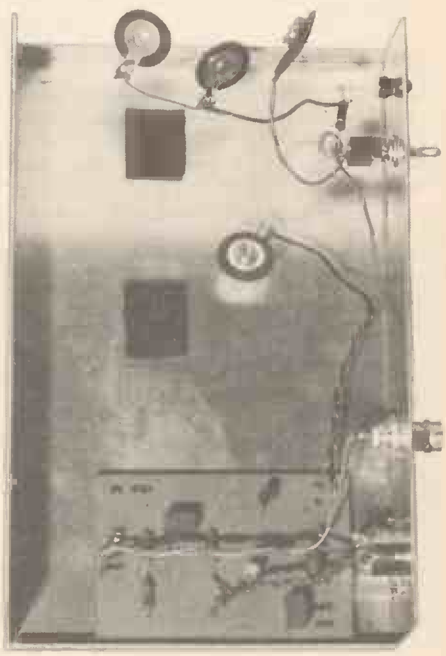
Fig. 1.7. Full size printed circuit board master for the Resistance Thermometer. This board is available from the *EE PCB Service,* order code: 8509-03.

(b) connect the decade box to the sensor terminals and set its resistance to 100·0Ω (this is the resistance of the RS sensor at 0°C)
(c) adjust VR1 until a reading of zero is obtained on the DVM
(d) set the decade box to a resistance of 138·5Ω (the resistance of the RS sensor at 100°C)
(e) adjust VR2 until the DVM reads exactly 100mV

The bridge is now calibrated and the platinum resistance sensor can be connected up instead of the decade box.

If a decade box is not available, then the bridge may be calibrated using the resistance sensor itself. It should be placed in an ice/water mixture and allowed to stand for several minutes and then step (c) carried out, in order to set the zero point.

Calibration at 100°C may be similarly achieved by placing the sensor in boiling water and adjusting VR2 for a 100mV ouput as in (e). Accuracy here depends upon the purity of the water and other conditions, but it should be adequate for most purposes.



Semiconductor Temperature Sensor

TEMPERATURE MEASUREMENT USING A SEMICONDUCTOR TEMPERATURE SENSOR

A NUMBER of semiconductor devices are available which produce an output current proportional to their absolute temperature. Commonly available are the LM334 and RS590 devices.

In the case of the LM334, a single resistor is used to set the current through the device to some value (the set current) which will then change linearly with the temperature at a rate of +0·33% per K rise in temperature. Fig. 1.8 shows a practical circuit for use with the LM334 to provide an output voltage of 0–100mV for a sensor temperature range of 0°–100°C, thus rendering it suitable for use with a DVM.

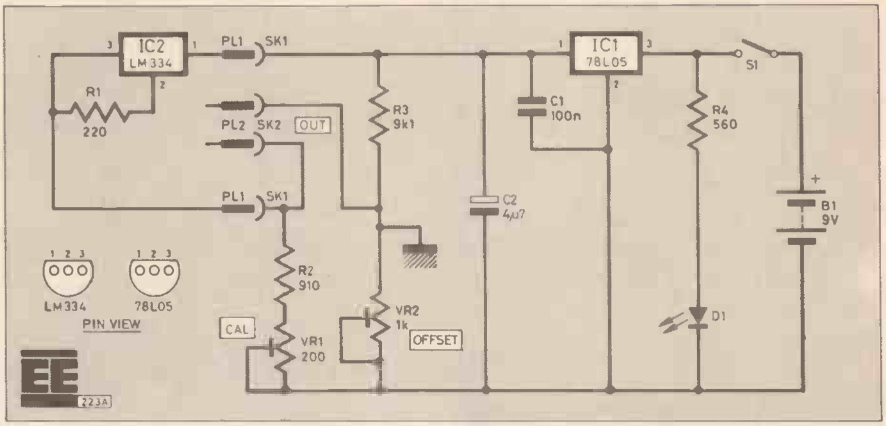


Fig. 1.8. Circuit diagram for the Semiconductor Temperature Sensor using the LM334.

DESCRIPTION OF THE CIRCUIT

The LM334 is a three-terminal device, the current between V+ and V– (Pins 1 and 3) being dependent upon the value of R1 which, in this circuit, is chosen to be 220. This gives a set current which changes at a rate of 1µA per degree centigrade change in the temperature.

This temperature-dependent current is passed through the combination of R2/VR1 and develops across it a p.d. which varies linearly with the temperature of the LM334 sensor. VR1 provides a measure of trim so that the p.d. across R2/VR1 will increase at the required rate of 1mV per degree centigrade change in the temperature.

At 0°C (=273K), the current through the LM334 is, allowing for component tolerances, very nearly 273µA and this produces across R2/VR1 a p.d. of 273mV. When measuring centigrade temperatures in the range 0°C to 100°C we need the output from the circuit to be zero when the sensor is at 0°C. The R3/VR2 combination is used to provide a 273mV positive offset voltage for the negative terminal of the output.

For stable operation, a regulated supply is needed and IC1, a 78L05 voltage regulator, provides a steady +5V supply for both the LM334 and the offset voltage.

CONSTRUCTION OF THE CIRCUIT

This is a relatively straightforward matter if the p.c.b. approach is taken. Components should be inserted as shown in the overlay diagram of Fig. 1.9, noting carefully the orientation of the 78L05 regulator.

The LM334 itself is connected to the rest of the circuit by means of a short length of twin cored cable (it is convenient to locate R1 at the sensor itself rather than on the p.c.b.). The actual lead used can be of almost any length desired because of the very small current which flows in it.

Fig. 1.11 shows a possible "probe" arrangement for the LM334. The LM334 itself is housed in a T092 casing and it resembles a small plastic-coated transistor. Its connections are shown in Fig. 1.8. In the assembly shown, the LM334 is mounted in a short aluminium tube which is closed at one end: the metal casing of an old OC82 transistor was used in the prototype. To ensure good thermal contact between the LM334 and the casing, a small quantity of heat sink compound was used.

The remainder of the probe consists of a length of rigid plastic tube (the case of an old felt-tip pen was used) and the 220 ohm current-setting resistor, R1, was contained in this. The twin lead terminates in a 5 pin DIN plug.

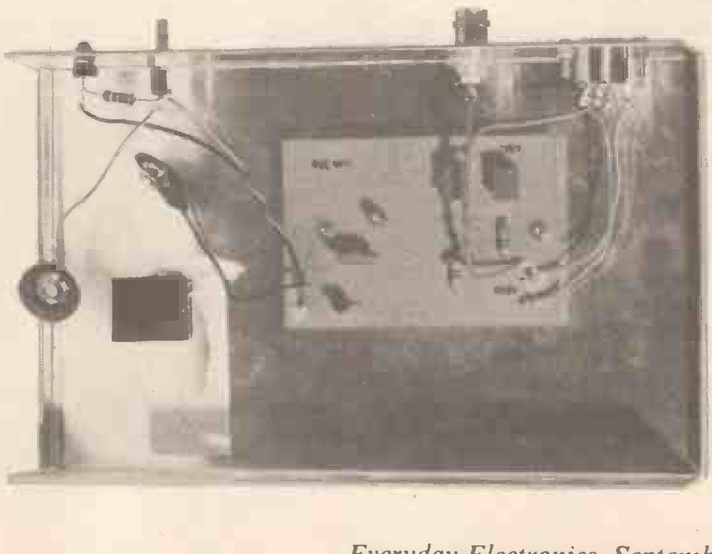
CALIBRATION OF THE COMPLETED TRANSDUCER

Calibration at 0°C and 100°C is necessary and the overall accuracy of temperature measurements will depend upon how accurately these temperatures can be reproduced. However, the linearity of the device does not warrant a precision of better than ±2°C, so melting ice and boiling water should provide adequate calibration points.

The following procedure should be followed:

(1) connect up a DVM to the output terminals and switch on
(2) set DVM to its 200mV range
(3) place the LM334 sensor probe into an ice/water mixture which has stood for ten minutes or so and leave it to reach the temperature of the mixture
(4) adjust the zero offset potentiometer VR2 until a reading of zero is obtained on the DVM
(5) place the probe in boiling water and leave it to reach that temperature
(6) adjust the sensitivity potentiometer VR1 until a reading of 100mV is obtained on the DVM
(7) repeat steps 3, 4, 5 and 6 until no further adjustment of VR1 and VR2 is necessary.

The temperature transducer is now calibrated and ready for use. It is worth noting that it can, in fact, measure temperatures in the range of –50°C to +150°C although with slightly impaired accuracy outside the calibration range.



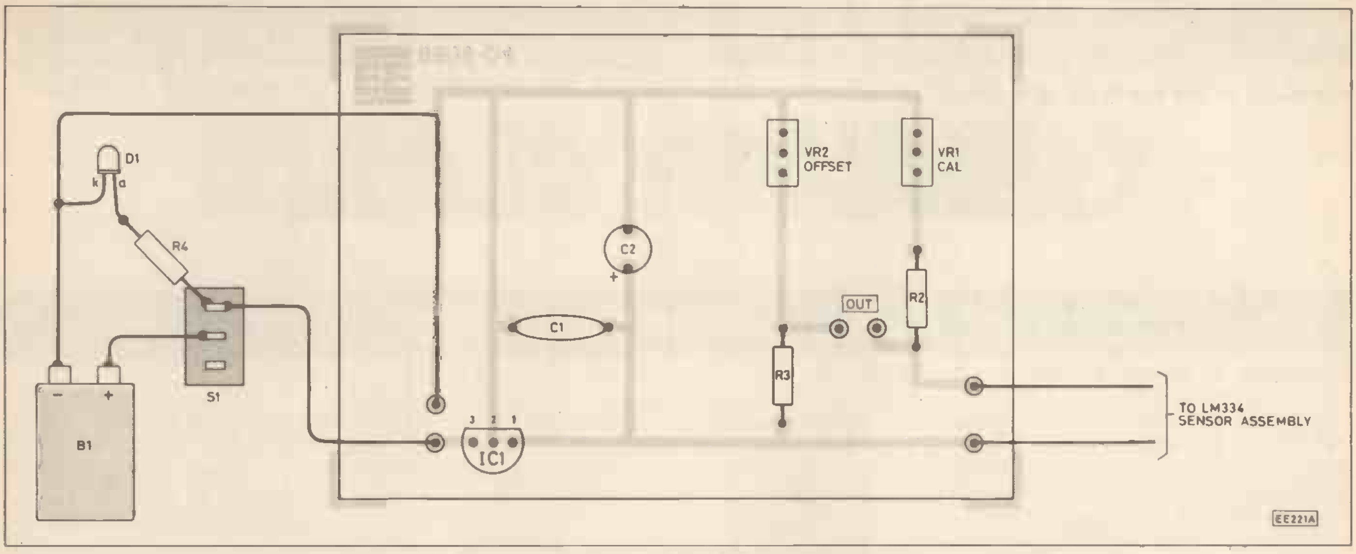


Fig. 1.9. Component layout and interwiring for the Semiconductor Temperature Sensor.

