EVERYDAY ELECTRONICS and computer PROJECTS

NOVEMBER 1983 90p

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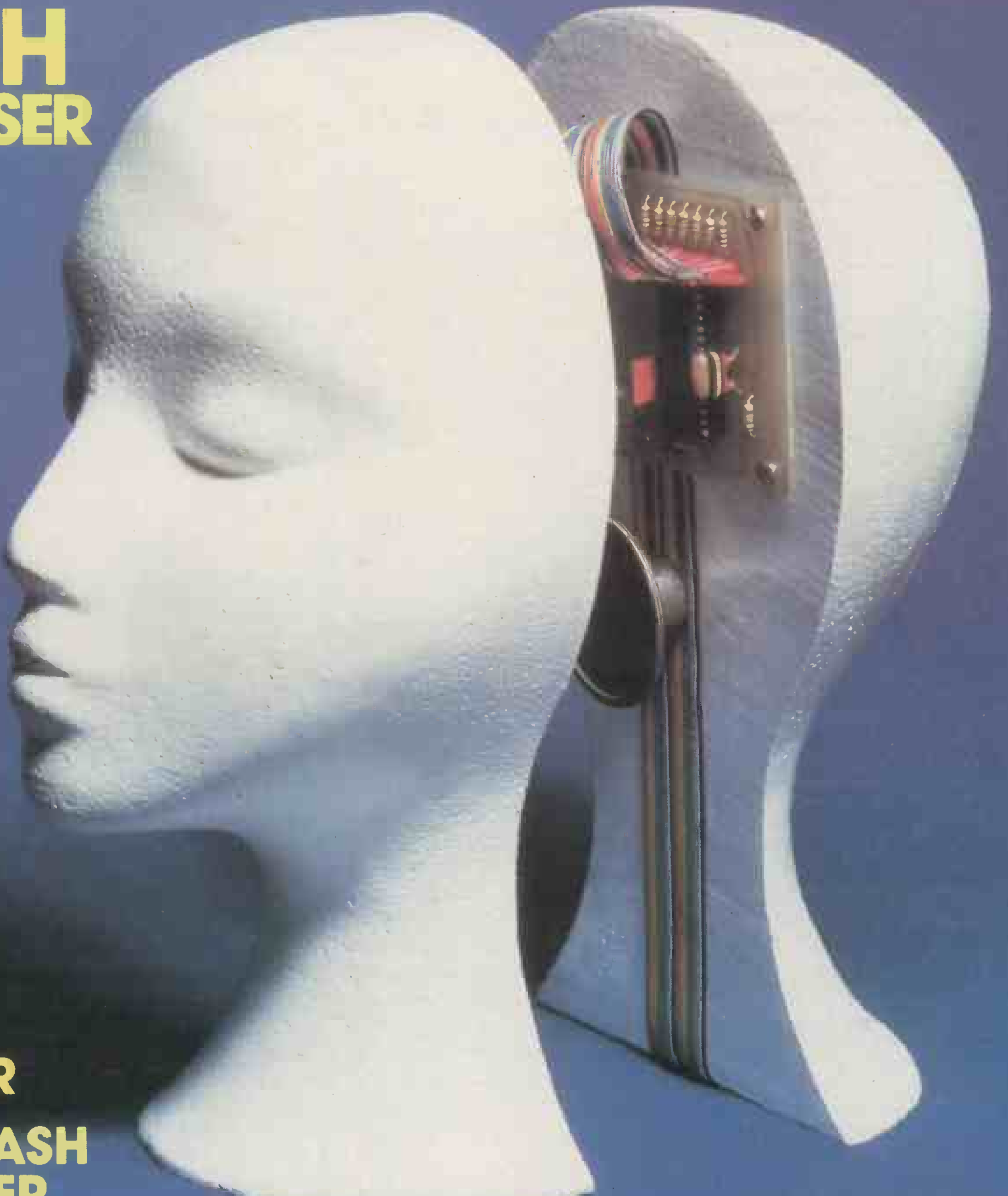

DIGITAL GAUSS METER

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MULTIMOD MUSICAL EFFECTS

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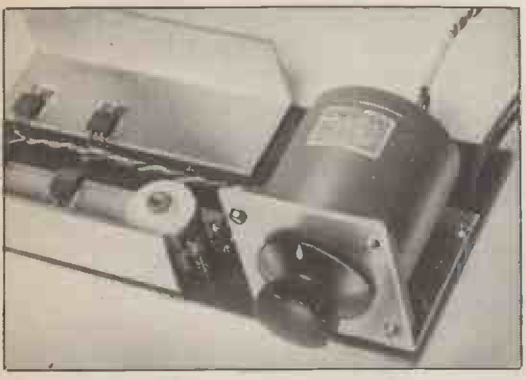
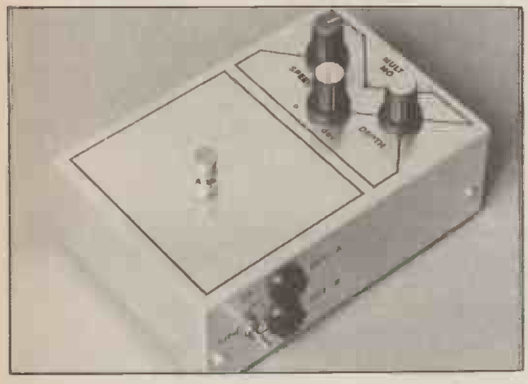
EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 11 NOVEMBER 1983

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





PROJECTS

SERIES

FEATURES

Our December 1983 issue will be published on Friday, November 18. See page 731 for details.

BI-PAK BARGAINS

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4 AMP – 400v – T0202 – TAG 136G

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VP13	50	Silver Mica Caps Ass. 5.6pf – 150pf	£1.00
VP14	50	Silver Mica Caps Ass. 180pf – 4700pf	£1.00
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VALUE PACKS

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VP34	200	Sil. Diodes Gen. Purpose Like OA200/BAX13/16	£1.00
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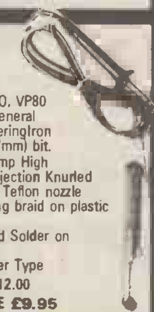
VP37	8	Black Instrument Type Knobs With Pointer ¼" Std	£1.00
VP42	10	Black Heatsinks To Fit TO-3, TO-220 Ready Drilled	£1.00
VP43	4	Power-Fin Heatsinks 2 × TO-3 2 × TO-66 Size	£1.00
VP44	1	Large Power Heatsink 90 × 80 × 35 mm Drilled For Up To 4 TO-3 Devices	£1.00
VP45	50	BC107/8 Type NPN Transistors Good Gen. Purpose Uncoded	£1.00
VP46	50	BC177/8 Type PNP Transistors Good Gen. Purpose Uncoded	£1.00
VP47	10	Silicon Power Trans. Similar 2N3055 Uncoded	£1.50

BI-PAK SOLDER – DESOLDER KIT



Kit comprises: ORDER NO. VP80
1 High Quality 25 watt General Purpose Lightweight Soldering Iron 240v mains incl 3/16" (4.7mm) bit.
1 Quality Desoldering Pump High Suction with automatic ejection Knurled anti-corrosive casing and Teflon nozzle
1.5 metres of De-Soldering braid on plastic dispenser
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OUR SPECIAL KIT PRICE £9.95

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1 Sheet PCB Transfers 210mm × 150mm
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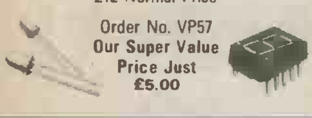
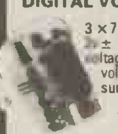


Order No. VP57
Our Super Value Price Just £5.00

DIGITAL VOLT METER MODULE



3 × 7 segment displays Basic Circuit. 0–2v ± instructions provided to extend voltage & current ranges Operating voltage 9/12v. Typ. Power Consumption 50mA

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SINGLE SIDED FIBREGLASS BOARD

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Comprising 4 × 1½ Amp rectifers mounted on PCB.
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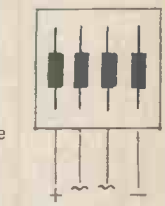

Size: 1 inch square
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IC BARGAINS

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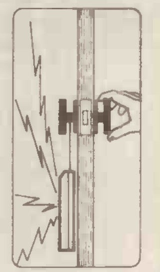

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LITRONIX DL 707R 14-pin

Red 0.3" Common Anode Display 0-9 with right hand decimal point TTL compatible 5v DC Supply. Data supplied

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AC125	30p	BC183C	12p	MPSA56	30p	ZTX500	18p	2N1308	80p
AC126	30p	BC183L	12p	MPSU05	65p	ZTX501	18p	2N1613	36p
AC127	30p	BC183LB	12p	MPSU56	60p	ZTX502	18p	2N2222A	30p
AC128	30p	BC184	12p	OC22	150p	ZTX503	18p	2N2369A	28p
AC132	90p	BC184B	12p	OC23	150p	ZTX504	30p	2N2646	68p
AC141	30p	BC184L	12p	OC26	100p	ZTX531	30p	2N2904A/5A	30p
AC142	30p	BC186	30p	OC28	200p	ZTX550	30p	2N2906A	60p
AC176	30p	BC187	30p	OC36	220p	2N696	35p	2N2907A	30p
AC187	30p	BC212A	14p	OC41	75p	2N698	45p	2N2926G	12p
AC188	30p	BC212L	12p	OC42	75p	2N699	40p	2N2926R	12p
AD149	80p	BC213	12p	OC70	60p	2N706A	26p	2N2926Y	12p
AD161	45p	BC213B	12p	OC76	60p	2N708	30p	2N3053	30p
AD162	45p	BC213L	12p	OC81	60p	BC237	18p	2N3054	75p
BC107	12p	BC214	12p	OC82	60p	BC238B	18p	2N3055E	60p
BC107A	14p	BC214B	14p	OC84	50p	BC307	18p	2N3442	150p
BC107B	14p	BC214L	12p	TIP29	30p	BC308	14p	2N3615	200p
BC108	12p	BF194	14p	TIP29A	35p	BC327	16p	2N3702	12p
BC108A	14p	BF195	14p	TIP29B	50p	BC328	16p	2N3703	12p
BC108B	14p	BF198	14p	TIP29C	45p	BC337	16p	2N3704	12p
BC108C	14p	BF199	14p	TIP30A	40p	BC338	16p	2N3705	12p
BC109	12p	BF200	35p	TIP30B	50p	BC441	36p	2N3706	12p
BC109B	14p	BF224B	20p	TIP30C	45p	BC461	36p	2N3707	12p
BC109C	14p	BF244B	35p	TIP31	38p	BC477	40p	2N3708	12p
BC140	35p	BF256	35p	TIP31A	40p	BC478	40p	2N3710	12p
BC141	35p	BF257	35p	TIP31B	40p	BC517	45p	2N3711	12p
BC142	35p	BF258	35p	TIP31C	45p	BC547	15p	2N3771	200p
BC143	35p	BF259	35p	TIP32A	40p	BC548	15p	2N3772	200p
BC147	12p	BF594	40p	TIP32C	40p	BC549	16p	2N3773	200p
BC148	12p	BF595	30p	TIP36C	140p	BC556	20p	2N3819	25p
BC157	12p	BFR39	20p	TIP41A	50p	BC557	16p	2N3820	45p
BC158	12p	BFR79	30p	TIP41B	50p	BC558	16p	2N3823	50p
BC159	12p	BFR80	30p	TIP42A	60p	BC559	16p	2N3866	100p
BC160	50p	BFX29	30p	TIP42B	65p	BCY70	20p	2N3903	15p
BC161	45p	BFX84	30p	TIP120	80p	BCY71	20p	2N3904	15p
BC167	15p	BFX85	30p	TIP121	80p	BCY72	23p	2N3905	15p
BC168	12p	BFX87	30p	TIP142	120p	BD131	50p	2N3906	15p
BC169	12p	BFX88	30p	TIP2955	70p	BD132	50p	2N5172	30p
BC170	20p	BFY50	28p	TIS43	36p	BD133	60p	2N5194	80p
BC171	13p	BFY51	25p	TIS44	40p	BD135	50p	2N5457	42p
BC172A	12p	BFY52	25p	TIS90	30p	BD136	40p	2N5458	48p
BC173	13p	BFY90	80p	TIS91	30p	BD137	40p	3N128	85p
BC177	20p	BRY39	40p	VN10KMA	75p	BD138	40p	3N140	85p
BC178	20p	BSX20	30p	VN66AF	95p	BD139	40p	3N141	85p
BC179	25p	BSX29	35p	VN88AF	110p	BD140	45p	3N163	110p
BC181	23p	BU105	170p	ZTX107	12p	2N914	36p	3N201	110p
BC182	14p	BU205	200p	ZTX108	12p	2N918	30p	3N202	125p
BC182B	14p	BU208A	220p	ZTX109	12p	2N930	30p	40406	80p
BC182L	12p	MJ2955	90p	ZTX300	15p	2N1131	30p	40407	80p
BC183	12p	MJE340	50p	ZTX301	18p	2N1132	30p		
BC183B	12p	MJE371	90p	ZTX302	20p	2N1303	80p		

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

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

CMOS

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

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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

LINEAR

		CA3090	415p	LM339	80p	LM3911	140p	SAA5020		TDA1008	347p	TL074	117p
		CA3130	105p	LM348	90p	LM3914	285p	SN76013N	295p	TDA1022	570p	TL081	40p
CA1310E	185p	CA3140	52p	LM358	62p	LM3915	285p	TAA621A	290p	TDA1024	120p	TL082	65p
CA1350E	90p	CA3240	125p	LM380	85p	LM3916	285p	TAA661B	175p	TDA2002	150p	TL083	92p
CA3020	230p	ICM7555	105p	LM381	170p	MC1458	70p	TBA120B	70p	TDA2003	345p	TL084	65p
CA3028	110p	ICM7556	200p	LM382	130p	MC1488	80p	TBA120S	68p	TDA2020	350p	UA748	40p
CA3035	270p	LF347	200p	LM384	160p	MC1489	90p	TBA120U	98p	TDA2030	340p	ZN414	95p
CA3043	305p	LF351N	55p	LM386	100p	NE555	20p	TBA540O	161p	TDA2102		ZN424	150p
CA3055	85p	LF353N	100p	LM387	140p	NE556	55p	TBA651		TDA2522		ZN425	400p
CA3065	150p	LM224	150p	LM389	110p	NE564	405p	TBA800	95p	TDA9400		ZN426	345p
CA3080	80p	LM301	30p	LM732	55p	NE566	173p	TBA810S	110p	TL061	50p	ZN427	715p
CA3081	225p	LM308	100p	LM747	75p	NE567	161p	TBA820	81p	TL062	75p	ZN1034	230p
CA3085	145p	LM311N	81p	LM1458	45p	NE570	391p	TBA920Q	175p	TL064	150p	ZN1040	750p
CA3086	65p	LM318N		LM3900	70p	NE571	387p	TCA270S	171p	TL071	50p		
CA3089	230p	LM324	50p	LM3909	92p	SAA5010		TDA1004	345p	TL072	60p		

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22 pin	25p	24 pin	80p
24 pin	30p	28 pin	100p
28 pin	32p	40 pin	150p
40 pin	35p		

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 — 16p 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
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	450p			79L24	45p

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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

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2A/50V	35p	10A/200V	200p
2A/100V	45p	10A/400V	200p
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Range	Price (1-99)	(100+)
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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.

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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.

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VOL. 12 NO. 11 NOVEMBER 1983

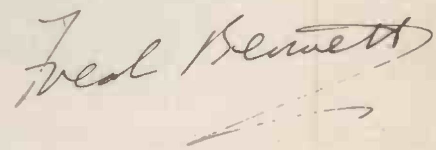
MORE THAN A GAME

THE popular fascination of home computers stems almost entirely from their ready use as fun machines. The ever-growing repertoire of software for games available in shops and stores in every high street, to say nothing of the products on offer through mail order, is sufficient proof of the manner in which most home computers are currently employed. It is indeed remarkable that a high proportion of computer users are hooked on this form of amusement and probably never even consider other more enlightened uses for their machines. For, with all due respect to the ingenious schemes conjured up by the compilers of these games, the end achievement must surely be considered flippant and banal considering the high technology involved and the tremendous capabilities of these machines.

Coincident with the dawning of the "leisure age", the arrival of the microcomputer has been most opportune. But it can give little satisfaction to contemplate the wide spread extension of the amusement arcade function while more meaningful applications of computing power have yet to be properly explored. What is possibly the most versatile tool of all to come into the hands of the ordinary person remains at present under exploited. Games software is heavily promoted and presented in attractive if often lurid packages; its appeal to the computer owner is understandable. But there is a real danger that by their very variety and abundance, games will divert attention from more serious and useful functions that this complex product of high technology is waiting to perform.

Apart from conventional data processing and computing tasks, the home computer has yet to make its impact as the brain centre for controlling external electrically operated systems or machinery. The essential link in such cases is electronic circuitry, the design and construction of which is well within the capabilities of the electronics enthusiast.

To this end computer owners will find much food for thought in our current series *Microcomputer Interfacing Techniques*. This month's article is concerned with computer control of stepper motors. There is also in this issue a one-off project for BBC Micro owners. Speech synthesis is a fascinating subject in its own right, and now thanks to large-scale integration, this faculty—unique otherwise to *homo sapiens*—can be added to an existing computer by means of the compact unit which is fully described in our pages.



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SPEECH SYNTHESISER FOR THE BBC MICRO

BY R.A. PENFOLD

THE normal method of communicating with a computer is to provide an input via the keyboard and to obtain an output by way of a monitor screen or printer, but these methods are used simply because they are easily implemented in practice, and not because they are invariably the most convenient to use. In many cases it would be far more convenient to give voice commands and to have the computer respond with a synthesised voice.

A great deal of research has been done in both these fields in recent years, and speech synthesis for small digital systems has been a practical proposition for some time now.

All simple methods of speech synthesis provide what is really quite a crude speech output, but intelligibility is adequate for most purposes. The problem with high quality speech synthesis is simply that it requires more memory than a small digital system can support (about 5 kilobytes per word).

This speech synthesiser project uses the GI SP0256 speech synthesiser chip which enables any desired words to be assembled and stored in a minimal amount of memory. The unit couples to the user port of the BBC Microcomputer (Model B), and its audio output can either be taken to an audio amplifier or fed to the analogue input of the computer 1MHz bus so that the speech is reproduced through the computer's internal loudspeaker.

SPEECH CHIP

The SP0256 is a very complex device which has a 2K × 8-bit ROM, a microcontroller, a 12-pole digital filter which models the human vocal tract, and a pulse width modulator. Fortunately this device is quite easy to use despite its complexity, and the block diagram of Fig. 1 shows a simple arrangement which works well in practice.

A 6-bit address bus is used to select the required sound or "allophone". The SP0256 does not have a store of complete words, but instead 64 basic sounds (including pauses) are available, and words are produced by stringing the appropriate allophones together.

This gives slightly inferior speech quality when compared to systems which store complete words, but it has the advantage of simplicity in certain respects, and a reasonable representation of any word can be produced so that this system effectively has an unlimited vocabulary.

It is essential to have the SP0256 correctly syncronised with the microcomputer which supplies the allophone addresses, and as speech is a very slow process by electronic standards this really means slowing down the flow of the allophone address to the correct rate for the SP0256. This is achieved using two handshake lines.

In order to get the speech chip to reproduce the allophone designated by the address fed to the *address bus*, a pulse signal is applied to the *speak* input. The *wait* output then sends a signal to the computer until the selected allophone has been completed. The most simple way of halting the flow of addresses during these periods is to use a software loop controlled by the signal from the SP0256, and this is the system used here.

The output of the speech chip is a train of pulses at a fixed frequency, but the pulse width is varied so that the average output voltage can be set at any level between the two supply rails. In order to smooth out this pulse train into a proper audio signal it is merely necessary to process the signal using a low-pass filter.

The audio output level is quite low, and a high gain amplifier is used to boost the signal to a level that can fully drive the analogue input of the BBC computer, or any normal audio power amplifier. The output can also drive a crystal earphone incidentally.

CIRCUIT DESCRIPTION

Fig. 2 shows the full circuit diagram of the Speech Synthesiser for the BBC Microcomputer.

Resistors R1 to R7 are merely used to

The completed Speech Synthesiser for the BBC Microcomputer. Note the small recessed slot for the ribbon cable.

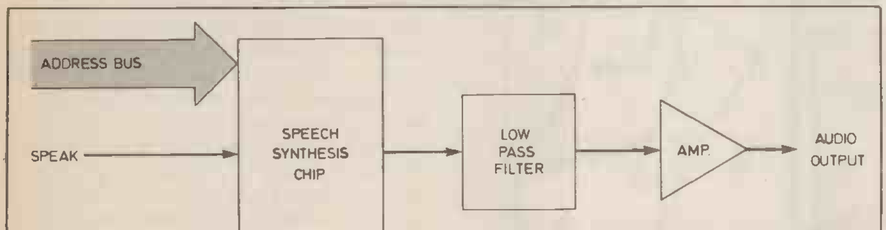

Fig. 1. System block diagram for the Speech Synthesiser.

protect inputs of the SP0256 (which is a MOS device) against static charges when the unit is not connected to the computer. The seven outputs and one input needed to operate the SP0256 could probably be provided by six of the user port data lines plus the two handshake lines (CB1 and CB2), but here the alternative method of using the 8 data lines (PBØ to PB7) is used.

PBØ to PB5 are used as the address bus, PB6 provides the "speak" pulse, and the "wait" signal from the SP0256 is taken to PB7. A slight problem was encountered with this system in the form of the audio output from the unit failing to cease at the end of the final allophone, but this was cured in the software (by adding a pause allophone at the end of each sequence) and not by any additional hardware.

A clock signal at about 3·2MHz is required, and the SP0256 has a built-in clock oscillator. This can be used with a crystal, but in this circuit inductor L1 is used instead, and by adjusting C3 the clock frequency (and pitch of the audio output) can be set at the desired level.

R8 and C1 are used to provide a negative reset pulse at switch-on.

R9 is the descrete load resistor for the output stage of IC1. The output amplifier uses TR1 as a high gain common emitter amplifier. An integrated circuit audio amplifier would probably not work well in this application due to the low supply potential of 5 volts (which is obtained from the user port of the computer). The low-pass filtering is provided by R10, C6, R11, C7 and C8.

COMPONENTS

Resistors

R1–7	1MΩ (7 off)
R8	100kΩ
R9	4·7kΩ
R10,11	22kΩ (2 off)
R12	1MΩ
R13	560Ω
R14	3·3kΩ

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See Shop Talk page 703

Capacitors

C1	100nF polyester
C2	100pF ceramic plate
C3	500pF compression trimmer
C4	270pF ceramic plate
C5	470nF polyester
C6	22nF polyester
C7,8	10nF polyester (2 off)
C9,10	100µF 10V elect. axial leads
C11	1µF 63V elect. axial leads

Semiconductors

IC1	SP0256 MOS speech synthesis i.c.
TR1	BC109C silicon *npn*

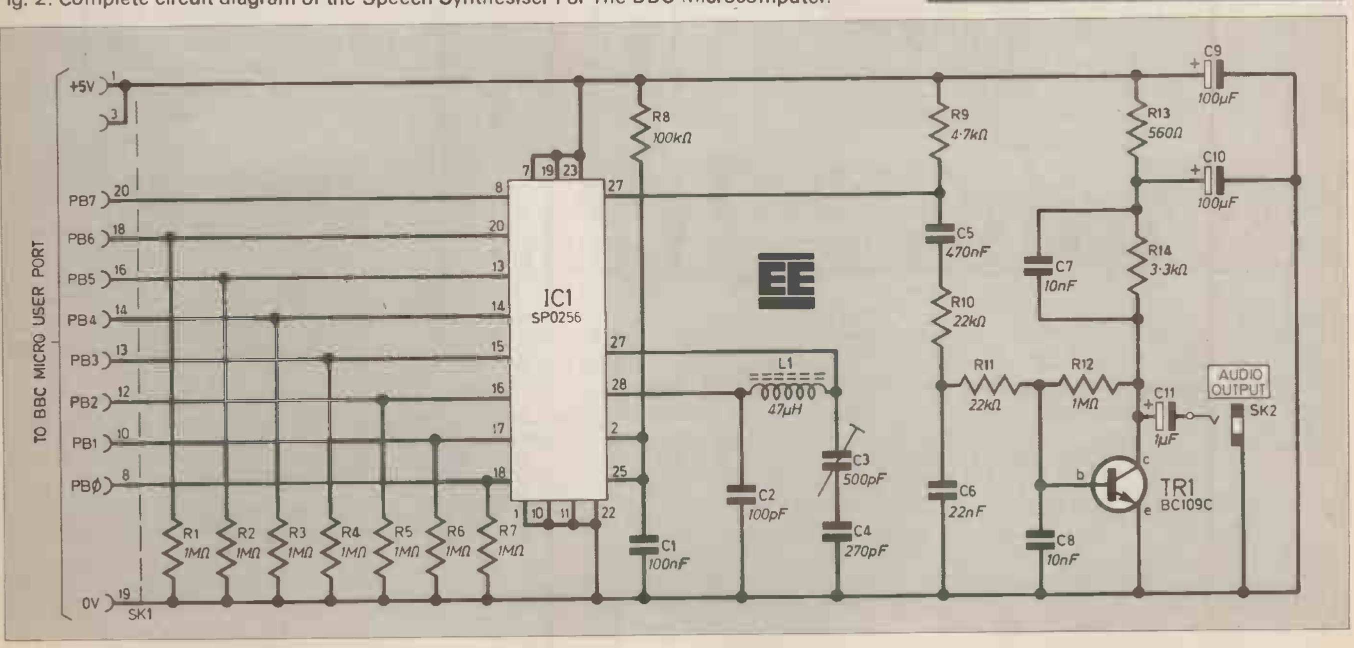
Miscellaneous

L1	47µH axial leads
SK1	20-way i.d.c. socket and cable to suit BBC Micro User Port
SK2	3·5mm jack socket

Printed circuit board: single-sided, size 107 x 72mm, *EE PCB Service,* Order code 8311–04; 28-pin d.i.l. socket; single-sided Veropins (20 off); 3·2mm screws, nuts, washers and 5mm long spacers; plastics case size 150 x 80 x 50mm; 34-way i.d.c. cable socket (optional).

Approx. cost Guidance only £20

Fig. 2. Complete circuit diagram of the Speech Synthesiser For The BBC Microcomputer.



CONSTRUCTION

COMPONENT ASSEMBLY

The unit is constructed on a printed circuit board, the full-size master pattern of which is shown in Fig. 3. This board is available from the *EE PCB Service*, Order code 8311–04.

The layout of the components on the p.c.b. topside is shown in Fig. 4.

IC1 is a MOS device and is not one of the cheapest i.c.s available at present. It should therefore be mounted in a (28-pin d.i.l.) i.c. socket, and it should not be plugged into position until the board is otherwise complete. Leave the device in its protective packaging until it is time to fit it onto the board, and handle it as little as possible. Make quite sure that IC1 is plugged in the right way round.

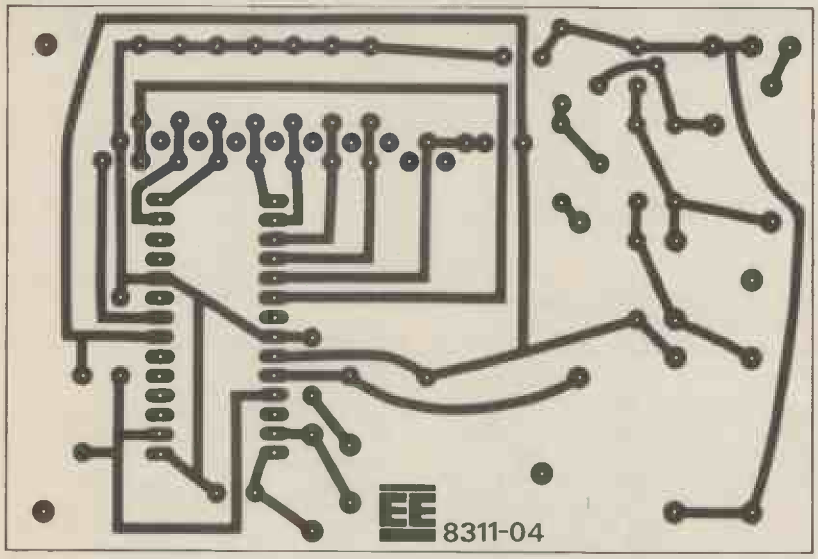


Fig. 3. Full size printed circuit board master. This board is available from *EE PCB Service*, Order code 8311-04.

Trimmer capacitor C3 requires a mounting hole about 5mm in diameter, and its tags are connected to the board using Veropins or short pieces of tinned copper wire.

RIBBON CABLE

The board is connected to the user port of the computer using a 20-way ribbon cable fitted with an i.d.c. header socket (which fits into the user port). The free end of this lead is wired to the printed circuit board, and this task will be much easier if the board is fitted with Veropins, and both the pins and leadout wires are tinned with solder prior to soldering them together. It is advisable to buy the cable and header socket ready-wired together. Be sure to connect the lead to the board the right way round (refer to page 499 of the "User Guide" if you are unsure about the user port pin numbering) and make sure that none of the leads are accidentally crossed over. The cable/Veropin connections should be sleeved as can be seen in the photograph, so remember to slide on the sleeving before making the soldered connection.

CASE

The completed board will fit into a plastic box having approximate outside dimensions of 150 × 80 × 50mm, but practically any case of about the same

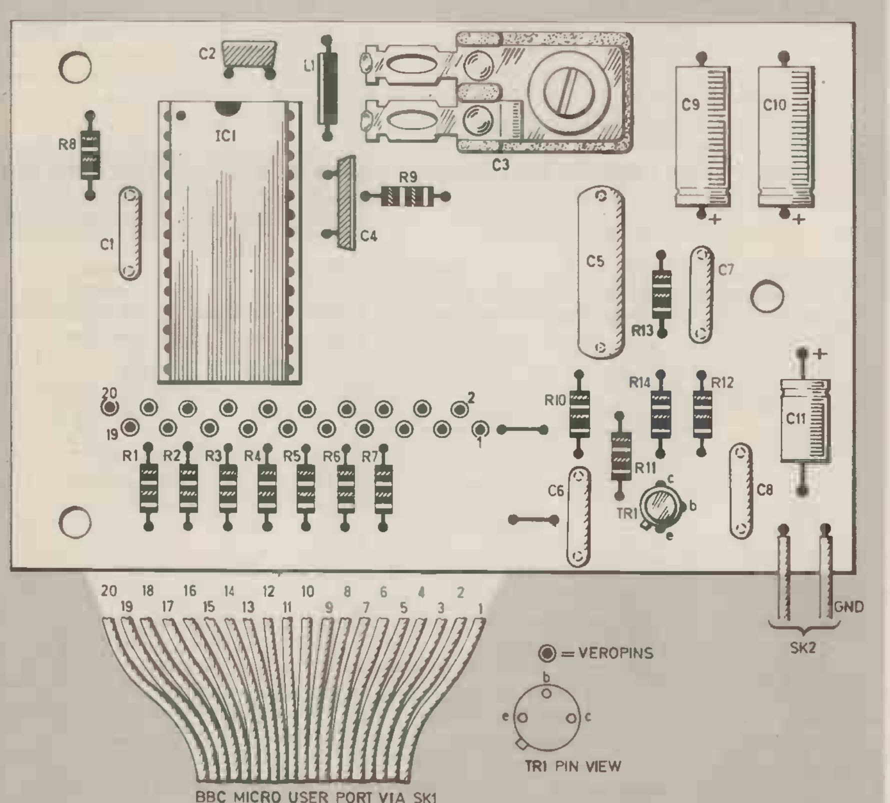


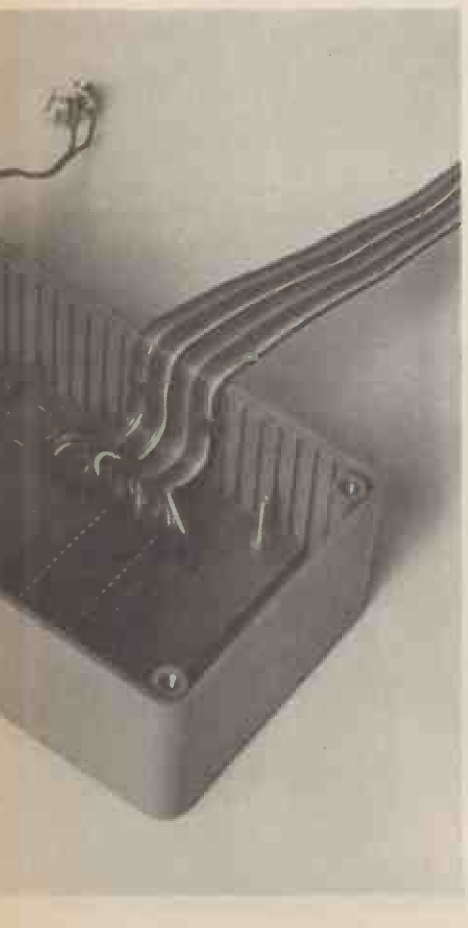
Fig. 4. Layout of components on the topside of the p.c.b. with wiring to BBC User Port.

Completed unit with lid removed showing ribbon cable gripper and sleeving over the cable/Veropin connections.

Table 1. Complete list of allophones and their addresses

ADDRESS	ALLOPHONE	EXAMPLE WORD	ADDRESS	ALLOPHONE	EXAMPLE WORD	ADDRESS	ALLOPHONE	EXAMPLE WORD
0	10ms PAUSE		22	UW1	tO	44	NG	aNchore
1	30ms PAUSE		23	AO	AUght	45	LL	Lake
2	50ms PAUSE		24	AA	hOt	46	WW	Wool
3	100ms PAUSE		25	YY2	Yes	47	XR	repaiR
4	200ms PAUSE		26	AE	hAt	48	WH	WHile
5	OY	bOY	27	HH1	He	49	YY1	Yes
6	AY	skY	28	BB1	daB	50	CH	CHurch
7	EH	End	29	TH	THin	51	ER1	summER
8	KK3	Comb	30	UH	bOOk	52	ER2	bURn
9	PP	Pit	31	UW2	fOOd	53	OW	nOW
10	JH	dodGe	32	AW	OUt	54	DH2	THey
11	NN1	thiN	33	DD2	Do	55	SS	veST
12	IH	sIt	34	GG3	wiG	56	NN2	No
13	TT2	To	35	VV	Vest	57	HH2	Hoe
14	RR1	Rural	36	EG1	GUest	58	OR	stORe
15	AX	sUcceed	37	SH	SHip	59	AR	alArm
16	MM	Milk	38	ZH	aZure	60	YR	cleaR
17	TT1	parT	39	RR2	bRain	61	EG2	Got
18	DH1	THey	40	FF	Food	62	EL	saddLe
19	IY	sEE	41	KK2	sKy	63	BB2	Business
20	EY	bEIge	42	KK1	Can't			
21	DD1	coulD	43	ZZ	Zoo			

size should suffice. SK1 is a 3·5mm jack socket and it is fitted at any convenient point on the lid of the case. It will be necessary to file away part of the main section of the case, and possibly part of the lid as well, in order to provide an exit hole for the ribbon cable. Due to the thinness of the cable only a very narrow slot needs to be made. A self-adhesive gripper for the ribbon cable could be fitted to the case internal side to relieve any strain on the cable soldered connections.



If the audio output of the unit is to be coupled back into the computer a 34-way i.d.c. header socket will be needed. The output of SK1 is then coupled to pin 16 of the header socket which in turn connects to the 1MHz Bus of the computer. The diagrams on pages 499 and 503 of the "User Guide" should help to clarify matters if you are unsure about the correct method of connection.

The output signal is at a fairly low impedance and high level, and it is not necessary to use a screened lead to couple this signal to the 1MHz Bus.

USING THE UNIT

The simple program given below probably represents the most convenient way of using the unit, but the notes explain the basic way in which the program works, and you can of course devise your own program if you wish. Assuming the sample program is used, this could be placed in a program as a PROCedure which could be called up as necessary, and even using several separate PROCedures to obtain several phrases would not use up a great deal of memory space.

The numbers of the required allophones are listed in the data statement (line 90), but note that the number 64 must be added at the end of the allophone list to bring things to a proper conclusion and to prevent the program from simply "crashing" at the end.

Table 1 gives a full list of the allophones, but a few points need to be borne in mind when compiling phrases from these. You cannot simply take the letters of a word, look up corresponding allophone numbers, and then use these. As most letters can be pronounced in more than one way this is not feasable, and it is for this reason that there are more allophones than letters in the alphabet. Actually most of the allophones represent more than one letter.

The correct way of assembling words is to break them down into their constituent sounds, and then search for the allophones which give the best match for these sounds. This can be a little difficult at first, but with a little practice it soon becomes quite easy.

Be prepared to experiment a little, and if you are unsure which allophone is best

Speech Synthesis Software

```
 10  ?&FE62=127
 20  REPEAT
 30  READ A
 40  IF A<64 THEN B=A+64:C=A ELSE B=64:C=0
 50  ?&FE60=B
 60  ?&FE60=C
 70  REPEAT UNTIL ?&FE60>127
 80  UNTIL A>63
 90  DATA (values of allophones separated by commas . . .),64
100  STOP
```

suited to a certain position in a word simply try all the likely candidates to determine which one sounds the best.

PAUSES

It is important to use pauses correctly in order to obtain the best results. With the written word there are spaces between each word, but with the spoken word these pauses are often absent.

Construct sets of allophones to suit the way words are spoken and not the way they are written down. Paradoxically, you may find that adding brief pauses in the middle of words sometimes helps to give better results. In particular, adding a short pause ahead of the allophones which have an abrupt start (such as numbers 9, 33 and 63) can sometimes help to emphasise them and give a better sound.

In some cases there are two very similar sounds in the list, and this is where one is a longer sound which is likely to be best at the beginning of a word, and the other is a shorter sound which is likely to be better at the end of a word. However, there are no strict rules about the use of these and they can work best when used the other way round.

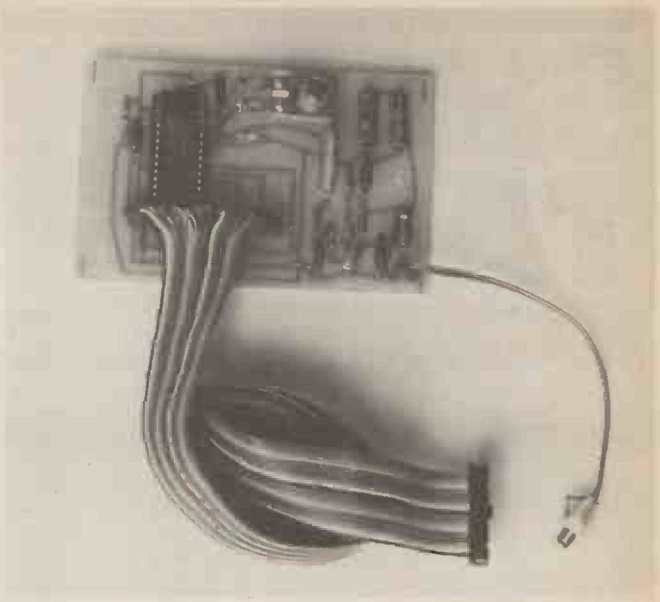
A few allophones can be doubled-up to give a longer sound (numbers 7, 12, 15, 23, 24, 26, 29, 30, 40 and 55), but with most this does not give acceptable results.

PROGRAM NOTES

Line 1Ø of the program sets up seven of the user-port lines as outputs. Lines 2Ø–4Ø are a REPEAT/UNTIL loop which sends the numbers of the allophones to the speech synthesis unit. The allophone numbers run from 0 to 63, so the loop is terminated when a number over 63 occurs. The numbers to be sent are held in data statements after the end of the loop.

As long as the number read from the data statement is less than 63, line 4Ø puts the value plus 64 into the variable B. This actually causes the start of the speech. Only a short trigger pulse is necessary, and line 6Ø cuts it off. Line 7Ø is a software pause which causes the program to wait until the synthesiser is ready for the next pulse.

