EVERYDAY ELECTRONICS and computer PROJECTS

OCTOBER 1983 90p

ELECTRONICS WITHOUT TEARS

HOME STUDY COURSE — TEACH-IN 84 STARTS THIS MONTH

HOME INTERCOM

ELECTRONIC PENDULUM
Prize Winning Project

SEDAC 83

SHORT WAVE RADIO

MULTIMETER Special Offer

Australia $1.60 New Zealand $1.60 Malaysia $4.95 IR £1.30 (inc V.A.T.)

electronize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION

IS YOUR CAR AS GOOD AS IT COULD BE ?

★ Is it **EASY TO START** in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain full output even with a near flat battery.

★ Is it **ECONOMICAL** or does it "go off" between services as the ignition performance deteriorates? Total Energy Discharge gives much more output and maintains it from service to service.

★ Has it **PEAK PERFORMANCE** or is it flat at high and low revs. where the ignition output is marginal? Total Energy Discharge gives a more powerful spark from idle to the engines maximum (even with 8 cylinders).

★ Is the **PERFORMANCE SMOOTH**. The more powerful spark of Total Energy Discharge eliminates the "near-misfires" whilst an electronic filter smoothes out the effects of contact bounce etc.

★ Do the **PLUGS and POINTS** always need changing to bring the engine back to its best? Total Energy Discharge eliminates contact arcing and erosion by removing the heavy electrical load. The timing stays "spot on" and the contact condition doesn't affect the performance either. Larger plug gaps can be used, even wet or badly fouled plugs can be fired with this system.

★ **TOTAL ENERGY DISCHARGE** is a unique system and the most powerful on the market - 3½ times the power of inductive systems - 3½ times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:

Performance at only 6 volts (max. supply 16 volts)

SPARK POWER — 140W, SPARK ENERGY — 36mJ
SPARK DURATION — 500μS, STORED ENERGY — 135mJ
LOADED OUTPUT VOLTAGE
50pF load — 38kV, 50pF + 500k — 26kV

We challenge any manufacturer to publish better performance figures. Before you buy any other make, ask for the facts, its probably only an inductive system. But if an inductive system is what you really want, we'll still give you a good deal.

★ **All ELECTRONIZE electronic ignitions feature: EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, STATIC TIMING LIGHT and DESIGNED IN RELIABILITY (14 years experience and a 3 year guarantee).**

★ **IN KIT FORM** it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2μF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most **NEW CARS** already have electronic ignition. Update **YOUR CAR**

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM

★ **2000 COMBINATIONS** provided by an electronic key - a miniature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).

★ **60 SECOND ALARM PERIOD** flashes headlights and sounds horn, then resets ready to operate again if needed.

★ **10 SECOND ENTRY DELAY** allows owner to dis-arm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Re-closing the door will not cancel the alarm, before or after it sounds, the key plug must be used.

★ **INSTANT ALARM OPERATION** triggered by accessories or bonnet/boot opening.

★ **30 SECOND DELAY** when system is armed allows owner to lock doors etc.

★ **DISABLES IGNITION SYSTEM** when alarm is armed.

★ **IN KIT FORM** it provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES. SUPPLIED COMPLETE WITH ALL NECESSARY LEADS AND CONNECTORS PLUS TWO KEY PLUGS

Don't Wait Until Its too Late - Fit one NOW!

fill in the coupon and send to:

ELECTRONIZE DESIGN Dept C · Magnus Rd · Wilnecote · Tamworth · B77 5BY · tel 0827 281000

TOTAL ENERGY DISCHARGE (6 or 12 volt negative earth)

☐ Assembled ready to fit ~~£26.70~~ £19.95
☐ D.I.Y. parts kit ~~£15.90~~ £14.95

TWIN OUTPUT for cars and motor cycles with dual ignition

☐ Twin, Assembled ready to fit ~~£36.45~~ £29.95
☐ Twin, D.I.Y. parts kit ~~£24.55~~ £22.95

☐ PLEASE SEND MORE INFORMATION

Goods normally despatched within 7 days.

Prices Include VAT. P+P £1-00 (UK)

C

CAR ALARM

☐ Assembled ready to fit £37.95
☐ D.I.Y. parts kit £24.95

I enclose cheque/postal order OR debit my Access/Visa card

VISA

Name _____

Address _____

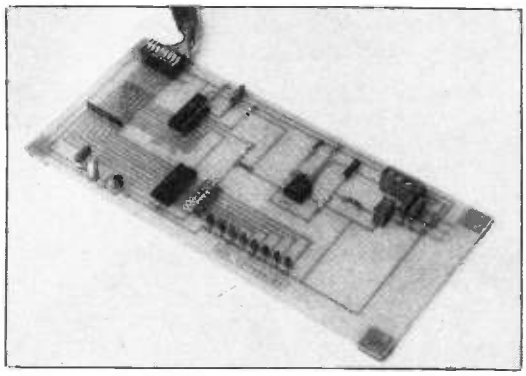
_____

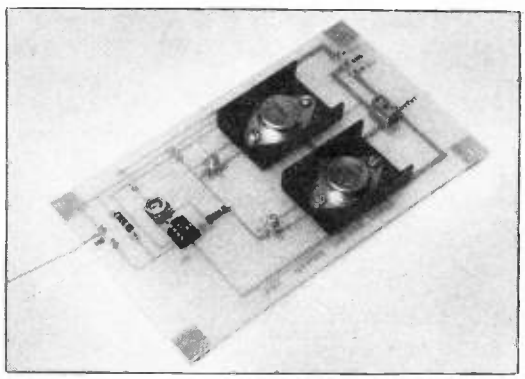
_____ Code _____

EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 10 OCTOBER 1983

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





PROJECTS

SERIES

FEATURES

Our November 1983 issue will be published on Friday, October 21. See page 658 for details.

Readers' Services ● Editorial and Advertisement Departments 625

Rapid Electronics

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

ACCESS AND BARCLAYCARD WELCOME

LINEAR

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

TRANSISTORS

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

ZTX108	8	2N3055	50								
ZTX109	12	2N3442	120								
ZTX300	14	▶2N3702	6								
ZTX301	16	2N3703	9								
ZTX302	15	▶2N3704	6								
ZTX304	17	2N3705	9								
ZTX341	30	2N3706	9								
ZTX500	15	2N3707	10								
ZTX501	15	2N3708	10								
ZTX502	15	2N3709	10								
ZTX503	18	2N3772	170								
ZTX504	25	▶2N3773	195								
2N697	20	▶2N3819	18								
2N698	40	2N3820	40								
2N706A	20	2N3823	65								
2N708	20	2N3866	90								
2N918	35	2N3903	10								
2N1132	22	2N3904	10								
2N1613	30	2N3905	6								
2N2218A	45	2N3906	10								
2N2219A	25	2N4037	45								
2N2221A	25	2N4058	10								
2N2222A	20	2N4060	10								
2N2368	25	2N4061	10								
2N2369	16	2N4062	10								
2N2484	25	2N5457	36								
2N2646	45	2N5458	36								
2N2904	20	2N5459	30								
2N2904A	20	2N5485	36								
2N2905	22	2N5777	45								
2N2905A	22	2N6027	30								
2N2906	25	40360	40								
2N2906A	25	40361	50								
2N2907	25	40362	50								
2N2907A	25	40408	70								
2N2926	9										
▶2N3053	23										
2N3054	55										

CABLES

20 metre pack single core connecting cable ten different colours 65p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m
10 way grey ribbon	38p/m
20 way grey ribbon	80p/m

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	SPECIAL OFFER!	
LM317T	120	78P05 10A +5V	
LM323K	350	only 390p each.	

DIODES

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

OPTO

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

Clips to suit - 3p each.

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

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500		FND507	
0.5"	100	0.5"	100

TIL313 0.3"115 TIL3120.3"115
TIL3220.5"115 TIL3210.5"115
LCD: 3½ digit 580p. 4 digit 620p.

HARDWARE

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

POTENTIOMETERS

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

TRIACS

	400V 8A	65	
	400V 16A	95	
400V 4A	50	8R100	25

JUMPER LEADS

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

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

COMPUTER CONNECTORS

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

RIBBON CABLE

Grey Ribbon cable. Price per metre

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

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers, Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 150V	80
		6A 400V	95
1A 50V	20	VM18 DIL	0.9A
1A 400V	35	200V	50

IDC CONNECTORS

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

MIN. D CONNECTORS

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

SOLDERING IRONS

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

RESISTORS

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

PCB MATERIALS

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

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid & screws	95	4 x 2¾ x 1¾"	95
		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1¾"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

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

LS TTL

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

TTL

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

74190	40		
74191	40		
74192	40		
74193	40		
74194	40		
74195	40		
74196	40		
74197	40		
74198	80		
74199	80		

CONNECTORS

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

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SO239 square chassis skt 38p.
SO239 round chassis skt 40p.
IEC 3 pin 250V/6A.

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

SCRs

▶C106D	30	
400V 8A	70	
400V 12A	95	

VERO

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

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

SWITCHES

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

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14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	98p
Soldercon pins	60P/100	

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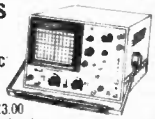

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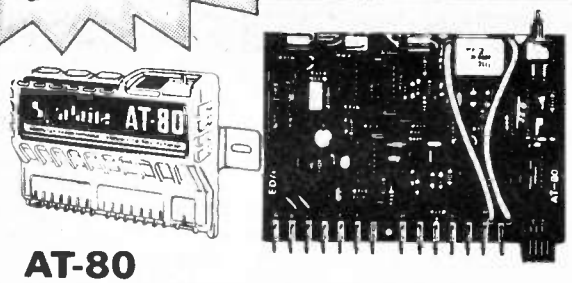

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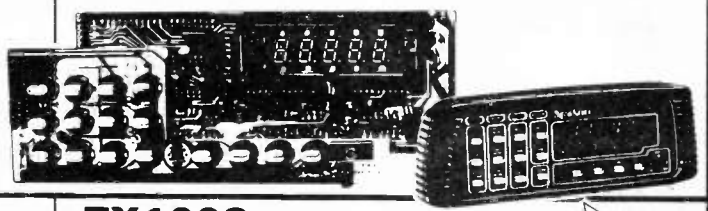

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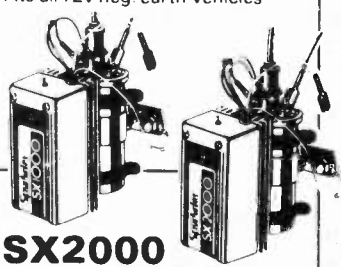

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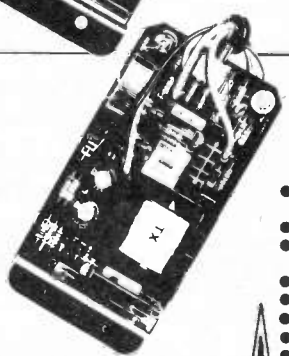

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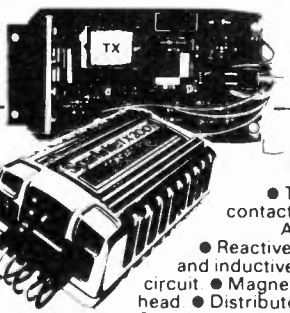

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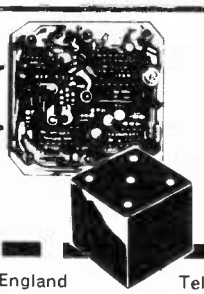

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WITHOUT TEARS

AUTUMN is in some respects an even more auspicious time for new resolutions than the new year. It is certainly true that the approach of the September equinox turns thoughts of many of us towards ways to occupy the longer evenings that lie ahead. Personal needs and fancies vary widely. There are those who prefer a casual, maybe inconsequential, kind of pastime. And there are those who wish to make a commitment to serious study over several months. In the latter case the choice of subject may be hard to resolve. So to the undecided may we put in a word or two in favour of electronics as an appropriate and interesting subject for home study.

The basic principles that govern *all* electronic circuits are not difficult to learn and can be readily proved by uncomplicated experiments carried out on any table top. With batteries as the source of power and the use of a circuit block for assembling components without any recourse to a soldering iron, the introduction to electronic circuits couldn't be easier.

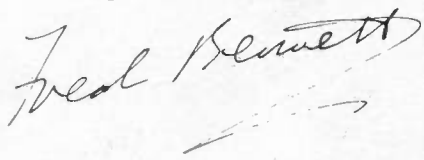
All this applies to our new twelve-part series *Teach-In 84*. We commend this home study course to all who would like to understand what makes electronics tick. No previous knowledge of electronic or electrical theory is needed. Anyone of any age should be able to follow these articles and rapidly become accustomed to handling components through the experiments. Furthermore all components needed for the twelve parts of *Teach-In 84* can be purchased as a complete kit from a number of our advertisers. All of which goes to reinforce our claim to present "Electronics Without Tears".

WIDER SCOPE FOR SCHOOLS

Talent for designing and building electronic equipment abounds amongst our secondary school students. This has been amply demonstrated over the past two years through the Schools Electronic Design Award Competition (SEDAC). The projects submitted have been impressive, covering an interesting range of applications within the limitations imposed by the rules which restricted the designs to those having a useful function in a school's science laboratory.

Electronic technology is versatile, and perhaps such limitations ought to be eased in future so that the scope for designs could be extended. This at any rate is the feeling of both sponsors, Mullard and Everyday Electronics. Therefore, the rules have been amended to permit entry of any electronic design having some specific use within a school's premises, or at any external event, indoors or outdoors, in which the school participates.

We confidently expect a large entry of designs and models representative of all aspects of applied electronics, in this coming third year of SEDAC. Scholars and teachers should note the particulars regarding SEDAC 1984 given elsewhere in this issue. Requests for registration forms should be sent in without delay.



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BY R. A. PENFOLD

HOME INTERCOM

WHILE communicating from one room to another in a loud voice can be quite effective, a more civilised and reliable way is to employ a simple intercom such as the one described here. The two stations are connected by a twin screened lead which can be up to 20 metres long if necessary.

The Home Intercom uses the loudspeaker at each station as a microphone as well. Although a loudspeaker does not give high quality output when compared to "proper" microphones, the quality is more than adequate for understandable speech.

Many intercoms use very simple amplifiers which give a reduction in sound quality, and a significant one at that. Furthermore, there is often no volume control so that overloading of the output stage occurs creating severe distortion.

This design achieves good quality reproduction by intercom standards as an integrated amplifier is used, and a volume control enables overloading to be prevented. Slight tailoring of the amplifier's frequency response is used to further improve matters.

THE CIRCUIT

The full circuit diagram of the Home Intercom is given in Fig. 1. The method of using the unit and the switching are common with virtually all intercom designs, that is, a high gain amplifier having its input fed from a loudspeaker and its output coupled to a second loudspeaker. The input loudspeaker is used as a moving coil microphone. By using simple send-and-receive change-over switching, the roles of the two loudspeakers can be reversed, and communications in both directions is then possible.

MAKING A CALL

For someone at the main station to call the remote station, it is necessary for them to switch the unit on, set the SEND/RECEIVE switch (S2) to "send", and talk into the microphone. The unit must also have some way of enabling the remote station to call through to the main one, and this is made possible by having the SEND/RECEIVE switch biased to the "receive" position, and having an extra battery and CALL switch in the remote unit.

If the CALL switch (S1) is operated, this additional battery (B1) supplies power to the amplifier, and the person at the remote unit is able to talk through to the main station (bearing in mind that the SEND/RECEIVE switch will be in the "receive" position).

The person at the main unit then switches the unit on and operates the SEND/RECEIVE switch as necessary. The CALL switch is *only* operated when initially establishing contact with the main station, and during normal operation, power is obtained from the battery (B2) at the main station.

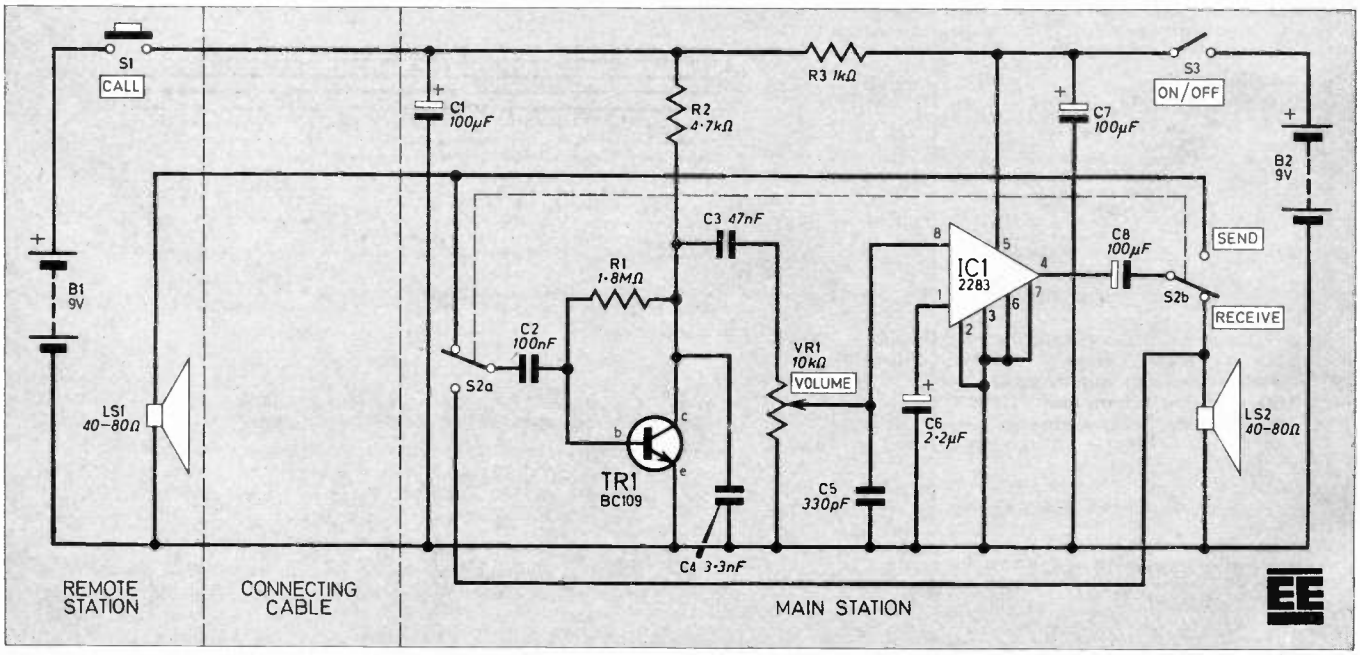
AMPLIFIER

This design uses a ULN2283 integrated amplifier (IC1) in the output stage, and this gives good quality provided the circuit is not overdriven. The maximum output power is around 100 to 150mW, and this is sufficient for an intercom where high volume levels are not normally required.

This i.c. has an internal negative feedback circuit which sets the voltage gain of the device typically at 43dB. If no external feedback resistor is used, as in this application where the full voltage gain of the device is needed, pin 1 is coupled to 0V by C6 and no series resistor is used.

The input of IC1 connects direct to the slider of the VOLUME control VR1 and no d.c. blocking capacitor is needed. C5 attenuates the high frequency response of

Fig. 1. Circuit diagram of the two-station Home Intercom. The connecting cable can be up to 20m long.

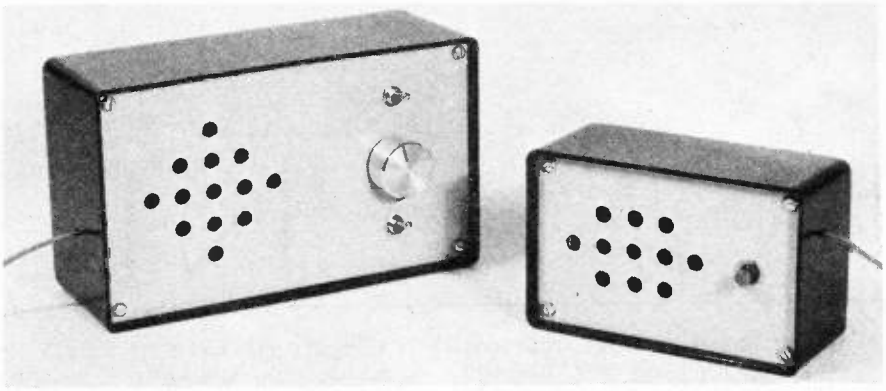


the unit and prevents IC1 from becoming unstable.

Although IC1 gives quite a high voltage gain, the output from a high impedance loudspeaker when used as a microphone is extremely small, and will normally be under 1mV. A considerable boost in gain is therefore needed, and this is provided by TR1 which is used as a conventional high gain common emitter stage.

This gives an increase in voltage gain of around 40dB. C4 rolls off the high frequency response of the circuit, and this is mainly necessary due to stray capacitance in the SEND/RECEIVE switching which would otherwise give sufficient feedback over the amplifier to produce strong oscillation.

The values of C2, C3, and C6 have purposely been made rather low so that the low frequency response of the circuit is severely attenuated. This is done to compensate for the excessive bass output of a loudspeaker used as a microphone, which otherwise tends to seriously impair intelligibility.



The complete Home Intercom system in matching cases.

The current consumption is about 13mA under quiescent conditions, but as the ULN2283 has a class A/B output stage the current drain increases substantially when the unit is used at high volume levels.

MAIN STATION

The main station is housed in a plastic box with an aluminium front panel and outside dimensions 160 × 100 × 60mm. A pattern of holes are drilled on the left section of the front panel to produce a speaker grille, and the loudspeaker is glued in place behind this. The three controls are mounted on the right-hand side of the front panel, and a small hole for the twin screened connecting cable is drilled in one side of the case.

The amplifier is built on a 0·1in matrix stripboard using the component layout shown in Fig. 2, and this requires a board

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See Shop Talk page 629

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C4	3·3nF ceramic
C5	330pF ceramic
C6	2·2µF 63V elect.

Semiconductors

TR1	BC109C silicon *npn*
IC1	ULN2283 audio power amplifier

Miscellaneous

VR1	10kΩ log. control potentiometer
LS1,2	40 to 80Ω miniature loudspeaker
S1	push-to-make momentary action push-button
S2	d.p.d.t. miniature biased toggle
S3	s.p.s.t. miniature toggle
B1	9V PP3 battery
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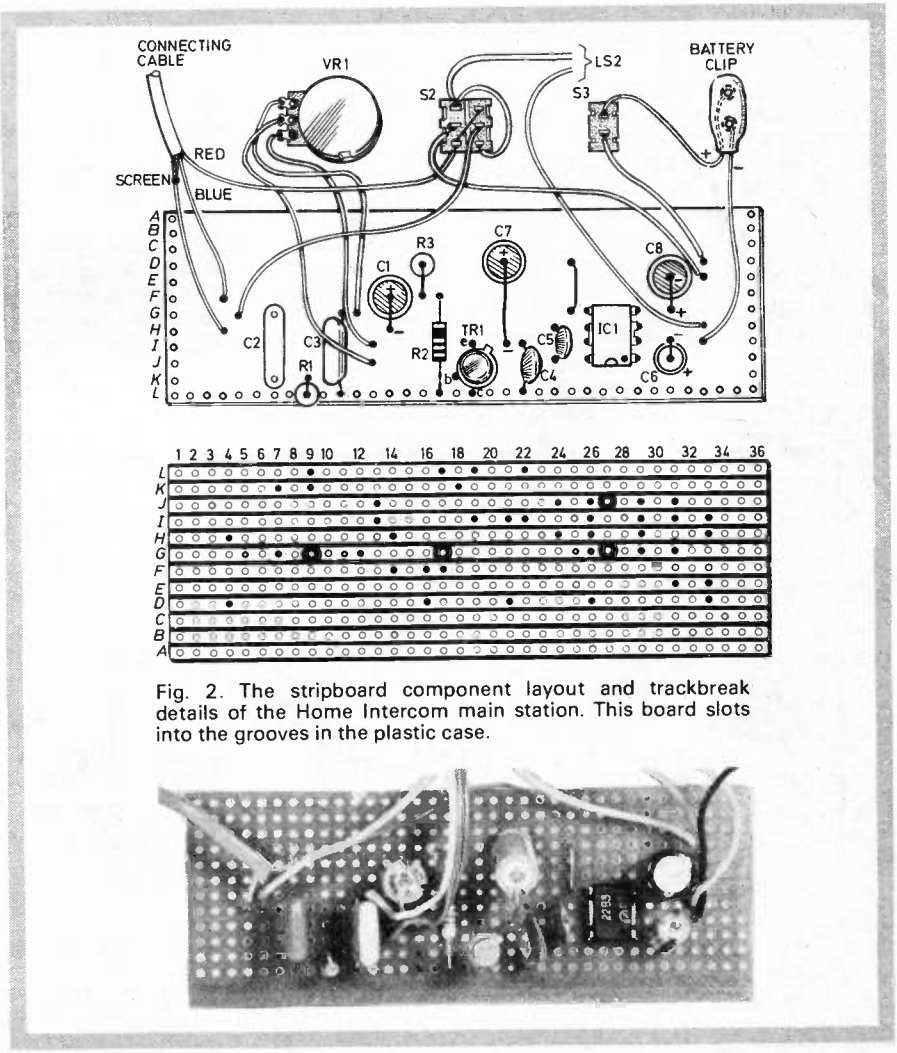
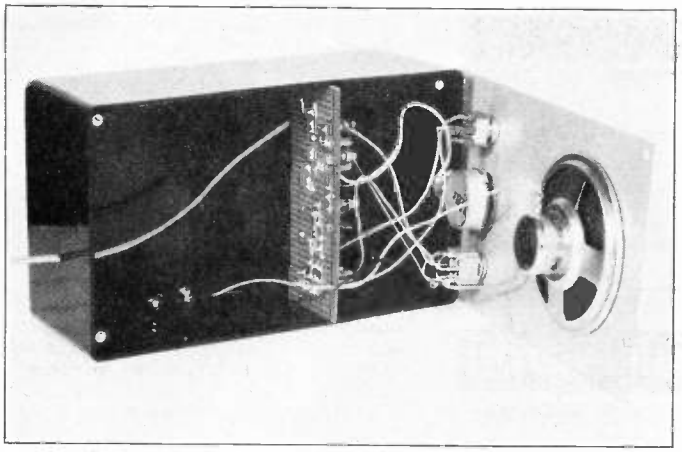
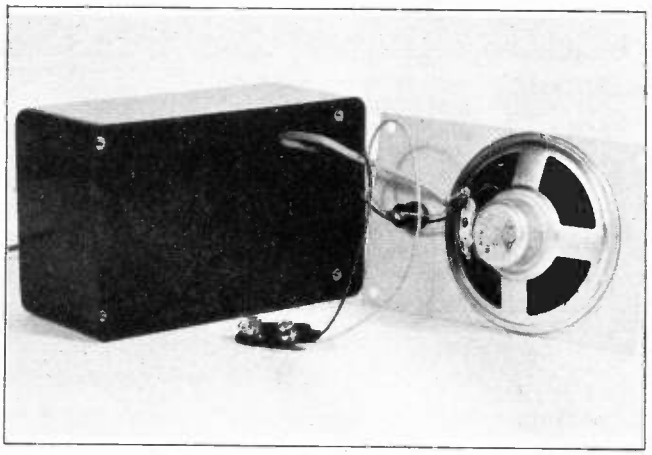


Fig. 2. The stripboard component layout and trackbreak details of the Home Intercom main station. This board slots into the grooves in the plastic case.



The main station of the Home Intercom showing the method of mounting the circuit board. The larger PP6 battery is also housed in this case.



The remote station wiring and loudspeaker mounting details. The smaller PP3 battery in this unit is only used when initially making a call.

having 36 holes by 12 strips. The resistors, capacitors, and link wires are fitted first, and then TR1 and IC1, ensuring that the semiconductor and electrolytic capacitors are inserted the right way round. On IC1, pin 2 and 3 and 5 and 6 are manufactured connected together in pairs.

Note the four breaks in the copper strips on the underside of the board which are made with the appropriate tool or a small drill bit.

CONNECTING CABLE

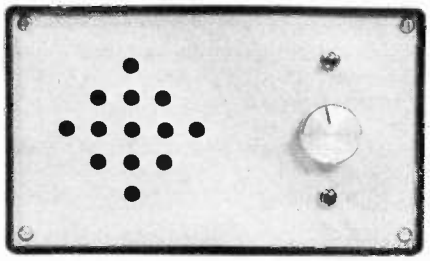
The connecting cable is passed through the hole in the case and wired into the circuit. The best wire to use is twin screened type since it is inexpensive, and the screening prevents stray pick-up of mains hum and radio signals in this cable. The capacitance in the lead will be quite high if a long lead is used, but this should not significantly affect the performance of the system as the microphones have a low output impedance. A three-way, non-screened cable is *not* recommended for use as the connecting cable, and would almost certainly give excessive break-through of unwanted signals.

The main station is completed by adding the remaining wiring, and slotting the component board into a set of vertical guide rails in the case, so that it fits into the space between the loudspeaker and the controls. The battery fits into the space behind the loudspeaker with foam rubber material to keep it in place when the front panel is fitted.

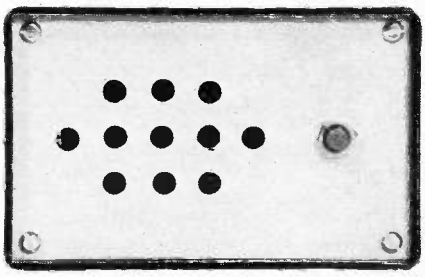
REMOTE STATION

The remote station is fitted in a case that matches the one used for the main station, but it has smaller dimensions of about 110 × 70 × 50mm. A similar matrix of holes are drilled to form a speaker grille on the left-hand side of the front panel, as for the main station.

