Hobby Electronics

SEPTEMBER 1983

AN ARGUS SPECIALIST PUBLICATION

Project Electronics For Everyone

85p

IN THE PIPELINE

Cable and Satellite TV Technology Revealed

Unique "Tremoleko" Sound Effect

No Fuss Sound Pressure Level Meter

Variable Power Supply Project

Gripometer Project – Test Your Strength!

Hobby Electronics

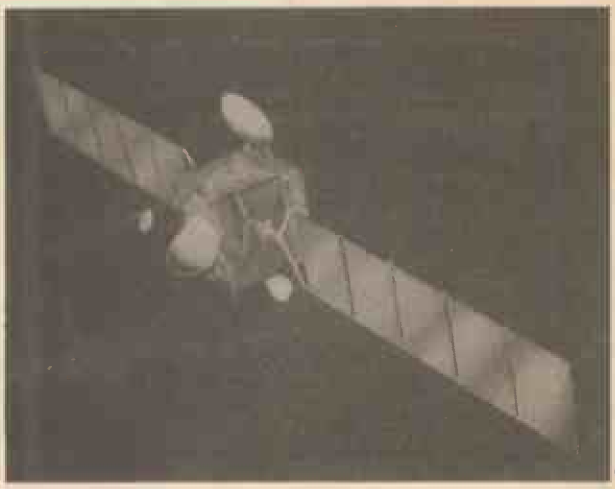
SEPTEMBER 1983
VOL 5 No 9

PROJECTS

FEATURES

REGULARS

Clever Dick *has been despatched overseas to do some important technical research into the effects of solar radiation on the body, not to mention modifications caused by treating the body in question with alcoholic spirits. He'll let you know the results when (if?) he gets back . . .*



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HE Gripometer — page 59

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ACCESS AND BARCLAYCARD WELCOME

LINEAR

555CMOS	80	ICL7106	790	LM339	45	LM3911	120	NE566	140	TL064	96
556CMOS	150	ICL7611	95	LM348	60	LM3914	175	▶NE567	100	TL071	30
709	25	ICL7621	180	LM358	50	LM3915	195	▶NE570	370	TL072	50
▶741	14	ICL7622	180	LM377	170	LM13600	105	NE571	370	TL074	95
748	35	ICL8038	295	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
9400CJ	350	ICL8211A	200	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
AY-3-1270	720	ICM7224	785	LM382	120	▶MF10CN	350	SL480	170	TL084	95
AY-3-8910	370	ICM7555	80	LM384	130	ML922	400	SL490	250	TL170	50
AY-3-8912	540	▶LF351	45	LM386	65	ML924	195	SL76018	150	UA2240	120
CA3046	60	LF353	85	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
▶CA3080	65	LF356	90	LM393	100	ML926	140	SP8629	250	ULN2004	90
CA3089	190	LM10	360	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3090AQ	375	LM301A	25	LM711	60	ML928	140	TBA800	75	ZN414	100
CA3130E	85	LM311	70	LM725	350	ML929	140	TBA810	96	ZN423	135
▶CA3140E	36	LM318	120	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3161E	100	LM324	40	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3189	290	LM334Z	100	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3240E	110	LM335Z	125	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
				LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
				LM3900	45	▶NE556	45	TL061	40	ZN459	285
				▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

AC125	35	BC149	9	BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
AC126	25	BC157	8	BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
AC127	25	BC158	10	BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
▶AC128	20	BC159	8	BC549	10	▶BFR81	20	TIP29C	60	ZTX301	16	2N3703	9
AC176	25	BC160	45	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC187	22	BC168C	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
AC188	22	BC169C	10	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AD142	120	BC170	8	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AD149	80	BC171	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AD161	40	BC172	8	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD162	40	BC177	18	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AF124	60	BC178	18	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AF126	50	BC179	18	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AF139	40	BC182	10	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF186	70	▶BC182L	8	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF239	75	BC183	10	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
BC107	10	BC183L	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
BC107B	12	BC184	10	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
▶BC108	10	BC184L	7	BD204	110	BSX29	30	TIP36C	135	2N1613	30	2N3905	6
BC108B	12	BC212	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC108C	12	BC212L	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC109	10	BC213	10	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC109C	12	BC213L	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC114	18	BC214	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
BC115	22	▶BC214L	8	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC117	18	BC237	8	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC119	35	BC238	14	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC137	40	BC308	12	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC139	40	BC327	14	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC140	28	BC328	14	BF198	10	MPF104	40	TIS43	40	2N2905	20	2N5777	45
BC141	30	BC337	14	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC142	25	BC338	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC143	25	BC477	30	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC147	8	BC478	30	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC148	8	BC479	30	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
				BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
				BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
				BF259	35	MPSU55	60	ZTX107	8	2N3054	55		

CABLES

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 rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m
10 way grey ribbon	38p/m
20 way grey ribbon	80p/m

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

CAPACITORS

Polyester, radial leads, 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p; 2200/63V - 140p; 4700/63V - 230p.
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 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.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p.

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270		
LM317T	120		
LM323K	350		

SPECIAL OFFER! 78P05 10A +5V only 390p each.

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms -1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

DIODES

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

TRIACS

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

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP(header plug) jumper 24 ins.	145	165	240	380
Dble ended DIP(header plug) jumper 6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	115	TIL312 0.3"	115
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

BRIDGE RECTIFIERS

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

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap suitable for ZX81 add-ons . . . 150
SPECTRUM 2 x 28 way edge connector wire-wrap suitable for SPECTRUM add-ons . . 200

RIBBON CABLE

Grey Ribbon cable. Price per metre

10 way	38	34 way	150
16 way	55	40 way	170
20 way	80	50 way	198
24 way	110	60 way	260

IDC CONNECTORS

	PCB Plug Straight	Socket	Edge Conn.
10 way	90	85	120
16 way	130	110	175
20 way	145	125	195
26 way	175	150	240
34 way	205	170	320
40 way	220	190	340
50 way	235	200	395
60 way	330	230	495

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

SOLDERING IRONS

Antex CS 17W Soldering iron	495
2.3 and 4.7mm bits to suit	85
CS 17W or XS 25W element	210
Antex XS 25W	525
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22swg solder	100

CONNECTORS

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

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.

Plug chassis mounting	38p
Socket free hanging	60p
Socket with 2m lead	120p

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

VOICE SYNTHESISER!

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoneme) system gives unlimited vocabulary.
Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones.
SP0256 . 990p. Data: 50p.

VERO

VEROBLOC◀	350
Size 0.1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT 48p
Miniature DPDT slide 12p.
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

MICRO

		6116P3	320	6852	240	8228	220
		6502CPU	325	6875	495	8251	250
		6522VIA	295	6880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551 ACIA	650	81LS96	85	8259	390
2114L2	75	6800CPU	220	81LS97	85	MC1488	55
2716	205	6802CPU	250	8080A	250	MC1489	55
2532	290	6809CPU	620	8085AC	340	Z80ACPU	290
2732	290	6810RAM	115	8156	350	Z80APIO	260
2764	540	6821 PIA	110	8212	110	Z80ACTC	260
4116P20	70	6840	360	8216	100	Z80ASIO	900
5101L-1	220	6850	110	8224	120	Z80ADMA	1150

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	98p

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts.	

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 10M . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . 6p each.

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc.)	45
Dalo etch resistant pen	100
Fibre glass board 3.75 x 8"	80
Fibre glass board 8 x 12"	200
Ferric Chloride crystals	100

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

4000	10	4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
4001	10	4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
4002	12	4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4006	50	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4007	14	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4008	36	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4009	24	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4010	24	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4011	10	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4012	15	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4013	20	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4014	45	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4015	40	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
		4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
		4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
		4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

LS00	11	LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
LS01	11	LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
LS02	11	LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS03	12	LS26	14	LS83	35	LS132	35	LS163	35	LS241	55	LS367	28
LS04	12	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS05	12	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS08	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS09	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS10	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS11	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS12	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS13	19	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS14	30	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS15	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
		LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
		LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
		LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

7400	11	7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
7401	11	7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
7402	11	7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7403	12	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7404	12	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7405	14	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7406	19	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7407	19	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7408	13	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7409	13	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7410	13	7432	20	7473	24	7496	38	74153	38	74176	35		
7411	15	7433	20	7474	19	7497	86	74154	47	74177	42		
7412	17	7437	23	7475	26	74100	78	74155	36	74179	75		
		7438	24	7476	25	74107	22	74156	36	74180	38		
		7440	14	7480	45	74109	24	74157	28	74181	100		
		7442	30	7482	65	74121	24	74160	55	74182	55		

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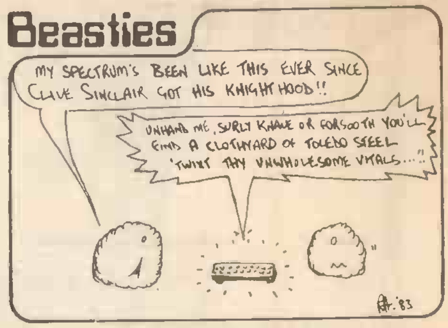
MONITOR

Well Done, Sir

Readers who can tear themselves away from their soldering irons long enough to read the Daily Rag or listen to the radio news will have heard that legendary all-round computer manufacturing and marketing genius Clive Sinclair (*Yes.* Sinclair, Clive, as in Sinclair, Spectrum and Sinclair, ZX81 . . .) has been honoured with a knighthood in this year's Birthday Honours list. The rumours say that this came as a complete surprise to Mr. Sinclair, but not to the rest of us. We always knew that the man who enabled the nation to pick up its micro with its daily papers and scared hell into the opposition deserved something special. Apart from a few million quid, that is. So. from Hobby Electronics editorial team, technical department and Beasties, well done, Sir . .

One problem. Do we address him as Uncle Sir Clive, or Sir Uncle Clive?



The Future Is Here As Soon As You Can Afford It

Questions and answers time again: **Grundig International**, well-known perpetrators of video, hifi and TV, have initiated a Marplan survey to find out who does what with their television, how, where and when.

Marplan came up with a few interesting facts about the Youth of the Nation and their possessions, and preferences. For instance, 46 per cent of British homes have a second television (we presume they mean one in working order!) and the 'old' telly is often purloined by the younger generation. About 18 per cent of children have their own TV set (. . . that's nearly one in five. My mind begins to boggle. Where did Marplan do this survey??) and, having got it, they watch breakfast telly in their bedrooms!

Their survey also showed that whereas nearly every family in the land has its own radio but only 50% of children do, only 27% of families have a cassette player, but 27% of children do. Against that, 76% of families have a record player, but only 25% of children — this is the portable generation, by the look of it. The kids apparently, from this sample, have not yet moved into the VCR-owing class, but Grundig suspect that there may be specimens lurking out there, the first of a new species. It seems that videos have also eased the family relationships by making it easier to get the kids off to bed with the promise of recorded programmes the next day.

(I can confirm this from experience. My in-laws find it a great relief to leave us in the charge of a recording of *The Old Grey Whistle Test* while they go peacefully to bed — same principle, isn't it?)

Another little factoid which emerges, which we all knew in our hearts, is that people, especially children, like to record their favourite programmes and watch them over and over again (so *that's* why the In-laws won't release the videotapes till after they've retired to bed). Never mind information content *Top Of The Pops*, *Grange Hill*, *Fame* and *Kenny Everett* are among the favourites. A significant number of families (11 per cent) watch rented video tapes *every day*.

Your MONITOR person, being an old fogie who merely worships television but was actually raised by a portable radio, finds it encouraging that 92 per cent of children listen to the radio, and many of them like it because they can use their imaginations more than with TV, and they aren't tied to watching, but can get on with something else. Like writing MONITOR, for instance.

Grundig seem to have confirmed a few more things which we all thought we knew anyway, but which nobody had got round to telling us officially: we like video because we can record programmes we would otherwise miss and watch them later (have you any idea the suffering this sort of thing causes to someone who doesn't *have* a video? Like me?); and that 76 per cent of people who don't have videos would like to have one if only they could afford it (right again!). And that people with two televisions (chance'd be a fine thing. I can't even afford *one* at the moment . . .) and who don't have the second one purloined by their offspring (knowing my luck, if I had one, the cat would snatch it) prefer to have one upstairs in the bedroom (so *that's* what the In-laws get up to . . .) so they can watch it in bed. (Right yet again!) Slightly less expected is that some people watch breakfast television in bed. (How can they? How do they get their eyes open at that time of the day??)

Well, it's nice to know you're nearly normal.

Another factoid which tends to be confirmed by experience is that people want an integrated viewing/listening system, with all their hifi, video, television, radio, and whatever played through one system with 'speakers running anywhere they are desired.'

At this point, Grundig just are not adventurous enough. They conclude that people would like to be able to play everything back through their TV sets. Not round here, you don't! Is anyone out there going to spend £500 on a new compact disc player and then put it through the telly?? Surely the whole point of those things is that they don't sound as if they have been put through a telly . . . words fail me!

Let's think positive. When is Grundig, or someone, going to come up with a decent, domestic-quality, domestic-priced multi-way switching amp? What about the household whose main problem is the inability to keep two cassette players, a record player, radio, television, video, home computer (come on. *Dream* a bit), closed circuit TV monitoring the food processor, several sets of headphones and an electric guitar running all at the same time? *This* is the future, believe me! These guys are just not thinking *big* enough.

Let's get off this provocative subject and onto something more mundane: Marplan have finally come up with some real observations on the effect of television in the bedroom.

For one, it's usually the man who has to leap out of bed to turn the telly off at the end of the evening's viewing. Either chivalry is not yet dead, or else it really is true that women are better at sleeping through a persistent din than men are. Having a television in the bedroom does interfere with other bedroom activities. 17 per cent said it was a problem trying to read and watch telly in bed at the same time. Others grumbled about the effect on knitting, Scrabble and pillow fights. Some even said that having a telly in the bedroom interfered with sex. Somebody ought to tell them to take the telly off the bed.

(Mind you, in a household where the main problem is getting the *cat* out of the bed, all this good advice isn't going to go very far, is it? These people don't know when they're well off, do they? Foam. Snarl.)

Apologies. This editorial bitterness is merely caused by the stress of having to be polite about the *Which Video* team so that we can use their TV occasionally. The things we go through . . . however, in order to deal with some of these problems, Grundig have produced a leaflet, *How To Choose And Use Your Television*. If you're interested in this, send a largeish SAE to **"TV Leaflet Offer", Grundig Press Office, 50 Upper Brook Street, London W1Y 1PG.** Unfortunately, it lacks a little bit of inspiration on the last range of points discussed above. How about a TV set with a book-prop on top? You have to think into the future, you know.

Cee Bee

At last, CB equipment for use on the 934 MHz UHF band is beginning to raise its head. A firm called BeeWare are producing a transverter, the LA83, which will convert a 27MHz transceiver to 934MHz by means of a PL Patch lead between the antenna output of the 27 MHz rig and the input of the transverter, and connection via an n-type connector to a 934MHz antenna.

For use as home base, the transverter needs a 5A PSU.

The 934MHz band, being UHF, is less prone to interference than 27 megs and (for the time being anyway!) as there are so few units able to access it, its twenty channels are far less crowded than the popular bands. How long will this last, we wonders? Perhaps the interest in UHF is another indication of a more "serious" approach towards hobby radio in general, along with the swing towards the more demanding rigours of Ham radio by people who began with an interest in CB.

The LA83 will retail for around £200.00, under the 'Grandstand' label. For further information, contact **BeeWare, Adam Leisure Group Ltd., Ripon Road, Harrogate, North Yorkshire, HG1 2AU. Tel: (0423) 501151.**

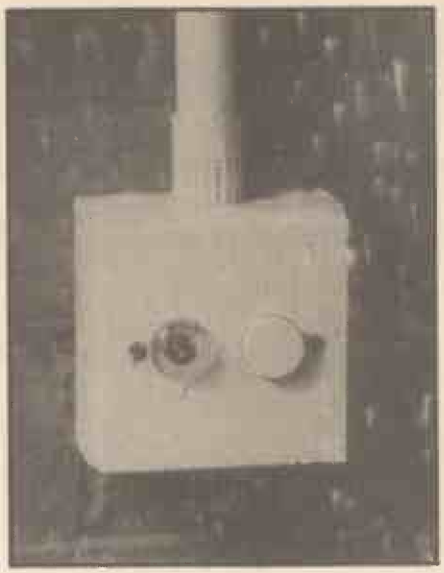
Splashproof Switch

Superswitch Electric Appliances have added a splashproof, outdoor model to the indoor remotely controlled light switches in their range. The three models now available, all switched by a small, infra-red transmitter, offer the convenience of remote switching for all domestic applications in and around the home.

The splashproof version is in an attractive, white, surface mounting case with a remotely actuated switch and a manual switching button. The Superswitch hand held infra-red transmitter which actuates the switch can be used as much as 50ft from it, and will operate through glass. Coming home at night, a driver can thus turn on the outside light without having to get out of the car or even open the window.

The new splashproof remote control switch (catalogue number 2715) will switch 5A maximum tungsten lamps or resistive loads, with a maximum of 2A5 for fluorescent or inductive loads. It can be mounted with conduit entry above, below or at the side of the box, with no danger of seepage from rainwater. The infra-red transmitter, measuring only 1.5 x 5.25 x 1 in, is powered by a 9V alkaline battery. It has been proven in use with the indoor switches in the range, and shown to give no interference with remotely controlled TV or video recorders.

Superswitch's latest product, which can be installed in one- or two-way switching circuits, has three modes of operation, set up by an internal switch during installation. The options are: switched on by infra-red beam, off manually; switched on as long as either



infra-red or manual switch is pressed, but goes off when released; switch on and subsequently off by either infra-red device or manual switch.

Superswitch say that they are in the business of providing convenience and security in the home. The model 2715 splashproof remotely controlled switch is the latest product with these objectives in mind. Further information from **Superswitch Electric Appliances Limited, 7 Station Trading Estate, Camberley, Surrey, GU17 9AH. Tel: (0276) 34556.**

Equipment Great And Small

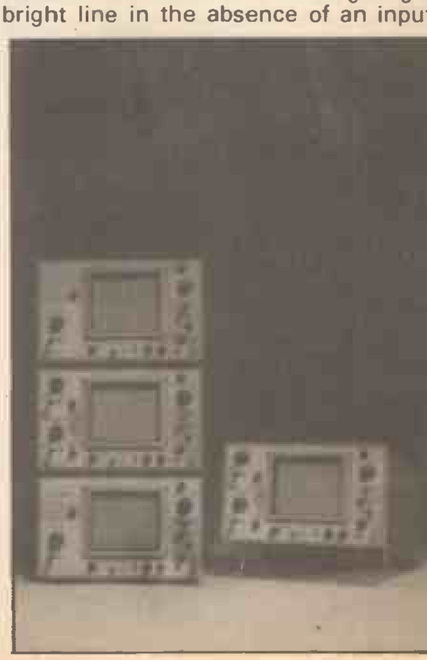
New from **Electronic & Computer Workshop** is a particularly strong general purpose knife, precision engineered in vanadium stainless steel. With a blade measuring 3¼in and a tough, moulded plastic amber coloured handle hinging down to encase completely and protect the blade when not in use, it fits safely and handily into pocker or tool box. The whole knife is of a very high quality, well engineered and with no play on the rivets. The tensioned handle has finger and thumb grips and clips hold it open or firmly hinged shut. It is priced £2.50 plus 45p p&p and VAT.

The **Crotech 3337** dual trace oscilloscope's specifications, overall size and rugged construction make it an effective instrument for the microcomputer and peripherals field service engineer. The front panel has related controls colour linked for ease of use.

A 30MHz bandwith is specified for the vertical deflection system, but the smooth roll off designed into the amplifiers is said to extend its response to 40MHz. The rise/fall time of the fast transient or pulse can be readily displayed and analysed via a built-in signal delay line operative on both channels and a fast 11ns7 rise time. The Post Deflection Accelerator (PDA) CRT operating at 10kV enables fast pulses at a relatively low reptition rate to be displayed. Deflection coefficients can range from 5mV to 20V/div. and are complimented by a variable control extending the range to 50V/div. This scope also features algebraic addition and subtraction (with Channel 2 inverted), valuable for the servicing and alignment of disk drives.

The 40ns to 1s/div. range on the horizontal deflection is covered by a 21 position calibrated timebase with x5 magnification. Vertical channel or external source selection and composite trigger for the investigation of non-frequency related signals, plus line frequency highlight the comprehensive triggering facilities of the 3337, which also gives selectable AC/DC trigger coupling. Further a single shot mode with a reset to capture intermittant or single transient signals is incorporated.

Additionally the 3337 will trigger up to 50MHz in either the Auto or Trigger level mode, the level mode ensuring reliable triggering for complex waveforms and the auto mode giving a bright line in the absence of an input



signal (level selection is also operational here).

The 3337 is priced at £405 plus £12.00 p&p and VAT.

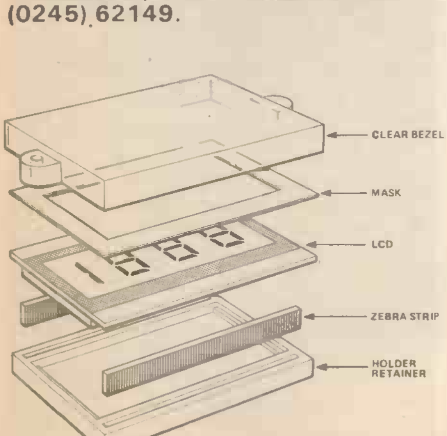
A microprocessor contolled EPROM programmer currently available from Electronic & Computer Workshop can be supplied in kit for £180 or built and tested for £270, plus £1.00 p&p and VAT.

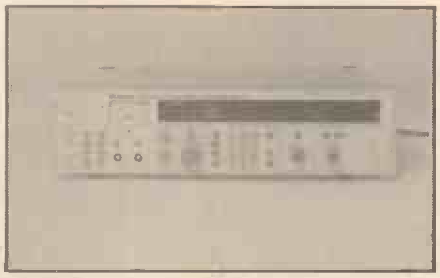
The programmer, a stand alone unit complete with power supply, housing and test sockets, has facilities to test, verify copy and program the following EPROMs: 2716, TMS2516, 2732 and 2732A for 16 or 32K. Specified controls include a hexidecimal keyboard plus function keys incorporated into a 24 key pad with 12 address LEDs, four function LEDs (error, program, OK and size) and two hexidecimal displays.

Available functions make this microprocessor based programmer a comprehensive unit. Functions include blank test and error, verify test and error, reset, input or modify data in user RAM at a desired address, parallel load capability from a DMA controlled RAM field, OK indication for successfully executed functions, increment function storing the input data via the hexidecimal , and jumping to the next address in the user RAM.

Currently available is a 3½ digit LCD module, of first class professional quality with 12.7mm high characters, costing £7.50 (plus 45p p&p and VAT). The LCD has an attractive bezel which secures and protects the LCD and incorporates high reliability Zebra strips. These strips consist of alternating parallel layers of conductive and non-conductive silicone rubber. Thus mounted, shock and vibration protection for the LCD is ensured. The connectors futher provide a gas tight seal of the contact surface to assure reliable operation in a hostile environment. The clear bezel ensures the LCD polariser is free from scratches. The assembly is available with a dual inline display, so that the viewing area is in the centre. Clever Dick says he's never *seen* a Zebra strip; can anyone advise him?

For more information, contact **Electronic and Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 62149.**





All Round Exhibition

A new home computing, video and electronics show with families in mind is going ahead at the Birmingham National Exhibition Centre on the 4th, 5th and 6th November (going off with a bang!!??). Atari, Sinclair and Ideal Toys are among the suppliers who are exhibiting at **Brainwave '83** where, we gather, the emphasis will be not only upon household and entertainments electronics, but on making the subject interesting to people of all ages and interest levels, not just for the very technically minded. More information will be appearing in the press, and doubtless in HE too, as it comes out.

Japanese CB Parts

Guildford CB has contacted us to say that, as well as stocking a large number of CB rigs and accessories, as well as a growing range of amateur radio gear (73s to you!), they specialise in hard-to-find Japanese transistors and CB rig components — obviously important for rig doctors who can't find replacement parts. Guildford also supply VHF and UHF aerials and some replacement high wattage valves, and standard tools, plugs and sockets, batteries and PSUs. Trade enquiries are welcome as well as the public, and credit cards are acceptable. I notice from their notepaper that they also do 'video' as well, although they don't specify what, exactly.

All enquiries to **Guildford CB, 34 Aldershot Rd., Guildford GU2 6AF. Tel: Guildford 577550, 571439 or 573868.**

DMM And Sig-gen

Thandar Electonics a new LED 3½ digit multimeter to their range of DMMs. There is still a large demand for a bench/portable LED instrument where dark conditions apply, and LCD are not suitable. Designated the TM355, the meter has a basic accuracy of 0.25%; AC and DC voltage ranges from 100uV to 1000V (750 AC), current ranges from 100na to 10M and resistance measurement of 100mR to 20MR plus diode check, and is priced at £75.00 plus VAT.

Thandar have also introduced three new AM-FM memory programmable signal generators to their Leader range of instruments. Designated the LSG-215, LSG-216 and LSG-217 they have the following specification: display tuning, address location and output level is indicated in digital format; a 100 point memory programmable for any mix of FM and AM modulation, plus output level and frequency (memory is supported by battery after switch off); full PLL synthesizer system with high stability oscillator; a peak indication meter; frequency ranges covering 0.1MHz to 115MHz (−9 to 120dBu). Accessories are also available to enable the use of remote controller and a plug in ROM unit to retain a specific programme. For further information please contact: **Thandar Electronics Ltd., London Rd., St. Ives, Huntingdon, Cambs PE17 4HJ. Tel: (0480) 64646.**

Look Into This

Do you wish to examine stress cracks, rod or tube dimensions, breaks in electronic circuits, etc.? If so, then according to **Hirsh Jacobson Merchandising Co.**, what you need is the Micro Mike pocket microscope.

Jesting aside, a little microscope like this, which gives 10x, 20x, 40x and 50x magnification, has a myriad of uses for anyone doing fine work or quality checking. The Micro Mike is USA-made and is guaranteed to function accurately indefinitely. It is a precision, professional instrument. The standard model is £8.80 (VAT and postage extra), or £10.80 for a model with a built-in measurement scale to 0.1mm. The model in our photograph shows the microscope on the left, with an attachment, the Microlite (£6.00) which is designed to shine a light precisely onto the field of the Micro Mike in dark places.

It clips into the pocket like a pen, is housed in a light, tough aluminium case, specially designed to focus light into the opening and protect its four lenses from dirt and scratches. Altogether a very handy little beastie — someone can give me one for my birthday, if they like!

Enquiries to **Hirsh Jacobson Merchandising Co. Ltd., 91 Marylebone High St., London W1M 3DE. Tel: 01 935 4709.** They do a nice brochure with some photographic samples of the microscope's uses.

Speech Synthesiser

For anyone with a micro and the confidence to know what they're doing with it, **General Instruments Microelectronics** has introduced a voice synthesis module, the VSM 2128-AL2.

The module contains a single chip, N-channel MOS/LSI circuit that is able, through stored allophones, to synthesise any phrase in English, through a stored allophone system. The module is interfaceable with digital systems using a standard 15-pin edge connector. Once selected, the module requires no support from user circuits, and enunciates all allophones and signals when complete.

The chip in use is General Instrument's SP0256-AL2 single chip speech synthesizer. The allophone technique of speech synthesis has a low bit rate. Each allophone has a six bit address, and assuming ten to twelve allophones a second in speech, synthesis requires less than 100 bits per second. It does not, unlike earlier techniques, require the synthesizing and storing of entire words as units.

The cost is around £50. For more information, contact **General Instrument Microelectronics Ltd., Times House, Ruislip, Middx. HA4 8LE. Tel: Ruislip 33355 or 35700.**

Any Old Ion?

Y'all may have heard of the healthgiving virtues of the Negative Ion. What is a negative ion? Never you mind — it's enough to know that negative ions are found in bracing sea air and similar locations, and breathing them, deeply or otherwise, makes your heart beat faster, eyes brighter, head clearer, chest broader, etc. More to the point, stuffy enclosed places are deficient in negative ions, especially places filled with cigarette smoke, hydrocarbon fumes (plastics, petrol, etc.) and inactivity. Which is a fairly good description of the interior of a travelling car.

Ionisers for the home and office are now being followed up by ionisers for the car. The "Mountain Breeze" ioniser is made by **Sidha Technology**, a Lancashire company which 'specialises in environmental health and high technology'. The ioniser works by pouring out a stream of negtive ions, clearing the air of dust, smoke and pollen, helping to relieve hay fever, stuffiness and car sickness and maintaining altertness and the ability to drive on safely with fewer brakes.

The unit can be plugged quickly into the cigarette lighter plug in the car, or permanently wired in. Power consumption is half a watt, so that it can be safely left on without running down the battery. The case is ABS plastic and measures 5 x 4¼ x 2½ in. The price is £00.00 and it will be available from high street stores as well as from Sidha.

Enquiries to **Sidha Technology Ltd., 15 Pit Hey Place, West Pimbo, Skelmersdale, Lancashire WN8 9PS. Tel: (0695) 22141.**

Pocket Wear

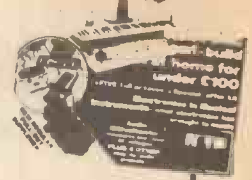
People working on the move will be interested in **Semiconductor Supplies'** 130g digital multimeter, which is small enough to go easily into a pocket the DM 2350.

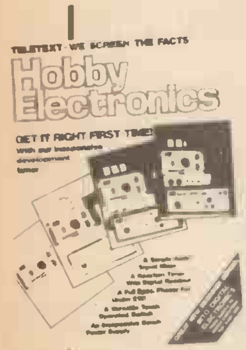
The meter has a 3½ digit LCD display, 10mm high with unit symbol (auto/AC/BT/Lo) and a sampling time of 2s per sample. Features include low power ohms for in-circuit resistance (less than OV4), three step protection by a bleep, a fuse and FET, AC/DC 10MR input impedance, high sensitivity with 200mV range and an adjustable bleep for continuity test work.

The DM 2350 costs **£55** plus VAT, and comes with carrying case, leads, battery, spare fuse and manual. A shunt is supplied to extend the AC amps range to 20A.

Enquiries to **Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Rd., Sutton, Surrey SM1 4RS. Tel: 01 643 1126.** HE

BACKNUMBERS





February 1980
Passion Meter, Win Indicator, Short Circuit Special, Kit Review Special, Into Electronics Construction Part 1.

May 1980
MiniClocks, 5080 Preamp, Model Railway Track Cleaner, 5080 Loudspeakers, Loudspeaker Crossover Design, Radio Controlled Model Survey.

June 1980
Microbe Radio Control System, Egg Timer, Two Watt Amplifier, Fog Horn, Short Circuits, LEDs and LED Displays.

July 1980
Sound-Operated Flash Trigger, 18 + 18 Car Stereo Booster, Hazard Flasher, Electronics in Photography, Electronic Espionage, Piezo Electricity.

August 1980
EquiTone Car Equaliser, Pass-The-Loop Game, Gaztec Gas Detector, OP-Amp Checker, In-Car Entertainment Survey, Introducing Microprocessors.