COMPONENTS

SEMICONDUCTOR TEMPERATURE SENSOR

Resistors

R1	220, 1%
R2	910, 2%
R3	9k1, 2%
R4	560, 5%

R1 to R3 $\frac{1}{2}$W metal film/oxide. R4 carbon film. Tolerances as given

Potentiometers

VR1	200, $\frac{3}{8}$in. square. 25-turn cermet trimmer
VR2	1k, $\frac{3}{8}$in. square. 25-turn cermet trimmer

Capacitors

C1	100n polyester
C2	4μ7 elect., radial leads

Semiconductors

D1	green l.e.d.
IC1	78L05 voltage regulator i.c.
IC2	LM334 programmable current source i.c.

Miscellaneous

B1	9V PP3 battery
PL1	5 pin DIN plug
PL2	BNC plug
S1	single-pole, sub-min. changeover switch
SK1	5 pin DIN socket
SK2	BNC socket

Case—203 × 127 × 51mm; printed circuit board, available from the *EE PCB Service*, order code 8509-04; stand-off mounting bushes for p.c.b.; battery connector clips; adhesive pads for battery; tube to house sensor i.c.; interconnecting wire; adhesive feet for case.

Approx. cost Guidance only £18

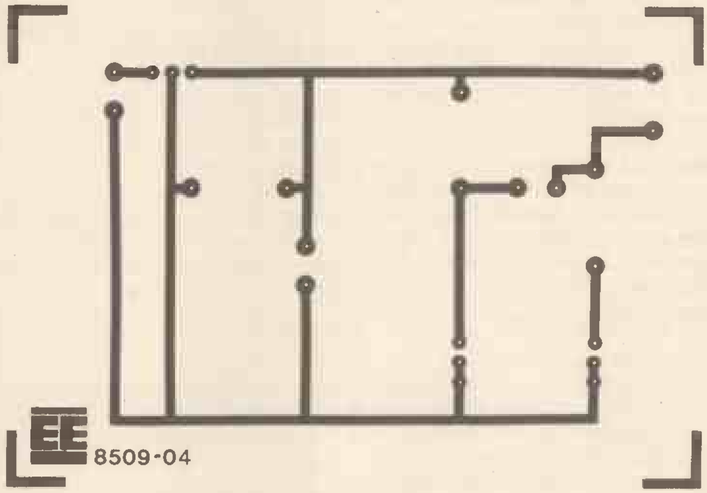


Fig. 1.10. Full size printed circuit board master for the Semiconductor Temperature Sensor. This board is available from the *EE PCB Service*, order code: 8509-04.

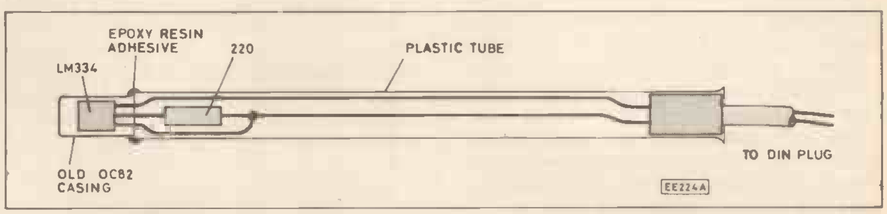


Fig. 1.11. Suggested proble assembly for the LM334.

NEXT MONTH: A strain gauge will be the subject of Part Two of this series.

CARAVAN ALARM

T. R. de Vaux Balbirnie

JUDGING from the large number of boats, bicycles and other valuables left unattended on organised caravan sites, outdoor enthusiasts must be among the world's most honest people.

There are times when the caravan is parked elsewhere, however, and it is here that the sneak-thief keeps a lookout for anything worthy of his attention. Fortunately, simple measures will deter all but the determined professional. This project will protect the caravan itself and also articles left inside and *outside*. In this last respect it is an improvement over existing alarms.

This alarm is only suitable for caravans having an independent 12 volt supply provided by a car battery. Such a system was described in the June, 1983, issue of *EE*. It could be used for other security applications not related to caravanning.

GENERAL DESCRIPTION

The Caravan Alarm is of the "link wire" type where breaking a continuous loop of wire triggers the warning device. On hearing this, the thief should beat a hasty retreat, leaving the goods where they are.

The system consists of a small control box at a secret place inside the caravan and a warning device (a car horn was used in the prototype) mounted underneath. Sockets inside and outside the caravan connect the link wires which pass through frames and handles of valuable articles—bicycles, gas cylinders, cameras, binoculars for example. A wire may be passed through a road wheel slot, effectively immobilising the caravan.

As well as plain link wires, microswitches, reed switches and mercury tilt-switches could all be made part of a comprehensive system. Link wires may be of any reasonable length and should be fitted with plugs and sockets at intervals to allow easy access for adding and removing items.

Once sounding, the alarm will not be silenced by re-connecting the link wire. It will operate for about half-a-minute, or some other preset time, then switch off. The alarm is then "locked out" and will not operate again until reset at the control box. The reason for this is that the thief, unlikely to re-connect the link wire, will not cause the battery to discharge by the circuit recycling and sounding the alarm continuously. This does mean that the system is insensitive to further attempted theft: the thief does not know this, however, and is unlikely to return. It is hoped that the alarm will not be required to operate very often and it is assumed that the owner will check up periodically. An l.e.d. indicator on the unit signals the locked-out condition when the owner returns.

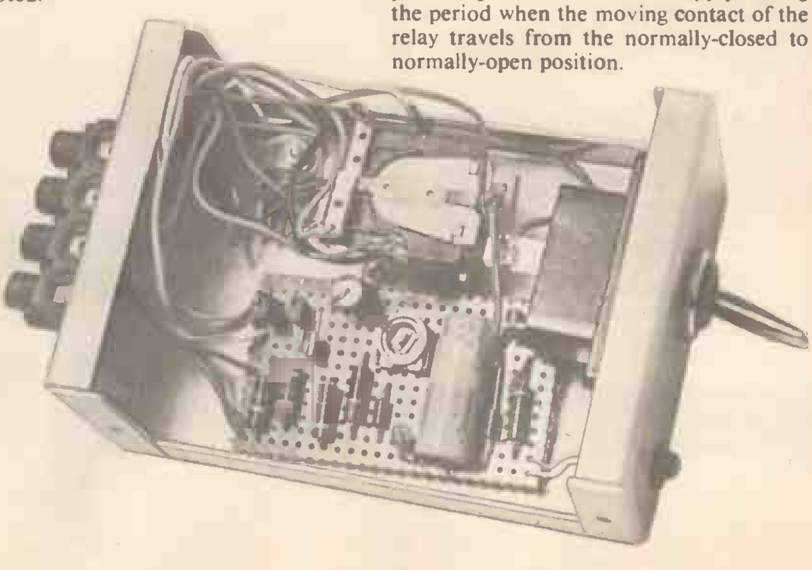
WARNING DEVICE

A car horn is suggested for giving the signal. The reason is that small audible warning devices are not loud enough for the purpose and more powerful devices are very expensive. Although the present circuit could operate any of these devices, car horns are readily available from car breakers' yards and are cheap, loud and weatherproof.

When choosing a used horn, buy a small modern one rather than a large metal-clad type from an old car. The latter consumes more current and could result in a short life for the relay contacts.

CIRCUIT DESCRIPTION

Referring to Fig. 1, it will be seen that TR1 and TR2 form a Darlington pair. The base of TR1 is kept at battery negative voltage as long as the link wire and any normally-closed switch contacts form a continuous circuit between points "A" and "B". This keeps both transistors off. If the link is broken, base current flows through R1 into TR1 via RLA1. The transistors now switch on, and the voltage across R2 rises. This triggers thyristor CSR1 and the warning device connected in its anode/cathode circuit sounds. If the loop is re-connected, the alarm will continue to sound since a thyristor, once conducting, will remain in this state until its anode/cathode current is interrupted.



Note that the collector current, and hence the gate current for CSR1, flows through the normally-closed contacts of relay RLA.

R1 has a very high value so that the continuous drain on the battery when the circuit is on "standby" is exceptionally low—about 6μA. A well-charged car battery can deliver such a current almost indefinitely—in fact, it would discharge by leakage far sooner.

With CSR1 conducting and the alarm sounding, current flows through D1, R5 and VR1. This charges C2 and the voltage across it gradually rises. After a time determined by the values of R5, VR1 and C2, the Darlington pair TR3 and TR4 switch on and the coil of RLA is energised. This component is fitted with a pair of changeover contacts. The normally-closed pair provides the flow of current in the anode/cathode circuit of CSR1. When the relay is energised by TR3/TR4, however, its contacts switch and interrupt the current flow through the thyristor, so silencing the alarm. At the same time, the collector current for TR1/TR2 and gate current to CSR1 stop flowing.

The normally-open contacts "latch" the relay by directing a continuous current through its coil. This is the "locked-out" condition. The l.e.d. (D3) connected in parallel with the coil signals this state. R7 limits the current through the l.e.d. and its value is higher than usual to reduce the current requirement yet allowing the l.e.d. to be sufficiently bright. D2 protects the transistors from possible damage due to the high back e.m.f. produced when the relay switches. C1 ensures reliable latching by providing current from the supply during the period when the moving contact of the relay travels from the normally-closed to normally-open position.

