198

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APRIL 82
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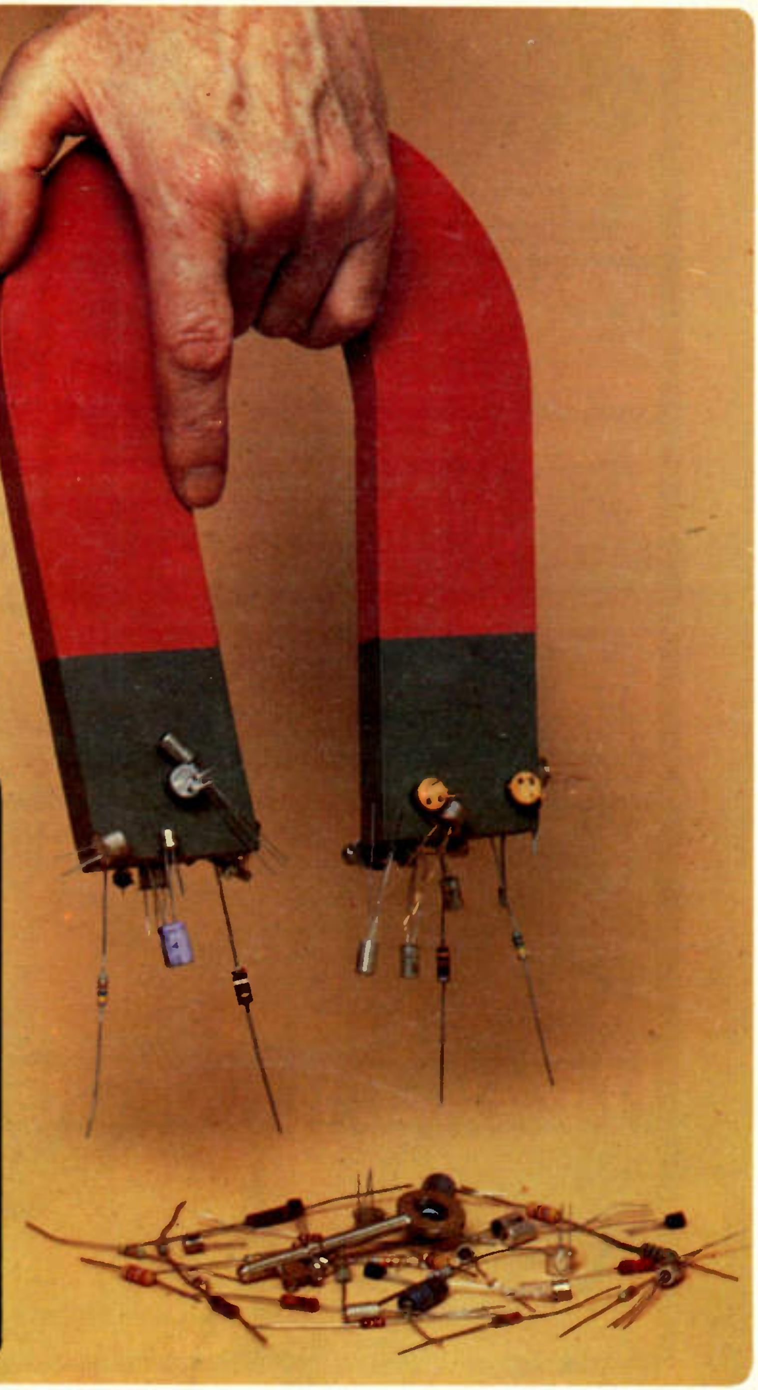

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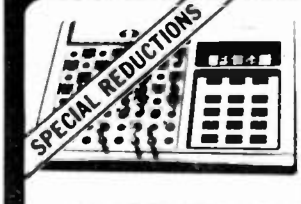

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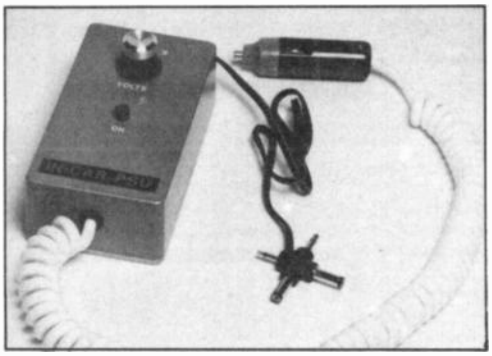
Everyday ELECTRONICS

VOL. 11 NO. 4 APRIL 1982

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



ZX81 cover photo—Sinclair Research Ltd.

SCHOOLS
Electronic Design Award
COMPETITION

Joint sponsors Mullard Ltd and EVERYDAY ELECTRONICS are delighted with the great response from secondary schools to their challenge. The judges have just completed their examination of entry papers and all participants will be notified directly of the results for Stage 1.

The twelve winning schools are to submit their working models for Stage 2 judging during May. An exhibition of models and presentation of prizes will take place at Mullard House, Torrington Place, London WC1, in June. Further news regarding SEDAC will appear in next month's issue.

Our May issue will be published on Friday, April 16. See page 251 for details.

KITS & COMPONENTS

DO YOU LONG TO HEAR YOUR DOORBELL RING?

Our latest kit gives you a pleasing three-note harmonically related tone sequence (not a microprocessor controlled buzz or the same old ding dong) at a touch of a button. This kit, based on a new integrated circuit, is supplied complete with a printed circuit board, loudspeaker and drilled box and requires only 9V battery and push button common to most households.

It may also be switched by logic in such applications as car alarms, clocks, toys, P.A. systems, etc. The unit produces a 150mW output and draws less than one 1uA from a PP3 battery when the tone ceases. Supplied complete with circuit and assembly instructions.

IDEAL PROJECT FOR BEGINNERS—Only £5

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MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50

TEACH—IN '82

EE Minilab	£13.50
Parts 1 - 6	£ 7.50
Parts 7 - 12	£ 4.90
Special price for all kits purchased together	£23.50

Woodwork not included

The above kits include all the components specified in the Teach-In '82 projects parts 1 - 12 plus sockets for ICs specified.

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DL1000K. This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. . . . . **Only £14.60**

DLZ1000K. A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. . . . . **Only £8.00**

Optional opto input DLA1 . . . . 60p
Allowing audio ("beat")—light response.

REMOTE CONTROL

Published remote control systems tend to be quite complex, requiring difficult-to-get components and a well-equipped lab to get them to work. If this has put you off making your own system we have just the kits for you. Using infra-red, our KITS range from simple on/off controllers to coded transmitter/receivers with 16 on/off outputs or three analogue outputs for controlling, e.g., TV or Hi-Fi systems. The kits are easy to build and simple to set up—and they are extremely versatile, controlling anything from garage doors to room lighting just by adding the required output circuits, i.e. relays, triacs, etc. If you can design your own system we stock a wide range of remote control components at very competitive prices.

We have compiled a booklet on remote control containing circuits, hints, data sheets and details of our remote control kits and components. So don't control yourself—**SEND US 30p and a stamped addressed envelope for your copy TODAY!**

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3mm & 5mm Round Red.....09p Green.....12p
Clips 3mm & 5mm.....03p Yellow.....12p

[Shaped Leds]		Red	Green	Yellow
Rectangular (Gravestone)		16p	16p	16p
Rectangular	▭ 5x2.5mm	17p	20p	20p
Square	□ 5x5mm	17p	20p	20p
Triangular	△ 5mm	17p	20p	–
Arrowhead	◁ 2.5x5mm	17p	20p	–

[Flashing Leds]
5mm diameter Red.......39p Flashing/Continuous.....42p

[Tri Colour Leds]
5mm round.......30p 5mm Rectangular........32p

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 x 71mm)	£17.40
(Ready Built)	£22.50

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6-Channel Mixer	SET90	96·67	Guitar Effects	SET42	15·92
Analogue Reverb	SET83	45·92	Guitar Multiprocessor	SET85	79·15
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Chorosynth	SET100	125·04	Guitar Sustain	SET75	11·77
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160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n 38p; 1µF 42p; 1µ5 45p; 2µ2 48p; 4µ7 58p.

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18V	7818	145p		—
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DPDT 6 tags	75p
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SWITCHES Miniature Non-Locking
Push to Make 15p Push to Break 20p
ROCKER: SPST on/off 10A 250V 28p
ROCKER: Illuminated DPST
Lights when on: 10A 240V 85p
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 45p
ROTARY: Mains 250V AC, 4 Amp 60p

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C804-5pF 10 15 25 50 pF	276p
100, 150pF	352p
'L' 3 x 310pF	725p
00·3 x 25pF	575p

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'DP' VALVE TYPE Range 1 to 5 Bl., Rd., Yl. Wht.	122p
6–7 B.Y.R.	110p
1·5 Green	150p
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B9A Valve Holder	42p
RDT2	145p
RFC 5	140p
RFC 7(19mH)	160p
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IFT 18/1·6	135p
IFT 18/465	152p
TOC 1	125p
MW5FR	122p
MW/LW 5FR	154p

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DIODES

AA129	22
BA100	15
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	9
3A/100V	15
3A/400V	16
3A/600V	17
3A/1000V	30
6A/400V	50p

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Diode 195

BRIDGE RECTIFIERS

(plastic case)

1A/50V	18
1A/100V	22
1A/200V	25
1A/400V	28
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	63
8A/400V	85
10A/200V	215
10A/600V	315
25A/200V	215
25A/600V	395
BY164	56
VM18 DIL	55

DIAC

ST2 25

SCRs Thyristors

1A/100V	42
5A/400V	40
5A/600V	48
8A/300V	60
8A/400V	75
8A/800V	95
12A/100V	78
12A/400V	95
12A/800V	188
15A/700V	180
2N4444	130
2N5062	32
2N5064	35
BT106	150
C106D	38
TIC44	24
TIC45	29
TIC47	35

TRIACS

3A/100V	48
3A/400V	56
8A/100V	60
8A/400V	68
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T28000D	128

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	28
7407	28
7408	16
7409	16
7410	14
7411	20
7412	20
7413	24
7414	32
7416	25
7417	25
7420	16
7421	20
7422	20
7423	22
7425	28
7426	30
7427	27
7428	28
7430	16
7432	24
7433	27
7437	27
7438	27
7440	17
7441	68
7442	38
7443	90
7444	90
7445	65
7446	55
7447	50
7448	50
7450	16
7451	16
7453	16
7451	16
7460	16
7470	35
7472	30
7473	30
7474	25
7475	40
7476	30
7480	48
7481	120
7482	70
7483	50
7484	80
7485	95
7486	26
7489	205
7490	28
7491	45
7492	30
7493	30
7494	34
7495	50
7496	45
7497	120
74100	85
74104	54
74105	55
74107	32
74109	35
74110	40
74111	55
74112	170
74116	88
74118	80
74119	90
74120	75
74121	30
74122	45
74123	50
74125	42
74126	40
74128	42
74132	48
74136	35
74141	70
74142	190
74143	250
74144	250
74145	70
74147	99
74148	75
74150	80
74151	45
74153	45
74154	75
74155	75
74156	75
74157	45
74159	99
74160	60
74161	60
74162	62
74163	64
74164	64
74165	62
74166	65
74167	185
74170	168
74172	290
74173	65
74174	72
74175	72
74176	55
74177	75
74178	95
74179	68
74180	65
74181	140
74182	75
74184	99
74185	99
74188	290
74190	70
74191	70
74192	70
74193	65
74194	75
74195	65
74196	65
74197	65

74LS

LS00	12
LS01	13
LS02	14
LS03	14
LS04	15
LS05	15
LS06	15
LS09	15
LS10	15
LS11	15
LS12	15
LS13	30
LS14	48
LS15	15
LS20	15
LS21	15
LS22	15
LS26	18
LS27	15
LS28	20
LS30	18
LS32	15
LS33	16
LS37	16
LS38	16
LS40	18
LS42	35
LS47	40
LS51	15
LS54	15
LS55	30
LS73	25
LS74	25
LS75	28
LS76	20
LS78	24
LS83	50
LS85	70
LS86	38
LS90	35
LS91	80
LS92	36
LS93	36
LS95	45
LS96	120
LS107	43
LS109	30
LS112	30
LS113	40
LS114	35
LS122	44
LS123	55
LS124	105
LS125	30
LS126	30
LS132	45
LS136	28
LS138	35
LS139	38
LS151	39
LS153	39
LS155	39
LS156	39
LS157	35
LS158	36
LS160	41
LS161	41
LS162	41
LS163	41
LS164	48
LS165	145
LS166	85
LS170	170
LS173	72
LS174	72
LS175	58
LS181	130
LS183	275
LS191	58
LS192	58
LS193	65
LS194	40
LS195	40
LS196	58
LS197	85
LS221	60
LS240	96
LS243	85
LS243	85
LS244	80
LS245	90
LS251	40
LS253	40
LS257	48
LS258	40
LS259	85
LS261	195
LS266	25
LS273	90
LS279	88
LS280	250
LS283	45
LS290	57
LS293	46
LS295	215
LS298	130
LS299	420
LS323	270
LS365	37
LS366	37
LS367	37
LS368	90
LS373	75
LS374	75
LS375	48
LS377	90
LS378	69
LS390	140
LS393	140
LS399	230
LS668	105

CMOS

4000	14
4001	14
4002	14
4006	66
4007	18
4008	62
4009	35
4010	40
4011	15
4012	18
4013	34
4014	75
4015	66
4016	32
4017	48
4018	88
4019	42
4020	61
4021	70
4022	66
4023	20
4024	45
4025	18
4026	130
4027	38
4028	58
4029	77
4030	50
4031	170
4032	125
4034	195
4035	85
4036	275
4037	115
4038	110
4039	290
4040	59
4041	78
4042	60
4043	70
4044	65
4046	75
4047	75
4048	55
4049	30
4050	30
4015	78
4052	78
4053	78
4054	125
4055	125
4056	120
4058	480
4060	90
4063	99
4066	36
4067	399
4068	22
4069	20
4070	26
4071	20
4072	20
4073	20
4075	20
4076	60
4081	26
4082	21
4085	65
4086	70
4089	140
4093	43
4094	168
4095	90
4096	90
4097	320
4098	88
4099	95
4161	99
4410	725
4411	695
4412	800
4433	770
4501	28
4502	90
4503	50
4507	40
4508	265
4510	68
4511	68
4512	75
4514	195
4515	195
4561	75
4518	42
4519	29
4520	78

LINEAR IC's

702	75
709C 8 pin	35
710*	48
733	75
741 8 pin	14
747C 14 pin	65
748C 8 pin	38
753 8 pin	165
810	150
2114L-300N	87
2114L-200	87
2708	175
2716-5V	210
4116-200N	75
9400CJ	350
AY-1-1313A	660
AY-1-1320	225
AY-1-5051	160
AY-3-8500	390
AY-3-8910	600
AY-5-1224A	235
AY-5-1230	450
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	120
CA3035	235
CA3036	270
CA3043	275
CA3045	365
CA3046	71
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	750
ICL7107	975
ICL8038CC	300
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	1950
ICM7217A	790
ICM7224	785
ICM7555	80
LA3350	250
LA4032	295
LA403P	340
LC7120	300
LC7130	340
LF351	48
LF353	95
LF355	85
LF356	95
LM10	425
LM301A	20
LM308T	95
LM311H	70
LM318	200
LM324	30
LM339	54
LM348	64
LM349	115
LM358	65
LM379	480
LM380	75
LM381N	145
LM382	125
LM384	140
LM386	90
LM387	120
LM389	95
LM1458	40
LM2917	195
LM3900	50
LM3909N	85
LM3911	128
LM3914	218
LM3915	220
LM3916	220
LM13600	125
MC1303	80
MC1304P	280
MC1310P	150
MC1488	55
MC1489	55
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC3302	150
MC3340	120
MC3360	120
MC3401	65
MC3403	110
MC3405	150
MFC6040	70
MK50398	635
MM5303	635
NE529	225
NE543	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562	410
NE564	420
NE565	120
NE566	150
NE567	140
NE570	425
NE571	420
RC4136D	69
S566B	245
SAB3209	428
SAB3210	298
SN76477	175
SP8629	200
TA7120	150
TA7130	160
TA7204	225
TA7205A	220
TA7222	175
TA7310	175
TBA120	70
TBA550Q	330
TBA800	80
TBA810	85
TBA820	80
TDA1004	290
TDA1008	310
TDA1022	425
TDA1024	108
TDA2020	320
TDA2030	320
TL061CP	40
TL064	98
TL071CP	30
TL074CN	100
TL081CP	25
TL083CN	75
TL084CN	95
UAA170	170
UAA1003	635
UPC575	350
UPC1025H	375
XR2206	300
Z80CPU	350
ZN414	88
ZN423	138
ZN424	130
ZN425E	345
ZN426E	300
ZN1034	200

Transistors

AC125	35
AC126/7	35
AC128	30
AC141/2	30
AC176	28
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
ACY39	85
AD149	78
AD161/2	42
AF118	90
AF139	40
AF178	75
AF239	78
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC148C	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167/8	10
BC169C	10
BC170	15
BC172/3	11
BC177/8	120
BC179/81	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC187	26
BC212/3	10
BC212L	10
BC213L	10
BC214	10
BC214L	10
BC236	10
BC237	14
BC307B	15
BC308B	16
BC327/8	15
BC338	15
BC441	34
BC461	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC557/8	15
BC559	15
BCY70/71	16
BCY72	20
BD131/2	48
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD144/5	198
BD205	110
BD214	115
BD245	188
BD378	70
BD434	55
BD517	75
BD695A	85
BD696A	85
BDY56	180
BF115	35
BF167	29
BF180	38
BF194/5	12
BF196/7	12
BF198/9	16
BF200	30
BF224	24
BF244/5	28
BF244B	30
BF256	35
BF257/8	32
BF259	35
BF274	42
BF336	40
BF451	35
BF594	30
BFR30/40	23
BFR41	23
BFR79	23
BFR80/81	24
BFR98	105
BFX29	28
BFX84	28
BFX85/86	28
BFX87/8	28
BFY50	23
BFY51/52	23
BFY56	32
BFY64	35
BFY81	120
BRY39	40
BSX20	20
BSY95A	25
BU105	170
BU205	190
BU208	200
E421	250
MD8001	250
MJ400	150
MJ491	175
MJ2955	90
MJE340	54
MJE370/71	100
MJE2955	99
MJE3055	70
MPF102	50
MPF103/104	30
MPF105	30
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	25
MPSU06	55
OC23/26	170
OC28	130
OC35/36	125
OC41/42	120
OC43	55
OC44	120
OC45	40
OC70/71	40
OC72/74	50
OC75/76	50
OC81	50
OC82	130
OC83/84	40
OC140	110
OC170/1	85
OC200	85
TIP29	34
TIP29A	38
TIP29B	50
TIP29C	52
TIP30	48
TIP30C	58
TIP31A	45
TIP31C	55
TIP32A	48
TIP32C	60
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	180
TIP35C	185
TIP36A	170
TIP36C	199
TIP41A	60
TIP41B	68
TIP42A	60
TIP42B	75
TIP120	90
TIP121	99
TIP142/7	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/45	45
TIS88A	50
TIS90	30
TIS91	32
VK1010	80
VK10KM	53
VK46AF	75
VK66AF	96
VK88AF	105
ZTX107/8	11
ZTX109	11
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX500	14
ZTX501/502	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	28
2N698	40
2N699	35
2N706A	19
2N708	19
2N918	33
2N1131/2	24
2N1303	60
2N1304/5	65
2N1671B	215
2N2219A	28
2N2220A	28
2N2221A	25
2N2222A	25
2N2369A	17
2N2646	48
2N2904/5	28
2N2905A	26
2N2906/7	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	40
2N3442	140
2N3663	15
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N308/9	10
2N3710/1	10
2N3771	170
2N3772	195
2N3773	276
2N3819	22
2N3820	38
2N3822/3	50
2N3866	90
2N3903/4	38
2N3905	15
2N3906	15
2N4037	48
2N4058	10
2N4061/2	10
2N4427	86
2N3859	78
2N4871	55
2N5172	18
2N5179	45
2N5191	75
2N5305	24
2N5457/8	30
2N5485	38
2N5642	750
2N5777	45
2N6027	32
2SA715	60
2SC1172	125
2SC495/6	70
2SC1096	85
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	65
2SC2314	85
2SC2166	165
2SC1679	190
2SD234	75
3N128	112
3N140	112
40316	85
40361/2	50
40408	95
40411	280
40467	95
40594/5	90
40603	90
40673	85

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A bulk purchase of PCB's from several well known computer games including Battleships, Simon, Logic 5 and Starbird enable us to offer these at incredibly low prices:

'STARBIRD'

Gives realistic engine sounds and flashing laser blasts—accelerating engine noise when module is pointed up, decelerating noise when pointed down. Press contact to see flash and hear blast of lasers shooting. PCB tested and working complete with speaker and batt clip. (needs PP3). PCB size 130 × 60mm. Only £2.95

'SIMON'

The object of this game is to repeat correctly a longer and longer sequence of signals in 3 different games. (instructions included) PCB contains chips, switches, lampholders and lamps, and is tested working, complete with speaker. Needs PP3 and 2 × HP11. PCB size 130 × 130mm Only £3·95.

'COMPUTER BATTLESHIPS'

Probably one of the most popular electronic games on the market. Unfortunately the design makes it impractical to test the PCB as a working model, although it may well function perfectly. Instead we have tested the sound chip, and sell the board for its component value only (PCB may be chipped or cracked): SN76477 sound IC; TMS1000 u-processor; batt clips, R's, C's etc. Size 160 × 140mm. Only £1·50. Instruction book and circuit 30p extra.

LOGIC 5 PANEL

Tested Logic 5 now sold out—but we have some PCB's with 10 LED's and chip on, but no keyboard. Not tested. 50p.

'MICROVISION' Cartridges

These are a small PCB with a microprocessor chip, designed to plug in to the microvision console. Only snag is, we don't have any consoles!! However, they can be used as an oscillator with 4 different freq. outputs simply by connecting a battery and speaker. Tested and working (as an osc) with pin out data. PCB size 72 × 60 mm. only 25p each!

RELAY/TRIAC PANEL

Z537 PCB 100 × 75mm containing a wealth of components; 2 × 12V DPCO min relays, 2 × 47μF 16V tants SC146E 10A 500V triac, C122D 8A 400V SCR, 555 timer, 10 × 1N4001 diodes, 2N5061 SCR, 2 × 3mm LED'S 3 × 2N3704, R's & C's—Amazing value—if bought seperately, parts would cost around £8!!. Our price for the panel, just £2·00.

200 ELECTROLYTICS £4·00

K524 Large variety of values/voltages, mostly cropped leads for PCB mntg. 1-1000uF, 10-63V. All new full spec components, not chuck-outs!! 200 £4, 1000 £17·50

COMPONENT PACKS

K503 150 wirewound resistors from 1W to 12W, with a good range of values. £1·75.
K505 20 assorted potentiometers, all types including single, ganged, rotary and slider. £1·70.
K511 200 small value poly, mica, ceramic caps from a few pF to ·02μF. Excellent variety. £1·20.
K514 100 silver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10%. £2·00.
K520 Switch pack—20 different, rocker, slide, rotary, toggle, push, micro, etc. Only £2·00.
K521 Heatshrink pack—5 diff. sizes, each 200mm. 50p.

1000 RESISTORS £2·50

We've just purchased another 5 million preformed resistors, and can make a similar offer to that made two years ago, at the same price!!! K523—1000 mixed ½ and ¼W 5% carbon film resistors, preformed for PCB mntg. Enormous range of preferred values. 1000 for £2·50; 5000 £10; 20k £36.

PANELS

Z521 Panel with 16236 (2N3442) on small heat sink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. 60p.
Z527 Reed relay panel—contains 2 × 6V reeds, 6 × 2S030 or 2S230, 6 × 400V rects + Rs. 50p.
Z529 Pack of ex-computer panels containing 74 series ICs. Lots of different gates and complex logic. All ICs are marked with type no. or code for which an identification sheet is supplied. 20 ICs £1·00; 100 ICs £4·00.
A504 Black case 50 × 50 × 78mm with octal base. PCB inside has 24V reed relay, 200V 7A SCR, 4 × 5A 200V rects, etc. 60p.

SWITCH BARGAIN

Push-on, push-off "table lamp" type, rated 2A 250V ac. 10p each, 15 for £1, 100 for £5.

TEACH-IN 82

Full set of parts as specified by "EE". All new goods, despatched by return of post.

★ All parts for the "MINILAB" only £17·50 + £1 post.

★ All components for first 6 parts of "TEACH-IN '82" £7·50 + 60p post.

★ All components for second 6 parts of "TEACH-IN '82" £4·00 + 40p post.

BUY ALL THREE SETS FOR £20 inc post.

FREE component identification Chart !!

FREE piece of Veroboard !!

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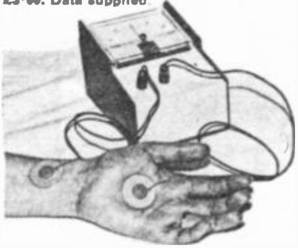

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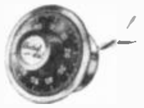

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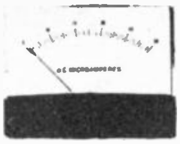

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748	35	CA3189E	290	★LM381	100	LM3911	120	NE571	425	TLO81	30
AY-3-1270	840	ICL7106	790	LM382	120	★LM3914	200	RC4136	90	TLO82	70
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★AY-3-8912	625	ICM7555	80	LM387	120	LM13600	120	★SN76477	250	★XR2206	300
CA3046	60	★LF351	40	LM393	100	MC1310	150	TBA800	80	ZN414	100
★CA3080	65	LF353	85	★LM709	25	MC3302	150	TBA810	95	ZN423	165
CA3089	215	LF356	90	LM710	50	MC3340	135	TBA820	80	ZN424	135
CA3090AQ	375	LM10	395	LM725	350	NE515	270	TBA950	290	ZN425E	390
CA3130E	90	★LM301A	25	LM733	75	NE529	225	TCA940	170	ZN426E	330
CA3140E	45	LM311	70	★LM741	14	NE531	150	TDA1004	300	ZN427E	650
CA3160E	100	LM318	85	LM747	75	NE544	165	TDA1008	320	ZN428E	400
		★LM324	40	LM748	35	★NE555	16	TDA1010	225	ZN1034E	200
		LM339	50	LM1458	40	★NE556	45	TDA1022	560		
		LM348	90	LM2917	200	NE565	120	TDA1024	125		
		LM358	50								

CMOS

4000	14	★4017	43	4036	285	4055	115	4082	20	4502	70	4529	150
★4001	12	4018	60	4039	295	4059	480	4085	65	4503	50	4532	95
4002	14	4019	35	4040	55	4060	85	4086	65	4507	38	4534	495
4006	65	★4020	55	4041	75	4063	90	4089	140	4508	200	4538	110
4007	17	4021	65	4042	55	4066	35	★4093	33	4510	65	4543	110
4008	58	4022	70	4043	60	4067	395	4094	14	★4511	50	4549	380
4009	30	4023	18	4044	65	★4068	15	4095	90	4512	70	4553	295
4010	35	4024	40	4046	70	4069	18	4097	340	4514	180	4555	45
★4011	13	4025	18	4047	70	4070	18	4098	85	4515	180	4556	48
4012	17	★4026	90	4048	55	4071	18	4099	95	4516	75	4559	390
★4013	22	4027	30	★4049	28	4072	18	40106	50	★4518	45	4560	180
4014	60	4028	55	4050	28	4073	20	40109	100	4520	70	4584	45
4015	60	4029	75	4051	60	4075	20	40163	100	4521	200	4585	99
★4016	22	4030	35	4052	70	4076	60	40173	100	4526	80	4724	140
		4031	170	4053	60	4077	25	40175	100	4527	90		
		4034	170	4054	110	4081	18	40193	120	★4528	75		

TTL

7400	11	7413	24	7442	40	7480	45	74107	30	74155	60	74177	75
7401	11	7414	35	7444	85	7482	70	74109	32	74156	60	74179	65
7402	12	7416	25	7446	60	7483	50	74121	28	74157	43	74180	65
7403	14	7417	25	7447	48	7485	75	74122	45	74160	60	74181	135
7404	14	7420	15	7448	50	7486	25	74123	48	74161	60	74182	75
7405	17	7421	20	7450	16	7489	180	74125	40	74162	60	74190	70
7406	26	7422	20	7451	16	7490	28	74126	40	74163	60	74191	70
7407	26	7427	28	7453	16	7491	45	74132	40	74164	60	74192	70
7408	15	7428	28	7454	16	7492	40	74141	65	74165	60	74193	65
7409	16	7430	15	7460	16	7493	30	74145	65	74167	180	74194	70
7410	14	7432	25	7472	25	7494	35	74147	100	74170	165	74195	63
7411	20	7433	27	7473	28	7495	50	74148	75	74173	60	74196	63
7412	20	7437	27	7474	25	7496	45	74150	75	74174	65	74197	63
		7438	27	7475	38	7497	120	74153	45	74175	70	74198	95
		7440	17	7476	30	74100	80	74154	75	74176	55	74199	95

LS TTL

LS00	13	LS21	15	LS76	20	LS125	30	LS161	42	LS221	60	LS365	38
LS01	14	LS22	16	LS78	24	LS126	30	LS162	42	LS240	90	LS366	38
LS02	14	LS26	18	LS83	50	LS132	45	LS163	42	LS241	80	LS367	36
LS03	14	LS27	15	LS85	70	LS136	30	LS164	50	LS242	80	LS368	50
LS04	15	LS30	16	LS86	25	LS138	35	LS165	120	LS243	85	LS373	80
LS05	15	LS32	16	LS90	35	LS139	35	LS166	85	LS244	80	LS374	80
LS08	16	LS37	16	LS92	38	LS145	75	LS170	170	LS245	120	LS375	50
LS09	16	LS38	16	LS93	35	LS147	160	LS173	70	LS247	75	LS377	90
LS10	16	LS40	16	LS95	45	LS148	95	LS174	60	LS251	40	LS378	70
LS11	16	LS42	38	LS96	110	LS151	40	LS175	60	LS257	40	LS390	75
LS12	15	LS47	40	LS107	45	LS153	40	LS190	55	LS258	45	LS393	75
LS13	25	LS48	80	LS109	30	LS154	120	LS191	55	LS259	95	LS399	220
LS14	40	LS51	16	LS112	30	LS155	45	LS192	55	LS266	25	LS541	135
LS15	15	LS55	30	LS113	30	LS156	45	LS193	60	LS273	90	LS670	175
LS20	15	LS73	25	LS114	30	LS157	35	LS195	50	LS279	50		
		LS74	25	LS122	42	LS158	36	LS196	60	LS283	45		
		LS75	27	LS123	55	LS160	42	LS197	68	LS353	100		

TRANSISTORS

AC125	35	BC157	10	BC549	10	BFX29	25	TIP29C	60	VN88AF	95	2N3053	23
AC126	25	BC158	10	BC558	10	BFX84	25	TIP30	45	★ZTX107	8	2N3054	55
AC127	25	★BC159	8	BCY70	18	BFX85	25	TIP30A	40	★ZTX108	8	2N3055	50
★AC128	20	BC160	45	BCY71	16	BFX86	28	TIP30B	50	ZTX109	12	2N3442	120
AC176	25	BC168C	10	BCY72	18	BFX87	25	TIP30C	60	ZTX300	14	★2N3702	6
AC187	22	BC169C	10	BD115	80	BFX88	25	TIP31A	45	ZTX301	16	2N3703	9
AC188	22	BC170	8	BD131	35	BFY50	23	TIP31B	45	ZTX302	15	★2N3704	6
AD142	120	BC171	10	BD132	35	BFY51	23	TIP31C	55	ZTX304	17	2N3705	9
AD149	80	BC172	8	BD133	50	BFY52	23	TIP32A	45	ZTX341	30	2N3706	9
AD161	40	BC177	18	BD135	50	BFY53	32	TIP32B	55	ZTX500	15	2N3707	10
AD162	40	BC178	18	BD136	30	BFY55	32	TIP32C	60	ZTX501	15	2N3708	10
AF124	60	BC179	18	BD137	30	BFY56	32	TIP33A	50	ZTX502	15	2N3709	10
AF126	50	BC182	10	BD138	30	BRY39	40	TIP33C	75	ZTX503	18	2N3772	190
AF139	40	★BC182L	8	BD139	35	BSX20	20	TIP34A	60	ZTX504	25	2N3773	218
AF186	70	BC183	18	BD140	35	BSX29	35	TIP34C	85	2N697	20	★2N3819	15
AF239	75	BC183L	10	BD204	110	BSY95A	25	TIP35A	160	2N698	40	2N3820	40
BC107	10	BC184	10	BD206	110	BU205	160	TIP35C	180	2N706A	20	2N3823	65
BC107B	12	★BC184L	7	BD222	85	BU206	200	TIP36A	170	2N708	20	2N3866	90
★BC108	6	BC212	10	BF180	35	BU208	170	TIP36C	195	2N918	35	2N3903	10
BC108B	12	BC212L	10	BF182	35	MJ2955	99	TIP41A	60	2N1132	22	2N3904	10
BC108C	12	BC213	10	BF184	25	MJE340	50	TIP42A	60	2N1613	30	★2N3905	6
★BC109	9	BC213L	10	BF185	25	MJE520	65	TIP120	90	2N2218A	45	2N3906	10
BC109C	12	BC214	10	BF194	12	MJE521	95	TIP121	90	2N2219A	25	2N4037	45
BC114	22	★BC214L	8	BF195	12	MJE3055	70	TIP122	90	2N2221A	25	2N4058	10
BC115	22	BC237	8	BF196	12	MPF102	40	TIP141	120	2N2222A	20	2N4060	10
BC117	22	BC238	14	BF197	12	MPF104	40	TIP142	120	2N2368	25	2N4061	10
BC119	35	BC308	15	BF198	10	MPSA05	22	TIP147	120	2N2369	11	2N4062	10
BC137	40	BC327	14	BF199	18	MPSA06	25	TIP2955	60	2N2484	25	2N5457	38
BC139	40	BC328	14	BF200	30	MPSA12	30	TIP3055	55	2N2646	45	2N5458	36
BC140	30	BC337	14	★BF244B	18	MPSA55	30	TIS43	40	2N2904	20	2N5459	30
BC141	30	BC338	14	BF245	30	MPSA56	30	TIS44	45	2N2904A	20	2N5485	36
BC142	25	BC477	30	BF256B	45	MPSU05	55	TIS45	45	2N2905	22	2N5777	45
BC143	25	BC478	30	BF257	32	MPSU06	55	TIS90	30	2N2905A	22	2N6027	30
BC147	8	BC479	30	BF258	25	MPSU55	60	TIS91	30	2N2906	25	40360	40
BC148	8	BC517	40	BF259	35	MPSU56	60	★VN10KM	45	2N2906A	25	40361	50
BC149	9	★BC547	7	BF337	40	TIP29	35	VN46AF	75	2N2907	25	40362	50
		BC548	10	BFR40	23	TIP29A	40	VN66AF	85	2N2907A	25	40408	70
				BFR80	25	TIP29B	55			2N2926	9	40594	100

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Submin. Toggle
SPST 55p SPDT 60p ★DPDT 50p
Miniature toggle
SPDT 80p SPDT centre off 90p
DPDT 90p DPDT centre off 100p
Standard toggle
SPST 35p DPDT 48p
★Miniature DPDT slide 12p
★Push to make 12p Push to break 22p
Rotary type adjustable stop
1P12W, 2P6W, 3P4W, 4P3W all 55p each
DIL switches
4 SPST 80p 6 SPST 80p 8 SPST 100p

CRYSTALS

100KHz	290p	6·0M	200p
200KHz	370p	6·144M	180p
1MHz	300p	7·00M	250p
1·008M	370p	8·0M	170p
1·8432M	300p	10·0M	180p
2·0M	270p	12·0M	290p
2·4576M	220p	16·0M	240p
3·276M	240p	18·0M	240p
3·579M	120p	18·432M	220p
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Polyester. 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; 1μ, 33p; 2μ2, 50p.

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.

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12VA	0-6, 0-6 @ 1A; 0-9, 0-9V @ 1.2A; 0-12, 0-12 @ 0-5A; 0-15, 0-15V @ 0.4A 275p each (plus 40p carriage).
24VA	0-6, 0-6V @ 1.5A; 0-9, 0-9V @ 1.2A; 0-12, 0-12V @ 1A; 0-15, 0-15V @ 0.8A; 330p each (plus 60p carriage)
50VA	0-12, 0-12V @ 2A; 0-15, 0-15V @ 1.5A; 400p each (plus 70p carriage)
100VA	0-30, 0-30V @ 1.6A 920p each (plus 80p carriage).

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1A 50V	22	6A 100V	80
1A 400V	35	6A 200V	90
		6A 400V	95

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20 metre pack single core connecting cable, ten different colours	65p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2·5A 3 core mains	23p/m
10 way ribbon	65p/m
20 way ribbon	120p/m

REGULATORS

Positive		Negative	
★78L05	25p	79LO5	65p
78L12	30p	79L12	65p
78L15	30p	79L15	65p
★7805	45p	★7905	45p
★7812	45p	★7912	45p
7815	60p	7915	60p
LM309K	130p	★LM323K	350p
★LM317T	120p	LM723	40p

SOCKETS

★8 pin	7p	22 pin	20p
★14 pin	9p	24 pin	22p
★16 pin	10p	28 pin	26p
18 pin	15p	40 pin	32p
20 pin	18p		

Soldercon pins 60p/100.

RESISTORS

¼W 5% Carbon film E12 series. 4·7Ω–10M. 1p each
½W 5% Carbon film E12 series 4·7Ω–4M7. 2p each
¼W 1% Metal film. E24 series 10Ω-1M 6p each

PANEL METERS

Size 60 × 46 × 35mm.

0–50μA	0–500mA
0–100μA	0–1A
0–500μA	0–50V AC
0–1mA	VU
0–10mA	0–300V AC
0–50mA	0–25V
0–100mA	0–30V DC

450p each.

VERO

Verobloc 350p
Size 0·1 matrix

2·5 × 1"	22p
2·5 × 3·75"	75p
2·5 × 5"	85p
3·75 × 5"	95p
VQ board	160p

Veropins per 100

Single sided	50p
Double sided	60p
Spot face cutter	105p

OPTO

★3mm red	8p	★5mm red	8p
★3mm green	12p	★5mm green	12p
★3mm yellow	12p	★5mm yellow	12p

Clips to suit 3p each.

Rectangular		TIL32	40p
★Red	12p	TIL78	40p
Green	17p	TIL111	60p
Yellow	17p	ORP12	85p

Seven Segment Displays

Com. cathode			Com. anode		
DL704	0·3in	95p	DL707	0·3in	95p
★FND500	0·5in	80p	FND507	0·5in	90p
TIL313	0·3in	105p	TIL312	0·3in	105p
TIL322	0·5in	115p	TIL321	0·5in	115p

All seven segment displays are supplied with connection details.
2N5777 45p Dual colour LED 60p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2,5mm	10p	10p
3 pin	12p	10p	3.5mm	★7p	★7p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	13p	13p	4mm	18p	17p

UHF (CB) Connectors
PL259 Plug 40p Reducer 14p
SO239 Square chassis socket 38p
SO239S Round chassis socket 40p

IEC 3 pin 250V/6A
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2m lead 120p

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CX 17W element	190p
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X25 25W element	190p
Solder pump desoldering tool	480p
Spare nozzle for above	70p
10 metres 22 swg solder	100p

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Red or black crocodile clips	6p
Black pointer control knob	15p
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TO220 twisted vane heatsink	28p
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OA90	8p	1N4006	7p
OA91	7p	1N4007	7p
OA200	8p	1N5401	15p
OA202	8p	1N5404	16p
1N914	4p	1N5406	17p
★1N4148	2p	400mW zen.	6p

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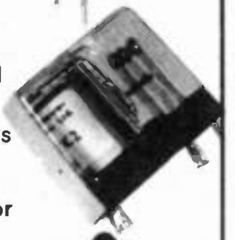

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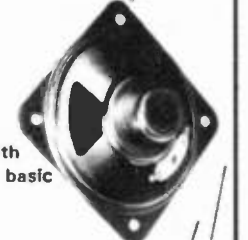

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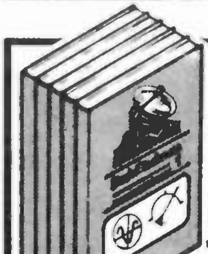

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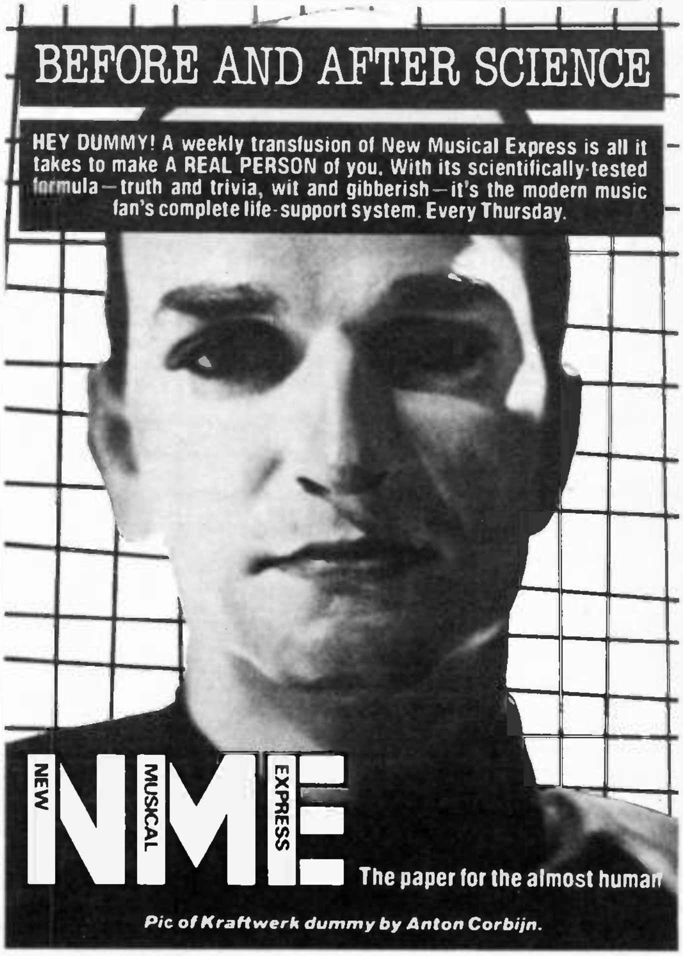

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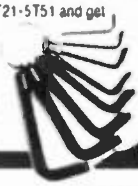

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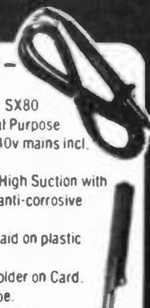

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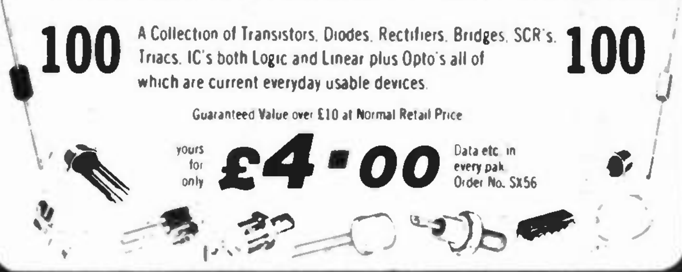

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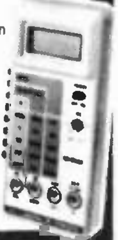

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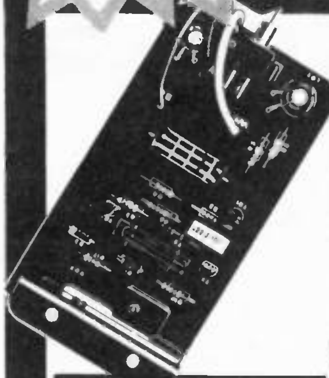

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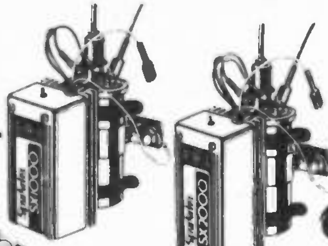

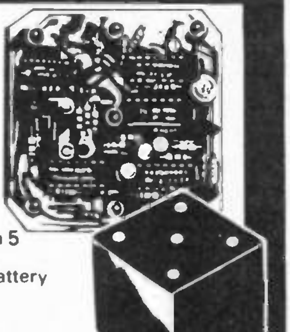

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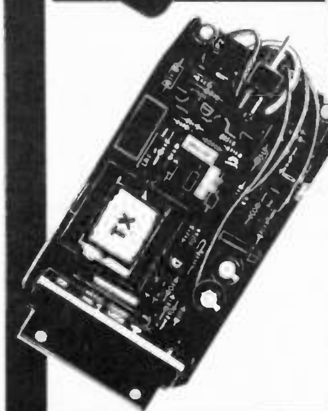

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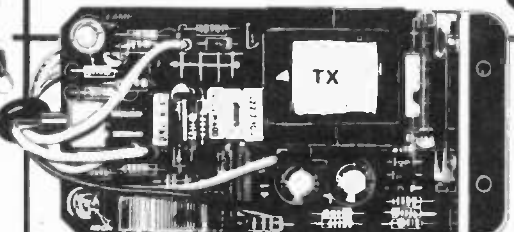

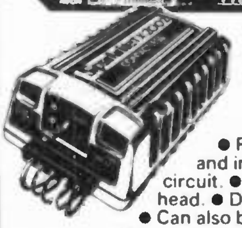

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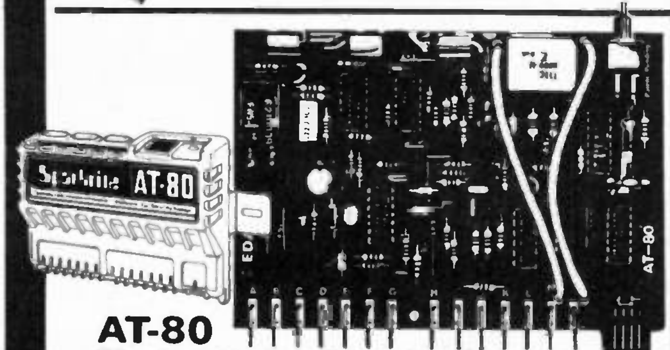

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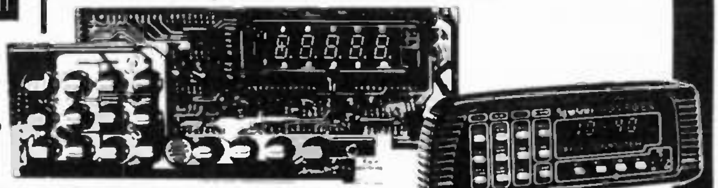

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Everyday
ELECTRONICS

VOL. 11 NO. 4 APRIL 1982

INCONSPICUOUS

Doodling with electronic circuits is a form of innocent amusement most of us indulge in from time to time. If one single subject has inspired such abstract designing more than any other, it is likely to be the electronic combination lock. Some years ago, immediately following the introduction of digital integrated circuits, this kind of activity reached well nigh craze proportions we recall. What opportunities for creating tantalising puzzles with labyrinthine circuitry these microchips gave us. That most of these doodles on paper never finally materialised in concrete form is beside the point: more than enough *did* and there has been no scarcity of practical designs for electronic combination locks to satisfy general needs.