September 1980
MicroMixer, Reaction Tester, Guitar Phaser, Development Timer, Teletext Explained, Into Digital Electronics Part 1.

October 1980
Kitchen Timer, Tug 'o' War Game, Light Dimmer, Freezer Alarm, Intruder Alarm, Temperature-Controlled Soldering Iron.

January 1981
Car Rev-Counter, Bench Amplifier, Sound-Into-Light Converter, Chuffer, Electronic Games reviewed.

February 1981
Heartbeat Monitor, High-Impedance Voltmeter, Medium Wave Radio, Two-Tone Train Horn, Audio Signal Generator.

March 1981
Public Address Amplifier, Windscreen Wiper Controller, Bicycle Speedometer, Photographic Timer, Microcassettes.

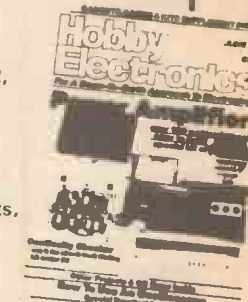
April 1981
Pre-Amplifier Part 1, Super Siren, Guitar Tremolo, Russian Roulette Game, Doorbell Monitor, Anatomy of a Space Shuttle.

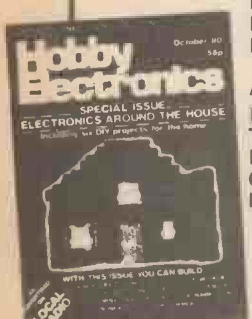
May 1981
Electronic Organ, Voice-Operated Switch, Infra-Red Controller, Pre-Amplifier Part 2, Audio Millivoltmeter.

June 1981
Power Amplifier Part 1, Continuity Checker, Envelope Generator, Early Radio, Gadgets, Games and Kits Supplement.

July 1981
Burglar Alarm, Doorbuzzer, Treble Booster, Electronic Aids for the Disabled, Power Amplifier Part 2.

August 1981
Electronic Ignition, Thermometer, Electronic Organ (final part), RPM Meter, Bench Power Supply, Radio Control Survey, Into Electronic Components Part 1.





All of the 1980 issues, except January and April, are still available together with the remaining issues from 1981.

All backnumbers cost £1.50 each. For those of you who only want copies of articles, we do offer a photocopying service. Each copy costs £1.50 and information as to its title and publication date should be given. Ordering backnumbers and photocopies could hardly be easier, just fill in the coupon, cut it out and send it to the appropriate address.

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FORWARD BIAS

Questions, answers and errata from readers and writers.

Telephone Timer

The Good News At Last

We have already apologised to readers for the regrettable failure of this project and announced our intention to correct the many design faults in it. The prototype *did* work and it was assumed that the circuit diagrams and PCB foil patterns supplied related to the working prototype, but it seems now that this was not the case. When we checked we found so many faults that the only recourse was to re-work the design and make new PCB foil patterns to ensure that it worked as described.

This task has been completed and all elements checked, double checked and checked yet again: not only does it work, but the circuit and PCB patterns exactly conform to the new prototype.

These new PCBs are now available and will be sent free of charge to any reader who sends us his old Telephone Timer PCBs together with an SAE adequate to cover the return postage (the boards are identica in size). This free replacement service is available only to readers who return their old boards to the HE editorial office (remember to remove at least the expensive components before you do!). First-time builders of the project must obtain their PCBs through our PCB service in the usual way.

We apologise again to readers both for the faults in the original project, which should have been spotted, and for the length of time it has taken us to correct matters: however we felt it was better to get it right the second time since we didn't the first.

We will be contacting all readers who have written concerning the Telephone Timer project to ensure that they have the opportunity to successfully complete the project. Ample time will be allowed for other, less demonstrative readers to exchange their PCBs, but we regret that the free replacement offer cannot be maintained indefinitely: it closes without fail on 9th December 1983 and old boards received after that date will not be exchanged.

If any reader is either unable or unwilling to strip down the old boards, we will supply a new PCB component overlay and circuit to enable the necessary changes to be made, but we do not recommend this. Because of the complexity of the design and the faults, a large number of track cuts and bridges are required and such a highly modified PCB cannot be expected to operate reliably. We will, however, supply the modifications notes to any reader who insists and encloses an SAE with his demand.

HE DigiTester

Nearly The Good News

This project is a good example of a design that looked good on paper but completely failed to work in practice. The situation was compounded when the original author was transferred overseas, leaving us with a handful of notes and a cover project to complete!

Once more the project has had to be re-worked, practically from scratch, and although not yet finished work is proceeding rapidly so that we are confident that the Digital Test Unit, as we have re-named it, will be ready for publication shortly.

Hobby 'Scope

No Good News Here

We are currently pursuing every avenue in our efforts to complete this outstanding project. The Hobby 'Scope was offered to us, accepted and commenced in the June 1983 issue: it will be completed.

The Big Ear

Good News To Come

This project has proved unreliable, when made up by large numbers of readers, because of variations in component tolerances — particularly varying IC specifications (we'd like to design all our projects around MILSPEC components, which would guarantee reliable performance, but they do tend to be somewhat expensive . . .)

However, we have recently commissioned a modification to the circuit which should take care of the problem, so look out for it on this page, soon.

Bat Light

Good News And Bad News

There were three errors in the published project: R12 was omitted from the component overlay; it should go between the two 'spare' pads that are between the supply voltage connections. The other two errors were in Figures 1a and 2 but since the PCB and overlay are otherwise correct, the project will work if it is constructed according to Figure 3, with R12 included.

All three corrections will be published in next month's Hobby Electronics.

COLLECTED BOOBS

Continuing excerpts from the Hobby Electronics Errata Box.

Short Circuit: Guitar Practice Amplifier *(HE August '79)*

On the **Circuit Diagram**, the +9V connection should be to pin 2 of IC1 and not pin 3 as shown.

Home Security System *(HE August '79)*

Figure 6: There is a track missing from the PCB for the siren. Link the junction of D1 and D2 to the adjacent pad where the 12V connection is made.

Figure 2: At the lower left corner of the Overlay, the wire marked Terminal Block 2 from R2 should be labelled Terminal Block 1. The 0V connection to Terminal Block 2 has not been shown — take it from any convenient point on the 0V track.

Miniboard Projects *(HE November '79)*

This article suffered from incorrect page layouts. To correct these, swap over the **Circuit Diagram.** Figure 1 on page 21 and Figure 1 on page 27, and swap over the *captions* for Figure 1 on page 21 and Figure 1 on page 23.

All the circuits and Parts Lists will now make sense.

Figure 3, page 22: On the component overlay, the resistor labelled R6 is actually R4.

Guitar Tuner *(HE November '79)*

Figure 1: C1 should be 0.uF as in the Parts List, not 1u0.

Figures 2 and 3: There should be a link from IC1 pins 8 and 9 to pin 7. C2 and R2 are transposed, but that won't affect operation.

Parts List: R3 should be increased to 100R to reduce current consumption.

R2D2 Radio *(HE November '79)*

Circuit Diagram: Q1 emitter should go to 0V; R5 should connect to the junction of C2, R1 and C3.

HE

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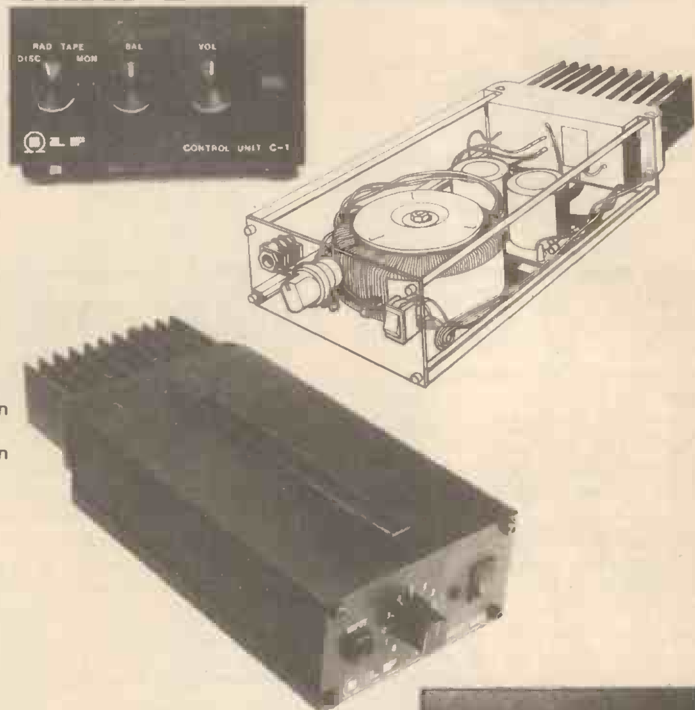

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Sound Pressure Level Meter

For those wishing to meet their sound, HE sounds out the meter — an easily calibrated Sound Pressure Level Meter, this is.

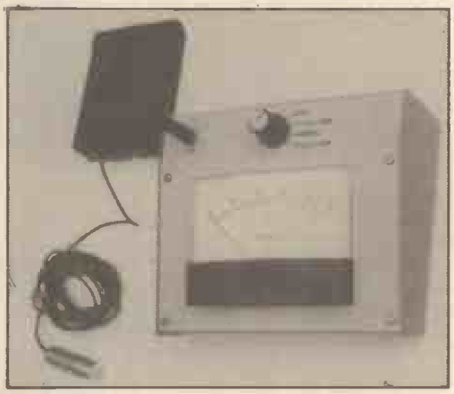
James E. Aman

The HE Sound Pressure Level Meter has been designed to provide a modestly priced and — most important — easily calibrated instrument for the measurement of sound levels in the range of 40 to 110 dB SPL. The range of sound pressure levels encountered in normal everyday living varies from about 50dB to around 100dB SPL (**Figure 1**), so the HE SPL meter is quite adequate for normal purposes, such as setting up a hifi system using a graphic equaliser and the SPL meter to check that the system is producing equal sound levels at all frequencies in the audio band. You can also use it for measuring the noise level from a neighbour's party before calling in the SAS!

On average the human ear can detect sound levels over a truly astounding range, from 0.0002 microbars up to 200 microbars, in fact (for comparison, the atmospheric pressure at sea level is 1,000,000 microbars). That is a range exactly of one million to one, and such large ratios are usually expressed as a logarithmic ratio with respect to an agreed reference level; in sound level measurement, the agreed reference level is 0.0002 microbars, corresponding to 0dB Sound Pressure Level (SPL). This level is also known as the Threshold Of Hearing and at the other end of the scale, around 120dB SPL, is the Threshold OF Pain, where a sound is so intense as to cause physical discomfort and possible injury. The level which is actually painful is very much an empirical level, different with different people, but 120dB SPL will cause degradation of hearing.

Traditionally the problem with SPL meters has been to devise a circuit which produces an accurate electrical analogue of the sound level, and then to calibrate a meter scale to accurately reflect changes in the sound pressure level. Normally the scale is logarithmic, since this is the only way to compress huge ratios into a meaningful scale (imagine a meter intended to read units from 0 to 1,000,000; that's an awfully long scale you've got there!)

The first problem is solved relatively easily by using a standard, known (but



inexpensive) microphone with a reliable linear response; that is, a given increase in the sound pressure level will produce a known increase in the microphone output.

The second problem is solved in a very radical manner, by using a digital integrated circuit to compress the linear scale of 1,000,000: 1 into a logarithmic scale ranging from 40 to 110dB SPL. The circuit, as you will see, consists of a switched range linear amplifier to boost the microphone signal; a precision rectifier to peak-detect the signal, and a logarithmic 30dB display driver coupled to a linear motor; the LM3915 LED bar-graph driver is used here as the linear answer to logarithmic metering! Now read on . .

Sound Circuits

Sound is picked up by an electret condenser microphone, which produces a very strong output to give a good signal-to-noise ratio and freedom from hum and interference. This is fed to the non-inverting input of IC1 via a fixed attenuator consisting of R1 and R2, to reduce the signal to a manageable level.

IC1 is wired as a switched-gain non-inverting amplifier. The feedback around the IC is taken via SW1 so that three different gains are available; thus the sensitivity is selectable by plus or minus 20dB. The four positions switch from Off to Scale -20dB, Normal Scale and Scale +20dB.

The supply rails to IC1 are isolated from the main supply by two transistors, Q1 and Q2. The value of

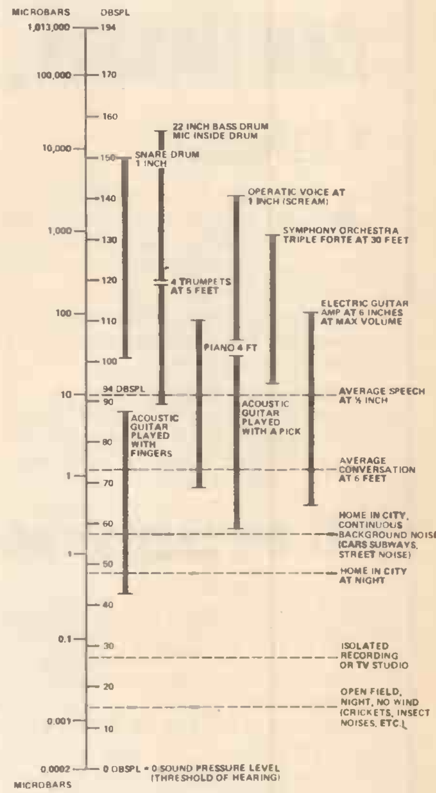


Figure 1. A sample of sound pressure levels encountered in everyday living (if you happen to live next door to a recording studio.).

the capacitors connected between base and earth are effectively multiplied by the beta (DC current gain) of the transistors, typicaly 100 for the types used, forming smoothing capacitors of around .02 farads. These keep the supply to IC1 rock steady, even when IC4 draws varying current, resulting in a very stable amplifier.

The output of IC1 is fed to IC2 for further amplification; it goes via PR1, which is used to set the overall system level.

IC3 is connected as a precision half-wave rectifier, where the threshold voltage (OV6) of the two diodes is effectively reduced by the equivalent of the open-loop gain of the op-amp. The precision rectifier is set-up as a peak detector; filter capacitor C8 is charged up on each positive peak, via R13, then discharges via R13 and R12.

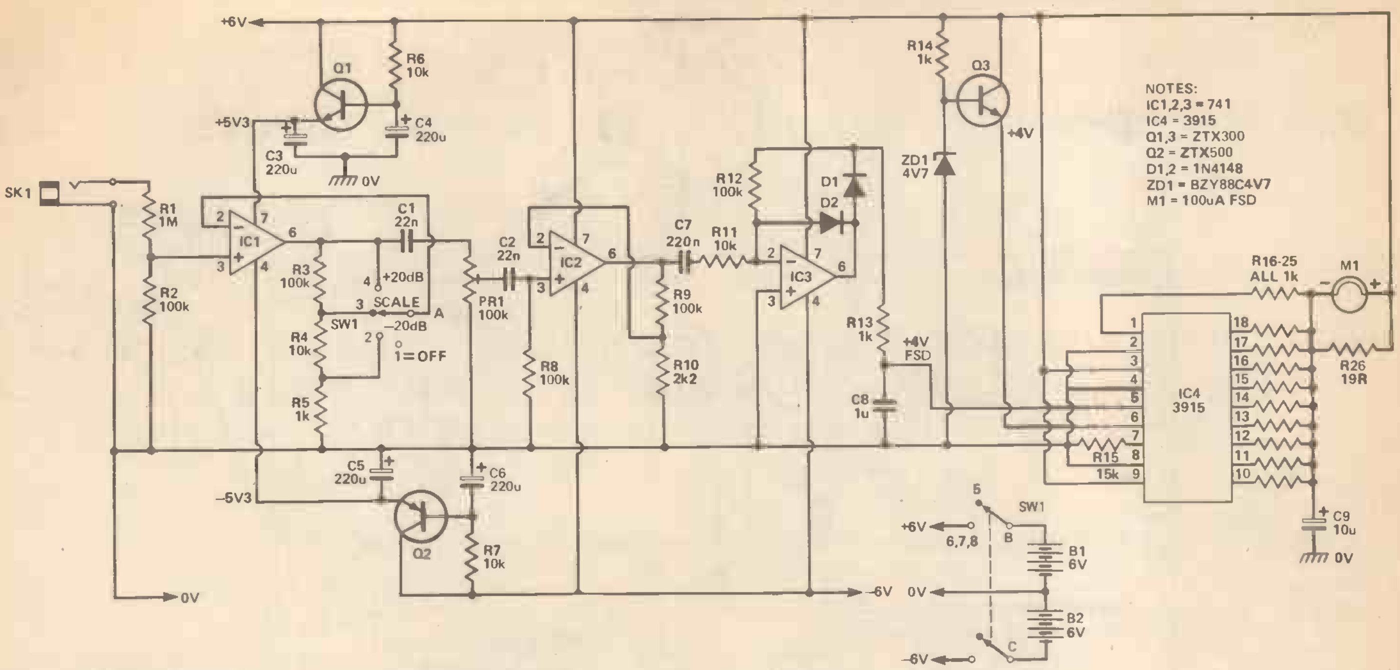


Figure 2. The circuit.

This arrangement gives the fast attack and slow decay times required for peak detection; to convert to average-reading, the values of R12 and R13 should be reversed, ie R12 should be 100k and R13, 1k.

The signal at the junction of R13 and C8 is a DC level, and this is fed to pin 5 of IC4, and LM3915.

This IC is normally used to drive an array of LEDs in either dot-mode, where only one LED is illuminated at one time, or in bar-mode, where the line of LEDs light up successively. It converts an analogue input voltage to directly drive up to ten LEDs, with the amplitude of the input determining the number of LEDs (in bar-mode) illuminated.

[*Internally the LM3915 is very similar to the array of comparators driving the LEDs in this month's Gripometer project* – **See Figure 4, overleaf.**].

Linear To Log

The LM3915 has logarithmic characteristics; each output is turned on by a successive 3dB increase in the input amplitude, which is exactly the required relationship for measuring sound pressure levels that vary linearly by a factor of over one million! Instead of tediously having to calibrate a logarithmic meter scale, this IC converts quickly and simply from linear scale to logarithimic.

Each output, which goes 'low' when it is 'on', normally drives an LED connected to V+, and for this reason the outputs are all open-collector, or 'uncommitted'; thus if each output is simply connected to V+ via individual resistors only, the total current that flows from the supply rail is the sum of the currents flowing into each output. In the circuit, the outputs are summed in resistors R16-25, while the total current is measured by M1. And since each output represents a 3dB increase at the input, the meter reading corresponds to the input level, on a logarithmic scale!

The outputs from IC4 are from pins 1 and 10-18; pin 9 is connected to V+ and sets the IC to bar-graph mode, so that as each output becomes active the current it draws is added to the others. Pin 7 is the 'reference output' normally used to set the size of the 'step' at which successive outputs turn on; it is not used for this purpose here, but the value of the resistor connected between pin 7 and OV also sets the maximum current available to each output, so that R15 limits the total current to around six milliamps for full scale meter deflection (corresponding to 90dB SP on the normal scale).

The reference voltage needed to set the step size for this application is 4V, provided by the emitter follower/Zener diode circuit consisting of Q3 and ZD1; the OV7 base-emitter drop of Q3 is neatly offset by using a 4V7 Zener. The reference voltage is connected to the high end of the internal divider chain at pin 6, and the low end of the chain is connected to OV, so that the maximum input voltage the IC can accept for full output is likewise, 4V. Pin 8, the 'reference adjust' input, is not used and is connected to OV.

The specified meter is a 100 microamp type, which would not respond with pleasure to a maximum input sixty times higher, therefore it is shunted by R26 to increase the current range.

Parts List

RESISTORS
(All ¼ watt 5% carbon)

R1	1M
R2, 8, 9, 12	100k
R3	100R
R4, 6, 7, 11	10k
R5, 13, 14	1kR
R10	2k2
R15	15k (see text)
R16-25	1k
R26	19R (see text)

CAPACITORS

C1, 2	22n polyester
C3, 4, 5, 6	220u 16V axial electro
C7	220n polyester
C8	1u polycarbonate
C9	10u 16V axial electro

SEMICONDUCTORS

IC1, 2, 3	LF351 JFET op-amp
IC4	3915 log display driver
Q1, 3	ZTX300 NPN transistor
Q2	ZTX500 PNP transistor
D1, 2	1N4148 etc
ZD1	BCY88C4V7

MISCELLANEOUS

SW1	3-pole 4-way rotary (see Buylines)
SK1	3.5mm (¼") mono
M1	100uA panel meter

Altai EM-104 microphone; case; PCB; 2 x HP7 battery holders, PP9 clips; wire, solder, nus and bolts etc.

BUYLINES ....**page 34**

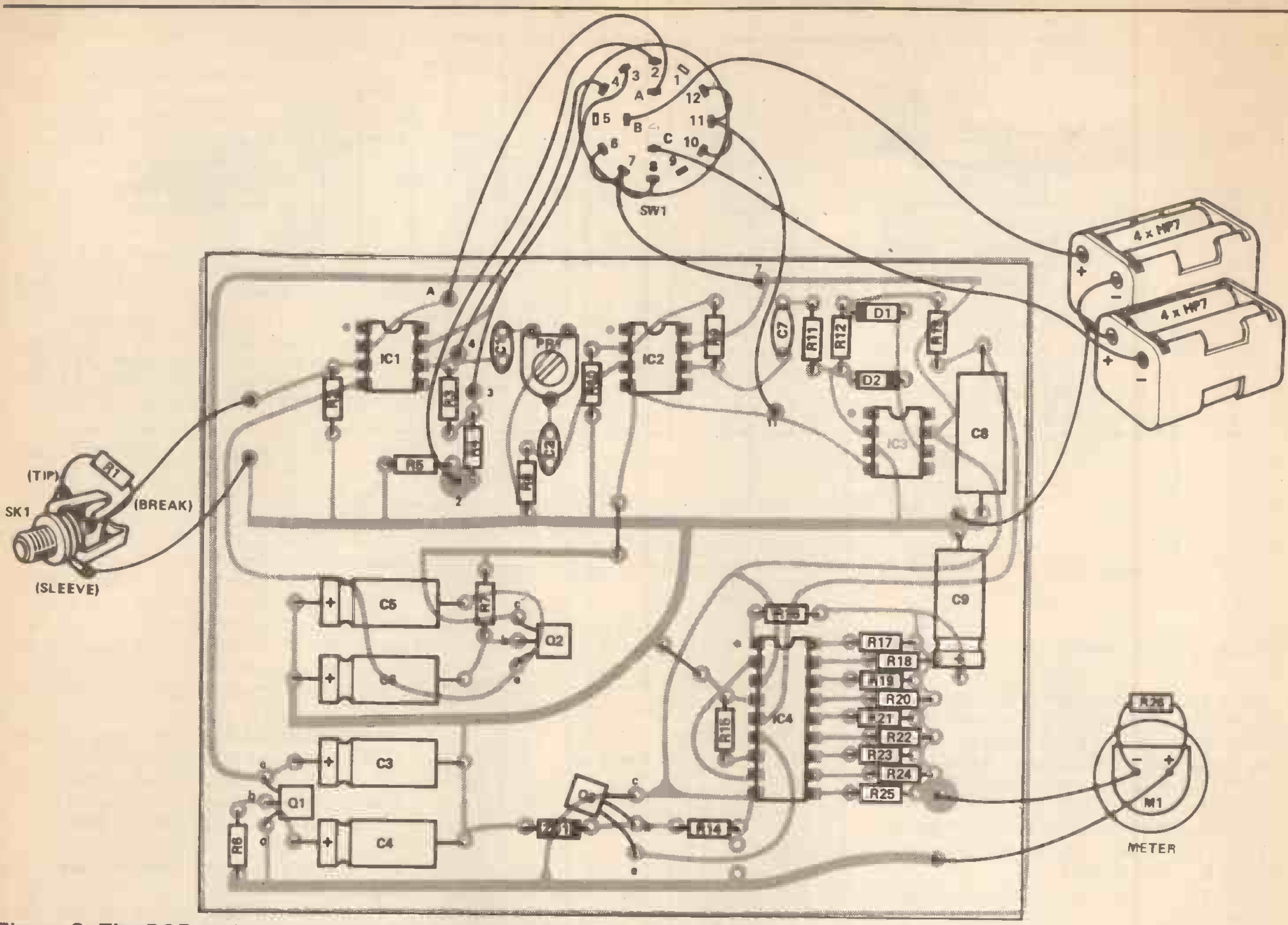


Figure 3. The PCB and components for the Sound Pressure Level Meter.

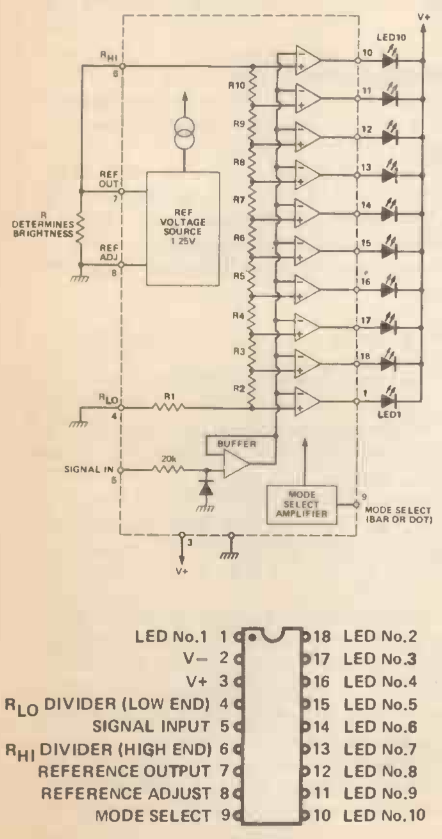


Figure 4. Inside the IC4, the LM3915 (see page 15 above).

Construction

Assembling this project should present no unusual problems. The PCB together with the component layout diagram (**Figure 3**) facilitate construction.

When wiring the microphone jack to the board, a twisted pair or screened lead should be used to minimise hum problems and R26 should be mounted directly on the jack socket. The one specified has an extra shorting contact which opens when a jack is inserted and this spare compact can be used to mount the R2-end of R1.

The meter shunt resistor R26 is made up from a 22 ohm resistor in parallel with 150 ohms, and these should be soldered across the meter terminals.

The range/power-on switch, SW1, should present few problems provided the specified type is used; it is a CK 3-pole, 4-way switch, readily available from most suppliers, and all the pins are numbered so they are simply connected to the numbered points shown in the overlay diagram.

Please note that the circuit is intended for use with an Altai EM-104 electret condensor microphone, which has a high level output and an exceptionally flat response for its type. They are readily available, but if another type is used then the calibration becomes a matter for the dedicated experimenter!

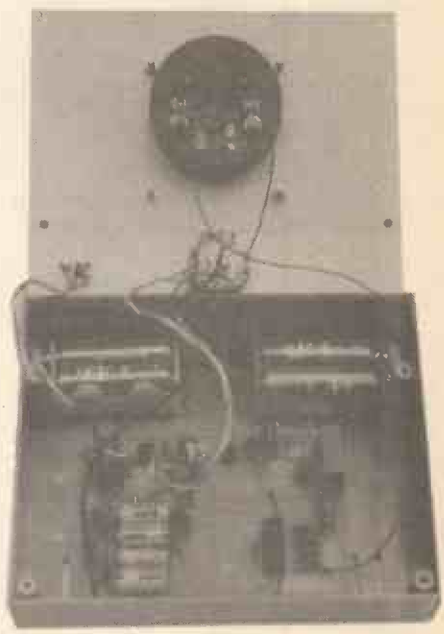


TABLE 1

SW1 POSITION	IC1 PIN 6
SCALE –20dB	150mV p-p
NORMAL SCALE	15mV p-p
SCALE +20dB	1.5mV p-p

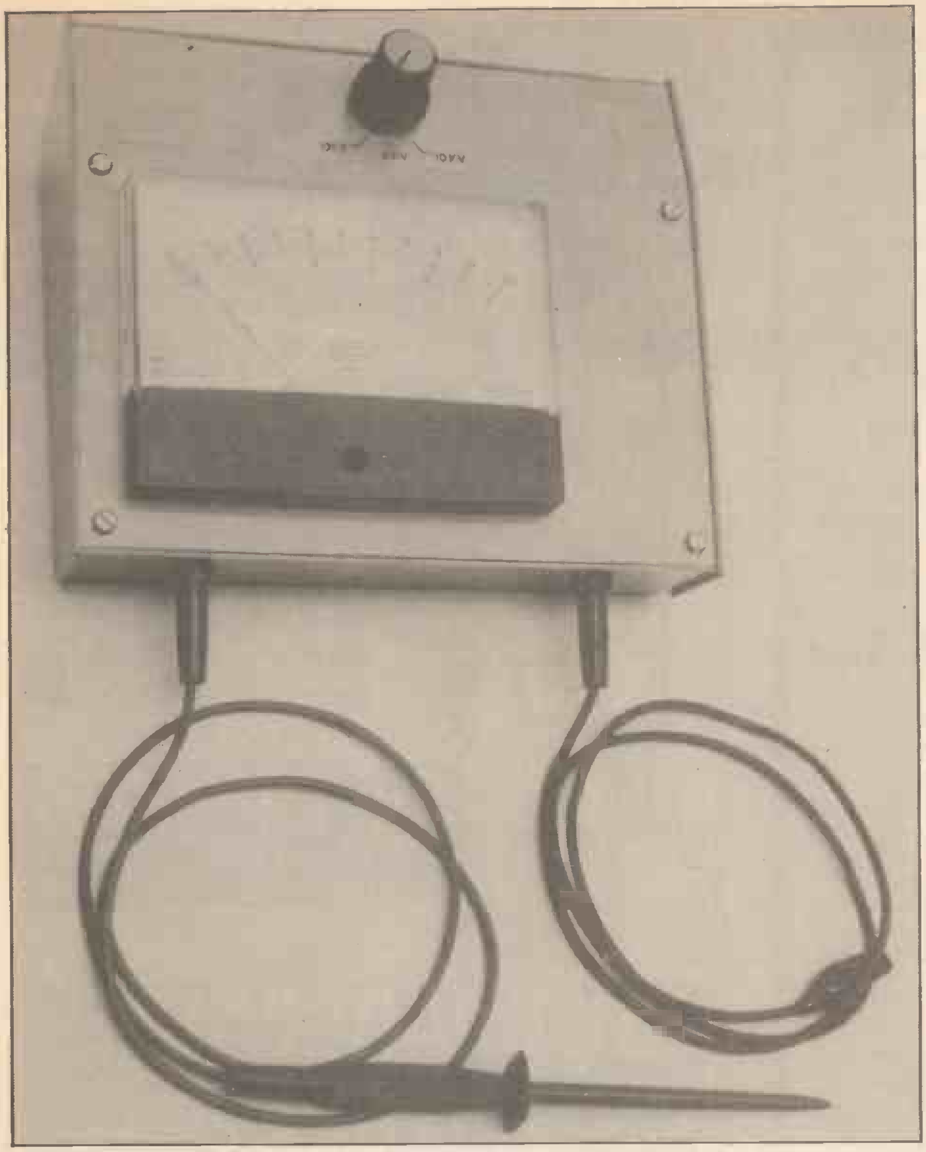


Table 2		
PIN 5 (V)	METER READING	CURRENT
4.0	90dB	6mA
2.8	87	5.4
2.0	84	4.8
1.4	81	4.2
1.0	78	3.6
0.7	75	3.0
0.5	72	2.4
0.36	69	1.8
0.25	66	1:2
0,17	63	0.6
0.	60	0.0

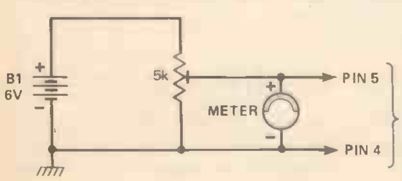


Figure 5. This circuit can be used to calibrate the IC4 circuit.