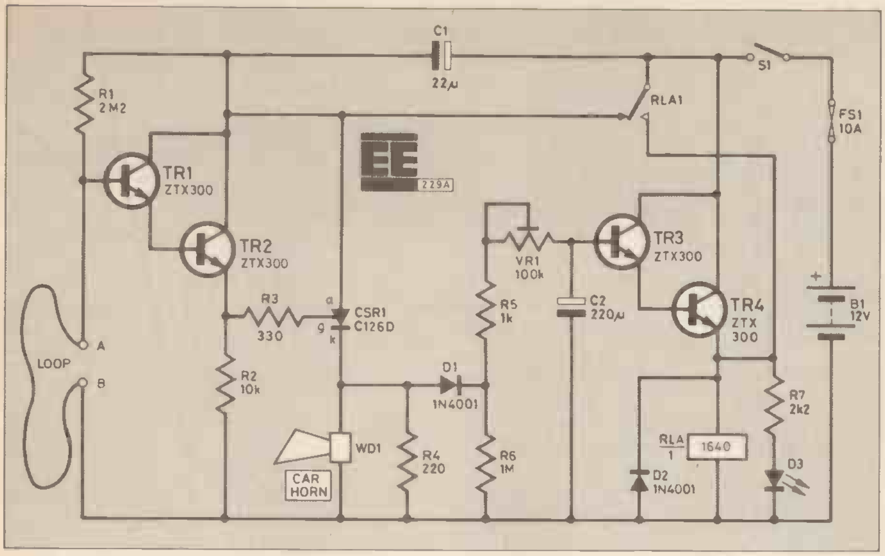


Fig. 1. Complete circuit diagram for the Caravan Alarm.

COMPONENTS

Resistors

R1	2M2
R2	10k
R3	330
R4	220
R5	1k
R6	1M
R7	2k2

All 0·4W ±5% carbon

See Shop Talk page 477

Potentiometer

VR1	100k miniature preset potentiometer —horizontal mounting

Capacitors

C1	22µ elect.15V
C2	220µ elect.15V

Semiconductors

D1,D2	1N4001 silicon diodes (2 off)
D3	TIL220 0·2in. red l.e.d.
TR1,TR2, TR3,TR4	ZTX300 *npn* silicon (4 off)
CSR1	C126D 7·5A thyristor with mounting kit

Miscellaneous

FS1	fuseholder with 10A fuse
RLA	12V d.c., 1640Ω coil, open relay with changeover contacts
S1	s.p.s.t. switch, rated at 6A

Case—102 × 70 × 38mm; 0·1in. matrix stripboard, size 12 strips by 22 holes; 5A terminal block —four sections needed; rubber grommet; horn or other warning device—see text; loop wire, including plugs and sockets as required; adhesive fixing pads (3 off).

When CSR1 is conducting, R4 allows a continuous current to flow. This is necessary since a car horn has internal contacts which repeatedly "make" and "break". Without R4, CSR1 would stop conducting after the first "break". R6 allows C2 to discharge when the alarm is off.

With the circuit locked-out, the current requirement rises to about 15mA. RLA has been chosen particularly for its high resistance coil as well as for contact suitability. This minimises current consumption and the battery could deliver this current for months if necessary.

SOCKETS

It is suggested that one socket is fitted inside and one outside the caravan. Naturally, readers will wish to fit the sockets according to their particular requirements. Any outside sockets should be reasonably protected from the effects of the weather. They should be of a type which does not have one terminal connected to the case.

The sockets, together with the normally-closed contacts of any switches being used are connected in series. Sockets not being used at a particular time will need to be fitted with dummy plugs with the pins connected together to maintain continuity of the loop.

Since S1 carries the total current—including that for the horn—it must be adequately rated—see the components list.

CONSTRUCTION

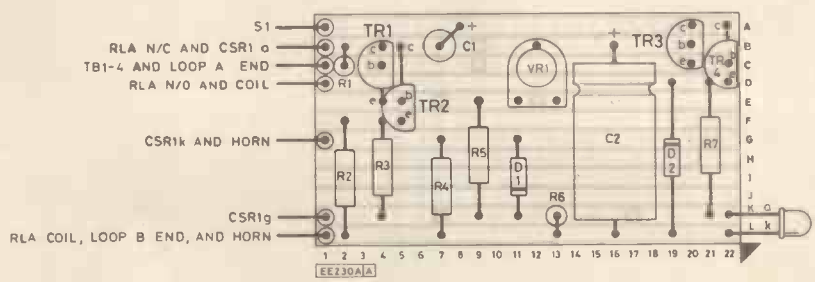
An *aluminium* case should be used for this project, since it acts as a heatsink for CSR1.

Refer to Fig. 2 and construct the circuit panel. In the prototype this was based on 0·1in. matrix stripboard 12 strips by 22 holes in size. Solder all components in position, as indicated, and break the strips in the six places. Note the special mounting of the l.e.d. and take care to observe the polarity of all three diodes and of both capacitors.

Solder connecting leads to strips A, B, C, D, G, K and L. In view of the large number of wires here, it would be wise to follow a colour code to avoid confusion. Finally, check for accidental "bridges" between adjacent copper strips.

Drill the case to accept S1, D3 and for thyristor and terminal block fixings. Drill a hole next to the terminal block position to carry the wires leading from the circuit panel. This hole must be fitted with a rubber grommet. Attach all remaining components and complete the wiring (see Fig. 3). Note that CSR1 is isolated from the case by means of the mounting kit consisting of a mica washer and a plastic bush (Fig. 4).

RLA is attached to the case using an adhesive fixing pad—this avoids metallic contact. If the relay were bolted in position, the case would assume battery positive voltage when the unit was switched on. This could cause a problem when mounting the



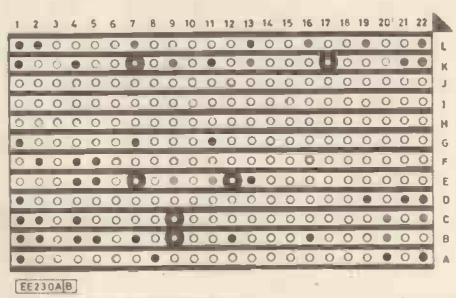


Fig. 2. Stripboard component layout and underside detail showing breaks to be made in the copper tracks.

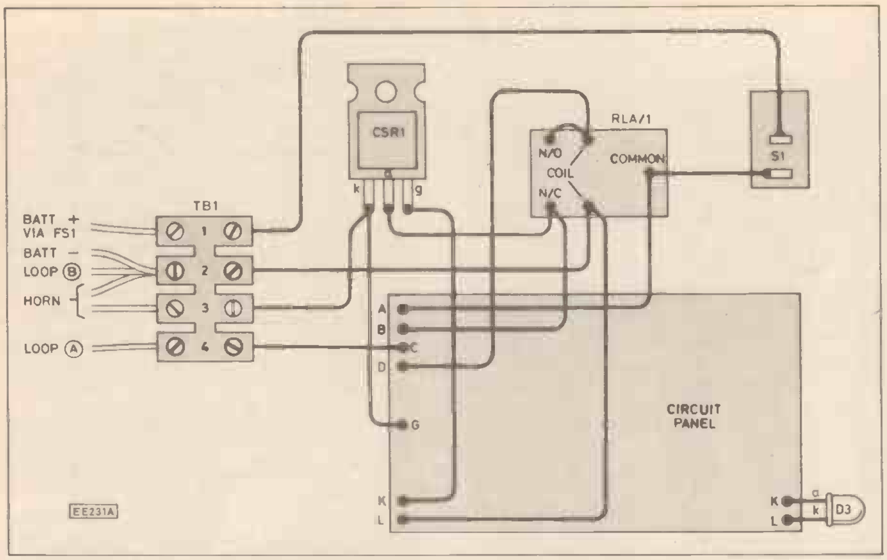


Fig. 3. Interwiring details for case mounted components. Note that the l.e.d. (D3) should be fixed using a plastic mounting clip.

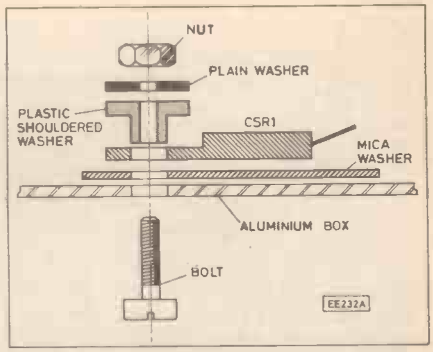


Fig. 4. Method of fixing the thyristor (CSR1) on the case using the mounting kit.

finished alarm since any metallic contact between the case and the caravan body would result in a short circuit and FS1 would blow.

The circuit panel itself is attached using a further adhesive pad. Make certain that no soldered connections on the underside can penetrate the pad and cause a short circuit to the case. Check that, with the lid in position, all connections remain well clear of the metal work.

TESTING

It is kinder on the neighbours if testing is carried out using a lamp instead of the horn! Begin by adjusting VR1 to approximately mid-track position. With S1 off, make the connections to TB1. Include the line fuse-holder carrying a 10A fuse in the positive battery lead. Use a short length of connecting wire to represent the link. Switch on and nothing should happen.

Now disconnect the link wire from TB1–4. The lamp should light and remain lit even if the link wire is re-connected. After a time, the lamp should go off and the l.e.d. will be seen to be glowing.

The circuit is reset by switching S1 off for a few seconds then on again. Adjust VR1 to give the desired delay time.

INSTALLATION

After a test with the horn, the circuit is ready for permanent installation. Another adhesive pad may be used to secure the box to the inside of the locker.

Do not omit the line fuse in the positive battery lead, as shown in Fig.1. With some horns, the negative connection is made through the vehicle chassis. In this case, simply connect TB1–2 to the chassis and omit the negative lead to the horn. □

Actually Doing it!!

IDENTIFYING component types is one thing, selecting the right value is another. It is easy enough to identify a resistor, but it is a little more difficult to distinguish between (say) a 2k2 resistor and a 10M type. This is due to the extensive use of colour codes to mark values on resistors, and to a certain extent on capacitors as well. The use of colour codes may seem to be an unnecessary complication, and from the beginner's point of view it is, but there are real advantages. The main one is that colour codes are less easily damaged to the point where they become unreadable than values that are marked using straightforward alpha-numeric characters. Another advantage is the ease with which the experienced user can pick out a component of the required value from a large batch of components. If the values are written on it, it is necessary to check through the components one-by-one until the required value is found.

Until recently the four band system was the only type of resistor colour coding in common use, but now a five band system receives a limited but significant level of use. Fig. 1 helps to explain these two very similar systems, but we will start with the four band coding. The first coloured band is the one which is marginally the nearest to one end of the resistor, and this gives the first digit of the value. Similarly, the second band gives the second digit. For example, red and violet respectively represent 2 and 7 when they appear as the first or second band, as shown in the table in Fig. 1. The third band is the multiplier, and indicates the amount by which the first two digits are multiplied in order to give the value in ohms. Again taking a simple example, orange represents ×1000, and a resistor having red, violet, and orange as its first three bands would have a value of 27000 ohms. A thousand ohms is usually abbreviated to a "kilohm" or "k", and a million ohms is normally abbreviated to a "megohm" or just "M". A 27000 ohm resistor would therefore be shown as 27k on a circuit diagram or in a components list.

