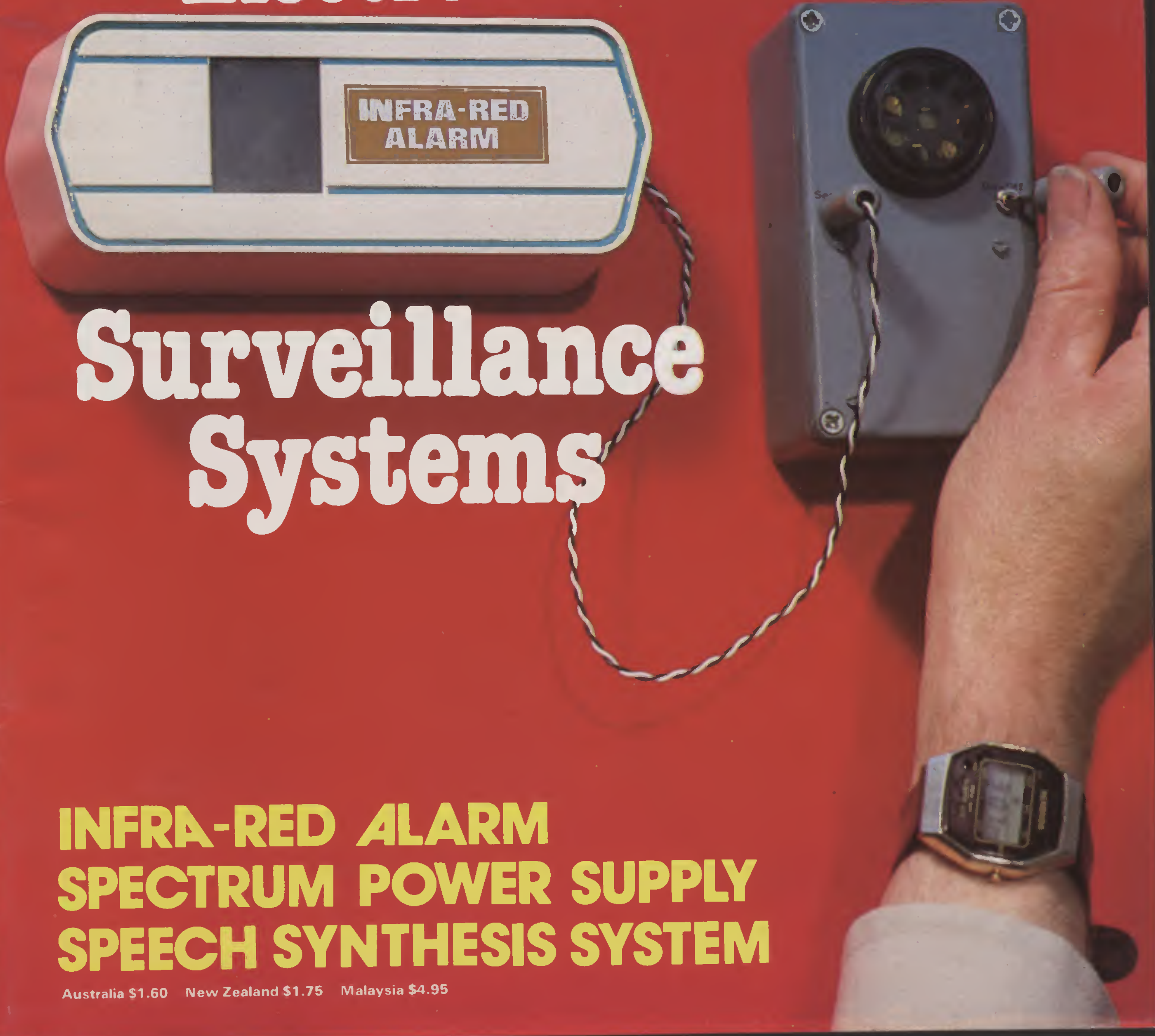
EVERYDAY ELECTRONICS and computer PROJECTS

461

JUNE 1984 90p

Electronic Surveillance Systems



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● Rush me_____of 35/24_____of 110/24 _____of 126/24 at £1.20 each together with one FREE film for each film ordered.

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EVERYDAY
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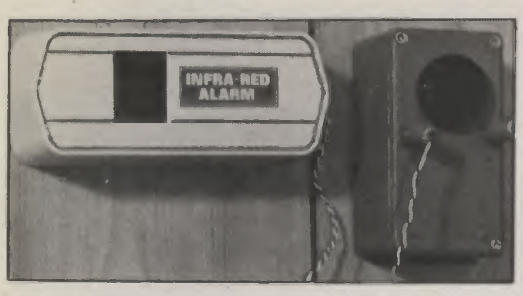
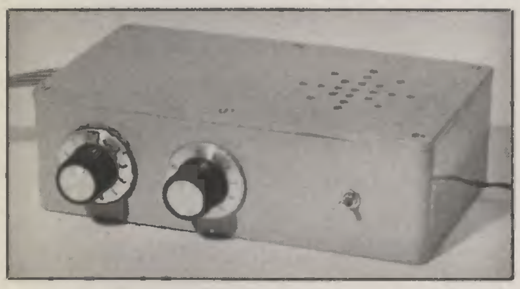
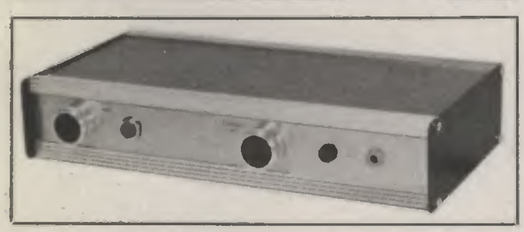
VOL. 13 NO. 6 JUNE 1984

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







Our July 1984 issue will be published on Friday, June 15. See page 399 for details.

PROJECTS

SERIES

FEATURES

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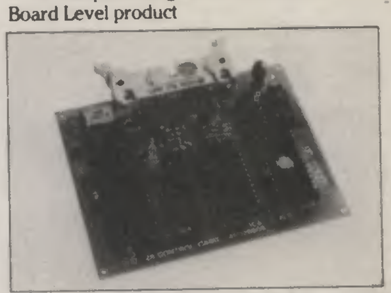

C12 Computer Cassette	21-00012	0.55
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BBC to 25 way D Male	03-10021	4.50
25 way D Socket	10-25200	1.90
25 way D Plug	10-25100	1.30
Cover for 25 way D	10-25322	0.93
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Z80 A Industrial Controller	40-82000	49.95
6802 Industrial Controller	40-68020	49.95
6502 Industrial Controller	40-65020	49.95
Z8 Basic/Debug Controller	41-00904	50.00

Nicad Batteries & Chargers

Minimum life 600 (300 PP3 size) full charge/discharge cycles. Batteries must be charged from a constant current source only. All batteries are supplied only with a residual charge and should be charged before used.

				1-9	10-49
AA	1.2V	500mAH	01-12004	0.80	0.74
'C'	1.2V	2.2AH	01-12024	2.35	1.99
'D'	1.2V	4.0AH	01-12044	3.05	2.85
PP3	8.4V	110mAH	01-84054	3.70	3.50
CH1/22 PP3 Charger 11mA for 16 hours			01-00159		4.30
CH8/RX Multi-purpose Charger			01-02204		9.40

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Battery Adaptor 01-12001 0.96

Sold in pairs: one to convert AA size to C size and one to convert C to D size. Both may be used together to convert an AA to D size.

Semiconductors

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LM301AN	DIL version	61-03011	0.44
LM308CN	DIL version	61-03081	0.65
LM311CN	Popular comparator	61-00311	0.46
LM324	Low power quad op amp	61-03240	0.67
LM339N	Low power quad comparator	61-03390	0.68
LM346	Programmable quad op amp	61-00346	3.72
LF347	Quad Bi-FET op amp	61-00347	1.82
LM348	Quad 741 type op amp	61-03480	1.26
LF351	Bi-FET op amp	61-03510	0.49
LF353	Dual version of LF351	61-03530	0.76
LM380N	1W AF power amp	61-00380	1.00
NE555N	Multi-purpose low cost timer	61-05550	0.45

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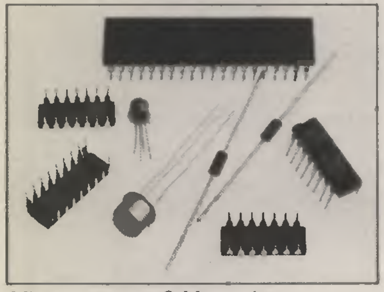
NE556N	Dual version of the 555	61-05560	0.50
uA741CN	DIL low cost op amp	61-07411	0.22
uA747CN	Dual 741 op amp	61-07470	0.70
uA748CN	741 with external frequency comp	61-04780	0.40
HA1388	18W PA from 14V	61-01388	2.75
TDA2002	8W into 2 ohms power amp	61-02002	1.25
ULN2283	1W max. 3-12V power amp	61-02283	1.00
MC3357	Low power NBFM IF system and detector	61-03357	2.85
ULN3859	Low current dual conversion NBFM IF and detector	61-03859	2.95
LM3900	Quad norton amp	61-39000	0.60
LM3909N	8-pin DIL LED flasher	61-39090	0.68
KB4445	Radio control 4 channel encoder and RF	61-04445	1.29
KB4446	Radio control 4 channel receiver and decoder	61-04446	2.75
ICM7555	Low power CMOS version of timer	61-75550	0.98
ICL8038CC	Versatile AF signal generator with sine/square/triangle OPs	61-08038	4.50
TK10170	5 channel version of KB4445	61-10170	1.87
HA12002	Protection monitor system for amps, PSUs, TXs etc	61-12002	1.22
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Eduro/US specs)	61-14412	6.85



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Z80A	Popular and powerful 8-bit CPU	26-18400	3.40
Z80AP10	2 port parallel input/output	26-18420	2.95
Z80A CTC	4 channel counter/timer	26-18430	2.90
Z8671	Z8 Micro comp. and Basic	26-08671	17.50
6116-3	16K (2kx8) CMOS RAM 200nS	26-36116	6.68
Z6132-6	32K (4kx8) quasi RAM 350nS	26-06132	15.00
4116-2	16K (16kx1) 150nS	26-24116	1.59
2764	64K (8kx8) 450nS	26-02764	9.50
2732	32K (4kx8) 450nS	26-02732	5.70

Voltage Regulators

7805	5V 1A positive	27-78052	0.40
7812	12V 1A positive	27-78122	0.40
7815	15V 1A positive	27-78152	0.40
7905	5V 1A negative	27-79052	0.49
7912	12V 1A negative	27-79122	0.49
7915	15V 1A negative	27-79152	0.49

Transitors

BC182	General purpose	58-00182	0.10
BC212	General purpose	58-00212	0.10
BC237	Plastic BC107	58-00237	0.08
BC238	Plastic BC108	58-00238	0.08
BC239	Plastic BC109	58-00239	0.08
BC307	Complement to BC237	58-00307	0.08
BC308	Complement to BC238	58-00308	0.08
BC309	Complement to BC239	58-00309	0.08
BC327	Driver/power stage	58-00327	0.13
BC337	Driver/power stage	58-00337	0.13
MPSA13	NPN Darlington	58-04013	0.30
MPSA63	PNP Complement to MPSA13	58-04063	0.30
J310	JFET for HF-VHF	59-02310	0.69
J176	JFET analogue switch	59-02176	0.65
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3SK88	Dual gate MOSFET-Ultra lo noise	60-04088	0.99
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TIP32A	Complement to TIP31A	58-15032	0.35
VN66AF	VMOS Power FET	60-02066	0.95
ZTX3866	E-line version 2N3866	58-03866	0.45
IN4001	Rectifier diode	12-40016	0.06
IN4002	Rectifier diode	12-40026	0.07
IN4148	General purpose silicon	12-41486	0.05

Silicon Controlled Rectifiers

BRY55-100	100V .8A	52-55100	0.50
C106DI	400V 4.0A	52-00106	0.70
C122DI	400V 8.0A	52-00122	1.45

3mm Diameter LEDs

V178P	Red	15-01780	0.15
V179P	Green	15-01790	0.16
V180P	Yellow	15-01800	0.18

5mm Diameter LEDs

CQY40L	Red	15-10400	0.12
CQY72L	Green	15-10720	0.15
CQY74L	Yellow	15-10740	0.15

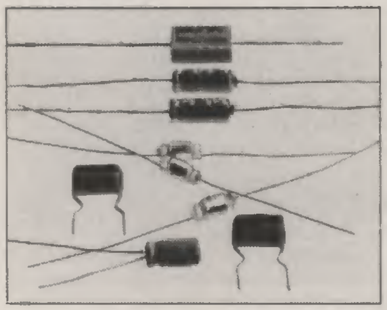
Infra-Red LEDs

CQY99	Emitter	15-10990	0.56
BPW41	Detector	15-30410	1.51

Tri Colour LED

V518	Orange-Green-Yellow	15-05180	0.60

Capacitors



Aluminium Electrolytics Radial PCB Mounting

			Pack of 4
10u	16V	05-10606	0.24
47u	16V	05-47606	0.28
47u	25V	05-47607	0.28
470u	6.3V	05-47705	0.36
470u	16V	05-47706	0.48

Tantalum Beads

			Each
1uf	35V	05-10501	0.18
10uf	16V	05-10601	0.28
47uf	6.3V	05-47601	0.45
47uf	16V	05-47602	0.92

Monolithic Capacitors

		Pack of 3
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10n	04-10304	0.42
100n	04-10404	0.45

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10n	04-10303	0.20

Polyester (C280)

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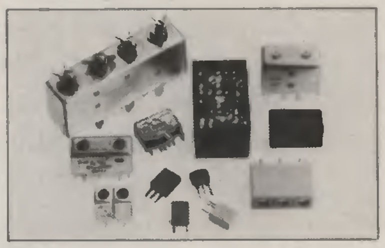
47n	04-47305	0.24
100n	04-10405	0.24
470n	04-47405	0.51
1uF	04-10505	0.66

R F Components



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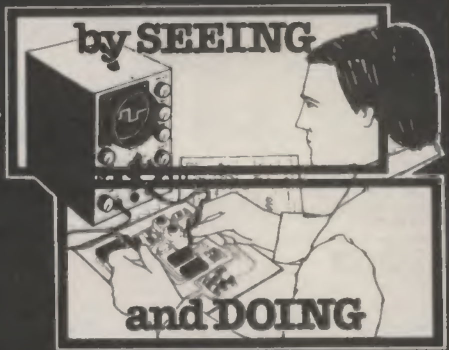

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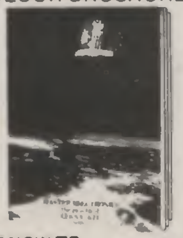

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AC132	90p	BC184B	12p	BF244B	35p	TIP31	38p	2N1613	36p
AC141	30p	BC184L	12p	BF256	35p	TIP31A	40p	2N2222A	30p
AC142	30p	BC186	30p	BF257	35p	TIP31B	40p	2N2369A	28p
AC176	30p	BC187	30p	BF258	35p	TIP31C	40p	2N2646	68p
AC187	30p	BC212A	14p	BF259	35p	TIP32A	40p	2N2904A/5A	30p
AC188	30p	BC212L	12p	BF594	40p	TIP32C	40p	2N2906A	60p
AD149	80p	BC213	12p	BF595	30p	TIP36C	140p	2N2907A	30p
AD161	45p	BC213B	12p	BFR39	20p	TIP41A	50p	2N2926G	12p
AD162	45p	BC213L	12p	BFR79	30p	TIP41B	50p	2N2926R	12p
BC107	12p	BC214	12p	BFR80	30p	TIP42A	60p	2N2926Y	12p
BC107A	14p	BC214B	14p	BFX29	30p	TIP42B	65p	2N3053	30p
BC107B	14p	BC214L	12p	BFX84	30p	TIP120	80p	2N3054	75p
BC108	12p	BC237	18p	BFX85	30p	TIP121	80p	2N3055E	60p
BC108A	14p	BC238B	18p	BFX87	30p	TIP142	120p	2N3442	150p
BC108B	14p	BC307	18p	BFX88	30p	TIP2955	70p	2N3615	200p
BC108C	14p	BC308	18p	BFY50	28p	TIS43	36p	2N3702	12p
BC109	12p	BC327	16p	BFY51	25p	TIS44	40p	2N3703	12p
BC109B	14p	BC328	16p	BFY52	25p	TIS90	30p	2N3704	12p
BC109C	14p	BC337	16p	BFY90	80p	TIS91	30p	2N3705	12p
BC140	35p	BC338	16p	BRY39	40p	VN10KMA	75p	2N3706	12p
BC141	35p	BC441	36p	BSX20	30p	VN66AF	95p	2N3707	12p
BC142	35p	BC461	36p	BSX29	35p	VN88AF	110p	2N3708	12p
BC143	35p	BC477	40p	BU105	170p	ZTX107	12p	2N3710	12p
BC147	12p	BC478	40p	BU205	200p	ZTX108	12p	2N3711	12p
BC148	12p	BC517	45p	BU208A	220p	ZTX109	12p	2N3771	200p
BC157	12p	BC547	15p	MJ2955	90p	ZTX300	15p	2N3772	200p
BC158	12p	BC548	15p	MJE340	50p	ZTX301	18p	2N3773	200p
BC159	12p	BC549	16p	MJE371	90p	ZTX302	20p	2N3819	25p
BC160	50p	BC556	20p	MJE2955	110p	ZTX303	20p	2N3820	45p
BC161	45p	BC557	16p	MJE3055T	80p	ZTX304	20p	2N3823	50p
BC167	15p	BC558	16p	MPSA06	25p	ZTX330	35p	2N3866	100p
BC168	12p	BC559	16p	MPSA56	30p	ZTX500	18p	2N3903	15p
BC169	12p	BCY70	20p	MPSU05	65p	ZTX501	18p	2N3904	15p
BC170	20p	BCY71	20p	MPSU56	60p	ZTX502	18p	2N3905	15p
BC171	13p	BCY72	23p	OC22	150p	ZTX503	18p	2N3906	15p
BC172A	12p	BD131	50p	OC23	150p	ZTX504	30p	2N5172	30p
BC173	13p	BD132	50p	OC26	100p	ZTX531	30p	2N5194	80p
BC177	20p	BD133	60p	OC28	200p	ZTX550	30p	2N5457	42p
BC178	20p	BD135	50p	OC36	220p	2N696	35p	2N5458	48p
BC179	25p	BD136	40p	OC41	75p	2N698	45p	3N128	85p
BC181	23p	BD137	40p	OC42	75p	2N699	40p	3N140	85p
BC182	12p	BD138	40p	OC70	60p	2N706A	26p	3N141	85p
BC182B	14p	BD139	45p	OC76	60p	2N708	30p	3N163	110p
BC182L	12p	BD140	45p	OC81	60p	2N914	36p	3N201	110p
BC183	12p	BF194	14p	OC82	60p	2N918	30p	3N202	125p
BC183B	12p	BF195	14p	OC84	50p	2N930	30p	40406	80p
				TIP29	30p	2N1131	30p	40407	80p
				TIP29A	35p	2N1132	30p		
				TIP29B	50p	2N1303	80p		

TTL

7400	18p	7417	28p	7447	75p	7486	35p	74119	70p	74160	65p	74190	58p
7401	18p	7420	20p	7448	55p	7489	140p	74121	35p	74161	55p	74191	55p
7402	18p	7422	28p	7450	21p	7490	37p	74122	41p	74162	46p	74192	55p
7403	18p	7425	28p	7451	20p	7491	45p	74123	41p	74163	46p	74193	55p
7404	18p	7426	28p	4753	21p	7492	40p	74126	70p	74164	46p	74194	52p
7405	18p	7427	30p	7454	21p	7493	41p	74132	65p	74165	60p	74195	52p
7406	32p	7428	30p	7460	21p	7494	41p	74135	50p	74166	60p	74196	55p
7407	32p	7430	26p	7470	25p	7495	41p	74141	51p	74167	185p	74197	55p
7408	25p	7432	26p	7472	25p	7496	41p	74144	250p	74170	195p	74198	95p
7409	25p	7433	35p	7473	30p	7497	60p	74145	575p	74173	120p	74199	95p
7410	18p	7437	30p	7474	35p	74100	95p	74147	125p	74174	65p	74221	60p
7411	25p	7438	30p	7475	40p	74104	58p	74148	65p	74175	65p	74279	60p
7412	26p	7440	23p	7476	35p	74105	58p	74150	70p	74176	46p	74284	95p
7413	26p	7441	51p	7480	30p	74107	30p	74151	46p	74177	55p	74285	95p
7414	37p	7442	40p	7481	110p	74109	30p	74153	46p	74180	50p	74366	64p
7416	28p	7443	71p	7482	70p	74110	41p	74154	81p	74181	121p	74390	325p
		7444	95p	7483	58p	74111	70p	74155	46p	74182	70p	74393	100p
		7445	71p	7484	81p	74116	70p	74156	46p	74184	105p		
		7446	71p	7485	75p	74118	65p	74157	35p	74185	105p		

LS TTL

74LS00	17p	74LS27	21p	74LS83	51p	74LS138	40p	74LS169	98p	74LS243	81p	74LS293	46p
74LS01	17p	74LS28	21p	74LS85	52p	74LS139	39p	74LS170	86p	74LS244	65p	74LS353	71p
74LS02	17p	74LS30	21p	74LS86	23p	74LS147	121p	74LS173	63p	74LS245	86p	74LS362	110p
74LS04	17p	74LS32	21p	74LS90	39p	74LS148	86p	74LS174	58p	74LS247	65p	74LS365	35p
74LS05	17p	74LS33	21p	74LS93	35p	74LS151	46p	74LS175	52p	74LS248	66p	74LS366	35p
74LS08	18p	74LS37	21p	74LS95	46p	74LS153	52p	74LS181	115p	74LS249	66p	74LS367	35p
74LS09	20p	74LS38	21p	74LS96	109p	74LS154	120p	74LS183	201p	74LS251	40p	74LS368	35p
74LS10	20p	74LS40	21p	74LS107	46p	74LS155	46p	74LS190	58p	74LS253	46p	74LS373	70p
74LS11	20p	74LS42	37p	74LS109	35p	74LS156	46p	74LS191	55p	74LS257	40p	74LS374	70p
74LS12	23p	74LS49	63p	74LS112	32p	74LS157	40p	74LS192	55p	74LS258	43p	74LS375	52p
74LS13	28p	74LS51	21p	74LS113		74LS158	40p	74LS193	55p	74LS259	67p	74LS386	130p
74LS14	32p	74LS54	21p	74LS114	32p	74LS160	40p	74LS194	52p	74LS260	30p	74LS390	55p
74LS15	21p	74LS55	21p	74LS122	46p	74LS161	40p	74LS195	52p	74LS266	32p	74LS393	55p
74LS20	21p	74LS63	138p	74LS123	46p	74LS162	40p	74LS196	52p	74LS273	63p	74LS395	98p
74LS21	21p	74LS73	25p	74LS124	166p	74LS163	43p	74LS197	52p	74LS275	145p	74LS398	310p
74LS22	21p	74LS74	25p	74LS125	37p	74LS164	48p	74LS221	63p	74LS279	40p	74LS541	130p
74LS26	21p	74LS75	28p	74LS126	35p	74LS165	60p	74LS240	81p	74LS280	110p	74LS629	200p
		74LS76	25p	74LS132	41p	74LS166	81p	74LS241	75p	74LS283	46p	74LS669	160p
		74LS78	25p	74LS136	28p	74LS168	97p	74LS242	80p	74LS290	60p	74LS670	120p

CMOS

CD4000	15p	CD4015	46p	CD4035	55p	CD4054	100p	CD4093	40p	CD4503	46p	CD4569	80p
CD4001	15p	CD4016	30p	CD4038	125p	CD4060	80p	CD4099	140p	CD4511	52p	CD4572	80p
CD4002	15p	CD4017	40p	CD4040	50p	CD4066	30p	CD4160	75p	CD4512	60p	CD4581	80p
CD4006	60p	CD4018	52p	CD4041	50p	CD4068	20p	CD4161	75p	CD4514	140p	CD4582	80p
CD4007	16p	CD4019	30p	CD4042	45p	CD4069	20p	CD4162	75p	CD4515	200p	CD4583	60p
CD4008	45p	CD4020	52p	CD4043	46p	CD4070	16p	CD4163	75p	CD4516	65p	CD4584	60p
CD4009	30p	CD4021	46p	CD4044	46p	CD4071	18p	CD4175	75p	CD4518	52p	CD4585	110p
CD4010	35p	CD4022	46p	CD4045	120p	CD4072	18p	CD4402	75p	CD4520	60p	CD40100	200p
CD4011	15p	CD4023	20p	CD4046	55p	CD4075	25p	CD4412	75p	CD4528	81p	CD40106	80p
CD4012	20p	CD4024	40p	CD4047	46p	CD4076	60p	CD4419	75p	CD4538	100p	CD40109	100p
CD4013	25p	CD4025	18p	CD4048	45p	CD4077	30p	CD4445	75p	CD4539	78p	CD40114	200p
CD4014	55p	CD4026	100p	CD4049	30p	CD4078	25p	CD4446	75p	CD4541	100p	CD40174	80p
		CD4027	25p	CD4050	30p	CD4081	25p	CD4449	75p	CD4555	60p		
		CD4028	45p	CD4052	70p	CD4082	25p	CD4501	35p	CD4561	110p		
		CD4029	55p	CD4053	60p	CD4085	72p	CD4502	70p	CD4568	80p		

LINEAR

CA1310E	185p	CA3090	415p	LM339	80p	LM3911	140p	SAA5020		TDA1008	347p	TL074	117p
CA1350E	90p	CA3130	105p	LM348	90p	LM3914	285p	SN76013N	295p	TDA1022	570p	TL081	40p
CA3020	230p	CA3140	52p	LM358	62p	LM3915	285p	TAA621A	290p	TDA1024	120p	TL082	65p
CA3028	110p	CA3240	125p	LM380	85p	LM3916	285p	TAA661B	175p	TDA2002	150p	TL083	92p
CA3035	270p	ICM7555	105p	LM381	170p	MC1458	70p	TBA120B	70p	TDA2003	345p	TL084	65p
CA3043	305p	ICM7556	200p	LM382	130p	MC1488	80p	TBA120S	68p	TDA2020	350p	UA748	40p
CA3055	85p	LF347	200p	LM384	160p	MC1489	90p	TBA120U	98p	TDA2030	340p	ZN414	95p
CA3065	150p	LF351N	55p	LM386	100p	NE555	20p	TBA540Q	161p	TDA2102		ZN424	150p
CA3080	80p	LF353N	100p	LM387	140p	NE556	55p	TBA651		TDA2522		ZN425	400p
CA3081	225p	LM224	150p	LM389	110p	NE564	405p	TBA800	95p	TDA9400		ZN426	345p
CA3085	145p	LM301	30p	LM732	55p	NE566	173p	TBA810S	110p	TL061	50p	ZN427	715p
CA3086	65p	LM308	100p	LM747	75p	NE567	161p	TBA820	81p	TL062	75p	ZN1034	230p
CA3089	230p	LM311N	81p	LM1458	45p	NE570	391p	TBA920Q	175p	TL064	150p	ZN1040	750p
		LM318N		LM3900	70p	NE571	387p	TCA270S	171p	TL071	50p		
		LM324	50p	LM3909	92p	SAA5010		TDA1004	345p	TL072	60p		

RIBBON CABLE

(Priced per ft)

WAYS	COLOUR
10	26p
20	53p
26	76p
34	100p

DIODES

		OA200	9p	1N5060	18p
AA119	15p	OA202	9p	1N5062	20p
AA215	16p	1N823	5p	1N5400	11p
BAX13	10p	1N914	5p	1N5401	12p
BY100	30p	1N916	6p	1N5402	14p
BY127	18p	1N4000	5p	1N5403	15p
BY133	20p	1N4001	5p	1N5404	16p
BY206	30p	1N4002	5p	1N5405	17p
BY207	30p	1N4003	6p	1N5406	18p
BY299	40p	1N4004	6p	1N5407	22p
BYX10	18p	1N4005	7p	1N5408	25p
OA47	10p	1N4006	7p	1S44	5p
OA90	8p	1N4007	8p	1S921	7p
OA91	8p	1N4148	5p	1S922	7p
OA95	8p	1N4448	6p	1S923	7p

D CONNECTORS

	MALE	FEMALE
9 way	75p	100p
15 way	100p	1140
25 way	140p	195p

D-CONNECTOR COVERS

9 way	110
15 way	110
25 way	125

I.C. SOCKETS

LOW PROFILE D.I.L Type	Price	TURNED PIN D.I.L. Type	Price
8 pin	10p	8 pin	35p
14 pin	12p	14 pin	50p
16 pin	14p	16 pin	60p
18 pin	18p	18 pin	65p
20 pin	24p	22 pin	75p
22 pin	25p	24 pin	80p
24 pin	30p	28 pin	100p
28 pin	32p	40 pin	150p
40 pin	35p		

RECHARGEABLE BATTERIES

HP2, 1.2v, 4.0AH	£3.95
HP2, 1.2v, 1.2AH	£2.60
HP11, 1.2v, 1.2AH	£2.40
HP7, 1.25v, 500mAH	£1.00
AAA, 1.2v, 180mAH	30p
PP3, 8.4v, 110mAH	£4.50

ZENER DIODES

BZX61C/1.4 watt: 3V3, 3V6, 3V9, 4V7, 5V6, 6V2, 7V5, 8V2, 10V, 11V, 12V, 13V, 15V, 18V, 20V, 22V, 24V, 27V, 30V, 33V, 36V, 39V, 43V, 47V, 56V, 68V, 75V, 82V, 100V, 180V, 200V 15p each

BZY88C/0.4 watt: 1V3, 2V7, 3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 15V, 16V, 18V, 22V, 24V, 27V, 30V, 33V, 36V 10p each

LEDs

5mm:	Red	10p	113:	Red	
	Green	13p		Red	20p
	Yellow	13p		Green	25p
3mm:	Red	10p		Yellow	25p
	Green	13p	323:	Tri.	
	Yellow	13p		Red	20p
COX21:	Red			Green	25p
	flashing	65p		Yellow	25p
251:	Rect/stack.		503:	Square	
	Red	20p		Red	20p
	Green	25p		Green	25p
	Yellow	25p		Yellow	25p

REGULATORS

LM304H	180p	UA723C	77p	78H12 (3A/5V)	
LM309H	80p	7805A	50p		460p
LM309K	130p	7812A	50p	78L05	35p
LM317K	350p	7812Kc	121p	78L12	35p
LM317T	130p	7815A	50p	78L15	35p
LM320/5	65p	7818A	50p	78L18	35p
LM320/12	65p	7824A	50p	78L24	35p
LM320/15	65p	7905A	55p	78L62	35p
LM320/24	65p	7912A	55p	79L05	45p
LM337T	180p	7915A	55p	79L12	45p
LM1469	324p	7918A	55p	79L15	45p
UA78P (8A/5V)	450p	7924A	55p	79L18	45p
				79L24	45p

ALUMINIUM BOXES

3 1/8" × 1 9/4" × 9/8"	
80 × 50 × 25	80p
100 × 65 × 50	1.20
100 × 70 × 40	1.20
100 × 100 × 40	1.20
135 × 70 × 40	1.20
135 × 105 × 40	1.40
180 × 125 × 65	1.95
205 × 155 × 75	2.50

VERO PLASTIC BOXES

White 71 × 49 × 25	60p
Blk 71 × 49 × 25	60p
Blk 120 × 80 × 35	1.10
Blk 180 × 110 × 55	1.75

VERO BOARDS

127 × 63	1.10
95 × 63	95p
431 × 63	3.17
127 × 95	1.20
95 × 95	1.15
431 × 95	4.20
454 × 119	5.50
63 × 25	pk of 5 1.30

THYRISTORS

				600mA/200V	45p	5A/400V	60p
				1A/50V	40p	5A/600V	70p
BT101	104p	T05 1A/400V	104p	1A/100V	45p	5A/800V	80p
BT102	104p	2N1599	40p	1A/200V	50p	7A/100V	55p
BT106	104p	2N4441	170p	1A/400V	60p	7A/200V	60p
BT107	132p	2N4444	150p	1A/600V	75p	7A/400V	70p
BT108	143p	2N5060	36p	1A/800V	90p	7A/600V	80p
TIC44	20p	2N5061	33p	3A/50V	46p	7A/800V	90p
TIC106D	40p	2N5062	42p	3A/100V	53p	10A/50V	55p
TIC106M	77p	2N5063	47p	3A/200V	58p	10A/100V	60p
TIC126D	99p	2N5064	47p	3A/400V	71p	10A/200V	65p
TIC206D	80p	600mA/20V	21p	3A/600V	79p	10A/400V	70p
TIC226D	90p	600mA/30V	24p	3A/800V	99p	10A/600V	88p
TIC246D	130p	600mA/100V	30p	5A/50V	43p	10A/800V	115p

TRIACS

2A/200V	50p
2A/400V	60p
2A/600V	60p
4A/400V	60p
6A/100V	80p
6A/200V	80p
6A/400V	90p
8A/400V	80p
10A/100V	80p
10A/200V	100p
10A/400V	110p
10A/400P	100p

BRIDGE RECTIFIERS

1A/50V	30p	6A/50V	75p
1A100V	30p	6A/100V	75p
1A/200V	35p	6A/200V	80p
1A/400V	40p	6A/400V	100p
2A/50V	35p	10A/200V	200p
2A/100V	45p	10A/400V	200p
2A/200V	50p	25A/200V	250p
2A/400V	55p	25A/400V	300p

Dalo Etch resist
£1.10

SOLDER

20 swg. 3 core

500g	495p

POTENTIOMETERS

Carbon track, ¼ watt log & linear values:

Range	Price
470R-2.2MR (single track)	40p
4.7K-2.2MR (dual gang)	100p
4.7K-2.2MR (single gang D/P switch)	90p

SLIDER POTS

60mm track, log & linear values:

Range	Price
5K-500K	80p

PRESETS

Pre-set pots ¼ watt

Range	Price
50R-4.7MR (mini vert. & horiz.)	10p

RESISTORS

High stability, ¼ watt, 5%

Range	Price (1-99)	(100+)
1R-10MR	2p	1p

High stability, ½ watt, 5%

Range	Price (1-99)	(100+)
1R-10MR	3p	1.5p

CAPACITORS

CERAMIC 1pF, 2p2, 2p7, 3p3, 3p9, 4p7, 5p6, 6p8, 8p2, 10pF, 12pF, 15pF, 18pF, 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, 82pF, 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF, 470pF, 560pF, 680pF, 820pF, 1000pF, 1n5, 1n8, 2n2, 3n3, 3n9, 4n7, 5n6, 6n8, 8n2, 10nF, 22nF, 47nF, 100nF 6p each

MYLAR: 100V 1nF, 2n2, 3n3, 4n7, 6n8, 10nF 7p each. 15nF, 22nF, 33nF, 47nF 9p each. 68nF, 100nF 11p each. 220nF 15p. 330nF 18p. 470nF, 20p.

POLYSTYRENE 22pF, 47pF, 68pF, 82pF, 100pF, 120pF, 150pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1000pF, 1200pF, 1500pF, 1800pF, 2000pF, 2200pF, 3300pF, 4700pF, 5600pF, 10nF 8p each

TANTALUM BEAD 3V: 100uF, 150uF, 220uF, 330uF 64p each. 470uF 110p. 680uF 160p. 6V3: 6u8, 12p. 10uF 13p. 33uF 33p. 47uF 25p. 100uF, 220uF 77p each. 470uF 160p. 10V: 15uF, 22uF 20p each. 33uF 33p. 47uF 40p. 68uF 63p. 220uF 110p.
16V: 2u2, 3u3 20p each. 4u7, 6u8 25p each. 10uF 32p. 22uF 35p. 16V: 33uF 40p. 47uF 60p. 100uF 95p. 220uF 105p. 25V: 15uF, 22uF 40p each. 47uF, 68uF 60p. 35V: 0.1uF, 0.22uF, 0.47uF 16p each. 1uF, 1u5 18p each. 2u2 25p. 3u3, 4u7 20p each. 6u8 30p. 10uF 40p. 47uF 60p.

ELECTROLYTIC Axial or Radial 16V: 10uF, 22uF, 33uF 10p each. 47uF, 68uF, 100uF 12p each. 125uF, 220uF 14p each. 330uF 18p. 470uF 24p. 680uF 36p. 1000uF 30p. 1500uF 40p. 2200uF 50p. 25V: 1uF, 10uF, 22uF, 47uF 10p each. 100uF 12p. 220uF 20p. 470uF 30p. 1000uF 40p. 2200uF 55p. 4700uF 115p. 35V: 120uF, 250uF 20p each. 40V: 6u8 10p. 470uF 30p. 1000uF 45p. 50V: 0.47uF, 1uF 8p each. 1uF (small) 12p. 220uF 35p. 63V: 1uF, 2u2, 4u7 7p each. 10uF, 22uF 10 each. 47uF 12p. 100uF 20p. 220uF 30p. 100V: 4.7F 48p. 160V: 10MF 32p. 250V: 0.01uF, 0.047uF, 0.1uF 10p each. 0.22uF 11p. 0.47uF 12p. 1uF 18p. 2u2 26p. 10uF 23p. 100uF 35p. 400V: 0.47uF 35p. 600V: 0.022uF, 0.047uF 30p each. 0.22uF, 67p. 1000V: 0.0022uF 27p. 0.022uF, 0.1uF 39p each.

POLYESTER C280 250V .01, .022, .033, .068, .1 8p. .15, .22, .33 10p. .47 12p. .68 20p. 1uF 26p. 2.2 50p.

SILVERED MICA 2p2, 3p3, 5pF, 10pF, 18pF, 20pF, 22pF, 25pF, 27pF 13p each. 30pF, 33pF, 39pF, 47pF, 50pF, 56pF, 68pF, 75pF, 82pF, 100pF, 120pF, 150pF, 180pF, 200pF, 220pF, 250pF, 270pF, 300pF 15p each. 330pF, 390pF, 470pF 19p each. 500pF, 560pF, 680pF 22p each. 820pF 24p. 1000pF 27p. 1500pF 32p. 1800pF 42p. 2200pF 45p. 2700pF 48p. 3600pF 55p. 3900pF 68p. 4700pF 83p. 5000pF 98p. 6800pF 115p. 8200pF 120p. 10000pF 125p.

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THE PROTECTOR

IT IS at this time of year that many readers tend to hang up their soldering irons and think more about holidays and weekends away than the construction of projects. It is precisely for these reasons that we have included in this issue the start of a short series on *Electronic Surveillance Systems*.

Together with an explanatory feature, looking at how electronics can help to protect your home and belongings, we have given details of building an infra-red project. This straightforward design is relatively easy to construct and install and provides inexpensive protection. The series continues with an ultrasonic alarm which will protect a small area and a radar alarm designed to protect a large room or corridor.

With the number of burglaries increasing perhaps a few hours spent on one or two of these projects might be prudent before your holiday.

THE INFORMER

It has always been the aim of EVERYDAY ELECTRONICS to provide as much basic information on electronics as possible. Over the years this has been much appreciated by both hobbyists and students alike. We will, of course, be continuing in just this way and hopefully providing even more information for anyone learning electronics.

With this in mind we would be pleased to hear from students, teachers and other readers about their particular requirements, interests and general problems. If you think we can help by providing information on certain areas or by expanding our coverage of others please let us know.

While we cannot undertake to answer letters on general problems concerning the understanding of electronics we can take steps to provide articles on requested problem areas within our pages. We do make every effort to cover the complete range of electronics and its applications, but it is quite possible that we have not explained a particular problem fully enough for you, or even left out a specialist area in which you have a particular interest.