S1 is positioned on the right-hand side of the panel and a small entrance hole is drilled for the connecting cable in one side of the case. Fig. 3 shows the small amount of wiring needed to complete the remote unit.



The main station front panel.



The remote station front panel.

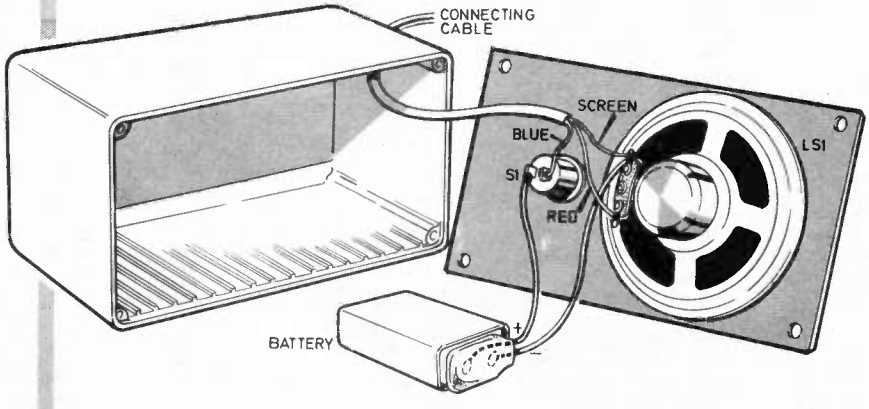


Fig. 3. The remote station wiring details. The PP3 battery is secured with double-sided adhesive foam pads.

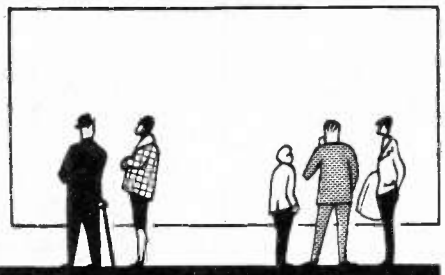
TESTING

A quick way of checking the completed Home Intercom is simply to switch on the unit and turn up the volume with the two stations in the same room, facing each other but spaced some distance apart. This should produce a "howling" sound from the main unit due to acoustic feedback.

Operating the SEND/RECEIVE switch should result in the howling coming from the remote unit. Switching off the Intercom and operating the CALL button on the remote unit should turn the amplifier on again and produce the howling sound from the main unit.

All that remains is to take the two stations into separate rooms and test with normal speech and finally mount the units in the chosen locations. □

SHOP TALK



BY DAVE BARRINGTON

Catalogues Received

The latest, over 200-page catalogue from **Benningcross Electronics** contains such items as soldering irons, smoke detectors, kits, telephone hand-set, case, tools and p.c.b. drills, cassette motors, loudspeakers and an extensive range of semiconductor and i.c. devices.

It is a pity that although the catalogue contains probably one of the largest range of individual items presently listed by an advertiser, the quality of printing leaves a lot to be desired. This is particularly relevant to the reproduction of the photographs. However, at £1 this 230-page catalogue is a very welcome addition to the components reference library.

Copies of the Benningcross Components Catalogue may be obtained from: **Benningcross Electronics, Dept. EE, 67 Vicarage Road, Watford, Herts WD1 8EJ.**

It may, at first glance, seem strange to mention a Mail Order catalogue in these pages. But a quiet revolution has been taking place in the "popular" mail order catalogue business. With the increasing appeal of electronics and computing, particularly in the games area, the amount of stock carried has increased quite considerably.

This is quite evident in the new **Argos** catalogue where, if you include digital watches, electronic typewriters (computer compatible) and in-car entertainment, nearly 50-pages of the 284-pages are devoted to electronics-based products. This may seem only a small proportion of the items listed, but when you consider the "state-of-the-art" products carried, it is quite an achievement.

Products stocked include: Silver Reed typewriter, with computer interface for BBC, Dragon, Tandy and Video Genie machines; the Casiotone MT-70 49-key, 4-octave electronic keyboard; Mattel Synsonic Drum Synthesiser and the Aquarius home computer (see *New Products*); the CBS Coleco Vision Expansion Module 2, car hazard driving video; and the Vectrex video game system with its own built-in monitor screen. The latter four items only released this month.

Teach-In '84

This month we start the first instalment of a new home-study course for the newcomer to electronics.

This 12-part series entitled *Teach-In 84* has been specially commissioned and uses a solderless "breadboard" system so that even the complete novice can tackle the demonstration "exercises".

Arrangements have been made with our advertisers to supply kits of parts, including the Ebbo Block System, for the complete 12-part series.

For details of suppliers and page number of their advertisement, see page 638.

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.

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

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

CONSTRUCTIONAL PROJECTS

Short Wave Radio

The variable tuning capacitors used in the *Short Wave Radio* are stocked by Ambit, Benningcross, Electrovalue, Rapid, Maplin and Magenta Electronics.

The transistor type BF244B used in the detector/r.f. amplifier stage is listed by Cricklewood and Rapid Electronics.

The aerial tuning coils are available direct from Denco (Clacton) Ltd., Dept EE, 355/9 Old Road, Clacton-on-Sea, Essex CO15 3RH. When ordering specify: Miniature Dual Purpose, Green, Ranges 3, 4 and 5.

Immersion Heater Tell-Tale

The thermistor GL16 used in the *Immersion Heater Tell-Tale* is a miniature bead type. It has a negative temperature coefficient (n.t.c.) and a resistance of 1MΩ at 20°C and a minimum resistance of 170Ω.

This thermistor is sometimes referred to as types G16 and THB11. It is available from Maplin and most major suppliers.

The double socket box and blanking plate should be available from any good electrical store. The LM324N quad op-amp is available from the following: Ambit, Magenta, Rapid and TK Electronics.

Home Intercom

The audio power amplifier, type ULN-2283, used in the *Home Intercom* appears to be only available from Ambit.

Temperature Transducer Amplifier

The sensing device used in the *Temperature Transducer Amplifier* is the 590kH and as far as we are aware is only available from RS Components (Order code 308-809). We would point out however that RS will only supply to recognised dealers and readers will have to order through their local component supplier.

Microcomputer Interfacing Techniques

All the "special" components called for in this month's constructional projects contained in the *Microcomputer Interfacing Techniques* series relate to the *Digital-to-Analogue Converter* (DAC) board.

The s.i.l. 8-commoned resistor pack (Code 140-271), the Darlington driver ULN2803 i.c. (Code 303-438) and the DAC0800 digital-to-analogue converter (Code 309-458) were obtained from RS Components. All these items should be ordered through your local RS stockist.

We do not expect any component purchasing problems for the *Model Car Petrol Tank* and the *Electronic Pendulum*—SEDAC Prize Winner.

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
Electronic Die (Aug 83)	8308-03	£4.56
High Power Interface *M.I.T. Part 2* (Aug 83)	8308-04	£5.08
Pedestrian Crossing Simulation *M.I.T. Part 2* (Aug 83)	8308-05	£3.56
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

IMMERSION HEATER TELL-TALE

BY T. R. de Vaux-Balbirnie

With the present high cost of electricity, many householders are looking for ways of reducing energy costs. One possible area of saving is in the use of immersion water heaters.

Since hot water is less dense than cold, the level of hot water in the storage tank "grows" downwards from the top. If a check is made on the hot-water level then only the amount required need be heated. The traditional method is to check by hand but this is difficult where a modern close-fitting jacket is used or if the cylinder is remote from the kitchen. The result is an excess of hot water; heated with energy which will be dearly paid for.

L.E.D. DISPLAY

The Immersion Heater Tell-Tale "feels" the tank electronically at four levels and operates a corresponding display of light emitting diodes. If, for example, the tank is half full of hot water, then the top two l.e.d.s will light but the bottom pair will stay off.

The circuit only works when a test button is pressed so normally there is no drain on the battery. The current consumption is only about 20mA with all four l.e.d.s on, so the battery should give many months of service.

Apart from the four sensors on the hot-water cylinder and associated wiring, the project is housed in a standard electrical double socket box with blanking plate. This may be of the surface-mounted or flush (sunk in the wall) type. If the project is on view it will blend with wall switches and power sockets.

Before commencing construction, it would be a good idea to check that it is possible to run the necessary wires from the cylinder to the proposed position of the unit.

CIRCUIT

The circuit is based on an LM324 Operational Amplifier i.c. This device contains *four* separate operational amplifiers and each is made responsible for one particular water level.

Fig. 1 shows the complete circuit diagram. It can be seen that the inverting inputs of the op-amps (marked "–") are connected to a potential divider consisting of two equal value resistors, R5 and R6. This sets the inverting inputs to about one-half of the battery supply voltage (about 4·5V). The other inputs, the non-inverting inputs (marked "+"), are each connected to a separate potential divider. One element of which is a thermistor (RTH1) and will be placed in contact with the water tank. The other consists of the fixed and variable resistors, R1 and VR1, connected in series.

THERMISTORS

Thermistors are heat-sensitive devices which *reduce* their electrical resistance when warmed (in the case of the negative co-efficient type used here). The voltage at the non-inverting input will rise, therefore, and eventually exceed the fixed voltage at the inverting input.

It is a characteristic of an op-amp that when the voltage at the non-inverting input exceeds that at the inverting input, it switches on and an l.e.d., placed in its output circuit, will light. VR1 can be adjusted so that the l.e.d. lights at the correct temperature. The purpose of R1 is to limit the current flowing through the thermistor should VR1 be set to near-zero resistance. The resistor in series with the l.e.d. limits its current to a safe working level.

All four channels act in an identical manner. As the hot-water level progresses downwards in the tank, the l.e.d.s will light in sequence.

Since this circuit *compares* two voltages applied to the inputs, it does not matter if the battery runs down to some extent. The only effect is that the l.e.d.s will glow less brightly.

COMPONENT BOARD

Construction is based on a piece of 0·1in matrix stripboard, 17 strips by 27

COMPONENTS

Resistors

R1–4	10kΩ (4 off)
R5,6	100kΩ (2 off)
R7–10	1kΩ (4 off)

All ¼ or ½W carbon ±10%

Semiconductors

D1–4	TIL220 5mm red l.e.d. (4 off)
IC1	LM324N quad op-amp
* RTH1–4	GL16 miniature bead, negative temperature coefficient thermistor (4 off)

*see note page 632

See Shop Talk page 629

Miscellaneous

VR1–4	470kΩ miniature horizontal preset (4 off)
S1	miniature push-button
TB1,2	5-way terminal block (2 off)
B1	9V PP3 battery

Stripboard, 0·1in matrix, 17 strips by 27 holes; double socket box and blanking plate; 14-pin i.c. holder; battery clip; 7/0·2mm connecting wire (5 colours); solid copper wire; mounting hardware.

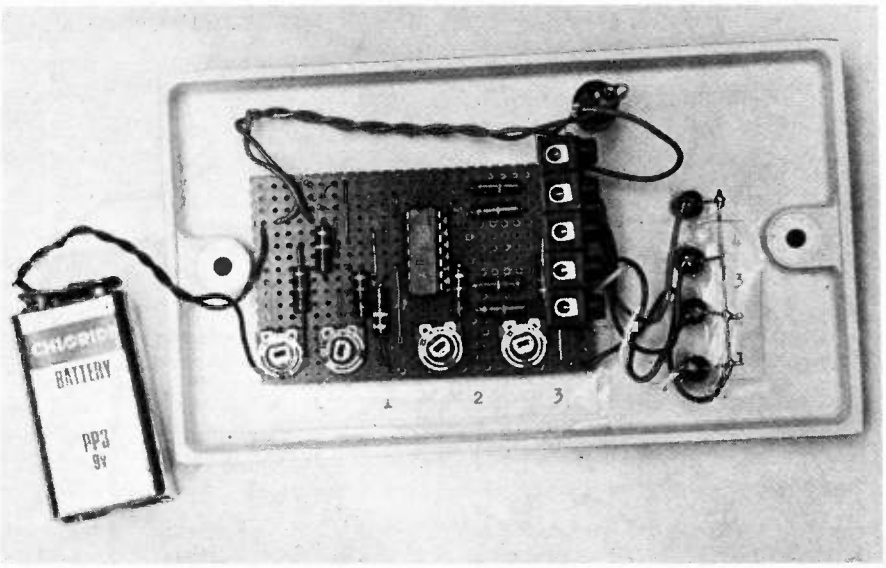
Approx cost. Guidance only £18.00

holes. Refer to Fig. 2 and begin by soldering the i.c. socket into position. Follow by making the seven links then add the components. Do not insert IC1 into its holder at this stage. Make the breaks in the copper tracks as indicated using a spot-face cutter or a small twist drill turned by hand. Note that no breaks are made in tracks *E* and *I* between the i.c. pins. Solder 50mm lengths of connecting wire to each of strips *B, D, J, L* and *Q*. These will be connected to the l.e.d.s later. Solder wires for S1 and the battery connector.

TERMINAL BLOCK

Prepare the terminal block TB1 by securing 20mm long bare copper wires to terminals 1 to 4. Leave TB1/5 unconnected. Best results are obtained by using the stiff wire obtained from the ends of discarded $\frac{1}{2}$W resistors. Shape the leads as necessary and connect them to strips *A, F, H* and *O* on the circuit panel (see photograph). Trim off excess wire.

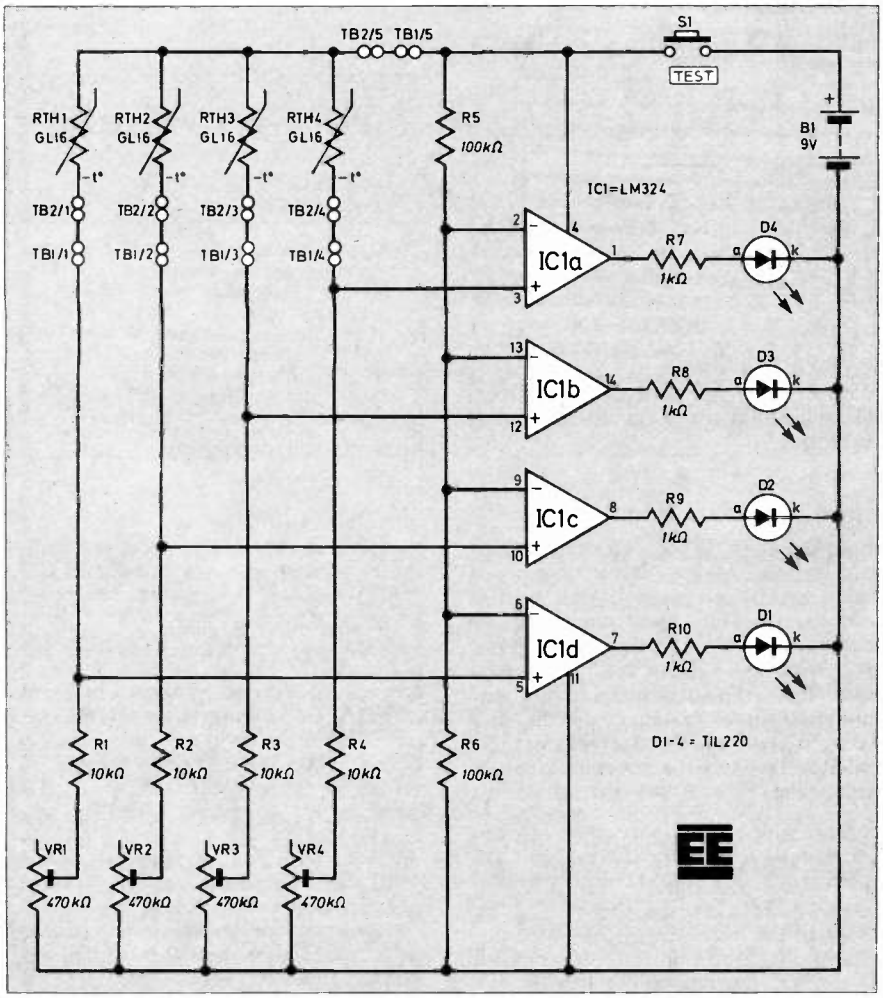
Before proceeding, check the circuit panel for errors. In particular, make sure that no accidental "bridges" have been made between adjacent copper strips.



The circuit board, l.e.d.s and terminal block TB1 mounted to the rear of the blanking plate of the double socket box. Note how TB1 has been bent upwards.

Finally, insert IC1 noting that it must be fitted the correct way round. Take care not to bend the pins.

Fig. 1. The circuit diagram of the Immersion Heater Tell-Tale. D1 indicates the temperature sensed by RTH1 at the top of the tank through to D4 indicating the temperature at the bottom.



CASE

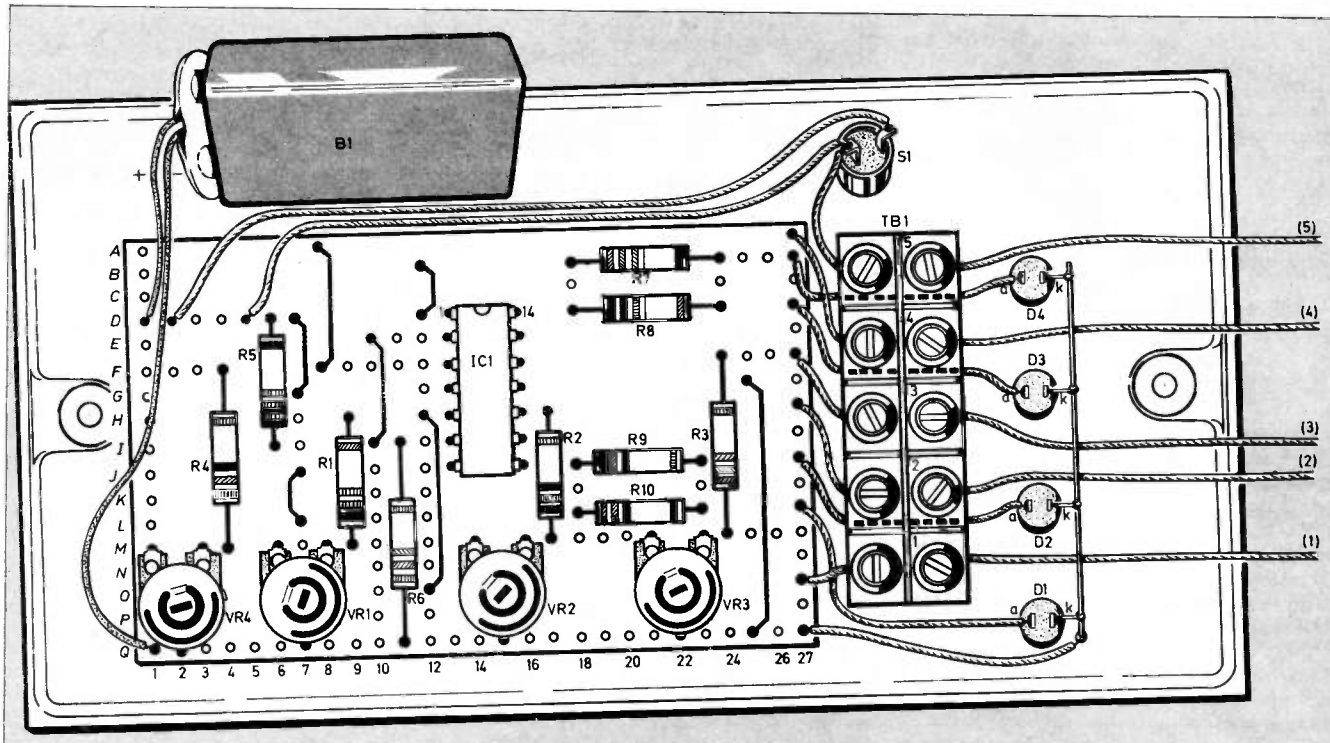
Attention may now be given to the casing. Double socket boxes and blanking plates to suit are stocked by electrical dealers and D.I.Y. shops. Drill holes in the blanking plate for the l.e.d.s as shown in the photograph. In the prototype these were 5mm diameter and spaced 12mm apart. The l.e.d.s may be secured behind these holes to give a neat appearance to the front panel. Alternatively, they could be fitted using proper mounting kits. Drill a hole for the push-button switch (S1) and mount this in position.

Mount the l.e.d.s so that the cathode (k) leads are all to the right-hand side of the circuit panel (see photograph). Use a very small quantity of quick-setting epoxy resin adhesive to secure. When the adhesive has hardened, carefully solder all the cathodes of the l.e.d.s together and connect to the wire already leading to strip *Q* on the circuit panel. Connect the wires leading to strips *L, J, D* and *B* to the anode leads of D1, 2, 3 and 4, respectively. Solder the wires to the switch. Connect the non-battery side of the switch to TB1/5 as shown in Fig 2.

THE THERMISTORS

Thermistors are very delicate components so great care is needed in preparation. They may also be damaged by excessive heat from the soldering iron. The original leads are very short and must be extended to about 500mm to enable them to be connected to TB2 (see Fig. 2). Begin by taking eight lengths of 7/0·2mm stranded wire and strip the insulation 5mm from each end. It is helpful if five colours are available; four pieces of one colour and one each of the others. Each thermistor will then be fitted with one common and one individually coloured lead.

Take one thermistor, slide a short piece of narrow sleeving—insulation stripped from scrap connecting wire—onto each



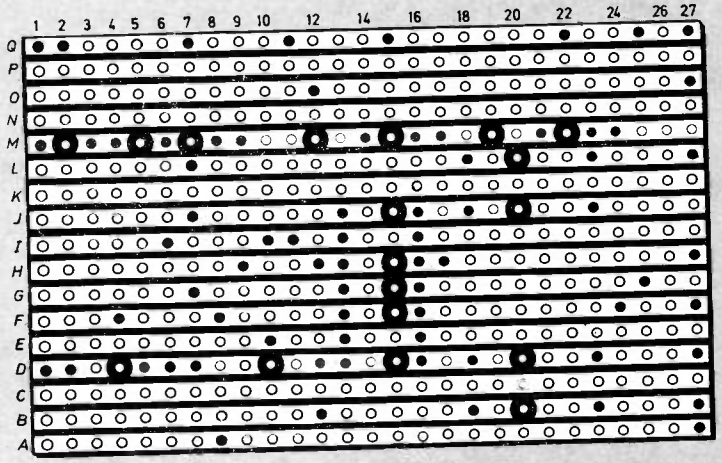


Fig. 2 (above and left). The circuit board layout and interwiring diagram. Note that the connections from the stripboard to TB1 are made with solid wire. All other wiring is carried out with a flexible multi-strand type. The thermistors are secured to the tank (see above right) at one-fifth intervals and terminated at TB2.

Fig. 3 (right). The method of extending the leads of the thermistors and sleeving the joints.

Note—Since completing the prototype Immersion Heater Tell-Tale, the author discovered that the considerably cheaper VA1067S rod thermistor can be used in place of the GL16 bead thermistor (RTH1 to 4). These are available from Maplin and, if used, must not make metallic contact with the copper cylinder.

lead so that about 10mm of bare wire is left exposed. Slide a 40mm length of thicker sleeving over two of the 500mm lengths of wire. Solder the wires to the thermistor leads. Finally, slide the thick sleeving over the joints to insulate them (see Fig. 3).

Ensure that the narrow sleeving is pushed hard up to the body of the thermistor otherwise the leads are likely to twist and cause a short circuit. A little glue may be used to keep the sleeving in position. Repeat the procedure for the other three thermistors and twist the leads for each together.

The thermistors may now be secured *temporarily* to the copper water cylinder; p.v.c. tape may be used for this. Position RTH1 about one-fifth of the distance down the tank, RTH2 about two-fifths and so on. Make certain that each thermistor makes good thermal contact with the cylinder. Each common wire connects to TB2/5. The remaining wires from RTH1, RTH2, RTH3 and RTH4 connect to TB2/1, TB2/2, TB2/3 and TB2/4, respectively. A five-way cable connects TB2 at the cylinder to TB1 at the unit.

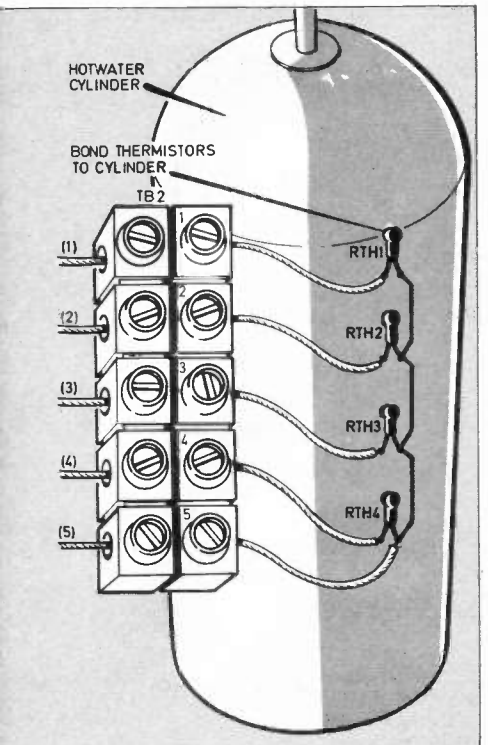
TESTING

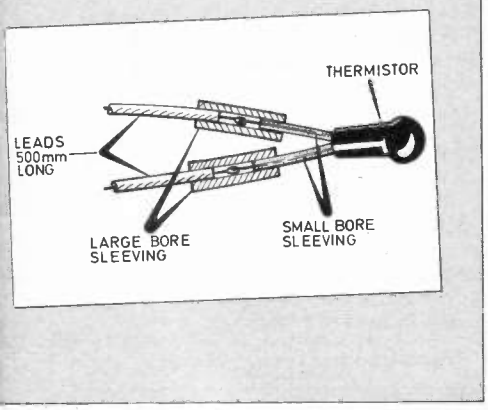
Start with a cold-water tank. Connect the battery and press the button. It is possible that one or more l.e.d.s will light. If so, adjust the appropriate variable resistor anticlockwise until it goes off.

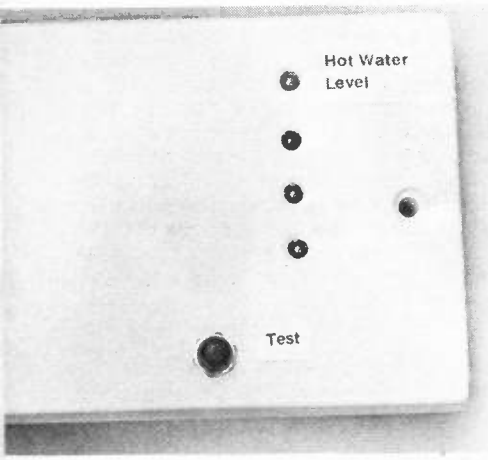
Heat up the water. When the water at the level of RTH1 is judged to be "hot" by hand, adjust VR1 until D1 just comes on. As the hot-water level reaches RTH2, RTH3 and RTH4, repeat the procedure adjusting VR2, VR3 and VR4.

Over the following few days, the best positions for the thermistors and ideal settings for VR1 to VR4 may be found. The thermistors can then be secured more permanently using epoxy resin adhesive. Make certain that the work has not disturbed the fitting of the cylinder jacket so impairing its efficiency. TB2 may hang loosely behind the cylinder. Note that drops of water on the thermistors may short circuit the leads and prevent their associated l.e.d.s from going off.

Used conscientiously, this project can help in reducing energy costs. It only remains to wait for reduced bills! □







COUNTER INTELLIGENCE

BY PAUL YOUNG

Component Buying

It is around this time of the year that the constructional scene starts in earnest, and I usually trot out my advice to component purchasers. I know that unless you are very favourably placed, most of your purchases will be by mail order, so for the benefit of the uninitiated I will sum up as briefly as possible:

Send for as many catalogues as you can afford and study them. Accept the fact that you will have to purchase from more than one supplier.

Use the retailer's own order form (usually supplied). Write clearly and put your name and address in BLOCK CAPITALS. Do not write queries on the order form.

Allow 10-14 days for delivery.

I have a theory on the evolution of component shops. When a new shop opens it has few customers and is able to give these few superlative service. The shop's reputation grows resulting in more customers until a point is reached where staff cannot cope and the good service deteriorates.

By this time the founder of the firm may be isolated in a plush office and is not aware of what is happening. This is a dangerous situation and if not dealt with, will cause irreparable damage.

Complaints

I mention this, because a few weeks ago I received a letter from Mr. Mills-Thomas of Pulborough, who complains of the performance of four mail order firms, two of them very well known, "No names, no pack drill", I will refer to them by letters:

Firm "A". Wrong Transistors sent. Transistor returned, no reply. Faulty i.c. returned and again no reply!!

Firm "B". Two incorrect items sent. Returned with packing slip, but no reply, nor to additional reminder!!

Firm "C". Order sent with extra for catalogue. Goods received, but no catalogue. Letter sent, then catalogue received, no apology.

Firm "D". Grossly overcharged on Barclay Card debit, on protesting received cheque in refund. No word of apology.

Certainly the first two complaints are serious. What action should you take if placed in a similar situation? I suggest that you write first to the Managing Director of the firm concerned and mark the envelope "personal". If this fails to effect a remedy, write to the magazine which is carrying the firm's advertising. In the final analysis the magazine bears the responsibility for any lapse on the part of their advertisers, so you can be certain that they will demand an explanation from the offenders.

If you still get no satisfaction, write to the magazine again; remember you are probably doing a service to other customers in ensuring that the culprit is brought back into line. I do, however, hasten to reassure readers that the number of complaints worked out as a percentage of satisfied customers is very low indeed.