The fourth band indicates the tolerance of the resistor. This simply means the guaranteed maximum error in the value of the component, bearing in mind that no resistor has precisely its marked value. A 100 ohm resistor with silver (10%) as its fourth band would have a true value of anywhere between 90 and 110 ohms. It is perfectly alright (if a trifle extravagant) to use a resistor having superior tolerance to that called for in the components list, and a 1% type could be used instead of a 5% type, but it would be unwise to use a component having an inferior tolerance rating to the one specified.

The five band coding is normally only found on resistors having a tolerance of 1% or better, and it accommodates non-standard values which are not available to amateur users. The first three bands indicate the first three digits of the value, but the third one will almost invariably be black (0). The fourth and fifth bands indicate the multiplier and tolerance, as in the four band system. Orange, orange, black, red, brown therefore represents 33k (3–3–0 × 100=33000 or 33k) with a tolerance of 1%. Probably the easiest way to tackle five band codes is to ignore the third band, work out the value using the four band system, and then multiply this by ten to compensate for the ignored band.

		Band Number				
	4 Band Codes	1	2		3	4
	5 Band Codes	1	2	3	4	5
Colour	Silver	—	—	—	0·01	10%
	Gold	—	—	—	0·1	5%
	Black	0	0	0	1	—
	Brown	1	1	1	10	1%
	Red	2	2	2	100	2%
	Orange	3	3	3	1000	—
	Yellow	4	4	4	10000	—
	Green	5	5	5	100000	—
	Blue	6	6	6	1000000	—
	Violet	7	7	7	—	—
	Grey	8	8	8	—	—
	White	9	9	9	—	—
	None	—	—	—	—	20%

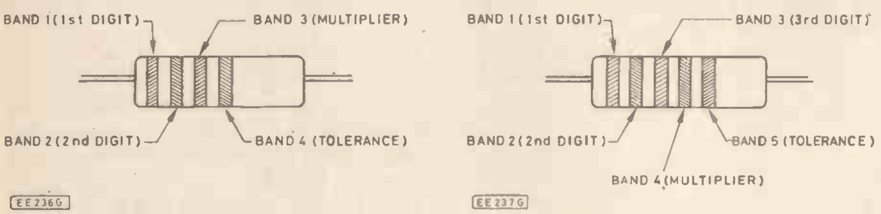


Fig. 1. Four and five band resistor colour codes. Do not assume that a resistor having a similar code to the one you require will have a similar value. If the "multiplier" is wrong the value will be wrong by a factor of at least ten.

Capacitor Codes

The Mullard C280 series and similar polyester capacitors are the only common types which use colour coding, although these days even these are not always colour coded. Fig. 2 shows the coding system used for this type of capacitor, and it is very similar to the four band resistor system. The first three bands give the value in exactly the same way, but it is in pico farads (pF) rather than ohms. Divide the value by 1000 to convert it to nano farads (nF) or 1000000 to convert it to micro farads (μF). If the first three bands were brown, black, and yellow, this would indicate a value of 100000pF (1–0 × 10000=100000). Pico farads are not normally used for large values, and 100000pF would be more likely to appear in the form 100nF or 0·1uF.

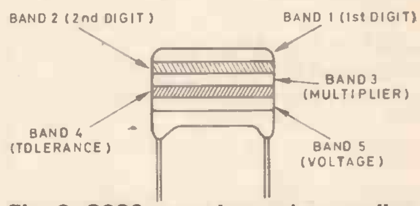


Fig. 2. C280 capacitor colour coding. This first three bands give the value (in pF) using the same system as for the four band resistor coding.

		Band	
		4	5
Colour	Black	20%	—
	White	10%	—
	Green	5%	—
	Orange	2·5%	—
	Red	2%	250V
	Brown	1%	—
	Yellow	—	400V

The fourth band indicates the tolerance, and the fifth one shows the highest d.c. voltage to which the component should be subjected. Voltage ratings are often omitted from components lists, and this is simply because most types of capacitor have very high voltage ratings whereas modern circuits mostly operate at low voltages, giving no risk of exceeding the voltage ratings.

Robert Penfold

DOWN TO EARTH

BY GEORGE HYLTON

"I RECENTLY bought some neon lamps designed for 240V a.c. operation. The lamps are sealed into a translucent plastic enclosure, and it is not possible to see if a current-limiting resistor is incorporated. How can I find out if it is, without breaking open one of the lamps?"

NEON LAMP CHARACTERISTICS

An interesting question. The characteristic of a neon lamp is that it passes no current until a critical voltage is applied. Then it "strikes", passing a current which rises almost without limit, and is destroyed, unless sufficient resistance is included in the circuit. Generally speaking, neons strike at around 120V and then "run" at a lower voltage, around 70V.

In the usual circuit (Fig. 1) the current is limited by R1. The behaviour of the lamp is shown in Fig. 2, where the upper curve is the mains voltage. The shaded part is the voltage which appears across the lamp. During each mains cycle this rises to the striking voltage (say 120V), falls instantly to the running voltage (say 70V), and then stays there, until the lamp goes out when the voltage falls too low to sustain the current. The voltage then follows the mains wave until the striking voltage is again reached during the next half cycle, when the process repeats.

Thus the lamp lights for a substantial portion of each half-cycle. For 50 Hz mains, this means that it lights 100 times a second. The current flows as shown in the lower graph.

To return to our problem: a typical current for a miniature neon of the type used in "mains on" indicators is 1mA. If the running voltage is 70V and the mains 240V this leaves 170V to be absorbed by R1. Of course the voltage changes over the mains cycle: 170V is an average. For a current of 1mA, R1 must be about 170k. Neon lamps are not precision components and the running voltage varies. So a likely standard-value resistance would in this case be 180k or 150k.

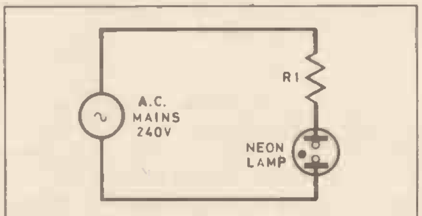


Fig. 1. Neon lamp circuit. EE238G

It's no use connecting an ohmmeter across the "unknown quantity" lamp, because the meter's internal battery voltage is far too low to make the lamp strike. So the resistance reading stays firmly at infinity.

The solution to the problem is to raise the voltage to well above the striking voltage, but make sure the current is limited. Perhaps the easiest way is to make use of the mains in a circuit with an additional resistor, R2, and a voltmeter, as shown in Fig. 3. Here the dotted-round part is the lamp unit. At present we don't know what value R1 has—if there is no built-in resistor it is zero! So we choose R2 to limit the current. Neons can be run for short periods at greater than normal currents so we needn't be too fussy about the size of R2—a reasonable value is 100k. (When making the test remember that the mains can be *lethal* and take precautions against contact with the circuit).

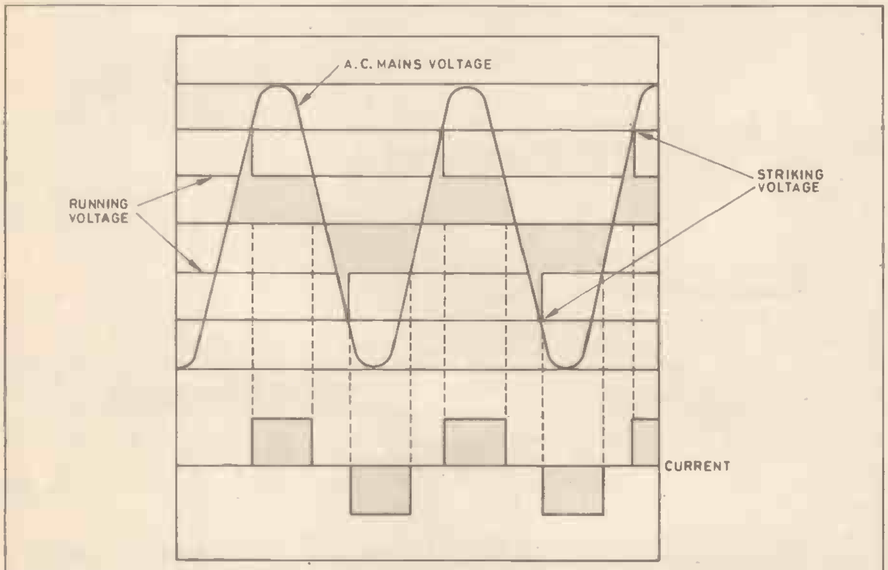


Fig. 2. Characteristic mode of operation for a neon lamp.

CALCULATING RESISTOR VALUES

Suppose we connect up and the neon lights, and the voltmeter across R2 reads 100V. This leaves 140V across the lamp unit. This is so much greater than the running voltage that R1 must be present.

If there is no meter-loading error, i.e. if 100V is the true voltage, then the current must be 100V/100k=1mA. If the neon runs at 70V then there must be 70V across R1 (since R1 and the neon together absorb 140V). It follows, since we have a current of 1mA through an unknown resistance which drops 70V, that R1 must be about 70k—in practice, probably larger.

When the lamp is operated normally, without R2, there must be about 240–70V=170V across R2 and the current must be 170/70000=2.4mA approximately.

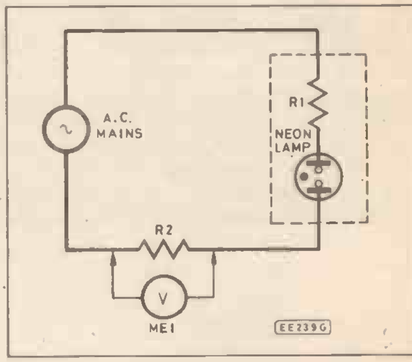


Fig. 3. Circuit for determining the approximate value of the ballast resistor.

BALLAST RESISTORS

The current limiting (or "ballast") resistor R1 must be adequately rated. For a 1mA neon the amount of power dissipated by R1 is quite small. Even if the full 240V appeared across a 100k resistor its dissipation would only be 240mW, so a "quarter-watt" component would just do.