It will be our aim over the coming months to tailor EVERYDAY ELECTRONICS to the needs of all students of electronics, be they nine or ninety. We would especially like our next Teach In series to be aligned to the requirements of secondary school students and are keen to hear from interested teachers of their needs.

Perhaps it seems a little premature to be thinking of our next Teach In when the present one is still in full swing. However, a great deal of research, planning and project building has to be done between now and September next year, so the sooner we know what you want the better.

On the subject of educational articles our next issue sees the start of a very informative series we have called *The Anatomy Of Your Micro*. It is once again a series that will appeal to the student just as much as the electronics hobbyist and the home computer fanatic. It will not concentrate on one particular microcomputer, but will explain the operation of the basic elements that make up every home computer, thus imparting a great deal of information on what makes a micro tick! Don't miss it, make sure your copy is ordered.

Mike Kenward

Readers' Enquiries
We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope or international reply coupons.
We cannot undertake to engage in lengthy discussions on the telephone.

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

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

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ELECTRONIC

Surveillance Systems...

I.F.H.Goult

CRIME, including robbery, is on the increase worldwide. In Britain there are approximately two million burglaries reported each year. Police statistics show that over 70 per cent of household burglaries are carried out by the under-18 age group, and quite a high proportion of these are under 14.

Whilst nothing would deter a really determined professional burglar, quite a simple intruder alarm would probably scare off the majority of unwelcome visitors.

The cheapest most common intruder detectors are pressure switches incorporated in mats placed under carpets. Several normally-closed pressure switches are wired in series. When any one contact is broken a relay drops out to initiate an alarm. Similar switches in series can be placed in doors and windows.

In all wired alarm systems, it is a break in the circuit which initiates an alarm. This prevents the alarm being put out of action by simply cutting the wire.

This article is concerned with the various electronic methods of detecting an intruder, mainly by the detection of movement through the area to be protected.

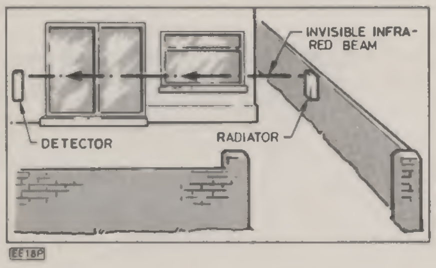
BEAM BREAK DEVICES

The simplest of the beam break devices is the beam of light across a doorway, which is detected by a photo-cell. This is one of the traditional methods of automatic door openers. Its disadvantage for intruder alarms is that the light beam is clearly visible in a dark house. This can be overcome by the use of an infra-red beam detector.

An infra-red beam can be generated from an infra-red emitting diode with a built-in lens to focus the energy into a narrow beam. The beam is detected by a photo-diode with an infra-red filter placed in front of it to prevent detection of ambient light. The detected signal is amplified to hold in a relay which in turn will hold a normally-closed contact open. If the beam is broken, the signal collapses to zero; the relay will be de-energised allowing the contact to close, and trigger any desired alarm. Typically it would switch on an alarm bell, but could equally well initiate a telephone signal to the police or other security organisations.

Allowing the relay to de-energise for alarm, guards against tampering with the supply or equipment in any way. This type of alarm is ideally suited to outdoor use as illustrated in Fig. 1. Note that the emitting diode is pulsed. This allows high peak pulse powers to be transmitted whilst keeping the average power dissipated in the diode comparatively low to prevent overheating. The amplifier in the receiver is a.c. coupled by capacitor C. This will pass the pulses but slow variations of ambient light will be blocked by this capacitor.

For indoor use infra-red emitter and detectors can be fitted into the same box and directed at an opposite wall. The detector picks up the reflected energy. In this case the alarm must respond to a change in detected level since any object or person moving across the beam will also reflect the emitted energy back to the unit to a greater or lesser extent than the wall.



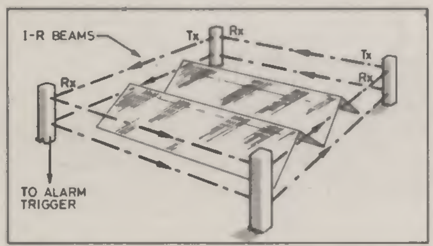


Fig. 1. Two infra-red beam break intrusion detectors.

The two systems are illustrated in the simplified block schematics of Fig. 2 together with a diagrammatic illustration of an infra-red emitting diode and photo-diode detector (Fig. 3).

When an electric current is passed through the gallium arsenide junction of the emitter diode the electron mobility is increased to release both heat and light energy. The impurities in the gallium arsenide are chosen to optimise infra-red emission.

Conversely, light energy penetrating the substrate of the silicon photo-diode affects the electron mobility within the substrate to create a flow of electrons in the form of an electrical current which will flow between the contacts through a suitable resistor, generating a voltage across the resistor proportional to the light energy penetrating the diode. The construction is optimised to give maximum current at the same infra-red wavelength as that emitted by the emitting diode.

PROXIMITY DETECTOR

A simple and cheap variation of the Beam Break Detector is an infra-red transceiver used as a proximity detector. A differential amplifier is biased off until the detected signal level exceeds a predetermined level, which must be greater than that of the nearest fixed reflecting object. Reflections from walls can be minimised by ensuring that the transceiver is not pointing directly at an opposite wall. This arrangement is illustrated in Fig. 4. An alarm will be triggered when a person is directly opposite or in the near vicinity of the transceiver.

ULTRASONIC BEAM

In the same way that sound waves are produced by a loudspeaker, so ultrasonic waves can be produced by an ultrasonic transducer. As with sound waves, these are pressure waves passing through air. A beam of ultrasonic pressure waves directed at a wall or door will be reflected back to the unit and detected by a second ultrasonic transducer (similar to a micro-

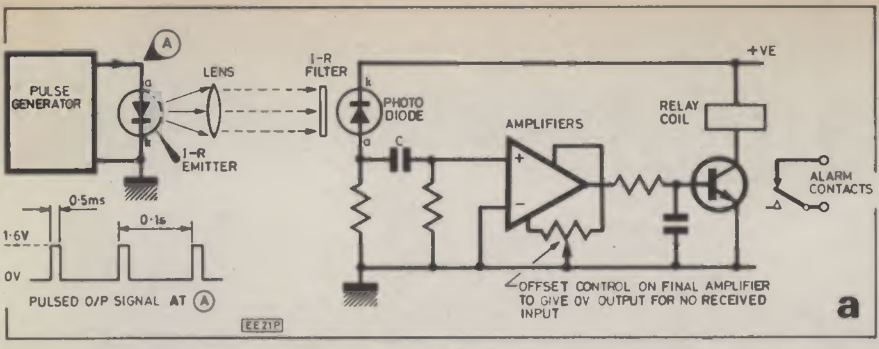
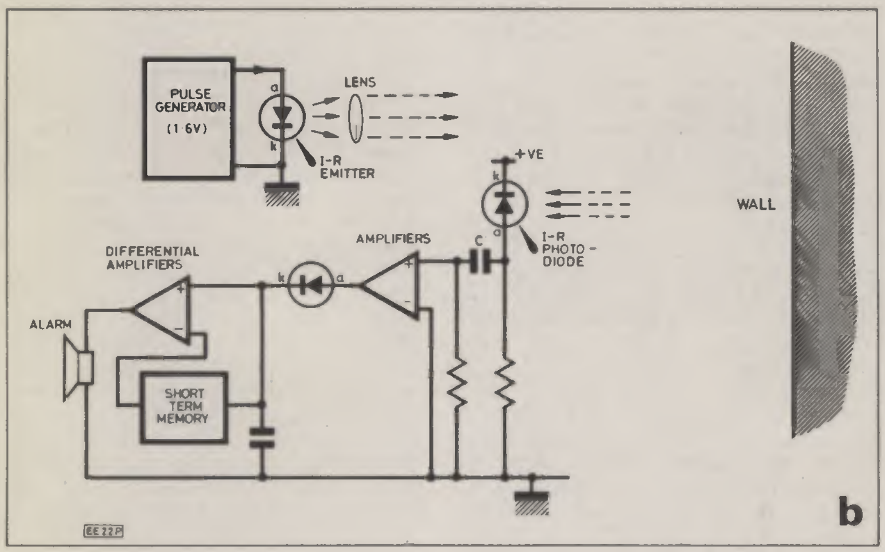


Fig. 2. (a) Infra-red beam fence arrangement. (b) Infra-red transceiver. The first amplifier is offset to give 0V output for 0V input.



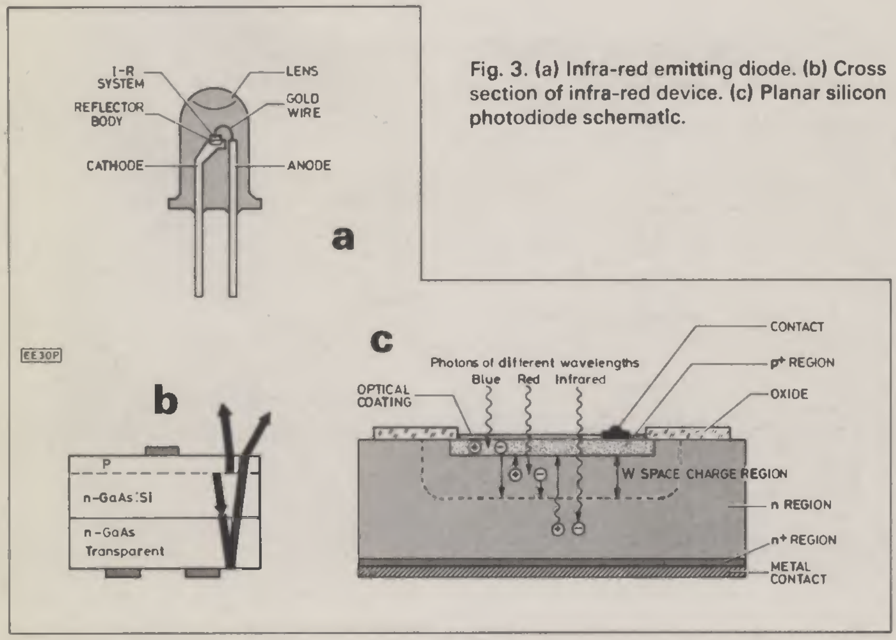


Fig. 3. (a) Infra-red emitting diode. (b) Cross section of infra-red device. (c) Planar silicon photodiode schematic.

phone). The receiver transducer output is amplified and the level noted. The level will be constant if the beam remains undisturbed. Any disturbance of the detected level by someone passing across the ultrasonic beam will trigger the alarm.

Ultrasonic transducers are readily available at a modest price and an ultrasonic intruder alarm having a limited range of up to eight feet is quite simple and inexpensive to make.

Compared to light, infra-red and radio waves, which can be generally classified as electromagnetic waves; sound and ultrasonic air pressure waves travel slowly. For instance, the speed of electromagnetic waves is 300 million metres per second. The speed of sound is approximately 1,100 feet per second and varies slightly with temperature. By transmitting a very short duration pulse of ultrasonic energy a few times per second, the reflected pulse will be detected at the receiver transducer after the completion of the transmitted pulse. This is illustrated in Fig. 6.

Using ultrasonic pulses has two advantages, which are:

1) It reduces power consumption enabling low power battery operation.
2) The receiver circuits can be desensitised during transmission so that only the reflected signal is detected by the receiver. This is *essential* if the transmitter and receiver are in the same box. The circuit arrangement for the transceiver is illustrated in Fig. 7.

An experimental circuit for a short-range intruder alarm kit to illustrate the above will be the subject of a later article.

PASSIVE INFRA-RED

The human body radiates approximately 100 watts of heat. It is possible to detect this heat to trigger an alarm.

Heat radiation is similar to light radiation, but like the infra-red transmitter for the infra-red beam-break intruder detector, it is at a wavelength below the visible range. Like light it can be reflected by a mirror. A concave mirror will focus heat onto a pyro-electric detector. Such a detector generates an electric current which relates to the amount of heat energy focused onto it.

Unfortunately the detector will respond to all forms of radiated heat, e.g., a radiator, an electric light bulb, and even car headlights shining through a window.

To overcome this, a mirror is used which will focus heat from defined areas in front of the detecting arrangement, but not from other areas. If the mirror is designed correctly there will be a series of "fingers" of space (zones) in front of the mirror which will focus the heat within the areas of these zones onto the detector. Areas between these zones will not focus onto the detectors. (See Figs. 8 and 9.)

Heat from a stationary source such as a fire or an electric light bulb will affect each zone to a constant degree. A person radiating heat passing through the zones will produce an alternating increase and decrease in current from the detector.

This alternating current can be amplified to trigger an alarm. D.c. current from fixed heat sources will be blocked. Faceted mirrors are made specially for the manufacturers of this type of detector and are not generally available. However, complete battery operated detection modules having zones as illustrated and giving an electrical trigger when heat movement is detected are available at a reasonable price. A later article will illustrate an intruder alarm system using a simple infra-red passive detector.

DOPPLER EFFECT MOVEMENT DETECTORS

The doppler effect is the well known train whistle effect. A train approaching at speed appears to have a higher pitched whistle than when it is receding. The train whistle, of course, produces sound pressure waves at the same frequency whether approaching or receding. But when it is approaching, pressure waves are moving towards the listener at a speed which is increased by the train speed; whereas they are moving away from the listener when the train has passed and therefore are received at a slower speed, i.e., lower frequency. This doppler effect can be utilised to detect movement.

ULTRASONIC DOPPLER DETECTORS

If an ultrasonic transducer produces pressure waves which are not in a narrow beam but are radiated in all directions in front of the transducer, and if all reflecting surfaces are stationary, the frequency of the waves at the receiving transducer will be the same as for the transmitter.

Any movement however, will increase or decrease the frequency of the received ultrasonic waves reflected off the moving object depending whether the movement is towards or away from the receiver.

The frequencies received by the transducer are compared with the transmitted frequency and if a difference is detected it will trigger an alarm.

Ultrasonic air pressure waves are reflected from air having different densities due to local heat: thus movement of comparative warm air from a radiator, or cold air coming in from a window, can produce a frequency difference at the receiver. In order to overcome these effects manufacturers introduce special signal processing circuits which respond only to the frequency changes characterised by a moving person, rather than by moving air.

For this reason ultrasonic doppler intruder detector circuits are somewhat more complex and not so suitable for home assembly.

MICROWAVE INTRUDER DETECTORS

These work on the same doppler principle as the ultrasonic doppler intruder

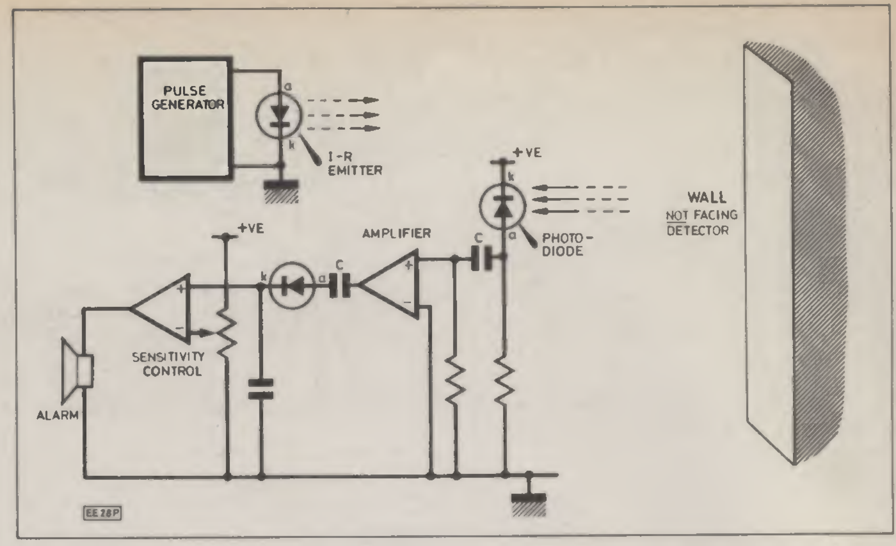


Fig. 4. IR proximity detector.

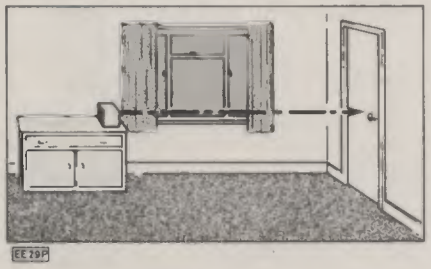


Fig. 5. An ultrasonic beam directed across a window will guard against an intruder entering via that window. If directed against a door it will also be disturbed by movement of the door. A beam aimed directly at a window, however, may give false alarms due to reflections from draughts of air at differing temperatures.

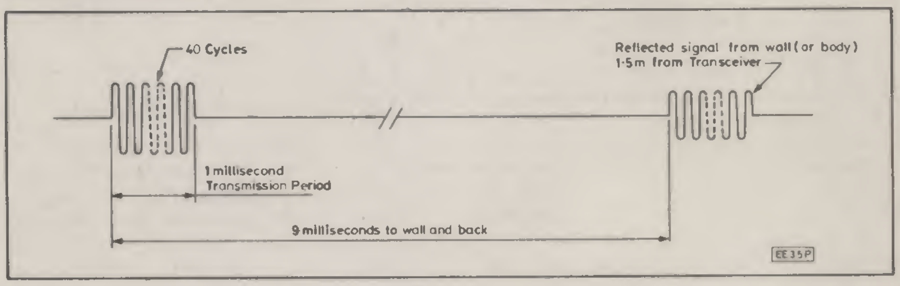


Fig. 6. Time scale for transmission and reception of ultrasonic pulse.

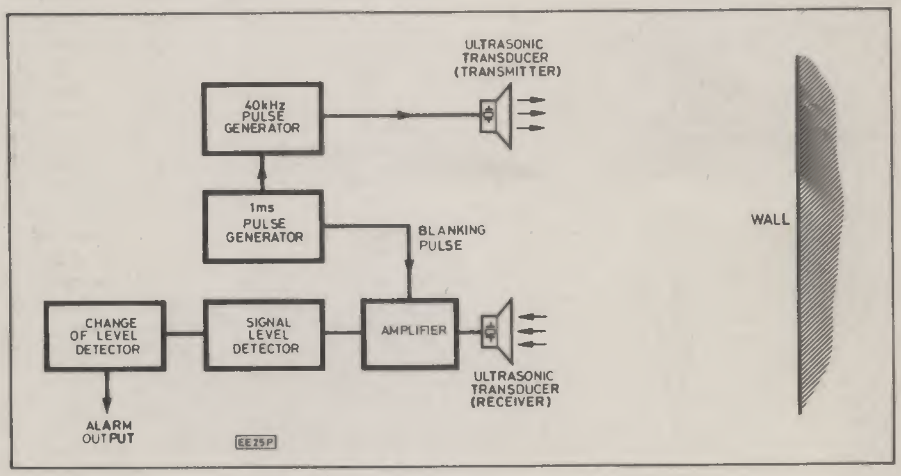


Fig. 7. Block diagram of ultrasonic transceiver.

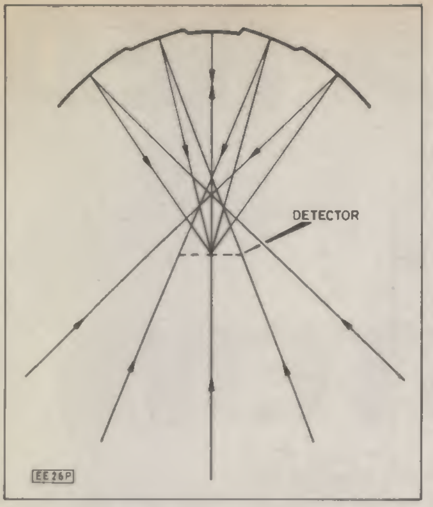


Fig. 8. Mirror with facets defining zones.

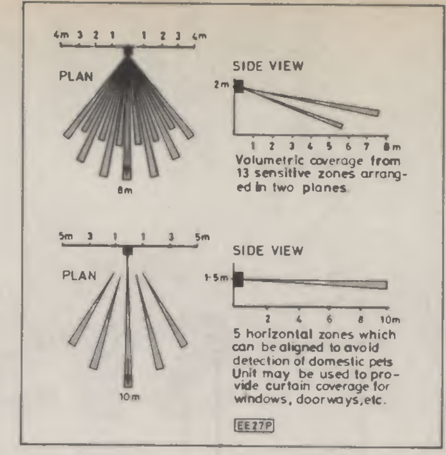


Fig. 9. Plan view of zones.

alarms but they radiate radio waves instead of air pressure waves.

The Home Office allocates a frequency of 10·687MHz for microwave transmitters used inside the house. A Home Office transmitter licence at a cost of about £3 for a five-year period is required to transmit for this purpose; although the power of the devices is usually only of the order of 10 milliwatts.

The advantage of the microwave transceiver is that it is not affected by air movement, but it is extremely sensitive to any physical movement within the area. The detailed operation of the microwave system will be described in another article, but briefly its operation is as follows:

A gunn diode oscillator generates electrical oscillations in a waveguide cavity. The signals are radiated by coupling to a horn aerial. Part of the signal is fed to a mixer diode in the same, or an adjacent waveguide cavity. This mixer diode will give an alternating output signal at the difference frequency between transmitted and received frequency. If there is no movement this "difference" frequency will be zero.

Any movement will give an output signal from the mixer diode related to the speed of movement. This a.c. signal is amplified and fed to trigger an alarm.

SNAGS OF EACH SYSTEM

Each of the above systems exhibits false alarm problems to a greater or lesser extent. There is now a law relating to alarms going off for prolonged periods. Most designs will have circuits to stop the alarm and automatically reset the system after a defined period. False alarms are particularly undesirable in the more sophisticated systems which are relayed to the police.

SIMPLE SWITCH SYSTEMS

These systems are fairly safe provided the alarm is switched off by the householder on re-entering the house. There is usually an alarm delay allowing about half a minute for the householder to switch off. Poor switch contacts or faulty connections will cause false alarms.

ULTRASONIC BEAM-BREAK ALARM

This is fairly reliable over a short range only; provided it is not in the vicinity of radiators or draughts. It is very susceptible to variable air currents as the range is increased beyond 15 to 20 feet. Like all beam-break devices it does not give area coverage. This can be useful; to guard the front door, for instance, whilst another part of the house is occupied.

INFRA-RED BEAM-BREAK INTRUDER ALARM

This is virtually trouble-free, but again does not give area coverage. It has the advantage of localised protection, allowing free movement in other areas.

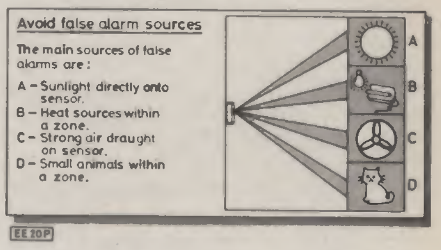


Fig. 10. Typical manufacturer's warning.

PASSIVE INFRA-RED

The most popular home intruder detector, this can give false alarms if the advice given by the manufacturer is not followed as typified in Fig. 10.

ULTRASONIC DOPPLER

The same false alarm conditions apply as for the passive infra-red—even strong sunlight can give undesirable hot spots in a room generating warm air currents, and possibility of false alarms.

MICROWAVE DOPPLER

Tends to be ultra-sensitive to movement, e.g., blowing curtains or swinging lampshades. □

BOOK REVIEWS

UNDERSTANDING RADIO WAVES

Author	Peter Bubb
Price	£8.50 (hardback)
Size	223 × 143mm, 176 pages
Publisher	Lutterworth Press
ISBN	0-7188-2581-0

LIKE many Electronic hobbyists, I like to maintain a general interest in all aspects of this diverse subject, without getting bogged down with boring detail and advanced theory. For those of you like myself, wishing to gain a broad insight into the world of radio waves and transmission principles, this book is well-worth reading. It covers simple wave concepts through basic electronic and radio theory, to microwave cooking.

Reading is made interesting yet concise, as each subject has a dedicated chapter with plenty of clear diagrams and data tables. There are whole chapters covering transmission lines, aerials, television, navigation and model control equipment. For those wishing to pursue a hobby in CB or amateur radio, there is plenty of detailed information on transmitters and receivers and a useful chapter giving a guide to obtaining a transmitting licence.

As with many books of this type, the fundamentals of electrical and electronic theory are covered in much the same way, providing essential background knowledge for people new to the subject. However, being reasonably competent in this area, I have begun to find it a little tedious. Even so, there is no real problem in skipping these chapters.

R.M.B.

25 Simple Shortwave Broadcast Band Aerials by E. N. Noll (B. Babani) Limp £1.95. Performance characteristics and practical details for construction and erection. Explicit diagrams.

INFRA-RED ALARM SYSTEM

I.F.H. GOULT

THIS is one of the most common forms of Intruder Alarms. It detects the heat radiated from a moving body.

In order to discriminate between constant sources of heat such as radiators and light bulbs, a faceted mirror focuses onto a pyro-electric heat detector (see Surveillance Systems). Only heat from defined zones in front of the mirror will be reflected onto the detector. A warm body moving from zone to zone will generate an alternating current output from the detector, which when amplified, will provide an alarm trigger output. Capacitor coupling within the amplifier will block the d.c. current from the detection of fixed heat sources.

The infra-red detector is supplied as a complete unit and provides an output which can be used to operate an alarm. It is operated from its own internal PP3 alkaline battery. There is very little current drain and a battery operating life of one to two years can be expected.

The trigger output is connected to a remote latch and alarm circuit, illustrated in Fig. 2. This too has its own independent PP3 alkaline battery which has negligible current drain when the unit is on standby. When latched it will operate the piezo-electric sounder or relay for one minute before switching off and re-setting.

ALARM LATCH AND TIMING CIRCUIT

Alarm Trigger: The circuit and interconnection with the IR sensor is illustrated in Fig. 2, light twin cable connects the +ve supply output of the Alarm Latch Unit to the positive power terminal of the IR sensor; and the alarm input to the negative alarm terminal of the sensor. A 10kΩ resistance, R8, is connected across these two terminals at the sensor. Resistor R8 prevents base current from flowing in transistor TR1. With no current flowing through TR1 the base of TR2 is at the same voltage as its emitter and this transistor is also in its no current state; no current will flow through the alarm sounder or relay.

If the sensor detects movement of heat across its sensitive zones it connects the negative alarm output to the internal negative voltage supplying TR1 with base current. TR1 in turn switches on TR2, to operate the sounder or relay. The collector of TR2 will become negative providing base current to TR1, through D1, keeping TR1 on when the alarm output from the IR sensor returns to its original state.

If the wire connecting the two units is cut or broken R8 will no longer hold TR1 off and R1 will allow sufficient base current to switch TR1 on and latch the alarm on.

Timing Circuits: Pins 3 and 4 of IC1 are a semiconductor switch which is operated by a control voltage on pin 5. The switch is closed when pin 5 is positive. When the unit is first switched on the negative terminal of C1 is at the positive supply voltage. The base of TR1 will be connected to the +ve supply rail through IC1 switch and, being a *pnp* transistor, it will be cut off. C1 discharges through diode D2, and R7, and R5 to the negative supply voltage at a rate determined mainly by C1 and R7. After about 20 seconds C1 will have discharged sufficiently for the semiconductor switch to open and the input will be free to accept an alarm trigger.

After the alarm has triggered, the collector of TR1 will be switched to the supply rail voltage, C1 will start to charge towards this voltage through R6. After about one minute it will have reached a voltage sufficiently positive to switch on the integrated circuit switch, cutting off TR1 and re-setting the circuit.

The alarm time may be increased by increasing the value of C1. R7 should be decreased in value proportionately otherwise the switch-on delay will be increased.

Note that the sensor switch-on delay may be three or four minutes, as will its recovery time after an alarm. Read the notes supplied with their IR sensor relating to recovery time after an alarm.

CONSTRUCTION

Construction is as illustrated in Fig. 4. The ON/OFF switch can take the form of a 2·5mm jack socket. The jack plug forming a key. This provides a very small and low-cost key switch.

The alternative relay can be placed in the position occupied by the sounder, the contacts being brought out either through a DIN connector or a further jack plug and socket.

OPERATION

No settings are required. Fit a PP3 alkaline battery to the sensor, and fit a PP3 alkaline battery to the alarm latch unit. Connect the sensor to the alarm latch unit as illustrated in Fig. 2. Connect R8 as illustrated.

Position the sensor and remote alarm unit as required. Remove jack key switch from alarm latch unit and ensure no movement for a few minutes. Next, move through the protected area and check that the alarm is triggered.

The alarm latch unit may be checked independently by connecting a 10kΩ resistor across the alarm input and alarm reference terminals. Remove key switch and wait 30 seconds. Using a short wire link, momentarily connect the alarm input to the negative supply line. The alarm should latch on. Any number of sensors may be connected to the alarm latch unit. □

SPECIFICATION

- Detects body movement within a 60 square foot area.
- Battery operated.
- Very low battery consumption.
- Small physical size.
- Independent unit will operate internal sounder or close independent relay contacts.
- Will switch off alarm and reset after defined period.

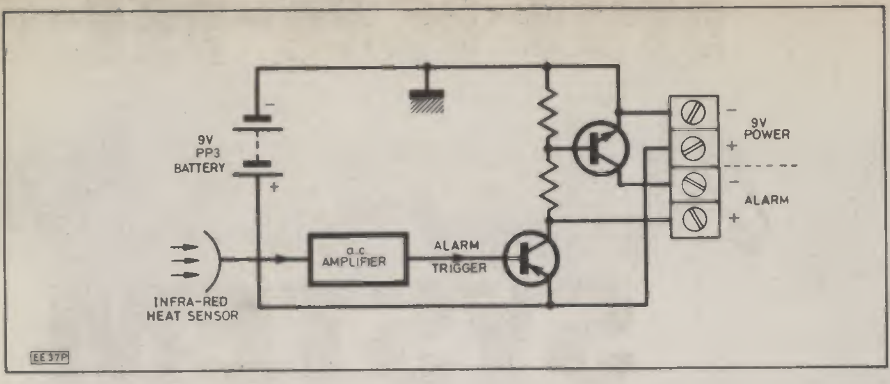
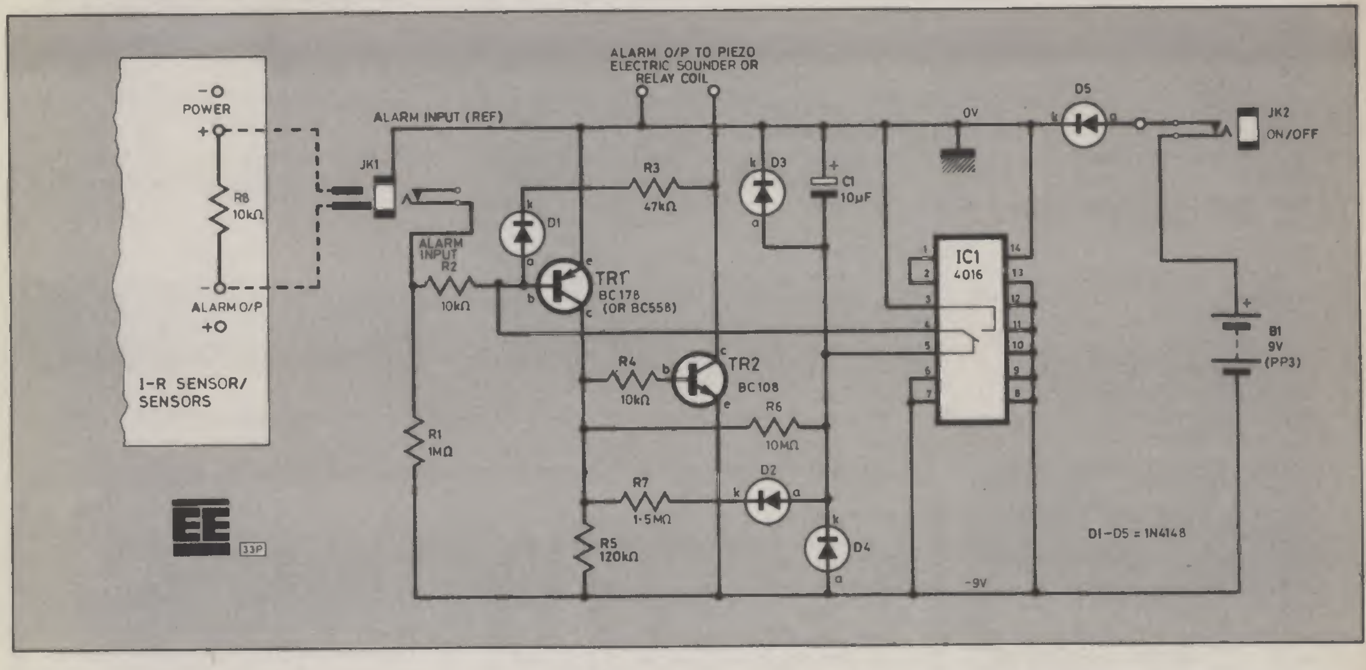


Fig. 1. Infra-red sensor unit internal circuitry.

Fig. 2. Alarm latch and timing circuit.



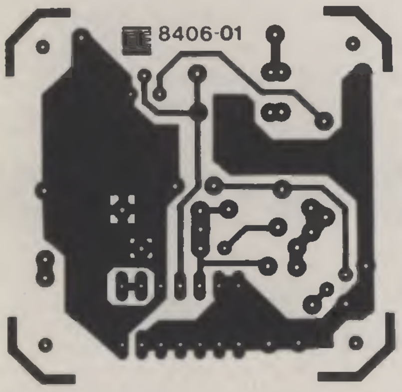
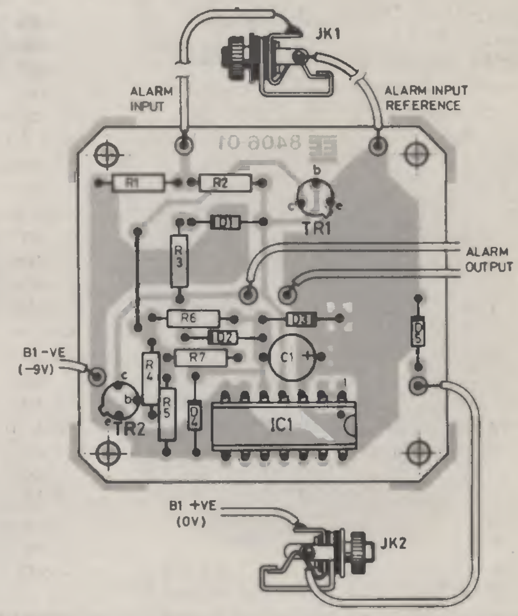


Fig. 3. Printed circuit layout for alarm latch (actual size).

Fig. 4. Component layout.



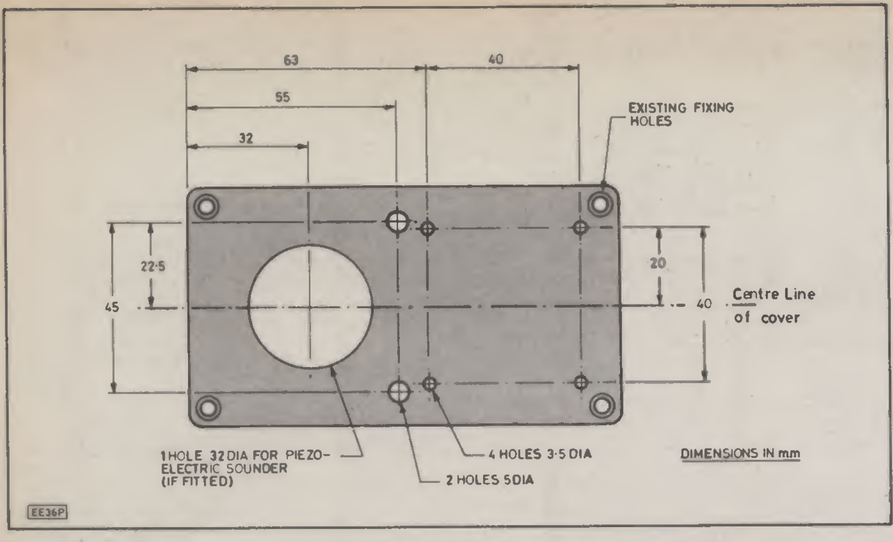


Fig. 5. Lid drillings. A cardboard template should be made first, so that the lid can be centre-punched without having to deface it with markings.
Right: The complete system in situ.

COMPONENTS

Resistors

R1	1MΩ
R2,4	10kΩ (3 off)
R3	47kΩ
R5	120kΩ
R6	10MΩ
R7	1·5MΩ
R8	10k

All $\frac{1}{4}$W carbon ±5%

See Shop Talk page 371

Capacitors

C1	10μF 16V tantalum bead

Semiconductors

TR1	BC178
TR2	BC108 or BC549
D1,2,3,4,5	IN4148 (5 off)
IC1	4016

Miscellaneous

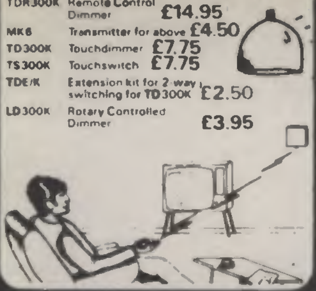
Infra-red detector unit IR881 (£35)*; aluminium die-cast box 114 x 64 x 55mm; 2·5mm socket with jack plug as on/off key; sounder x70 WO6*; alternative relay 12V output; Ambit International Stock No 01-06108.

Approx. cost Guidance only £48

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w of lighting.

TDR300K	Remote Control Dimmer	£14.95
MK6	Transmitter for above	£4.50
TD300K	Touchdimmer	£7.75
TS300K	Touchswitch	£7.75
TDE/K	Extension kit for 2-way switching for TD300K	£2.50
LD300K	Rotary Controlled Dimmer	£3.95



MINI KITS

MK1 ELECTRONIC THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater (1KW). Mains powered. £4.60

MK2 SOLID STATE RELAY
Switches 240V ac motors, lights, heaters from logic/computer circuits. Zero voltage switching, opto isolated. Supplied without triac £2.80

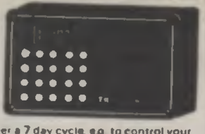
MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Max load 3KW (240V ac). Temp. range up to 90°C £6.50

MK5 MAINS TIMER
Mains powered timer enabling a load up to 1KW at 240V ac to be switched on (or off) for a variable time from 20 mins to 35 hrs. Longer or shorter periods possible with minor component changes. £6.50

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises two MK2s with latch circuit enabling the MK12 kit to control two mains loads independently. Two output triacs not supplied. (See remote control kits.) £4.50

NEW! MK19 DC CONTROLLED AUDIO AMPLIFIER
May be used with virtually any stereo audio amplifier to control bass, volume, treble and balance remotely either using a wire link or the MK11 infra red receiver. A 1 of 10 decoder with LEDS is also included for remote input selection/display. (See remote control kits.) £10.70

MICROPROCESSOR CONTROLLED MULTI-PURPOSE TIMER



Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it — the clock will do the rest.