Computer Selling

While no one has yet designed a computer that will automatically deal with complaints, one firm has used them successfully for selling second-hand cars. The theory is quite simple—the seller provides the computer firm with all the relevant details of the car he wishes to sell, who then feeds the information into the computer.

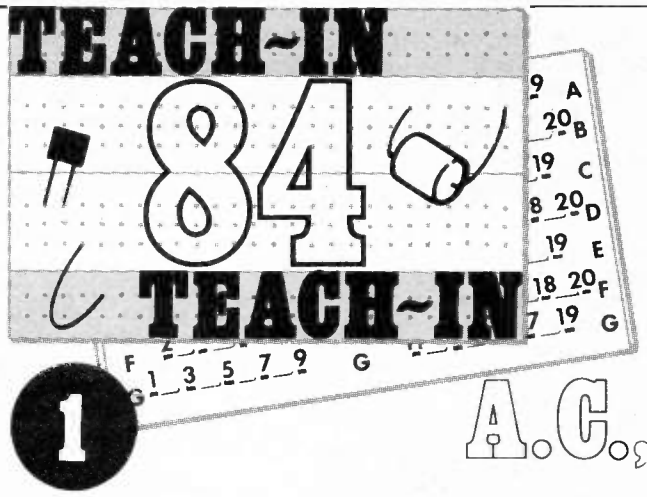
A would-be buyer comes along and tells the firm all his requirements, which again are fed into the computer, and then at the press of a button one is matched with the other. I don't know how the financial arrangements work, but I suppose the seller pays a percentage to the firm on the completion of the sale.

As far as I can tell, the idea seems to work, but when it was extended to the sale of houses, it flopped! At least, this was the experience of a friend of mine, who tried to sell his house this way. He did not receive a single enquiry!!

Robot Commits Suicide

Finally, a tale that comes from America about an electronically controlled robot. It was designed in Florida to work inside a nuclear reactor. It seems the robot didn't fancy the job, so it worked its arm around into an unnatural position and proceeded to batter itself to pieces.

Is this the first known case of an electronic suicide? Mind you, I cannot vouch for the veracity of the story—it seems to me to be highly suspect.



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.

A.C., D.C. & SIGNALS

BY GEORGE HYLTON

WELCOME to *Teach-In 84*. In this series, which will run for one year, we'll avoid the need for soldering by making use of a commercial electronic breadboard. Components and connecting leads are simply plugged-in.

The recommended breadboard is the EBBO Building Block System. This has a small "tray" into which various modules are slotted. A variety of modules are available for use in the EBBO System. We'll use those which accept individual components and transistors, battery holder modules, integrated circuit modules and power supply (battery) rails.

Certain items (such as earphones) will, for convenience, first be attached to a piece of electrician's terminal block, which will then be connected to the breadboard with long leads.

COMPONENTS

All components and other items required for the experiments in the entire series are listed in Table 1.3 and can be obtained from a number of retailers as complete kits. See page 638.

TOOLS

Only a few tools are required: a small pair of long-nosed pliers and a small pair of wire cutters, both preferably with insulated handles; a small screwdriver, $\frac{1}{8}$in blade.

TEST METER

A small inexpensive multimeter, to measure volts, milliamperes and ohms, is needed. The multimeter recommended for this series is the KEW7S and is available to EVERYDAY ELECTRONICS readers at a special price. See page 657.

If you already have a multimeter with a sensitivity of 1,000 ohms per volt or greater it should be usable, but some of the voltage readings it gives may differ a little from those with the KEW7S.

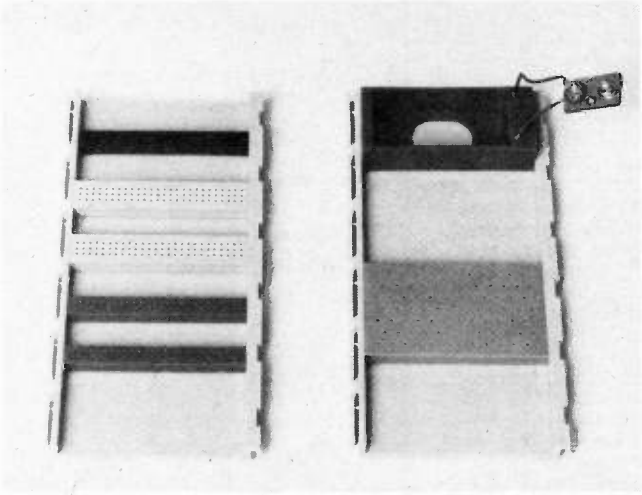
It is desirable that your meter should have a d.c. voltage range of less than 10 volts (V) full scale deflection, though you can get by with a range of 0–10V for most experiments. Don't attempt to use your meter on its current ranges. (It may then be too susceptible to overload.)

A.C., D.C., AND SIGNALS

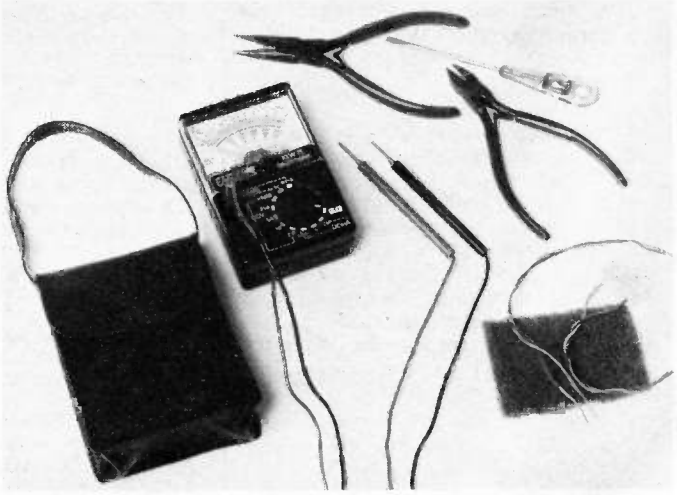
In electronics, most of the circuits carry currents which are mixtures of d.c. (direct or steady current) and a.c. (alternating or time-varying current). Usually the d.c. comes from a battery or the equivalent power supply. It is there to make the transistors in the circuit work. Once working, the transistors are used to handle a.c. signals.

The word "signal" is used very loosely in electronics. Originally, of course, a signal was just that—a beacon or a light or a flag, for example. Then when the electric telegraph was invented it came to mean the electrical equivalents of these visible signals.

Morse Code signals, for instance, are currents in a telegraph line, switched on or off by tapping a contact key. When telephone transmission became possible it was natural to enlarge the meaning of signals to include speech. And so onto radio signals, television signals and digital signals as used in computers.



The EBBO Building Block System used in the Teach-In 84 series. *(Left)* the Basic Integrated Circuit Starter Pack. *(Right)* the Basic Discrete Component Starter Pack.



Other equipment required for Teach-In 84. Small Multimeter (Eagle KEW7S), long-nosed pliers, wire cutters, small screwdriver, a piece of Scotchbrite scouring material, and multimeter adaptor lead.

Any voltage or current which carries some sort of information—audible, visible, mathematical or whatever, is now called a signal.

Interesting though some of these signals may be you will never learn how to design or understand circuits for them unless you first have a firm grasp of the principles of d.c. Fortunately many of these principles can easily be extended to a.c. So in learning d.c. circuit design you are laying the foundations for everything else.

CURRENT

We all know that electric currents flow through wires. An electric current is really a flow of electric charges, carried by electrons or other kinds of charge-carrying particles. But we don't need to go into the physics of the thing. As far as we are concerned, d.c. electric currents are pushed around circuits by batteries. We'll use a 9V dry battery, or perhaps enough 1·5V cells to make up 9V.

Current flows out of the positive terminal of a battery, goes round the circuit, and flows back into the negative terminal. It can only flow if there is a conducting path connecting positive to negative. This path can be a wire, a computer, your own body, anything that conducts electricity.

Just as much current flows back into the negative battery terminal as comes out at the positive. If it didn't, there would be a "traffic jam" of electric charges somewhere along the line and this would itself inhibit current flow.

At first sight, an electric circuit seems like a case of perpetual motion. Surely, the current can go round and round for ever. If as much gets back into the battery as leaves it, then nothing is lost! But you know it can't be so.

ENERGY

Energy is expended in driving the current. Strictly speaking, the energy is not so much expended as changed from one form to another. What starts life as electrical energy is turned into some other kind, usually heat, which is lost into the air. You can see the process at work in an ordinary electric light bulb, whose filament (a thin conductor) gets intensely hot.

There is a limit to the amount of current which any power source can safely deliver without either internal damage or (in the case of less severe overloads) shortening its life. For a miniature 9V pocket transistor radio battery this safe current may be only a few thousandths of an ampere, that is, a few milliamperes (1,000mA = 1A).

RESISTANCE

We need some means of restricting and adjusting the current we draw from our battery. This is the job of resistance.

In the pioneering days of electrical research, Georg Simon Ohm found that some materials conducted currents less efficiently than others. Long wires were worse than short ones. Thin wires were worse than thick ones. Iron wires were worse than copper ones. By selecting the length, thickness and material of a wire the amount of current could be adjusted.

Looked at another way, some conductors offer more resistance to current flow than others. More battery voltage is needed to push the same amount of current through a high resistance than through a low one.

RESISTORS

Metal wires were originally used to produce resistance, or, as we'd say now, to make a resistor. For a high resistance a long length of wire was needed. To pack this into a reasonable space often two parallel rows of nails were driven into a wooden baseboard (Fig. 1.1) and the wire threaded through them zigzag fashion.

Nowadays, we are fortunate in being able to buy, for a few pence each, compact resistors in the form of ceramic rods on which are deposited a resistive "track" in the form of a thin film of metal (for the

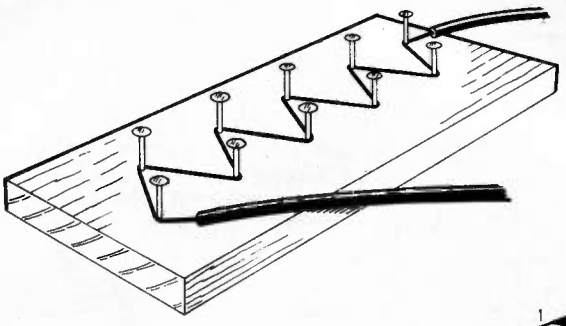


Fig. 1.1. A wire resistance on wooden board, with nails as supports.

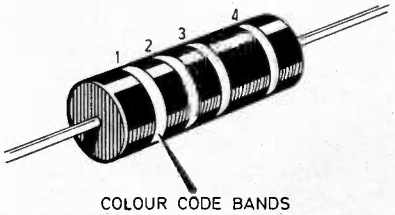
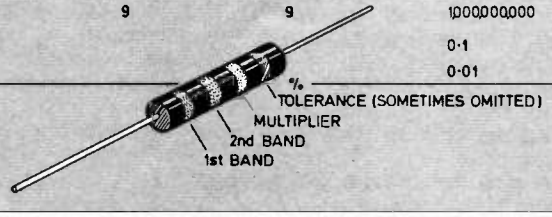


Fig. 1.2. Modern resistor with colour code bands.

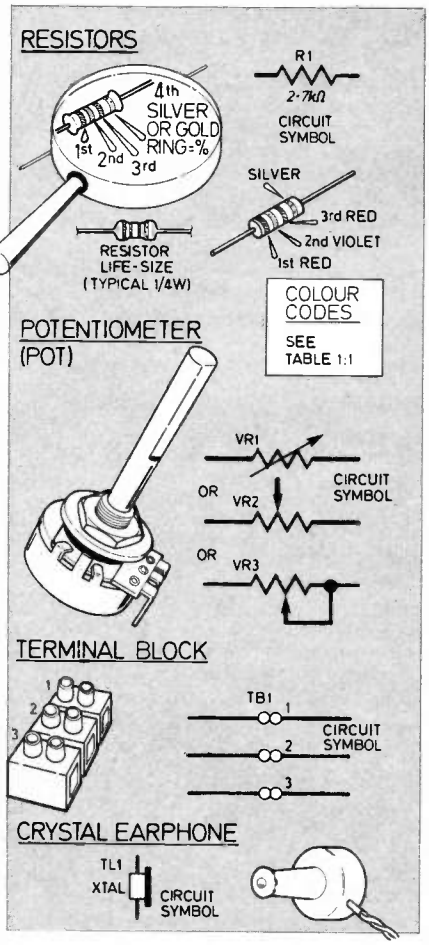
TABLE 1.1: RESISTOR COLOUR CODE

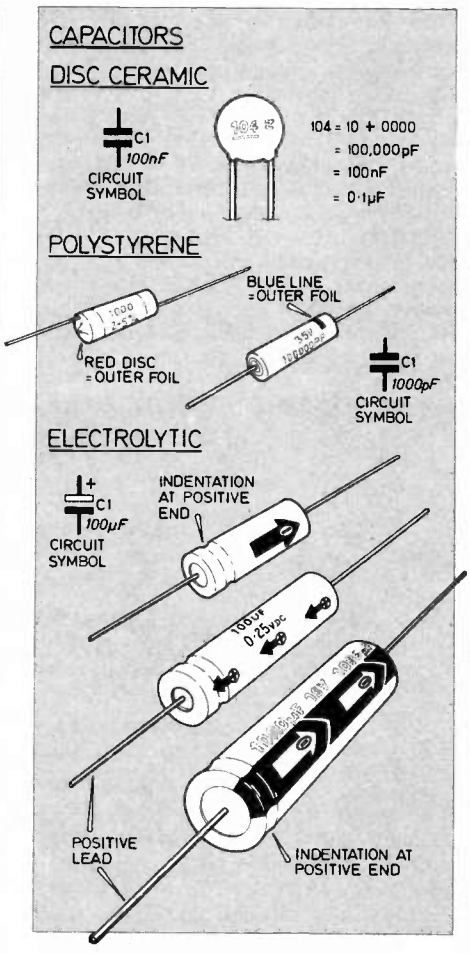
Band (ring) Colour	BAND 1 (1st Figure)	2 (2nd Figure)	3 (Multiplier)	4 (Tolerance %)
BLACK	0	0	–	–
BROWN	1	1	10	1
RED	2	2	100	2
ORANGE	3	3	1,000	3
YELLOW	4	4	10,000	4
GREEN	5	5	100,000	–
BLUE	6	6	1,000,000	–
VIOLET	7	7	10,000,000	–
GREY	8	8	100,000,000	–
WHITE	9	9	1,000,000,000	–
GOLD			0·1	5
SILVER			0·01	10

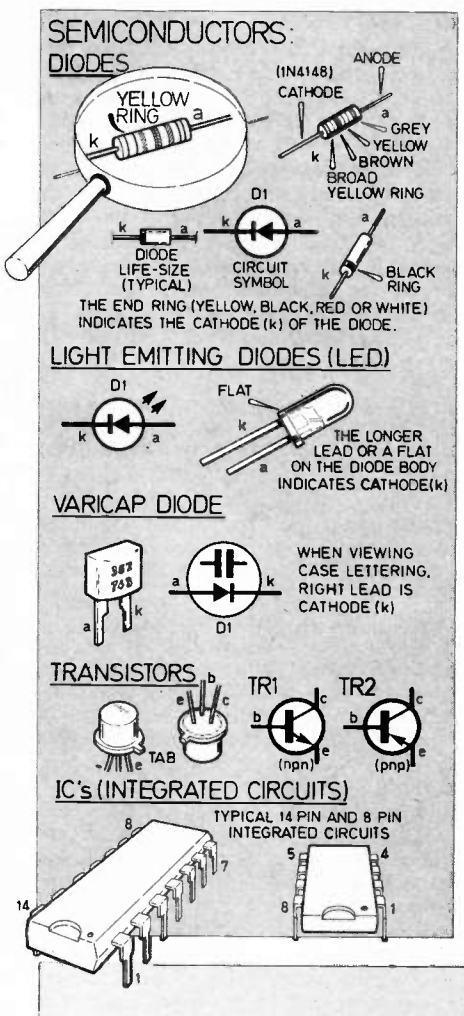


Examples:

① BAND	COLOUR			② BAND	COLOUR	
1	RED	2		1	ORANGE	
2	VIOLET	7		2	ORANGE	
3	YELLOW	×10,000	= 270,000 OHMS OR 270kΩ	3	RED	= 3·3kΩ
4	GOLD	±5%	±5% TOLERANCE	ABSENCE OF BAND 4 = ±20% TOLERANCE		







lower resistances) or carbon (for the higher ones) (Fig. 1.2).

The standard range begins at 1 ohm and extends upwards to 10 million ohms (ten megohms, 10M).

Interesting to note the original zigzag is still used as the symbol for resistance on circuit diagrams. You may come across an alternative symbol, a thin rectangle, in certain publications.

COLOUR CODE

The carbon or metal-film resistance track is insulated by a layer of special paint which gives the resistor its body colour. The electrical value of the resistance (the number of ohms) is usually indicated by an additional colour code. Bands of colour are printed round the body near one end, see Table 1.1.

The first two bands indicate the first two figures of the resistance value. This means that they can stand for anything between "1" and "99". Example: Red means "2". If the first two bands from the end of the body are both red, the resistance begins with 22.

The next colour tells you if there are any noughts after the 22. For example, since red means "2", if the third band is also red this means that two noughts must be added. So the resistance value is 2,200 ohms.

On diagrams this may be written 2,200Ω, 2·2k, or 2k2. Here the Greek capital letter omega (Ω) is the standard symbol for ohms, and k means 1,000 ohms (1 kilohm).

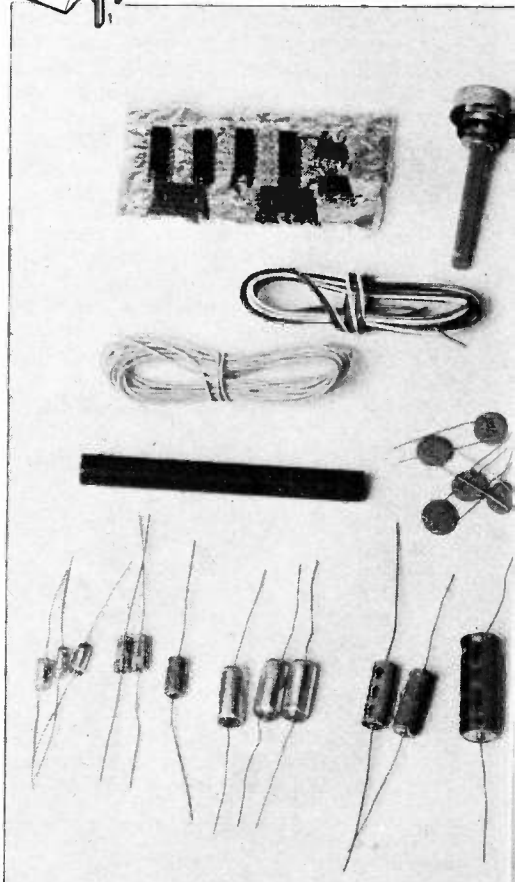
What if no noughts need be added? In this case, the third band is black, which means zero—thus zero noughts. So a 22-ohm resistor is coded red, red, black. On diagrams this is written 22Ω or 22R.

TOLERANCE

There is a fourth coloured band. This tells you how accurate the resistance value is. Precision is expensive. Fortunately, most circuits will work with resistances which vary from the chosen

Table 1.2

TERM	SYMBOL	MULTIPLIER	POWER
GIGA	G	1,000,000,000	10^9
MEG	M	1,000,000	10^6
KIL	k	1,000	10^3
MILLI	m	0·001	10^{-3}
MICRO	μ	0·000001	10^{-6}
NANO	n	0·000000001	10^{-9}
FEMTO	f	0·000000000000001	10^{-15}



value, so long as they don't vary too much.

The permitted amount of variation in value for a given type of resistor is called the tolerance, and is given as a percentage variation from the nominal value.

The Table 1.1 gives the complete colour code. It will seem awkward at first but you'll soon get used to it. The great practical advantage is that since the bands go right round the body of a resistor it is always possible to see them. A printed number (which is also sometimes used) can be obscured if it is facing the breadboard rather than the outside world.

Fig. 1.3. Outline drawings of the component types included in the Teach-In 84 Kit. Characteristic markings indicating values and polarity of lead-out wires are given; also circuit symbols.

This photo shows the full kit of components for Teach-In 84. *Starting top left:* integrated circuits ('chips') (6) and holders (2) all mounted on conductive foam, potentiometers (2), crystal earphone;

Connecting wire, 12-way terminal blocks (2), ferrite aerial rod, disc ceramic capacitors (5), light-emitting diodes (3), varicap diodes (1 dual), signal diodes (4), transistors (5 + 5);

Capacitors: 1µF polystyrene (3), 10µF electrolytic (2), 2·2µF electrolytic (1), 10nF polystyrene (3), 100µF electrolytic (2), 1,000µF electrolytic (1), Resistors (100).

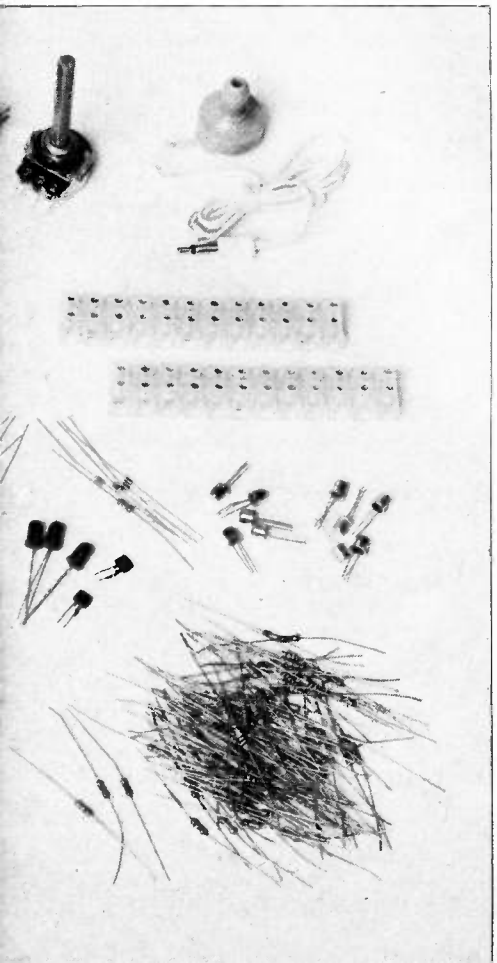


TABLE 1.3

Components required for experiments during the 12 Parts of *Teach-In 84*.

Complete kits for all these items may be obtained from retailers advertising in this magazine, see list on page 638.

RESISTORS

Quantity	*Value*	*Quantity*	*Value*
10	100Ω	10	33kΩ
10	330Ω	10	100kΩ
10	1kΩ	10	330kΩ
10	3·3kΩ	10	1MΩ
10	10kΩ	10	10MΩ

All are carbon film-type resistors, 5% tolerance, $\frac{1}{3}$ or $\frac{1}{4}$ watt rating

POTENTIOMETERS

Quantity	*Value*
2	10kΩ

Log. law carbon track, plastic shaft 6mm (dia.) × 50mm (approx.)

CAPACITORS

Quantity	*Value*	
1	1000µF	Electrolytic type;
2	100µF	16V or 25V rating.
2	10µF	Very large types (higher
1	2·2µF	voltage ratings) are NOT suitable.
5	100nF	disc ceramic
3	10nF	polystyrene
3	1nF	polystyrene

Electrolytic and polystyrene capacitors should have axial leads. All wire leads should be about $1\frac{1}{2}$in long; short lead-out wires are NOT suitable.

DIODES

Quantity	*Type*	
4	1N4148	silicon signal diode
1	KV1236	dual varicap diode
3	—	light emitting diode (l.e.d.) 5mm, red

TRANSISTORS

Quantity	*Type*	
5	BC107B	high gain *npn* transistor (suitable alternatives: BC108B, BC108C, BC109)
5	BC179	high gain *pnp* transistor (suitable alternatives: BC177B, BC178B or C)

Both types are encased in metal cans (TO18) and base connection is the centre lead.

INTEGRATED CIRCUITS

Quantity	*Type*	
2	CA3140E	MOSFET op-amp 8-pin d.i.l.
2	4069UB	hex inverter 14-pin d.i.l.
2	4001UB	dual 2-input NOR gate 14-pin d.i.l.

SUNDRIES

Quantity	*Description*
1	Ferrite aerial rod 9·5mm ($\frac{3}{8}$in) dia., 100mm (4in) long
2	14-pin dual-in-line (d.i.l.) holders
1	Crystal earphone
2	12-way 2-amp terminal block, polythene.
	Connecting wire, plastic insulated, single strand (0·6mm):
3	Three pieces, different colours, each 1 metre in length
1	One piece (of another colour) 2 metres in length for coil winding.

EBBO BREADBOARD MODULES

Quantity	*Type*
1	Basic Discrete Component Starter Pack
1	Basic Integrated Circuit Starter Pack

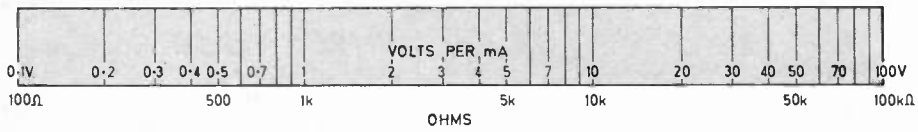


Fig. 1.4. Chart showing the voltage needed to drive 1mA through resistances from 100 ohms to 100 kilohms.

RESISTANCE, VOLTAGE, CURRENT

The resistance value can be described by saying how many volts are needed to drive a current through a resistance. If a current of one ampere (1A) is driven when 1V is applied the resistance is 1 ohm.

In electronics we are usually concerned with much smaller currents and much higher resistances. If 1V drives only 1mA the resistance is 1,000 ohms (1kΩ). A 1kΩ resistance (commonly in speech "one kay") requires 1V for every 1mA that flows through it. If 9V is applied to 1kΩ the current is 9mA. More voltage, more current.

The chart (Fig. 1.4) shows how many volts per milliampere for different resistances. To find out how many volts are needed to drive 1mA through a resistance you read off the voltage opposite the resistance value. Opposite 1k, for instance, is 1V. This means that 1V will drive 1mA through 1kΩ. For 5kΩ, on the other hand, 5V is needed for 1mA.

For currents other than 1mA you do a bit of simple arithmetic. Example: What voltage is needed to drive 5mA through 1kΩ? The chart says that 1V drives 1mA so for 5mA you need five times the voltage; that is, 5V. Current is proportional to voltage. To be more precise:

Current = Voltage ÷ Resistance

which is one way of stating Ohm's Law, the basic rule which governs all d.c. circuits and many a.c. ones.

EXPERIMENT 1.1

LIGHTING A LAMP

Light-emitting diodes (l.e.d.s) must never be connected directly across a battery. If they are so connected they either do nothing or draw an enormous current which destroys them.

In practice, l.e.d.s are lit from a power supply which delivers more voltage than they need; the excess voltage is "dropped" by including a resistance (Fig. 1.5) which also limits the current.

Suppose we decide to run a red l.e.d at the very modest current of 1mA, which is just about enough to make it glow dimly. Our battery is 9V. The chart Fig. 1.4 shows that 9V drives 1mA through 9kΩ. However, the l.e.d. absorbs about 2V, so the resistance R needs only to absorb the remaining 7V. The chart links 1mA and 7V to 7kΩ, and this is the required value for R.

Here the circuit designer is up against a practical problem. Cheap resistors are not usually made to a 7kΩ resistance. The nearest standard values are 6·8kΩ and 8·2kΩ. Clearly, 6·8kΩ will allow a little more than 1mA to flow and 8·2kΩ a little less. Since the l.e.d. can safely pass much more than 1mA (most l.e.d.s are run at around 10mA) we might opt for 6·8kΩ which is the closer standard value.

In fact, we are going to use 10kΩ which is a nice round value, which we'll need for later experiments. How much current will it pass in our circuit? Assuming that the l.e.d. still uses up 2V, we are in effect left with a reduced battery voltage of 7V. The chart shows that 10V drives 1mA through 10kΩ. Commonsense says that 7V will drive proportionately less current. Since 7V is 7/10 of 10V, the current will be 7/10 of 1mA, which is 0·7mA.

First make sure you connect your l.e.d. the right way round. Unlike resistors, which pass current equally well in either direction, l.e.d.s work only when the current flows in one particular direction.

A l.e.d. has a "current entry" lead, called the anode (a) and a "current exit" lead called the cathode (k). The anode must always face towards the positive terminal of the battery. This means that if you trace the circuit back from the anode against the direction of current flow you eventually arrive at battery positive.

The cathode lead-out of many l.e.d.s is indicated (none too clearly) by a small flat area near it on the plastic case. It is suggested that you mark the cathode black and the anode red, by slipping short lengths of plastic sleeving (stripped from connecting wire) over the appropriate lead-out wires.

METER ADAPTOR LEAD

To use the multimeter with the EBBO Blocks, an adaptor lead is required. This is easily made by cutting a 3-way section off from one 12-way terminal block, then connecting a piece of connecting wire about 12 inches long to each outer terminal.

These two leads (preferably one red and one blue or black) should be twisted together to within 2 or 3 inches of the ends. Remove the plastic insulation from the ends, leaving one inch bare as "probes" which will fit the holes on the EBBO blocks.

The multimeter probes are secured to the outer terminals of this block, their colours (red and black) corresponding to the colours of the wire leads already fitted. See photo.

COMPONENT BLOCK

Before actually fitting components into the EBBO block read carefully the instruction booklet that comes with the EBBO kit.