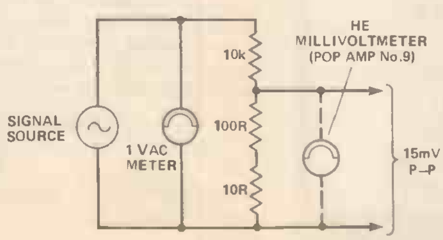


Figure 6. Using a millivoltmeter to calibrate the SPL meter.

Calibration

With most sound pressure level circuits, accurate calibration requires an extensive range of test equipment and near-perfect acoustic conditions] but not this time! So long as the specified microphone is used, calibration of the HE SPL Meter is simplicity itself. For best results, an oscilloscope should be used, but an ordinary multimeter will do if less accuracy is acceptable.

First disconnect the microphone from the input jack and connect instead the output of an audio signal generator; the signal should be 15mV peak-to-peak at a frequency of ≈1kHz. Now, with an oscilloscope if one is available, observe the output of IC1 at pin 6; it should follow the readings given in **Table 1** as the range switch SW1 is rotated.

Leave the range switch on Normal Scale, move the 'scope probe to monitor the output of IC2 and adjust PR1 to bring this to 500mV p-p. Now you should be able to observe 2.5VDC at pin 5 of IC4 and a meter reading of 84, equivalent to 84dB SPL.

If the needle fails to come up to 84 — don't despair! It can be "tweaked in" by adjusting the value of either R15 or R25; reducing the value of R15 increases the current drive to the meter while increasing the resistor reduces the current; making R26 lower reduces the current but increasing it makes the meter read higher.

For those purists who doubt the effectiveness of the circuit, **Table 2** gives the voltages on pin 5 of IC4 for meter readings at selected points (the meter current is also given to allow a different meter to be used, if necessary — the value of the shunt, R26, will need to be re-calculated though).

The simple circuit of **Figure 5** can be connected between pin 5, IC4 and OV, first lifting R13, to check the calibration of the IC4 circuit against the values given in **Table 2**, if desired.

Scopeless

If an oscilloscope is not available, the SPL meter can be calibrated with a multimeter set to the AC volts range. (*Pop Amp No. 9, the High Impedance Millivoltmeter, is ideal for this purpose*).

With the meter set to its most sensitive AC range (eg 3V FSD), connect it across the signal source as shown in **Figure 6** and adjust the generator for a reading of 1VAC; then with the attenuator network shown, the required 15mV p-p can be applied to the input for a reading of 2.5VDC at IC4 pin 5, and a meter reading of 84dB SPL.

The meter scale face plate should be removed by its two screws and rescaled from 60 to 90dB across its 11 graduations, ie 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90dB SPL.

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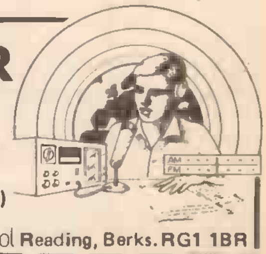

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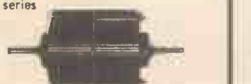


EXTRA POWERFUL 12v MOTOR
Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £7.95 + £1.50 post.
(This is easily reversible with our reversing switch – Price £1.15).

MAINS MOTORS
We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements. Some new ones just arrived.
67 R.P.M. Motor: 1/10 hp. reversible mains operated split phase motor with gear box – shaft fitted with chain sprocket £11.50 plus £2 post.
100 R.P.M. Motor: 1/16 hp. Mains driven reversible motor with gear box, ½" shaft from gear box – Very powerful £16.50 plus £3 post.
BALANCED MOTOR: Disc or tape drive motor 1500rpm reversible – mains operated. 3" dia 2¾" long with good length 3/8" spindle £4.60 plus 80p post.

CROSSOVER NETWORKS
2-way: 4 or 8 ohm impedance – power input up to 25W, crossover frequency 2kHz with wiring dig. 87p each.
3-way: 4 or 8 ohm – power input up to 60W, crossovers at 700kHz and 3500kHz with wiring diagram. £1.15.

– BARGAIN OF THE YEAR –
The AMSTRAD Stereo Tuner.

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

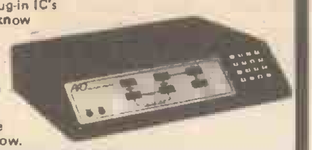
Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115 – 270 KHz, medium wave band 525 – 1650KHz, FM band 87 – 108MHz, mono, stereo & AFC switchable, tuning meter to give you spot on stereo tuning, optional LED wave band indicator, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board.

Offered at a fraction of its cost: **only £6.00** + £1.50 post + insurance.

THIS MONTH'S SNIP

A PRESTEL UNIT, complete except for 6 plug-in IC's – so far as we know the unit would work once the missing IC's are fitted. Price: £19.75 + £2.00 Post. Contains all the items listed below.



VIEWDATA EQUIPMENT
ORACLE VB 100 PCB
This is the heart of many viewdata systems, including the Prestel Unit which we are currently selling. This board uses 25 I.C.'s, 5 transistors, 2 crystals and very many other components. It has a TV aerial input and a TV UHF modifier (AZTEC UM 1233). We offer this board, new, unused and complete except for 6 of the 25 I.C.'s at £5.75. The plug in holders for the missing I.C.'s are on the board wired ready to receive them.

MINIKEY SERIES KL
This is an American made membrane keyboard with silver contacts as used on Prestel to dial into the British Telecom phone system. It is really miniature, only 60mm x 65mm x 5mm thick. It has 16 press buttons, giving standard 0-9 numbers and ABCD facilities. There are two other buttons engraved asterisks. This is an extremely well made board. £4.60.

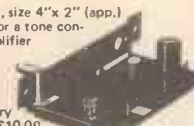
TELEPHONE LINE TERMINATION UNIT
As used with Prestel but undoubtedly suitable for other applications. Important components are phone line isolation transformer and 3 Clare Reed Relays. All mounted on a pcb with I.C. and other components P.C.B. size approximately 7" x 1¾" – £3.45.

VOLTAGE STABILISED POWER SUPPLY
As used with Prestel this has a mains input transformer with a 13v - 0 - 13v 20 watt mains transformer. Rectifiers and semi-conductors all mounted on P.C.B. size approximately 4¾" x 2". The stabilised DC output from this is –27v – 12v – 0 +0 +12v +27v. Price £4.60.

INSTRUMENT CASE
As used with the Prestel unit this comprises an ali chassis and a moulded front plastic cover secured to the chassis by self-tapping screws. Overall size approx 12"x 10" x 2½" deep. On the front is fitted the minikeyboard as described above and although originally intended for Prestel, this case should have other uses including telephone answering machine, etc. Price £5.75 + £1.50 post.

X-RAY EQUIPMENT
Beautifully made by the American GEC Company. We have a whole range of spares, all unused. **X-RAY TROLLEY** - This could be motorised, mains or battery driveb with self retractable flex lead, so it could be used for carrying other mains operated equipment which need to be manouvered easily in a relatively confined space. Switching and breaking is done from the handle and there is ample room and capacity for heavy transformers and smaller equipment. The overall size of this trolley is approx. 3' x 2' x 3'6" Price £69.
X-RAY HEAD This comprises the x-ray tube in a radiation proof housing with plug in lead connectors. The tube enclosed in the housing is a hospital size tube and unused and new. Price £69.
EHT TRANSFORMER & RECTIFIER UNIT We estimate that the output voltage of this is probably 30 or 40 KV. Completely enclosed in an oil filled container, size 13" x 14" x 15". There are four rectifier sections, each using 20 EHT rectifiers connected in series these plug in for ease of replacement. The unit is powered by a 600 cycle supply. Price £69. **600 CYCLE SUPPLY UNIT** Mains operated through a step down transformer, this contains all the electronic components to operate the equipment. Price £57.50.

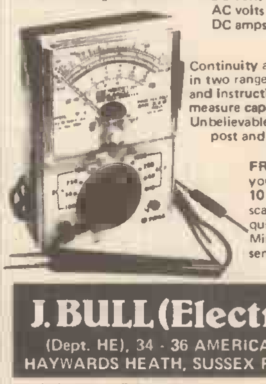
MINI MONO AMP
on p.c.b., size 4"x 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.



50 THINGS YOU CAN MAKE
Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 Items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and notes on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

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 enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send £2.50.

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MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: write for quote. Shop open 9.00 – 5.30, mon to Fri, not Saturday.

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Mains operated – ex-computer.
Woods extractor
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6" – £6.95, Post £1.25
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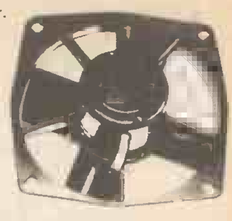
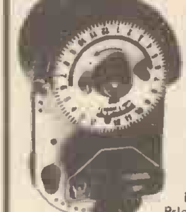
4"x 4" Muffin 115v, £4.50. Post 75p.
4"x 4" Muffin 230v. £5.75. Post 75p.
9" American made £11.50, post £2.00.
12 volt 6½" extractor £6.90, post £1.50.



AUTO & ISOLATION TRANSFORMERS
2 KW ISOLATION TRANSFORMER 230v in 230v out with tapped primary and secondary, facilities any voltage changes that might be needed. This is a very heavy transformer, American made but not encased. The terminals are along the top on insulation board panels. Both primary and secondary are split so this sould also be used as a 2KW isolation step down transformer. £57.50. Carriage at cost depending upon the distance. This is approx half the regular price.
2 KW AUTO TRANSFORMER Similar type of transformer to the above but has only the one winding. £28.50 + carriage £3.
1 KW ISOLATED AUTO TRANSFORMER It is not generally realised that many of the American made tools intended for 115v, if used on building sites and similar damp conditions must be isolated from the mains for safety reasons, as in many cases the insulation of this equipment is not good enough for 230v. We have American made isolated auto transformers, completely enclosed in sheet metal case with carrying handle with 230v lead and 110v American type plug. Price £46.00 + £4.50 post.
300 WATT AUTO TRANSFORMER completely encased, lead for the 230v input, American type plug for the 115v output £6.90 + £1.50 post.
100 WATT AUTO TRANSFORMER not enclosed terminals, output primary with tappings for voltage adjustments. Made to rigid specification for the GPO £4.60 + £1 post.
AMERICAN 2 PIN FLAT SOCKETS for use with these auto transformers – £2.30 each.

3M FACSIMILE EQUIPMENT
– send or receive a document in 4 minutes. This equipment is used for sending letters and almost any data through the telephone system – "Mail by Phone". The machines we have are the 3M 600BB with autofeed complete with ansafonettes and connector box. We have three sets of the equipment, it is not old, in fact it was used only for about a year (1980-81), believed to be in good order and certainly in a very good condition – cost new over £10,000. We will accept £500 the lot – buyer to examine and take away on an "as seen" basis.



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 case - £1.75.
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 controller for the Immersion heater. Price of adaptor kit is £2.30.

IONISER KIT
Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.
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Morse Trainer – complete with key	£2.99
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Drill control kit – made up	£6.95
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Transmitter surveillance kit	£2.30
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Aerial direction indicator	£5.50
40 watt amp – hifi 20hz – 20kHz	£9.50
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Power supply for one or two 115 watt amps	£17.50
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Hobby Electronics

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October issue on sale at your newsagent from 9th September. Place your order now!

Although these articles are being prepared for the next issue, circumstances may alter the final content.

This is the Great

Hobby Electronics

Computer-Controlled Model Railway COMPETITION

Sponsored by Oric Products International Ltd., Beatties of London Limited and ASP Software (a division of Argus Specialist Publications Ltd.).

WHEN it was proposed that there should be a Grand Computer Controlled Model Railway Competition for the 1983 Breadboard exhibition, we rapidly became bogged down with seemingly endless complications. We spent most of the time during discussions simply explaining jargon: what, to a computer hardware man, is a "dead frog"? Something unpleasant by the roadside, was the popular answer! On the other hand our modelling consultant was somewhat bemused by the many acronyms that punctuate conversations between computer buffs: who, or what is a PIA? Bits of what? What is a multiplexer, and so on, and on, and on . . . !

In the end we were all quite bewildered — but this confusion ultimately gave us the clue to our Computer Controlled Model Rail Competition: no one, it seems, truly knows how best to marry a computer to a complex model rail layout or what it should do and, particularly, how it should be done.

We decided, finally, that the simplest and best approach would be to throw the thing wide open, with only a few essential restrictions. The only rule of the competition, then, is that the winning entry will be that which demonstrates the most ingenuity, usefulness and practicality in adapting a modern home computer to control a model railway layout — the what, how and why we quite happily leave to our readers!

The essential limitation we felt obliged to impose is that the layout should measure no more than 6ft by 2ft — in other words, something that can be transported to the Breadboard exhibition in Hammersmith in late November this year.

We anticipate that most of the entries will be from constructors who have an existing computer interfaced layout, but the competition is open to all comers so anyone who wants to "have a go" will be welcome in the lists. For the benefit of those who fancy their chances at the Grand Prize, here are a few ideas that resulted from the meeting of the minds in Hobby's editorial offices (we won't mention the ideas that evolved later, down at the Royal George!).

- A fairly simple software application would be to write a program for storing and modifying timetables and operating schedules; an extension of this idea would be an interface to position sensing circuits so that an operator would know not only when the next train was due to leave, but also when it was safe to start down the track.

- One of the most obvious ideas proposed was to program a mimic board which could show not only the track layout but the condition of signal lights and with 'train in section' indication: colour would be necessary for user-friendliness!

- Ways to adapt microprocessor technology to model train control: one option that might be easily constructed would be to computer-control sections of track rather than individual trains. However completely automatic running is not the goal of most railway modellers, so any system should allow lots of room for the operator to control the layout himself.

And that is about the limit of the ideas we came up with before brain fog set in. We'll leave it to the inventiveness and competitive spirit of our readers to stun the judges with brilliant projects we should have thought of . . . but didn't!

1 FIRST PRIZE

Hot off the production line, an Oric 48K colour computer, donated by Oric Products International Ltd.

2 SECOND PRIZE

Gift vouchers to the value of £50, redeemable on model rail products at any Beatties of London shop.

3 THIRD PRIZE

£25 worth of games and utility program tapes from ASP Software.

Entry forms, together with an entrance fee of £1.00 (cheque or money orders only, please) should be sent to:
The Exhibition Manager, BB83, ASP Exhibitions, 145 Charing Cross Road, London WC2H 0EE.

Closing date is 31st October 1983. Judging will take place at Breadboard '83, Cunard Hotel, Hammersmith, London W6, on either Wednesday 23rd or Thursday 24th November 1983. Entrants will be informed of the day on which they will be required to present their layouts at the exhibition. Finalists will be asked to demonstrate their layouts at some time(s) during the open days of Breadboard '83 (25, 26, 27th November) and layouts will be available for collection between 1600 and 1800 hours on Sunday 27th November. **The judges decision will be final and no correspondence will be entered into.**

Entry Form

PLEASE USE BLOCK CAPS

NAME: ....

ADDRESS: ....

....

TEL NO: .... AGE ON 30TH NOV. 1983: ....

BRIEF DESCRIPTION OF LAYOUT AND FUNCTIONS: ....

....

....

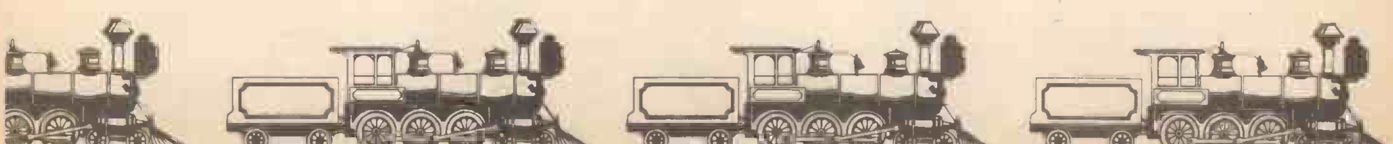
....

SCALE: .... SIZE OF LAYOUT: (MAX 6FT X 2FT): ....

COMPUTER USED: ....

COMMERCIAL PERIPHERALS USED: ....

....



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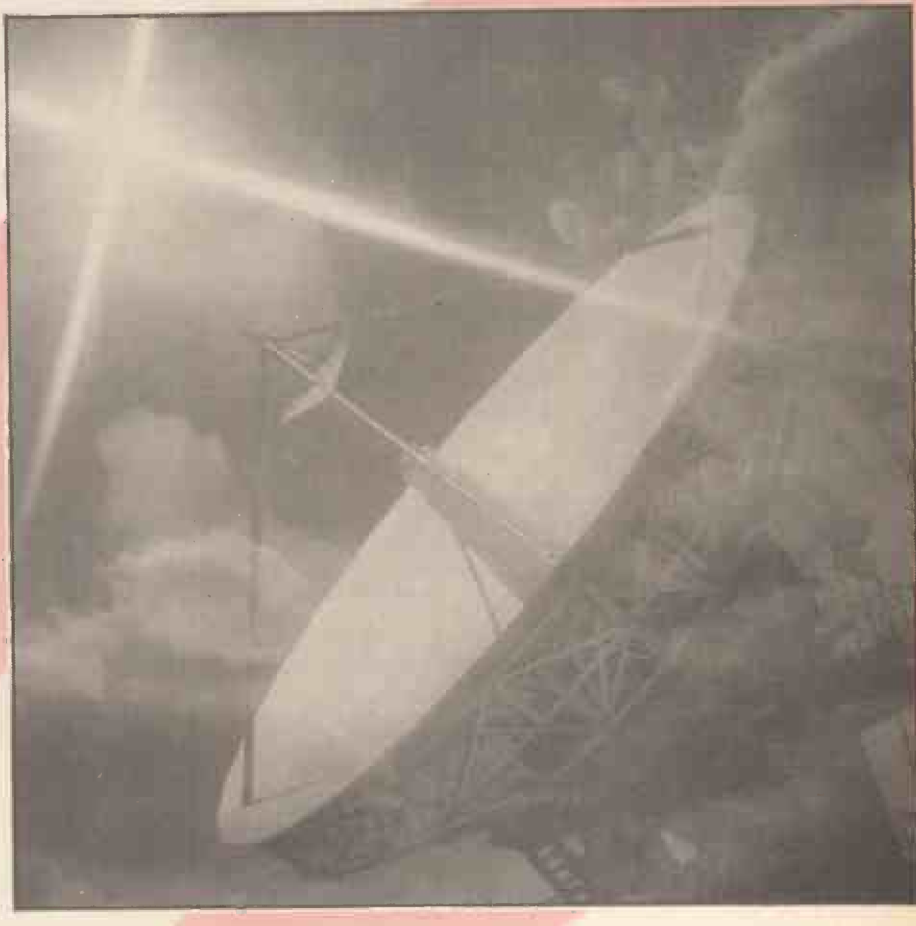
CABLE AND SATELLITE TV

Helen Armstrong
Graham Brant

The arrival of television distributed by cable and by Direct Broadcast Satellite will give a wider viewing choice than ever before. We explain how the different systems will function and interact.



Courtesy of British Telecom

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IT IS APPROPRIATE that 1982, as Information Technology Year, saw the green light for both satellite and cable television, as well as the launching of Channel 4. The technological advances of the past decade have resulted all at once in a rapid expansion in the electronic media, which seems likely to change the face of broadcasting as we know it in a surprisingly short time. The technical and political aspects of these sudden changes present problems, not only new, but highly complex, considering the international nature of broadcasting. The debates go on. Only time will tell what form of programme networking will emerge, or how it will affect the TV system we have at the moment. Television has already invaded the territory of the cinema with video, and the uncertainties attending the arrival of rival video systems may be thrown into deeper confusion as television diversifies still further.

Cable Sources

Cable transmission began as long ago as 1929, with the distribution of radio programmes. The first television systems in this country started in 1948 with companies such as EMI, British Relay and Rediffusion being the early pioneers. From the start the cable systems in the UK have been localised, providing only BBC, IBA and some local community television programmes.

In the USA however, where cable TV is already a fact of life, the lack of a single national television network prompted the growth of cable in areas with little or no service, which was in the vast majority of areas away from the big city centres. VHF systems were generally used since VHF television sets were readily available.

Cable television systems have been set up in various new town developments around the country on an experimental basis, starting in 1966 with Washington, Co. Durham, and extending later to Irvine in Scotland, Craigavon in N.Ireland, Brackla in Wales and Milton Keynes, Walderslade and Martlesham in England. The networks used dual cables, coax for the television signal and telephone cable for the audio. These were all set up and run by British Telecom. But all the schemes set up in the sixties and seventies ran into the Government's refusal to let them carry anything other than the two BBC and one ITV channels.

In November 1980 the Home Secretary licenced several pilot subscription TV schemes until December, 1983. Apart from British Telecom, companies involved were Rediffison, Visionhire, Philips Cablevision, Greenwich Cablevision and Radio Rentals — mostly big TV rental companies. The new schemes included general release feature films and independent TV channels. However, what will happen when the initial period runs out is not known — except that it is now generally accepted that cable TV is here to stay and that it will include material completely independent of the BBC and IBA/Independent ITV companies. One result of this is bound to be an expansion of independent programme-making companies, with no involvement in transmission at all, simply making their own features to market to television companies. Cable networks are also allowed to supply feature films after one year's general release, as opposed to three years for the BBC and IBA — a purely economic arrangement.

Cable networks often use recording and transmission equipment which does not entirely match the 'broadcast standard' used by the big organisations, but this is hardly likely to cause a serious degradation of picture and sound quality — certainly less than that occurring with an ordinary domestic VCR, probably less than that caused by a slightly ill-adjusted telly — not a serious problem.

A 'spider man' services undergrounds cables.

The System Today

With the present UHF television network the programme source, whether live or prerecorded, is generated at the studio or by an outside broadcast (OB) unit. Programme selection is carried out at a main broacasting centre, or network switching centre, before the transmitter network is fed with the desired signal. The main UHF signal is then broadcast from about fifty or so high powered transmitters. Some, Crystal Palace for example, transmit at a power of 1MW erp from the aerial complex. Together these signals reach about 85% of the population of the UK through the extensive network of relay stations, either in operation or in the process of being built, which provide 'fill in' signals in areas of poor reception. Some of these are very localised indeed, particularly in mountainous areas where small valleys can be completely shielded from signals by surrounding hills.

The relay station building programme has now achieved an overall coverage of 99% of the population, which is perhaps one of the highest in the world from a terrestrial system — one of the advantages of being in a small country where networking efforts can be co-ordinated into a single system.

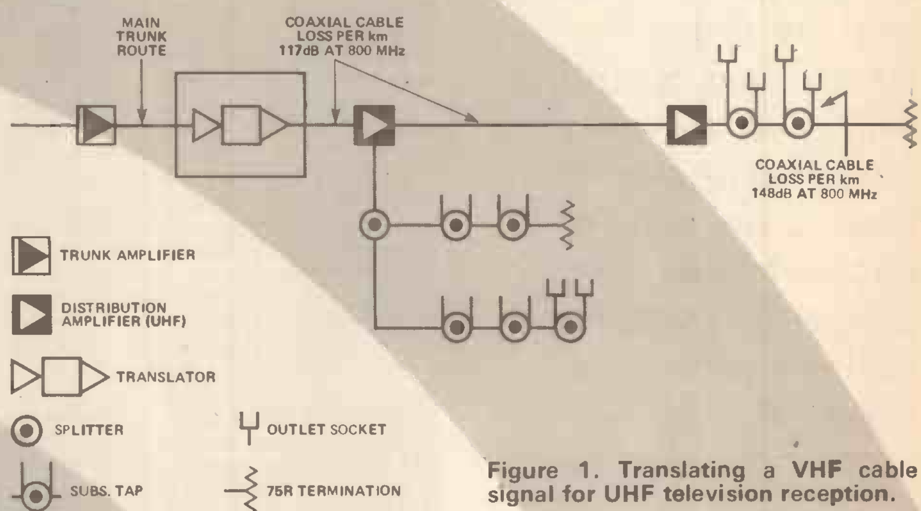
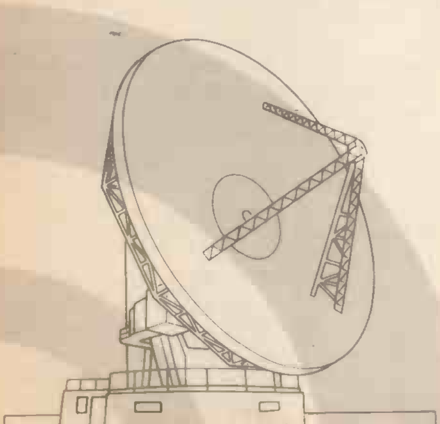


Figure 1. Translating a VHF cable signal for UHF television reception.

The initial costs were low, about £1 per potential viewer, but with small relay stations serving communities of down to 200 people the cost is more like £100 per head. With such an extensive network already in existence, it is perhaps not surprising that many people are sceptical of the future success of cable and satellite TV. Both the IBA and the BBC view cable with suspicion because of the potential loss of viewers and the higher costs generated by more programme competition. The BBC needs a large audience to justify the television licence fees, and the IBA likewise needs viewers to generate advertising revenue.

It is worth remembering that the large UHF stations are near population centres which could easily be cabled, whereas the relays tend to be located in rural areas which are unlikely to be served by cable. Even plans to run TV cables along sewer networks will not succeed in carrying cables to many country areas!



Cable Works

There have been two approaches to cable distribution systems: Frequency Division Multiplex (FDM) and Space Division Multiplex (SDM) systems. With FDM, a number of television channels are sent down one cable, usually coaxial, whereas with SDM a separate cable is used for each channel, usually with balanced feeders rather than coaxial.

Anything up to seven channels can be provided, but many of the old experimental systems cannot even take Channel 4. About half of the existing channels are VHF, but most are UHF, and will therefore not need an adaptor for the average domestic television set. There are a few systems which use VHF for main trunk distribution and convert to UHF for local distribution. Although most of these systems only relay BBC

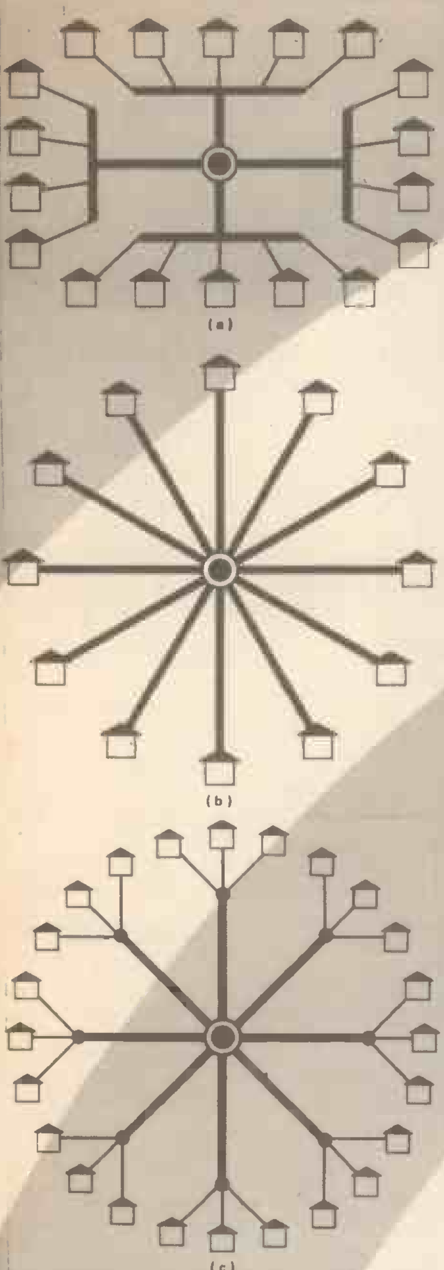


Figure 2. Alternative distribution networks: a) Tree and Branch b) Star and c) Multi-star.

and IBA programmes, there are a few which provide a pay-TV service, for example in such places as Milton Keynes and Greenwich, London. Most of these existing systems are technically worn out, and further developments have been slow to take place due to the good terrestrial broadcast system. On the Continent, operators have been allowed to broadcast foreign programmes as well as those produced locally, but development has still not taken place on the scale of that in the USA.

The USA cable systems were initially of six to twelve channel capacity using VHF frequencies, mainly relaying a number of channels from an off-air reception point. These later developed into thirty-channel systems, which included channels provided specifically by the specialist cable TV companies. There are now a few 'super' systems in the cities such as New York and Los Angeles, and these provide up to 104 channels along two cables each of 52 channels capacity. Frequencies used are 54 to 400MHz, with the 5 to 35MHz spectrum available for viewer feedback, electronic voting, etc.

Star And Branch

While it might appear straightforward to connect every television consumer into a cable system, the architecture is not simple. There are two distinct systems in use in the UK, both using FDM: the 'Tree and Branch' system and the 'Star' system. The most common is the Tree and Branch, which is easiest to implement . With Tree and Branch all consumers are simply looped together with all services available to each consumer. The system is rather inflexible and has a number of drawbacks. The signal is continually split up on the outward transmission, requiring large numbers of distribution amplifiers which are very prone to producing distortion and unwanted by-products. In a similar fashion any unwanted signals on the network are continually added if they are feeding back to the source, ie the television company. This problem is usually apparent with random noise — and noise in the network can be a problem when added up. To overcome this a very high standard of network screening is required, because any extraneous interference has the potential of disturbing the whole system. If a two-way service such as electronic voting is desired, then a very complex digital protocol is required to sort out the mass of data which would arrive at the TV company at the same time.

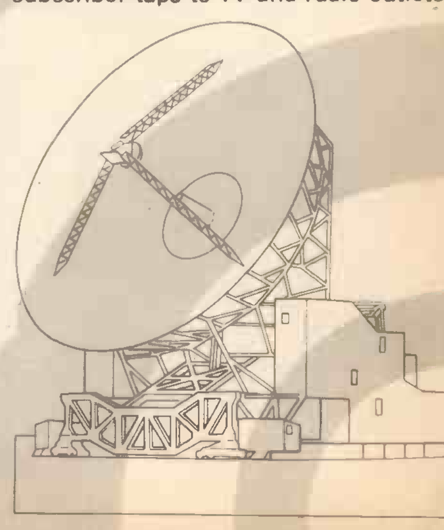
The Star system has a more complex architecture, but is more versatile and can be readily expanded over a period of time after the main system has been constructed. The disadvantages are very much less than the Tree and Branch, especially with regard to distortion and interference problems at one point in the network, which would be very unlikely to be transmitted to any other part. The technology is very much newer though, and more technical research may be required, unlike the Tree and Branch system, which could be implemented tomorrow. This would provide a good chance to export British technology rather than import foreign products, such as happend in the rush for CB. The architecture is very similar to British Telecom's "System X" telephone system, and it could well be that they are the best candidates to install any future network.