- 7mm LED 12 hour display
- Day of week, am/pm and output status indicators
- 4 open collector outputs for driving relays, triacs, etc.
- 50/60Hz mains operation
- Battery backup saves stored programmes and continues time-keeping during power failures. (Battery not supplied)
- Display blanking during power failure to conserve battery power
- 18 programme time sets
- Powerful 'Everyday' function enabling output to switch every day but use only one time set
- Useful 'sleep' function — turns on output for one hour
- Direct switch control enabling output to be turned on immediately or after a specified time interval
- 20 function keypad for programme entry

NOW ONLY
£39.00

- Programme verification at the touch of a button
- Plastic box with attractive screen printed front panel 15 × 10 × 5.5cm

(Kit includes all components, PCB, box, assembly and programming instructions)
Order as CT6000

XK114 OPTIONAL RELAY KIT
Kit includes one relay, PCB to accommodate up to 4 relays, terminal blocks, etc., to fit inside CT6000 box. Provides up to 4 3amp 240V AC changeover contacts. £3.90

Additional relays £1.65 each

DISCO LIGHTING KITS

DL 1000K
This value for money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control £15.95

DLZ 1000K
A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. £8.95

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

DL 3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built-in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply and lamps (1Kw channel) Only £12.95

24 HOUR CLOCK/ APPLIANCE TIMER KIT

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

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

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL 7126 (a lower power version of the ICL 7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required — details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.50

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. £5.50

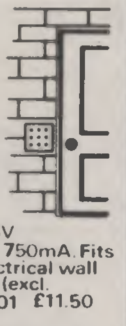
COMPONENT PACKS

PACK 1	650 Resistors 47 ohm to 10 Mohm — 10 per value £4.00
PACK 2	40 × 16V Electrolytic Capacitors 10μF to 1000μF — 5 per value £3.25
PACK 3	60 Polyester Capacitors 0.01 to 1μF 250V — 5 per value £5.55
PACK 4	45 Sub miniature Presets 100 ohm to 1 Mohm — 5 per value £2.90
PACK 5	30 Low Profile IC Sockets 8, 14 and 16 pin — 10 of each £2.40
PACK 6	25 Red LEDs (5mm dia.) £1.50

LCD 3½ DIGIT MULTIMETER

19 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistence (0 — 2M) + NPN & PNP transistor gain and diode check. Input impedence 10M. Size 180 × 140 × 50mm. Complete with battery, test leads and carrying case **ONLY £32.00**

ELECTRONIC LOCK KIT



With hundreds of uses in doors, garages, car anti-theft devices, electronic equipment etc. Only the correct easily changed four digit code will open it! Requires a 5 to 15V dc supply. Output 750mA. Fits into standard electrical wall box. Complete kit (excl. front panel) XK101 £11.50

Electronic lock mechanism for use with the above kit. 70 150 £14.95

WE ALSO STOCK A WIDE RANGE OF ELECTRONIC COMPONENTS

SEE CATALOGUE FOR DETAILS

INFRA RED GARAGE DOOR CONTROLLER KIT

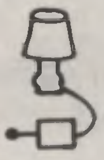
For opening and closing motorised garage doors plus switching garage and drive lights on and off up to a range of 40ft and numerous other applications like controlling lights and TV's etc. in the home. Ideal for aged or disabled persons, this coded kit comprises of a mains powered infra red remote control receiver with a normally open relay output plus two latched transistor outputs; battery-powered four button transmitter and an opto isolated solid state mains switch. As with all our kits, full instructions are supplied.

XK103 £25

Extra transmitters XK105 £10.00

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities — and no wiring!



The Kit comprises a transmitter with pre-drilled box and two receivers.

XK112 £42.00
ADDITIONAL RECEIVERS XK111 £10.00

REMOTE CONTROL KITS

These kits have been designed to enable infra red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi Fi or TV. The exact application will determine the interface circuitry (not supplied) between the receiver and the device to be controlled. In many cases this could by a relay or triac. General instructions and applications are supplied with the kits. The kits are coded and provide a high degree of noise immunity and security.

MK18 Transmitter Kit For use with MK11 MK12 Receivers and MK9 10 13 keyboards. Requires PP3 battery. Size 8 × 2 × 13 cms. Range approximately 60ft £6.80

MK11 Receiver Kit Mains powered. Provides 10 latched plus 3 analogue outputs. Ideal for controlling audio amplifiers, TV or lighting circuits where control of lamp brightness is required £13.50

MK13 Transmitter Keyboard £4.35

MK19 DC Controlled Stereo Amplifier Kit If control of stereo amplifier is required the MK19 may be used providing for remote control of base, treble and volume (or balance). This kit also includes a one of 10 decoder with LEDs for remote selection of programme or channel. May be connected between the pre amp and power amp sections of almost any audio amplifier £10.70

MK12 Receiver Kit Mains powered. Provides up to 16 latched or momentary on off outputs. The latched version is suitable for applications where only one of the 16 outputs is to be on at any one time eg. TV channel selection. The momentary version provides an output only during transmission. Lines may be latched separately if required (circuit supplied). This may be used in conjunction with the MK15 Dual latched Solid State Relay to switch mains loads eg. radio, lights, TV

MK12 (state latched or momentary)	£13.50
MK9 4 way Transmitter Keyboard	£1.90
MK10 16 way Transmitter Keyboard	£5.40
MK15 Dual Latched Solid State Relay	£4.50

SINGLE CHANNEL UNCODED INFRA RED KITS

MK6 Transmitter — supplied with hand held plastic box. Requires a 9V PP3 battery. Range approximately 20ft £4.50

MK7 Receiver Mains powered with triac output to switch up to 500W at 240V a.c. On off or momentary output available £10.50

MK16 Mains Powered Transmitter For continuous operation such as burglar alarms, automatic door operators, etc. Range approximately 6 ft. May also be powered from 9v dc £3.50

MK17 12V d.c. Receiver For use with MK6 or MK16. Relay output with DP 3A change over contacts. May be used as latched, momentary or break beam receiver. Operates from 6-13V dc £10.50

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T.V. SOUND TUNER

SERIES II BUILT AND TESTED Complete with case. **£26.50** + £2.00 p&p.

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains-operated.

Also available with built-in headphone amp. ONLY £32.50 + £2.00 p&p.

This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 10½"x7½"x2¼".
E.T.I. kit version of above without chassis, case and hardware. £16.20 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT COMPLETE WITH CASE

ONLY £34.50 plus £2.75 p&p.

• NOISE REDUCTION SYSTEM. • AUTO STOP. • TAPE COUNTER. • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS. • TWIN V.U. METER. • WOW & FLUTTER 0.1%. • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts, i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire. Featured in April P.E. reprint 50p. Free with kit.

BSR RECORD DECKS

Auto-Changer model - takes up to 6 records with manual override. Supplied with stereo ceramic cartridge.
£12.95 plus £1.75 p&p.

3 speed, auto, set-down; with auto return. Fitted with viscous damped cue, tubular aluminium counter-weighted arm, fitted with ceramic head. Ideally suited for home or disco use.
£17.50 plus £1.75 p&p.

Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco. 13"x11" approx.
£14.95 plus £1.75 p&p.

SPECIAL OFFER! Replacement st. cassette tape heads. £1.80 ea. Add 50p p&p to order. Philips st. mag. cartridge. £3.95 + 60p p&p.

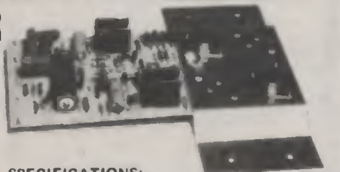
PLINTH to suit BSR Record Player Deck (with cover). Size 16½"x 14¾"x 2¾". Cover size: £14½"x 13¾"x 3½". Due to fragile nature, Buyer collect only. Price: £8.95.

STEREO TUNER KIT

SPECIAL OFFER!
£13.95
+ £2.50 p&p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with P.E. (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System. Front scale size 10½"x2½" approx. Complete with diagram and instructions.

125W HIGH POWER AMP MODULES



The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

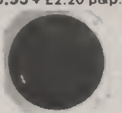
Accessories: Stereo mains power supply kit with trans. £10.50 + £2p&p. Mono: £7.50 + £2p&p.

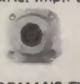
SPECIFICATIONS:
Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

KIT **£10.50** +£1.15 p&p. BUILT **£14.25** +£1.15 p&p.

HI-FI SPEAKER BARGAINS

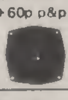
AUDAX 8" SPEAKER £5.95 + £2.20 p&p.
High quality 40 watts RMS bass/mid. Ideal for either HiFi or Disco use this speaker features an aluminium voice coil and a heavy 70mm dia. magnet. Freq. Res.: 20Hz to 7kHz. Imp.: 8 ohms.





AUDAX 40W FERRO-FLUID HI-FI TWEETER Freq. res.: 5KHz - 22KHz. Imp.: 8 ohms. 60mm sq. £5.50 + 60p p&p.

GOODMANS TWEETERS 8 ohm soft dome radiator tweeter (3¾"sq) for use in systems up to 40W.
£3.95 ea + £1 p&p. £6.95 pr + £1.50.



MONO MIXER AMP

Ideal for halls and clubs.
£45.00
+ £2 p&p.

50 Watt, six individually mixed inputs for 2 pickups (Cer. or mag), 2 moving coil microphones and 2 auxiliary for tape tuner, organs etc. Eight slider controls — 6 for level and 2 for master bass and treble, 4 extra treble controls for mic. and aux. inputs. Size: 13¼"x6¾"x 3¾" app. Power output 50 W RMS (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

All mail to: 21A HIGH ST, ACTON W3 6NG.
Callers: Mon - Sat 9.30 - 5.30. Half day Wed.
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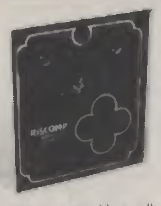
R T V C

SECURITY

Install your own system and save using built and tested modules

A COMPLETE INTRUDER ALARM

EASILY ASSEMBLED ULTRASONIC UNIT CK 5063



Requires no installation. Easily assembled using our professionally built and tested modules

- Adjustable range up to 25ft.
- Built-in entrance & exit delay
- Built-in timed alarm
- Key operated switch - Off, Test and Operate
- Provision for an extension speaker
- Fully self-contained
- Uses US 5063, PSL 1865 Key Switch 3901, 3 Speaker 3515

only £37.00 + V.A.T.

Now you can assemble a really effective intruder alarm at this low price using tried and tested Riscomp modules. Supplied with full instructions, the kit contains everything necessary to provide an effective warning system for your house or flat. With a built-in LED indicator and test position the unit is easily set-up requiring no installation. It may simply be placed on a cupboard or desk. Movement within its range will then cause the built-in siren to produce a penetrating 90dbs of sound, or even 110db s with an additional speaker. All parts included and supplied with full instructions for ease of assembly.
Size 200 x 180 x 70mm Order as CK 5063

DIGITAL ULTRASONIC DETECTOR US 5063

only £13.95 + V.A.T.

NEW

- 3 levels of discrimination against false alarms
- Crystal control for greater stability
- Adjustable range up to 25ft.
- Built-in delays
- 12V operation

This advanced new module uses digital signal processing to provide the highest level of sensitivity whilst discriminating against potential false alarm conditions. The module has a built-in exit delay and timed alarm period, together with a selectable entrance delay, plus many more outstanding features.

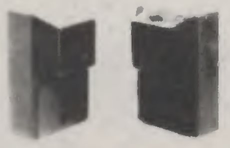
ULTRASONIC MODULE US 4012

£10.95 + V.A.T.

- Adjustable range from 5-25ft.

This popular low cost ultrasonic detector is already used in a wider range of applications from intruder detectors to automatic light switches and door opening equipment, featuring 2 LED indicators for ease of setting up.

INFRA-RED SYSTEM IR 1470 only £25.61 + V.A.T.



Consisting of separate transmitter and receiver both of which are housed in attractive moulded cases, the system provides an invisible modulated beam over distances of up to 50ft. operating a relay when the beam is broken. Intended for use in security systems, but also ideal for photographic and measurement applications. Size 80 by 50 by 35mm.

10% OFF INSURANCE

Install our system and save on your household contents insurance. Send for details.

SIREN MODULE SL 157

Produces a loud penetrating sliding tone which, when coupled to a suitable horn speaker, produces S.P.L.'s of 110dbs at 2 metres. Operating from 9-15V. Price £2.95 + V.A.T.

5½" HORN SPEAKER HS 588

This weather-proof horn speaker provides extremely high sound pressure levels (110dbs at 2 metres) when used with the CA 1250, PS 1865 or SL 157. Price £4.95 + V.A.T.

3-POS. KEY SWITCH 3901

Single pole, 3-pos. key switch intended for use with the CA 1250. Price £3.43 + V.A.T.
Please allow 7 days for delivery

ALARM CONTROL UNIT CA 1250

Price £19.95 + V.A.T.

The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system whether a highly sophisticated installation or simply controlling a single magnetic switch on the front door.

- Built-in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back-up with trickle charging facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

SIREN & POWER SUPPLY MODULE PSL 1865

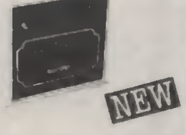
only £9.95 + V.A.T.

NEW

A complete siren and power supply module which is capable of providing sound levels of 110dbs at 2 metres when used with a horn speaker. In addition, the unit provides a stabilised 12V output up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 to form a complete alarm.

HARDWARE KIT HW 1250

only £9.50 + V.A.T.



NEW

This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 by 180 by 70mm

ULTRASONIC MODULE ENCLOSURE

only £2.95 + V.A.T.

NEW

Suitable metal enclosure for housing an individual ultrasonic module type US 5063 or US 4012. Supplied with the necessary mounting pillars and screws etc. For US 5063 order SC 5063; for US 4012 order SC 4012.

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Add 50p post & packing to all orders
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SHOP TALK

BY DAVE BARRINGTON

Soldering Irons

It is most likely that the first purchase any "teacher" will recommend to the beginner to electronics, apart from a regular order for EE, is the acquisition of a soldering iron. So, for those readers who are about to purchase their first iron we feel a few basic guides would be helpful.

To make a soldered joint in electronic circuits an electric soldering iron is required. This is a special tool to heat up the joint to a sufficient temperature to melt the "solder" as it is *applied* to the required joint.

Basically the soldering iron consists of a coil of resistive wire—similar to the bar on an electric fire—which is in contact with a solid shaped metal rod called the "bit." Current through the coil causes the bit temperature to rise.

Try to choose an iron that is lightweight, well balanced, easy to handle and has an adequate length of mains cable. Some irons are fitted with lightweight "flexi-" or extendible coiled mains cable that will not "pull" on the iron when in use.

If you decide to purchase an iron without a stand, we suggest you choose one with a built-in hook or anti-roll collar, so that when placed on the work surface the iron bit stands proud of the work surface and cannot roll across the work area with disastrous consequences.

Irons are classified by their power rating or heat capacity measured in watts. One rated between 15 and 25 watts should be quite adequate for projects published in EE.

The choice of bits or "tips" is another important factor when choosing your iron. We suggest that a range from 1·5mm, 3mm and 4mm diameter would be the most useful choice. This should include a "needle" point and a "chisel" shaped tip.

Although the iron plated tips will cost slightly more, they will more than pay for themselves with a longer lifetime in use.

When making a joint use resinous-flux-incorporated solder *never* unfluxed types. Typically, 18 s.w.g. or 22 s.w.g. "Multicore" solder from **Bib Audio/Video** is ideal for EE projects.

The solder should NOT be melted onto the iron. Instead, the iron is used to heat the two surfaces and the solder melted onto and around the "cleaned" contact area.

Finally, there are many irons on the market to choose from at widely differing prices. Choice will obviously be dictated by the amount of money you can afford, but we strongly recommend you purchase the best possible. A little extra outlay now will more than pay for itself over the years.

Most of our advertisers carry a fairly large range of irons and will be only to pleased to offer advice.

Desoldering

One of the simplest and possibly cheapest forms of desoldering joints on a circuit board, for removal of components, has always been by the use of a "solder wick" to draw reheated molten solder away from the required area, so releasing the suspect component.

The only problem with this method has been that with the greater refinement of devices being manufactured they have, in some cases, become more susceptible to excessive heat and possible damage. The result being that in certain instances, the capillary action of the "wick" has tended to be too slow.

Now, a new range of fine non-corrosive desoldering braid from **Adcola Products** is claimed to be "super fast".

The braid is claimed, due to its fine weave construction, to be 50 per cent faster acting and prevent possible component damage because of the reduction heat transference. It is also claimed to be suitable for use with low temperature/wattage irons, holds more solder and leaves less flux residue behind.

The material is supplied in either 5ft or 100ft reels, in six sizes ranging from 0·035in to 0·0220in and cost between 84p to 99p per 5ft reel.

For more details readers should write to: **Adcola Products Ltd., Dept EE, Adcola House, 113 Gauden Road, London SW4 6LH.**

Another method of desoldering components from a circuit board is the use of a suction pump. This type of tool is usually used in conjunction with a soldering iron to draw, by suction or vacuum action, the reheated molten solder away from the joint and up the barrel or nosel of the "gun".

The latest product from **OK Industries** incorporates its own heating tip and is claimed to be a truly one-hand desoldering gun.

For more details and prices of the SA-6 desolder tool contact: **OK Industries, Dept EE, Dutton Lane, Eastleigh, Hants SO5 4AA.**

CONSTRUCTIONAL PROJECTS

Speech Synthesiser

Although a 64-ohm loudspeaker was found to give quite adequate output for the *Speech Synthesiser*—this month's *Microcomputer Interfacing Techniques* project—a better choice would be a 15-ohm type.

The speech processor (IC1) type SP0256-AL2 is available from **Rapid Electronics** and **Technomatic Ltd., Dept EE, 17 Burnley Road, London, NW10.** When purchasing this device be sure to buy one with the suffix-AL2.

Infra-Red Alarm System

The first constructional project chosen for our new series on *Electronic Surveillance Systems* is a *Infra-Red Alarm System.*

Only one item is a "special" and this is the infra-red detector IR881. This is available (£35 each)—Mail Order—from **Avionic Systems (Heathrow) Ltd., Dept EE, Viscount Way, Hounslow, Middlesex TW6 2JW.**

Spectrum Bench PSU

The ZN428E D/A Converter used in the *Spectrum Bench PSU* is available from **Rapid, Enfield, Maplin** and **Magenta Electronics.**

The Spectrum 28-way edge connector is now carried by most of our component stockists advertisers.

We cannot foresee any component buying problems for the *Channel Select Switch, Hot Water Tank Indicator* or the *Train Wait* projects.

Spectrum Bench PSU

R.A. Penfold

DIGITALLY controlled power supplies have been in existence for many years now, but they are primarily used in sophisticated electronics laboratories and until recently they have not been a practical proposition for most amateur users. This is due to the complexity and high cost of such equipment when compared to conventional bench power supply units.

With many electronics enthusiasts now owning a home-computer the situation has changed, since a computer can be used to control the unit and the television set (or monitor) can be used as the voltage display. This enables a very simple digital power supply unit (which is not much more complex than a conventional type) to be produced.

This power supply project is designed for use with the Sinclair ZX Spectrum computer, but can be adapted for use with some other machines. It covers a voltage range of 0 to 18 volts in 0·1 volt increments with excellent voltage accuracy, and output currents of up to about 1 amp are available. Voltages of up to approximately 24 volts can be obtained, but above 18 volts the maximum current available progressively reduces. The output is well smoothed and regulated. Current limiting is incorporated with four switched nominal limits of 50mA, 100mA, 500mA, and 1 amp. Even prolonged short circuits on the output are unlikely to cause any damage to the unit.

OPERATING PRINCIPLE

The basic set-up used in a digitally controlled power supply is shown in the block diagram of Fig. 1. The required output voltage is generated by a digital number generator in conjunction with a digital-to-analogue converter. The number generator could be a very simple circuit, and could even just be mechanical switches, but it would normally be a fairly sophisticated circuit that would enable the required voltage to be selected using a keypad. Additional features are sometimes included, such as the ability to automatically vary the output voltage over specified limits while the user looks for any adverse effects this might have on the equipment powered from the unit.

A display shows the number produced by the generator, and this also represents the selected output voltage. An amplifier is used at the output of the circuit to enable high output currents to be taken from the unit. As the output voltage from a digital-to-analogue converter has a maximum value of typically only about 2·5 volts, the amplifier would probably need to provide voltage gain as well, in order to give a useful output voltage range.

BLOCK DIAGRAM

The block diagram of Fig. 2 shows the arrangement used in the design featured in this article. The data bus of the computer is used to provide the digital number, and a feature such as automatic varying of the output voltage can easily be handled by the software. The number will only appear very briefly on the data bus, and an 8-bit latch is therefore used to store the number and provide a continuous output for the digital-to-analogue converter. A control pulse decoded from three outputs of the computer is used to latch the signal on the data bus at the appropriate instant.

The output of the converter is fed to what is virtually a conventional bench power supply circuit. The first stage is an error amplifier which, by means of a negative feedback action, stabilises the output voltage. This stage also steps up the voltage from the digital-to-analogue converter by a factor of about ten times. In theory this gives an output voltage range of 0 to 25·5 volts in 0·1 volt steps, but in practice the supply voltage of the circuit is inadequate to give voltages at the high end of this range. The error amplifier can only supply an output current of about 20 milliamps, and a buffer amplifier plus an output stage are needed in order to enable output currents of up to 1 amp to be comfortably accommodated.

CURRENT LIMITING

The current limiting circuit is fitted at the output of the unit, and this pulls the output of the error amplifier (and therefore the output of the unit as a whole) lower in voltage if an excessive current flow is detected, so that the output current is unable to rise much further. It is quite possible to digitally control the current limit threshold of a power supply, and other features such as monitoring the output voltage using the computer are quite feasable. However, due to the lack of input/output ports on the Spectrum this would require substantially more hardware, and neither of these features have been included in the final design.

CIRCUIT DESCRIPTION

The full circuit diagram of the unit is shown in Fig. 3. IC1 is the digital-to-analogue converter, and this is a Ferranti ZN428E. An advantage of this device for this particular application is that it has a built-in latch which enables its inputs to be fed directly from the data bus.

The latch is operated via a control signal fed to pin 4 of the device, and it is a transparent latch. In other words it lets the input signals flow straight through to the converter when the control signal is low, and it latches as the control input is taken high. Normally the control terminal should be high, and a brief negative pulse is used when new data is to be latched into the device. In this circuit the latching pulse is gated from address line 5, the negative write line, and the input/output request line of the Spectrum, using the simple OR gate formed by D1, D2, D3 and R1. These three lines go low and latch IC1 when data is OUTputted to

Fig. 1. Block diagram of a digital p.s.u.

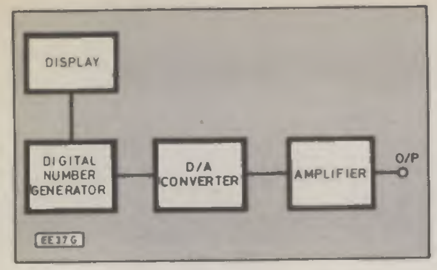


Fig. 2. Block diagram of the Bench p.s.u.

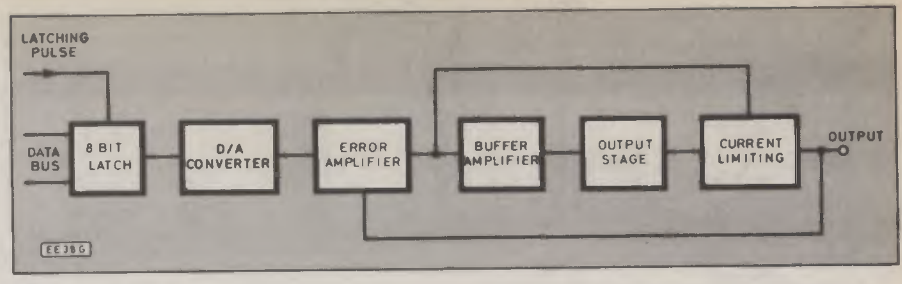
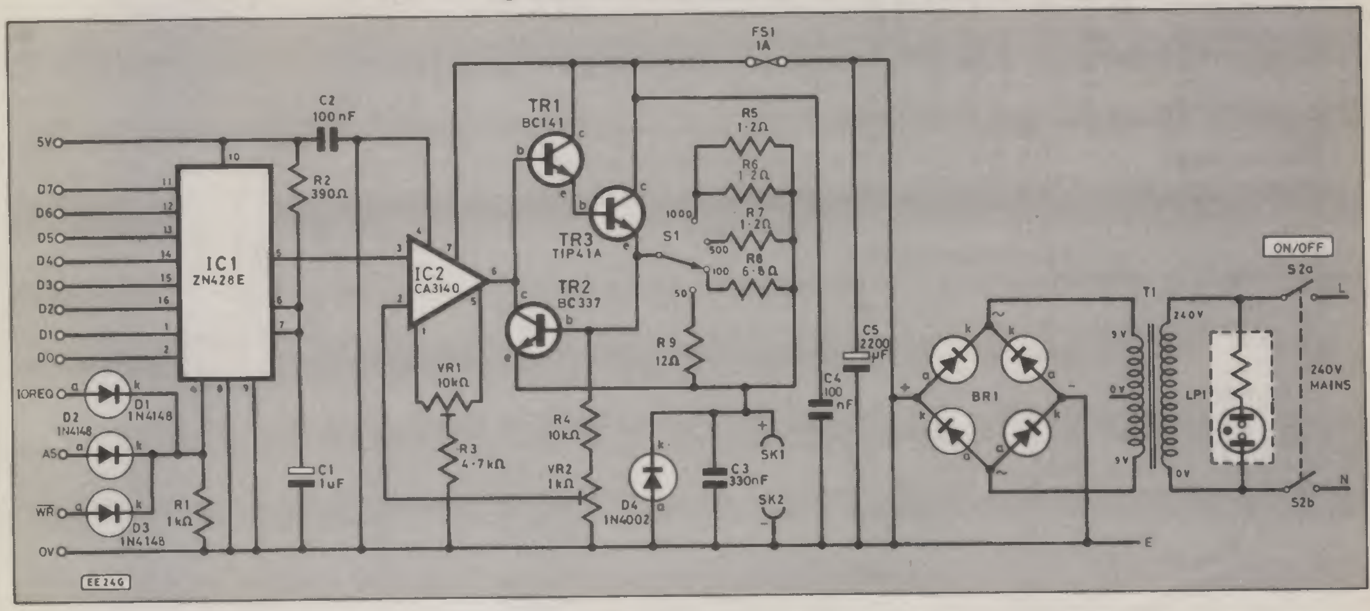


Fig. 3. Circuit diagram of the Bench p.s.u.



address 65503. There are in fact other addresses which could be used, but 65503 is the best one as it does not take any of the other address lines low and will not interfere with any of the Spectrum's internal input/output circuits.

The ZN428E has an internal 2·5 volt voltage reference. R2 and C1 are the load resistor and decoupling capacitor for this. The converter is a conventional type based on R-2R ladder resistor network and electronic switches. Power for IC1 is taken from the 5-volt output of the Spectrum edge connector.

ERROR AMPLIFIER

IC2 is a CA3140 op-amp and it is used as the error amplifier. Negative feedback is taken from the output of the power supply via R4 and VR2, and the latter is adjusted to give the circuit the correct level of voltage gain. VR1 and R3 are the offset-null control for IC2. Their purpose is to enable the circuit to be adjusted for accurate results at low output voltages. The output of the CA3140 can swing down to virtually zero volts, but with the voltage drop through other sections of the circuit the output of the circuit as a whole can go right down to zero. This enables the supply to be used when developing very low voltage circuits, and it also permits the supply to be effectively switched off under software control.

The buffer and output stages use TR1 and TR3, respectively, as straightforward emitter follower amplifiers. The current limit circuit uses as the sense resistance whichever resistor (or resistors) are switched into circuit using S1. The output current flows through the selected resistance, and the voltage developed across this is proportional to the output current. If the current flow is excessive a voltage of more than about 0·6 volts will be developed across the resistance and TR2 will be switched on. This diverts some of the output current of IC2 through TR2 and the load across the output, causing the output voltage to fall. This prevents the output current from rising to a level that gives much more than about 0·6 volts across the sense resistor even with a short circuit on the output. The calculated limit currents are 50mA, 100mA, 500mA, and 1 amp, but these are subject to normal component tolerances, and the two lower figures are significantly boosted by the diverted output current of IC2.

Capacitor C3 helps to give the unit a good transient response and D4 protects the circuit in the event of a reverse voltage being accidentally connected across the output.

The Spectrum power supply could be used to power the main circuit, but this would give the unit quite low maximum output voltage and current figures. A straightforward full-wave power supply circuit is therefore used to power the driver and output circuitry so that the unit has a more useful output voltage and current capability.

CONSTRUCTION

A printed circuit board measuring 60 × 110mm takes most of the smaller components. The design of the p.c.b. is shown in Fig. 4 with the component layout shown in Fig. 5.

There are four link wires and it is a good idea to fit these in place first. The ZN428E used for IC1 is a fairly expensive device and it would be advisable to fit this in a 16-pin d.i.l. i.c. socket, making quite sure that it is connected the right way round. IC2 can be either a CA3140E (8-pin d.i.l.) or a CA3140T (TO-99 metal encapsulation) device, but in either case it is a MOS component and the appropriate handling precautions should be taken. Use Veropins at points on the board where it will connect to off-board components such as T1 and the Spectrum edge connector.

The connections to the edge connector (which should be a 2 × 28-way type, preferably having the appropriate polarising key) are made via a piece of 13-way ribbon cable about half a metre or so in length. The diagram on page 160 of the

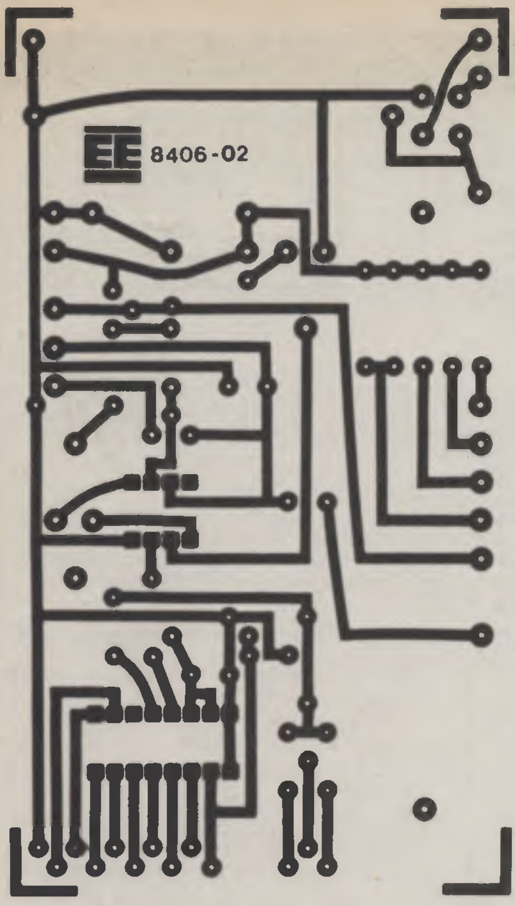


Fig. 4. P.c.b. design for the p.s.u.

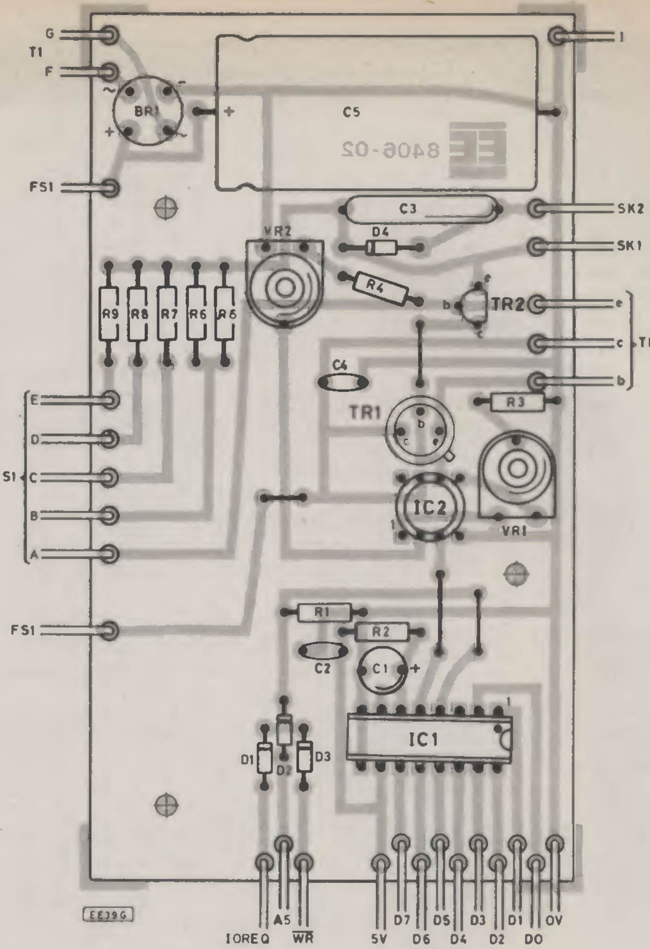


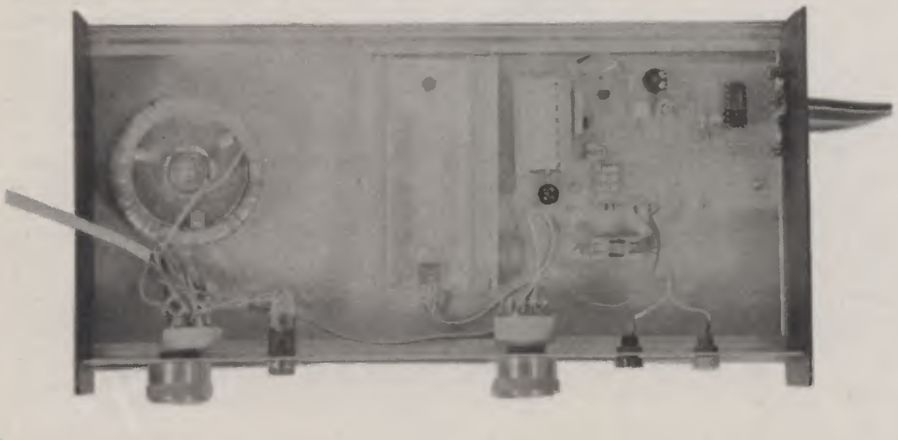
Fig. 5. Component layout.

Spectrum manual shows the connections to the edge connector. Make absolutely certain that the connector is wired-up correctly, and the use of multi-coloured ribbon cable is strongly recommended as this makes identification of each lead very easy.

TOROIDAL

T1 is a toroidal transformer on the prototype, but any mains transformer having twin 9-volt secondary windings (or a 9–0–9 volt type, or a single 18 volt winding) rated at 1·66 amps or more, can be employed in the unit. A soldertag fitted on the mounting bolt of T1 provides a chassis connection point, or, alternatively, a soldertag can be bolted to the base of the cabinet.

TR2 requires a substantial heatsink, and it might be possible to use the case as the heatsink. However, on the prototype a redpoint heatsink type 4Y was used, and this was bolted to the base panel of the case. TR2 should be mounted on one of the mounting bolts and the usual mica washer and plastic insulating bush must be used to insulate TR2 from the heatsink (and the case which is earthed to the negative supply rail). Use a continuity tester to make quite sure that the insulation is effective. Ventilation holes could be drilled in the rear panel, but using this method of heatsinking this does not seem to be essential.



A hole for the mains lead should be drilled in the rear panel, and this should be fitted with a grommet to protect the cable. Using the specified case the ribbon cable can be taken through the gap between the base panel of the case and one of the side panels, but obviously it will almost certainly be necessary to cut or file out an exit hole for the cable if a different case is used.

Use spacers about 12·5mm long on the mounting bolts for the component panel so that it is held well clear of the base panel and there is no risk of the connections on the underside of the board short-circuiting through the base. Fit FS1 into a chassis mounting fuseholder and then wire up the unit as shown in Fig. 6 (in conjunction with Fig. 5).

SETTING UP

Start with both VR1 and VR2 adjusted so that the wipers are roughly at the middle of their tracks. Use a multimeter to monitor the output voltage of the unit. With everything connected up and switched on the command OUT 65503,150 should give very roughly 15 volts at the output of the unit. By adjusting VR2 it should be possible to trim the reading on the multimeter to precisely 15 volts. The command OUT 65503,1 should result in the ouput potential dropping to a very low figure, and by means of VR1 it

COMPONENTS

Resistors

R1	1kΩ
R2	390Ω
R3,4	4·7kΩ (2 off)
R5,6,7	1·2Ω $\frac{1}{2}$W (3 off)
R8	6·8Ω
R9	12Ω

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

Potentiometers

VR1	10kΩ 100mW horizontal preset
VR2	1kΩ 100mW horizontal preset

Capacitors

C1	1μF 63V radial elect.
C2,4	100nF disc ceramic (2 off)
C3	330nF polyester
C5	2200μF 40V axial elect.

Semiconductors

D1,2,3	1N4148 (3 off)
D4	1N4002 100V 1A
BR1	50V 1A bridge rectifier
TR1	BC141 silicon *npn*
TR2	BC337 silicon *npn*
TR3	TIP41A silicon *npn*
IC1	ZN428E D/A converter
IC2	CA3140E or CA3140T MOSFET op-amp

Miscellaneous

SK1	Red 4mm socket
SK2	Black 4mm socket
T1	Twin 9-volt 1·66A toroidal mains transformer
FS1	20mm 1A quick-blow fuse
S1	Rotary mains switch
S2	4-way 3 pole rotary type (only 1 pole used)
LP1	240V panel mounting neon

Instrument case about 300 × 150 × 60mm, Printed circuit board, two control knobs, 20mm chassis mounting fuseholder, Redpoint heatsink type 4Y, 16-pin d.i.l. i.c. socket, 8-pin d.i.l. i.c. socket, 2 x 28-way Spectrum type edge connector, Veropins, ribbon cable, mains lead, fixings, etc.

COMPONENTS approximate cost £35

See **Shop Talk** page 371

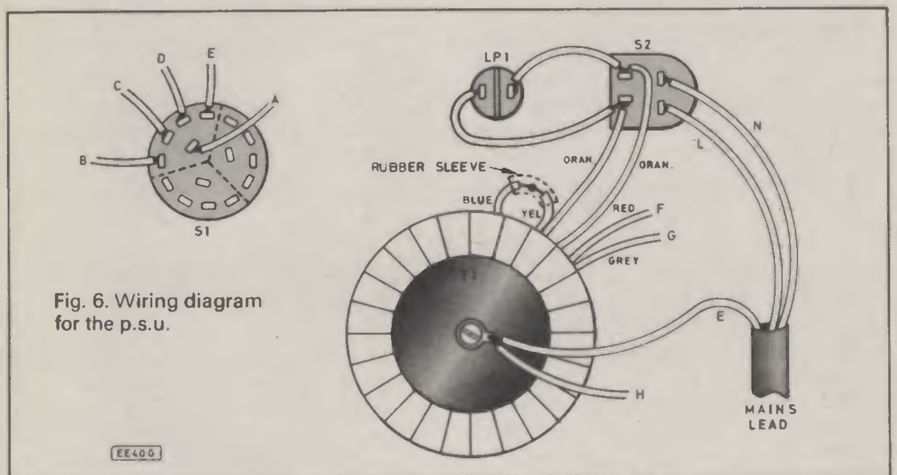


Fig. 6. Wiring diagram for the p.s.u.