When the value read from the data statement is 64, the program sends a "pause" value to the synthesis unit. If this was not done, the sound from the last allophone would continue indefinitely. The loop is then terminated, and the program ends.



The completed printed circuit board showing component layout, wiring to the audio output socket SK2 and ribbon cable attached to the micro 20-way user port socket.

THE PROGRAM AS A PROCEDURE

Normally, in a large program, it will be necessary to have the speech synthesis procedure able to produce several words or phrases, depending on the circumstances when the procedure is called—perhaps different answers in response to keyboard input, or a series of questions.

It is not necessary to have a separate procedure for each phrase. The various phrases can be held in separate data statements, and the line number of the phrase required can be passed to the procedure as a parameter. Within the procedure, RESTORE is used to set the DATA pointer to the required line. The following is a short example of how this is done. See page 105 of the "User Guide" for a full explanation of passing parameters.

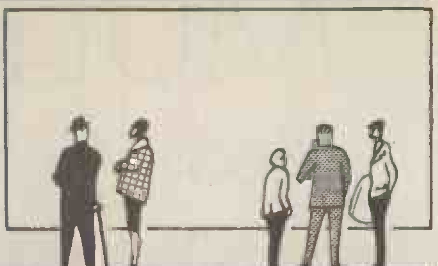
```
 9Ø  A$=GET$
1ØØ  IF A$="Y" THEN W=111Ø
       ELSE W=114Ø
11Ø  PROCspeech (W)
12Ø  . . . rest of program . . .
```

The procedure would be as in the listing below. Note that the name of the variable (in this case "W") does not have to be the same in the procedure and in the main program. □

Program Using Procedures

```
1ØØØ  PROCspeech (W)
1Ø1Ø  ?&FE62=127
1Ø2Ø  RESTORE W
1Ø3Ø  REPEAT
1Ø4Ø  READ A
1Ø5Ø  IF A<64 THEN B=A+64:C=A ELSE B=64:C=Ø
1Ø6Ø  ?&FE6Ø=B
1Ø7Ø  ?&FE6Ø=C
1Ø8Ø  REPEAT UNTIL ?&FE6Ø>127
1Ø9Ø  UNTIL A>63
11ØØ  DATA . . . . . .
111Ø  DATA . . . . . .
112Ø  DATA . . . . . .
113Ø  (as many data lines as required,
114Ø  each phrase ending with '64')
115Ø  ENDPROC
```

SHOP TALK



BY DAVE BARRINGTON

Catalogue Received

The latest Components (Sept-Dec) Catalogue from **Verospeed** certainly lives up to its title on the front cover, of being "The Electronics Superstore".

With over 300 pages of components ranging from advanced microprocessor devices to the humble resistor it is a catalogue to be treasured. An obvious bonus is the practice of each page to carry both the order code and price.

Copies of the Verospeed Sept-Dec 1983 Components can be obtained from: **Verospeed, Dept EE, Boyatt Wood, Eastleigh, Hants SO5 4ZY.**

Fault Finding

It was only two issues ago that we mentioned a company, Webb Logic Systems, prepared to "service" readers projects and return them in working order. We have now heard from a small company in Scotland who are prepared to offer the same type of service.

For more details readers should write to **John Williams (Electronics), Muirtown Basin, P.O. Box 18, Inverness, IV1 1YT, Scotland.**

Teach-In 84

Readers wishing to purchase kits for the new *Teach-In 84* series may obtain them from the following advertisers. Prices appear in their relevant advertisement in this issue.

SUPPLIERS OF KITS FOR TEACH-IN 84

Please refer to advertisement on page stated.

Bi-Pak *(page 695)*
PO Box 6,
Ware, Herts.

Greenweld Electronics *(page 752)*
43 Millbrook Road,
Southampton, SO1 0HX.

Magenta Electronics *(page 756)*
135 Hunter Street,
Burton-on-Trent, Staffs
DE14 2ST.

TK Electronics *(page 692)*
11 Boston Road,
London, W7 3SJ.

CONSTRUCTIONAL PROJECTS

Camera/Flashgun Trigger

The only component purchasing problems likely to be encountered when constructing the *Camera/Flashgun Trigger* is the supply of the "matched" infra-red emitter and detector devices.

The only source we have been able to locate for the supply of both the TIL100 and the TIL38 infra-red emitter and detector is Maplin. These are listed as Order code YH70M and YH71N.

Car On/Off Touch Switch

The relay used in the prototype model for the *Car On/Off Touch Switch* was an "Autolec" type obtained from an automobile spares shop. These relays usually have contact ratings of approximately 30A.

Other, cheaper 12V relays with less current capabilities may be used but the relay contacts must be able to handle the current requirements of the system being controlled.

Multimod Effects Unit

The semiconductor devices called-up for the *Multimod Effects Unit* are stocked by Benningcross Electronics and Maplin. Maplin stock all other components required for this project.

The Siemens type capacitors are also stocked by Rapid, Cricklewood, Electrovalue and Magenta Electronics.

Digital Gauss Meter

The Hall effect sensor, type UGN-3501M, used in the *Digital Gauss Meter* is an 8-pin Sprague device. This device is only available from Magenta Electronics Ltd., Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST.

All other components, including the display, are stocked by Maplin Electronic Supplies.

Microcomputer Interfacing Techniques

The stepper motor used in our model for the *Stepping Motor Board* was a Superior Electric "Slo-Syn" type purchased from Stewart of Reading, Dept EE, 110 Wykeham Road, Reading, RG6 1PL. The price for this motor is £15.53, including VAT and carriage.

The BD203 transistor is not very common, but any TO-220 *npn* transistor with a collector current rating not less than 3A, such as the TIP31A or TIP41A, will do.

BBC Speech Synthesiser

The speech synthesiser i.c., type SP0256, forming the "voice" of the *BBC Speech Synthesiser* project is obtainable from Maplin Electronic Supplies.

The 47μH coil is stocked by RS Components, Order code 228-163. This item will have to be ordered through a local stockist as they do not supply direct to the public.

EE PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service, see list right. 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, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

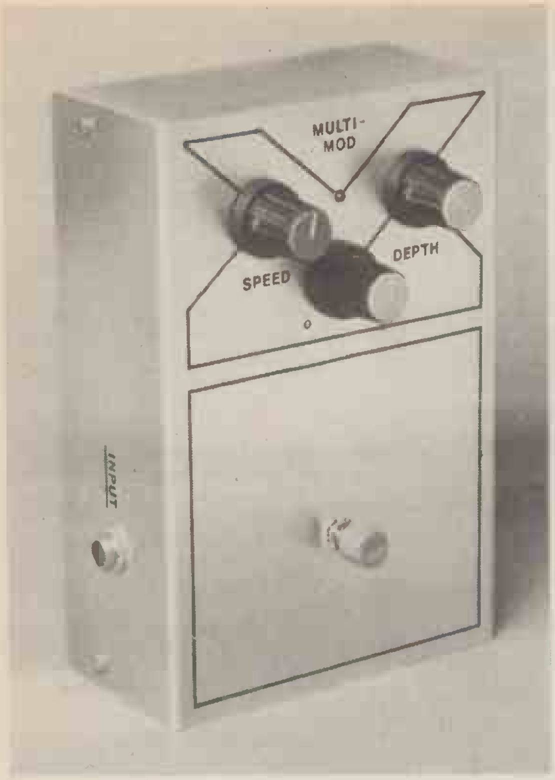
We regret that the ordering codes for the August projects have been incorrectly quoted in the Sept-Oct issues. Correct codes are give below.

Please note that when ordering it is important to give project title as well as order code.

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

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

*Set of four boards. M.I.T.— Microcomputer Interfacing Techniques, 12-Part Series.



MULTIMOD

MUSICAL EFFECTS UNIT

A VERSATILE SPECIAL EFFECTS UNIT THAT GENERATES A VARIETY OF OUTPUTS FOR ELECTRONIC INSTRUMENTS, INCLUDING TREMOLO, STEREO AUTO REPEAT, F2 AND DIFFERENTIAL MODULATION AND A MULTITUDE OF INDIVIDUAL SOUNDS FOR THE SERIOUS MUSICIAN.

By J. D. Rogers

TREMOLO depends on two circuit blocks, a Voltage Controlled Amplifier (v.c.a.) and a slow speed waveform generator or "control oscillator". There are many other effects possible using this basic v.c.a./oscillator arrangement, which is where the Multimod comes in.

It can be used just as a high quality tremolo, but other facilities have been added which bring the effects more into line with contemporary sounds. Noise, distortion, output impedances and battery drain are all low. An optional l.e.d. indicator is included which shows when EFFECT is selected by blinking at the modulation rate and just comes on approximately every 30 seconds when NORMAL is selected to indicate that the unit is still switched on.

A problem with many designs for this type of circuit is breakthrough of control voltages into the audio output causing clicks or thumps. This unit is free of these, partly due to the design of the component layout using two circuit boards at opposite ends of the case, one for the audio path and the other for the control voltages, thus keeping these physically isolated from each other. Using two small rather than one large board also makes construction easier and leaves excellent access to all components should this be necessary.

CIRCUIT DESCRIPTION

Low noise op-amps (two in one LF353 dual package) are used for the audio circuit but are not necessary for the control circuits so a low-cost quad op-amps (MC3403) is used there. See circuit diagram, Fig. 1.

The audio input is buffered and amplified by IC1a then fed to a v.c.a. which is formed by a field effect transistor (TR1) and IC1b. Source to drain resistance of f.e.t.s can be controlled by a voltage on their gate terminal. In this circuit, any change in the source-drain resistance will alter the gain of IC1b because the latter is an inverting amplifier stage whose gain is determined by the value of R9 divided by the value of R8 in series with the f.e.t.'s resistance.

So, by altering the control voltage to the f.e.t., the gain can be modulated. A d.c. voltage via R21 is used to set the resting bias to the required point so that a fluctuating voltage via C6 from a slow speed oscillator can then be added to cause modulation.

Shunt resistor R24 across the DEPTH control potentiometer VR3 makes its rotational "law" even more extreme than logarithmic, this is to allow controllable mild to strong tremolo effects in the first three-quarters of the potentiometer's rotation while still leaving available very strong modulations near the top of its range, where the effect becomes an enveloped "auto repeat".

Obtaining good modulation is not as easy as it seems. The f.e.t. could be biased by a hit and miss method to almost any point on its operational resistance curve and still give *some* sort of effect when modulated. There is, however, only a certain range where usable quality effects are given and an even smaller range where modulation is the smoothest, most symmetrical and distortion-free.

To set this optimum point would normally involve critical voltage measurements at the f.e.t.'s gate, but in this unit, by careful attention to levels and impedances it has been worked so that this point will be arrived at automatically when the f.e.t. is biased such that the *overall* gain between IC1a output and IC1b output rests at unity. This point can be found by a simple, but accurate, audible method, described later under the heading "Setting Up". The control oscillator modulates the gain both above and below this unity gain point.

For consistent results, the d.c. bias must not alter with changes in battery condition, so a diode (D1) is used to provide a stabilised reference voltage of about 0·6V, which is then amplified and adjusted by IC2a and the preset VR1 to give the required bias.

OPPOSITE PHASE

At the output, opposite phase signals from the v.c.a. and the pre-amplifier are mixed in set proportions via R10,11,12 and 13. This allows three differently modulated versions to be generated while needing only the one v.c.a./control oscillator system. It is only possible to do this because the v.c.a. can be set at a known point, as described above. R15 and R16 are used to trim the final levels to equal the original input volume. Two of the signals are fed to separate output jacks (SK2 and SK3) while the third is fed to a switch (S2) which can route it to either of the outputs.

Modulation of the two outputs is opposite, so as one is increasing, the other will be decreasing, while the switched effect is another type of modulation

"F2" which is described later.

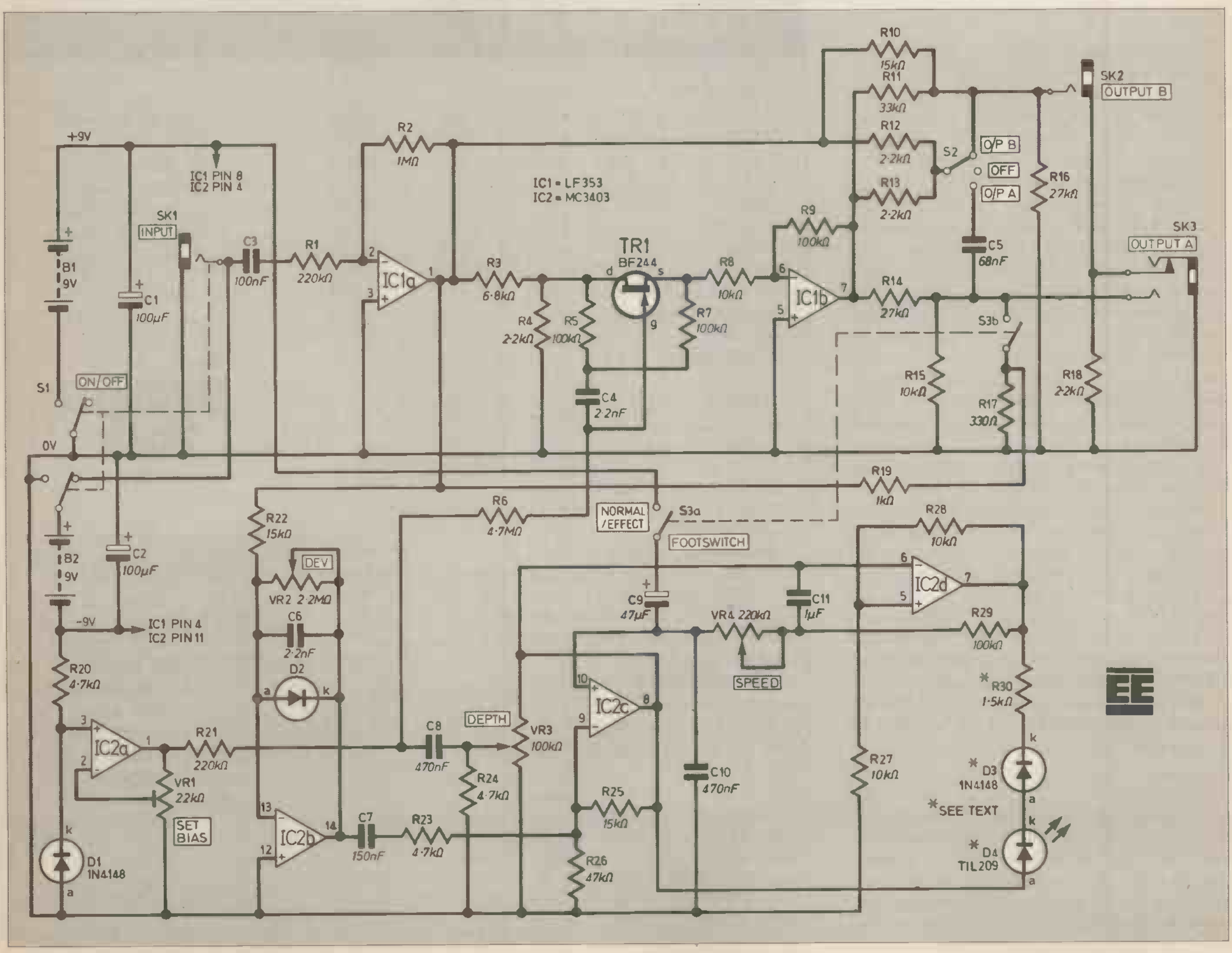
Instrument amplifiers always have an input impedance of at least 47 kilohms and so will have negligible loading effect on the output mixing networks of this unit.

Using f.e.t.s as audio modulators can cause distortion, but there is a method of cancelling this to insignificant levels and this is employed here. It consists of feeding the gate with a voltage equal to half the signal appearing across the drain and source terminals. This is performed by R5, R7 and C4.

The control oscillator consists of IC2c and IC2d, and is a novel design developed specifically for this unit to provide smooth waveforms over a wide frequency range. Added interest is given by the DEV circuit (Delayed Entry and Varispeed). This uses the audio input signal and amplifies and rectifies it to give a voltage that when fed to the control oscillator alters both the speed and size of its output.

This allows, for example, notes to be struck and the modulation to come in smoothly after a delay determined by how quickly the notes decay and how high the DEV control is set.

Fig. 1. Circuit diagram of the Multimod Musical Effects Unit.



CONSTRUCTION

CIRCUIT BOARDS

Two small circuit boards are required and can be obtained by cutting one of the standard sizes of Veroboard (37 holes by 35 strips) just to one side of its middle, leaving 17 copper strips on one piece (the control board) and 18 on the other (the audio board). Having cut the boards to size, make all the necessary breaks in the strips as shown in Figs. 2 and 3.

First solder onto the boards all the links and flat-lying resistors, then the i.c. sockets, the preset VR1, TR1, the capacitors and the upright resistors.

The SPEED and DEPTH potentiometers (VR3 and VR4) are soldered directly onto the control board, which is thus conveniently held in place within the unit when these potentiometers are mounted onto the case. Veroboard holes are slightly too small to accept potentiometer pins and so the relevant holes should be *slightly* enlarged using a small file or drill. The centre pin of VR3 needs to be bent backwards since it is soldered onto the *adjacent* copper strip to the other two pins. VR4's pins are simply left in line.

CASE

Drill the case as shown in Fig. 5. If a different case is used then the layout can be altered to suit *except* that VR3 and VR4 must be 48mm apart in order to fit, since they are a fixed distance apart on the control board.

Clean the case after this and letter it as required using Letraset or similar rub-down transfers. This must then be protected from wear using a clear varnish (such as the aerosol types available from Letraset). When the varnish is dry the panel components can be mounted, including the control board which is attached to two of the potentiometers.

The two output sockets are mounted above each other on one side of the case, and so the connection required between SK2 earth and SK3 earth-break-contact can be made by soldering these two pins together where they lie (see Fig. 4).

Interwire all components as shown using multi-stranded 7/0·2mm wire. It is always worth taking care to route all wiring as neatly as possible, as this can make the difference between a satisfying project and a troublesome "birds nest". Connections to the control board are easily routed down the edges of the case where they will be out of the way.

The audio board is retained at one end in between S2 and SK2/3, so S2 should be covered with a small piece of insulation tape to prevent the circuit board shorting against it. The other end of the audio board is conveniently held in place by using a self-adhesive Velcro mount. Stick one of the Velcro squares against the side of the case, the other square can then be bent into an "L" shape and pushed onto the square and against the

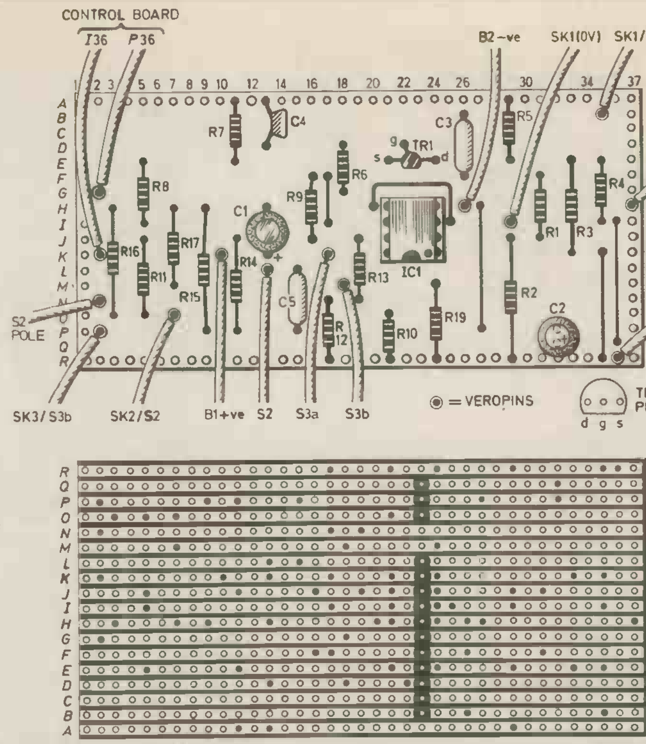


Fig. 2. Component board layout and underside view of the audio board.

COMPONENTS

Resistors

R1	220kΩ	R11	33kΩ	R21	220kΩ
R2	1MΩ	R12	2·2kΩ	R22	15kΩ
R3	6·8kΩ	R13	2·2kΩ	R23	4·7kΩ
R4	2·2kΩ	R14	27kΩ	R24	4·7kΩ
R5	100kΩ	R15	10kΩ	R25	15kΩ
R6	4·7MΩ	R16	27kΩ	R26	47kΩ
R7	100kΩ	R17	330Ω	R27	10kΩ
R8	10kΩ	R18	2·2kΩ	R28	10kΩ
R9	100kΩ	R19	1kΩ	R29	100kΩ
R10	15kΩ	R20	4·7kΩ		

All ¼W carbon ±5%

Capacitors

C1,2	100μF 10V elect. radial lead (2 off)
C3	100nF polyester C280
C4,6	2·2nF mylar (2 off)
C5	68nF polyester C280
C7	150nF polyester C280
C8,10	470nF polyester—Siemens type (2 off)
C9	47μF 25V elect.
C11	1μF polyester—Siemens type

See Shop Talk page 703

Semiconductors

D1,2	1N4148 silicon (2 off)
TR1	BF244 *n-channel* f.e.t.
IC1	LF353 dual op-amp
IC2	MC3403 quad op-amp

Additional components for l.e.d.

R30	1·5kΩ
D3	1N4148 silicon
D4	TIL209 3mm red l.e.d.

Miscellaneous

VR1	22kΩ miniature horizontal preset
VR2	2·2MΩ log. control potentiometer (Maplin FW29G)
VR3	100kΩ log. control potentiometer (Maplin FW25C)
VR4	220kΩ lin. control potentiometer (Maplin FW06G)
SK1/S1	6·3mm 2-pole jack socket with d.p.d.t. switch (Maplin BW80B)
SK2,3	6·3mm 2-pole switched jack normally closed (2 off)
S2	s.p.d.t. centre-off miniature toggle
S3	d.p.d.t. latching push-button (footswitch)
B1,2	9V PP6 battery (2 off)

Aluminium case, 153 x 102 x 51mm (Maplin type AB13); 0·1in matrix stripboard, 37 holes by 18 strips and 37 holes by 17 strips; control knob (3 off); 14-pin i.c. holder; 8-pin i.c. holder; battery clip (2 off); 7/0·2mm wire.

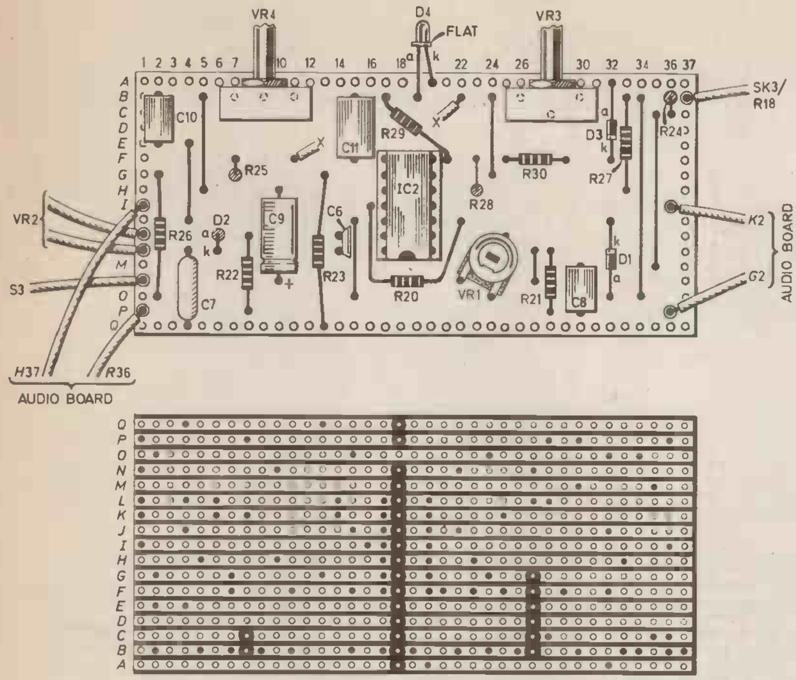
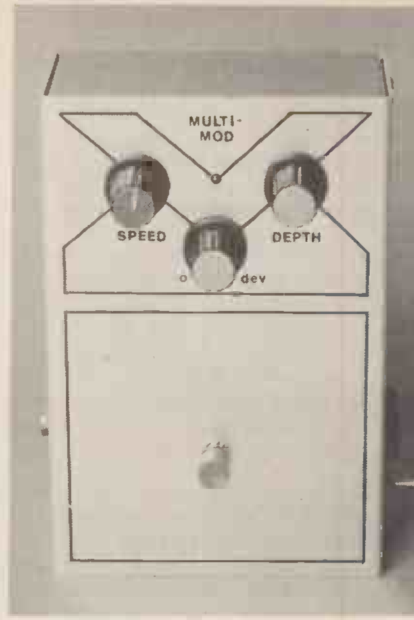
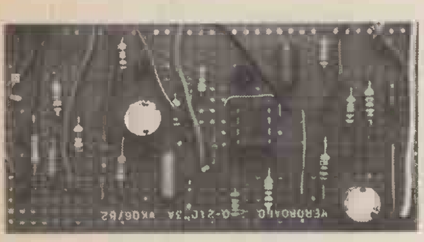
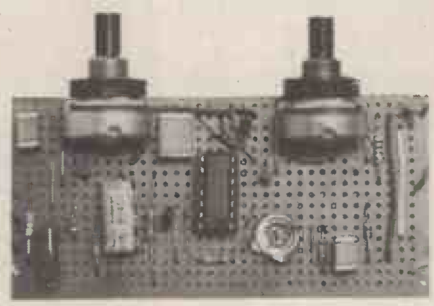


Fig. 3. Component board layout and underside view of the control board.



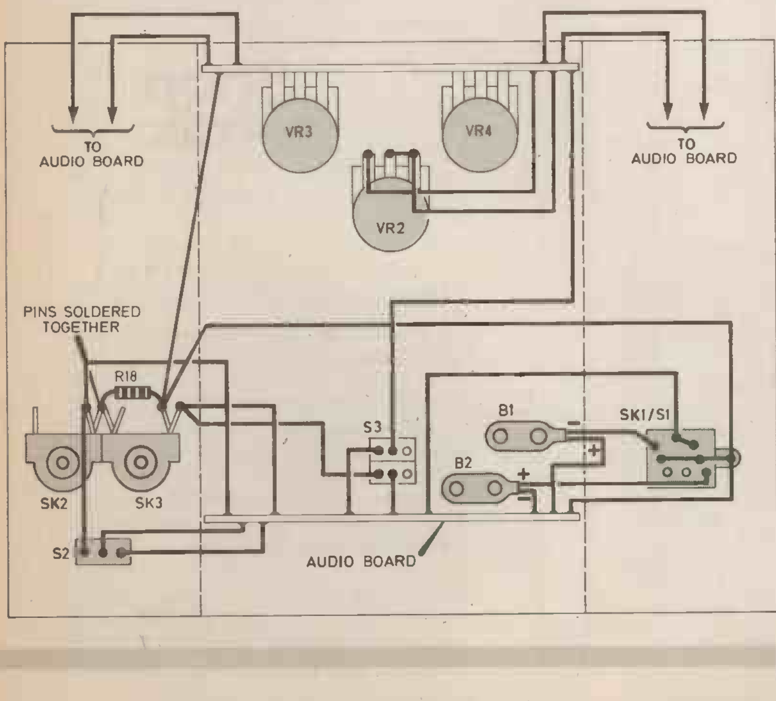
COMPONENTS
approximate
cost **£14**





Internal view of the prototype model showing the two board construction and the positioning of the batteries.

Fig. 4. Case mounted component layout and interwiring diagram for the Multi-mod. Refer also to Figs. 2 and 3.



board, thus holding the board against the plastic body of SK1. See photo.

The internal layout is such that there is ample room for two PP6-type batteries, and these are retained in position horizontally between the potentiometers and jack sockets. A piece of plastic foam should be placed *over* the batteries to retain them vertically before the base is screwed on. Smaller PP3-type batteries can be used but these work out more expensive in the long run.

Standard "PP3" connectors will fit either type of battery and will also fit six pen cell battery holder packs. Using the suggested case it may be found that the base will not fit properly because its lip hits the spacing washers behind SK2, but this is easily solved by cutting a "flat" onto the fibre washers.

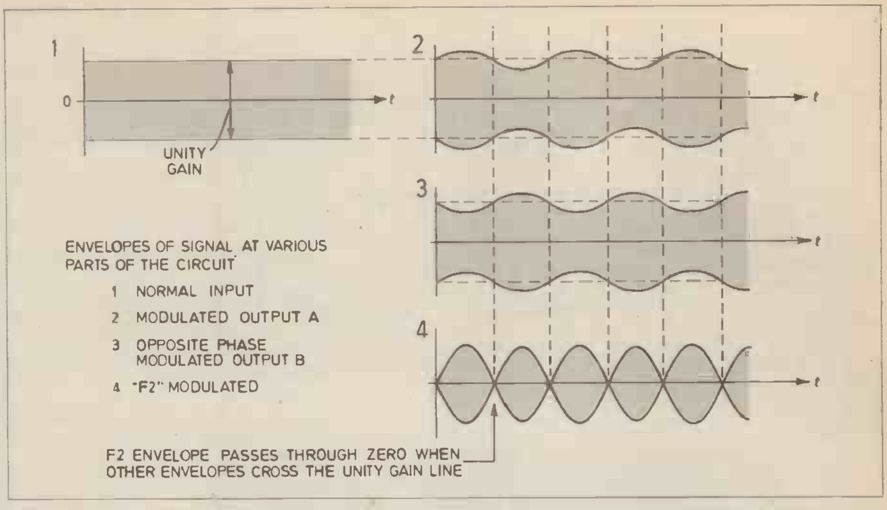


Fig. 6. Waveform diagram showing the normal input, complementary outputs of OUTPUT A and B and the F2 modulated output.

SETTING UP

Using OUTPUT B, turn DEPTH to zero and set S2 downwards. Now, while playing a sound into the unit, carefully adjust the SET BIAS preset on the control board using a small screwdriver until the least possible volume can be heard, this being at a "null point" on the preset, either side of which the sound level increases. The unit is now set up and should need no further attention.

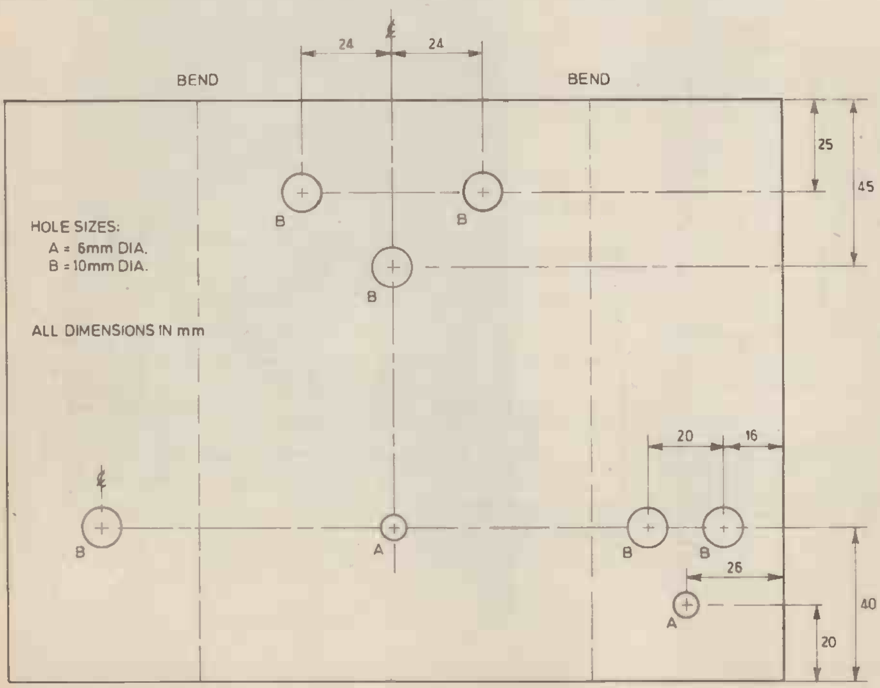
CIRCUIT OPTIONS

If the optional l.e.d. indicator is required, then a hole just big enough for D4 should be drilled in the case halfway between VR3 and VR4. The l.e.d. is then soldered to the control board with its leads shaped to position it in the hole. Any l.e.d. can be used, but the "miniature" red type is the best visually.

The output arrangement used for the prototype is probably the most useful one, but other combinations are possible. You basically have four different signal sources available to choose from: (1) plain signal from R17/19, (2) modulated signal from R14/15, (3) oppositely modulated signal from R10/11 and (4) "through zero" modulated signal from R12/13.

Any of these can be used or processed separately or blended in various ways. Resistor values of 27 kilohms or over should be used for such blending, so as not to upset the existing network. Finally, if this unit is intended for recording use with a stereo studio mixer, then stereo imaging will be better if a simple inverter stage is added to OUTPUT B, as this brings the audio signals at the outputs in phase.

Fig. 5. Case drilling details. For clarity, the top of the case is shown folded flat.



EFFECTS AND SETTINGS

Selecting NORMAL by the footswitch S3 always gives a straight untreated signal at OUTPUT A regardless of where any of the unit's controls are set.

For tremolo, OUTPUT A is used, S2 is left in its central OFF position, and the speed and depth controls can be set anywhere up to three-quarters full. A slight slow tremolo suits electronic piano, imparting a "Fender Rhodes" feel.

The DEV control can be adjusted to delay the entry of modulation, or to give a tremolo on single notes but steady signal when chords are played, modulation then coming in gradually (and slowing) as the sound decays. This can be more expressive on guitar for example than normal tremolo, and also prevents the loss of attack that can otherwise occur when the attack part of a note happens to coincide with the trough of a modulation cycle.

With DEPTH set at full the effect becomes Autorepeat, and switch S2 can be used to change the rhythm of the repeats at either output. Repeat effects are indispensable for the more modern/electronic types of music, and it is well worth noting that echo-like effects are possible by using Autorepeat on sounds that have a naturally decaying envelope.

STEREO AND OTHER EFFECTS

For stereo effects, send OUTPUTS A and B to separate amplifiers, or left and right of a stereo system. As one becomes attenuated, the other is boosted (see Fig. 6), giving the impression that the sound source is moving between the speakers, especially if these are more than a few feet apart. Setting DEPTH to full gives stereo Autorepeats, which used on piano arpeggio playing, for example, can sound like many notes cascading from all directions. Using only one amplifier, OUTPUTS A and B can be sent to two different channels, which will then alternately dominate over each other.

A unique "F2" effect is available from OUTPUT B with S2 set downwards. This is a "through zero" modulation, because in each modulation cycle, when the envelope drops towards zero, instead of turning up again it continues through the zero point into the antiphase region. This doubles the apparent repeat frequency (hence the name F2) and alternate envelopes of sound are of opposite phase with a "transient silence" in between. See Fig. 8.

Experience has shown that a nice "spacey" effect can be obtained by sending a "straight" signal to an amplifier and "F2" modulated signal to a much smaller secondary amplifier. For example, the author uses a cheap practice amplifier on top of the main one. This works only because a small volume of F2 signal can give a large ambient effect due to the psycho-acoustic properties of the phase reversals in it.

RHYTHMIC PHASING

The impression given is that the main amplifier is also being modulated when in fact it is not. Complex "rhythmic phasing" effects are also possible by mixing (for example, at the two inputs of an amplifier) the signal from OUTPUT A direct, and the signal from OUTPUT B (set to F2), and sent via a phase-shifter unit. The Multimod depth and the relative speeds of Phaser/Multimod should be adjusted by ear for best effect (try about 4Hz and 1·5Hz, respectively).

Differential modulation is available from OUTPUT A with S2 upwards, and is unusual in that signals below a certain frequency (approximately 320Hz) are modulated at the basic rate, while all frequencies above this point are modulated at double the rate and with a "through-zero" characteristic. See Fig. 7.

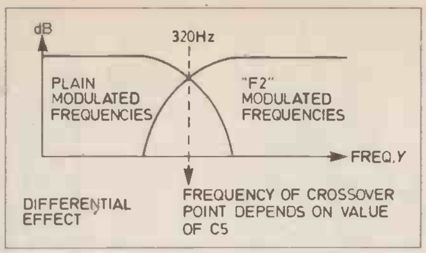


Fig. 7. The crossover frequency of the "F2" modulated frequencies.

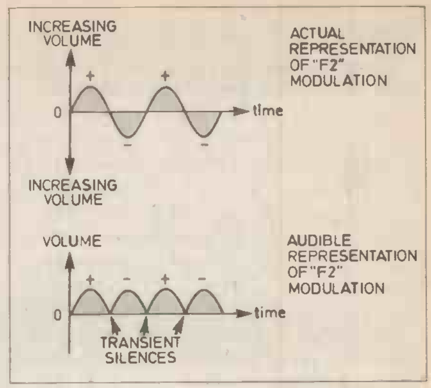


Fig. 8. Waveform diagrams of F2 modulation showing the actual representation of the output and the audible representation including "transient" silences.

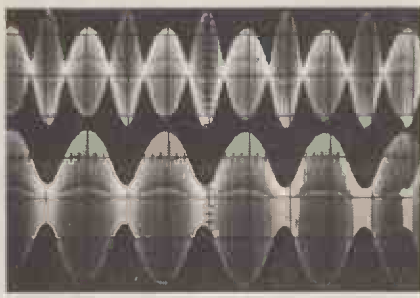
So, for example, with a square-wave input signal from a synth at 100Hz, the fundamental and second harmonic will be modulated in one way while all the other harmonics (up to say, 10kHz) will be modulated differently. Thus a complex effect is set up which is more modern sounding than plain amplitude modulation.

RING MODULATION

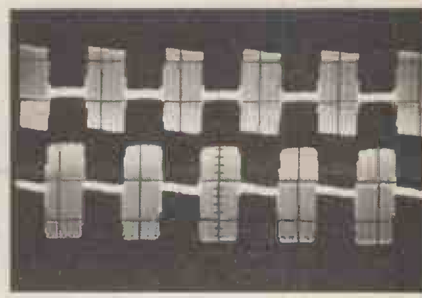
Use OUTPUT B with S2 down, set SPEED to full and DEPTH to halfway. The oscillator will go up as far as low audio frequencies, and this makes ring-modulation-type effects possible, bell-like sounds, etc. Note that the circuit is not purpose designed as a ring modulator, this is just a "by-product".

The audio input frequencies intermodulate with the control oscillator frequency to generate sum and difference frequencies. The original input sound is cancelled out by antiphase mixing via R12/R13, leaving only the newly-formed products as an output. □

Oscillogram of F2 modulation (top) and Tremolo.



Oscillogram of stereo repeat modulation.



PLEASE TAKE NOTE

Microcomputer Interfacing Techniques Part 3
(September 1983)

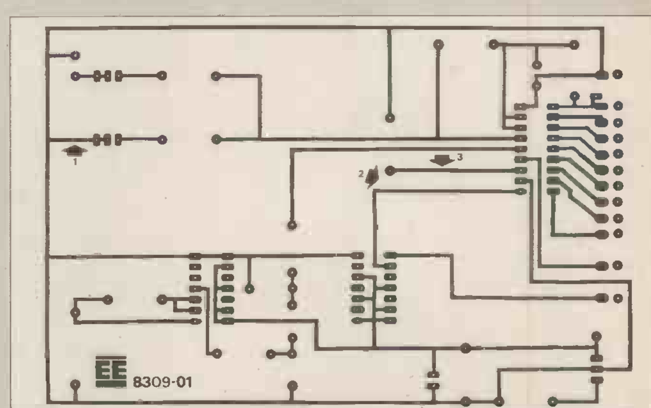
High Speed Analogue-To-Digital Converter—On Fig. 3.4, the circuit diagram (page 581), the table in the bottom right-hand corner must be altered at location X, VIC-20 to read CB1 and not CA1 as shown.