Forty Into One Won't Go

It is unlikely that any future service would be permitted to use VHF, as there are too many mobile radio, aeronautical and general communication services present in the UK, and any break in a large scale cable TV distribution system would provide a potentially major source of interference. It is likely that frequencies would be restricted to those in the UHF TV band. This provides theoretically a maximum of forty channels per cable; there are however a number of factors which drastically reduce this figure. Local TV transmission channels must be avoided to prevent mutual interference. Local oscillator radiation must also be considered; when a TV receiver is tuned to one channel, then the local oscillator will usually be at the frequency very near that of another channel in the UHF band. This signal is often radiated from the receiver and can cause problems to a view in the network viewing the channel. Adjacent channels cannot be employed either, since the normal domestic receiver is not selective enough to differentiate between any two consecutive channels. Having taken these factors into account, it seems that it is only possible to utilise between seven and nine of the forty channels at any one time! For interference-free reception, . optical fibre distribution would provide a solution, but the high cost of a decoder for each consumer is unlikely to prove attractive in the near future. Perhaps the best solution is provided by the Star system.

The main distribution trunks could then be optic fibres feeding flexibility points, while the individual cables feeding the consumer would use UHF. To overcome the shortfall in capacity of these local cables, programme selection could be carried out remotely at the flexibility points; in the ideal case the consumer would merely type in the programme of his choice. Unlike the Tree and Branch system, therefore, each consumer would not necessarily be in receipt of every channel.

Programmes are received, firstly, by an aerial array, and then processed into a form which can be routed along trunk cables, which may be up to 12km long. This requires the signal to be converted down to VHF to prevent disasterous attenuation in the cable — even then, amplification is needed every 420m. Subsequently, a translator link restores the signal back to UHF, with a VHF bypass for 405 line transmission, and radio. From there the signal goes through a series of cable splitters and subscriber taps to TV and radio outlets



in subscribers' homes. Another option which has only been tried experimentally so far is the use of optical fibres for cable transmissions. The economics of cable are such that the cost is approximately £12,000 per mile. It could cost £6M alone to cable Bromley in London! To cable the large UK cities and achieve a 50% population penetration could cost 2½ to 3½ billion pounds.

Bearing in mind the controversy over Channel 4, it is likely that some organisation will need much more convincing on potential returns before committing themselves to such an investment. The coming of cable-TV is unlikely to create more than a few hundred jobs in the long term, not the thousands predicted in the popular press. A scheme of thought against cable TV is that with the increasing ownership of VCRs, the younger generation are happy with what they have, and the older generation are perfectly content with existing media. This is, however, a rather pessemistic view.

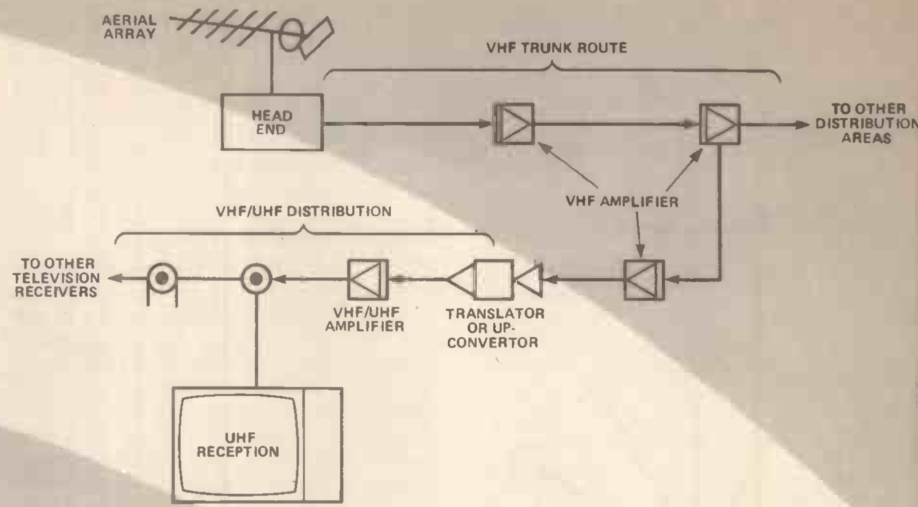
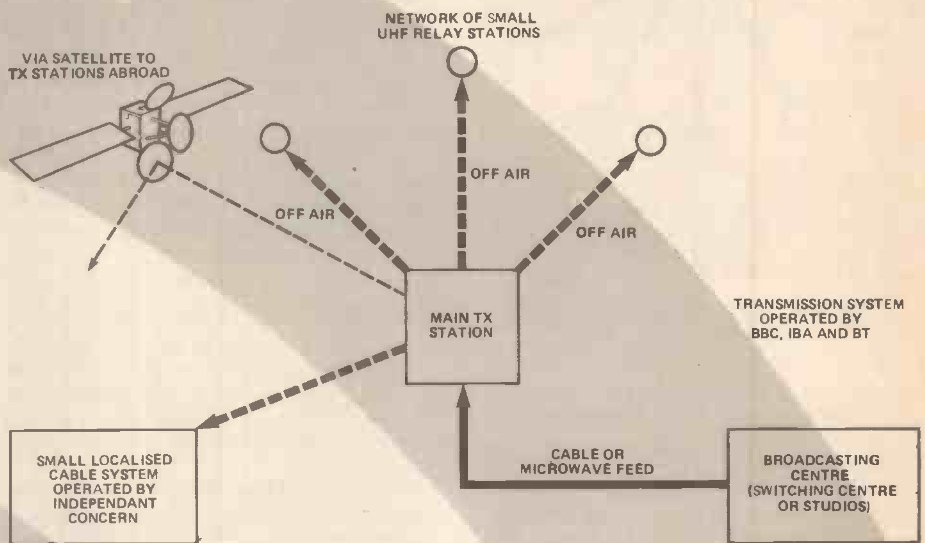


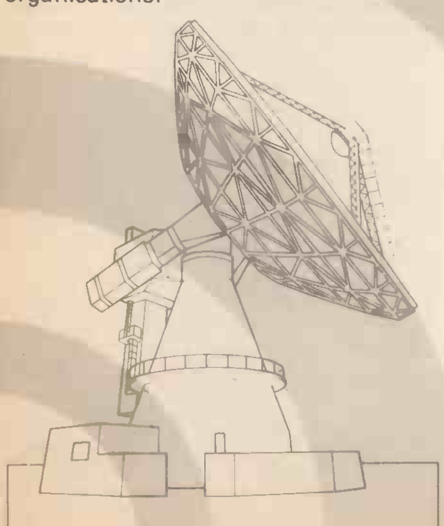
Figure 3. A typical hybrid VHF/UHF cable system.
Figure 4. Modes of distribution in the existing television network.



Direct Broadcast Satellite

While cable television shows some signs of being a more conspicuous public issue, as well as a more established basic technology, 'satellite TV', referred to as DBS (Direct Broadcast Satellite) TV, to distinguish it from transmissions which make part of their journey from source to main transmitter via satellite links), is going to be with the general public first. It is, ironically, easier to put up a satellite to carry TV signals than it is to install ground cables to every television owning household in the UK.

DBS will also be different from cable TV in that it will be under the control of the public broadcasting concerns, the BBC and the IBA. They are under obligation to make the service available to everyone; therefore, the transmissions need to be capable of being received by all households. However, the responsibility for obtaining the dish aerials needed to receive DBS is of course in the hands of the viewer, not the broadcasting organisations!



Government gave the go-ahead for DBS in the UK in 1982, with the BBC scheduled to start transmission in 1986. The international Telecommunications Union, of which Britain is a member, allocated five satellite channels to each member country in 1977. After thinking about opting out of DBS altogether, the BBC has chosen to participate and has been given two of the UK's five channels. The IBA has not yet been given one, but it is improbable that it won't; however, the remaining three channels remain unallocated as yet. One plan put forward is that one of their channels will be run on an extra license, and concentrate on 'quality' material from archives and foreign programmes — the best of everything, as it were; the other channel would then be a 'commercial' channel, funded by some form of subscription.

The UK's first DBS satellite, Unisat 1, a Eurostar class satellite 21 metres from 'wingtip' to 'wingtip', is being built by United Satellites Ltd., a company jointly owned by British Aerospace, British Telecom and GEC. British Aerospace is responsible for the design of the satellite itself, with GEC-Marconi doing the transponders, and the actual operation of the transponders carried out by British Telecom. Unisat 1 will carry the BBC's two channels, so other satellites will eventually follow to carry channels used by other authorised broadcasters on the remaining three UK channels. In 1978, the European Space Agency (ESA) launched its Orbital Test Satellite (OTS), for experiments with television and telecommunications in general. The OTS is now being used already by one British company — Satellite Television PLC — for broadcasting, but only into Europe.

FM Transmissions

The transmission system employed is different from that used for terrestrial services, in order to achieve maximum efficiency from the power available in the satellite. The TV signal is modulated onto an FM carrier in a 27mHz wide channel. The use of FM, as opposed to AM, saves about 20dB of transmitting power for equal performance. Each adjacent channel uses different polarisation, which together with the signal capture effect of FM systems, allows a degree of channel overlap so that there are forty channels between

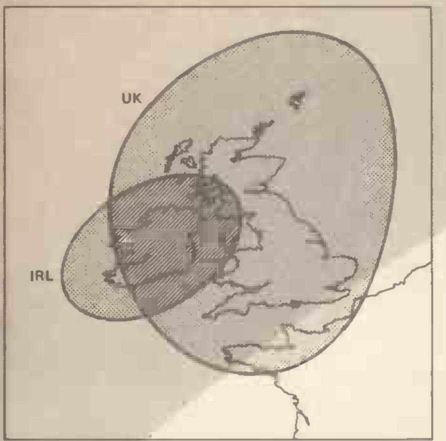
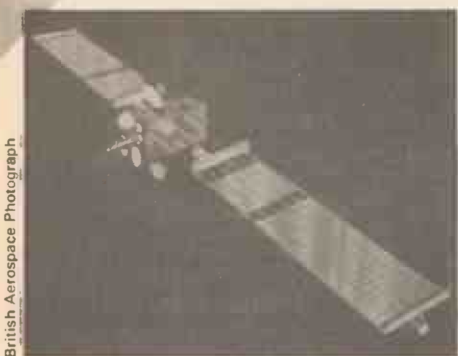


Figure 5. The Direct Broadcast Satellite's likely 'footprints' over the UK and Ireland.



An artist's impression of the Unisat satellite.

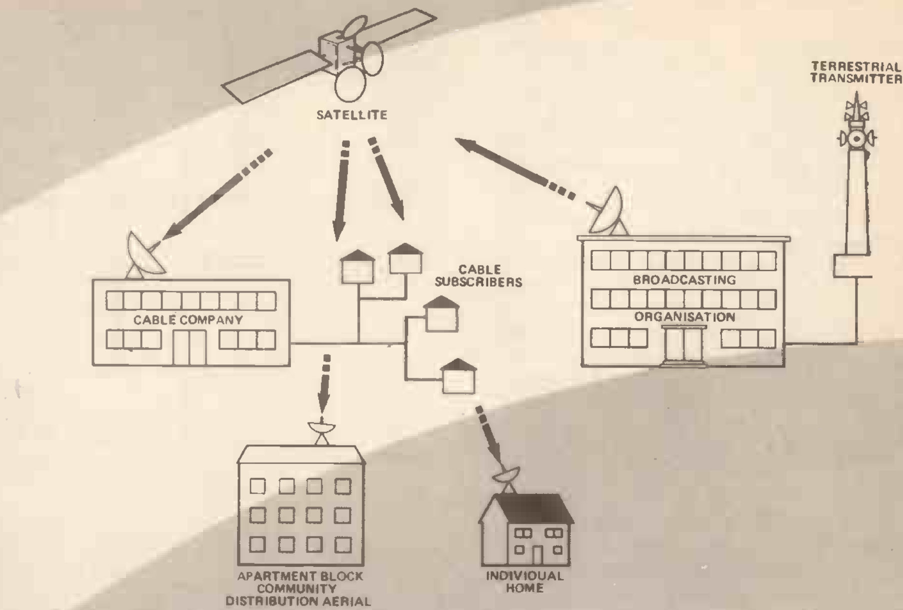


Figure 6. The integration of all modes of transmission.

11GHz7 and 12GHz5, with 19MHz2 channel spacing. With each channel being 27MHz wide, and the spacing between only 19MHz2, side-by-side channels are only assigned to countries in widely differing geographical positions. Also, circular polarisation is used — whenever the same channels are being used by countries which are not widely geographically divided (as must happen in some cases) opposite polarisations are used. Satellite locations above the equator, spaced at intervals of six degrees, were allocated to counties according to the suitability of their position in relation to their prospective satellite.

The UK's satellite position is 31°W, just off the eastern edge of Brazil, with Ireland, Iceland, Portugal and Spain in the same position (so that these related countries can receive each others' transmissions without complicated aerial adjustments). Our channel numbers are, 2, 6, 10, 14 and 18, with right-handed polarisation; several other countries in Europe share the same channels, but with left-hand polarisations.

The satellite must send its transmissions to fall over a narrow area, the UK being only a small land mass. The region 'covered' by the beam when it falls on the earth is shaped, because of the shape of the Earth and the angle of the beam, like an elongated egg, and is called the 'footprint' (a term normally used to describe the area covered by signals or noise affecting the ground from above it). There will be a fringe area where reduced signals will be obtainable, but within our own footprint the signal strength will probably be around 140uV per metre, needing a dish aerial of about a metre in diameter to get a good signal.

Get The Picture?

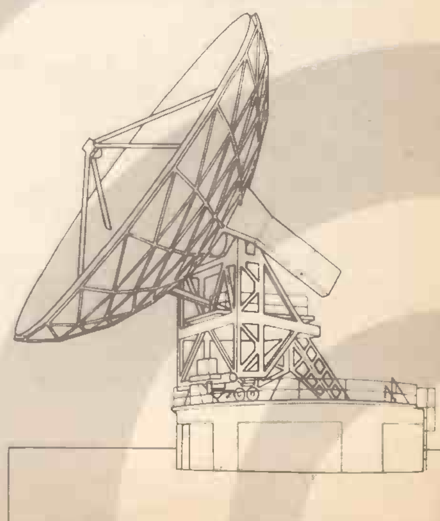
Obtaining a good signal, however, will require a far more precise alignment than with a UHF aerial (and no twiddling it about on top of the TV set, either!) The beam will be narrow and quite low in the sky, and the accuracy of the alignment will have to be within about 0.1°, probably needing special measuring equipment to get an accurate fix — a professional job. This means that the expectation of being able to rotate the aerial easily to pick up European stations, which has been aroused in the popular press somewhat, will not be fulfilled unless some kind of precision mount with predetermined positions is provided (and this is, of course, without taking into account the different European Television standards, some of which are incompatible or only partially compatible with the British PAL system).

The low elevation of the satellite beam will also mean that places to the north, or in hilly areas, or simply behind massive buidings, may not be able to receive the signal. Fortunately, in many cases planners are already looking at communal receiver dishes and distribution systems to keep costs down, and this may be the answer.

So, there is more to DBS reception than merely putting a dish aerial on your roof. The dishes will have to be stabilised against the effects of temperature change, rain and hail, wind etc. and possibly fully enclosed. Other equipment will be needed to sort out the polarisation, to alter the frequency of the received signal for normal UHF TVs, and to convert it from FM to AM. The signal from the dish aerial may also be amplified by a low noise amplifier before being converted to UHF frequencies. The UHF signal is then routed to the set top terminal where the decoding process takes place.

The aerial itself simply comprises a reflecting surface — the 'dish' — which focusses the signal to a central point, and a 'feedhorn', which actually picks up the microwaves; this is sited on a tripod or similar support, and can be adjusted for the best reception. The dish itself is made of aluminium (or aluminium over a fibreglass support), as though popular pictures show a round dish, by the time they become common a quadrilateral shape is more likely to abound, as this is easier to transport.

The 27MHz bandwidth for each DBS channel is wider than the 8MHz channel width used for UHF telly in the UK, which gives a lot of opportunity to improve on the present PAL-based system with the help of the extra signal space. In fact, the BBC has already presented a system known as E-PAL (Extended Pal) for just this purpose. However, IBA has come up with a completely new system, known as MAC (Multiplexed Analogue Component)



which has now been chosen by an Advisory Panel set up to examine alternative television systems for use with satellite broadcasts, and accepted by the Government. (The document to consult is *Direct Broadcasting By Satellite: Report of The Advisory Panel On Technical Transmission Standards*, HMSO Cmnd 8751, 1982, £5.20.)

A New Standard

MAC has been developed entirely to suit DBS's FM system, is technically more advanced than E-PAL, and is better suited to adapting for High Definition TV, which is still far off but definitely in sight in the future. It's a forward-looking system, much more than E-PAL, whose primary virtue (other than the fact that it is a good TV system) is that it is compatible with current TV receivers.

MAC has found favour with the commercial interests involved as well, including the cable TV companies since, as we said above, much DBS programming will make the final leg of its journey along the cables, being a cheaper option than each of us setting up a private dish aerial. Modifying E-PAL to meet all the cable companies' requirements looks like being uneconomic, so the Advisory Panel recommended MAC on this basis as well as that, having no sub-carrier, it would have been better suited to cable TV. They also decided, ironically, that it would be easier to adapt present receivers to MAC than to E-PAL, for comparable quality. MAC will also be easier to scramble to prevent unauthorised reception of DBS broadcasts — ie ones that haven't been paid for!

At the moment, the European Broadcast Union members are looking at the possibility of a single standard for the whole of Europe — a great boon if television is to have an international audience, and seen decidedly as a means of generating more revenue for the individual television companies. One effect of the increased diversification of television away from the licence-funded BBC with, effectively, only one (two since the arrival of Channel 4) commercial rival, is increased competitiveness between programme-makers and television transmitting bodies.

It is felt that MAC has a likelihood of being chosen as a common European standard, gradually superseding the variations on PAL and SECAM being used in Europe at present. It remains to be seen, of course, whether Europe will opt for MAC as a common standard at all! But EACEM, the European TV manufacturers' Association, has shown some interest in MAC. If television is to look into the future and not simply cling to existing technology, which is slowley but surely becoming outdated, then it makes sense to make bolder moves to help the new developments along.

You Pays Your Money . . .

The questions of exactly how consumers will pay for their cable and DBS programming is far from being resolved. The government has decided against the 'pay-as-you-go' method for cable TV, and so it seems likely that this will be the case for DBS too, especially if DBS and cable are as intimately linked as it looks as though they might be. One projected method of getting a choice of channels to cable and DBS viewers' receivers is to have subscription channels, so that the viewer only receives the channels which he has paid to view. This also relieves the problem of a limited number of channels being available to any one receiver at one time.

Obviously some method of protection is required to prevent unauthorised viewing. There are two possible approaches to this problem, the negative, where the original signal is left intact, and the positive, were the signal is electronically encoded in some way.

An example of the first approaches is the fitting of a filter in the consumer's feed which removes any channels which have not been paid for. There are two drawbacks to this: firstly there is an initially large capital expenditure in supplying filters, and secondly, the system is not very tamper-proof.

With this in mind, most systems have opted for some form of encryption. This can range simply from inverting the video to give a negative picture to unconverting receviers, to the Racal-Oak system, where each frame is randomly sent positive or negative modulated, with the sound sent as 'packets' of digital pulses inside the sync pulse. Of course, the more complex the encryption system, the higher the cost of the equipment needed by each consumer to decode the signal. If an operator accepts a protection ratio of about 90%, then an optimum system can probably be found.

Satellite and cable TV complement each other. And for a future National Broadcasting System it is likely to be mandatory that all cable companies will distribute BBC and IBA programmes plus the DBS channels. This, together with single satellite receiving terminals for community TV distribution systems should prevent a sudden rash of unsightly dish aerials sprouting all over the countryside and will save the consumer money. But the individual in a rural area without cable will not miss out — a single dish aerial can be installed, for less than the price of a video recorder.

One thing looks certain: the terrestrial TV network is here to stay. Some areas, without cable, and also (especially in the north) facing more problems with clear DBS reception, will be largely reliant on the present system for many years to come. Nevertheless, the future would appear to be rosy, with plenty of exciting and innovative developments in the air — or should that be "in the pipeline"? **HE**

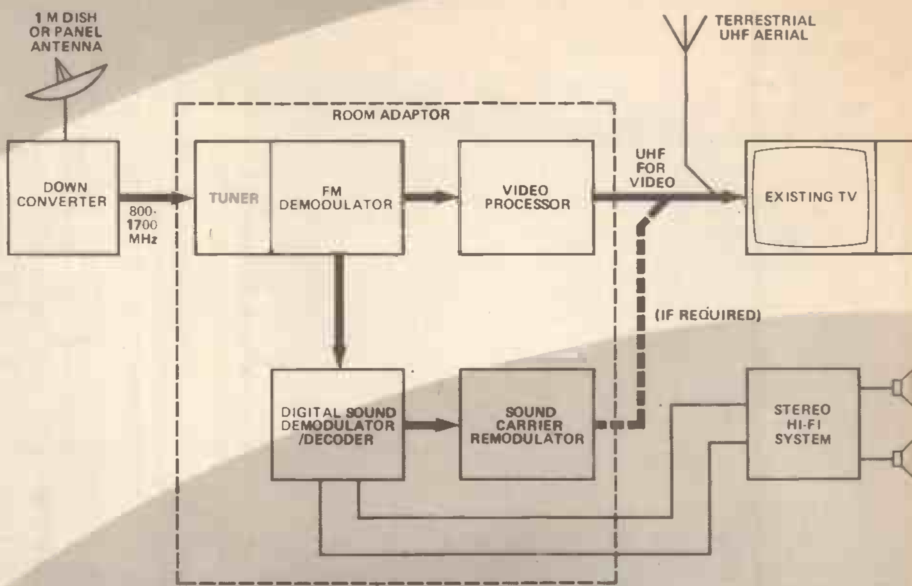


Figure 7. Stages in translating a DBS signal for a UHF receiver.

An array of solar cells, destined for a communications satellite, takes shape at British Aerospace.

POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point of View!

Alternator Alternatives

Dear Editor,
In HE May '83, you replied to M. J. Maddison regarding the use of car alternators. Perhaps the following information may be of assistance in what is usually a very misunderstood subject.

Firstly, the different categories must be appreciated.

1. Six diode alternators: these require an external source of current to energise the motor, usually via a relay. (Examples: Lucas 11AC, Duceillier AC28, Simms (early model), CAV AC7 (early model), etc.)

2. Nine diode alternators: self-exciting, that is, they have some residual magnetism in the rotor. (Examples: Lucas 15AC, 16AC, 17AC, 20AC, etc., CAV AC7, AC203, BUTEC A10, Bosch, Ducellier, Motorola, Hitachi etc.)

3. Permanent magnet alternators, usually single phase and usually fitted to motor-cycles but there are exceptions.

4. Nine diode alternators with the voltage regulator fitted as in integral unit. These are a modification on category 2.

The current output of the alternators using a wound rotor is achieved by sensing the output voltage which in turn is used to control the current flowing through the rotor. Permanent magnet rotor alternators again sense the voltage, but utilise thyristors to control the output current.

In regard to using any alternator driven by a windmill, what must be looked at is the desired voltage (bearing in mind batteries will have to be used) and the speed at which the alternator produces a current of 0.5A (cutting-in speed).

Obviously by using a 12V regulator on a nominal 24V alternator suitable control can be achieved with a lowering of the cutting-in speed. However, if the alternator is chosen with this in mind, an alternator can be found which will begin to charge at 250 rpm.

In the main these units are those which are direct drive on a diesel engine, which are slow running anyway.

In this country the two units which are suitable are the 12V or 24V BUTEC H10 units as fitted to Gardener diesel etc. The 12V unit gives up to 100A at full stick with the 24V unit giving over 30A. The CAV AC203 from a bus (note: not a coach) is completely sealed and gives 80A at 28V and uses a voltage and a current regulator. The snag is that these are expensive.

The choice of what he uses in Kimbali depends on what is available. It is probably that an oriental unit is a better choice out there.

Fancy electronic control systems are not required as the standard units are usually OK. The BUTEC regulator is completely repairable with a 6V7 Zener, a BC108 and a 2N3055 plus a few other bits.

If a small car gearbox is used driven backwards, ie the windmill blades driving the gearbox at the propshaft end and the alternator mounted where the clutch is normally four or five differing alternator speeds would be available. You could even drive the alternator backwards and be astounded that it worked exactly the same as forwards!

Finally, Bosch manufacture a special unit which fits on the axle box of a railway wagon to supply power for lighting, refrigeration etc. This works as soon as the train moves, no matter how slowly.

Yours faithfully,
H. D. Briggs,
Telford,
Shropshire.

PS. Regarding the "Stall Thief" (HE May '83), this can be achieved to a great extent by supplying the relay winding from the warning light terminal on the alternator. This terminal is the auxiliary output from the three diodes whose purpose is to supply the rotor energising current. The voltage goes from 0V when stationary to system voltage 12V or 24V at cut-in speed.

This means that any relay so connected will function at tickover or a slightly higher engine speed. With the relay fitted as in the Stall Thief on a mini, for example, the engine will be governed to a speed of about 550rpm, which means it takes about fifteen minutes to drive it off a pub car park.

Extra connections on the coil or distributor are a giveaway to the "tea leaf". The old Triumph 1300 got over this by using a thin but sturdy coax which looked like standard car-type cable.

Thanks for the suggestion. The Stall Thief author says, yes, this is a simple and ingenious adaptation which should present no problems.

Incidentally, the Police reckon that if you can stall your Tea Leaf for fifteen or twenty minutes, he will tend to feel that easier pickings can be had elsewhere. "If he's really determined to get in", they say "He will". The art is to confuse him into giving up!

Ignition Transformations

Dear Sirs,
I have just made the HE electronic ignition from HE April 1980 and have a small problem with it.

The spark is small and weak and therefore cold-starting is non-existent, but once running it seems to be ok. Instead of the large 47k resistor I have had to put a 56k one in, the storage capacitors although the correct value are a higher voltage, and thirdly there is a small possibility that the transformer may be a 12V one.

Please could you indicate which of the above three might cause the problem or anything else that might cause a very poor spark.

Yours faithfully,
Richard Stummer,
Dibden,
Hampshire.

You have three problems here. First, there is no 47k resistor in the circuit to change; the large resistor R9 is 47R, not "k", and the correct value (47 ohms) should be used.

The transformer is used as a step-up transformer, and the larger the ratio the larger the voltage induced in the primary. Since 9:240 equals 1:26 and 12:240 equals 1:20, a 12V transformer will not produce as much primary voltage.

The third problem you may not be aware of: the transformer is a 9-0-9V type, and a centre-tap must be connected to the V+ line, immediately below T1 on the circuit diagram. This connection was omitted from a published circuit.

As long as the voltage rating of the capacitors is higher than that specified, you're quite safe.

Ignition Transformation Part II

Dear Sir,
Some time ago I built the HE CD Electronic Ignition system from HE April '80. The design performs very well. I noticed that you recommend this unit for use with four or six cylinder negative ground cars, 12V. What if I wanted to use your design on my Honda CG125 motor cycle? Is this possible? It's 6V, single cylinder four stroke).

I thought that a change in the transformer voltage – say a 6-0-6 secondary, might compensate for the 6V ignition system – but do I need to change any other values? eg C3, C4 and/or R7 and 88? I would be very grateful if you could advise me.

Thanking you for your time and hoping to hear from you soon.
Yours faithfully,
C. S. Thompson,
Levenshulme,
Manchester.

There is no easy answer to this one — it effectively needs a redesign on the circuit, which we are not able to do. Have any other readers tried adapting this system for a motorbike?

Components Quest

Dear Sir/Madam,
I have written to you to ask for some information. The problem is that in your magazine the majority of addresses of electronic component suppliers are in the south and I would like to know the addresses of suppliers in the Birmingham area. This would be very convenient as I live in a small town near Birmingham.
Yours faithfully,
A. Patel,
Bilston,
West Midlands.

That's interesting — I hadn't noticed that there was a southern bias in our components directory. It's not intentional. We contacted every supplier whose address we actually had, and with a few exceptions who either did not want hobby custom or had moved away, we published details from all of them.

Your first and best recourse is the Yellow Pages phone directory, which you will find in your public library. Try phoning names under *"Electronics Components Suppliers"* and *"Radio Equipment Suppliers"* and anything similar. When you ring up, ask the person you speak to if he or she knows of any other suppliers locally. Do that a few times and you will be able to build up a file of suppliers in your area.

Your other solution, of course, is to go mail-order.

Look What The Cat Dragged In . . .

Dear Ed.,
With reference to my Radio Controlled Gerbil project (HE April '83): I was perturbed to see some of your readers thought this was a 'joke'. As a professional electronics designer, such correspondence put into print could seriously damage my career. Indeed, the Arts Council have already rescinded their grant so work on follow-up projects such as the Robot Muskrat and Solar Powered Tortoise have been put in jeopardy (a small town in Suffolk, I believe.) I am currently trying to raise funds from the RSPCA, but if this dogged criticism continues my chance of sponsorship will be catastrophically affected.

Don't these people realise that without such advances in rodent technology the human race would never have been able to put non-stick frying pans into space?? It's time they took their heads out of the sand, and stuck them in the nearest microwave.
Yours sincerely,
Dave Fountain,
2 Rat Terrace,
Clacton-on-Sea,
Essex.

PS. Whatever you do, don't print my address in the magazine.

You don't know when you're well off, mate! Never mind the outraged readers. Hibernia The Balrog wants to see you about your abuse of semicolons, and our technical department who has been scouring restaurants in vain for Artificial Gerbil Fur, wants a word with you, too. All he was offered was a load of 'fresh' stuff, and that was full of bullet holes, too. On the bright side, some minor modifications made in the office mean that you can apply to the British Confections Council for further sponsorship. Where did you say you lived?

Instant Assistants

Dear Sir,
I am writing with reference to a letter in HE April '83 from Paul Jenkin of Cornwall. In this letter he raised a couple of queries. 1: I have traced some references to an MOC3020 in an old RS catalogue which describes it as an opto-coupled triac. This is in the July to October 1981 edition of the catalogue. I take the liberty of quoting data from the catalogue:

Technical specification: diode: 1f max. 50mA at 25°C; Vr max. 3V; Vf max. 1.5V at 1f 10mA; triac: Vorm 400V; It (rms) max. 100 100mA; Vtm 3V at It 100mA; coupled characteristics: input current to trigger triac 5mA typ. 20mA Max. (main terminal voltage 3V, 150R load); isolation voltage (peak withstanding) 7500VAC for 5s; operating temperature range -40°C to +100°C. Pin 1 is the anode, pin 2 is the cathode and pin 5 is labelled 'substrate, do not connect'.