Connect up a 10kΩ resistor and l.e.d. using the *light blue* Discrete Component Block from the EBBO kit. Fig. 1.6 shows the physical arrangement which corresponds with the circuit in Fig. 1.5.

On the diagrams in this *Teach-In* series, letters and figures with circles round them refer to the labelling of the points on the EBBO blocks. If only a letter is given it means you can use any point in that row. But remember that the discrete component block has two separate areas of terminal points, the left-hand area is not connected to the right-hand area. Use one area only for this experiment, as shown in Fig. 1.7.

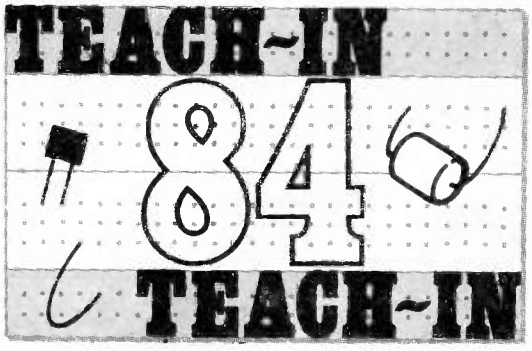
If component leads are dull and tarnished, brighten them up with a piece of Scotchbrite scouring material before inserting into the component block.

BATTERIES

The EBBO kit contains a battery holder which takes a miniature 9V pocket transistor battery. Rather than use the cheapest form (PP3) choose a calculator type battery which can deliver greater currents.

To use a PP3-type battery clip with the EBBO battery holder connect its red (+) lead to C(+) and its black one to C(–). You can now connect the battery to the block by plugging leads into the spare positions on the holder, (+) to row A on the block and (–) to row G, see Fig. 1.7.

If all your connections and the polarity of the l.e.d. are correct the l.e.d. will glow dimly enough to be seen in a room that



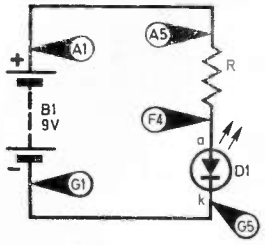


Fig. 1.5. Theoretical circuit diagram for light-emitting diode (l.e.d.) D1 with current-limiting resistance R. (Encircled letters and numbers refer to holes on component block.)

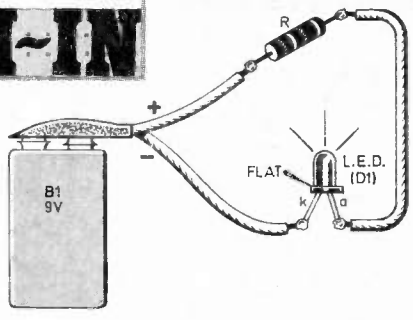


Fig. 1.6. A graphic representation of Fig. 1.4.

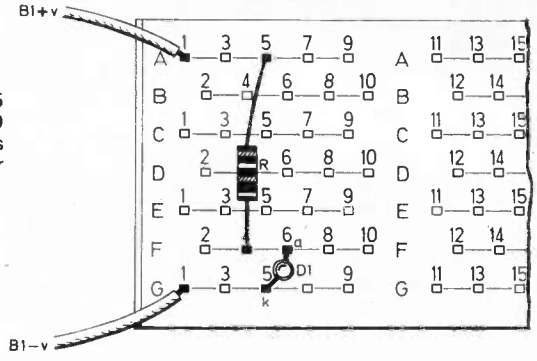
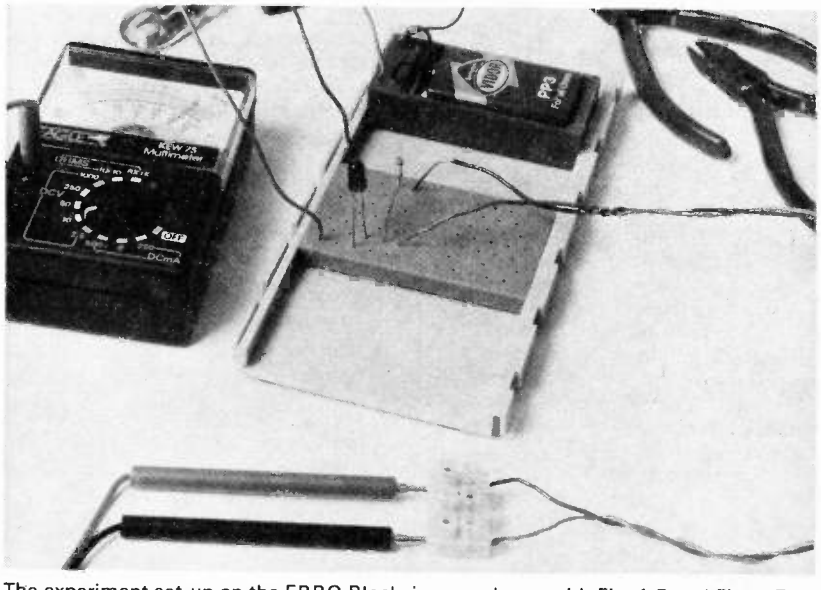


Fig. 1.7. The circuit of Fig. 1.5 assembled on the EBBO Block. The two left-hand leads go to the battery holder module. (See photos)



The experiment set-up on the EBBO Block, in accordance with Fig. 1.5 and Fig. 1.7.

CHECK YOUR PROGRESS

Questions on *Teach-In 84 Part 1*

Q1.1 What resistance values and tolerances are indicated by these codes?

a. orange, orange, brown, brown
b. brown, black, yellow, gold
c. red, violet, orange, gold
d. green, blue, green, red
e. brown, black, gold, gold
f. yellow, violet, gold, gold

Q1.2. Resistance, voltage and current are related. Fill in the missing one:

a. 10V, 10kΩ, (?)
b. 10V, 10mA, (?)
c. 5mA, 2kΩ, (?)

Q1.3 A l.e.d. is to be run at 10mA from a 12V battery. If its running voltage is 2V what resistance is required to set the current?

Answers next month

isn't brightly lit. Once you have got it working, you can brighten it up by replacing the 10kΩ with a 1kΩ.

However, before doing so, set your test meter to 10V d.c. and measure the voltages as indicated in Fig. 1.8. Note what they are and repeat using 1kΩ instead of 10kΩ for R.

Do not attempt any more measurements. Leave your meter on the 10V range and switch off the circuit by unplugging the positive battery connection.

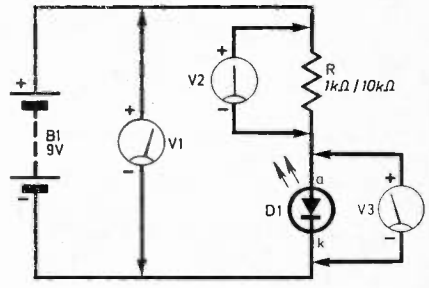


Fig. 1.8. Showing where to connect a 10V d.c. meter to measure three different voltages in the circuit.

Next month: Batteries and Resistors

MODEL CAR 'PETROL TANK'

BY A.P. DONLEAVY

TO ADD another hurdle to the competitive aspect of model car racing, each car can be given a petrol tank which is emptied at a rate depending on the speed of the car. With an empty tank, the car comes to a stop until the tank is refilled, which takes a certain amount of time.

A "petrol gauge" gives the state of the tank and the "tank" is in fact, a capacitor. The fuel gauge consists of a l.e.d. which changes colour from green to red as the tank empties.

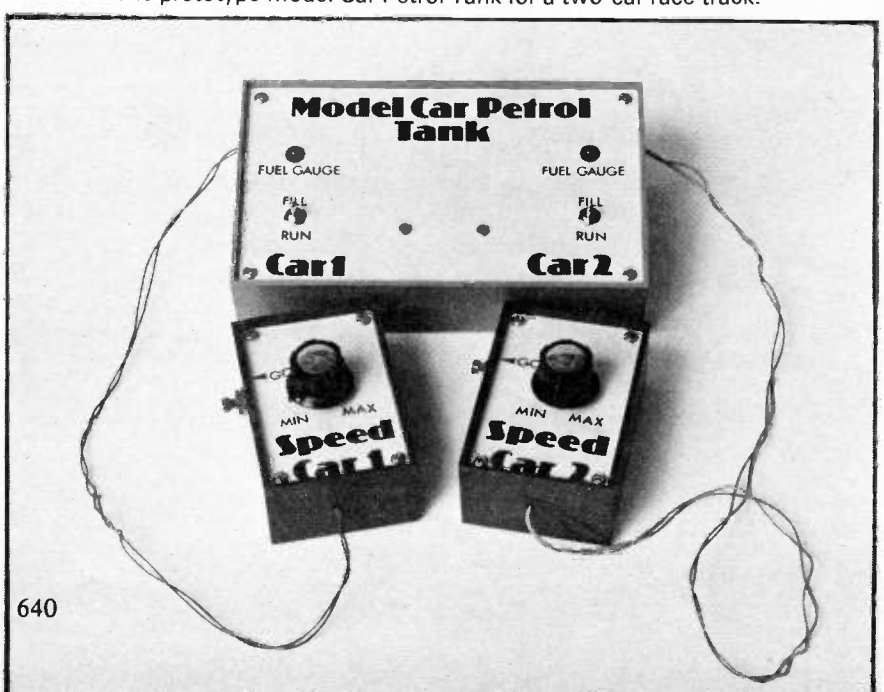
CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. There is an identical circuit for each track so only the circuit for one track is drawn. The numbers in brackets next to IC2 inputs give the corresponding i.c. pin connections for the other channel and all duplicated component references are prefixed by 100.

The "tank" is represented by C1, which is full when the capacitor is discharged. The charging up of this capacitor through R3 and IC1, an adjustable current source, represents the emptying of the tank. The current to charge the capacitor is governed by IC1, which in turn depends on the series resistance of R2 and VR1. For a given value of R2 and VR1, the current remains constant even though the voltage across the terminals of IC1 changes as the capacitor charges.

The current flowing to C1 causes a volt drop across R3. This voltage is applied to the non-inverting (+ve) input of IC2a (Pin 3). IC2 consists of four operational amplifiers, all of which are used in this project.

The prototype Model Car Petrol Tank for a two-car race track.



The output (Pin 1) of op-amp IC2a is connected directly to the inverting input. This gives it unity gain, that is the output voltage follows the input voltage at the non-inverting terminal.

The output of this op-amp is connected via R4 to the base of TR1, the emitter of which is connected to the base of TR2. It is the collector TR2 which provides the drive current for the racing car. The available current to drive the car from TR2 will depend on the output voltage at Pin 1 of IC2a and the value of R4. The speed of the car depends on the current supplied by TR2.

OPERATION

The operation of the unit is then as follows: the capacitor C1, initially discharged, is charged up by the current which is adjusted by the setting of VR1. R2 limits the maximum current. The higher the current, the higher the voltage drop across R3, thus the higher the voltage at the output of IC2a, and the higher the current from TR2, hence the faster the car travels.

The voltage at the v+ terminal of IC1 continually falls as C1 charges until it comes to a point where the voltage at the v+ terminal is insufficient to allow the correct functioning of IC1 (about 1V). At this point the current starts dropping, and also the voltage across R3. This in turn leads to a reducing current from TR1 and TR2.

Another limiting factor is that unless the voltage at Pin 1 IC2a is at least equal to the two base-emitter voltage drops of TR1 and TR2 (about 1·4V), these transistors will not be turned on. Hence even though IC1 is functioning at 1·4V, the output transistors would cease to pass any current, thus stopping the racing car.

In practice, what happens is that at maximum speed the voltage at Pin 3 is about 3V. This maximum speed can be maintained until the voltage at IC1 v+ has dropped to about 4V, after which the current through R3 starts dropping, leading to a continuously reducing current from TR2, until it eventually becomes zero.

To refill the tank, S2 switches R1 to C1 and discharges it at a rate determined by R1. During this refill period, no current flows through R3, so Pin 3 is at ground potential and the car is stopped.

In the normal operation, S1 must be closed, otherwise IC1 sees an infinite resistance between Pin's R and V−, and passes negligible current. S1 is included to allow a sudden stop without needing to adjust the potentiometer VR1.

The petrol consumption will continue to occur whether or not the car is on the track, so the inclusion of S1 is a petrol saving device to allow for the frequently occurring situation of the cars coming off the tracks.

FUEL GAUGE

The "fuel gauge" is contained in the circuitry of IC2b, TR3, TR4 and D1. D1 contains two l.e.d.s, one red and one green in a single package, connected by a common anode. By varying the currents individually through the l.e.d.s it is possible to change the colour of the display from red to orange (or yellow) to green.

The state of the tank is represented by the voltage across the terminals of the capacitor C1. The voltage of the negative terminal of C1 is measured by op-amp IC2b, also connected as a unity gains voltage follower. In the tank's full state, the voltage at Pin 5 IC2b will be at almost supply potential. The output (Pin 7) will also be at this potential, thus TR4 will be turned on, and the green diode in D1 will be alight. R6 controls the maximum current passed by TR4.

TR3 will be turned off, so the overall display colour will be green. As the tank empties, the voltage at Pin 5 and hence Pin 7 of IC2b will drop. At some point current will start to flow through TR3, thus turning the red half of D1. As the voltage continues to decrease, the red will get brighter and the green will become extinguished.

When both l.e.d.s are alight, the display will be various shades of orange depending on the currents through each. D2, a green l.e.d. is included to allow the base voltage of TR4 to rise to about 3V before it starts to pass any current. The high forward voltage drop of the diode achieves this. Thus the display colour gives an indication of the charge on the capacitor, that is the state of the tank.

D3 and C2 are intended to protect the supply to the circuitry from the noise generated by the cars and to smooth the rectified AC mains supply. More will be said about the power supply later.

PRACTICAL ASPECTS

The circuit and component values in Fig. 1 were designed round a 6V racing track. To optimise the performance of the unit for any particular racetrack the constructor must expect to do some experimentation, and if necessary modify some of the component values.

R4 sets the maximum current available from TR2 and this must be chosen to suit the maximum current required by the car. Measure the current for maximum speed using the track's own controller, then by trial and error, find the value of R4, which will give this same output current.

It may well be found that a different value will be required for each track, since the combined gains of TR1 and TR2 will probably be different for each channel. The value of R4 will be between 100 kilohms and 330 kilohms.

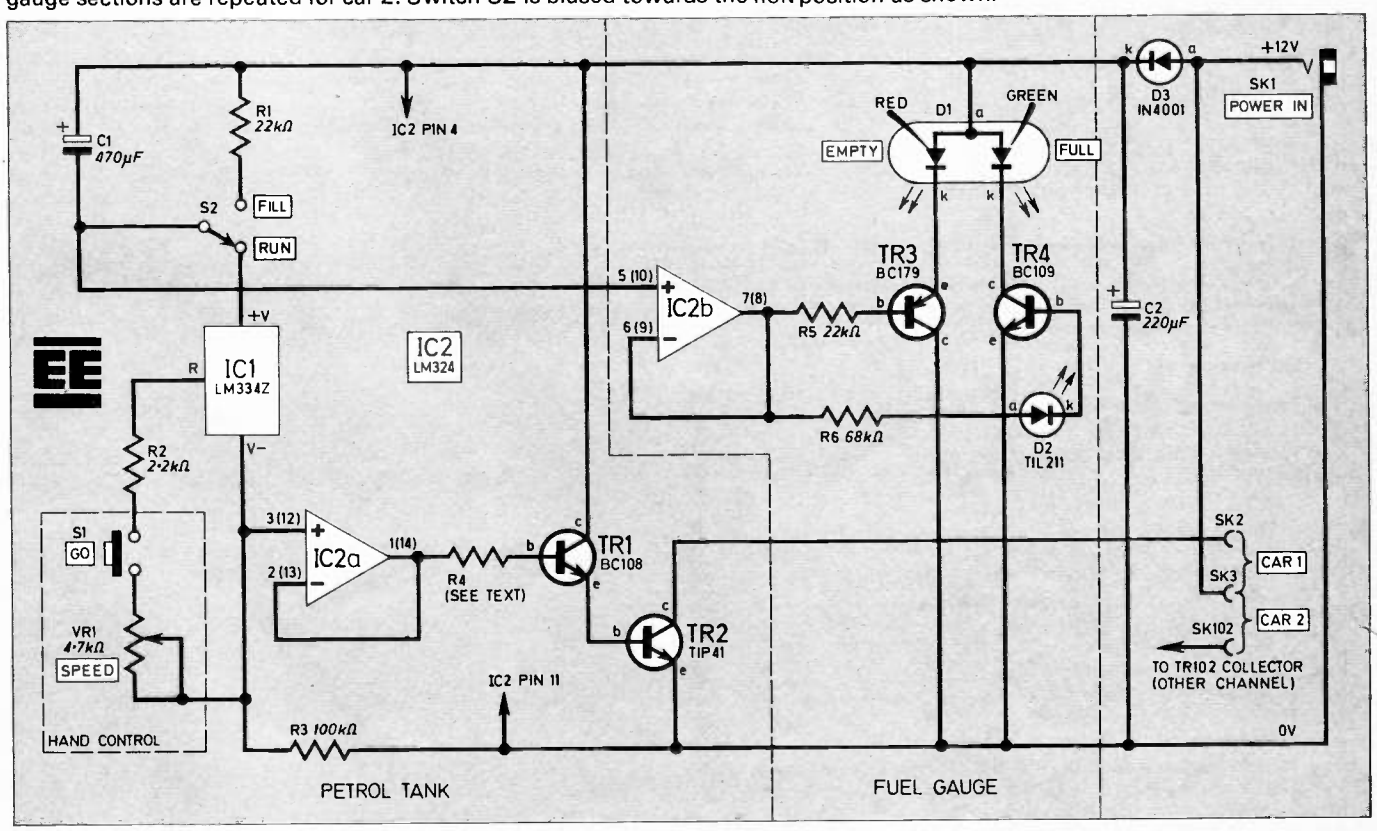
For the gauge circuitry, the values of R5 and R6 determine the calibration of the fuel gauge. For constructors who wish to be fairly exact about this, choose R6 so that the green l.e.d. gives negligible light at about 3V on Pin 7 of IC2b.

POWER SUPPLY

The circuitry, except for the output transistors, is designed to operate on a supply voltage between 9V and 12V. It could operate on less, but this would reduce the tank capacity. The current delivered by the output transistor TR2 will be approximately the same irrespective of supply voltage.

However, it will only supply the maximum current to the car if the supply voltage is equal to, or greater than, the normal operating voltage for the car. It is

Fig. 1. Circuit diagram of the Model Car Petrol Tank. Only one channel is shown and the hand control, petrol tank and fuel gauge sections are repeated for car 2. Switch S2 is biased towards the RUN position as shown.



envisaged that the existing power supply of the racetrack is to be used and the various different power supplies are as follows:

1 12V d.c. rectified mains supply—this is the simplest case, and may be connected directly to the unit as shown in the circuit diagram.

2 9V battery or rectified d.c. from a mains unit—again may be connected directly to the circuit. If the tank runs dry too quickly, this can be compensated for by either increasing the value of C1, or by reducing the value of R4 which in turn will require the setting of VR1 to be altered to compensate for the speed. This reduces the charging rate of the capacitor but leaves open the possibility of overloading the car.

3 Battery or d.c. rectified supply from a mains unit of less than 9V—in this case it may be necessary to provide a separate power supply for the circuitry of IC2, TR1, TR3 and TR4 by a 9V battery or a calculator adaptor, connected by a common ground to the other supply. Fig. 2 shows the circuit for this.

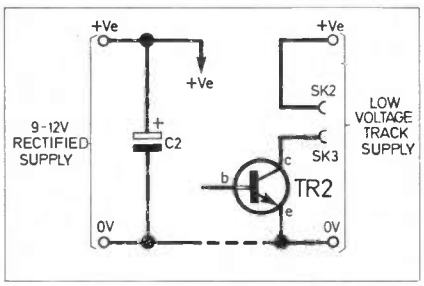


Fig. 2. Power supply modification for low voltage tracks. Note common 0V.

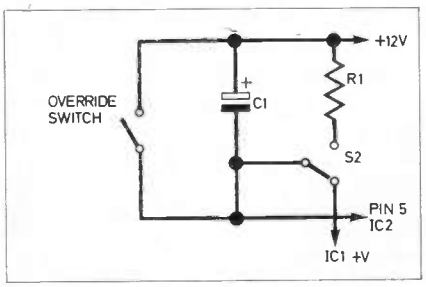


Fig. 3. Additional override switch.

COMPONENTS

Almost any small signal *npn* transistors could be used for TR1 and TR4 and similarly other small signal *pnp* transistors for TR3. For TR2, other high current *npn* types could also be used. A heatsink must be fitted.

The prototype used 2·5mm banana sockets and plugs to connect track to control box. A 2·5mm jack plug and socket was used to connect the power supply to the control box.

If at any time it is required to override the tank circuitry and run the car continuously, the addition of an extra switch to connect the v+ input of IC1 to the positive supply will achieve this. Fig. 3 shows the circuit for this. The prototype did not have this facility.

COMPONENTS

See Shop Talk page 629

Resistors

R1,101	22kΩ (2 off)
R2,102	2·2kΩ (2 off)
R3,103	100kΩ (2 off)
R4,104	see text
R5,105	22kΩ (2 off)
R6,106	68kΩ (2 off)

All ¼W carbon ±5%

Capacitors

C1,101	470µF 16V elect. (2 off)
C2	220µF 16V elect.

Semiconductors

D1,101	tri-colour common anode l.e.d. (2 off)
D2,102	TIL211 green l.e.d. (2 off)
D3	1N4001 silicon
TR1,101	BC108 *npn* silicon (2 off)
TR2,102	TIP41 *npn* silicon (2 off)
TR3,103	BC179 *pnp* silicon (2 off)
TR4,104	BC109 *npn* silicon (2 off)
IC1,101	LM334 adjustable current source (2 off)
IC2	LM324 quad op-amp

Potentiometers

VR1,101	4·7kΩ carbon lin (2 off)

Miscellaneous

S1,101	push-to-make momentary action (2 off)
S2,102	s.p.d.t. biased toggle (2 off)
SK1	2·5mm mono jack
SK2	2·5mm banana red
SK3	2·5mm banana black
SK102	2·5mm banana green

0·1in matrix stripboard, 29 strips by 33 holes; console type case, 100 x 160 x 40 (front) x 60mm (rear); hand-held case, 85 x 55 x 35mm (2 off for hand controls); 2·5mm banana plug (3 off); control knob (2 off); l.e.d. clip (2 off); 14-pin i.c. holder; TO220 type heatsink (2 off); 7/0·2mm wire; mounting hardware; Veropins.

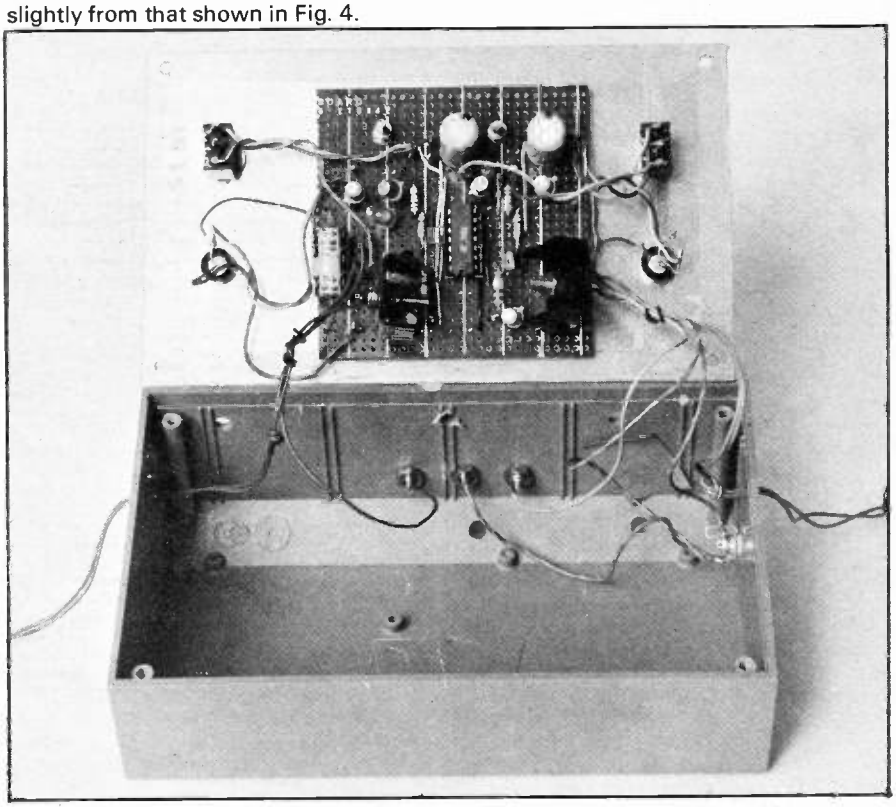
CIRCUIT BOARD

The main part of the circuit is constructed on a piece of 0·1in matrix stripboard, the layout of which is shown in Fig. 4. The underside view shows all track-breaks. When assembled, the board is secured to the lid of the case using four screws with short spacers to prevent the solder joints shorting on the lid.

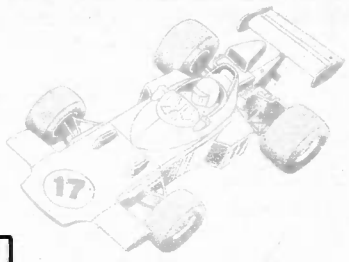
The two l.e.d.s, D2 and D102, are soldered directly to the board as their function in the circuit does not require them to be seen. Note that R4 (and R104) is soldered to a pair of Veropins to facilitate the select-on-test procedure.

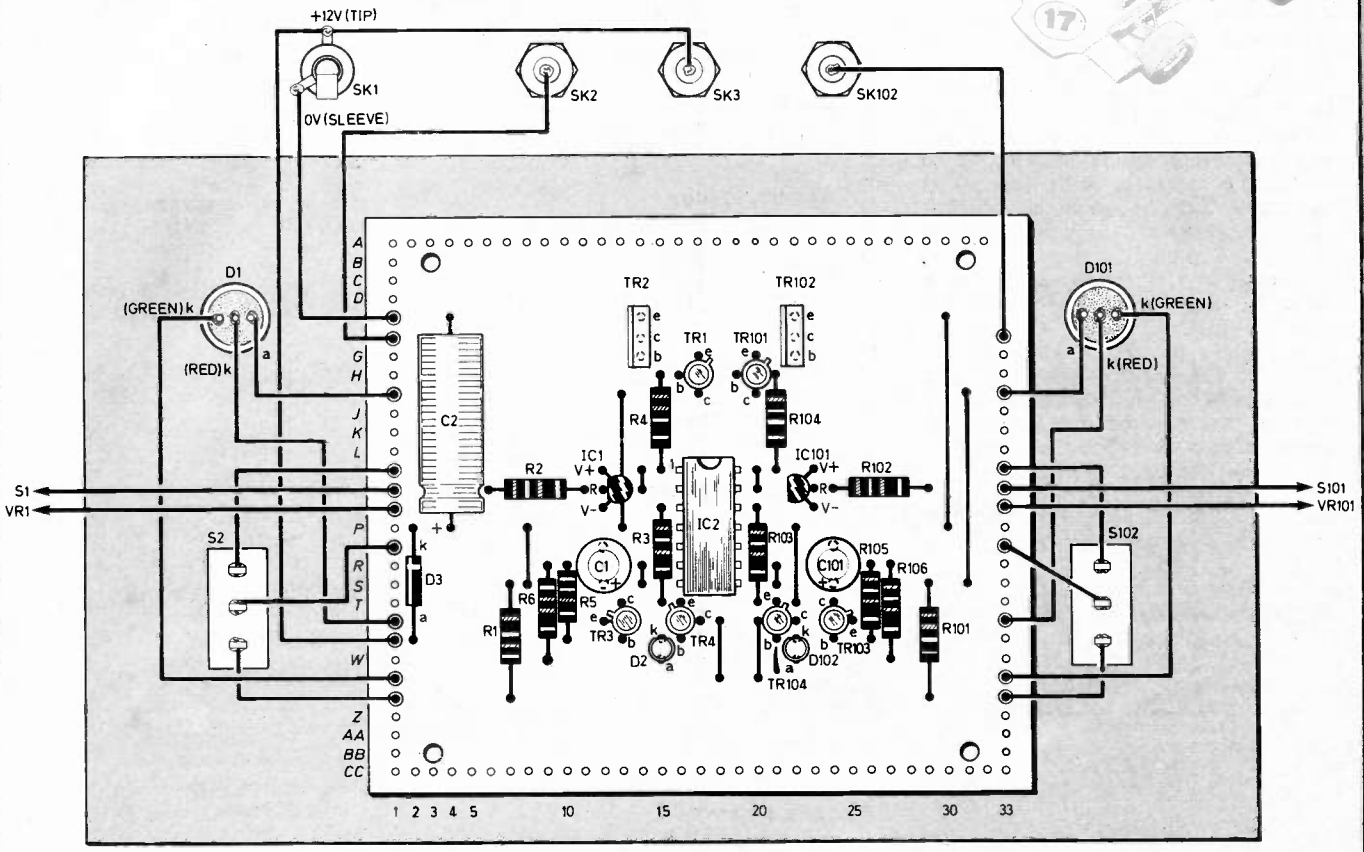
Transistors TR2 and TR102 are fitted with heatsinks as these components get quite warm. Any heatsink suited to a TO-220 type package will suffice. All usual precautions to be taken when inserting semiconductor and polarised capacitors and all wired connections to be taken to Veropins.