On Fig. 3.5 (page 583), the artwork of p.c.b. number 8309-01, three modifications are required as follows (see diagram, right):—

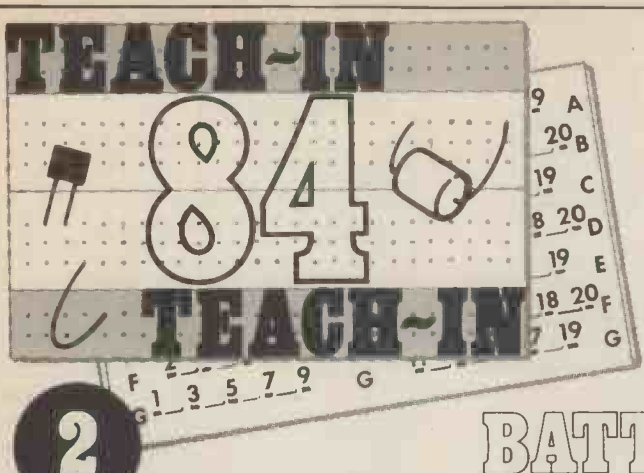
- 1 Add track/wire link
- 2 Remove track
- 3 Add track/wire link

To effect modifications 1 and 3, tinned copper wire can be soldered to the existing track and for modification 2, a scalpel or small file can be used to cut through the track.

On Fig. 3.6 (page 583), capacitor C4 should be re-labelled C1, and capacitor C1 should be re-labelled C4 to correspond with the circuit diagram.



Modifications required on the p.c.b. artwork (Fig. 3.5, page 583). Note that this diagram has not been reproduced actual size.



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.

BATTERIES & RESISTORS

BY GEORGE HYLTON

IN PART ONE you used a very simple graph (Fig. 1.4) which enabled you to read off the voltage needed to drive 1mA through any resistance from 100Ω to 100kΩ. But to deal with currents other than 1mA you had to do some arithmetic. This can be avoided by using a different sort of graph, or *nomograph*, which deals with a whole range of currents, resistances, and voltages. See Fig. 2.1.

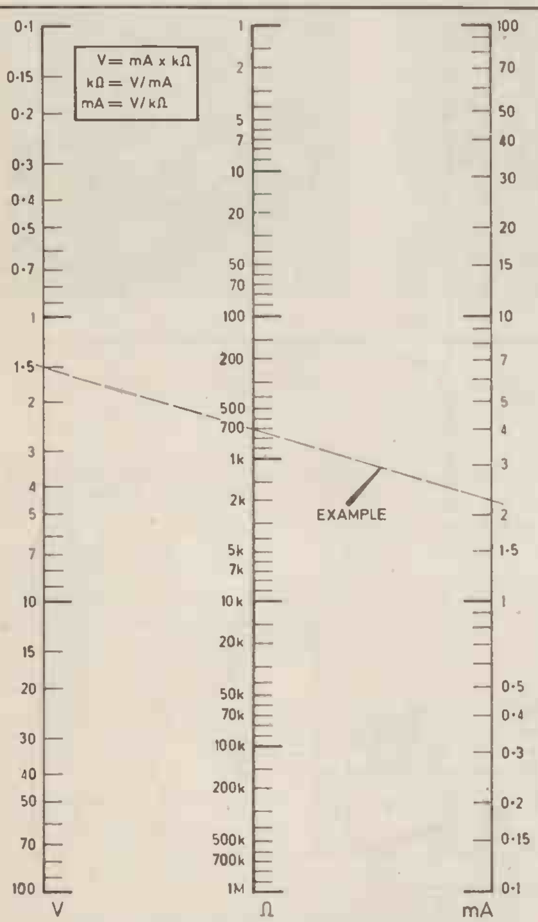


Fig. 2.1. Nomograph for solving Ohm's law problems. The example line shows that 1·5V applied to 700Ω drives a current of about 2·1mA.

CALCULATIONS MADE EASY

A straight edge laid across the nomograph (as shown faintly in Fig. 2.1) does the calculation for you. A stretched black thread is even better because it doesn't cover up anything. *Example:* What current flows when 1·5V is applied to 700Ω? To find out, the thread is positioned so as to join 1·5V and 700Ω as shown. It then continues to the third scale, which it cuts at about 2·1mA. This is the answer.

If you know any *two* of the quantities, volts, ohms or milliamps, the chart will give you the *third*. It solves the three calculations:

Current = Voltage/Resistance
Resistance = Voltage/Current
Voltage = Resistance × Current

BATTERIES

If you take just two 1·5V dry cells of the usual torch type and stack one on top of the other (Fig. 2.2a) the voltage across the stack is 3V. This shows that the cells are both "pushing" in the same direction, so their voltages add.

If you stack them pointing in opposite directions (Fig. 2.2b) their voltages cancel and the meter reads zero. Not a useful arrangement, but a useful experiment. Opposing voltages try to cancel one another out. This principle keeps cropping up in other types of circuit.

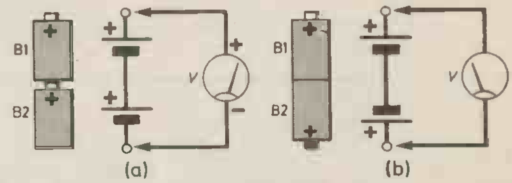


Fig. 2.2. (a) Two 1·5V cells in a "series-aiding" stack. (b) In a series-opposing stack the cell voltages cancel.

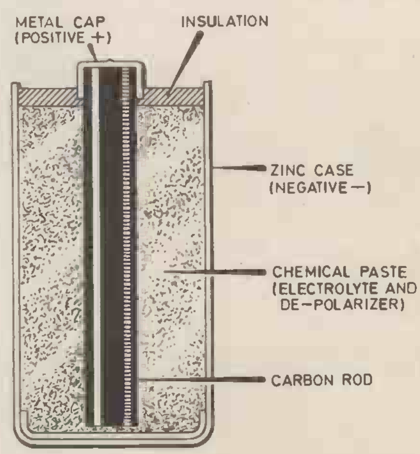


Fig. 2.3. Section through a typical 1·5V dry cell.

A 9V battery pack contains six 1·5V cells. If you dismember an old 9V battery such as a PP3 you'll find six layers in it. Each layer is a 1·5V cell.

CELLS IN PARALLEL

Cells stacked as above are said to be in series. But they can also be used together in a side-by-side or parallel arrangement.

If you could take a thin laser beam and slice neatly down the middle of a 1·5V torch cell you'd expose the contents shown in Fig. 2.3.

This "half cell" would still work because all the necessary ingredients are present: the metal case, which is either zinc or steel coated with zinc on the inside, the black chemical paste which fills the cell, and the carbon rod in the middle.

It is the chemical interaction of these three components which determines the voltage. Since they are the same for our half cell as for a whole cell the voltage is not halved but remains 1·5V.

What *is* halved is the capacity of the cell to deliver current. If an intact cell can deliver 100mA for two hours before its chemicals are used then half a cell can deliver the same current for only half the time, or half the current for the same time.

If the two "half cells" are now put back together the voltage stays at 1·5V but the lost capacity is restored.

This "thought exercise" helps to solve the problem posed by Fig. 2.4. What voltage does the meter read? It reads 1·5V because the two cells behave just like our two half cells. Connecting them in parallel like this increases the current capacity, but not the voltage.

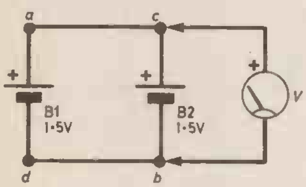


Fig. 2.4. A "thought exercise". What voltage does the meter read?

INTERPRETING DIAGRAMS

What happens to the voltage if two cells are connected as in Fig. 2.5a? At first sight, it seems that the meter should read 1·5V since it is connected across cell B1. But wait a minute! It's also connected, wrong way round, across cell B2. This should move its pointer backwards.

Points in this circuit are labelled *a,b c,d*. The line from *a* to *b* is just a plain connection between cells and has no resistance. We can make it as long or as short as we like without affecting the working of the circuit. Similarly with *c-d*, another plain connection.

Let's stretch *a-b* and contract *c-d*, as at (b). Eventually *c-d* contracts so much that cell B2 is pulled right up against cell B1 (as at Fig. 2.5c).

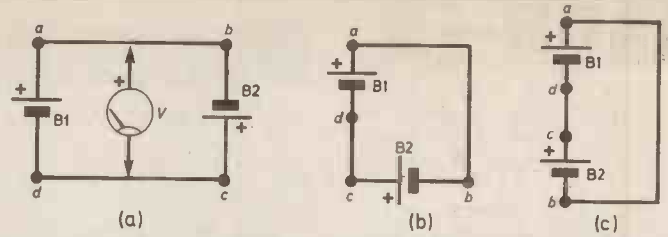


Fig. 2.5. (a) Another "thought exercise". What voltage does the meter indicate? (b) and (c) Stretching the connection from *a* to *b* while contracting *c–d* pulls cell B2 closer to B1 without affecting the circuit.

Cells B1 and B2 are now seen to be in series, as in Fig. 2.2a. So they form a 3V battery. There's just one snag. We've ruined the battery by connection *a-b*, which is a short-circuit across its terminals. Not much point in trying to figure out what a meter would read, now!

This little exercise shows how the operation of a circuit can sometimes be made clearer by rearranging the circuit diagram.

EXPERIMENT 2.1

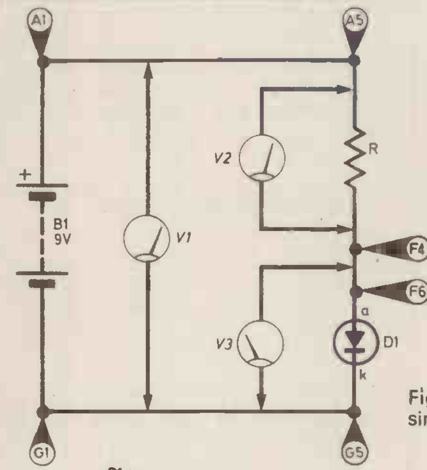
MEASURING VOLTAGES

Last month I left you with the problem of measuring the voltages in your l.e.d. circuit Fig. 1.5 and now reproduced here as Fig. 2.6. The meter is set to its 10V d.c. range and is connected, in turn, to three positions in the circuit. See Fig. 2.7.

Position *V1* measures the battery voltage. For a new 9V battery this will probably be about 9·6V.

Position *V2* gives the voltage across the resistor R. In our calculations we assumed this to be 7V, but you'll have found that it is nearer to 8V if your battery is new and the l.e.d. is a red one.

The voltage *V3* is the running voltage of the l.e.d. and is usually rather less than 2V for a red l.e.d. and may be more for one of a different colour. *V3* doesn't change much when you swap 1kΩ for 10kΩ for R. This shows we were justified in assuming that the l.e.d. absorbs much the same voltage irrespective of the current flowing through it.



Test-bed set-up for Fig. 2.6.

Fig. 2.6. The three different voltages in a simple l.e.d. circuit, as Fig. 1.5.

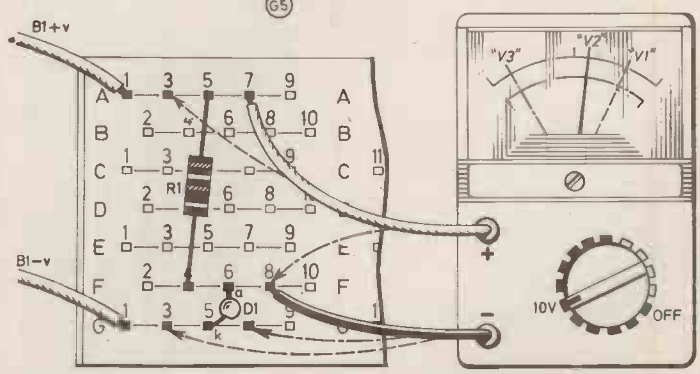


Fig. 2.7. The circuit of Fig. 2.6 assembled on the EBBO Block. The meter is connected for *"V2"* reading. Dotted lines show the alternative connections for the meter for *"V1"* and *"V3"* readings. NOTE: the meter leads are in practice connected to the block via the adaptor lead as described in Part 1 and shown on next page.

METER LOADING ERRORS

With R = 10kΩ, you may notice that when you connect your meter across it the l.e.d. brightens. This is because some extra current flows from the battery through the meter and then on through the l.e.d.

This is an illustration of the way a circuit can be disturbed by connecting a measuring instrument to it. If the instrument draws current from the circuit, as yours does, the readings are as a result never quite right. In the present case the error caused by the meter "loading" the circuit in this way is small, but in other cases it can be serious.

EXPERIMENT 2.2

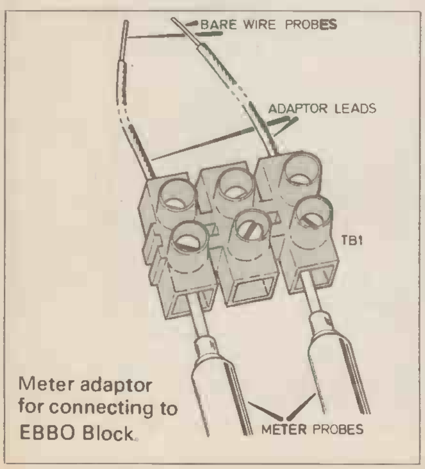
This can be illustrated by removing the l.e.d. (D1) and connecting the meter in its place. Current now flows from battery (+) through R, through the meter and back to battery (–). The meter is trying to read the battery voltage but R is in the way.

With R = 1kΩ the meter reading is quite close to the true battery voltage, as you can check. (If it isn't, you are using an unsuitable type of meter.)

With R = 10kΩ, and a (2,000 ohms per volt) meter like the KEW7S, the voltage reading is appreciably lower. This is because a "2,000Ω/V" meter set to its 10V range has a resistance of 20kΩ.

The battery drives current through R then the meter. The result is that some of the voltage is absorbed by R, leaving less than the full voltage at the meter itself. So it "reads low". The lower the resistance of the meter compared with R the greater the error.

To minimise this type of error the meter should have a very high resistance. This means that it must draw very little current, ideally none at all. Unfortunately, sensitive meters are expensive and often delicate, too. Fortunately, as we'll see later in this series, electronics can be called in to remedy the situation and turn an insensitive meter into a sensitive one.



Meter adaptor for connecting to EBBO Block

EXPERIMENT 2.3

RESISTANCES IN PARALLEL

Connect three 10kΩ resistors in your l.e.d. circuit (Fig. 2.8a). Removing one resistor dims the l.e.d. a little. Removing another dims it further. Evidently, when all three are in the circuit the l.e.d. receives some current via each one. If you remove all the 10kΩ resistors and substitute a single 3·3kΩ resistor (b) the l.e.d. lights as brightly as with all three 10kΩ resistors in place.

It looks as if three 10kΩ in parallel are the equivalent to one 3·3kΩ. Let's find out.

First of all we'll connect three 10kΩ in parallel (Fig. 2.10a) and measure their combined resistance with the ohmmeter setting of our multimeter. See Fig. 2.11.

If you connect an ohmmeter to a circuit with the power supply on, the meter will certainly give the wrong answer and may be wrecked in the process.

So, first disconnect your battery.

Now, set up the ohmmeter. To do this, select an ohms range and "zero" the meter. This usually entails connecting the meter leads together, which moves the pointer towards the zero marking on the ohms scale.

Now turn the "ohms zero adjuster" to set the pointer to zero. Disconnecting the leads makes the pointer go back to the other end of the scale, to the "infinity" mark.

You can now measure the "total", or rather the *effective*, resistance of your three parallel 10kΩ resistors. (If necessary, select a different resistance range to bring the pointer nearer the middle of its scale. Most meters have at least

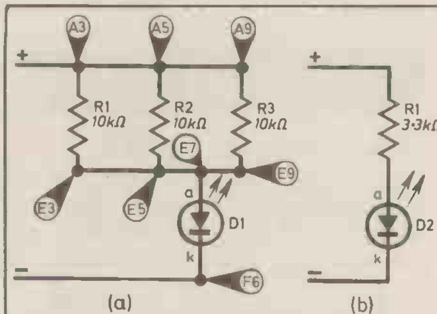


Fig. 2.8. (a) Each 10kΩ resistor passes a quota of current to the l.e.d. (b) The single 3·3kΩ resistor gives the same brightness as in (a).

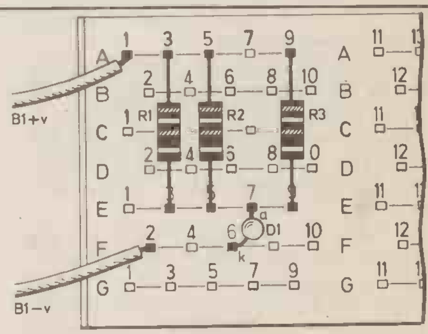


Fig. 2.9. The circuit of Fig. 2.8(a) assembled on the EBBO Block.

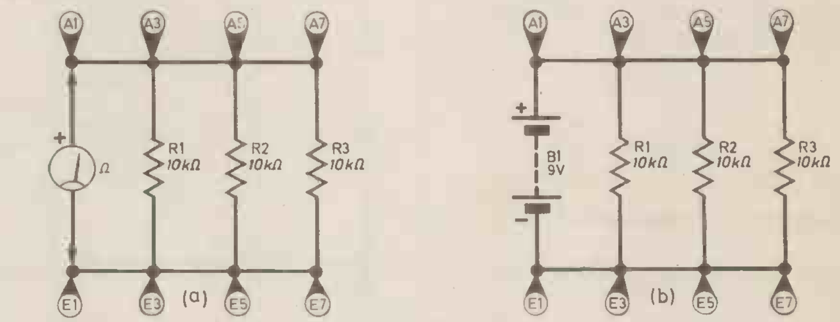


Fig. 2.10. Three resistors in parallel. (a) Ohmmeter measurement. IMPORTANT: Disconnect battery before connecting meter. (b) Each resistor is connected to the full battery voltage of 9V.

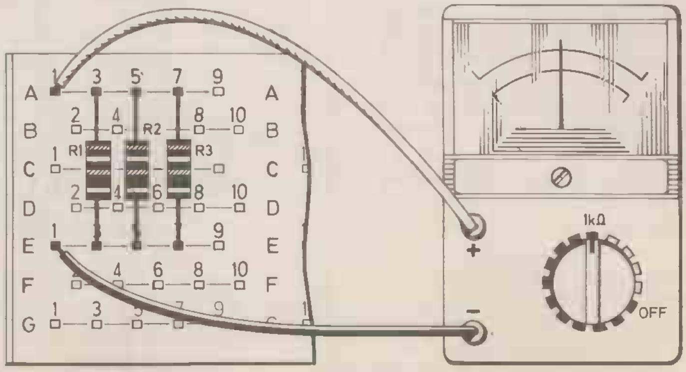


Fig. 2.11. The circuit of Fig. 2.10(a) assembled on the EBBO Block.

two ohms ranges.) The result should be a reading of about 3·3kΩ. Remember that your resistors have tolerances, and so does your meter!

Immediately after making your measurement, set your meter back to its 10V d.c. range. This will avoid accidentally connecting an ohmmeter to a live circuit next time you use it.

In Fig. 2.10b each 10kΩ has 9V across it and (from the graph) must pass 0·9mA. That makes 2·7mA all told. The battery sees a resistance which passes 2·7mA when 9V is applied. The graph (Fig. 2.1) connects 9V and 2·7mA with a little over 3·3kΩ. Calculation is more precise:

Resistance = Voltage/Current

So the effective resistance of three 10kΩ in parallel is

$$\frac{9}{2{\cdot}7} = 3{\cdot}333 \ldots \text{k}\Omega$$

or, using a vulgar fraction, $3\frac{1}{3}$kΩ. This is exactly one-third of 10kΩ.

When *equal* resistances are in parallel, the rule for finding the equivalent single resistance is: divide the individual resistance value by the number of resistances.

Thus two 10kΩ in parallel are equivalent to one 5kΩ; three are equivalent to 3·33 . . . kΩ; four to 2·5kΩ; five to 2kΩ, and so on.

Things become more complicated when unequal resistances are paralleled, but we'll deal with that later. For now, I'll just say that it is often very useful to connect resistors in parallel because you can then make up non-standard values. Suppose you need 6kΩ. The nearest standard values are 5·6kΩ and 6·8kΩ. But 12kΩ is standard and two 12kΩ in parallel give 6kΩ.

EXPERIMENT 2.4

RESISTANCES IN SERIES

Connect three 1kΩ resistors in series across your 9V supply (Fig. 2.12a). Measure the voltage across each one. It should be 3V approximately in every case. Since the same current flows through each resistance, and they are all equal, the battery voltage must be shared among them: 9V battery, 3V each. Now, 3V and 1kΩ imply 3mA. So this is the current. The 9V battery sees a resistance which draws 3mA.

From the graph, Fig. 2.1, 9V and 3mA give 3kΩ. So in the case of equal resistances in series you just add them together.

Better still, it works with unequal ones. If you swapped a single 2kΩ for the upper two of your 1kΩ the current would be unaltered. The 2kΩ would absorb 6V and the 1kΩ 3V. And 2kΩ + 1kΩ = 3kΩ as before.

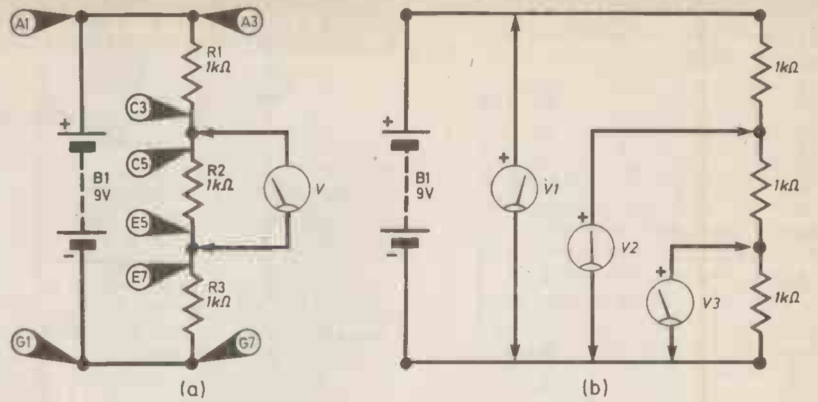


Fig. 2.12. Three resistors in series. (a) Measuring the voltage across each. (b) Measuring the voltages with respect to battery (–).

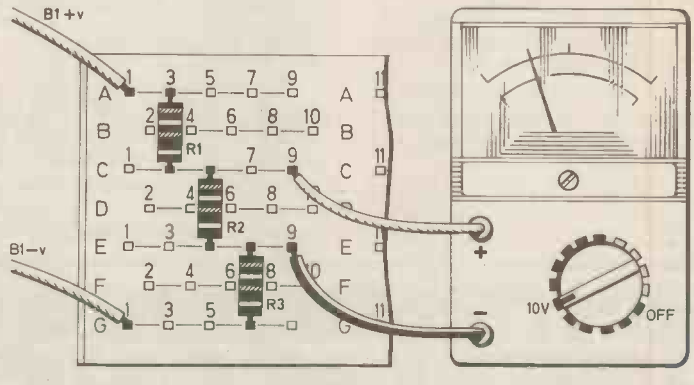


Fig. 2.13. The circuit of Fig. 2.12(a) assembled on the EBBO Block.

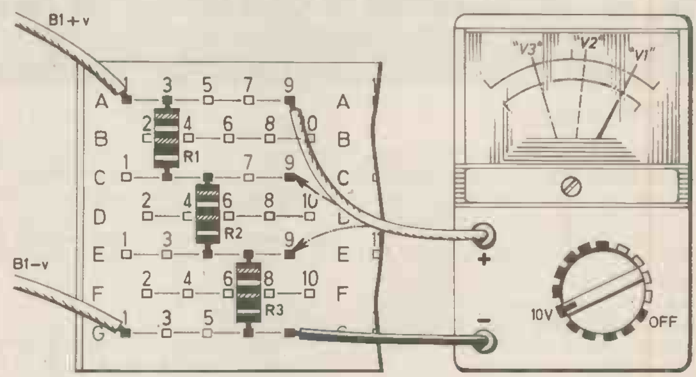
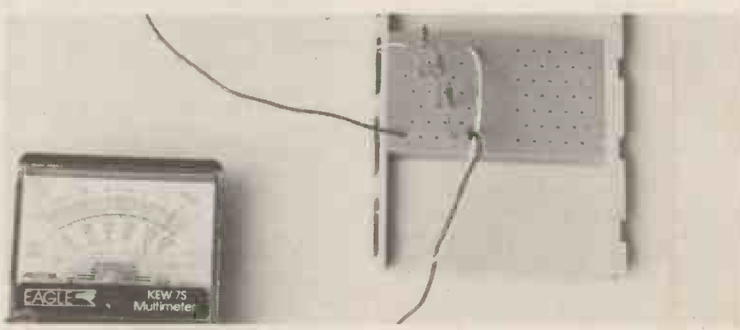


Fig. 2.14. The circuit of Fig. 2.12(b) assembled on the EBBO Block. The meter is connected for *"V1"* reading. Dotted lines show the alternative connections for the meter for *"V2"* and *"V3"* readings.



Test-bed set-up for Fig. 2.14.

CHECK YOUR PROGRESS

Questions on *Teach-In 84 Part 2*

Answers next month

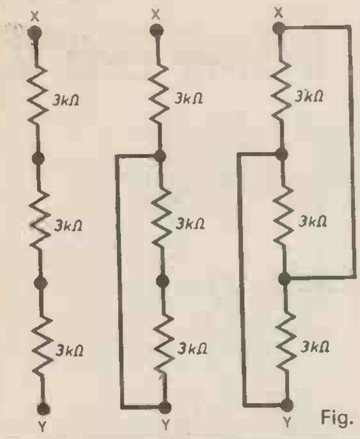


Fig. 2.15

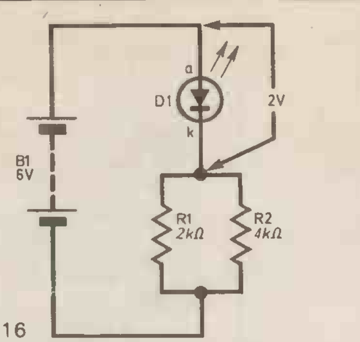


Fig. 2.16

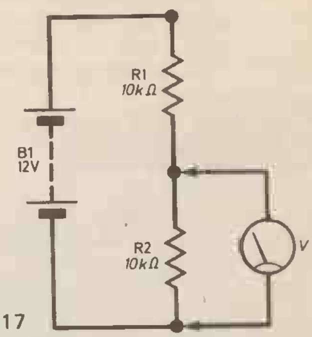


Fig. 2.17

Q2.1 Fill in the missing amount of current, voltage or resistance for a circuit containing the two quoted:
- a. 12V, 6k, ...
- b. 3mA, 3·3k, ...
- c. 9V, 0·5mA, ...

Q2.2 See Fig. 2.15. What is the equivalent resistance between X and Y in each case?

Q2.3 See Fig. 2.16. How much current flows through the l.e.d.?

Q2.4 See Fig. 2.17. What voltage does the meter indicate? It is a 1,000Ω/V instrument switched to its 10V range.

ANSWERS TO PART 1

Q1.1 (a), 330Ω, 1%; (b), 100kΩ, 5%; (c) 27kΩ, 5%; (d) 5·6MΩ, 2%; (e) 1Ω, 5%; (f) 4·7Ω, 5%.

Q1.2 (a) 1mA; (b) 1kΩ; (c) 10V

Q1.3 1kΩ

WITH RESPECT TO

If you measure the three voltages indicated in Fig. 2.12b, *V1* is the battery voltage (9V); *V2* is 6V and *V3*, 3V. When one terminal of a meter is always connected to the same point, as yours is now to battery (–), the voltage readings are described as being "with respect to" battery (–), or whatever point is common to all the measurements.

This way of using a common point as a reference corresponds to a map-maker's use of sea-level as a zero or datum point. Voltages are often measured in this way.

Next month:
Potentiometers and Transistors

COUNTER INTELLIGENCE

BY PAUL YOUNG

Computer Remedy

It must have been very difficult to decide whether to embrace the computer or exclude it. It was certain to bring criticism either way but I for one am delighted with the outcome in the pages of EE.

I think in the end, even the most outspoken critics will agree, that the development of the integrated circuit resulting in the microcomputer, is the most important happening in the world of electronics since the invention of the transistor. As far as its uses are concerned we have only scratched the surface.

I was reminded of this recently when my kindly television expert, to save me the trouble of humping our monster colour TV several miles to his workshop, asked me the symptoms, and was able to tell me immediately what parts to change.

Now if computers can be used for diagnostic medicine, it must surely be possible to use them for trouble-shooting with any complicated electronic or even mechanical apparatus. All the necessary knowledge would be fed into a vast memory system which your repair man of the future would be able to tap into any time he was stuck. Obscure faults could be rectified in minutes and the amount of man hours saved would be quite staggering.

There is a well-known story of a large vital machine in a factory coming to a grinding halt, and the management calling in the expert. The expert surveys the machine for a few minutes and then gives it a mighty swipe with a hammer. Immediately it springs into life. When the bill for his services arrives, it reads: To hitting the machine with a hammer = One Penny. To knowing where to hit it = Fifty Pounds. In the future the computer will be able to reduce that amount very considerably.

Dischord

Although his letter was published in the October Issue, I would like to thank Mr. Stone for his most interesting remarks. My friend made the suggestion of replacing the present piano keyboard with a typewriter keyboard. Mr. Stone's main objection is, that the piano keyboard is analogue whereas the typewriter is digital making it difficult to put any expression into the playing. In other words the harder you hit the piano key the louder it sounds, whereas with the electronic key it makes no difference.

I understand the argument, although the same criticism could be levelled at the standard organ. I sent a copy of his letter to my friend, and here is the gist of his reply:

"I do not think that anyone who has successfully mastered the standard keyboard would change to a new design. There will be old type instruments for the foreseeable future but I am visualising a new generation of music makers, of all ages.

Within my own circle I know of many youngsters who started out to learn to play the piano but within a few months became so disenchanted with the difficulties and sheer tedium of it all they gave it up. How sad!

At the other end of the scale there are oldies like myself who take up music making late in life as an enjoyable hobby for retirement. In between there are millions who for one reason or another have never had the time or opportunity to master the idiotic system that we have been saddled with since the middle ages.

Can you imagine the enjoyment all these people would get from a system that enabled them to play reasonably proficiently in a matter of months? And the subsequent boost in sales of such an instrument, which, with modern electronics could produce a full orchestra from a package no larger than a small portable typewriter."

Talking of typewriter keyboards, I am assured on good authority, that the layout of the keyboards is going to be redesigned. This will be a blow for the thousands of "touch typists", although I notice that all the modern microcomputers such as the Sinclair ZX Spectrum, BBC, and the Acorn are still using the familiar "QWERTY" layout.

I always imagined learned professors working far into the night to perfect this layout. Well maybe they did, but not for the reasons that we imagine. Far from designing a layout that would speed up the typing, they designed it to slow the typists down, since the early machines were not capable of coping with the speeds these young ladies could attain!!

Hot Air

A final note on Ionisers. After explaining to a colleague how to make a tester for checking their output (See Sept. issue) he gave me a pitying smile and said: "Yes, but of course you can do it equally well by holding a lighted match near it, the draught causes the flame to flicker". Poor old Paul Young is again deflated.

1984 SCHOOLS Electronic Design Award COMPETITION

Build for the Future and Reap the Rewards

THE TWELVE FINALISTS WILL SHARE OVER £3000 AND PARTICIPATE IN AN ALL-EXPENSES-PAID TWO-DAY VISIT TO LONDON DURING JULY 1984

For the third year running **Mullard Ltd.**—the largest electronic components company in the UK—and **Everyday Electronics** join forces to present a rewarding challenge to Secondary Schools within the United Kingdom.

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FIRST PRIZE	The Sedac Trophy and £300	Plus a selection of components valued at £200
SECOND PRIZE	£200	
THIRD PRIZE	£100	

NINE RUNNERS-UP. A selection of components valued at £100.

In addition, **all twelve finalists** will receive a certificate and one year's subscription to EVERYDAY ELECTRONICS—*and* will enjoy an **all-expenses-paid two-day visit to London during July 1984.**

Science teachers of Secondary Schools are invited to apply for a Registration Form which contains full details of this competition.

Write to: SEDAC Schools Competition, Room 2130, King's Reach Tower, Stamford Street, London SE1 9LS.

Secondary School Pupils—make sure your school accepts this challenge and enters this contest. So bring this announcement to the attention of your science teacher or the head of your school.

Closing date for Registration: 15 November 1983

Closing date for submission of Papers: 31 January 1984

SCHOOLS ELECTRONIC DESIGN AWARD COMPETITION (SEDAC)
SPONSORED BY MULLARD LTD AND EVERYDAY ELECTRONICS

MICROCOMPUTER INTERFACING TECHNIQUES

INCLUDING MANY USEFUL CONSTRUCTIONAL PROJECTS

PART FIVE: STEPPER MOTOR CONTROL

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

CONVENTIONAL direct current electric motors provide a mechanical output in the form of a continuous, smooth rotation. Speed and direction are easily controlled and, in the last article, a digital-to-analogue converter was interfaced to a microcomputer to achieve this objective.

If precise control of rotational position is required with a d.c. motor then it is almost essential to provide some form of feedback from the motor shaft which can be used to sense its position and adjust the supply to it accordingly. This arrangement is known as a servo system and such systems are commonplace in positional control systems.

Stepper motors offer a completely different approach to the problem of controlling position as they are designed to produce a mechanical output which will respond to a command signal by rotating in discrete increments or "steps" rather than the smooth, spinning motion of their d.c. counterparts. The direction and number of these steps can be controlled by applying appropriate pulses to the stator windings of the motor.

The degree of precision to which the motor shaft may be positioned depends upon the number of steps per revolution of the rotor. Many stepper motors offer a resolution of 200 steps per revolution, that is, the shaft may be positioned in 1·8 degree steps. It is, in fact, possible to achieve 0·9 degree resolution with such a motor by a technique known as "half step excitation" (or single/dual phase excitation).

STEPPER MOTOR DESIGN

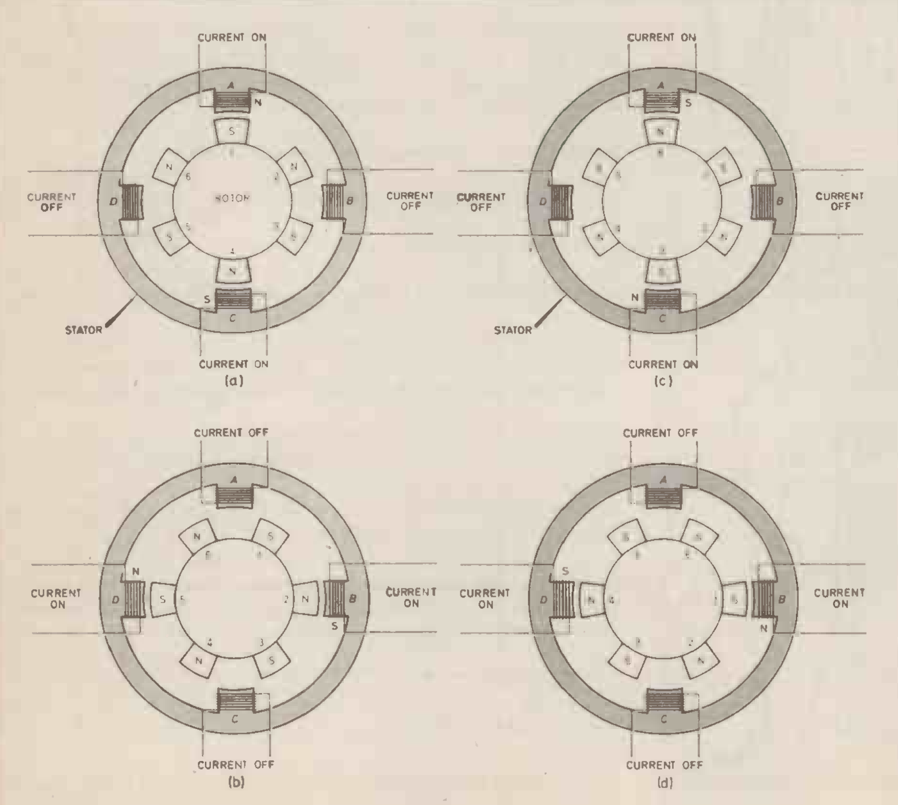
In order to allow a stepped mechanical output, the construction of a stepper motor is clearly very different to that of a conventional d.c. motor and it is worthwhile considering how such characteristics are achieved.

Many stepper motors employ a technique known as "four phase excitation" and this system is depicted in Fig. 5.1.

The rotor is formed with six magnetic poles, three north and three south, as shown. The laminated soft-iron stator is formed with four poles which are excited by coil windings *A, B, C* and *D*.

In Fig. 5.1(a), coils *A* and *C* are energised with currents flowing in directins so as to make pole *A* a N-pole and pole *C* a S-pole. The permanently magnetised poles 1 and 4 of the rotor will be attracted as shown and the rotor will be held in this position.

To accomplish the next step clockwise, the current in stator winding *A* and *C* is turned off, whilst simultaneously, pole



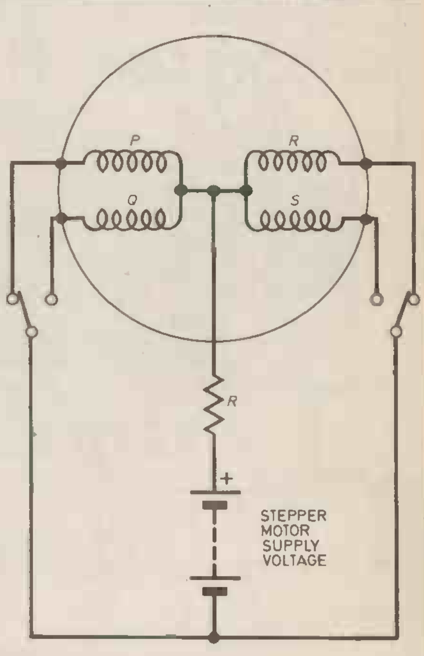


Fig. 5.2. Bifilar windings of stator poles.

Fig. 5.1 (left). Stages in the excitation of stepper motor phases.

windings *B* and *D* are energised with currents flowing in such a direction as to make *B* a S-pole and *D* a N-pole. The rotor will turn one step and occupy the position shown in Fig. 5.1(b). Further steps can be created by appropriate stator coil excitation and these are shown in Figs. 5.1(c) and 5.1(d).

In order to reverse the direction of rotation of the shaft, it would be necessary to reverse the directions of current flow in the stator windings. This could be achieved with a dual rail (+ and –) power supply for the driver circuitry, but many stepper motors are provided with bifilar pole windings which simply means that each stator pole winding carries two coils, wound in opposite directions. Each coil in the pair is connected in series with the corresponding coils of the other stator poles.

A simplified diagram of the electrical arrangement is shown in Fig. 5.2, from which it is clear that either coil may be energised to produce a pole of the required sign. *P* and *Q* are wound in the opposite sense and constitute the bifilar-wound coil of one stator pole. Likewise *R* and *S* are wound on the diametrically opposite pole.

A low value resistor is normally included in the power supply to the phases in order to decrease the electrical inertia of the highly inductive windings; this permits a more rapid increase of current at switch on and hence gives faster start up characteristics.

In this application the stepper motor has four coils, but only two of these have current flowing through them at a particular time. The stepper motor will move from one fixed position to another by applying pulses to the driver board in the correct sequence:

Clockwise Rotation

Step No.	Output to drivers			
	Ø	1	2	3
1	1	1	Ø	Ø
2	Ø	1	1	Ø
3	Ø	Ø	1	1
4	1	Ø	Ø	1
1	1	1	Ø	Ø

Anticlockwise Rotation

Step No.	Output to drivers			
	Ø	1	2	3
1	1	1	Ø	Ø
2	1	Ø	Ø	1
3	Ø	Ø	1	1
4	Ø	1	1	Ø
1	1	1	Ø	Ø

It should be apparent that these rotations constitute cyclic shifts in opposite directions.