However, resistors also have maximum voltage ratings. The voltage in this type of circuit might well exceed this rating in the case of some types of resistor. So if you find that a ballast resistor must be added, err on the side of making it too large (electrically or physically) rather than too small.

Neons emit some light even when the current through them is minute, which is why they are used (with large-value ballast resistors) in the "mains tester screwdrivers" used by electricians. A few microamps through the body is harmless.

RIAA PREAMPLIFIER INPUT SELECTOR

R.A. PENFOLD

LIKE practically any branch of electronics, things in the audio world have changed steadily over the years. This can lead to a situation where a piece of equipment that has served its purpose well for several years becomes dated and lacking in certain respects. In the case of the author's tuner/amplifier the power amplifier section still offers a respectable level of performance, and in the lower to middle price range power amplifier designs have changed surprisingly little over the past few years. A point that is demonstrated by the fact that several popular amplifiers are still in production and selling well after four or five years.

At the front end things are a little different. A few years ago signal to noise ratios of about 60dB were common for magnetic pickup inputs, but these days a signal to noise ratio of over 70dB can be achieved using readily available components. Presumably due to deteriorating electrolytic smoothing capacitors, the level of mains "hum" from a magnetic pick-up preamplifier often increases over a period of years, and can become comparable or even slightly higher than the ordinary background "hiss". Another problem is simply that these days many people wish to use a variety of signal sources, such as different types of tape deck and a compact disc player. While most modern amplifiers and receivers are well equipped with input sockets, older types generally just have pick-up and tape inputs, plus a single auxiliary input.

This project is designed to overcome these shortcomings by providing three switched inputs that feed into the auxiliary input of the amplifier or receiver. A high quality, low noise magnetic pick-up preamplifier is included at one input, and this is used in place of the built-in preamplifier. The other two inputs just feed straight through to the auxiliary input, and are suitable for items of equipment such as a second tape deck and a compact disc player. In other words the unit effectively provides an extra auxiliary input and a high quality magnetic pick-up input.

EQUALISATION

A magnetic pick-up preamplifier must provide a fairly high voltage gain since the output from this type of pick-up is typically only around five millivolts r.m.s., whereas a power amplifier normally requires an input signal at about one hundred times this level. However, the preamplifier must also provide equalisation (tailoring of the frequency response) in order to give the system a flat overall response.

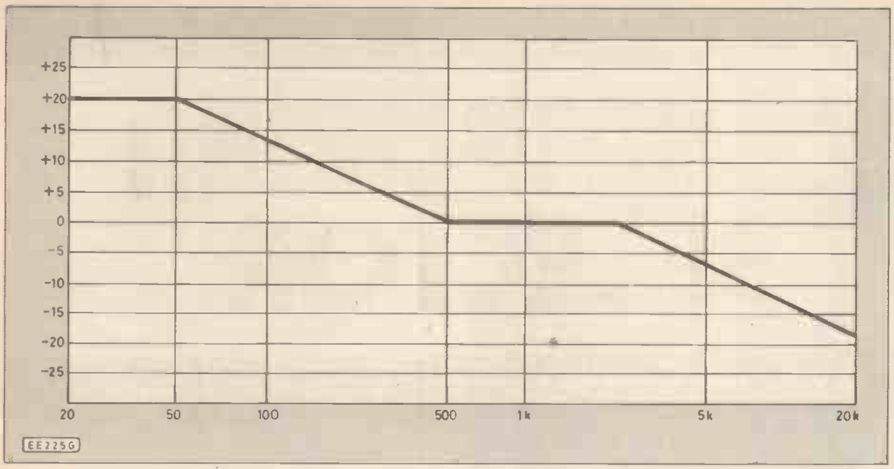
The equalisation during playback is needed to counteract the RIAA equalisation which is introduced during the recording process. The RIAA (recording) equalisation characteristic really consists of two separate sections. One of these is the pre-emphasis that is used in most broadcasting and recording systems. This consists of a certain amount of treble boost at the recording or transmission stage (the pre-emphasis), and complementary treble cut at the receiver or playback equipment (de-emphasis). The result is an overall frequency response that is flat, but an improved signal to noise ratio due to the treble cut used during playback. This reduces background noise of the "hiss" variety which is an inherent part of any recording or transmission system.

The treble boost used during the recording process consists of a 6dB per octave boost at frequencies above 2120Hz. In more simple terms, a doubling in frequency above 2120Hz results in a doubling of the voltage gain. The preamplifier must therefore provide a 6dB per octave roll-off above 2120Hz (doubling in frequency giving a halving in the voltage gain).

The other part of the equalisation is a 6dB per octave roll-off at frequencies from 500Hz to 50Hz, and the preamplifier must therefore provide a boost of 6dB per octave over this frequency range. The purpose of this equalisation is to prevent excessive groove modulations. It has to be remembered here that the movement of the cutting head varies not just with the signal amplitude, but with frequency as well. The method of recording used for all normal records is the constant velocity type, where the speed at which the cutting head moves is controlled by the amplitude of the signal (the higher the amplitude the higher the velocity). The frequency of the signal is irrelevant. As a result of this, at high frequencies the cutting head has hardly started to move in one direction before the signal starts to decay, and then a change of polarity dictates a move in the opposite direction. This gives a large number of very small groove modulations.

With low frequencies a much longer time passes before the signal level starts to fall back to zero and change polarity, so that much larger but fewer groove modulations are produced. This is exactly the same effect that results in no perceptible movement of a loudspeaker cone if the unit is fed with a strong high frequency signal, whereas a low frequency signal of the same strength is sufficient to practically drive the diaphragm against the end stops.

In a disc recording context the effect of the large low frequency modulations would be to result in the grooves merging together, and the vertical movement of the cutting head could presumably result in holes being



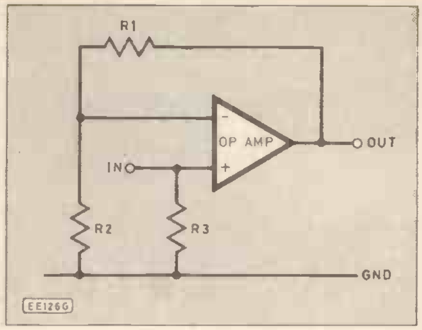


Fig. 2. Op.amp non-inverting mode configuration

Fig. 1. The ideal RIAA playback characteristic

cut right through the master disc. Obviously the problem could be overcome simply by reducing the amplitude of the whole signal, but this would give an unacceptable reduction in the signal to noise ratio of around 20dB. By only reducing the amplitude of low frequency signals the signal to noise ratio only deteriorates at these frequencies. While even this loss of performance is undesirable, it does not prevent excellent results from being obtained in practice.

The ideal playback response for an RIAA playback amplifier is shown in Fig 1. The sub-audio response is not shown, but this should be rolled off so that any sub-audio signals generated by record warps etc. are attenuated.

FEEDBACK

Frequency selective negative feedback is the normal way of providing RIAA equalisation, and most circuits are based on an operational amplifier working in the non-inverting mode, or an equivalent of this. Fig 2 shows the basic circuit for an operational amplifier in the non-inverting mode.

Three resistors are used to control the voltage gain and input impedance of the amplifier. Resistor R3 biases the non-inverting input to the 0V earth rail, and as an operational amplifier (in theory anyway) has an infinite input impedance, the input impedance of the amplifier is equal to the value of R3. In practice the input impedance will be slightly lower than R3, but the margin of error is normally too small to be of any consequence.

Resistors R1 and R2 are the negative feedback network which control the voltage gain of the circuit. In theory an operational amplifer has infinite voltage gain, and in practice it is extremely high at d.c. and low frequencies. The signal which is amplified is the voltage difference across the two inputs. As one would expect, a positive output is produced if the non-inverting (+) input is at the higher voltage, and a negative output is generated if the inverting (–) input is at the higher voltage. Due to the very high voltage gain of the operational amplifier only a very small voltage difference is required across the inputs in order to drive the output fully positive or fully negative.

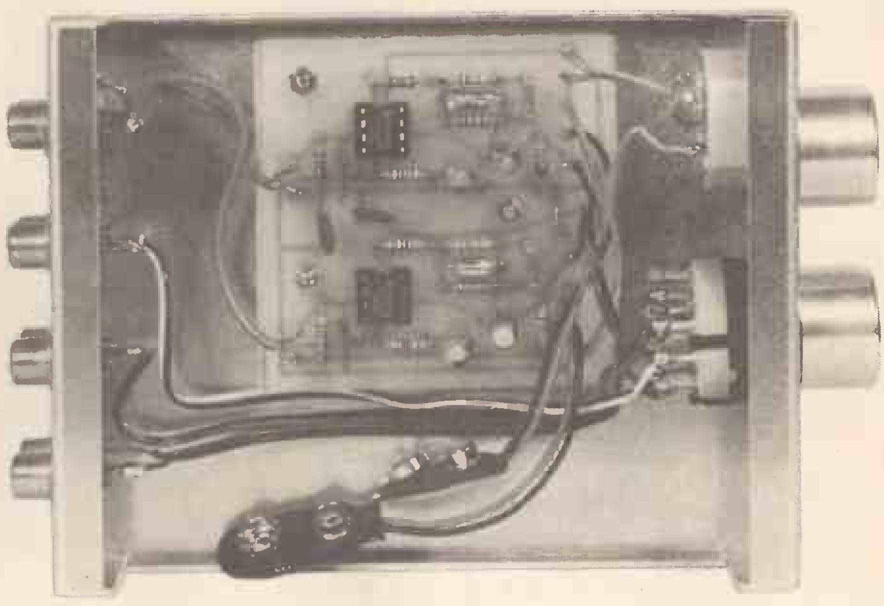
The effect of R1 and R2 is to maintain a voltage balance at the two inputs of the operational amplifier. Thus, under quiescent conditions the output is maintained at precisely the same voltage as the non-inverting input, or at the earth rail potential in other words. This must be so, since a positive output potential would take the inverting input more positive due to the coupling via the potential divider formed by R1 and R2. This would unbalance the inputs, sending the output negative to restore the balance. A negative output potential would have a similar effect, but by taking the inverting input negative of the non-inverting one the output would be sent more positive, again restoring the balance.