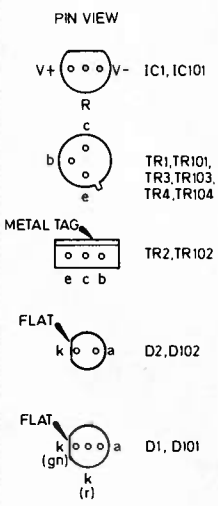
View inside the console case showing the heatsinks on the power transistors. Note that this unit was constructed on Vero V-Q board and therefore the layout differs slightly from that shown in Fig. 4.

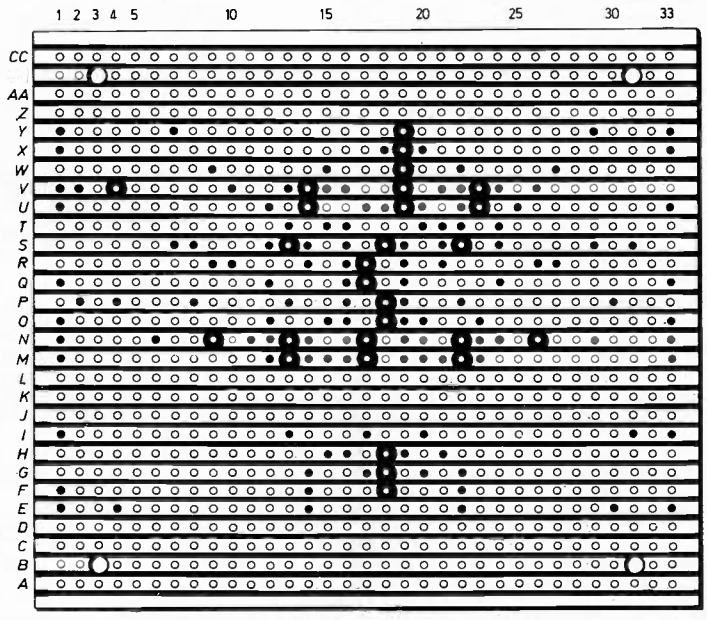


MODEL CAR *'PETROL TANK'*









COMPONENTS approximate cost £14 excluding cases

Fig. 4. Stripboard layout for both channels of the Model Car Petrol Tank. Note that the TO-220 type heatsinks for TR2 and TR102 are not shown but must be securely fixed to the metal tabs of these transistors.

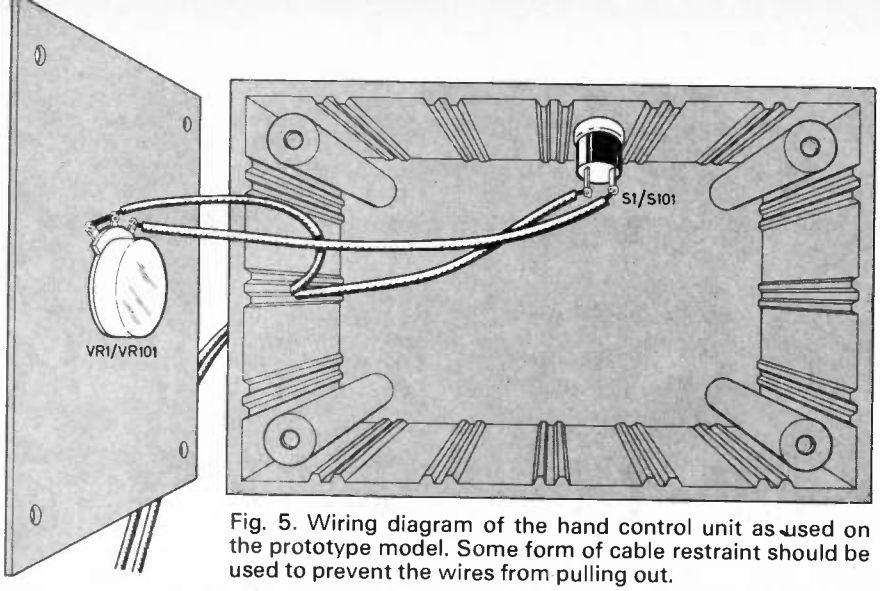


Fig. 5. Wiring diagram of the hand control unit as used on the prototype model. Some form of cable restraint should be used to prevent the wires from pulling out.

HAND CONTROLS

The GO switch S1, and the SPEED control VR1, are mounted into a hand-held box (one for each channel) connected to the control box by a suitable length of twin cored wire. The prototype model uses two small square cases, 85 × 55 × 35mm, but the constructor may wish to use a purpose built hand-held box such as the Vero type 202-21026G with a thumb wheel potentiometer of the type available from Maplin (part number *BW06G Edge Control* with part number *BW09K Edge Knob)*. See Fig. 5 for layout.

The unit is housed in a console case with a 157 × 92mm front panel. The FUEL GAUGE l.e.d.s (D1 and D101) and the FILL/RUN switches (S2 and S102) are mounted on the front panel either side of the circuit board assembly.

The 2·5mm banana sockets to the track and the power input jack socket are mounted in the back and side wall of the case, respectively. Two small holes allow for the wires to the hand controls and some form of strain relief must be used to prevent these wires pulling out. A ratchet type cable tie is ideal.

Some additional ventilation holes are required in the back of the case as the power transistors generate some heat.

TROUBLE SHOOTING

The operation of the unit can be tested without connecting it to the track. If the unit appears completely dead, then check the polarity of the incoming power supply connections. Also check that diode D1 is correctly inserted.

If the operation of VR1 does not regulate the speed of the car, or the car does not work at all, then check the voltage at the base of TR1; this should be about 1·4V. Check also that the voltage at Pin 1 of IC2 (or Pin 14 for the other track) varies with the setting of VR1 (S1 closed) with the tank at least partially full. If it does, then either TR1 or TR2 must be suspect.

If the voltage at Pin 1 does not vary with VR1 (S1 closed) check to see if the voltage at Pin 3 (or 12) varies with VR1. If it does then IC2 is faulty, assuming it has been correctly wired.

To investigate any malfunctions of the fuel gauge, check that the voltage at Pin 5 (or 10) follows that of the negative terminal of C1, thus eliminating a wiring error. Then check that the output Pin 7 (or 8) also follows this voltage. If not then IC2b may be faulty, or else the Pin's 6 and 7 (or 8 and 9) are incorrectly wired, possibly shorted to another track. If IC2b is functioning correctly, then any fault in the fuel gauge operation will lie either in D1 being faulty or incorrectly wired.

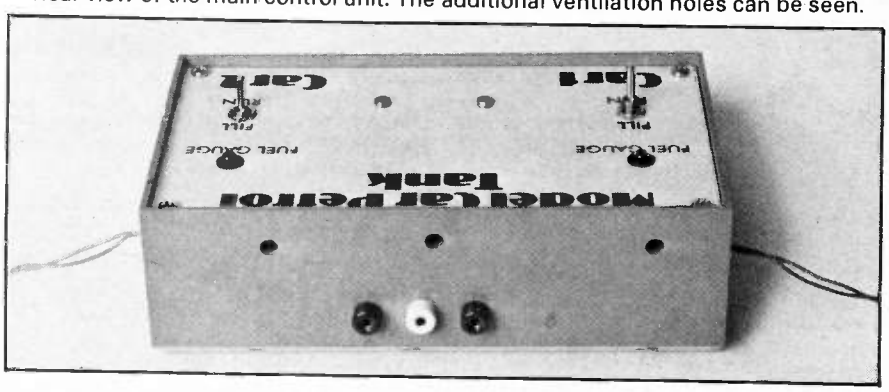
IN USE

The existing speed controllers are not needed, as the speed is now controlled by VR1. The hand control is held in one hand while depressing switch S1, and the speed regulated with VR1 using the other hand.

Should a collision occur or a car leave the track, the petrol consumption will automatically stop if S1 is released while rectifying the situation on the track. When the fuel tank indicator shows red, the tank may be filled by switching S2 to FILL, until the l.e.d. is green, or for how long the driver considers necessary to finish the race.

If the constructor finds the tank empties too quickly or too slowly, then increase or decrease the value of C1. If the tank refilling time is too long or too short, increase or decrease the value of R1, respectively. □

Rear view of the main control unit. The additional ventilation holes can be seen.



PLEASE TAKE NOTE

Car Intruder Alarm *(August 1983)*

The circuit diagram (Fig. 1, page 520) shows the positive side of the car battery connected via the ignition switch. This has been drawn incorrectly and no connection to the ignition is required.

The circuit diagram also shows the transistor TR1 connected straight to the car horn. TR1 is insufficient to drive the car horn and an automobile relay should be placed in the circuit to switch the horn.

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FIRST PRIZE	The Sedac Trophy and £300	Plus a selection of components valued at £200
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NINE RUNNERS-UP. A selection of components valued at £100.

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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

TEMPERATURE TRANSDUCER AMPLIFIER

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

THIS article describes the construction and use of a simple Temperature Transducer Amplifier that provides an output voltage directly proportional to the temperature of the sensor in Celsius. The temperature range capability of the sensor is from −55 to +150 degrees Celsius.

This unit has been specifically designed for use in the laboratory where it is to be connected to a computer via an A-to-D converter to automatically read, store, calculate and graphically display the results from heat experiments in the physics and chemistry laboratories. See *Computer Aided Experiments*, page 674.

However, it is not restricted to such applications and could be connected to a voltmeter (suitably labelled) to give the temperature reading of say a person's body temperature, room or greenhouse temperature and many other environments, on a Fahrenheit, Celsius or Kelvin scale.

TEMPERATURE SENSOR

The circuitry has been designed around the 590kH temperature transducer, IC1.

The temperature transducer itself is a high impedance current source producing a current proportional to the absolute temperature, 1μA per Kelvin rise in temperature. The temperature range of this sensor is from −55 to 150 degrees Celsius maximum, being linear to within 0·8°C over this range.

The fact that this is a high impedance current source makes the device ideal for remote temperature sensing, since it is virtually insensitive to voltage drops over long lines.

The simplest configuration for the sensor is in series with a resistor R, as shown in Fig. 1. The 1μA per Kelvin is then transformed to a p.d. per Kelvin across the resistor R. So that if R = 10 kilohms, the p.d. across it is 0·01 volts per Kelvin. Therefore, on the Kelvin temperature scale, 273 Kelvin produces 2·73 volts across the resistor; 273 Kelvin is equivalent to 0 degree C on the Celsius scale, that is, at the temperature of melting ice.

Since most people are more at home with the Celsius scale, it is better to produce an output per degree Celsius rather than per Kelvin. This is done using the arrangement of potentiometers shown in Fig. 2. VR1 provides, after adjustment, the voltage needed to convert from Kelvin to degree Celsius, that is, −2·73 volts, while VR2 zeros the transducer output at the "ice point", that is, 0 degrees C, the temperature of melting ice. The complete arrangement produces an output of 0·01 volts per degree C suitable for feeding into the non-inverting input of an op-amp.

THE AMPLIFIER

The complete circuit diagram of the amplifier is shown in Fig. 3.

IC2, a 741 op-amp is configured in the non-

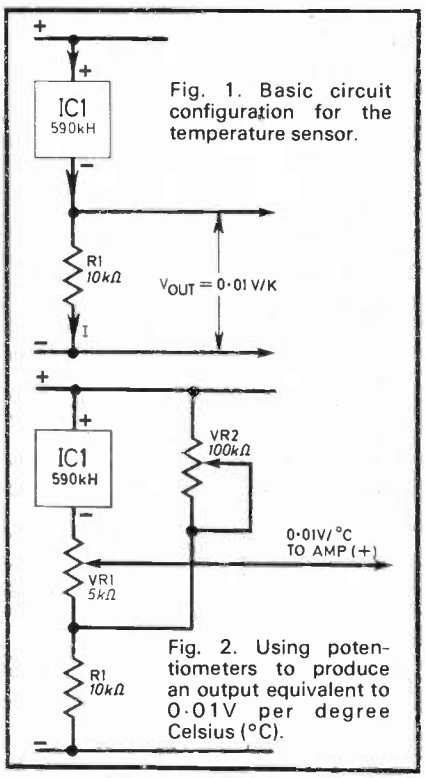
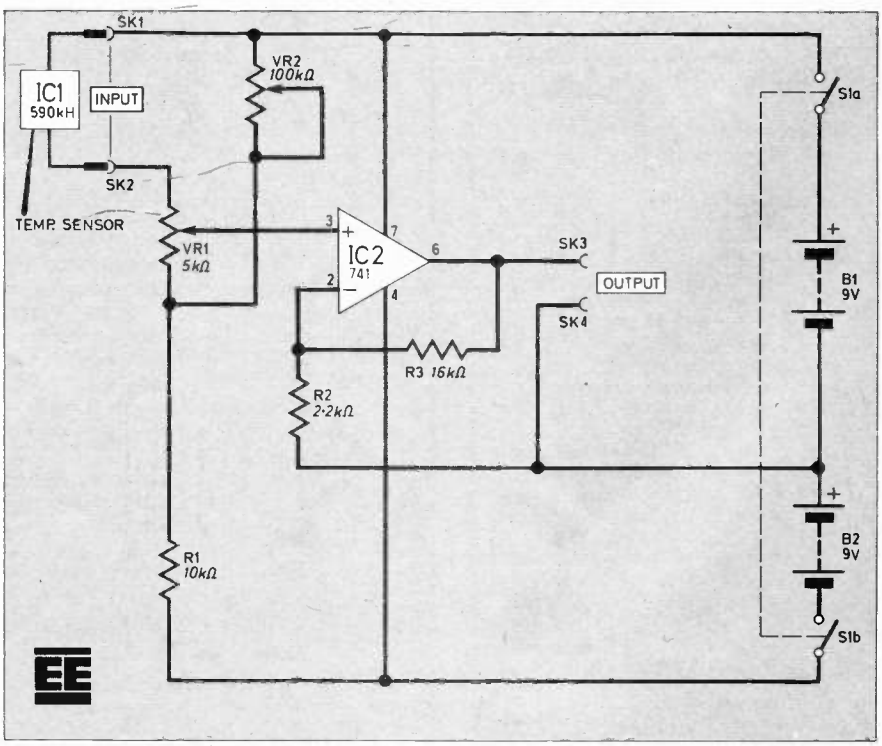


Fig. 1. Basic circuit configuration for the temperature sensor.

Fig. 2. Using potentiometers to produce an output equivalent to 0·01V per degree Celsius (°C).

Fig. 3. Complete circuit diagram for the Temperature Transducer Amplifier.



inverting mode with feedback to give a closed loop gain of:

$$A_{vf} = (R3 + R2)/R2$$

Substituting in the circuit values gives:

$$A_{vf} = (16k\Omega + 2{\cdot}2k\Omega)/2{\cdot}2k\Omega = 8$$

The amplifier in this configuration has a very high input impedance given by:

$$Z_{inf} = A_v B Z_{in}$$

where A_v = open loop gain $\triangleq$ 200,000
B = feedback fraction $= R2/(R2 + R3)$
Z_{in} = input impedance without feedback $= 2 \times 10^6$ ohms
Z_{inf} = input impedance with feedback.

Therefore substituting these values gives:

$$Z_{inf} = 2 \times 10^5 \times (2{\cdot}2k\Omega/18{\cdot}2k\Omega) \times 2 \times 10^6 \triangleq 10^{11} \text{ ohms}$$

which is quite a high order of magnitude.

The values of R2 and R3 produce a closed loop gain of ×8, thus an input of 0·01 volts per degree C from the transducer circuit will produce an output of 0·08 volts per degree Celsius at the amplifier, so that 100 degrees C will produce 8 volts.

COMPONENTS

Resistors

R1	10kΩ
R2	2·2kΩ
R3	16kΩ

All ¼W carbon ±5%

See Shop Talk page 629

Potentiometers

VR1	5kΩ linear
VR2	100kΩ linear

Semiconductors

IC1	590kH temperature transducer
IC2	741 op-amp

Miscellaneous

B1,2	9V type PP3 (2 off)
S1	miniature d.p.d.t. toggle
SK1	4mm panel mounting socket, red
SK2,3	4mm panel mounting socket, black (2 off)
SK4	4mm panel mounting socket, green

Stripboard: 0·1 inch matrix size 18 strips × 24 holes; 8-pin d.i.l. socket; PP3 battery clips (2 sets); control knobs to suit VR1 and VR2 (2 off); 6BA fixings (2 sets); stranded connecting wire; case, Vero General Purpose Plastic Box, type 202-21390D size 120 × 80 × 35mm or similar.

Approx. cost Guidance only £11

The op-amp uses a ±9 volt split supply, provided by two PP3 batteries, which are switched in and out of circuit by S1, a double pole switch.

ASSEMBLY

The construction of the unit is relatively straightforward with the amplifier circuitry assembled on a piece of 0·1 inch matrix stripboard, 18 strips × 24 holes. Full assembly and wiring details are contained in Fig. 4. The links are made with plastic covered single core wire. A cut-out in one corner of the board is required to accommodate the batteries in the specified case.

Begin assembly by cutting the board to shape, drilling the two fixing holes and then making the necessary breaks in the copper tracks on the underside of the board. There are 12 in all. A d.i.l. socket was used to hold IC2 in the prototype and constructors are advised to do likewise.

Position and solder the components as shown. Attach sufficient lengths of flying lead (stranded type) to comfortably reach the case mounted components when fitted.

Prepare the case lid and base and secure the appropriate components as shown in Fig. 4. Use red and black for the input 4mm sockets, and green and black for the output sockets, black in each case being the ground (0V) connection.

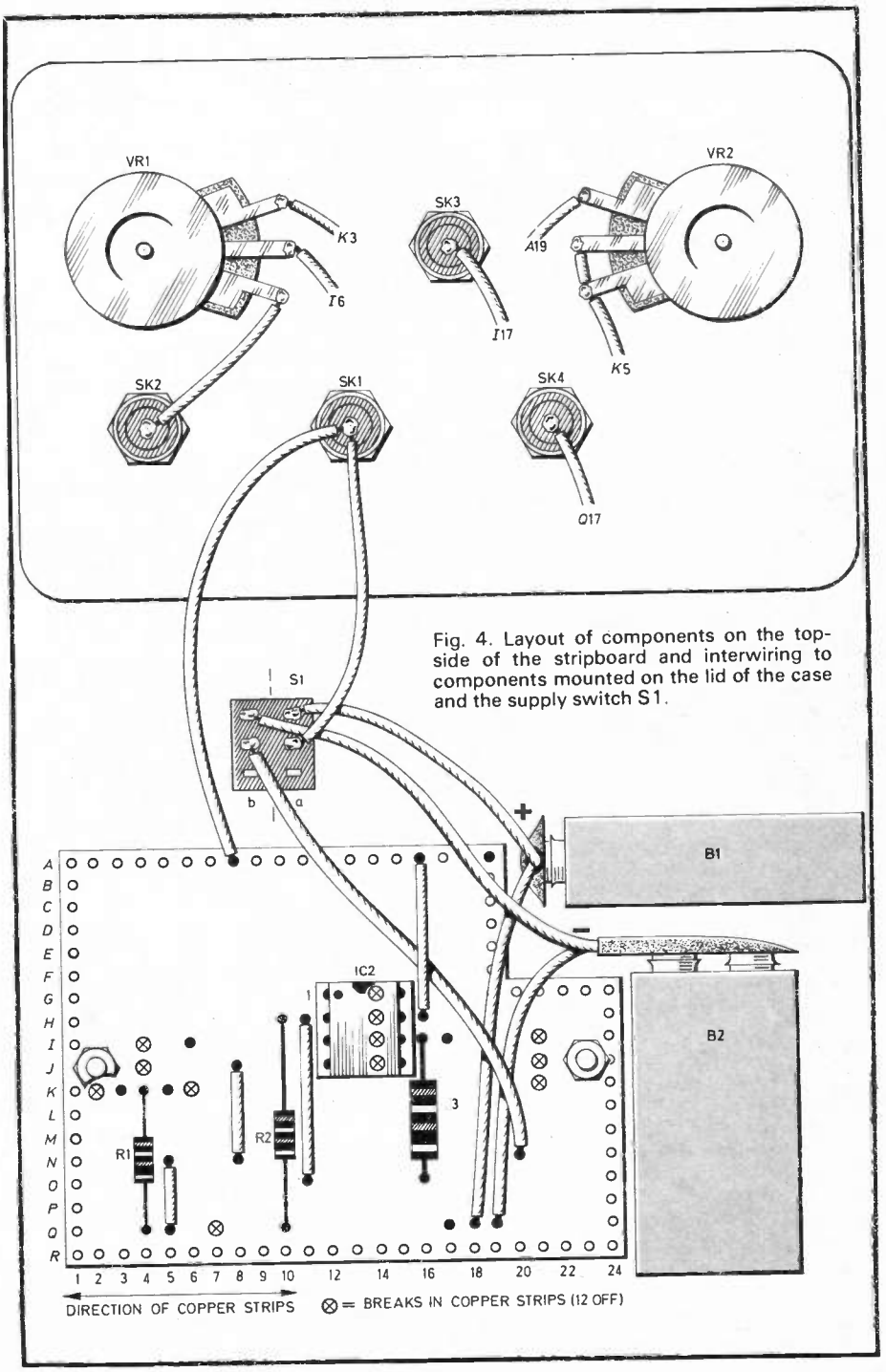
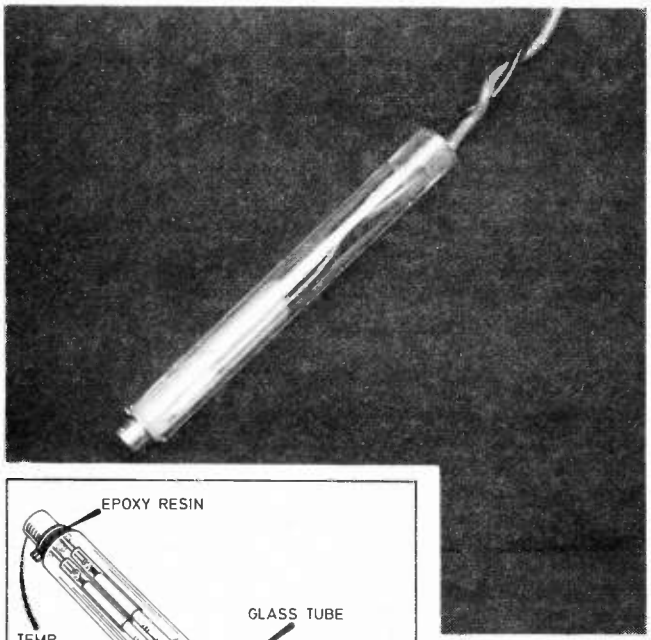


Fig. 4. Layout of components on the top-side of the stripboard and interwiring to components mounted on the lid of the case and the supply switch S1.



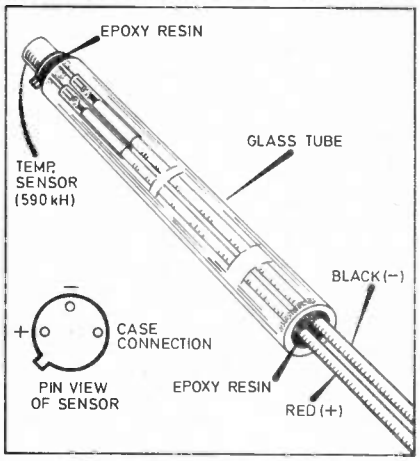
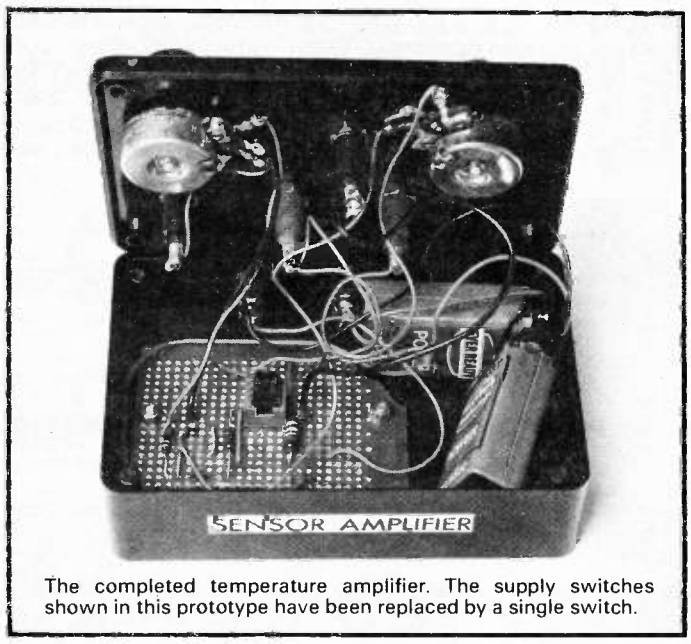


Fig. 5. Details of the construction of the sensor "probe". The completed sensor is shown in the photograph above.



The completed temperature amplifier. The supply switches shown in this prototype have been replaced by a single switch.

Fit the completed board in the case using 6BA fixings and then wire up as shown. When complete, insert IC2, paying attention to the orientation of this device to complete the construction. Attach labels to identify the panel controls and sockets.

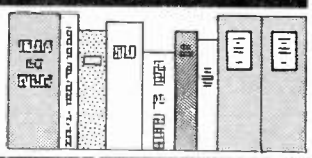
SENSOR/CALIBRATION

The sensor itself is shown in Fig. 5 and in the photograph. Suitable lengths of plastic covered wire are soldered to the (+) and (−) pins of the sensor and eventually terminated by 2 × 4mm plugs, red and black respectively, which plug into the input sockets of the amplifier of the corresponding colour.

The temperature transducer is mounted on the end of a glass tube, and both ends are sealed with epoxy resin for water-proofing, so that the can-head protrudes from above the resin. Once it dries, the apparatus is ready for calibration.

Immerse the transducer in a mixture of ice and water (0 degrees C) and plug the red and black 4mm plugs with the correspondingly coloured sockets on the Amplifier box. Connect the amplifier output and ground to a d.c. voltmeter (10V full scale) and switch on. Using VR1, zero the output. If the needle doesn't zero completely, then adjust VR2 until the output is 0 volts. The apparatus is now ready for use. □

BOOK REVIEWS



HOW TO DESIGN AND MAKE YOUR OWN PCB

Author	R. A. Penfold
Price	£1.95 Limp edition
Size	178 × 110mm. 66 pages
Publisher	Bernard Babani Ltd.
ISBN	0-85934-096-1

FOR a new-comer to electronics as well as to the experienced hobbyist, a need will eventually arise to design and make your own boards.

The book, How To Design And Make Your Own PCB contains three chapters starting with Simple PCB Production, which describes equipment and procedures for producing printed circuit boards. The remaining two chapters are Photographic Methods and Designing and each chapter is easily explained with diagrams to support the text.

Overall, a very useful book for anyone who is contemplating constructing their own boards and the book will also provide some very useful hints for the experienced constructor.

R.A.H

ELECTRONICS SERVICING PART 2 CORE STUDIES

Author	R. Lewis
Price	£6.95 Limp edition
Size	234 × 157mm. 142 pages
Publisher	Macmillan Press
ISBN	0-333-30594-9

THE approach to the theory is strictly non-mathematical and physical explanations have been used throughout.

The book contains eight chapters starting with LCR Circuits, a chapter which considers the effects of applying direct and alternating voltages to circuits containing one or more of the electronic components, resistors, inductors and capacitors.

The remaining chapters are Transformers, Semiconductor Diodes and Applications, Transistors and other Semiconductor Devices, Voltage Amplifiers, Waveform Generation and Shaping, The Cathode Ray Tube and Simple Mechanisms and finally Power Supplies.

Each of the eight chapters is easily explained with diagrams to support the text and finally there is a set of self-test questions and answers at the back of the book. A good book which will help anybody studying electronics.

R.A.H

Books in Brief

The Video Camera Handbook by Peter Lanzendorf (David & Charles). £9.95. Using simple terms, this book explains the systems available for home video taping, the right tripods, lenses and filters. How to achieve correct lighting, how to make sound recordings and produce script and screenplay are also covered.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Development News

Through my post at home I get literally dozens of press releases a day, covering audio, electronics and video. My last postman had to retire with a bad back.

Obviously it's impossible to write about everything I receive. So I read it all, make background phone calls for more information if something looks especially interesting, and then file it away for the future using a Sinclair Spectrum to cross reference related items.

For instance, by making a note of what new integrated circuits are becoming available for designers you can get a clear indication of what new gadgetry is likely to come on the market in a year or so's time. But if you think that being a journalist is just about re-writing press releases, think again.

Last week, Mullard, the British company owned by Philips of Eindhoven, sent me a press release on a new i.c. that integrates the entire circuitry for an f.m. radio receiver, from aerial input to audio output. This, said the press release, will let designers build an f.m. radio into a pencil, wristwatch or keyring.

It uses a non-standard intermediate frequency. Usually the i.f. for an f.m. radio is 10·7MHz, but in the Mullard chip it is 70kHz. Curiosity aroused, I phoned Mullard to ask how they had overcome distortion problems, and how a low i.f. helps them make the chips smaller.

A week, and several phone calls later, I am still no nearer an answer. Believe it or not, there's no one in Mullard UK who can explain what's written in the company's press release. I've now been promised a call from an expert in Eindhoven who may or may not be able to help.

Tele News

Another release is a clear pointer to a new generation of low-cost gadgetry that couples to your telephone and is triggered by an incoming ring. Texas Instruments are now selling chips that are powered by the incoming ring signal to produce a regulated 5-volt output which connects the phone line to a microprocessor or system that handles voice or data signals.