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5 REM voltage control program
10 REM by John Penfold
20 CLS
30 PRINT AT 2,5;"SELECT
FACILITY"
40 PRINT AT 5,5;"A.  Automatic
Decrease."
50 PRINT AT 10,5;"M.  Manual
Selection."
60 PAUSE 0
70 LET a$=INKEY$
80 IF a$="A" THEN GO SUB 200
85 IF a$="a" THEN GO SUB 200
90 IF a$="M" THEN GO SUB 500
95 IF a$="m" THEN GO SUB 500
100 GO TO 20
200 CLS
210 PRINT AT 5,5;"Enter the
starting voltage."
220 INPUT startv
230 IF startv>25.5 THEN GO TO
210
240 PRINT AT 7,5;"Enter the end
voltage."
250 INPUT endv
260IF endv>startv THEN GO TO 240
270 PRINT AT 9,5;"Time between
steps?(secs)"
290 INPUT time
295 IF time=0 THEN LET
time=0.001
300 CLS : PRINT AT 5,5;"From
";startv;" to ";endv;"V."
310 PRINT AT 7,5;"Time interval
";time;" secs."
320 FOR v=10*startv to 10*endv
STEP -1
330 OUT 65503,v
335 PRINT AT 9,5;"Output
";v/10;" volts  "
340 PAUSE 50*time
350 NEXT v
360 CLS : PRINT AT 5,5;"X to
exit"
370 PRINT AT 7,5;"R to reset"
380 PRINT AT 9,5;"any other key
to repeat"
400 LET r$=INKEY$
410 IF r$="x" OR r$="X" THEN
RETURN
420 IF r$="r" OR r$="R" THEN GO
TO 200
430 GO TO 300
500 CLS
510 PRINT AT 5,5;"Enter the
voltage"
520 INPUT volts
525 IF volts>25.5 THEN GO TO 500
530 IF volts>18 THEN PRINT AT
1,10;"FULL CURRENT NOT
AVAILABLE"
535 PRINT AT 7,5;volts;" VOLTS"
540 OUT 65503,volts*10
550 PRINT AT 15,5;"X to exit"
560 PRINT AT 17,5;"Any other key
to reset"
570 PAUSE 0
580 LET r$=INKEY$
590 IF r$="x" OR r$="X" THEN
RETURN
600 GO TO 500
```

Table 1. Voltage Control Program

should be possible to trim the output voltage to 0·1 volts.

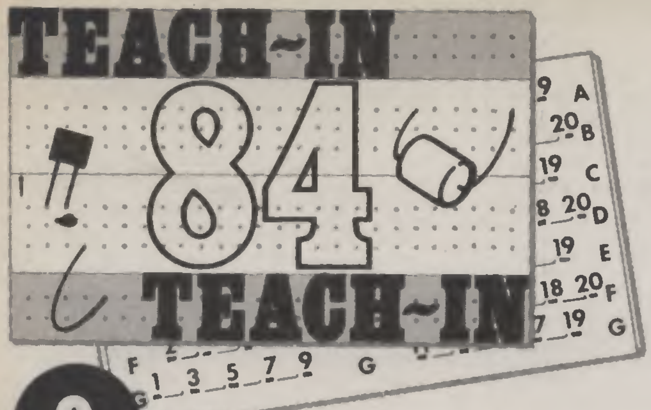
This procedure is repeated a few times until the output voltages are correct and no further improvement in accuracy can be attained.

PROGRAM NOTES

The suggested program in Table 1 gives two modes of operation. In one the output voltage is fixed, and only the required voltage needs to be specified. In the other the voltage is automatically varied from the selected maximum voltage to the selected minimum potential. Here the duration of each 0·1 volt decrement has to be specified as well, and three figures therefore have to be entered into the computer. Lines 20 to 100 are a simple "menu" to choose the desired mode of operation, and each mode is handled by a subroutine.

The first of these is at lines 200 to 430 and is the more complex (giving the automatic voltage fall). Lines 230 and 260 are traps for "silly" inputs, and line 295 prevents a PAUSE 0 (which would give an indefinite pause). However, if line 295 is omitted and 0 is entered, the output voltage will decrement by 0·1 volt each time a key is pressed. Lines 300 to 310 print a screen display of the settings in use. As the output voltage is decremented the current output voltage is displayed on the screen by line 335. When the end voltage is reached the rest of the routine offers options to exit to menu, repeat, or reset.

The second routine gives a fixed output voltage. The required voltage is input at line 520, and line 525 is a trap for illegal values. Line 530 prints a warning that the full current is not available if a potential of more than 18 volts is selected. Line 535 displays the output voltage, and line 540 calculates and outputs the appropriate value. The remaining part of the routine offers the choice of resetting the voltage or exiting to the menu. □



9

A TWELVE-PART HOME STUDY COURSE IN THE PRINCIPLES AND PRACTICE OF ELECTRONIC CIRCUITS. ESSENTIALLY PRACTICAL, EACH PART INCLUDES EXPERIMENTS TO DEMONSTRATE AND PROVE THE THEORY.
USE OF A PROPRIETARY BREADBOARD ELIMINATES NEED FOR SOLDERING AND MAKES ASSEMBLY OF CIRCUITS SIMPLE.
THE IDEAL INTRODUCTION TO THE SUBJECT FOR NEWCOMERS. ALSO A USEFUL REFRESHER COURSE FOR OTHERS.

By GEORGE HYLTON

RADIO SYSTEMS

ELECTRONICS really began as radio. Even now there is more fun to be had from building and operating simple radio receivers than almost any other electronic activity. Moreover, it is possible, using only a small number of modern transistors, to achieve something approaching the usable limits of sensitivity.

MODULATION SYSTEMS

The essence of the communications game is information. Information is what has to be transmitted. Noise is what gets in the way. There are certain golden rules for coping with noise. One, so natural that we all adopt it automatically when speaking in a noisy environment, is to increase volume. Another is to transmit more slowly. A third is to present the information in a form which is as different as possible from the noise, so that it is easy to distinguish.

In the simplest communications systems, the "sender" is just switched on and off. A flashing light is such a system. It can be used for sending Morse code signals. Early electrical communications systems used the same on-and-off format. In line telegraphy, all the Morse tapper key did was to connect a battery to the telegraph wire. The current was either fully on or fully off.

In radio telegraphy it is not possible to transmit direct current. Only high-frequency a.c. can be radiated from an aerial. When the Morse key of a simple radio telegraphy transmitter is pressed down the output of a high-frequency oscillator is fed to the aerial. Different Morse transmitters can use oscillations on different frequencies to avoid interfering with one another.

CARRIER WAVE

This kind of transmission is often called "c.w.". This is short for "carrier wave". The carrier wave is the radiated oscillations, which carry the coded information. The frequency of the transmission is called the carrier frequency.

Frequency and wavelength are just different aspects of the way the energy radiated by the transmitter changes with time and distance. The waves radiate outwards like ripples on a pool when a stone is thrown in. The distance from wave crest to wave crest is the wavelength. The number of crests that pass by in one second is the frequency.

There is no simple way of converting speech and music into on-off signals like Morse. This is a pity, since on-off signals are very different from noise and easy to distinguish from it. Some very modern telephony systems do convert speech into Morse-like signals as we'll see later. But in the early days equipment for encoding speech in this way just didn't exist. In-

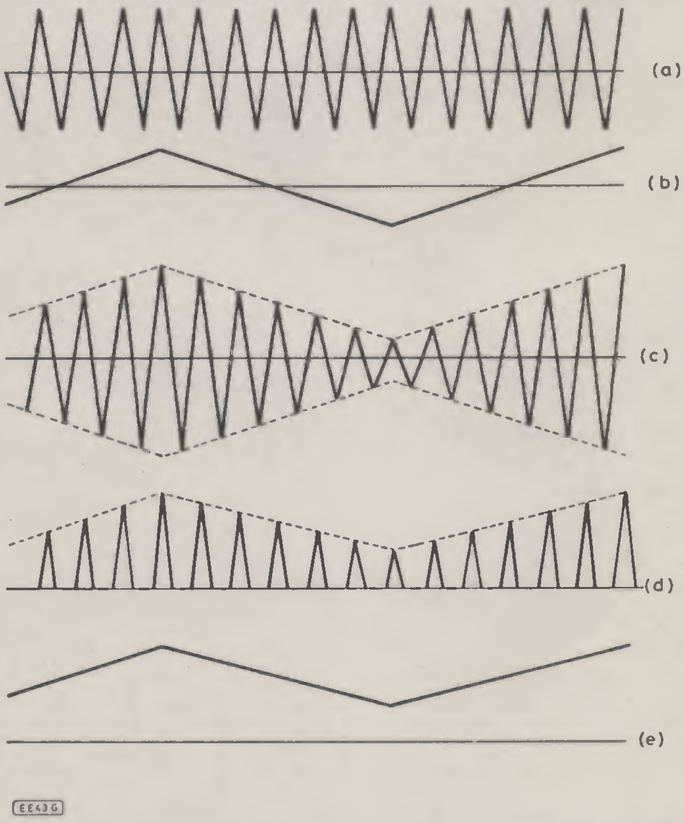


Fig. 9.1. Modulation and detection. (a) unmodulated carrier wave; (b) audio wave; (c) amplitude modulated wave when audio is made to vary the carrier amplitude; (d) half-wave rectified version of (c). This can be regarded as a sequence of samples of the original audio wave, (b); (e) smoothed version of (d) contains both audio and a d.c. component.

stead, the speech waveforms were made to control the strength of the radio transmission, instant by instant.

AMPLITUDE MODULATION

In Fig. 9.1, (a) is the carrier wave and (b) is a part of the speech waveform, drawn as a triangular wave for simplicity though in reality speech is much more irregular. If the strength of (a) is controlled by (b), the result is (c). Controlling the strength or "amplitude" of a carrier wave in this way is called amplitude modulation or a.m. The a.m. wave is all high-frequency a.c. and so can be radiated.

But it can't be heard. The frequency is far beyond the limit of hearing. So an essential part of any radio receiver is some means of turning the high-frequency a.m. wave back into an audio wave.

DETECTION

The simplest answer is something we looked at when considering power supply units: rectification. The incoming a.m. (usually after amplification) is applied to a half-wave rectifier. This, on its own, would yield the wave of (d), a sequence of d.c. pulses each of which is a sample of the original audio amplitude.

By adding a reservoir capacitor the gaps between pulses are filled in, giving waveform (e), which is the original audio superimposed on some d.c. The d.c. is easily blocked off by adding a coupling capacitor. This way of recovering the audio is called "detection".

PULSE CODE MODULATION

Fig. 9.1d gives a clue to a possible way of converting speech into code signals. Suppose, at the transmitter, such samples of the audio wave are produced, but not transmitted directly. In effect, the samples are a series of "voltage readings" each one giving the amplitude of the audio at a particular instant. Now, voltage readings are numbers. Using modern high-speed digital techniques numbers can be converted automatically into code. The code generally used is the binary code in which any number is represented as a sequence of equal-sized pulses.

To communicate speech in this way samples are taken and encoded in real-time, that is as fast as the speech itself. Each sample or voltage reading is transmitted as a c.w. signal consisting of a train of high speed pulses. At the receiver each sequence of pulses is turned back into a voltage sample and the voltage samples smoothed to reproduce the original audio waveform.

For telephone quality speech it is necessary to take 8,000 voltage samples per second. Each sample is encoded into a chain of perhaps ten code pulses. So altogether 80,000 code pulses a second may be used for one speech channel. No wonder it took the development of transistors and integrated circuits to make commercial use of this system, "pulse code modulation" feasible.

The great advantage of p.c.m. as it is called for short is that it doesn't matter how much an individual pulse gets distorted in transmission so long as it is still recognisable as a pulse at the receiving end. It can then be restored to its original shape as if no distortion had ever occurred.

FREQUENCY MODULATION

In frequency modulation (f.m.) the amplitude of the transmitted carrier is kept constant. But its frequency is made to vary in step with the changing intensity of the sound waves which make up the broadcast programme.

Frequency modulation can be made fairly noise-proof. The price paid is that each f.m. transmission occupies a large amount of "frequency space" so only a limited number of f.m. transmissions can be packed into a given waveband.

With a.m. the packing is much closer. In the medium-wave band (roughly 500kHz to 1,500kHz) European stations are spaced 9kHz apart. The frequencies given in programme schedules are the carrier frequencies.

When amplitude-modulated, a fuzz of new frequencies is created on either side of the carrier. The extent of these "sidebands" is the same as the extent of the audio frequency range. If all audio up to 10kHz is transmitted then an a.m. station on 600kHz would actually transmit 590kHz to 610kHz, that is, 10kHz on either side of its carrier. With f.m., sidebands are also created but they can extend much further from the carrier—in f.m. broadcasts, for perhaps hundreds of kHz.

Simple rectification fails to detect an f.m. signal because its amplitude is constant. The f.m. must first be turned into a sort of a.m., then rectified. Circuits which do this are called frequency discriminators, or often, just discriminators.

SELECTIVITY

There are two possible ways of selecting the radio station you need from all the others. One is to sample the incoming waves at instants which correspond to the peaks of the waves of the wanted station. When this is done the wanted station yields the maximum signal, and unwanted stations on different frequencies are converted to high frequency noise which can be rejected by a "low-pass filter", that is a network which allows low frequencies to pass but attenuates high ones.

The other way—and at present this is the usual method—is to select the wanted station with a "band-pass filter" which allows the carrier and sidebands to pass but attenuates everything else. In this way the wanted transmission is allowed to pass through the filter at full strength but all others are weakened.

Ideally, of course, other stations would be completely blocked, but real-life filters are not good enough so a strong unwanted station close in frequency to the wanted one may still get through.

This ability to pick out a wanted station is called selectivity.

TUNED CIRCUITS

The usual circuit for producing selectivity (Fig. 9.2a) is made up of a capacitance (C1) and an inductance (L1) in parallel. It is called a parallel-tuned circuit, and when correctly driven with signals it acts as a band-pass filter.

You know from previous parts of *Teach-In* that a capacitance is an energy-storage device. It stores energy as an electric charge, a stored "voltage". An inductance also stores energy, but in quite a different way. The energy associated with an inductance is stored in the form of a magnetic field. An inductor is an electromagnetic device. The strength of the magnetic field is proportional to the current flowing in the inductor.

If a charged capacitance is "shorted" by connecting an inductance across it (Fig. 9.2b) the charge rushes out in the form of a current. This current, flowing through the inductance, sets up a magnetic field. The field is itself a store of energy.

OSCILLATIONS

When the inductance is fully charged with field, current flow stops. The field then collapses, but in collapsing it induces a voltage in the inductance, and this voltage drives a current back into the capacitance.

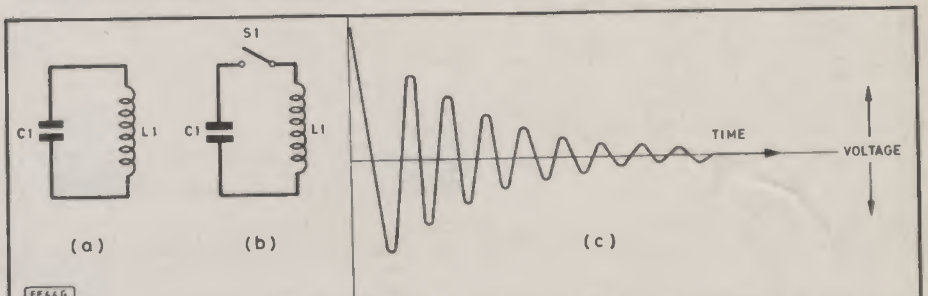


Fig. 9.2. (a) a parallel-tuned circuit; (b) arrangement for discharging C1 through L1; (c) how the voltage behaves after S1 is closed.

When the capacitance is fully charged, current flow stops, then the capacitance starts to discharge again, driving a current into the inductance which produces a magnetic field . . . and so on.

Current flows from capacitance to inductance, inductance to capacitance, and it would go on oscillating back and forth in this way forever, if it weren't for the fact that in a real circuit some of the electrical energy is turned into heat, mainly by the resistance of the wire used to make a practical inductor. These losses cause the current to die away.

RESONANT FREQUENCY

It so happens that the process of shunting current to and fro between inductance and capacitance occurs most readily at one particular frequency. This is the frequency at which the reactance of the inductance is the same as the reactance of the capacitance. (Remember, reactance is to L and C what resistance is to conductors.) It's called the natural or resonant frequency.

Just as a guitar string is tuned to one frequency so is a tuned or resonant LC circuit.

Fig. 9.2c shows how the voltage across a parallel-tuned circuit dies away after S1 is closed to connect the previously charged C1 across L1.

If the LC circuit is driven continuously by a current which contains a random mixture of all frequencies (Fig. 9.3a), those frequencies nearest the resonant frequency f_0 give rise to the biggest voltages. Above or below f_0 the response is reduced (Fig. 9.3b).

If instead of a random mixture of frequencies the current comes from an aerial picking up a mixture of transmissions on different frequencies the tuned circuit emphasises those near its natural frequency. The sharpness of the peak in the response depends on the losses in L and C: the lower the losses the narrower the peak. This can be expressed in a general way by a quantity called Q.

QUALITY FACTOR

The Q or "quality factor" of a resonant circuit is a number which is large when the losses are small. The "bandwidth" of the circuit between the two frequencies where the response is about 70 per cent of maximum is called the "3dB bandwidth" and is easy to calculate if you know Q:

$$\text{3dB bandwidth} = f_0/Q$$

Thus if f_0 = 200kHz and Q = 50 the 3dB bandwidth is 4kHz. Well away from f_0, the shape of the curve is not much affected by the Q.

LOOP AERIALS

If a conductor is placed in a changing magnetic field a voltage is induced into the conductor. This fact is made use of in the kind of aerial used in pocket receivers for medium and long-wave transmissions. The principle of the loop aerial (or frame aerial) is illustrated in Fig. 9.4a.

If a radio wave is travelling in the direction shown it strikes wire AD first and BC last. In doing so it induces a voltage (V1) in AD and V2 in BC. Nothing is induced in AB and DC because these wires are end-on to the wave so it cannot "see" them.

The induced voltages V1 and V2 oppose one another, but are unequal. The difference between them is available for driving current to the receiver. The reason why V1 and V2 are unequal is that the wave is moving. If BC is at present feeling the crest then AD must be feeling what comes after the crest. In this case, V2 is greater than V1.

If, instead of travelling parallel to the paper, the wave was moving head on towards the paper it would hit all the wires at the same time. In this case the voltages would really be identical and there would be no output to the receiver.

So a loop aerial is blind in certain directions. This is a nuisance for broadcast reception but it does make possible direction-finding receivers which can be used, for example, to get a "fix" on a distress signal.

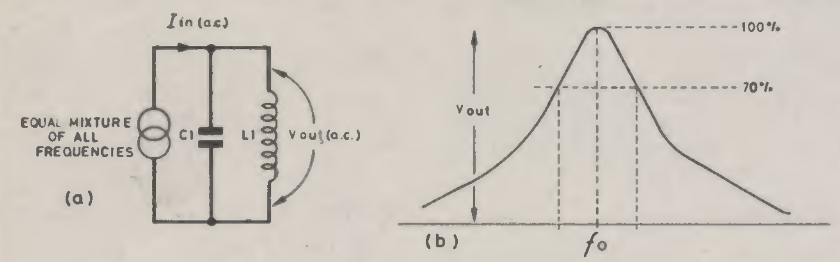


Fig. 9.3. (a) tuned circuit current-driven by a mixture of all frequencies; (b) how the output voltage depends on the frequency. The band between the "70%" points is the "3dB bandwidth" of the tuned circuit.

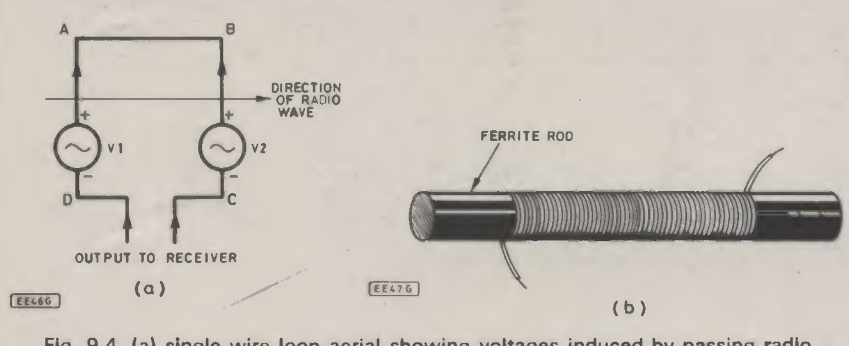


Fig. 9.4. (a) single-wire loop aerial showing voltages induced by passing radio wave; (b) Ferrite rod aerial in which the loop is a coil round the rod.

FERRITE ROD AERIALS

Ordinary loop aerials are too big for pocket radios. Fortunately it is possible to increase efficiency by filling the loop with magnetic material. This concentrates the radio wave. A small loop then picks up enough signal.

Metallic magnetic materials are too "lossy" at radio frequencies, so a ceramic magnetic material, ferrite, is used. What matters in a loop aerial is the area of the loop, not its shape. Ferrite aerial rods are usually round or oval and the loop consists of many turns of insulated wire (Fig. 9.4b). Such a coil has enough inductance to function as the L of an LC tuned circuit.

To vary the tuning (change the tuned frequency) L or C or both must be varied. In practice, C is often made in the form of a mechanically variable tuning capacitor. We, however, shall use a more recent device which can be plugged straight into your EBBO discrete breadboard. This is yet another kind of semiconductor diode, called a "varicap" (variable capacitance diode).

VARICAP DIODE

When a varicap is reverse biased (anode negative) it behaves like a capacitor with two plates. The spacing of the plates depends on the voltage applied. So by adjusting the bias voltage the capacitance can be varied.

The specified varicap is type KV1236. This is a dual type incorporating two diodes only one of which we need at present. The two diodes can be separated by holding one gently but firmly with pliers and snapping off the other along the crease in the plastic casing. The capacitance of this device varies from 30pF to 450pF as the bias is changed from 8·5V to 2V.

EXPERIMENT 9.1

RECEIVER CIRCUIT

Examine Fig. 9.5. This is the circuit of a simple a.m. receiver.

TR1 and TR2 form a direct-coupled amplifier of a type familiar to you. TR1 is operated at a very low collector current. Negative half-cycles of a strong input signal reduce this current to zero. Positive ones increase it substantially. The current through TR1 then approximates to the pulsed waveform of Fig. 9.1d. In short, TR1 acts as a detector. Filling in the gaps is done by C2. TR2 thus receives d.c. plus audio. The d.c. has little effect because negative feedback in this circuit resists d.c. changes. The audio is amplified by TR2.

At the input circuit, bias is applied via R2 which has a high resistance to avoid loading the tuned circuit formed by D1 and the ferrite aerial inductance L1. (The lower end of L1 is effectively a.c.-connected to D1 by C3, and C1 a.c.-connects the tuning diode to L1.)

The EBBO layout for the simple radio-receiver circuit is shown in Fig. 9.6.

The aerial is a 100mm rod made of "medium frequency" ferrite of 9mm diameter (= 4in × $\frac{3}{8}$in). Wind tightly with 50 turns of insulated connecting wire. Tape the ends of the wire to the rod and leave about 150mm (6in) for connecting. A longer rod may be used but a shorter one is unlikely to produce enough voltage.

The receiver should tune to the medium-wave band, which extends from 520kHz to about 1·6MHz in Europe.

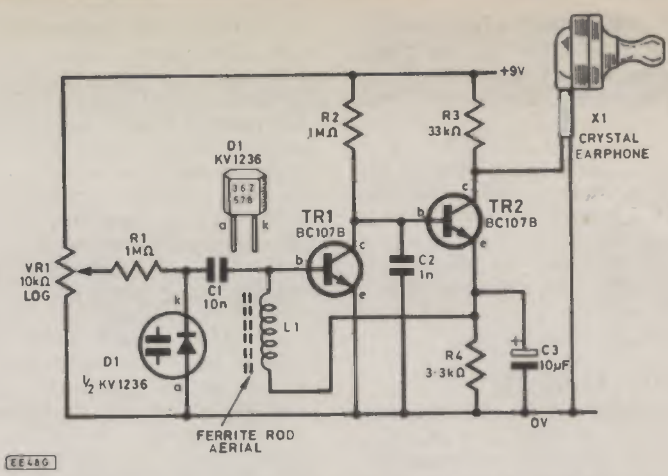
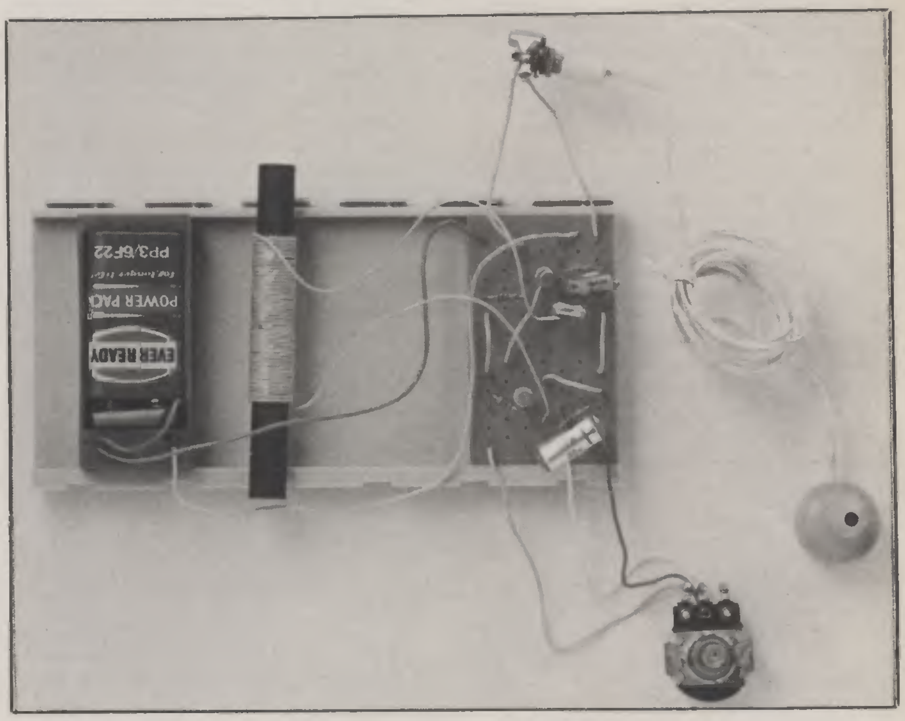
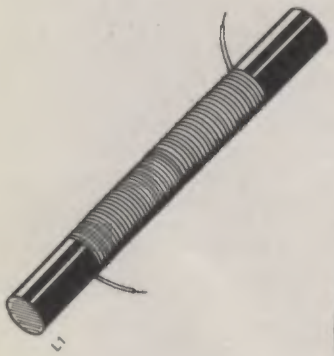


Fig. 9.5. Simple a.m. radio. L1 is the ferrite aerial winding and is tuned by variable capacity diode D1.





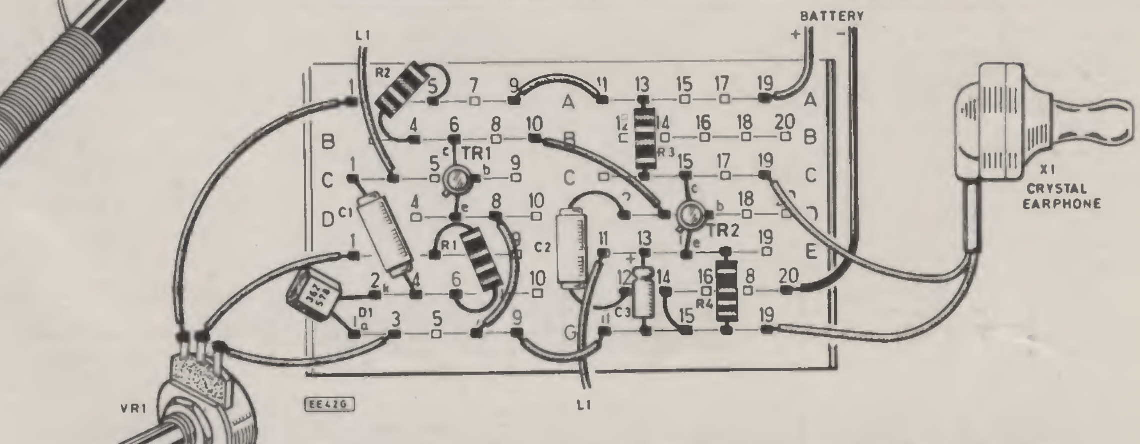


Fig. 9.6. The EBBO discrete board layout for radio circuit given in Fig. 9.5. To add the reaction circuit, Fig. 9.7, remove the link between *D*8 and *G*7 and replace it with potentiometer VR2; connect L2 between *D*4 and *G*5.

EXPERIMENT 9.2

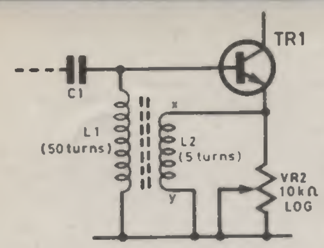


Fig. 9.7. Add-on "reaction" circuit.

When you have got Fig. 9.6 working and picking up at least one station, however faintly, improve the sensitivity by adding controlled positive feedback.

REACTION

To do this, wind a second coil of five turns over the middle of L1. Connect it and a second 10kΩ potentiometer (VR2) in the emitter circuit of TR1, see Fig. 9.7. (Remove the link from TR1 emitter to battery negative first.)

Turn VR2 to maximum and tune across the band with VR1. If a continuous screech is heard at some point which does not change as VR1 is altered, turn down VR2 until it just stops. When VR1 is now varied, some stations appear as whistles whose pitch changes as they are tuned in. Turn down VR2 until the whistle just stops and the station now comes in at increased strength.

If neither screeches nor whistles are heard, don't despair. It probably means that L1 is connected "wrong way round". (Exchange its two connecting points X and Y on the board and try again.)

How does the feedback work? L2 is energised by TR1 emitter current. Its magnetic field embraces L1. So L2 and L1 form a sort of transformer. Energy is fed from TR1 via L2 to L1. The resulting voltage in L1 is applied to TR1 and the process repeats.

If the feedback is positive, the circuit can oscillate. Turning down VR2 reduces feedback and enables the circuit to be set to a just-not-oscillating condition. This greatly increases not only the sensitivity but also the selectivity, because the tuned circuit passes on more fed-back signal at its resonant frequency than at other frequencies. This sort of controlled positive feedback is called regeneration or reaction.

BEAT FREQUENCY

If the circuit is oscillating and an incoming carrier is almost correctly tuned in, the carrier and local oscillation interact to produce a "beat frequency". This is a new frequency equal to the difference between the two.

If the incoming carrier frequency is 600kHz, and the local oscillation 605kHz, the beat frequency is 5kHz and is audible as a whistle. If you adjust VR2 to give a weak "beat" and listen carefully you can tell that the incoming programme is mixed up with the beat frequency. But it isn't intelligible.

This ability to generate beat frequencies is exploited in a much-used type of receiver, called a superhet.

Superhet is short for "supersonic heterodyne". Heterodyne is a fancy word for beat, and supersonic here means what we nowadays call ultrasonic, that is, too high in frequency to be heard.

In a superhet, the incoming carrier is mixed with a local oscillation on a very different frequency; so different, in fact, that the resulting beat is itself a radio frequency—in pocket a.m. radios it is usually in the region of 455kHz. This beat is called the intermediate frequency or i.f. for short. Programme sidebands of the incoming station get transferred to the i.f. So if the i.f. is rectified the programme is recovered.

I.F. AMPLIFICATION

It is what can be done to the i.f. signal before it is rectified that makes the superhet so attractive. It can be amplified and filtered first, to increase sensitivity and selectivity. By making the local oscillation frequency adjustable, any incoming carrier can be made to give the same i.f.

If, for example, you want to receive 200kHz, mixing with a local oscillation of 655kHz gives a beat of 455kHz, the standard i.f. If you want to receive 300kHz, all that's needed is to re-adjust the local oscillation to 755kHz; the beat is 455kHz, as before.

Having converted any station you want to the i.f., it is easy then to pass the i.f. through many tuned circuits, all set permanently to the i.f., and to amplify the i.f. signals in fixed-tuned amplifiers with LC circuits as their collector "loads". This gives both high gain and selectivity.

CHECK YOUR PROGRESS

Questions on *Teach In 84 Part 9*
Answers next month

Q9.1 In Fig. 9.5 (radio receiver), TR1 base-emitter voltage is only about 0·5V. Using this information estimate how much battery current is drawn by the complete receiver.

Q9.2 A superhet is tuned to 30MHz. If its i.f. is 9MHz what must be the local oscillator frequency?

ANSWERS TO PART 8

Q8.1 (a) 40mA; (b) 100Ω; (c) 450mW; (d) 56mA.
Q8.2 (a) 190Ω; (b) 99mW total; (c) 33mW.
Q8.3 (a) About 13V; (b) About 27V.
Q8.4 (a) Push-pull, full-wave; (b) 16V; (c) 50mA minimum; (d) 70mA; (e) a, 33V, b, 35mA. (Keeps power same as push-pull.)
Q8.5 2A. The 100mA is the average over one whole cycle, that is, two half-cycles, so if D1 conducts for 10 per cent of a half-cycle this is 5 per cent (1/20) of a full cycle and enough current must be supplied in this period.

SUPERHET FEATURES

Fig. 9.8 is a block diagram showing the main features of a superhet receiver without going into circuit details. Because the signal and local oscillator frequencies are so far apart, each has its own separate tuning. But the signal and oscillator circuits are tuned simultaneously by a single control. (Indicated by the linked arrows.)

As your own receiver shows, the blocks marked "mixer" (frequency changer) and "local oscillator" can be combined into a single transistor, a "self-oscillating mixer", but are often separate.

The i.f. amplifier has a very high gain, perhaps as much as 100,000. When strong signals come in, the gain is automatically reduced by feeding back the rectified d.c. from the detector (which of course increases as the strength of the signal carrier increases) in such a way as to reduce the gain. This automatic gain control (a.g.c.) reduces the effect of differences between strong and weak stations.

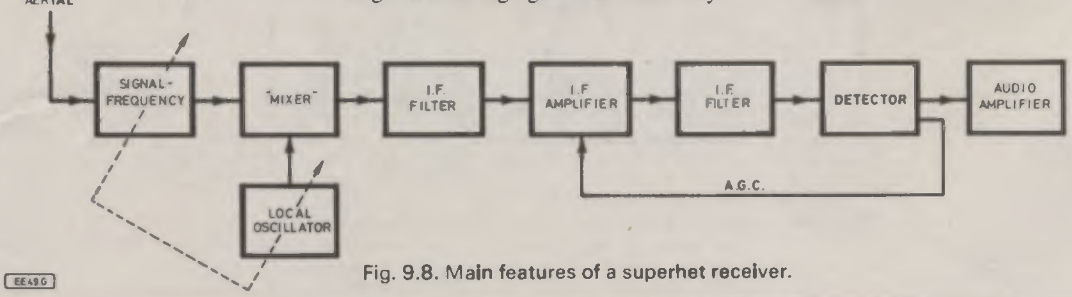


Fig. 9.8. Main features of a superhet receiver.

REFINEMENTS

Superhets for professional use incorporate various refinements. These are gradually penetrating into the better class of domestic receiver, especially those designed for serious listening on the short-wave bands.

To receive Morse (or c.w.), the detector is equipped with an additional oscillator which operates at a frequency close enough to the i.f. to produce audible beat tones with an incoming carrier (which has been changed to the i.f. in the mixer, of course). This is called a b.f.o. (beat frequency oscillator). There may be several i.f. filters, with different bandwidths. The user selects whichever is appropriate to the type of signal: narrow for c.w., wide for speech, wider for music.

SINGLE-SIDEBAND

To economise in bandwidth and transmitter power, commercial and amateur radio telephony (speech) signals are often sent as single-sideband (s.s.b.) transmissions. In these, the carrier and all the side frequencies on one side of it are suppressed. Only the remaining sideband, for example, above the carrier frequency, is transmitted.

All the a.m. programme information is still contained in this remaining sideband, which can be selected by a sharp i.f. filter (for example, 4kHz wide). To detect it, the missing carrier has to be supplied, and this is done by setting the b.f.o. to the exact i.f. and mixing this b.f.o. and the single-sideband signal in the receiver's detector, which for this purpose is often a special kind called a "product detector", rather than a simple diode.

The frequency of an LC oscillator is affected by temperature changes and can "drift" seriously in a short-wave receiver. To avoid this, high-class receivers nowadays often use a frequency synthesiser instead. Quartz crystal oscillators (which are much more stable than LC ones) generate basic frequencies which are multiplied or divided to yield the wanted local oscillator frequency.

AERIALS