With regard to his query on data for the Ferguson 3400, has Mr. Jenkin checked his local reference library? They might have copies of Electrical and Electronic Trader *magazine, who may have done one of their excellent service sheets on the 3400. I hope that some of this information may be of assistance.*

To change the subject, I have noticed that magazines specialising in CB Radio are fast disappearing from the market, but there must still be a considerable interest in CB. As HE was one of the first UK mags to cover CB (if not the first?) how about resuming some coverage of CB?
Yours faithfully,
M.L. Peake,
Bilston,
West Midlands.
PS What is an HE binder?

Thank you very much, Mr. Peake. To show that CB is far from a lost cause, not only is our relation CB Radio Today still flourishing but we have also had a new arrival recently in Ham Radio Today. Ironically, one spinoff of CB radio has been an increase in the popularity of amateur radio. Can't be bad! On top of that, HE still runs articles (our popular Radio Rules series concluded last month) and projects on amateur and CB — see our CB Selective Caller project in HE January '83, for instance.

Dear Sir,
With reference to the letter published on page 17 of your April issue from Mr. Paul Jenkin, I am enclosing some information concerning the device about which he enquired and would be obliged if you would kindly pass it on to him in the stamped envelope also enclosed.
Yours faithfully,
J. G. Lewis,
Saintfield,
Co. Down.

Dear Sir,
In the April issue a reader enquired about a device marked MOC3020 . . . this is manufactured by Motorola and consists of an LED optically coupled to a silicon bilateral switch. They are for applications requiring isolated triggering of triacs.
Ray Harris.

There you are . . . ask and it shall be given unto you. Our thanks to Mr. Lewis and Mr. Harris. We will pass on the information to Mr. Jenkin as soon as we can extract his address from our April file.

HEBOT Hint

Dear Sir,
In HE November '82, you showed the HEBOT II compatible with the ZX81. I own a 16K ZX Spectrum. Will HEBOT work on this, will I need an interface, if so which one and will all the poles be the same in the programs? I am a new learner to computers and electronics so please can you reply advising me on these matters.
Yours gratefully,
A. J. Arnsby,
Cleestanton,
Shropshire.

No, the interface actually supplied with HEBOT II will not operate on a ZX Spectrum. The HEBOT decodes address lines A6 to A15, and if you look at the table of edge connector functions accompanying the ZX Sound Board project (see HE June '83), you will see that the Spectrum and ZX81 edge connectors, while very similar, are not compatible for addresses above A12. HEBOT's address will be different, but if you use the interface board published in HE September '82, you will have full use of your 16K memory because, when set up to operate from the Spectrum, this board addresses I/O space, rather than memory space. HE

BUYLINES

Tremoleko

An important point to remember when building this project is that it is going to be subject to heavy wear and tear, probably kicked around on if not off a stage and regularly stomped by heavy footed guitarists! To protect the delicate PCB and components, then, it's worth investing a few extra pence in a solid die-cast aluminium box that can stand up to the worst abuse!

The cost of the parts for the project, including a die-cast box, heavy duty switch is £8.30 (and this covers VAT, p&p) from **Rapid Electronics**. The PCB as usual is being supplied by our own PCB Service.

SPL Meter

One component in this project is critical if the easy calibration procedure is to be followed, and that is the electret condensor microphone. The specified type is an Altai model EM-104; if some other microphone is used then the calibration procedure will not produce accurate SPL measurements and the ambitious constructor will have to devise his own method of setting up the meter!

Fortunately this microphone is readily available from a number of sources, and to make things even easier, **Greenweld Electronics** (443 Millbrook Road, Southampton SO1 0HX) have kindly offered to supply all the components for the SPL Meter, including the EM-104, the 100uA panel meter and box, for just £19.95 including VAT, p&p. The PCB can be made at home from the pattern published on the PCB Printout page, or purchased from Hobby's PCB Service.

Gripometer

All the electronic components may be easily purchased from a mail-supplier such as **Cricklewood** or *Europa Electronics*, though there may be some difficulty with the slide potentiometer (essential) and the orange LED (nice but not essential — use another another red or yellow instead). The cost of the components should be around £5.00.

A certain amount of persistance and ingenuity may be needed to complete the mechanical construction — but we know that HE readers have plenty of both!

Our prototype was constructed from a simple three-sided framework of 1"x1½" timber, covered top and bottom by appropriately sized sheets of hardboard, but any construction method may be used so long as it works.

The prototype was covered in bright yellow Fablon to provide an inexpensive and bright appearance, with the opening edge of the framework uncovered to allow access to the "cheat switch". But if you want to be a little bit clever, mount the cheat switch so that the tip of the plunger is just inside the framework and carry the Fablon down across that edge, sealing it off. Then the switch is concealed but can still be operated through the flexible Fablon covering — if you know it's there!

Variable Power Supply

A complete kit of parts for this project is available from **J. Bull** for £13.80.

TREMOLEKO

A classic echo-effect unit is expensive to make, but the HE Tremoleko not only gives a fair echo effect, but is inexpensive and straightforward to build — ideal for the guitar player who wants to experiment with different effects.

R. A. Penfold

THE CONVENTIONAL WAY of electronically processing a signal to give an echo effect is to use a delay line of some kind, to give a delay of between 100ms and 1 second, and to feed the delayed signal back to the input of the line. The signal is therefore fed through many times, getting weaker each time it is fed back to the input and giving a good analogy of a natural echo and an excellent sound effect.

An obvious drawback of this system is the cost of a delay line which gives a sufficiently long delay time for this application. A bucket brigade type, having a few thousand delaying stages, is the lowest cost approach but even this method is not particularly cheap.

But there is an alternative system which is very simple and inexpensive indeed. Results obtained are not as good as those using more sophisticated techniques, which give a true echo effect, but it is a system well worth trying if a true echo is not feasible within your budget, of if you like experimenting with simple effects units.

The technique is simply to "chop" up the signal from a synthesiser or any other electrical or electronic instrument which has a suitable output signal. The main requirement is that the instrument should have a fast attack plus a relatively slow decay, like the envelope shown in **Figure 1(a)**. Any monophonic synthesiser should be capable of giving a suitable output signal, and a guitar also gives an output of the correct type. When the signal is

"chopped" by effectively just switching it on and off at a rate of a few Hertz, this gives an envelope of the type shown in **Figure 1(b)**.

This gives a signal which is similar to that obtained if a short burst of signal is applied to an echo effect unit, with an initial high signal level followed by a signal bursts of identical length but steadily decreasing amplitude, and quite interesting results can be obtained in practice, especially if the unit is used in conjunction with other effects such as spring-line reverberations. However, it is important to realise that the effect obtained is not a genuine echo, and that a signal having a long decay is needed at the input to give an output which sounds like a short percussion signal. Results are not likely to be very convincing if the input signal does not have a suitable decay characteristic, or if the signal changes considerably as it dies away. A voice signal, for example, would probably not give good results when used with the unit (although you might find the effect interesting even though it might not be at all convincing as an echo effect).

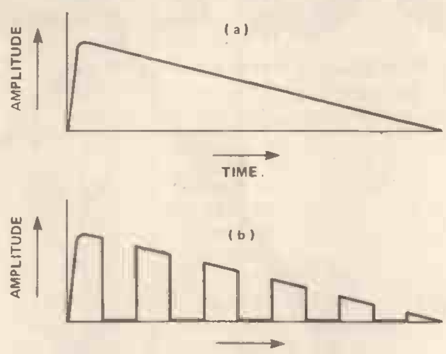


Figure 1. How the input signal is 'chopped' by the Tremoleko.

The Circuit

A simple VCA based on a VMOS transistor is used as the basis of the unit, as can be seen from the circuit diagram of **Figure 2**.

A VMOS transistor has a very high drain-to-source resistance if the forward gate bias is zero (or very low), but this resistance drops to about 2 ohms if a forward gate bias of a few volts is applied to the device. In this circuit the VCA is formed by R6 and the drain-to-source resistance of Q1. There is very little voltage drop through R6 when Q1 is switched off,

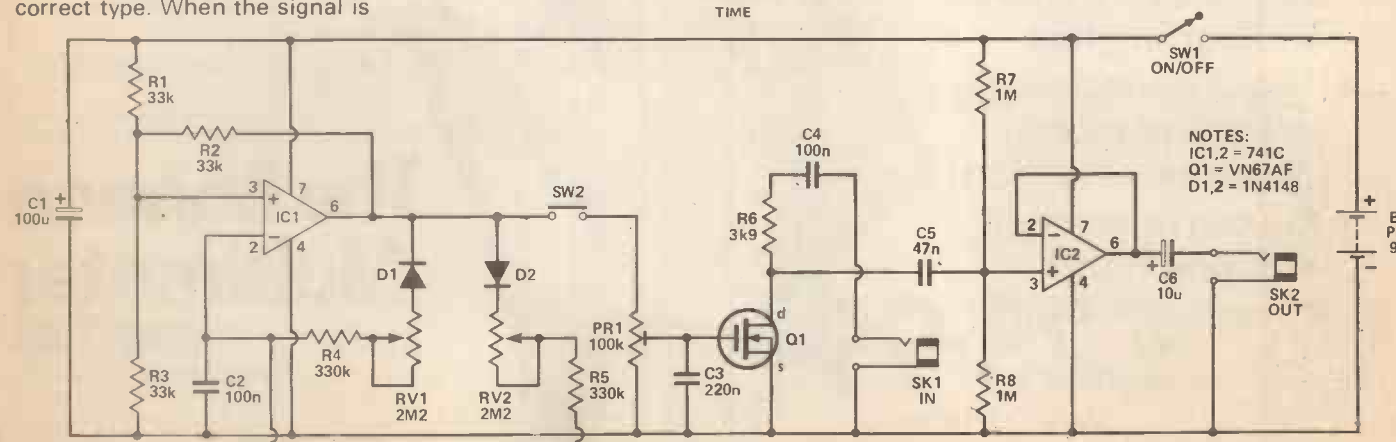


Figure 2. The circuit.

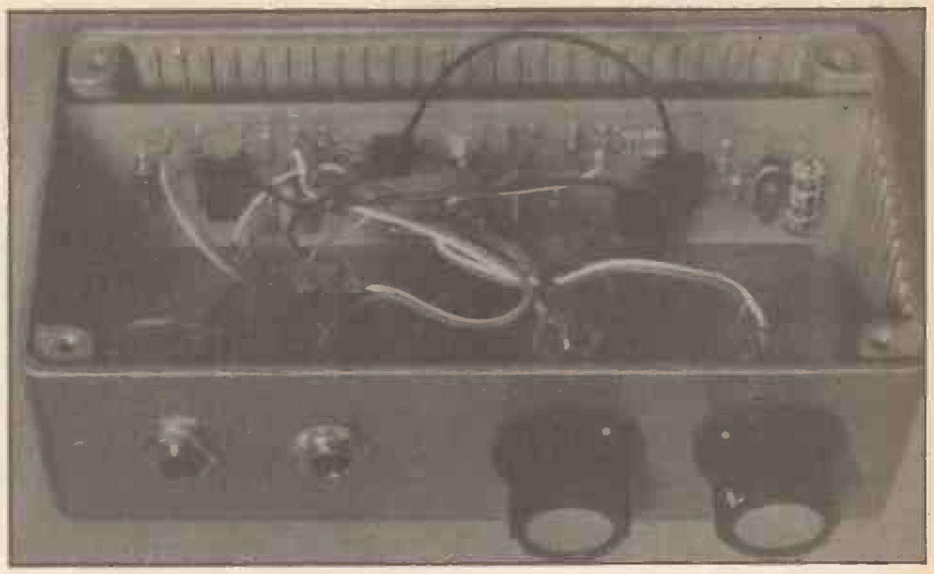
due to the high input impedance of the buffer amplifier formed by IC2 and its associated components, so the signal reaches the output virtually unattenuated, but when Q1 is switched on, most of the input voltage is dropped across R6 and a high level of attenuation (typically about 66dB) is produced.

Although this is a fairly crude form of VCA it is adequate for the present application, and does have an important advantage over most of the more complex alternatives in that there is no DC shift at the output as the circuit switches from the high attenuation state to the low attenuation one, and vice versa. This avoids the generation of "clicks" or "thuds" which would inevitably result if even a small DC voltage shift was produced by the circuit.

"Clicking" sounds could also be generated if the VCA was switched very rapidly between states so that the "chopped" signal had a very rapid rise and fall time. This would give a very unnatural effect, and much better results are obtained if the switching speed is slightly, but significantly slowed down. This is the purpose of C3.

IC1 is used in the pulse generator circuit, in what is basically a well known and frequently used configuration. However, it is slightly different to the standard circuit in that steering diodes D1 and D2 have been included in the timing circuit, and this gives separate timing resistances for the high and low output periods of the circuit. R4 and RV1 control the low output time while R5 and RV2 control the high output period. Apart from permitting the mark-space ratio of the control signal to be adjusted, these two controls also give a substantial degree of control over the operating frequency of the pulse generator. The frequency range is from about 2HZ with both RV1 and RV2 at minimum resistance to over 10HZ with both controls set at maximim.

SW1 enables the output of the pulse generator to be disconnected from the VCA; Q1 is then cut off, the input signal passes straight through to the output, and the effect is cut out. RV3 is needed to match the output voltage swing of the pulse generator to the input requirements of the VCA, and to an extent the effect obtained

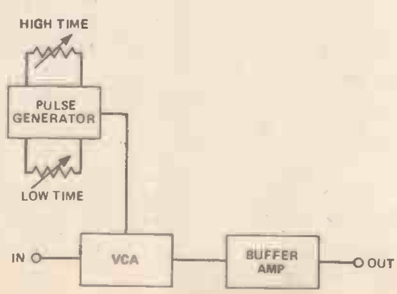


How It Works

The input signal is passed through a voltage controlled attenuator (VCA) and then to the output signal socket by way of a buffer amplifier. The latter is simply needed to give the unit a low output impedance and to ensure that the output of the VCA is not excessively loaded. The VCA will provide an easy path for the input signal if the control voltage is low, but it will provide a very high level of attenuation and effectively block the input signal if the control voltage is a few volts or more.

A pulse generator is used to generate the control voltage, and as this has an output voltage which switches between virtually the negative supply voltage and almost up to the positive supply potential, the VCA is switched between its minimum and maximum attenuation levels. This gives the required "chopping" of the input signal to give the quasi-echo effect.

Two controls enable the high and low output times of the pulse generator to be independently adjusted, and this gives a useful degree of control over the effect obtained. Apart from enabling the "chopping" frequency to be adjusted, it enables short bursts of signal to be allowed through the VCA, short gaps to be placed in the signal, or the on and off periods of the signal to be roughly equal.



Parts List

RESISTORS
(All 0W25 carbon)
R1, 2, 3 .... 33k
R4, 5 .... 330k
R6 .... 3k9
R7, 8 .... 1M

POTENTIOMETERS
RV1, 2 .... 2M2
1 in carbon
RV3 .... 100k
0W1 horizontal preset

CAPACITORS
C1 .... 100u 10V
axial elect
C2, 4 .... 100n
polyester
C3 .... 220n
polyester
C5 .... 47n
polyester
C6 .... 10u 25V
axial elect

SEMICONDUCTORS
IC1, 2 .... 741C
op-amps
Q1 .... VN66AF or VN67AF
VMOS transistor
D1, 2 .... 1N4148
g.p. silicon diodes

MISCELLANEOUS
SK1 .... 6.32mm jack
with DPDT contacts
SK2 .... 6.35mm jack
B1 .... 9 volt PP3
SW1 .... heavy duty
push button switch
105x80x50mm diecast aluminium box; battery connector; two control knobs; printed circuit board; two 8-pin DIL IC sockets; Veropins; wire, etc.

BUYLINES .... page 34

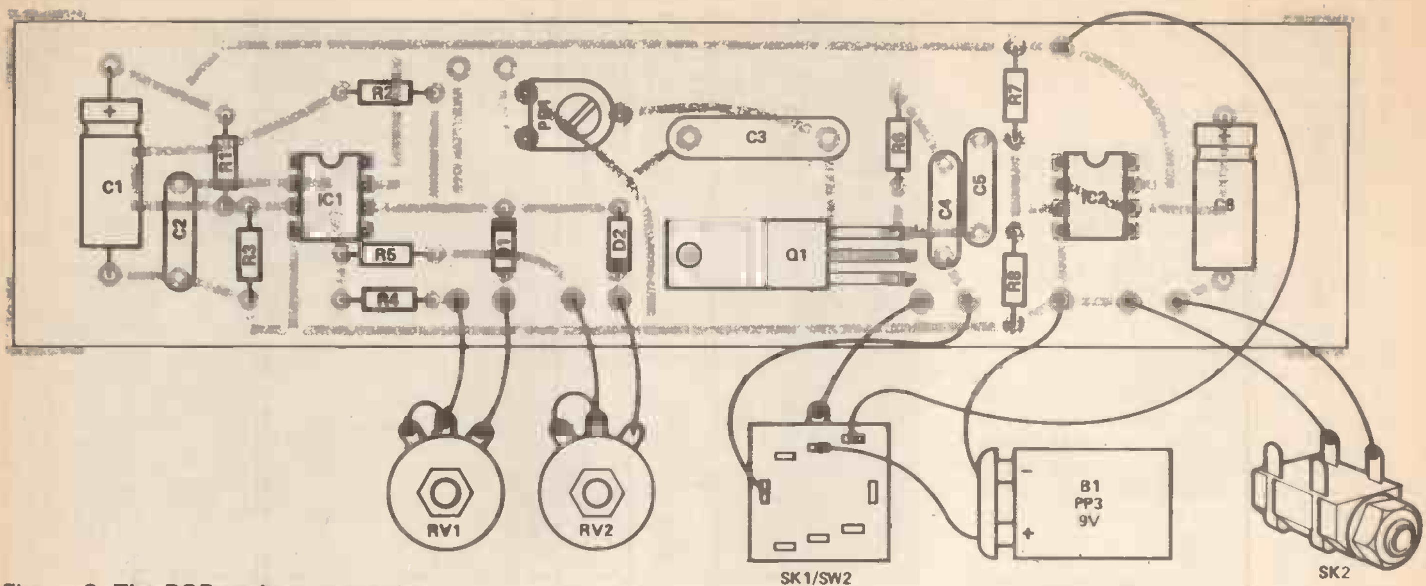


Figure 3. The PCB and components.

can be varied using RV3 since it sets the depth of the amplitude modulation.

The current consumption of the circuit is about 4mA, so a PP3 9V battery is an adequate power source. source.

Construction

Details of the printed circuit board are shown in Figure 3. Q1 is a MOS device, but both the VN66AF and VN67AF types have built-in 15 volt Zener protection diodes which render normal MOS handling precautions totally unnecessary. These devices are power types, but lower power VMOS devices (such as the VN10KM) should have a low enough "on" resistance to give good results in this circuit. Also the two devices specified are reasonably inexpensive and are readily available! Q1 is mounted horizontally so that it does not protrude too far above the board and prevent it from being installed in the case. This device dissipates an insignificant amount of power and obviously does not require a heatsink, but it is a good idea to bolt it to the printed circuit board so that it is firmly anchored in place.

In other respects construction of the board is quite straightforward, but the careful to fit the semiconductors the right way round. Also, it is helpful to fit Veropins at points where connections to off-board components will be made.

A diecast aluminium box having approximate outside dimensions of 150 x 180 x 50mm is reasonably inexpensive but makes a very tough and neat housing for the project. SW1 can be a heavy duty push button type fitted on the top panel of the case, and it can then be operated by foot (although an ordinary toggle or other type can be used if preferred). The two other controls and the two sockets are mounted on the front panel (one of the 150 by 150mm sides of the case), and SW2 is a set of make contacts on input socket SK1. The unit will therefore switch on and off automatically when a jack plug is inserted into or removed from SK1. A socket having a single set of make contacts does not seem to be available so a type having DPDT contacts is used for SK1, but note that only two of the six switch tags of this component are connected into the circuit and that the other four are ignored. Of course, if preferred SW2 can be an ordinary switch and SK1 can be a standard unswitched socket.

When the printed circuit board has been connected to the rest of the unit using the usual multistrand hook up wire, the board can be fitted in place inside the case. It slots into a set of guide rails, fitting into the set nearest the rear of the unit with the component side of the board facing towards the front of the unit. There are several suitable spaces where the battery can be positioned.

In Use

The unit is simply coupled between the instrument and the amplifier using normal screened jack lead. Signals of up to about 5 or 6 volts peak to peak can be processed without clipping and severe distortion being produced, and as the noise level of the unit is quite low there should be no difficulty in using it with a fairly low level signal such as that obtained from a low output guitar pick-up. Thus, in most cases there should be no problems when the unit is connected into a system, but it would be advisable to use some preamplification if the unit is fed from a *very* low level source such as a microphone.

A little experimentation with the two pulse length controls plus the controls of the synthesiser or other instrument should soon show what settings give the best effects. Similarly, a little experimentation with RV3 will enable it to be set for optimum results. In general, the further RV3 is advanced in a clockwise direction the deeper the amplitude modulation of the input signal, but if RV3 is advanced too far it will probably be found that Q1 becomes permanently switched on and little output signal at all will be obtained!

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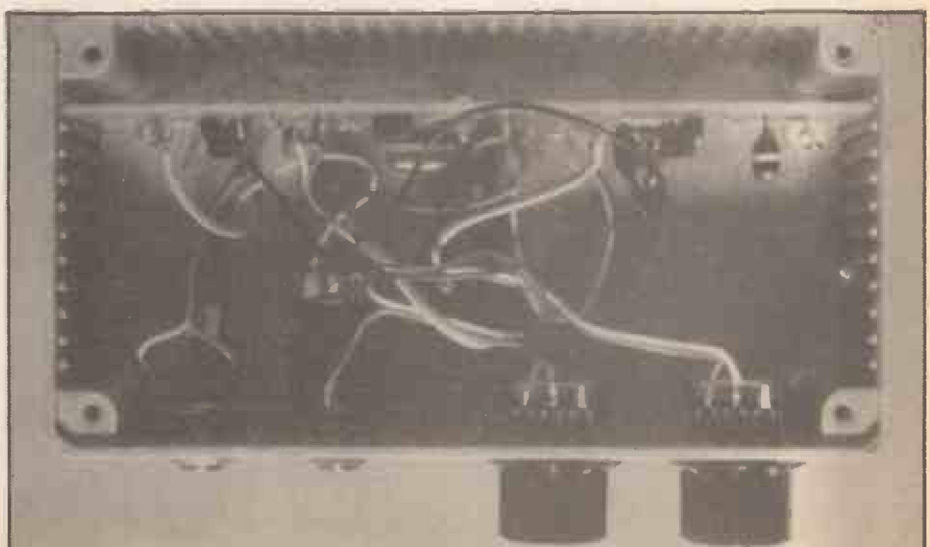

CAREERS IN ELECTRONICS '83

Hobby Electronics looks at the varied world of Studio Engineers in broadcasting.

Shelley Partridge

LAST MONTH we looked at starting a career as a Transmitter Engineer with the Independent Broadcasting Authority or the BBC. This month we will concentrate on opportunities for trainee Engineers and Technical Operators in television and radio stations.

Some of you may well be attracted by the idea of playing a creative part in TV or radio programme making through operating sound or camera equipment in a studio. Perhaps you have used video cameras at school or college, or built your own hi-fi equipment; perhaps you belong to a cine club, are a radio ham or work for a hospital radio station, and therefore you would like to make your career working with technical equipment in broadcasting. Because so many people want to work in broadcasting, competition for trainee posts is always fierce. However, you are someone who has a clear idea of the job you would like to do, have found out what qualifications you need to apply for training, and are determined to obtain these qualifications and you are already a dedicated amateur and the kind of person who can work in a team, and cope with some pressure and hassle, then your chances of getting started in a broadcasting career have never been so good as they are now and will be over the next few years.

Both radio and television broadcasting are expanding. The BBC now provides two and a half extra hours of television each day in its Breakfast TV show; Independent Television's new company TV-AM began transmitting in February this year; Channel 4 went on air in autumn '82. Channel 4's money has stimulated the setting up of many independent film and video production companies. Facilities companies providing television studio space, post-production services and technical expertise to these independents to make programmes for broadcasting and other purposes (training, sales, corporate communications), have been springing up, particularly in London, but also now in other regional centres. Cable and satellite television are only just around the corner, as you know only too well from this month's cover feature.

So let's consider which organisation may offer trainee opportunities, and what they will expect from you in the way of personal and academic qualifications, then look at recruitment and training patterns for each major broadcasting organisation, and conclude by offering some basic tips on how to get started.

Picture courtesy BBC.

Where The Work Is

The BBC employs some 28,000 people in radio and television, with a substantial concentration in various locations in central and west London, but also at regional centres throughout the country. The BBC is the only broadcasting organisation which recruits school and college leavers regularly as trainees into a limited number of job categories. For the financial year 1983/84 the BBC are recruiting far more technical trainees than in recent years and anticipate that trainee recruitment will remain at a high level over the next several years.

Collectively the sixteen Independent Television Companies (including TV-AM), plus Independent Television News (owned by all the ITV companies except TV-AM which has its own news service), employ nearly the same numbers in television broadcasting. These employees are, however, dispersed in much smaller units. Thames Television, for example, the largest ITV company, employs about 2,500 people in its Teddington and Euston studios. There are now forty Independent Local Radio stations on air, spread throughout the country, and another ten due to come on air in the next year or so. They vary in size from

Picture copyright Thames Television.

Monitoring sound and vision signals before transmission.

Picture courtesy BBC.

Tape editing in a BBC television sound gallery.

fewer than thirty employees to over one hundred. The Independent Broadcasting Authority is responsible for selecting and appointing ITV and ILR companies; supervises programme planning; controls the advertising and transmits the programmes for all the Companies.

Each ITV and ILR company recruits staff individually. Most of the ITV companies recruit trainees from time to time, the five largest — Thames, London Weekend, Yorkshire, Granada, Central Independent — taking the majority. Although one or two ITV companies (notably Thames and ITN) recruit technical trainees regularly and provide systematic training, in general trainees are recruited on an ad hoc basis when needed, and training is informal.

Basically both the BBC and ITV companies are looking for the same sort of young people to train as engineers and technical operators, in terms of qualifications and qualities, the numbers taken on by the ITV companies being just simply much smaller. This means that competition is always severe for the relatively few trainee posts which do arise in Independent Television, most recruitment being of people with relevant experience. However, in 1983 due to the current expansion in broadcasting generally and difficulties in finding suitably experienced technical staff, a number of ITV companies are recruiting engineering and technical operations trainees.

Channel Four is a programme commissioning, not a programme making company. Its staff consists of experienced broadcasters and producers (who plan and coordinate programming), administrators and transmission engineers. The Channel is currently commissioning up to 50% of its programmes from independent film and video companies as well as from the other ITV companies. A few independents are large enough to have their own small studios and editing facilities; many use the studio and post-production services of the television facilities companies. Some of these companies are now beginning to recruit trainee operators and audio/video engineers since qualified and experienced people in these fields are in short supply.

Recruitment And Training

Broadcasting organisations demand a variety of pre-entry qualifications from young people who apply for trainee positions. These employers are also at least as concerned to see how you have demonstrated keen interest through practical amateur activities. Applicants selected for training are more likely to have participated, for example, in a local cine or photographic club; college video or radio programme making, hospital or local radio; may have built hi-fi and electronic equipment, run a disco, recorded a pop group, or play a musical instrument. Appreciation is not enough; you need practical experience gained preferably on your own initiative rather than through school studies alone . . . in other words the sort of people who read Hobby Electronics!

Whatever the differences between broadcast radio and television and the video industry in terms of recruitment and training, the personal qualities you need to succeed in these organisations are similar. You should be able to work as a member of a team, long often irregular hours and remain calm and efficient under pressure. You need lots of common sense, a cheerful co-operative personality, and a bright, alert, inquiring mind. All these employers would like to encourage more suitably qualified women to apply for training; opportunities are very good. So make sure you choose to study the right subjects — particularly physics and maths.

The BBC

The BBC recruits Technical Assistants (trainee engineers) for network radio and television studios in London and the regional centres (Birmingham, Bristol, Manchester, Wales, Scotland, N. Ireland). 'Technical Assistants/Television and Radio studios' are trained to test, repair and maintain all equipment used to broadcast programmes, and control switching and routing; also to set up and align broadcasting equipment and in some areas operate it.

Training is completed in approximately three years, beginning with the twelve week 'A' course at the BBC Engineering Training Centre at Evesham. This course goes over basic principles studied in 'A' level Physics and introduces trainees to studio operations — studio layout, camera techniques, sound desk operation. Those who pass (any who fail have to leave the BBC) then proceed to induction and on the job training in television or radio for about eight months before returning to Evesham for the 'B' course. This is ten weeks in-depth study of basic principles and radio and television applications. Then follows another ten to twelve months 'on-the-job' experience before the final return to Evesham for the 'C' course — a detailed study of broacasting engineering theory, how equipment works, fault finding, using manuals. On successful completion of the 'C' course the TA qualifies and becomes a Reserve Engineer.

To apply for a Technical Assistant's post you need 'O' Levels grades A/C or CSE '1' in maths, physics and English plus maths and physics studied to 'A' level or a TEC certificate/diploma in electronics/electrical engineering (with merit passes). You should have a keen interest in and knowledge of electronics possibly audio or video systems.

The BBC also recruits young people with Higher TEC or degree qualifications in Electronics, Electrical Engineering or Applied Physics for direct appointment as Engineers. The BBC's system of recruiting TAs aged 18 to 21 as potential engineer, as well as direct entry graduate engineers, provides suitably qualified young people with an unique choice and opportunity. For, if you have developed an interest in broadcasting engineering early, have studies the right subjects at school and then join the BBC as a TA you can do as well as the graduate engineer. Promotion after training is up to the individual.

Picture copyright Thames Television.

Directors and vision mixers in a Thames Television control room.

Technical Operators

The BBC has recently created a new grade, Recording Operator, to deal with the increased work-load resulting from the great amount of pre-recording of BBC programmes on video-tape, and is currently offering a number of trainee opportunities in West London — at Television Centre, Lime Grove and New Enterprises Studios. Recording Operators prepare and operate video

Picture courtesy IBA.

film and tape equipment used for recording, editing, transmitting TV programmes and studio inserts. They are responsible for lining up programme material on magnetic tape or film and for ensuring equipment gives the highest standard or reproduction. You must be over 18, with 'O' Levels grade A/C or CSE '1' in maths, physics and English, plus science study — particularly physics — to 'A' Level or the equivalent TEC. You need good visual ability (an interest in film-making or art), *and* aural and technical ability (shown by such interests as sound recording, music, hospital/amateur radio or electronics. Training will be begin with the 'A' course at Evesham; then five months 'on-the-job' in video tape and five months in tele-cine, plus further courses at Evesham.

The BBC also recruits Camera Operators to work in television studios at Television Centre, Lime Grove and the Open University at Milton Keynes, Audio Assistants to work in radio and television studios in the Regions; and Technical Operators, Radio to work in Broadcasting House and External Services, Bush House. All Technical Operators start with the 'A' course at Evesham followed by on-the-job training and experience, and reach qualified operator status in three years.