The chip is ideal for a telephone answering machine, a data modem or facsimile machine. Cost, if you buy in hundreds, is just £1.40 each.

Talking of telephones, I've just received news from British Telecom, who proudly announce that they have created 300 new jobs. How? By setting up three Telcare centres. Telcare stands for Telecom Customer Attitude Research, and the centre's sole job is to phone up Telecom subscribers and ask what they think of British Telecom.

Personally, I would have thought that, with so many people already telling BT what they think for free, in letters to the press and to BT, that Telcare is an expensive luxury that BT subscribers can ill afford.

Finally, my favourite press release of the week; a blank sheet of paper with just the PR company's name and address and the words "Press Release" printed at the top. Perhaps they've just got nothing to say this week.

Technology Cabaret

You don't normally associate nightclubs with high technology, especially a Parisian nightclub. But I found out differently when I ended up at the Lido, probably the most famous of all Paris nightclubs.

Please understand, I wasn't paying the bill! With drinks at around £10 a time on top of the meal, I'm not recommending that anybody else spends their hard-earned money that way either.

The technology at the Lido helps explain the high cost and raises an interesting point on the future of live entertainment. In addition to a fifty strong dance group, and a string of conjurers, jugglers and balancing acts, there's a full orchestra and singers out of sight in the gallery. They keep in touch with the stage through closed circuit television and headphones.

Perhaps inevitably the opening routine show relies on lasers, with several raw beams split into fantail arrays by diffraction gratings. The whole cabaret floor either rises up as a stage, or drops down and slides away to reveal an enormous pit.

Up from this pit, with a throbbing of hydraulics, rises either a swimming pool or a genuine ice-skating rink in a refrigerated tank. At the back of the stage they unveil a miniature Niagara Falls, that pumps real water by the thousands of gallons.

In one dance routine, jungle witch-doctors with scuba gear hidden under their masks, carry flaming torches into the swimming pool. They then stay underwater for the rest of the act with the flaming torches held aloft out of the water. Other fireworks are lit underwater. Don't forget that a firework doesn't need oxygen to burn, it's provided by the chlorate or nitrate in the firework mix.

The star comedian is obviously an ex pick-pocket, whose act involves stealing watches, wallets, socks, ties and braces from the audience without their knowing.

His star trick was to sit a dozen or so members of the audience on chairs on the stage, and then give each of them a mild electric shock through the chair seat—I'm still trying to work out how that was done.

Bad Taste

High-spot of the evening and pinnacle of bad taste was a re-enactment of the Hindenburg disaster. Half the stage was turned into a mock-up of life on board the airship, with back projected film of the trans-Atlantic flight from Germany to America.

Then there's a switch to Lakehurst, New Jersey, where the ground crew try to hold the dirigible down by ropes. True to history, it bursts into real flames. Four Lido performers, clad in protective clothing, and drenched in burning paraffin, leap out of the Hindenberg cabin and writhe around on stage, burning to death in distressingly realistic fashion.

We the public have now grown so used to seeing dramatic stunts and spectacles on film and on television, that the only way a live show can compete is to mount spectacles of this kind. But the cost of mounting such a show, with all the necessary technology and as many technicians backstage as performers on stage, is so high that most of us can't afford to go and watch it!

. . . *Post Script*

I finally obtained some technical information on the new Mullard chip, by talking to Philips in Eindhoven. It's a clever design. Normally the i.f. for f.m. radio is 10·7MHz, and at that frequency you can't possibly integrate the necessary coils and capacitors in a chip. But at the low i.f. frequency of 70kHz you can use *RC* filters.

Unfortunately, the low i.f. makes it impossible to achieve the ±75kHz deviation normal for f.m. so the designer, a Mr. Kasperkovitz, devised a feedback circuit to keep distortion down to acceptable limits even at an i.f. deviation of only ±15kHz.

Digital War

The hi fi world is now in the throes of a civil war over digital audio. One faction says that Compact Disc (the laser-read digital audio disc developed by Philips with the subsequent help of Sony), is the best thing to happen to audio since the microgroove LP and stereo.

The more level headed among them admit that the system is suffering from teething problems. Players and discs aren't yet perfect. But who expects any new technology to be perfect from the day it is launched?

The other faction vehemently argues that Compact Disc is inherently imperfect because the coding standards adopted can't ever produce a sound as good as you get from an analogue disc. Even when the players and the discs are working perfectly, and recordings are tailor-made to the new medium, it will still be inadequate.

For the record, if you will pardon the unintentional pun, I firmly believe that the system isn't yet right, but it is potentially better than anything an analogue disc can deliver. The best argument I can muster in favour of this, other than gut feeling, is a comparison with the digital audio systems used by the BBC for at least ten years to transmit f.m. stereo radio sound around the country, between v.h.f. transmitters.

Whereas Compact Disc audio is sampled at 44·1kHz, and coded into 16-bit words, the BBC has for ten years been sampling at 32kHz and coding into 13-bit words. So for ten years almost every f.m. stereo radio programme has been piped through a digital chain that is far inferior to Compact Disc.

I wonder why the people who are now complaining about what they call the nasty digital sound of Compact Disc, haven't been complaining over the last ten years about what should be the even more nasty digital sound of BBC v.h.f. radio?—*Any comments to the Ed.*

MICROCOMPUTER INTERFACING TECHNIQUES

INCLUDING MANY USEFUL CONSTRUCTIONAL PROJECTS

PART FOUR: DIGITAL-TO-ANALOGUE CONVERSION

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

A DIGITAL-TO-ANALOGUE converter (DAC) produces an analogue output that is proportional to a binary code presented at its data inputs.

The reader should refer to Fig. 4.1 which shows a theoretical 2-bit digital-to-analogue converter.

The incoming 2-bit logic signal is applied to electronic switches, SØ and S1, which close on receipt of a logic 1. The closure of a switch connects voltage sources V1 and V2 to the input of an operational amplifier which sums them and thus presents an analogue voltage at its output which will depend upon the binary signal presented to the DAC input.

The truth table for this simple arrangement is given in Table 4.1.

Table 4.1

Digital Inputs		Analogue Output
D1	DØ	
Ø	Ø	0V
Ø	1	1V
1	Ø	2V
1	1	3V

The relationship between the digital input and the resulting analogue output voltage can be represented graphically, as shown in Fig. 4.2. In this simple arrangement the smallest increment of the analogue output voltage that can be produced is 1·0V and this level of resolution is clearly not adequate for most purposes.

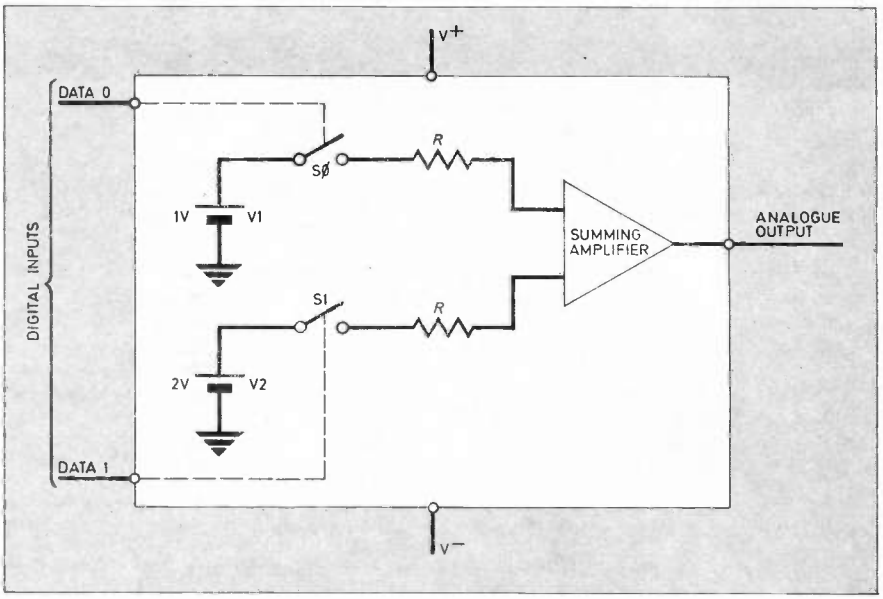


Fig. 4.1. Theoretical representation for a 2-bit digital-to-analogue converter (DAC). SØ and S1 are electronic switches operated by logic signals on the data lines.

As with ADCs, resolution is a function of the number of bits available, so a DAC offering 8-bit conversion will produce an analogue output in 256 discrete increments of the full scale output.

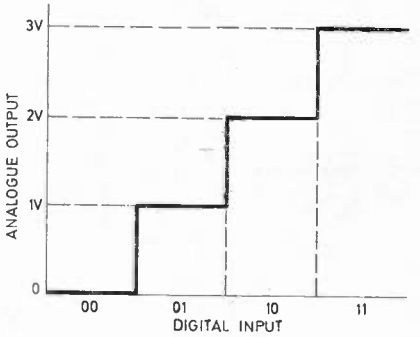
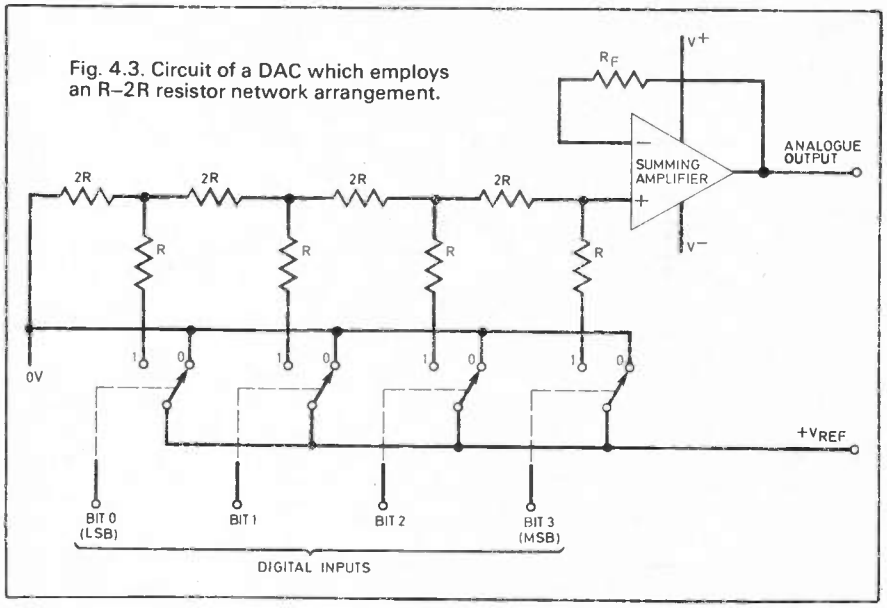


Fig. 4.2. Coding states of a 2-bit DAC. Relationship between digital input and the resulting analogue output is clearly shown.

In practical integrated circuit DACs, the switched voltages are derived from a network of precision resistors and a fixed reference voltage. A possible arrangement which employs a resistor network, often called an R-2R ladder, is shown in Fig. 4.3.

The converter employed by the authors uses a DAC0800 device, the internal circuitry of which is shown in diagrammatic form in Fig. 4.4.

Fig. 4.3. Circuit of a DAC which employs an R–2R resistor network arrangement.



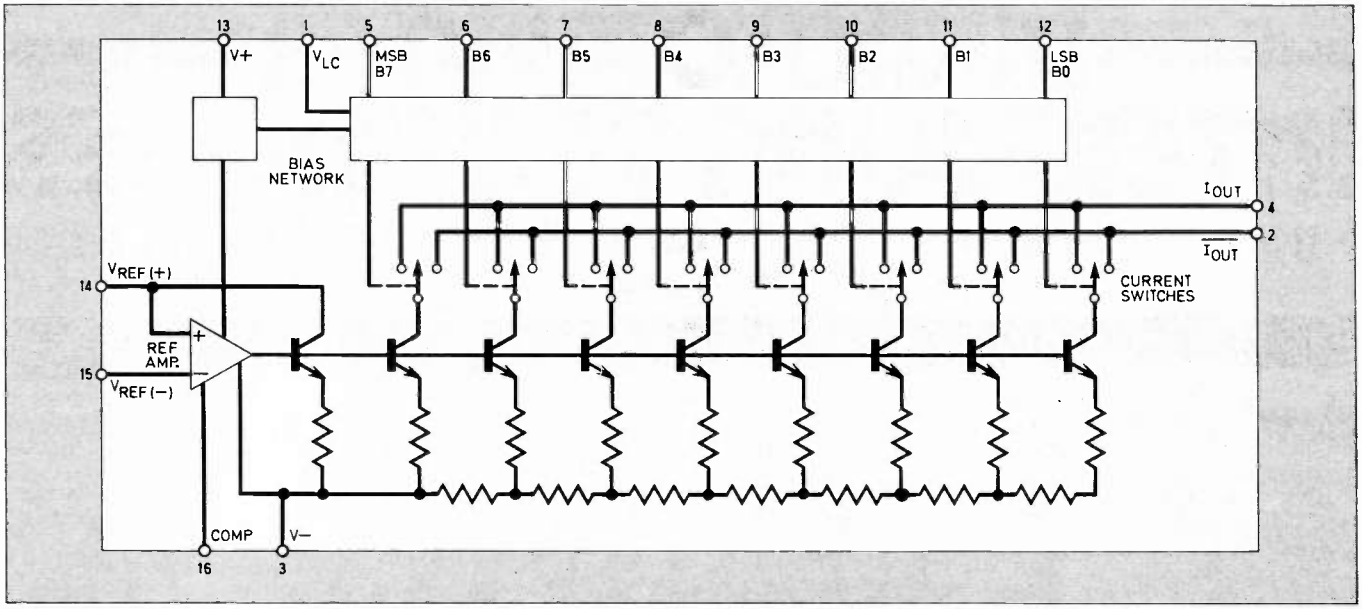


Fig. 4.4. Block schematic diagram for the DAC0800 8-bit converter device used in the Digital-to-Analogue Converter.

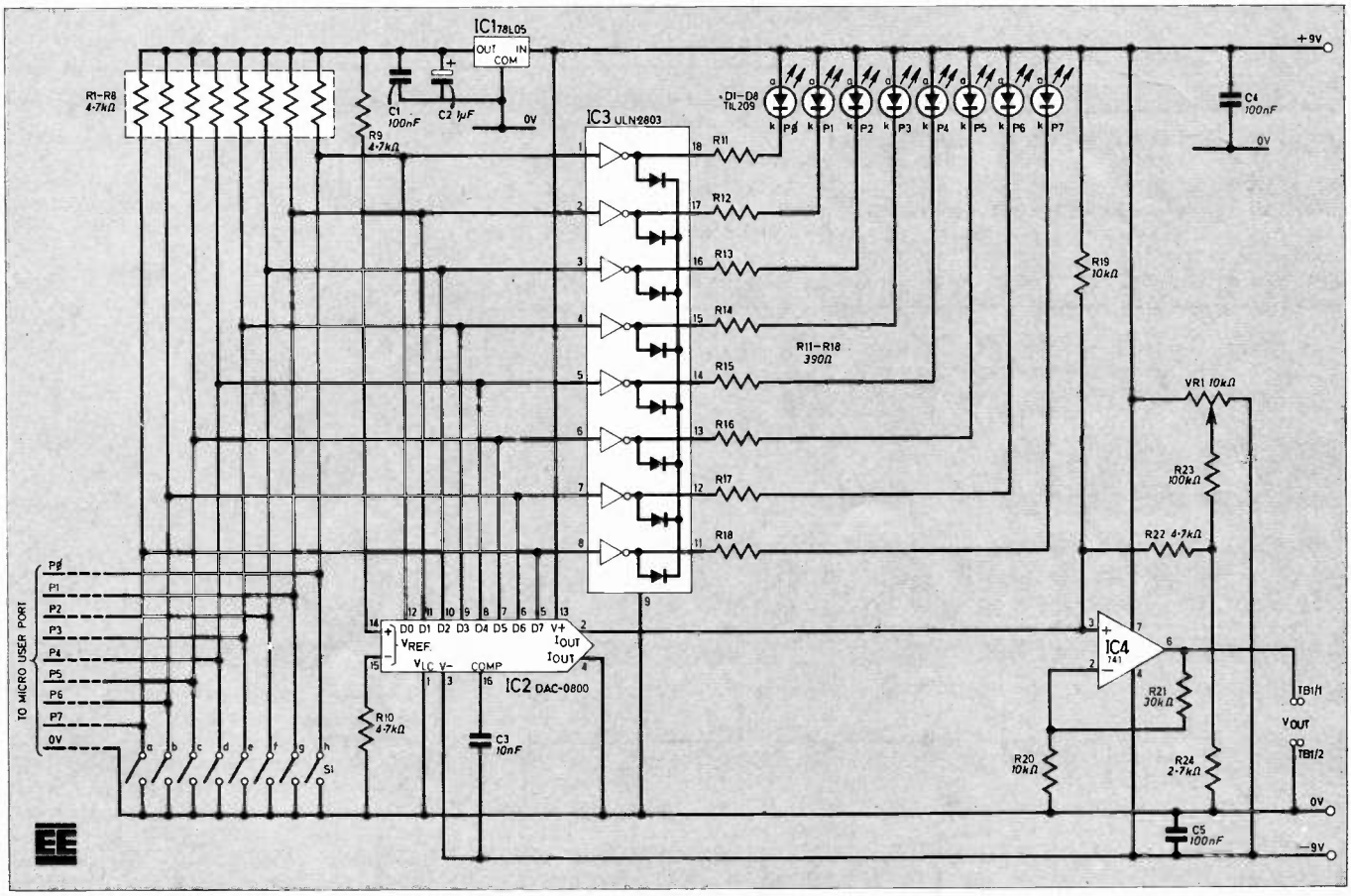
The DAC0800 is an 8-bit converter and the digital signals applied to the electronic input switches SØ–S7 of the DAC are derived from the microcomputer user port.

The R-2R ladder network permits an output current to flow according to the combination of electronic switches closed. This is determined by the logic levels of the eight signal lines from the user port which operate the input switches of the DAC. The overall magnitude of the output current is dependent upon the currents flowing in the network which in turn depends upon the reference current flowing. This is controlled by $+V_{REF}$ and $-V_{REF}$ and is typically in the order of 2mA.

The DAC0800 does not posses an internal reference as does, for example, the Ferranti ZN428 and this allows rather more flexibility. A simple Zener diode circuit or some other voltage stabiliser can be used to provide $+V_{REF}$; $-V_{REF}$ is often grounded.

Two analogue current outputs are provided on the DAC. These are com-

Fig. 4.5. Complete circuit diagram of a Digital-to-Analogue Converter.



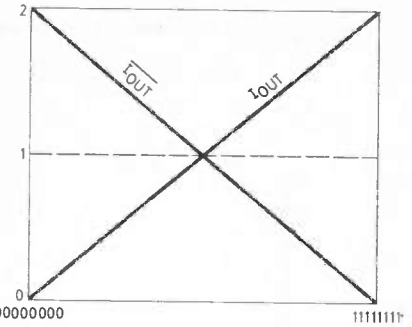


Fig. 4.6. Relationship between I_{OUT} and $\overline{I_{OUT}}$.

plementary currents, that is, as one increases there is a corresponding decrease with the other; this is depicted in Fig. 4.6.

The DAC0800 device performs the conversion process very rapidly, 100ns settling time being typical. Input switching levels are TTL compatible, although they are easily adjustable to other logic levels. The device will function satisfactorily with supply rail voltages between ±4·5V to ±18V.

DAC CIRCUIT DESCRIPTION

The complete circuit of the Digital-to-Analogue Converter (DAC) is shown in Fig. 4.5. TTL logic level inputs to the DAC (IC2) may be derived from the microcomputer user port or selected manually by switches S1a to S1h (an 8-way s.p.s.t. d.i.l. switch is used here). With any switch closed, the input line to which it is connected is brought down to 0V (logic 0). An open switch allows the input line to be pulled up to the +5V line, forcing it to a logic 1. Resistors R1–R8 are used for this purpose and, for convenience, an 8-way commoned s.i.l. (single-in-line) resistor network package was employed.

Logic conditions on the input lines are indicated by l.e.d.s D1 to D8, the octal Darlington driver IC3 being used to control these l.e.d.s. This section of the circuitry is optional and may be omitted if desired.

IC1 is a 78L05A voltage regulator which provides both $+V_{REF}$ (+5V) and the logic 1 levels when manual switching is used. The DAC0800 positive and negative supplies are derived from the +9V and −9V supplies to the board. PP9 batteries are quite adequate for the supply.

Logic threshold levels on IC2 are set by pin 1, which is grounded and gives TTL level operation of the digital input lines. Pin 16 allows for some compensation of the internal reference amplifier and this is provided for by the inclusion of C3 between pin 16 and $-V_{CC}$ (−9V). The positive V_{REF} is, as previously mentioned, set at +5V, whilst $-V_{REF}$ is taken to ground by R10, a 4·7kΩ resistor.

As with analogue-to-digital converters, DACs can be connected for either unipolar or bipolar operation. The DAC board utilises the bipolar technique which allows the output from the board to go both positive and negative with respect to ground. Bipolar operation is achieved by applying an offset voltage to the output of the DAC. This voltage is adjusted (by VR1) until the output is zero for a digital input of half full range (that is, logic levels 10000000 at the input). Positive and negative full scale outputs are not quite symmetrical about 0V since the 8-bit binary signal (representing 255 equal voltage steps) is not divided into two equal sections about 10000000.

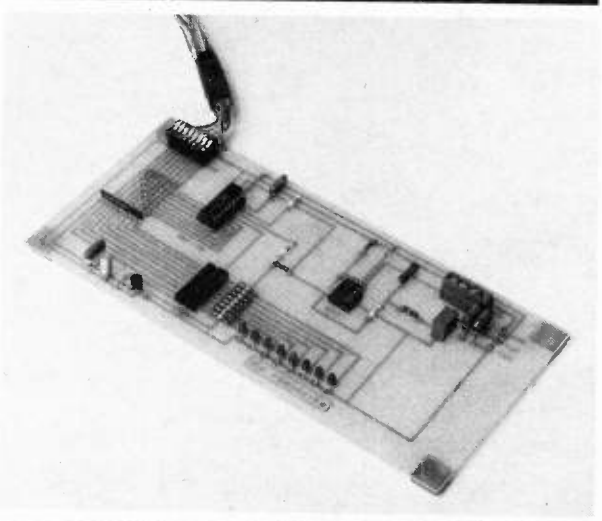
IC4 is a conventional non-inverting operational amplifier circuit which buffers the output from the DAC and provides a small voltage gain.

Table 4.2 shows the relationship between digital signals and the analogue output levels for the DAC board.

Table 4.2. Basic Bipolar Output Operation

Scale	Digital Input m.s.b. b7	b6	b5	b4	b3	b2	b1	l.s.b. bØ	Analogue Output (VOLTS)
Positive full scale	1	1	1	1	1	1	1	1	+6·450
Positive full scale — l.s.b.	1	1	1	1	1	1	1	Ø	+6·400
Zero scale + l.s.b.	1	Ø	Ø	Ø	Ø	Ø	Ø	1	+0·053
Zero scale	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0·000
Zero scale — l.s.b.	Ø	1	1	1	1	1	1	1	−0·078
Negative full scale + l.s.b.	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	−6·460
Negative full scale	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	−6·510

DIGITAL TO ANALOGUE CONVERTER BOARD CONSTRUCTION



ASSEMBLY DETAILS

The components for the Digital-to-Analogue unit are accommodated on a single-sided printed circuit board, size 200 × 98mm. The pattern to be etched on the board is shown in Fig. 4.7. This board is available from the *EE PCB Service*, Order code 8310-01.

Position and solder the components on the board topside as shown in Fig. 4.8. Order of assembly is not important. Use of i.c. sockets for the d.i.l. integrated circuit is advised. In the prototype, S1 was also fitted in a d.i.l. socket. Pay attention to orientation of the l.e.d.s and IC2 and the other i.c.s when inserted in their holders after construction is complete.

The s.i.l. resistor package has its common pin marked on the body with a spot. Make sure this component is fitted the right way round.

The appropriate wires of the ribbon cable from the user port connector are to be soldered directly to the same p.c.b. land areas which accommodate the uncommoned side of switch S1. The wires

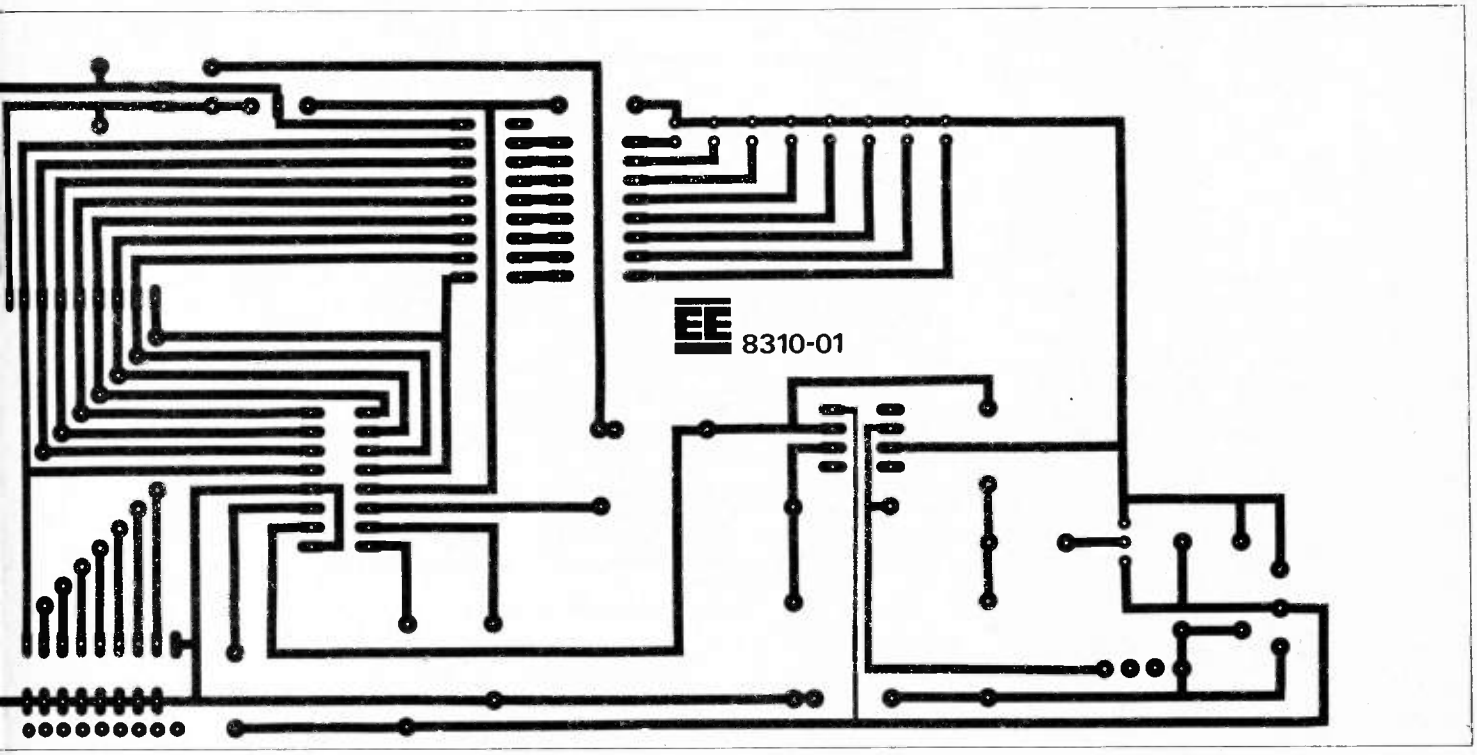
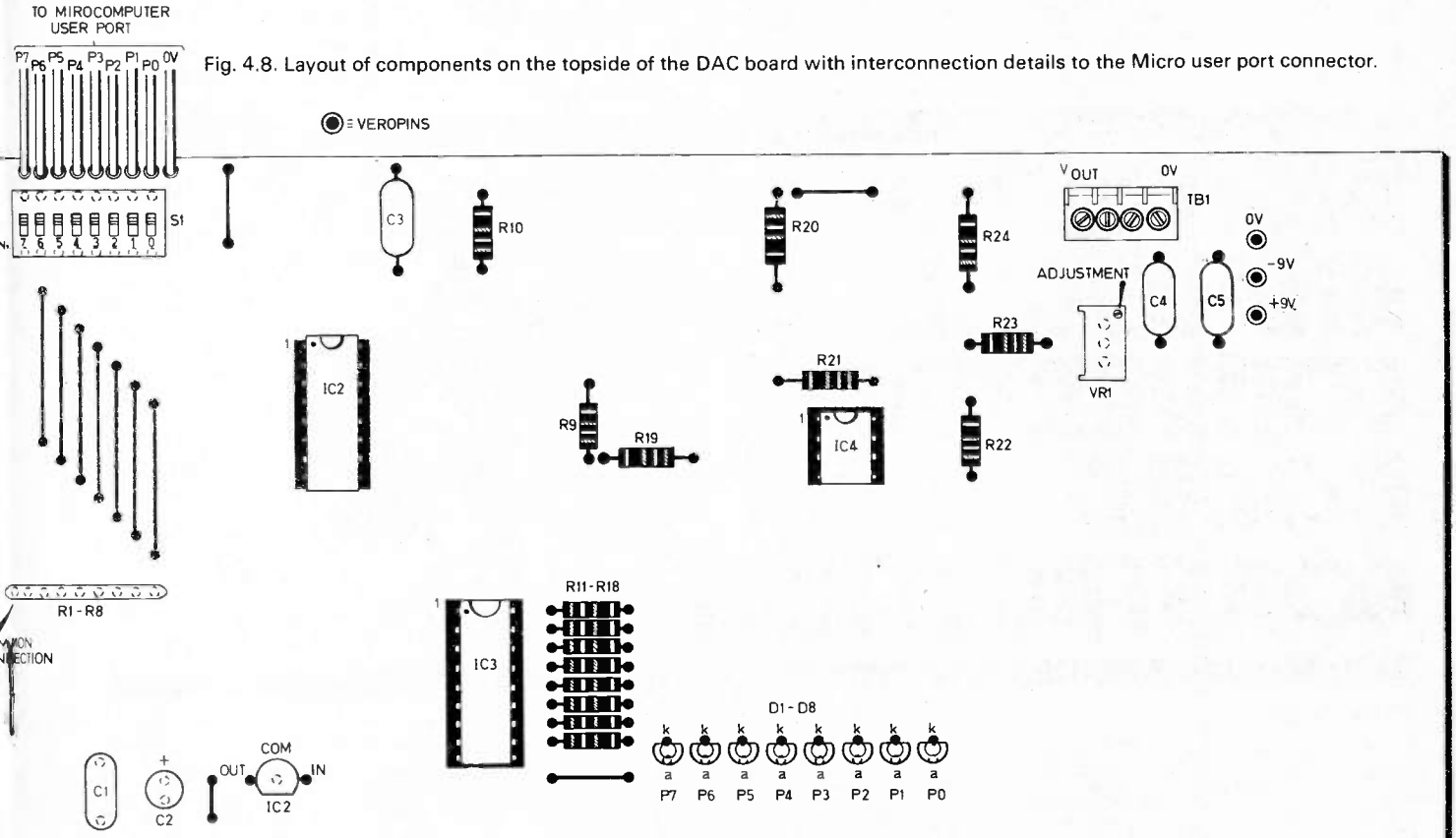


Fig. 4.7. Master pattern (actual size) for the DAC board. This board is available through the *EE PCB Service;* Order code 8310-01.