The generation of these pulse sequences and their application to the stepper motor can be achieved by:

(1) a hardware system
(2) a mixed hardware/software system
(3) a software system

In any case, the current requirements of the motor will be considerable and a TTL/power interface board is required.

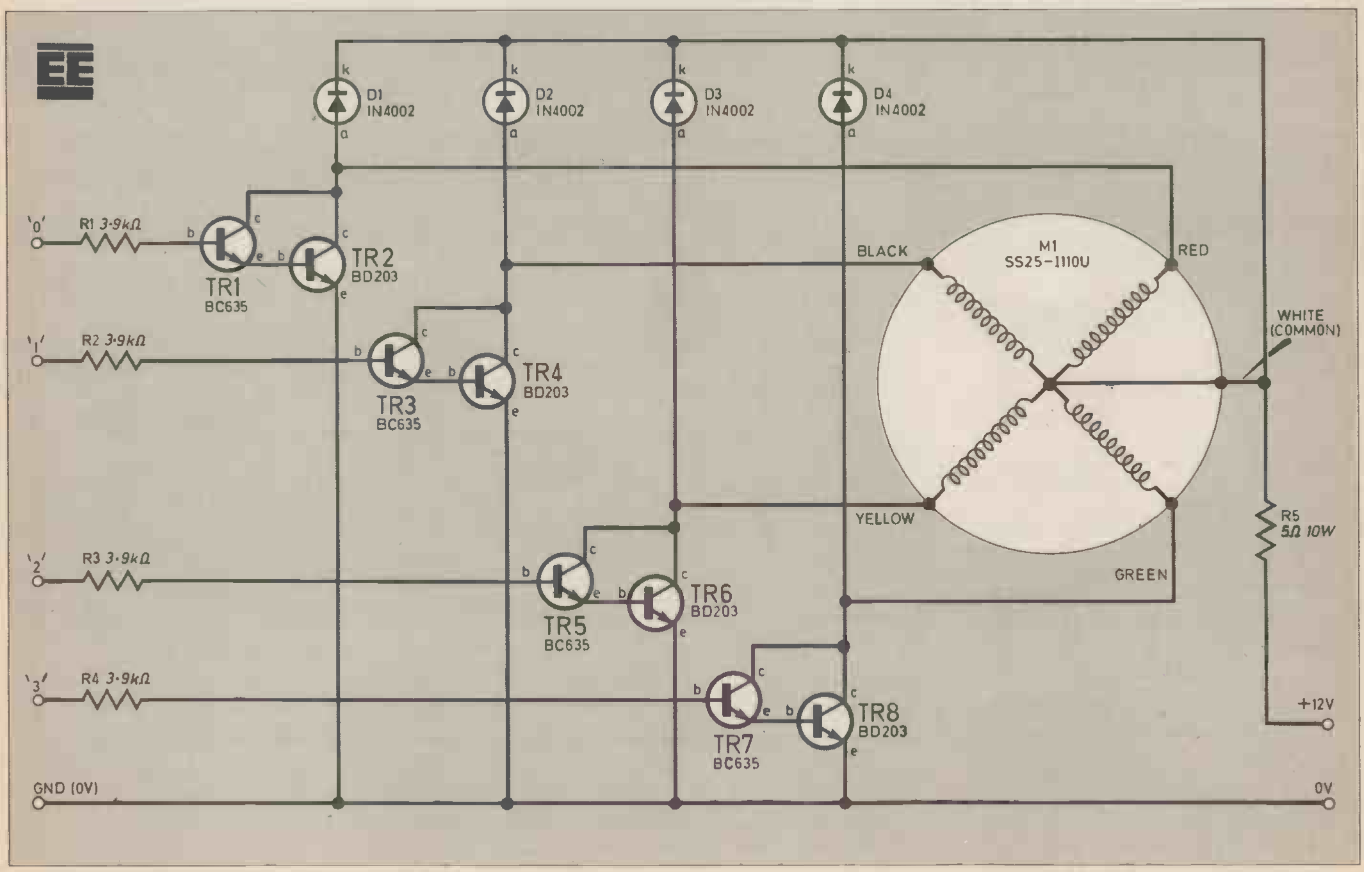
TTL/POWER INTERFACE BOARD

The circuit diagram of the TTL/Power Interface for Stepper Motor is shown in Fig. 5.3.

TTL level control pulses are applied to the bases of TR1,3,5,7, which form Darlington pairs with the power driver transistors TR2,4,6,8. The collectors of these are connected directly to the motor phases so that currents in them may be turned on and off.

Diodes D1–D4 afford protection against damage to the Darlington pairs by the back-e.m.f. across the windings at current switch off. R5 is included to facilitate easier starting, as already described. The total power consumption of the board is dependent upon motor loading, but a 12V supply at around 2A is adequate for most conditions.

Fig. 5.3. Full circuit of the TTL/Power Interface Driver for a stepper motor.



TTL/POWER INTERFACE FOR STEPPER MOTOR

CONSTRUCTION

The components forming the circuit of Fig. 5.3 with heatsinks and mounting bracket are fitted on a single-sided printed circuit board, size 202 × 95mm as shown in Fig. 5.4. The full-size master pattern for the p.c.b. is shown in Fig. 5.5. This board is available from the *EE PCB Service*, Order code 8311–01.

The dimensions and drilling details for the motor mounting bracket and heatsinks are shown in Fig. 5.6. The heatsinks are secured to the board using the power transistor fixing screws and in one case also by the fixing for R5. This resistor as shown has a wattage higher than necessary and may be rated at 7W or more.

The transistors TR2,4,6 and 8 must be fitted to the heatsink using mica washers and insulating bushes. This is necessary because the metal tabs on these devices are internally connected to the collector terminal. Use heatsink compound on all mating surfaces to maximise heat transfer from the device to the sink.

Next fit the motor to its bracket and then this assembly to the board. Use shake-proof washers on all fixings. A large pointer knob should now be fitted to the motor shaft.

Assemble the remainder of the components as shown in Fig. 5.4. Take care to connect the diodes and transistors the correct way round, and that the lead-outs from the stepper motor reach the correct connection points.

FLYING LEADS

The flying leads connect to the board in the same manner as earlier projects in this series. The wires feed through blank holes from above to reach track lands on the underside thereby providing a strain relief mechanism for the soldered joint. Use wire having different insulation colours for the five control leads to facilitate easy recognition.

Fit six self-adhesive rubber feet to the board underside for support and clearance of the standing surface. Thoroughly check the board before applying power, or connecting up.

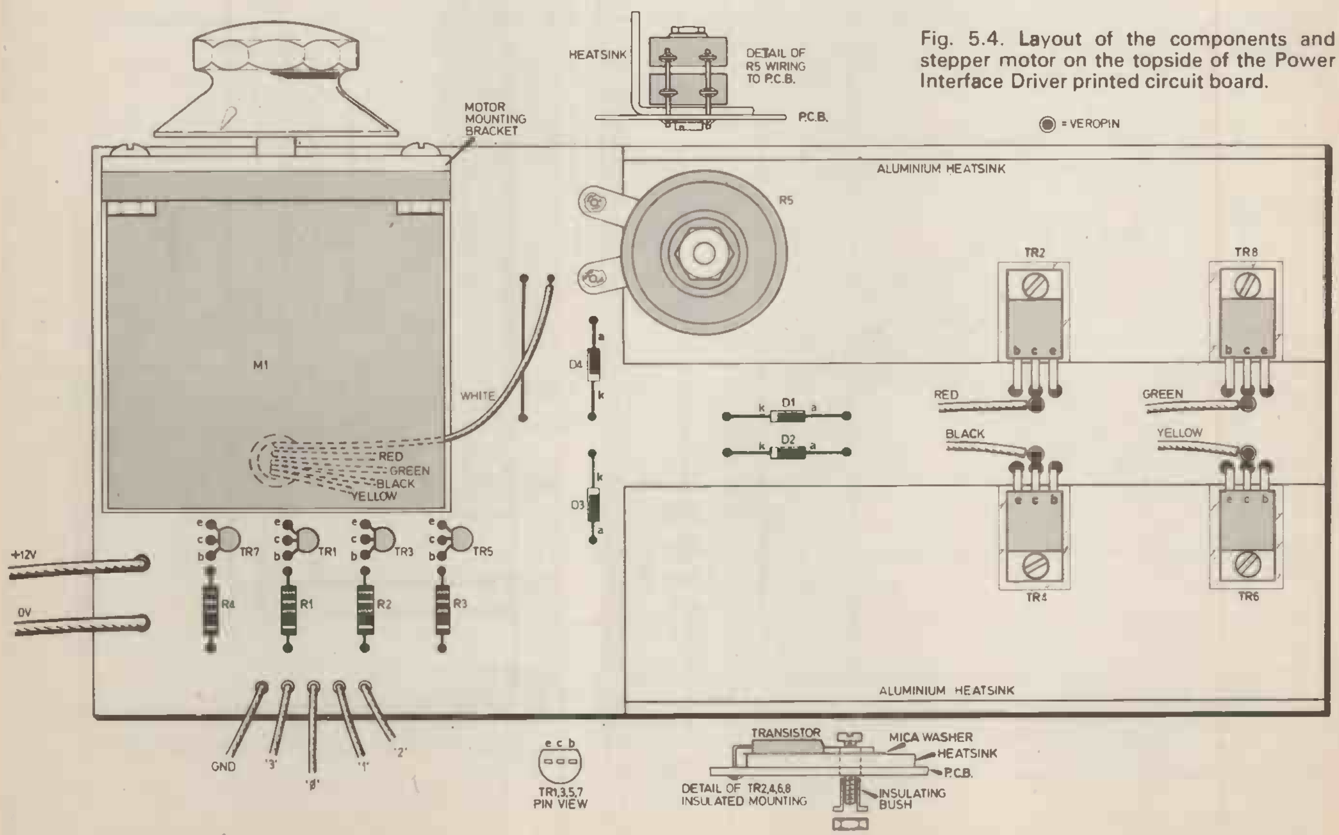


Fig. 5.4. Layout of the components and stepper motor on the topside of the Power Interface Driver printed circuit board.

COMPONENTS – £25

Resistors

- R1–4 3·9kΩ ¼W carbon ±5% (4 off)
- R5 5Ω 7W

Semiconductors

- D1–4 1N4002 1A 100V silicon (4 off)
- TR1,3,5,7 BC635 silicon *npn* (4 off)
- TR2,4,6,8 BD203 or similar *npn* silicon (4 off)

See Shop Talk page 703

Miscellaneous

- M1 SS25–I110U or similar 4-phase stepper motor

Printed circuit board: single-sided, size 202 x 95mm, *EE PCB Service,* Order code 8311–01; aluminium sheet for bracket and heatsinks 134 x 58 x 2mm, 114 x 75 x 2mm (2 off); TO-220 insulating kits (4 sets); 6BA fixing (8 sets); 4BA fixings (4 off) heatsink compound; large control knob with pointer; 7/0·2mm wire, selection of insulation colours; heavy duty stranded wire for power supply leads; self-adhesive rubber feet (6 off); single-sided Veropins (4 off).

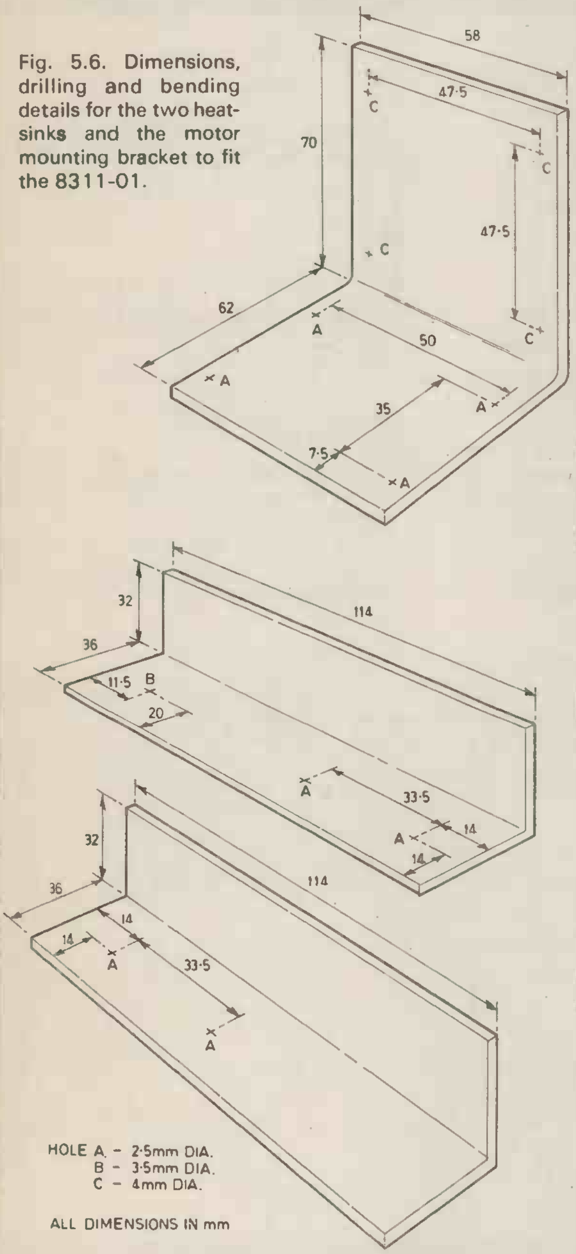


Fig. 5.6. Dimensions, drilling and bending details for the two heatsinks and the motor mounting bracket to fit the 8311-01.

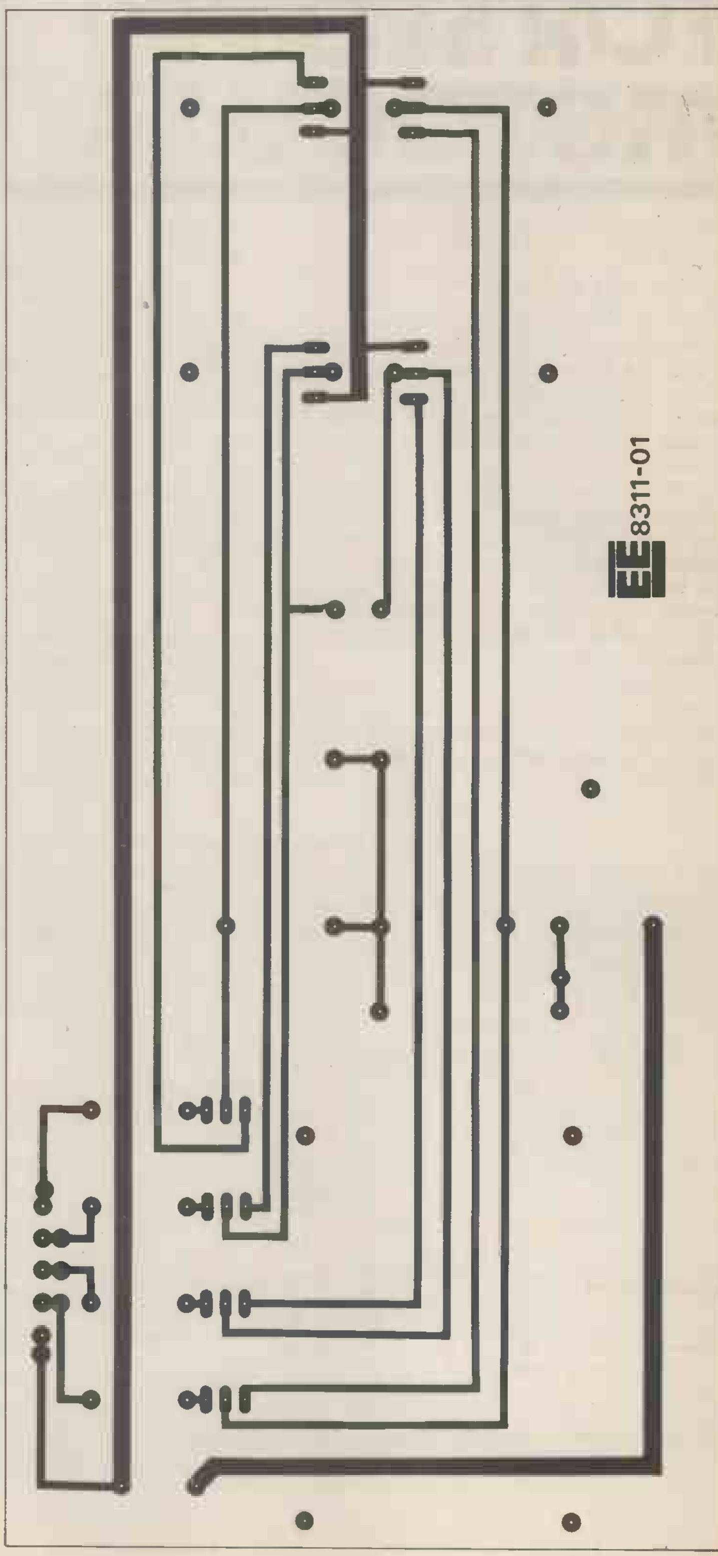
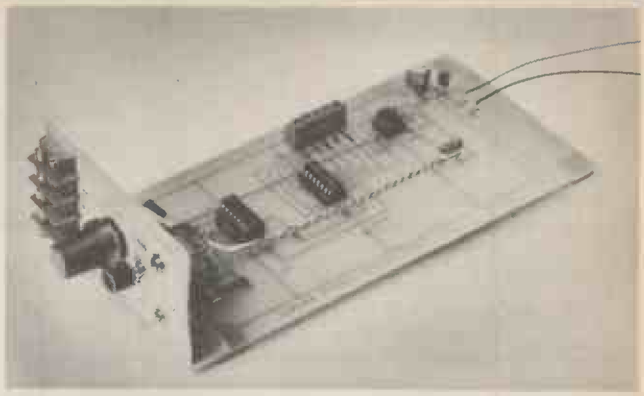


Fig. 5.5 (right). Actual-size master p.c.b. pattern to be etched for the Power Interface Driver. This board is available from the *EE PCB Service,* Order code 8311-01.

STEPPER MOTOR MANUAL CONTROLLER



HARDWARE CONTROL OF THE STEPPER MOTOR

A hardware solution to control the operation of the stepper motor involves using a 4-bit shift register to provide the data output to the coils and the use of three manual switches. The complete circuit for such a controller is shown in Fig. 5.7.

Closure of S1 loads the fixed TTL binary pattern, applied to the data inputs of the 74LS194, onto the data output lines applied to the stepper driver board.

Switch S2 acts as a simple on/off switch to control the running of the motor. When this switch is open motor rotation is inhibited.

Switch S3 controls the direction of rotation of the stepper motor. When open the motor moves clockwise and when closed an anticlockwise rotation is obtained.

Fig. 5.8 shows the pin-out diagram for the 4-bit 74LS194 shift register.

Any pattern presented to the data inputs on the chip will be mimicked on the data outputs to the stepper coils provided pins 9 and 10 are held high. When a clock pulse is received at pin 11 then this data is shifted to the left or right depending on the logic levels applied to pins 9 and 10. This is summarised in Table 5.1.

Table 5.1. Shift left and right

Pin 9	Pin 10	Data outputs
Ø	1	Shift right
1	Ø	Shift left

In this application the binary pattern (11ØØ) is applied to the data inputs of the 74LS194 (pins 3, 4, 5, 6, respectively). The two logic 1 bits cause excitation of the appropriate motor windings.

The logic circuitry made up from IC1 gates, encodes the three switch combination and applies appropriate control signals to pins 9 and 10 of the shift register.

The truth table of Table 5.2 explains the action of this circuitry and how the required conditions are established.

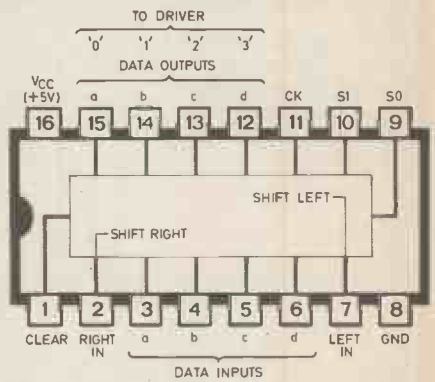


Fig. 5.8. Pin-out details of the 74LS194, a 4-bit shift register.

Fig. 5.7. Complete circuit diagram for the Stepper Motor Manual Controller for use with the Power Interface Driver.

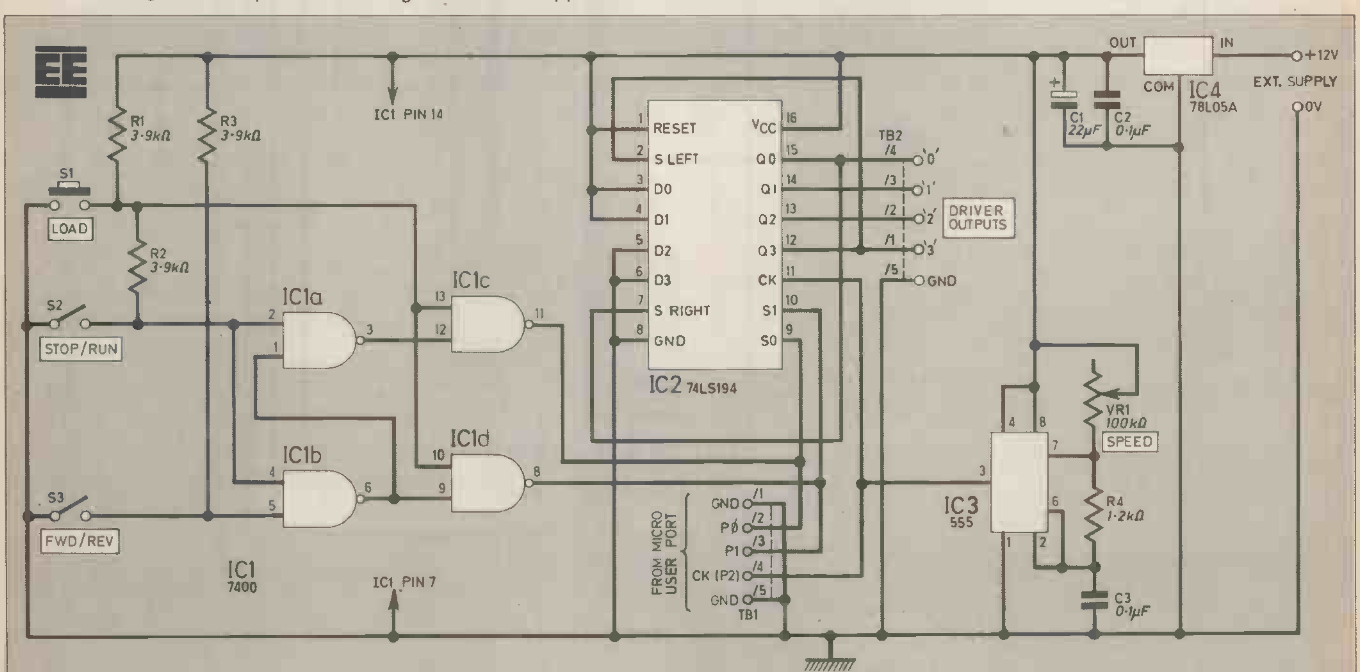


Table 5.2. Shift Register Control Logic Truth Table

Switch conditions			IC1a pin no.			IC1b pin no.			IC1c pin no.			IC1d pin no.			Motor function
S1	S2	S3	1	2	3	4	5	6	12	13	11	9	10	8	
Open	Open	Open	Ø	1	1	1	1	Ø	1	1	Ø	Ø	1	1	Rotate left
Open	Open	Closed	1	1	Ø	1	Ø	1	Ø	1	1	1	1	Ø	Rotate right
Open	Closed	Open	1	Ø	1	Ø	1	1	1	1	Ø	1	1	Ø	Inhibit
Open	Closed	Closed	1	Ø	1	Ø	Ø	1	1	1	Ø	1	1	Ø	Inhibit

Shift register load switch S1 is open during operation, the initial load function (1 —▶ Ø —▶ 1 transition) having been performed.

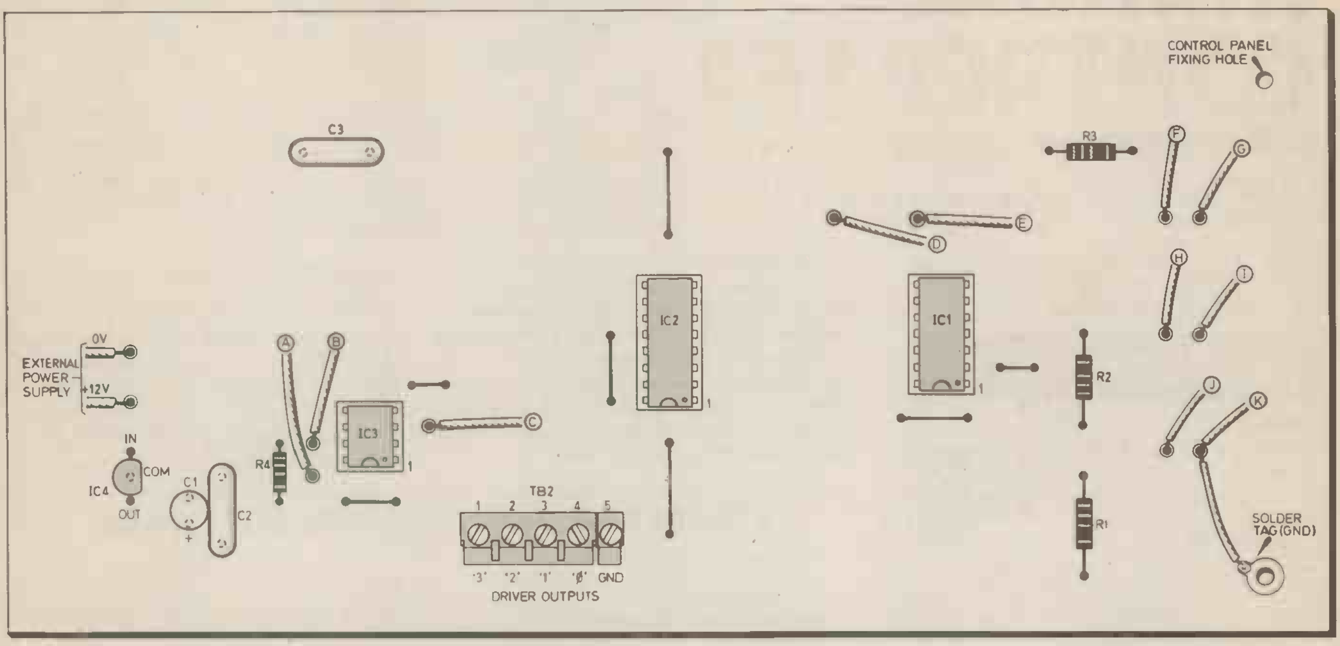
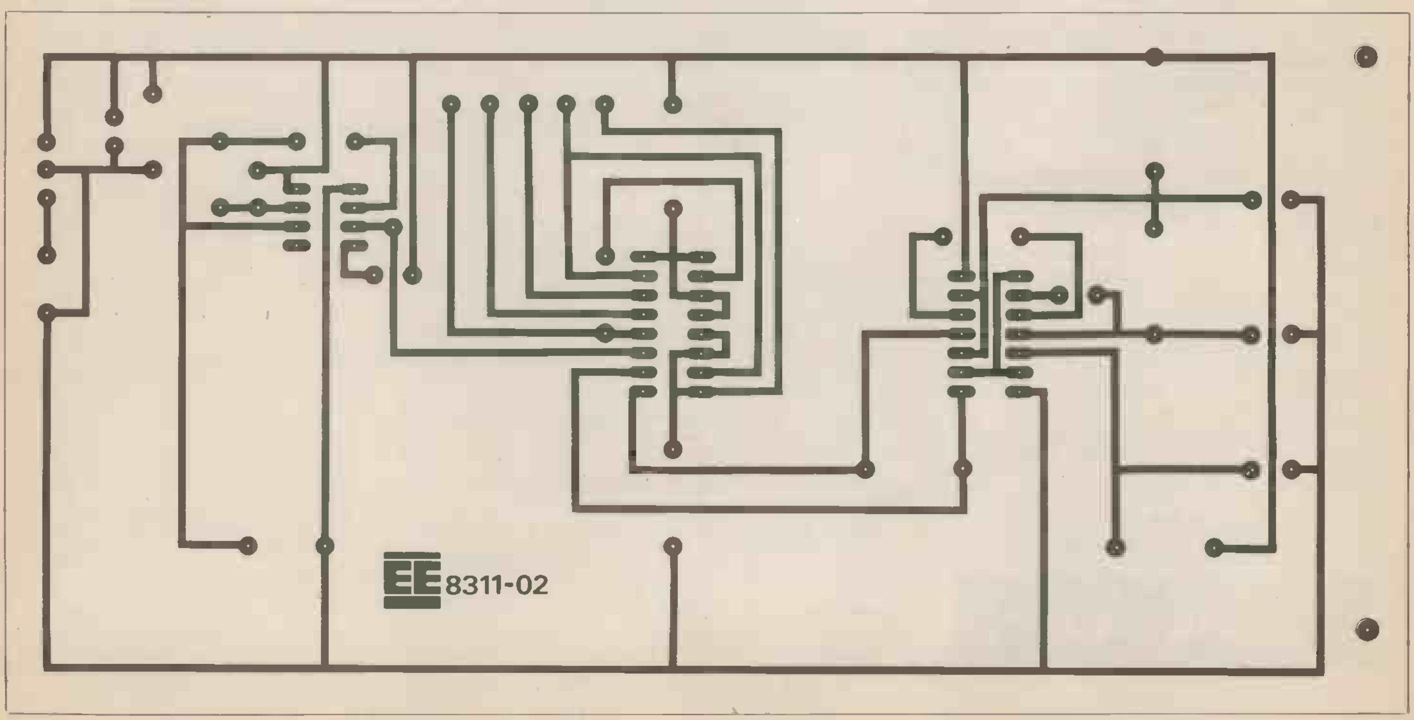


Fig. 5.9. Layout of the components on the topside of the Manual Controller p.c.b.

Fig. 5.10. The actual-size master p.c.b. pattern to be etched for the Manual Controller p.c.b. This board is available from the *EE PCB Service*, Order code 8311-02



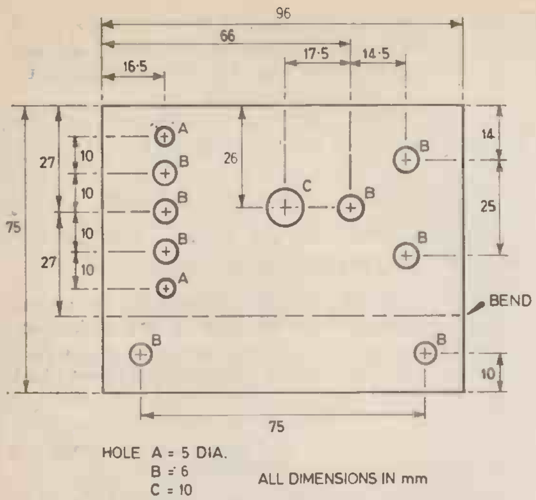


Fig. 5.11. Drilling details for the control panel of the Manual Controller.

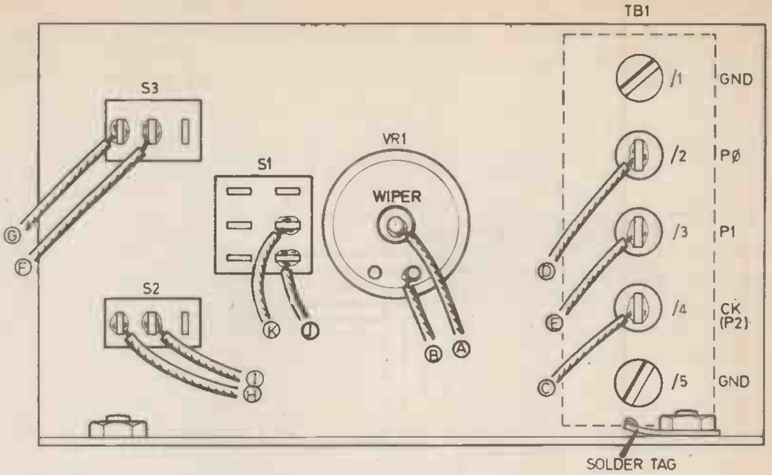


Fig. 5.12. Position of the components on the Manual Controller front panel with complete wiring details to the p.c.b. This panel is "earthed" via the solder tag connection at one panel fixing.

The remaining section of the logic board comprises the clock circuitry, IC3 and associated components. A 555 timer is used in the astable mode and variation of VR1 allows TTL pulses to be generated over a frequency range of approximately 10Hz to 100Hz, thus enabling the speed of the motor to be controlled.

A 78L05A +5V regulator is included in order that the logic board may be operated from the same 12V supply as is used for the driver board.

COMPONENTS

See Shop Talk page 703

Resistors

R1–3	3·9kΩ (3 off)
R4	1·2kΩ
All ¼W carbon ±5%	

Capacitors

C1	22µF 16V elect. radial
C2,3	0·1µF polyester type C280 (2 off)

Semiconductors

IC1	7400 TTL quad 2-input NAND
IC2	74LS194 low-power Schottky TTL 4-bit shift register
IC3	555 timer i.c.
IC4	78L05A +5V 100mA monolithic voltage regulator

Miscellaneous

VR1	100kΩ linear potentiometer
S1	single-pole, push-on, push-off
S2,3	miniature single-pole toggle (2 off)
TB1	5-way right-angle barrier strip
TB2	5-way p.c.b.-type terminal block (see text)

Printed circuit board: single-sided, size 202 × 95mm, *EE PCB Service*, Order code 8311–02; 4BA solder tag; single-sided Veropins (10 off); d.i.l. sockets; 8-pin, 14-pin, 16-pin (1 off each); self-adhesive rubber feet (4 off); 7/0·2mm insulated wire; tinned copper wire for links; control knob; 4BA fixings (4 sets) aluminium for control panel, 96 × 75 × 1mm.

Approx. cost Guidance only **£13**

CONSTRUCTION

The circuitry of Fig. 5.7 is assembled on a printed circuit board, single-sided, size 202 × 95mm as shown in Fig. 5.9. The master pattern to be etched is shown full-size in Fig. 5.10. This board is available through the *EE PCB Service*, Order code 8311–02.

STEPPER MOTOR CONTROL SOFTWARE

```
10 REM BBC MICROCOMPUTER
20 ?65122=255:REM DATA DIRECTION REGISTER CONFIGURED FOR OUTPUT
30 ?65120=?65120OR3:REM ENABLE LOADING OF SHIFT REGISTER OUTPUTS
40 ?65120=?65120AND254:REM CLOCKWISE ROTATION (AND253 REVERSE)
50 FOR X=1 TO N:REM NUMBER OF STEPS
60 ?65120=?65120OR4:REM CLOCK PULSE HIGH
70 ?65120=?65120AND251:REM CLOCK PULSE LOW
80 ?65120=?65120OR4:REM CLOCK PULSE HIGH
90 REM INSERT GOSUB FOR TIMING DELAY TO CONTROL SPEED
100 NEXT X

10 REM VIC-20 MICROCOMPUTER
20 POKE37138,255
30 POKE37136,PEEK(37136)OR3
40 POKE37136,PEEK(37136)AND254
50 FOR X=1 TO N
60 POKE37136,PEEK(37136)OR4
70 POKE37136,PEEK(37136)AND251
80 POKE37136,PEEK(37136)OR4
90 REM INSERT GOSUB FOR TIMING DELAY TO CONTROL SPEED
100 NEXT X

10 REM PET MICROCOMPUTER
20 POKE59459,255
30 POKE59457,PEEK(59457)OR3
40 POKE59457,PEEK(59457)AND254
50 FORX=1 TO N
60 POKE59457,PEEK(59457)OR4
70 POKE59457,PEEK(59457)AND251
80 POKE59457,PEEK(59457)OR4
90 REM INSERT GOSUB FOR TIMING DELAY TO CONTROL SPEED
100 NEXT X

10 REM COMMODORE 64 MICROCOMPUTER
20 POKE56579,255
30 POKE56577,PEEK(56577)OR3
40 POKE56577,PEEK(56577)AND254
50 FORX=1 TO N
60 POKE56577,PEEK(56577)OR4
70 POKE56577,PEEK(565770AND251
80 POKE56577,PEEK(56577)OR4
90 REM INSERT GOSUB FOR TIMING DELAY TO CONTROL SPEED
100 NEXT X
```

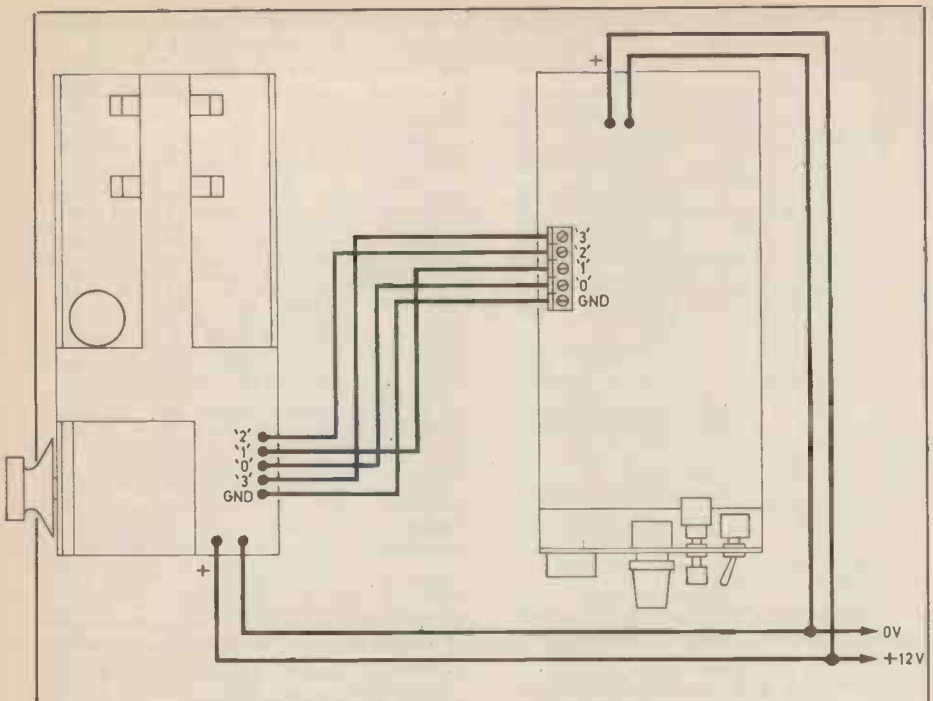


Fig. 5.13. Control of a stepper motor using hardware only.

A bracket needs to be made from about 1mm thick aluminium to form the control panel of the unit. Dimensions and drilling details are given in Fig. 5.11. Begin by preparing this part, labelling the control positions and securing all components as shown in Fig. 5.12.

Assemble the components as shown in Fig. 5.9 using sockets to hold the integrated circuits. A 5-way p.c.b.-type terminal block was constructed using a 4-way with a 1-way cut from a second 4-way type. Veropins were used for all flying lead connections but these may be omitted if desired. Pay attention to the polarity of IC4 when soldering to the board and check with Fig. 5.9 when inserting the i.c.s into their sockets.

The complete "hardware" control system is shown in Fig. 5.13.

HARDWARE/SOFTWARE CONTROL OF THE STEPPER MOTOR

A combination of both hardware and software can be used in this project by applying the three user port signal lines PØ, P1 and P2 to the SØ, S1 and clock (CK) inputs of the 74LS194, see Fig. 5.14. Provision has been made on the logic board for these connections, but IC1 and IC3 must, of course, be removed from their sockets. The BASIC listings given below show how the stepper motor can be under software control for each of the four microcomputers that have been discussed in this series.