Camera and Sound Operators work as junior members of a technical operations team in television studios or outside broadcast unit. They set up and operate cameras and associated equipment or sound reproduction equipment, sound booms and microphones, working closely with the production team. Radio Technical Operators route sound programme sources and completed programmes in the main control room, and operate sound reproduction equipment in radio stations. They are responsible for maintaining high technical quality of sound output.

For all Technical Operator grades you must be 18 plus with 'O' levels in maths, physics, English or TEC in electrical engineering. You need a good grasp of electricity and magnetism and appropriate practical interests.

The BBC has a small annual intake of Trainee Sound Managers, mainly graduates, for network radio — people with both technical and creative ability. They recruit periodically for the Local Radio Station Assistant's Registry and look for potential broadcasters from University/Polytechnic media studies type courses, with radio experience.

Independent Television

Only Thames Television among the ITV companies offers a formal Technical Training Scheme. About twelve trainees are recruited each Spring to begin nine months at the Teddington Training Centre in October. The 1983 scheme is recruiting sound technicians, engineers and two film editors. Successful candidates are in age range 20 to 30, have completed a Higher TEC or degree course relevant to TV engineering (eg Ravensbourne College Higher TEC) or a film/television course or offer relevant professional experience.

ITN recruit six Trainee Broadcast Television Engineers each year to begin training in September and ask for Higher TEC in electrical/commmunications engineering with a broadcasting bias.

Facilities Companies

In the past the Facilities Companies have recruited only experienced staff, but are now also beginning to take on trainees. They look for technically minded young people with an interest in video systems and a background in electronics, usually over 18. You could be recruited as a trainee video tape operator or audio/video engineer or as an operator to do high quality transfer and cassette duplication work.

Getting Started

Broadcasting attracts many highly intelligent and well qualified people. Many of the trainee engineers and operators offer qualifications and relevant experience whether amateur or professional above the minimum required. Because so many talented young people like the idea of working in broadcasting, both the BBC, and ITV Companies can take their pick from many hundreds of able young people who apply each year.

The BBC has produced a comprehensive series of leaflets on training schemes, different jobs and careers with the Corporation which they

Picture courtesy BBC.

A BBC engineer setting up a video tape recorder.

will send on request. Be sure to specify the kind of work which interests you. These leaflets may also be available in your local careers office. The individual ITV companies provide information leaflets on jobs within their organisations which they will also send on request. In addition, The Independent Television Companies Association is preparing an information pack on behalf of all the ITV companies which will shortly be available; again, when writing be sure to specify the jobs which interest you.

For information on engineering and technical operator recruitment at the BBC write to:

The Engineering Recruitment Officer,
BBC Broadcasting House,
London W1A 1AA.

The IBA will supply up-to-date list of ITV and ILR companies; write to:

The Information Officer,
The Independent Broadcasting Authority,
70 Brompton Road,
London SW3.

These addresses are also in the IBA handbook *Television & Radio 1983* published each year and obtainable from most bookshops. For The Independent Television Companies Association, write to:

The Training Adviser,
ITCA Ltd.,
Knighton House,
52-66 Mortimer Street,
London W1N 8AN.

Looking For The Opening

The BBC advertises vacancies in specalist publications such as the amateur electronics and radio press (according to type of work), in *The Listener*, and sometimes *The Guardian* media page (Mondays). Details of trainee schemes aimed mainly at graduates are notified to University and Polytechnic careers services; those open to school and college leavers are notified to Local Authority Careers Offices in Central London and the South East, and in the Regional centres. Ask your careers officer for details (address and 'phone number in local telephone directory).

Trainee vacancies with the ITV companies must first be notified to the Trade Union (ACTT), 3 Soho Square, London W1. They are occasionally advertised in the national/specialist press, and are sometimes filled without advertising from the suitable speculative applications already held on file. So make sure you get your letter on file when you feel you have a realistic chance of being considered.

A small but interesting number of technical trainee vacancies with video production and facilities companies are notified to Inner London careers offices and to the Capital Radio Jobfinder service. You should also try making direct approaches to some of these companies. There are various reference books which will give you company details (eg *Contacts in Stage, Television, Screen & Radio; The Video Yearbook; The Creative Handbook*) held at the Westminster Central Reference Library and other good reference libraries.

If you are interesting in working in Independent Local Radio you should apply direct to the stations which interest you. You could also look into the courses offered by the National Broadcasting School, 14 Greek St., London W1, which provides training in radio production, engineering and journalism for ILR. Unfortunately, although these course are subsidised by the IBA, they are still expensive and Local Authority grants are not usually available.

Finally some tips for all would-be broadcasters:

—Achieve as high a standard of education as possible ensuring you are studying the appropriate subjects.

—Join a cine club or still photographic club at school, college or in your local area. If you are keen on sound, get involved with hospital or local radio, run a disco, record your local group.

—Find out as much as poss. le about the industry by reading books available on working in radio and television, by talking to people who work in the industry, by obtaining free audience tickets for a television studio show recording, by attending the Inner London Education Authority's Christmas Careers Lectures for sixth formers on television broadcasting if you live in the London commuting area (information from your careers officer).

—Watch films and television programmes analytically — which techniques make different programmes work?

—Look into the relevant further and higher education courses. If you decide to apply for a course, check the prospects well in advance to ensure you will be able to offer the right entry qualifications. Make your application as early as possible in the year before you wish to begin the course, and make early enquiries about your grant aid which may be available from your local education authority.

Picture courtesy IBA.

—Prepare yourself to go to interviews, sometimes at short notice; be ready to ask questions.

—Seek further advice and guidance from your local careers officer.

Don't consider a career in broadcasting simply because you think it will be exciting and glamorous. The glamour soon wears off. A camera operator with a heavy cold filming in filthy weather, who has to spend hours waiting for the weather to clear will hardly find the job glamorous.

Good luck with your search!

Shelley Partridge is a Careers Officer working for the Inner London Education Authority's Careers Service and specialises in the Broadcasting, Film and Video Industries.

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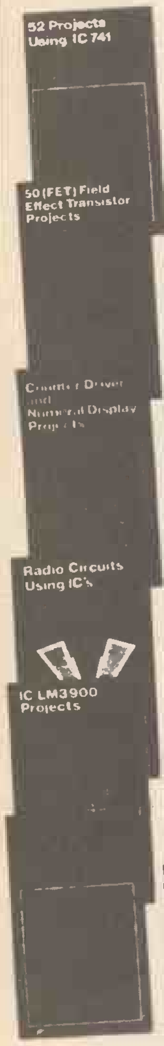

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74LS377	60p
74LS378	60p
74LS390	45p
74LS393	45p
74LS399	160p
74LS467	90p
74LS540	90p
74LS541	80p
74LS610	£19
74LS612	£19
74LS626	150p
74LS628	150p
74LS670	150p
74LS687	400p

4000 SERIES

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4076	48p
4077	18p
4078	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
4500	575p
4502	60p
4503	45p
4505	400p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4543	75p
4553	245p
4555	35p
4556	35p
4560	120p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
40085	90p
40097	50p
40102	140p
40103	170p
40106	36p
40109	100p
40163	60p
40174	50p
40175	50p
40193	60p
14411	£7
14412	£8
14416	380p
14419	280p
14490	350p
14495	300p
40244	60p
40245	180p
40373	160p
40374	160p

LINEAR ICs

AD7581	1150p
ADC0808	990p
AY1-5050	99p
AY3-1270	825p
AY3-1350	350p
AY3-8910	350p
AY3-8912	500p
CA3019	80p
CA3028	120p
CA3046	70p
CA3048	220p
CA3059	285p
CA3060E	350p
CA3080E	70p
CA3086	48p
CA3089	200p
CA3090AQ	375p
CA3130E	90p
CA3140E	40p
CA3140T	90p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
D7002	390p
DAC1408-8	£2
DAC0800	200p
DAC0808	200p
DG308	300p
HA1366	190p
HA1388	250p
ICL7106	700p
ICL7650	400p
ICL7660	200p
ICM7217	750p
ICM7555	80p
LC7120	300p
LC7130	325p
LC7137	270p
AN103	200p
LF347	150p
LF351	48p
LF353	95p
LF356P	95p
LF357	110p
LF1331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308	45p
LM308N	75p
LM310	120p
LM318	150p
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM384	140p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM393	100p
LM394	300p
LM709	36p
LM710	50p
LM711	70p
LM723	35p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM10 11	480p
LM1014	150p
LM1801	300p
LM1886	£5
LM1889	350p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	250p
MB3730	400p
MC1310P	150p
MC1458	36p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	65p
MF10CN	300p
MK50398	£7
ML920	800p
MN57160	620p
MN6221A	600p
NE531	140p
NE532	130p
NE533	140p
NE555	16p
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NE564	420p
NE565	120p
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PLL02A	500p
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SAA1900	£16
SAD1024A	850p
SFF9634	800p
SN76477	450p
SN76488	450p
SN76489	480p
SN76495	400p
SP0256ALZ	£10
SP0256AL2	£12
TA7120	150p
TA7204	150p
TA7205	250p
TA7222	150p
TA7310	150p
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TBA800	80p
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TDA1004A	300p
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TDA1010	200p
TDA1022	500p
TDA1024	120p
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TDA2006	350p
TDA2020	320p
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TL062	60p
TL064	95p
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TL072/82	45p
TL074	100p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
UA2240	120p
UAA170	170p
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ULN2004	75p
ULN2068	290p
ULN2802	200p
UPC575	275p
UPC592H	275p
UPC1156H	275p
UPC1185	£5
XR2206	300p
XR210	400p
XR2211	575p
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ZN423E	130p
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BC109C	14p
BC117	20p
BC169C	10p
BC172	12p
BC177/8	17p
BC179	18p
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BC184	10p
BC187	30p
BC212/3	10p
BC214	10p
BC237	15p
BC327	16p
BC337	10p
BC338	16p
BC461	25p
BC516/7	36p
BC547B	12p
BC548C	9p
BC549C	12p
BC557B	18p
BC559C	16p
BCY70	20p
BCY71	20p
BD132	80p
BD135/6	40p
BD139	40p
BD189	60p
BD232	95p
BD233	75p
BD235	75p
BD241	70p
BD242A	70p
BF256B	45p
BF257/8	30p
BFR39	20p
BFR40/1	20p
BFR79	20p
BFR80/1	25p
BFR96	180p
BFX30	34p
BFX86/7	25p
BFX88	25p
BFX89	150p
BFY50	24p
BFY51/2	24p
BFY56	30p
BFY90	75p
BRY39	40p
BSX19/20	20p
BU104	225p
BU105	170p
BU108	250p
BU109	225p
BU126	150p
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BU205	175p
BU208	200p
BU406	145p
BUX80	400p
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MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	£4
MJE340	50p
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TIP33C	80p
TIP34A	90p
TIP34C	80p
TIP35A	120p
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2N697	20p
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2N918	35p
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2N2222A	25p
2N2369A	17p
2N2484	25p
2N2646	40p
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2N2907A	25p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3553	240p
2N3702/3	10p
2N3704/5	12p
2N3706/7	10p
2N3773	200p
2N3819	20p
2N3823	30p
2N3866	90p
2N3904	15p
2N3906	15p
2N4037	65p
2N4056	65p
2N4124	27p
2N4126	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5062	35p
2N5087	27p
2N5089	27p
2N5172	27p
2N5192	75p
2N5245	40p
2N5401	50p
2N5457/8	30p
2N5459	30p
2N5460	60p
2N5485	36p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
BYX36300	20p
OA47	8p
OA90/91	9p
OA95	9p
OA200	3p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	5p
1N4005	6p
1N4006/7	7p
1N5401/2	12p
1N5403/4	14p
1N5404/7	19p
S920	9p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	380p

PCB MOUNTING RELAYS

6 or 12V DC
Coil SPDT 2A
24DC 160p

6 or 12V DC
Coil DPDT 5A
24V DC
240V AC 200p

6 or 12V DC
Coil SPDT 10A
24V DC
240V AC 225p

OPTO ELECTRONICS

2N577	40p
OCP71	180p
ORP12	120p
ORP60	120p
ORP61	120p
TIL78	55p

OPTO ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
MOC3020	150p
ILQ74	240p
TIL11	70p
TIL12	70p
TIL13	70p
TIL116	70p

LEDs

0.125"	
TIL32	55p
TIL209 Red	9p
TIL211	12p
TIL212 Ye	14p
TIL216 Red	18p
0.2"	
TIL200 Red	10p
TIL222 Gr	12p
TIL228 Ye	14p
Rectangular LEDs (R,G.Y)	30p
NSB5881	570p
TIL311	600p
TIL312/3	110p
TIL321/2	130p
TIL330	140p
7750/60	200p

DISPLAYS

31015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	90p
FND507	90p
MAN3640	175p
MAN4640	200p

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

LOW PROFILE SOCKETS BY TI

8 pin	9p
14 pin	10p
16 pin	11p
18 pin	16p
20 pin	18p
22 pin	22p
24 pin	24p
28 pin	26p
40 pin	30p

WIRE WRAP SOCKETS BY TI

8pin	25p
14 pin	35p
16 pin	40p
18 pin	50p
20 pin	60p
22 pin	65p
24 pin	70p
28 pin	90p
40 pin	100p

VERO BOARDS

2.5" × 5"	95p
2.5" × 3.75"	86p
2.5" × 17"	330p
3.75" × 3.75"	95p
Vero Block	410p
3.75" × 5"	90p
3.75" × 17"	410p
4.75" × 7.9"	530p
2.5" × 1"	110p
Spot Face Cutter	130p

SWITCHES

TOGGLE SWITCHES
Subminiature
SPST £60p, SPDT 65p
DPDT 70p
Rotary Switches
IP120w, 2P6w, 3P4w, 4P3w 55p
DIGITAST SWITCHES)xP
Push to make (R,G,B)15p
Push to break (Black) 10p
Slide Switch DPDT 10p
Square PCB Switch 65p

RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calender receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided.

Ready Built Unit .... £145 + £5.00 carr.
Reprint of ETI articles at £1.00 + s.a.e.

AS DESCRIBED IN JUNE/JULY/AUGUST ISSUE

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Complete Kit £64.00 + £1.00 p&p
8V 1.8A PSU £7.00 + 70p p&p
1802 Ref. £7.00
IDEAL for HOBBYISTS — learn and explore the workings of microprocessors and unravel the mystical field of computers.
INVALUABLE for training centres, schools and industries — gives effective insight into micros to engineers, electricians etc not directly involved in the computer field.
INEXPENSIVE — a truly low cost teaching aid — in fact a short step towards developing new ideas and systems.

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(incl VAT) Carr £8/unit
Model A to Model B upgrade kit **£50**
Fitting charge **£15**

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TELETEXT ADAPTOR £195
WORLDWISE 8K ROM £39
TORCH Z80 DISC PACK £780
Business, Education and Fun Software in stock
FLOPPY DISC INTERFACE
INC. 1.2.0.5. **£95** and **£20** installation

BBC FLOPPY DISC DRIVES

Single drive 5¼" 100K **£230** + £6 carr.
Dual drive 5¼" 800K **£699** + £8 carr.

BBC COMPATIBLE DRIVES

These drives are supplied in BBC matching colour cases.
SINGLE 100K **£150** 200K **£215*** 400K **£265**
SINGLE WITH PSU 100K **£185** 200K **£260*** 400K **£330**
DUAL WITH PSU 200K **£355** 400K **£475*** 800K **£595**
* These drives are supplied with a switch between 40 and 80 tracks.

Drive Cables: Single £8 Dual £12
Disc Manual & Formatting Diskette £17.50

MICRO TIMER

The programmable clock/timer is a 6502 based dedicated micro computer with memory and 4 digit 7 segment displays to form an extremely versatile timing device with following features:

- 24 hour 7 day timer
- 4 completely independent switch outputs
- 6 digit 7 segment display output to indicate real time turn-off times and reset times
- Individual outputs to day of week, switch and status LEDs
- Data entry through a simple matrix pad

Further details on request
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PSU .... £7.00 + 70p p & p
Construction details supplied

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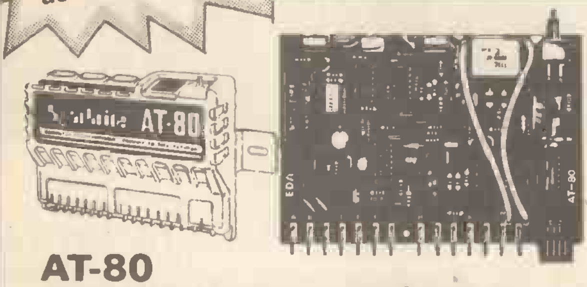

AT-80

Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
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- Over 250 components to assemble

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● A most sophisticated accessory. ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd. ● Affords 12 functions centred on Fuel, Speed, Distance and Time. ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on. ● Facility to operate LOG and TRIP functions independently or synchronously. ● Large 10mm high 400ft-L fluorescent display with auto intensity. ● Unique speed and fuel transducers giving a programmed accuracy of + or — 1%. ● Large LOG & TRIP memories. 2,000 miles. 180 gallons. 100 hours. ● Full Imperial and Metric calibrations. ● Over 300 components to assemble. A real challenge for the electronics enthusiast!

SX1000

Electronic Ignition

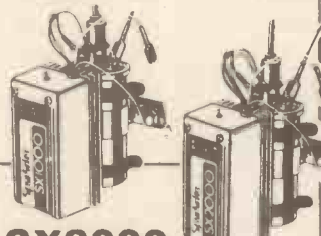
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

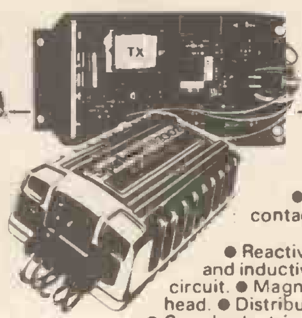
TX1002

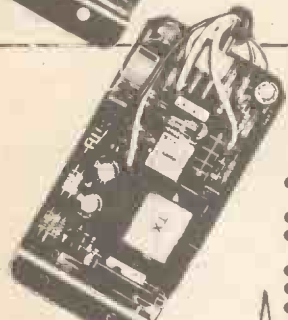
Electronic Ignition

NEW

● Contactless or contact triggered ● Extended coil energy storage circuit ● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.







SX2000

Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002

Electronic Ignition

● The ultimate system ● Switchable contactless. ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor triggerhead. ● Distributor triggerhead adaptors included. ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble

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MAGIDICE

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- Over 100 components to assemble

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AT 80	£32.95
VOYAGER	£64.95
MAGIDICE	£9.95

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Keith Brindley

I PROMISED in the August issue of HE that I would discuss electronic components in this month's All About Electronics. And the first component family that we all need to know about in any study of electronics is the family of resistors. We've already talked about resistance of course; we know that a resistor is something which allows an electric current to flow through it. But the current is actually *controlled* by the value of the resistor. For instance, if the voltage across the resistor is maintained constant, increasing the value of the resistor would automatically reduce the current flowing through it. The three variables of current, voltage and resistance are totally described by Ohm's Law, which say simply that the ratio of the voltage across a body to the current through the body equals a constant which is the resistance of the body. Ohm's Law can be summarised by the formula

$$\frac{V}{I} = R$$

from which

$$V = IR \text{ and } \frac{V}{R} = I$$

can be derived. These three formulae mean that if we know any two of the three variables associated with a resistance, the third can be calculated.

We can express Ohm's Law and these three formulae graphically, as **Figure 1** shows. The graph in **Figure 1** shows three important points about the relationship between voltage across and current through a resistance:

- it is linear, ie a straight line
- it passes through the origin
- it occurs for negative values of both voltage and current.

A relationship which is defined for negative values of voltage and current is important because it means that Ohm's Law can be applied to resistors used with AC usage — where voltage and current alternate between positive and negative values.

What Is A Resistor?

With our knowledge of the interdependence of each of these variables of current, voltage and resistance we can now go on to look at the make-up of a resistor. As you know, in electronics there are specific components which we call resistors. Size of each type is not necessarily related to value — in other words you could have a resistor of value 10MR (ie 10 megohms = 1×10^6 ohm) which is smaller than a 10R resistor. No — size is normally related to the power which a type of resistor can dissipate (ie, release as heat to the surrounding air — more of that later!).

One type of resistor which we met two months ago was simply a length of nichrome wire. Now, nichrome wire is made with a very even and constant diameter throughout its length. If you were to do a couple of experiments with two lengths of such wire — having different diameters — you would find that their resistance is proportional to length and inversely proportional to cross-sectional area. So: the longer the wire, the higher the resistance; the thicker the wire the lower the resistance (both fairly obvious, I think!). The actual resistance of the wire can be calculated by using the formula

$$R = p\frac{1}{a}$$

where 1 = length, a = cross-sectional area and *p* is the *resistivity* of the wire.

Any material has its own resistivity: for example, the resistivity of copper is 1.72×10^{-8} ohms per metre and the resistivity of aluminium is 2.82×10^{-8} ohms per metre, and the resistivity of nichrome is 1.10×10^{-8} ohms per metre. So the resistance of a length of material can be calculated from knowledge of these three variables.

If we take the example of nichrome wire and calculate the resistance of a one metre length of wire, of cross-sectional area $0.1 mm^2$, it will give us a good idea of the use of this resistance formula. Now, the resistivity of nichrome is 110×10^{-8} ohm metre, so the resistance is

$$\frac{1}{a} = \frac{110 \times 10^{-8} \times 1}{1 \times 10^{-7}}$$

$$= 11R$$

From this result, it is fairly obvious that although a material such as nichrome wire exhibits the principles of resistance we couldn't use it to manufacture resistors to any great value — just think of the length of wire needed to make a 1M resistor.

To make high value resistors a material with a higher resistivity must be used. The most common material used is carbon. Carbon belongs to a group of substances we call semiconductors. For one reason or another (as we'll find out over the coming months) semiconductors are the most important elements in the electronics world. Other semiconductors often used are germanium and silicon.

Carbon's high resistivity (about 180×10^{-8} ohms per metre) means that high resistances can be manufactured with quite small body sizes. Two main types available are:

1) solid carbon resistor (**Figure 2**). Graphite (a form of carbon) is compressed into a thin rod and metal leads are connected to each end. The rod and connections are encased in an insulating body.

2) Carbon film resistor (**Figure 3**).

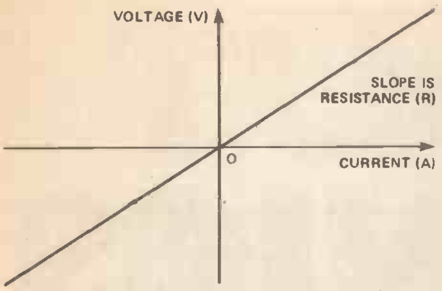


Figure 1. Showing the graphical relationship between voltage across a resistor and current through it.

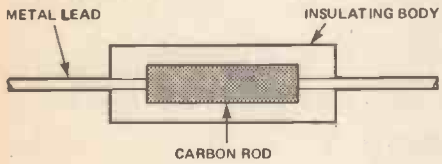
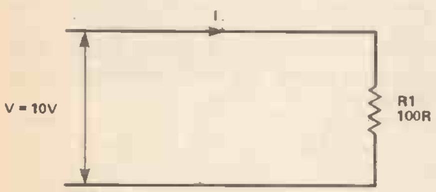


Figure 2. Make-up of a solid carbon resistor.



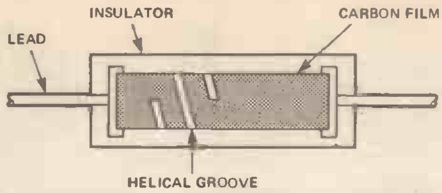


Figure 3. How a carbon film resistor is made-up.

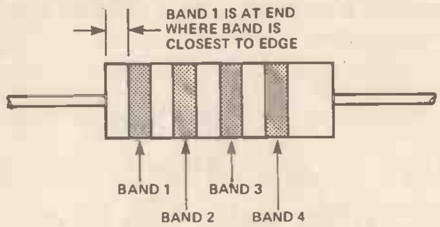


Figure 4. The resistor colour code and a table relating to each band and its colour to a resistor's value. The bulk of the colours (red to violet) are the colours of the spectrum.

Figure 5. Simplest resistor circuit it is possible to make — a single resistor connected to a 10V power source.

Graphite is deposited as a thin film on a ceramic insulating body. A groove is cut into the film until the required resistance is reached. Then metal caps are crimped to the ends to form connections and the whole resistor is coated with an insulator.

Resistors made from carbon are cheap and can be made to quite a high accuracy (say, within 5% of the required value). They are therefore used a lot in electronics. But they do, however, have some disadvantages:

- their resistance varies a great deal with changing temperature
- they are prone to resistance changes due to mechanical shock or just age.

So, for more exacting requirements we use other types

- metal film
- metal oxide film.

Construction is similar to carbon film resistors but a layer of metal or metal oxide is deposited on the insulating body. These make much more stable resistors and generally speaking better accuracy can be achieved (say, ± 1% of the required value).

NPV

Generally speaking a wide range of values of resistors is needed — anything from a fraction of an ohm to several million ohms can be seen in any common piece of electronic equipment. It would obviously be impossible to manufacture every possible value: and anyway, resistors are rarely their exact quoted value — some are made with a tolerance of ± 20%, ie they could have a value within the range 20% under to 20% over the specified value. So to provide reasonable coverage of all possible values, resistors are made to standard ranges. A typical standard is the E12 range shown in **Table 1**.

Other standard ranges give different resistance. For example, common American resistances may have values such as 3K32 and 6K65. When we specify a particular resistor calculated for a circuit, then we have to use the nearest value to it from the standard range. The standard range value is known as the *nearest preferred value* (NPV). To differentiate values of resistors (they all look the same, after all, don't they?) we code them with an internationally accepted code known as the *resistor colour code*. Resistors are coloured with thin loops or bands around their bodies. Coding and decoding what the different bands mean is quite straightforward and is shown in **Figure 4**.

Each of the first two bands stands for a digit. The third band stands for the 'multiplier' — quite simply the number of zeros behind the first two digits.

Thus a colour-coded resistor whose first three bands are red, violet, yellow would be of value 270000: red = 2, violet = 7, and yellow = four zeros, ie 27k. The fourth coloured band (if used at all) gives the resistor's tolerance.

Now we've looked at resistor values and codes it only remains to look at power ratings, and then we can go to look at circuits using resistors. Last month we discovered the heating effect of an electric current. Power is dissipated in the form of heat whenever a current flows through a resistor, and, if that heat is too great, the value of the resistor may change, or worse still, the resistor may be damaged — it may 'burn-out'. Manufacturers give resistors power rating, and the actual power which a resistor dissipates must always be less than its power rating.

Power dissipated by a resistor is calculated from the power formula we saw last month

$$P = IV \text{ (measured in watts)}$$

or because $V = IR$ and $I = V/R$.

$$P = I^2R = \frac{V^2}{R} \text{ watts}$$

So, knowing the voltage across a resistor, or the current through it, or both, the power dissipated by a resistor in a particular application can be calculated and a resistor can therefore be used of high enough rating.

Resistors In Circuits

We have looked at some simple circuits using resistors over the last two months. It's worth repeating them here, I think, before moving on to more complex circuits. The simplest circuit we could possibly build is shown in **Figure 5**.

E12 Resistance Values

10	100	1K	10K	100K	1M
12	120	1K2	12K	120K	1M2
15	150	1K5	15K	150K	1M5
18	180	1K8	18K	180K	1M8
22	220	2K2	22K	220K	2M2
27	270	2K7	27K	270K	2M7
33	330	3K3	33K	330K	3M3
39	390	3K9	39K	390K	3M9
47	470	4K7	47K	470K	4M7
56	560	5K6	56K	560K	5M6
68	680	6K8	68K	680K	6M8
82	820	8K2	82K	820K	8M2

Table 1. Resistor values in the E12 range. The first column lists the basic resistor values; all other resistors are simple decades of the basic resistors

The voltage across the resistor, V, is indicated by the arrow shown beside the resistor. The arrow head indicates the more positive side. Current is indicated by the arrow head within the circuit, which should always point in the direction of current flow, ie from positive to negative.

In the circuit of **Figure 5**, if V = 10 volts and R1 = 100R the current, I, must equal (from Ohm's Law)

$$\frac{V}{R} = \frac{10}{100} = 0A1$$

The resistor must therefore be capable of dissipating at least

$$\frac{V^2}{R} = \frac{100}{100} = 1 \text{ watt}$$

Figure 6 shows a more complex example of a circuit using two resistors. Such a circuit is often known as a voltage, or potential, divider because the voltage at the junction of the two resistors is always a strict ratio of the voltage across the whole circuit. We can think of the two resistors as forming a circuit which will provide an output voltage which is always a particular ratio of an input voltage.

The voltage at the resistor junction (classed as the output voltage, V_{out}) is given as the ration of the output resistor (R2), to the total resistance (R1+R2), times the input voltage (V_{in}). As a formula

$$V_{out} = \frac{R1}{R1+R2} \times V_{in}$$

And, in the circuit of **Figure 6**

$$V_{out} = \frac{500}{1500} \times 12 = 4V$$

Certain types of resistors (potentiometers — called 'pots' for short) make use of this potential dividing capability to allow a continually variable output voltage to suit the application. The volume controls of a hi-fi system or TV are good examples of this. Such a pot is placed at the amplifier input of the equipment, and the output voltage is controlled by the ratio of the two resistors **Figure 7** shows the make-up of a simple pot. By varying the position of the 'wiper' (ie, the junction of the two resistors), the ratio between the two resistors is changed and so the output voltage changes. You should have gathered, from the example of a pot used to control volume from an amplifier, that pots (in fact all resistors too) can be used with AC voltages and signals as well as DC. **Figure 8** shows the circuit symbols of a pot.

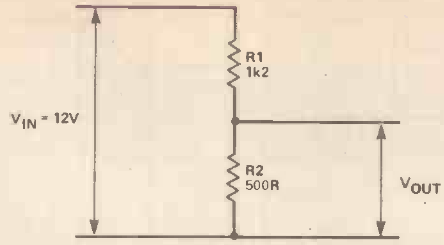


Figure 6. A voltage divider or potential divider is made with two resistors. The output voltage, V_{out}, is a ratio of the input voltage, V_{in}.

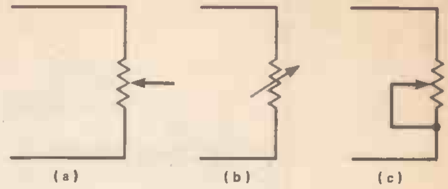


Figure 8. a) **Symbol of a pot used as a potential divider. b) Symbols of a pot used as a variable resistor — either symbol is correct, but version c shows correctly how the pot is physically connected in a circuit.**

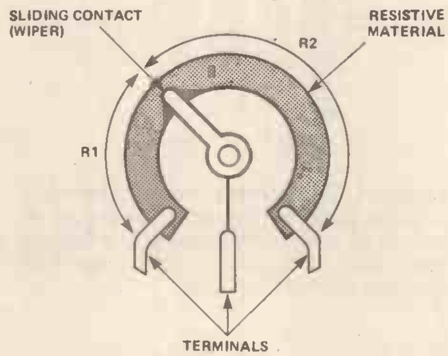


Figure 7. **Make-up of a pot — a potentiometer. The wiper can rotate around the resistive material altering the ratio between R1 and R2.**

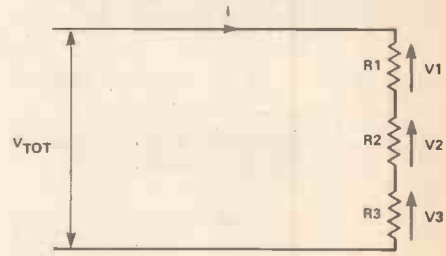


Figure 9. A more complex circuit, consisting of three resistors in series. The total voltage is made up of three voltages across each resistor. The current flows equally through each resistor.