Short-wave receivers seldom use loop aerials. Instead some form of wire or metal-rod aerial is used. This responds to the electric field of the radio wave. All radio waves are made up of moving electric and magnetic fields. The electric field is the "voltage" part of the wave and the magnetic field the "current" part.

If the transmitting aerial is vertical the electric field is also vertical and the transmission is said to be "vertically polarised". To receive it the receiving aerial should also be vertical. Transmissions may be polarised vertically, horizontally or circularly, which is a mixture of the former two.

Have fun with your receiver. Next month we'll take a brief look at some digital circuits which can sometimes be used for other purposes, and ponder over the philosophy of designing things.

Next Month: Non-linear Circuitry

LETTERS

Positive Approach

Sir—I took up electronics as a hobby on my retirement and being an OAP I think my intelligence is not what it used to be. I can never continue learning unless I have mastered the basics.

I can understand the biasing *npn* transistors with a positive voltage shunted from the positive rail, but in Experiment 4.4, Fig. 4.10, page 34, January '84, you are, apparently biasing TR1 from the negative rail feeding emitter of TR2. Why?

I have another blockage. This is, the feeding of a positive voltage from an *npn* collector through a capacitor! Now I always understood that if one plate of a capacitor is positive the other plate is negative, therefore I fail to see how the negative plate of a capacitor can "turn-on" an *npn* transistor?

I am truly "hooked" on electronics so if I am going to progress further I do need to understand these two problems.

I would certainly appreciate the answers and thank you sincerely in anticipation.

A. Waddington,
Dagenham,
Essex.

Dear Mr. Waddington—Your first problem is really about the direction in which current flows between one point in a circuit and another. It is often difficult to visualise this just by looking at a circuit, because there often seems to be alternative routes for a current.

What is needed is a handy rule which will enable the direction of flow to be deduced. Here it is, and to illustrate it I'll use the network of resistance in Fig. 1. The problem is, which way does current go through resistance C? Does it go from X to Y or from Y to X?

To find out, disconnect C. The circuit now reduces to two parallel paths across the battery. Current flows via A and B or via D and E.

If the voltage at X is measured with respect to battery negative it has some value less than the full battery voltage. Suppose it is 5V. Similarly, there is some voltage at Y. Suppose this is 3V. Both these voltages are positive, but the voltage at X is more positive by 2V.

Since current always tries to flow from more positive points to less positive points current here will try to flow from X to Y. So if C is now reconnected current flows from its X end to its Y end. There is no easy way to tell how much current but at least we know the direction.

In the kind of circuit you ask about (Fig. 2), disconnect R1. This removes base bias from TR1 which ceases to conduct. But TR2 still receives base current via R2 which causes collector current to flow via R3.

Both these currents flow down to battery negative (−V) through R4 as shown. Therefore point X must be more positive than point Y which is battery −V. If R1 is reconnected current must flow from X to Y via R1 and the base-emitter junction of TR1. Thus TR1 is turned on as required.

Similar considerations apply to your second problem (Fig. 3). It is true that in npn amplifiers the "collector" plate X of an inter-stage coupling capacitor is usually more positive than the "base" plate, Y. But this does not prevent the base from being more positive than the emitter.

To give typical examples, in a 9V operated circuit the "collector" plate may be at 4V and the "base" plate at 0·7V. As far as the capacitor is concerned it carries a charge of 3·3V. But as far as the second transistor is concerned its base is at +0·7V compared with its emitter.

This +0·7V does not come from the capacitor. It comes from a d.c. bias arrangement such as a resistance between collector and base. The capacitor merely passes on small alternating currents (a.c.) which momentarily make the base more positive or less positive and so modulate the second transistor's collector current at signal frequency.

I hope you continue to enjoy electronics with the help of "EE".—George Hylton.

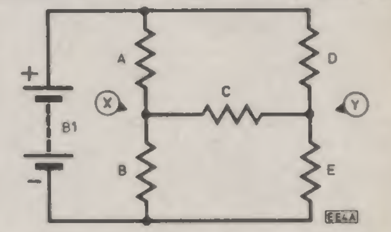


Fig. 1

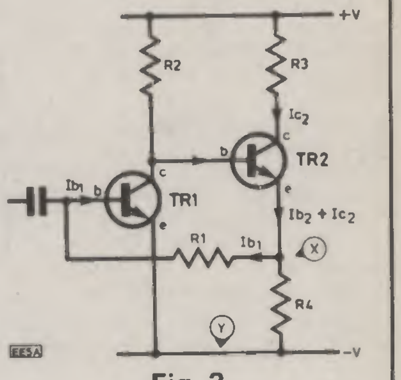


Fig. 2

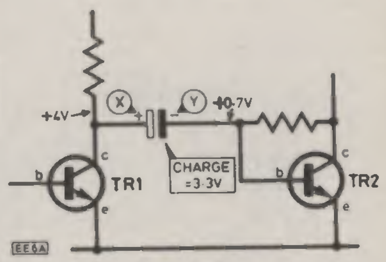


Fig. 3

MICROCOMPUTER INTERFACING TECHNIQUES

INCLUDING MANY USEFUL CONSTRUCTIONAL PROJECTS

PART TWELVE: SPEECH SYNTHESIS

BY J. ADAMS B.Sc., M.Sc. & G.M. FEATHER B.Sc.

IT IS no longer appropriate to remark that the power of speech allows man to be differentiated from the lower forms of life and mere machines. The wide range of products with speech enhancement, such as the BL Maestro, is indicative of the rapid advances in this exciting field.

The advent of the microprocessor together with the rapid appearance of various speech synthesisers have certainly enhanced the capability of machines to reproduce or create the human voice.

REPRODUCTION OF SPEECH

The very complex waveforms with frequencies ranging from 15kHz down to about 10Hz which make up speech can be faithfully reproduced using the technique of waveform digitisation.

One of the simplest methods is to feed the continuously varying electrical signals obtained from a microphone into a high-speed analogue-to-digital converter (such as that described in Part 3 of this series, Sept 83). The translated digitised waveform is then stored as a series of binary numbers in contiguous memory locations within the address space of the microcomputer.

This digital representation of the sound can be recovered when required and passed through a digital-to-analogue converter (such as that described in Part 4 of this series, Oct 83), so that the resulting recovered analogue electrical signal can be fed via an amplifier to a loudspeaker to reproduce the original sound.

The remarkable fidelity it is possible to obtain using such techniques is exemplified by digital music recordings.

This method of reproduction is shown diagrammatically in Fig. 12.1.

However, there are some drawbacks to the use of this approach. Word generators of this type are by their very nature highly uneconomical in memory usage. This is a direct consequence of the high sampling rate necessary to capture every nuance of the uttered word. Fortunately, such sampling rates (exceeding 70,000 bytes per second) are not essential to produce speech which is both acceptable and understandable, as readers who have used a telephone should realise.

Although quite drastic reductions in memory usage can be achieved by discarding redundant information, the word generator approach, if it is not to sound too unnatural, still requires in the order of 3,000 bytes of memory to store a single second of speech.

PITCH

Another disadvantage is that human speech has many subtle stresses, inflections, intonations, pitch changes and breathing spaces to form its complex structure. For example, the question "Now?" sounds very different to the emphatic "NOW!".

Although humans soon learn to lower or raise the pitch of voice at will, the words in a word generator tend to be somewhat neutral entities and are hence rather robot-like.

In addition, this approach causes a further hindrance as it makes it more difficult to modify programs. This is a result of the scope of a particular program being limited to the specific block of vocabulary available to it.

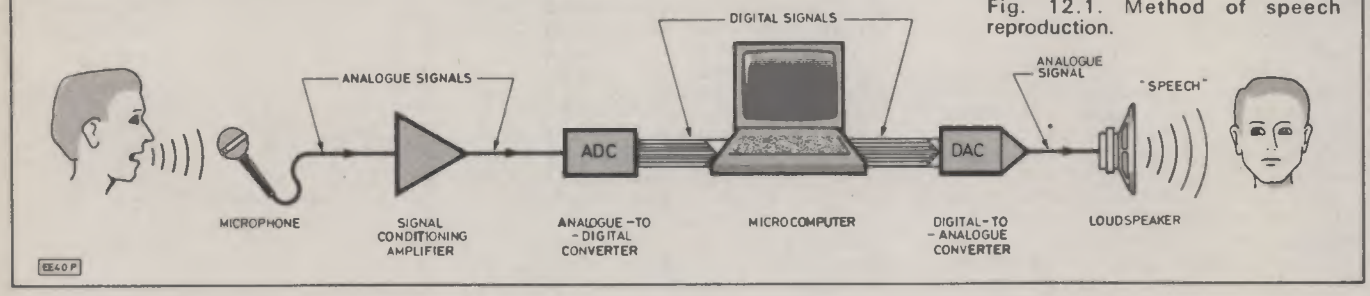


Fig. 12.1. Method of speech reproduction.

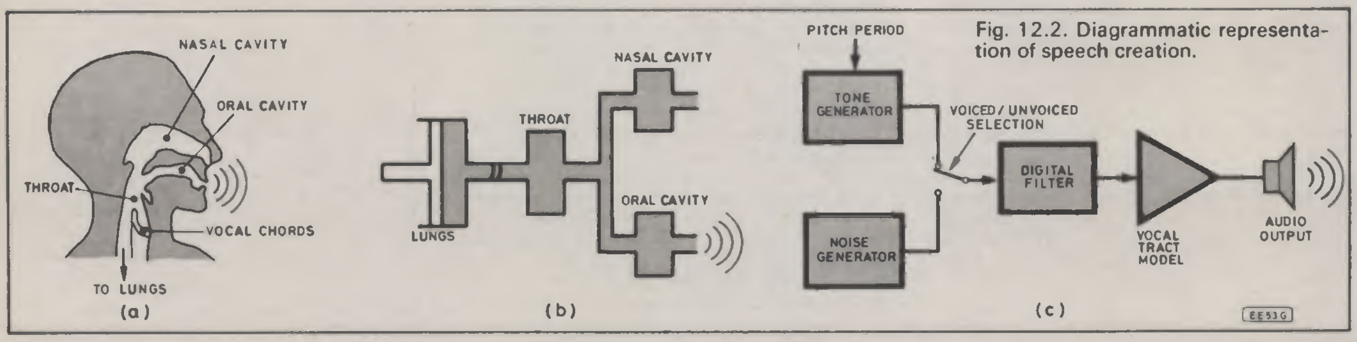


Fig. 12.2. Diagrammatic representation of speech creation.

CREATION OF SPEECH

Another approach to the problem involves creation of the appropriate sound by the electronic modelling of the human vocal tract.

As "voiced" speech originates from the vibration of the vocal chords, the rate of such vibration determines the pitch of the sound. "Unvoiced" sounds—those without pitch such as "s"—are produced by the face, teeth, tongue and lips.

Other structures like the oral and nasal cavities are also essential as they act as resonating chambers and give the voice its human and individual quality. This is shown in diagrammatic form in Fig. 12.2.

The voiced/unvoiced switch determines whether a tone generator or a noise generator is used as the sound source. The derived signal is fed into a digital filter which acts as a model for the vocal tract. The output is then amplified before the appropriate audio signal is produced.

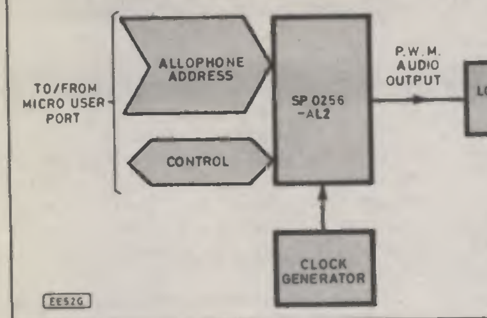


Fig. 12.3. Block diagram for the speech synthesiser system.

THE SP0256 SPEECH PROCESSOR

This month's constructional project employs the General Instruments SP0256 speech processor. The chip is extremely complex in its internal circuitry and includes a 16K ROM for storage, a 12-pole digital filter and a pulse width modulator. The actual generation of the coefficients for the filter that models the vocal tract is complicated, but the implementation of the system is a great deal easier. A block diagram of the speech system is shown in Fig. 12.3.

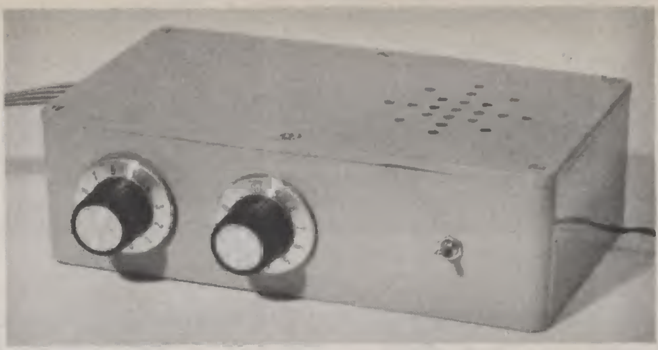
In essence, the SP0256 is based on an "allophone" system which allows the user to select individual speech sounds and string these together to fabricate words.

The SP0256 has an allophonic set, which is an inventory of 64 simple English speech sounds and is shown in Table 12.1. This system provides an unlimited vocabulary, since the stored units correspond to sounds, not words. The emphasis in this approach shifts to the programmer to select the appropriate sounds to represent the word.

Table 12.1. Complete List of Allophones, their Addresses and Sample Words.

Allophone	Decimal Value	Sample Word
AA	24	gOt
AE	26	bAt
AO	23	sOng
AR	59	hARm
AW	32	mOUth
AX	15	sUcceed
AY	6	skY
BB1	25	buBBle
BB2	63	Bat
CH	50	ditCH
DD1	21	neeD
DD2	33	Do
DH1	18	faTHer
DH2	54	THey
EH	7	lEft
EL	62	angLE
ER1	51	bettER
ER2	52	tURn
EY	20	bAY
FF	40	Fort
GG1	36	Guess
GG2	61	Glass
GG3	34	biG
HH1	27	Hem
HH2	57	Hoe
IH	12	thIs
IY	19	spEEch
JH	10	Jumbo
KK1	42	Computer
KK2	41	WalKing
KK3	8	Comb
LL	45	Lake

Allophone	Decimal Value	Sample Word
MM	16	Mask
NG	44	writiNG
NN1	11	biN
NN2	56	Now
OR	58	cORe
OW	53	allOphone
OY	5	jOY
PA1	0	10 ms pause
PA2	1	30 ms pause
PA3	2	50 ms pause
PA4	3	100 ms pause
PA5	4	200 ms pause
PP	9	Pig
RR1	14	Rug
RR2	39	dRain
SH	37	SHip
SS	55	weSt
TH	29	THick
TT1	17	biT
TT2	13	To
UH	30	fUll
UW1	22	compUter
UW2	31	fOOd
VV	35	Vessel
WH	48	While
WW	46	Wool
XR	47	bEAr
YR	60	fEAr
YY1	49	You
YY2	25	Yes
Zh	38	aZure
ZZ	43	Zoo



SPEECH SYNTHESISER

CIRCUIT DESCRIPTION

The block diagram of the system is given in Fig. 12.3. The SP0256 chip requires clock pulses at a frequency of about 3·2MHz and whilst internal circuitry can be used to develop these, in this application an external CMOS clock is used.

The pulse width modulated audio output signal from the SP0256 is processed by a low-pass filter network so as to develop a low-level analogue audio signal. This is amplified by an audio amplifier integrated circuit.

For a more detailed analysis of the circuitry, the reader should refer to Fig. 12.4, which shows the complete circuit diagram of the speech synthesiser.

Pins 13 to 18 of the SP0256 (IC1) are the phoneme address lines of the device and these are controlled by the micro user port lines P0 to P5. Pin 20 requires a negative pulse to load the phoneme address on P0–P5 in the device. This is derived from user port line P6. Pin 8 is the "busy" output from the SP0256 and this is read by user port line P7.

The SP0256 is a CMOS device and resistors R1 to R8 are included in the circuit to protect the inputs when the board is not in use.

The clock circuitry is based around IC2, a 4011 CMOS quad 2-input NAND gate package which, in this application, is wired as an astable multivibrator operating at the required frequency of about 3·2MHz. Only two of the four gates are used. VR1 provides a measure of frequency adjustment and hence voice pitch control.

Pins 2 and 25 require a $\overline{\text{RESET}}$ input and the R9/C1 combination provides this at switch on.

Pin 24 is the audio output and requires a load resistor; R10 is used here.

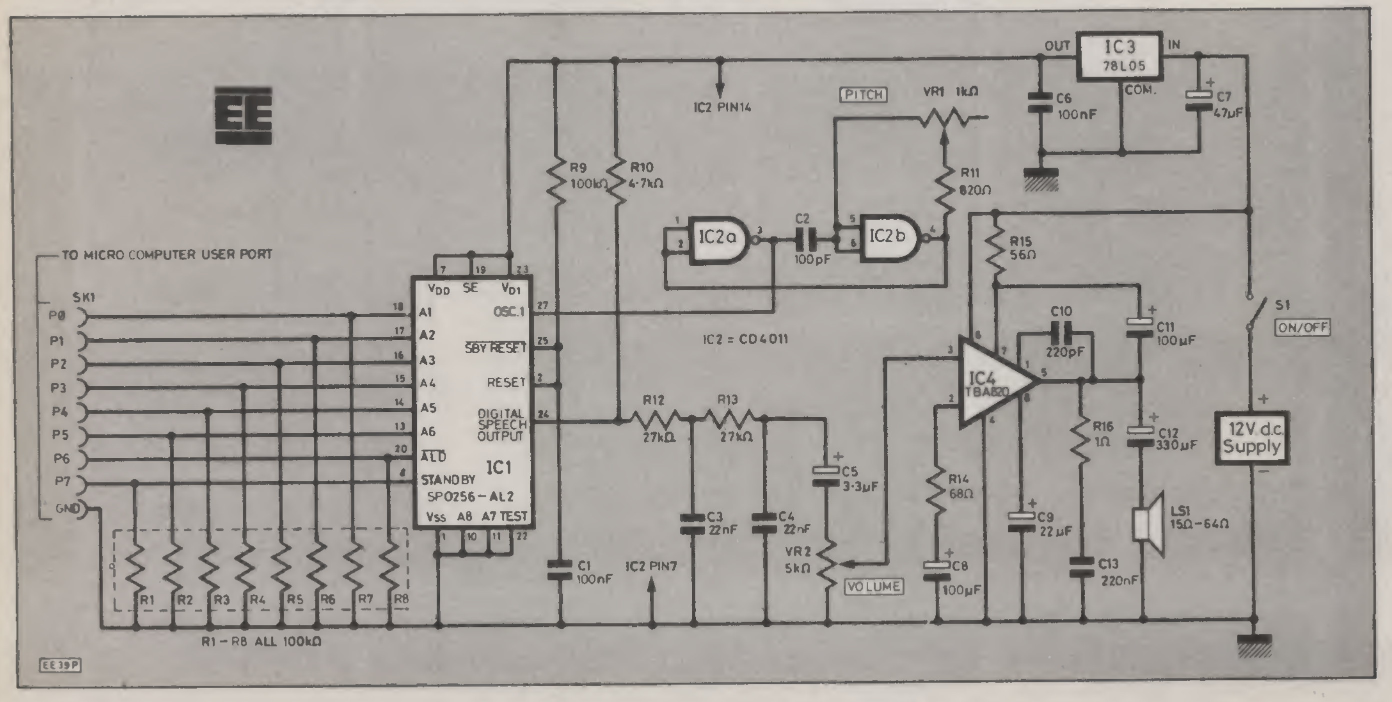
The $+V_{cc}$ supply for these sections of the circuitry is set at +5V, this being provided by IC3, a 78LO5 voltage regulator. Capacitors C6 and C7 provide adequate h.f. and l.f. decoupling for this supply.

The pulse width modulated output from IC1 is taken to the passive low-pass filter network of R12/C3/R13/C4 which centres on a frequency of about 4·5kHz.

AUDIO OUTPUT

The integrated circuit IC4 is the audio amplifier section and the arrangement of components here is quite conventional for this device. It is operated at a supply voltage of +12V and, under this condition, can deliver approximately 1·5W into a 16Ω loudspeaker. The loudspeaker employed in the prototype has an impedance of 64Ω and provides adequate volume.

Fig. 12.4. Complete circuit diagram for the Speech Synthesiser. The power supply is external to the completed unit.



CONSTRUCTION

CIRCUIT BOARD

The majority of the components seen in the circuit diagram are mounted on a single printed circuit board, size 120mm × 86mm. The track pattern to be etched on the board underside is shown actual size in Fig. 12.5. This p.c. board is available from the *EE PCB Service*, Order code 8406–03.

The completed board is fitted to the base of the case using a single 15mm long 3mm fixing with a sandwich of self-adhesive foam between the board underside and case.

The layout of the components on the board topside is shown in Fig. 12.6. Constructors are advised to use i.c. sockets for the d.i.l. i.c.s, in particular IC1 and IC2, both CMOS devices. These devices should be minimally handled during assembly and the usual precautions observed when handling is necessary.

Fit the components to the board as shown but do not insert IC1 and IC2 in their sockets until later. Pay attention to component polarities and note that with the s.i.l. resistor package the "spot" marked is alongside the commoned connection.

ASSEMBLY

Constructors will find wiring-up much easier if Veropins are used for cable and wire connections to the board.

A slot will need to be made in the case to accommodate the ribbon cable exit from the case. Next, prepare the case to accept the case mounted components and any exit holes for wires, and then secure these items in place. Fit the assembled p.c.b. in its position in the case as shown in the photographs and interwire as shown in Fig. 12.6. Connection details for the user ports of the four micros considered in this series can be found in Part 1 of the series, *EE* July 83.

When all interwiring is complete, the two CMOS i.c.s should be mounted in their sockets on the board, paying special attention to orientation of these devices.

It only remains for the control knobs to be fitted and the lid of the case to be secured to complete the project. Four self-adhesive rubber feet fitted to the case base will prevent the unit sliding around in use as well as enhancing its appearance.

COMPONENTS

See Shop Talk page 371

Resistors

R1–R8	8-commoned 100kΩ (9-pin s.i.l.)
R9	100kΩ
R10	4·7kΩ
R11	820Ω
R12	27kΩ
R13	27kΩ
R14	68Ω
R15	56Ω
R16	1Ω

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

Capacitors

C1	100nF
C2	100pF
C3	22nF
C4	22nF
C5	3·3μF 10V elect.
C6	100nF
C7	47μF 16V elect.
C8	100μF 16V elect.
C9	22μF 16V elect.
C10	220pF
C11	100μF 16V elect.
C12	330μF 16V elect.
C13	220nF

COMPONENTS approximate cost £25

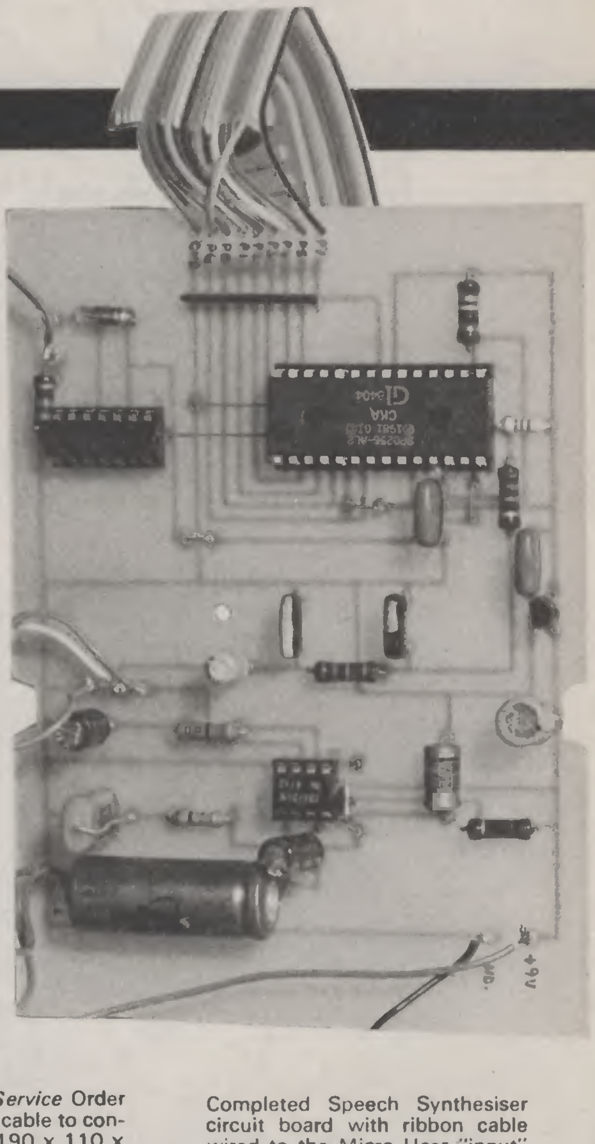
Semiconductors

IC1	SP0256-AL2 speech processor (28-pin d.i.l.)
IC2	CD4011 CMOS quad 2-input NAND gate
IC3	78L05 +5V 100mA monolithic voltage regulator
IC4	TBA820 monolithic audio power amplifier i.c.

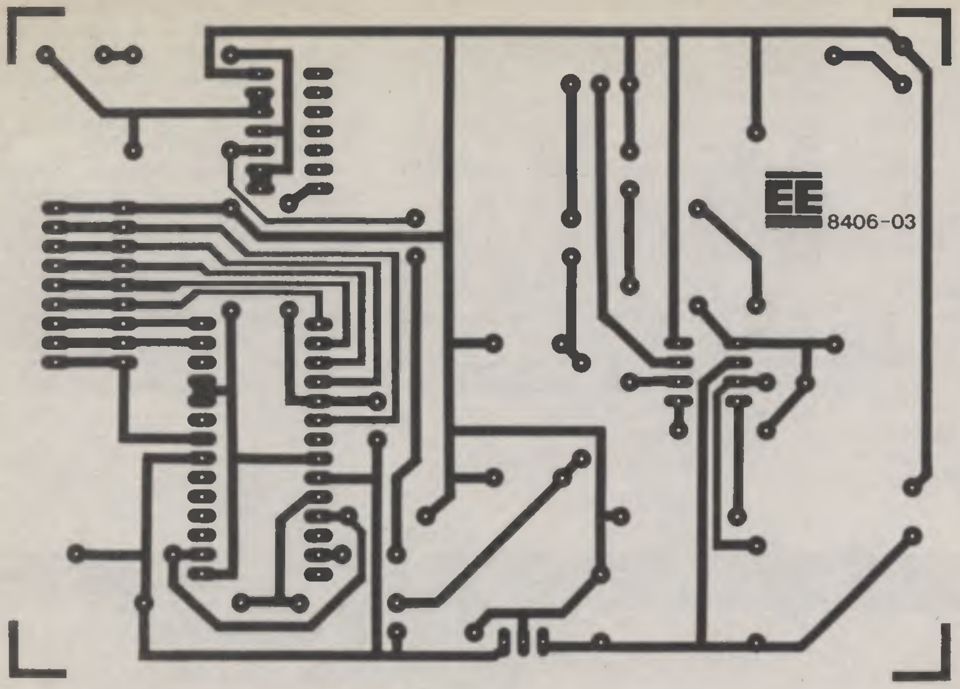
Miscellaneous

VR1	1kΩ carbon lin. law potentiometer
VR2	5kΩ carbon log. law potentiometer
S1	miniature on/off toggle
LS1	miniature loudspeaker coil impedance 15 to 64 ohms
SK1 or PL1	socket or plug to suit the particular Micro User Port

Printed circuit board: single-sided size 120 × 86mm, *EE PCB Service* Order code 8406-03; d.i.l. sockets 1 off each 8-pin, 14-pin, 28-pin; ribbon cable to connect unit to micro, length and no. of ways to suit; case, plastic size 190 × 110 × 60mm; single-sided Veropins (18 off); control knobs for potentiometers (2 off); self-adhesive rubber feet (4 off); 15mm long 3mm fixings to secure board to case; self-adhesive foam rubber strip to sit under p.c.b.; lengths of hook-up wire to connect to external power supply.



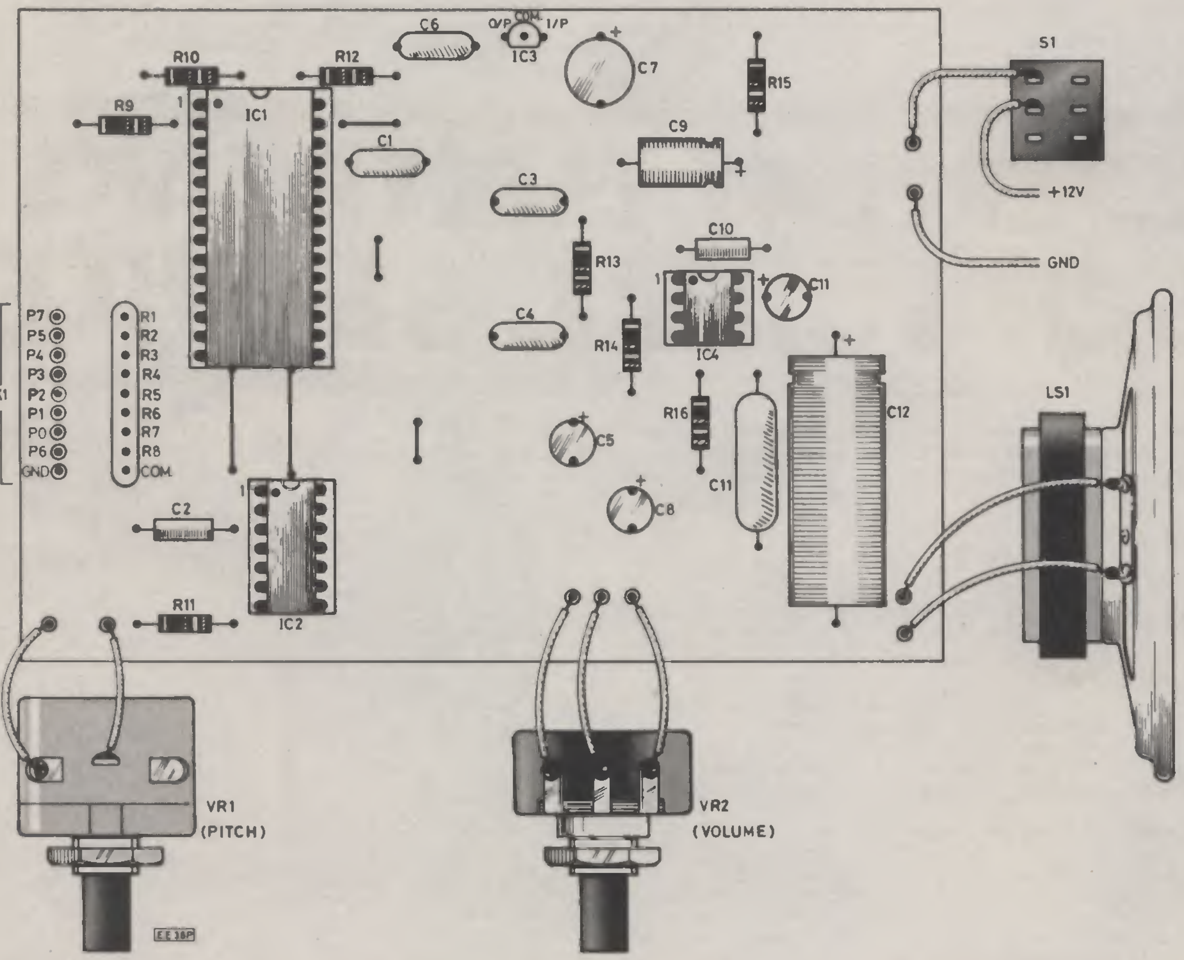
Completed Speech Synthesiser circuit board with ribbon cable wired to the Micro User "input" Veropins.

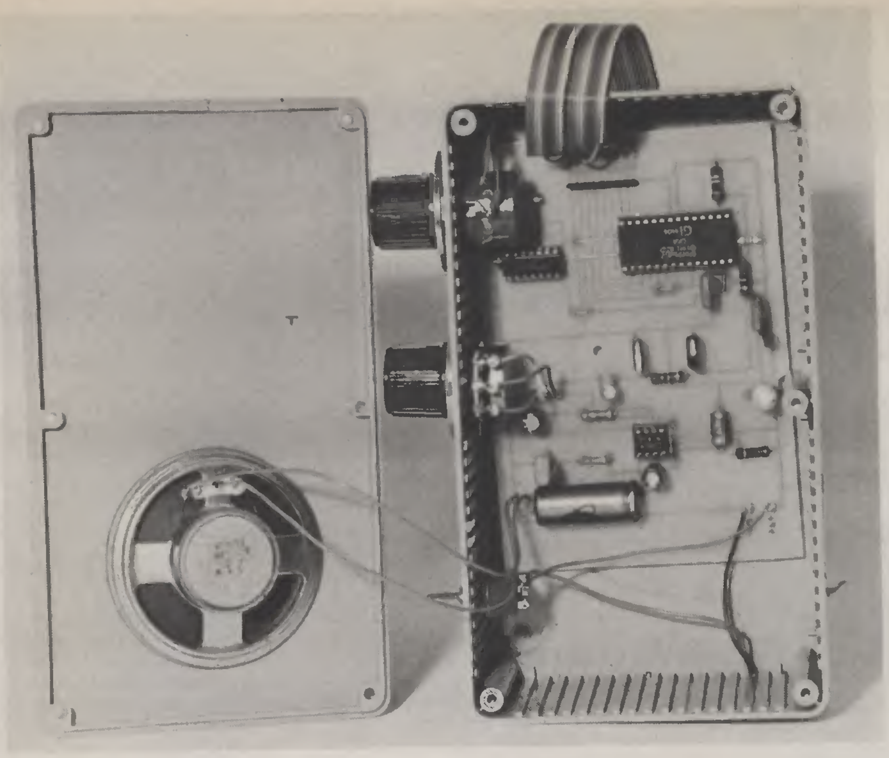


SPEECH
SYNTHESISER

Fig. 12.5 (left). Actual-size master pattern for the Speech Synthesiser. This board is available from the *EE PCB Service,* Order code 8406–03.

Fig. 12.6 (below). Layout of components on the top-side of the Speech Synthesiser board and interwiring to case mounted components. Check that all links (5 off) are wired on the board.





The completed Speech Synthesiser model with cover removed to show positioning of circuit board and control potentiometers. The speaker is mounted on the rear of the lid of the case.

Some constructors may wish to incorporate a suitable connector to the unit to allow the external power supply to be simply plugged in. A larger case will be required if a power supply is fitted inside. This could be battery or mains derived.

SOFTWARE

The software to run the speech processor using the BBC Model B, PET, VIC-20 and Commodore 64 uses some of the simple input/output techniques covered in detail in this series of articles.

The code selecting the appropriate allophone is placed on user port lines P0–P5 configured for output by the data direction register.

User port line P6 is also configured to be an output line as it is used as a "handshake" line to load the data into the speech device. This is accomplished by taking this line "low".

User port line P7 must be configured as an input line as it acts as an input "handshake" which will go "low" on a true acknowledge from the speech processor.

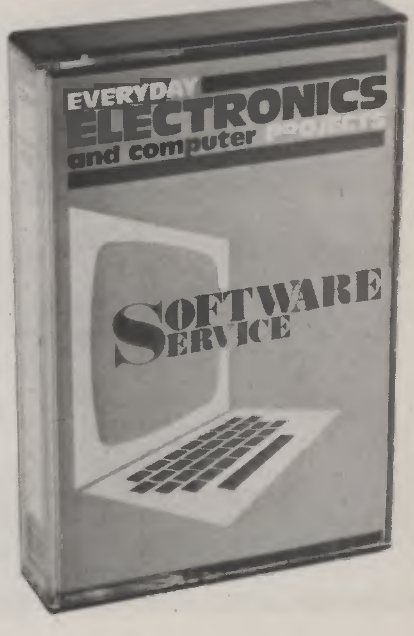
This process is repeated for other allophones and the speech created by concatenating the allophonic sounds. □

Next month starts a new series "Anatomy of Your Micro"
See page 399 for details

EVERYDAY ELECTRONICS SOFTWARE SERVICE

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

All prices include VAT, postage and packing. Remittances should be sent to Everyday Electronics Software Service, Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG.. Cheques should be crossed and made payable to IPC Magazines Ltd.



PROJECT TITLE	CASSETTE CODE	CASSETTE COST	LISTING CODE	LISTING COST
ZX81 SPEED COMPUTING SYSTEM (Feb 83)	T001	£2.95	L001	£2.95
REAL-TIME CLOCK (*Apple II*) (May 83)	T002	£2.95	L002	£2.95
REAL-TIME CLOCK (*BBC Micro*) (May 83)	T003	£2.95	L003	£2.95
EPROM PROGRAMMER (*TRS-80 & GENIE*) (June 83)*	T004	£3.95	N/A	—
STORAGE 'SCOPE INTERFACE (*BBC Micro*) (Aug 83)	T005	£2.95	—	
ELECTRO-CARDIOGRAPH (*BBC Micro*) (Jan 84)	T006	£2·95	—	—
EPROM PROGRAMMER/ROM CARD (*ZX81*)** (Feb 84)	T007	£3.95	—	—

*Includes Command List with examples.
**Includes Keyboard Overlay.

EVERYDAY news ... from the world of

LEVELLING THE LOAD

Telemetering and Control of Domestic Electricity Supplies

A microchip-based metering system for domestic electricity supplies is currently undergoing field trials in three hundred homes located in three areas: Broadwood, near Guildford (South Eastern Electricity Board); Ilkeston, near Derby (East Midlands Electricity Board), and Kingswinford, near Dudley (Midlands Electricity Board).

Developed by South Eastern Electricity (SEEBOARD) engineers, the system involves a Credit and Load Management Unit (CALMU) which is installed adjacent to the existing electricity supply meter, plus a Touch Panel Unit for the customer's use. The latter is fitted in a convenient place, usually in the kitchen, and at a touch of a key provides a readout of the total consumption to date, or separate consumption figures for the three different circuits available.

The current tariff rate for each circuit can be instantly displayed, also the hours during which these particular tariffs operate, and the amount of the electricity account to date. Finally, the touch of another key displays the time.

Gas and Water Metering

This does not exhaust all the possible uses for the customer's touch panel, since other keys are available for allotment to gas and water supplies. The linking-in of these two additional services is seen as a realistic extension of the system in the near future and the gas and water authorities are collaborating with the Electricity Boards in this major development.

To the consumer, the main attraction of this system lies in the ability to monitor the electricity consumption at any time and to be selective in the use of the three circuits during different periods of the day, thus purchasing electricity at the most economical rate.

Information from the CALMU is fed by normal telephone line to the Area Board main computer. Eventually it is expected that billing of customers will be automatically performed through this remote reading of customers' meters. But the Electricity Board Authorities stress that the demise of the visiting meter reader is unlikely to happen for a considerable time to come.

Radio Switching

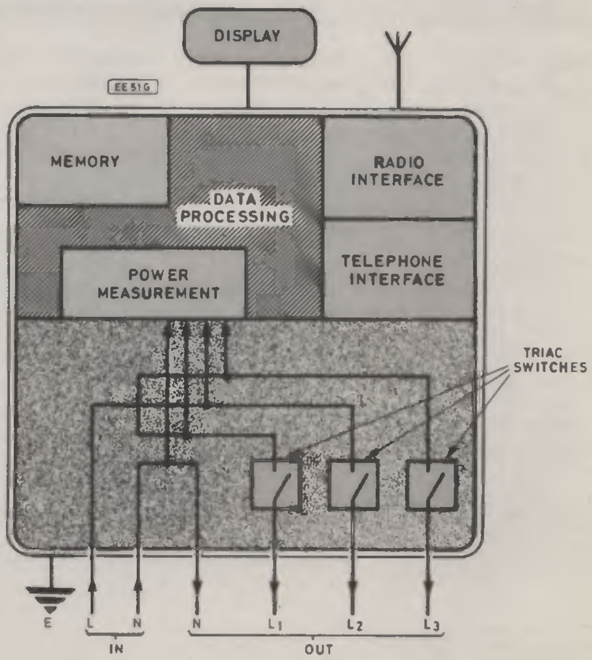
The information fed to the Area Boards will enable the supply authorities to keep a close watch on consumption trends. By monitoring actual demand and perhaps also by anticipating an imminent rise in demand through the interpretation of other information such as weather forecasts or TV programmes, it will be possible to selectively switch off the supply to one power circuit for say 15 minutes or maybe half an hour, thus avoiding the need to bring into operation stand-by power stations which are expensive to run for short periods.

Consumers would not suffer in any marked degree by these short

(above left). A CALMU "touch" control panel installed in the home.

(below left). A SEEBOARD electrician installing a CALMU unit.

(below). Block diagram of the arrangement of the Credit and Load Management Unit or CALMU.



interruptions in supply to fires and immersion heaters because of the inherent thermal time lag associated with such appliances. The same would apply to gas or oil-fired central heating systems run with the aid of an electric pump.

The selective remote switching is performed by a signal transmitted on the *BBC Radio 4* carrier and is picked up by a receiver incorporated in the CALMU.

Visiting homes where the system is installed, EVERYDAY ELECTRONICS was impressed by the neat and unobtrusive installation and also by the housewives' ready acceptance of the touch panel. A number of customers claimed to have already reduced their electricity bills through careful monitoring of consumption. Although in one house direct comparison of watts consumed as recorded by the conventional meter and the CALMU suggested that new ideas do not come entirely free of cost!

It was explained that the higher reading on the CALMU was a short-term phenomenon due to the instant response of the electronic metering. Over a period the accumulative reading was likely to agree closely with that of the more sluggish conventional meter. In any event, SEEBOARD informed us that during these field trials the customer will be charged for each quarter according to the *lowest* of the two readings.

Tariffs

The use of this micro-based electronic metering system permits a wider range of tariffs to be introduced; this is, of course, dependent upon separate mains circuits within the home. The customer is free to choose which piece of equipment to connect to which circuit.

The three circuits available are:

1. Continuous and normal cost;
2. With short interruptions at medium cost;
3. Night rate at lower cost.

An essential partner in this system is British Telecom who provide the necessary exchange switching functions to link up with the Area Boards' monitoring and computing equipment. The system is, of course, applicable only to telephone subscribers.

The CALMU equipment has been manufactured by Mullard under licence for the Electricity Boards.

ACORN GROWS UP

The Acorn BBC Microcomputer can now become a professional drawing tool with the help of a new graphics system from Acorn Computers Ltd.

Called "Acorn Bitstik", the new peripheral uses the increased power and speed of the new 6502 Second-Processor.

The heart of the system is the Bitstik itself, a 3-axis joystick (rotation and *X–Y*) with three push buttons. The buttons select functions from screen menus making the Bitstik completely independent of the host BBC Micro.

The complex graphics software for the Bitstik is held on a special ROM chip that plugs into the Micro. The system master utilities are provided on an 80-track floppy disc, and a second disc acts as a drawing "buffer".

The Acorn Bitstik System, including joystick, ROM, utility discs and user guide, costs £375 incl. VAT.

Radio Micro

We are writing to inform you of a new Radio Amateur Micro User group that has just been formed for radio amateurs who use their microcomputers within the hobby. It is primarily for owners of the BBC MICRO, although other types may be supported if demand is apparent.

Contact: R. A. Webb, 39 Aldworth Road, Stratford, London, E15 4DN.

The world's first high powered laser circuit pattern writing equipment for large-scale integration (LSI) chips has been developed jointly by Mitsubishi Electric and Tokyo Electron Co. of Japan.

Airborne Computers

Eastern Airlines, which forbade the use of portable computers on their commercial flights in 1983, has had a change of heart and will now allow their use, except during take-off and landing.

Originally, they had feared that possible r.f. emissions from portable personal computers might interfere with the navigational systems in the cockpit.

They have also approved the use of electronic games, calculators and portable recorders.

Radio-controlled toys, walkie-talkies, portable telephones, radios and televisions are still "grounded".

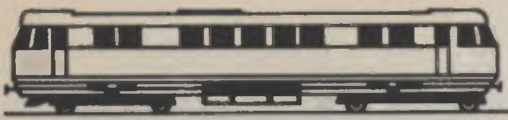
A NEW EINSTEIN

Relatively speaking, it would appear that Tatung (UK) have got most of their sums right with their very latest Einstein Home/Small Business Computer.

They have taken the well tried and tested Z80A 8-bit microprocessor; the Texas TMS9129 display processor chip; the Teac FD30A "super-silent" 3-inch compact floppy disc drive; the GI AY-308910 sound chip; Tatung/Crystal Basic (developed by Crystal Research); added a full QWERTY typewriter keyboard and come up with a British designed and manufactured machine that will compete with the best.

When all this is added together you end up with a machine for £499 that features: a built-in disc drive using 3-inch floppy discs with 500K bytes total (250 per side); a 64K RAM user memory with an additional separate 16K RAM for graphics; full typewriter style keyboard, wide language range. Other built-in features, available at rear sockets, are: RS232-C port; 4-channel A-to-D Converter; external disc drive, for two drives; Tatung pipe and a Centronics parallel printer port.

The colour monitor will add an extra £250 to the cost.



TRAIN WAIT

BY C. J. BOWES

MANY model railway enthusiasts like to add a certain amount of automation to their layouts. This enables them to set part of the track to semi-automatic operation, whilst giving fuller attention to more complex operations in other areas of the layout.

The Train Wait provides such automation and, although it was designed to halt a train in a station for a short while, has many other applications including halting a train whilst another goes over a crossing, halting a train in a tunnel to give an impression of added track length and making a train run continuously up and down a section of track.

The unit uses a relay with all its contacts brought out to a terminal block as the control device. This enables it to be versatile and work correctly, irrespective of the nature and polarity of the supply to the track.