In more recent years the availability of keypads has further helped the development of electronic combination locks as serious functional devices and assured their ready acceptance in a society now well accustomed to the digital keyboard.

One advantage of the combination lock (electronic or otherwise) is that no removable key is involved. But in another respect it is like any conventional lock with a keyhole, in that its presence is advertised by the tell-tale knob or keypad. This is not a serious objection in many cases, such as external doors, for the existence of a lock of some description is a foregone conclusion anyway.

But there could be situations where it might be felt vitally important not to betray the existence of a secured area or compartment—of whatever size. In this strategy the first line of defence is based on concealment and in not attracting attention. The Magnetic Lock meets such a requirement. The particular design described in this issue does require a key—of a special kind—but there is no giveaway keyhole or keypad. Nothing at all need be visible externally to suggest the presence of a locking device. And that is not all. Should the key fall into the hands of some unauthorised person its significance will not be apparent; but even if it were, there remains the problem of just how and exactly where it is used. On that intriguing note we leave the subject, certain that readers will want to learn more from the article itself.

FLAG FLYING

Good to know of one home-brewed electronic product that is at the top of the charts. Britain's electronic entrepreneur Clive Sinclair is flying high, with over a third of a million ZX81 personal computers sold—some to Japan and the USA.

Owners of the ZX81 will find our plug-in 2K Ram Pak of special interest. This inexpensive project will increase the memory of the standard machine sufficiently for many general needs.

Anytime we can help, Clive!

Fred Bennett.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

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Capacitance/Frequency Meter

BY A.P. DONLEAVY

THIS instrument was originally designed exclusively as a capacitance meter, but the addition of a few extra components enables it to function as a frequency meter, with a degree of accuracy sufficient for the needs of most amateur constructors. The scale ranges from approximately 1,000pF to 10μF in the capacitance mode and from 50Hz to 1MHz as a frequency meter. The power is supplied either from a 9V PP3 battery or from a mains calculator adaptor via a 2·5mm jack socket.

CAPACITANCE METER

Fig. 1 shows the block diagram of the meter, and we shall use this to describe the operation of the circuit.

With S1 in position c as shown, the instrument measures capacitance. A monostable (single shot) multivibrator produces a pulse, the duration of which is proportional to the unknown capacitance (C_{ext}) under test, this capacitor forming part of the time constant circuit of the monostable.

During this period, clock pulses from the clock oscillator are counted by the latch/counter circuit, the frequency of oscillation of the clock being adjustable so as to calibrate the display reading. The pulses from the clock oscillator are stored in the latch of the latch/counter and only transferred to the display at the end of the monostable timing pulse. This is achieved by feeding the timing pulse into the latch monostable which is triggered by the negative going edge (also referred to as the "trailing edge"), the resulting latch pulse being very narrow, only about three microseconds long, and it is this pulse which "latches" the stored number of clock pulses into the display.

The negative going edge of the latch pulse also triggers a third monostable, the reset monostable, the purpose of which is to reset the counter and hold it at zero so that pulses from the clock oscillator are not counted during this period. The negative going edge of this reset pulse is also fed back to the timing monostable and the whole sequence restarts. The period of the reset pulse is about one second, although in theory it need only be a few microseconds, but this would give far too many readings per second of the unknown capacitance, hence causing the last digit to flicker rapidly and appear as an "8".

So it is in this way that the meter counts a number of clock pulses for a period of time governed by the unknown capacitance and displays this figure as a direct capacitance value.

DIVIDE-BY-TEN

The divide-by-ten circuit is used to extend the range of the meter by dividing the clock pulse frequency by

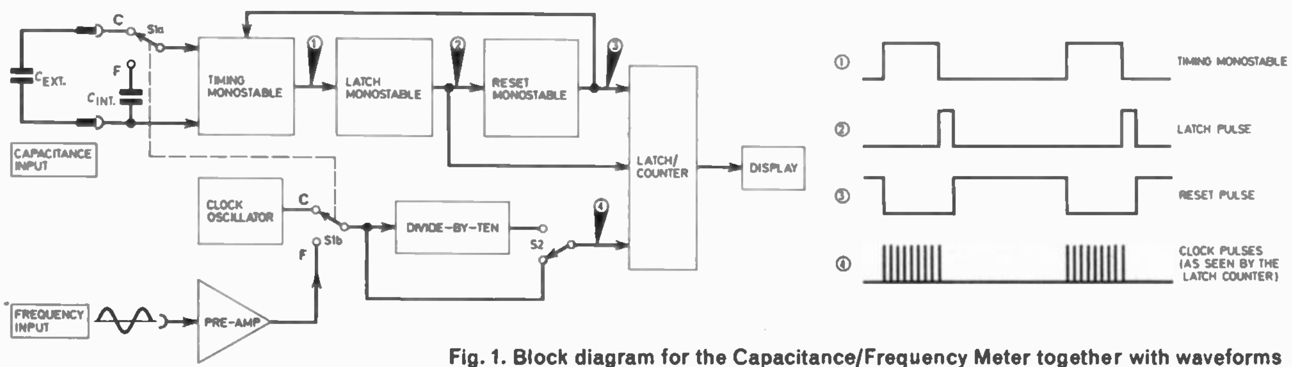


Fig. 1. Block diagram for the Capacitance/Frequency Meter together with waveforms for both modes of operation.

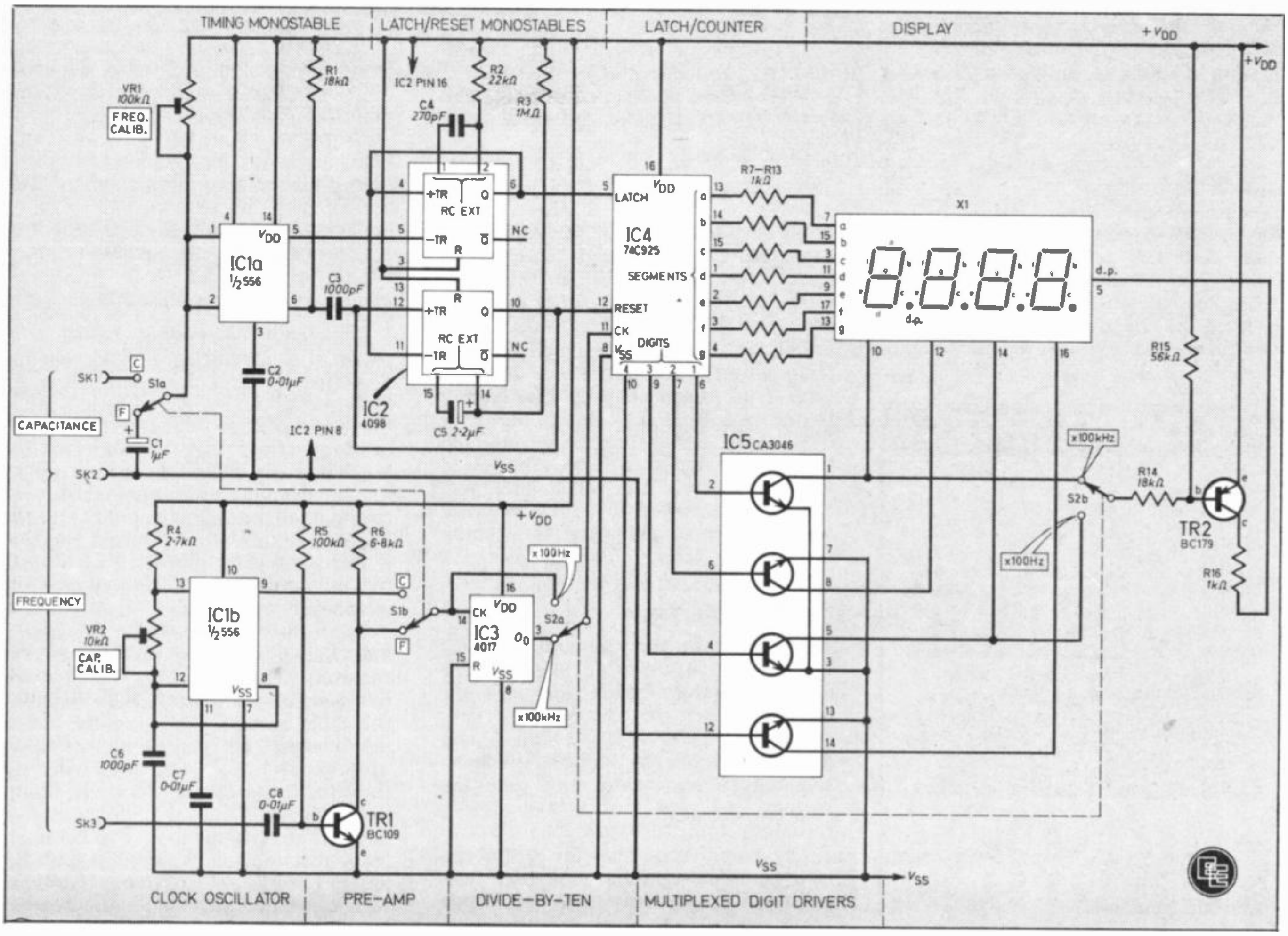


Fig. 2a. Circuit diagram for the Capacitance/Frequency Meter. Note the pin numbers on X1 are for the National Semiconductor display.

ten for evaluating the higher value capacitors. This facility is brought in with S2.

By switching S1 to position F the instrument can now be used for the measurement of frequency.

FREQUENCY MEASUREMENT

As a frequency meter, the operation is very similar to above, only a capacitor of known value (C_{int}) is used to set a fixed timing monostable pulse width. The unknown input frequency is fed into the meter via a pre-amplifier, either directly or divided by ten (again to extend the range and dependant on the position of S2), to the latch/counter. The display now gives a direct reading of frequency, calibration being achieved by varying a resistive element in the timing monostable time constant circuit.

The waveforms shown in Fig. 1 are present in both modes of operation but note that waveform 4, the clock pulses, are always present but the latch/counter only recognises them when the reset input is at logic 0. Note also that in the frequency mode, these pulses will be the unknown input signal.

CIRCUIT DESCRIPTION

The full circuit diagram is shown in Fig. 2. IC1a, half a 556 dual timer i.c., is connected as the timing monostable, with VR1 and C1 forming the time constant components in the frequency mode and VR1 and the unknown capacitor determining this in the capacitance mode.

IC1b, the other half of the 556, is connected as the internal clock oscillator, the frequency of which is adjusted by VR2, this allowing calibration in the capacitance mode. Note that the frequency calibration by means of VR1 must be carried out first, followed by capacitance calibration with VR2, as adjustment of VR1 will affect both modes of operation.

IC2, a CMOS 4098 dual monostable i.c., contains both the latch and reset monostables, the pulse width from each determined by C4/R2 and C5/R3 respectively. The negative edge of the reset pulse from pin 10 of IC2 is coupled back to IC1a via C3 and R1, the reason for these components being that the retriggering pulse must be of a shorter duration than the timing pulse and this would not be so if a direct connection was made.

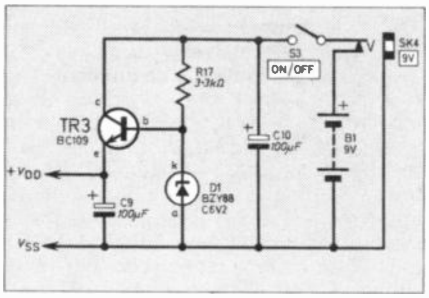


Fig. 2b. Power supply arrangement for the circuit. Insertion of a battery eliminator jack cuts out the internal battery

IC3, a CMOS 4017 decade counter/divider, i.c. is wired as a divide-by-ten and TR1 forms the preamplifier stage for the unknown input signal.

MULTIPLEXED DISPLAY

The latch/counter circuit consists of IC4, a 74C925 CMOS four digit counter with multiplexed seven-segment outputs. This i.c. counts the clock pulses at pin 1 when pin 12 (reset) is low and only when pin 5 (latch) goes high will the display give the information contained in the counter. In this circuit, the information in the counter is transferred to update the display only during the brief period of the latch pulse.

The display is multiplexed and a CA3046 (or the equivalent LM3046, CA3086 etc) is used to drive the four digits. This i.c. contains five individual *npn* transistors, only four of which are used.

The circuitry associated with TR2 drives the decimal point on the display and this is moved accordingly with S2b, S2a being the switch to bring the divide-by-ten circuit.

With S2 in position "X 100kHz", the meter can measure up to 1 megahertz and the display reading must be multiplied by 100,000. The capacitance is given directly in microfarads in the range 0·001μF to 10μF. The decimal point is after the most significant digit.

COMPONENTS

Resistors

R1, 14	18kΩ (2 off)
R2	22kΩ
R3	1MΩ
R4	2·7kΩ
R5	100kΩ
R6	6·8kΩ
R7-13, 16	1kΩ (8 off)
R15	56kΩ
R17	3·3kΩ

All ¼W carbon ±5%

See Shop Talk page 233

Capacitors

C1	1μF 16V electrolytic
C2, 7, 8	0·01μF polyester (3 off)
C3, 6	1000pF polystyrene (2 off)
C4	270pF polystyrene
C5	2·2μF tantalum bead
C9, 10	100μF tantalum bead (2 off)

Semiconductors

D1	BZY88 6·2V, 400mW Zener diode
TR1, 3	BC109 silicon *npn* (2 off)
TR2	BC179 silicon *pnp*
IC1	556 dual timer
IC2	4098 CMOS dual monostable
IC3	4017 CMOS decade counter/divider
IC4	74C925 CMOS 4 digit counter with multiplexed 7-segment output
IC5	CA3046 silicon *npn* transistor array
X1	Calculator display National NSA 1298 (see text)

Miscellaneous

S1, 2	d.p.d.t. miniature toggle (2 off)
S3	s.p.s.t. miniature toggle
SK1, 3	4mm socket, red (2 off)
SK2	4mm socket, black
SK4	2·5mm jack socket, switched
VR1	100kΩ multiturn preset Spectrol type 43P.
VR2	10kΩ multiturn preset Spectrol type 43P.
B1	9V PP3 battery

Stripboard, 0·1 inch matrix, 32 strips by 42 holes; aluminium instrument case, 150 × 105 × 45 mm; red display filter approx 50 × 25mm (for X1); battery connector; 16 pin d.i.l holder (3 off); 14 pin d.i.l. holder (2 off); 7/0·2 p.v.c. sleeved equipment wire; board mounting hardware M2·5 (6BA).

With S2 in the "X 100Hz" position, the meter measures from 50Hz to 100kHz, this time the display reading must be multiplied by 100. Again the capacitance meter reads directly in microfarads, from 0·1μF to the maximum of 10μF. The decimal point is after the third most significant digit.

The instrument is designed to work from either a 9V battery or a calculator type mains adaptor. The supply to the circuit (V_{DD}) should be about 5·5V and although this is not too critical, it should not be allowed to fall much below this value, otherwise the pulse from pin 10 of IC2 may not be sufficient to retrigger the timing monostable, IC1a.

COMPONENTS

All resistors and capacitors should be as small as possible and for this reason tantalum bead capacitors are used in place of electrolytic types (except for C1). TR1, 2 and 3 can be replaced by any similar specification silicon transistors and potentiometers VR1 and 2 are three-quarter inch long multiturn presets.

The display used in the prototype is a common cathode nine digit calculator display, only four of which are used. Individual displays of larger size could be used as indeed could the four digit "bubble" displays in the d.i.l. package, but larger displays will draw more current, and therefore make battery operation less feasible and the size of the box may also need to be increased.

There are several types of calculator display, some with edge connector type mounting, as in the case of the National Semiconductor display used in the prototype model (part No. NSA 1298), and it was for this type that the component board has been laid out and the pin numbers on the circuit diagram refer to. Other types may require modification to the wiring and when purchasing a display, check with the supplier that the pin connection information is available (see Fig. 3).

Generally speaking, calculator displays, often supplied as surplus stock, are cheaper than the alternatives already discussed, their only drawbacks, being the somewhat miniature digits and the need for an additional red filter.

The segment current limiting resistors R7 to 13 and R16 could be of a lower value to increase the display brightness but this would be at the expense of increased current consumption, which on the prototype was about 40mA.

CONSTRUCTION starts here

CIRCUIT BOARD

The main component board is a piece of 0·1 inch matrix Veroboard, 32 strips by 42 holes with the plain unpunched copper strips found along the edge of the board left on. It is in these strips that the four mounting holes are drilled as shown in Fig. 4. The original prototype meter was constructed on a special d.i.l. circuit board, but this type of board requires a fairly large number of wire links so the design was transferred to stripboard.

There are 82 breaks in the tracks and the position of these must be carefully checked. The components can now be inserted, proceeding with the d.i.l. holders (this greatly assists in locating the positions of other components) followed by resistors, capacitors, semiconductors and finally links. Small, straight links of no more than 5 holes long can be made from resistor lead croppings but the longer links and particularly those which bend, must be formed from insulated wire. Ideally, the flying leads from the board to the front panel should be soldered to Veropins as this strengthens the joint considerably.

The display can be mounted directly into the board but may require to be soldered onto a row of pins inserted into the board, particularly if a slightly different display is used and any pinout changes can be accommodated at this stage (see note on alternative type of display).

INSTRUMENT CASE

To mark the board mounting holes in the bottom of the case, use the board itself as a template (prior to any components being assembled on it), placing it in position as shown in Fig. 5.

A drilling guide for the front panel is shown in Fig. 5, and the hole in the rear panel for SK4 must be large enough to clear the mounting bush and nut of the socket. The reason for this being that SK4 is to be isolated from the chassis so it is first mounted on a piece of insulating material (a piece of plain Veroboard for example) and this is then glued behind the back panel, none of the socket's metalwork touching the case.

The board is mounted into the case with long screws (M2·5 or 6BA),

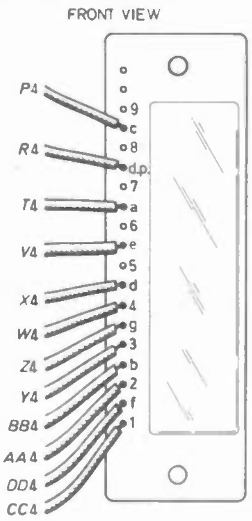
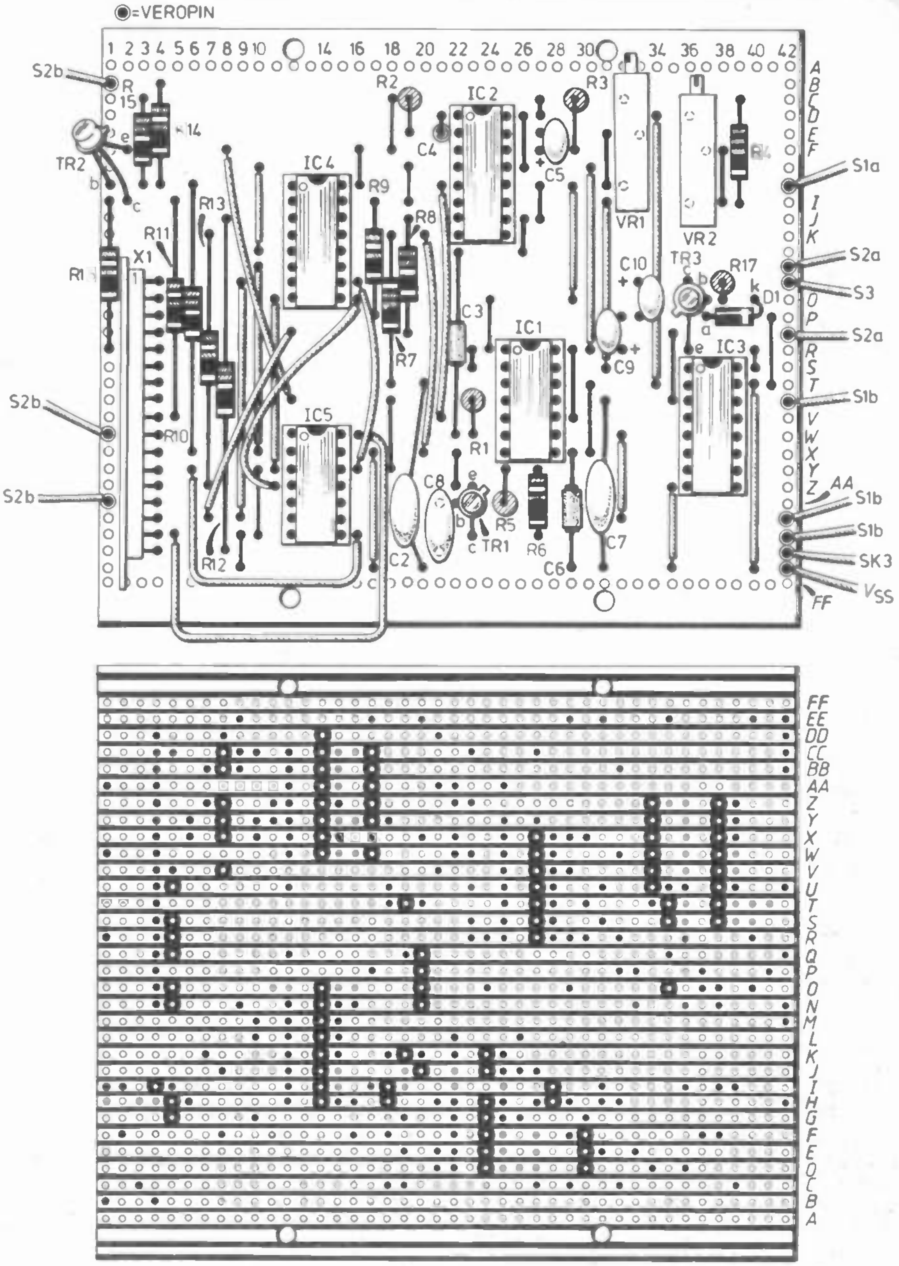


Fig. 3. Additional wiring data for the alternative Bowmar 9-digit l.e.d. display. This display will need to be screw mounted to the front panel.

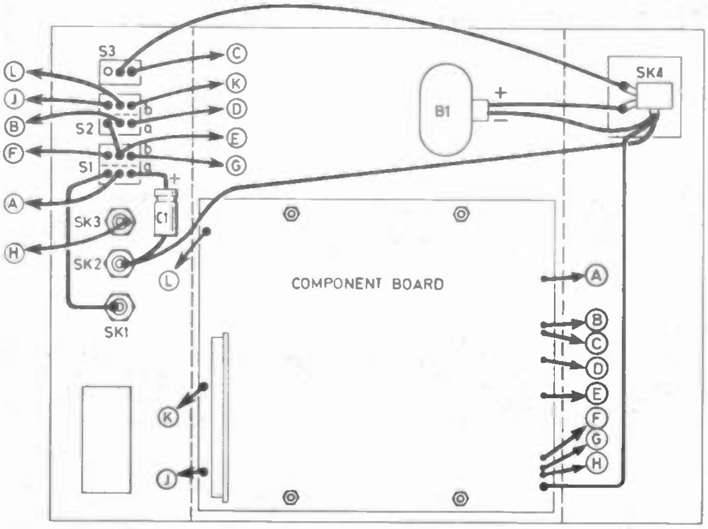
Fig. 4 (right). Component layout on the stripboard together with an underside view showing the cuts to be made in the copper tracks.

Note that there are 82 breaks to be made in the copper tracks and these should be made before inserting the topside components.

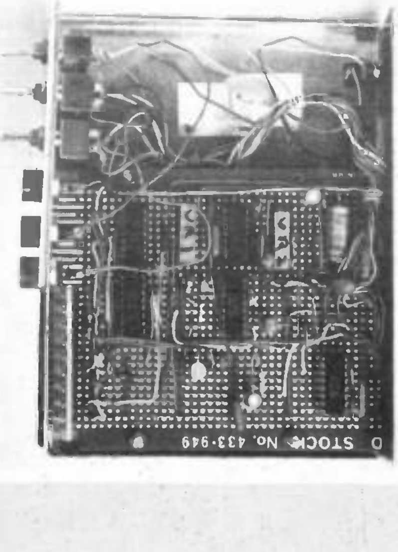


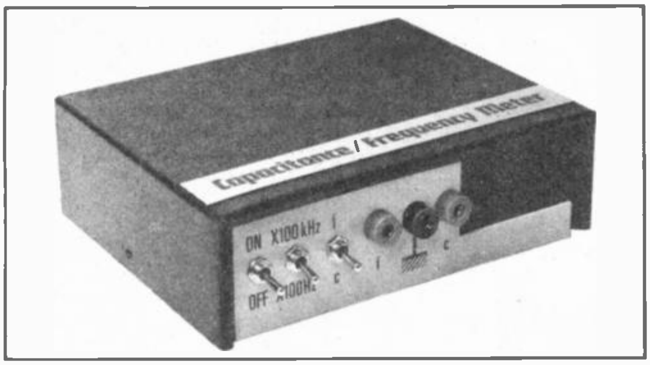
COMPONENTS approximate cost £17

Fig. 5 (below). The case has been laid flat to show position of circuit board, switches, sockets and display cutout.

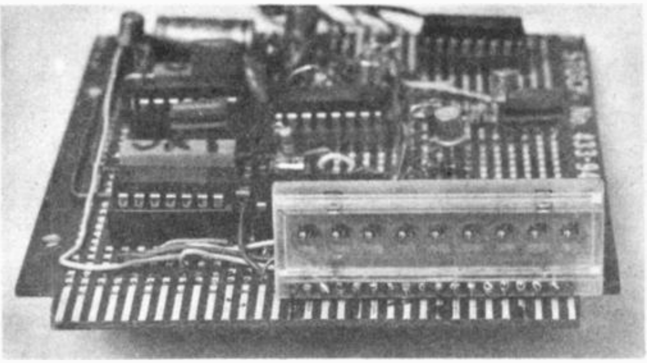


Prototype meter showing positioning of switches and the use of a d.i.l. circuit board.





Front panel arrangement showing lettering and filter over the display cutout.



Close-up of the display module used on the d.i.l. board prototype.

the reason being that this allows up and down adjustment to get the display accurately behind the window in the front panel, but the board height is typically 12mm meaning the screws must be at least 15 to 20mm long.

Having assembled the case with all switches, sockets and board, wiring can commence.

FINAL ASSEMBLY

Using Fig. 5 as a guide, all interconnections can be made with flexible, stranded wire. Note the mounting of C1 between SK2 and S1a and that this capacitor is an electrolytic and not a tantalum bead, as the bead would not be robust enough.

Care must be taken when wiring SK4 ensuring that the V_{ss} lead is soldered to the outer sleeve terminal, the lead from S3 goes to the other contact and the battery positive wire is connected to the switched contact (only connected when no plug is in the socket).

CALIBRATION

The meter must first be calibrated as a frequency meter, and this is carried out by adjusting VR1 until the display matches a known input frequency. If a signal generator is available then this should be used to set up the instrument, but failing this, a crystal oscillator of known frequency must be built to the circuit given in Fig. 6. Any suitable crystal in the range 100 to 200kHz can be used for X1.

Another, though less satisfactory method of calibration is to take a couple of meters of wire and form it into a loose coil of about 150mm in diameter. Insert the free ends into the input terminals of the meter, and dangle the coil over the back of a turned on television set. The coil will pick up the flyback pulses from the scan coils, the frequency being 15,625Hz for a 625 line system. However, the disadvantage of this method is the possibility of picking up other frequencies from the set.

Calibration of the capacitance range is performed using a capacitor of known value (as high a tolerance as is available) and adjusting VR2 until the display corresponds with the value. A high value component, for example, 0·47μF (not electrolytic or tantalum), is ideal.

If the frequency is recalibrated for any reason, it will also affect the capacitance readings, whereas the capacitance range can be altered without upsetting the frequency calibration.

If a frequency or capacitance is beyond the range of the meter, the display will show an inconsistent result.

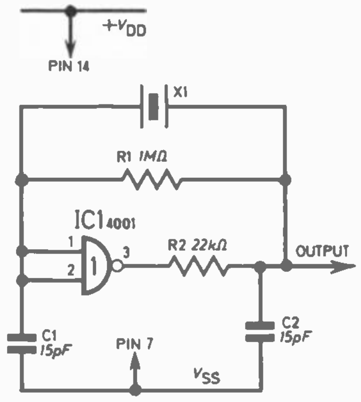


Fig. 6. Crystal oscillator circuit for calibrating the frequency meter mode. See text for X1.

TROUBLE SHOOTING

The following points may be helpful if the instrument does not work when first turned on.

The display should always show four digits and a decimal point, irrespective of faults elsewhere in the circuit and if it only reads four zeros in the capacitance mode, check that the clock oscillator is working (IC1b) by looking for a signal on pin 9 of IC1. Now check that the timing pulse is being generated by connecting to the test terminals a high value capacitor (say 10μF) and measuring the voltage across it using a high impedance voltmeter. The voltage should continually rise and then fall, recycling about once every second. If it only rises initially when first turned on, then either IC1 is at fault or more likely, there is no reset pulse coming from IC2 to retrigger the timing pulse.

Attention can then be turned to IC2, this can be easily investigated by removing IC1 from its socket (assuming it has one!) and measuring the voltage at pin 6 of IC2. This should be at 0V. Pin 10 should also be at 0V and whilst these measurements are being taken, pin 5 must be tied to $+V_{DD}$ via a resistor and this is achieved by inserting the ends of the resistor in pins 5 and 14 of the now empty IC1 socket.

Momentarily short pin 5, IC2 to 0V and pin 10, IC2 should go high (approx $+V_{DD}$) for about one second, then fall to zero volts again.

If this does not happen then either the wiring of this i.c. is incorrect or it is a defective device. If however these measurements are correct but the fault persists when IC1 is replaced, then assuming the wiring is correct, IC1 is faulty.

IN CONCLUSION

The meter will of course be only as accurate as the standard it is calibrated against and in many instances this will be, in the case of the capacitance range, an off-the-shelf component and for the frequency, a signal generator which may not have seen the calibartion engineers test bench for many a year. However, it is felt that for the majority of enthusiasts, it will serve to be a very useful and indeed, accurate enough, tool to have in the workshop.

Its single board construction, dual power supply options and low cost and simplicity make it a very attractive project for the amateur constructor wishing to expand his range of test gear. ⌑

By Dave Barrington

Two aids that may help the constructor or service engineer to enhance the finished layout of a project and carry out "on-the-spot" running repairs attracted our attention this month.

Conductive Paint

A new conductive paint-on preparation from Comma Oils & Chemicals intended for the motoring fraternity is an ideal instant printed circuit board "repair kit" in a bottle.

Known as Electrocure 7, its main application is for repairing car rear window heating elements. However, this specially formulated silver based paint makes it easy to make-good broken tracks on p.c.b. boards and even stripboard.

Comma's Electrocure 7 conductive paint.

It can also be used for repairing most low voltage equipment where there is a broken connection. A feature of the product is that it has been developed for use on non-solderable surfaces, including glass, plastics, acrylics and ceramic.

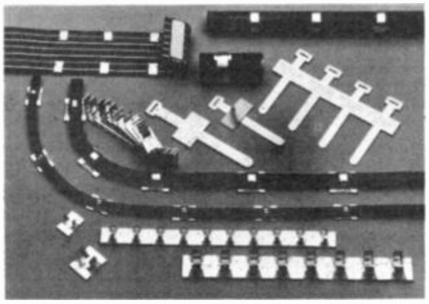
Expected to be stocked by most motoring accessory shops, more details of price and addresses of nearest stockists can be obtained from Comma Oils & Chemicals Ltd., Dept. EE, Mark Lane, Gravesend, Kent DA12 2QX.

Cable Clips

Neat wiring makes it that much easier to trace out circuits and locate faults. Apart from wiring spirals, cable retainers and the use of the usual method of tie-cord, any new addition is welcome.

A range of Brandauer self-adhesive cable clips from Stotron provide an inexpensive method of fixing round or ribbon cable to most clean surfaces. The clips can handle round cables from just a few millimetres to 19mm (¾in). Ribbon cables from 13mm (½in) to 75mm (3in) can also be accommodated by a selection of clips with widths in stages of 6mm (¼in).

For more details of stockists and prices write to Stotron Ltd., Dept EE, Unit 1, Haywood Way, Ivyhouse Lane, Hastings, East Sussex.



Cable clips from Stotron

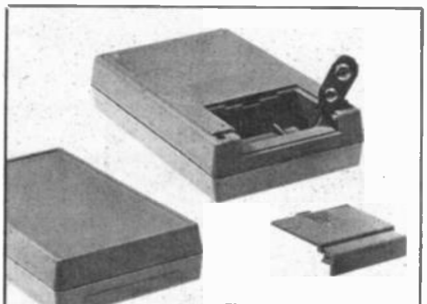
Case

A range of cases just being marketed by OK Machine & Tool feature a special battery compartment.

Called the HP-BAT-9V, the case has a removable battery "hatch" in its back panel, together with the battery clip and lead. The case is constructed of ABS material, measuring 92mm × 145mm × 28mm, and is ideal for housing all hand-held instruments.

Four standard colours are offered, grey, tan, black and blue but special custom colours are available to order.

The HP-BAT-9V case is available from OK's usual retail outlets, or direct from OK Machine & Tool (UK) Ltd., Dept EE, Dutton Lane, Eastleigh, Hants, SO5 4AA.



The HP enclosure from OK Machine & Tool

Catalogue

The latest catalogue we have received comes from Rheinbergs Science who have been appointed exclusive distributor for the complete range of astronomical and scientific equipment and kits from Edmundson Scientific Products of America.

From lasers and holograms to fibre optics and science kits the Edmundson range consists of over 4,000 items. To promote these, Rheinbergs have equipped a showroom at Tonbridge, Kent, and have issued two catalogues outlining the complete range.

The General Scientific edition consists of 48 pages. in colour, and covers optics, holography, tools, motors, microscopes and laboratory equipment. The Science Fun kits include electronics, electricity and magnetism, solar energy and a digital electronic computer kit.

Copies of the catalogue can be obtained free from Rheinbergs Sciences Ltd., Dept EE, Sovereign Way, Tonbridge, Kent TN9 1RW.

CONSTRUCTIONAL PROJECTS

Capacitance/Frequency Meter

The display used in the prototype model of the *Capacitance/Frequency Meter* was a nine digit calculator display, only four digits being used.

We have been informed by Bart Trepak of TK Electronics that they have a Bowmar 9-digit display suitable for this project. This is available from TK for the sum of 55p plus VAT. Note, the pinning for this device is different and will have to be "hard-wired" to the board as indicated in the article.

The multiturn potentiometers are Spectrol types and stocked by Watford Electronics.

The only source of supply we have been able to locate for the four decade counter/latch i.c., type MM74C925, is Ambit International.

Magnetic Lock

The only sourcing problems likely to be encountered in the *Magnetic Lock* is the supply of the Hall Effect devices.

The magnetically-operated TL170C Hall effect i.c. contains an output transistor with open collector for use on voltages up to 30V. This device seems to be only available from Maplin Electronic Supplies, stock number WQ75S (TL170C). They are also suppliers of suitable bar magnets, stock number FX72P.

Ram Pack

The integrated circuits called up in the *2K Ram Pack* should be readily available from most advertisers, but in case of difficulty they are listed by Watford Electronics, Ambit, and Electrovalue.

Readers who are not able to make their own printed circuit for this project may be interested to learn that Proto Design are able to supply one.

The cost for this board is £2·21 including VAT and postage and packing, and can be obtained from Proto Design, Dept EE, 14 Downham Road, Ramsden Heath, Billericay, Essex, CM11 1PU.

The double-sided edge connector used in our model was cut from a 77-pin wire-wrap type to form a 23-pin version. Only a *Wirewrap* edge connector is suitable for this project and *must* be used. This is available from Redditch Electronics, Dept EE, 21 Ferney Hill Avenue, Redditch, Worcs, B97 4RU, price £2·95 + 40p p/pkg.

Light Actuated Switch

There are no unusual components in the *Light Actuated Switch* although care should be taken when choosing a suitable relay. This must have a 12V coil and mains rated contacts capable of carrying sufficient current for the load being switched. In any case they should not be rated at less than 3A. A suitable type would be the Pigmy Mains Relay available from Electrovalue.

In-Car P.S.U.

The integrated circuit type LM317T used in the *In-Car P.S.U.* is available from Tandy stores.

2K RAM PACK
FOR THE SINCLAIR ZX81

BY V. TERRELL

This project has been specially designed to meet the expected memory expansion needs of the ZX81 Personal Computer user who may not immediately require or be able to afford the massive 16K byte Ram Pack from Sinclair at a cost of over £50.

THE "add on" Ram Pack to be described gives the ZX81 (1K) microcomputer an extra 2K of RAM. It works in conjunction with the ZX81 internal 1K of RAM therefore providing a total of 3K of usuable memory. All the necessary voltages and signals are readily available from the p.c.b. dual finger-set at the rear of the ZX81 including its power supply (5V). The unit simply plugs in and is immediately ready for use.

MEMORY STORE

The 2114 memory chips used in the unit can each store 4-bit wide data at 1024 addresses. Because the ZX81 data bus is 8-bits wide, the four chips in the Ram Pack are wired in pairs, each pair allowing data to be stored at 1024 addresses 8-bits wide.

CIRCUIT OPERATION

The complete circuit diagram for the ZX81 Ram Pack is shown in Fig. 1. The address lines A0-A9 are wired in parallel to the two pairs memory chips, IC1-4. These 10 lines carry information to call up any one of the 1,024 address locations as selected by the computer.

The eight lines D0-D7 carry data which can either be written (stored) into memory when the R/$\overline{W}$ pin is low, this being controlled by the $\overline{WR}$ (write) line from the ZX81, or when this line is high, data may be read from the memory and processed by the computer.

The two 1K memory blocks IC1, IC2 and IC3, IC4 are enabled only when their $\overline{CS}$ pins are low, a high will disenable them.

The ZX81 RAM starting address is 16384 and decoding is required to enable the Ram Pack to be positioned 1K beyond this address.

DECODING

Address decoding for the extra RAM is accomplished using IC5, a three-to-eight line decoder i.c. with tristate outputs. The three inputs A0, A1 and A2 on IC5 form a three-bit binary number (eight decimal numbers). The output corresponding to the binary input goes to a logic low with the remainder at logic high.

The decoding is not unique since an output will go low for the various combinations of 1s and 0s to the inputs, irrespective of the conditions of address lines A12 and A13, but does not need to be taken into account in this 2K system.

The i.c. as stated earlier is a tristate device which means that the outputs can be disenabled (effectively disconnected) by suitable control signals to the three enable pins $\overline{EN1}$, $\overline{EN2}$, EN3 on IC5. The bar indicates that a low is required on $\overline{EN1}$ and $\overline{EN2}$ and a high on EN3 to "connect" the outputs to the following circuitry.

A logic high on address line A14 means that memory between 16K and 32K has been selected by the processor which is the requirement here. When addressing memory for read or write, the processor generates a low on $\overline{MREQ}$ at a time when the

Table 1: Decoder truth table.

Inputs				Outputs			Chip Enabled
A14	MREQ	A10	A11	Q0	Q1	Q2	
1	0	0	0	0	1	1	ZX81 Internal RAM
1	0	1	0	1	0	1	IC1, IC2 (First extra 1K)
1	0	0	1	1	1	0	IC3, IC4 (Second extra 1K)

If A14 is low or $\overline{MREQ}$ high, all outputs are high impedance.