If R2 is omitted, the output will be at the same potential as the inverting input since there will be no significant voltage drop through R1. The output is therefore maintained at the same voltage as the non-inverting input due to the balancing action, and the circuit acts as a unity voltage gain buffer stage. With R2 in circuit things are different, as R2 introduces losses through R1 by a normal potential divider action. This necessitates a larger output voltage for a given input voltage in order to maintain the input balance, and the circuit provides voltage gain. In fact the voltage gain is equal to (R1 + R2)/R2. This is the "closed loop" gain (the gain of the circuit as a whole) which should not be confused with the "open loop" gain (the gain of the operational amplifier itself).

PRACTICAL CIRCUIT

The circuit diagram for one channel of the stereo preamplifier is shown in Fig 3. Most of the components are duplicated in the other channel, but exceptions are C1, C2, S2, and the batteries. Switch S1 is a three way four pole rotary switch, but in this circuit only two poles are used (one in each channel). In the components list and construction diagram the components in the second channel are ten higher than those in the first channel (e.g. the equivalent of C1 in the other channel is C11).

The circuit has dual balanced supplies, which is normal for operational amplifier circuits where the output may need to have



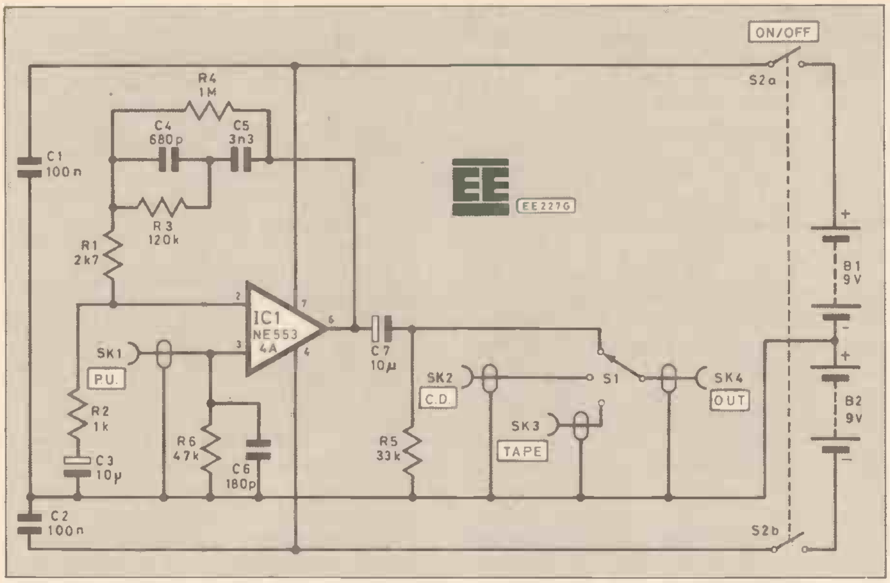
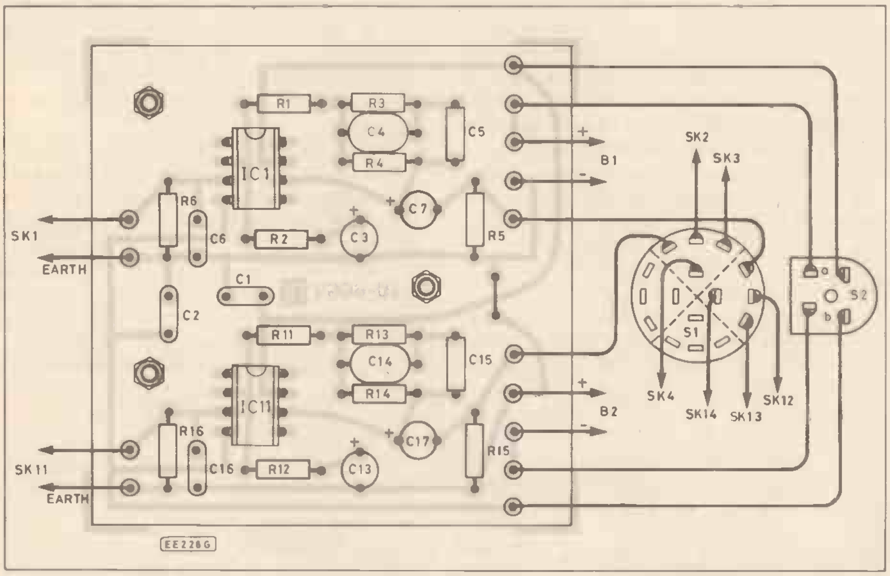


Fig. 3. Circuit for one channel of the RIAA Preamplifier Input Selector



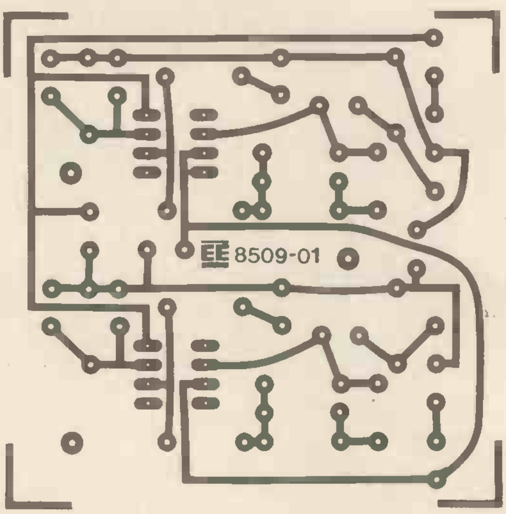
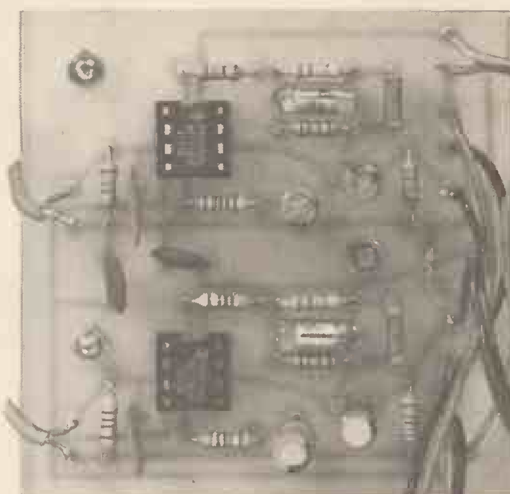


Fig. 4. Layout and wiring of the unit



COMPONENTS

See **Shop Talk** page 477

Resistors

R1,R11	2k7 (2 off)
R2,R12	1k (2 off)
R3,R13	120k (2 off)
R4,R14	1M (2 off)
R5,R15	33k (2 off)
R6,R16	47k (2 off)

All $\frac{1}{4}$W 5% carbon

Capacitors

C1,C2	100n ceramic (2 off)
C3,C7, C13,C17	10u 25V radial elect. (4 off)
C4,C14	680p polystyrene (2 off)
C5,C15	3n3 carbonate (2 off)
C6,C16	180p ceramic plate (2 off)

Semiconductors

IC1,IC11	NE5534A (2 off) low noise op. amp.

Miscellaneous

S1	3 way 4 pole rotary switch
S2	Double pole rotary on/off switch
SK1 to SK14	Phono sockets (8 off)
B1,B2	9 volt PP3 size (2 off)

Printed circuit board, available from the *EE PCB Service*, order code 8509-01; two control knobs; aluminium case about 133 by 102 by 38mm; two 8 pin d.i.l. i.c. holders; two PP3 style battery connectors; wire, solder, etc.

Approx. cost Guidance only **£15.00**

either polarity with respect to the earth rail. The unit could be powered from a mains power supply capable of providing between about plus and minus nine to 15 volts at a few milliamps, but care would have to be taken in order to avoid stray coupling of mains hum into the signal path. With a battery supply the hum level of the circuit is zero, and there is no problem with induced hum if the unit is positioned close to the pick-up.

Resistor R6 is the bias resistor for the non-inverting input of IC1, and a value of 47k is a suitable match for most pick-ups, but obviously a different value could be used here if necessary. Capacitor C6 serves two purposes; firstly it helps to prevent stray high frequency feedback from producing instability, it also helps to give a higher capacitance load for the cartridge, which usually gives a flatter frequency response. However, if the unit is used in conjunction with one of the few cartridges that are intended for low capacitance loads it might be beneficial to reduce the value of C6 and C16 to 47p.

The negative feedback circuit is more complex than just two resistors, and R1 in Fig 2 is replaced in the practical circuit with three resistors and two capacitors. The capacitors have an impedance that is frequency dependent. Their impedance reduces as the frequency is increased, and this property provides the equalisation. At low frequencies neither C4 nor C5 provide a low enough impedance to significantly affect the voltage gain of the circuit, and it is consequently set at about 60dB (1000 times) by the feedback resistors.

At higher frequencies C5 exhibits a lower impedance, and it effectively shunts R3 across R4 at frequencies above 500Hz, giving a voltage gain of about 40dB (100 times) and effectively producing the required bass boost. At frequencies of more than about 2kHz or so the impedance of C4 falls to a significant level and provides the treble cut. The equalisation curve obtained will not precisely match the ideal RIAA replay characteristic, but errors are normally within 1dB and are not significant.

Capacitor C3 provides the sub-audio roll-off part of the RIAA replay characteristic. It also provides d.c. blocking so that the d.c. voltage gain of the circuit is unity rather than 1000 times. This is important as practical operational amplifiers have small offset voltages, this results in the output drifting away from the earth potential, and a high d.c. voltage gain can multiply this effect to the point where the circuit fails to operate properly. Capacitor C7 and resistor R5 are used to eliminate any small d.c. offset that is present at the output of IC1.

The NE5534A specified for IC1 is a special very low noise and distortion type intended for critical audio applications. The circuit will work using less expensive operational amplifiers such as the LF351 and TL071, but these would provide a signal to noise ratio some 10dB or more higher. With the NE5534A the signal to noise ratio is typically about 75dB with reference to an output of two volts peak to peak. Incidentally, the standard NE5534 will also operate well in the circuit, but would give slightly inferior results.

Switch S1 is the input selector switch, and this merely couples the required signal source through to the output socket.