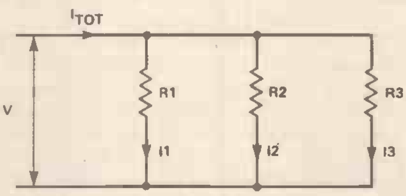


Figure 10. Three parallel resistors. In this circuit the voltage across each resistor is the applied voltage, V, but the total current I_{tot}, is made up of the three separate currents through each resistor.

More Complex Circuits

Electronic circuits, of course, are usually far more complex than those of say, potential dividers and some methods must be established to help us understand them. Take for example the circuit in **Figure 9**. As the resistors are in series, the current, I, must flow through each of them. The *voltage* across each of these resistors depends upon each resistors value according to the formula.

$$V = IR$$

and the total voltage, V_{tot} equals the sum of the individual resistor voltages, ie

$$V_{tot} = V_1 + V_2\ V_3$$

However, when resistors are in parallel, as in **Figure 10**, the voltage across each resistor is equal, therefore the *current* through each is dependent on its resistance, according to the formula

$$I = \frac{V}{R}$$

and the total current, $I_{tot} = I_1 + I_2 + I_3$.

Equivalent Circuits

We can simplify complex circuits which may seem difficult to understand into *equivalent circuits* — circuits which theoretically perform the same job with a minimum of components. (I say 'theoretically' because these equivalent circuits might not work in a practical arrangement — they are often only used to aid our understanding of complex circuits.)

A simple example can be made of the *circuit in* **Figure 9**. The series resistors can be replaced by a single equivalent resistor. Its value can be found by using the formulae associated with Ohm's Law. We know the total voltage, V_{tot}, and we know the current, I. Therefore, the equivalent resistor.

$$R = \frac{V_{tot}}{I}$$

But, we also know that $V_{tot} = V_1 + V_2 + V_3$.

So: $$R = \frac{V_1 + V_2 + V_3}{I}$$

But, $V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$, so

$$R = \frac{I(R_1 + R_2 + R_3)}{I}$$

therefore $R = R_1 + R_2 + R_3$

In other words, if resistors are in series (and this applies to any number of resistors), their equivalent resistance is found by simply adding their individual resistances. Likewise in the circuit of **Figure 10** where three resistors are in

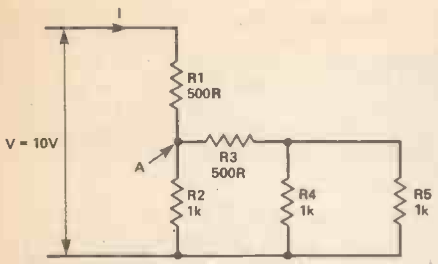


Figure 11. Quite a complex electronic circuit, but we can reduce it in complexity to an equivalent circuit.

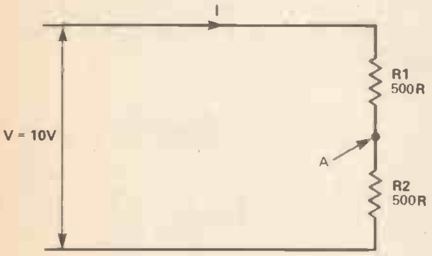


Figure 12. An equivalent circuit of that in Figure 13, used to calculate the voltage at point A.

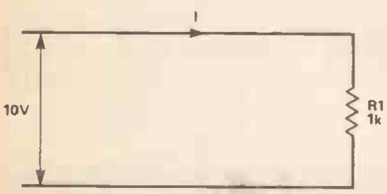


Figure 13. Another equivalent circuit of that in Figure 13, used to find the current, I, in the circuit.

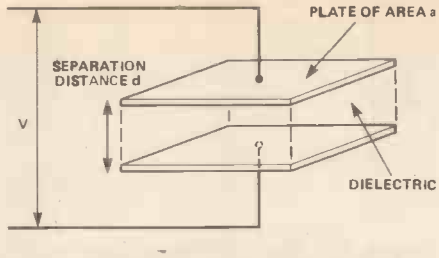


Figure 14. Basic form of a capacitor — two parallel conductive plates separated by a dielectric.

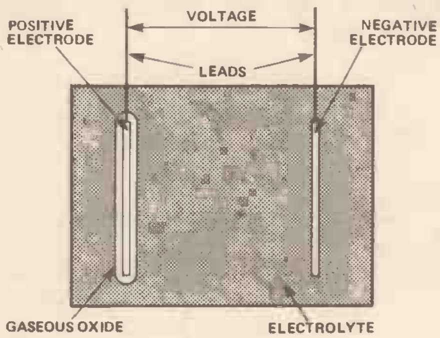


Figure 15. An electrolytic capacitor. The 'plates' are formed by the positive electrode and the surface of the electrolytic. The dielectric is the gaseous oxide layer around the positive electrode.

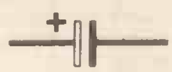


Figure 16. The circuit symbol for an electrolytic capacitor, showing that it is polarised and must be inserted the correct way round into a circuit. The solid bar indicates the negative lead.

parallel, we know that the equivalent resistance

$$R = \frac{V}{I_{tot}}$$

But, we know that $I = I_1 + I_2 + I_3$, and

$$I_1 = \frac{V}{R_1},\ I_2 = \frac{V}{R_2},\ I_3 = \frac{V}{R_3}$$

$$R = \frac{V}{\frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}}$$

$$= \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

or, inverting both sides

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

In other words, for parallel resistors (any number) the reciprocal of the equivalent resistor is found by adding the reciprocals of the individual resistors.

Don't be put off by all of this: it's often easier to calculate the equivalent value of paralleled resistors than it would first appear. For instance, if two equal valued resistors are in parallel (say, two 10k resistors) the equivalent value is half of the value of a single resistor (ie, 5k). If three equal valued resistors are in parallel the equivalent value is one third the value of a single resistor (ie, 3k3, following the above example). With four equal resistors, the equivalent is one quarter, and so on.

The equivalent resistance of two unequal resistors (R_1 and R_2) in parallel can be calculated quite easily by the simple formula:

$$R = \frac{R_1 \times R_2}{R_1 + R_2}$$

However, if there are three or more unequal resistors in parallel then you'll have to use the reciprocal formula, but that doesn't happen often, thankfully.

Armed with all this knowledge, it is possible now to simplify some quite complex circuits. An example might be something like that in **Figure 11**.

We might have to calculate the current I, and the voltage at point A in the circuit. It looks complicated but, in fact, isn't. Take it in the following stages:

1) Calculate the equivalent resistance resistors R4 and R5 — ie, two resistors of 1k in parallel = 500R
2) Calculate the equivalent resistance of R3 in series with that in stage 1 ie, two resistors of 500R in series = 1k
3) Calculate the equivalent resistance of R2 in parallel with that in stage 2 ie, two 1k resistors in parallel = 500R
4) The circuit has now been reduced to that in **Figure 12**. The voltage at point A must be 5V ie, it is at the mid-point of the potential divider formed by the two resistors
5) The total equivalent resistance is formed by two 500R resistors in series (= 1k) and so the final equivalent circuit is as shown in **Figure 13.**

From the formulae associated with Ohm's law, the current.

$$I = \frac{V}{R} = \frac{10}{1000} 10\text{mA}$$

QED! Simple, isn't it?

The second component family we need to look at is that of capacitors. Any capacitor (**Figure 14**) consists essentially of two parallel plates of conducting material separated by an insulator (called a dielectric). When a capacitor is inserted in an electric circuit (such as that in **Figure 14**) so that the voltage appears across the capacitor plates, electrons gather on the negative side. Similarly electrons are repelled from the positive side so that a depletion of electrons occurs there. The circuit symbol for a capacitor is shown in **Figure 15.**

If the capacitor was instantly disconnected from circuit in this condition this gathering of electrons on one plate and depletion on the other will remain — the capacitor is said to hold its 'charge'.

The capacitance of a capacitor is a measure of its ability to hold this charge and is measured in Farads (abbreviated F). One Farad is a large unit in electronic terms and so capacitors of values in uF (microfarad ie, 10^{-6}F); nF (nanofarad ie, 10^{-9}F), pF (picofarad ie, 10^{-2}F) are often used.

In the same way that resistance of any material can be calculated from the formula

$$R = \rho \frac{1}{a}$$

so can capacitance of a capacitor be calculated from the formula:

$$C = \epsilon \frac{a}{d}$$

where a is the area of the capacitor plates and d is the distance between plates. The constant, ϵ, is the *permittivity* of the dielectric used in the capacitor (I suppose it could be called 'capacitivity' but that's a bit of a mouthful!). Different insulators have different permittivities and in the same way that conductors are chosen for resistors because of their resistivity, so insulators are chosen for capacitors because of their permittivity.

Although the basic idea of a capacitor consisting of two plates separated by a dielectric remains true whatever dielectric is used, the actual shape and appearance is altered due to the physical characteristics of the dielectric. There are three common solid dielectrics: polyester, ceramic and mica. In addition, there is a capacitor whose dielectric is the thin layer of metal oxide which occurs due to electrolysis — this is known as an electrolytic capacitor. The four types are:

1) Ceramic
Ceramic is very brittle and cannot be easily shaped so capacitors are formed on the simple parallel plate basis already described. Ceramic has a high permittivity and so quite high capacitor values can be made with small body sizes.

2) Mica
Like ceramic, mica is very brittle and cannot be shaped, so again mica is only used in a parallel plate arrangement. Mica's permittivity is not so high as ceramic's, so for the same body size only lower capacitor values can be made. Mica's main advantage is the fact that it allows highly accurate capacitors (± 1%) to be achieved.

3) Polyester
Polyester film is easily shaped and can be rolled between aluminium foil (the plates) to give large areas of plates therefore high capacitor values can be made with small body size.

4) Electrolytic
Electrolytic capacitors depend on the electrolysis of a liquid electrolyte to form a layer of gaseous oxide on one of two electrodes inserted into the electrolyte (**Figure 16**).

T.ie two 'plates' consist of the positive electrode *and the liquid electrolyte* (not the negative electrode!) The distance between the plates is the thickness of the gaseous oxide. Electrolytic capacitors are *polarised* and so must be inserted into circuit the correct way round otherwise damage will occur. In practice they are marked with a symbol (+) or (—) in indicate polarity, or sometimes the positive end of the capacitor body is ridged. The circuit symbol of an electrolytic capacitor is shown in **Figure 17**.

It is impossible to manufacture accurate values of capacitors using electrolytic dielectrics but nevertheless they are extremely useful due to the fact that very high values (say, 10000F) can be made with relatively small body sizes.

All capacitors have a voltage rating and the potential difference applied to a capacitor's leads must never exceed the rated voltage (which is normally printed on the capacitor's body). In a lot of cases the voltage rating will be high enough for the majority of applications but electrolytic capacitors for example have quite low ratings eg 10V and care should be taken to make sure the rating of any capacitor is not exceeded.

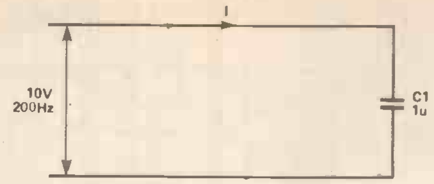
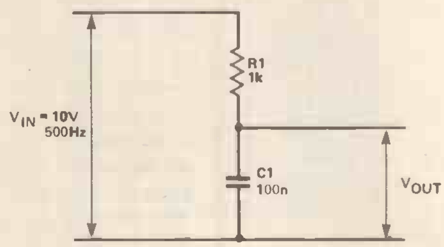


Figure 17. The simplest AC capacitor circuit, Calculation of the current flowing in the circuit is identical to a resistor circuit as long as we know the reactance of the capacitor] and that depends on the source voltage frequency.



The reactance of C1 at 500Hz $= \frac{1}{2\pi \times 500 \times 100 \times 10^{-9}} = 3k2$

Therefore $V_{OUT} = \frac{3k2}{4k2} \times 10 = 7V6$

Figure 18. A potential divider using a capacitor circuit. The output voltage depends not only on the value of the capacitor but also on the frequency of the input voltage!

Now capacitive effects are very different in DC circuits from AC circuits. So different in fact that I am going to leave their DC effects until another month. For the rest of this instalment I will concentrate on capacitors in AC circuits.

I have already pointed out that resistors can be used in AC *or* DC circuits and all calculations are identical in either. The circuits used with resistors can be used with capacitors too, however the similarities between resistor circuits and capacitor circuits only occur when *the power sources of the capacitor circuits are AC.*

For example, the circuit of **Figure 18** shows a capacitor of value 1uF connected to an AC source of 10V at 200Hz. Note that even though the power source is AC, I have assumed the circuit to be drawn in an instant in time — and at the particular instant in question the voltage at the top of the circuit is positive (hence the voltage arrow is pointing upwards and the current arrow heads points to the right). The voltage and current could equally have been the opposite way round if a different instant were chosen.

Now, how can we calculate the current in the circuit?

The answer comes from the fact that any capacitor has *reactance* (don't worry about what it is — just think of it for the time being as an AC resistance!) measured like resistance, in ohms, but given the symbol X. Now, a capacitor's reactance is given by the formula

$$X = \frac{1}{2\pi f}$$

From this formula, you will see that the reactance is inversely proportional to frequency of the source. So the capacitor's reactance will go down as the frequency goes up.

In other words, we need to know the frequency of the source to define exactly what the circuit does.

At 200Hz a capacitor of value 1uF will have a reactance

$$X = \frac{1}{2\pi fc} = \frac{1}{2\pi \times 200 \times 1 \times 10^{-6}}$$

$$= 800R$$

So, the current I in the circuit of **Figure 17**.

$$I = \frac{V}{R}$$

or, more correctly speaking.

$$I = \frac{V}{X} = \frac{10}{800} = 12mA5$$

Likewise, any other of the circuits using resistors, that we have looked at this month can be used with capacitors (but AC only remember!)

Let's take a last look at the potential divider circuit but with a capacitor instead of one of the resistances, as in **Figure 18**.

The output voltage is defined exactly as before (but using reactance X, instead of resistance R2) in the formula. That is

$$V_{out} = \frac{X}{X+R_1} \times V_{in}$$

But, we know that reactance, X, changes with frequency, so the output voltage of the potential divider must also change as applied frequency changes! This concept is an important one — it forms the basis of many things, eg tone controls of an amplifier, and we will be studying it a great deal.

But that's enough for this month: we have seen a lot of new things — components, circuits, formulae etc. Next month we will look at another family of components — the most important as it happens. Like resistors, this family uses semiconductors as its main elements but with very different effects.

HE

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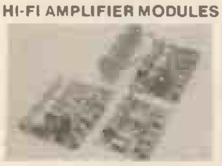

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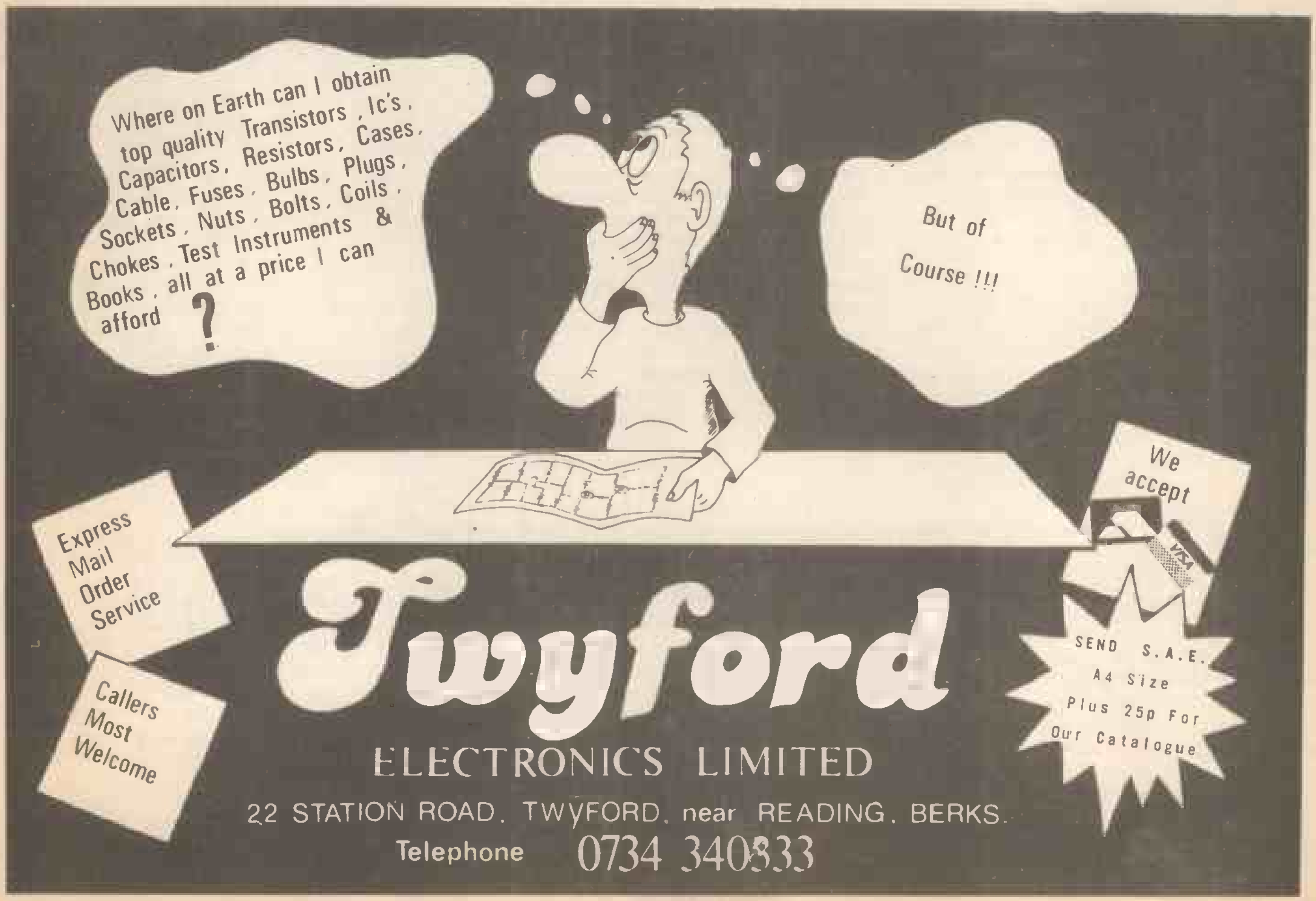


Variable Power Supply

Chuck out your batteries and get plugged into the HE 3 - 30 volt Power Supply.

G. Macaulay

NO MATTER what your interest in electronics, there are two items of test gear that are essential. One is the common or garden multimeter and the other is a good power supply unit.

Most projects which appear in this publication need a power supply in the range of 3-30V, with a current consumption from a few hundred microamps to several hundred milliamps. Sometimes projects can be run from batteries — but since it costs nearly two thousand times more for battery power than for mains electricity, it obviously makes good sense to use the latter!

Looked at this way, a PSU can be seen as a good investment which will pay for itself in a short time. The design presented here is both simple to build and inexpensive, moreover it has a professional performance. The design is also tried and tested, since several hundred have already been supplied in kit form over the the last couple of years.

The desirable features of such a PSU are fairly easy to summarise.

Firstly, it must be capable of delivering about an amp of current; this will allow items such as power amps to be driven directly from the supply. It must also have a metered output so that the voltage can be set accurately, while low ripple is an important requirement, especially when powering audio and logic circuitry; this design has less than 10mV ripple voltage on the output.

Apart from these specifications, short circuit protection is essential — otherwise you will soon end up with a dead supply, and have to replace the output stage.

Considering the confined space in which many constructors work, it is almost inevitable that the output will be shorted out sooner or later! No power supply can be guaranteed to operate into a short indefinitely, but the present design will withstand limited duration short circuits without damage.

Last but by no means least the power supply must be portable. 'Murphy's Law' will dictate that the power supply will always be needed in the most inaccessible places!

The Current

The PSU has been designed specifically for experimenters and so meets all the requirements just outlined. Its output is fully variable from three to thirty volts and has automatic current limiting set at approximately 1.1 amps; the ripple voltage is typically 3mV peak-to-peak, 1mV RMS.

The circuit diagram is shown in **Figure 1**. For descriptive purposes it can be broken down into three parts: first, raw DC at about 30V is generated from the secondary (24V) winding of T1 by the bridge rectifier BR1 and is smoothed by the 2000u capacitor formed from C1, C2.

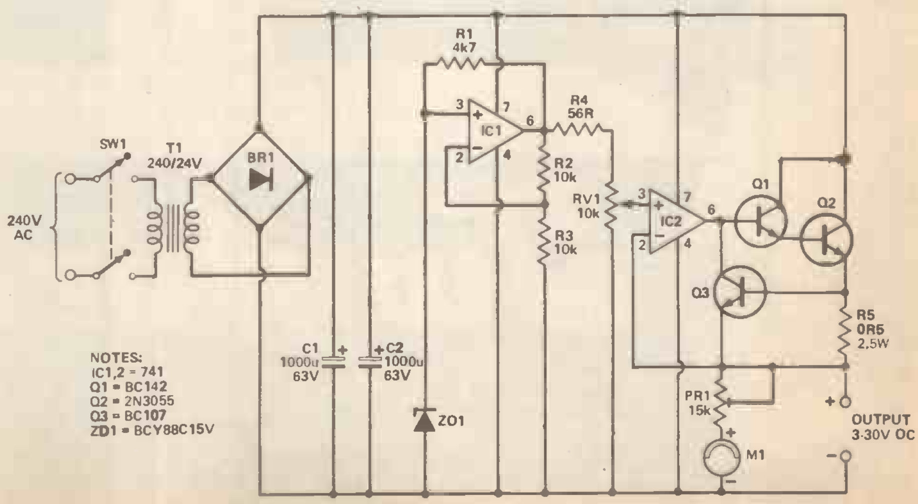
The next section, based on IC1, generates a very stable, ripple-free reference voltage. The IC is connected as a comparator with a gain of two; at the switch-on, the Zener ZD1 presents a high impedance and therefore almost the full output voltage appears at pin 3 (the drop across R1 due to an input current of microamps is negligible). The output is also coupled to the inverting input, pin 2, via the voltage divider formed by R2 and R3, so that about half the input is applied to pin 2. Therefore no matter what the condition of the output when power is first applied, the non-inverting input is always more positive than the inverting input, so output *must* swing towards the positive rail.

But as it passes the Zener voltage, pin 3 stabilises at 15V, and the output remains rock steady on 30V. Once stabilised, the current drive to ZD1 is virtually constant and this results in very little ripple voltage on the reference output.

A proportion of the reference voltage is picked off by RV1 and drives the non-inverting input of IC2, another comparator but with a gain of one.

(Editorial Note: Although this circuit is tried, tested and has been proved to be generally reliable, it may not work as described with some 741 ICs. If any instability is encountered, reliable operation can be guaranteed by connecting a resistive divider of 10k and 4k7 between the 30V rail and 0V, and

Figure 1. The Circuit.



connecting a 1N4148 signal diode from the junction of the resistors to the cathode end of ZD1 (connect the cathodes together). Then, at power-on, the doiode is forward biased, placing about 10V across ZD1 and ensuring a positive output from IC1. As soon as the voltage on the inverting input passes 10V, the new diode is reversed biased and the op-amp will maintain a constant current drive to ZD1. However this modification will only be required in exceptional cases – and it may be simpler just to use a 741 from a different batch.)

Parts List

RESISTORS
(all ¼ watt 5% carbon, except as noted)
R1 .... 4k7
R2, 3 .... 10k
R4 .... 56R
R5 .... OR5
2½ watt wire-wound

POTENTIOMETERS
RV1 .... 10k
1in carbon
PR1 .... 15k
vert pre-set

CAPACITORS
C1, 2 .... 1000u 63V
axial electro

SEMICONDUCTORS
IC1, 2 741
op-amp
Q1 .... BC142
Q2 .... 2N3055
Q3 .... BC107
ZD1 .... BCY88C15V
BR1 .... 1A6/200V
PIV
bridge rectifier

MISCELLANEOUS
SW1 .... DPDT
(part of RV1)
T1 .... 240/24V, 1½A
M1 .... 2mA panel meter
PCB; case (see Buylines); control knob; 2 x sping-clip terminal; cable clamp; wire, solder, nuts and bolts etc.

BUYLINES .... page 34

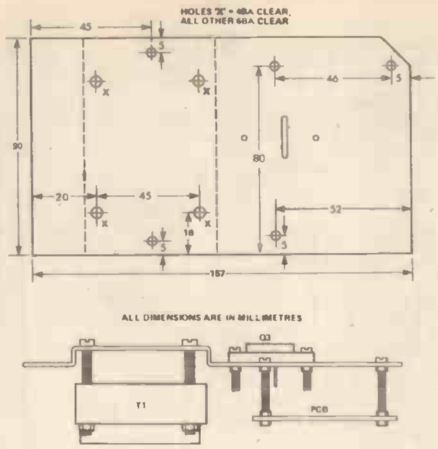


Figure 2. Assembly positions for the power supply's internal mountings: above, where and how to drill; below, the assembly seen from above.

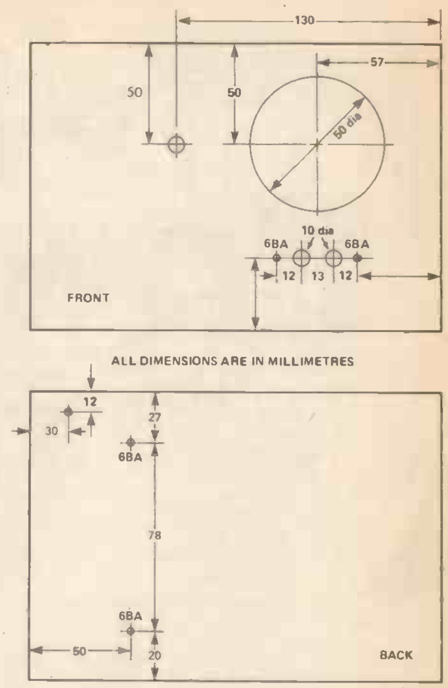


Figure 3. The external mounting positions: above, the front; below, the back.

Pin 6 of IC2 drives the Darlington pair, Q1, 2. Because these are connected in the feedback loop around IC2, the output voltage at the emitter of Q2 will exactly equal the input voltage on pin 3, since the pin 6 voltage will be forced slightly higher to compensate for the base-emitter voltage of the two transistors, plus the voltage dropped across R5. At the same time, any fluctuation in output voltage caused by varying load currents will be reflected around the feedback loop, and will be similarly compensated for at the output of IC2.

The output voltage is monitored by M1 via scaling resistor PR1; current limiting and short circuit protection are provided by monitoring the voltage across R5, which is in series with the load. If excessive current is drawn from the supply, this voltage will go above the OV6 level required to turn on Q3, which then shunts current away from the base of Q1, thereby limiting the output current.

The circuit provides limited protection against operation into a short, and this should be avoided for prolonged periods because Q1 will eventually (and sooner than later) overheat and blow out. However at current of 1A or less, there is no danger of this occurring.

Construction

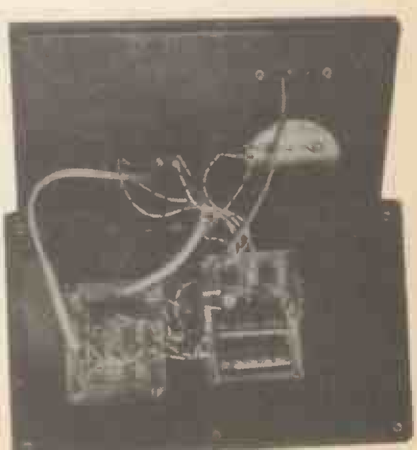
The work involved here falls neatly into two parts, mechanical and electronic; however it is far easier to do the mechanical part first. Start with the meter; examine the back of this and you will see two brass nuts. Undo these and remove the retaining shroud.

Next, following **Figure 2**, drill the front of the case. Attach the pot, SK1 and meter into position. Once this has been accomplished attention can be turned to the heatsink. **Figure 2** shows the position of all the mounting holes whilst **Figure 3** shows the general arrangement of the completed assembly. Although it is possible to mark out all the hole positions it is easier, in practice, to use the PCB and transformer mounting holes as a template, as this also saves a considerable amount of time.

The transformer and Q2 can now be mounted. The mounting holes for the latter are already drilled in the heatsink; Q2 does not require an insulating kit in this application.

Lastly the mounting holes for the heatsink assembly should be drilled in the back of the box as shown in **Figure 2**, and this completes the mechanical assembly.

Now the electronics can commence. The overlay and interwiring is shown in **Figure 4**. The PCB should be wired first, paying attention to the correct orientation of the electrolytics and semiconductors. Once the board has been completed it should be checked for solder blobs, dry joints etc before



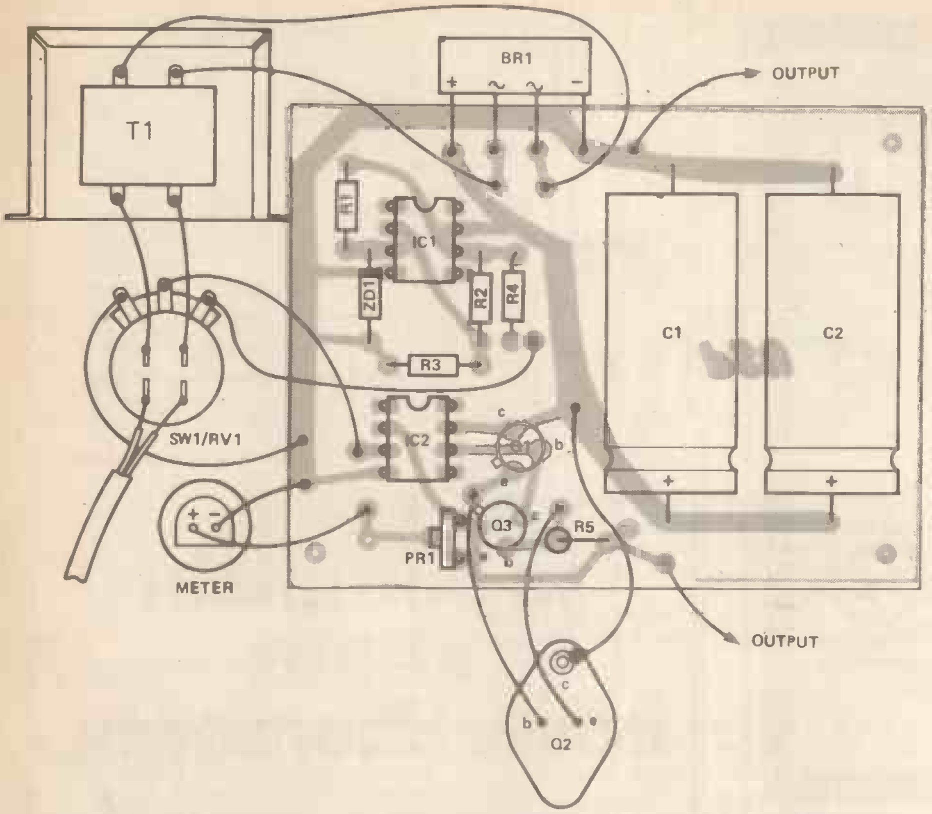


Figure 4. The components. The trick is to get the wire links short enough so that they don't make a 'rat's nest' and long enough so that they don't pull off if any components work loose in transit.

being mounted onto the heatsink.