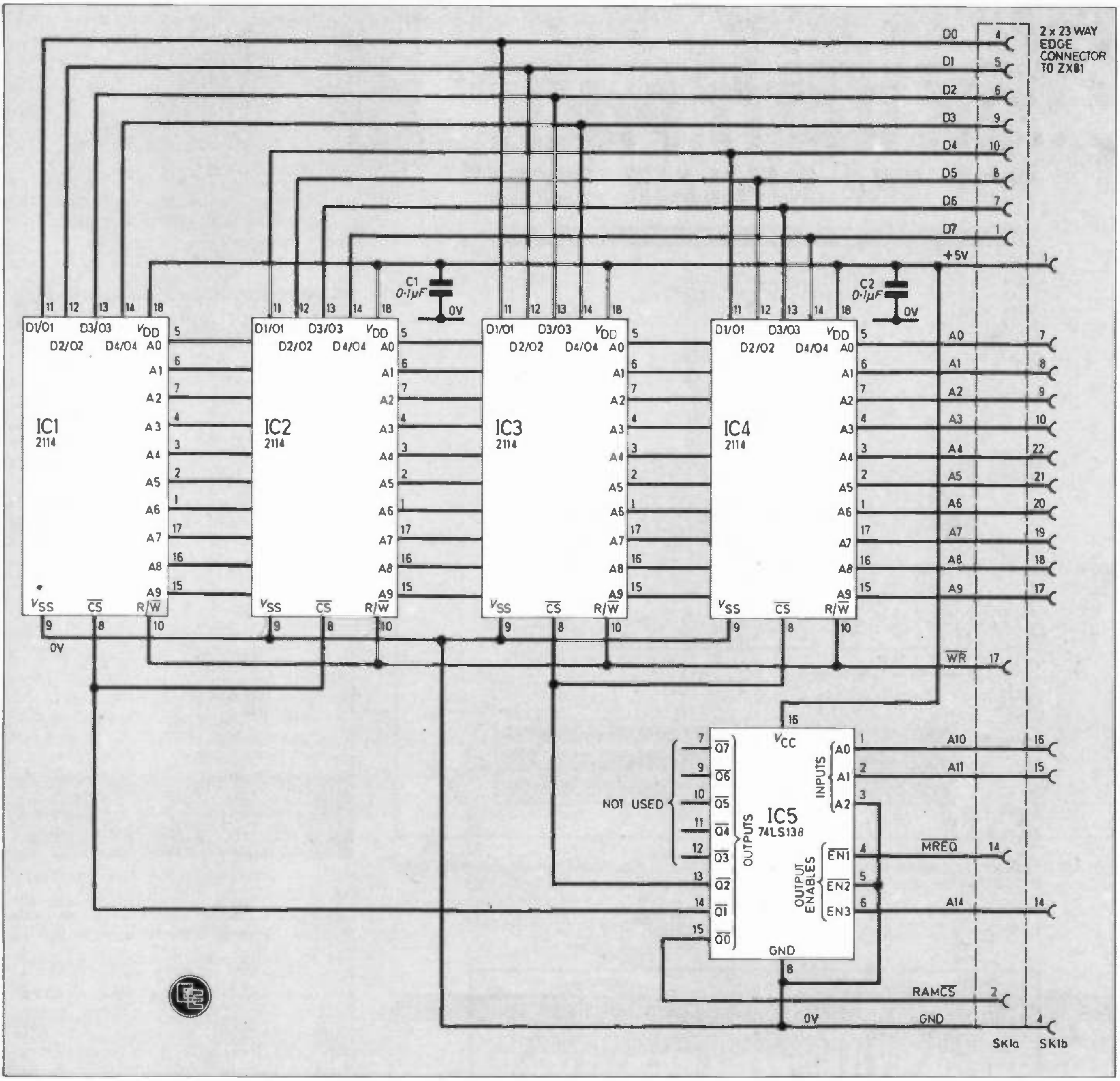


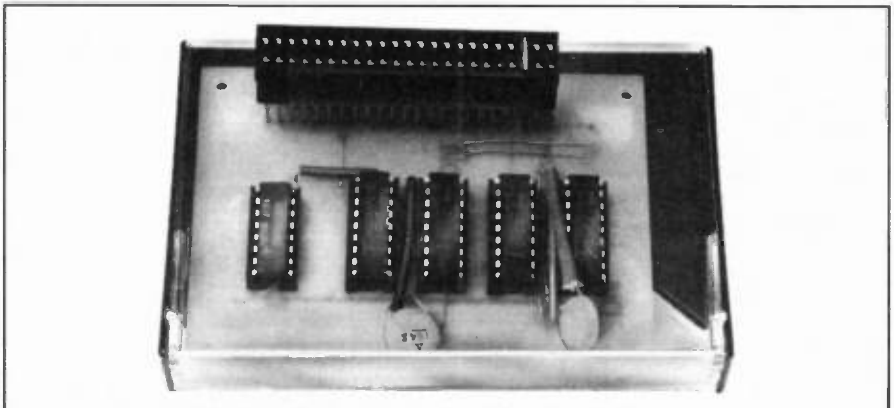
Fig. 1. The complete circuit diagram for the 2K Ram Pack for the ZX81.

address bus is stable. Thus addressing memory above 16K causes one of the outputs $\overline{Q0}$ to $\overline{Q2}$ to reach the RAM i.c.s. This is summarised in Table 1. Q3 is not used.

TRUTH TABLE

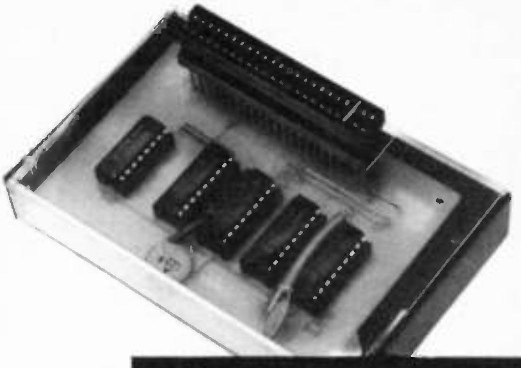
The truth table for the decoder (IC5) reads as follows: When $\overline{Q0}$ is high the internal 1K RAMCS pin is disenabled. $\overline{Q1}$ low enables the $\overline{CS}$ pins of IC1, IC2 selecting the first 1K of memory. $\overline{Q2}$ low enables the $\overline{CS}$ pins of IC3, IC4 selecting the second 1K of memory.

Decoupling capacitors C1 and C2 are required for each RAM pair to filter away any transients that may occur on the supply rail.



The Ram Pack completed and installed in its case.

2K RAM PACK
FOR THE SINCLAIR ZX81



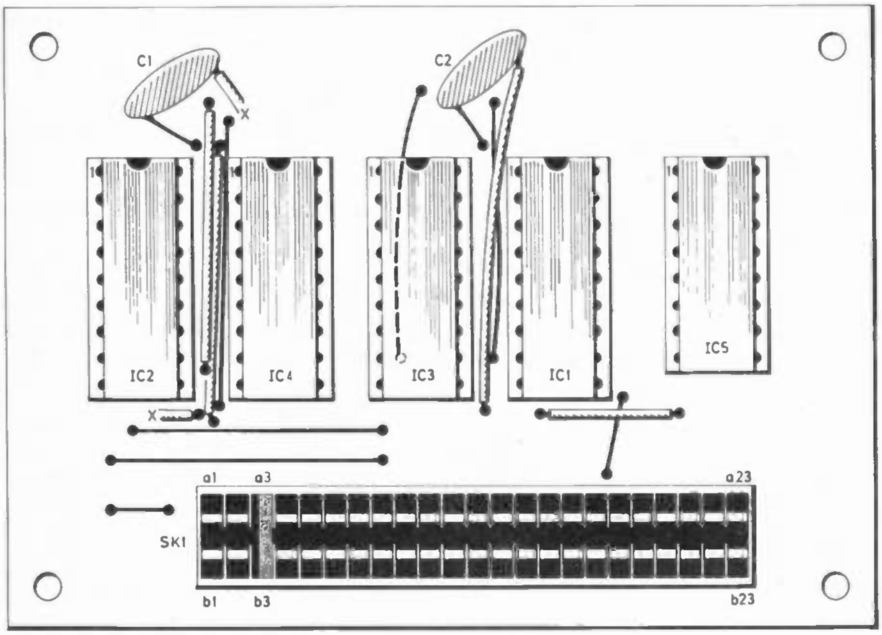


Fig. 3. Layout of the components on the topside of the p.c.b. Note that a link wire runs underneath IC3 socket. It is important to use sleeving on some of the link wires.

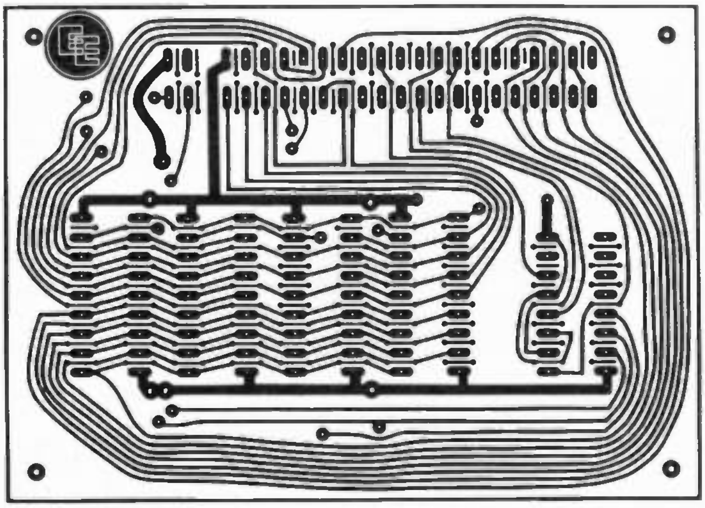


Fig. 2. Full size master of the pattern to be etched on the p.c.b. viewed from the copper side.

COMPONENTS

Capacitors

C1, C2	0·1μF disc ceramic (2 off)

Semiconductors

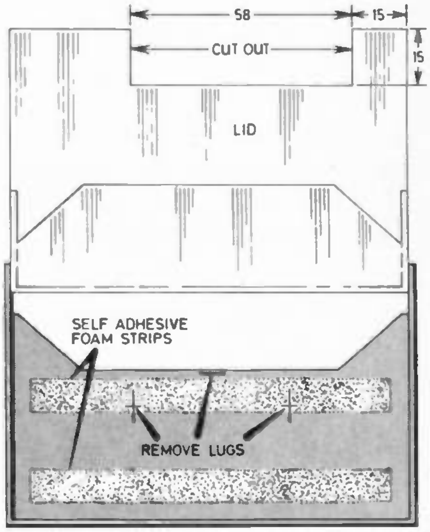
IC1-4	2114-2 4096 bit MOS static RAM i.c. (1K × 4 bit) (4 off)
IC5	74LS138 TTL tristate 3-to-8 line decoder

Miscellaneous

SK1	0·1 inch pitch 2 × 23 way edge connector, wire wrap type with at least 3cm long pins

Printed circuit board: single sided, size 91 × 65mm; low profile d.i.l. sockets, 18-pin (4 off), 16-pin (1 off); cassette tape case; double sided self adhesive foam pads or strip; tinned copper wire; sleeving; solder.

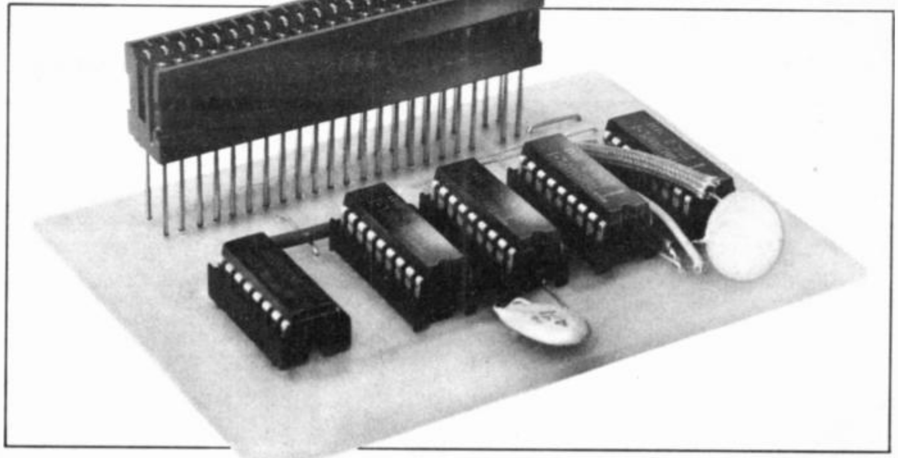
Approx. cost Guidance only **£10**
See page 233



ALL DIMENSIONS IN mm

Fig. 4. Cut-out dimensions in the plastic cassette tape case to allow the edge connector to meet with the ZX81 p.c.b. The foam pads cushion the p.c.b. when the case lid is closed.

CONSTRUCTION starts here



The fully assembled p.c.b. It can be seen that pin 3 on both sides of SK1 has been removed and that a polarising key has been fitted. This key is important and ensures that the connector accurately aligns with the ZX81 finger set.

EDGE CONNECTOR

The 2×23-way connector may be cut to size from a longer connector and should be of the wire wrap type with pins at least 3cm long. These pins must also be able to be removed to allow a polarising key to be located in the socket across positions 3A and 3B as shown in Fig. 3.

If a "key" is not supplied with the socket it can be cut and shaped from any suitable insulating material of the correct thickness and glued into place.

PRINTED CIRCUIT BOARD

The circuit is built on a single-sided p.c.b. size 91×65mm. The full-size master of the pattern to be etched is shown in Fig. 2.

The printed circuit board tracks are quite close together so therefore care must be taken when soldering. It is suggested that a fairly small bit be used together with 22 s.w.g. solder.

Start by fitting the ten link wires as shown in Fig. 3. Next solder the five i.c. sockets followed by the two capacitors C1, C2.

Locate and solder the edge connector so that its pins protrude through the board by no more than 2 to 3mm. Before inserting the i.c.s, thoroughly check all soldered joints making sure adjoining tracks are not bridged with solder.

CASE

Details for fitting the Ram Pack into the cassette case are shown in Fig. 4. Remove the small plastic lugs in the case with a pair of side-cutters. The cut-out for the edge connector is made by cutting two slots with a junior hacksaw, then scribing between these on both sides with sufficient depth so that the plastic may be broken out.

The two strips of self adhesive foam are positioned as shown to cushion the printed circuit board, the case lid is simply secured down with Sellotape.

TESTING

The unit can easily be tested by using the ZX81 "ramtop" test. Plug the unit in, then switch the ZX81 on and type in the following:

PRINT PEEK 16388 + 256 * PEEK 16389 NEW LINE.

You should see 19456 displayed on the screen.

The result 19456=16384+3K of RAM. This short programme retrieves and displays the contents of locations 16388 and 16389 which contain the least and most significant bits respectively of the address plus 1 of the highest RAM location in circuit.

This information has been "poked" into these locations during the system set-up routine which is initialised at switch-on.

The following is a list of software available on the Sinclair 16K cassettes that were successfully loaded by the author using the 2K Ram Pack.

Cassette No.2 (16K)	Cassette No.4 (16K
Crash	Substrike
Train	Codebreaker
Division	Twenty One
	Mayday

NOTE. Always make sure the ZX81 is switched off before inserting or removing the Ram Pack. ⌑

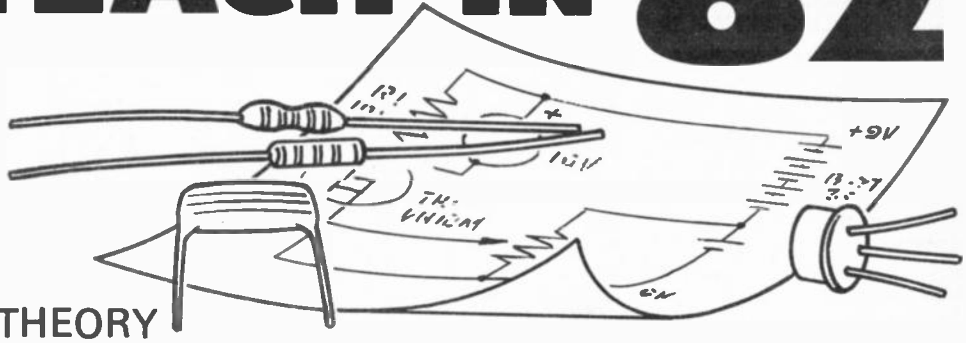
JACK PLUG & FAMILY...

BY DOUG BAKER

EE TEACH-IN 82

PART 7

BY O.N. BISHOP



BASIC ELECTRONIC THEORY WITH EXPERIMENTS

AMPLIFIERS AND AMPLIFIER MODULE

In Part 5 we saw how a single bipolar transistor can be used to amplify a voltage. In those amplifiers (Figs. 5.9 and 5.11) the input was taken to the base and the output was taken from the collector. The emitter was part of both the input circuit and the output circuit. We say that the transistor is being used in the **common-emitter connection.** This is the most frequently used way of using a transistor for amplifying.

In Fig. 7.1 input goes to the emitter and output is taken from the collector. The base is common to both circuits, so this is the **common-base connection.**

The base-emitter current varies according to V_{IN}. The collector current is h_{FE} times greater than this. As I_C varies, the p.d. across *R3* varies in proportion, causing variations in the value of V_{OUT}. Thus the gain of this amplifier is the same as that of a common-emitter amplifier, but we lose the advantage of the high input impedance of the base. The main use for this amplifier is at very high frequencies.

In a common-emitter amplifier the small capacitance between the emitter and base regions has a relatively large effect (the Miller effect). Voltages cannot change rapidly enough and gain is considerably reduced at high frequencies. The Miller effect is much smaller in the common-base connection, making this connection specially suitable for high-frequency amplifiers.

The **common-collector connection** (Fig. 7.2) might seem to have no advantages, since the base-emitter voltage must always be 0·6V (for a silicon transistor) and any increase in base voltage is matched by an equal increase in emitter voltage. Whatever the value of h_{FE}, the gain of the amplifier is always unity. Such an amplifier is called an **emitter-follower**, for the voltage at the emitter exactly follows the changes in voltage at the base.

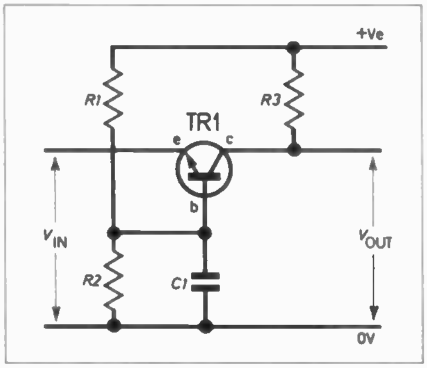


Fig. 7.1. Common base amplifier.

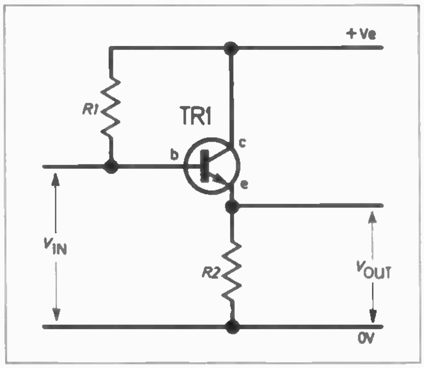


Fig. 7.2. Common collector amplifier (emitter-follower).

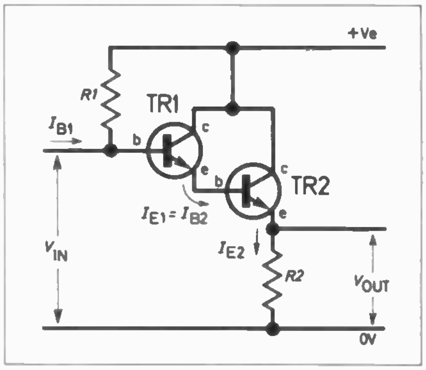


Fig. 7.3. Transistors wired in the Darlington pair configuration.

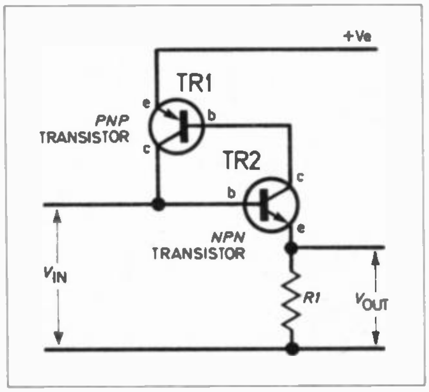


Fig. 7.4. Complementary transistor arrangement (*npn* and *pnp*) connected to obtain very high gain.

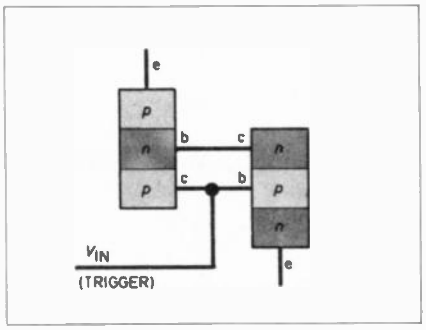


Fig. 7.5. Shows the connected regions of the two transistors of Fig. 7.4.

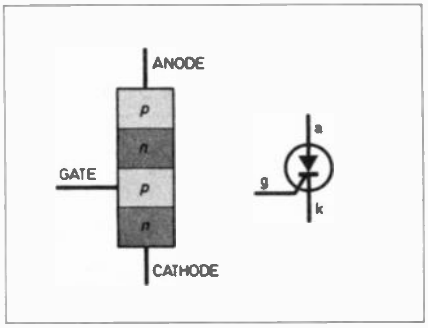


Fig. 7.6. Transistors of Fig. 7.5 combined to make a thyristor.

The advantage of this amplifier is that it has high input impedance (it draws little current on its input side), but has low output impedance (it can provide a lot of current on its output side). It is useful for connecting a high-impedance output to a low-impedance input when we do not need voltage amplification.

INCREASING GAIN

Fig. 7.3 shows two transistors connected, so that the emitter current from one becomes the base current of the other. If the gain of TR1 is h_{FE1}, then $I_{E1} = h_{FE1} \times I_{B1}$. For TR2, $I_{E2} = h_{FE2} \times I_{B2}$. But $I_{B2} = I_{E1}$. Therefore $I_{E2} = h_{FE2} \times h_{FE1} \times I_{B1}$. The gain of the **Darlington pair**, as this arrangement is known, is the *product* of the gains of the two transistors. If they each have a gain of 100, the gain of the pair is 10,000.

We can connect *npn* and *pnp* transistors to form a high-gain pair as in Fig. 7.4.

When power is first applied, TR2 is off, so its collector voltage is high. This makes the base of TR1 high so TR1 is off too. No current can flow to TR2 so it stays off. The transistors hold each other off and no current flows.

If we then supply a very small current to the base of TR2, it begins to turn on. Voltage at its collector falls, drawing current from the base of TR1 (current flows *out* of the base of a *pnp* transistor, not *into* the base as in an *npn* transistor). TR2 begins to turn on, allowing current to flow to the base of TR2 and turning it further on. Its collector voltage falls further, turning TR1 further on. This process continues—even though the original source of current at the input is removed—until both transistors are fully on and a large current is flowing through them. Here we have a circuit wnich can be turned on by a very small, very short pulse.

Fig. 7.5 shows how the regions of TR1 and TR2 are connected and in Fig. 7.6 we see how to make a single four-layered device which has the same action as the two transistors. Such a device is called a **thyristor.**

A thyristor is a current-switching device. No current flows through it until a positive pulse has been applied to its *gate*. A small, brief pulse is enough. Then current flows indefinitely from *anode* to *cathode*. If the current is interrupted (for example by turning off the supply) or is reduced below a certain value, conduction stops and another pulse at the gate is required to start it again. Current cannot flow from cathode to anode, so this device has some of the properties of a diode.

EXPERIMENT 7.1

Low-noise amplifier

The circuit of Fig. 7.7 can be assembled on *Minilab* as shown in Fig. 7.8. When you have built and tested it you will find that it gives a much louder sound than the one-transistor amplifiers already investigated.

Noise in an amplifier consists of currents caused by the random motion of electrons across the junctions of the transistors. These small randomly-occurring changes in current become amplified. We hear a hissing or rushing sound at the loudspeaker.

If a large amount of noise occurs in the first stages of an amplifier, the noise currents are of the same order of size as the signal current from the microphone. Amplification acts on signal and noise equally, causing a noisy output. It is therefore particularly important to minimise noise in the first stages.

In this circuit we use BC109 transistors which are specially made to have low noise. They also have high gain. Noise is kept to a minimum by making the collector current small in the absence of any signal. Ignoring R8, I_C is approximately 12/470,000 = 25μA.

The fluctuations in I_B caused by a signal from the microphone cause voltage fluctuations at the R7/TR1 collector junction, and hence at the base of TR2 which acts as a second amplifier. Now that the first stage of amplification is complete we can allow greater collector current. Hence the low value of R11 compared with R7.

Further amplification by TR2 gives a varying voltage which is coupled by C7 to TR3. The latter is wired as an emitter-follower; no further amplification is required, but the high impedance output of the low-noise amplifier must be matched to the low impedance of the speaker.

Here we do not need a low-noise transistor but prefer instead one which can carry a larger current. Since a ZTX300 can carry up to 500mA, R15 could be reduced to 18Ω giving an increase of volume. An 80Ω loudspeaker could be wired in place of R15 and LS1 and would also give greater volume.

Try holding the microphone close in front of the loudspeaker (Fig. 7.9). You should hear a loud high-pitched whistle. Small noises in the room are picked up by the microphone, amplified, and are emitted by the loudspeaker. Now they are louder and are picked up again and amplified again.

EXPERIMENT 7.1

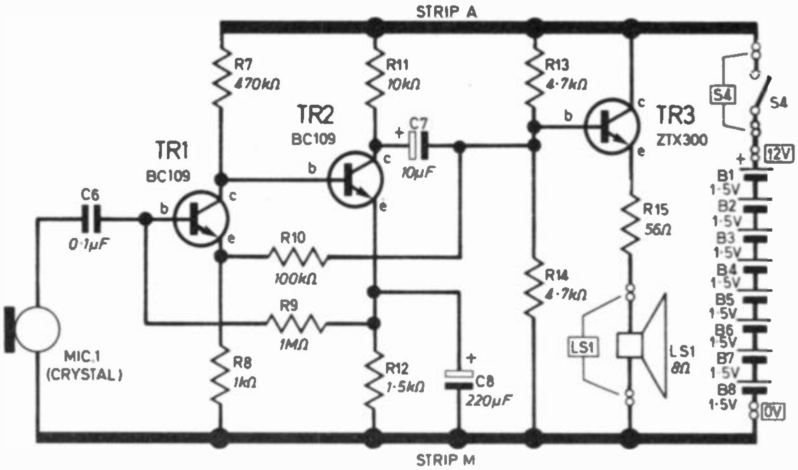


Fig. 7.7. Circuit diagram of a high gain, low noise amplifier with emitter follower amplifier (last stage).

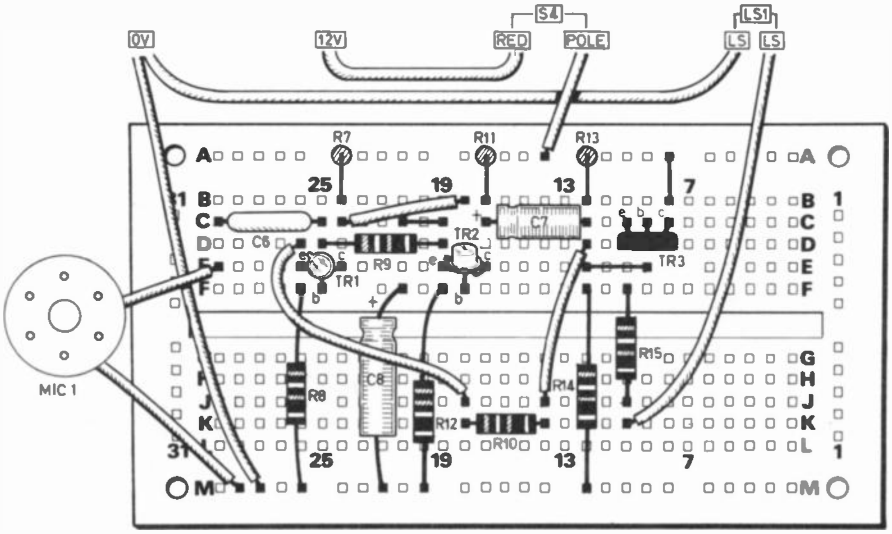


Fig. 7.8. The layout of the components on the Verobloc for the circuit in Fig. 7.7 (Expt. 7.1).

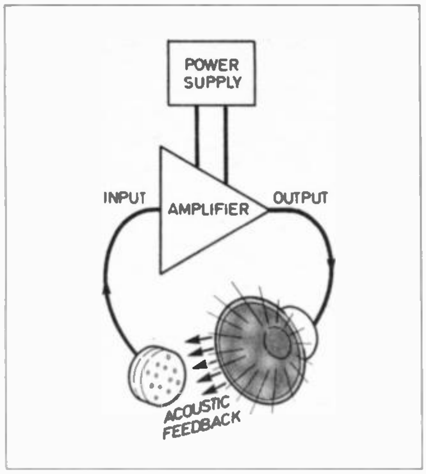


Fig. 7.9. Acoustic feedback (positive feedback).

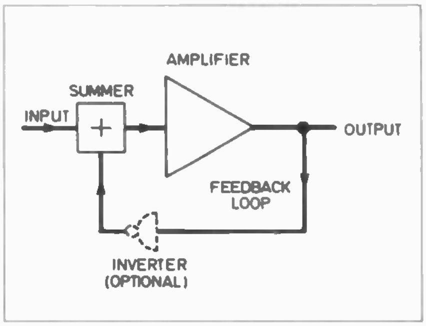


Fig. 7.10. A feedback loop.

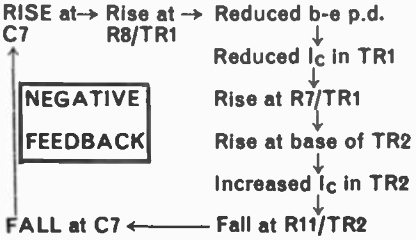
This process continues until a very loud sound is being emitted from the speaker. The signal passes round and round a loop. It is amplified each time round. Its power becomes increased, using the power obtainable from the battery.

Most of the added power spreads into the air of the room, but a small fraction is fed back to the microphone. We have **feedback**. Since the signal fed back acts to produce a further *increase* in volume, we call this **positive feedback**.

FEEDBACK LOOPS

Fig. 7.10 outlines the main stages of feedback. If we include an inverter (a NOT gate for example) in the feedback loop, we have **negative feedback**. A good example of this is found in the amplifier of Fig. 7.7. The voltage at C7 varies according to the signal. A small fraction of these voltage changes is fed back through R10 to the emitter of TR1.

How the negative feedback loop in Fig. 7.7 works is illustrated below:

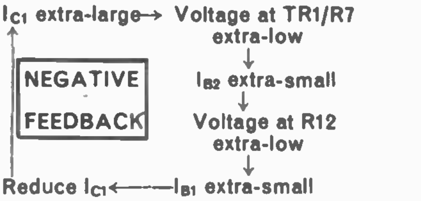


Negative feedback tends to cancel out the rise at C7. The extent to which it does this is determined by the value of R10. The greater the feedback, the greater the effect and the lower the gain of the amplifier.

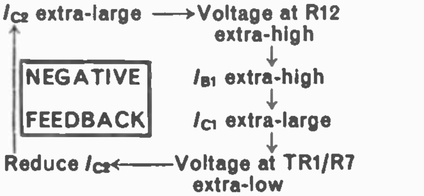
Although negative feedback reduces the gain of the amplifier, it has the advantage of stabilising its gain, irrespective of the h_{FE} of each transistor. The gain no longer depends on differences in h_{FE} due to manufacture, or to variations caused by changes in temperature.

R9 provides feedback of the potential at R12/TR2. It is unaffected by the audio signal, for this is by-passed by C8, as explained last month. The steady d.c. level at R12/TR2 is used to bias TR1. If the h_{FE} of TR1 happens to be exceptionally large, even a small signal could saturate the transistor, causing distortion. The same could happen if TR2 has extra-high h_{FE}. Feedback stabilises such conditions.

If TR1 has extra-high h_{FE}, then the following chain of events occur:



If TR2 has extra-high h_{FE} the following occurs:



The effect of the loop is to stabilise the no-signal conditions of the amplifier.

AMPLIFIER MODULE

The Amplifier Module to be installed in *Minilab* is essentially that shown in Fig. 7.7, but has been re-drawn in Fig. 7.11 in the conventional circuit diagram format and so the component references follow on from the existing permanently wired *Minilab* components (including the Astable Module). The low-noise amplifier is a handy bench instrument which we shall use in later experiments. It is assembled on Verostrip already fitted to the *Minilab* and is to reside next to the existing module.

The layout of the components on the board and interwiring to *Minilab* are shown in Fig. 7.12. To carry out construction the Verostrip must first be removed from the rear panel. It should not be necessary to remove any wiring already connected to this board.

Before replacing the board, thoroughly check over the board, especially on the underside for solder bridges between tracks. Run the blade of a screwdriver between the tracks to dislodge any bridges which may bethere.

TESTING THE MODULE

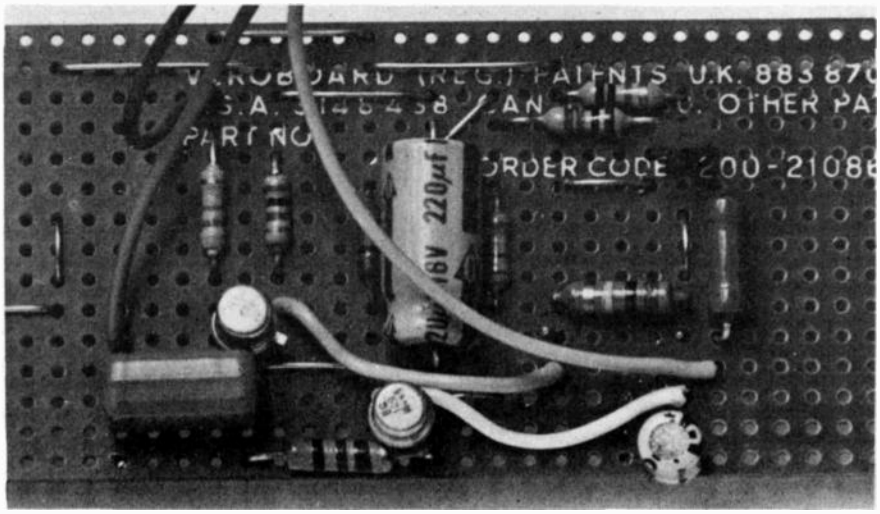
The module may be tested by wiring up as shown in Fig. 7.13. Switch on at S7. Speak into the microphone to hear your voice reproduced in the loudspeaker.

OPERATIONAL AMPLIFIERS

Operational amplifiers are very high-gain amplifiers (×200,000 for example) which usually come in the form of integrated circuits. They normally work on a dual power-supply, as in Fig. 7.14, where we split the 12V battery supply to provide +6V and −6V.

The amplifier has two inputs. If both inputs are at the same voltage, the output voltage is 0V (relative to the 0V line). If the voltage at the non-inverting (+) input, is higher than that at the inverting (−) input, a positive voltage appears at the output. If the inverting (−) input has the higher voltage, a negative voltage appears at the output. All input voltages must lie between the limits of the power supply (between −6V and +6V in this case).

Close-up of the Amplifier component layout section on the Verostrip.



AMPLIFIER MODULE

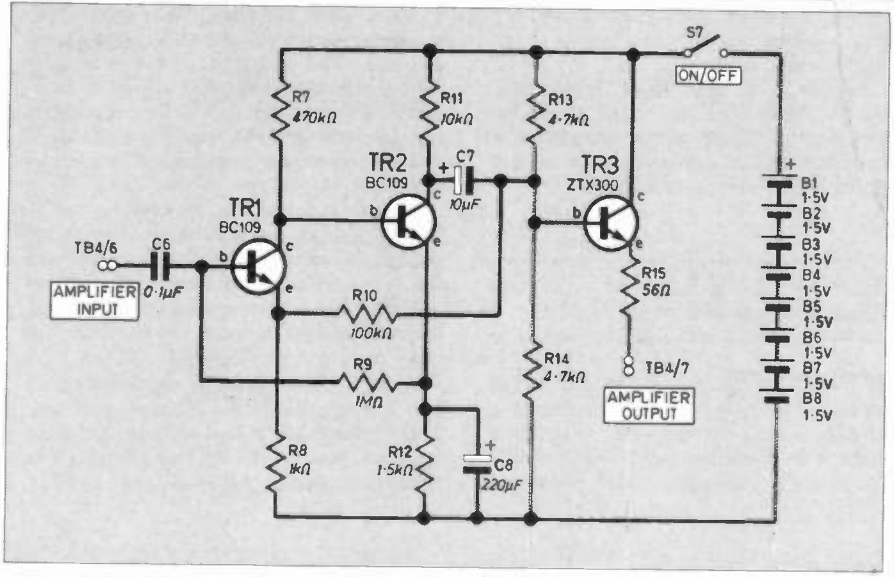
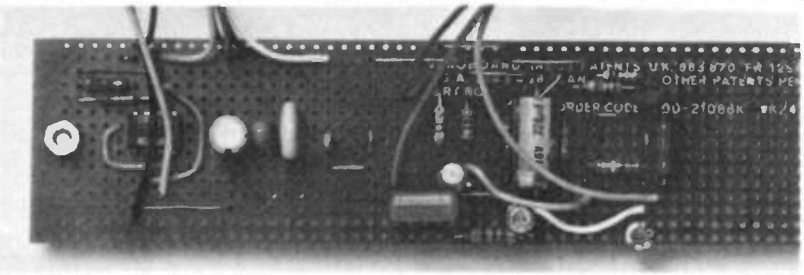


Fig. 7.11. The complete circuit diagram for the Amplifier Module to be fitted inside the Minilab. Note that the component reference numbers follow on from those already resident in the Minilab.



The amplifier components mounted on the Verostrip next to the Astable section.

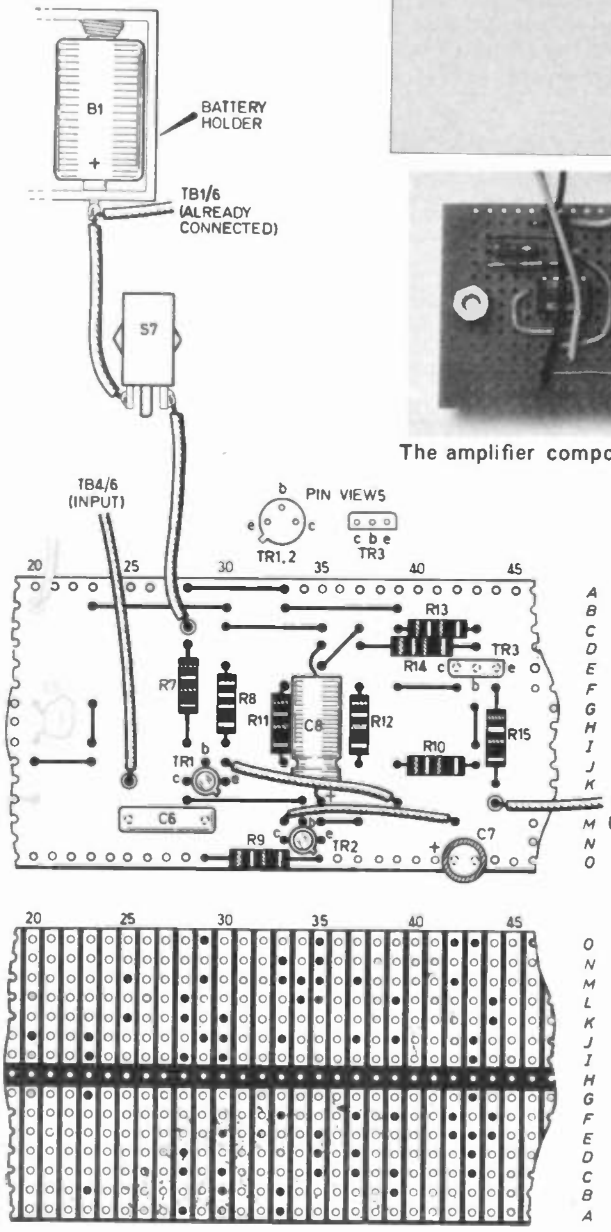


Fig. 7.12. The layout of the components for the Amplifier Module on the Verostrip together with complete interwiring details. The OV line for the amplifier is obtained from the Astable Module.

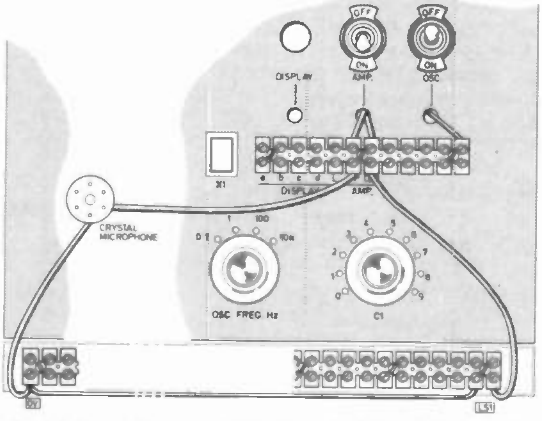
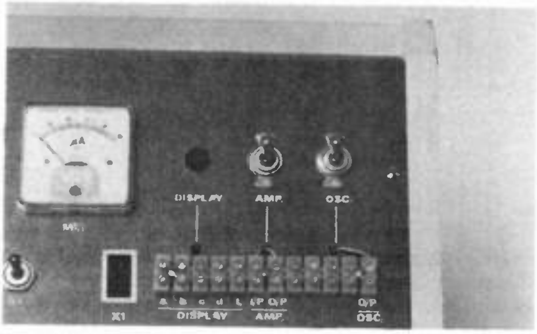


Fig. 7.13. Interwiring to test the installed Amplifier Module



Minilab from panel showing the amplifier section.

The output voltage of the 741 op-amp cannot swing to the full extent toward −6V or +6V, though in other types, such as the CMOS op-amps, voltage can swing freely over the whole range.

Op-amps have high input impedance; 2MΩ for the 741 and as high as 10^{12}Ω for CMOS op-amps. Their output impedance is only a few tens of ohms. Now let us see how these amplifiers may be used.

EXPERIMENT 7.2
Op-amp voltage follower

In Fig. 7.14 the output of IC2 is fed back to the inverting input. VR2 acts as a potential divider to provide a variable voltage source of between 0V and +6V. The layout for this experiment is shown in Fig. 7.15 (a) and 741 pinning details in Fig. 7.15b.

Turn potentiometer VR2 fully anticlockwise to obtain 0V at its wiper (and at pin 3). The output reads 0V. Now turn VR2 slowly clockwise. The voltage at pin 3 should rise from 0V to 6V. You can check this by removing the wire between pin 6 and the meter and connecting it instead to pin 3 (*H17*). Carry out this check for a number of different settings of VR2.

As the input voltage rises, the output voltage rises too. At first it keeps pace with the input voltage but eventually it lags behind, for it cannot exceed about 5V. For the low voltages at least, the amplifier has unity gain; output = input.

What happens is that as input voltage to pin 3 rises, the output voltage rises too. There is feedback of this voltage and, since feedback goes to the inverting input, it is negative feedback. With feedback, the output changes so as to keep both inputs at equal voltages. If pin 3 is raised to +2V, pin 3 must be brought to +2V too. The circuit can be stable only when the output is 2V. As a result, output follows input. The amplifier behaves in a similar way to the emitter-follower circuit (Fig. 7.2). The uses of the circuit are the same too—linking a high output impedance to a low input impedance.

PART 6 ANSWERS

6.1. 5·7nF, or 5700pF.
6.2. Storing charge, coupling parts of circuits, passing a.c. signals, smoothing out rapid voltage changes.
6.3. 3·3 microcoulombs.
6.4. Carbon—it is a conductor.
6.5. 74·2Hz

EXPERIMENT 7.2

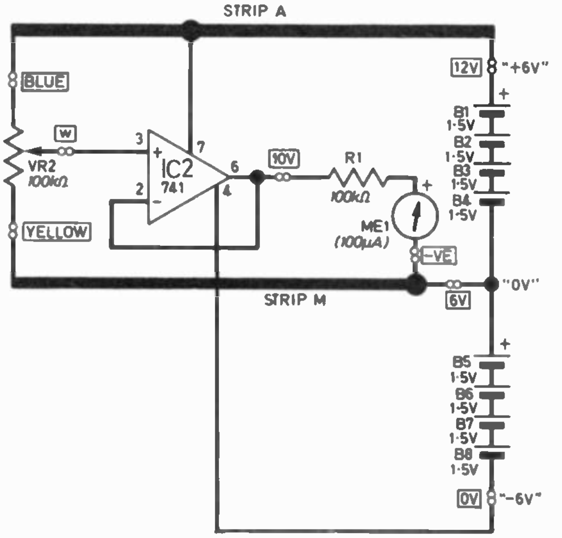


Fig. 7.14. Circuit for investigating the action of an op-amp voltage follower, Expt. 7.2.

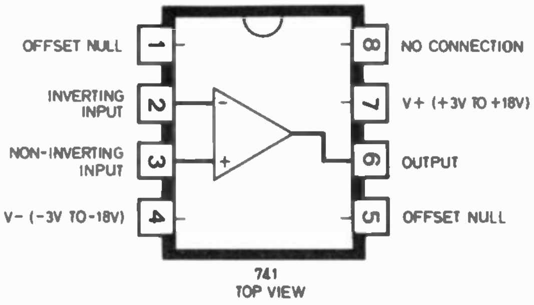


Fig. 7.15b. Pinning details for the i.c. op-amp, 741 used in Expts. 7.2 and 7.3.