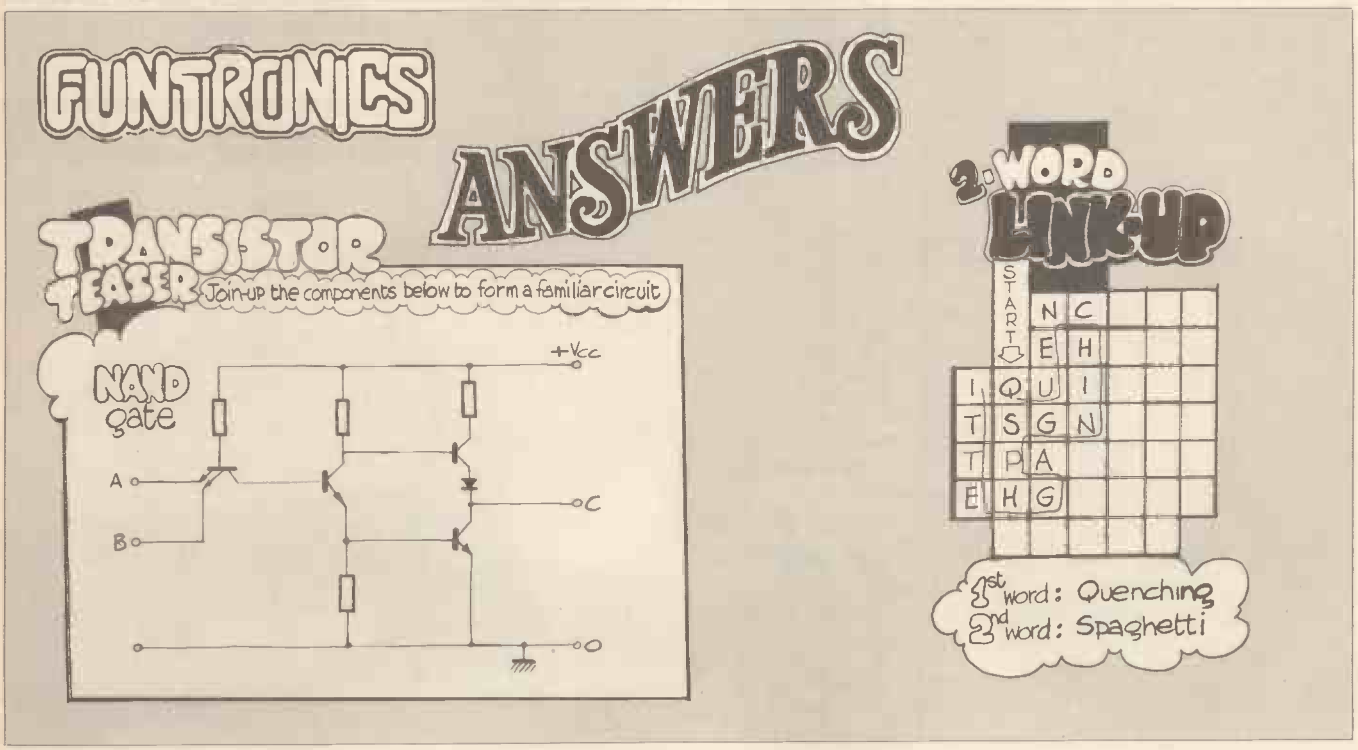
CONSTRUCTION

Details of the printed circuit board and wiring are shown in Fig 4. The printed circuit board is straightforward and easy to construct or may be purchased from the EE PCB Service. The NE5534A is not a MOS integrated circuit, but as it is a fairly expensive device it is definitely still worthwhile fitting IC1 and IC11 in 8 pin d.i.l. i.c. holders. Printed circuit pins are used at the places where connections to off-board components will be made when the board is wired to the rest of the unit.

An aluminium box which measures approximately 133 by 102 by 38 millimetres is suitable as the housing for this project. Most other cases of about this size should also be suitable, but a metal case should be used so that the circuit board and wiring are screened from sources of electrical interference. Also, some earth connections are carried via the case which must therefore be of metal construction. The two controls are mounted on the front panel, the sockets are fitted on the rear panel, and the circuit board is mounted on the base panel of the case, leaving sufficient space for the batteries to one side of the board. Spacers are used over the mounting bolts to keep the connections on the underside of the board clear of the metal case.

To complete the unit the point to point wiring is added. It is a good idea (but not essential) to use screened leads to connect the board to SK1 and SK11, but ordinary hook-up wire can be used for the other leads.

In use the unit is connected to the rest of the system via normal twin screened phono leads. The unit must, of course, be switched on when the preamplifier is in use, but at other times it should be switched off to conserve the batteries. It is possible that with some combinations of cartridge and amplifier a higher level of gain will be needed. This can be accomplished by reducing the value of R2 and R12 to 560 ohms.□



The Man Behind the Symbol

Nº3 André Marie Ampère

by Morgan Bradshaw

WE HAVE seen how Volta's discovery enabled man to produce low electric power from batteries, but to obtain higher power he had to make magnets move. The man who did much to establish the relation between electricity and magnetism or, as he called it "electrodynamics", was the French mathematician and physicist Ampere who gave his name to the practical unit of electric current. (Table 1).

INFANT PRODIGY

Andre Marie Ampere was born on 22 January 1775, in the village of Polemieux, near Lyons, the son of a merchant, who was also the local Justice of the Peace.

Young Andre showed astonishing capabilities at a very early age. He had a phenomenal memory and it is said that he was calculating before he could read or write. He had read all the books in the family library by the age of eleven and written a treatise on conic sections by the age of 13.

His father took him to the Academy in Lyons to use the library, and young Andre discovered that he would have to learn Latin in order to study the great works of reference which were printed in that language. This he did in record time. He had already become an accomplished mathematician, and he had studied botany and zoology, quite an achievement for a boy who had never been to school and who was completely self taught.

COMES THE REVOLUTION

Then in 1793 tragedy struck. Lyons had revolted against the tyranny of the French Revolution, the army of the Convention who hated all forms of authority captured the town and Andre's father was thrown into prison, and soon after taken to the Place Bellecour and publicly guillotined. Forced to watch, the shock was so great upon the mind of the eighteen year old Ampere that he remained in a state of apathy and near madness for almost three years.

Then in 1796 he met Julie Carron who gave him back his "zest for life". By this time he was short of money and, so that they could be married, Ampere started to give private lessons in mathematics and languages. On 2 August 1799 at the age of 24, he married his beloved Julie and one year later a son Jean Jacque (named after his grandfather) was born. Once again Andre was a happy man, he was now Professor of Physics and Chemistry in the town of Bourg, but after one year he accepted a senior post at the Academy at Lyons where he had astonished the professors with his capabilities when a child.

In 1804 tragedy struck Ampere a second blow, his wife to whom he was devoted, died of a chest disease. He did little for five years except to compose some tragic latin verse. Then in 1809 after publishing a thesis on the mathematical theory of gambling, he was recommended for the post of Professor of Mathematics at the Polytechnic in Paris.

He lived only for his work publishing many scientific papers, was elected to the Academy of Science in 1814, and made Inspector General of the French Universities, a post involving much travel.

OERSTED GETS THE NEEDLE

On 11 September 1820 the academy heard that the Dane, Hans Christian Oersted (who we will meet later), had discovered that a magnetic compass needle moved when placed near a wire carrying an electric current.

TABLE 1: THE AMP (A)

The flow of electric current is measured in amps. Just as we used the water pressure analogy for the volt (V), so we can compare electric current with the flow of water.

As a practical example the current which flows through a domestic chandelier holding four, 60-watt lamps when connected to a 240V mains supply would average one ampere (A).

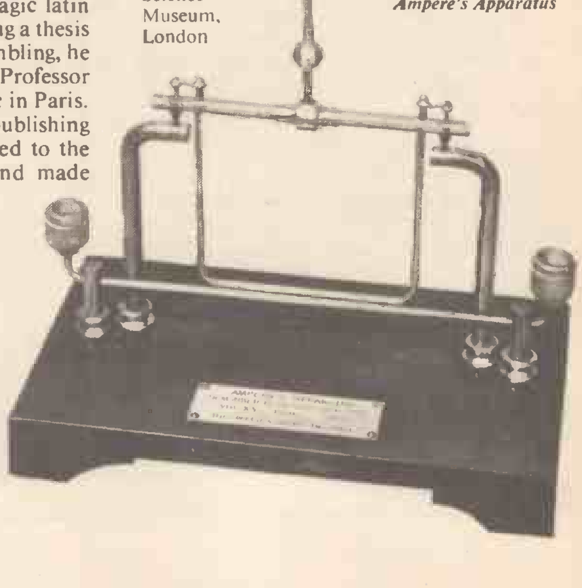
Sir Charles Bright, the English telegraph engineer who supervised the laying of the first Atlantic cable, was one of the first to recognise the need for a practical unit of current with an internationally acceptable name and in 1881 the Ampere along with the Volt was adopted at the first meeting of the International Electrotechnical Commission.

The volt is the product of the ampere and the ohm.

The news of this discovery so excited Ampere that he worked night and day experimenting on the relationship of electricity and magnetism, and just one week

Photos: Science Museum, London

Ampère's Apparatus



later on 18 September he presented to the academy the results of his experiments which showed that when electric current is passed through two parallel wires in the same direction they are attracted, and when the current flows in opposite directions they repulse.

He also proved that the force of attraction or repulsion is directly proportional to the strength of the currents, and inversely proportional to the square distance between them. This became known as *Ampere's rule.*

Ampere was now completely dedicated to the new source of power. His little workshop was crowded as he demonstrated his many experiments including one that showed the action of the earth's magnetic field on a wire in which current flows. His discoveries led to many developments based upon magnets especially the electromagnet, the heart of the telegraph.

He gave many public demonstrations and one of his contemporaries reported "a gasp would go up from the audience as Ampere twisted insulated copper wire round an iron horseshoe joined the ends of the wire to Volta's battery, and showed how the horseshoe attracted a quantity of nails, and how it let them fall the moment the current from the battery was shut off".

Ampere died of pneumonia in Marseilles on 10 June 1836 and his death was transmitted to Paris by the Semaphore. Yet to come was the telegraph, telephone, and radio for which he had helped lay the groundwork.

COUNTER INTELLIGENCE

BY PAUL YOUNG

Young Tycoon

On the largest stand at a big electronics exhibition salesmen are talking in hushed whispers. "Here he comes," says one, and they fall back respectfully while the President of the company and six of his top executives advance to meet their distinguished visitor.

Who can it be you may wonder, a captain of industry, a leading electronic tycooon, the head of a large bank? No, it is none of these people, it is a thirteen-year-old schoolboy called, Rawson Stovall,

Rawson is an all-important figure in the electronic games industry. Months of research and the likelihood of success hangs on whether Rawson likes the end product. He is the right age and knows more about what the consumer wants in the games market than any of our experts, said one executive. When he talks, we listen.