Fig. 4.8. Layout of components on the topside of the DAC board with interconnection details to the Micro user port connector.



COMPONENTS

Resistors

R1–8	4·7kΩ s.i.l. commoned resistor network
R9,10,22	4·7kΩ (3 off)
R11–18	390Ω (8 off)
R19,20	10kΩ (2 off)
R21	30kΩ
R23	100kΩ
R24	2·7kΩ

See Shop Talk page 629

Capacitors

C1	100nF polyester type C280
C2	1µF 6V elect. radial
C3	10nF polyester type C280
C4	100nF polyester type C280
C5	100nF polyester type C280

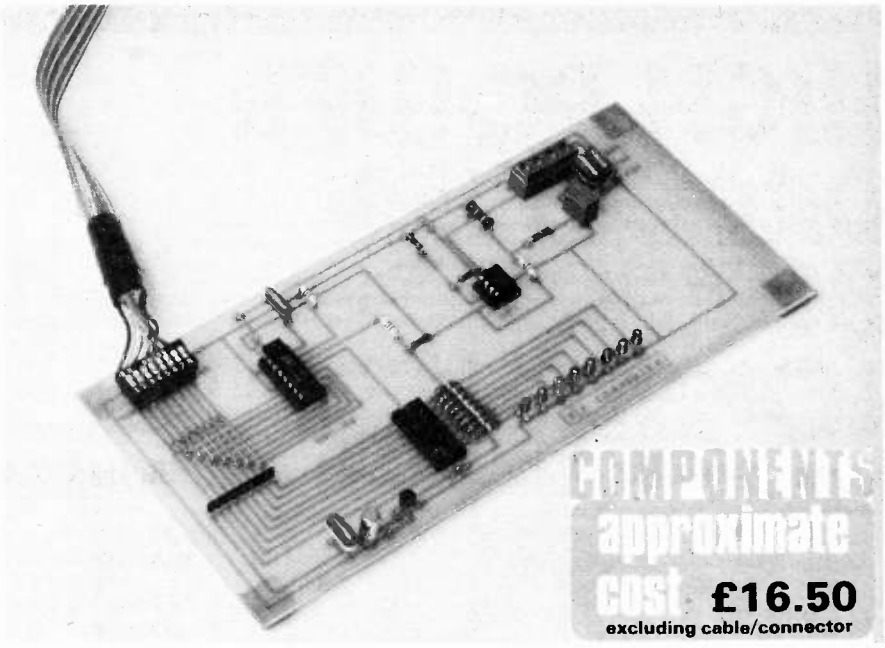
Semiconductors

D1–8	TIL209 red l.e.d. (8 off)
IC1	78L05 monolithic 5V 100mA voltage regulator
IC2	DAC0800 digital-to-analogue converter
IC3	ULN2803 octal Darlington driver
IC4	741 op-amp

Miscellaneous

VR1	10kΩ ⅜-inch cermet multi-turn preset
S1	8-way s.p.s.t. 16-pin d.i.l. switch
TB1	4-way p.c.b. mounting screw terminal block

Printed circuit board: single-sided size 200 x 98mm, *EE PCB Service;* Order code 8310-01); Veropins single-sided (3 off); tinned copper wire (for board topside links); d.i.l. sockets, 18-pin (1 off), 16-pin (2 off), 8-pin (1 off); self-adhesive rubber feet (4 off); ribbon cable and connector to suit computer user port.



should be soldered after passing through the holes adjacent to S1 commoned contacts. This arrangement acts as a strain relief mechanism to protect the soldered cable connection.

SOFTWARE

Controlling the DAC from BASIC is extremely simple. The eight lines available at the user port must be configured for output by setting all bits in the data direction register for the port.

Once this has been accomplished then any bit pattern introduced into the I/O register will cause the corresponding output signals to operate the data input switches on the DAC and produce the appropriate output voltage.

The following BASIC program allows the conversion of a digital input into a scaled analogue output.

Example One

Line	BBC	VIC–20	PET	Commodore 64
1Ø	<— — — — — — — — — REM SINE WAVEFORM — — — — — — — —>			
2Ø	?65122=255	POKE37138,255	POKE59459,255	POKE56579,255
3Ø	<— — — — — — — — — — FOR X = Ø TO 255 — — — — — — — —>			
4Ø	<— — — — — — Y = 128 + INT(128*SIN(X*3.1417/128) — — — — — —>			
5Ø	?6512Ø=Y	POKE37136,Y	POKE59457,Y	POKE56577,Y
6Ø	<— — — — — — — — — — NEXT X — — — — — — — — —>			
7Ø	<— — — — — — — — — — GOTO 3Ø — — — — — — — — —>			

Example Two

Line	BBC	VIC–20	PET	Commodore 64
1Ø	<— — — — — — — — REM SAWTOOTH WAVEFORM — — — — — — —>			
2Ø	?65122=255	POKE37138,255	POKE59459,255	POKE56579,255
3Ø	<— — — — — — — — — FOR X=Ø TO 255 — — — — — — — —>			
4Ø	?6512Ø=X	POKE37136,X	POKE59457,X	POKE56577,X
5Ø	<— — — — — — — — — — NEXT X — — — — — — — — —>			
6Ø	<— — — — — — — — — — GOTO 3Ø — — — — — — — — —>			

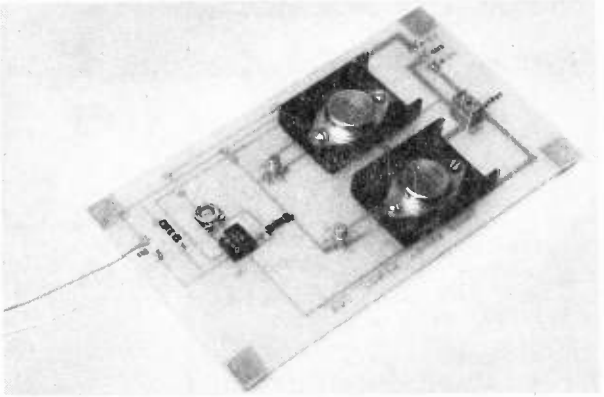
Example Three

Line	BBC	VIC–20	PET	Commodore 64
1Ø	<— — — — — — — — REM TRIANGULAR WAVEFORM — — — — — — —>			
2Ø	?65122=255	POKE37138,255	POKE59459,255	POKE56579,255
3Ø	<— — — — — — — — — FOR X=Ø TO 255 — — — — — — — —>			
4Ø	?6512Ø=X	POKE37136,X	POKE59457,X	POKE56577,X
5Ø	<— — — — — — — — — — NEXT X — — — — — — — — —>			
6Ø	<— — — — — — — — — FOR X = 254 TO 1 STEP –1 — — — — — —>			
7Ø	?6512Ø=X	POKE37136,X	POKE59457,X	POKE56577,X
8Ø	<— — — — — — — — — — NEXT X — — — — — — — — —>			
9Ø	<— — — — — — — — — — GOTO 3Ø — — — — — — — — —>			

Line	BBC	VIC–20	PET	Commodore 64
5	<— — — — — — — — REM DAC PROGRAM — — — — — — — —>			
1Ø	?65122=255	POKE37138,255	POKE59459,255	POKE56579,255
2Ø	<— — — — — — — — — — INPUT X — — — — — — — — —>			
3Ø	<— — — — — — — — IF X < Ø OR X > 255 THEN END — — — — — — —>			
4Ø	?6512Ø=X	POKE37136,X	POKE59457,X	POKE56577,X
5Ø	<— — — — — — — — — — GOTO 2Ø — — — — — — — — —>			

BASIC is quite adequate for any slow applications such as the real-time control of mechanical devices or a programmable power supply. Machine code software, however, is often required for waveform generation (music or speech for example) but BASIC can be used to produce alternating waveforms with longer periods.

HIGH POWER DAC DRIVER BOARD CONSTRUCTION



HIGH POWER DRIVER

Whilst the DAC board is capable of providing programmable voltages over a wide range, the current that may be drawn from it is small because of the limited power capability of the buffer amplifier. Fig. 4.9 shows the circuit of an add-on power amplifier (the DAC Power Driver board) which will provide programmable voltages at currents of several amperes when connected to a suitably rated power supply.

The analogue output from the DAC board is applied to the non-inverting input of IC1, a 741 operational amplifier, the output of which drives the complementary Darlington power amplifier stages TR1/TR3 and TR2/TR4. Overall negative feedback is applied to the inverting input of the operational amplifier which reduces the voltage gain of the circuit to unity. An offset null provision is necessary and this is achieved by the inclusion of VR1. Input impedance is set at 12kΩ by R1.

Output transistors TR3 and TR4 are high power (115W) devices and must be provided with adequate heatsinks if large load currents are envisaged. The prototypes employed have heatsinks rated at 14°C/W and these were adequate for currents up to about 2A; larger currents will necessitate the use of larger heatsinks.

The board is quite capable of driving small d.c. motors whose speed and direction can thus be programmed.

ASSEMBLY

The High Power Driver circuitry of Fig. 4.9 is assembled on a single-sided printed circuit board, size 177 × 96mm. The pattern to be etched on this board is shown in Fig. 4.10. The black regions represent the copper tracks to remain after etching. This board is available through the *EE PCB Service*, Order code 8310-02.

The components are positioned on the p.c.b. topside as shown in Fig. 4.11. The order of component assembly is unimportant. Input and power supply connections in the prototype were made by soldering to board fitted Veropins, with the output connection accessible via a screw terminal block. Spacing of the Veropin location points allow p.c.b.-type screw terminal blocks to be fitted if desired.

The power transistors TR3 and TR4 need to be fitted on heatsinks and these are sandwiched between board and device and held by 4BA screws and nuts. Use heatsink compound or silicone grease on touching surfaces to increase thermal conductivity from device to heatsink.

Screw fix these assemblies before soldering the two leads from the transistor to the board.

The collector connection is made at the case of these transistors, via the fixing nut and screw, the heatsinks must not be allowed to come into contact with one another.

Next Month: *Stepper Motor Control.*

COMPONENTS

Resistors

R1	12kΩ	R2	390Ω

All ¼W carbon ±5%

Capacitor

C1 470pF ceramic

Semiconductors

TR1 BC107 silicon *npn*
TR2 BCY71 silicon *pnp*
TR3 2N3055 silicon *npn*
TR4 MJE2955 silicon *pnp*

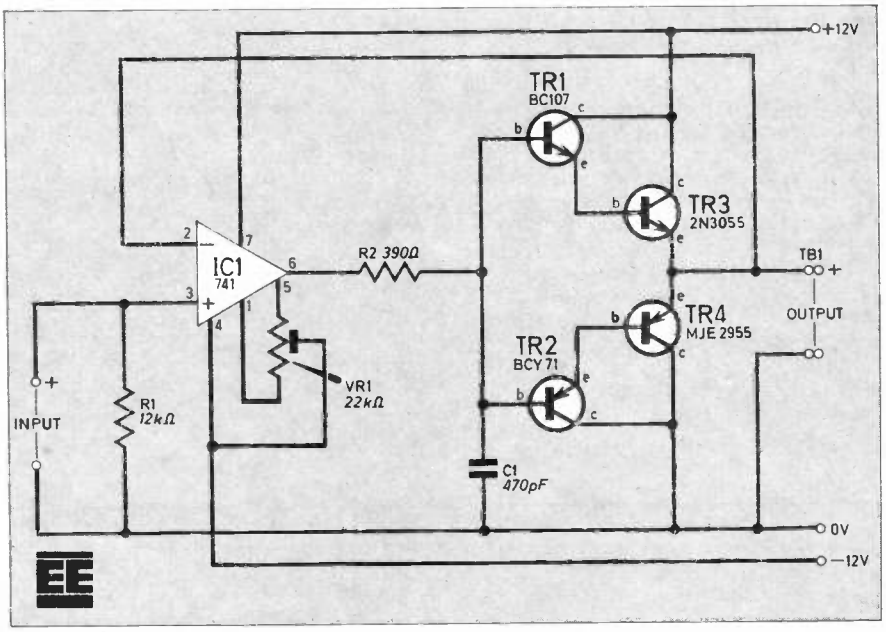
Miscellaneous

VR1 22kΩ horizontal skeleton preset
TB1 2-way p.c.b. mounting screw terminal block

Printed circuit board: single-sided size 177 × 96mm, *EE PCB Service*, Order code 8310-02; single-sided Veropins (5 off); 8-pin d.i.l. socket; heatsinks, TO-3 type 14°C/W or better (2 off); self-adhesive rubber feet (4 off); 4BA fixings (4 sets).

Approx. cost Guidance only **£9.60**

Fig. 4.9. Circuit diagram of an add-on High Power Driver.



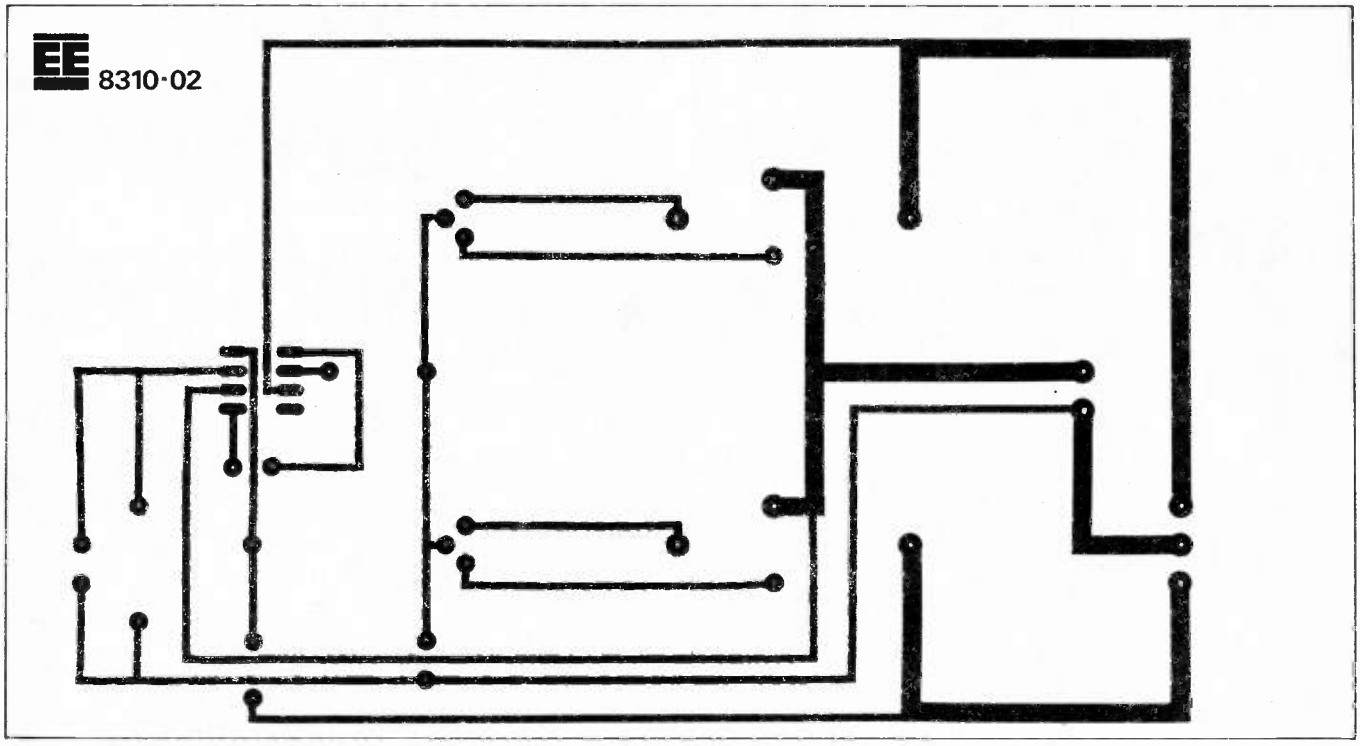


Fig. 4.10. Master pattern (actual size) for the High Power Driver. This board is available through the *EE PCB Service;* Order code 8310-02.

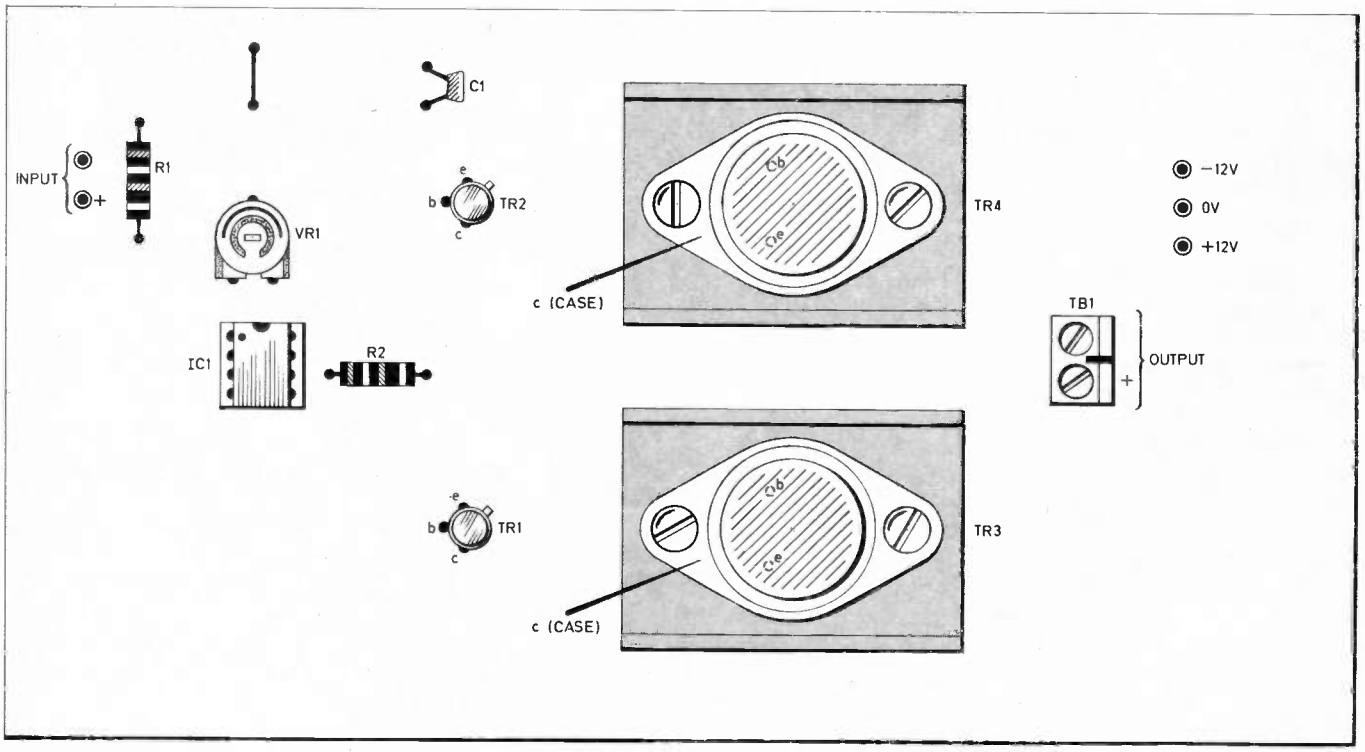


Fig. 4.11. Layout of components on the topside of the p.c.b. The heatsinks for the two power transistors are indicated by the tone areas.

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0–500μA, 0–5mA, 0–250mA.
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NOVEMBER FEATURES

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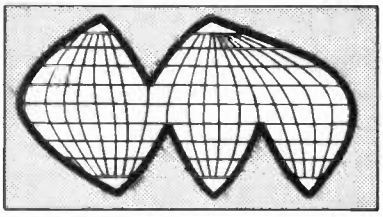
EVERYDAY ELECTRONICS and computer PROJECTS

NOVEMBER 1983 ISSUE ON SALE FRIDAY, OCTOBER 21

RADIO WORLD



BY PAT HAWKER G3VA

All Change

Changes in the regulation of amateur radio licences in the UK have been coming thick and fast. First, following the General Election, the entire Radio Regulatory Department in Waterloo Bridge Road was transferred lock, stock and barrel, from the responsibility of the Home Secretary to the Secretary of State for Trade and Industry.

Then, on 27 July, DoTI published the final report of the "Independent Review of the Radio Spectrum (30–960MHz)" by the three wise men chaired by Dr James Merriman recommending the setting up of an entirely new ministerial department to be responsible for telecommunications, including all radio regulatory matters but (as a third choice) RRD to be with DoTI rather than Home Office. But the report had virtually nothing to say about amateur radio or CB.

The following day, DoTI announced in Parliament the transfer on 19 September of amateur radio licensing (including the issue and renewal of licences) back to its old home, the Post Office, who already issue CB licences. Unlike CB, however, amateur radio licences will not be issued over the counter but dealt with by postal application at the PO headquarters. (The address will be: Radio Amateur Licensing Unit, Chetwynd House, Chesterfield, Derbyshire S49 1PF, telephone Chesterfield (0246) 207555 who will issue the necessary application forms, etc).

A plus point is that the Post Office is guaranteeing a turn round in normal conditions of five days and at peak times of ten, and are to put all records on computer. The long delays of dealing with Waterloo Bridge House should soon be over.

The minus points? These are difficult to predict and it may be only my natural pessimism that makes me feel that more and more amateur radio in Europe is being lumped in with CB by people who fail to see that the two are essentially different.

This is not to deride CB, a useful leisure pastime and a low-cost communications facility which I was advocating many years before the Home Office finally gave way. I have always believed that not only is amateur radio a more fulfilling hobby but also has genuinely contributed to self-training, technical education and the advancement of the radio sciences.

First Impressions

The impression I have is that the authorities, whichever ministry is involved, nowadays are concerned only with reducing the administrative burden of catering for the 48,000 (and still expanding) UK radio amateurs. Unlike the USA, USSR and Japan, the UK has consistently declined to introduce any form of "incentive" licensing, or any form of "novice" licence.

But then little official encouragement is given these days to British licensees to progress from the Class B (v.h.f.-only) to the Class A (v.h.f./h.f.) licence. Even the current president of the R.S.G.B. (a former senior member of the Radio Regulatory Department) is reported to have emphasised recently that "the Class B permit is in no way to be regarded as inferior to the Class A version but simply reflects an interest in v.h.f./u.h.f. techniques rather than in h.f.-bands communication".

This is hardly a positive encouragement to Class B licensees to prepare for a 12 words per minute Morse test! A very different attitude from the American Radio Relay League which continues to support graded Morse tests for all amateur radio licences!

The Merriman Report

As someone with an interest to declare in both radio communications and broadcasting I would have liked to feel that the three wise men of the Independent Review committee have been truly impartial in their recommendations. But the fact is that, both in the interim and final reports, broadcasting has been clobbered unmercifully by a committee on which broadcasting was not represented at all, although accounting, at the outset, for the use of 45 per cent of the spectrum between 30 and 960MHz. This percentage may seem excessive until you remember that virtually every single person in the UK benefits from broadcast services of entertainment, information and education; relatively few from their own mobile communications.

On the other hand, most of us have a suspicion that the very large parts of the spectrum reserved for Defence purposes are vastly under-used in peacetime and are unlikely ever to be filled even in a major war. Yet the Merriman report saw little scope for any reduction in Defence spectrum, a conclusion with which one presumes at least one of the three wise men—a former Assistant Chief of Defence Staff (Signals) and now a member of a firm prominent in Defence communications equipment—must have been in full agreement.

One recalls that no attempt has been made to re-establish the old Television Advisory Committee. The committee incidentally that presupposed the re-engineering and Bands 1 and 111 for 625-line television.

There are many other curious features of the Merriman report. The insistence that UK frequency block allocations remain "an official secret". The idea that an American FCC-type regulatory body could not work because only a government-body can deal with Defence frequencies. Why not leave detailed Defence assignments to MoD in the American manner?

The more one reads the report the more one gains the impression that the "independent review" was set up with two ideas in mind: (1) to wrest RRD away from the Home Office; and (2) to clobber the broadcasters. It appears to have succeeded in both.

In The Background?

There is a deep-rooted belief that complaints to broadcast engineers about the quality of or faults in broadcast transmissions tend to be met with a single stock phrase: "It was all right leaving me".

In practice this is often an entirely justified statement: a networked broadcast signal goes through such a complex path after it leaves its originating studio that there is almost unlimited scope for the gremlins to get to work.

An example, fortunately of a rare type, occurred recently on one of my recordings for the weekly IBA's Engineering Announcements that go out on Tuesdays (9.15 a.m.) on *Channel 4*. As luck would have it I was describing the new automatic test equipment (MATE) becoming available to the 50 IBA mobile maintenance teams that spring into action when anything goes wrong at a transmitter, most often these days due to the effects of lightning on overhead mains supply lines or on equipment. But my words were accompanied by background music that seemed determined to become "foreground".

A first reaction was that the producer or someone in master control had decided to liven up the programme but had overdone it a bit. When I enquired, everyone firmly denied having any part in jazzing me up and assured me it was all right leaving them.

Finally, it was discovered that the music was entering the system at BT's National Television Switching Centre in London. But the mystery remains—whose music was it? Where was it originated? How did it get mixed into network television? And for what purpose was it going along high-quality music lines? Only British Telecom knows the answers!

Signals From Space

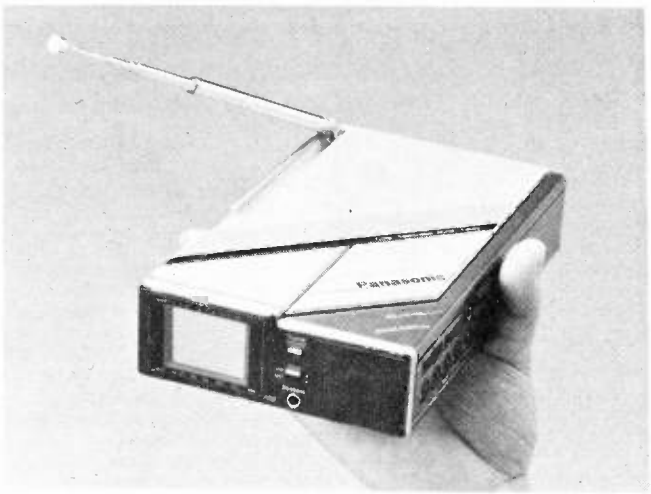
Although there are still sensitive receivers attached to giant aerials searching (so far vainly) for radio signals that could denote the existence of extra-terrestrial intelligence, enormous scientific knowledge has been gained over the past 50 years from random noise and also from the curious pulsar signals, first observed in the 1960s and initially thought to come from those elusive little green men.

It was exactly 50 years ago that Karl Jansky of Bell Laboratories, first announced that he had found that radio signals were coming from space, while investigating atmospherics. And almost 45 years since an American radio amateur, Grote Reber, W9GFZ, built the world's first steerable radio telescope.

It is also 41 years since British radar expert J. S. Hey recognised that what was thought to be deliberate enemy jamming was the result of an enormous solar flare and became "the father of British radioastronomy," inspiring Sir Bernard Lovell, Sir Martin Ryle and J. L. Pawsey to begin intensive investigations that developed into the science of radioastronomy and so opened a new window on space.

EVERYDAY news ... from the world of

WORLD'S SMALLEST COLOUR TV



Pictured here is the world's smallest colour TV from National Panasonic Division of Matsushita Electric of Japan which had its first public showing at this year's Chicago Consumer Electronics Show.

Designed around a conventional, but newly-developed, 1·5in screen, miniature picture tube, the colour "Travelvision" is equipped with video input terminals, making it convenient as a video monitor as well as a portable TV. The set can be powered from a.c., d.c. car battery, rechargeable and dry batteries.