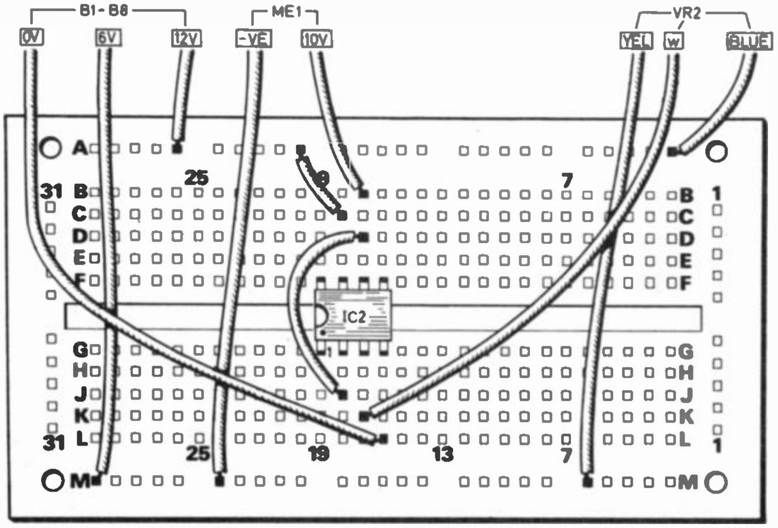


Fig. 7.15a. The layout of the components on the Verobloc for Expt. 7.2.

EXPERIMENT 7.3

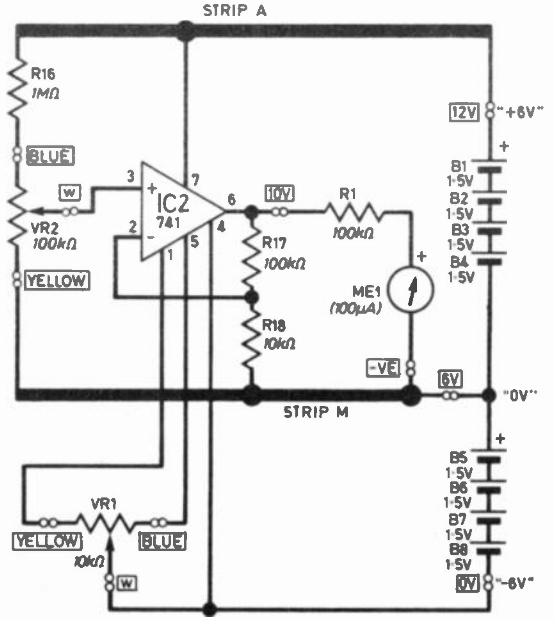


Fig. 7.16. The circuit of a non-inverting op-amp amplifier with fixed gain and offset null control.

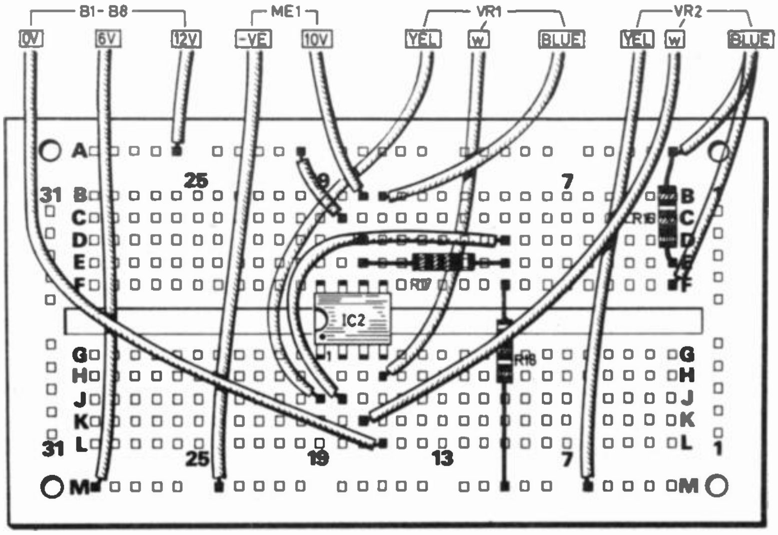


Fig. 7.17. The circuit of Fig. 7.16 wired up on the Verobloc.

EXPERIMENT 7.3

Non-inverting amplifier

Fig. 7.16 shows feedback being taken from a potential divider (R17/R18), so that only a fraction of the output voltage is fed back. This circuit may be wired up on the Verobloc as shown in Fig. 7.17.

QUESTION TIME

7.1. In the common-collector connection, which terminal of an *npn* transistor is connected directly to the positive rail?

7.2. Which type of connection is used to minimise the Miller Effect?

7.3. How is the gain of a Darlington pair calculated?

7.4. Which capacitors are used for a.c. coupling in Fig. 7.7?

7.5. Why are BC109 transistors used for the first stages of amplification in Fig. 7.7?

7.6. What type of feedback is used to stabilise the gain of an amplifier?

7.7 What is the purpose of the offset null adjustment of an operational amplifier?

7.8. If pin 3 (Fig. 7.14) is taken to −3·5V, what will be the output at pin 6?

7.9. If pin 3 (Fig. 7.16) is taken to −0·1V, what will be the output at pin 6?

7.10 In Fig. 7.16 if R16=1MΩ, R17=6·8kΩ, and the voltage at pin 3=0·01V, what will be the output at pin 6?

No amplifier is perfect, so the output may not be *exactly* 0V when both inputs are equal. To begin with, plug the wires *from* pins 2 and 3 (*J18* and *K17*) directly into the 0V rail (strip *M*). Pins 1 and 5 allow for adjustment of the **offset null**; to carry out the nulling, you will need to connect the wire from B17 to ME1 "100μA" instead of "10V"; turn VR1 until the meter reads exactly 0V. Do not alter VR1 after this. Reconnect the wires according to Fig.7.17.

Resistor R16 forms a potential divider with VR2, and sets the maximum possible voltage at VR2 wiper (fully clockwise) to 0·55 volts approximately.

$$\text{Max. voltage at wiper} = \frac{100\text{k}\Omega}{100\text{k}\Omega + 1\text{M}\Omega} \times 6\text{V} \simeq 0{\cdot}55\text{V}$$

Thus turning VR2 we obtain a range of voltages from 0V to about 0·55V. Although there may be unevenness in the track of the potentiometer, it is reasonable to assume that the subdivisions of the scale from 0 to 9 correspond to voltages 0, 0·06, 0·12, 0·18, 0·24, 0·30, 0·36, 0·42, 0·49 and 0·55V, respectively. Read the output voltage on ME1 for each setting (0 to 9) of VR1.

At each setting (except possibly the last) the output voltage is 11 times the input voltage. Gain is ×11.

V_{IN} is the voltage at pin 3. Pin 2 must be brought to this voltage. When the circuit is stable the voltage at R17/R18 junction equals V_{IN}. Since R17 and R18 make a potential divider,

$$V_{OUT} = \frac{R17 + R18}{R18} \times V_{IN}$$

$$= \frac{100\text{k}\Omega + 10\text{k}\Omega}{10\text{k}\Omega} \times V_{IN}$$

$$= 11 \times V_{IN}$$

By choosing suitable values for R17 and R18, we can set gain to *any value* within reasonable limits. Try using different values for R17 and R18, then measure the gain obtained. Check this against the calculated value (R17 + R18)/R18.

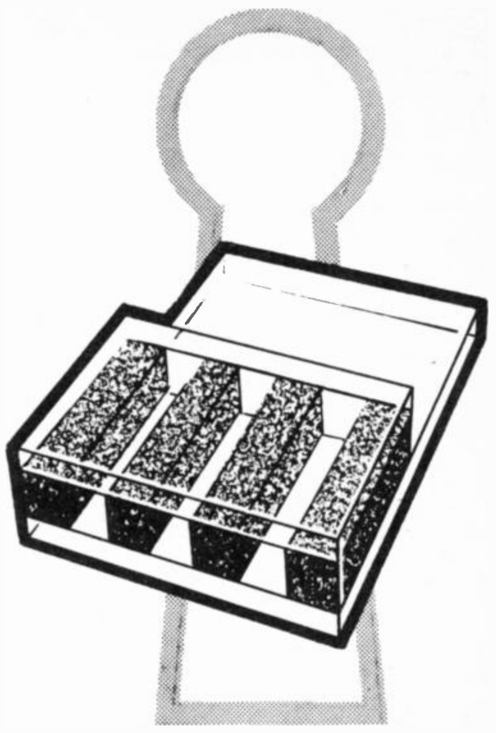
Also try connecting R16/VR2 across the 0V and −6V rails and reversing the connections to ME1. Then you can see that the amplifier responds equally well to negative input voltages.

Note that the gain of this circuit is determined solely by the values of R17 and R18. Variations in the performance of individual i.c.s, or variations due to temperature have no effect on gain.

In Experiment 7.3 we joined pin 6 to pin 2 making R17 = 0. R18 was the value of the load (the meter) connected between pin 6 and the 0V rail. If R17 = 0, then gain = R18/R18 = 1, as found by trial.

There will be more about op-amps in Part 12.

To be continued



MAGNETIC LOCK

BY R.A. PENFOLD

The Key

to a lock that doesn't betray its presence. Virtually impossible to crack. Ideal for hidden compartments.

ELECTRONIC lock designs are by no means a rarity, and published circuits of this type are invariably for combination locks. This design is rather different in that it is opened by a key, and the key is basically just four magnets. However, in order to open the lock the magnets must be in the right position simultaneously, and they must have the correct polarity.

Without the correct key a lock of this type is practically impossible to "crack", even in the case of a very simple design such as the one described here.

The lock is mains powered, and it operates a relay which can in turn be used to operate a solenoid lock mechanism or any other item of electrical equipment. The circuit is built around four Hall Effect switches which are semiconductor devices that respond to a magnetic field.

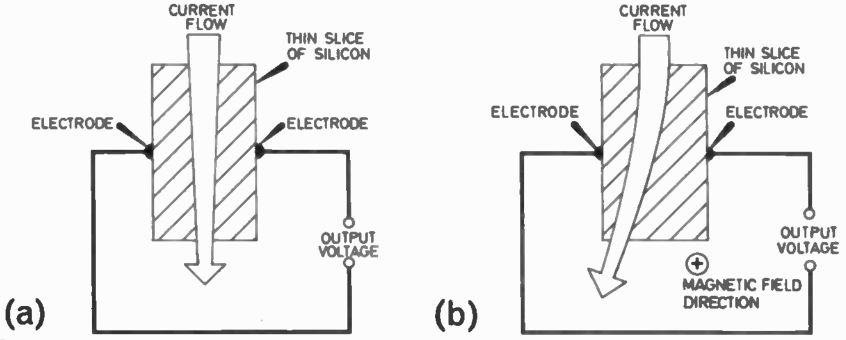


Fig. 1. Illustrates the basic principle of the Hall Effect sensor (a) in the absence of any magnetic field, output voltage is zero (b) with a magnetic field present (into the page), the current flow is distorted providing a voltage difference between the slice electrodes and consequently a voltage level at the output.

HALL EFFECT SWITCH

A Hall Effect sensor is basically just a thin slice of silicon fitted with two electrodes, as shown in Fig. 1(a). If a current is passed through the slice of silicon a potential gradient will be produced in the silicon. In other words there will be zero volts at the bottom of the slice, steadily rising to the full supply voltage at the top of the slice. There will be about half the supply voltage at each of the electrodes as these are both half way up the slice of silicon. This gives no voltage difference across the two electrodes, and zero output voltage.

A magnetic field has the effect of deflecting the current carriers in the silicon slice, and this is similar to a magnetic field deflecting the electron beam of a cathode ray tube. If the magnetic field is in the direction indicated in Fig. 1(b) then this deflection results in a distortion of the potential gradient, with a consequent rise in voltage at one electrode and a voltage reduction at the other electrode.

If the magnetic field is reversed there will be an opposite distortion of the potential gradient, giving an identical change in voltage at the electrodes, but of the opposite polarity.

Thus a magnetic field gives an output voltage from the sensor, and the polarity of the output voltage is dependent on the polarity of the magnetic field. The output voltage is also proportional to the strength of the magnetic field incidentally.

A Hall Effect sensor will only respond to a magnetic field in the direction shown in Fig. 1(b), or a field in the opposite direction. A magnetic field at right angles to this direction will give no output voltage at all.

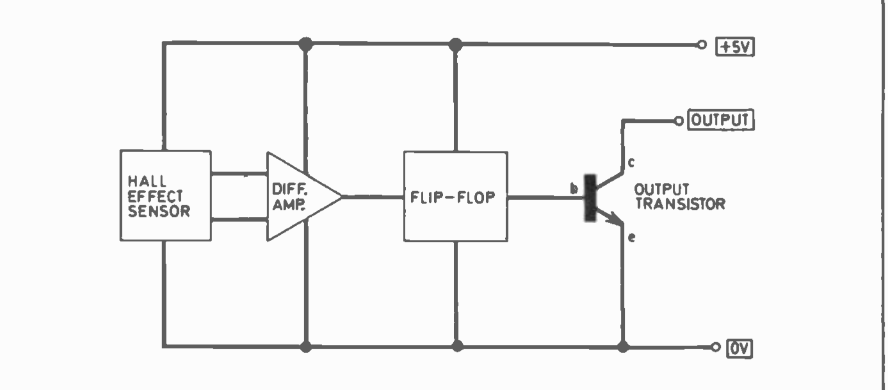


Fig. 2. Block diagram of the Hall Effect switch i.c.

HALL EFFECT DEVICES

The Hall Effect devices used in this design are all TL170C Hall Effect switches, and the block diagram of Fig. 2 shows in simplified form the arrangement used in the TL170C (which is an integrated circuit and not just a simple Hall Effect sensor).

The output of a Hall Effect sensor is applied to a differential amplifier and provided a suitable magnetic field is applied to the sensor the output of the amplifier will go full positive (high, or logic 1) or fully negative (low, or logic 0), depending on the polarity of the magnetic field.

The output of the differential amplifier is fed to the input of a flip-flop which in turn feeds the base terminal of a common emitter switching transistor. At switch-on the output of the flip-flop goes low and the transistor is switched off.

MAGNETIC FIELD

If a magnetic field of suitable strength and polarity is applied to the device the output of the differential amplifier will go high and "set" the flip-flop so that its output goes high and switches on the output transistor.

With the magnetic field removed the output of the differential amplifier returns to its quiescent level of about half the supply voltage, and the state of the flip-flop and output transistor remain unchanged. A magnetic field of adequate strength and opposite polarity to the original one sends the output of the differential amplifier low, and this "resets" the flip-flop and switches off the output transistor. Removing the magnetic field results in the output of the differential amplifier returning to its quiescent level of half the supply voltage, and there is no change in the state of the flip-flop or output transistor.

SWITCHING BY MAGNETIC FIELD

The device can therefore be switched from one state to the other by applying a magnetic field of suit-strength and polarity. In practice this means that applying one pole of a reasonably powerful magnet to one side of the device causes the output transistor to be switched on and to latch in the on state. Applying the other pole of the magnet to the same face of the device causes the output transistor to switch off and latch in the off state.

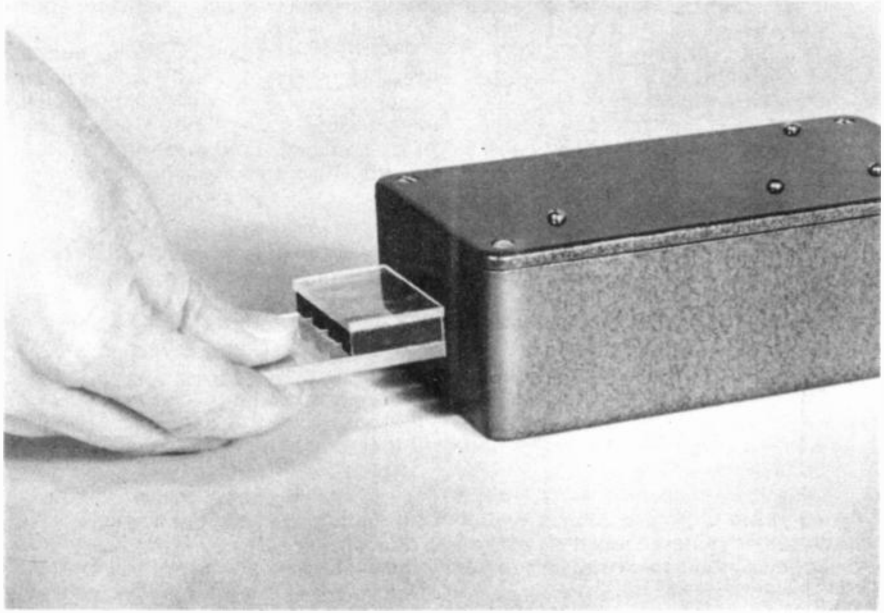
The device can be switched on and off in the same way if the magnet is applied to the opposite face of the device, but the poles of the magnet will have the opposite effect if this is done. In other words, if the device was previously switched on by a south pole and off by a north pole, applying the magnet to the opposite face of the device will result in south pole switching it off and a north pole switching it on.

The TL170C is designed to operate from a 5 volt supply, and has an absolute maximum supply voltage rating of 7 volts. However, the output transistor can withstand a collector voltage of up to 30 volts and can handle collector currents of up to 20 milliamps.

THE CIRCUIT

Refer to Fig. 3 for the complete circuit diagram of the Magnetic Lock.

The four Hall Effect switches are IC1 to IC4, and these each have a discrete load resistor for the output transistor. The load resistors are R1 to R4. The output of each Hall Effect switch feeds the base of TR1, and a simple OR gate is formed in this part of the circuit by diodes D1 to D4.



The finished prototype being tested before installation and fitting of the terminal blocks.

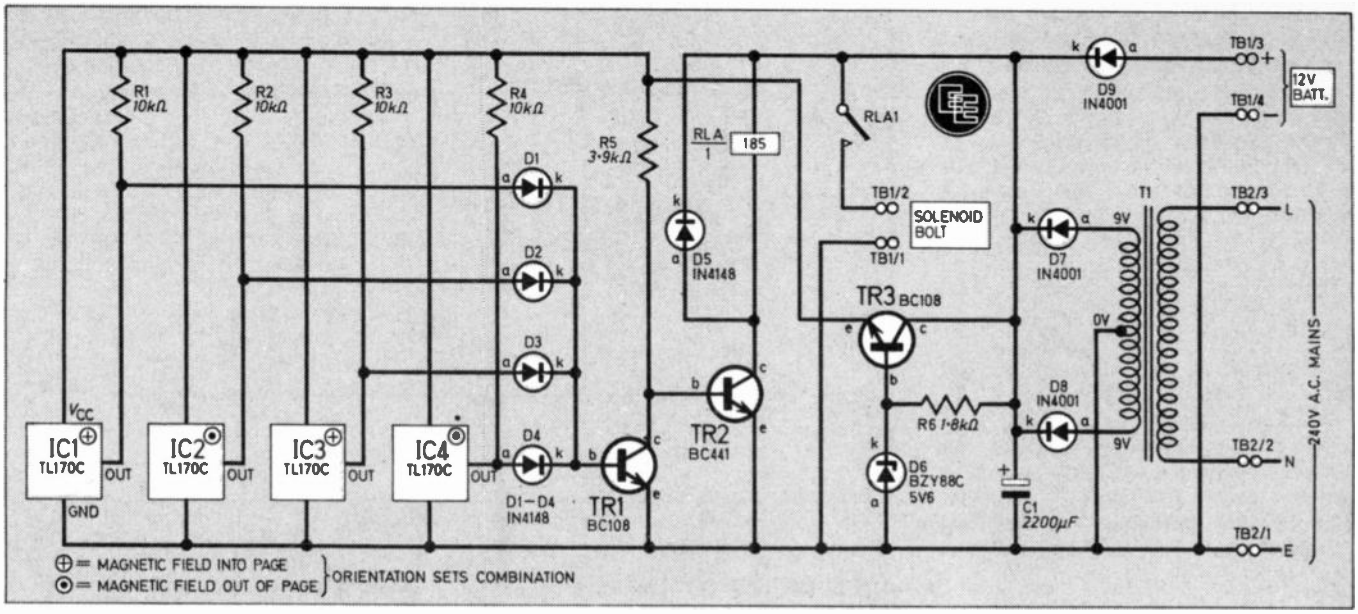


Fig. 3. The complete circuit diagram of the Magnetic Lock. The unit is mains powered but has battery back-up.

If one of the four outputs goes high it will feed a base current to TR1 via one of the gate diodes, and TR1 will be biased hard into conduction. If one of the outputs goes low it will not be able to cut off TR1 since one of the diodes will prevent it from tapping off any of the base current of TR1.

Thus, if any of the outputs are high TR1 will be switched on, and all four must be low in order to switch off TR1.

TR2 is the relay driver transistor, and with TR1 switched off TR2 is biased into conduction by R5 and the relay RLA is activated. If TR1 is switched on, TR2 becomes cut off and the relay is de-energised.

At switch-on the Hall Effect switches all assume the off state and their outputs all go high, switching TR1 on, and TR2 and the relay off. It is essential that the relay should not be activated at switch-on, as otherwise a brief power failure would be sufficient to make the lock open!

MAGNETIC KEY

If the magnetic key is used to switch on all four Hall Effect switches the four outputs all go low. TR1 switches off, TR2 switches on, and the relay is operated. Reversing the key switches the Hall Effect devices off again, and the circuit reverts to its original state with the relay switched off.

The key can therefore be used to open and close the lock, and in order to open the lock all four Hall Effect devices must be switched on. It is only necessary to switch off one of these devices in order to close the lock, although for maximum security all four devices should be switched off.

MAINS SUPPLY

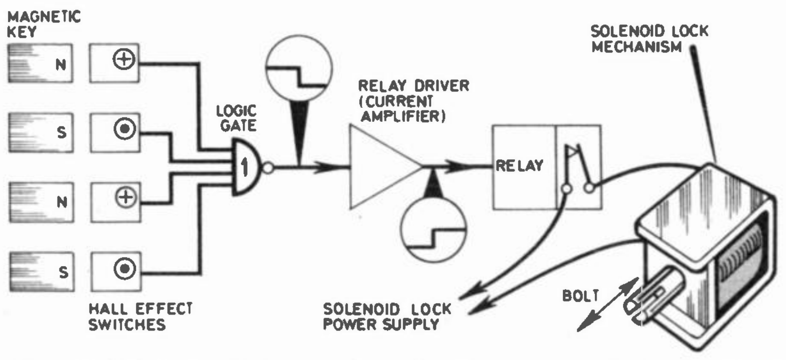
The mains power supply uses T1, D7, D8, and C1 in a straightforward fullwave circuit which gives a well smoothed but unregulated d.c. output of about 13·5 volts under zero load. The output drops to around 10 volts when the supply is subjected to maximum load.

This unregulated supply is perfectly suitable for the relay driver circuitry, but a lower and more stable supply voltage is needed for the Hall Effect devices. This is derived from a series regulator circuit, comprising TR3, R6, and Zener diode D6.

HOW IT WORKS

⊕ = MAGNETIC FIELD INTO PAGE

⊙ = MAGNETIC FIELD OUT OF PAGE



Four Hall Effect switches are operated by a "magnetic key" which is made up from four correctly positioned magnets to have the appropriate pole (north or south) facing their respective Hall Effect devices.

The outputs from the four Hall Effect switches feed a 4-input NOR gate. This gate produces a logic low output only when all four switches are activated, that is, produce a logic high.

The gate output operates a relay via a relay driver circuit. The normally open relay contacts close only when the output of the gate goes low, and these supply power to the solenoid lock mechanism (or other load) to release the bolt.

Thus it is necessary to operate all Hall Effect devices simultaneously to open the lock. The lock is de-activated simply by reversing the key so that the Hall Effect switches are turned off.

The above diagram shows the key in the position for opening the lock.

Although D6 gives a stabilised potential of nominally 5·6 volts, there is a voltage drop of approximately 0·6 volts across the base/emitter junction of TR3, so that a nominal supply potential of 5 volts is available from the output at TR3 emitter.

BATTERY BACK-UP

A failure of the mains supply would of course immobilise the magnetic lock. To guard against such an eventuality a battery back-up has been incorporated in this design.

A 12 volt battery can be connected to the unit via connector block TB1/3, 4. The diode D9 will isolate the battery so long as the mains power supply circuit is delivering a voltage of 12V or more to the h.t. line. Should this potential fall, D9 will conduct thus bringing the external battery into circuit.

COMPONENTS

See Shop Talk page 233

Resistors

R1	10kΩ
R2	10kΩ
R3	10kΩ
R4	10kΩ
R5	3·9kΩ
R6	1·8kΩ

All 1/3W carbon ±5%

Capacitor

C1	2200μF 16V p.c.b. elect.

Semiconductors

IC1-4	TL170C Hall-effect switch i.c. (4 off)
TR1	BC108 silicon *npn* transistor
TR2	BC441 silicon *npn* transistor
TR3	BC108 silicon *npn* transistor
D1-5	1N4148 diode (5 off)
D6	BZY88C5V6 5·6 volt 400mW Zener diode
D7, 8, 9	1N4001 diode (3 off)

Transformer

T1	Standard mains primary, 9V - 0V - 9V secondary rated at 75mA, or more

Relay

RLA	6/12 volt coil 185 ohms or more, and contacts of the required type and rating (see text).

Miscellaneous

Case (see text). 0·1in matrix stripboard (36 holes by 21 strips). 4-way connector block (TB1). 3-way (mains) connector block (TB2). Mains lead and mains plug fitted with 3 amp fuse. Four 1in by ¼in (25mm by 6·35mm) bar magnets (Maplin or Electrovalue) wire, solder.

CONSTRUCTION starts here

CIRCUIT BOARD

With the only exception of the mains transformer T1, the components are all assembled on a 0·1in pitch stripboard. This has 21 copper strips by 36 holes. The component layout is shown in Fig. 4. Construction of the component panel is quite straightforward, and there are only three breaks in the copper strips.

RELAY

If the relay is a modern miniature type having a plastic casing it can be glued to the board, and two pieces of single strand tinned copper wire can be soldered in place so that they help to hold the relay in position. The relay coil is then wired to the board using a couple of short insulated leads.

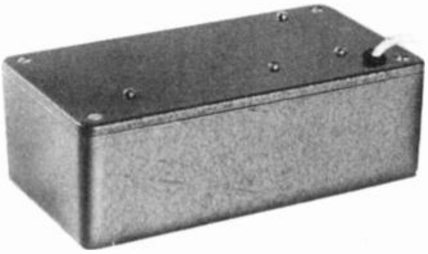
With other types of relay it might be necessary to devise some other method of mounting, but any reasonably modern relay should be small enough to fit into the available space on the board (although the board can obviously be made larger if necessary).

Make sure that the relay has contacts of adequate voltage and current rating for whatever load they will control, and also ensure that the relay is a six or 12 volt type having a coil resistance of no less than 185 ohms.

HOUSING THE UNIT

Mechanically the construction of the unit must be varied to suit the exact application of the lock and the conditions under which it will operate. The case housing the electronics should obviously be a strong metal type and should be installed in such a way that there is no easy way for an unauthorised person to gain access to the circuitry. A diecast aluminium box is probably the best choice.

The key will operate the Hall Effect devices at a maximum range of about 5 or 6mm, and, like most substances, aluminium does not significantly hinder a magnetic force.



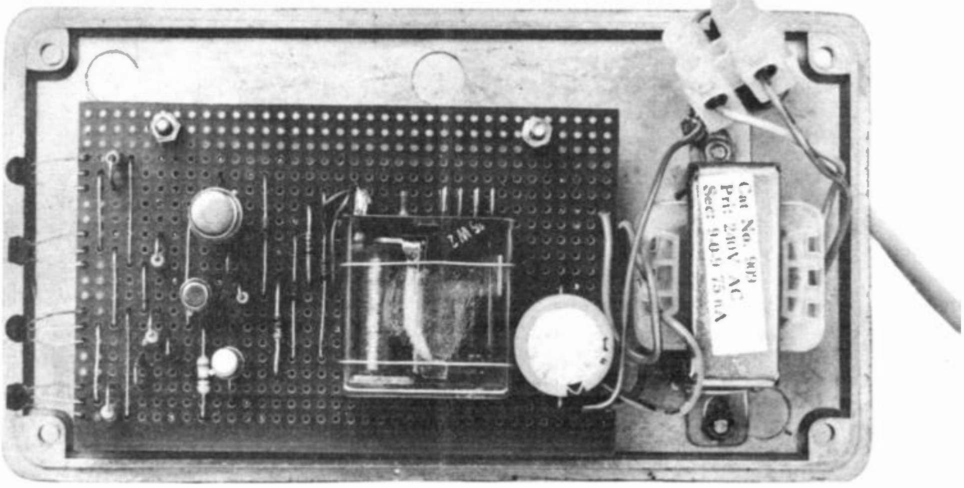
The completed unit housed in a robust metal case.

With the component panel mounted so that the Hall Effect devices are next to one side panel of the case, and the leadouts of the Hall Effect devices formed to bring these components against the side of the case if necessary, the key will operate the circuit even through a very thick case provided the key is accurately positioned.

MAKING THE KEY

The key itself consists of four 25mm x 6·4mm bar magnets glued between two pieces of plastic or plywood, as can be seen in Fig. 5 and the accompanying photograph. The Hall Effect switches are orientated on

Plan view of the lid containing the assembly. Note that the battery back-up diode has not yet been fitted, and wiring to the terminal blocks is yet to be completed. Also, the relay flying leads are still to be attached.



MAGNETIC LOCK

COMPONENTS approximate cost £14·50

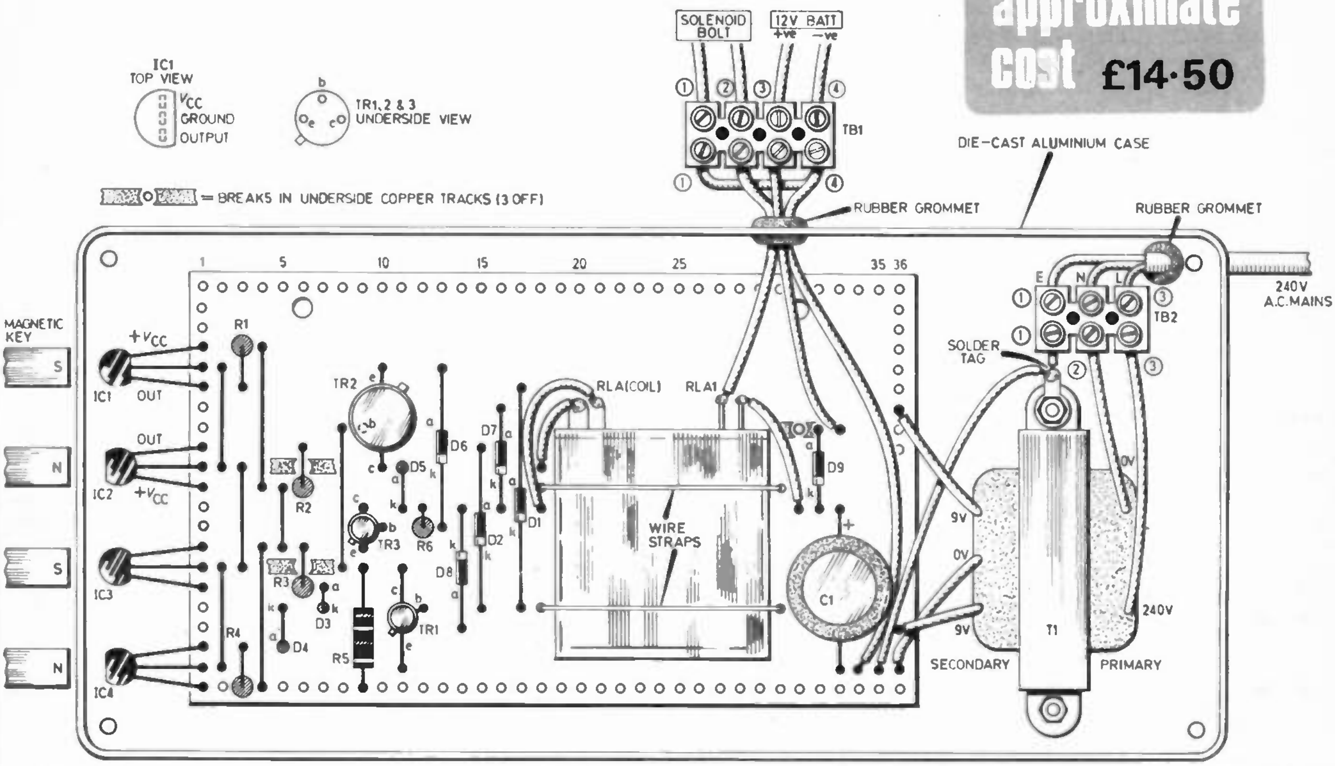
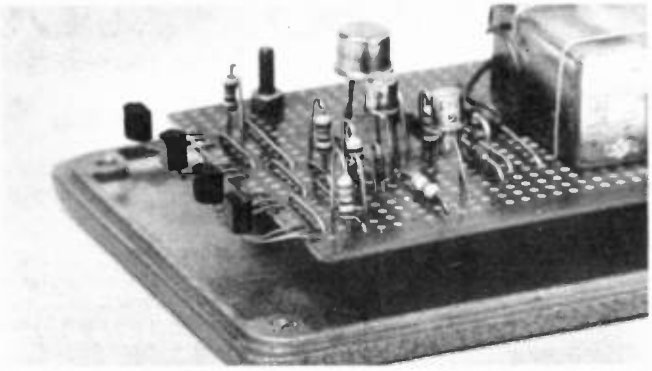


Fig. 4. The layout of the components on the topside of the stripboard and position within the diecast aluminium case. Note the orientation of the sensors to agree with the magnetic key, details below. Note that there are three breaks to be made in the strips on the underside.



Shows the orientation and position of the Hall Effect i.c.s in relation to the board and case.

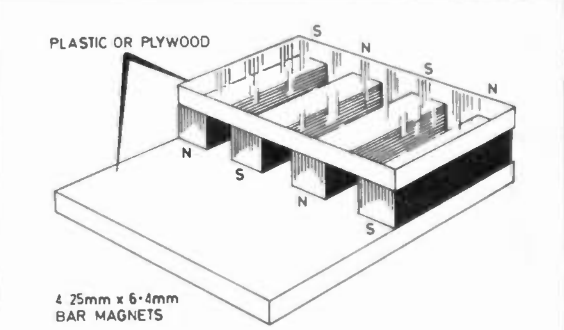
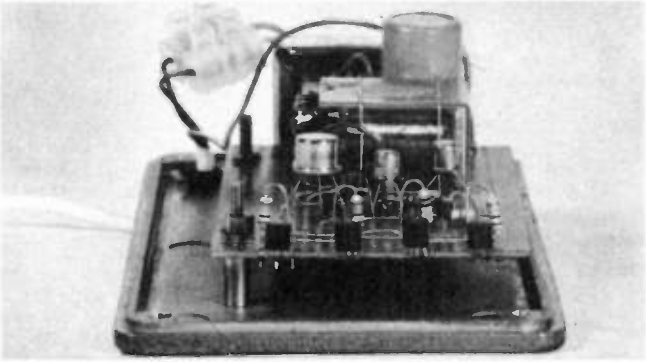
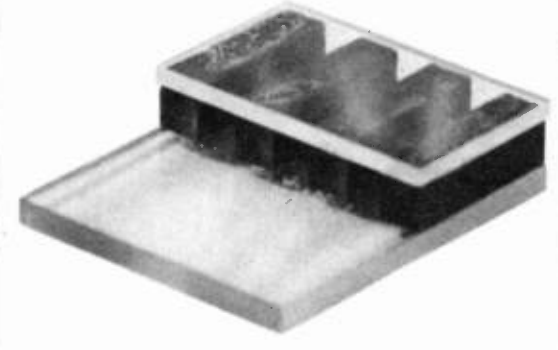


Fig. 5. Construction details for the magnetic key.



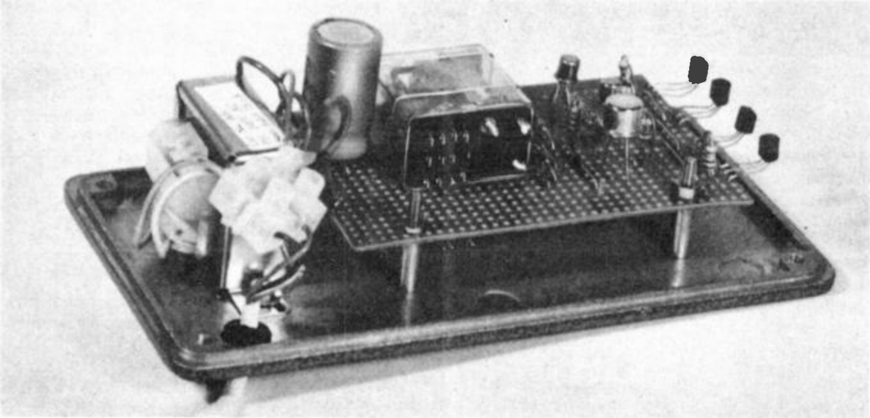
Shows method of mounting the board to the case; two 10mm long plain spacers are employed.



The prototype magnetic key.

the component panel in such a way that the key must present alternate north and south poles to the unit in order to operate it, and the magnets are not lined up with the same polarity.

If the magnets are lined up side by side with alternate polarities they will tend to attract one another and hold together in one lump. If two magnets next to one another have the same polarity they will not hold together and will repel one another slightly. This should eliminate any problems with getting the magnet polarities correct. Of course, the spacing of the magnets must match that of the Hall Effect switches (12·7mm between centres).


The near completed prototype unit. Note that we have used a three-way screw terminal block in preference to the two-way block seen here.

OPERATION

Applying the key to the unit at the correct point and with the correct orientation will cause the lock to open, and rotating the key through 180 degrees (end-over-end or sideways) will close the lock. Trial and error can be used to find which orientation produces which effect.

In theory it is possible to open the lock using a single magnet if you know exactly where to apply the magnet, and what pole to apply. In practice this is practically impossible, and there is a tendency to switch off one Hall Effect device when the magnet is positioned to switch on one of the others. The only easy way of opening and resetting the unit properly is to make up a key.

If preferred, the Hall Effect devices can be mounted off-board, and connected to the board by way of three-way insulated cables. The devices can then be positioned at any desired points on the interior of the case. ⌑

FORMING AN ELECTRONICS CLUB

By T.R.de Vaux-Balbirnie

Some words of wisdom for any member of staff thinking of embarking upon an exciting and rewarding enterprise, which will not be without its hazards.

So you want to form an electronics club! There are things you should know because it is not going to be easy. The actual "electronics" part will probably be the least of your worries. The hardest part will almost certainly be that of finance. In these times of "tight" money, you are unlikely to obtain assistance from local authorities or school funds. Your only recourse will be self-finance and more will be said about this later.

Club aims

You will need to establish the aims of the club, even though these aims may be rather vague. Is the club to be educational and used to supplement existing courses? Perhaps it will be organised simply to improve technical skills in circuit building. Is it to have a leaning towards audio and musical work or radio and TV? Is it going to be a "computer" club?

Most likely, it will be a club of general activities where members engage in building their own projects with you acting as adviser.

Will the club be willing to help in related fields like P.A. for sports events or stage lighting for the drama group? In return for a "home" and the use of electricity and perhaps some equipment it will probably be necessary to make yourselves useful in some such activities.

With broad aims defined, it then becomes necessary to discuss the funding arrangements.

Funding

Although existing bodies may be unwilling to give money towards the running costs, it is possible that they will grant you a loan. Although loans have the nasty habit of having to be repaid, they can be very useful in getting the club started.

Another idea is to charge an entry fee—non-returnable in cases of "dropping out"—to be used to purchase "communal" components for the club. These jointly-owned components are invaluable for experimental work. It will be understood that where communal components are permanently built into circuits they will have to be paid for.

Even when carefully used, such components will eventually fail—wire ends break off and so on—so a steady flow of cash is needed. Whether or not to fine members who damage components through carelessness is up to you but culprits are not usually easy to find!

A repair service

Some cash may be raised by taking on basic repair work. The club (hopefully) will soon gain a reputation for speed and efficiency coupled with realistic charges. Since the public think of electronics as an extremely complicated subject, they will see any repairs as near-miracles! If you think that you would be out of your depth taking on this type of work consider the facts.

Semiconductor devices these days are extremely reliable and seldom fail. Likely causes of trouble are in mechanical components such as switches, potentiometers and plugs and sockets. An example is the earphone socket on a radio which silences the internal loudspeaker when the earphone is plugged into it. Components like this are easily and cheaply replaced. Poor quality sound from a tape recorder often indicates that the heads need thorough cleaning.

Profitable Game

It is better to avoid mains equipment for repair just in case you should become legally involved over a poor job.

A TV game was brought along a few weeks ago with a "jumpy" bat. Most dealers were unwilling to repair it and the few who would quoted high fees and a long wait. It was obvious that the potentiometer in one of the hand controls had failed. Replacement took 10 minutes and cost 40p. The customer had his game back within the week at a charge of £2·50. He was delighted to pay it. Even at today's prices £2·10 will buy quite a lot of components.

Another way to raise money is to sell finished projects—again, avoid those which are mains operated. Projects for cars are popular, as are musical circuits for special effects. You may even run a service to install them!

Component supply

You will need good suppliers of components. Unless you are lucky in having a properly geared-up dealer in your area, you will need to purchase by mail order. There are many excellent firms advertising in electronics magazines. Some supply free catalogues but often you will be asked to pay about £1. This may seem expensive at first but the possible savings will soon pay for the catalogues.

It will be necessary to shop around to some extent as prices can vary quite a lot. Remember, however, that it is foolish to save a few pence here and there on components only to be faced with extra charges for packing and postage. You must also keep an eye on V.A.T. when comparing prices and remember that V.A.T. is payable on the postage and packing charges also. It sometimes happens that a "nice letter" from a bona-fide club will bring a free catalogue. Look for the larger advertisements in magazines—these can be almost a catalogue in themselves.

Club Buyer

It is a good idea to appoint one member of the club to be in charge of purchasing and keeping an up-to-date "shortages list". He or she can work out the best time to place an order and how to do it in the cheapest way.

Although you should always look for special offers and "bargain packs" which often give excellent value, it is not always a good idea to buy untested components. These can waste a lot of time even though the price may seem very attractive.

When members use up communal components by building them into permanent projects, they should enter the item on the shortages list if the stock is run down. They should then pay for the components. Members will be expected to pay a realistic price for components bearing in mind the convenience of the method. This price may be set in an "internal catalogue" at, perhaps, 25 per cent above cost. The profit will restock communal components and go towards the cost of basic equipment.

Storage

Good storage arrangements for electronic components are essential. Nothing is worse than boxes of assorted components. To begin with, egg boxes, margarine tubs and yoghurt containers may be used, but a more permanent system must be planned. Sets of interlocking plastic drawers are inexpensive and may be added to as the need arises. Large wooden drawers may be divided into compartments using hardboard. In this way, each value of resistor may have its own place. A "Dymo" labelling machine will be found very useful.

Salvage

Let it be known that you are collecting—sometimes junk can furnish some good components. Unfortunately, some junk is totally useless. It is impossible to specify just what is acceptable and what is not so you will need to accept graciously anything which comes along and make the occasional discreet trip to the local authority refuse dump.

Local electronics industry sometimes helps bona-fide organisations. They will give away their own throw-outs providing you do not sell them. Circuit panels replaced under guarantee can provide a wealth of useful components. It is worth enquiring at your local radio and TV repair shop. Sometimes they will provide you with junk.

Literature

Magazines are an essential source of ideas. You should subscribe to at least one of them. Enquire about the Everyday Electronics group subscription scheme. This enables educational establishments to obtain copies of the magazine at a special discount rate. As well as current issues, you should collect old magazines. These provide ideas and it often happens that old circuits are easily updated. Someone may be placed in charge of keeping a catalogue of useful articles for future reference.

Equipment and Tools

You will need some basic equipment but, perhaps, some of it can be borrowed. A few soldering irons and multimeters will certainly be required. An oscilloscope is sometimes useful but is not essential. Certain basic tools like pliers, side cutters, wire strippers, tin snips, screwdrivers and files will be needed.