As shown in the diagram the board is mounted by means of long 6BA screws, secured in position by nuts either side of the board. Ensure that the board is about 1½ in above the heatsink to facilitate connection to Q2. Before mounting the board, solder flying leads to it, leaving each about a foot long.

Once the PCB is mounted final assembly can commence. Connect the flying leads to their respective destinations, shortening them as required, then fit the completed assembly to the back of the case and the construction is completed.

Setting Up

Adjust PR1 to the half-way point and RV1 to minimum, then switch on. Now if your take RV1 to about the mid-point, there should be an indication on the built-in meter.

Connect a multimeter, set to read at least 30VDC, across the output and tweak RV1 until it reads 30V. Then with the lid removed — and being extremely careful not to come into contact with the mains wiring! — adjust PR1 until the PSU meter also reads 30V. This completes the set-up adjustments and rotating RV1 should now produce an output voltage between 3 and 30V for you to use as you please.

HE

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GRIPOMETER

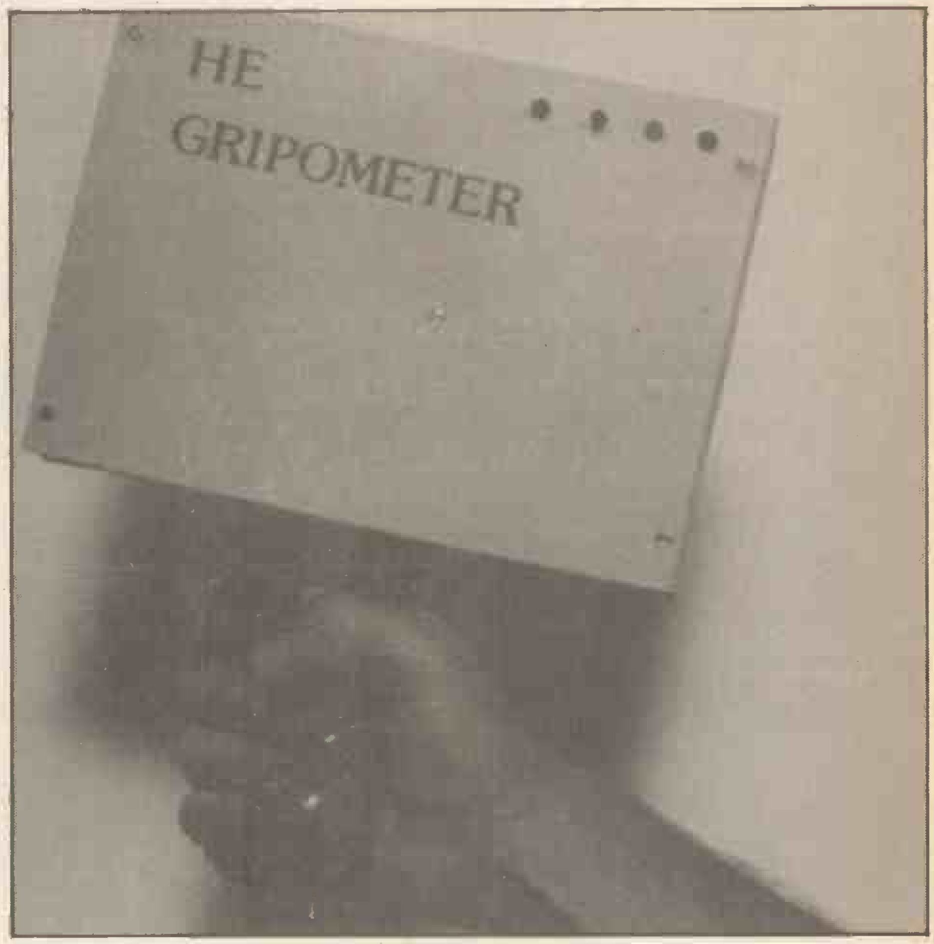
How strong are you? The answer's in your hands!

Ian Hickman

ARE YOU still feeling your way in the Wonderful World of Electronics? Or beginning to get the hang of it and looking for an interesting project to tackle? Either way, look no further! Here is a project which is not too complex, is educational and at the same time fun to build — and use. The components are all standard and inexpensive, so there's no problem there. Furthermore, just to keep your feet on the ground and remind you that electronics has to interface with the everyday world of people and things, the project involves just a wee bit of mechanics. (Did I hear you say UGH! — never fear, for those who can't face the constructional work, a full kit of parts is being made available).

When I visited the annual fair as a lad, beside the big attractions like the steam roundabout with its mechanical organ, and the Dodgems there were smaller attractions as well — perhaps there still are. Among these were various "try-your-strength" stalls, like the punch bag and the one with a bell twenty feet up in the air which you could ring (if you were Superman) by wielding an enormous mallet. There was also one with a couple of handles you could squeeze, and a dial which measured the strength of your grip. This last one always fascinated me, though as a lad I couldn't even reach the handles and in any case preferred to save my pennies for the Helter-Skelter.

The fairground Test-Your-Grip machine was doubtless all done with good-old fashioned mechanics, but HE now presents an *all electronic* Gripometer. This is a gripometer with another difference too: with the aid of a secret "go faster" button, you can astound your friends with your superhuman strength!



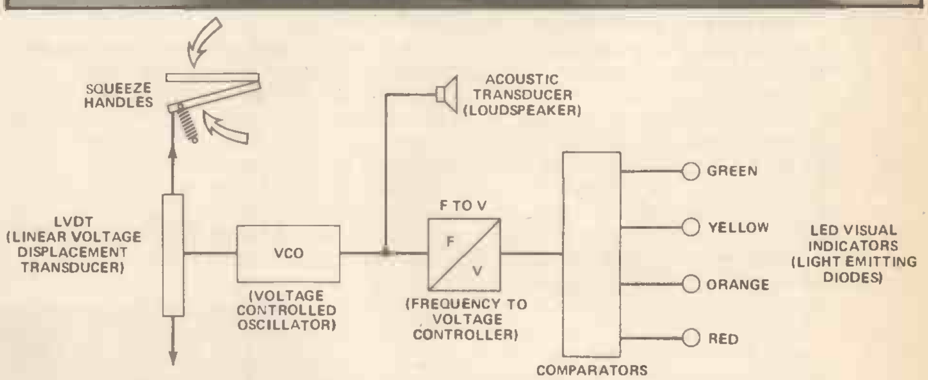


Figure 1. A block diagram of the HE Gripometer.

Putting On The Squeeze

Figure 1 shows a block diagram of the Gripometer. The "linear displacement transducer" is quite simply a slider type potentiometer with 60mm travel, and it is operated by a level with a spring return. If you have grappled with the "O" level physics syllabus, you will recognize the three types of lever in **Figure 2**. The type-3 lever is the one which provides the least mechanical advantage for the "effort" — your hand — and is therefore just the one for our Gripometer! Your handgrip is opposed by a spring and the resultant

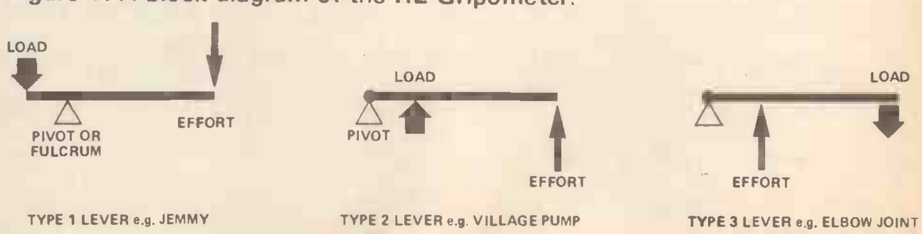


Figure 2. The three basic types of lever.

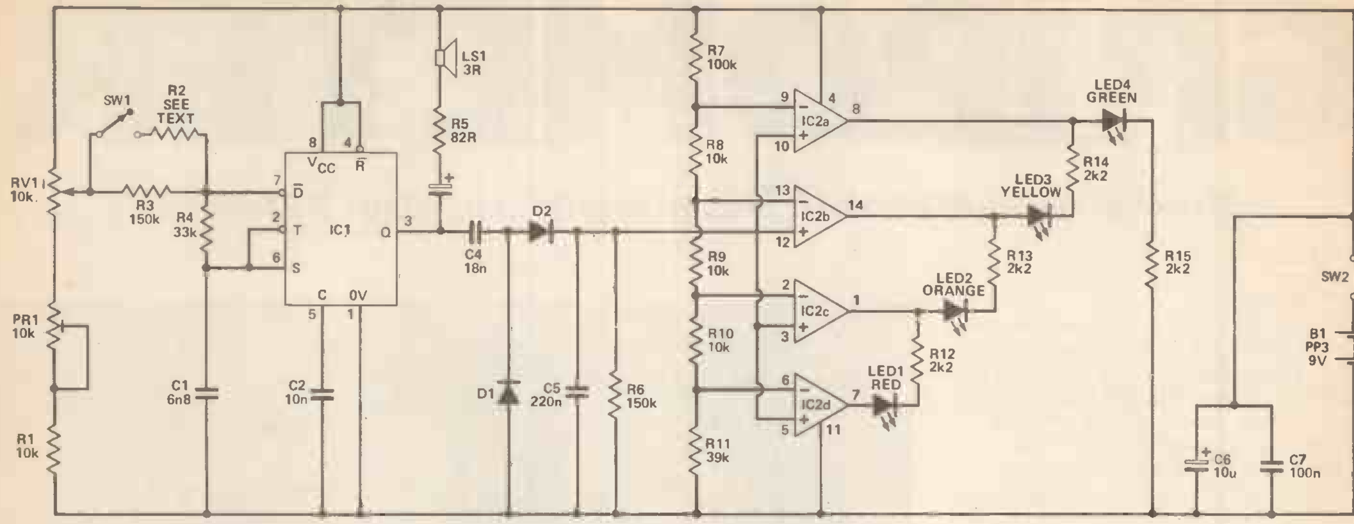


Figure 3. The Gripometer circuit.

movement of the lever works the linear potentiometer as in **Figure 4**.

This brings us to the circuit diagram of **Figure 3**, in which the linear potentiometer is RV1. The normal position of the wiper is near the bottom end of its travel, due to the action of the spring. In this position, the voltage at the wiper is less than ⅔ of the battery voltage, with the result that (as explained elsewhere) the timer IC, IC1, will not oscillate. As the handgrip is squeezed, the wiper of RV1 moves upwards towards the postive supply rail, +9V. IC1 thus starts to oscillate as a low frequency, getting higher and higher as the wiper moves upwards. The output at pin 3 is drives the loudspeaker, giving a higher pitched sound the harder you squeeze the handles.

The pulse output waveform at pin 3 of IC1 is also applied to a simple frequency to voltage converter circuit, consisting of C4, D1 and D2, C5 and R8. On the negative going edge of a pulse at pin 3 of IC1, D1 conducts, leaving C4 discharged. On the following positive going edge, D2 turns on and the pulse voltage is shared between C4 and C5. As C5 is the larger, only a little of the voltage appears across it, but C4 is discharged again on the next negative going edge and adds a little charge to C5 on the next positive going edge again, and so on. The charge added to C5 on each positive edge builds up the voltage across C5 until a balance is reached with the discharge current through R8. The higher the frequency of the waveform at pin 3, the more charge per second is fed via D2 onto C5, and so the higher the voltage across it, although the relationship is not linear. This voltage is applied to the non-inverting (+ve) inputs of all four op-amps of IC2. The inverting (-ve) inputs of the op-amps are connected to voltages derived from the potential divider chain R9, 10, 11, 12 and 13. When IC1 is not oscillating, there is of course no voltage across C5, so the non-inverting input of each op-amp is at a lower voltage than its inverting input.

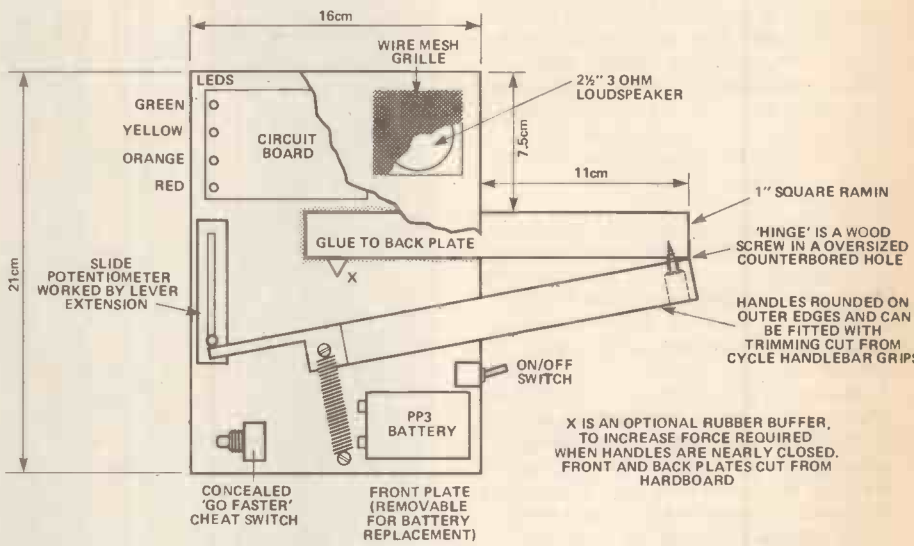


Figure 4. The mechanics of the Gripometer.

Consequently, the output of each and every op-amp is at 0V and none of the LEDs (light emitting diodes) LED1 - LED4 is lit.

As you squeeze the handles harder and the pitch of the sound rises, the voltage at the non-inverting input of op-amp IC2d will exceed that at the inverting input. Thus the output voltage of IC2d will rise to +9V, turning on LED1. As the pitch, and the voltage across C5, rises even higher, the output of IC2c will rise to +9V, extinguishing LED1 and lighting up LED2. Then LED3 lights up and finally — if you are very strong — LED4 lights. Due to the deliberately arranged ripple on the voltage across C5, between one LED extinguishing and the next one lighting there is an intermediate state where both are alight. Thus although there are only four LEDs (red, orange, yellow and green) there are eight states.: All Off, Red, Red+Orange, Orange, Orange+, Yellow, Yellow+Green and Green.

Note that there is no feedback around the four op-amps — they are

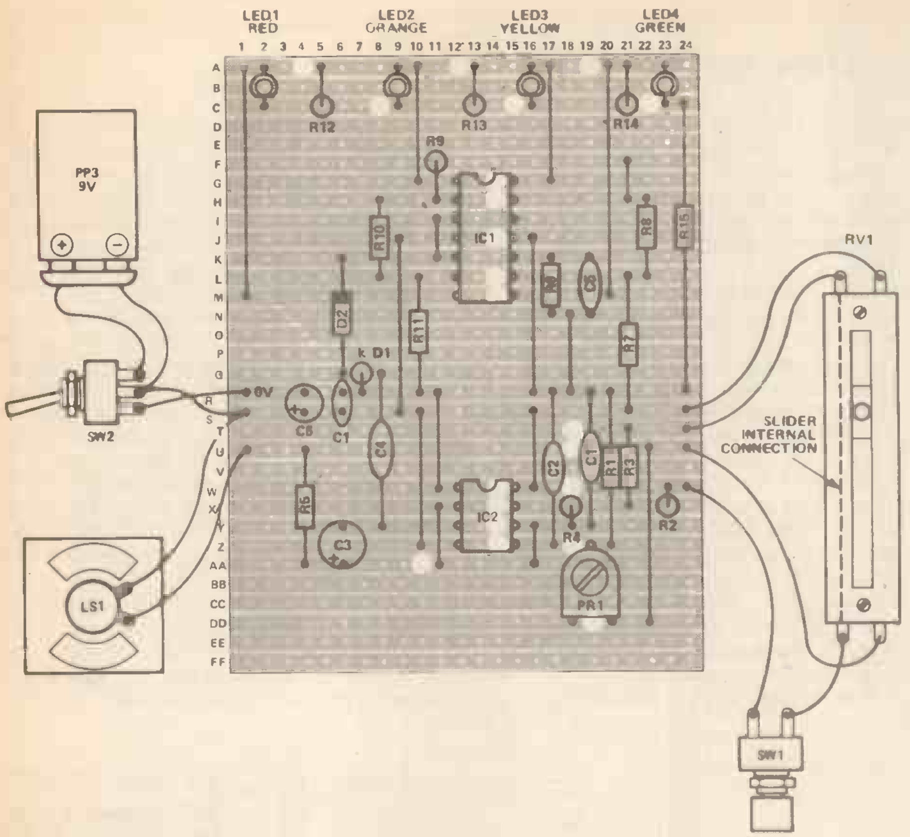


Figure 5. The Veroboard layout.

used "open loop", as simple comparators.

So that is basically how it works. The naughty bit is associated with SW1. The frequency of oscillation depends not only on the voltage at the slider of RV1, but also on the resistance between there and pin 7 of IC1. Closing SW1 connects R4 in parallel with R5, and results in a higher frequency of oscillation for any given setting of RV1. That is to say, the same frequency of oscillation will be achieved for a lower setting of RV1 which is equivalent to making your grip seem much more muscular than it really is!

Construction

No detailed dimensions are given as you will want to make your gripometer to suit your particular handgrip — you may even want to make the whole thing back to front if you are left handed! However, **Figure 4** gives typical leading dimensions, and the construction method should be clear from this figure and the photograph. Note that for convenience a tension spring is used in place of the compression spring shown diagrammatically in **Figure 1**. You should be able to find a suitable spring at your local DIY or junk shop. By fitting it further from or close to the fulcrum (hinge point) you will make the handles harder or easier to squeeze respectively, and this provides a convenient method of adjusting the effort required. You should aim to enable yourself to move the wiper of RV1 about ⅔ of the way up. Then, when the whole unit is complete, if R4 is around 220 (you can experiment with different values here) you should be able to light the yellow LED, whereas with SW1 open the strongest man in the world won't be able to!

The electronics can be built up on a small piece of Veroboard as shown in **Figure 5**. This fits at the top of the unit so that the four LEDs are easily visible by the person trying his strength, as well as by bystanders. The loudspeaker (2.5in, 3R) fits next to the Veroboard, whilst the battery and on/off switch can be fitted at the bottom of the unit. The "cheat" switch SW1, which is of the "push for ON, push again for OFF" variety, was mounted so as to be readily accessible but not *too* obvious.

Setting Up

Before switching on for the first time, thoroughly check out the construction of the Veroboard circuitry and the wiring to other components — loudspeaker, RV1, SW1 and SW2. In particular, make sure that all the diodes, including the LEDs are connected the right way round. Next, disconnect RV1 from the spring lever and set it at the top of end (+9V) of its travel. Momentarily connect the 9V battery and you should hear a high pitched note from the loudspeaker. If you don't, disconnnect the battery immediately and look for the fault. This could be a missing connection, but could just as easily be an unintentional extra one, where you have failed to cut completely one of the tracks of the Veroboard, say. It is worth examining each cut individually with a watchmaker's eyeglass, even more so if you have used a twist drill rather than a proper VERO track cutter.

When you have the sound responding to the movement of RV1, check that one or other of the LEDs lights. With RV1 reconnected to the spring lever, check that its rest position is near the PR1 end of its travel. Adjust PR1 so that there is no sound from the loudspeaker, but so that a low pitch is emitted as soon as the handles are squeezed. With a fresh PP3 battery and SW1 closed, you

Parts List

RESISTORS
(All ⅛ watt 5%)

R1, 8, 9, 10	10k
R2	220k see text
R3, 6	150k
R4	33k
R5	82k
R7	100k
R11	39k
R12, 13, 14, 15	2k2

POTENTIOMETERS

RV1	10k 65mm slide pot
PR1	10k horiz. preset

CAPACITORS

C1	6n8 polyester
C2	10n polyester
C3	47u 16V radial electro
C4	18n polyester
C5	220n polyester min. layer
C6	10u 16V radial electro
C7	100n disc ceramic

SEMICONDUCTORS

IC1	555
IC2	LM324 quad op-amp
D1, 2	1N4148
LED1	0.2" Red
LED2	0.2" Orange
LED3	0.2" Yellow
LED4	0.2" Green

MISCELLANEOUS

SW1	SPST push-on/push-off
SW2	SPDT toggle
LS1	2½", 3R

Veroboard, 32 strips x 24 holes; Veropins; PP3 battery and clip; wire, solder, nuts and bolts, etc.

BUYLINES .... **page 34**

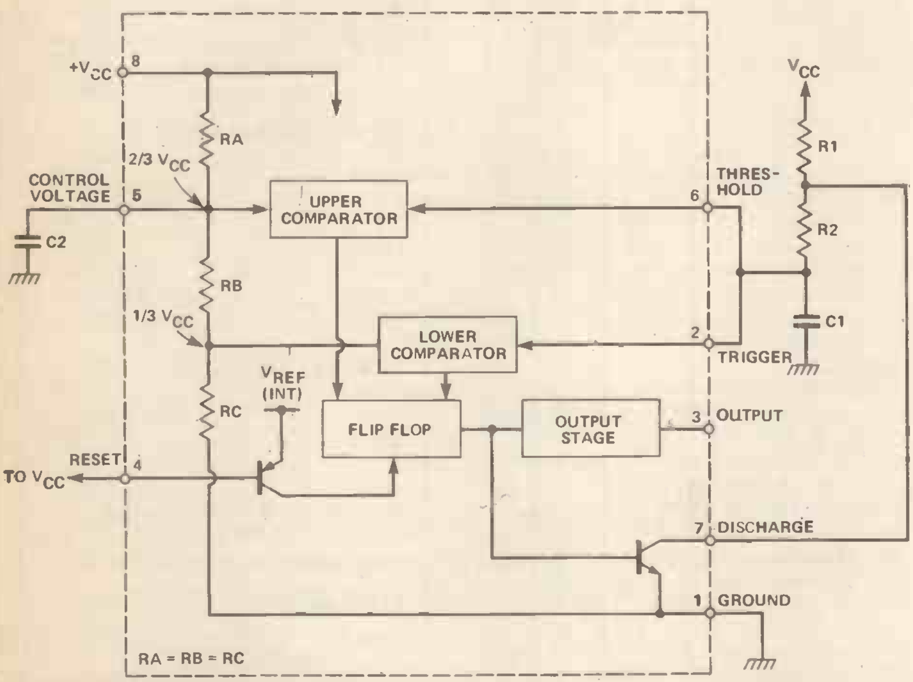
Inside the 555

The figure below shows the internal architecture of the versatile 555 timer integrated circuit, a popular IC made by most manufacturers. It can be used in a number of ways, either as a monostable (a "one shot", which produces a single output pulse each time it is triggered) or as an astable (a free-running circuit which produces a repetitive pulse train). In this project we use it as an astable and do not need the facility for resetting the flip-flop, so we connect the RESET input, pin 4, to the positive supply at pin 8.

Whenever the voltage at pin 2 (TRIGGER) falls below ⅓ Vcc, the lower comparator sets the flip-flop, which turns off the DISCHARGE transistor at pin 7 and drives the output at pin 3 high. Whenever the voltage at pin 6 (THRESHOLD) rises above ⅔ Vcc, the upper comparator resets the flip-flop which turns on the discharge transistor and drives the output low. The absolute values of the internal resistors RA, RB and RC which set the trigger and threshold voltages are not very accurate, but their ratios are precise. C2 is simply a decoupling capacitor. The operation of the stable connection shown is as follows.

The voltage at pins 2 and 6 will rise as C1 charges up through R1 and R2 in series, aiming at +Vcc. However, when it reaches ⅔ Vcc, the upper threshold is exceeded, the upper comparator will reset the flip-flop and the discharge transistor will turn on hard. This will effectively ground the junction of R1 and R2. The voltage at pins 2 and 6 will therefore start to fall as C1 discharges via R2, aiming at ground potential (zero volts). However, as soon as the voltage across C1 falls below ⅓ Vcc, the trigger voltage level, the comparator sets the flip-flop, turning the discharge transistor off again and the cycle repeats.

The voltage at pins 2 and 6 is therefore a sawtooth waveform oscillating between ⅓Vcc and ⅔Vcc and back again, whilst the output at pin 4 sits alternatively "high" (nearly at Vcc) and "low" (near OV ground). If R1 is increased, the frequency of oscillation will fall and vice versa, and similarly with R2. If instead of increasing R1, we return it to a voltage less than +Vcc, this will have the same effect. As we return it to a progressively lower voltage, less than ⅔Vcc, the frequency will fall right down to zero, since the voltage across C1 can never operate the upper comparator, and the circuit stops oscillating altogether. Of course when the discharge transistor is ON, C1 is discharged via R2 regardless of R1, so the negative going half of the oscillation always takes the same length of time. Thus at low frequencies, the "square" wave driving the loudspeaker in **Figure 3** becomes very asymmetrical.



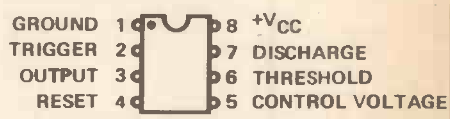
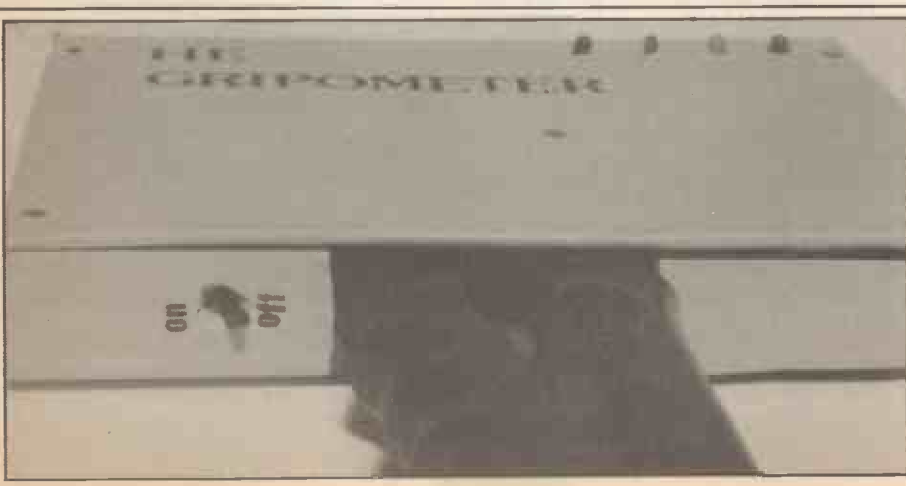


Figure 6. The diagram (left) and table (above) show the internal architecture of the 555 timer IC used in the Gripometer. This is described in detail in the box above.



should just be able to light LED4. If you can close the two handles completely, you should fit a stronger spring, but you should have sorted that out early in the constructional stage! With SW1 open it should not be possible to light LED4 even with the two handles completely closed. Note that a fresh battery should be used — as the battery voltage falls the audible output is largely unaffected, but it gets harder and harder to light the last two LEDs!

Having got it all working, you can fit the front panel and decorate it as you will. The Gripometer handles can be finished off using brightly coloured cycle handlebar grips, cut to fit round the outside edge of the handles. This not only provides a comfortable grip, it also adds a professional touch to the finish.

Naturally, when you hand it to your friends to try, SW1 will be open. Before demonstrating your own amazing strength, a little stagecraft — exagerated adjustment to your grip and loud clearing of the throat — will provide the necessary cover for you to push SW1. And for your next trick . . . !

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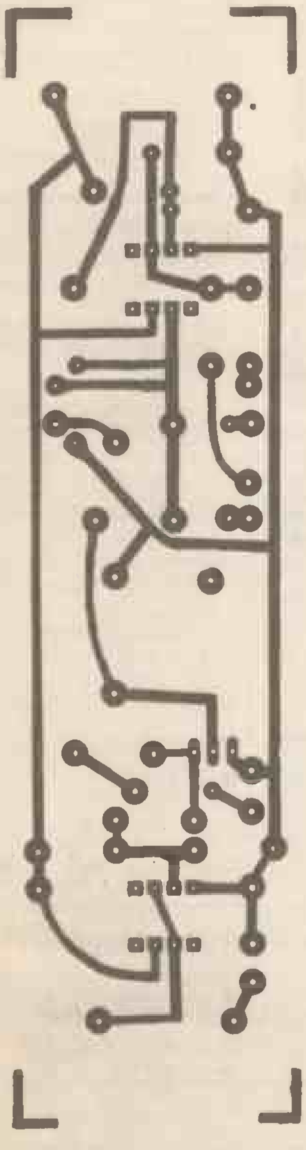
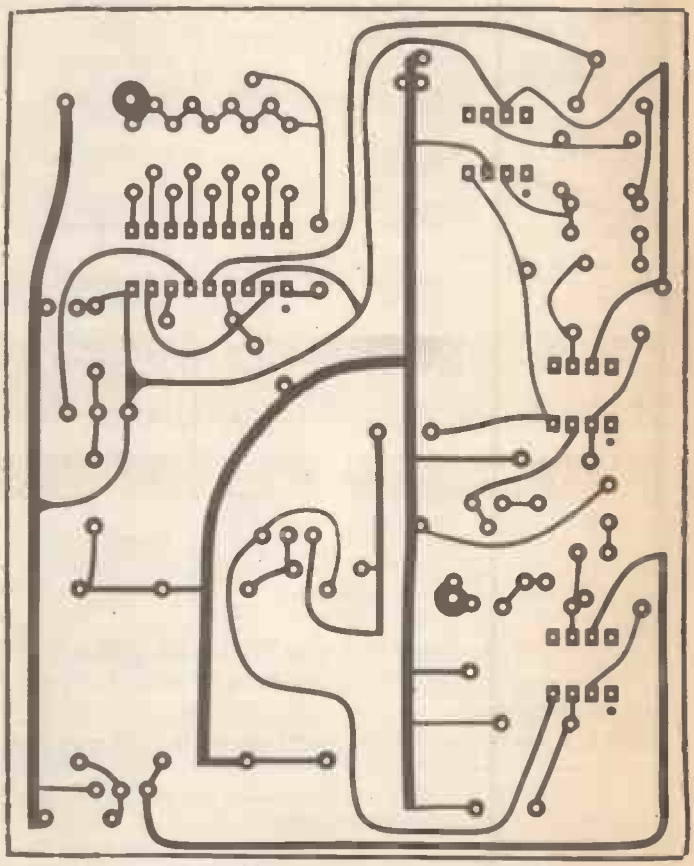


Above: The PCB foil pattern for the Tremoleko project.



Above: The master pattern for the SPL Meter.

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