CIRCUIT DESCRIPTION

The circuit of the Train Wait is shown in Fig. 1. It is intended that the power for the unit will be derived from the 12V a.c. supply provided at most controllers for the connection of ancillary units such as point motors.

The circuit incorporates a suitable bridge rectifier (D1-4) and smoothing capacitors (C1 and C2). The power supply, which is of conventional design delivers approximately 15V across the power supply rails to drive the circuitry of the unit.

TRIGGER

The sensor which detects the presence of the train is a normally open reed switch, S2. This is buried in the ballasting of the track and is operated by magnets placed on the undersides of selected locomotives. This enables only certain trains to operate the system so that, for instance a slow passenger train could be made to halt whilst a goods train or passenger express would not.

Operation of the reed switch by a magnet, causes it to close. This short circuit grounds the junction of R1 and R2 with R3 and causes the voltage present at this point to fall from nearly that of the positive power rail, to 0V.

This is used to trigger the pulse generating circuit described below, and this in turn triggers a 555 timer circuit, which provides the required time delay.

PULSE GENERATOR

One of the design requirements associated with the use of 555 timer circuits in applications like this is that the trigger input of the 555 timer *must* return to the same voltage as that of the power supply line before the period of time set by the delay components has elapsed. In this design, the locomotive will stop over the reed switch and thus its use to directly trigger the 555 timer circuit is ruled out.

To overcome this problem, use is made of a triggering circuit which converts the continuous nature of the actuated reed switch to a single, negative-going pulse, which is of a shorter duration than the minimum delay time. This operation is achieved with the use of three NAND gates (IC1a, IC1b and IC1c) and their associated components. Timing details of this circuit are shown in Fig. 2.

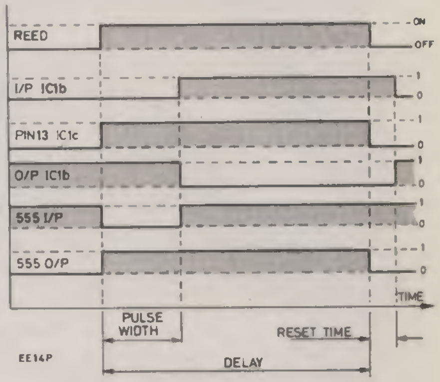


Fig. 2. Timing diagram.

When the reed switch is open, the voltage at the junctions of R2 and R3 is at almost the same potential as that of the power supply positive rail. This falls to 0V as soon as the reed switch is operated by the train magnet. The inputs of IC1a are connected together to form an inverter and the change in input voltage causes the gate output to switch from logic 1 to logic 0.

The input of IC1b is connected across capacitor C3 and as this capacitor is as yet uncharged, the output of the inverter remains at logic 1. The outputs of

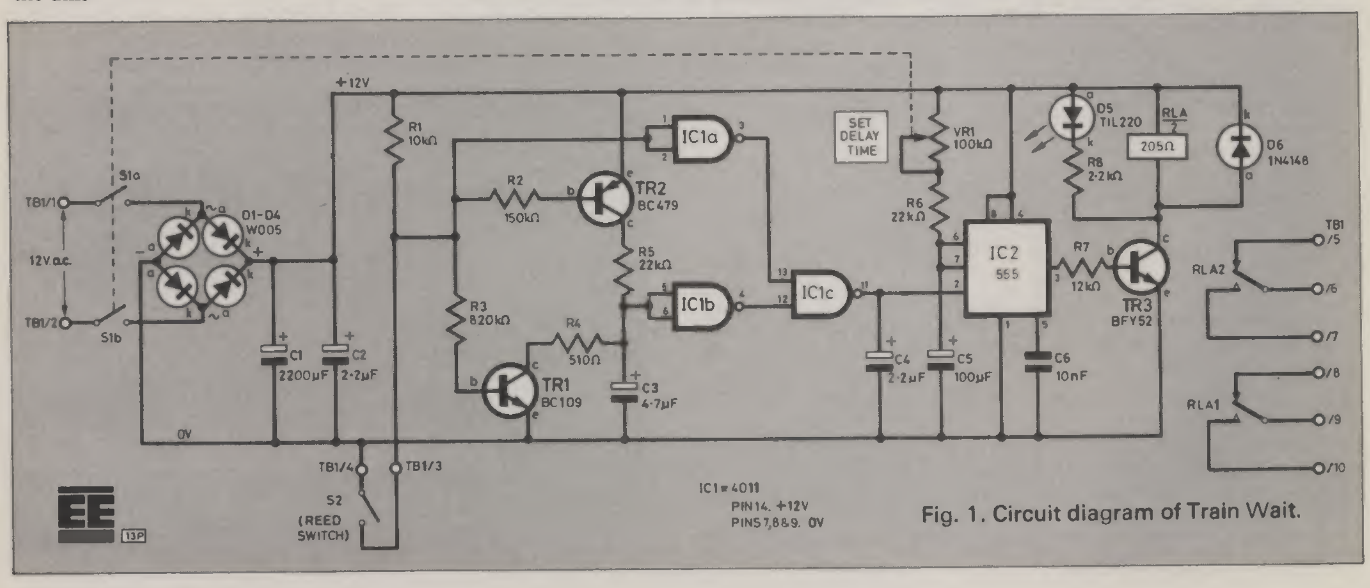


Fig. 1. Circuit diagram of Train Wait.

the gates of IC1a and IC1b are combined by IC1c which is connected as a standard NAND gate.

With the reed switch unoperated (open), the output from this gate is at logic 1 but as soon as the output from IC1a changes from logic 1 to logic 0 on the operation of the reed switch, the output from IC1c switches from logic 1 to logic 0. This starts a negative-going pulse which is used to trigger the 555 timer.

When the reed switch, S2, is closed the voltage change at the junction of R1 and R2 causes the voltage present at this point to be approximately −15V with respect to the emitter of TR2. R2 causes the voltage present at the base of TR2 to be approximately −0·7V with respect to its emitter. This transistor conducts and the resulting current flow through TR1 charges capacitor C3 through R5.

When the voltage present at the positive side of C3 exceeds the switching voltage of IC1b (typically half the power supply voltage), the output of the gate switches from logic 1 to logic 0. This causes the output of IC1c to switch from logic 0 to logic 1, thus returning the voltage at the trigger connection of IC2 to the power supply voltage.

The base of TR1 is connected via R3 to the switched end of R1 so that when the reed switch is not activated by a train magnet, the transistor conducts and the capacitor is discharged through R4. This ensures that the system is ready for retriggering very shortly after a locomotive has moved away. The duration of the negative-going pulse produced by this circuit is determined by the time constant of R5 and C3. With the values given, a pulse of approximately half a second is produced. This is significantly shorter than the minimum time for which the output of the 555 timer is likely to be required to be active.

DELAY

The train is stopped by a relay driven by a 555 timer connected as a monostable. The circuit used is standard and utilises a timing circuit composed of VR1, R6 and C5. The time delay produced by the circuit can be calculated from the formula:

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

(Where t = the time delay in seconds, R = the resistance in ohms and C = the capacitance *in farads*). The circuit utilises R6 to set the minimum time delay period and this is increased by the addition of the resistance set on VR1. This should be a *linear law* component if the time delay produced is to follow in proportion to the rotation of the control knob.

The stopping action of the circuit utilises the relay, RLA. The use of a relay is essential since the polarity of the supply to the track (its voltage and its waveform) is governed by the train controller. The relay switches this current and is in effect, an electrically-operated switch. The nature of the voltage it is switching has no effect on the operation of the rest of the circuit.

The output from the 555 timer is not sufficient to directly drive the relay. TR3 is therefore used as a current amplifier to overcome the problem. D5, an l.e.d., is wired in parallel with the relay to give an indication of the fact that the halt circuit is in operation. This is particularly useful in cases where track controlled by the unit is out of the operator's sight. D6 is included in the circuit to dissipate the back e.m.f. generated when the relay de-energises.

COMPONENTS

Resistors

R1	10kΩ
R2	150kΩ
R3	820kΩ
R4	510kΩ
R5	22kΩ
R6	22kΩ
R7	12kΩ
R8	2·2kΩ

All ½W ±2%

Capacitors

C1	2200μF 16V elect.
C2	2·2μF 16V tantalum
C3	4·7μF 16V tantalum
C4	2·2μF 16V tantalum
C5	100μF 16V elect.
C6	10nF disc ceramic

Semiconductors

D1–4	W005 1A 50V bridge rectifier
D5	TIL220 0·2in red l.e.d.
D6	1N4148 signal diode
TR1	BC109 *npn* silicon
TR2	BC479 *pnp* silicon
TR3	BFY52 *npn* silicon
IC1	4011B CMOS quad 2-input NAND gate
IC2	555 timer

Miscellaneous

RLA	12V, 205Ω coil miniature p.c.b. mounting relay
VR1/S1	100kΩ linear control potentiometer with d.p.d.t. switch
S2	miniature reed switch, normally open
TB1	10-way terminal block

See Shop Talk page 371

Printed circuit board: single-sided size 115 × 35mm, *EE PCB Service,* Order code 8406-04; plastic case, 120 × 65 × 40mm; knob to suit VR1; l.e.d. clip; 14-pin d.i.l. holder; 8-pin d.i.l. holder; wire.

Approx. cost
Guidance only **£14**

CONSTRUCTION

CIRCUIT BOARD

The construction of the unit is reasonably straightforward if the printed circuit board shown in Fig. 3 is used and the unit is mounted in the box specified in the components list. A problem might arise if a different relay is used and for this reason, it is advisable to obtain the relay and check its pinning against that shown in the diagram before etching the printed circuit board.

The printed circuit board track layout is shown in Fig. 3. The design can be transferred to a suitable board by any convenient technique and the board subsequently etched and drilled. Alternatively, the board can be obtained from the ***EE PCB Service,*** Order code 8406-04.

It will be necessary to make the holes used for the relay contacts larger than those normally required for mounting the components and this should be taken into account if you wish to alter the design either to make use of a different box or relay.

The mounting of the components onto the circuit board follows normal practice with construction being aided by mounting the smaller components first. The component layout is shown in Fig. 4. Care should be taken to ensure that all polarised components such as capacitors and diodes are correctly orientated. It is advisable to allow for the use of sockets for all i.c.s.

The connections to the potentiometer are made by wiring the middle terminal and one of the outside connections of VR1 to the appropriate point on the printed circuit board. The remaining outer terminal is left unconnected.

Once the printed circuit board has been completed, the unit should be carefully inspected for poorly soldered joints and broken or short circuited tracks. It can then be tested for correct operation prior to being mounted in its case.

To test the unit it is necessary to connect the appropriate points on the printed circuit board to a source of 12V a.c. and to apply a short circuit between the connections to the reed switch. If the unit is functioning correctly, the relay should energise for a time which varies with the rotation of VR1.

CASE

Once the printed circuit board has been tested, the case can be drilled and prepared for the insertion of the p.c.b. The unit is designed with the intention that VR1 and the l.e.d. will be mounted on the removable lid of the case and that the terminal strip will be mounted on the side of the case.

The terminal strip is likely to be supplied as a 12-way strip and it will be necessary to cut it to size. The bottom of the case can be drilled to accommodate fixing screws with which to mount the unit on the control panel. The layout of the unit is shown in the accompanying photographs.

Care should be taken when drilling the case to ensure that there is adequate room inside it to accommodate the components mounted on the p.c.b., as well as those mounted on the top and side of the case. This is best achieved by placing the printed circuit board into the slots in the case and then marking its position and that of any protruding components *lightly* on the face of the panel in pencil.

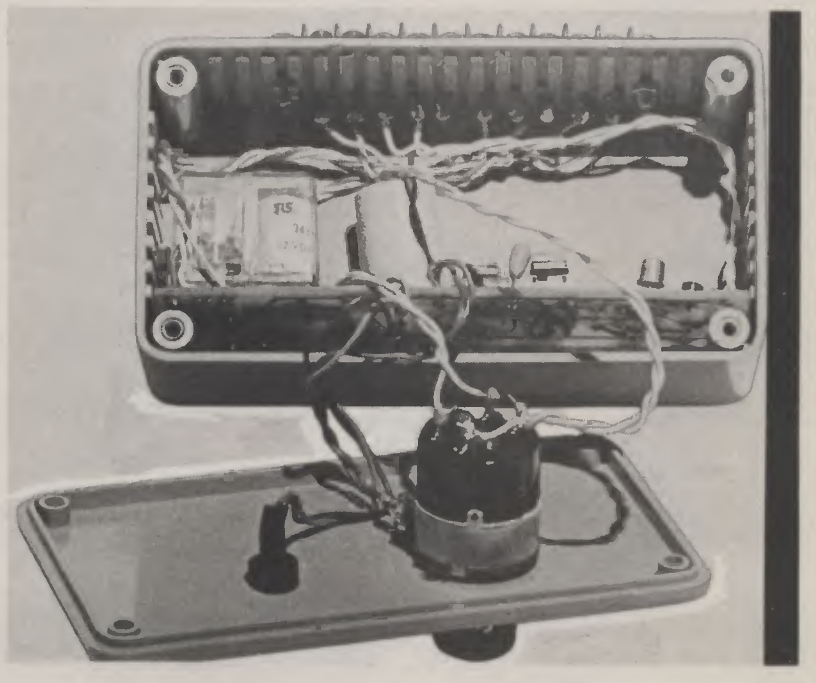
The position of the two panel mounted components (VR1 and the l.e.d.) can then be marked and appropriately sized holes drilled in the case. The terminal strip should then be offered up to the side of the case and the mounting holes and the holes through which the connections pass into the case marked and drilled.

The case should then be thoroughly cleaned and rub-down lettering applied to ledgend the control potentiometer and indicator l.e.d. The lettering can be protected by applying several coats of clear spray varnish. Once the varnish has dried, the connections can then be made from the p.c.b. to the terminals and the board inserted into its retaining slots.

INSTALLATION

The position of the unit should be determined and the positions of the holes through which the wires connecting the Train Wait to the rest of the layout should be marked on the baseboard. Once the holes have been drilled, the unit can be screwed to the baseboard.

The wires connecting the Train Wait to the layout are connected as shown in Fig. 5. The method of wiring in the relay



connections to the layout depends on the actual use to which the unit will be put. It will be necessary to place the reed switch under the track at an appropriate point.

If the track is ballasted, the reed switch can be buried in the ballast and then held secure by means of the ballast fixing adhesive. The wires for the reed switch are passed through holes drilled in the baseboard under the track and fed back through the appropriate holes to the switch terminals on the Train Wait unit.

SIMPLE HALTING SYSTEM

If the Train Wait is to be used to operate a delay either at a station, a tunnel or a crossover, then only the normally closed pair of relay contacts will be needed to provide the control and the remaining pair of contacts can be used to operate signals.

The section of track which is controlled by the unit must be isolated from the remainder of the layout by inserting insulating rail joiners into the layout at both ends of the controlled system.

REVERSING FOR A BRANCH LINE

A slightly more complex arrangement can be used to make a train run continuously up and down a branch line provided that there is no intention of running any other trains along that line whilst the unit is in operation.

The reed switch is placed at one end of the branch line and the controller set so that the train initially runs towards it. When the train triggers the switch, the relay will operate and reverse the current feed to the track. This causes the train to reverse down the track.

The duration control must be set so that the relay operates for the correct length of time for the train to reach an appropriate point at the other end of the line at the time that the relay de-energises. The current now flows through the track in the same direction as it did previously. The train reverses its direction and once more proceeds towards the reed switch starting the cycle all over again.

OPERATING THE SYSTEM

Operation of the system is very simple. The locomotives which are to operate the Train Wait must have a small magnet attached to their underside. On metal bodied locomotives this is easily accomplished by simply placing the magnet in the appropriate position and letting its magnetism keep it there. With plastics bodied locomotives, it will be necessary to find some method of attachment such as double-sided adhesive tape.

The Train Wait is switched on by rotating the duration control and a suitable time delay set with the control by experimentation. From then on, any locomotive equipped with a magnet will trigger the reed switch and be halted for the same period of time. Locomotives not equipped with magnets will not trigger the system and will not be halted.

Care must be taken to ensure that a suitably strong magnet is used to ensure reliable triggering. If it is desired to disable the unit for any reason so that all trains pass over the controlled section of track without halting, it is only necessary to turn off the Train Wait by rotating the duration control to the "off" position. □

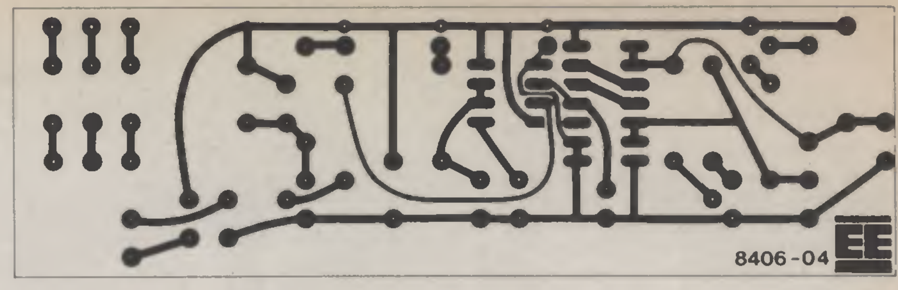


Fig. 3. P.C.B. layout.

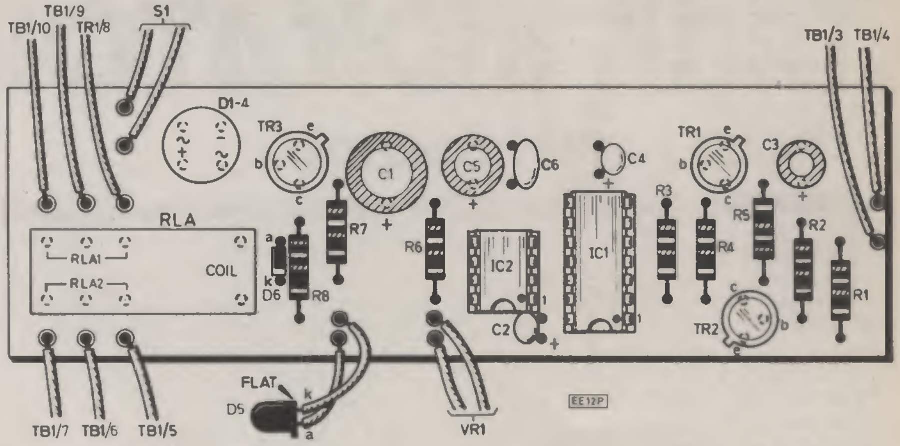


Fig. 4. Component layout.

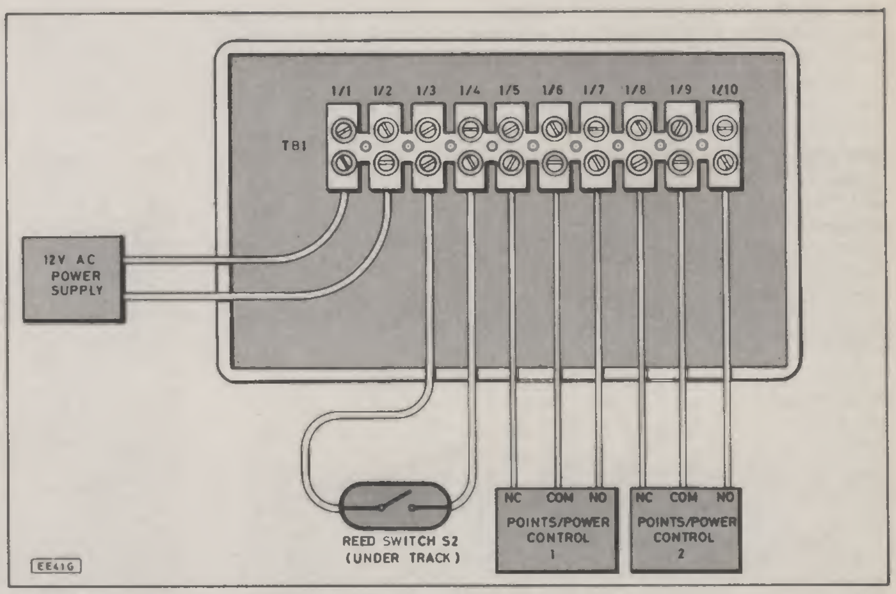


Fig. 5. Wiring diagram.

HOT WATER TANK INDICATOR

A.H.Robson

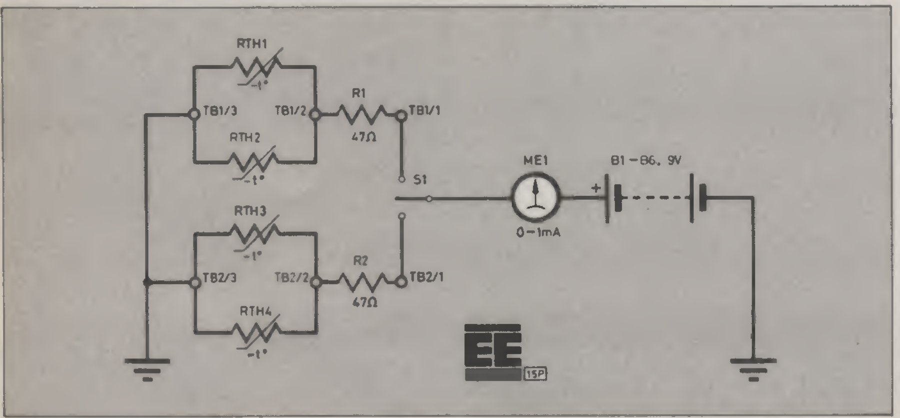


Fig. 1. Circuit diagram for the Hot Water Tank Indicator.

KEEPING the domestic hot-water tank at its maximum temperature throughout the whole day can be wasteful on fuel, and any way of reducing the expense is welcome. Therefore a check on tank temperatures will lead to economy, and the device described here is designed with savings in mind.

The simple circuit uses two thermistors at each of two points on the hot-water tank, connected to a milliammeter for readout temperature. See Fig. 1.

CONSTRUCTION

Select high and low positions at the rear of the tank where the sensors are unlikely to be disturbed. Each thermistor/resistor assembly is constructed in exactly the same way. Screw the pair of parallel thermistors and the resistor into a terminal block and protect the leads with sleeves. Fix the block to the tank with impact adhesive and stick strips of thin adhesive tape to the tank under the thermistors and resistor. Pull the thermistors gently apart so that they are spread out on the tape. Cover the thermistors with strong adhesive tape to provide a close thermal contact with the tank, see Fig. 2 and photos.

With both sensing assemblies securely in place, take the leads to earth at a convenient main "water" pipe and secure with a jubilee clip. Connect the ends of a twin wire to each assembly and channel the leads to the location of the switch and meter components. The latter should be adjacent to the hot-water controls.

Choose a concealed place to keep the

COMPONENTS

Resistors
R1,2 47Ω (2 off)
¼W carbon ±5%

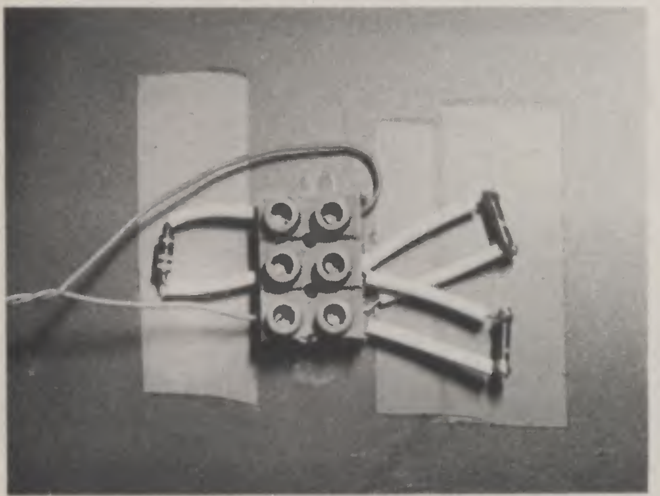
See Shop Talk page 371

Thermistors
RTH1–4 thermistor 85kΩ approx. at 25°C (4 off)

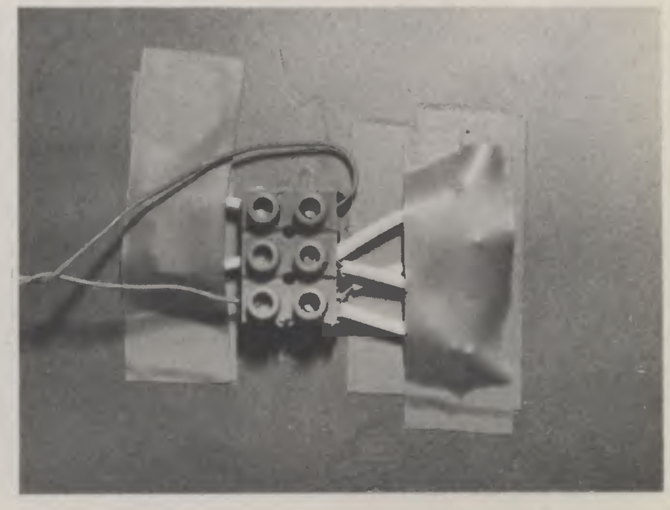
Miscellaneous
2-way, centre-biased switch; 0–1 milliammeter; six HP7 type batteries series mounted in special holder (Verospeed); two terminal blocks, each with three channels; twin flex; single flex; two miniature jubilee clips; self-adhesive tape, thin and heavy duty.

Approx. cost Guidance only **£8.00**

Thermistor and resistor in place on hot-water tank. Adhesive tape cover not yet applied.



Thermistor and resistor in place on hot-water tank. Adhesive tape cover on.



batteries in a special holder; HP7 cells are quite adequate for this circuit which consumes very little current. Complete the circuit by taking a lead from the nearest water pipe.

CALIBRATION

It is now time to make a trial on the response of the meter needle to the temperature levels. Note the positions of the needle when the tank is hot and then cold. If, when hot, the needle goes off-scale, apply layers of tape between tank and thermistors until needle returns to the scale.

The scale of the meter should be covered with a strip of thin card coloured in sections of blue, pink and red to represent the temperature ranges of the tank water. No difficulty should be experienced in removing the perspex front of the meter for this purpose. A spot or two of adhesive will keep the coloured sections in place.

All that is now required to read off the state of the hot-water supply is a quick flick up and down of the switch. □

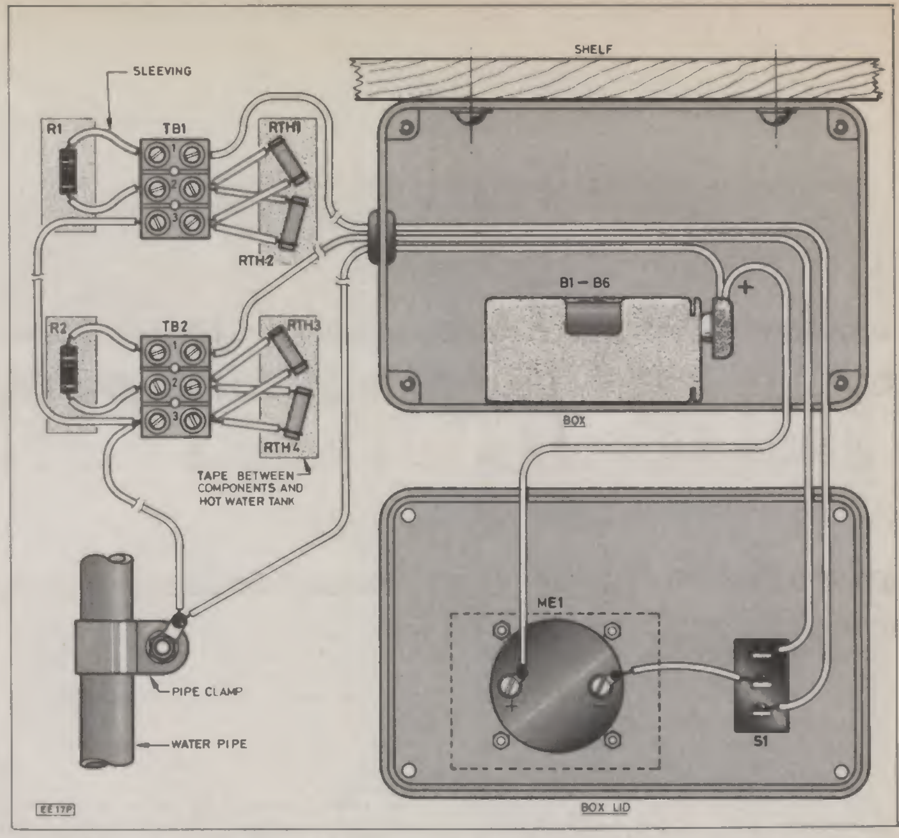


Fig. 2. Method of mounting thermistors in terminal blocks and interwiring to battery, meter and temperature switch S1. The battery holder contains six HP7 cells.

COUNTER INTELLIGENCE

BY PAUL YOUNG

Leap Year

Most of the monthly periodicals start to prepare their copy up to three months before publication date, which explains why I am writing this in early March.

What is the significance of this date, curious readers may ask? Well, for a start it is Leap Year, and I have no doubts that many of our readers, who are bound to be handsome, are busy resisting the advances of predatory females, who try to deflect them from their study of electronics.

But I digress. The real interest to me was the fact that February had twenty-nine days. Having purchased one of those watches that do everything except bath the baby, I was about to put it to the test. At the touch of a button it tells you the date, and in addition it works out the Leap Years and puts in the extra day.

So it came about, that at one minute to twelve on the twenty-eighth of February, I stood with my hand on the button ready to denounce the maker's claim. Two minutes past twelve and "Press". "Good Grief it does, there it is in black and white, the twenty-ninth of February!!" Sceptical Young is wrong again.

Mind you, I have got to wait to the year 2000 to give it the ultimate test. As I am sure you all know, any year divisible by four is a Leap Year, the exception being those that end in two zeros.

Even if it had given the wrong answer, I have to admit these little time-pieces are astonishingly good, and cheap.

I could suggest one improvement, and that is, that they make the presentation analogue instead of digital, because the human brain can take it in much more quickly. Perhaps one of our knowledgeable readers could tell me if it is possible, still using liquid crystal to form the large and small hands instead of numbers. *(Yes it is and a number of watches of this type are now available—Ed.)*

Holistic Medicine

Holistic medicine has entered the realm of electronics in a very direct way. Two examples come to mind. The first is a development of the piezo crystal effect. It is well known that if these crystals are compressed or expanded they produce a voltage.

A few years ago, nautical Young decided to take a sailing course at Old Bosham, and staying in the same house was a heart specialist. One evening he was talking about electronic heart pacers, and explained that the main difficulty was replacing the batteries.

He told me he was working on the idea of a rechargeable battery using a piezo crystal to recharge it. The crystal was to be fixed in a position between two ribs so that the rib movement supplied the motive power to generate the current.

Today, they have developed a flexible tape using minute crystals and the slightest movement of the tape produces a voltage. Strangely enough this tape has also been found to be efficacious in healing wounds.

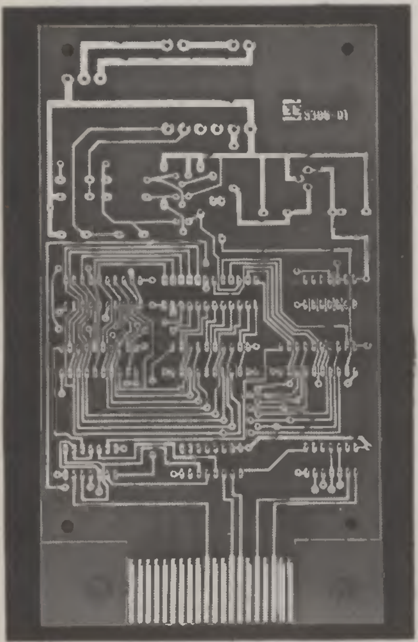
The second example is the use of magnetic tape which also speeds up wound healing. Certainly if you had too much of this tape on you, navigating a small boat or aircraft would be tricky as it would play havoc with the compass.

I remember Richard Fairey, son of the aircraft manufacturer, telling me that he was torpedoed during the war and was lucky enough to be in a lifeboat equipped with an engine. Unfortunately they placed the magnetic compass too near the engine, and instead of reaching America, finished up in the arctic circle.

Talking of magnetic cures, there are on the market magnetic bracelets, which many people swear by. They allegedly cure rheumatism, backache and other ailments and I cannot resist ending with a story of a lady suffering from rheumatism and whose dog was limping for the same reason.

She purchased two magnetic bracelets, one for herself and one for the dog. A week later the dog was cured while she was no better. She confronted her doctor and told him of this strange turn of events requesting an explanation. "Ah, Madam," said the doctor, "The reason it works on the dog, is that he believes in it".

EVERYDAY ELECTRONICS PRINTED CIRCUIT BOARD SERVICE



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

We regret that the ordering codes for the August projects have been incorrectly quoted in the Sept-Oct issues. Correct codes are given here.

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps.

Readers ordering both p.c.b.s *and* software cassettes may send a single cheque/PO for the combined amounts listed.

*Set of four boards.

**Calibrated with C1, VR1 and IC3 fitted.

M.I.T.—Microcomputer Interfacing Techniques, 12-Part Series.

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

Please allow 21 days for delivery.

PROJECT TITLE	Order Code	Cost
Eprom Programmer, TRS-80 (June 83)	8306-01	£9.31
Eprom Programmer, Genie (June 83)	8306-02	£9.31
Eprom Programmer, TRS-80 & Genie (June 83)	8306-03	£1.98
User Port Input/Output *M.I.T. Part 1* (July 83)	8307-01	£4.82
User Port Control *M.I.T. Part 1* (July 83)	8307-02	£5.17
Storage 'Scope Interface, BBC Micro (Aug 83)	8308-01	£3.20
Car Intruder Alarm (Aug 83)	8308-02	£5.15
High Power Interface *M.I.T. Part 2* (Aug 83)	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Part 2* (Aug 83)	8308-04	£3.56
Electronic Die (Aug 83)	8308-05	£4.56
High Speed A-to-D Converter *M.I.T. Part 3* (Sept 83)	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Part 3* (Sept 83)	8309-02	£4.48
Stylus Organ (Sept 83)	8309-03	£6.84
Distress Beacon (Sept 83)	*8309-04	£5.36
Distress Beacon Pocket Version (Sept 83)	8309-05	£3.98
D-to-A Converter *M.I.T. Part 4* (Oct 83)	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4* (Oct 83)	8310-02	£5.13
Electronic Pendulum (Oct 83)	8310-03	£5.43
TTL/Power Interface for Stepper Motor *M.I.T. Part 5* (Nov 83)	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5* (Nov 83)	8311-02	£5.70
Digital Gauss Meter (Nov 83)	8311-03	£4.45
Speech Synthesiser for BBC Micro (Nov 83)	8311-04	£3.93
Car On/Off Touch Switch (Nov 83)	8311-05	£3.11
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6* (Dec 83)	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6* (Dec 83)	8312-02	£5.29
TRS-80 Twin Cassette Interface (Dec 83)	8312-03/09	£7.43
Environmental Data Recorder (Dec 83)	8312-04	£7.24
Touch Operated Die (Dot matrix) (Dec 83)	8312-05/06	£4.34
Touch Operated Die (7-segment) (Dec 83)	8312-05/07	£4.34
Continuity Tester (Dec 83)	8312-08	£3.41
Central Heating Pump Delay (Jan 84)	8401-01	£3.33
Biological Amplifier *M.I.T. Part 7* (Jan 84)	8401-02	£6.27
Temp. Measure. for ZX Comps (Jan 84) Analogue Thermometer Unit	8401-03	£2.35
Analogue-to-Digital Unit	8401-04	£2.56
Games Scoreboard (Jan 84)	8401-06/07	£9.60
Eprom Programmer/ROM Card for ZX81 (Feb 84)	**8402-01	£7.84
Oric Port Board *M.I.T. Part 8* (Feb 84)	8402-02	£9.56
Negative Ion Generator (Feb 84)	*8402-03	£8.95
Temp. Measure. & Control for ZX Comps (Feb 84) Relay Driver	8402-04	£3.52
Latched Output Port *M.I.T. Part 9* (Mar 84)	8403-01	£5.30
Buffered Input Port *M.I.T. Part 9* (Mar 84)	8403-02	£4.80
VIC-20 Extension Port Connector *M.I.T. Part 9* (Mar 84)	8403-03	£4.42
Commodore 64 Extension Port Connector *M.I.T. Part 9* (Mar 84)	8403-04	£4.71
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Data Acquisition "Output" *M.I.T. Part 10* (Apr 84)	8404-03	£5.20
Data Acquisition "PSU" *M.I.T. Part 10* (Apr 84)	8404-04	£3.09
Timer Module (Apr 84)	8404-05	£3.58
A.F. Sweep Generator (Apr 84)	8404-06	£3.55
Quasi Stereo Adaptor (Apr 84)	8404-07	£3.56
Simple Loop Burglar Alarm (May 84)	8405-01	£2.92
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Interface/Motor Drive	8405-02	£4.75
Collision Sensing	8405-03	£3.04
Power Supply	8405-04	£4.53
Infra Red Alarm System (June 84)	8406-01	£2.55
Spectrum Bench PSU (June 84)	8406-02	£3.99
Speech Synthesiser *M.I.T. Part 12* (June 84)	8406-03	£4.85
Train Wait (June 84)	8406-04	£3.42

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Fool's Harvest

Some magazines now have a ban on *April Fool* jokes. The situation has got completely out of hand.

Probably the most famous joke was the "BBC TV Panorama" prank that was transmitted on Monday, 1st April, 1957. Cameraman Charles de Jaeger was working on a story in Switzerland, near Lugano. For a bit of fun the film crew bought 20lb of spaghetti and stuck it onto some laurel bushes with Sellotape. Then they filmed local farmers gathering the spaghetti harvest. Richard Dimbleby read a script which explained how it was a bumper spaghetti crop this year.

When the film transmission ended the studio cameras cut to Dimbleby alongside a large calendar. But the BBC's phone lines at Lime Grove were still jammed with puzzled callers.

More recently there was the "Guardian" supplement about the imaginary Isle of San Serife. There have also been some neat technical hoaxes.

A video magazine fooled some readers with the story of an experimental 3-D TV transmission. The station was to transmit two separate signals, one vertically polarised and one horizontally polarised, for pick-up by two separate aerials, one horizontal and one vertical. These pictures would then be displayed on the screen with crossed polarisation and viewed with crossed polarised spectacles.

Actually it might work! Satellites use cross polarisation to transmit two different signals on the same channel. Over the years there have been any number of schemes patented for displaying crossed polarised images on a TV, like the crossed polarised images projected in a cinema for 3-D.

There was even a scheme, and I am assured it was serious, to screen two different films in a cinema at the same time, one with vertical polarisation and the other with horizontal. The audience, listening on headphones, could choose which film they wanted to watch.

Double Take

The snag with *April Fool* jokes is that they annoy the reader who suddenly realises that he or she has been wasting time reading a leg pull. But the wrath of a reader is nothing compared to the wrath of an editor who unwittingly publishes something that turns out to be a hoax.

I do hope, for the sake of Japanese company Pioneer, that a press release sent out in mid-March isn't an *April Fool's* joke. If it is a joke, then any editor who has published it in good faith will be hopping mad.

"Hi fi speakers that hang on the wall and double as bulletin boards," says Pioneer promising that the *Decor* range of flat speakers will be on sale in April at £150.90. There's a nice photograph of a cork noticeboard which supposedly contains a 14cm cone woofer and 6·6cm cone tweeter.

Masaji Okubo, named as Pioneer's hi fi product manager, is quoted as saying that "traditional values are changing and Pioneer are in the forefront of producing products that narrow the gap between home accessories and home entertainment". But how can a cone be flat?