Power supplies

Rather than using mains operated power supply units, batteries will be found more convenient. Many circuits use 9 volt supplies and the physically larger batteries will be found cheaper in the long run than the smaller ones so use PP9s rather than PP3s. An alternative is to tape together two 4·5 volt "bell" batteries connected in series—these provide an excellent power supply capable of delivering fairly high currents. An excellent life may be expected in normal service.

For car circuits, access to a 12 volt battery will be needed for testing. Sometimes you can make do with three off 4·5 volt batteries in series but where high currents are required a car battery or some "Ni-Fe" cells will be needed. When using batteries like these it is essential to provide a line fuse since an accidental short circuit could allow an enormous current to flow.

Materials

Although much experimental work will be carried out on prototype boards like "S-Decs", plenty of stripboard or Veroboard will be needed for permanent work. Veroboard with a pitch of 0·1 in will be found very convenient. Materials for making printed circuits will be found useful at times.

You will need a ready supply of single core connecting wire as well as the stranded variety. A small stock of sheet aluminium will also be found useful.

Make up plenty of lengths of stranded wire with combinations of crocodile clips, plugs and bare ends. These are invaluable.

Good luck with the club, but beware! It is likely to take you over!

Everyday ELECTRONICS

The MAY issue brings an Extra 8-PAGE SUPPLEMENT

A Constructors Guide to discrete and integrated devices

COMPREHENSIVE PUBLIC ADDRESS SYSTEM 50 WATTS OF POWER

SEVEN INPUTS—Mic (4); Disc; Tape; Auxiliary—FULL MIXING OF ALL INPUTS—VU METER—8 OHM and 166 (line) OUTPUTS—OPERATES FROM EITHER MAINS OR 12V CAR BATTERY—TWO UNIT CONSTRUCTION.

TWO-TONE TRAIN HORN

Another realistic effect for the model railway enthusiast.
Simulates the sound made by the horn of a diesel or electric train.

L.E.D CAR VOLTMETER

Monitors state of car electrics system under all conditions, by indicating battery voltage in 0·5V steps.

MAY 1982 ISSUE
ON SALE
FRIDAY, APRIL 16

BIG-NINE INDICATOR

An extended form of dice, with 0 to 9 randomly indicated on 7-segment display.

INTRODUCTION TO LOGIC

PART

BY J. CROWTHER

FLIP-FLOPS

There are four main types of flip-flop (bistable multivibrator) used in practise. They are:

(1) The R.S. or S.R. (set/reset)
(2) The R.S.T. (set/reset/trigger)
(3) The J.K. flip-flop (this is the true storage unit)
(4) The D-type flip-flop (data)

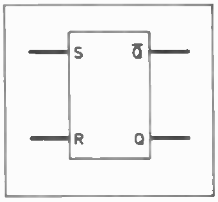


Fig. 12.1. Circuit symbol for an R.S. flip-flop.

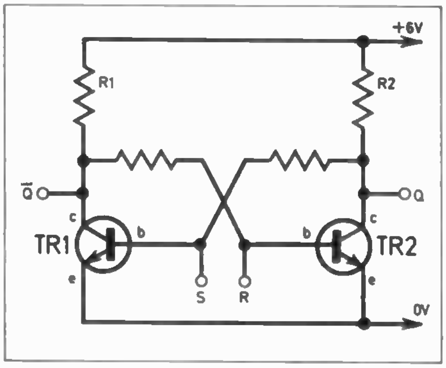


Fig. 12.2. Basic circuit of an R.S. flip-flop.

(1) The Set/Reset flip-flop

The circuit symbol and basic circuit of an R.S. flip-flop are shown in Figs. 12.1 and 12.2 respectively.

On switching on, one transistor will start to conduct fractionally before the other, and in this case suppose we assume TR2 conducts first. This will cause a voltage drop across R2 and the output at *Q* will start to fall making the base of TR1 more negative thus reducing the current through TR1. The effect of this is to reduce the voltage drop across R1, making the output at *Q̄* rise and consequently turning TR2 on even more giving a larger voltage drop across R2. The *Q̄* output will drop still further and this sequence continues until TR2 is conducting fully and TR1 is cut off resulting the output at *Q* falling to nearly zero (logic 0) and output *Q̄* rising to 6V (logic 1). This all happens almost instantaneously.

The transistors will stay in this state until a positive pulse is applied to the base of the "off" transistor, input *S* for TR1, switching it on. This will cause the voltage across R1 to drop so that output *Q̄* falls to zero and the base voltage of TR2 also falls switching it off. This means there will be no volts drop across R2, causing the output at *Q* to rise to 6V.

Once again the transistors will stay in this state until a positive pulse is applied to the base of TR2 at input *R*, switching the flip-flop back to the original state.

To summerise, a positive pulse at input *R* resets the *Q* output to logic zero and a positive pulse at input *S* sets the *Q* output to logic one. The first pulse will change the output state, the next pulse will change it back to its initial state, and so on.

(2) The R.S.T. flip-flop

The R.S.T. flip-flop is a development of the R.S. type, requiring only one input terminal to change the output state of the flip-flop, see Fig. 12.3.

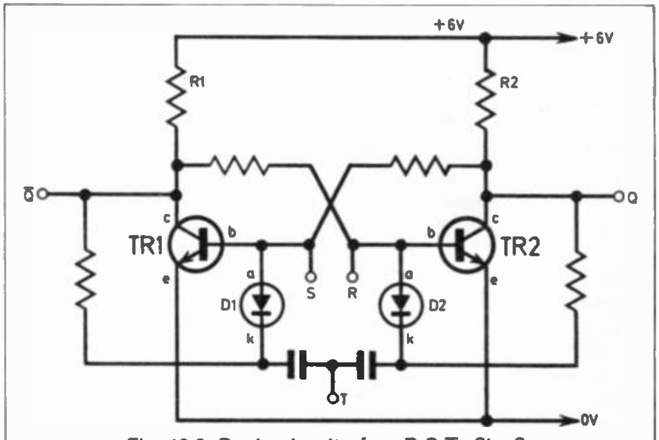


Fig. 12.3. Basic circuit of an R.S.T. flip-flop.

On switching on, suppose that TR2 is conducting and TR1 is cut off, so output *Q* will be at logic 0 (approximately 0·25V) and *Q̄* at logic 1 (say 5V). Since TR2 is conducting its base will be 0·6V and TR1 base will be at 0V as it is turned off so the potentials on diodes D1 and D2 will be as in Fig. 12.4.

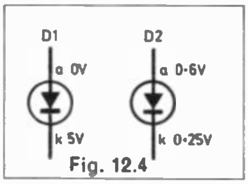


Fig. 12.4

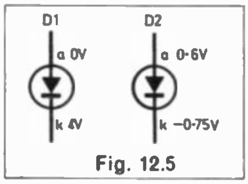


Fig. 12.5

For a diode to conduct, the anode (a) must be 0·6V positive with respect to the cathode (k), so here both diodes are reverse biased and will not be conducting and the two transistors will remain in the same state, that is TR2 on and TR1 off.

If a negative pulse of 1V is now applied to the *T* input, the cathode potentials of these two diodes would change, see Fig. 12.5.

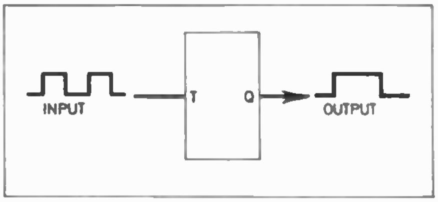
Diode D2 is now forward biased and will conduct, and so reduce the base potential of TR2 to below 0·6V, switching it off. Consequently, there will be no volts drop across R2 and output *Q* will rise to logic 1, TR1 will be turned fully-on causing output *Q̄* to fall to logic 0.

The flip-flop will stay in this state until it receives another pulse at input *T*, upon which it will switch back to the original state, each pulse arriving at *T* being steered to the on transistor to switch it off by the diode steering circuit.

Since the pulses are fed to the diodes via capacitors, only a change in voltage level (from high to low) will trigger the flip-flop, so the R.S.T. is triggered by the falling edge of input pulse and not by a logic level as in the case of the R.S. type.

For this reason the R.S.T. flip-flop requires two input pulses to give one output pulse as shown in Fig. 12.6, and this circuit can therefore be used to divide a frequency by two. Cascading

Fig. 12.6. Circuit symbol for R.S.T. flip-flop showing operation. It acts as divider (÷2).



two R.S.T. flip-flops in series so that the output of the first triggers the second would divide by four, three would divide by eight and so on.

The *R* and the *S* inputs are retained in this circuit, and a logic level on either of these will overide the *T* input.

Differences between R.S. and R.S.T. circuits:—

(a) Two inputs for the R.S., and only one for the R.S.T.

(b) A voltage level triggers the R.S. but a change in voltage level triggers the R.S.T.

(c) A stream of pulses to a single input of the R.S. (either the *R* or *S*) will give no change of state after the first pulse but a stream of pulses to the *T* input of the R.S.T. causes the output to change back and forth.

(3) The J.K. flip-flop

The J.K. flip-flop is similar to the R.S.T. (see Fig. 12.7) the difference being that the cathodes of diodes D1 and D2 are connected to the *J* and *K* inputs instead of the *Q* and $\bar{Q}$ outputs. The inputs applied to the *J* and *K* terminals must be complementary, that is if *J* is at logic 1 then *K* must be at logic 0, and vice-versa.

Suppose that TR2 is conducting and TR1 is cut-off at switch on, then output *Q* will be at logic 0. Now if a logic 1 is applied to the *J* input and a logic 0 to the *K* input, this would have no effect as the diodes are reverse biased. If a negative pulse of 1V is now applied to terminal *T*, D2 will be forward biased and therefore conduct and switch TR2 off, resulting in no volts drop across R2 and the *Q* output will be high (logic 1), TR1 turning on to give a logic 0 at $\bar{Q}$.

If a second pulse arrives at *T* with *J* and *K* still at 1 and 0 respectively, it will have no effect as it would be steered to the off transistor, therefore a trigger pulse at *T* will only change the state of the flip-flop if the logic levels of the *J* and *K* inputs are reversed.

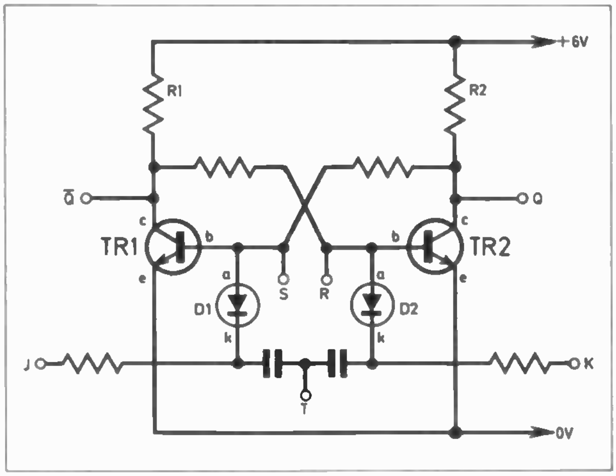


Fig. 12.7. The basic circuit diagram of a J.K. flip-flop.

A trigger pulse at *T* will only change the state if the logic levels at *J* and *K* are different, so a logic 1 or 0 can be stored at the *J* terminal until a trigger pulse arrives at *T*, when the stored level will be released at output *Q*.

(4) The D-type flip-flop

The D-type flip-flop is a modified version of the J.K. flip-flop, the *J* and *K* inputs being replaced by a single *D* (data) input, the complementary input to the *K* terminal being achieved by inverting the *D* input with a NOT gate whereas the *D* input if fed directly to the *J* terminal as shown in Fig. 12.8.

MAKING FLIP FLOPS WITH LOGIC GATES

(1) The R.S. flip-flop

An R.S. flip-flop can be constructed using two NAND gates, and suppose that on switching on, the *Q* output is at 0 and the $\bar{Q}$ output is at 1 as shown. If both the $\bar{R}$ and the $\bar{S}$ inputs are at logic 1, there will be two 1's on the inputs of gate 2 holding its output at 0, and a 1 and 0 on the inputs of gate 1 giving a 1 on the output.

If the $\bar{S}$ input terminal is changed to a 0, there will now be a 1 and 0 on the inputs of gate 2 resulting in a 1 at the output and this consequently puts two 1's onto the inputs of gate 1 changing its output to a 0.

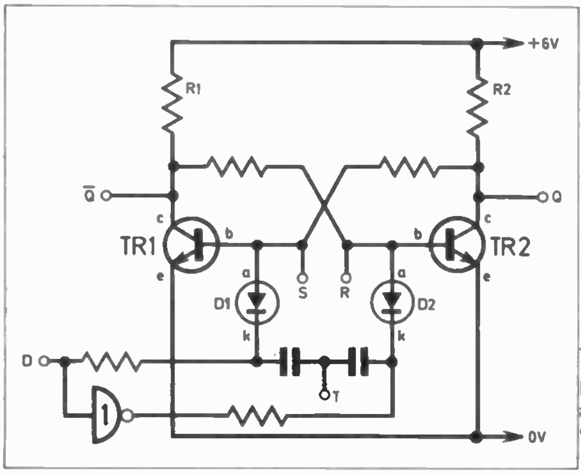
Changing the $\bar{S}$ input back to a 1, resulting in a 1 and 0 on the inputs of gate 2 giving a 1 at the output and with the two 1's still on gate 1 inputs, its output remains at 0, therefore the state of the flip-flop has not changed.

To change the flip-flop back to its original state, a logic 0 must be applied to the $\bar{R}$ input. Therefore a logic 0 on the $\bar{S}$ input sets the *Q* output to logic 1, and a logic 0 on the $\bar{R}$ input resets the *Q* output back to 0

Note that the transistor R.S. flip-flop requires logic 1's on the inputs to change its state, whereas the NAND gate version requires logic 0's, so the terminals are marked $\bar{R}$ and $\bar{S}$ instead of *R* and *S*, the bar over the letter indicating that a logic 0 changes the state of the flip-flop.

(2) The J.K. flip-flop

If a logic 1 is applied to the *J* input and the *K* and *T* inputs are at logic 0, then the outputs of gates 3 and 4 will be at logic 1. Now the outputs of gates 3 and 4 are connected to the $\bar{R}$ and $\bar{S}$ inputs of an R.S. flip-flop consisting of gates 1 and 2 with the *Q* output at 0 and the $\bar{Q}$ output at 1. If the *T* input is pulsed with a logic 1, the output of gate 4 would go low as it now has two 1's on the inputs, and this will change the state of the outputs of the flip-flop (*Q* will go to 1 and $\bar{Q}$ will go to 0). A further pulse on the *T* input would return the $\bar{S}$ terminal to 0 but this will have no effect on the output states of the flip-flop as a logic 0 is required on the $\bar{R}$ input to change it back to its original state. A pulse on the *T* input will only change the output state if the logic states of the *J* and *K* inputs are reversed.



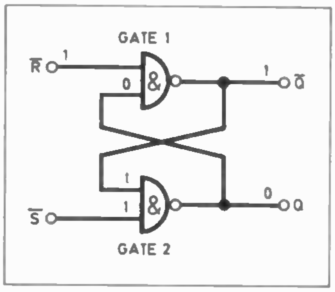


Fig. 12.9. Making an R.S. flip-flop from NAND gates.

Fig. 12.8. The basic circuit of a D-type flip-flop. Compare with Fig. 12.6.

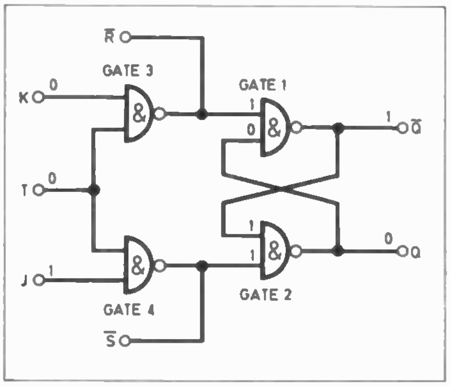


Fig. 12.10. Making a J.K. flip-flop from four NAND gates.

THE END

Everyday News

MARCHESA SPEAKS TO THE QUEEN

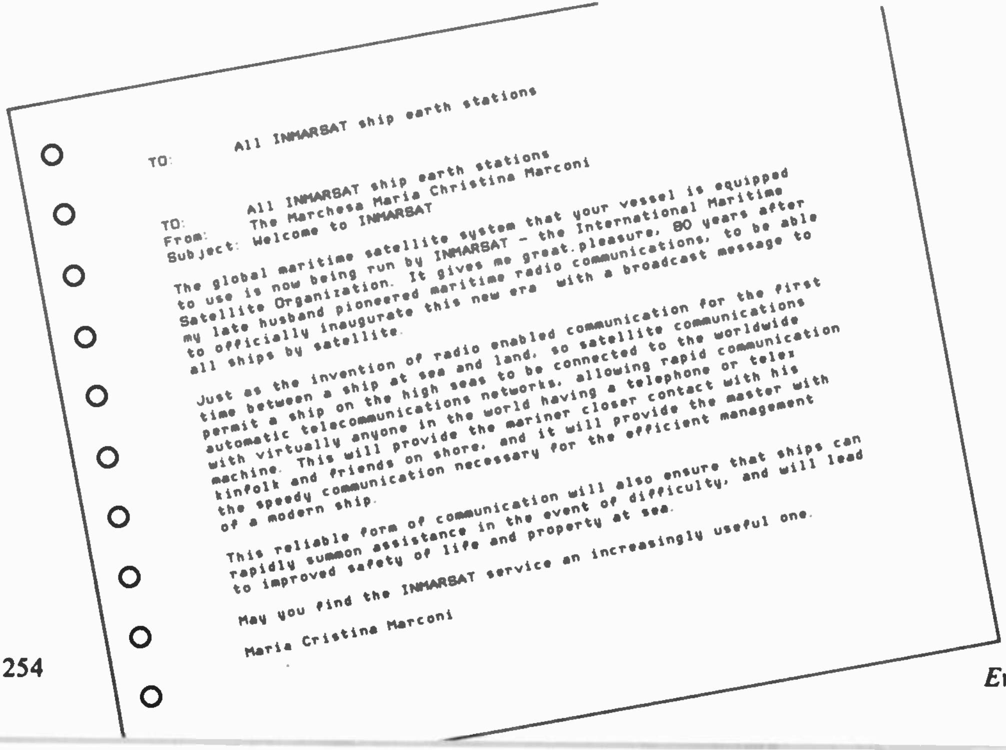
The Marchesa Maria Cristina Marconi and Princess Elettra Giovanelli, widow and daughter of Guielmo Marconi, inaugurated the* Inmarsat *marine communications satellite system in London

WITH the inauguration of the *INMARSAT* marine communication satellite system in London recently, there unfolded another chapter in the fascinating story of maritime communications—a story which is really only 100 years old, for it was only in 1896 that Guglielmo Marconi managed to establish telegraphic contact between two points some 30 miles apart, so enabling ships at sea to be out of sight of, and yet to be in contact with the land as well as each other.

Elected Lord Rector of St Andrews University shortly before his death in 1937, Marconi entitled his inaugural speech, "The Path of the Inventor". In it he stressed his original intention, as the first developer of radio, to have been to "make the seas safer for seafarers by giving ships a means of communication". This too, is a declared aim of the *INMARSAT* organisation and it was fitting that the Marchesa Maria Cristina Marconi, his widow, was the guest of honour at the inauguration.

To inaugurate the *INMARSAT* system, the Marchesa Marconi spoke by satellite to the master of the liner Queen Elizabeth 2, Captain Peter Jackson. The ship was at that time in the South Atlantic, south east of Rio de Janeiro, headed for Cape Town on its world cruise, and the call went via the Southbury coast earth station in the USA.

To inaugurate the INMARSAT system, the Marchesa Marconi spoke by satellite to the master of the liner Queen Elizabeth 2, Captain Peter Jackson. The ship was at that time in the South Atlantic, south-east of Rio de Janeiro, headed for Cape Town on its world cruise, and the call went via Southbury coast earth station in the USA.
Calls were also made to two other ships—one in the Indian Ocean Region and one in the Pacific Ocean Region. In the first case, INMARSAT's Director General, Mr Olof Lundberg, spoke to the general cargo vessel Wakanami Maru, the call going via Yamaguchi, Japan. He then called the tanker Robert Miller off southern Victoria, Australia, via the new Ibaraki coast earth station in Japan. (Everyday Electronics exclusive photo).



TO: All INMARSAT ship earth stations

TO: All INMARSAT ship earth stations
From: The Marchesa Maria Christina Marconi
Subject: Welcome to INMARSAT

The global maritime satellite system that your vessel is equipped to use is now being run by INMARSAT - the International Maritime Satellite Organization. It gives me great pleasure, 80 years after my late husband pioneered maritime radio communications, to be able to officially inaugurate this new era with a broadcast message to all ships by satellite.

Just as the invention of radio enabled communication for the first time between a ship at sea and land, so satellite communications permit a ship on the high seas to be connected to the worldwide automatic telecommunications networks, allowing rapid communication with virtually anyone in the world having a telephone or telex machine. This will provide the mariner closer contact with his kinfolk and friends on shore, and it will provide the master with the speedy communication necessary for the efficient management of a modern ship.

This reliable form of communication will also ensure that ships can rapidly summon assistance in the event of difficulty, and will lead to improved safety of life and property at sea.

May you find the INMARSAT service an increasingly useful one.

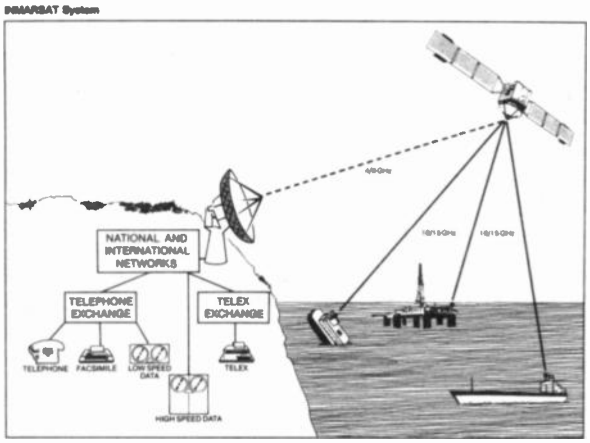
Maria Cristina Marconi

Milestones

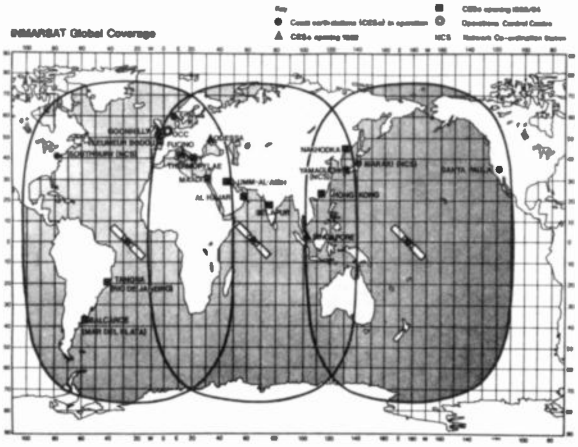
While on the subject of maritime communications, it is perhaps appropriate to reflect on a few milestones: In 1899, the American liner *St Paul* is believed to have been the first vessel to have "a floating wireless station aboard". In November of 1899, she received a wireless message from the Marconi station on the Isle of Wight.

In 1906, the radio telegraph distress signal *SOS*, a rhythmic three dots, three dashes, three dots in Morse code, was adopted at a Berlin conference as the international call for help at sea. Some persons interpret *SOS* as meaning Save Our Ship or Save Our Souls but the letters actually have no intrinsic meaning.

. . . from the World of Electronics



Outline of the maritime satellite communications system.



Global coverage of the seas by the Inmarsat satellite system.

Sunday, April 14 in the year 1912 saw the tragedy of the sinking of the luxury liner *Titanic* with the loss of 1503 lives, including her wireless operator, Mr. J. G. Phillips, whose *SOS* was heard first by the radio officer on the ship *California* at 11.20p.m. The *Titanic* tragedy inspired regulations requiring increased transmitting power and 24-hour manning of radio rooms for passenger-carrying ships.

In 1922, the first ship-to-shore two-way voice communications took place between a station at Deal Beach, New Jersey and the *SS America*, 400 miles at sea.

The word *MAYDAY* was adopted in 1927 as the international distress call for maritime radio telephone. "Mayday" originated in M'aidez, which is the French for "Help me".

In 1929, high seas radio telephone services became available to the public and technology developed fairly fast from then on. It was 1965 that saw the first commercial communications satellite, *Early Bird*.

The year 1976 saw the launch of the *Marisat* satellites over the Atlantic, Pacific and Indian Oceans. *INMARSAT* (which is where we came in) came into being on July 16 1979. February 1, 1982 saw *Inmarsat* leasing the commercial capacity on all three existing *Marisat* satellites as part of its initial space segment.

END FOR THE VALVE

The end of an era has come with the production of the last domestic receiving valve by Mullard.

The Mullard name has been synonymous with receiving valves for over 60 years. More than 1,000 million have been produced by the company's Blackburn plant during the last 40-odd years.

It is estimated that it has taken over 80,000 man-years to develop and manufacture the billion or more valves, and that in total they have consumed some two million miles of wire, 25,000 tons of glass and 20,000 million metal parts.

UK TOP SPOT

A survey of the investment intentions of 500 electronics companies in the USA revealed the UK as the favourite location for setting up overseas operations between now and 1985. West Germany came second and Ireland third.

The criteria included availability of skilled labour, transport, good communications and labour relations as well as financial incentives, the latter ranking only third in importance. But, warns the poll, the UK position only holds if the UK keeps in the EEC.

SAFT (UK) Ltd is spending £0·5 million on a new plant at Hampton, Middlesex, for making lithium oxide cells and batteries.

—ANALYSIS

ENERGY UPDATE

The energy crisis of recent years has been overshadowed by more pressing anxieties of world trade recession and unemployment. There is even a glut of oil today but the long-term problems of energy supply have not gone away and possible solutions are still being vigorously pursued.

We are now reconciled to higher costs of energy although in fact all energy sources are fundamentally free. In a single week more energy falls on the earth from the sun than is contained in all our fossil fuels deposits built up through the ages. What costs money is its collection and conversion to useable form.

Direct conversion of solar energy into electricity is as yet uneconomic in favourable climates such as California, even more so in the UK where the present alternative energy favourites are harnessing of tidal power in the Severn Estuary, wave power on the Atlantic seaboard, and wind power at a number of proposed sites.

In terms of end-cost to the consumer, efficiency and continuity of supply, wave power could be the "best buy" according to laboratory tests and analysis backed up by small-scale sea trials. But the marine engineering problems are formidable and the final cost of getting electricity ashore on the most optimistic estimates is still much greater than that from land-based oil or coal-fired turbine generators.

Windmills are easier to erect and experimental systems are being built on Orkney and in Carmarthen Bay, initially with some 200kW power to be followed by 3MW units. But even a very large windmill only generates about one thousandth of the power of a conventional power station.

The immediate practical approach is conservation. Here micro-electronics plays a major role in "fine-tuning" of air conditioning systems. New levels of efficiency are being achieved in other areas such as lighting where the 16W 2D lamp from Thorn gives a light output comparable with a standard 100W incandescent bulb.

While the scientists, engineers and technologists are busy on the problem of future energy sources we can all help to conserve existing supplies. Waste not, want not, is an old saying but still a wise one.

Brian G. Peck

RADIO WORLD

By Pat Hawker, G3VA

Empire Broadcasting

Several years ago I wrote a short note under the heading "50 years of Empire broadcasting". How come? you may wonder, since it was not until this year that the BBC began holding a series of events in London to commemorate "the fiftieth anniversary of broadcasting to the world" marking the official start of the old "Empire Service" from Daventry in 1931, and inspiring *The Times* to pen a gushing piece on "A service on which the sun still never sets" in praise of Bush House's External Services.

In truth, these were services on which the sun very nearly never rose. For several years the BBC, and in particular its first renowned director-general, Sir John (later Lord) Reith, was firmly opposed to h.f. broadcasting which had been pioneered in the USA in the mid-twenties by Frank Conrad at Pittsburgh under the experimental callsign W8XK (later KDKA).

In fact it was not the BBC but a well-known British amateur radio operator, Gerald Marcuse, G2NM, who launched the first regular service aimed at listeners in all parts of the British Empire. This was in September 1927, some months before the BBC tentatively started experiments using a Marconi transmitter, G5SW, at Chelmsford.

With Post Office permission, Marcuse broadcast daily, usually in the afternoons, on 32·5 metres from his home at Caterham, Surrey using a "studio" in the home of a friend and neighbour, Percy Valentine. He also (without permission) relayed some BBC medium-wave programmes. He rebroadcast the chimes of Big Ben, heard for the first time across the oceans, from his 100 ft-high aerials and 1·5 kW transmitter.

Occasionally, orchestras and guest soloists and singers were squeezed into the small studio. "Outside broadcasts" included bird songs from his garden and the relay of local church services.

His broadcasts were often relayed by other amateurs overseas, including one in the West Indies. As a result Gerald Marcuse was soon receiving fan mail including a letter from a lady who wrote: "I am enchanted with your voice which I hear every Sunday morning and I have three lovely daughters and a flourishing business. If you would like to come over you can have the pick of the daughters and the business."

Despite such an invitation, Gerry remained in the UK broadcasting regularly until Post Office permission was withdrawn in 1929, so leaving Empire broadcasting to G5SW until the official BBC service began in 1931.

Amateur Satellites

The Russians certainly have a sense of showmanship. Recently they launched their second series of amateur radio space satellites, satellites that pick up amateur 144MHz transmissions and send them back again to amateurs listening on 29MHz, so permitting long distances to be covered on VHF.

This time, instead of the expected one or two spacecraft they sent up no less than six: *RS3* through to *RS8* as company for the still working *Oscar 8* and *UoSat* (UK *Oscar 9*) Britain's first satellite for amateurs interested in scientific studies, launched in September 1981, and which has been undergoing a long period of checking out.

The Russians have asked amateur operators throughout the world not to use excessive power when working through these satellites. They feel 70 watts effective radiated power, or say a 10-watt transmitter with a reasonably high gain aerial, or under 100 watts with a dipole, is sufficient.

As for the other amateur space satellites, Wednesdays are reserved for planned experimental purposes. The British AMSAT-UK group runs a net on 3780kHz each evening Mondays to Saturdays at 7 p.m. and on Sunday mornings at 10.15 a.m. to discuss and pass on the latest news about the various amateur satellite activities.

Black Broadcasting

It was not until World War II was approaching that the foreign language services began and soon the BBC had a new rival: the "black" broadcasting operation of the Political Warfare Executive, run by Rex Leeper from Woburn Abbey and using transmitters operated by one of the wartime Special Communication Units controlled by the Secret Service.

One of the tricks of "black" broadcasting is to pretend that you are transmitting from Country *A* when in fact you are in Country *B*. A rather different situation has arisen in Switzerland and large parts of France which are now the targets of a powerful 1000kW (effective radiated power) VHF/FM "private" transmitter located 4000 metres above sea level on the Italian side of Mont Blanc.

This like vast numbers of other "private" Italian commercial stations, is operating in breach of the international Radio Regulations. Nations may not be speaking peace across the frontiers any more; instead they're flogging toothpaste!

Channel Rescue

For many years the most important radio navigational aid for ships was the simple direction-finding (d/f) loop or alternatively the Bellini Tosi twin loop and radiogoniometer. Both of these systems were developed as early as the first decade of the 20th century. For many years ships not equipped with loops could call-up the 500kHz coast stations who would take cross-bearings and then radio the result to the ship.

The coming of radar, the Decca Navigator and Loran has diminished the importance of d/f but the system is enjoying a new lease of life with its modern extension to VHF. A note from Racal Communications reports the use of their v.h.f. d/f equipment to effect a dramatic rescue of four people on a cabin cruiser during a violent gale in the English Channel.

The cabin cruiser en route from Cherbourg to the Isle of Wight ran into a force ten gale and coastguards found by d/f that it was some 15 miles away from the position estimated by the skipper. The d/f equipment also assisted the coastguards to guide the Poole lifeboat to the distressed craft.

The traditional d/f technique has the advantage that it can be used to locate accurately a craft carrying no other equipment than a standard marine V.H.F. two-way radio telephone. It is thus proving a valuable aid to the safety of shipping in the Channel.

Silent Room

In my library is a fascinating little wartime booklet published by Pitman at the princely sum of six old pennies: "Wireless Operating Simply Explained". It is full of good advice, rather in the manner of Victorian texts.

I like particularly a little section on "silence", including the following: "A wireless cabin should always be quiet. With faint signals or if atmospheric interference is bad, an operator needs all his hearing unimpeded to read signals.

"Imagine the feelings of the operator on watch when someone bursts into the wireless room whistling the latest popular air, bangs an attache case down, and proceeds to exchange noisy badinage with a colleague . . . The wireless cabin should resemble the consulting room of a Harley Street specialist and not a stag party."

Personally, I can recall radio stations of that era where the only time they resembled a consulting room was when half the night watch was stretched out on the floor asleep! And where the operators had to face the challenge of the station cat suddenly jumping playfully on to their keying arms. Something which I am sure Mr. Crook would have said should be "sternly discouraged". I was reminded of this by the recent High Court case in which radio intercept operators of the Composite Signals Organisation sued the Attorney-General for loss of hearing, after spending decades listening to weak signals in their headphones.

Other recommended "don'ts" included reading papers or books while on watch, working with headphones on your cheeks, placing pork pies, sandwiches etc on the operating bench. I have the impression that Mr. Crook had a good idea of what used to go on in radio stations!

ON WATCH

Readers who are wireless operators or ex-operators are likely to have some amusing "On Watch" tales to recount.

Why not share them with other readers? Pat will be delighted to hear from you.

By D. BUTLER

Simple Sound Box For The Experimenter

THIS project will enable the constructor to take the first tottering steps towards music synthesis with a voltage controlled oscillator (v.c.o.) sound effects unit. The varied and interesting sounds it produces are generated by a circuit, the heart of which is the 4046 CMOS micropower phase locked loop i.c. used here as a v.c.o.

CIRCUIT DESCRIPTION

The circuit diagram is given in Fig. 1, IC3 being the 4046 CMOS i.c. mentioned above. An external resistor and capacitor, R7 and C4 respectively, govern the operating frequency of this v.c.o. and, with the component values given, is in the order of 1kHz.

The operation of the oscillator is dependent upon a voltage applied at pin 9 and from the circuit diagram it can be seen that there are two sources of this control voltage: (1) directly from a separate clock oscillator consisting of IC1a and IC1b, VR1 and C1; or (2) from IC2, a psuedo-random generator. Switch S2 controls which of these two options is selected.

We shall first examine the former option, whereby two NAND gates, IC1a and IC1b, from a 4011 CMOS i.c. are used as an oscillator, the timing components being potentiometer VR1 and capacitor C1. This gives a minimum operational frequency of approximately 0·5Hz with the potentiometer at its highest resistance.

So with S2 in the DIRECT position the output of this oscillator at pin 4, IC1b is coupled via D4 to the control input of IC3, thus supplying a series of pulses to the v.c.o. Therefore with a positive pulse on pin 9, IC3 will oscillate and when the input drops, it will stop.

Capacitor C3 decouples the v.c.o. input to give a decay effect to the tone generated.

All this happens when switch S1 is closed (in the VARITONE position) and

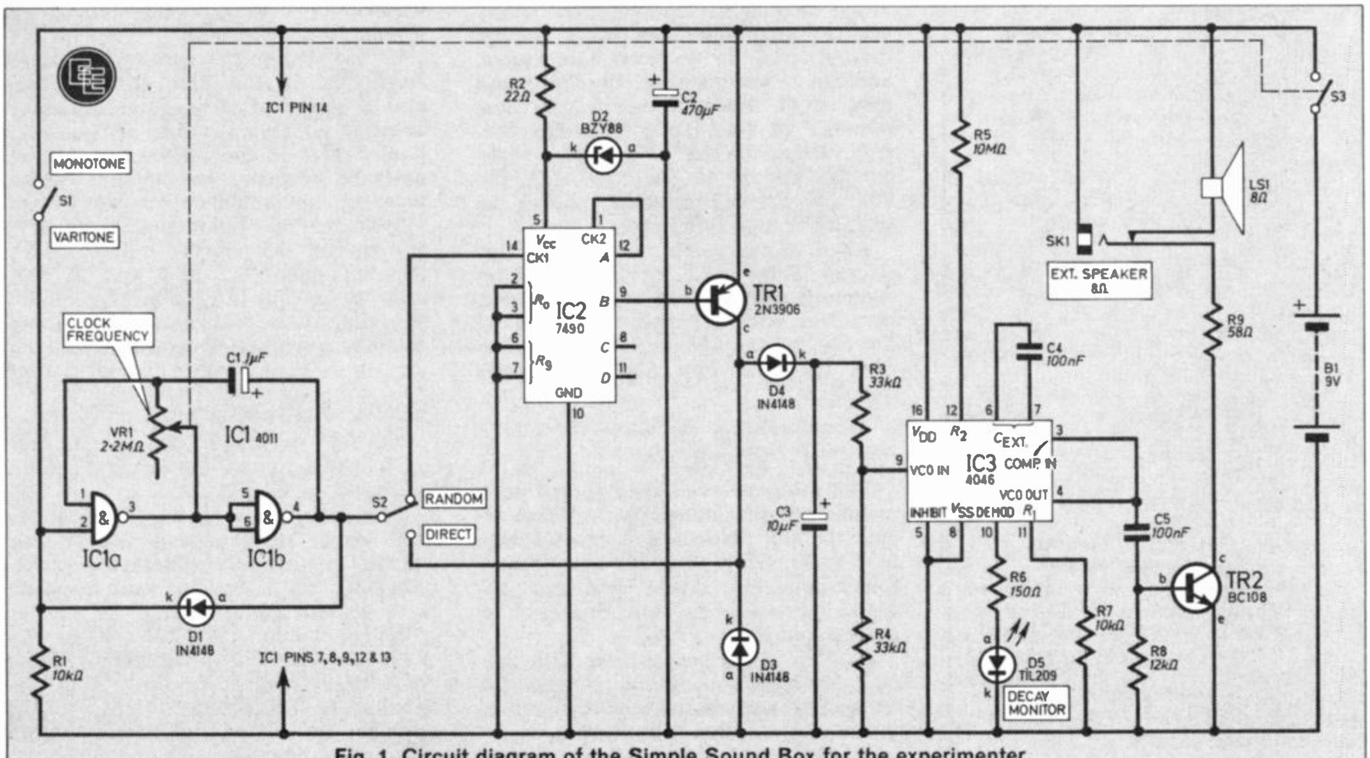


Fig. 1. Circuit diagram of the Simple Sound Box for the experimenter.

on opening S1 (MONOTONE), a constant note will be generated.

Now to discuss the second option with S2 in the RANDOM position.

RANDOM

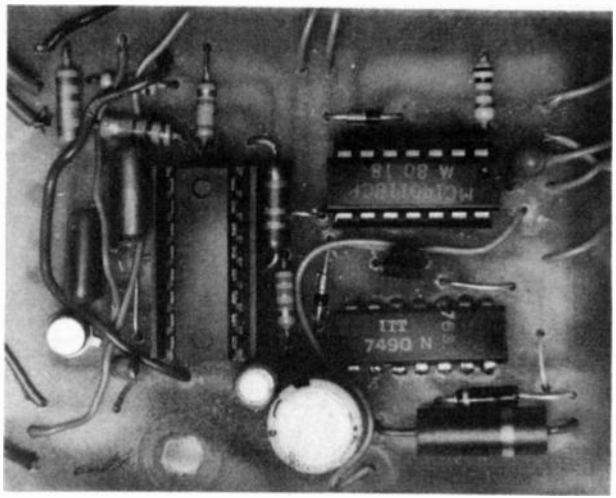
In this case, the output from IC1b is connected to the clock input, pin 14 of IC2, a 7490 TTL decade counter wired as a randomiser.

As the i.c. is a TTL device it requires a 5V power supply, so the 9V battery voltage is regulated with a 5·1V Zener diode, D2, and resistor R2. Note that R2 must be a 1W resistor as it sinks quite a lot of power. C2 is a supply decoupling capacitor.

The output of IC2 at pin 9 is a psuedo-random sequence of pulses so the resulting effect from the v.c.o. cannot be easily predicted.

Transistor TR1 amplifies the TTL output level to that compatible with the CMOS devices, that is swinging between the nine volt battery supply rails.

COMPONENTS approximate cost £8·25



Close-up of the prototype circuit board.

COMPONENTS

Resistors

R1, 7	10kΩ (2 off)
R2	22Ω 1W
R3, 4	33kΩ (2 off)
R5	10MΩ
R6	150Ω
R8	12kΩ
R9	58Ω

All ¼W carbon ±5% except where stated

Capacitors

C1	1μF 10V tantalum bead
C2	470μF 10V elect. radial lead
C3	10μF 10V elect. radial lead
C4, 5	100nF polyester (2 off)

Semiconductors

D1, 3, 4	1N4148 silicon (3 off)
D2	BZY88 C5V1 400mW 5·1V Zener diode
D5	TIL209 red l.e.d.
TR1	2N3906 *pnp* silicon
TR2	BC108 or similar *npn* silicon
IC1	4011 CMOS quad 2-input NAND gate
IC2	7490 TTL decade counter
IC3	4046 CMOS phase locked loop

Miscellaneous

S1	s.p.s.t. miniature toggle switch
S2	s.p.c.o. minature toggle switch
S3/VR1	2·2MΩ carbon lin. potentiometer with integral s.p.s.t. switch
LS1	8Ω 0·3W minature speaker
SK1	3·5mm jack socket, switched contacts

Case 120 × 100 × 45mm; single-sided p.c.b. 70 × 55mm; l.e.d. mounting clip; battery clip; 14 pin d.i.l. i.c. holder; 16 pin d.i.l. i.c. holder; epoxy resin adhesive; 7/0·2 PVC sleeved wire; knob (for VR1); board mounting hardware.

V.C.O. OUTPUT

The output of IC3 at pins 3 and 4 is coupled via C5 to TR2, a single transistor amplifier, and speaker LS1 provides the audible output, socket SK1 giving the option of an external amplifier and/or speaker.

The l.e.d., D5, is connected internally to the v.c.o. and it monitors the operation of IC3.

Power is supplied to the circuit from a nine volt PP3 battery although a battery eliminator is recommended as the power consumption is around 90mA at the highest frequency level. Switch S3, an integral part of VR1, is the main unit ON/OFF switch.

CIRCUIT OPTIONS

As the circuit stands, the sound effects available are still rather limited and to expand the range, adding a jack socket to the input (pin 9) of IC3 will enable the constructor to feed an alternative control voltage to the v.c.o. Series resistor R3 should be retained and the voltages applied must of course be of CMOS compatible levels.

Also to vary the operating frequency of the v.c.o. itself, a potentiometer of say 10 kilohm can be added in series with R7 and the value of C4 can be experimented with, however no less than 50pF is recommended.

CIRCUIT BOARD

The prototype was constructed on a printed circuit board, 70 x 55mm in size, the foil pattern of which is given in Fig. 2. This diagram also shows the component layout and no problems should be encountered in assembling it.

Just the usual precautions with getting the polarity of the electrolytic capacitors and diodes and the orientation of the transistors correct.

All three i.c.s. are shown in holders, however IC2, the TTL device can be soldered directly to the board if desired with no danger of any damage.

CASE

Any enclosure of suitable dimensions will be suitable, bearing in mind the size of the potentiometer, switches, speaker and p.c.b. The original prototype uses a plastic box 120 x 100 x 45mm with a screw-on lid.

Four holes are to be made in the lid to accommodate the two switches S1 and S2, the potentiometer VR1 and l.e.d. D5 and these are to be made in the positions shown in the photograph of the finished unit. The potentiometer requires a 10mm diameter hole, the remainder of the lid mounting components needing a 6·4mm diameter hole.

A "grille" for the speaker needs to be drilled in the base of the case, and a series of 3 to 4mm diameter holes in a "star" pattern will suffice. It also adds to the appearance of the unit to slightly countersink these holes on the outside.

Two further holes are necessary, one in the side of the unit for SK1 (6·4mm diameter) and one in the base to accept the mounting pillar for the p.c.b. (diameter of which depends upon screw size used.)