FULL SOFTWARE CONTROL OF THE STEPPER MOTOR

Readers who wish to implement a complete software solution to the control of the stepper motor should connect the four output lines PØ, P1, P2, P3 from the microcomputer user port directly to the four inputs of the stepper driver board, see Fig. 5.15. The correct binary patterns are then loaded in sequence, into the I/O register for the port.

Next month: 4-channel ADC

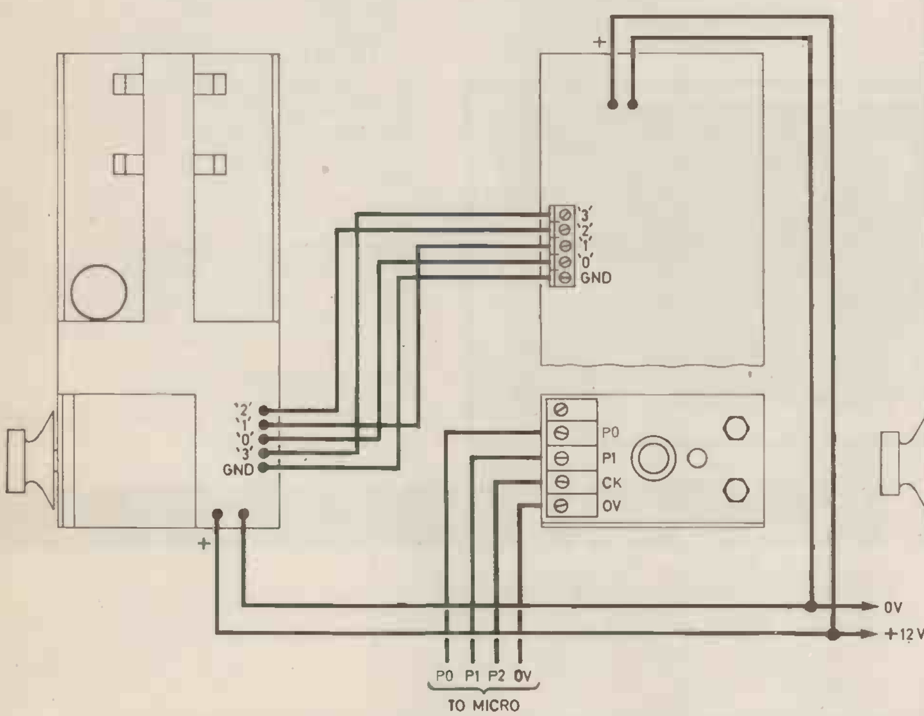


Fig. 5.14. Control of a stepper motor using a mixed hardware/software solution.

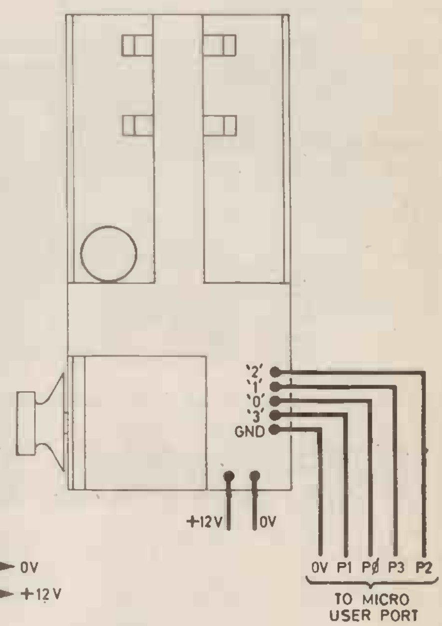


Fig. 5.15. Software only control of the stepper motor.

SPECIAL REPORT

RML380Z MIC

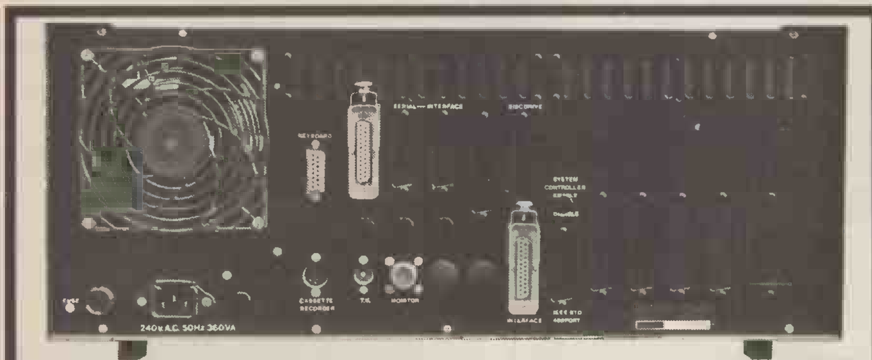
THE first thing about the 380Z microcomputer, made by Research Machines Limited, Oxford, is that it is British and a top quality design.

THE SYSTEM

The system is based around the Z80A-CPU with the full 64K RAM memory space, although smaller and cheaper versions are also available.

Originally the 380Z was a cassette-based system and to a certain extent it was like its name suggests, a "research machine", comprising a big metal box, with two cards, the CPU and VDU cards, and slots for more add-on cards. A person, probably a researcher, would complete his/her own circuitry and interface it to the CPU card, placing his own card(s) in the slots provided. Looking at the photograph, with the disk-drives removed and only two boards inside one can see plenty of room for expansion.

(Above) The RML380Z Microcomputer with keyboard console. (Below) Rear panel of the RML380Z showing the various connectors.



In time, of course, this space became filled with add-on RAMS, floppy disk controllers, 80-character boards, colour boards and so on, so bringing it up to the machine it is now.

Input is from a full keyboard and programming can begin either in BASIC or any of the other languages RML provide on disk or tape, for example, their version of COBOL, FORTRAN or ASSEMBLER or if you fancy a spot of word processing then TXED will assist you admirably.

EXTENDED BASIC

BASIC is big and powerful and is called "Extended BASIC version 5", although the latest is that there is now a BASIC version 6.

Initially RML provide the user with a disk containing CP/M, a BASIC disk(s) and ZASM, the Z80 assembler.

DISK DRIVES

At power-on the VDU displays Cos 3.4 on the bottom left of the screen. Most systems have two disk drives, each drive capable of handling double-sided diskettes in the MDS ($5\frac{1}{4}$). There is also the FDS (8 inch disks) available.

Allowing for the operating system, each side of the MDS provides 72K bytes for storage of programs and data. The drives are lettered (A,C) for the top floppy disk drive and (B,D) for the bottom drive. A and B being the uppermost side in each case.

On inserting the system's disk into drive A, say, and typing B (that is, BOOTING) CP/M is loaded into memory, thus providing the CP/M built-in commands DIR, ERA, REN and TYPE, and the transient commands STAT, FORMAT, MOVCPM, SYSGEN and PIP.

DCR enables the user to examine a disk directory of files and software whenever the disk to be examined is in the drive. ERA is a file eraser, REN remains a file, TYPE is a command used to display contents of a file stored on a disk.

STAT tells the user the currently available disk space for use, either reading from or writing to. FORMAT is necessary when preparing a new disk. These must be formatted first before use, otherwise only error messages will result. MOVCPM is used in conjunction with SYSGEN to copy CP/M onto other disks so that the master systems disk can be safely put away. Naturally, any disks with copied CP/M are for personal use only, since every user has to sign a legally binding agreement to preserve CP/M copyrights. Finally PIP is used for making copies of programs or indeed complete disks.

MEMORY MAP

BASIC is as mentioned, big and powerful. It uses the first 12K for the interpreter and some wordspace. Above this comes the variables and arrays. Above this is a memory area A, termed the cache and is reserved from BASIC by the CLEAR command. This area can be used for user machine code subroutines by POKEing the code into the memory locations. RML supply the user with a routine for determining the exact whereabouts of this area.

Above this area comes CP/M which normally lies in the top 4K of user memory, but can be moved down in order to provide the user with another cache area (A) for more subroutines. Above this comes the monitor ROM and VDU addresses plus wordspace.

BASIC COMMANDS

BASIC provides all the usual commands, such as, LOAD, SAVE, LIST, LLIST utilities, plus some extra features, such as, LOADGO, MERGE and MERGEGO.

LOADGO loads the program from disk file and automatically RUNS it, MERGE is a very useful command which allows the user to combine lines of program on disk file with a program already in memory. The MERGEGO command is a combination of the LOADGO and MERGE commands, the specified file is merged into a current program and the new combined program is extended at a specified line number. NEW deletes the current program.

There are also comprehensive EDIT facilities, with the insert mode (±) probably being most commonly used to correct spelling, omissions, and so on. There is a wide variety of EDIT facilities, too many to be listed here.

FILE HANDLING

The bulk of the other BASIC commands are for data transfer input and output, program control, and the usual variety of numeric and storing functions.

However, there is a comprehensive set of file handling commands some of which need to be mentioned.

To create a file requires a

CREATE#1Ø, "NAME" statement. To close a file is equally as easy,

CLOSE#1Ø and to reopen a file requires

OPEN#1Ø, "NAME".

These are supplemented by other file-handling commands, the most important of which being

INPUT#1Ø, X, Y

This takes the X, Y data from disk files and reads it into memory.

PRINT#1Ø, X, Y takes the X, Y data from memory to disk file. Other interesting commands for file-handling are:

X=GET(#1Ø), which gets a character from the input file.

A=LOOKUP ("NAME") which is a function which allows a program to determine whether a file exists.

For commercial and administrative or educational use, the use and handling of files is at the heart of retrieval and storage systems. Accounts invoices, dare one say, school reports (the black disk as opposed to the black book), all can be stored on a small-sized diskette, easily stored away.

GRAPHICS

The graphics on the 380Z can either be chunky or high resolution. The chunky graphics are in fact quite good, with the top 20 lines of the VDU screen used for graphics and the bottom 4 used for scrolling. So, in 40 characters per line mode, bearing in mind that each character is 3 × 2, the screen can be treated as an array of dots 60 high × 80 wide.

The screen is opened for graphics by the GRAPH 1 command and GRAPH Ø (or TEXT) restores the full screen scroller. The PLOT command is used for plotting points, characters or strings anywhere on the screen.

There is also a LINE command which draws a straight line from the coordinates of the last point to the next specified position.

If the 380Z has an 80-character board, that is, 80 characters per line, then the VDU divides into a 160, 60 matrix. The same commands apply as before, but PLOT can have a fourth character and so can LINE.

The fourth character, Z, sets up attributes and can have values from Ø to 255, but only the least significant four bits control the attributes.

HIGH RESOLUTION MODE

However, as mentioned, there is also a high resolution graphics facility with its own 16K bytes of RAM, which operates as 16K of memory if HRG are not used. In normal use the output from the HRGraphics board is mixed with the output from the 380Z memory mapped VDU, which allows graphics and text to be superimposed. Similar commands are available as for low resolution graphics, but within a CALL to a subroutine command.

High Resolution is set by the statement:

CALL "RESOLUTION", Ø, 2 at the start of a program, but this is a specific command of a general statement.

CALL "RESOLUTION", X, Y

where X = Ø or 1. When X = Ø, high res. mode is specified, giving a 192 × 319 array on the VDU, and when X = 1 is specified this is medium res. mode, giving a 96 × 160 array on the VDU screen.

The second character Y sets the number of bits to be used for each pixel. A pixel is that element of graphics memory that determines the intensity of a single point. In HR mode, two bits are available giving a choice of four intensities, that is, colours with a colour board, else shades of grey.

USER DEFINED GRAPHICS

There are many other features which give the user flexible graphics, a CALL "CHARSIZE", XE, VE gives magnification on the screen with XE the magnification in the X direction, and YE in the Y direction. Also a CALL "DEFCHAR" enables the user to define his/her own characters by changing the bits of the row or column comprising the character. There are also many CALLS to pointer subroutines to enable the user to dump his/her graphics onto a printer.

INPUT/OUTPUT

The 380Z has good input/output facilities. All standard models have a User Port, which also doubles as a parallel printer port, comprising eight bits in and eight bits out.

The whole user port is memory mapped as opposed to I/O mapped at location 65411 (&FBFF) of memory. By using the appropriate POKE statement, POKE 64511,XXX where XXX is between 0 and 255, the eight output bits can be activated to operate external devices, or by using the appropriate PEEK statement, PEEK(64511) the eight input pins can be read from external devices.

There is also the option to buy the PIO board from RML (Z80A-PIO, parallel input-output). These are input/output chips specially made for the Z80A family which are programmable and have two sets of input and output ports, Port A and Port B, each port having eight-bits.

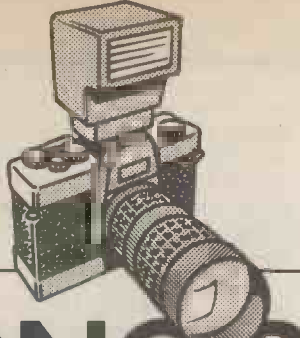
The Z80 PIO operates through the IN and OUT instruction since the PIO board is not memory mapped. This is quite an expensive optional extra, and usually, for a large number of control situations, the User Port should suffice.

CONCLUSION

In conclusion this is an excellent machine, but it is expensive and not many home users will be able to purchase one. □

ROCOMPUTER

BY A.A. CHANERLEY B.Sc. M.Sc.



BY R. A. PENFOLD

LONG RANGE CAMERA FLASH GUN TRIGGER

WITH some types of action photography it is impossible for a human operator to act fast enough to take a satisfactory photograph. It is then necessary to use some form of automatic triggering of the camera or a flashgun in order to obtain a fast enough response time to take the photograph before the subject moves out of frame.

INFRA-RED

The trigger unit described in this article is of the broken infra-red light beam type, and it can be used to operate either a flashgun or a camera. The camera can only be triggered by the unit if it has an electro-magnetic shutter release for which a suitable trigger cord is available, or if the camera is equipped with an automatic winder or motor drive which has a remote control socket.

The prototype has been tested with a Minolta XD7 (directly triggered) and with a Pentax LX (operated via the autowinder), and worked with both of these. Automatic operation is possible with most modern S.L.R. cameras, and the unit should function properly with any that have this facility. It should also work properly with any normal electronic flashgun.

SYSTEM DIAGRAM

Fig. 1 shows the block diagram of the trigger unit, and it can be seen that there are two units in the system; the transmitter and the receiver. The unit uses a pulsed infra-red beam rather than a steady visible light beam as this system gives improved reliability.

A d.c. coupled visible light system would be susceptible to spurious triggering due to changes in ambient light level and shadows failing on the sensor, even if precautions were taken against this. A steady beam with an a.c. coupled receiver seems to be just as susceptible to spurious operation as a simple d.c. circuit.

TRANSMITTER

The system employed has proved to be reliable, and attempts to induce spurious operation proved to be fruitless. The transmitter is an oscillator operating at a frequency of a few kilohertz and driving an infra-red l.e.d. so that the beam of light is actually a series of brief infra-red pulses.

Although of no practical significance, it should be pointed out that there is no visible light output from the l.e.d. because infra-red radiation cannot be seen by human vision, and there is no significant output from an infra-red l.e.d. at the shorter wavelengths of the visible light spectrum.

RECEIVER

The receiver uses an infra-red photodiode to detect the incoming pulses, and as this device has a built-in infra-red filter, it does not respond to other types of light.

The voltage pulses produced by the photodiode circuit are quite small, being no more than a few millivolts, even if the system is used at short range. A high gain audio amplifier is used to boost these pulses to a few volts peak-to-peak, and they are then rectified and smoothed to produce a strong d.c. signal.

This signal is used to operate a monostable multivibrator via a d.c. amplifier stage, this monostable normally held in the off state.

If the beam is momentarily broken, a number of pulses will be prevented from reaching the receiver, causing the d.c. output of the smoothing circuit to rapidly decay and trigger the monostable. The monostable then produces an output pulse of a little over one second in duration which is used to switch on a high voltage power transistor which operates the camera or flashgun.

It is necessary to use a high voltage power device at the output since the unit will need to handle a high voltage when used with an electronic flashgun, and fairly high currents when operating a camera via an autowinder or motor drive.

A gain control is fitted in the amplifier section of the receiver, and this is adjusted so that the infra-red beam produces a signal which only just prevents the unit from triggering under normal conditions. This helps to give the unit a fast response time and enables quite small and fast-moving objects to trigger the receiver.

TRANSMITTER CIRCUIT

Fig. 2 shows the circuit diagram for the transmitter. The oscillator circuit based around IC1, a 555 in the astable mode, pulses the infra-red l.e.d.s, D1 and D2. The short output pulse length helps to keep down the dissipation in these two devices.

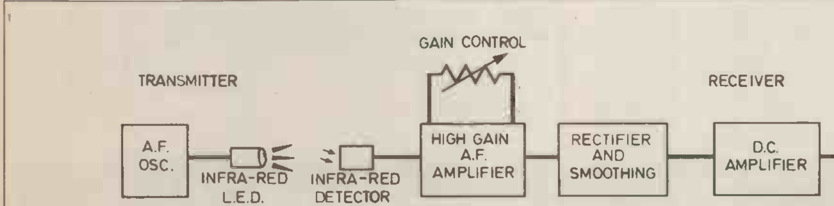


Fig. 1. Block diagram of the Long Range Camera/Flash Gun Trigger. By using two infra-red l.e.d.s in series in the transmitter, a range of three to four metres is obtained.

The infra-red diodes D1 and D2 need to be pulsed at a current of several hundred milliamps, and this is substantially higher than the maximum output current that the 555 device can provide. TR1 is therefore used as an emitter follower buffer stage which boosts the output current drive of the circuit, and R4 is used to limit the maximum current flow to a suitable level.

Apart from the increased l.e.d. current, the infra-red light output of the circuit is also boosted by using two diodes in series, and the supply voltage has to be 7·5V to permit this. Although the two l.e.d.s are pulsed at a current which is far in excess of their maximum continuous current rating, they do not sustain damage since they are switched off for more than 80 per cent of the time due to the short output pulse length used. This gives an average output current of under 100 milliamps.

CIRCUIT BOARD

A suitable component layout for the transmitter is shown in Fig. 3, and this is based on a 0·1 inch pitch stripboard having 20 holes by 14 copper strips. Construction of the board is quite straightforward, and ensure that the six link wires and five breaks in the copper strips are not overlooked. TR1 will get slightly warm in use, but it does not require a heatsink.

Due to the high current consumption of the unit (over 100 milliamps average consumption) high capacity batteries are consequently needed. Ideally, six C (RX14) or D (RX20) size ni-cad cells should be used to power the unit, but five ordinary HP2 cells could be used. Smaller batteries would give a very short operating life and may be unable to provide a high enough current at all.

COMPONENTS

TRANSMITTER

See Shop Talk page 703

Resistors

R1	120kΩ
R2	22kΩ
R3	3·3Ω ½W ±5%

All ¼W carbon ±5% unless otherwise specified

Capacitors

C1	220µF 10V elect.
C2	2·2nF ceramic or mylar

Semiconductors

D1,2	TIL38 infra-red transmitter (2 off)
TR1	TIP32A *pnp* silicon
IC1	555 timer

Miscellaneous

S1	s.p.s.t. miniature toggle
B1	6 off RX14 (HP11 size) or RX20 (HP2 size) ni-cad rechargeable cells (see text)

Case to suit; 0·1in matrix stripboard, 20 holes by 14 strips; l.e.d. mounting clips (2 off—for D1 and D2); battery holder and clip to suit (see text); 7/0·2mm wire; tripod bush or hot shoe accessory mount.

Approx. cost Guidance only **£4.00**

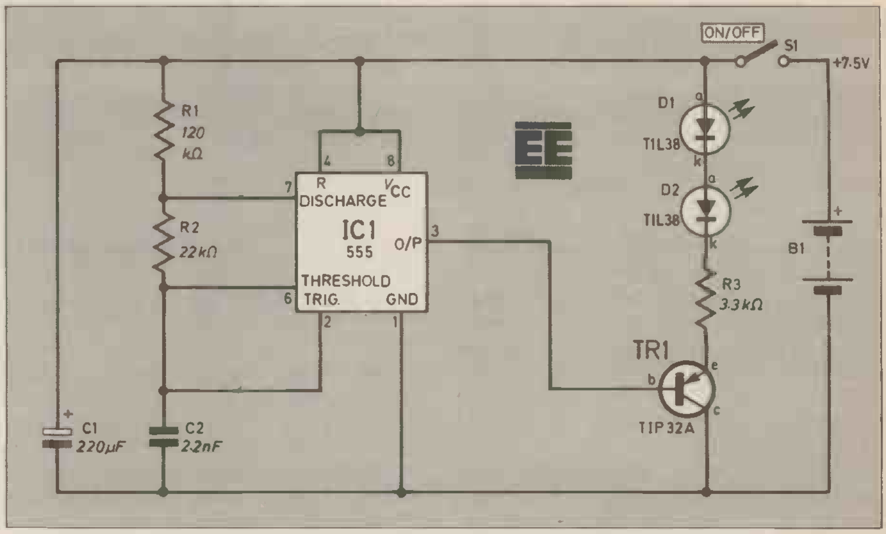
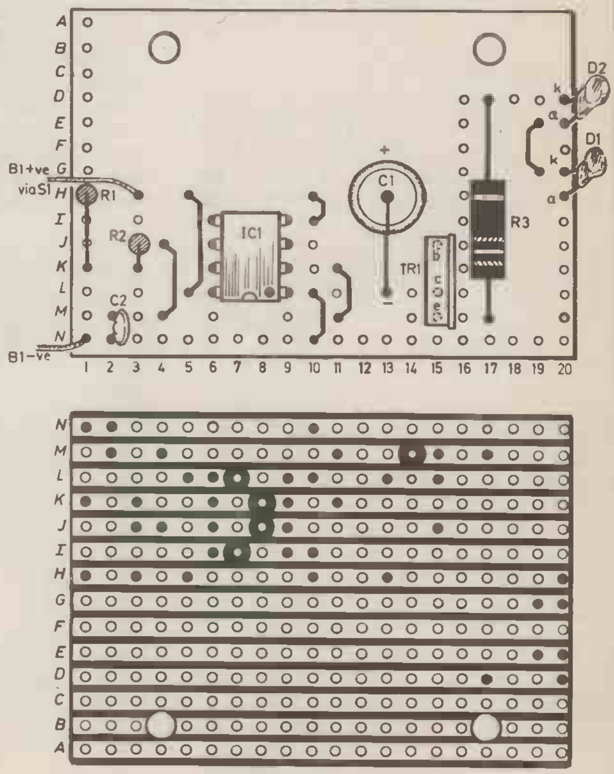
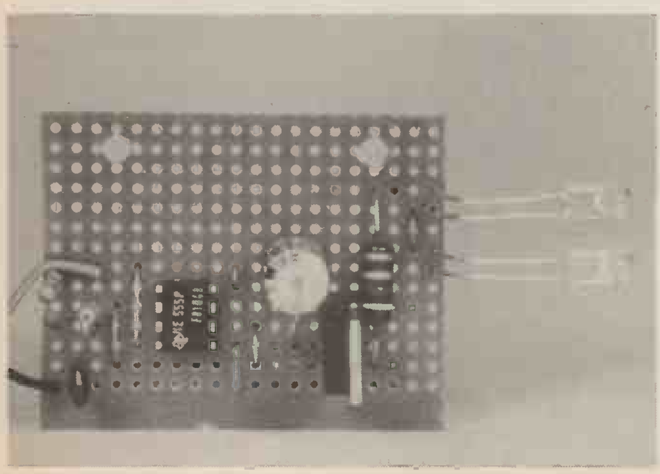


Fig. 2. Circuit diagram of the transmitter.

Fig. 3. The component board layout of the transmitter section. Note that l.e.d.s D1 and D2 are preformed as shown in the photograph below.





MOUNTING BUSH

It is useful to fit the case with a tripod mounting bush, and a suitable bush can be taken from a flash adaptor of the type used to fit a flashgun on a tripod.

The two rivets are drilled out so that the top and bottom sections of the adaptor can be separated, and the base section is then bolted to the case by fitting the bolts through the holes which were formerly occupied by the rivets. The unit can then be mounted on an accessory shoe or on a tripod since the adaptor has an accessory foot as well as a standard quarter inch tripod bush.

RECEIVER CIRCUIT

The circuit diagram of the receiver is given in Fig. 4.

D1 is a photodiode and it is reverse biased by R1. The infra-red pulses from the transmitter produce an increase in the leakage current of D1, giving a series of small negative pulses at the junction of R1 and D1. These pulses are coupled by C2 to a common emitter amplifier based on TR1, and the output is coupled by C3 to a volume control type variable attenuator, VR1.

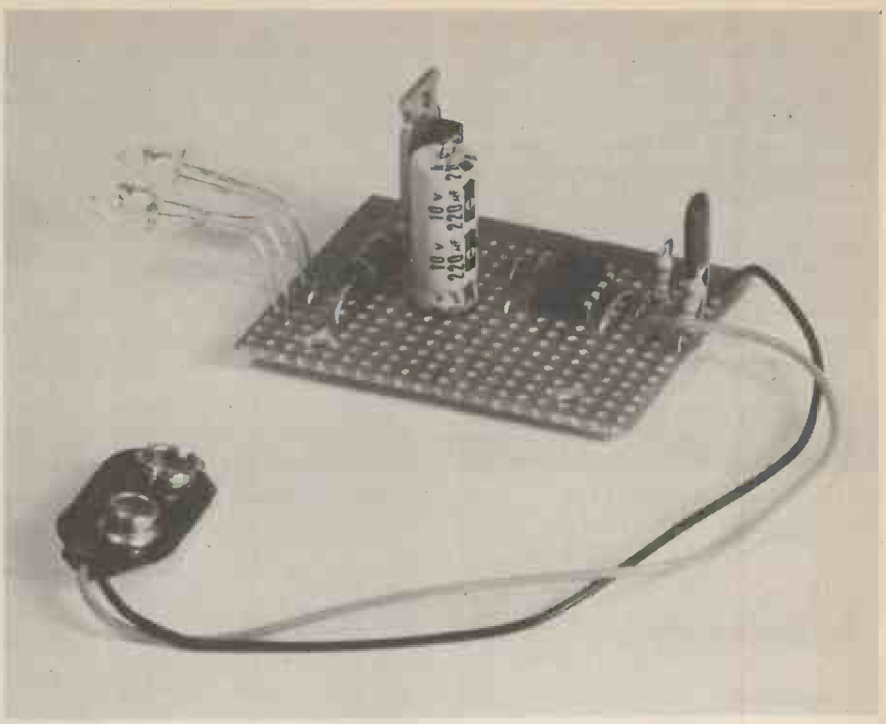
The signal is then taken to a second common emitter amplifier, TR2, by C4. C5 attenuates the high frequency response of this stage slightly in order to prevent instability.

The output from TR2 is rectified and smoothed by D2, D3 and C7. Under normal conditions this produces a negative bias which is strong enough to bias TR3 into conduction so that its collector terminal is at virtually the positive supply potential.

MONOSTABLE

The monostable is a conventional 555 i.c. type, and R7 plus C8 set the output pulse duration at a nominal 1·1 seconds.

In order to trigger IC1, its input at pin 2 must be taken below one third of the supply voltage, and this will happen if the input to the unit ceases, even briefly, as the charge on C7 will then rapidly decay and TR3 will switch off.



R8 then takes pin 2 of IC1 to the negative supply voltage, and the positive output pulse is produced at pin 3 of IC1. This switches on TR4 as it receives a heavy base current via R9; the large base current being necessary to ensure a low voltage drop across the collector-emitter terminals of TR4.

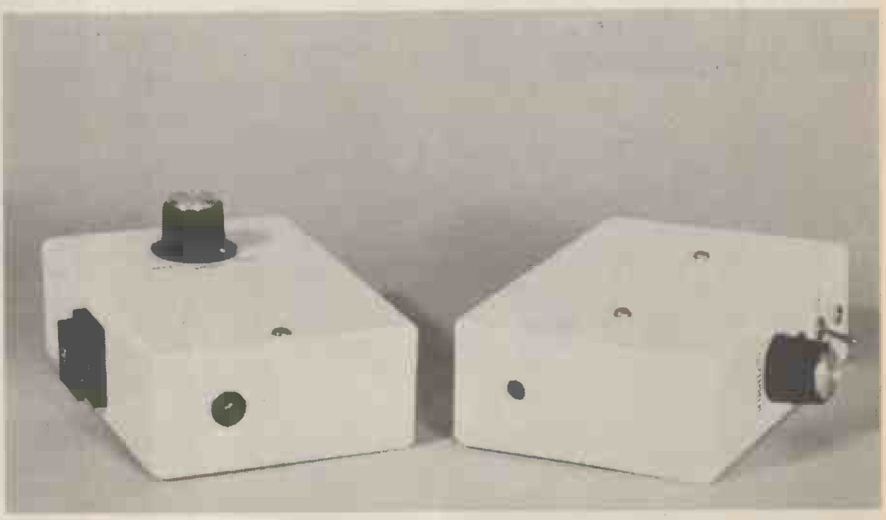
Indicator D4 is also switched on when IC1 is triggered, and this is helpful when setting the unit up ready for use.

The current consumption of the unit is about 9mA under stand-by conditions, and around 55mA during the output pulses from IC1. A ni-cad PP3 is used to power the prototype, but an ordinary PP3 is also a suitable power source.

RECEIVER CONSTRUCTION

The receiver uses a plastic case, about 120 × 80 × 40mm, and the general layout of the unit can be seen from the accompanying photographs. VR1, D4, S1 and SK1 are mounted on one side of the case which then becomes the top panel of the unit. A tripod bush is fitted on the base panel of the case.

Fig. 5 shows the component layout of the 0·1in matrix stripboard panel which accommodates the other components except the battery. The board has 15 strips by 30 holes and it is constructed using the normal techniques.



(Left): Receiver front panel layout. (Above): The completed transmitter and receiver. The mounting adaptor can be seen on the side of the transmitter.

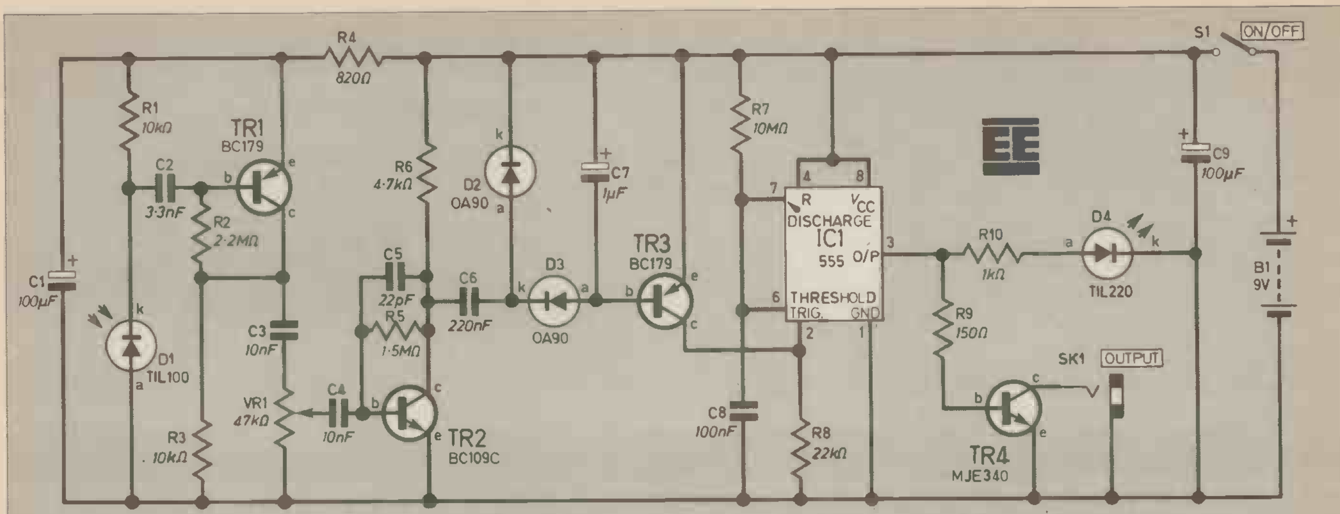


Fig. 4. Circuit diagram of the receiver section of the Long Range Camera/Flash Gun Trigger.

COMPONENTS

RECEIVER

Resistors

R1,3	10kΩ (2 off)
R2	2·2MΩ
R4	820Ω
R5	1·5MΩ
R6	4·7kΩ
R7	10MΩ
R8	22kΩ
R9	150Ω
R10	1kΩ

All ¼W carbon ±5%

See **Shop Talk** page 703

Capacitors

C1,9	100μF 10V elect. (2 off)
C2	3·3nF ceramic plate
C3,4	10nF polyester C280 (2 off)
C5	22pF ceramic plate
C6	220nF polyester C280
C7	1μF 63V elect.
C8	100nF polyester C280

Semiconductors

D1	TIL100 infra-red photodiode
D2,3	OA90 germanium diode (2 off)
D4	TIL220 5mm red l.e.d.
TR1,3	BC179 *pnp* silicon (2 off)
TR2	BC109C *npn* silicon
TR4	MJE340 *npn* silicon plastic power
IC1	555 timer

Miscellaneous

VR1	47kΩ log. carbon control potentiometer
S1	s.p.s.t. miniature toggle
SK1	2·5mm jack socket
B1	PP3 size ni-cad battery (see text)

Plastic case, 120 x 80 x 40mm (or similar); 0·1in matrix stripboard, 15 strips by 30 holes; control knob; l.e.d. holder; battery clip; 7/0·2mm wire; output lead; tripod bush.

Approx. cost Guidance only £7.00

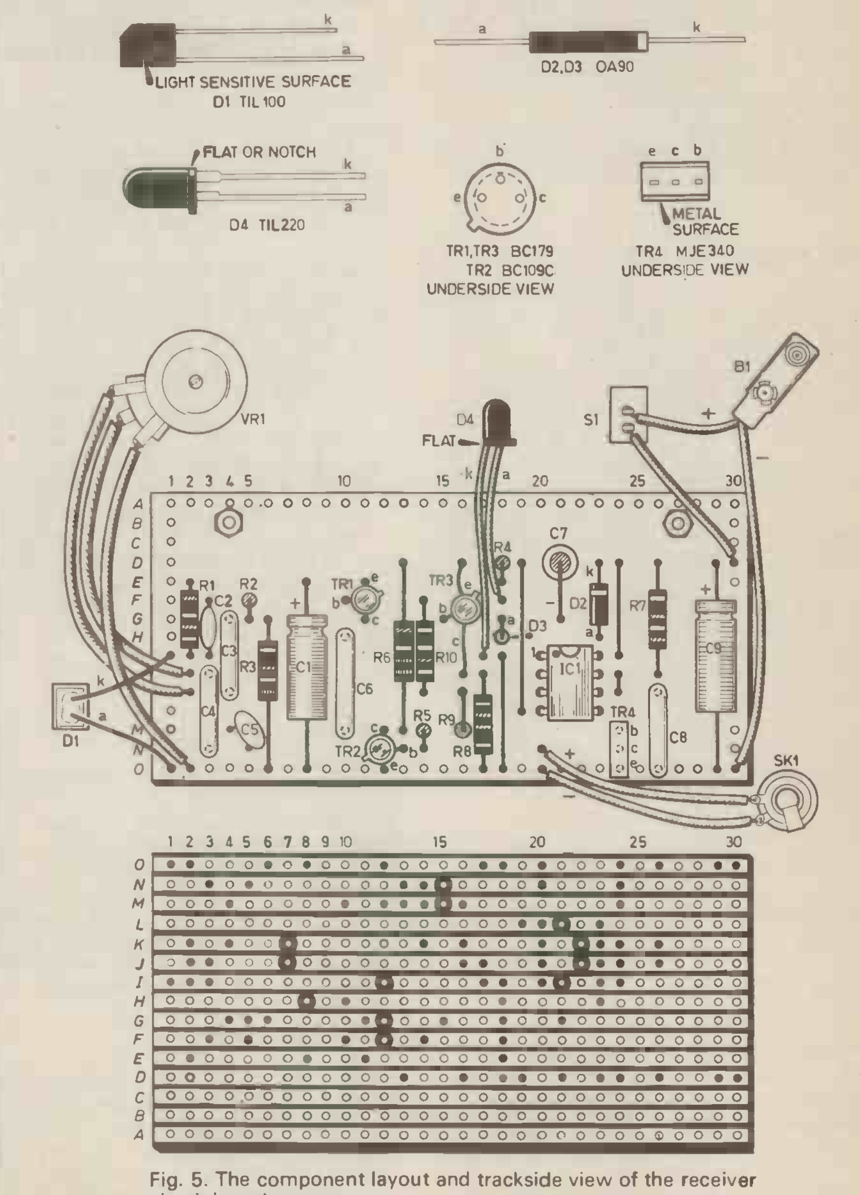
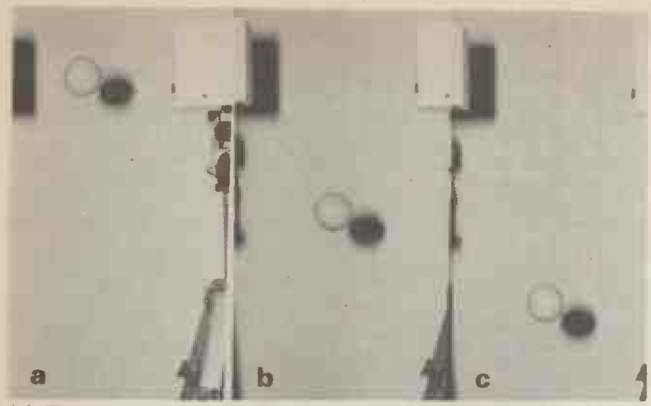
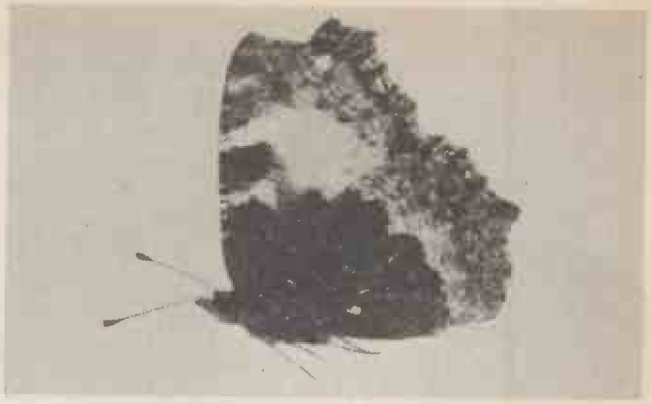


Fig. 5. The component layout and trackside view of the receiver circuit board.



(a) The dropped ball photographed by triggering the flash gun. (b) There is a small delay if the camera is triggered and the mirror lock-up is used. (c) A longer delay, when mirror lock-up is not used.



Small tortoiseshell butterfly.

The leadouts' wires of D1 are left long so that with the board mounted in the case, D1 can be positioned with its sensitive surface behind a hole about 6 or 7mm in diameter drilled in the case. The sensitive surface is the large one which does not carry the type number of the device.

Fig. 5 also shows the wiring to the off-board components, and this is all perfectly straightforward apart from the connections to SK1 which must have the correct polarity if the unit is to function properly.

FLASHGUN CONNECTION

If the unit is to be used with a flashgun, this can be connected to the receiver via a flash extension lead having the normal plug removed, and a 2·5mm jack plug fitted instead. With this plug connected to SK1 and the flashgun switched on, a voltmeter set to read 250V or more at full-scale deflection can be used to check the polarity of the voltage across SK1. With the plug removed, the two leads from the component panel are connected to SK1 accordingly.

If the unit is to be used to operate a camera or winder, a remote control lead of the appropriate type can be used to make the connections to the receiver. The push-button switch is removed from the lead and replaced with a 2·5mm plug which connects with SK1. As before, a multimeter (set to the 10V d.c. range in this case) is used to check the polarity of the voltage across SK1 so that the leads from the component panel can be connected with the correct polarity.

If the unit is to be used with a flashgun and a camera or winder, make sure that all the leads are connected with the right polarity.