As you probably will have guessed, this is happening in America, where at the moment the computer business is having a hard time. Since August last year 18,000 jobs in the industry have been lost. Regretably we are not faring much better in the UK and quite recently I read that Mr. Robert Maxwell has had to rescue the wizard, Sir Clive Sinclair.

Super Battery

I suppose if anyone asked me what the shelf life of the average pen torch type of battery was, I would have said about eighteen months to two years. In the light of a recent experience I must now revise my estimate.

I have one of these cheap, maid-of-all-work multimeters that has a sensitivity of a thousand ohms per volt, will measure a.c. and d.c. voltage, limited d.c. current and with a fairly basic and not very accurate ohms range. I use it mainly for checking mains and making continuity tests.

The other day I was checking a suspect kettle element, when I noticed that the meter needle was only just flickering. In a flash brilliant Young had worked out that the battery needed replacing. I began to wonder when I last changed the battery and I realised that this was the original battery supplied with the meter. Now for the surprise, I purchased this meter about thirty years ago!!

With a certain amount of trepidation I undid the case. What Leclanche miracle was I going to find? I removed the penlite battery. It was marked Number 555 and underneath in large letters were the words "FIVE RAMS". Above was the actual drawing of the five rams.

Having decided that four of them were dead and fifth very sick, I replaced the battery. I was also pleased to note that there was no sign of leakage of electrolyte. What did disappoint me was the bottom line. "Made in Hong Kong". All the same, I feel it would be inadvisable on the grounds of personal safety, to visit your local supplier and ask for a Five Rams battery.

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

DESIGNER'S KIT

A COMPREHENSIVE designer's kit for their family of 6301 microprocessors has been produced by **Hitachi**.

It is claimed that it will be particularly useful because of the versatility of the 6301 family which includes nine chips, three versions; 13 different operating modes; three speeds; four package styles and wide operating temperature versions.

The kit includes an EPROM on-chip CMOS microcomputer (HD63701XOC), an adaptor, a user's manual, datasheets and full support literature and is supplied for the sum of £80.

For further information contact:

Hitachi Electronic Components (UK) Ltd.,
Dept EE, Hitec House,
221-225 Station Road,
Harrow, Middlesex,
HA1 2XL.

SMALL WORLD

THE world's smallest and lightest portable compact disc player, is the claim being offered by **Technics** to describe their latest CD model SL-XP7. Small enough to fit in the palm of a hand, it measures only 126mm × 126mm × 31·9mm and weighs 520 grammes.

Slightly smaller than a CD jacket/cover, it features a newly developed fine focus single beam laser pick-up system and 15-step random access programming selection.

The development of the FF1, a miniaturised fine focus single beam laser pick-up has been the main factor contributing to the compact size and performance. This optical system which, it is claimed, has improved performance over other three beam units, features a digitally controlled servo system using digital circuits to monitor laser tracking and focus accuracy.

The free floating mechanism of the optical deck is specially designed to resist physical shock, which is an important consideration in a portable system. The friction-free 4-wire suspension uses four special metallic wires to support the focus lens.

The 15-step random access programming facility allows the user to select tracks on the disc to be played in any order. The memory/recall key can also be used during play to obtain a recall display showing which tracks have been programmed.

For static or home use the unit is powered by an a.c. adaptor, but for total portability, an optional carrying case, with rechargeable battery pack is available.

ALIGNMENT TAPE

IF YOU are one of the 200,000 owners of the Amstrad CPC464 home computer, then you may be interested in the latest combined cassette cleaner and azimuth alignment tape system from **Kiltdale**.

Developed and manufactured by Kiltdale, it is claimed that the azimuth tape allows the user to effectively align his own recorder to assure virtual 100 per cent effeciency when loading software.

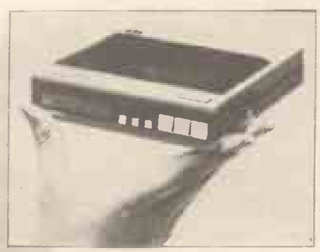
Azimuth misalignment occurs when the recording head is not exactly at right angles to the tape. Although cassette heads are correctly aligned at the factory, general wear and tear will cause misalignment and the associated difficulties in program loading.

After prolonged use dirt will build up in the head gaps causing the tape to lose contact with the head. Use of the head cleaner will gently polish the head and remove the dirt at the same time.

The azimuth alignment is a process which requires the user to locate a small screw near the play/record head. By adjusting this screw and with the aid of the indicator arrow, it is claimed to take only a matter of seconds to complete the necessary adjustment.

The package, which retails for £4.99, includes a combined head cleaner and azimuth tape, a screwdriver, indicator arrow and full instructions. In addition to the Amstrad CPC464 and Sinclair Spectrum, Kiltdale will be introducing further packages for the BBC, Commodore 64 and Atari machines during the next few months.

Kiltdale Ltd.,
Dept EE, Liddington Industrial Estate, Leckhampton Road,
Cheltenham,
Gloucs, GL53 0DL.



The SL-XP7 Stereo CD Player is due for release on the UK market in November and is expected to sell for less than £300.

Technics/Panasonic UK Ltd.,
Dept EE, 300-318 Bath Road,
Slough, Berkshire, SL1 6JB.

PCB SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service, see list. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: EE PCB Service, Everyday Electronics Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG. Cheques should be crossed and made payable to IPC Magazines Ltd.

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue.

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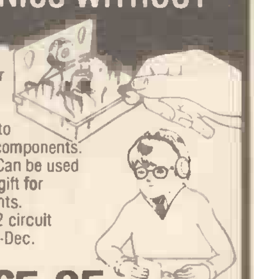

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1 DT-01 Digital Trainer

For breadboarding, digital circuits, flip-flops and monostable multivibrators, counters, encoders, decoders, multiplexers, demultiplexers and sequencers, registers, LED and 7 SEGMENTS LED displays, memory devices, etc.

SPECIFICATION

AC ADAPTOR JACK: I/P DC +12V, 800mA.
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BATTERY, 1.5V × 4
PULSE SW: Two bounce-free pushbuttons.
LOGIC SW: Eight logic level switches in DIP type.
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B-023 BREADBOARD: Solderless breadboard with 1580 interconnected tie points.
CLIP TERMINAL: Logic probe clip terminal.
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LED DISPLAY: Eight LED buffered logic level indicators.
BNC JACKS.
SELECT SW: Clock range selection.
LOW: 10 – 40 HZ.
HIGH: 1K – 20K HZ.
BANANA JACKS.
CLOCK ADJ: Fine adj. of clock frequency.
Includes Logic Probe.

2 MPF-1/88

SPECIFICATION

MICROPROCESSOR: 16 bit CPU, Intel 8088, 4.77 MHz version with an 8-bit data bus.
RAM MEMORY: 4K standard RAM on two 2K byte RAM chips. Expandable to 24K by using three 8K byte RAM chips.
ROM MEMORY: 16K standard ROM on two 8K byte ROM chips. Expandable to 48K by using three 16K byte ROM chips.
ROM memory contains program code for the monitor, line assembler, and disassembler.
DISPLAY SCREEN: 20 character × 2 line LCD display shows any 2 lines of a 20 character × 24 line logical screen.
KEYBOARD: 59-key, full-size QWERTY keyboard.
PRINTER INTERFACE: Centronics standard parallel interface with 16-pin connector.
CASSETTE INTERFACE: Can be used with any monaural cassette recorder.
RECORDING SPEED: 1000-2000 bits/second.
BUS CONNECTOR: 62-pin IBM

3 MPF-1/65

SPECIFICATION

ADVANCED INTERACTIVE MONITOR: The heart of the MPF-1/65 software resides in 16K bytes of ROM.
DISASSEMBLER: The built-in disassembler allows the user to list 6502 microprocessor instructions on both printer and video display.
SCREEN EDITOR.
TEXT EDITOR.
TWO PASS ASSEMBLER.
PRINTER DRIVER.
DEBUGGING FEATURES.

INPUTS AND OUTPUTS

AUDIO SPEAKER.
AUDIO CASSETTE INTERFACE: 1000-Baud
PARALLEL PRINTER INTERFACE: Centronics/EPSOM
VIDEO MONITOR INTERFACE.
COLOUR TV INTERFACE.
SYSTEM EXPANSION CONNECTOR: 50 pin connector to provide interface with RS-232c or ROM cartridges.
KEYBOARD: Standard calculator 49 key keyboard with 153 ASCII codes.
PROFESSIONAL DOCUMENTATION: User's Manual and Monitor Source Code Listing Manual are standard.

4 MPF-1P

SPECIFICATION

Z80 CPU high performance microprocessor with 158 instructions.
4K RAM, Battery Back-up circuits provided for the user to keep the contents of the RAMs.
8K ROM, sophisticated monitor expandable to 16K.
8K of sophisticated monitor, including text editor, two pass assembler, line assembler, break point, system initialization, keyboard scan, display scan, tape write and tape read, register and memory modification, insert, delete, move relation, fill and step execution.
20 digits, 14-segment green phospherescent display.
49-key alphanumeric keyboard including editing and functional keys.
Audio cassette interface: 165 baud average rate for data transfer between memory and cassette
Extension connectors: all CPU buses usable for expansion.
2.25" diameter speaker.
9V, 1.0A adaptor provided.
Three complete self-learning textbooks with experiments and applications.

5 MPF-1B

SPECIFICATION

CPU: Z80 CPU high performance microprocessor with 158 instructions.
RAM: 2K bytes expandable to 4K bytes.
ROM: 2K bytes of sophisticated monitor expandable to 8K bytes.
INPUT/OUTPUT: 24 system I/O lines.
MONITOR: 2K bytes of sophisticated monitor. Monitor includes system initialization, keyboard scan, display scan, tape write and tape read.
DISPLAY: 6-digit, 0.5" red LED display.
AUDIO CASSETTE INTERFACE: 165-Baud
EXPANSION FACILITY: Z80-P10 16 uncommitted lines. Z80-CTC 4 uncommitted timer channels.
USER AREA: Provides a 3.5" × 1.36" wire wrapping area for user's expansion.
POWER REQUIREMENT: 9V, 1.0A adaptor is provided.
KEYBOARD: 36 keys including 19 function keys, 16 hex digit keys, and 1 user-defined key.

Multitech

FLIGHT ELECTRONICS LTD

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