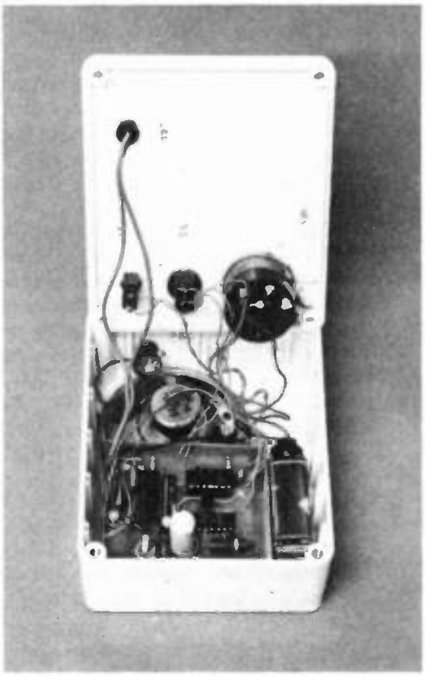
FINAL ASSEMBLY

Having prepared the case and p.c.b., the unit can be wired together as shown in Fig. 3.

The speaker is to be glued down with epoxy resin adhesive above the "grille" pattern in the base, the p.c.b. mounted on a spacer and secured with a screw and nut.

Wiring to be completed with the p.v.c. sleeved 7/0·2 equipment wire (or similar) and the controls to be labelled as illustrated.

Once completed, different sound effects can be created by manipulating S1 and S2 together with VR1. ⌑



Prototype with lid raised showing assembly within the case.

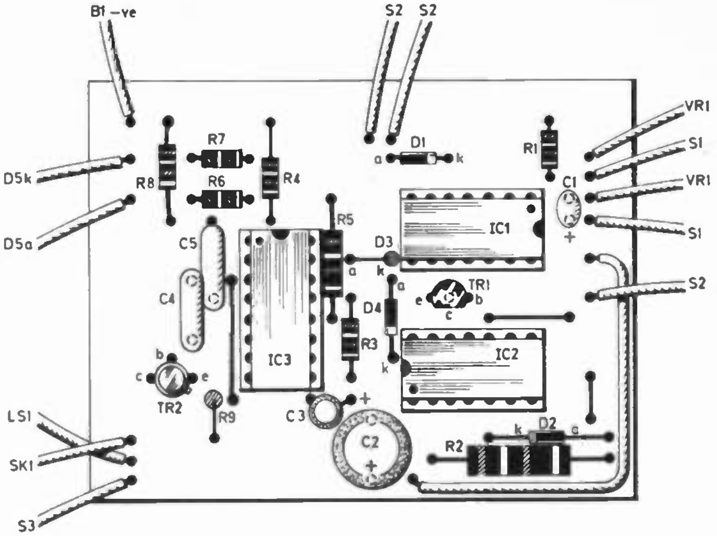


Fig. 3. Layout of the components on the topside of the p.c.b. and wiring details to other components.

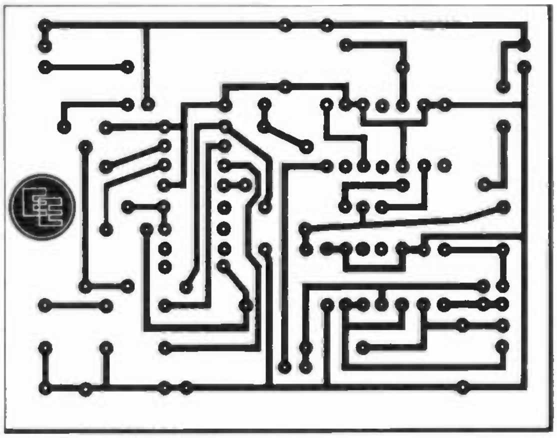


Fig. 2. Full size master for the pattern to be etched on the board. Viewed from copper side.

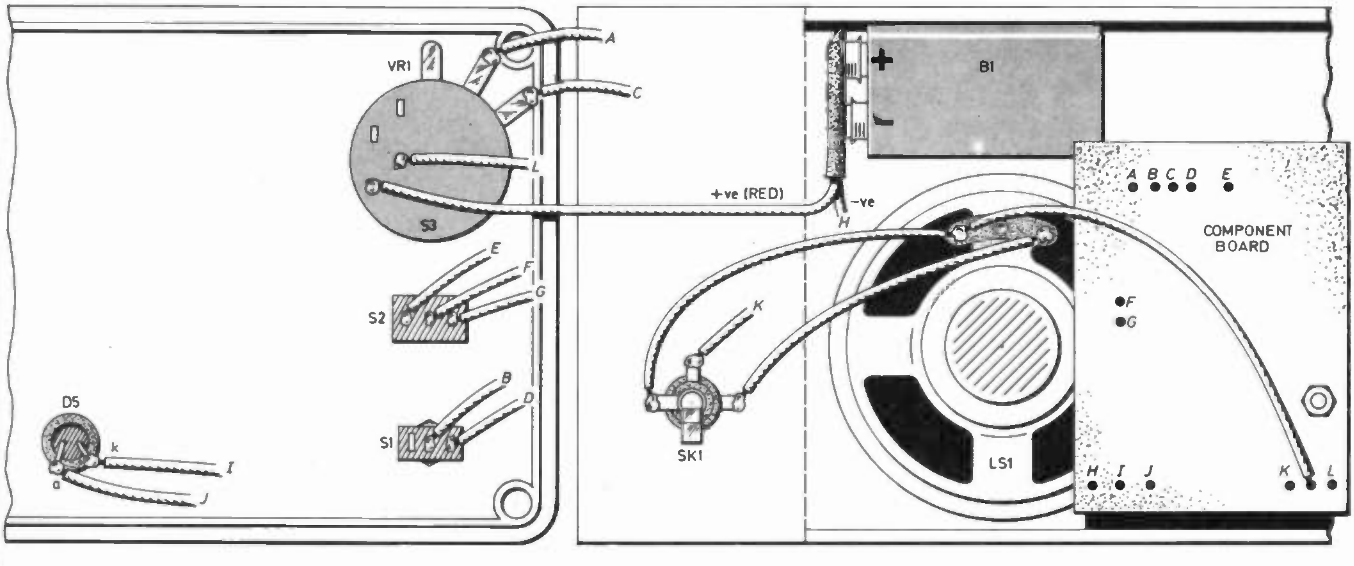
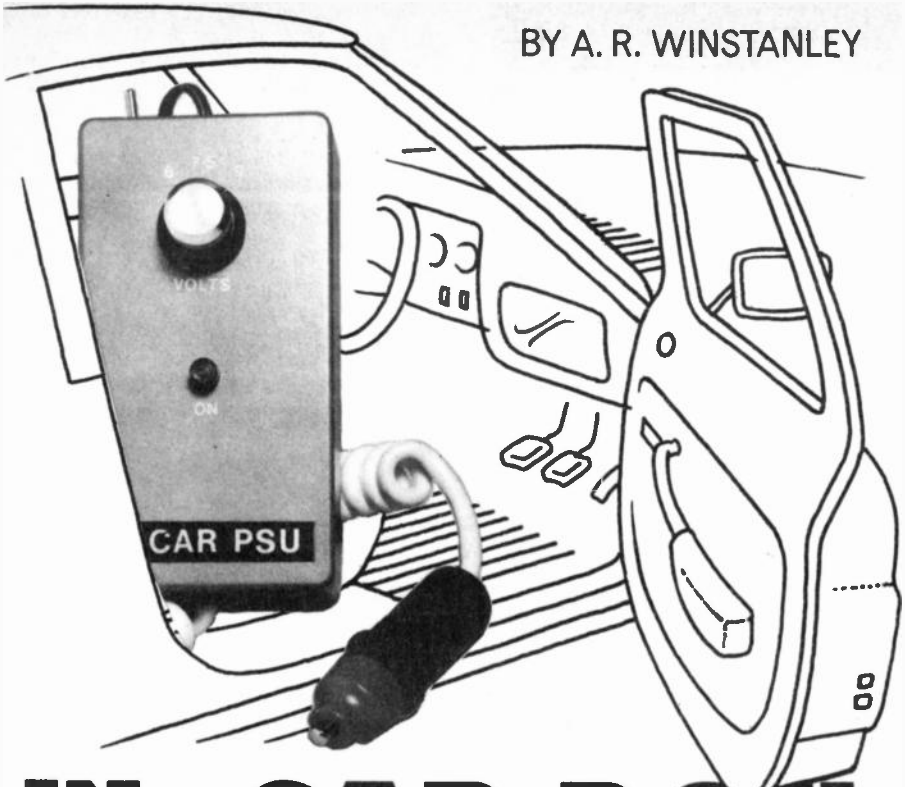


Fig. 3. Position and interwiring of the case mounted components. All flying leads from these components run to the circuit board.

IN-CAR P.S.U.

BY A. R. WINSTANLEY



ONE of the more economical methods of providing music in the car, apart from singing to oneself, is to take along a portable cassette recorder which operates from its own dry batteries. Obviously if a long journey is envisaged then it is often a good idea to carry several spare batteries for the cassette recorder as well!

The main problem of course is that cassette recorders seem to have a voracious appetite for dry cells. It would be more desirable to operate the unit from the car battery, thereby saving the recorder's own batteries for use in and around the house. However, as the car battery is normally rated at 12V, this is not immediately possible. Some sort of adaptor is required which converts the 12V of the car's electrical system to that needed by the cassette recorder. Most cassette recorders operate from either 6V or 7·5V and draw between 400 and 500mA maximum.

The In-Car P.S.U. described here is such an adaptor. Apart from providing 6 or 7·5V, it will also give 9V d.c., the three voltages being available at the touch of a switch. With a maximum current rating of 2·2A (but see later), not only will it operate cassette recorders, but other devices as well — torches, lanterns, battery shavers and radios to mention but a few.

Virtually the only requirement is that the device to be powered from the In-Car P.S.U. must have an appropriate socket fitted to enable the d.c. supply to be connected to the apparatus. With many cassette recorders, for example, this presents no problem.

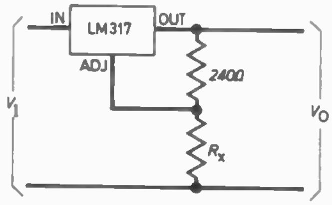


Fig. 1. The LM317T in basic voltage regulator configuration.

The circuit itself is quite simple and straightforward. This is because a modern easy-to-use integrated circuit has been used as the basis of the design. The i.c., a three-terminal variable voltage regulator type LM317T, is shown in its basic configuration in Fig. 1.

It can be seen that the three terminals are named *input, output* and *adjustment*. A 240 ohm reference resistor is normally placed between output and adjustment, and across this resistor exists a precision 1·2V reference voltage. By varying the value of R_x, a resistor placed between adjustment and ground, the output voltage may be altered. In fact, using a 240 ohm reference resistor, the value of R_x is given by the formula

$$R_x = (200 \times V_o) - 240 \text{ ohms}$$

where V_o is the output voltage in volts. To obtain 6, 7·5 and 9V output voltages therefore we require values of R_x to be 960, 1260 and 1560 ohms respectively.

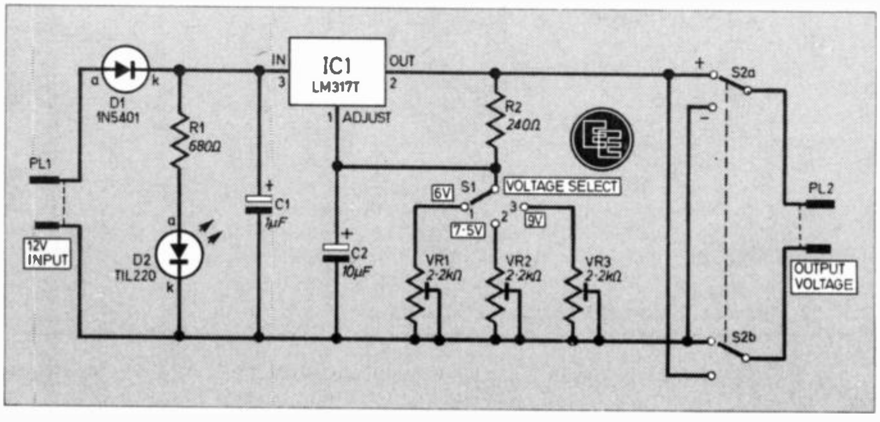
The maximum current available is 2·2A, but this will depend on the temperature and power dissipated by the i.c. The device, incorporates thermal overload shutdown and internal current limiting and is available in several packages. It is the TO-220 encapsulation (LM317T) that is employed in this design.

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 2. S1 is a one-pole three-way rotary switch which selects different values of R_x (Fig. 1) thereby enabling 6, 7·5 or 9V to be obtained. Note that three preset resistors in Fig. 2 replace R_x in Fig. 1; these are trimmed so that exact output voltages can be obtained. This does mean however that a voltmeter will be required to measure the output voltages during setting up.

D2 is a light-emitting diode which illuminates when the unit is operating. R1 is its associated series resistor which limits the forward current

Fig. 2. The complete circuit diagram of the In-Car P.S.U.



COMPONENTS

See
Shop Talk
page 233

Resistors
R1 680Ω
R2 240Ω
Both ¼W carbon ±5%

Capacitors
C1 1μF 16V or greater tantalum bead
C2 10μF 16V tantalum bead

Semiconductors
D1 1N5401 3A rectifier
D2 TIL220 or similar red l.e.d.
IC1 LM317T adjustable voltage regulator i.c. (TO-220 case)

Miscellaneous
S1 single-pole three-way rotary
S2 miniature d.p.d.t. toggle
VR1-VR3 2·2kΩ miniature carbon preset (3 off)
PL1 two-pole plug to suit car (for example a plug to suit the car cigar/cigarette lighter socket)
PL2 two-pole plug to suit equipment (Spider or Universal—see text)
Printed circuit board, 61 × 27mm; case type BIM 5004/14, diecast aluminium, size 121 × 66 × 40 with p.c.b. guides (see text); lens clip for D2; insulating bush and mica washer for IC1 (TO-220 kit); knob; grommets (2 off); 6BA fixings for IC1.

through the l.e.d. to a reasonable level—about 15mA.

C1 is a tantalum bead capacitor placed across the input to eliminate transients and noise which often are present on the car 12V supply rail. C2 bypasses the adjustment terminal to ground to improve the ripple rejection of the i.c. D1 is a heavy-duty rectifier which protects the circuit from accidental reversed polarity.

CONNECTORS

The 12V input connection to the unit was made, on the prototype, with a twin-core curly lead terminated in a cigar-lighter plug: this enabled the unit to be connected quickly and easily into the car cigar-lighter socket. The form of connector can be varied to suit one's need. For example, a dashboard-mounting two-pin non-reversible connector is available from motor accessory shops and this could be used if a cigar lighter is not available.

The output connector can also be altered to meet requirements. To achieve maximum versatility however, it is recommended that a 4-way "spider" or universal connector is used. This comprises a 2·5mm and 3·5mm jack plug, together with a 2·1mm and 2·5mm power plug moulded onto the end of a twin-core lead. This means that the unit can power almost every type of apparatus which has the usual forms of external power sockets fitted.

The one remaining problem relates to the polarity of the P.S.U. output. The author's radio/cassette recorder requires a 2·1mm power plug with the tip at 0V and the "body" of the plug at +6V. It is likely however that other loads may require a reversed polarity to this, with the tip of the plug positive and the "body" negative.

S2 has been included in the output to switch over the polarity of the spider plug as necessary. This switch needs to have a heavy action on the operating lever to prevent the switch being accidentally knocked over whilst the unit is in operation. A reversed voltage polarity with some devices could have dire results!

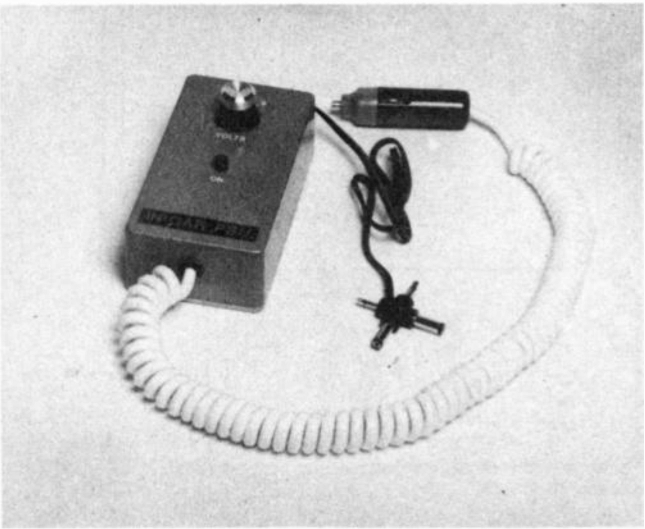
CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

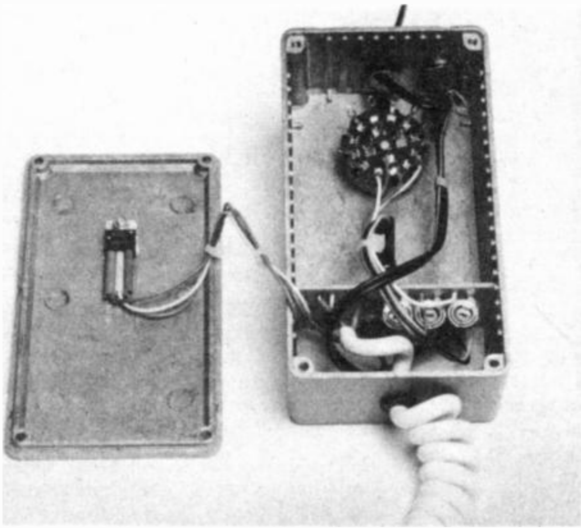
The circuit, with the exception of IC1, is constructed on a glass-fibre printed circuit board measuring 61×27mm. The unit is built into a diecast Bimbox type 5004/14 measuring 121×40×66mm. The dimensions of the p.c.b. are such that it can slide directly into the p.c.b. guides formed on the inside of the specified case, thus eliminating any requirements for p.c.b. mounting pillars.

If another metal case is used then it is necessary that the p.c.b. is mounted in a different manner. Probably 8BA mounting hardware can be used here. A full size master pattern

The finished unit ready for use in the car. You can see the "universal" or "spider" connector.



In the final stages of assembly, the prototype with lid removed showing in particular the p.c.b. inserted in a slot and the i.c mounted to the lid.



IN-CAR P.S.U.

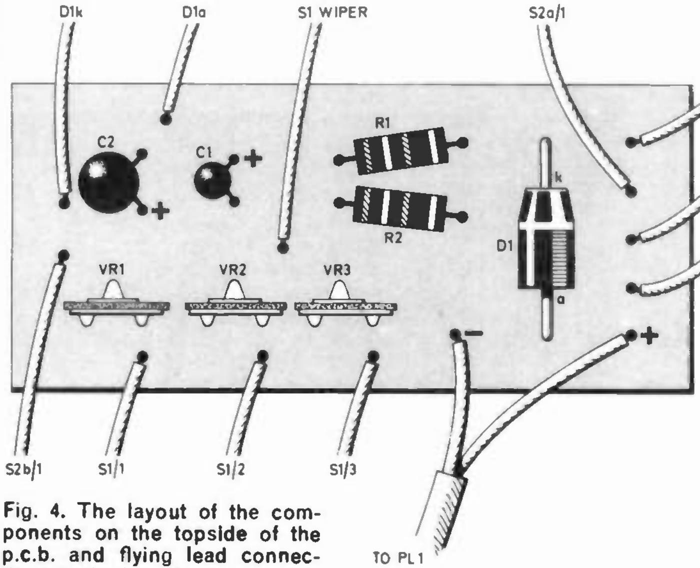


Fig. 4. The layout of the components on the topside of the p.c.b. and flying lead connections to the board.

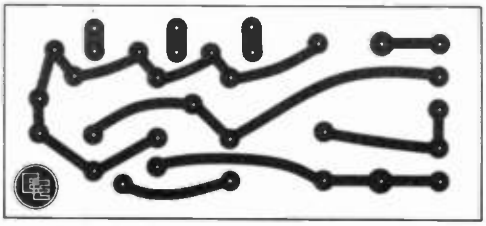


Fig. 3. Full-size master of the pattern to be etched on the board. Black regions denote the copper to remain after etching.

COMPONENTS approximate cost £10·50

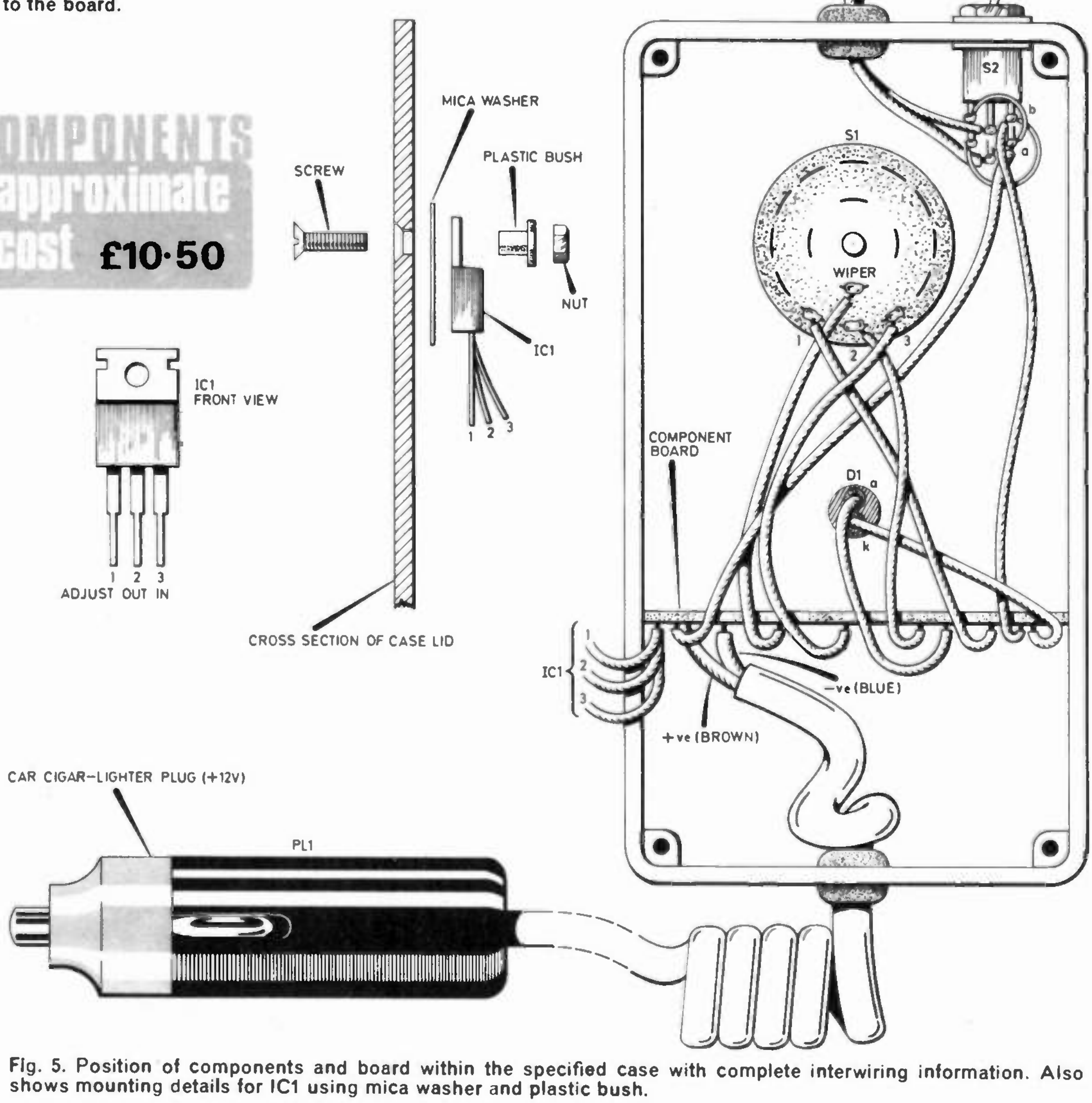
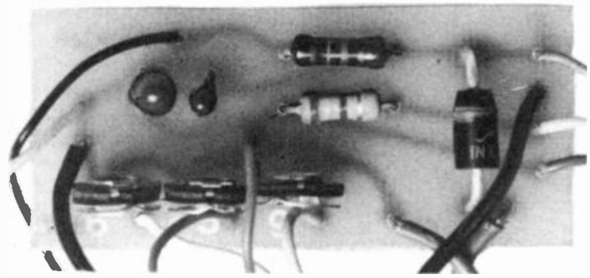
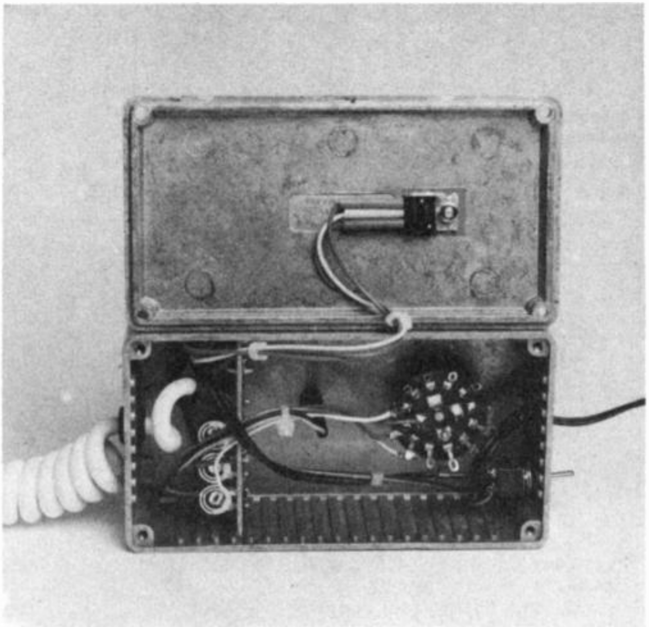


Fig. 5. Position of components and board within the specified case with complete interwiring information. Also shows mounting details for IC1 using mica washer and plastic bush.



Close-up view (above) of the prototype p.c.b. with all components in position.



Plan view of the completed prototype. Note the use of cable ties for the three groups of wiring.

to be etched on the board is given in Fig. 3.

Assembly details of the components on the top side of the p.c.b. are shown in Fig. 4. The polarities of the tantalum capacitors are nearly always marked on the bodies, and it is very important that these components are soldered in the right way round, as is the case with D1 and D2. The latter has a flat alongside its cathode.

The p.c.b. should be completed in accordance with Fig. 4 and then the diecast box can be prepared.

CASE

The lower section should be drilled to suit the rotary switch, the toggle switch S2, and the l.e.d. Two holes are also needed to enable the 12V input and output leads to pass through and these holes should be fitted with a grommet. It is advisable to fit cable retaining clips to both of these cables.

IC1 is mounted on the removable lid of the box, which acts as a heatsink—hence the necessity for a metal box to be used. A diecast box has the added advantage that it is very tough and will withstand quite severe knocks.

It was decided that the galvanised finish of the diecast box was somewhat less than aesthetic and so it was resprayed in an attractive shade of gold. If constructors wish to do the same it should be noted that an initial coat of primer may be required. The paint should of course be applied once all the metalworking has been completed.

After the box has been drilled and painted, the lettering can be applied to the case as required. Proprietary rub-down lettering can be used here. Note that clear protective lacquer should *not* be used over a cellulose paint finish. Experience has shown that the two tend to react unfavourably!

INTERWIRING

Once the p.c.b. and case have been completed, all interwiring can be carried out, as detailed in Fig. 5. The l.e.d. is mounted using either the usual black plastic bush/clip or alternatively a more attractive, though more costly, lens-clip may be employed, as in the prototype. The integrated circuit should be mounted on the lid of the box using a TO-220 insulating kit, so that the metal tab of the device is isolated from the case.

With regard to the rotary switch, a one-pole, three-way switch is required. This is best realised using a four-pole three-way switch. Only one pole is wired up. The remainder of the switch is ignored, as Fig. 5 illustrates.

General-purpose flexible wire, preferably having a minimum rating of 1·5A can be used throughout. All flying leads, plus the input and output leads, can be soldered directly to the p.c.b.; constructors may wish to use Veropins if required.

Check all of the interwiring and set the three presets to midway before proceeding to the setting up stage. This comprises applying 12V to the input, either from the car electrics or a bench power supply unit and then adjusting the appropriate preset until 6V, 7·5V and 9V are measured at the output connected to a 10V d.c. voltmeter for the three settings of S1.

The unit once calibrated in the manner described is then complete and ready for use.

OUTPUT CURRENT

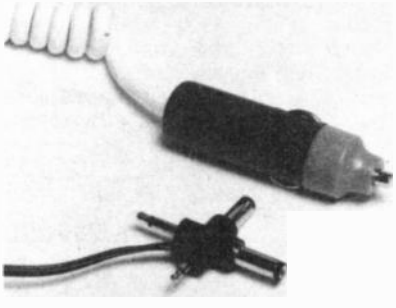
It was mentioned earlier that the i.c. has built-in current limiting which operates at 2·2A, reducing the current level as necessary if the i.c. temperature increases.

The **peak** current available from the i.c. therefore is 2·2A. To operate the unit at such current levels for a prolonged period is impracticable. Whilst short-circuits and very heavy loads will not damage the i.c., as the device is not well heatsinked (the diecast box is not terribly efficient at this), the i.c. temperature can be expected to build up with a consequent reduction of the maximum current available.

Under worst case conditions the i.c. may shut down altogether. In such cases the device will be very hot indeed—probably too hot to touch. When powering cassette units and other devices with a current consumption of about 500mA or less, the i.c. wil barely get warm. The maximum recommended current for prolonged use is about 1A. This will ensure that no thermal problems are experienced.

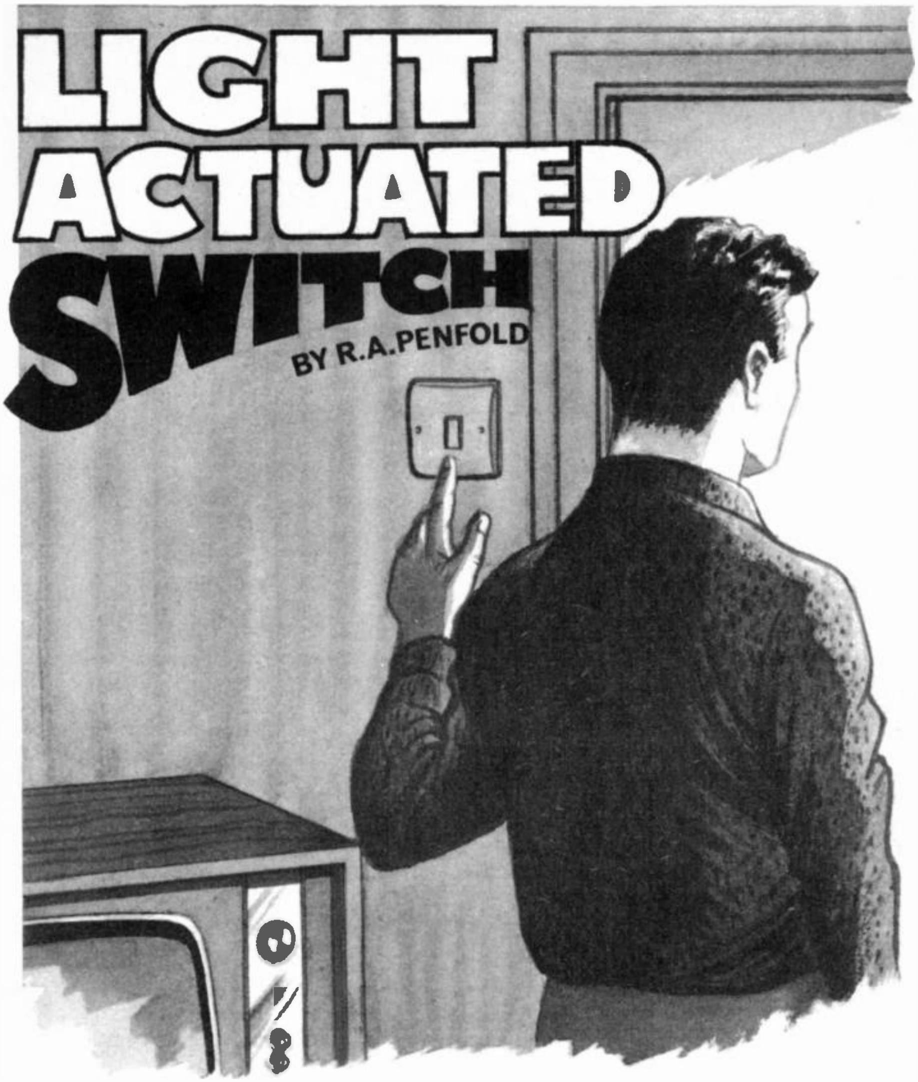
Finally, note that temporary short-circuits will not damage the p.s.u. unit but ensure that the circuit in the car's electrical system will carry the 2A or so which flows under such conditions.

The cigar-lighter plug and power supply connector used by the author.



LIGHT ACTUATED SWITCH

BY R.A. PENFOLD



Although a great many light activated switch designs have been published in the past, these have virtually all been circuits which respond to the ambient light level, switching on or off at some predetermined light intensity.

This circuit is different in that it is designed to switch on some item of equipment when an electric light is switched on, and switch it off again when the light is switched off. Apart from this continuous mode of operation, the unit can be used in a single operation mode where it switches off both itself and the controlled equipment when the light is extinguished.

FLUCTUATING INTENSITY

For reliable results the unit must be designed to respond to light of rapidly fluctuating intensity, and not to any particular light level. Since mains lighting is run from a 50Hz a.c. supply, the light level increases to a peak and then dies away during the course of each mains half cycle, producing the rapid variations to which the unit responds. Natural light does not pulsate in this way and is much more consistent in the short term, making the unit almost immune to this type of lighting.

The unit could be used by someone who watches TV in bed, or perhaps by someone who listens to a mains powered radio which cannot easily be conveniently situated.

This light activated switch can be used to automatically switch off the set when the bedroom light is extinguished, obviating the need to get out of bed and switch the set off manually. Another possible application is to ensure that a TV set, hi-fi, or other equipment is not accidentally left switched on overnight.

THE CIRCUIT

The complete circuit diagram of the Light Activated Switch is shown in Fig. 1. A simple unregulated supply of about 9 volts is obtained from the straight forward fullwave rectifier circuit which uses T1, D1, D2, and C1. LP1 is merely the panel neon on/off indicator, and this must be a type having an integral series resistor for normal mains operation.

The heart of the unit is PCC1, a cadmium sulphide photoresistor, and this has a resistance which varies from over 10 megohms in total darkness to only a few tens of ohms in very bright conditions. Together with R2 this forms part of a potential divider, and variations in the light level received by PCC1 cause similar variations in the output from the potential divider.

When PCC1 is subjected to mains lighting, the rapid changes in intensity generate a rapidly alternating output from the potential divider. This is coupled by C3 to a single transistor amplifier. Natural light only produces very slow changes in intensity at a significant amplitude, and these will be blocked by C3, as will the d.c. level produced by the photocell circuit.

Components R1 and C2 considerably smooth and decouple the supply for the photocell circuitry. This is necessary to prevent mains hum from being coupled into the amplifier from the supply lines via R2, which would block the operation of the circuit. This decoupling also prevents instability due to positive feedback through the supply lines.

AMPLIFIER

TR1 is used as a conventional common emitter amplifier having collector load resistor R4 and base bias resistor R3. The amplified output from its collector is coupled to a rectifier and smoothing circuit using D3, D4, and C5. In the presence of a suitable input signal this produces a strong positive d.c. bias which switches on TR2, and activates the relay which is connected as its collector load.

Of course, in the absence of mains lighting being detected by PCC1, a suitable signal is not present in the circuit, and the relay is not activated. D5 is a protective diode, and this suppresses the high reverse voltage that would otherwise be generated across the relay coil as it switched off. If not suppressed, this voltage spike could damage the semiconductor devices in the circuit.

SWITCHING

For continuous operation it is necessary to close S1. Power is then continuously applied to the circuit, and the relay closes whenever PCC1 is subjected to mains light source. When the relay is energised, RLA2 closes and supplies power to the controlled equipment.

If the unit is required to switch itself off when the light is switched

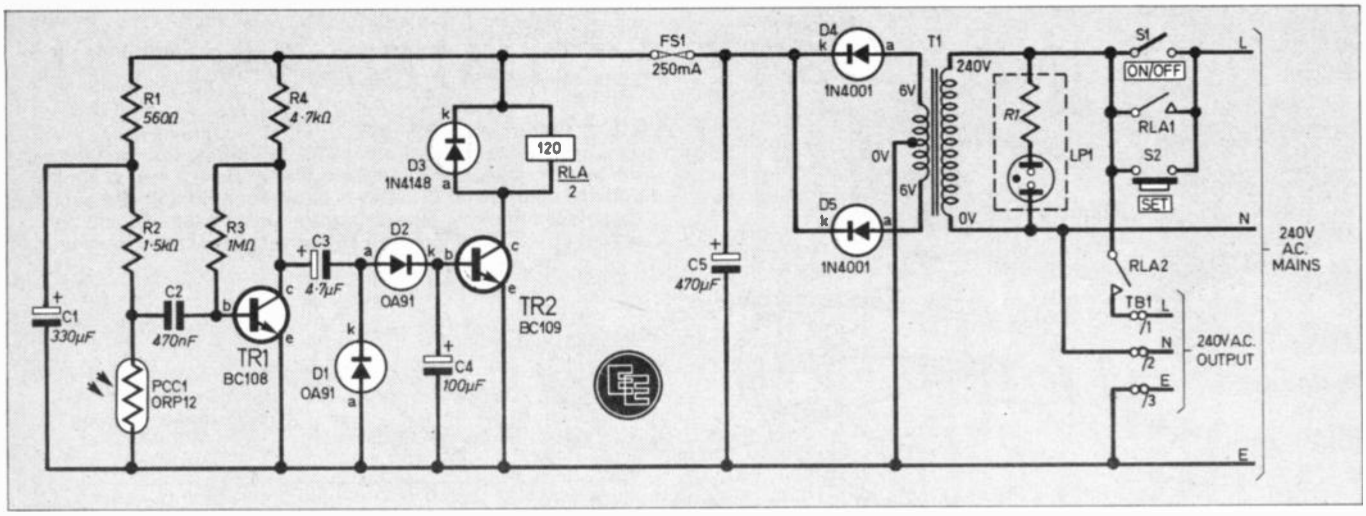


Fig. 1. Full circuit diagram of the Light Actuated Switch.

off, S1 is left in the open position, and push button switch S2 is depressed until the relay is activated (which happens almost immediately). When S2 is released, power will be applied to the unit by way of relay contact RLA1, and to the controlled equipment through both RLA1 and RLA2.

When the light is switched off and the relay contacts open, power will be disconnected from both the controlled equipment and the light switch circuitry. Switching the light on again then obviously has no effect on the unit.

CONSTRUCTION starts here

STRIPBOARD

The main circuitry is built on a piece of 0·1 inch matrix stripboard size 18 strips by 23 holes, and the component layout is given in Fig. 2. There is one break in the copper strips, and be careful not to omit the single link wire.

Solder in the resistors and capacitors first, and leave the semiconductor devices until last. Diodes D3 and D4 are germanium devices and they are susceptible to damage by overheating. It is therefore advisable to use a heatsink on each lead of these components when they are being soldered into circuit, or at least make sure that they are quickly soldered into place so they do not overheat.

Finally, the board is completed by connecting the seven insulated flying leads, all of which are about 100mm or so long. These can be trimmed to length when it is time to connect their free ends.

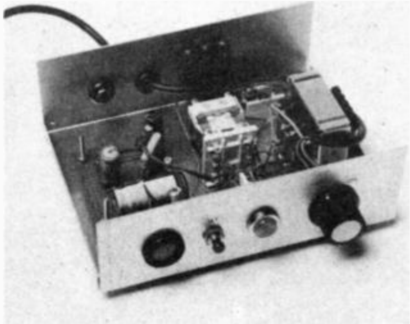
CASE

The prototype is housed in a metal instrument case which measures approximately 152×114×51mm, but any case of metallic construction and about these dimensions should also be usable. The general layout of the unit can be seen from the photographs, and is not critical, although neither T1 nor any mains wiring should be positioned close to PCC1 or its wiring.

A soldertag is fixed on one mounting screw of T1 to provide a chassis connection point to which the mains earth can be connected. For reasons of safety it is essential to ensure that the case is properly earthed.

The specified relay can be mounted using a single short 4BA screw which fits into a threaded hole in the base of the relay. It is possible to use an alternative relay if it has suitable ratings, but it may then be necessary to construct a mounting bracket of some kind.

The photocell is mounted on the front panel, and if a suitably large grommet can be obtained, this can be used as a sort of panel mounting holder for PCC1. Alternatively it is possible to drill a couple of holes in the panel to accommodate the lead-



Interior view of the unit. Note the connector block TB1 on the inside rear panel for connecting up the external equipment.

COMPONENTS

See **Shop Talk** page 233

Resistors

R1	560Ω
R2	1·5kΩ
R3	1MΩ
R4	4·7kΩ

All ¼W carbon ± 5%

Capacitors

C1	330µF 10V elect.
C2	470nF polyester type C280
C3	4·7µF 16V elect.
C4	100µF 10V elect.
C5	470µF 16V elect.

Semiconductors

TR1	BC108 *npn* silicon
TR2	BC109 *npn* silicon
D1, 2	OA91 100V, 20mA germanium point contact diode (2 off)
D3	1N4148 small signal silicon diode
D4, 5	1N4001 50V, 1A silicon rectifier diode (2 off)
PCC1	ORP12 cadmium sulphide light dependent resistor

Miscellaneous

T1	mains primary/6-0-6V 250mA secondary
S1	s.p.s.t. mains rotary
S2	push-to-make, release-to-break mains rated switch
RLA	12V 120 ohm coil with two sets mains rated n.o. contacts, MES 12V power relay or similar.
FS1	250mA 20mm quick-blow cartridge fuse in chassis mounting holder
TB1	three-way 5A screw terminal block
LP1	mains neon indicator with integral series resistor

Case, 152 × 114 × 51mm, Harrison type BC1 or similar; stripboard, 0·1 inch matrix, size 18 strips by 23 holes; knob; interconnecting wire, 6BA mounting hardware for stripboard; 5A three core mains cable; interconnecting wire; grommets (3 off).