There have been various flat speaker designs over the years, the most recent using a new type of plastics which behaves like a piezo crystal and flexes when fed with an electric signal. Electrostatic speakers are flat. In Germany an inventor recently secured financial backing from the Government to develop a patented flat speaker design.

The technology of flat speakers is complex. If Pioneer have really licked the problems, why no explanation of the technology used?

The best *April Fool* story I ever heard dates back to the days of valve hi fi. In an April issue a technical magazine reported on a special new output valve that could be plugged into a mono amplifier and thereby convert to stereo operation.

Inevitably some readers fell for it and couldn't wait to buy the magic valve. The winner was a smart salesman who cashed in on all the publicity and started selling "special" valves to convert a mono amplifier to stereo!

Space Hopping

What follows is NOT an *April Fool's* joke. It is a straight report of a bizarre hoax that took place thirty years ago. But the story keeps re-surfacing. It's been in Reader's Digest and recently turned up in an American popular newspaper as "TV's most incredible mystery" with all kinds of occult implications.

In September 1953 British TV viewers saw the test card for an American TV station KLEE-TV, broadcasting from Houston, Texas. Nothing odd in that, you may say. TV signals often skip across continents by reflection from the upper atmosphere. The odd thing was that KLEE-TV had ceased broadcasting three years earlier!

Immediately the theorists got to work. The signal, they said, had gone out into space, bounced off a distant planet and come back to earth three years later. The distant planet, of course, would have to be $1\frac{1}{2}$ light years away. But that didn't deter the theorists. They also didn't bother to check that the furthest planet is only five light *hours* away and the nearest star is four light years off.

The story keeps on coming round. Roger Bunney, writing in *Television* magazine in 1978 took it up with sceptism and quoted the "Bermuda Triangle," by Charles Berlitz. "British viewers watching their TV programmes were surprised to see the pictures fading and being replaced by broadcasts from KLEE-TV . . . the problem was investigated by a firm called Atlantis Electronics of Lancaster, who are unable to find any solution".

An acknowledged expert on long distance TV reception, Bunney reported that there was no trace of a firm called Atlantis. In any case, he said, the BBC, with all its technical resources, hardly needs to call in an outside organisation!

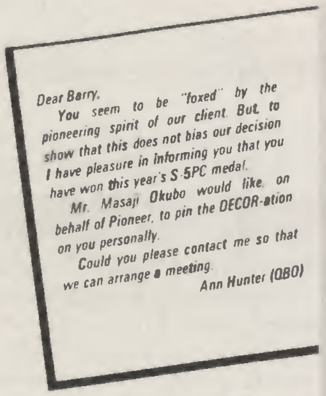
I recently checked with the BBC and although there is no documentation, old hands remember the incident well. Viewers in Ayr saw the Houston test card. But the BBC's conclusion at the time was that it was someone in the Clyde area transmitting on low power and using an original Houston test card.

Probably when the KLEE station closed down all its test cards were either sold off or dumped in a dustbin. I know of at least one British TV enthusiast who has a private collection of old test cards and could, if he wanted, play a similar trick with a low power transmitter.

Bunney also checked the sun spot cycle at the time of the incident, and found that it would not have supported strong reflections. When you bear the inverse square law in mind, signals travelling three light years through space ($1\frac{1}{2}$ light years out and $1\frac{1}{2}$ back) would be far too weak to over-ride a strong local station when they finally arrived in Scotland.

Most important, and what the popular press consistently overlooks, the TV standard used in America in the 50s was quite different to that used in Britain. In America the standard is 525 lines, with 30 pictures a second and negative modulation. In the UK, at that time, we were using 405 lines, with 25 pictures a second and positive video.

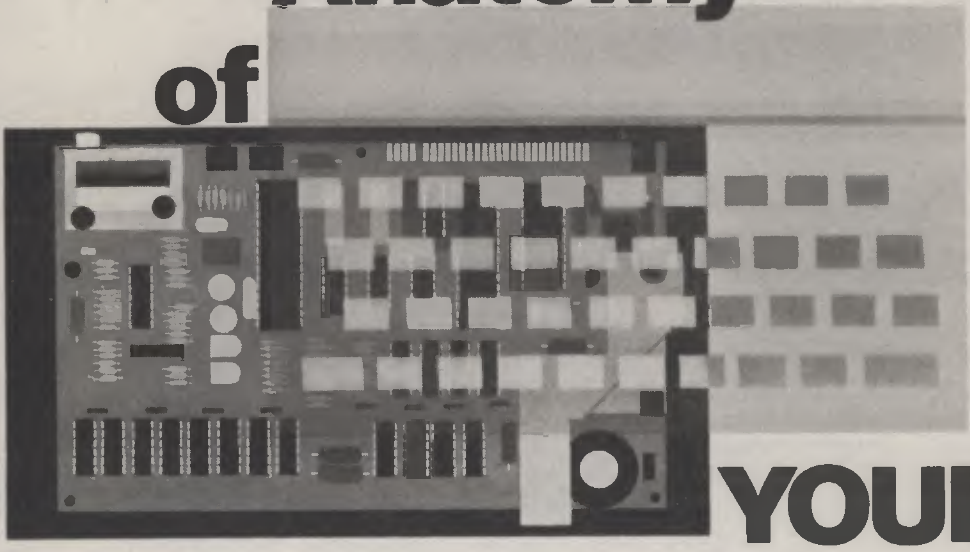
There is one loose end. I have checked both hard and paper back versions of Berlitz's book, "The Bermuda Triangle". I can't find any reference to the KLEE-TV incident!



Dear Barry,
You seem to be "foxed" by the pioneering spirit of our client. But to show that this does not bias our decision I have pleasure in informing you that you have won this year's S-5PC medal.
Mr. Masaji Okubo would like, on behalf of Pioneer, to pin the DECOR-ation on you personally.
Could you please contact me so that we can arrange a meeting.
Ann Hunter (OBO)

JULY FEATURES...

Anatomy of YOUR Micro



OWEN BISHOP IS THE ANATOMIST IN THIS MAJOR NEW SERIES. THERE ARE NOW TWO DOZEN OR MORE DIFFERENT PERSONAL COMPUTERS ON THE MARKET, OFFERING A SOMETIMES BEWILDERING VARIETY OF FEATURES. THE *ANATOMY OF YOUR MICRO* SHOWS WHAT THEY HAVE IN COMMON: CPU, ROM, RAM, I/O PORTS, AND EACH OF THESE SUB-SYSTEMS IS EXAMINED IN DETAIL.

IN THE FIRST PART, OWEN CONSIDERS THE LANGUAGE THAT THE MICRO ACTUALLY UNDERSTANDS; TWO DIFFERENT VOLTAGE LEVELS. HE THEN LOOKS INTO THE HEART OF THE COMPUTER—THE MICROPROCESSOR.

Car Lights Reminder

This unit warns the driver when daylight falls below a certain level and also if the ignition is switched off before the lights at the end of a journey.

ULTRASONIC Alarm System

Sets up an ultrasonic field reaching as far as ten feet from the transducer. Any movement within this field will trigger the alarm.

Electronic Lock

An electronic combination lock with a difference. Can be used to prevent unauthorised use of any mains operated appliance such as computers, videos and home-base CBs.

EVERYDAY ELECTRONICS and computer PROJECTS

JULY 1984 ISSUE ON SALE FRIDAY, JUNE 15

OSCILLATORS

Part One: THE SYMMETRIC MULTIVIBRATOR

By J. R. DAVIES

A variety of different types of resistance capacitance feedback oscillators, all having wide use, are described in this short series. Some of the circuits are based on discrete semiconductors, others on familiar i.c.s. In addition to theory of operation, design pointers for particular needs and applications are given. Each part in the series also includes a detailed circuit for a practical project.

IT IS appropriate that we start this series by considering the symmetric or astable multivibrator, for this is an old and well established semiconductor RC oscillator. Despite the fact that more recent integrated circuit oscillators offer an equivalent or improved performance, many experimenters still use the symmetric multivibrator in their projects because of its simplicity, its reliability (provided certain basic rules are observed) and its economy of components.

CIRCUIT OPERATION

The basic multivibrator circuit is shown in Fig. 1.1. When the supply is applied, both transistors in the multivibrator are biased for linear operation, giving a very high level of mutual amplification between the two. Due to circuit imbalance one of the transistors cuts off initially whilst the other stays turned on, and the circuit then settles into regular oscillation with the transistors turning on and off alternately.

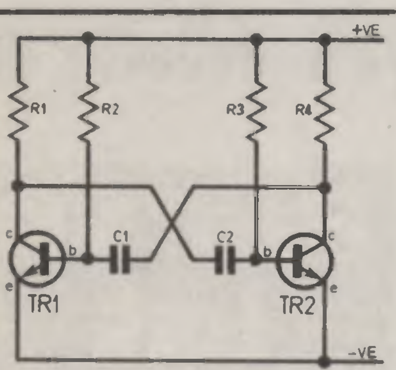


Fig. 1.1. The symmetric multivibrator, with *npn* transistors.

At one instant in the multivibrator cycle TR2 will be on and TR1 cut off, with C2 fully charged via R1 and the base-emitter junction of TR2. C1 was charged during the previous half-cycle, and its left-hand side causes TR1 base to be negative of the lower supply rail, keeping this transistor cut off. At the same time, C1 is now discharging through R2.

After a period the left-hand side of C1 takes TR1 base about 0·6 volt positive of the lower supply rail, causing TR1 to conduct and its collector voltage to fall. This fall in voltage is passed through C2 to the base of TR2 and TR2 collector voltage rises, causing TR1 base current to increase via R4 and C1. The high mutual amplification inherent in the circuit results in a rapid changeover, ending with TR1 turned fully on and TR2 cut off.

Since C2 has been charged to the full supply voltage (less 0·6 volt dropped in the base-emitter junction of TR2) it initially takes TR2 base negative of the lower supply rail by that voltage, after which it discharges by way of R3. When C2 has discharged sufficiently to allow the base of TR2 to be about 0·6 volt positive of the lower supply rail, TR2 commences to draw current and another rapid changeover takes place, ending with TR2 turned on and TR1 turned off. So the cycles proceed.

CYCLE TIME

The length of time in each cycle when TR1 is turned off is controlled by the values of C1 and R2, and the length of time when TR2 is turned off is controlled by the values of C2 and R3.

Let us assume for the moment that the forward voltage drop in the base-emitter junction of TR2 is not 0·6 volt but is zero, and also that there is zero voltage across TR1 collector and emitter when this transistor is turned on.

At the instant in the cycle when TR1 is turned on, the left-hand side of C2 is effectively connected to the lower supply rail and its right-hand side is taken negative of the lower rail by the supply voltage, as shown in Fig. 1.2(a). C2 then discharges via R3 until, after a period of time, its right-hand side reaches the same voltage as the lower rail, as indicated in Fig. 1.2(b), and turns on TR2.

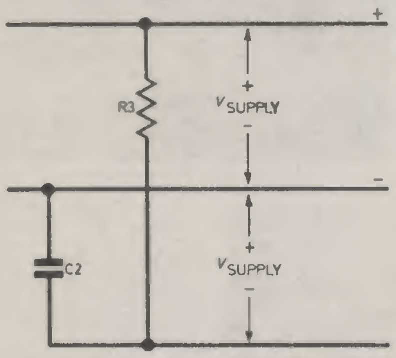


Fig. 1.2(a). Assuming zero forward voltage drop in the base-emitter junction of TR2, the voltage conditions at the instant when TR1 turns on are as shown here.

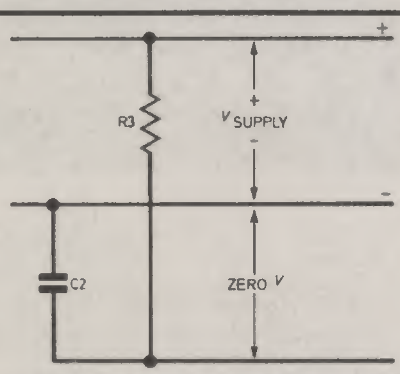


Fig. 1.2(b). Voltage conditions later, at the instant of turn-on in TR2.

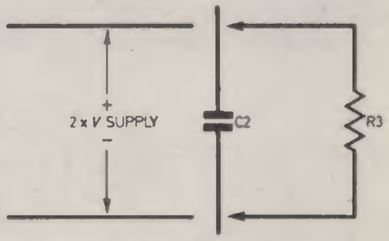


Fig. 1.2(c). The same time period would elapse if C2 were charged to twice the supply voltage and then discharged to supply voltage by R3.

Now, thinking only in terms of discharge time, we would get the same period of time if the left-hand side of C2 were connected to any steady voltage point other than the lower supply rail whilst still being discharged by R3. This steady voltage point could be the positive rail itself. We then arrive at the situation illustrated in Fig. 1.2(c).

Here, C2 is initially charged to twice the supply voltage, after which R3 is connected across it. The voltage across C2 will then drop to the supply voltage value in the same period of time as occurs between the conditions of Fig. 1.2(a) and Fig. 1.2(b).

R-C FACTOR

The time in which the voltage across a charged capacitor falls to half the initial value when a resistor is connected across it is almost exactly 0·7 times the time constant of the capacitance and the resistance. Thus, in Fig. 1.1 the time in the multivibrator cycle when TR2 is cut off is equal to 0·7 times the time constant of C2 and R3.

Similar reasoning tells us that the time when TR1 is cut off is 0·7 times the constant of C1 and R2. If C2 equals C1 and R3 equals R2 the total length of the multivibrator cycle is 1·4CR and the frequency is

$$\frac{1}{1{\cdot}4CR}$$

Convenient units are microfarads and megohms, with time in seconds and frequency in hertz.

So if C2 (=C1) is 1·5μF and R3 (=R2) is 100kΩ, 0·7 times the time constant for these two components is 0·7 × 1·5 × 0·1, or 0·105 second.

The length of the multivibrator cycle is then twice this, at 1·4 × 1·5 × 0·1 or 0·21 second, and the frequency (press the reciprocal key on your calculator!) is 4·76Hz to three significant figures. For higher frequencies try 0·01μF and 47kΩ; 0·7 times the time constant is 0·000329 second, cycle length is 0·000658 second, and frequency is 1520Hz.

EFFECT OF BASE-EMITTER VOLTAGE

These results are based on our assumption of zero forward voltage drop across the base-emitter junction of a silicon transistor. Actually, the forward base-emitter voltage drops in both TR1 and TR2 are about 0·6 volt so that C2 is charged to slightly less than the voltage indicated in Fig. 1.2(a) and has to discharge to slightly more than is indicated by Fig. 1.2 (b).

The overall result is that our calculated times will be a little short of the actual times given in practice, and our calculated frequencies will be a little high.

We also assumed zero volts between the collector and emitter of a turned on transistor, whereas in fact that voltage will be of the order of 0·1 volt, but we can ignore the error this small voltage introduces.

In practical work with multivibrators the calculated times and frequencies using the 0·7 and 1·4 multipliers are sufficiently close, for normal purposes, to the actual times and frequencies which will be given, and the calculated figures afford a good starting-off point if we want to build a multivibrator having a precise frequency of operation.

We will in most instances be using relatively wide tolerance resistors and capacitors in any multivibrators we make up, and these components will allow a spread in the actual times and frequencies obtained which is much wider than any inaccuracy introduced by assuming zero forward base-emitter voltages.

CALCULATED FREQUENCIES

Fig. 1.3(a) shows a multivibrator with a calculated frequency of 984Hz, and Fig. 1.3(b) shows another with a calculated frequency of 0·0152Hz. The calculated length of the cycle with the Fig. 1.3(b) multivibrator is 65·8 seconds, and its operation can be monitored by connecting a testmeter switched to read volts across either of the 22kΩ collector resistors. Due to the wide tolerances on value associated with electrolytic capacitors, the actual cycle length can lie between some 60 and 100 seconds.

You will find that, when the associated transistor turns on, the voltage across its collector load resistor rises quickly, and that the voltage, when the transistor turns off, falls slowly. This effect is due to cross-coupling capacitor charging, as is discussed later in this article under the heading "Output Waveform".

If an analogue voltmeter (that is, a voltmeter with pointer and scale) is connected across either of the 1kΩ collector

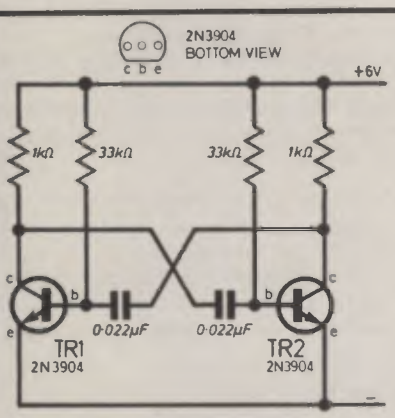


Fig. 1.3(a). A multivibrator with a calculated frequency of 984Hz.

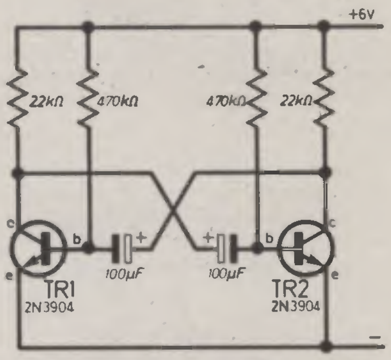


Fig. 1.3(b). The cycle length of this multivibrator lies, in practice, between some 60 and 100 seconds.

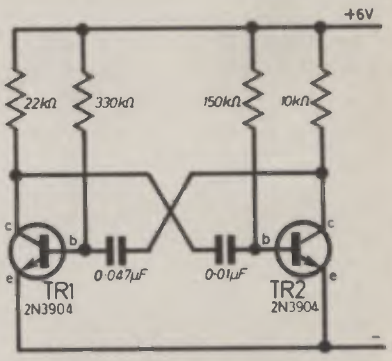


Fig. 1.4. With this multivibrator the transistors are turned off for different lengths of time during the cycle.

Table 1.1: MULTIVIBRATOR FREQUENCIES

	0·001μF	0·0033μF	0·01μF	0·033μF	0·1μF	0·33μF	1μF	3·3μF
10kΩ	71·4kHz	21·6kHz	7·14kHz	2·16kHz	714Hz	216Hz	71·4Hz	21·6Hz
27kΩ	26·5kHz	8·02kHz	2·65kHz	802Hz	265Hz	80·2Hz	26·5Hz	8·02Hz
68kΩ	10·5kHz	3·18kHz	1·05kHz	318Hz	105Hz	31·8Hz	10·5Hz	3·18Hz
100kΩ	7·14kHz	2·16kHz	714Hz	216Hz	71·4Hz	21·6Hz	7·14Hz	2·16Hz
270kΩ	2·65kHz	802Hz	265Hz	80·2Hz	26·5Hz	8·02Hz	2·65Hz	0·802Hz
680kΩ	1·05kHz	318Hz	105Hz	31·8Hz	10·5Hz	3·18Hz	1·05Hz	0·318Hz
1MΩ	714Hz	216Hz	71·4Hz	21·6Hz	7·14Hz	2·16Hz	0·714Hz	0·216Hz
2·7MΩ	265Hz	80·2Hz	26·5Hz	8·02Hz	2·65Hz	0·802Hz	0·265Hz	0·0802Hz

Calculated frequencies with equal capacitors and base resistors.

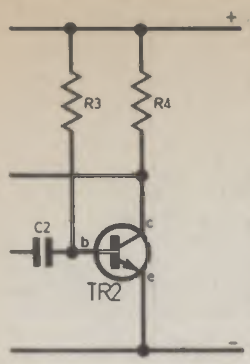


Fig. 1.5. The right hand section of the multivibrator of Fig. 1.1.

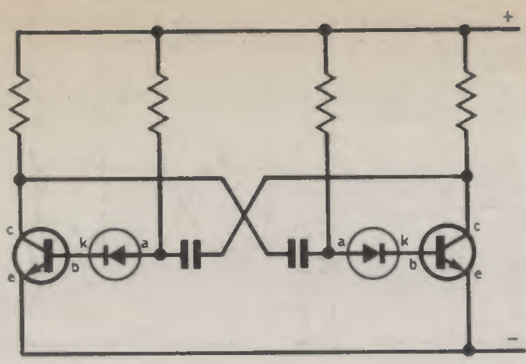


Fig. 1.6(a). Problems with base-emitter breakdown voltages can be removed by inserting small silicon signal diodes, as here.

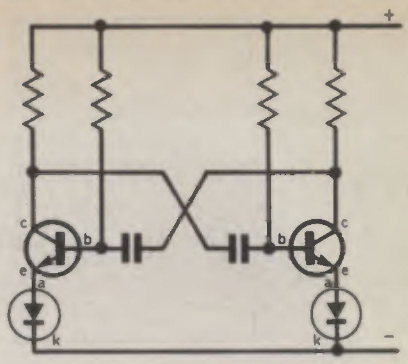


Fig 1.6(b). An alternative approach is to insert the diodes in the transistor emitter circuits.

load resistors of Fig. 1.3(a) it will give a steady reading of about 3 volts. This is because it reads the average voltage, which on succeeding oscillator half-cycles alternates between zero (for most of the half-cycle) and 6 volts.

Table 1.1 gives a guide to multivibrator frequencies by showing calculated frequencies for different values of R and C when the two R's and C's are equal. The Table covers some six decades of frequency.

UNBALANCED OPERATION

If it is required that one transistor in the multivibrator is turned off for a different period of time than the other transistor, the values of the base resistors and cross-coupling capacitors are calculated accordingly. Frequency is given by adding 0·7 times the time constant of one resistor and capacitor pair to 0·7 times the time constant of the other pair, and inverting the result.

In Fig. 1.4 the left-hand transistor is turned off during the cycle for 0·0109 second (0·7 x 0·047 x 0·33) and the right-hand transistor is turned off for 0·00105 second (0·7 x 0·01 x 0·15). The total cycle length is 0·01195 second and calculated frequency is 83·7Hz.

DESIGN AIMS

A transistor multivibrator may refuse to start or may give erratic results if a few simple rules are not observed. These requirements can be explained with the aid of Fig. 1.5, which shows the right-hand part of the multivibrator of Fig. 1.1.

For reliable oscillation, the base resistor, R3, should have a value which allows TR2 to turn fully on as the other transistor turns off. When TR2 is fully on, very nearly the same voltage is dropped across both R3 and R4, so that the current in these resistors is inversely proportional to their values.

If TR2 has a current gain, h_{fe}, of 100, and R4 is equal to 1kΩ, it would be preferable not to give R3 a value greater than 100kΩ. The multivibrator would still quite possibly oscillate with values in R3 greater than 100kΩ, but these would not allow full turn-on in the transistor during the cycle and the frequency and performance could be erratic. In extreme cases the multivibrator might not start after switch-on of the supply.

Conversely, R3 should not be given too low a value, as TR2 might then be forced to remain turned on all the time and the multivibrator would not oscillate. In practice this normally happens if R3 is given a ridiculously low value, say much lower than R4.

The same remarks apply, of course, to R1 and R2 in Fig. 1.1. R2 should not be given a value which is greater than R1 multiplied by the current gain of TR1, nor should R2 be given an exceptionally low value.

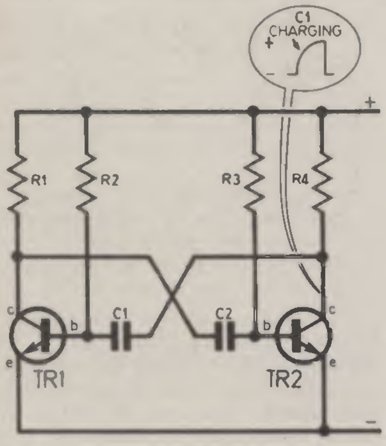


Fig. 1.7. The leading edge of the positive-going pulse at the collector of either transistor is rounded due to the charging of the cross-coupling capacitor which connects to it.

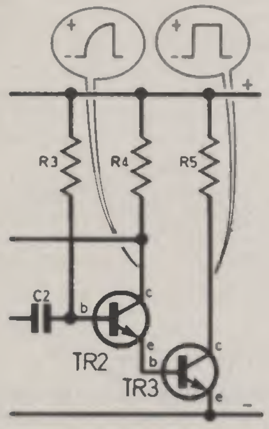


Fig. 1.8. Adding a third transistor, TR3, allows pulses with sharp leading edges to be produced. Because of the current gain provided by TR3, R5 can if desired have a much lower value than R4.

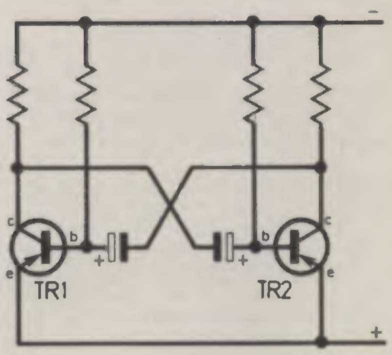


Fig. 1.9. *PNP* transistors may be employed in the multivibrator. The supply polarity is reversed, as also is the polarity of any electrolytic capacitor used for cross-coupling.

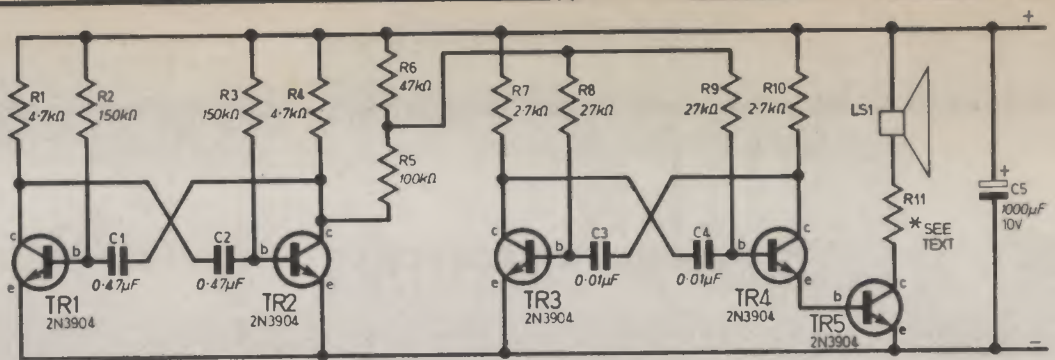


Fig. 1.10. An audible warning device employing two multivibrators. The low frequency multivibrator in which TR1 and TR2 appear continually modulates the frequency of the second multivibrator incorporating TR3 and TR4.

BASE-EMITTER BREAKDOWN

Another point to be taken into account is the reverse base-emitter breakdown voltage of the transistors to be employed in the multivibrator.

If the base of an *npn* transistor is taken more and more negative of its emitter, a voltage will be reached at which the base-emitter junction breaks down. This breakdown does not cause any damage to the transistor (provided there is not a flow of excessive current) and the base-emitter junction simply acts like a Zener diode.

If, in Fig. 1.5, the supply voltage were 9 volts and the reverse base-emitter breakdown voltage of TR2 were 7 volts, the right-hand side of C2 could not go negative of the lower supply rail by more than 7 volts when it causes TR2 to cut off. Normally, there will not be any damage to TR2, and the main result will be that the discharge time for C2 and R3 in the multivibrator cycle becomes shorter than it should properly be.

This problem can be overcome by inserting diodes in series with the transistor bases, as in Fig. 1.6(a), or in series with the transistor emitters, as in Fig. 1.6(b).

A much easier method of avoiding the base-emitter breakdown effect is simply to run the multivibrator at a supply voltage of 6 volts or less. Most silicon transistor specifications show maximum reverse base-emitter voltage ratings in the range of 4 to 6 volts, and in practice the actual breakdown voltages are nearly always comfortably in excess of 6 volts.

OUTPUT WAVEFORM

An output may be obtained from the collector of either transistor in the multivibrator. The leading edge of each positive-going pulse in the multivibrator cycle is rounded, as shown in Fig. 1.7, due to the charging of the appropriate cross-coupling capacitor.

Looking at Fig. 1.7, we can consider the instant in the multivibrator cycle when TR2 turns off and its collector is taken positive by R4. The positive excursion of the collector is slowed down at first because C1 is being charged via R4.

An output with sharp leading edges may be obtained by inserting a third transistor in the emitter circuit of TR2, as illustrated in Fig. 1.8. The third transistor turns on and off in sympathy with TR2, and produces the waveform shown. The additional transistor is useful, also, if it is desired to have the multivibrator drive a low impedance load, such as a speaker.

UNBALANCE

Since there are now two base-emitter junctions in series, those of TR2 and TR3, with each junction having a forward voltage drop of about 0·6 volt, the actual length of the period in the multivibrator cycle when TR2 is cut off is a little longer again than the calculated value employing the 0·7 multiplier.

If a 50:50 square-wave is required from the circuit it can be balanced by inserting a silicon diode (or the base-emitter junction of a fourth transistor) in the emitter circuit of TR1 in the manner which was shown in Fig. 1.6(b). The fact that there are now two base-emitter junctions in series at the right-hand side of the multivibrator, and a base-emitter junction and a diode at the left-hand side, means that supply voltages of up to 12 volts can be used without introducing base-emitter breakdown problems.

We have employed *npn* transistors in the circuits illustrated. Of course *pnp* transistors can also be used, whereupon the supply polarity has to be reversed, as also the polarity of any electrolytic capacitors employed for cross-coupling. See Fig. 1.9. Transistor types are not critical, and for most applications virtually any small *npn* or *pnp* transistors can be used in the multivibrator.

WARNING DEVICE

We shall end the first part of this series with a fairly simple project in which two multivibrators are employed in an audible warning device. The circuit appears in Fig. 1.10.

TR1 and TR2 form a multivibrator having a frequency of around 10Hz. TR3 and TR4 form a second multivibrator with TR4 driving a speaker via TR5.

If the upper ends of R8 and R9 were returned to the positive supply rail, the frequency of oscillation would be around 2·6kHz. They are instead connected to the junction of R5 and R6, with the result that the frequency is lowered when TR2 in the 10Hz multivibrator is turned off because of the extra resistance introduced by R6.

The frequency is lowered still further when TR2 is turned on and the voltage applied to R8 and R9 is reduced, since the discharge currents available through R8 and R9 for C3 and C4 are then lower, and the discharge time periods in the cycle increase.

C5 provides a low bypass impedance across the supply rails and is needed to prevent unwanted couplings between the two multivibrators if the 6-volt supply has a relatively high internal impedance. It will be found that the circuit runs for a few cycles of the 10Hz multivibrator when the 6-volt supply is removed and C5 discharges.

LOUDSPEAKER

The speaker can have any impedance between 15Ω and 80Ω, and the collector load for TR5 should total approximately 100Ω. With a 15Ω speaker, R11 can be 82Ω, and with an 80Ω speaker it can be 22Ω. In general, the audible output power increases as speaker impedance increases and the value of R11 reduces. The current consumption from the 6-volt supply is approximately 20mA.

The circuit produces an attention-catching "chirrupy" tone as the second multivibrator is switched between its two frequencies by the first. If TR2 is turned off by short-circuiting its base to the negative rail, the audio oscillator produces its high tone. If TR1 is turned off by temporarily connecting its base to the negative rail, and thereby turning TR2 on, the audio multivibrator produces its low tone.

Part Two of this series will discuss the 555 and ICM7555 i.c.s and their use in oscillator applications.

CHANNEL SELECTION SWITCH

FOR MUSICAL INSTRUMENT AMPLIFIERS

BY P. BAILEY

IN RECENT years a large number of musical instrument amplifiers with two input channels have been fitted with a facility which allows the performer, via a footswitch, to electronically switch between the two channels. This eliminates the need to alter controls on the amplifier or unplug leads, something which can be difficult on a dimly lit stage.

The facility to instantly switch between two channels on an amplifier is very useful for guitarists, since one channel can be set to overload, giving distortion, whilst the other can be set to give a clean sound, these then being available for selection during a performance. However, there are many musicians with two-input or two-channel amplifiers which do not have any switching facility, and it was primarily to fulfill this need that the Channel Selection Switch was designed.

SWITCHING NOISE

A simple s.p.d.t. footswitch could be used to perform the above function, however, this method suffers from switching noise. This is caused by the mechanical bounce of the switch contacts as they change over, and is particularly noticeable in audio applications. Many of the cheaper effects pedals available on the market use this method of direct switching, producing a "pop" when operated, which becomes more obvious if echo or reverberation effects are being used.

The Channel Switch overcomes this by employing electronic switching, and in addition to its use with amplifiers, the unit can be used with effects pedals to switch them in and out silently. Also, each channel has an l.e.d. to show when it has been selected. Different colour l.e.d.s are used to distinguish between channels, a useful feature when performing.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. As can be seen, the circuit is very straightforward, being based around one i.c., the CMOS 4016 quad bilateral switch. Dealing with the controlling circuitry first, the d.p.d.t. footswitch, S1, is connected so that one of its poles is connected to the positive rail (logic high), the other pole being connected to 0V (logic low), this reversing when the switch is activated.

The two filter circuits R6, C6, and R7, C5, remove the noise from the switch so that there is a smooth transition between low and high levels at pins 6 and 12 on IC1. The CMOS switches IC1c and IC1d are connected as an electronic s.p.d.t. switch, pins 9 and 10 being commoned together and connected to the positive rail.

The switches in the 4016 are operated when the control terminals are taken high. Therefore, the footswitch selects either IC1c or IC1d to be on, thus illuminating D1 or D2, and giving a visual indication of which channel has been selected.

AUDIO SWITCHING

Considering the audio switching circuitry, IC1a and IC1b are connected in the same configuration as IC1c and IC1d, and also the control terminals of IC1a and IC1b are connected to IC1c and IC1d respectively. The common connection of the unit is thus switched between channel 1 and channel 2.

It should be noted that the 4016 switches pass signals in both directions and hence SK1, SK2 and SK4 on the Channel Switch can be used as inputs or outputs. The potential divider R4, R5 biases the CMOS switch inputs to half supply potential via R1, R2 and R3, thus allowing the maximum input voltage swing possible.

The unit is powered by an internal 9V PP3 battery, but provision is made for an external power supply to be used if desired, as is customary with commercial effects units. The unit is switched on by the insertion of a standard mono jack plug into stereo jack SK4, and the insertion of a 3·5mm jack plug into SK3 disconnects the battery and allows external power to be used.

Since the main active component in the circuit is IC1, which can operate on a supply voltage of 3V to 18V d.c., the unit can be powered from a wide variety of external supplies, although the brightness of the l.e.d.s will be affected.

CIRCUIT BOARD