USING THE SYSTEM

The exact set-up used must obviously depend upon the type of shot being taken, but the transmitter and receiver must be carefully arranged so that the object to be photographed breaks the beam at the correct point in the frame, and in the plane of perfect focus.

With many shots it is possible to simply have the beam running straight across in front of the camera with transmitter and receiver units just out of frame. In other cases it may be better to have the receiver unit mounted on a flash bracket at the side of the camera and angled across in front of the lens, with the transmitter mounted on a tripod and sited on the other side of the camera just out of frame.

When dropping objects through the beam it is usually quite easy to ensure that they break the beam at the correct point, but with insects the standard method is to use a simple tapering flight tunnel to guide the insect to the correct point.

The beam from the transmitter should be reasonably accurately aimed towards the detector at the receiver, and S1 of the transmitter should only be set to the "high" position if inadequate range is obtained with it set to the "low" position.

The l.e.d. indicator on the receiver switches on each time the unit is triggered, and glows continuously if the two units are too far apart or VR1 of the receiver is backed-off too far. Do not be tempted to back-off VR1 to the point where the unit barely has sufficient range as this will give poor reliability by making the unit prone to spurious triggering. Advancing VR1 slightly from this point will not seriously reduce sensitivity and will give good reliability.

FLASHGUN OPERATION

As the accompanying test shots show, the system has a virtually instant response time if it is used to trigger the flashgun. The disadvantage of this system is that it is necessary to lock open the shutter (using the "B" or "T" setting), activate the system, and then close the shutter. The photograph must be taken under fairly dark conditions so that the ambient light does not ruin the shot.

CAMERA OPERATION

Using the unit to operate the camera or winder is more convenient since the ambient light level is no more of a problem than with normal flash photography. There is typically a delay of about a tenth of a second before the flash fires which can sometimes be awkward, but is often of no real consequence and can even be used to advantage with some types of shot. The delay can be substantially reduced using the "mirror lock-up" on cameras that have this feature.

Most electronic flashguns give a flash duration of about 0·5 to 1 millisecond, which is short enough to "freeze" most action. Sometimes a shorter flash duration is needed, and this can be obtained using an automatic flashgun close to the subject, or using a manual flashgun having a variable power control which is set well back. This typically gives a flash duration of only about 0·05 to 0·1 milliseconds which is short enough to "freeze" virtually any action.

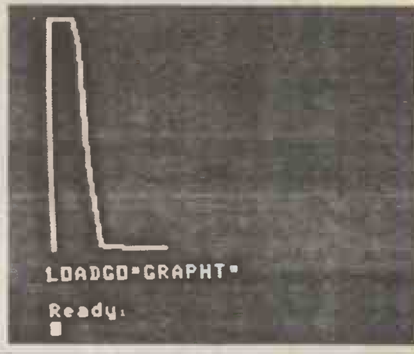
One final point is that it is advisable not to connect the receiver to the camera or autowinder (if this method is used) before switching on the receiver and transmitter as this could lead to unwanted triggering of the system. Similarly, switching off the transmitter and receiver before disconnecting the lead to the camera or autowinder could produce an unwanted triggering. □

COMPUTER AIDED EXPERIMENTS

USING THE RM380Z MICROCOMPUTER

BY A. A. CHANERLEY B.Sc. M.Sc.

3. TRANSISTOR VOLTAGE-TRANSFER CHARACTERISTIC



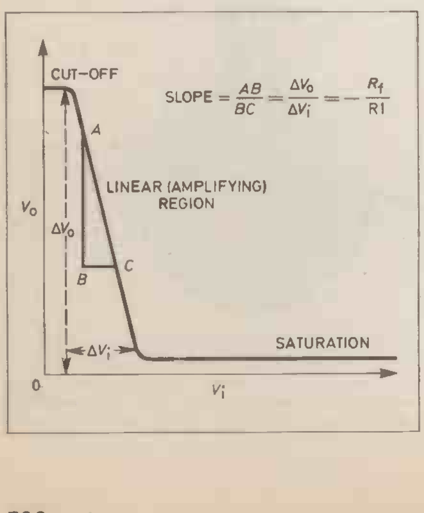
THIS experiment illustrates the mode of operation of a transistor. Most readers will probably know that a transistor is an amplifier, but it is also a switch, and can switch rapidly from a high state (cut-off) to a low state (saturation). This action forms the basic building block of all computer elements, if we assign, for example, a logic 1 to the high state and a logic 0 to the low state, that is, binary arithmetic.

The experiment shows three distinct regions in the voltage—transfer characteristic of here, a BC109 transistor: horizontal cut-off and saturation regions, and a sloping portion which is the amplifying part of the transistor characteristic, see Fig. 3.1.

The latter shows that for a small input voltage swing ΔV_i a large, amplified, output voltage swing is obtained, ΔV_o. The ratio of V_o/V_i gives the amplification factor, the "gain", which in this type of amplifier configuration is equal to the ratio of the resistors R_f/R1.

The voltages V_i and V_o are fed directly to channels 1 and Ø, respectively, of the Analogue-to-Digital Converter (ADC) described in the Sept 83 issue of EE, and the software reads the two ADC channels, and immediately plots the characteristic on the VDU. The microcomputer used here is the RML380Z, as before for the diffraction pattern and the cooling curve experiments. Again, as with all such experiments any microcomputer can be used with virtually any ADC, providing due care is taken in attenuating, or boosting the inputs as required by the specifications of the interface used, and suitable software is developed.

Fig. 3.1. Voltage transfer characteristic.



VOLTAGE SHUNT NEGATIVE FEEDBACK AMPLIFIER

The circuit diagram for this experiment is shown in Fig. 3.2. A BC109, configured as a voltage amplifier by using a shunt feedback resistor R_f to provide base bias. This serves to stabilise the gain, input impedance and so on of the amplifier, though providing an overall reduction in gain, against the effects of temperature. (For example, suppose the ambient temperature rises, more electrons have sufficient energy to escape from lattice atoms and the collector current rises.)

Looking at Fig. 3.2 we see:

$$V_{cc} = I_L R_L + V_o$$

V_{cc} remains fixed, since it is the supply voltage; I_L increases therefore V_o must decrease, that is, the collector voltage decreases. Looking at nodes "a" and "b", the potential difference across them thus decreases, hence the base current also decreases thereby reducing the collector current to a value less than it would be without this method of feedback.

To calculate the value of the voltage gain, we first look at the node "a".

At this point,

$$I_i = I_f + I_b$$

but I_b, the base current is very small and so we can say

$$I_i = I_f$$

Looking at the input, the current I_i is, from Ohm's law,

$$I_i = (V_i - V)/\text{R1}$$

but since V is very small, then

$$I_i = V_i/\text{R1}$$

Similarly,

$$I_f = (V - V_o)/R_f$$

but again since V is small, then

$$I_f = -V_o/R_f$$

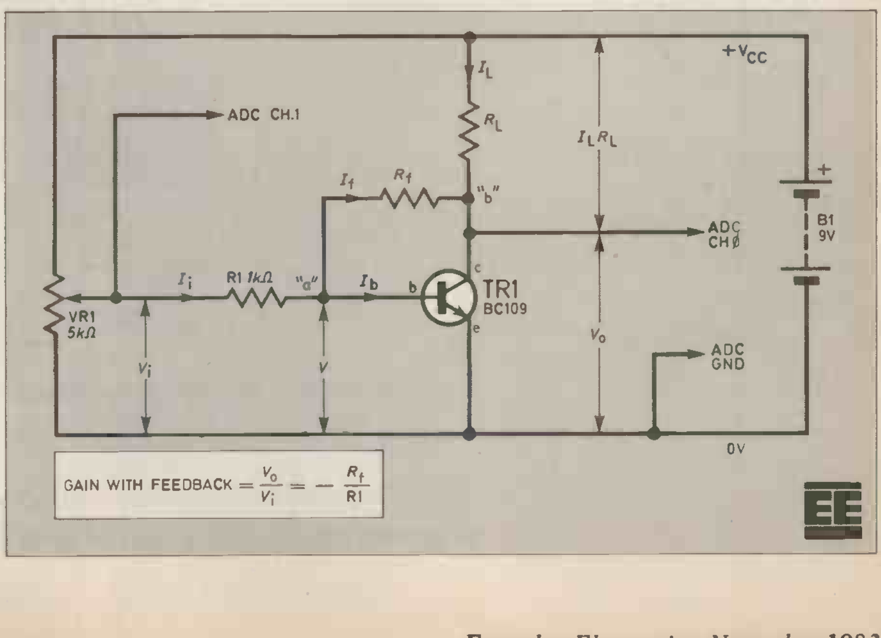
Hence, equating I_i and I_f as above, we have

$$V_i/\text{R1} = -V_o/R_f$$

On re-arranging,

$$\text{Gain} = V_o/V_i = -R_f/\text{R1}$$

Fig. 3.2. The amplifier circuit under investigation.



COMPUTER AIDED EXPERIMENTS SOFTWARE: EXP. 3

TRAN

```
1Ø GRAPH 1
15 CALL"RESOLUTION",Ø,2
16 A=Ø
2Ø POKE64511,8
3Ø POKE64511,Ø
4Ø Y=PEEK(64511)
5Ø POKE64511,1
6Ø X=PEEK(64511)
7Ø CALL "LINE",X*2,Y,3
75 A=A+1
76 PRINT A
78 POKE(&6ØØØ+A),Y
79 POKE(&64ØØ+A),X
9Ø GOTO3Ø
```

STORET

```
1Ø CREATE#1Ø,"TRAN.DAT"
2Ø FOR I=24576 TO (24576+35)
3Ø BYTE=PEEK(I)
4Ø PRINT#1Ø,I;",";BYTE
5Ø NEXTI
52 FOR V=256ØØ TO (256ØØ+35)
54 BYTE=PEEK(V)
56 PRINT#1Ø,V;",";BYTE
58 NEXT V
6Ø CLOSE#1Ø
```

POKERT

```
1Ø OPEN#1Ø,"TRAN.DAT"
2Ø FOR I=24576 TO (24576+35)
3Ø INPUT#1Ø,ADDR,BYTE
4Ø POKE ADDR,BYTE
5Ø NEXT I
52 FOR V=256ØØ TO (256ØØ+35)
54 INPUT#1Ø,ADDR,BYTE
56 POKE ADDR,BYTE
58 NEXT V
6Ø CLOSE#1Ø
```

GRAPHT

```
4Ø GRAPH 1
5Ø CALL"RESOLUTION",Ø,2
6Ø CALL"PLOT",Ø,Ø,3
8Ø FOR N=1 TO 18
9Ø X=PEEK(&64ØØ+N)
1ØØ Y=PEEK(&6ØØØ+N)
11Ø CALL"LINE",X,Y,3
12Ø NEXT N
13Ø CALL"LINE",PEEK(&64ØØ+(N)),
     PEEK(&6ØØØ+(N)),Ø
14Ø CALL"LINE",Ø,Ø
15Ø END
```

COMPONENTS

R1	1kΩ
R_f	A selection of values between 1kΩ and 27kΩ
R_L	1kΩ
All ¼W carbon ±5% or better	
VR1	5kΩ linear potentiometer
TR1	BC109 or other similar *npn* general purpose transistor
B1	9V type PP3

Solderless breadboard; battery clip to suit B1; plastic covered connecting wire; ADC with input leads.

This expression should be numerically equal to the slope on the experimentally derived transfer characteristic.

EXPERIMENT AND SOFTWARE

The complete amplifier circuitry can be assembled on a solderless breadboard as shown in Fig. 3.3. V_i is provided by the 9V supply divided by a 5-kilohm potentiometer. The maximum voltages are therefore within the limits of each of the ADC channels used, since each one can take up to 10V maximum when used in the unipolar mode.

The pinout for the BC109 is given in Fig. 3.3. This is a view looking directly at the pins on the underside. The emitter is closest to the index tab on the case. You should prevent any wiring making contact with the case as the latter is internally connected to the collector.

Rotating VR1 spindle alters the amplitude of the input signal to the amplifier and consequently the output amplitude.

R_f is the component used to determine the gain of the amplifier and suggested values range from 1kΩ to 22kΩ.

Choose a value for R_f and insert in the circuit. Run the software and rotate VR1 spindle from fully clockwise to fully anticlockwise. A curve similar to that shown in Fig. 3.1 will be plotted on the screen. This curve is known as the voltage-transfer characteristic.

Change the value of R_f and repeat to obtain another curve.

An interesting feature can be obtained on the 380Z microcomputer by a judicious use of software. Shown in the heading is a photograph of the VDU for one experiment using a set value of R1 and R_f, which determine the gain of the amplifier. However, by altering the value of R_f (the feedback resistor) a different gain is obtained which alters the slope of the characteristic. This new plot can be obtained and superimposed on the old plot by deleting lines 1Ø and 15 of the main programme called "TRAN". To RUN this programme from line 1Ø each time will initialise the high resolution graphics and so obliterate the previous plot.

The procedure then is to RUN the full programme for the first plot, then change the feedback resistor, delete lines 1Ø and 15, clear the screen of any verbiage and re-RUN the programme this time from line 16. Another plot will be obtained with a different slope and so comparisons can be made.

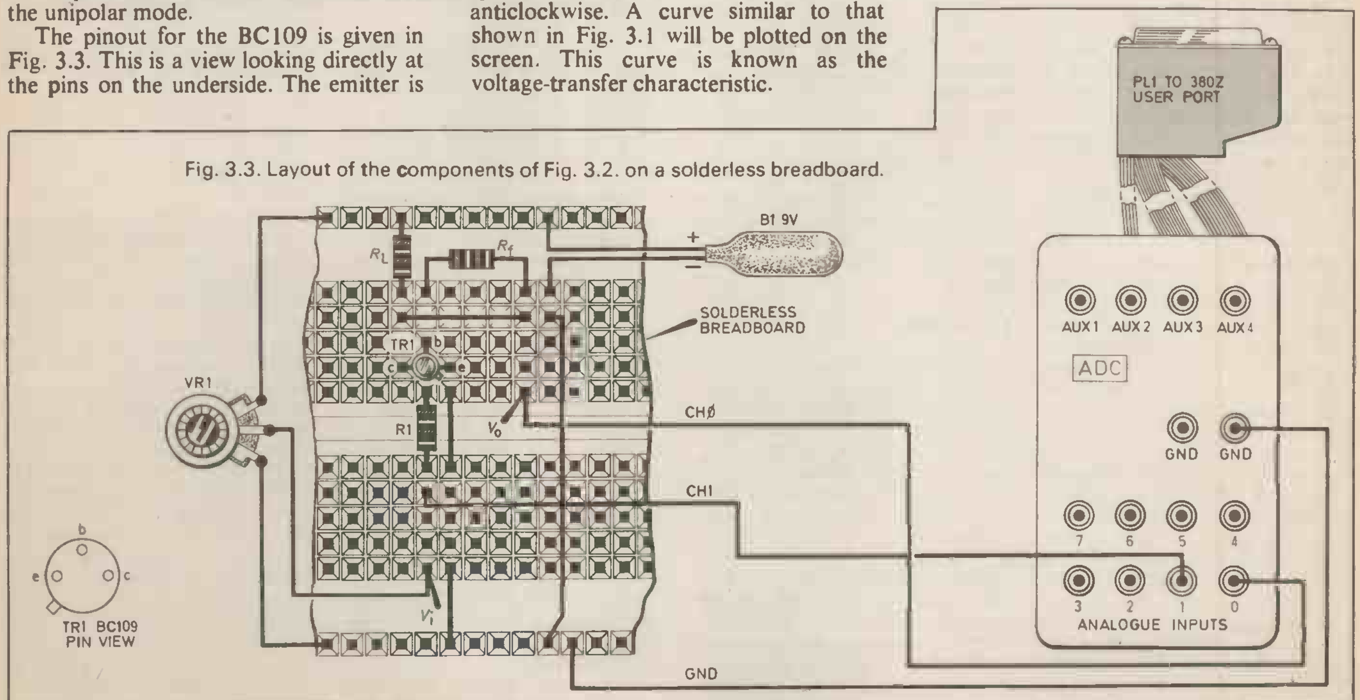
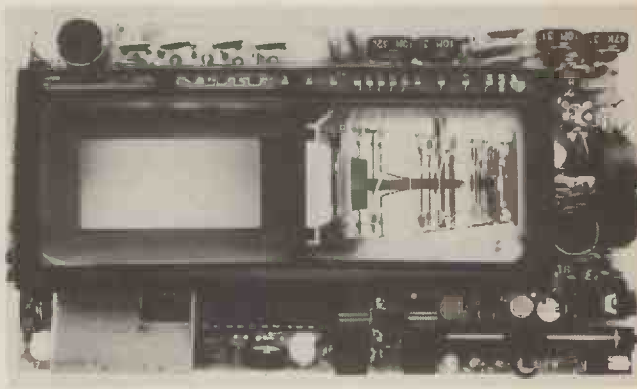


Fig. 3.3. Layout of the components of Fig. 3.2. on a solderless breadboard.

SINCLAIR GOES FLAT OUT



THE WORLD'S smallest television set was finally launched by Sir Clive Sinclair on 16 September. The long awaited flat-screen TV will go on sale for £79.95 including VAT, about a third of the cost of its nearest rival.

As initial demand is expected to outstrip supply, it will only be available by mail order from Sinclair Research until production is in full swing, so retail outlets will have to wait until possibly next year for supplies. In order to avoid the problems of previous mail order operations, no payment will be accepted until the product is ready for dispatch.

With the lesson learnt from the calculator boom in the seventies, Sinclair is going into large-scale production to thwart the inevitable competition from the East. Building up to 10,000 units per month by the end of the year, projected worldwide sales figures of one million sets per year are confidently predicted.

Sinclair will first satisfy the home market before exporting a slightly modified version to the USA. This model will also receive v.h.f. transmissions as most American channels broadcast on this band. Japan is the third target but they "will have to wait" until the first two markets are catered for.

Although not the first flat-screen TV set on the market (pre-empted by the Sony Watchman), it does contain a number of other "firsts"; it is the first TV to use a single i.c. for the majority of signal processing functions, and it uses unique Polariod flat batteries (flat in profile—*not* in output!) originally developed for instant film packs. These 6V Lithium batteries provide 15 hours of viewing, some six times that of its nearest competitor's battery life.

The set is actually 140 × 90 × 30mm (about the size of an average paperback book) with a two-inch diagonal screen and it weighs in at 280 grams. Options include a mains adaptor for £7.95 and a pack of three batteries costs £9.95, again, initially only from Sinclair by mail order.

The development of the flat-screen TV has taken six years and £4 million, and features of this multi-standard set include automatic standard switching for reception of most u.h.f. transmissions worldwide (except France) and just two controls, on/off—volume and tuner. Line and frame hold are taken care of automatically and brightness and contrast are preset.

The demand for a pocket television has already been tested with the Microvision models (which used a conventional two inch tube), and contrary to popular belief, this version was a success as sales figures met with expectations. Sir Clive pointed out that due to high production costs and power consumption, the Microvision was never intended to be a big seller but to pave the way for the flat-screen TV. He added that several Japanese manufacturers had followed him into this market and are still selling sets at a considerably higher price than his.

When speaking of the new flat-screen TV, Sir Clive said: "I believe it, and its successors, can achieve for television what the transistor radio did for wireless, and create a new one-per-person product."

Flat Screen

The key element in the new TV is the flat-screen cathode-ray tube (c.r.t.) which measures 108 × 45 × 20mm. It is three times brighter, requires between one quarter and one tenth the power and occupies half the volume of a conventional c.r.t. with the same size screen.

The tube is assembled from just two sheets of glass, a flat front plate and a vacuum-formed backing plate. The phosphor screen is coated on the interior of the backing plate and is viewed from the same side that the electrons strike.

The electron gun is set to one side of the screen with its axis parallel to the screen. Two sets of electrostatic deflection plates in the gun assembly provide horizontal and vertical scanning (the same technique is used in oscilloscope c.r.t.s), and a third set bends the beam towards the phosphor screen. In contrast, the Sony flat-screen tube uses the more power-hungry scanning coils.

To correct the distortion of the rasta scan that inevitably occurs with this type of construction, both electronic and optical techniques are employed. First, the screen height is reduced by two thirds but the width is kept constant. This narrows the angle subtended by the electron beam onto the screen, reducing both the distortion and the deflection power.

The picture height is restored optically by means of a Fresnel lens. This lens does limit the viewing angle, however, so it really can only be comfortably watched by one person.

The tube assembly lends itself to low-cost mass production, and as with all Sinclair products, the manufacture is sub-contracted out, in this case to Timex in Dundee where a purpose-built assembly line has been set up.

Single Chip

The other element in the design which has enabled Sinclair to produce such a small and cheap set is the custom i.c. Designed by Sinclair Research and produced by Ferranti Limited, it is a complex linear/digital circuit with a number of advanced features subject to patent applications. So secret are these features that the patents were only filed the day before the launch.

The chip's principle function is to take the i.f. output from the tuner, recover the video and sound signals and feed them to the c.r.t. and speaker. Additional information is extracted from the video signal to synchronise a multi-standard line and field scan system (it caters for all 625- and 525-line systems) which generates the correct picture display on the screen.

electronics

Warning Triad

An acoustic warning device for drivers which emits a signal as soon as reverse gear is engaged had been developed by Siemens.

The device is based on the SAB0600 gong module, which emits a musical triad (a chord of three notes). The warning signal is triggered by the reversing-light switch.

ATLANTIC LINK

Major contracts to provide ABC and CBS of America with their own dedicated transmission facilities across the Atlantic, enabling the companies to transmit live and taped TV programme material 24 hours a day has been awarded to British Telecom.

Satellite capacity for television transmission is limited. Now, Intelsat, the International Telecommunications Satellite Organisation, has made more capacity available, and ABC and CBS have leased exclusive use of these facilities from British Telecom.

Switch Off

The Home Secretary has announced that all the remaining 405-line v.h.f. BBC and IBA transmitters will be closed down by the end of next year. As a result of this decision the BBC and IBA have had to revise their programme of the closures of the remaining transmitters.

The full list of 405-line v.h.f. stations, in the order they are expected to close, is available from either the IBA or BBC Engineering Information Departments.

CableMusic has signed an agreement to supply Greenwich Cablevision with its eleven-hour music service from January 1984.

Greenwich was one of the first areas to adopt the experimental cable system in 1963 and covers Greenwich, Plumstead and Woolwich areas of London.

Since August the BBC's External Services programmes for the Far East have been transmitted by satellite to Singapore. From there they are relayed to millions of listeners as far apart as Hong Kong and New Zealand.

BLEEP BLEEP

A new radiopaging service has recently been introduced by British Telecom whereby a numeric message of up to 10 digits can be transmitted to an individual bleeper. In this way the user can receive a telephone number or any other numeric information whereas the conventional bleeper can only provide up to four audio signals. For instance, service organisations could send vital coded information directly to personnel in the field.

Incorporating a v.h.f. receiver, a microprocessor and a liquid crystal display, the Panasonic pager is powered by a single AA battery. The pager has two memories each of ten digits. The alerting signal may be muted so that information may be received and retained in the memory without emitting an embarrassing "bleep".

New Partner for Tina

The multinational manufacturer of electronic test equipment and prototyping systems, Global Specialties Corporation has become a wholly owned subsidiary of North American Specialties Corporation of Flushing, New York, part of Interplex Inc. The move follows the acquisition by North American of GSC's outstanding minority interests.

Chairman and Chief Executive Officer of the Interplex Group of Companies, Jack Seidler has become Chairman and Chief Executive of Global. Comments Tina Knight, Managing Director of GSC's UK operation, which handles worldwide sales outside the Americas, "We believe these changes will be beneficial to our operation, and with the strength of a large group behind us we see tremendous opportunities for the future".

Compact List

Poised to score an industry "first" in the marketing and promotion of Compact Discs are HMV Record Shops.

They have prepared, what they claim, the first authoritative and comprehensive list of Compact Discs. This list is available free in leaflet form and covers approximately 300 titles currently or shortly available.

Binatone International, claimed to be the UK's largest consumer electronics company, has deferred plans to launch into the home computer market. The company originally intended to introduce two models this autumn.

The recommended retail price of their M5 Home Computer from CGL has been reduced. The new suggested retail price will be £149.95 including VAT. Software prices are unchanged.

British Telecom (West Midland) is using Tandata Marketing's TD1100 viewdata adaptors to access its own Prestel and Telecom Gold services.

USA Breakthrough

Pioneered in Britain and already adopted as the standard system in many overseas countries, "World System Teletext", has made the breakthrough into the toughest market of all.

A recent ruling by the US Federal Communications (FCC), declaring an "open door" policy for teletext, has paved the way for the adoption of the system in the States and already an export order for a significant number of teletext decoder assemblies has been placed with Mullard. The specially designed decoders enable setmakers there to offer World System Teletext immediately on the US 525-line network.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Computer Record

You can now buy pop singles and albums that contain a computer program as well as music. It's a logical idea but not all plain sailing.

One problem is that there's no common loading standard for all computers, so a program for a Sinclair ZX81 won't load onto a Spectrum or an Apple or vice-versa. Also it's awkward loading from a gramophone, because you need to arrange a mono output feed of controllable level terminated by a mini jack to interface with the computer input. There may be imbalance and phase discrepancies between stereo channels.

Any dust in the gramophone record grooves will cause digital glitches that make the computer register a load error. So it's usually more convenient to dub the computer program from gramophone record onto cassette tape, and then load in the usual way.

This is why some companies are now issuing their music and computer programs on cassette format. But that's not the end of the story. The loading procedure isn't standardised, nor the memory capacity that's needed to hold a program.

Pop Program

In February this year a small company, Mainframe of Hemel Hempstead, released a pop 45 rpm, 7 inch single called *Radio* (distributed by PRT) that had a short computer message on one side. This can only be used with an Apple computer, and essentially it just congratulates the user on decoding the message.

They then followed through with a second pop single which has music on one side and four identical computer programs on the other. One program is suitable for an Apple computer, the next a Sinclair ZX81, the third a Sinclair Spectrum and the fourth a BBC Micro. To load the program from the disc you either interface direct between gramophone and computer, or dub the disc recording onto tape and then load from tape.

Mainframe warn users to check levels carefully, because signal overload will cause a loading error. They also advise users not to play the disc too often, without storing the program on tape, because groove wear will corrupt the digital signal. If all else fails, says Mainframe, try using one side of the stereo signal only to eradicate errors caused by discrepancies between left and right channels.

The loading routine is straightforward. For instance, for the Spectrum simply key Load, then, " ", then Enter and run the tape or disc. In reward you get a short written program, promising a computer competition to be incorporated in an LP later in the year. This is followed by a nice graphics program that is modulated by an audio input, in disco style.

Hit and Miss

In May EMI released what the company claimed to be the "first computer-game pop single" which contained music, a graphics program and a couple of video games. The EMI single, by Chris Sievey, can only be used with a ZX81. Two programs are needed to cope with either 1K or 16K models. The EMI claim to being "first" produced an angry response from Mainframe who felt they weren't getting credit where it was due.

Until someone claims differently, it seems safe to dub the recent Pete Shelley LP called XL–1 from Island Records as the first full-length album to contain a computer program. It's available on LP, disc or cassette, and contains a lengthy program for a Spectrum.

When you run the program in synchronism with the music, it displays the lyrics, along with artistic graphics. But, be warned. Although it is easier to dub from cassette than disc, the cassette pack contains sketchy instructions which will be inadequate for many users.

You do not load the Shelley program in the normal way. You need to go into the extended mode. I only found this out after phoning the record company for advice.

To load the Shelley album on a Spectrum use the following routine; key Load, " ", go into Extended mode (press caps shift and symbol shift simultaneously), press the Input key, and then Enter. The instruction on the cassette reads simply "for ZX Spectrum type load " " code."

In my opinion these instructions are wholly inadequate for anyone other than a computer buff. Also, there is no warning on the cassette that the program will only load into a 48K Spectrum because it overflows a 16K memory.

Doubtless by now Island Records will have received so many phone calls from puzzled users, that they will have vowed either to put better instructions on the next cassette, or never again issue a computer record.

Hi Fi Video

Both the VHS and Beta formats have now come up with ways of encoding f.m. stereo sound in the video waveform, to give far higher fidelity than you can get from the conventional domestic video tape.

Both VHS and Beta achieve high fidelity sound from domestic video by using a generally similar technique. The sound is recorded as an f.m. signal by the rotating video heads. But the VHS and Beta hi fi systems differ in detail.

Beta Hi Fi was the first system to be announced and it's already on sale in Japan and the USA. But there are no firm plans as yet for Britain.

In Beta Hi Fi the f.m. carrier is slotted into the video waveform. It goes between the relatively low frequency colour or "chroma" signal and the higher frequency black-and-white or "luma" signal, which is itself in the f.m. spectrum.

To make room for the f.m. audio signal, it's necessary to trim the deviation of the f.m. luma signal, which means some loss of bandwidth and picture clarity. This hasn't mattered in the USA and Japan where 525 line picture quality is pretty poor anyway. But for Europe the 625 line picture will show up loss of definition.

There's also the added problem that in Europe the video head drum rotates more slowly (1500 rpm instead of 1800 rpm) so the video writing speed is less, which in itself limits the available bandwidth. This is why there are no firm plans yet for Beta Hi Fi in Europe.

3-D Recording

There are, however, firm plans for VHS Hi Fi. It should be on sale here later this year. In this format two extra heads are mounted on the video drum and these handle the f.m. carriers for the stereo audio.

The audio and video heads trace the same path across the tape so the audio and video tracks are superimposed one on top of the other. But as the drum rotates, the f.m. audio is laid down a split second ahead of the video.

Because the f.m. audio carrier is of relatively low frequency it records deep into the surface of the tape. Remember that it's a natural phenomenon, in magnetic recording, that lower frequencies extend deeper into the magnetic coating than higher frequencies; it's the magnetic equivalent of electrical skin effect.

So, when the high frequency video signal is laid down, a split second after the audio, it wipes out the top layer of the audio recording and replaces it with video. The end result is a layered recording, with audio underneath and video on top.

This is only part of the story. The audio heads must read only the audio, while the video heads read only the video. They are able to do this because the audio heads are mutually angled by ±30 degrees and the video heads are mutually angled by ±6 degrees. This means there's a large mutual offset between the video heads and the audio heads.

With some electronic trickery, like relative phase shifting for each line of the picture signal, there's no crosstalk between audio and video. So the VHS Hi Fi recorder achieves the apparently impossible; high quality audio and high quality video recorded one on top of the other in the same tape track, without any mutual interference.

This is one of the first practical applications of vertical or depth recording, where different magnetic signals are separated in depth within the tape coating. In future we'll be hearing more and more of this 3-dimensional technique, because it means that more signal can be recorded in the magnetic coating of a tape or disc than has hitherto been thought possible.

Radio Litter

Radio stations give away car stickers, and then send out sticker patrols to take the numbers of cars which are showing them. A presenter then reads out the car numbers and their owners can call at the radio station to claim a free tee-shirt, funny hat, or a new sticker.

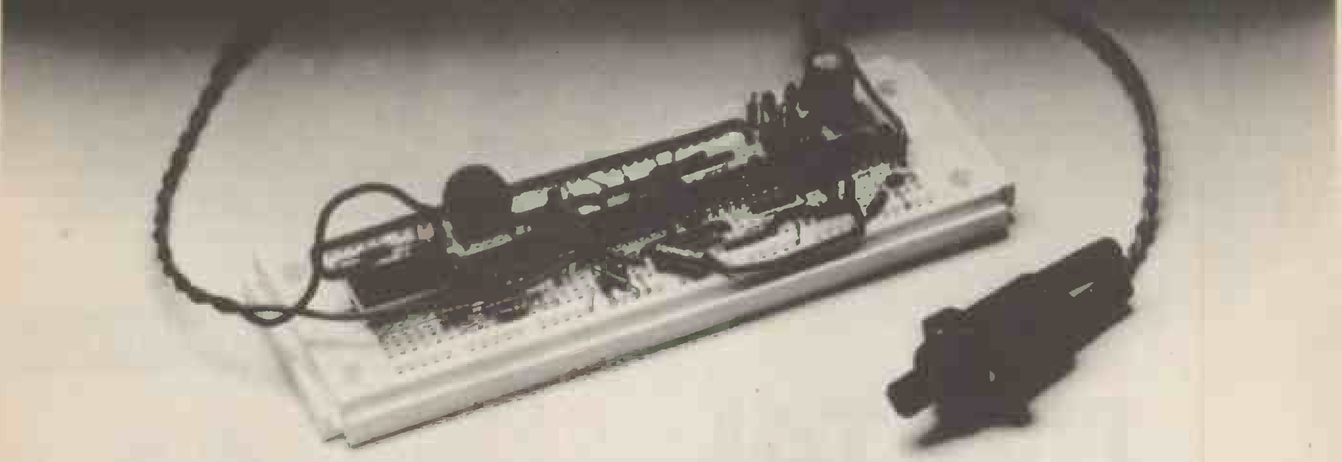
Why not (I wonder), do something really useful with the sticker patrols? While collecting the numbers of cars which display the station's sticker, they could also collect the numbers of cars which leave litter.

You know the kind of thing I mean. The driver winds down the window, lobs out a cigarette packet or fish and chips' wrapper, and accelerates.

If the radio station sticker patrols blew a public raspberry at every car that they saw dumping litter, radio would be helping to keep Britain clean.

You win every time!

When you get this NEW & FREE project from GSC



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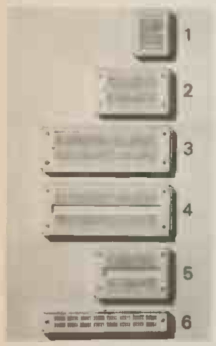

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DIGITAL GAUSS METER

BY R. ROWE

THIS instrument is designed for the accurate measurement of small amounts of magnetic flux. Useful in laboratories or educational establishments.

The unit of measurement used by the instrument is the gauss which is the electromagnetic unit of magnetic flux density. The SI unit of magnetic flux density is the tesla (T) which equals 10^4 gauss.

CIRCUIT DESCRIPTION

The complete circuit diagram of the meter is shown in Fig. 1. The circuit is based around the 7106 (IC4) which is a high performance, low power $3\frac{1}{2}$ digit analogue-to-digital converter (ADC). The 7106 was chosen because it is cheap, accurate, and displays a relatively high immunity to radio frequency interference (r.f. signals not being uncommon in a physics laboratory). The pin details of the 7106 are shown in Fig. 2.

The magnetic flux detection is achieved using the UGN-3501M Hall effect transducer (IC1), thus giving a differential output proportional to magnetic flux, this being easily interfaced with IC4.

MAGNETIC FLUX DETECTOR

On experimenting with the sensor it was discovered that on withdrawal from a magnetic field the transducer acquired a slight offset. The use of a bulk degausser erased the offset. Clearly large current degaussers on a portable instrument are out of the question. Low current degaussing circuitry was investigated but had little effect. Consequently a thumbwheel potentiometer VR2 is used to zero the liquid crystal display (X1).

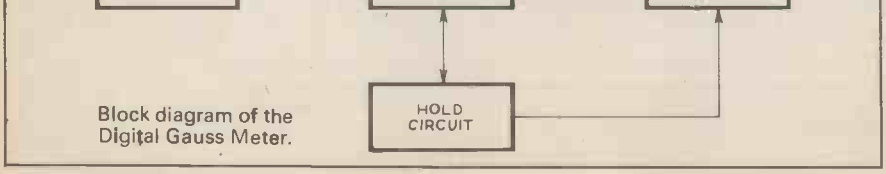
The magnetic flux detector IC1 is biased to be linear up to ±3000 gauss, where ± depicts magnetic polarity. Two 470-ohm (R1,2) resistors are situated in the probe with the Hall effect transducer to prevent oscillations.

The Perspex housing containing the magnetic flux detector IC1, with the pin connections clearly marked is shown in Fig. 3. Note the housing used for the detector is left to personal choice and remember that metal based materials must not be used.

The probe unit is then sealed with silicone rubber allowing easy access if necessary.

The integrated circuit IC4 utilises the dual ramp principle. The input voltage charges a capacitor for a fixed time, IC4 then counts how long a reference voltage takes to discharge the capacitor C5. This count is then displayed with the input polarity, and to ensure that the charge and discharge are linear an integrator is used. C2 connected to pin 27 (IC4) and R9 pin 28 comprise part of the integrator while C3 is the auto-zero capacitor (pin 29).

The capacitor (C3) holds any drift voltage which is either subtracted or added to the input voltage thereby correcting any drift in input voltage. R8 and VR1 are used to set the full-scale deflection of IC4 and calibrate the device.



Block diagram of the Digital Gauss Meter.

COMPONENTS

See Shop Talk page 703

Resistors

R1,2	470Ω (2 off)
R3	100kΩ
R4	3·3kΩ
R5	75kΩ
R6	82Ω
R7,10	56kΩ (2 off)
R8	27kΩ
R9	47kΩ
R11	3·9kΩ

All $\frac{1}{4}$W carbon ±5%

Capacitors

C1	22nF polycarbonate
C2,5	220nF (2 off) polycarbonate
C3	470nF polycarbonate
C4	100pF monolithic ceramic

Semiconductors

D1,2,3	1N4148 silicon diodes (3 off)
TR1	BC107 silicon *npn*
IC1	UGN-3501M Hall effect transducer
IC2	4051 CMOS single 8-channel analogue multiplexer/demultiplexer
IC3	4047 CMOS low-power monostable/astable multivibrator
IC4	7106 $3\frac{1}{2}$ digit analogue-to-digital converter
X1	l.c.d. $3\frac{1}{2}$ digit

Miscellaneous

VR1	10kΩ lin. multiturn cermet preset
VR2	5kΩ lin. (thumbwheel type)
S1	push-to-make
B1	9V PP3 battery

Printed circuit board: single-sided, size 100 × 83mm; *EE PCB Service*, Order code 8311-03; plastic case, 145 × 90 × 35mm (Pac-Tec Order code HP11 batt.); rubber grommet; insulated connecting wire.

Approx. cost Guidance only **£30.00**

CLOCK

The clock used to generate timing pulses for IC4 is made up of R10 and C4 connected to pins 39 and 38, respectively.

The differential outputs of IC1 are fed directly to the inputs of IC4. For zeroing, a potentiometer (VR2) is used across the inputs with the wiper of VR2 connected to earth via R11. This ensures that the output of the sensor is not taken straight to earth as this will damage the sensor.

A hold facility to freeze the display is necessary as any slight movement of the sensor results in a change of magnetic flux present at the transducer. Therefore the hold will ensure that an accurate measurement is obtained.

The only way to freeze the display is to disable the clock so that X1 cannot be updated. This does create a problem, as there are no clock pulses, the display which is normally driven by two 180 degree antiphase square waves is driven by a d.c. voltage. If this is allowed to occur for more than a minute will lead to the eventual burning out of the display.

When the clock is disabled, the back plane (pin 21) of IC4 goes either high or low, depending on whether it is in a sink or source state.

If a square wave is applied to the back plane in either of the two states, all of the segments will go on as the current can flow in both directions through the display. The back plane of X1 is switched to either normal condition where it is connected to pin 21 of IC4 via two channels of the analogue multiplexer (IC2). Alternatively the connection may be made through either D2 or D3 but this is dependent on whether the back plane of IC4 is high or low with respect to the astable multivibrator IC3.

ADDRESS

The integrated circuit, IC2, is addressed using a 3-bit binary coded decimal word comprised of the state of the back plane of IC4, which is also gated under normal conditions to X1 and S1. It is not feasible to take this address directly from the oscillator of IC4 because under normal conditions the oscillations would trigger IC2.

Therefore TR1 which is switched into saturation by the HOLD switch S1 is used to take pin 40 (IC4) to earth via R7, to disable the clock.

Resistor R4 is used to keep TR1's base at earth when the hold facility is not in use. D1 stops the transistor from being affected from any circuitry beyond this point. D1 and R3 which is connected to the +4V rail, reduces a 9V supply to a 5V supply which is then used by IC2 and IC3. IC4 internally generates +4V which is used to drive the display. Note that the 9V supply is provided by a PP3 battery.