Approx. cost Guidance only £10

LIGHT ACTUATED SWITCH

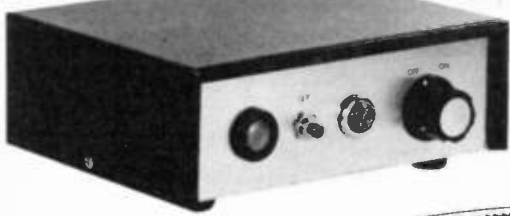
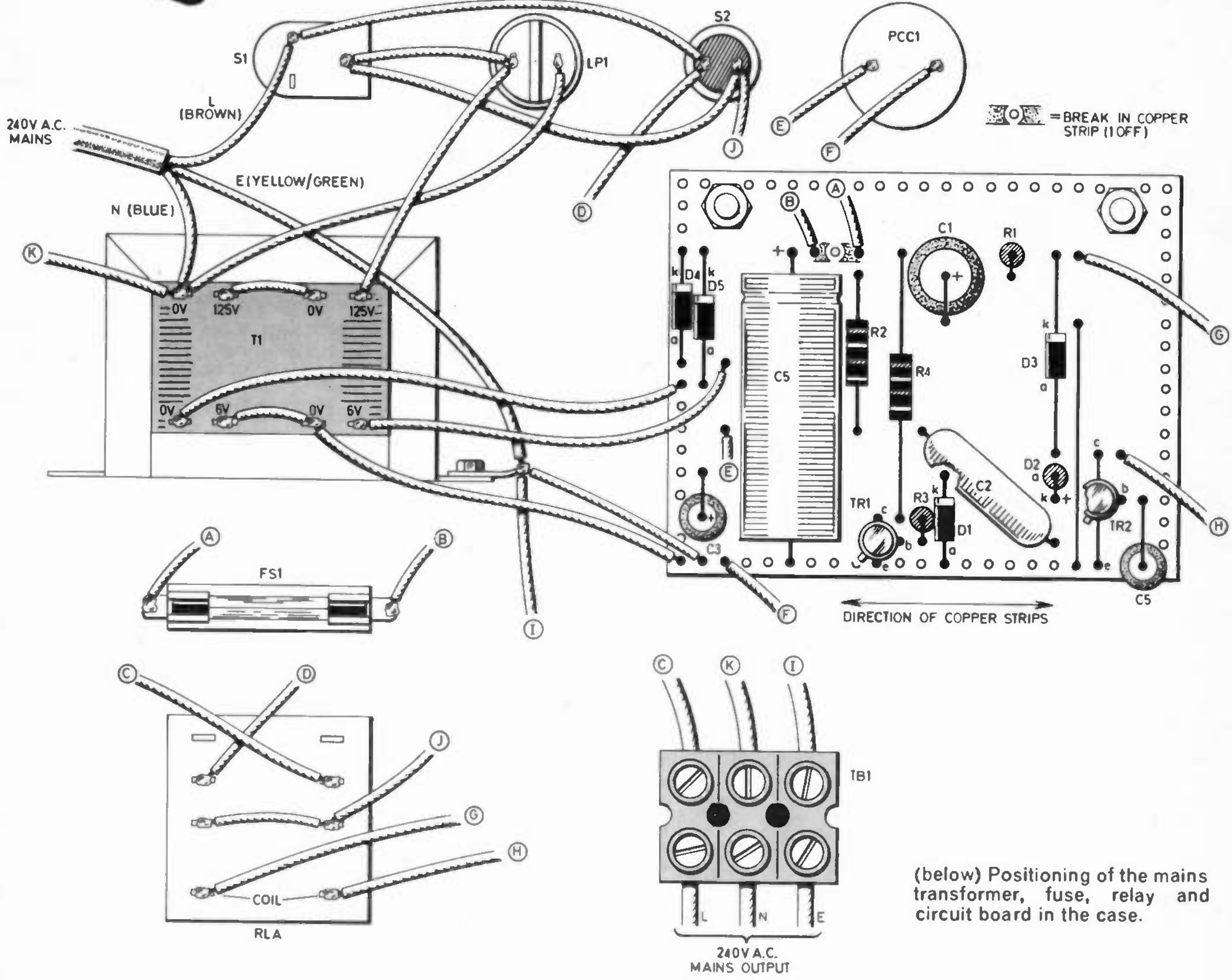
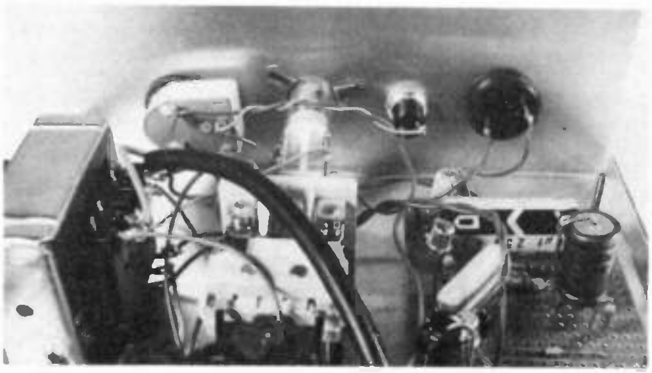


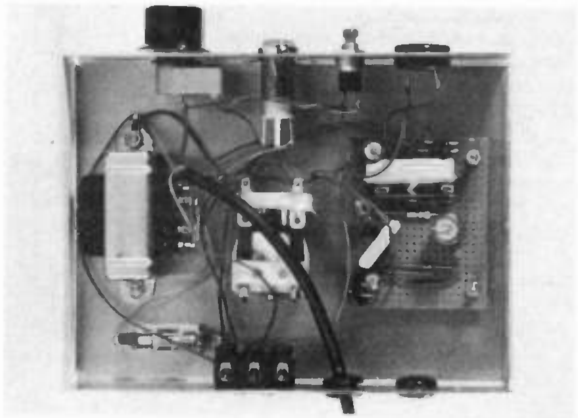
Fig. 2. Circuit board layout and full interconnection diagram. The secondary connections to T1 are below the primary so full transformer connections are shown on the left. A similar detailed diagram for the relay is shown bottom left. The output cable is led into the case through a rubber grommet and connected up via TB1. Photo left shows exterior of completed unit.

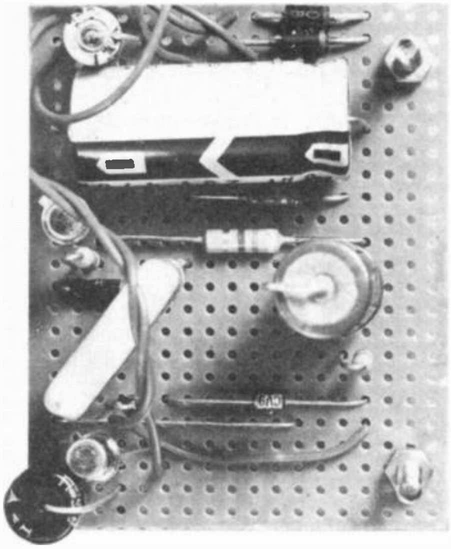


(below) Positioning of the mains transformer, fuse, relay and circuit board in the case.

Rear wiring to front panel components.







Close up view of the circuit board.

out wires of PCC1 (which protrude from the rear side of the component), and then glue it to the front panel, making quite sure that the leadouts do not short circuit to the metal casing.

The component panel is mounted on the base of the cabinet using two 6BA bolts and fixing nuts. Spacers are used to ensure that the connections on the underside of the board are kept well clear of the metal casing. Two holes are drilled in the rear panel to take the mains input and output leads, and these should be fitted with grommets to protect these cables.

WIRING

Once all the drilling and component mounting has been completed, the point to point wiring can be undertaken. This is all illustrated in Fig. 2. Be very careful not to make any errors here as much of the wiring is carrying the mains supply, and errors could prove to be expensive or even dangerous. Suitably rated mains cable must be used for wiring that will carry mains power.

The connections to the controlled equipment can be made via a three way terminal block which can be mounted on the rear panel of the case. These blocks are normally sold in twelve way lengths, and a block of the appropriate length is cut from one of these using a sharp modelling knife.

If preferred, a larger case fitted with a mains outlet socket could be used, and the three output leads would then connect to this socket. However, this would be more complicated and expensive, and is probably not worthwhile unless the unit is to be used with more than one item of equipment.

TESTING

Before connecting the unit to the mains it is recommended that the wiring should be thoroughly checked over once or twice. It is then just a matter of first checking that with S1 closed, the unit switches on and off in sympathy with any mains light which throws light onto PCC1.

Then S1 should be closed and S2 should be operated so that the single operation mode can be checked. The unit should be quite sensitive, and a shaded 40W light bulb will operate the prototype reliably at a distance of 7 metres or so. However, strong natural light falling on the photocell will inevitably reduce sensitivity somewhat. ⌘

LETTERS

Demorgan's Theorem

Readers of the *Introduction to Logic* series by J. Crowther may be interested in the following comprehensive method of converting expressions of even the most complicated kind.

Example. Demorganise: $A.\overline{B}.(C+D)$

Bracket terms not already so:

$(A).(\overline{B}).(C+D)$

Complement each bracket:

$\overline{(A)}.(B).\overline{(C+D)}$

Complement whole function:

$\overline{(\overline{A}).(B).\overline{(C+D)}}$

Change signs between brackets for opposite signs (that is, "+" to "." and "." to "+"):

$\overline{\overline{(A)}+(B)+\overline{(C+D)}}$

Remove extra brackets:

$\overline{\overline{A}+B+\overline{(C+D)}}$

The next exercise is slightly more difficult.

Demorganise:

$\overline{\overline{A+B+C}+\overline{D}+E}$

$\overline{\overline{(A+B)}+\overline{(C)}+\overline{(D)}+\overline{(E)}}$

$\overline{(A+B)+(C)}+\overline{\overline{(D)}+\overline{(E)}}$

$(A+B)+(C)+(D)+(E)$

$(A+B).(C)+(D).(E)$

$(A+B).C+D.E$

The following three are spot-at-a-glance conversions which can be memorised.

$\overline{A}+\overline{B}=A.B$

$\overline{A}.\overline{B}=\overline{(A+B)}$

$\overline{A}+\overline{B}=\overline{A.B}$

H. L. Taylor,
Old Trafford,
Manchester.

The Saga of 'Circuit Sam'

Now 'Circuit Sam' was a whizz-kid bright
With a knowledge of amps and ohms
And a store of bits, and half-built kits,
And esoteric tomes.

His secret scheme and cherished dream
Was a plan for a robot brain
And he said, "It's true, if I carry it through,
That I'll never work again."

"I'll take in problems day by day
To be solved for a standard fee—
And my bank account will soon amount
To £X to the nth degree.

So 'Circuit Sam' took his half-built kits
To see what he could use
And from a surplus bench supply
He took the quick-rise fuse.

His darkroom timer came to hand
And yielded L.E.D.'s,
And his signal tracer traced no more
When he took its F.E.T.'s.

Thus bit by bit, through every kit,
'C. Sam' a-scrounging came,
And he acted rash in his headlong dash
To build that robot brain.

He ravished all his cherished gear
With a mind too fixed to change
For he'd promised himself that
future wealth
Would replace the entire range.

Then night and day for a month or two
He worked at his Euroboard
And the network grew with 'and', 'go-to',
Till all human knowledge was stored.

When the data banks, in serried ranks,
Were 'bursting at the seams'
Old 'Circuit Sam' gave heartfelt thanks,
Having realised his dreams.

On the final day, in a mood quite gay,
Sam pressed the action switch
And the lights came on and the
motors whirred
And the touch pads gave a twitch.

When the current reached its
working point
The synthesizer spoke
And it said, "Dear Sam, for my
starting plan,
You're just the very bloke."

"I find your feedback systems work
With an ease that sets you free
And I know the thought will not please
you, but I think
They'd just suit me."

"So I've searched around in my data banks
For the skill to set me free
And I've found it now, and to you
my thanks—
It is transplant surgery."

Terrence Lee

DOWN TO EARTH

BY GEORGE HYLTON

Designing A Simple A.M. Radio

A READER enquired recently about designing the tuning circuits for a simple radio. What he had in mind was a type of A.M. radio receiver which is just one step up from a crystal set.

In the days of germanium transistors a very simple circuit (Fig. 1) was often used. Here the transistor TR1 acts as a combined detector and audio amplifier. The circuit works only with strong signals, which means that the user must live close to a transmitter and must attach a long enough aerial to the receiver.

The transistor is operated without bias and to turn it on a peak signal voltage of about 100mV is required. Signals much smaller than this have no effect.

With modern silicon transistors the circuit as it stands is virtually unusable, because the turn-on voltage for silicon is about 500mV and only very strong signals are detectable.

For this reason, when silicon transistors are used in place of germanium the circuit has to be modified to provide enough d.c. bias to turn on the transistor slightly all the time. The arrival of a signal then turns it on more (on positive half cycles if it is the usual *npn* silicon type) or less (on the opposite half cycles).

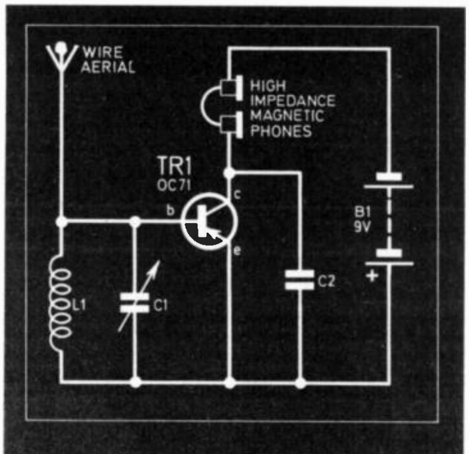


Fig. 1. A simple receiver based on a single germanium transistor.

This detects the signal and gives an audio output to the sensitive old-fashioned magnetic earphones, which are of the high-impedance (1 kilohms up) type used with crystal sets. Reception of signals of a few tens of millivolts is then possible.

Damping

This type of circuit is neither sensitive nor selective. In view of the fact that only one transistor and one tuned circuit are used this may not be surprising. However, the performance is even worse than these limitations imply.

The reason lies in the way in which the transistor reacts upon the tuned circuit. A parallel *LC* circuit like this behaves as an inductance at low frequencies, a capacitance at high frequencies and a resistance at its resonant frequency.

This resistance—called the dynamic resistance to distinguish it from the static resistance of the wire in the coil—can be quite high. For a typical medium-wave circuit with an inductance (L1) of around 200µH the dynamic resistance at 1MHz is of the order of 100 kilohms.

Selectivity arises from the fact that the impedance changes very rapidly near resonance, falling off as the frequency moves away from the resonant frequency.

To obtain full selectivity the *LC* circuit must be used to couple the aerial to the transistor in such a way that as much as possible of this rapid variation of impedance is preserved. The amount of signal passed on must be made to vary in sympathy with the variation of impedance.

The Fig. 1 type of circuit does not act in this optimum way. As a result selectivity is lost. Look at it this way. The transistor has an input resistance. This is connected across the tuned circuit (L1, C1), in parallel. Now, two resistances in parallel always come to less than either resistance alone. If the input resistance of the transistor is 1 kilohm then the combination of it and the dynamic *LC* resistance cannot exceed 1 kilohm. So instead of the net impedance rising to a sharp peak of 100 kilohms at resonance it climbs gently to a much flattened one of less than 1 kilohm. The *LC* circuit is *damped* by the transistor and selectivity is much reduced. It is further reduced by the long aerial which also has a damping effect.

Matching

The textbook answer to the damping problem is matching. By using transformer techniques (Fig. 2) energy can be transferred from aerial to tuned circuit and from tuned circuit to transistor with the greatest efficiency. It is just a matter of putting the best number of turns on the coupling windings L2 and L3.

Unfortunately L3 needs a much smaller number of turns than L1, which means that much less signal voltage is applied to the base of the transistor than appears across the tuned winding L1. This step-down in voltage makes for poor detection.

So although Fig. 2 is an advance on Fig. 1 as far as selectivity goes it is not much use from the point of view of sensitivity.

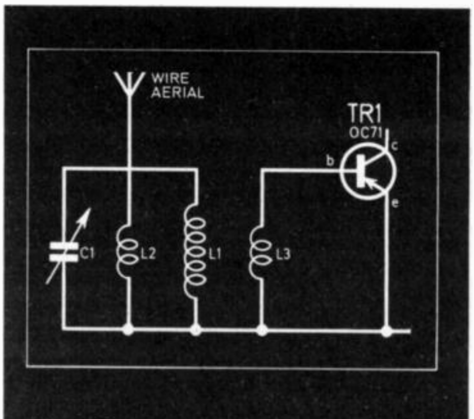
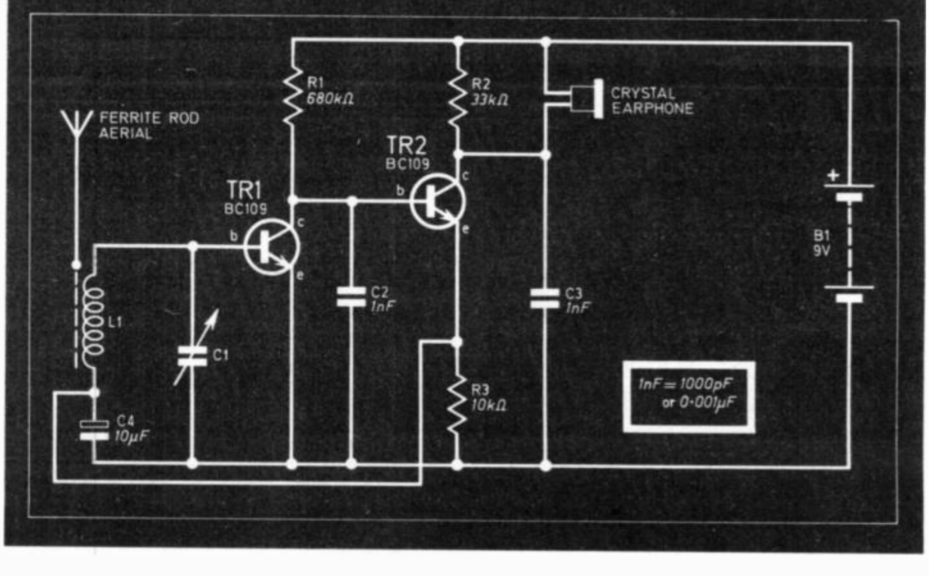


Fig. 2. Matching between aerial and tuned circuit (C1, L1) and between the latter and the transistor is delivered by transformer action. This results in efficient transference of energy.

Fig. 3. A two-stage receiver using silicon transistors. Note the ferrite rod aerial.



Transistor Input Impedance

What is needed is some means of applying the maximum possible voltage to the detector transistor (to obtain the best detection efficiency) while at the same time minimising damping.

With modern silicon transistors one option remains. By operating the detector transistor at a very low collector current its input resistance can be raised from the usual few thousand ohms to hundreds of thousands of ohms. The tuned circuit can then be connected directly to the transistor, maximising the signal voltage.

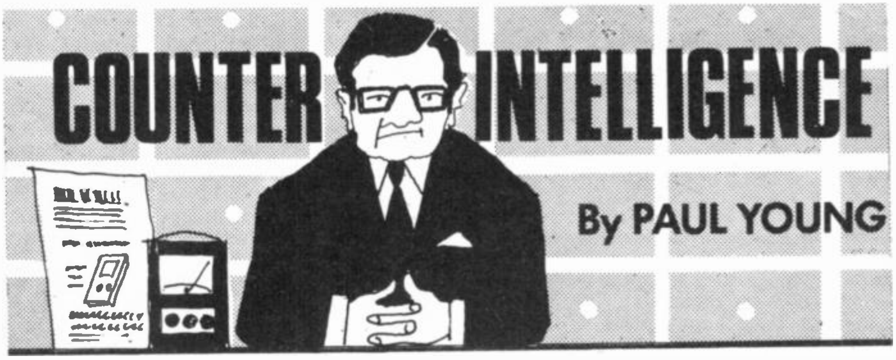
The input resistance in kilohms is roughly equal to 25 times the current amplification (hfe) divided by the emitter current in microamperes. If a transistor is operated at an emitter current of $10\mu A$ and at that current has an amplification of 100 at the relevant frequency (say 1MHz) then its input resistance is 250 kilohms, which is satisfactory.

Practical Circuit

Unfortunately, a transistor operated at $10\mu A$ can deliver very little audio output current. So a second stage must be added. Fig. 3 is a convenient arrangement which sets the current in TR1 automatically to the correct value.

Aerial

In some locations, a ferrite rod carrying L1 will give local-station reception. An outside aerial will certainly pull in more stations but will reveal the limited selectivity of a single tuned circuit. The traditional answer to that problem is to apply positive feedback. But that's a topic for a separate Down to Earth.



COUNTER INTELLIGENCE

By PAUL YOUNG

Off Day

I expect, dear reader, like me, you have your off days. By ten in the morning you are saying, "This is not my Day" and by four in the afternoon, you are saying, "It's a pity I didn't stop in bed all day".

A few weeks ago, in the middle of the cold snap I had such a day. Neither my car nor my wife's car would start and I suspected the battery. I removed it and placed it by the battery charger.

My only excuse for what happened next, is that I was cold and in a hurry. Wait for it!! That Electronic Wizard, Paul Young, connected positive to negative, and negative to positive. The result was spectacular!

Although I whipped the leads off in a flash, when I came to assess the damage, I found that I had burnt out the transformer, blown up the rectifier and burnt out the meter. You have to admit, that when old Paul Young blunders, he makes a thorough job of it. Anyway the steel case is still perfect!

Before I am asked why the fuse didn't blow, I will tell you. The fuse was in the battery lead. The battery leads were rather long, and in order to get a better charge I shortened them, and cut out the fuse!

Capacitor Kit

A few years ago we designed a resistor kit which has proved very popular with constructors, giving them a good selection of preferred values over the whole range. What I have always wanted to do, is to offer a complimentary kit of fixed capacitors.

This is obviously much more difficult as there are the additional problems of size and voltage. All that is certain, is that in the small values (1 picafarad to 1000 picafarad) you have a choice of, silver mica, polystyrene, or ceramic.

In the middle range (1000 picafarad to 1 microfarad) you have paper, polyester, or mixed dielectric and in the high range you can have electrolytic or tantalum. I am determined to try and produce packs, but I would particularly welcome advice from readers, as to what they think, in their opinion, is required.

Some time ago I mentioned that my wife suffers with stomach pains during thunderstorms, and our readers, helpful as usual, made some useful suggestions. After sifting through all the information, the most likely cause seemed to be that thunderstorms produce an excess of ions in the atmosphere.

I thought the answer might be to make an Ioniser to produce negative ions. I purchased a kit from Tom Powell who is a regular advertiser in Everyday Electronics. It was very easy to make and at £16 approximately, shows a considerable saving over the commercially built ones which are nearer £50.

As to the results of my wife, we haven't proved conclusively yet how effective it is, but she did say it made the air seem much fresher and breathing much easier. I have since learned that Barts and other medically establishments find Ionisers very beneficial in cases of asthma, although a friend of mine who is a sufferer, says they do not work in all cases.

Good Citizens

In my last article, I made a brief mention of Citizen Band Radio and said I thought the idea an excellent one especially for the sick, the old and the bedridden.

I was reminded of this today, when an old friend of mine said that CB radio had been a flop in this country. I expressed my surprise and gave my reasons. He agreed with me; not only had he bought one, but it was the finest investment he had ever made.

I asked him to elaborate, which he did. Jack lost his wife a few months ago and is naturally very lonely. By means of his CB radio he has gained many friends, as there is a wonderful cameraderie sprung up between CB users.

He gave me two specific examples. A few days before Christmas he was chatting to a CB'er who asked him his plans for Christmas day. Jack, with his customary humour, said he would stick a piece of mistletoe into his sausage and consume it in lonely splendour.

"We will soon see about that" said his CB friend. "Be ready at noon, you are having lunch with me and my family." They came and fetched him, gave him a splendid lunch, and later in the day ran him home.

Another time he mentioned that his eye was troubling him, and he had to get to Moorfields Hospital. Fifteen minutes later, a car drew up at his door and another CB friend ran him up to Moorfields, waited an hour while he received treatment, and then returned him safely home.

The marvellous thing was, that all these people were comparative strangers to Jack. The last time I wrote, I gave CB radio a pat on the back. I can see now I underestimated its real value and did not do it justice. This is an attempt to make amends.

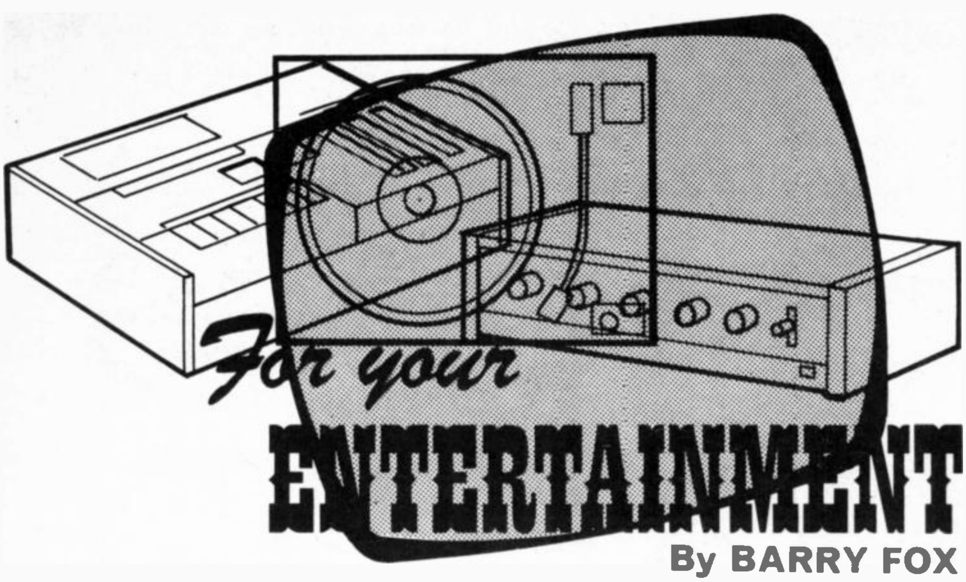
BRIGHT IDEAS

CAPACITOR MEASUREMENT

To measure the value of capacitors greater than about $1\mu F$ using a standard multimeter, select a high resistance range, apply the leads to the capacitor (for electrolytics the black terminal is positive), and note the pointer's greatest initial swing.

Calibrate with a few known capacitors and either tabulate μF against resistance, or plot a graph. This will be a straight line if "log-log" graph paper is used.

D. Marshall,
Loughborough,
Leics



For your ENTERTAINMENT

By BARRY FOX

Bond of Honour

Electronics firms, especially in Japan, are very secretive over their semiconductor factories. Although the basic techniques for producing chip circuits are well known, each firm has its own special know-how which is a guarded secret.

The Japanese firm Matsushita, makers of National Panasonic and Technics equipment, has a large semiconductor plant in the Japanese town of Nagaoka. Recently, and for the first time ever, they allowed a party of journalists to look round the production facilities.

Mitsushita's interest in semiconductors dates back to 1952 when the company signed a "technical" co-operation agreement with Philips of Eindhoven.

The agreement still stands firm. Philips still sell Matsushita electronic components in Europe under the Philips brand-name and still have a 35 per cent share in the Matsushita Electronics Corporation.

The commercial link between MEC and Philips has often been misinterpreted. "Philips own 35 per cent of Matsushita" was a recent headline. The truth is that although MEC is a large company, it's still just a small part of the vast Matsushita empire, which is now the largest consumer electronics conglomerate in the world.

The Matsushita-Philips link has had far reaching implications in Europe. As part of the original agreement of 30 years ago Matsushita gave an undertaking not to export any raw TV tubes to Europe. So the only way that a Matsushita tube comes to Europe is inside a completed TV set or computer terminal.

This has clearly been a serious commercial handicap to Matsushita who make 5·5 million colour TV tubes a year. It has also been a hidden shield for the European electronics industry. Perhaps most important of all it underlines how seriously the Japanese take a business undertaking; once given, it is always honoured.

Developments

Although no cameras were allowed inside the Nagaoka plant, and all the work is done in clean atmosphere rooms behind glass windows, it was possible to pick up some valuable information. VLSI products are now routinely made using a 2 or 3 micron rule scale. But two electron beam machines can draw masks to a rule below 1 micron. This is enabling Matsushita to integrate the digital/analog conversion circuitry needed for digital tape and disc recording onto a handful of chips each around 6mm square and each containing the equivalent of 15,000 circuit elements.

They have also developed a gallium-arsenide solid state laser for use in a digital disc player. This has a cost of only a few tens of dollars and a life of 50,000 hours.

Production Techniques

The Nagaoka factory introduced a new technique for chip production in 1980. The raw silicon slices are loaded by the dozen into a cartridge like a slide magazine. Normally the slices are 4inch diameter wafers, but for test purposes smaller (3 inch) wafers are used. Operators only handle the cartridges, never the wafers.

After the wafers have been coated with photo-resist material they are optically exposed to the image of the solid state circuit to be made. The coating is photographically developed and the wafer put through etching, washing, diffusion and ion-implant processes.

Apart from the manual transport of the cartridges between machines, everything is automatic. The wafers are lifted from the cartridges by robot hands at each process stage.

The completed wafers, with hundreds of individual i.c. circuits spread as a mosaic over the surface, are then 100 per cent tested. Testing is automatic by tiny probes which are pushed down onto the wafer surface to make contact.

Testing

There are two tests, first a d.c. parameter test and then a dynamic function test where the chip is electrically "inserted" into the actual circuit in which it will finally have to function.

It takes 18 seconds per chip to conduct 34 dynamic test functions. Although lengthy this, totally automated, process ensures that every single circuit is 100 per cent checked. Those circuits on the wafer which are found faulty are marked with a black dot.

The wafers are now passed to another machine which automatically scores lines between the several hundred individual devices on each wafer slice and breaks it into individual chips.

A television microscope shows what is going on at the chip surface. The wire bonder moves so fast that it is almost invisible. It takes only around 5 seconds to bond all the wires and connections to each chip.

Location of the chip with the bonding machine is automatic, using *X* marks for optical centring Optical sensing also enables the machine to ignore any chip from the wafer surface which is marked with a black dot, signifying faulty.

To give some idea of the scale of the operation I counted around 200 automatic bonding machines, all in action, spaced along a corridor nearly 100 metres long.

Not surprisingly Matsushita aren't willing to discuss yield and failure rates. They say "yield is high" but add that the fault rate at the edges of each wafer is around 75 per cent whereas the success rate at the centre is around 75 per cent.

The Nagaoka plant has an astonishing output: 6·5 million LSIs a month, 25 million i.c.s, 170 million silicon transistors, 130 million diodes, 35 million l.e.d.s and 6 million silicon power transistors. Remember these are monthly figures!

Computer Designed

The most astonishing sight is the Computer Aided Design of the masks. Each individual chip circuit (of which there are several hundred on each silicon wafer) starts life as a photographic replica of the circuit which is then etched into physical reality by the photo resist technique.

Clearly it's impractical to make the mask as small as the final circuit. Instead the mask is made large and optically beamed onto the wafer in reduced size, like looking through the wrong end of a telescope.

Until recently MEC were using masks 300 times the size of the final chip circuit, but have now gone to masks 2,400 times the chip size. Up to 14 masks can be used for each chip, one exposed after the other.

This is where Computer Aided Design comes in. As MEC puts it "humans can't cope with the problem". The circuit is "drawn", stage by stage, by keying instructions into a computer terminal.

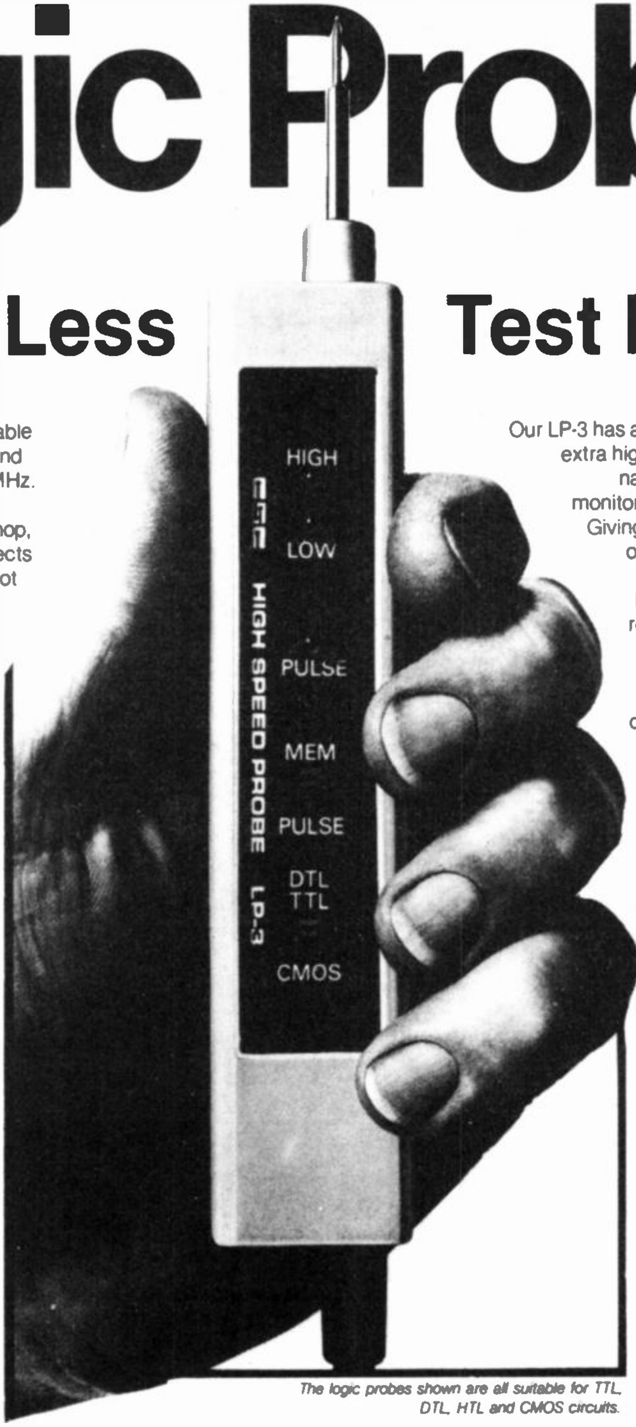
The terminal screen shows how the components will lie, and simple keyboard commands replace one component with another, alter spacing or alter connections between components and so on. The final circuit can then be automatically drawn, on a giant sheet of tracing paper (2½ metres square), by a robot head which holds four different colour pencils and moves under computer control.

It seems that Matsushita is drawing onto tracing paper only as a visual check. The photo mask is directly created by feeding digital data down a line from the CAD computer and into a mask making machine. Details were secret but presumably the data controls the movement of a laser or electron beam to "draw" the mask onto film.

Bearing in mind it was the first time MEC had allowed outsiders into the Nagaoka factory, it was a revealing experience. As I left I was bothered by a nagging thought. If this is what they are prepared to show me, what is happening in those parts of the factory which aren't on view?

The Logic Probes

Spend Less Test More



LP-1 Logic Probe

The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transistions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices. All for less than the price of a DVM

£31.00*

○Model LP 3 illustrated

LP-2 Logic Probe

The LP-2 performs the same basic functions as the LP-1, but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers.
(Available in kit form LPK-1 £12.50)

£18.00*

○Model LP 3 illustrated

**price excluding P.&P. and 15% VAT·*

LP-3 Logic Probe

Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at 1/1000th the cost. LP-3 captures one shot or low-rep-events all-but-impossible to detect any other way. All without the weight, bulk, inconvenience and power consumption of conventional methods.

£49.00*

○Model LP 3 illustrated

The New Pulser DP-1

The Digital Pulser: another new idea from G.S.C. The DP-1 registers the polarity of any pin, pad or component and then, when you touch the 'PULSE' button, delivers a single no-bounce pulse to swing the logic state the other way. Or if you hold the button down for more than a second, the DP-1 shoots out pulse after pulse at 1000 Hz. The single LED blinks for each single pulse, or glows during a pulse train. If your circuit is a very fast one, you can open the clock line and take it through its function step by step, at single pulse rate or at 100 per second. Clever! And at a very reasonable price. **£51.00***

○Model LP-3 illustrated

The logic probes shown are all suitable for TTL, DTL, HTL and CMOS circuits.

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SQUARE one FOR BEGINNERS

PERHAPS the humble switch is the most basic electronic component of all; a mechanical device for interrupting the flow of an electric current in a circuit. The most obvious example being the on/off switch fitted to almost all domestic appliances, and this simply connects or disconnects the mains to the equipment.

Modern technology has evolved a range of electronic, semiconductor and even magnetic switches but here we shall restrict discussion to the mechanical switch, to make or break the flow of electricity between the contacts.

SWITCH CONFIGURATIONS

The simplest form of switch is the *Single Pole Single Throw* (abbreviated to s.p.s.t.) and as the name suggests, this type has a single "pole" along with one other terminal, connection being made betweeen the two when the switch is operated.

The next configuration to look at is the *Single Pole Double Throw* switch (abbrieviated to s.p.d.t.), and once again this type has only one "pole" but with two other terminals and activating this type will switch the current flowing through the pole from one terminal to the other. For this reason it is also known as a *Single Pole Change-Over* switch.

DOUBLE POLE SWITCHES

The *Double Pole Single Throw* switch (d.p.s.t.) is really two on/off type switches in the same package and activated simultaneously by the same mechanism. That is, they are mechanically linked but electrically isolated from each other.

In similar fashion, the *Double Pole Double Throw* (d.p.d.t. switch is in fact two change-over switches mechanically linked and operated by the same mechanism. Once again the two halves of the d.p.d.t. switch are electrically isolated from one another. Also referred to as a *double pole change-over* switch.

LATCHING ACTION

A latched switch is one which, having been operated, will stay in that state until it is operated again.

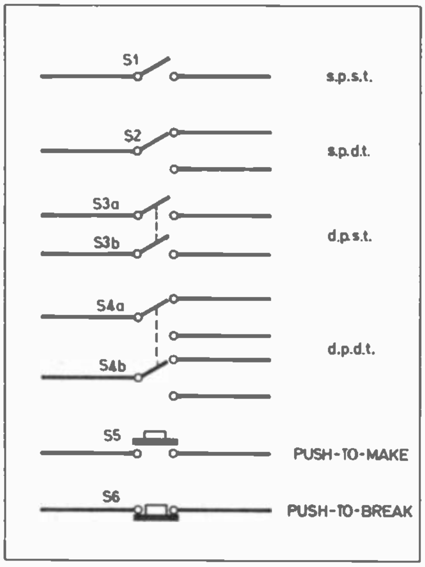
However, not all switches are latching, an alternative type being the non-latching or momentary action switch. In this case, the switch will change its state when depressed but return to its original state when the actuating force is removed.

Miniature push-button switches are examples of non-latching switches and can be broken down into a further two catagories: the *push-to-make* switch, being off in the natural state and switching on when pressed (also described as having *normally open* contacts); and the *push-to-break* switch, being on in the normal state and switching off when pressed (said to have *normally closed* contacts).

LEVER SWITCHES

Probably the most familiar switch is the lever or toggle switch which uses a pear shaped metal lever (or "dolly") to activate it and the mechanism is completely enclosed in a black moulded housing with only the solder tags exposed.

Incidentally, the non-latching version of this type is often described as a *biased toggle* switch.



PUSH BUTTONS

The miniature push-button switch, mentioned previously, is usually a small cylindrical device with a sprung-loaded round button to activate it.

A more complex push-button switch is the latching, modular type that, with the aid of an interlocking bar and mounting bracket, can be made up into a bank of switches like those used for input selection on hi-fi amplifiers, operating so that actuating one switch will cancel any other switch that is actuated at that time. Each switch can have two, four or six sets of change-over contacts and are a little more expensive with the additional cost of the interlocking hardware and the clip-on buttons.

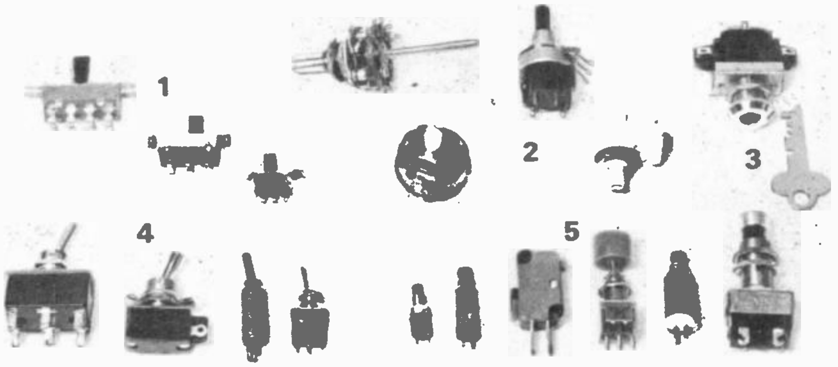
OTHER SWITCHES

Another modular switch system is the rotary wafer switch, consisting of a rotating switch mechanism onto the spindle of which is placed wafer switch elements, the maximum number of positions usually being twelve. The pole of the switch element is connected to a wiper contact which sweeps around the wafer as the switch is rotated thus making contact with the terminals of the switch. Each position is latched and an adjustable stop enables the switch to be custom designed for any number of "ways".

The microswitch is a useful device to understand, usually being a single pole change-over switch operated by a very small push-button and requiring very little actuating force.

This type of switch is frequently used to indicate the presence of something, for example, an open door operating the switch (ideal for burglar alarms).

Fig.1. (left) The circuit symbols of the four basic switch configurations plus the two types of push-button switch. Photograph (below) showing groups of various types of switch, including: (1) slide switches; (2) rotary switches, including the wafer type; (3) key operated on/off switch; (4) toggle switches ranging from a large d.p.d.t. to a miniature s.p.d.t. and (5) push-button switches, including a microswitch, third from left, and a latching type, extreme right.



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

On the Shelf

The latest Piccolo from Revox is not a new musical instrument, but a new loudspeaker enclosure just introduced to their range of audio equipment.

With a front panel measuring only 220mm × 140mm, the Piccolo is designed for sitting on the bookshelf. The enclosure contains a bass/mid-range driver and a dome tweeter loudspeaker.

With a claimed frequency response of 80Hz to 22kHz ±3dB, the Piccolo will handle up to 35W and retails at £90 plus VAT per pair.

F. W. O. Bauch Ltd, Dept EE, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ.

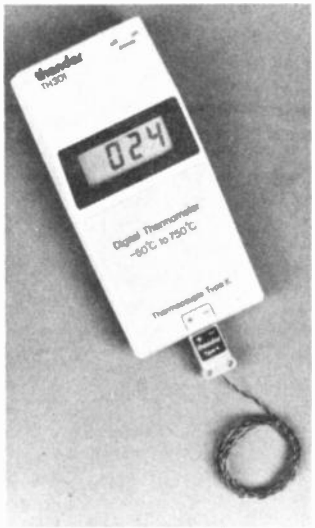
DIGITAL THERMOMETER

A hand-held digital thermometer has just recently been launched onto the market by Sinclair Electronics.

Marketed under the brand name of Thandar, the TH301 features a large l.c.d. read-out display and covers a temperature range of −50 to 750°C, with a 1°C resolution. It is claimed that by using the latest technology, over 1,000 hours of battery life is obtainable.

A range of thermocouples are offered as optional extras and include mineral filled, hypodermic, right angle and surface thermocouples.

The Thandar TH301 Digital Thermometer costs £59·50 plus VAT and is supplied with battery and fast response bead thermocouple.



Sinclair Electronics Ltd, Dept EE, London Road, St Ives, Huntingdon, Cambs PE17 4HJ.

A Good Case

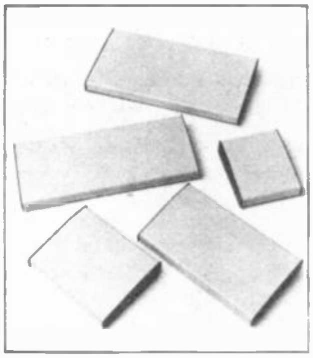
A new range of low profile consoles have recently been marketed by Boss Industrial Mouldings.

The sloping fronts on the BIM 2600 make them ideally suited for applications where meters, keyboards and switches have to be easily visible to the eye.

Ranging in size from 178mm × 261mm with an overall height of 51mm, the cases are of two piece, all aluminium, construction in which the whole unit is held together by screws running through base rubber feet into hank bushes.

The standard colour scheme for the cases is brown base and beige top panels. Alternative colours, together with special vent slots or cutouts, are available at extra cost.

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



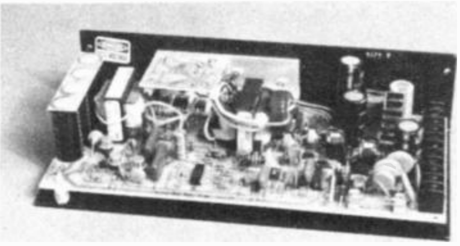
NEW POWER

As part of a new expansion programme, and to introduce a new range of power supplies, BICC-Vero Electronics have created a new division within the company which will trade under the name of BICC-Vero Distribution, Power Conversion Division.

As such, the Power Conversion Division will become sole UK distributor of the Boschert range of switched power supplies. The company will also act as master supplier to the Boschert distribution network within Europe and Scandinavia.

Based in Silicon Valley, Boschert Inc became a BICC company in 1981. They are an acknowledged leader in switched mode power supply technology, particularly in the field of open frame units. Products range from 25 watts to 400 watts, with accent on reliability.

BICC-Vero Distribution Ltd, Power Conversion Division, Dept EE, Stansted Road, Boyatt Wood Industrial Estate, Eastleigh, Hants.



POCKET MICROSCOPE

A pocket microscope, which may be useful for checking for possible "shorts" between copper tracks on p.c.b.s and stripboards, is now being marketed by Stotron.

With a 20 times magnification, the Scope Mark-III is just 125mm long and has a graticule showing linear and angular measurements. Illumination is from standard 1·5V penlight batteries.

A micro-stand, with spring clips for sample slides, is available as an option so that the device can be used like a conventional microscope.

The recommended retail price, with stand, is expected to be under £20.