The components in the prototype were mounted on a piece of 0·1in matrix stripboard, 11 strips × 24 holes, as shown in Fig. 2. If the recommended case is used, this size of circuit board will be found to fit into the guide slots in it, no fixing being necessary. The cut-out in the board is to allow the battery leads to pass through, and the piece can be removed using a junior hacksaw.

After making the breaks in the copper strips, the socket for IC1 should be mounted, as this will aid the positioning of the other components. It should be noted that all strips are broken in columns 1 and 24. This is to prevent the metal case from shorting all the strips together at the ends. The prototype used

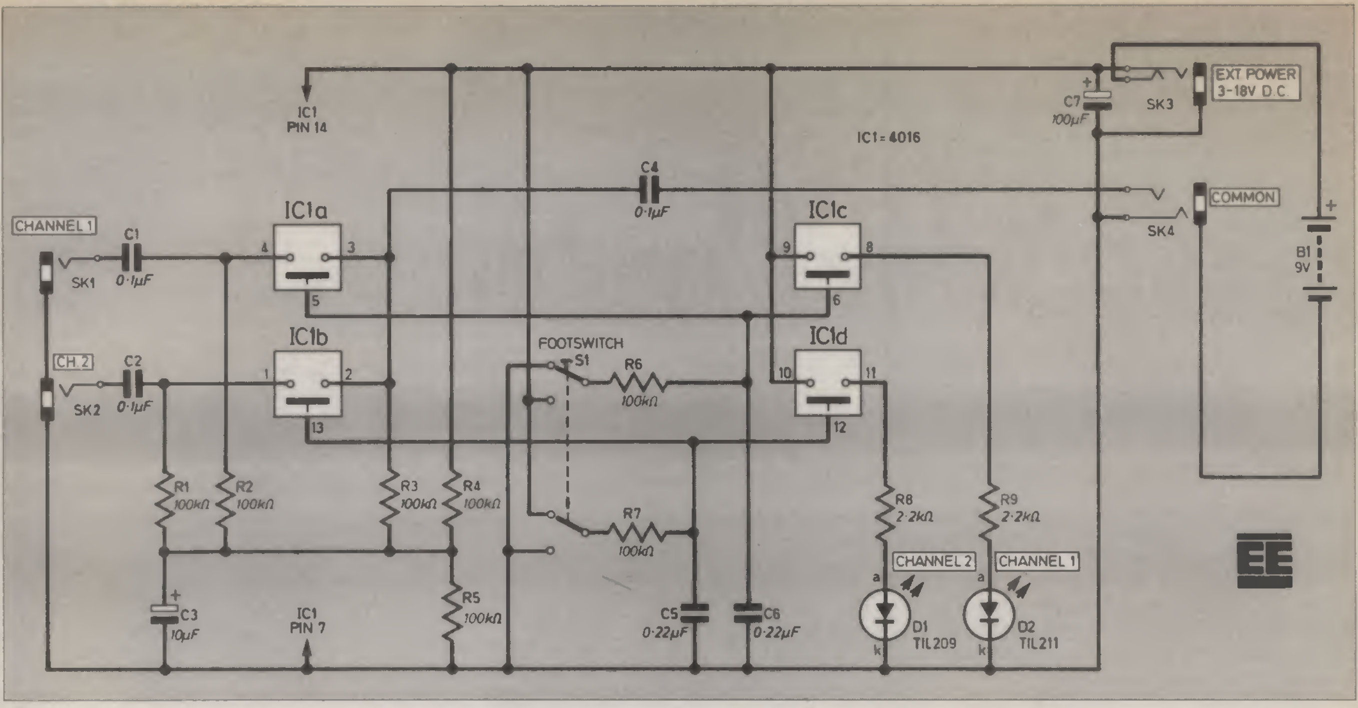


Fig. 1. Circuit diagram of the Channel Selection Switch. Note the insertion of a mono plug into stereo socket SK4, switches the unit on.

Veropins for all external connections to the circuit board, and these should be mounted next, if used.

The remaining components and wire links should now be fitted, IC1 not being inserted at this stage. Check that C3 has been connected the correct way round, there is usually a + marked on the body, identifying the positive lead.

CASE

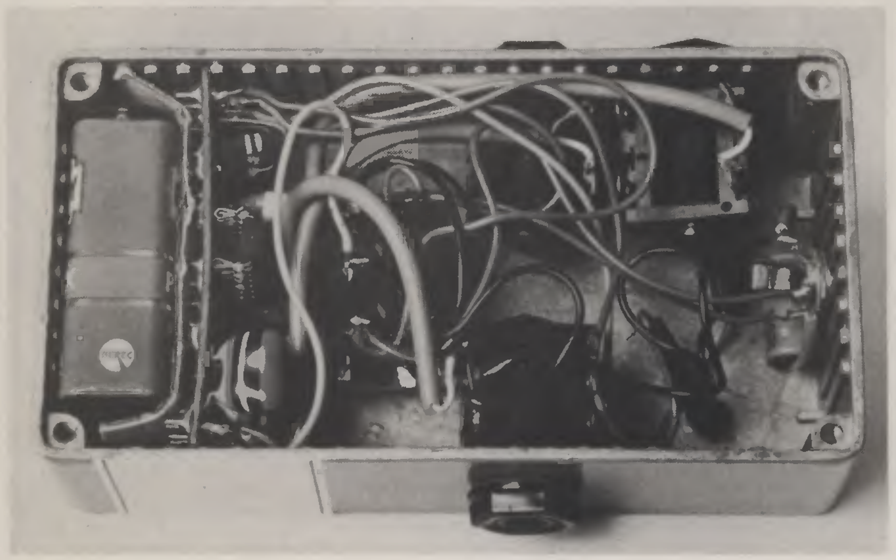
The case should not be prepared. The prototype used an aluminium diecast box, sized 120 × 65 × 40mm. This has internal vertical guide slots which were used to hold the circuit board in place. This box provides good screening for the circuit and is also very robust, an important requirement for a foot-operated unit.

The stripboard is fitted into the case as shown in Fig. 2. A piece of cardboard should be placed between the board and battery as shown, to insulate the underside from the battery casing. Note that if the footswitch is mounted too close to the end of the case, the circuit board and battery may not fit.

The case should have two holes for the l.e.d.s and one for the footswitch drilled in the top, three holes for the 0·25in jack sockets and one for the 3·5mm jack socket drilled in the sides, the general layout for these holes being obtained from Fig. 2. Burrs should be removed from the insides of the holes, and the sockets and switch fitted. The l.e.d. holders should not be fitted at this stage.

The circuit board should now be wired

View inside the case of the finished unit showing wiring details.



COMPONENTS

Resistors

R1–7	100kΩ (7 off)
R8,9	2·2kΩ (2 off)

All ¼W carbon ±10%

Capacitors

C1,2,4	0·1μF polyester C280 (3 off)
C3	10μF 25V tantalum bead
C5,6	0·22μF polyester C280 (2 off)
C7	100μF 25V elect.

Semiconductors

IC1	4016B CMOS quad bilateral switch
D1	TIL209 3mm red l.e.d.
D2	TIL211 3mm green l.e.d.

Miscellaneous

SK1,2	0·25in mono jack socket (2 off)
SK3	3·5mm jack socket with break contact
SK4	0·25in stereo jack socket
B1	9V PP3 battery
SW1	d.p.d.t. footswitch

Stripboard 0·1in matrix, size 11 strips × 24 holes; aluminium diecast box size 120 × 65 × 40mm; 14-pin d.i.l. socket; PP3 battery clip; l.e.d. clips to suit D1 and D2; lightweight single-core screened cable; 7/0·2mm stranded wire; short length of sleeving.

Approx. cost
Guidance only **£7**

up to the external components in accordance with Fig. 2, the connections to S1, D1, D2 and SK3 being made with insulated, stranded wire. It is advisable to make all flying leads long enough to allow the board to be removed from the case. Place sleeving over the connections to D1 and D2 as a precaution against accidental short circuits. On the l.e.d.s, the flat on the package denotes the cathode (k) which is connected to 0V. Care should be taken when soldering to the l.e.d.s, as these can be overheated and the leads break off easily.

The use of wire of various colours, such as can be obtained from a short length of multicore cable, will lead to less mistakes and greatly simplify fault finding. Connections to SK1, SK2 and SK4 are made using single-core screened cable. It may also be advisable to use sleeving on the leads of C7, and care should be taken to ensure correct orientation of this component.

On the prototype the case was connected to 0V via the metal body of SK3, however, if a different type of socket is used for this it may be necessary to make a separate chassis connection.

TESTING

When all wiring has been completed, IC1 can be inserted, taking care to avoid touching the pins, and to insert the i.c. the right way round. The battery can now be connected and the unit checked. A 0·25in mono jack plug should be inserted into SK4, and this should cause one of the l.e.d.s to light. If the footswitch is now operated, the other l.e.d. should light. If neither, or both, l.e.d.s light (together), disconnect the battery and recheck the wiring.

Once the unit is functioning correctly, with the battery disconnected all the circuitry can, with care, be removed in one piece to facilitate painting of the case. The prototype was given two coats of grey spray-on primer, and then three coats of green spray paint, each coat being allowed to dry before applying the next. Once the final coat was dry, the front of the case was lettered with Letraset. This done, the case was given two coats of clear polyurethane varnish to give protection to the lettering. Finally, four self-adhesive plastic feet were fixed to the lid so as to give the unit a grip on the floor.

All of this done, the l.e.d. holders may now be fitted into their holes, and the circuitry returned to the case, the l.e.d.s being pushed into their respective holders.

IN USE

As was explained earlier, the primary use of the Channel Selection Switch is in switching between two inputs on a twin channel amplifier. This connection is shown in Fig. 3a. The two amplifier inputs may have separate tone and volume controls, or may be simply "normal" and "bright" inputs. If the constructor is fortunate enough to own two amplifiers, then the unit could even be used to switch between these.

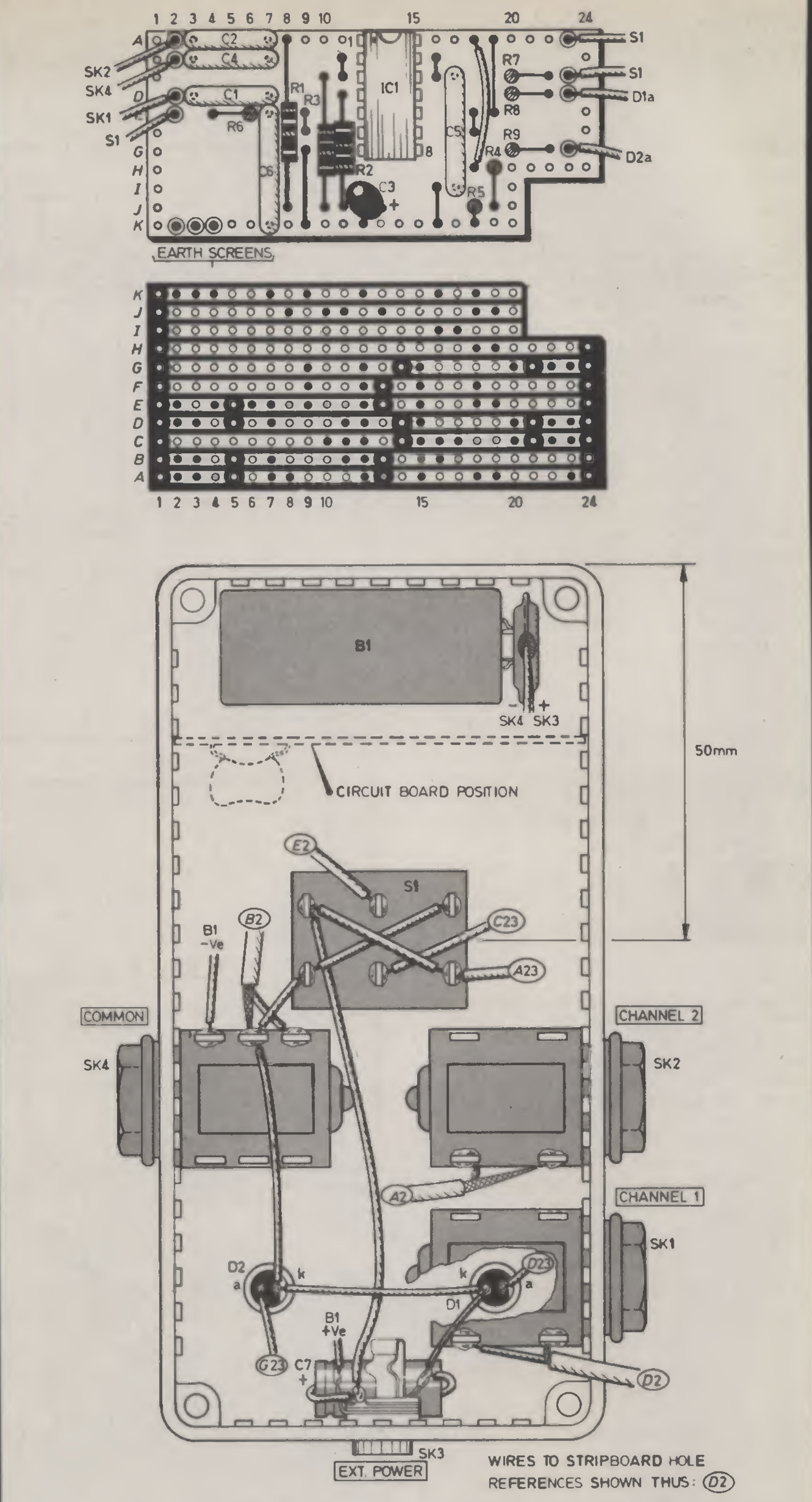
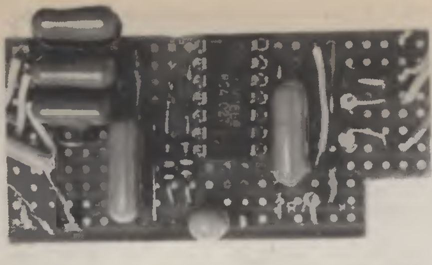


Fig. 2. Circuit board layout and case assembly diagram for the Channel Selection Switch. Interwiring details are also given and note that the 0V connection to the board is made via the earth screens of the screened cables from SK1, SK2 and SK4. The position of the board is shown dotted and a piece of cardboard must be placed between the board and the battery, B1.



The input to the Channel Switch can be from an organ, guitar, synthesiser, and so on, since most signal levels can be accommodated. Cross-talk from one channel to the other is negligible; however, if a very large signal of several volts peak-to-peak is present, some breakthrough to the other channel may occur and in this case the offending signal should be attenuated.

Also previously mentioned was the fact that the Channel Selection Switch can be used to switch an effects pedal in and out of circuit silently. This application is shown in Fig. 3b. It is particularly useful to be able to switch an effects pedal silently when recording. The unit can also be used to select one of two effects pedals. It is impossible to do this with the normal series connection of effects pedal units, since one must be switched off and the other switched on, requiring two foot actions. The set-up for this is illustrated in Fig. 3c.

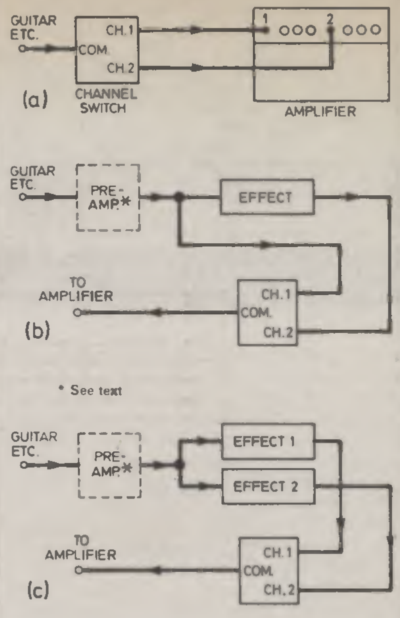


Fig. 3. Applications of the Channel Selection switch showing; (a) switching between two inputs on an amplifier; (b) switching an effects pedal in and out silently; and (c) switching between two effects with one foot action.

In both Figs. 3b and 3c the effects units should be left on all the time. A problem may be encountered here, as some effects pedals owing to their design, alter the signal at the input as well as at the output. For example, some distortion pedals distort the signal at the input to an extent.

The result of this in the configuration shown in Fig. 3b could be that the untreated signal is altered by the effect. This is only apparent with a low-level signal from a high impedance source such as a guitar or microphone, and with many effects units may not be noticeable at all. The remedy is to place a pre-amplifier as shown dotted in Figs. 3b and 3c. This could be a simple home-made unit or one of the many pre-amp/line driver pedals that are commercially available.

It should be noted that Figs. 3b and 3c require a two-way lead for connection to the instrument.

If the unit is to be used with a bass guitar then the values of C1, C2 and C4 will need to be increased, some experimentation being required to find the most suitable values. If it is desired to prolong the life of the battery then the power consumption can be cut by omitting D1 and D2; however, battery drain is low since IC1 is CMOS, and only one l.e.d. is on at a time. If external power is to be used, SK3 may have to be altered to suit the power supply. □

CIRCUIT EXCHANGE

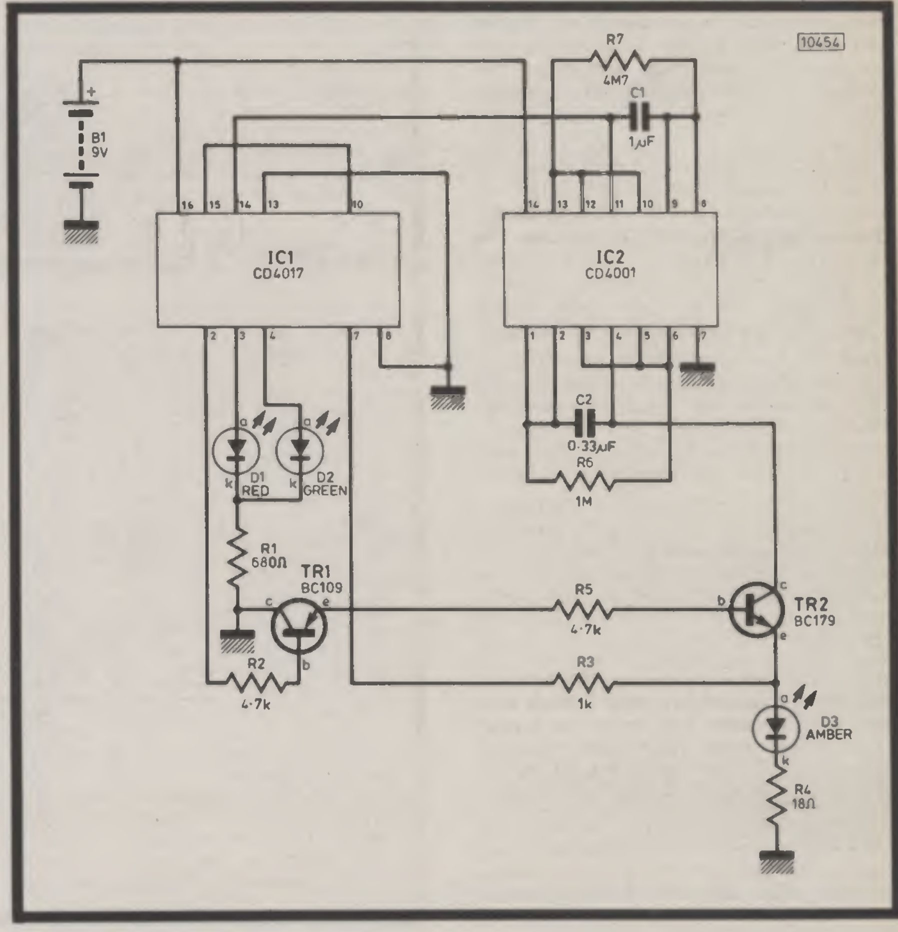
This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part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

PELICAN TRAFFIC LIGHT WITH FLASHING AMBER

This circuit will emulate the operation of a pelican crossing using three l.e.d.s. The sequence of lights is; red, flashing amber, green, then amber and back to red.

The l.e.d.s are controlled by the first four outputs of the Decade Counter (IC1), with the fifth output acting as the reset. The counter derives its clock pulses from an oscillator constructed using two NOR gates. This forms half of IC2, the other half being used as an oscillator to flash the amber l.e.d., via TR1 and TR2.

Mark Ellis,
Wembley,
Middlesex.



RADIO WORLD

BY PAT HAWKER G3VA

CQ Mars

In the March *Radio World* it was noted that Rugby Radio (GBR), which operates on the very low frequency of 16kHz (18,750 metres), has world-wide coverage. When this transmitter, with its enormous aerial, was built in the mid-1920s it was the world's most powerful radio station—and therein rests a curious tale of misplaced enthusiasm. With its very low frequency, the ionosphere forms a virtually impenetrable barrier both by day and night. But in the 1920s much less was known about the ionospheric layers, and the Post Office became involved in a series of attempts by believers in a Martian civilisation to send telegrams via GBR to their extra-terrestrial friends.

In particular, a Dr. Mansfield Robinson, who claimed to be already in telepathic communication with Martians, persuaded the Central Telegraph Office to accept messages addressed to Mars. He also tried less successfully to persuade the Post Office to change the frequency of GBR to 10kHz (30,000 metres), which he believed would be more successful! The text of one message, in what Dr. Robinson said was Martian language, read cryptically: OPESTI NIPITIA SECOMBA, but another included LOV TO MARS X ERTH. *He insisted on this spelling.*

Correct Tariff

The Post Office officials were much concerned to charge Dr. Robinson the correct tariff and to make sure that actual delivery of the message was not guaranteed. They decided that 1s 6d (7·5p) per word was appropriate and suggested dual transmission (15p per word). For the three mysterious groups Dr. Robinson duly sent a cheque for nine shillings (45p). GBR was instructed to call M M M DE GBR before sending the telegram.

A CTO official was anxious that the Post Office should not turn away a potential source of revenue and memo'ed: "Dr. Robinson is singularly serious in this business and we may expect other messages from him. I do not think we could have any conscience-pricking as regards taking his money for he is perfectly sane and seems to have devoted his life to the study of possible intercommunication with the planet. In fact, he said that a colleague of his had obtained as long as four years ago definite signals from Mars, but was a 'weak-kneed scientist' who refused to allow the information to be published."

In 1926–29 the "secret" messages to Mars blew-up into a major sensation with columns of comment in the popular press. Newspapers sought unsuccessfully to have reporters at the St. Albans receiving station, where a listening watch was carried out for possible replies from Mars. A Grace Walker at Rhyl joined in by sending a telegram to Mars, c/o Postmaster General "Love to Mars". Scientists discussed at length the views of Dr. Robinson. Cartoonists had a field day from his description that Martians men were 7ft 6in high, the women 6ft high, and they ate three electrified apples a day—their young hatched out of eggs.

Today, I suspect it would cost you more than 45p to send a British Telecom message to Mars, delivery guaranteed or not. Meanwhile, the full story of GBR's deep space communications is preserved in the Post Office archives.

More Use VHF/FM

For many years the broadcasters in the UK have been urging us to listen to radio on VHF/FM rather than medium/long wave a.m. Better quality with extended frequency and dynamic ranges, less electrical and co-channel interference, and the added attraction of stereo. Yet the occasional surveys have shown repeatedly that most people, for most of the time, listen on a.m., although with considerable regional variations. One reason is the much greater use of a.m. car radios, another the lower cost a.m. portables. Others include: ease of tuning, dislike of fiddly telescopic aerials and batteries being more quickly exhausted. But there is another, less often mentioned, reason: listeners dislike change and prefer to stick with what they know. It is young people who tend to make most use of new technology and bring about a gradual swing to new systems.

For many years, large numbers of American listeners similarly stayed faithful to a.m., and the f.m. commercial stations had a hard struggle to survive. One result was the introduction of Subsidiary Communications Authorisation (SCA) that provided each f.m. station with the possibility of putting out an independent monophonic channel by using a subcarrier centred on 67kHz. The SCA facility could be used for extra revenue-earning services, such as providing continuous background music for local stores, known as store-casting.

Today, most Americans have grown up with f.m. and in the major urban areas this accounts for up to two-thirds of radio listening, with Dallas (Fort Worth), Texas, the highest at 69·4 per cent; Chicago being 54·7 per cent. The market with the highest share of a.m. listening is San Francisco, with 42·7 per cent of the radio audience.

The swing towards f.m. in recent years accounts for the growing interest of a.m. broadcasters in their own brand of stereo, though this is still beset by the problem of four competing systems.

F.M. broadcasters have further benefited from a recent relaxation of the FCC rules governing the use of SCA, permitting the use of two SCA sub-carriers instead of one, and allowing these to be used for virtually any purpose. Emerging as one possibility is the use of the second sub-carrier to provide radio-paging over an area, or even national basis.

Although the SCA system has never been adopted in Europe, the digital "Radiodata" proposals are nearing adoption as a standard transmission capable of many applications—including radio-paging, though such an application in the UK would clearly be subject to DoTI approval.

Detecting Lies

The decision to introduce the use of the polygraph or lie-detector into UK security and intelligence establishments goes to show how the authorities can be misled by pseudo-science. A devastatingly critical article in the highly-respected scientific journal *Nature* by David Lykken of the University of Minnesota puts it thus: "The ever-expanding dependency on this pseudo-scientific technique, in the face of both reason and evidence, implies an alarming degree of irrationality among decision-makers in private industry, in the criminal justice system and even at the highest levels of government".

He points out that the type of polygraph test used for screening job applicants for high-security posts assumes that physiological reaction to accusatory questions is evidence of deception. He adds: "There is no credible scientific evidence concerning the validity of such screening tests. Since highly socialised persons (religious, conscientious persons) tend to fail polygraph tests even when truthful, whereas poorly socialised persons—or sophisticated ones such as the KGB agents trained at their anti-polygraph school in Poland—tend to pass such tests even though lying, it is possible that the use of polygraph screening may produce results that actually are opposite to those intended."

David Lykken shows that the idea that it is possible to test the truth of a criminal's statement from a "tremor in the blood" goes back to Daniel Defoe in 1730. It was a Californian police officer who developed, in the 1920s, the first recording polygraph which made continuous tracings of breathing movements and "average" blood pressure, and his assistant produced a portable instrument in 1930.

David Lykken insists: "All anyone can determine from a polygraph chart is that the subject was more aroused or disturbed by one question than by another; one cannot tell why he was disturbed, or whether the question elicited guilt or fear or anger." It is all rather like the traditional check of looking for blushing, trembling, averted eyes and other indications of guilty nervousness—and just as liable to come up with the wrong answer.

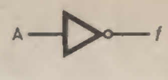
In one notorious case in the Pentagon, 36 members of the US Defence Resources Board were tested to find who had leaked information. The polygraph identified just one guilty person—later proved innocent. The real culprit was not identified and therefore must have sailed through his polygraph test!

SQUARE one FOR BEGINNERS

A	B	f
0	0	0
0	1	1
1	0	1
1	1	1

$f = A + B$

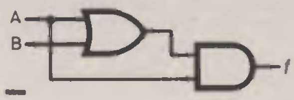
Fig. 2. OR gate truth table and symbol.



A	f
0	1
1	0

$f = \overline{A}$

Fig. 3. INVERTER truth table and symbol.



$f = (A + B).A$

Fig. 4. Simple two-gate circuit.

A	B	A+B	(A+B).A
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

Fig. 5. Truth table for Fig. 4.

STANDARD dual-in-line integrated circuit logic packages now appear in almost every project in EVERYDAY ELECTRONICS. The way these i.c.s can be connected to do useful things can really only be understood by making use of the "truth table" for each package. Fortunately, this is actually very easy, given a prior knowledge of a few simple logic equations. The use of these equations is usually called Boolean Algebra, after George Boole, who formalised this method of reasoning in 1847.

BOOLEAN EQUATIONS

Consider the 2-input AND gate, Fig. 1. The output (f) is true—logical 1 or 5 volts—only when both A and B inputs are true. The symbol for the AND function is a dot, and we can write A.B = f. This is obviously a convenient shorthand for "f is true only when both A and B are true". Similarly, the OR function, Fig. 2, can be written in this shorthand way using the standard symbol for logical OR, which is "+".

Table 1 below gives some standard Boolean equations: the bar over a letter indicates inversion, and an inverter, together with its symbol and truth table is shown in Fig. 3.

The equations may look odd at first, but it must be remembered that they make statements about logical events. The equation A + 0 = A, for example, says that if one of the inputs to a 2-input OR gate is held low (0), then the output will be the same as whatever appears on the other input, A. This can only be 0 to 1, so the equation says, "For a 2-input OR gate, when one input is permanently low (at zero volts), the output will be low when the other input is low, and high when it is high".

In a similar way, A.1 = A applies to a 2-input AND gate with one of its inputs permanently high.

SIMPLIFYING LOGIC CIRCUITS

As an introduction to the usefulness of this notation, consider the circuit of Fig. 4. Inputs A and B are first OR'd together and then the result is ANDed with A to produce the output. In shorthand, (A + B).A = f.

But a glance at Table 1 shows us that this is just A—in other words the whole circuit could be replaced by a single piece of wire. To show that this is true, the truth table of Fig. 5 demonstrates that the output follows the A input exactly.

ANALYSING LOGIC FUNCTIONS

The notation extends to gates with three, four, or more inputs, and can also be extremely helpful in analysing circuits. As a simple example, consider Table 2. This is a table for a gate which gives a true output when either one, but not both, of its inputs are true. This is known as the Exclusive-OR function, and such gates are available as logic packages. By noting under what conditions the output is true (that is, either not-A AND B, or A AND not-B), its equation can be written as $f = \overline{A}.B + A.\overline{B}$. Further, if such a gate was necessary but not available, it could be constructed directly from this equation by making use of inverters, AND gates and OR gates connected together as in Fig. 6.

Table 1. Some standard Boolean equations

$A + 0 = A$	$A.0 = 0$	$A + A.B = A$	$(\overline{A + B + C}) = (\overline{A}.\overline{B}.\overline{C})$
$A + 1 = 1$	$A.1 = A$	$A + \overline{A}.B = A + B$	$(\overline{A.B.C}) = (\overline{A} + \overline{B} + \overline{C})$
$A + A = A$	$A.A = A$	$A.(A + B) = A$	
$A + \overline{A} = 1$	$A.\overline{A} = 0$	$A.(B + C) = A.B + A.C$	

A	B	f
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 1. AND gate truth table and symbol.

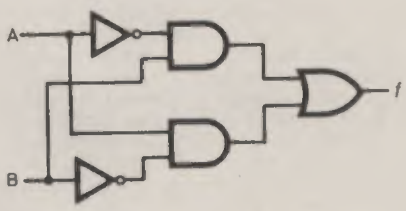


Fig. 6. Circuit for A EX-OR B.

Table 2
Exclusive-OR truth table

A	B	f
0	0	0
0	1	1
1	0	1
1	1	0

CIRCUIT EXCHANGE

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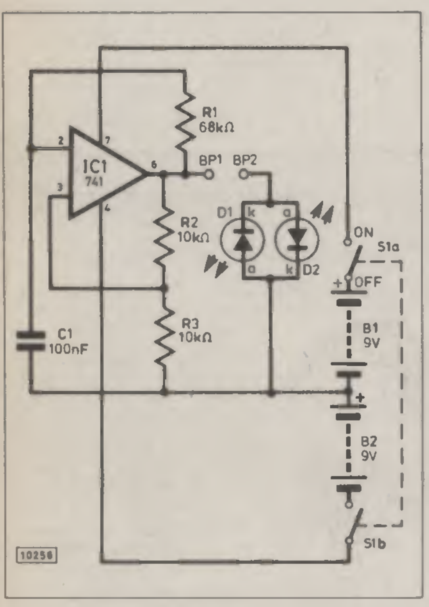
SIMPLE AND QUICK DIODE TESTER



Most electronics experimenters seem to have plenty of diodes in their junk boxes, either salvaged from old units or purchased at low bulk prices. The problem is to find out which diodes are good, which are bad and in the case of the former, which end is which (cathode or anode).

Of course most diodes can be tested using a conventional ohmmeter. However, there are simpler ways, one being to use the diode checker described here.

Simply by connecting a diode's leads to its binding posts (in either polarity), you can tell whether or not it is good and identify the anode and cathode.

Op-amp IC1 forms a simple square-wave oscillator whose output swings from about full positive to full negative levels with respect to ground. If a good diode is connected between BP1 and BP2 with its cathode toward BP1, D1 is forward biased and glows. D2 remains dark because it is reversed biased. If the diode is reversed so that its anode is at BP1, D2 glows and D1 is dark. If a diode is connected which is open circuit, D1 and D2 will remain dark and if a short circuit is connected, both D1 and D2 will light.

Hamid-Reza Tajzadeh
Tehran,
Iran.

DIGITAL CAPACITANCE METER

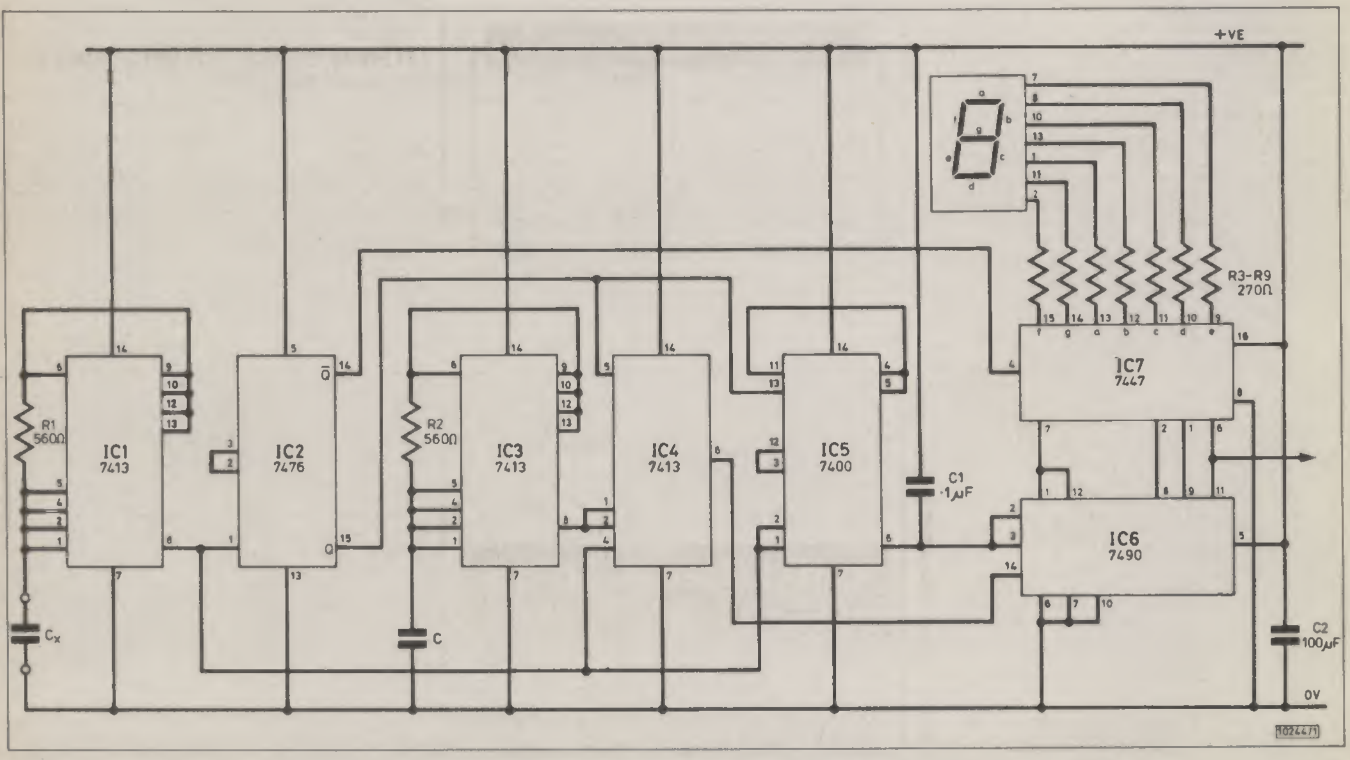
This is a low cost design for a capacitance meter which can be used with a one or two digit display. If two digits are used, over 10 per cent accuracy can be obtained.

The unit works by counting pulses, the frequency of which is dependent on the value of the capacitor under test. A gate control is set up at a known frequency (selected by the switched capacitor), which enables and resets the decade counter. If Cx = C then one pulse is counted, if Cx = C times 10 then 10 pulses are counted; i.e., the counter reads the number of times Cx is greater than C. To produce different ranges, C can be switched to give 10nF, 100nF, 1µF, 10µF and 100µF.

The square-wave generator, IC3, produces pulses of a frequency set by C. These are counted through the gate IC4 for a period governed by the square-wave generator IC1. The display is driven by IC7 which converts the outputs from the decade counter IC6.

This circuit could easily be fitted into a suitable box to make a good quality test instrument.

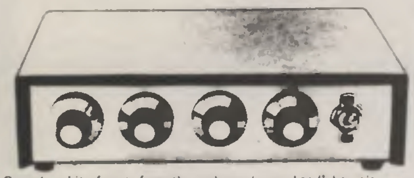
W. A. Adam,
Kettering, Northants.



PREVIOUSLY ADVERTISED STILL AVAILABLE

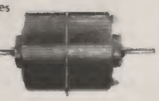
Tape punch and reader	£22.50
Bench isolating transformer 250 watt	£7.75
BOAC in-flight stereo unit	£1.50
Drill assortment 4 each 25 sizes between .25mm & 2.5mm	£11.50
Battery condition tester, less box	£1.75
Nicad chargers, mains	£0.75
Flourescent inventor 13 watt from 12v	£3.50
Ten digit stitch pad pb phone etc.	£1.95
Uniselector 2 pole 25 way	£4.60
Water valve mains operated	£2.50
Counter 6 digit mains operated	£1.15
ditto 12v resettable	£3.45
Double glazing clear PVC sheet, 23½" wide per running ft.	£0.15
Locking mechanism with 2 keys	£1.15
Magnetic Clutch	£4.50
Mouth operated suck or blow switch	£2.30
Solenoid with slug 8 - 12v battery op.	£1.82
ditto 230v mains	£2.30
Timer Omron STP NH 110v AC Coil	£6.90
Key switch with 2 keys dp mains	£1.75
Air valve mains operated	£3.75
Latching relay mains operated	£3.50
Dry film lubricant aerosol can	£0.65
Coin op switch, cased with coin tray	£4.60

8 POWERFUL MODEL MOTORS (all different)
for robots, meccanos, drills, remote control planes, boats, etc. £2.95.



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

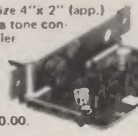
12 volt MOTOR BY SMITHS
Made for use in cars, etc. these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. They have a good length of ¼" spindle — **Price £3.45.**
Ditto, but double ended £4.25.
Ditto, but permanent magnet £3.75.



EXTRA POWERFUL 12v MOTOR
Probably develops up to ¼ h.p. so it could be used to power a go-kart or to drive a compressor, etc. £7.95 + £1.50 post.

THERMOSTAT ASSORTMENT
10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 — 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 - however, you can have the parcel for £2.50.

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.



— 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

Hi Fi sound from your Spectrum 1 watt amp — pm speaker & instructions £2.45

REVERSIBLE MOTOR with control gear
Made by the famous Framco Company this robust motor is approx 7½" long, 3½" dia. 3/8" shaft. Very powerful, almost impossible to stop. Ideal for operating stage curtains, doors, ventilators, etc. Even garage doors if properly balanced. Offered complete with control gear as follows:
1 Framco motor with gear box — 1 push to start switch
1 manual reversing & on/off switch — 2 limit stop switches
1 circuit diag. of connections — ONLY £19.50 + postage £2.50.

FOR SOMEONE SPECIAL
Why not make your greeting card play a tune? It could play 'Happy Birthday', 'Merry Christmas', 'Wedding March', etc. or 'Home Sweet Home', etc. Wafer thin 3 part assemblies, for making cards musical. Mini microchip speaker and battery with switch that operates as the card is opened. Please state tune when ordering. Complete, ready to work £1.25.

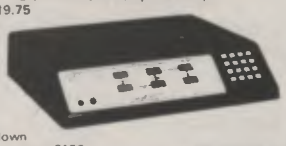
JOYSTICK
WHY PAY £10 OR MORE — Make yourself a Joystick — full details were given in Dec/Jan 'Sinclair Projects'. We will supply complete kit for £2.30. Although designed for the Spectrum or ZX81 it is equally suitable for any home computer.

TELEPHONE ITEMS (ex-GPO)

Plug and Wall socket — 4 pin or 5 pin	£3.45
Plugs only 4 pin or 5 pin	£1.15
Modern desk telephone	£7.50
Heavy black old type	£5.50
External bell unit	£6.50
Bell ringing power unit	£4.50
Pick up coil	£1.15

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

PRESTEL UNIT
— brand new and complete except for 7 plug in IC's — Price: £19.75 + £2.00 p&p.
Note: British Telecom may not connect this equipment as there is no manufacturer to guarantee it, however it is well worth buying for its immense breakdown value — sold originally at over £150.



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

BELLS & ALARMS

Hooter/Siren 6v - 12v	69p
Loud, med & soft buzzer	75p
Open buzzer ex G.P.O.	50p
12" Gong cast iron cased ALARM BELL 12v dc	£19.50
6" Gong 12v dc	£7.50
6" Gong mains	£8.50

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.

TELEPHONE & INTERCOM CABLES
15 conductors colour coded 200mt coil £59.00
10 conductors colour coded 200mt coil £39.00
Flex extension lead twin rubber
.5mm ideal grass cutters etc .250mtn coil £25.00
50 meter coil £6.75

MAINS TRANSFORMERS

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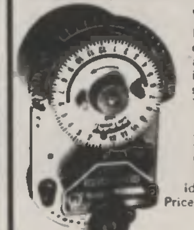

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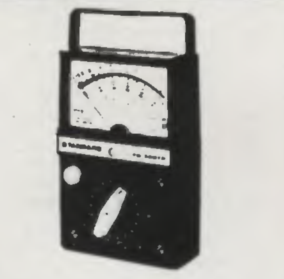

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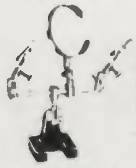

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