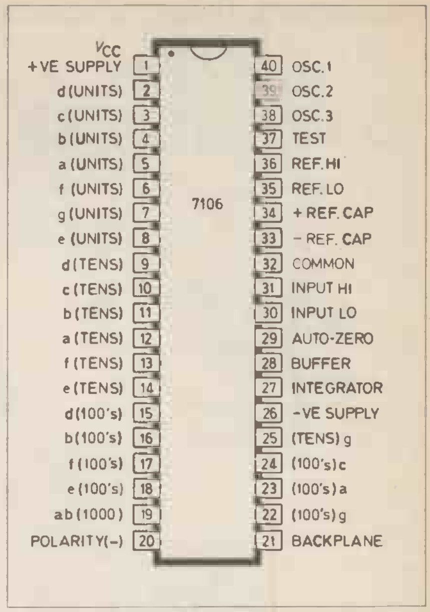
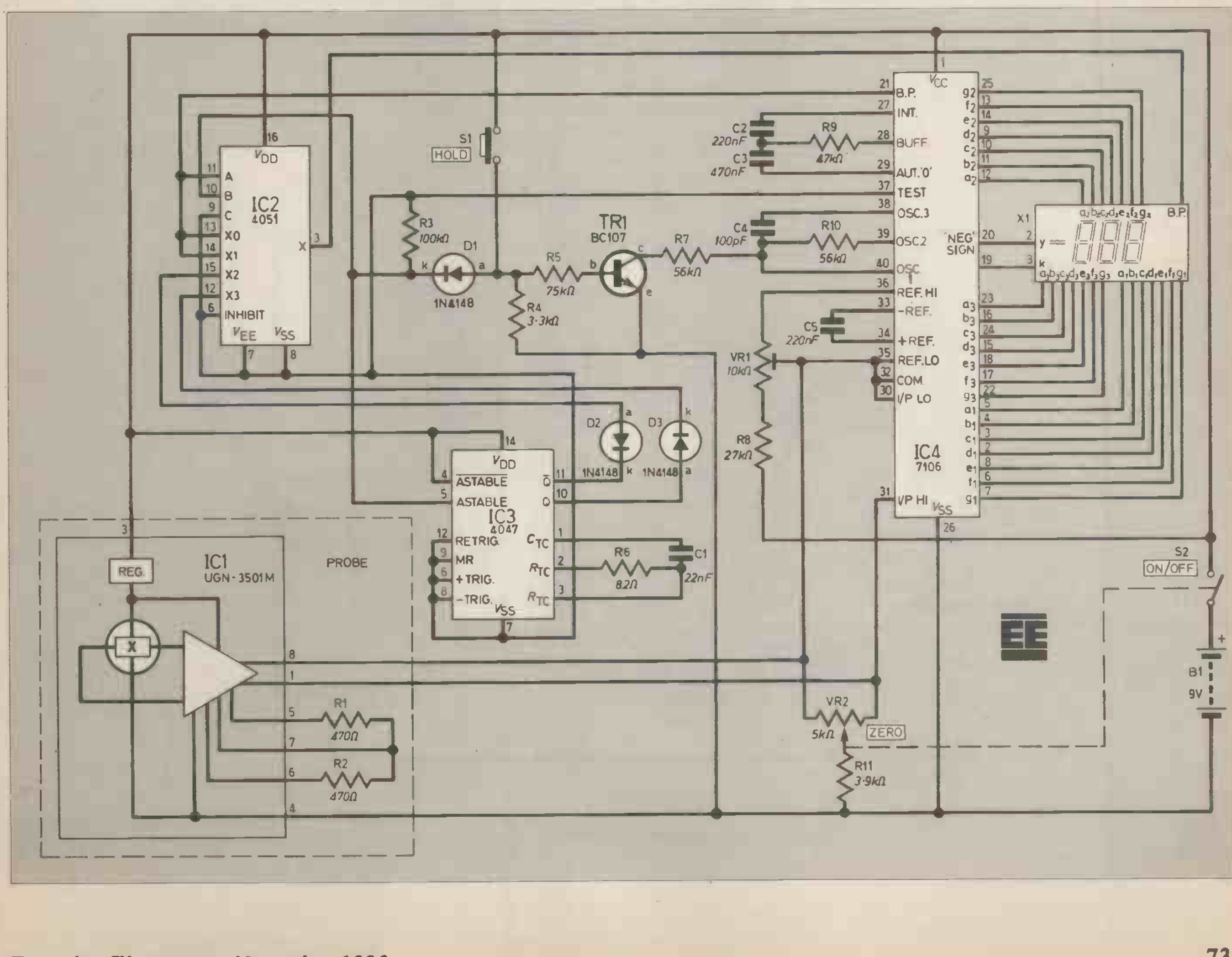


Fig. 2. The pin details for the $3\frac{1}{2}$ digit analogue-to-digital converter.

Fig. 1. Complete circuit diagram for the Digital Gauss Meter.



DIGITAL GAUSS METER

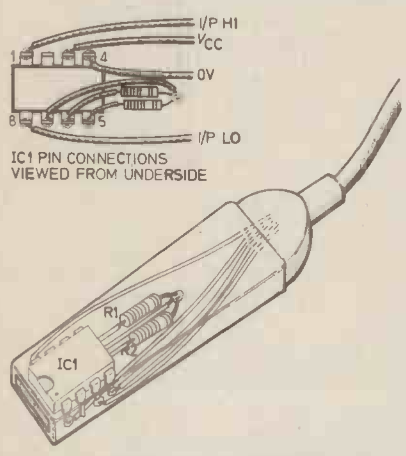


Fig. 3. The Perspex housing for the probe showing the magnetic flux detector mounted inside, with the wiring details clearly marked.

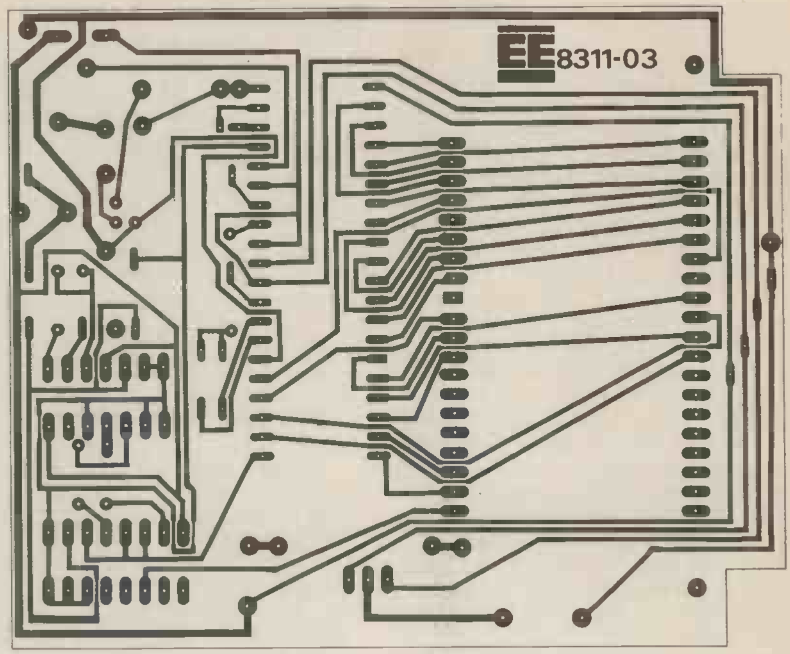


Fig. 4. Single-sided p.c.b. master.

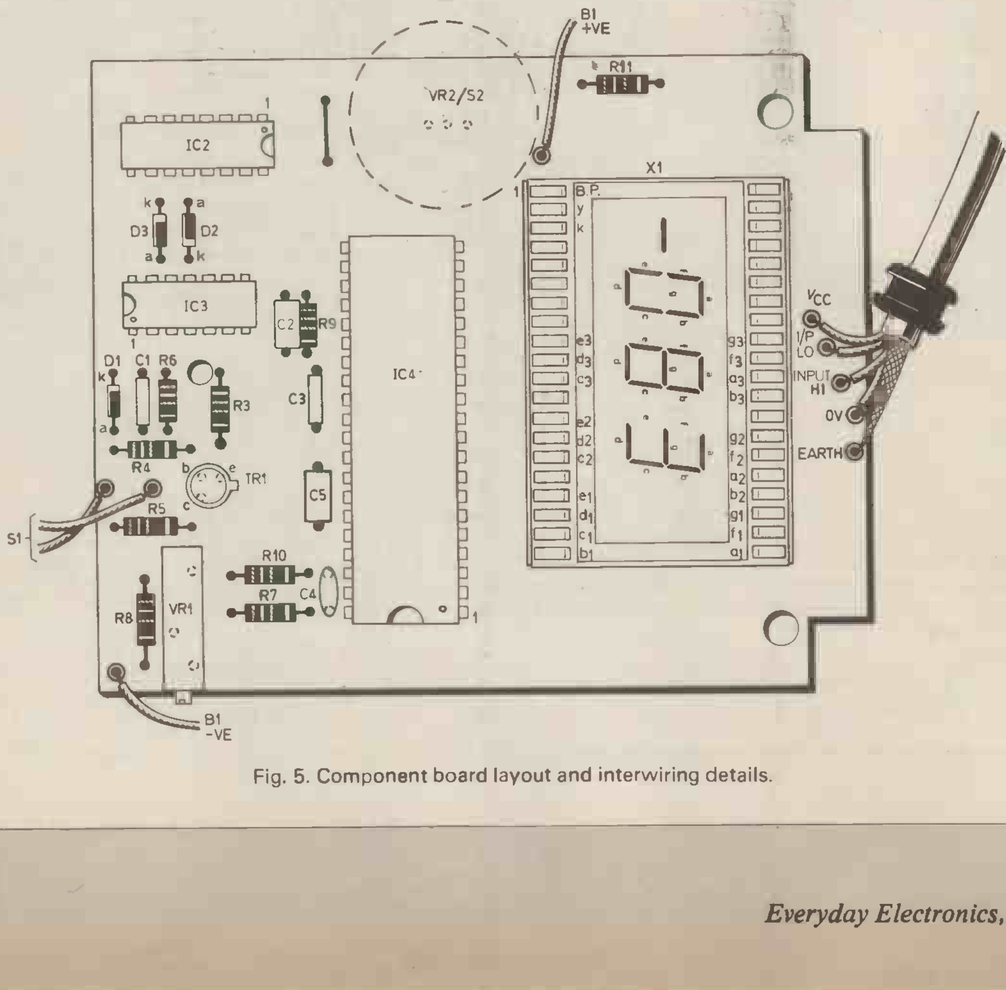
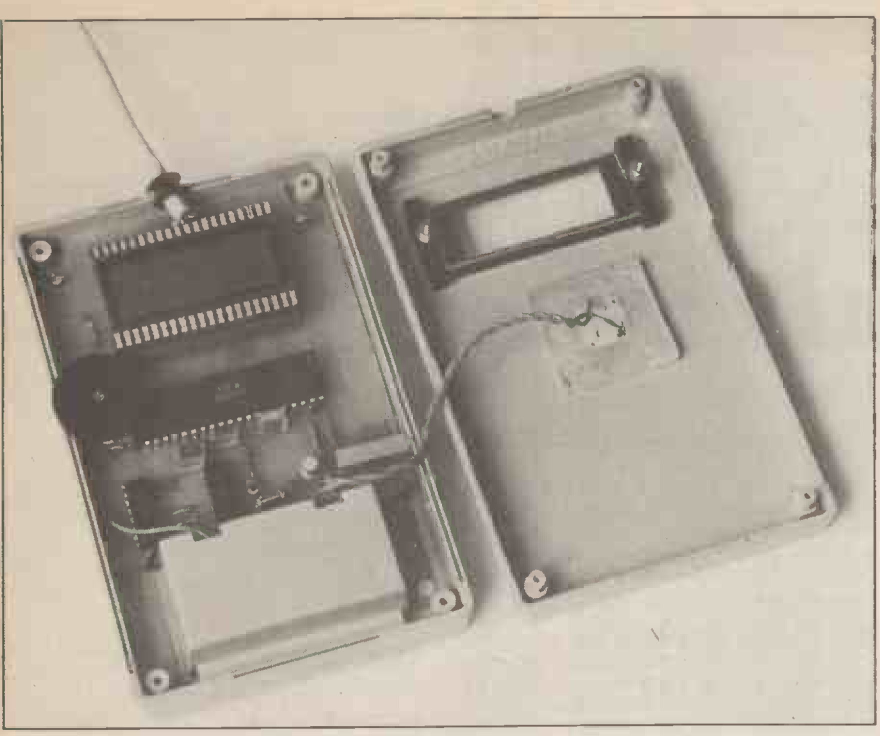


Fig. 5. Component board layout and interwiring details.



Lid removed, showing interwiring details inside the case.

The square wave produced by the hold circuitry when applied to the back plane of the display must be of the same amplitude as the normal drive waveform. Both IC2 and IC3 are driven between 9V and 4V with respect to ground, and IC4 provides +4V rail for this use.

When S1 is depressed IC3 receives a transition from low to high which enables it; this is also fed to IC2 for the 3-bit word.

PRINTED CIRCUIT BOARD

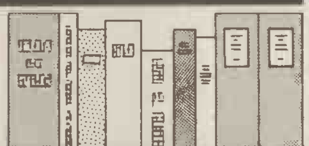
The prototype unit was constructed on a single-sided printed circuit board, size 100 × 83mm. The p.c.b. master pattern to be etched is shown actual size in Fig. 4. This board is available through the *EE PCB Service*, Order code 8311-03.

The layout of the components on the topside of the board are shown in Fig. 5. Where the relative positions of the case mounted components can be seen and the board wiring to them.

CASE

The project is mounted in a plastic case having dimensions of 145 × 90 × 35mm although any case of similar dimensions should be suitable. □

BOOK REVIEWS



NEWNES BOOK OF VIDEO SECOND EDITION

Editor	K. G. Jackson
Price	£6.95
Size	245 × 185mm. 128 pages
Publisher	Butterworth & Co. Ltd. (Newnes Technical)
ISBN	0 408 01319 2

FROM an "almost recognisable picture" with an Ampex recorder in 1952 through to a most modern "high tech." security video system of the 80s, the Newnes Book of Video, 2nd Edition (1983), covers it all; and the amount of detail provides an interesting and informative read. The eight authors, under the editorship of K. G. Jackson, take us through the many development, innovations and applications of video over the years.

Each of the chapters are written by specialists and the authors include Gordon King, Bob Roberts and Dr. David Matthewson. The chapter headings are mainly self-explanatory, except perhaps the first: "The Video Centre" which is a little ahead of its time, but meaning a video equivalent of the Music Centre. The other chapters are: TV Receivers, Tape Recorders, Disc Players, Cameras, Programmes with a Single Camera, Antennas, Cable Distribution, Teletext and Viewdata, TV Games and Computers, Security and Surveillance. At the end of each chapter is a very useful boxed list of further reading suggestions.

At the end of the book eight pages contain a list of 319 suppliers and manufacturers' addresses; there are 12 pages of useful video-related advertisements and finally a two-page comprehensive index.

D.J.G.

MASTERING ELECTRONICS

Author	J. Watson
Price	£10.00 hard cover £2.95 limp
Size	220 × 145mm. 382 pages
Publisher	Macmillan Press
ISBN	0 333 34423 5 (hard) 0 333 34424 3 (limp)

ONE of the Macmillan Master Series, this one sets out to take the reader into the vast and varied world of electronics. And in the words of the author, it is "a tall order" to cover all aspects in one book. Tall order it may be, but Mastering Electronics succeeds in introducing the reader to the basic principles in most areas of this subject; from simple electricity, through analogue techniques to digital circuits and computers.

With such a wide subject matter, it would be impossible to cover everything comprehensively, so consequently more space is devoted to the important basic fundimentals of electronics than to advanced topics, where only an introduction is given.

Designed as either a self-teaching course or textbook (it follows the structure of most recent syllabuses), the text keeps mathematical descriptions to a minimum and contains a great deal of good clear line drawings and photographs. Practical examples are accompanied with tried and tested designs for the student to build.

The book uses SI metric units throughout and British Standard symbols for circuit diagrams (BS 3939), including "box" type logic symbols (rather than the distinctive shape logic symbols as used in EE and most other publications).

G.P.H.

Books in Brief

An Introduction to Programming the ORIC-1 by R. A. & J. W. Penfold (Bernard Babani). Limp £1.95. A comprehensive but concise guide to programming the ORIC-1 microcomputer. There are ten chapters contained within, starting with simple commands and later dealing with more involved topics like animated graphics and using sound commands.

RADIO WORLD

BY PAT HAWKER G3VA

Age of contestants

I must be one of the increasing number of amateur radio operators who believe that there are now far too many "contests" that reduce the frequency bands to a shambles. Too often the rules encourage contacts with virtually any other station in order to exchange hundreds of standard signal reports bearing virtually no relationship to true signal strength and either a serial number or zone number. With normal power there is no challenging difficulty in making such fleeting contacts and the contests have become little more than a test of physical endurance rather than station design or even operating ability.

However, I admit to having a soft spot for some of the h.f. contests where the rules eliminate mass swapping of numbers. One of these is the annual All Asian contest where one is limited to contacts with stations in Asia and where, to add to the interest, the code number to be exchanged consists of the age of the operators.

It has long been evident from this contest that such events appeal most to those in their late 'twenties or early 'thirties. This appears to stay constant over many years. This year I made a further check and found that the average age of the Asian stations I contacted was 29·1 years.

The Asiatic Russian amateurs were a little older (32·1 years average) than the non-Russians, mainly Japanese, where the average was 27·5 years. Youngest was 16 (Israel), oldest 48 (Japan) though some London-area ground-wave stations could be heard giving ages of over 60 years.

I suspect that in the UK the younger generation of amateurs are attracted more to v.h.f. than h.f. contests, reflecting the rapid growth in the number of Class B (v.h.f. phone-only) licences. At the end of June 1983 there were 23,204 Class A British amateurs but being rapidly overhauled by Class B (22,904 licences) plus 1694 "reciprocal" licences issued to foreign visitors to the UK.

Talkabout

In the January 1981 issue of *Everyday Electronics* I mentioned briefly ("Open line" page 50) the French experiments in "conference" telephone arrangements that provide a social open line for casual conversations, rather along the lines of a CB radio net.

The French set up systems in Montpellier and Lozére where by dialling a specific telephone number you could find yourself linked to up to ten similarly minded callers. The French then used a sociologist to check up on the use being made of the system which, as far as one could judge, seemed to fulful a socially-useful purpose without encountering too many of the problems that might have been anticipated—such as those that caused the Americans hurriedly to close-down public facsimile links when they found these were mainly used for sending obscene drawings.

Inspired perhaps by the French experiment and another such service in Brazil, British Telecom this year has been operating a similar pilot "Talkabout" service in Bristol. In four months some half-million callers checked in on this chat-around-the-clock service.

Since the calls are charged at normal rates, it can be expensive to stay on the line for long periods though one user attempted a record 24-hour talkabout at a cost of some £60. But for the average user it probably works out less costly than buying CB equipment. Man behind British Telecom's Talkabout is Dr. Alex Reid who hopes it will prove more profitable than his earlier protege, Prestel.

Unlike the French Open Line, both Talkabout and Brazil's Dial-a-Friend are, at least to some degree, supervised services. There are seven monitors on the Bristol Talkabout who can cut-off a really objectionable caller, though the controls are exercised lightly. In Brazil it is said that Ministers listen into discover what people have on their mind—perhaps the Brazilian telephone number should be "Orwell 1984" though on the whole it seems a light-hearted affair that serves to keep the lines busy and radio channels less crowded.

There is an old phrase about never using radio where "line" will do, though this is often quoted in support of the view that radio frequencies should be reserved for mobile and portable units, a viewpoint that ignores for instance the value of on-air broadcasting to the public.

Language and Electronics

The need for a "lingua franca"—a universal language—has long been recognised. The medical profession, the Roman Catholic church use Latin; international diplomacy was for long conducted in French; science depends on English.

International radio operating created "radioese" a mixture of codes and abbreviations. In 1887, Dr. Zamenhof of Warsaw constructed his own universal language for everyday use (Esperanto) but despite the efforts of some dedicated enthusiasts this has never become really established. How many of us would recognise "Sinjoroj" on a door to indicate "Gentlemen" as readily as we accept the current sexist graphical symbols.

But although English is the major language of international science, every country publishes magazines and periodicals in its own language or, as in Belgium, Switzerland or South Africa, sometimes periodicals containing articles in a mixture of languages.

Accurate translation of technical electronics material is sometimes aided by, but sometimes made more difficult by, the enormous number of abbreviations. Machine translation using computers attracted much attention 20 years ago but then most projects lapsed as the practical difficulties became more and more evident.

There has however been a recent revival of work in this field spurred on by R&D budgets approved by European Common Market countries (Eurota) and by Japanese projects. A further boost is recent work in the USA using low-cost microprocessor-based systems designed to assist rather than replace human translators who then provide the finishing touches to clean up those problems of syntax and punctuation, and words with multiple meanings that tended to defeat the earlier attempts to do it all by computer.

One multi-language "Microcat" (microcomputer-assisted-translation) system has recently been marketed in the USA at about $20,000 for a complete package—or about one quarter the price of translation software for use with professional minicomputers.

The Radio Marti battle

For almost two years the American government has been seeking authorisation for funds to establish a high power medium wave station, Radio Marti, for broadcasting in Spanish to Cuba. This has been against bitter opposition from American broadcasters who fear a propaganda radio war that could reduce the orderly American medium wave band to the shambles found in Europe.

Now it looks like a compromise with broadcasts likely to be restricted to an existing Voice of America facility in Florida that already uses 1180kHz. Cuba threatened to build 500kW transmitters using American "clear channels" designed to provide excellent coverage even at night.

Standing Hazard?

It is generally agreed that normal use of conventional amateur radio transmitters presents virtually no serious radiation risks (low-energy non-ionising radiation) either to the operator or to anyone else. This however assumes, for instance, that hand-held v.h.f. transceivers (which may have a short helix aerial within a few inches of the operator's eyes) has an output power of less than 7 watts, a safe-power-limit endorsed by the National Radiological Protection Board.

Recently, however, I received a letter from a north-country radio amateur who experienced severe head pains in the region of his right eye lasting several hours. This experience began a few hours after he had watched a demonstration of two-way 144MHz amateur operation from a stationary car with a gutter-mounted seven-eight's wavelength aerial. The mobile equipment had an output of some 25 watts and my correspondent admits that he had been standing beside the vehicle with his eyes only a few inches from the aerial.

Whether the pains my correspondent suffered were actually due to r.f. radiation is open to doubt, but nevertheless the experience draws attention to an unexpected hazard, for it is by no means unusual for relatively powerful mobile equipment to be used from a parked vehicle. Where this is done it is clearly advisable for any observers to keep their eyes feet rather than inches away from the aerial.

SECURITY
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- Built in delays
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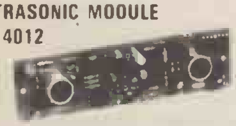
only £13.95 + V.A.T.

ULTRASONIC MODULE US 4012



- Adjustable range from 5-25ft.

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

£10.95 + V.A.T.

INFRA-RED SYSTEM IR 1470

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, the system is available at

only £25.61 + V.A.T. Size: 80 × 50 × 35mm.

POWER SUPPLY & RELAY UNIT PS 4012

Provides stabilised 12V output at 85mA and contains a relay with 3 amp contacts. The unit is designed to operate with up to 2 ultrasonic units or 1 infra-red unit IR 1470. Price £4.25 + V.A.T.

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, the module contains an inhibit facility for use in 'break to activate' circuits. 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.

ALARM CONTROL UNIT CA 1250

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
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- Test loop facility

Price £19.95 + V.A.T.

SIREN & POWER SUPPLY MODULE PSL 1865

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 or US 4012 to form a complete alarm.

Price £9.95 + V.A.T.

HARDWARE KIT HW 1250

only £9.50 + V.A.T.

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

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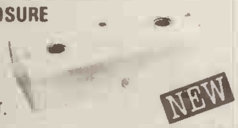

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BY P. BARBER

CAR ON/OFF TOUCH SWITCH

THE touch switch was designed as an alternative to the normal on/off mechanical switches used to control high current loads in a car. However, it can easily be adapted for any application where on/off switching is required.

The feature of the design is that only one set of touch contacts are needed and touching them reverses the state of the switch. This has the advantage of reducing the overall size of the touch switch required and also allows more accurate use, especially at night when it would be difficult to distinguish between the "on" and "off" sets of contacts in the dark interior of a car.

The logic of the circuit is based on easily available CMOS integrated circuits, and the heavy current switching is handled by a relay. The author considered using a large transistor instead of a relay; however, it was decided that as the current rating of the switch was to be around 15 amps (15A), a relay would be safer and cheaper.

The circuit board and relay are both mounted in the same plastic case and this can be installed either behind the dashboard or under the bonnet of the vehicle. The touch plate, along with an indicator lamp, are mounted on a small aluminium panel which can be screwed or bolted to the dashboard.

DESIGN CRITERIA

The circuit is based on a CMOS decade counter which controls the switching action. The counter is "clocked" by a voltage pulse generated when the two touch contacts are connected via skin resistance. With a decade counter, as the name suggests, normally each of its ten outputs would go high in turn, however, in this design only two outputs are considered, as binary counting is required. Therefore the counter is wired so that the third clocking pulse causes the counter to be reset.

This means that only the first two outputs can ever go high, and one of the two will be high at any one time. The second output is fed to a buffer network of CMOS inverters connected in series, and this in turn controls a transistor output stage which drives the relay. When the counter is clocked, the relay will be switched on when the second output is high, and off when it is low. This provides the required switching action.

SWITCH OPERATION

A problem which would normally affect this type of design is the rapid flicking on and off when the switch is operated, leaving the final state of the switch unpredictable. This is because finger contact rarely produces a steady connection immediately the plate is touched, and this causes a series of pulses to be produced. Indeed, even if a piece of wire is used to short the contacts, this effect is still present. In order to overcome this obviously undesirable situation, a pulse "stretching" network is used to increase the length of the pulse, thus overcoming the initial intermittent contact.

The CMOS counter used in this design is fairly particular about the quality of the clock waveform used to drive it, if accurate clocking is to be achieved. In this application it was found that the best results were obtained by applying the voltage generated by the touch switch to a Schmitt trigger, and then feeding the sharp output wave through a capacitor to the clock pin (14) of the counter.

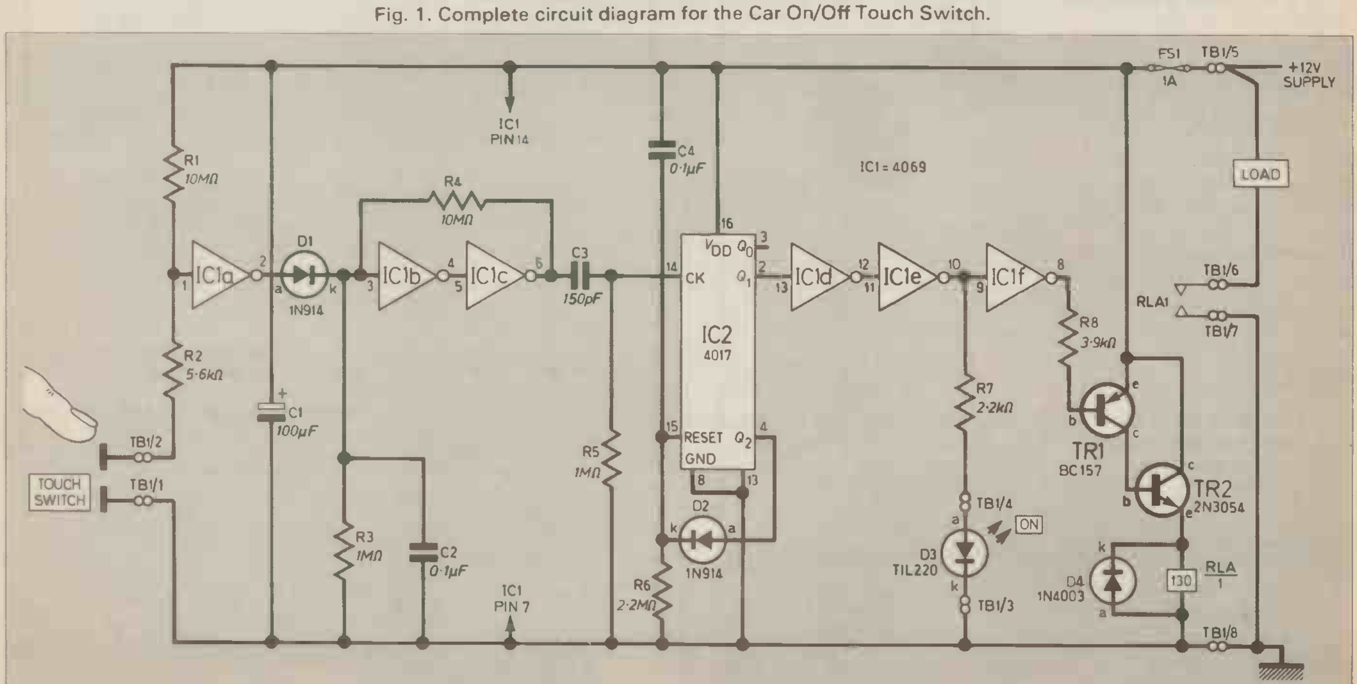
POWER SUPPLY

It was found unnecessary to stabilise the supply voltage to the circuit, provided the car battery was in a reasonable condition and could supply the required load current without a significant voltage drop. No erratic operation due to power supply problems should be encountered.

However, if the switch is being used to control mains voltages, and a small transformer is used to power the switch then it may be necessary to include some type of simple voltage regulator in the supply. See note in installation section about connecting the switch to the positive supply.

When the switch is in the off state, current consumption is negligible and there is no need for any mechanical method of switching the circuit off, even if a dry-cell battery is used. However, if a mains transformer is being used, then a method of disconnecting from the mains will have to be provided.

Fig. 1. Complete circuit diagram for the Car On/Off Touch Switch.



CIRCUIT DESCRIPTION

The complete circuit diagram for the touch switch is shown in Fig. 1. The input of the inverter IC1a is normally held high by R1, and therefore its output is low. When the contact points of the touch switch are connected via skin resistance the potential divider formed takes the input of IC1a below its transfer voltage and its output goes high.

The output of IC1a then charges capacitor C2 via diode D1, and the input of the Schmitt trigger formed by IC1b, IC1c and R4 goes high. The output goes high accordingly and a clocking pulse is fed to the clock pin (pin 14) of the counter (IC2) by C3. C2 will start to discharge through R3 as soon as the resistance across the touch switch contacts is removed.

Although the output of IC1a will be low, D1 prevents C2 discharging through IC1a and therefore the discharge time is dependent on the value of R3. Until the voltage on C2 drops below the transfer voltage of IC1b, the Schmitt trigger will remain in a high state. This is the stretching method of controlling the clocking pulses and thereby eliminating the flickering effect described in the Switch Operation section.

TIME DELAY

The delay produced is only a fraction of a second and this is plenty of time to overcome the flickering problem. If required the value of R3 can be increased to allow a larger time gap between successive operations of the switch. This larger time gap may be useful if delicate equipment is being handled by the switch, where rapid on/off switching could cause damage.

DECADE COUNTER

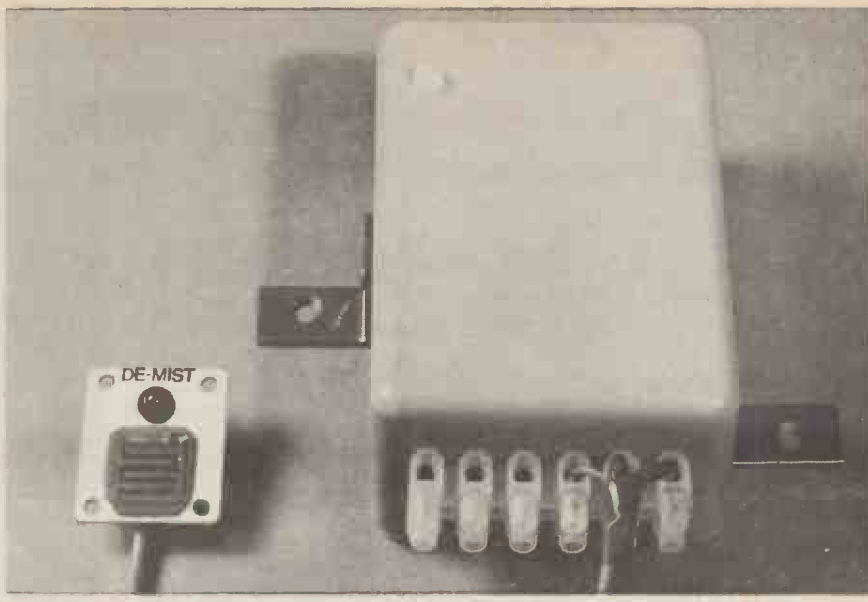
Only the first three outputs of the decade counter (IC2) are used. The decoded decimal output "0" (pin 3) is the "off" output and when this is high the switch is off. Output "1" (pin 2) is the "on" output and when this goes high the switch will be on. Output "2" (pin 4) is required to reset the counter and is connected via D2 to the reset pin (pin 15).

When the reset is taken high the counter resets with output "0" going high. Therefore in response to pulses fed to the clock pin (pin 14), outputs "0" and "1" will alternately go high, causing the switch to change state accordingly.

RELAY

In order to drive the relay (RLA1) and thus perform the actual switching, the on output is taken to a series of inverter gates IC1d, IC1e and IC1f, which buffer the output. When the on output is high the input of IC1d and the output of IC1e are also taken high. This switches on the light emitting diode D3 which is the ON indicator light.

The output of IC1e is then inverted by IC1f and the base of transistor TR1 goes low via R8. This allows TR1 to conduct and the current is then amplified by TR2 to drive RLA1. D4 is placed in the circuit to prevent damage from large back-e.m.f. voltage spikes from the relay.



The capacitor C1 is a small smoothing capacitor and C4 ensures that the counter is reset when the device is powered on, by briefly taking the reset pin high. A small fuse (FS1) which may be less than 1A is placed in the circuit as protection. Note that FS1 does not handle the load current.

CONSTRUCTION

CIRCUIT BOARD

The components are mounted on a single-sided p.c.b. of approximate dimensions 76 × 51mm as shown in Fig. 2. All components and interconnections are shown in Fig. 3, and the i.c.s should be placed in position last on the p.c.b. and care exercised when handling the CMOS. It is advisable to use d.i.l. holders for the i.c.s. The transistor TR2 is a large device and should be mounted on the board using fixing screws.

This board is available from the *EE PCB Service*, Order code 8311–05.

CASE

The case chosen for this project was a plastics case measuring 113 × 75 × 34mm although any case of similar size should be suitable. The plastics case must be drilled to accept the circuit board mounting bolts, and any fixings required for the case itself. If the case is to be placed under the bonnet, the author recommends using right angle brackets with one bolted to each side of the box (longest sides only) and slightly offset to give better stability. The case can then be screwed down without fear of cracking the plastic. A small hole must be provided to run the various leads through.

If the case is to be mounted under the bonnet, both sides of the completed p.c.b. should be given a good coating of clear protective lacquer or varnish. The circuit board can then be mounted in the box, making sure that no metal bolts or washers touch any copper tracks—use

COMPONENTS

Resistors

R1,4	10MΩ (2 off)
R2	5·6kΩ
R3,5	1MΩ (2 off)
R6	2·2MΩ
R7	2·2kΩ
R8	3·9kΩ

All ¼W carbon ±5%

See **Shop Talk** page 703

Capacitors

C1	100μF 16V elect.
C2,4	0·1μF polyester (2 off)
C3	150pF disc ceramic

Semiconductors

D1,2	1N914 silicon (2 off)
D3	TIL220 0·2in red l.e.d.
D4	1N4003 rectifier
TR1	BC157 silicon *npn*
TR2	2N3054 silicon *pnp*
IC1	4069 CMOS hex inverter
IC2	4017 CMOS decade counter

Miscellaneous

RLA1	12V, 130-ohm coil with 30A rated contacts
FS1	1A 20mm fuse

Printed circuit board: single-sided size, 76 × 51mm, *EE PCB Service*, Order code 8311-05; plastics case, 113 × 75 × 34mm (Maplin Order code PB1); terminal block 7-way; insulated connecting wire; 16-pin d.i.l. holder.

Approx. cost Guidance only £12.00

fibre washers to separate them if they do. The relay can also be bolted into the box if there is sufficient room and take care to ensure that it is securely positioned.

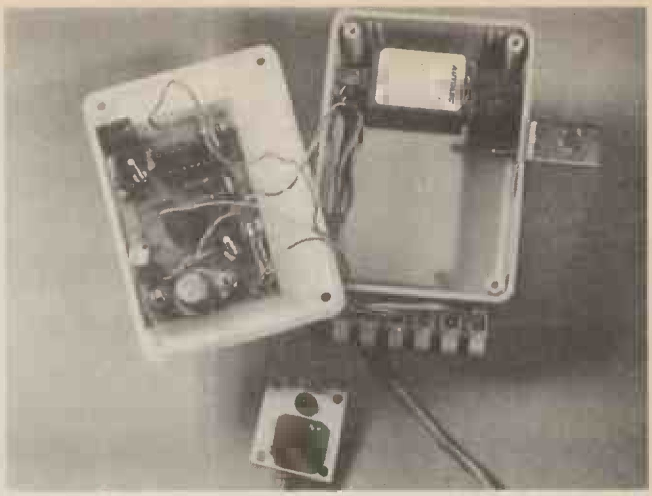
TOUCH SWITCH

The touch switch is a small p.c.b., used copper side upwards and etched to give two sets of contacts. A piece of aluminium is used as the panel to mount the touch switch and indicator D3. The small p.c.b. is attached to the aluminium panel using a quick setting epoxy resin.

TERMINAL BLOCK CONNECTIONS

To make the internal car connections easier it is advisable to use terminal block connections. It is suggested that an 8-way block is used, this can then be fixed to the outside of the case with epoxy adhesive.

The terminal block connections are as follows: the touch switch is connected via TB1/1 and TB1/2, the cathode of l.e.d. D3 is connected to TB1/3 and the anode to TB1/4. The positive side of the car battery is connected via TB1/5 and the relay contacts are connected via TB1/6 and TB1/7, respectively. The remaining earth connection is made via TB1/8.



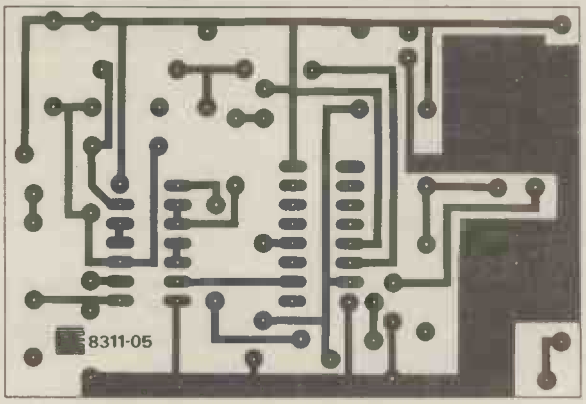


Fig. 2. Single-sided p.c.b. master.