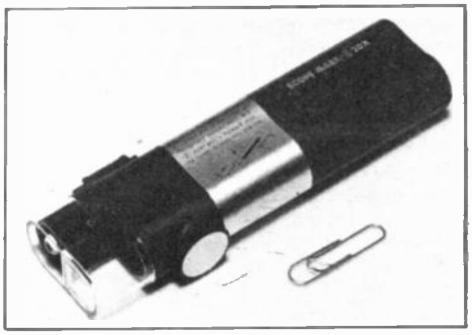
Stotron Ltd, Unit 1, Dept EE, Haywood Way, Ivyhouse Lane, Hastings, East Sussex.

HOOKED

A newly formed company, I & J Products, has taken over the UK franchise for the popular EZ Hook test probes.

The range originated with a single test probe, and has advanced to DIP testers and p.c.b. probes.

I & J Products Ltd, Dept EE, Kingsbury House, 7a Christchurch Road, Ringwood, Hants



CIRCUIT EXCHANGE

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

Payment is made for all circuits published in this feature.

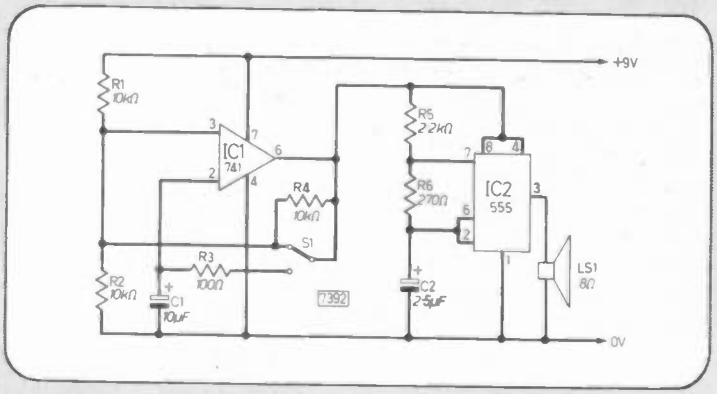
Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

AUDIBLE HEADS OR TAILS

This circuit was built as a binary decision maker, using the 741 op-amp. It is connected as an astable with an equal mark/space ratio when microswitch S1 is depressed. When S1 is released pin 6 of IC1 goes high or low depending on logic state at the moment of release.

The timer chip, IC2, is connected as an astable multivibrator and with S1 depressed generates a high frequency note in LS1. When S1 is released it will either switch to a low tone or go off altogether.

* M. Warren,
Lewes,
East Sussex.



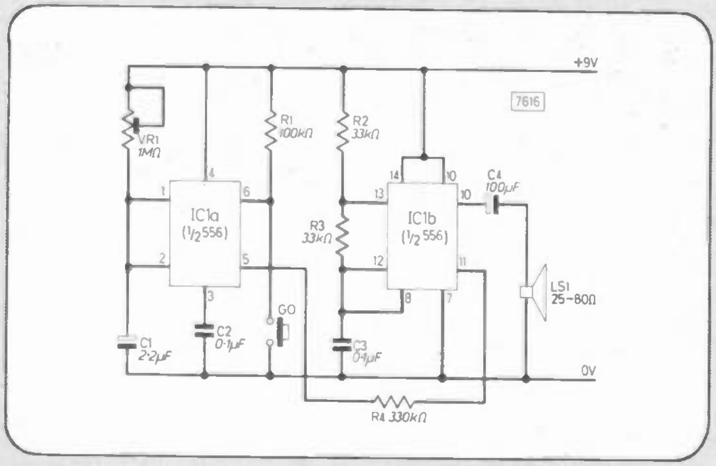
** Please let us have your full address.*

"TWO-SECOND-RULE" TIMER

This simple timer was designed as a safety aid to car drivers. The prototype has been successfully used for some time. It is based on the well-known two-second-rule safety factor.

This method of use is simple, but it may well prove to be a lifesaver. A landmark is chosen, such as a bridge or a motorway signal. As soon as the bonnet of the car in front of you reaches the mark the "go" button is depressed. The tone produced immediately changes. If your car bonnet reaches the mark before the tone reverts to normal you are too close to the car in front and should drop back. When not in use the device produces a continuous tone to remind you to switch it off.

Half of a 556 dual timer is used as a monostable while the other half is used as an astable. The frequency of the astable may be altered by applying a voltage to pin 11. When the "go" button is depressed the monostable produces an output whose duration is dependent on the value of C1 and VR1. This output modulates the frequency of the astable.



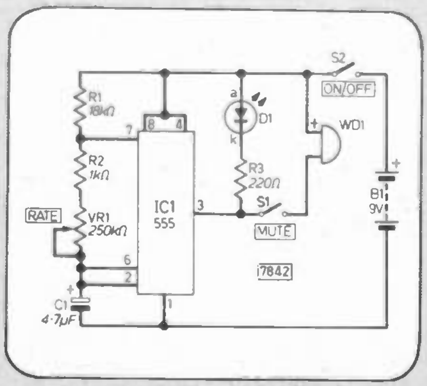
When initially setting the timer, VR1 should be adjusted to give a 2 second tone change when the "go" button is depressed.

Chris Sinclair,
Hull,
N. Humberside.

ELECTRONIC METRONOME

This circuit is for a simple electronic metronome. It is based on a 555 timer i.c. wired as an astable multivibrator. The component values have been chosen to give a set of pulse rates from about 30 to 220 beats per minute. D1 is a l.e.d. and its brightness is controlled by R3. WD1 is a 6V solid state buzzer which can be muted by opening S1. The unit is calibrated with a stopwatch by counting the pulses in one minute.

Andrew White,
Formby, Liverpool



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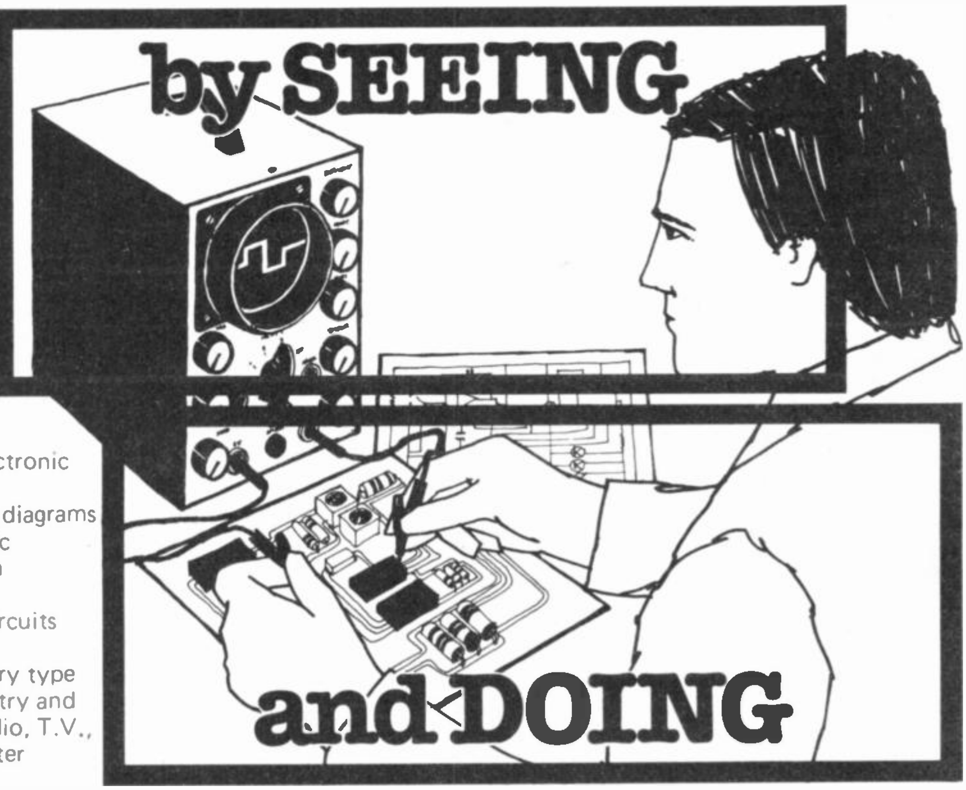

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Sinclair ZX81 Personal Comp the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
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- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

uter-

Available now- the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you can plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST, Camberley, Surrey, GU15 3BR.

Qty	Item	Code	Item price £	Order Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

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74LS76	30p
74LS85	80p
74LS86	38p
74LS90	44p
74LS92	59p
74LS93	57p
74LS107	40p
74LS112	38p
74LS123	82p
74LS125	45p
74LS126	42p
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74LS136	42p
74LS137	110p
74LS138	45p
74LS139	70p
74LS145	120p
74LS148	165p
74LS151	77p
74LS153	77p
74LS155	94p
74LS156	94p
74LS157	60p
74LS161	78p
74LS163	90p
74LS164	90p
74LS165	75p
74LS166	165p
74LS173	100p
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74LS175	94p
74LS191	90p
74LS193	90p
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Teach-in 82! Bulk purchase of components so prices reduced List 1 and 2. Now £22·50 List 3 £6·35 list 1, 2, & 3 £27·50.

Reprints of above kits 40p + S.A.E. Teach-in Reprints 40p each from October 1981.

Mains Ioniser Kit includes parts & Drilled Case £19·00

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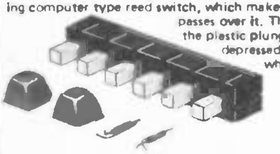
COMPUTER KEY SWITCHES (make your own keyboard)



These are for making up on a p.c.b. and consist of a vertical mounting computer type reed switch, which makes circuit when a magnet passes over it. The magnet is located in the plastic plunger which in turn is depressed by a push rod, to which the legended top is fixed. These are made up in banks of 6, price £2.30 per bank of 6 (including tops)

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage whichever suits you best. Price £12.50 + £3.00 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1.85. Suitable 80ohm earpiece 69p.

COMPUTER PRINTER FOR ONLY £6.95

Japanese made Epson 310 — has a self-starting, brushless, transistorised d.c. motor to drive the print hammers, print drum — tape forward/reverse and paper feed.
Complete in module form with electronics including Printer Synchro Signal Amplifier & Printer Reset Signal Amplifier. Brand new and with technical data. £6.95 + £1.35 post. Data separately for £1.00.

SUPER HI-FI SPEAKER CABINETS

Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

GOODMANS SPEAKERS

6½" 8 ohm 25 watt £4.50. 2½" 8 ohm tweeter. £2.50. No extra for postage if ordered with cabinets. Xover £1.50.

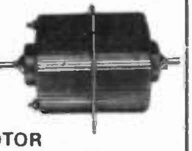
VU METER SNIP

Approximately 1 5/8" square, suitable for use as a recording level meter power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1,00 or 10 for £9.00.

MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

12v MOTOR BY SMITHS



Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45.
Ditto, but double ended £4.25.

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post.

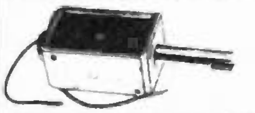
THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 — 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 — however, you can have the parcel for £2.50.

UNIVAC KEYBOARD BARGAIN

50 keys, together with 5 miniature toggle switches all mounted on a p.c.b. together with 12 i.c.'s, many transistors and other parts.
£13 50 + £2.00 post.
This is far less than the value of the switches alone. Diagram of this keyboard is available separately for £1.

SOLENOID WITH PLUNGER



Mains operated £1.99
10 — 12 volts DC operated £1.50.

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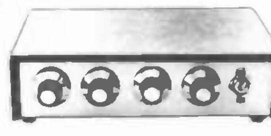
MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post.
FREE GIFT — buy this month and you will receive a pair of Goodman's eliptical 8"x 5" speakers to match this amplifier.

3 CHANNEL SOUND TO LIGHT KIT



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 snip price is £14.95 in kit form or £25.00 assembled and tested.

FIVE UNUSUAL SWITCHES
For inventors, experimenters, service engineers, students or in fact anyone interested in making electrical gadgets. The parcel contains: — delay switch — motor driven switch — two-way and off switch — polarity changing switch — and humidity switch. Our regular price for these switches bought separately is over £10, but this month you can have the 5 for £2.50.

THIS MONTH'S SNIP

IONISER — AIR FRESHENER

Headaches, tiredness and that "Thundery Weather Feeling" — Scientist's say are caused by an excess of positive ions, they also say that heaters and other modern aids can cause this ion unbalance. The answer is a negative ion generator or ioniser — this mains operated device will fill your home, office or workshop with a refreshing breeze neg. ions, which you will find both stimulating and invigorating. Complete kit in neat sturdy plastic case. £14.95.

SPIT MOTORS

These are powerful mains operated induction motors with gear box attached. The final shaft is a ½" rod with square hole, so you have alternative couplingmethods — final speed is approx. 5 revs/min, price £5.50. — Similar motors with final speeds of 80, 100, 160 & 200r.p.m. same price.

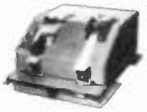
EXTRACTOR FAN

Mains operated — ex. computer.
5" Woods extractor £5.95. Post £1.50
5" Plannair extractor £6.50. Post £1.25
4" x 4" Muffin 115v. £4.50. Post 75p.
4" x 4" Muffin 230v. £5.75. Post 75p.

8 POWERFUL BATTERY MOTORS

For models, maccanos, drills, remote control planes, boats, etc. £2.95.

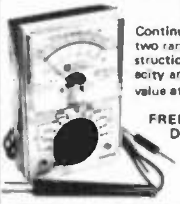
TAPE PUNCH & READER



For controlling machine tools, etc, motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. £17.50 pair. Post £4.00.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 — 100 mA.



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 60p post and insurance.

FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30. (not licenceable in the U.K.)

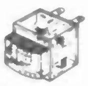
RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit. (not licenceable in the U.K.).

FM RECEIVER

Made up and working, complete with scale and pointer needs only a headphone, ideal for use with our surveillance transmitter or radio mike. £5.85.

LEVEL METER



Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. 75p.

POCKET AUDIO COMPONENT TESTER

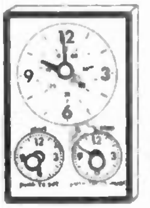
With it you can quickly test diodes, rectifiers, transistors, capacitors, check wiring and p.c. boards for open circuits, find the anode and cathode of a diode or rectifier and whether a transistor is PNP or NPN, which are the base collector and emitter connections. Condensers, if bad, give a continuous signal, but if good, give intermittent signals of varying length depending on their value. The test current is very low (2uA) and the voltage only 1.4V, so it is also possible to check MOS devices, as well as sensitive transistors without fear of damaging them. The unit is supplied complete with internal battery, which should last many months. Price £3.45.

VENNER TIME SWITCH

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. These are without case but we can supply a plastic base £1.75 or metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controllerfor the immersion heater. Price of adaptor kit is £2.30.

STEREO HEADPHONES

Very good quality, 8 ohm impedance, padded, terminating with standard ¼" jack-plug £2.99 post 60p.



TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs. £2.50.

DELAY SWITCH

Mains operated — delay can be accuretely set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps — second contact opens a few minutes after 1st contact. £1.95.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

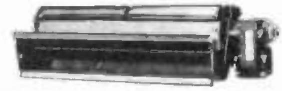
MEDIUM & 2 SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the aerial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2.30

MUGGER DETERRENT
A high-note bieeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

TANGENTIAL BLOW HEATER



2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.

12V SUBMERSIBLE PUMP

Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £9.50.

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20kΩ/V d.c.
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mini 20

The Mini 20 is an ideal instrument for the constructor.

This special offer is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £10 on the normal retail price.

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12/24V RANGE PRI 220/240V
SEC 0 12V 0V 12V

TYPE	AMPS		PRICE	P/P
	12v	24v	£	£
213	1	0·50	2·65	0·94
71	2	1	2·77	1·20
18	4	2	3·98	1·57
68	3	1·5	3·46	1·57
85	5	2·5	6·06	1·57
70	6	3	6·67	1·57
108	8	4	8·03	1·57
116	12	6	9·31	2·10
17	16	8	11·46	2·25
187	30	15	19·23	2·50
232	40	20	27·01	5·00

30/60V RANGE PRI 120/220/240V
SEC
VOLTS 6 — 30 — 0 — 30

TYPE	AMPS		PRICE	P/P
	30v	60v	£	£
124	1	0·5	3·30	1·57
126	2	1	6·36	1·57
127	4	2	7·86	1·90
125	6	3	11·78	2·10
123	8	4	14·72	2·40
40	10	5	17·10	2·40
120	12	6	19·44	2·55
121	16	8	27·70	2·90
122	20	10	32·05	4·50
189	24	12	37·02	5·50

AUTOTRANSFORMERS 240/220 – 115V
65VA – 10KVA
0V 115V 220V 240V

TYPE	VA	PRICE	P/P
		£	£
25	65	3·90	1·20
64	80	4·82	1·20
4	150	6·21	1·57
69	250	7·54	1·57
53	350	9·73	2·10
67	500	11·70	2·40
83	750	13·51	2·25
84	1000	18·31	2·55
95	2KVA	34·36	5·50
73	3	64·74	5·50
57	5	97·85	7·00
101	10	179·05	10·50

15/30V RANGE PRI 220/240V
SEC

TYPE	AMPS		PRICE	P/P
	15v	30v	£	£
112	1	0·50	2·84	1·20
79	2	1	3·29	1·20
3	4	2	6·18	1·57
20	6	3	7·19	1·90
21	8	4	8·52	1·90
51	10	5	10·57	2·10
117	12	6	11·94	2·25
88	16	8	18·14	2·40
89	20	10	18·54	2·55
90	24	12	20·57	2·80
91	30	15	23·63	2·90
92	40	20	33·21	5·00

48/96V RANGE PRI 120/220/240V
SEC
VOLTS 12 — 48 — 0 — 48

TYPE	AMPS		PRICE	P/P
	48v	96v	£	£
430	1	0·5	4·09	1·57
431	2	1	7·84	1·57
432	4	2	12·94	2·25
433	6	3	14·62	2·40
434	8	4	20·04	2·70
435	10	5	28·75	2·90
436	12	6	36·16	4·50
437	16	8	39·47	5·50

CASED AUTOTRANSFORMERS
240V LEAD IN 115V 2PIN SOCKET OUT

TYPE	VA	PRICE	P/P
		£	£
56W	20	6·60	0·94
64W	80	8·43	1·57
4W	150	10·86	1·90
69W	250	13·17	2·10
67W	500	20·46	2·40
84W	1000	30·24	2·80
95W	2000	54·83	5·50
73W	3000	78·67	7·00

25/50V RANGE PRI 120/220/240V
SEC
VOLTS OUT 5 — 25 — 0 — 25

TYPE	AMPS		PRICE	P/P
	24v	50v	£	£
102	1	0·50	3·29	1·43
103	2	1	4·09	1·43
104	4	2	7·65	1·73
105	6	3	9·09	1·90
106	8	4	12·24	1·90
107	12	6	18·15	2·20
118	16	8	22·46	2·55
119	20	10	27·05	2·55
109	24	12	32·44	4·50

MAINS ISOLATORS (SAFETY SCREEN)

TYPE	VA	PRICE	P/P
		£	£
149F	60	8·40	1·90
150F	100	9·71	1·90
151F	200	13·84	2·25
152F	250	18·69	2·40
153F	350	20·77	2·80
154F	500	26·03	2·90
155F	750	36·75	5·50
156F	1000	47·42	6·50

LINE ADJUSTMENT AUTOTRANSFORMERS
0 200 210 220 230 240 250

TYPE	VA	PRICE	P/P
		£	£
415C	50	2·31	0·94
416C	100	3·46	0·94
417C	200	4·00	1·20
418F	350	6·26	1·57
419F	500	6·74	1·90
420E	750	8·33	2·10
421F	1000	11·64	2·25

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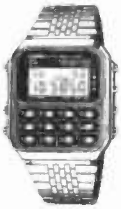

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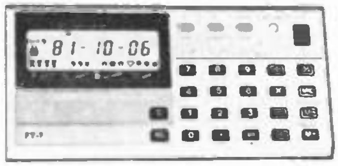

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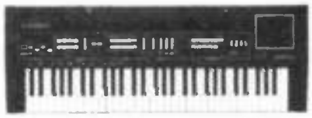

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IN914	3p	2p
LED		
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2"	8p	7p
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16 pin	9p	8p

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AC126/7	18
AC128	18
AC141/2	30
AC176	25
ACY17/18	69
ACY19/20	69
ACY21/22	69
ACY28	69
AD161/62	40
AF114/5	49
AF116/7	49
AF124	59
AF125/26	59
AF127	59
BC107/8	10
BC108C	12
BC109	10
BC109C	12
BC117/119	24
BC141/2	22
BC143	22
BC147/8	8
BC149	8
BC157/8	9
BC159	9
BC160/1	38
BC167/8	9
BC169/70	9
BC172/3	9
BC182/3	8
BC184L	8
BC212/3	8
BC214L	8
BC237/8	12
BC239	12
BC252	12
BC237/8	12
BC307/8	14
BC327/8	14
BC337/8	12
BC441/61	32
BC477/8	38
BC516/7	38
BC547/8	12
BC549C	13
BC556/7	13
BC558/9	13
BCY70/71	14
BCY472	18
BD131/32	39
BD135/36	39
BD138/39	39
BD140	39
BF115	32
BF154/8	20
BF167/73	24
BF184/85	24
BF194/95	10
BF196/97	12
BF224B	24
BF244B	30
BF257/8	34
BF259/74	34
BFR39/89	30
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BFX85/6	26
BFX87/8	26
BFY50/51	22
BFY52	22
BU205/8	190
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MJE2955	95
MJE3055	85
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MPF103/4	35
MPF105/6	35
MPSA05/6	22
MPSA12/55	30
MPSA56/66	30
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OC45	38
OC71/72	38
OC81/82	48
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2N1131/2	28
2N2217/18	38
2N2221	21
2N2222A	22
2N2369A	18
2N2646	40
2N2904/5	28
2N2906/7	28
2N2926	10
2N3053	28
2N3054	65
2N3055	45
2N3108	40
2N3702/3	9
2N3704/5	8
2N3706/7	9
2N3708/9	9
2N3710/11	9
2N3819	23
2N3903/4	9
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CA3046	68
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LF351	45
LF353	90
LF355	82
LF356	90
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LM308	92
LM311N	69
LM318	195
LM324	42
LM334	95
LM339	55
LM348	62
LM349	119
LM377	165
LM378	199
LM3795	399
LM380	72
LM381	160
LM382	120
LM384	135
LM387	118
LM389	90
LM1310	145
LM3401	55
LM3900	40
LM3909	68
LM3911	120
LM3914	210
LM3915	218
LM3916	218
MC1303	85
MC1310	145
MC1458	39
MC1496	70
NE529	220
NE531	135
NE543H	210
NE544	179
NE555	18
NE556	55
NE564	419
NE565	120
NE566	150
NE567	145
NE570	445
NE571	418
RC4136	69
RC4151	199
SA5560	145
SA5570	145
SL490	340
SN76013	240
SN76023	240
SN76115	215
SN76226	295
SN76227	95
SN76477	175
SN76660	118
TBA800	79
TBA810S	92
TBA820	60
TDA1022	570
TDA1034	349
TDA2006	230
TDA2030	320
TL071	29
TL072	55
TL074	99
TL081	29
TL082	44
TL084	95
XR2206	299
XR2207	370
XR2216	650
XR2266	725
2N414	80
2N425E	345
2N1034E	199

CMOS

4000	14
4001	14
4002	14
4006	65
4007	16
4008	60
4009	32
4010	36
4011	15
4012	18
4013	32
4014	75
4016	30
4017	45
4018	65
4019	40
4020	40
4021	70
4022	85
4023	20
4024	42
4025	18
4026	130
4027	35
4028	55
4029	75
4030	50
4031	169
4033	140
4035	90
4040	58
4041	78
4042	59
4043	70
4044	65
4045	168
4046	75
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4048	53
4049	29
4050	29
4051	76
4052	79
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4054	125
4055	125
4060	88
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4066	35
4067	390
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4085	65
4086	70
4093	40
4098	86
4099	95
4502	90
4503	50
4507	39
4508	260
4510	68
4511	68
4512	75
4514	190
4515	195
4516	75
4518	29
4519	28
4520	78
4522	125
4526	95
4527	110
4528	80
4529	150
4532	100
4538	110
4541	140
4543	130
4553	298
4555	50
4556	55
4566	170
4584	48
4585	95
40106	75

DIAC

D32	22
BR100	22

Diodes

1N4001/2	5
1N4003/4	6
1N4005/6	6
1N4007	7
1N4148	4
1N5401/4	15
1N5406/8	17
1N914	4
OA90/91	8
OA95	8
BY100	25
BY126/7	13

Thyristors

·8A/60V	23
·8A/100V	28
·8A/400V	38
4A/400V	35
4A/600V	48
5A/200V	36
5A/400V	38
5A/600V	46
8A/400V	59
8A/600V	90
12A/400V	90
12A/600V	125
2N5062	30

Triac

·6A/400V	44
4A/400V	50
4A/600V	54
8A/400V	66
8A/600V	78
8A/800V	99
12A/400V	80
12A/600V	185
16A/400V	99
16A/600V	115
16A/800V	199
T2800D	120

Bridge Rectifiers

1A/50V	15
1A/100V	20
1A/400V	28
1A/600V	32
2A/50V	32
2A/200V	39
2A/400V	44
2A/600V	63
6A/100V	80
6A/400V	90
6A/600V	120
10A/200V	210
10A/600V	340
25A/200V	230
25A/600V	389

74LS

LS00	12
LS01	13
LS02	14
LS03	14
LS04	15
LS05	15
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LS257	46
LS258	40
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LS266	22
LS273	90
LS279	85
LS283	12
LS293	42
LS298	130
LS352	180
LS353	130
LS365	35
LS366	35
LS367	35
LS368	85
LS373	72
LS374	75
LS377	90
LS386	225
LS390	60
LS393	60
LS670	155

TTL7400

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193	60
194	72
198	72
197	82
193	62
199	99
221	95
259	80
273	90
279	90
288	90
298	90

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1A 10220 Plastic Casing			
5V 7805	45	7905	55
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RESISTORS — 5%
¼ & ½W — 1 Ω-10M-2p

ULTRASONIC TRANSDUCERS
40kHz Transmitter & Receiver 350p pair.

Now our name means more, than ever before.

If the name BICC-Vero sounds only half familiar, that's not the only difference you're going to notice.

Because not only have we added to our name we've also added to our technology. Building upon our well established industrial product range and incorporating the very latest ideas and techniques to ensure that you too are working at a state-of-the-art standard.

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And because we're professionals we appreciate the very real professionalism of the hobbyist market – and service it accordingly.

Yes, we're sure you'll notice the difference. As well as that pleasantly familiar personal touch.

BICC-VERO ELECTRONICS LTD.

Industrial Estate, Chandlers Ford,
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Tel: Chandlers Ford (04215) 62829.

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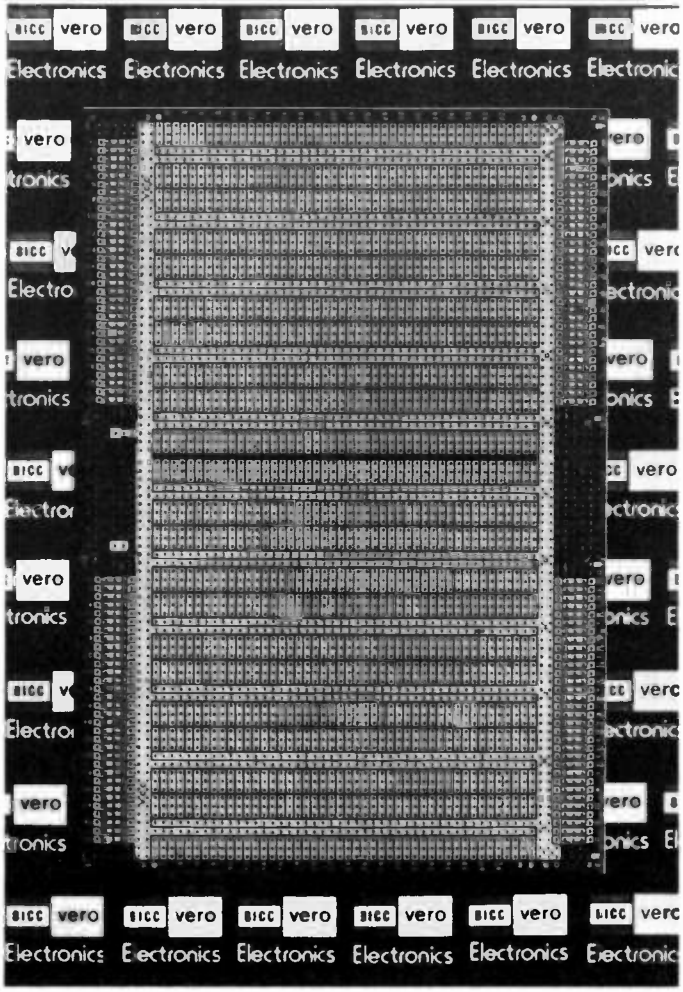
The mechanics of electronics

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Timing
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Electronic
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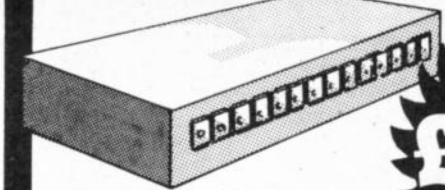


LOOK

P.E. STEREO CASSETTE RECORDER KIT

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire.

Self-assembly simulated wood cabinet. £4.50 + £1.50 p+p.

INTRODUCTORY OFFER – ONLY

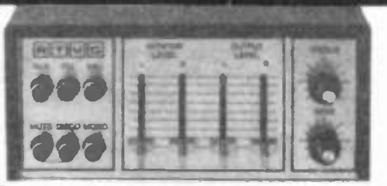
£32.95

+ £2.75 p&p.

Featured in April issue Practical Electronics, reprint 50p - Free with Kit.

- NOISE REDUCTION SYSTEM
- AUTO STOP
- TAPE COUNTER
- SWITCHABLE E.Q.
- INDEPENDENT LEVEL CONTROLS
- TWIN V.U. METER
- WOW & FLUTTER 0.1%
- RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING
- FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TAPES

STEREO AMPLIFIER KIT



- **Featuring latest SGS/ATES TDA 2006 10 watt output IC's with in-built thermal and short circuit protection.**
- **Mullard Stereo Preamplifier Module.**
- **Attractive black vinyl finish cabinet, 9"x 8¼"x 3¾" (approx).**
- **10+10 Stereo converts to a 20 watt Disco amplifier.**

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amp assembly kit and mains power supply. Also features 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia with matching knobs and contrasting cabinet. Instructions available, price 50p. Supplied FREE with kit.

£16·50

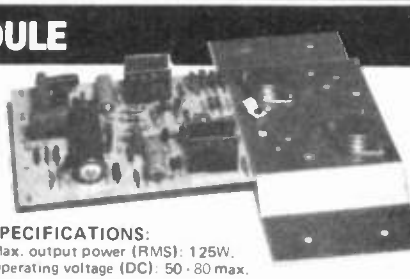
+ £2.90 p&p.

SPECIFICATIONS:	Suitable for 4 to 8 ohm speakers
Frequency response	40Hz – 20KHz
Input sensitivity	P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls	Bass ±12db @ 60Hz Treble ±12db @ 10KHz
Distortion	0.1% typically @ 8 watts
Mains supply	220 – 250 volts 50Hz.

8" SPEAKER KIT Two 8" twin cone domestic speakers. £4.75 per stereo pair plus £1.70 p&p. when purchased with amplifier. Available separately £6.75 & £1.70 p+p.

125W HIGH POWER AMP MODULE

KIT: **£10·50** + £1.15 p&p BUILT: **£14·25** + £1.15 p&p.

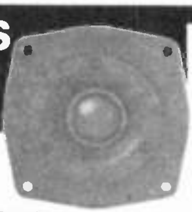


The power amp kit is a module for high power applications – disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES: Suitable mains power supply kit with transformer: £7.50 plus £3.15 p&p.
Suitable LS coupling electrolytic: **£1.00** plus 25p p&p.

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

HI-FI SPEAKERS AT BARGAIN PRICES

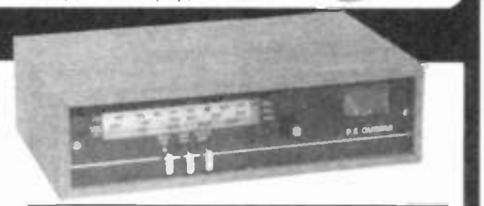


GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3¾"sq.) for use in up to 40W systems, with 2 element crossover.
£3.50 each (p&p £1) or £5.95 pair (p&p £2).

35 WATT MICRO 2-WAY SPEAKER SYSTEM
Unit comprises one 50w (4"app.) Audax soft dome tweeter HD100. And one 5" Audax bass/midrange 35w driver HIF11JSM. Complete with 2 element crossover. Total impedance of system 4 ohms.

£7.95
PER SET + £2.70 p&p.

P.E. STEREO TUNER KIT



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

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

£17·95
Plus £2.50 p&p.

Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x8½"x3¼".
£3.50 Plus £1.50 p&p.

SPECIAL OFFER! TUNER KIT PLUS:
• Matching I.C. 10 watt per channel Power amp kit. • Mullard LP1183 built pre-amp, suitable for ceramic pick-up and aux. inputs. • Matching power supply kit with transformer. • Matching set of 4 slider controls for bass, treble and volumes.
£21.95 + £3.80 P&P.

PRACTICAL ELECTRONICS CAR RADIO KIT SERIES II

2 WAVE BAND, MW – LW

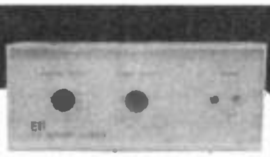
• Easy to build. • 5 push button tuning. • Modern design. • 6 watt output. • Ready etched and punched PCB. • Incorporates suppression circuits.

All the electronic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type pre-aligned and assembled, and a Bird pre-aligned push button tuning unit.

Suitable stainless steel fully retractable aerial (locking) and speaker (6"x4"app.) available as a complete kit. £2.50/pack + £1.50 p&p.

£12·95
+ £2.00 p&p.

TV SOUND TUNER KIT



£11·45
+ £1.50 p&p.

As featured in E.T.I. December '81 issue. Kit of parts including PCB, UHF tuner and selector switch with all components excluding case.

• Transformer £1.50 + £1.50 p&p (p&p free on transformer if ordered with kit). • Ready built LP1183 Module for simulated stereo operation. £1.95 + 75p p&p.

MONO MIXER AMP

£39·95
+ £3.70 p&p.

50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls – six for level and two for master bass and treble, four extra treble controls for mic. and aux inputs. Size: 13¼"x 6½"x3¾"app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

BIRD AUDIO STEREO CAR RADIO BOOSTER

To boost your car radio or radio cassette to 15W r.m.s. per channel.

£9·95 + £1.50 p&p.

ALL MAIL TO:
21A HIGH STREET, ACTON, W3 6NG.

Note: Goods despatched to UK postal addresses only. For further information send for instructions 20p plus stamped addressed envelope. All items subject to availablity. Prices correct at 31/1/82 and subject to change without notice. Please allow 7 working days from receipt of order for despatch.

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Open 9.30 – 5.30pm. Closed all day Thursday.
RTVC Limited reserve the right to update their products without notice.

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MANUFACTURERS SURPLUS high quality components I.C.s, transistors, diodes, thyristors, capacitors, resistors, switches, etc. 100 assorted £1·25 post free. U.H.A. LTD, 62 Wellington Road South, Stockport, Cheshire.

NEW 1982 ACE COMPONENT CATALOGUE. Let your problems be our business. Be certain; have your components delivered quickly and efficiently and get that project working. Send 30p now for the easy to use 1982 catalogue to: ACE MAILTRONIX, Dept EE, 3A Commercial Street, Batley, West Yorkshire WF17 5HJ.

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TURN YOUR SURPLUS capacitors, transistors etc., into cash. Contact Coles Harding & Co., 103 South Brink, Wisbech, Cambs. 0945 4188. Immediate settlement.

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The only magazine for all vintage sound enthusiasts, packed with articles by top writers, covering gramophones, phonographs, 78s, wireless, news, history, reviews, etc.
Bi-monthly. Annual subscription £8·75 (airmail extra). Send 75p for sample copy.
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BELL'S TELEVISION SERVICE for service sheets on Radio, TV etc. £1·25 plus SAE. Colour TV Service Manuals on request. SAE with enquiries to BTS, 190 King's Rd. Harrogate, N. Yorkshire. Tel: 0423 55885.

Any single service sheet £1/L.S.A.E. Thousands different Repair/Service Manuals/Sheets in stock. Repair data your named T.V. £6·50) with circuits £8·50). S.A.E. Newsletter, Price Lists. Quotations.

AUSEE, 76 CHURCHES,
LARKHALL, LANARKSHIRE
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SOUND ENGINEERS

If you're following a career in Sound Engineering or interested in learning all aspects of recording studios you should attend one of our weekend studio courses. Topics covered include:

- A. The basics of studio construction, wiring and materials used.
- B. Types of microphone uses, techniques, and limitations.
- C. Use of 2" 16 track machine, lining up, remotes, etc.
- D. Use of 24 Channel Desk and all controls.
- E. Effect equipment, ADT, reverb, Echo, etc.
- F. Ancilliary equipment.
- G. Mixing and Editing.

There are a maximum number of 8 students on each course and every one is tutored to their own level of knowledge with regard to their needs and interest. The cost is £98 for the weekend including hotel accommodation overnight. **Details: please phone 01-580 4720 or 01-636 5308 during office hours.**

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4/82

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WANTED, Teach in kits, basic tools, equipment. PRICE, 15 Colbourne Road, Tipton, West Midlands DY4 8RU.

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HEATHKIT SELF INSTRUCTION PROGRAMMES plus trainer as new. £150. Reigate 47304 evenings.

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CWO Please. Postage. Add 35p postage and packing.

PROTO DESIGN, 14 DOWNHAM RD., RAMSDEN HEATH, BILLERICAY, ESSEX, CM11 1PU
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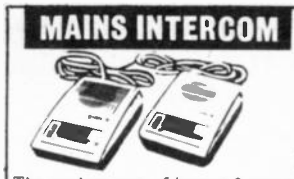

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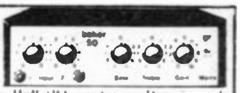

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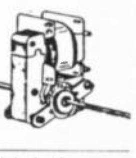

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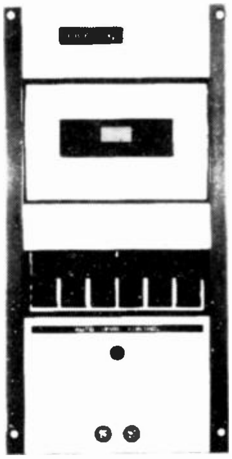

6 piano type keys

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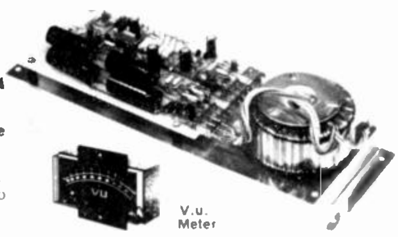
OMP **POWER AMPLIFIER MODULES**

100 WATTS R.M.S.



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T.H.D. 00 1%
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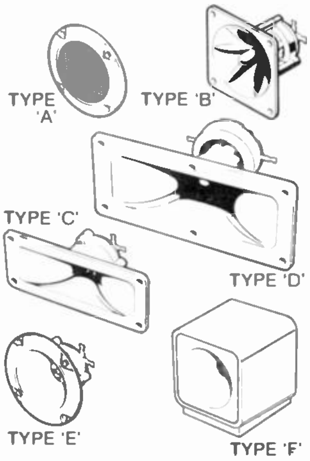

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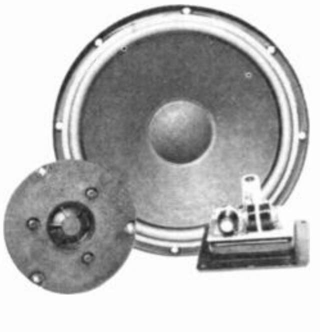

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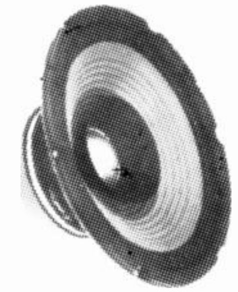

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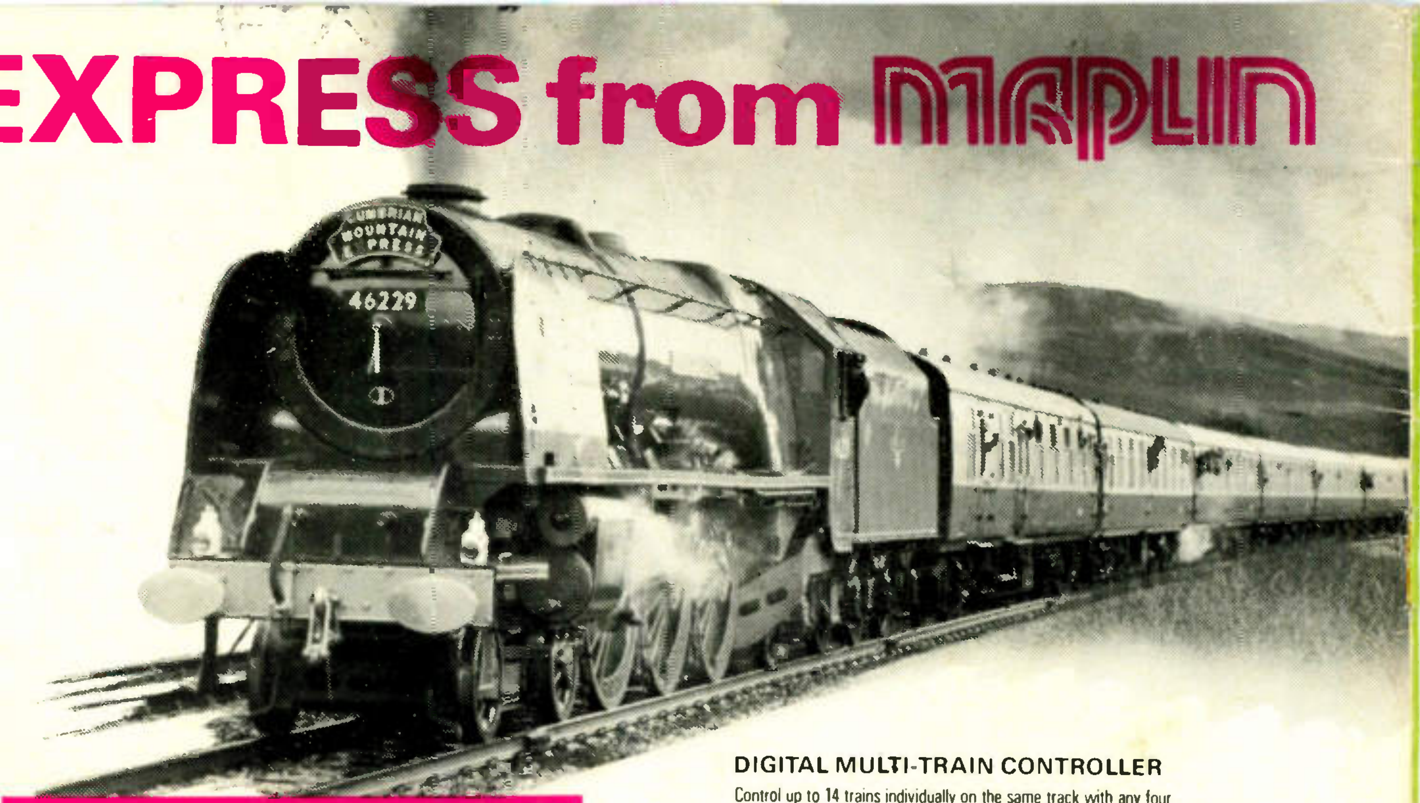

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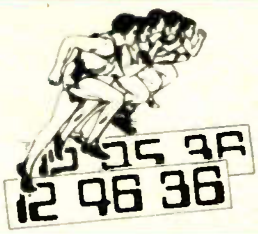

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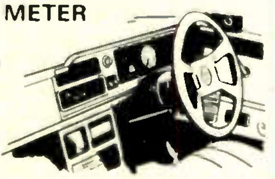

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