◉ = VEROPIN

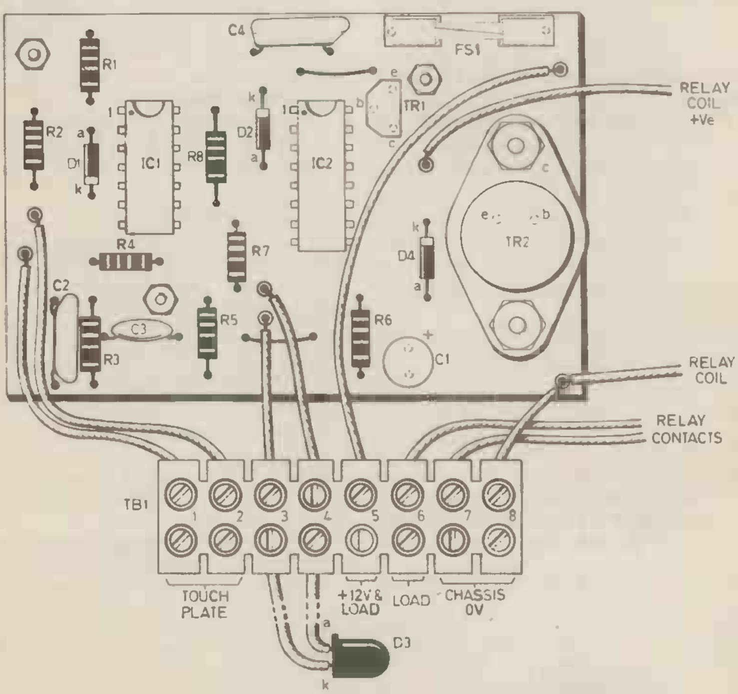


Fig. 3. All the component and offboard wiring details are shown. Terminal block wiring details are also shown.

INSTALLATION

The aluminium panel containing the touch switch and D3 should be mounted on the car dashboard using self-tapping screws and clips if required. Only a small hole to run the lead through is necessary, but the constructor may find a suitable cut-out in the dashboard is already present for accessories.

The lead from the aluminium panel can then be connected to the unit. Earth and fused positive leads must now be provided. The earth can be taken from any convenient point on the car body. If a spare fuse is not available on the car fuse box, a lead from the battery with an in-line fuse is acceptable. The lead must obviously be of heavy duty; however if the length of this lead is considerable then it may be advisable to supply the load (via the relay) and the circuitry using independent leads to prevent the voltage suddenly dropping when a large current flows to the load, causing erratic switching. Ideally the selected fuse position on the fuse box will be activated by the ignition switch, as it is inadvisable to draw large currents from the battery without the engine running and thereby charging the battery.

It is assumed that the constructor has the lead to the actual load available. All car accessory switching is only done on the positive supply, with the unit being earthed near its mounting position. This should therefore not prove to be a problem, as the touch switch is a direct alternative to the mechanical manual switch and no other adaption is required.

POSITIVE EARTH VEHICLE

If the vehicle has a positive earth, the switch can still be used with no changes to the circuitry (provided the power supply is correctly connected); however connections to the relay will need alteration. This should be easily achieved, so no detailed explanation is necessary. □

LETTERS

More Spectrum

Sir—On first sight I was very pleased to read of your new series entitled *Microcomputer Interfacing Techniques* (July), but on opening the magazine I was disappointed to find that it is aimed at computers that incorporate the 6502 microprocessor.

I own a Sinclair Spectrum and after seeing the *ZX Spectrum Amplifier* (April) I hoped that there would be more to come. Having learnt the basic language and got over the initial games craze I would like to use my machine for further applications.

Come on EE how about an article or series that explains how to use the Spectrum to control robots, model trains, central heating systems and so on. After all, it is the most popular microcomputer in Britain and therefore an article such as this can't be bad for business, can it.

I would hate to have to turn to another publication for my information since I like your method of presentation.

M. Snook,
Formby,
Merseyside.

I do not think it is true that we have altogether deserted owners of Sinclair machines. May I refer you to page 421, in the July issue, where the final paragraph states "ZX81 users can follow this series by adding an I/O User Port Board to their machines."

Such a device was described in detail in our August 1983 issue, again with reference to ZX81 owners. Thus you will see that the current MIT series is not by any means restricted to one particular computer.

Apart from all this, we have a number of other projects which are specifically designed for use with the Spectrum and other Sinclair computers, so I do not think you will have to take the threatened course of "turning to another publication". We intend to give all popular computers a fair crack of the whip in our pages in the coming months.—Ed.

Car Intruder Alarm

Sir—With regard to my recently published *Car Intruder Alarm* (see August issue), it has come to my notice that some constructors may find that the output transistor for the car horn (TR1) will overheat and not switch on the horn, as I found myself when recently changing the horn in my car.

Should this happen it can be easily remedied as shown in Fig. 2. As car horns vary from car to car it is worth checking the current consumption of the horn before commencing construction of the project.

The emitter of TR1 is connected to earth and the collector removed from the p.c.b. and connected to the base of the additional transistor TR3. The emitter of TR3 is connected to the terminal block TB1/1. A medium power *pnp* transistor (e.g. BD132) is bolted to a small heatsink and to the plastic case. This should solve the problem.

The constructor may also like to take the precaution of increasing D11 to a higher

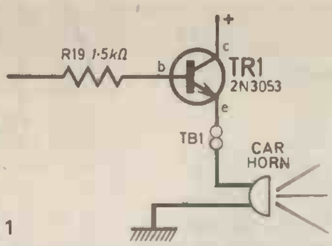


Fig. 1

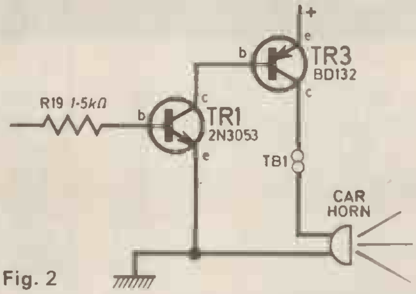


Fig. 2

current rating—the dry cell battery B1 will rapidly go flat if asked to supply the car horn, so D10 need not be changed.

I regret that I was not aware of this when designing and testing this project and I hope that you will convey my apologies to any reader who experiences this difficulty.

Peter Barber,
Glastonbury,
Somerset.

Caravan Alarm

Sir—I have been reading your June '83 issue of EVERYDAY ELECTRONICS and am interested in the two articles on caravanning, *Caravan Power Supply* and *Caravan Fridge Alarm.* I have been caravanning for 20 years and have covered thousands of kilometres (or should I say miles?). I am not in full agreement with the two projects described in your magazine.

Taking the power supply first. There is no way you can re-charge the spare battery at 2A and hope to maintain it in a charged state.

In South Africa we travel much greater distances than you folks in the UK. I personally try to limit my trips to 200 miles per day when on a touring holiday. At an average towing speed of 50 mph, this gives you a travelling time of 4 hours and at a charging rate of 2A = 8 amp/hrs minus battery efficiency, if the battery is a bit long in the tooth the answer will be a lemon.

This charge is nowhere near the discharge rate of lights, TV and other equipment. The only practical solution I have found is one of those small portable lighting plants, the one I have is a 400W unit and weighs only 50lb, is very silent in operation and charges at 12V 6A or 220V 400W, for food mixer, drilling machine and 220V tyre pump. An added advantage is that in the evening with the TV and lights on you can run the engine and float your battery, and of course for long stops, it is indispensable.

Another important point. Do not put your spare battery in the caravan. No matter how careful you are the acid is eventually going to impregnate everything around it. Plastic or glass-fibre boxes with lids (as used in boats) are obtainable and can be mounted on the hitch; this is also very convenient for tapping into the caravan plug wiring.

Why all the bother with transistors and delicate thermistors called for in the fridge alarm, when all you require is a robust bi-metal strip secured to the "hot spot"? The bi-metal strips are obtainable with heavy-duty 25A contacts and will give you years of trouble-free operation.

Unfortunately, both the bi-metal and the thermistor have a time lag due to the slow cooling of the refrigerant, but the bi-metal could be mounted close to the flame in a gas fridge with a subsequent reduction in time lag.

If you want to use transistors and you have a gas fridge, then the answer is a photo transistor or a photo diode focused on the flame. This will give you instantaneous flame failure alarm and is, in fact, standard equipment on many oil-fired boilers.

I enjoy your magazine very much and have built several of the projects; we are, however, less fortunate than you folks as regards availability of parts and *price.*

W. D. Orr,
East London, S. Africa.

T. R. de Vaux-Balbirnie replies:

Dear Mr. Orr—Thank you for your comments concerning the two articles for caravanners. You raise a number of points and I will reply to each in the same order.

Regarding the rate of charge. The important point here is that the auxiliary battery is not required to provide the total power requirement. Some will be provided by the car battery whenever possible. This is the purpose of S4, the "Car/Aux" switch and is an important feature of the design. The car battery will be kept well charged by relatively short trips and may be expected to give a half to two-thirds of the total requirement.

At your suggested figure of 8Ah per day supplied on a touring holiday, I think this would be entirely satisfactory for the average UK user. We use a black and white television requiring 1A, two fluorescent lights (but usually only one used at a time) rated at 0·8A, a few little-used filament lights, radio, cassette player and inverter for a 240V razor. The TV might be used for 2 hours per day, the lights will be used for a similar period. The other equipment probably uses about 1Ah per day. This amounts to some 6Ah per day. If only half of this was provided by the car battery, then some 12 days' service could be expected without charging the auxiliary battery at all.

I think your figures reflect a more exuberant life-style with food mixer, electric drill, tyre pump, etc. I have steered readers away from this project where their power consumption is high in favour of using sites with mains hook-up points and suitable equipment.

The point about the siting of the auxiliary battery is accepted. To use a glass-fibre box on the hitch would be an excellent plan. I did not want readers to install the battery next to the gas bottle due to the potentially lethal consequences of a spark combined with a gas leak!

Regarding the fridge alarm. I think that avoiding a mechanical part is still important even if it costs a little more. Also, this system can be adjusted for best results. Thus, the constructor finds a convenient position for the thermistor unit then adjusts for best effect.

As a project, I could not endorse a flame failure device even though it seems attractive. This is because a poorly-made and badly fitted device could possibly interfere with the combustion of gas resulting in the emission of carbon monoxide.

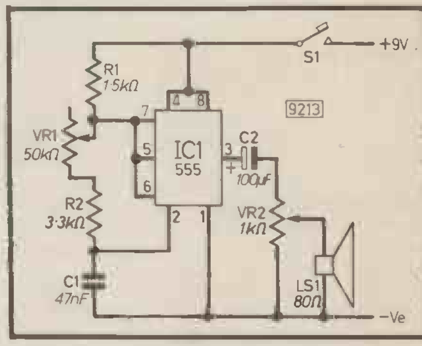
CIRCUIT EXCHANGE

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.

MORSE PRACTICE OSCILLATOR

THE NE555 timer i.c. is used in the astable mode, VR1 is the frequency control and can be adjusted to give an audio pitch from a few hundred Hz to a few kHz. VR2 is the volume control which is used to feed a high impedance speaker of about 50–80 ohms. The morse key S1 is connected in the positive supply rail and switches the unit on when depressed.

William A. Jones,
Belfast,
N. Ireland.



LIGHT-OPERATED CIRCUIT WITH PRESET SWITCH-OFF

MANY light-operated circuits are available to switch on lights when darkness arrives and these will switch off again the following morning. It usually is not, however, required that the light remain on all night. This circuit will switch on when the daylight fades, but will switch off after a pre-determined time. It could, therefore, also be used as a type of "security light".

PCC1, R1 and VR1 bias TR1 into conduction during daylight. The resistance of PCC1 increases when daylight fades causing transistor TR1 to switch off. The resultant positive collector voltage on pin 2 of IC1 causes a low input to pin 9. This causes pin 10 to go high and this high is fed to the base of TR2 via R16, causing this to switch on. The negative voltage on the collector then activates the relay, switching on the light.

This same high output of pin 10 also enables the 555 counter, IC2, the output of which is then passed to the clock input of IC3. This is a binary counter, pin 3 of which goes high after 8192 clock pulses have been received. The high output on this pin is fed back to pin 6 of IC1. This causes pin 1 of IC1 to go low, and after inversion by gate IC1c, the output of pin 10 becomes low, switching off TR2 and also dis-enabling IC2. The relay is deactivated and the light, therefore, switches off.

When daylight arrives, the collector voltage of TR1 goes low (TR1 switches on) and, via gate IC1d, a high input is fed to pin 11 of IC3, thus resetting the counter so that the operation is automatically repeated the following evening.

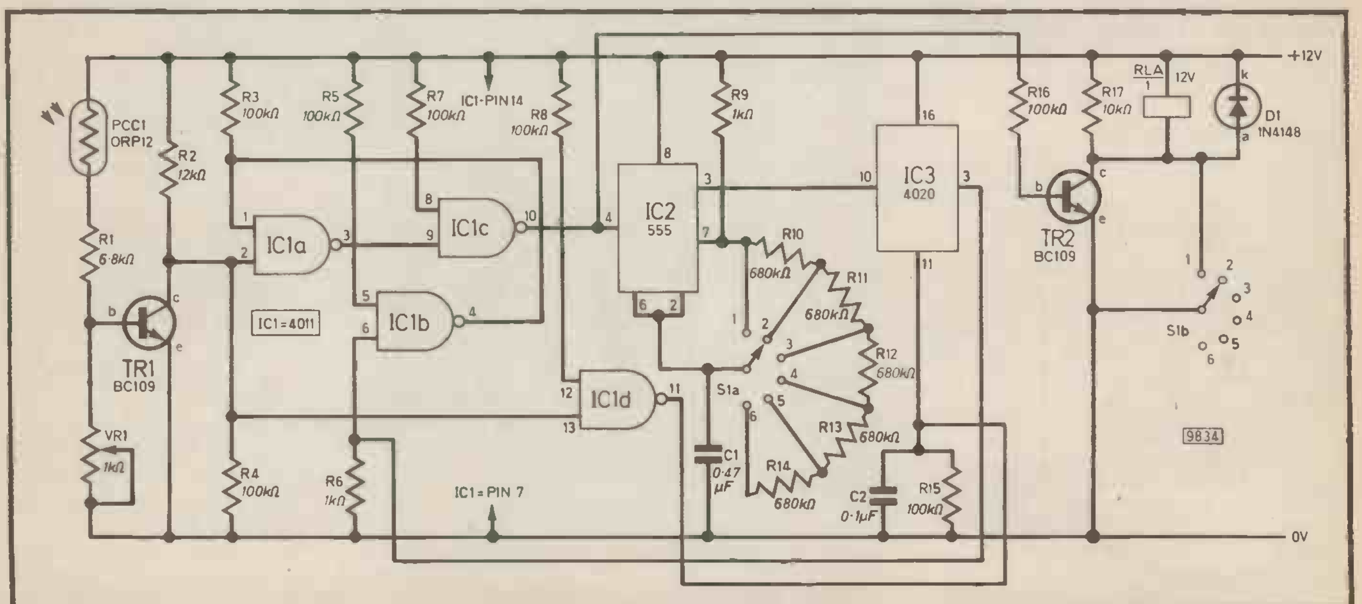
Preset VR1 sets the triggering light level.

The frequency of the clock output from IC2 is set by S1a which, with the resistor values given, gives a switch on time variable from approximately 1 hour to 5 hours, in hourly steps. As great accuracy is presumably not required for this circuit, no provision has been made for setting the exact timing of the clock output. This can, however, be done by incorporating a preset to allow the voltage on pin 5 of IC2 to be varied.

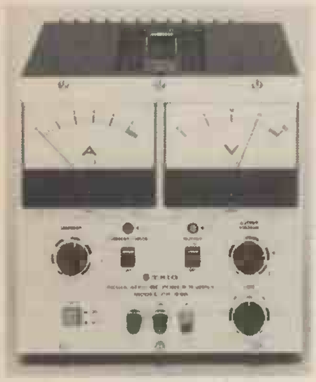
S1b allows over-riding of the timing action by connecting the collector output of TR2 to the negative rail, thus causing the light to remain on indefinitely. C2 prevents transients resetting IC3 when the relay opens. Switching the unit off and on again, will, however, reset IC3.

A 12-volt regulated supply should be incorporated and the relay must be a 12-volt relay suitable for switching the load required. PCC1 can be mounted at a suitable window.

E. Selberg,
Cape Town,
South Africa.



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



POWER SUPPLY

A SERIES regulated d.c. power supply that can be constantly varied from 0 to 18V and 0 to 5A by front panel coarse and fine manual controls has just been introduced by **House of Instruments.**

Manufactured by the Japanese company Trio, the PR655 has large independent dual meters for both current and voltage indication. Other features include: remote sensing; fixed current protection circuit; series/parallel master/slave mode; and l.e.d. indication of regulated voltage and current operation.

Front panel switching is provided to disconnect output terminals for voltage and current adjustments to be made with the load connected.

The price of the PR655 Regulated D.C. Power Supply is £305 plus VAT and carriage. For more details and data leaflet write to:

House of Instruments,
Dept EE, Clifton Chambers,
62 High Street, Saffron Walden,
Essex CB10 1EE.

DIGITAL SOLDERING

A NEW "soldering station" from **Antex** features a digital readout of the tip temperature to within +5 per cent.

Known as the TCSUD, the unit includes a coiled, anti-burn, iron protector, sponge tip cleaner and a 50W soldering iron. The recommended retail price for the soldering station is £67.50.

Antex,
Dept EE, Mayflower House,
Plymouth, Devon.

SPECTRUM/ TANDY LINK-UP

AN interface to link the Sinclair ZX81 or Spectrum home computers with the Tandy four-colour printer plotter CGP-115 has been developed by **Softest.** Priced at £35, the interface includes connectors, leads, software on cassette, instructions, postage and packing.

They have also released a screen copy program (£5) which, when used in conjunction with the same interface, enables the Spectrum screen to be copied on to the Tandy printer.

In addition to printing text at 12 characters per second, the equipment can be used for graphic material having an effective plotting range of 96mm on the *X* axis divided into 480 steps and no limit on the *Y* axis. Four pen colours, red, green, blue and black, are standard.

Softest,
Dept EE, 10 Richmond Road,
Romsey, Hants SO5 8LA.

DIGITAL MULTIMETER

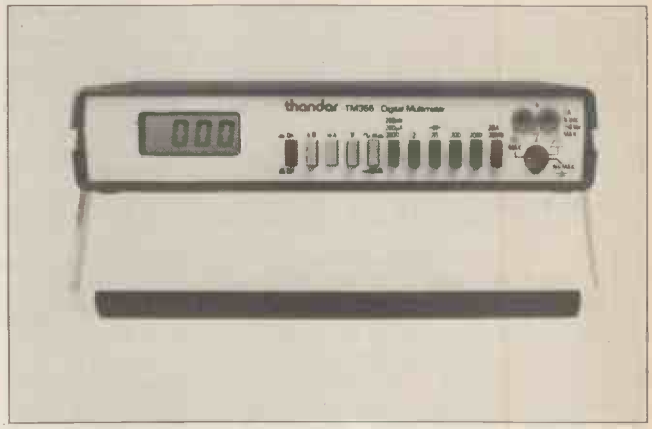
A BATTERY-OPERATED laboratory quality $3\frac{1}{2}$ digit multimeter with a 0·5in liquid crystal display is announced by Thandar **Electronics.**

The TM356 has a measurement capability of d.c. and a.c. volts; d.c. and a.c. current; resistance and diode check in 29 ranges, permitting measurement from 100µV to 1000V (750V a.c.), current from 100nA to 10A, and resistance from 100mΩ to 20MΩ.

The instrument is housed in a ABS moulded case with handle/stand, making it suitable for portable as well as bench work.

The TM356 Digital Multimeter will sell for £85, plus VAT.

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



WIRING AIDS

PACKS of versatile, specially designed ties, and self-adhesive clips, which can be used for an infinite number of fastening jobs, for instance, when routing wiring in a project or for interconnecting separate units, has been introduced by **Hellermann Insuloid.**

Designated Ty-its, the nylon ties are available either releasable in size 140mm and 250mm, or non-releasable in 100mm, 150mm and 200mm lengths. They are expected to retail from around 49p, including VAT, per pack depending on size.

The self-adhesive clips, Stiki-Clips, are also moulded in tough nylon and are available in three different sizes to accommodate wiring, tubing or piping with a maximum outside diameter of up to 6mm, 13mm or 18mm respectively. The recommended retail price is 69p, including VAT, per pack depending on size.

Hellermann Insuloid,
Dept EE, Sharston Works,
Leestone Road, Wythenshawe,
Manchester 22.

SQUARE one FOR BEGINNERS

ABBREVIATIONS	
f_T	frequency at which gain reduces to unity
h_{FE}	d.c forward current transfer ratio (gain)
$I_{C(max)}$	maximum continuous collector current
I_{pk}	peak emitter current at avalanche
$i_{p(max)}$	peak point emitter current
P_{TOT}	maximum power dissipation
V_{b1b2}	maximum allowable voltage across b1 and b2
V_{CBO}	maximum collector-to-base voltage, emitter open circuit
V_{CEO}	maximum collector-emitter voltage, base open circuit
η	intrinsic stand-off ratio
npn / *pnp*	transistor polarity

UNITS	
V	volts
mV	millivolts (10^{-3}V)
μV	microvolts (10^{-3}V)
A	amps
mA	milliamps (10^{-3}A)
μA	microamps (10^{-6}A)
nA	nanoamps (10^{-9}A)
W	watts
kHz	kilohertz (10^3Hz)
Ω	ohms
kΩ	kilohms (10^3Ω)
MΩ	megohms (10^6Ω)
μs	microseconds (10^{-6}s)
dB	decibel

Audio and hi fi amplifier circuits are amongst the most popular projects for home constructors and many linear i.c.s are available to simplify the designs. We have listed here a number of the more common devices and given a brief specification for each, along with package outline diagrams. Some of the abbreviations (above) apply to other semiconductors not listed (mainly transistors), but have been reproduced to assist readers when consulting component data tables.

Audio Preamplifiers

Device	No. per package	Supply Voltage (V)	Quiescent current (mA)	Input resistance (kΩ)	Typical T.H.D. @ 1 kHz (%)	Equivalent input noise (μV)	Package Key
CA3052	4	2 to 16	26	90	0·65	1·7	C
LM381	2	9 to 40	10	100	0·1	0·5	B
LM382	2	9 to 40	10	100	0·1	0·8	B
LM387	2	9 to 30	10	100	0·1	0·8	A
LM1303	2	(±)4·5 to 15	15	25	0·1	—	B

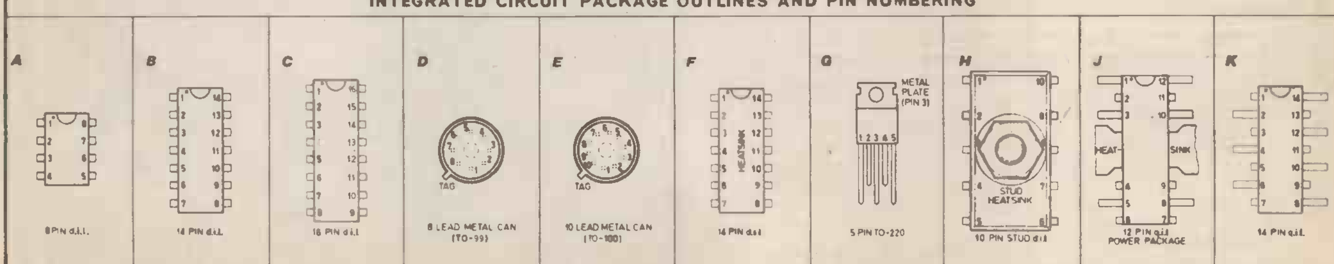
Audio Amplifiers—Mono

Device	Supply Voltage (V)	Output Power @ 10% T.H.D. into 4Ω	8Ω	16Ω	Input Impedance (Ω)	Output Protection	Quiescent current (mA)	Typical T.H.D. @ 1kHz (%)	Package Key
LM380	8 to 20	4·2^{18V}	4^{18V}	2·2^{18V}	150k	yes	7	0·2% @ 18V 2W	B
LM383	5 to 25	7	—	—	150k	yes	45	0·2% @ 14V 4W	G
LM384	12 to 26	3·5^{22V}	5·7^{22V}	3·5^{22V}	150k	yes	8·5	0·25% @ 6V 125mW	B
LM386	4 to 12	0·3^{26V}	0·8^{12V}	0·9^{12V}	—	no	4	—	A
LM388	4 to 12	2^{12V}	1·5^{12V}	1·1^{12V}	—	no	10	—	B
LM389	4 to 12	0·3^{26V}	0·8^{12V}	0·9^{12V}	50k	no	6	0·2% @ 6V 125mW	B
LM390	4 to 10	2^{12V}	1·2^{9V}	0·7^{9V}	—	no	10	—	B
MC3360	5 to 12	—	—	0·35^{9V}	—	no	3	0·7% @ 9V 50mW	A
SL414A	16 to 20	—	3^{18V}	2·2^{18V}	100M	yes	75	0·3% @ 18V 1W	H
SL415	16 to 25	—	5^{24V}	3·8^{24V}	100M	yes	75	0·3% @ 24V 1W	H
TBA800	5 to 30	—	—	5^{24V}	5M	no	9	0·5% @ 24V 2·5W	J
TBA810	4 to 20	6	—	—	5M	yes	12	0·3% @ 14V 2·5W	J
TBA820	3 to 16	1·6^{9V}	2^{12V}	—	5M	no	4	0·4% @ 9V 500mV	K
TDA2006	(±)6 to 15	12	8	—	5M	yes	40	0·1% @ 12V 4W	G
TDA2030	(±)6 to 18	18±^{17V}	11±^{17V}	—	5M	yes	50	0·1% @ ±14V 8W	G

Audio Amplifiers—Stereo

Device	Supply Voltage (V)	Typical Voltage (V)	Output power into 8 (W)	Input impedance min. (MΩ)	Output protection	Channel separation (dB)	Quiescent current (mA)	Typical T.H.D. @ 1kHz (%)	Package Key
LM377N	10 to 26	20	2·5	3	yes	70	15	0·1 @ 20 V 2W	B
LM378N	10 to 35	24	5	3	yes	70	15	0·1 @ 24V 2W	B
LM379N	10 to 36	28	7	3	yes	70	15	0·2 @ 28V 4W	F

INTEGRATED CIRCUIT PACKAGE OUTLINES AND PIN NUMBERING



Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

Sparkrite

SELF ASSEMBLY ELECTRONIC KITS

PRICES REDUCED ON SUPER SAVE D.I.Y. KITS

SX 1000 Electronic Ignition

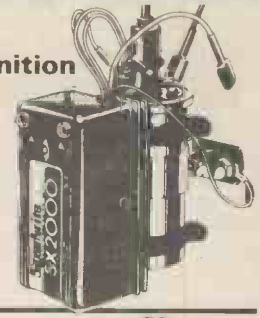
● Inductive Discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Patented clip-to-coil fitting ● Easy to assemble, easy to fit ● Contact breaker triggered – includes bounce suppression circuit.

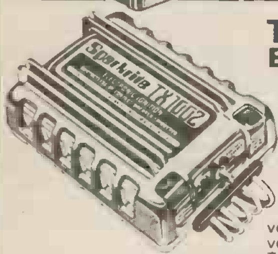
SUPER SAVE

SX 2000 Electronic Ignition

● Reactive Discharge ● Combines inductive & capacitive energy storage ● Gives highest possible spark energy ● Patented clip-to-coil fitting ● Easy assembly sequence ● Contact breaker triggered – includes bounce suppression circuit.

SUPER SAVE





TX 1002 Electronic Ignition

● Inductive discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Contactless or contact breaker triggered ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● Easy to build ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.

TX2002 Electronic Ignition

● Two separate systems in one unit! ● Reactive Discharge OR Inductive Discharge, with three position changeover switch ● Gives highest possible spark energy ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless or contact breaker triggered ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.

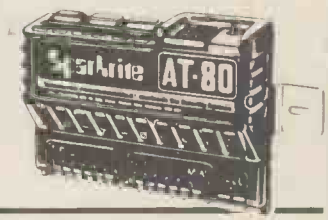
AT-40 Electronic Car Alarm

● Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed using concealed switch ● 30 second delay-to-arm: 7 second entry delay ● Can alternatively be wired to exterior key switch ● Flashes headlights & sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Low consumption C-MOS circuitry.

NEW

AT-80 Electronic Car Security System

● Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed from outside vehicle by magnetic key fob passed across sensor pad adhered to inside of windscreen ● Individually programmable code ● 30 second delay-to-arm ● Flashes headlights and sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Function lights to assist setting-up ● Low consumption C-MOS circuitry.



SUPER SAVE

ULTRASONIC Intruder Detector

● Supplementary to AT-40 & AT-80 ● Will work in conjunction with any door switch input or voltage sensing alarm ● Detects attempted break-in and movement within passenger compartment & triggers alarm ● Includes high efficiency ultrasonic transducers ● Crystal controlled for low drift ● Ingenious sensitivity control allows freedom from false alarms ● Low current consumption

NEW

VOYAGER Car Drive Computer

● 12 functions centred on Fuel, Speed, Distance and Time ● Single chip microprocessor ● Large high brightness fluorescent display with auto-dimming feature ● High accuracy distance & fuel transducers included ● Displays MPG, L/100km and miles/litre at the flick of a switch ● Visual & audible warnings of excess speed, ice, lights-left-on ● Independent LOG & TRIP functions ● Low consumption crystal controlled circuitry.

SPECIAL OFFER

"FREE" MAGIDICE KIT WITH ALL ORDERS OVER £40.00

MAGIDICE Electronic Dice

● Triggered by waving hand over dice ● Completely random selection ● Bleeps & flashes during 4 sec tumble ● Throw displayed for 10 seconds then flashes to conserve battery ● Low consumption C-MOS circuitry.

82 BATH ST., WALSALL WS1 3DE.

SUPER SAVE

SPARKRITE (A Division of Stadium Ltd.) 82 Bath Street, Walsall, WS1 3DE England Tel: (0922) 614791 — Allow 28 days for delivery

KIT	OLD PRICE	NEW PRICE
SX 1000	~~£12.95~~	£11.95
SX 2000	~~£19.95~~	£18.95
TX 1002	£22.95	£22.95
TX 2002	£32.95	£32.95
NEW! AT-40	—	£9.95
AT-80	~~£32.95~~	£24.95
NEW! ULTRASONIC	—	£17.95
VOYAGER	£64.95	£64.95
MAGIDICE	~~£9.95~~	£6.95

PRICES INC. VAT, POSTAGE & PACKING.

NAME ____________

ADDRESS ____________

I ENCLOSE CHEQUE(S)/POSTAL ORDERS FOR

£ ________ KIT REF. ________

CHEQUE No. ________

EE/11/83

PHONE YOUR ORDER WITH

BRANDLEADING BRITISH ELECTRONICS

CUT OUT THE COUPON NOW!

T.V. SOUND TUNER BUILT AND TESTED

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.
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: 11¾" x 8½" x 3¼".

£24·95 + £2.00 p&p.

E.T.I. kit version of above without chassis, case and hardware. £12.95 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

£32.95 + £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 TAPES.

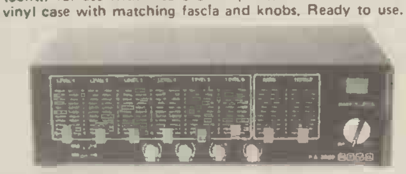
Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts, i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.
Featured in April issue P.E. Reprint 50p. Free with kit.
Self assembly simulated wood sleeve – £4.50 + £1.50 p&p.

SPECIAL OFFER! £31.00 plus £2.75 p&p Complete with case.

MONO MIXER AMP

Ideal for Church halls & Club houses. **£45.00** + £2.00 p&p.

50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic. and aux. inputs. Size: 13¼"x6½"x3¾" app. Power output 50 watts R.M.S. (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.



Matching AKG Microphone to suit (with speech and music filter). Complete with lead. ONLY £9.95 plus 75p p&p.

VHF STEREO TUNER KIT

• SPECIAL OFFER! •
£13.95 Plus £2.50 p&p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.
FEATURES: VHF, MW, LW Bands, Interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to strict P.E. specification, Front scale size: 10½" x 2½" approx. Complete with diagram and instructions.

125W HIGH POWER AMP MODULES

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

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

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

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

STEREO CARTRIDGES

PHILIPS
Magnetic cartridge with diamond stylus. Model No. GP-397 III. Output: 2mV. Separation 22dB. Stylus 0.6mm diameter. **£3.95 each** plus 60p P&P.

GARRARD
Sonotone Garrard Ceramic cartridge. 75mV. With turnover Sapphire stylus. **£2.95** plus 60p p&p.

STEREO CASSETTE DECK

Stereo cassette tape deck transport with electronics. Manufacturer's surplus
– brand new and operational
– sold without warranty.

£11.95
plus £2.50 p&p.

Just requires mains transformer and input/output sockets and a volume control to complete.

Supplied with full connection details.

HI-FI TWEETER BARGAIN

GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3¾"sq.) for use in up to 40W systems; with 2 element crossover.
£3.95 each (p&p £1) or
£6.95 pair (p&p £1.50)

SPEAKER KIT 2 WAY 10 WATT

8" bass/mid range and 3¾" tweeter. Complete with screws, wire, crossover components and cabinet. Cabinet comes in flat pre-mitred D.I.Y. form. Finish - chipboard covered wood simulate. size 14½"x 8¾"x 4". PAIR for ONLY
£12.50 plus £1.75 p&p.

AUDAX 8" SPEAKER

HIGH QUALITY 40 WATTS RMS BASS/MIDRANGE

Ideal for either Hi-Fi or Disco use this speaker features an aluminium voice coil a heavy 70 mm diameter magnet.
Frequency res: 20Hz to 7KHz.
Impedance: 8 ohms.

£5.95
+£2.20 p&p

AUDAX 40W FERRO-FLUID HI-FI TWEETER

X/over on 5kHz -22kHz. 60mm square. 8 ohm.

£5.50
+60p p&p

All mail to:
21A HIGH STREET, ACTON W3 6NG.
Note: Goods despatched to U.K. postal addresses only. All items subject to availability. Prices correct at 30/9/83 and subject to change without notice. Please allow 14 working days from receipt of order for despatch. RTVC Limited reserve the right to update their products without notice. All enquiries send S.A.E.

ALL CALLERS TO: 323 EDGWARE ROAD, LONDON W2. Telephone: 01-723 8432.
(5 minutes walk from Edgware Road Tube Station)
Now open 6 days a week 9 – 6. Prices include VAT.

Telephone or mail orders by ACCESS welcome.

R T V C

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
Flood lamp waterproof GEC	£9.90
Battery condition tester, less box	£1.75
Nicad chargers, mains	£0.75
Flourescent inventor 13 watt from 12v	£3.50
Cassette mechanism with heads	£4.50
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
Fire alarm break glass switch	£3.75
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
Auto transformer 1000 watts (plus postage for transformer)	£19.50 £3.00

3 CHANNEL SOUND TO LIGHT KIT

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

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

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**.

CROSSOVER NETWORKS

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

— BARGAIN OF THE YEAR —

The AMSTRAD Stereo Tuner.

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

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

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

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

THIS MONTH'S SNIP

MULTI PURPOSE BINS
10 interlocking bins can be wall or bench mounted, each size approx 109x53x100mm, high impact plastic. Come complete with 2 wall mounting bars.

Snip price **£3.95 + £1.50 post.**

REVERSIBLE MOTOR WITH CONTROL GEAR

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

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

£19.50 plus postage £2.50

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

ROTARY WAFER SWITCHES

5 amp silver plated contacts. ¼" shaft. 1" dia. wafer.
Single wafer types, 29p each, as follows:

1 pole 12 way	2 pole 6 way	3 pole 4 way
4 pole 3 way	6 pole 2 way	4 pole 3 way

Two wafer types, 59p each, as follows:

2 pole 12 way	4 pole 5 way	4 pole 6 way
6 pole 2 way	8 pole 3 way	12 pole 2 way

Three wafer types, 99p each:

9 pole 4 way	6 pole 5 way	6 pole 6 wat
	12 pole 3 way	18 pole 2 way

STOP PRESS! CASSETTE MECHANISM — Front loading with heads. Brand new: £6.95

A PRESTEL UNIT, brand new and complete except for 7 plug in ICs — so far as we know the unit would work once the missing ICs are fitted. **Price: £19.75** + £2.00 post.

WATERPROOF HEATING WIRE

60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with pvc. Dozens of uses — around water pipes, under grow boxes, in gloves and socks.

TIME SWITCH BARGAIN

Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs **FOR ONLY £2.50.**

ROPE LIGHT

4 sets of coloured lamps in translucent plastic tube arranged to give the appearance of a running or travelling light. With variable speed control box, ideal for disco or shop window display. Complete, made up, ready to plug into mains. £36.00 + £2 post.

50 THINGS YOU CAN MAKE

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

YOURS FOR ONLY £11.50 plus £3.00 post.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures:
DC volts 10, 50, 250, 1000.
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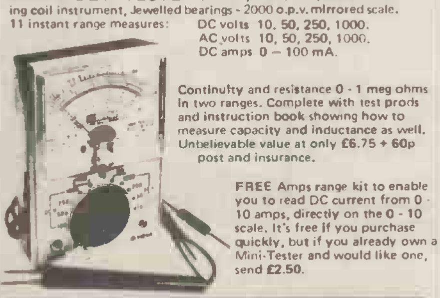

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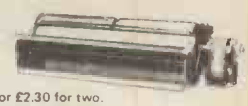

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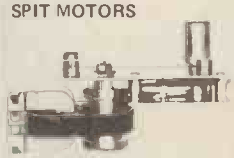

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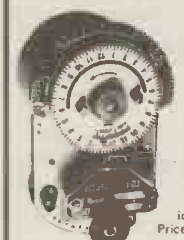

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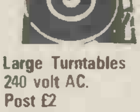

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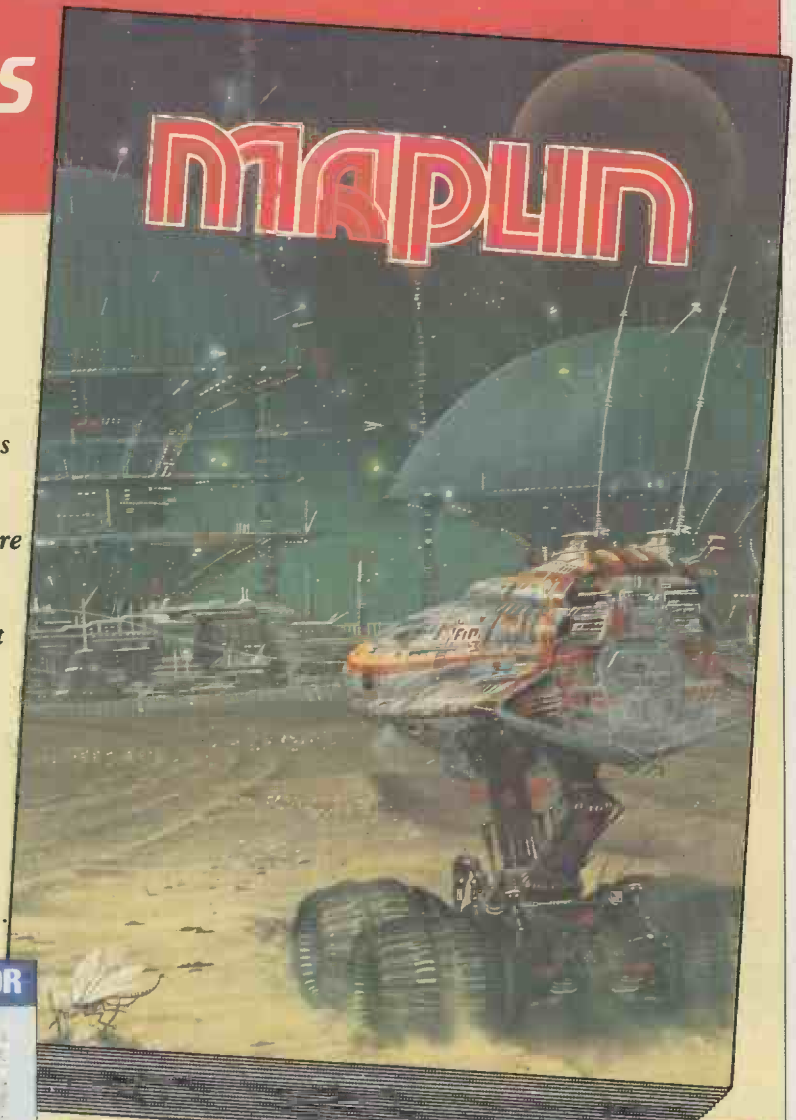

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