Before you rush out to try and purchase a set, it should be pointed out that Travelvision is only suitable for the American TV broadcast system. To-date, no plans have been tabled for the UK and European systems.

Designed specially for the American market, it looks as though Travelvision has stolen a march on the Sinclair flat-screen TV. As the Americans would say, "Eat Your Heart Out Clive".

COMPUTER FAIR

THE second London Computer Fair, sponsored by *Practical Computing* and *Your Computer*, was held at Earls Court from 16 June for four days. Last year, this event saw nearly 38·5 thousand visitors through its gates and this year, the figure has increased to nearly 48 thousand.

The growth of the Computer Fair reflects the enormous growth in the personal computer market, for it is users at this end of the market that the show caters for. Machines ranging from the diminutive Sinclair ZX81 at £40 to powerful business microcomputers costing more than £3000 will account for an astonishing £1·4 billion worth of business in 1983.

Such is the success of this event that similar shows have been organised for the North (Belle Vue, Manchester, 24–26 November, 1983), the Midlands (Bingley Hall, Birmingham, 3–6 May, 1984) and back in London for a special Christmas Fair at the Wembley Conference Centre (15–18 December, 1983).

All the major manufacturers were at the Fair although few had anything really new to display. However, with lots of working machines on their stands, potential purchasers can get "hands-on" experience and talk to the experts all under one roof.

Software to try out was also in abundance, mostly in the form of arcade type games (and the imagination of some of these games compilers is stretched to incredible limits!), but also some home and business management systems.

The Acorn stand was devoted entirely to the BBC microcomputer range and the forthcoming Electron computer was noticeable only by its absence. However, they were demonstrating the Econet local area network, which can link up to 254 BBC micro stations in a data exchanging system.

Exhibiting at their first UK exhibition, Oric Products International had on display the 16K and 48K machines and the recently launched Oric four-colour printer. This retails at £170 and has full alphanumeric and graphics capabilities.

Maplin Electronic Supplies introduced Cashtel (Computer Aided SHopping by TELephone) at the Computer Fair, a system whereby customers can interrogate Maplin's stock levels and place orders directly using a variety of computers at home. Also displayed was their extensive range of hardware, software and add-on kits.

Also worthy of a mention is the new Texas Instruments CC-40 portable computer. With a liquid crystal display and measuring only 240 × 145mm, the CC-40 offers true briefcase portability. With 6K of on-board RAM expandable to 18K and low cost peripherals including a printer/plotter, Wafertape data storage and RS232 interface, it forms a versatile system.

A company more known for their high quality add-ons for the ZX81, Memotech had their first public showing of the all new MTX-500 computer, suitable for home, business or educational use. Standard features include 32K of user RAM (expandable to 512K), 16K resident ROM, 16 colours and a 79-key keyboard.

In all, there were over 130 exhibitors, 23 of these in the special "Sinclair Village", a separate portion of the show dedicated exclusively to companies producing a whole range of goodies for the ZX81 and Spectrum. Finally, a "Club Avenue" for regional and national computer clubs completed the scene, some of which now produce very professional magazines for members.

electronics

LIVING WITH ROBOTS

The British Engineerium, Off Nevill Road, Hove, East Sussex has launched a new exhibition called Living With Robots *and the official opening took place on 29 July, with Patrick Moore, the television presenter presiding over the ceremony.*

The display incorporates many of the more famous robots of television fame. A replica of K9, the Dr Who robot was on display but it did not seem too impressed with its surroundings and would not work. Star Wars was also represented with replicas of models used in the film on show and last but not least the industrial robots like the 600-Fanuc, a programmable robot welder.

London Earth Station

A satellite earth station in the heart of London's dockland is to be built by British Telecom International.

The earth station, London's first, will be operational early next year. It will transmit television programmes to cable TV systems in the UK and in Europe, and provide the capital's businesses with advanced telecommunications services.

The earth station will be located at Pier Road, North Woolwich, close to the old King George V Dock. Initially two dish aerials, 13m (43ft) in diameter, will be ready for service early in 1984. One will operate through the European Communications Satellite (ECS) and the other through an INTELSAT satellite.

The Western Australian Government is to establish a Technology Directorate as a focal point for its drive to encourage technological development in the area.

SHUTTLE POWER

A contract worth more than $100,000 has been placed by NASA with Gould Micro Power Products Division to provide zinc-air power packs for use on board the Space Shuttle.

The power packs, which each contain 60 zinc-air power cells, will be used to operate an in-cabin radio system that enables astronauts to communicate with each other and with the ground, while maintaining freedom of movement inside the orbiter.

RADIO TRANSFER

The Radio Regulatory Department, including the Directorate of Radio Technology, has been transferred from the Home Office to the Department of Trade and Industry.

The Broadcasting Department of the Home Office is not being transferred. Its responsibilities include: constitutional aspects of broadcasting; cable programme services; direct broadcasting by satellite (DBS); BBC and IBA finance; TV licensing; technical planning policy; and local and community radio.

EVENTS

The ***Great Home Entertainment Spectacular*** takes place from 17 to 25 September at Olympia, London.

The 10th International Broadcasting Convention—***IBC '84***, will be held at the Metropole Conference & Exhibition Centre, Brighton from 21 to 25 September. Technical Sessions will be run throughout the show.

Sponsored by Jeffries Hi Fi, the ***South Coast Hi Fi Show*** *is to be held at the Royal Albion Hotel, Old Steine, Brighton, from 11 to 13 November, 1983.*

The international cable and satellite television industry is to have a major exhibition at its European focal point in Basel, Switzerland. ***"Eurocast '84"*** *will take place in the halls of the Swiss Industries Fair from 5 to 9 May next year.*

HRH Prince Philip talking to Mr. & Mrs. Frank Chorley after the award ceremony.

Prince Philip Medal

The 1983 Prince Philip Medal of the City and Guilds of London Institute was presented to Mr. Frank Chorley by HRH Prince Philip in the Music Room at Buckingham Palace. Mr. Chorley is Deputy Chairman and Managing Director of Plessey Electronic Systems Ltd.

Since 1962, the City and Guilds of London Institute has conferred the Prince Philip Medal, its highest award, on an individual who has received an Institute qualification and subsequently shown outstanding achievement in technology or in service to industry. Only one medal is awarded each year and the final choice is made by HRH Prince Philip who is the Institute's President.

British Lead

British standards are being used in ninety-eight per cent of viewdata and teletext sets throughout the world. This is revealed by a survey undertaken for British Telecom, Mullard Ltd. and the Department of Trade and Industry.

The survey, which identified more than 2¼ million viewdata and teletext sets in 26 countries, was carried out by the US-based consultancy, CSP International Inc.

All amateur radio licences will be issued and renewed by the Post Office headquarters in Chesterfield on behalf of the Secretary of State for Trade and Industry.

The annual salary survey of pay and other benefits in computing, conducted by the National Computing Centre, once again shows that, on straight salary terms, salaries tend to be higher in the public sector than in private industry.

NO FAIR THIS YEAR

Electronic Hobbies Fair Victim of Recession

An announcement in this issue explains the reasons behind the decision not to proceed with this year's Electronic Hobbies Fair. The news will be a great disappointment to thousands who enjoyed their visit to last year's Fair and had been looking forward to this year's event. Additional special attractions had been lined up to extend the overall interest of the Fair, and a number of national organisations had declared their intention of participating. But in the end the whole exhibition depended upon the retail trade that serves the hobbyist and home constructor.

Trade is still in the doldrums and despite frequent optimistic predictions from economists, the eagerly awaited revival still seems as far off as ever. So, for the present, we can only hope for a general improvement before too long, and for a future Electronic Hobbies Fair that will signal this change in fortunes in an unmistakable manner.

LETTERS

Two-Tone

Sir—Seeing Mr. Johns' item in the July '83 *Circuit Exchange* (page 423) about his *Two-Way Doorbell* reminded me of the modification I made to the *Modulated Tone Doorbell* from the March '81 issue of EVERYDAY ELECTRONICS.

This involves inserting a "steering diode" between the two halves of the circuit. An additional switch, S2, will apply 9V to both halves, giving a frequency modulated tone as normal. The original switch, S1, now only applies the power to IC1b and associated components, giving a single, clear tone.

A. B. Wilson,
Bradley,
Yorkshire.

To effect Mr. Wilson's modifications, the diode is placed in the 9V line between IC1a and IC1b with the cathode (k) towards IC1b (referring to Fig. 1, page 180, March '81 issue). It is important that the power connection to IC1 (pin 14) is transferred to the IC1b side of the circuit. Pins 4 and 10 remain as shown.

The additional push-button switch (S2) is connected between the anode (a) of the diode and the positive (+) of the battery, B1. A 1N4148 diode is a suitable device. Some alteration of stripboard layout is necessary.

Key Question

Dear Paul Young—With reference to your piano keyboard question in *Counter Intelligence* in the August issue of EE.

Established musicians will quite naturally be against typewriter or computer keyboards. I can imagine that after having spent years in becoming proficient on a traditional keyboard, the thought of spending a long period adjusting to an "alien" keyboard, trying to rid yourself of deeply ingrained techniques would come as a deep shock. I think that it is thus quite understandable that musicians will not like the idea of new-type keyboards.

On the other hand there is one vast disadvantage of computer keyboards. Piano keyboards are essentially "analogue" devices. They produce a sound whose loudness is proportional to their velocity. In other words, hit the keys harder and you get a louder noise. Computer keyboards, on the other hand, are "digital" devices. They are either "on" (pressed) or "off" (not pressed). This lack of expression due to using electronic keyboards is a serious handicap to a musician's creativity. This lack of expression is not such a handicap as one may suppose, as good recording and re-mixing facilities can work wonders. It does, however, mean that "live" playing is severely restricted.

The ideal solution is to produce a musical instrument which can be "pre-programmed" by a computer keyboard or played "live" by a traditional keyboard, with "dynamic expression" (the harder you hit the keys, the louder the sound produced). The Fairlight computer musical instrument possesses all these (and a great many more) abilities, its only real drawback being its price. At around £14,000 each I don't think I will be giving many as Christmas presents this year.

I have noticed that from time to time you have expressed an interest in the paranormal. One method of testing for telepathy is achieved by allowing a computer to secretly choose one of five "Zener cards". The subject under test then has to guess which card the computer chose. This process continues for a set number of guesses after which the computer prints the percentage of correct guesses.

You will be asked to submit 100 guesses by the computer. The arithmetic behind the results is as follows:

In five guesses you may score one by pure chance.

In 100 guesses you may score 20 by pure chance.

Hence any score significantly above, say 25 per cent (a statistically adjusted figure to take into account the small number of guesses) may, if repeatable, indicate precognition.

For more information about current thoughts and research in this field consult the book "Mind Over Matter" by Kit Pedler, published by Thames/Methuen. This book provides a layman's guide to the subject and, perhaps most important of all, is completely non-sensationalistic: a definite antidote for an overdose of the Von-Daniken's!

In conclusion, may I say that I have read and enjoyed your articles in EE since 1974 and have enjoyed them all. Please keep it up, your article is the first thing I read when I receive EE.

Christopher Stone,
Hull,
North Humberside.

Soft Apple

Sir—As a rule, I do not purchase an electronics magazine unless an initial perusal reveals an interesting article likely to be completed without too much difficulty.

Accordingly, the article *Real-Time Clock Apple II* in EVERYDAY ELECTRONICS (Vol. 12, No. 5, May 1983) caught my attention and was read with interest.

However, a closer study prompts me to believe that the article is incomplete, as generally throughout the article and specifically on page 274, reference is made to enclosed programs for initialisation, testing, setting and reading the clock when installed on the Apple II and these appear to have been omitted from the above edition. Your comments would oblige.

D. Elliott,
Brisbane,
Australia.

In reply to your comments concerning the omission of the program listings for this article, it is not our normal policy to print the software (unless it is a very short routine—a test program for example) as we are primarily an electronics magazine and therefore more concerned with the hardware. All programs are available from the EE Software Service, *either in cassette form or as a listing. The order codes for this project (Apple II version) are T002 and L002 respectively, and the current price is £2.95 inclusive.*

We regret any confusion arising from the wording of this article.

Oric Interface?

Sir—I read with interest the article *Microcomputer Interfacing Techniques* by Mr. Adams and Mr. Feather, in your July '83 issue.

I am an avid reader of your publication and found the article most enlightening; however, I noticed you select four specific microcomputers and provide abundant details with relation to those particular machines. However, as the owner of an Oric 1 64K computer, I am at a complete loss to know how to utilise the information contained in the last edition.

I would be obliged if it were possible for you to supply details in order that the circuitry in question can be interfaced with the Oric and look forward to hearing from you at your earliest convenience.

N. R. Fineman,
Southgate,
London.

Unfortunately your Oric 1 computer does not have the necessary user port to carry out the interfacing techniques described in this series. Although the Oric uses the 6502 microprocessor (as used by the four computers described in the series), it does not have the 6522 Versatile Interface Adaptor integrated circuit on board so an additional user port add-on is required.

At present, we do not have a suitable circuit on file, but you may be able to obtain one from an outside supplier. However, we have noted the need for such a project and a design may well be featured in the not too distant future.

Gen On The Generator

Sir—I have followed the *Test Gear '83* series with zest, making each project as soon as your magazine comes out. So what has happened to the *Frequency Meter?*

Incidentally, the value of the tantalum bead capacitor (C15) in the *Pulse Generator* (July '83 issue) cannot be obtained. It is listed as a 100µF, 25V component, but a 100µF, 10V tantalum capacitor is readily available and works well.

The VHF Aerial Pre-Amplifier by Hamid Reza Tajzadeh *(Circuit Exchange,* August '83) was found to be of little use as all modern TVs are UHF but it worked well on my car radio. Also, is there more "gen" on the *Pulse Generator* testing and use?

L. R. B. Turner,
North End,
Portsmouth.

With regard to Mr. Tajzadeh's VHF Pre-Amp, the TV system in Iran is still VHF (unlike our own, which has recently switched exclusively to UHF) but we felt that this circuit would be useful in other applications, for example, f.m. radio.

As far as more information on testing and using the Pulse Generator, *it is our usual policy to only publish the details supplied by the author if we deem these to be sufficient. However, if you have any particular problems, we would be happy to answer them or forward your query to the author.*

Concerning the Frequency Meter, *the final unit in the series, unfortunately due to circumstances beyond our control this instrument will not now be featured in this magazine. We hope this has not inconvenienced too many readers.*

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.

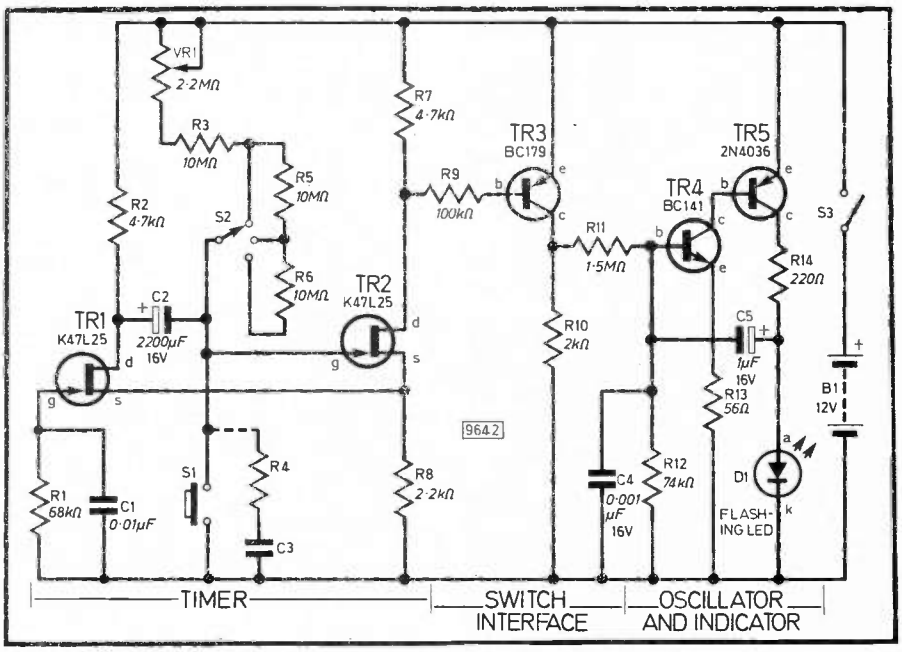
F.E.T. DARKROOM TIMER

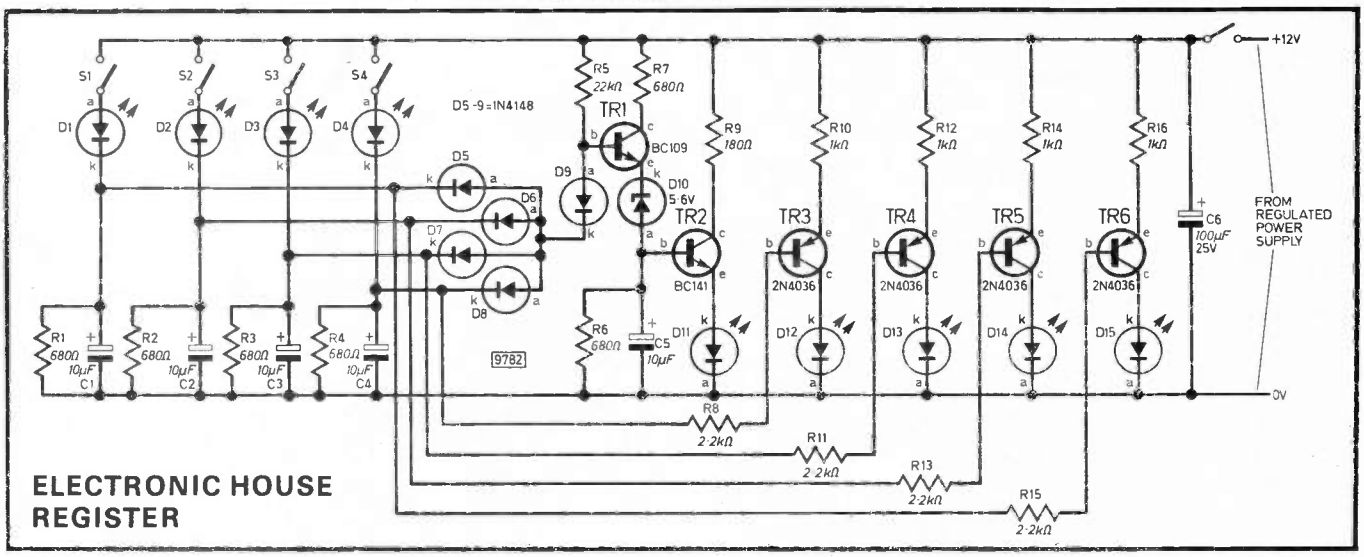
My circuit comprises a pair of f.e.t. transistors wired as a monostable, a transistor interface switch, and oscillator circuit that drives an l.e.d. on and off (flashing) when the set time is reached.

The timing monostable is made up of f.e.t. transistors TR1 and TR2 wired in the source (emitter) coupled mode with capacitor C2 and R3, R5, R6 and potentiometer VR1 being the time determining components.

The advantage of using f.e.t. transistors is obvious as we all know that these are voltage operated devices and as such does not impose limitations on the values of timing resistors; thence an extended time is possible. S1 is the time start push-button switch, which when depressed pulls TR2 gate to earth potential, reducing TR2 conduction, thus reducing the voltage created by resistor R8. TR1 then begins to conduct and brings down its source voltage across R2.

Toh Eng Kiong,
Singapore.





ELECTRONIC HOUSE REGISTER

This circuit is capable of monitoring four occupants in a house; of course my basic design could be expanded to register more than this number.

When the main switch is ON, l.e.d.s D12–D15 are lighted, indicating that the four occupants are OUT with switches S1 to S4 opened. L.e.d.s D1–D4 are fitted in the occupants' rooms and will only be lighted when their respective switches are closed, to indicate that the occupant of that particular room is IN. For example, S1 for l.e.d. D1, S2 for l.e.d. D2, etc. When this happens any of the related l.e.d.s D12 to D15 will switch OFF. When all the four occupants are IN each closing their respective switches S1 to S4, l.e.d.s D1 to D4 light up, whilst D12 to D15 shut off and D11 will glow to indicate that all four occupants are IN. The master indicator l.e.d. D11 and individual room indicators D12 to D15 are contained on the main control panel installed in the Monitor's room.

This system is effective to eradicate the problems of determining the presence of the four occupants especially in the night when the main house door has to be closed, thus ensuring that none of the occupants are shut out. Of course this system can only operate effectively if the occupants are made to remember to switch on their respective switches when in their rooms and to shut off (open) the respective switches when leaving.

Toh Eng Kiong, Singapore.

SHORT WAVE RADIO

BY R. A. PENFOLD

Covers the entire short-wave spectrum from 1·5MHz to 30MHz in three tuning ranges

DESPITE increasing competition from other fields of amateur electronics, short-wave radio remains very popular, and deservedly so. Commercial communications receivers tend to be rather expensive, but it is possible to learn a great deal about short-wave radio and have just as much fun using an inexpensive home-constructed receiver.

The short-wave radio described here covers the entire short-wave spectrum in three tuning ranges which are (approximately) as follows:

Range 3 1·5MHz to 4·8MHz
Range 4 4·6MHz to 14·5MHz
Range 5 9MHz to 30MHz

Ready-made coils are used and the range numbers used above are those of the coil manufacturer (Denco). Plug-in band changing is used, and this simply entails plugging-in the appropriate coil for the desired tuning range. This is a common method of band changing in simple short-wave sets, and helps to minimise the cost and complexity of the set.

The output of the set is intended for high impedance (4000 or 2000 ohm) headphones, but medium impedance types also produce good results. A crystal earphone gives acceptable quality at minimal cost. A low impedance earphone is *not* suitable.

An external aerial is required, but this does not need to be a large or elaborate type, and even a few feet of wire mounted indoors will give quite good reception.

THE CIRCUIT

The circuit is a tuned radio frequency (t.r.f.) type, and although this is a basic type of receiver, it can nevertheless give very good results if used skilfully. Fig. 1 shows the circuit diagram of the receiver.

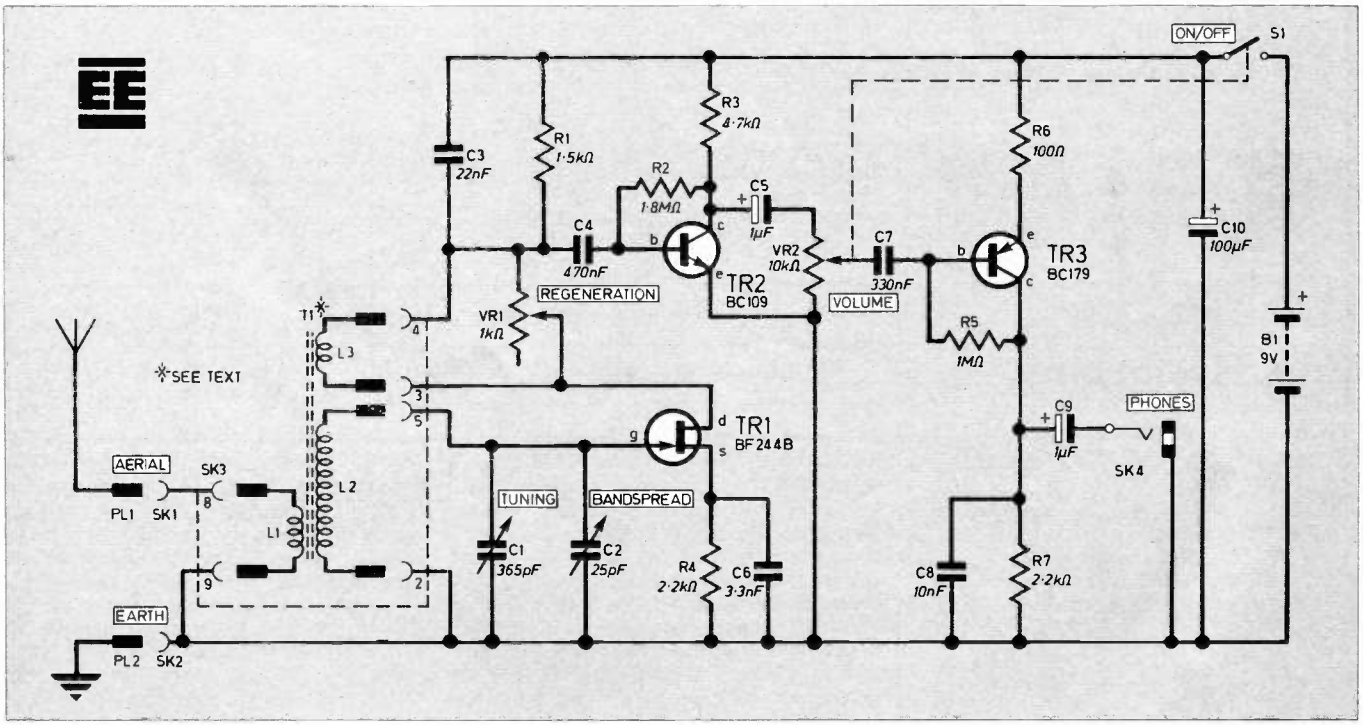
The aerial signal is coupled to the primary winding (L1) of r.f. transformer T1. The main secondary (L2) of T1 forms a parallel tuned circuit with variable capacitors C1 and C2. This tuned circuit acts as a simple filter which selects signals over a narrow band of frequencies, and attenuates signals outside this passband. C1 is the main TUNING or BANDSET control, and C2 is used for fine tuning and is called the BANDSPREAD control.

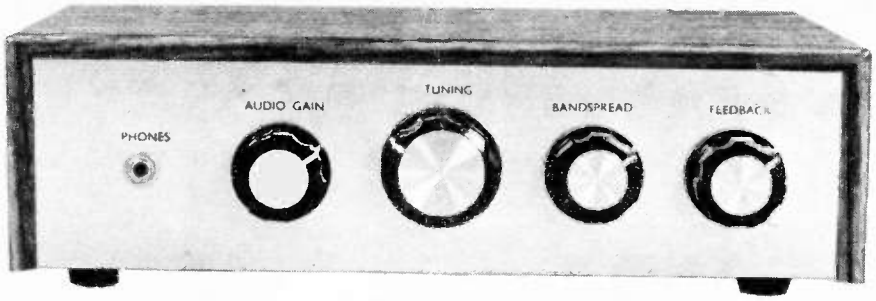
The output of the tuned circuit is directly coupled to the input of a common source amplifier based on TR1. This stage provides detection in addition to r.f. amplification. Detection is produced because TR1 tends to amplify one set of half cycles more than the other, giving an inefficient form of rectification. C3 is the r.f. filter capacitor and C4 couples the audio output signal to the next stage of the receiver.

A third winding (L3) on T1 is included in the drain circuit of TR1, and this provides positive feedback over the circuit. In this way, some of the signal is coupled back to the input of the circuit to be amplified for a second time. This is known as regeneration, and VR1 shunts the L3 winding on T1 so that the amount of regeneration can be controlled. The higher the resistance through VR1, the less it shunts the feedback winding L3 and the greater the amount of regeneration that is obtained.

Apart from boosting the gain of the circuit, regeneration has two other useful effects. Firstly, there is more feedback at frequencies towards the centre of T1's passband than there is towards the edges of the passband. This tends to boost gain more at the centre than at the edges, shar-

Fig. 1. The circuit diagram of the Short Wave Radio. T1 is the interchangeable Denco tuning coil.





pening the response of the filter. Thus the "selectivity" of the receiver is increased so that it is more able to pick out the desired station from the crowded short-wave bands.

Secondly, the efficiency of the rectification provided by TR1 is boosted by the regeneration, giving a substantial improvement in detection efficiency.

There is a limit to the amount of regeneration that can be used, and if this limit is exceeded, the detector stage goes into oscillation and proper reception becomes impossible. For optimum results, the level of regeneration should be set just below this threshold.

As the audio output from TR1 is at a very low level, it is necessary to have a large amount of audio amplification to produce a strong enough output for sufficient volume from the set. Therefore, two stages of audio gain are used, and the first of these is a high gain, common emitter stage built around TR2.

The signal is then coupled by C5 to VOLUME control VR2 and then to a second common emitter amplifier, TR3. The full gain of TR3 is not needed and is therefore used to introduce negative feedback which reduces the voltage gain of this stage. C8 reduces the high frequency response of the output stage and aids the stability of the circuit.

The current consumption of the circuit is about 4mA, and a small 9V battery (PP3 size) is more than adequate to supply such a small current.

CONSTRUCTION

METAL CASE

A metal instrument case measuring about 230 × 130 × 64mm (or any similar metal case) is used to house the receiver. It is necessary to use a metal case as some of the connections are carried through the case. The general layout of the unit can be seen from the photographs, and it is strongly recommended that this should not be radically altered as it is important to keep some of the leads in the r.f. part of the circuit reasonably short.

Mechanically, the receiver is quite straightforward apart from the mounting of C1 and T1. C1 can either be mounted using three countersunk 4BA screws passing through the front panel and into threaded holes in the front plate of the component, or by a single 4BA screw passing through the bottom panel of the case and into a threaded hole in the base plate of the capacitor.

The second method is the simpler of the two, but spacers must be used over the mounting screw to bring C1 to the correct height. With either method, it is essential to use short screws that will penetrate C1 by no more than 3 or 4mm, as the threads might otherwise damage the plates.

COIL BRACKET

T1 is mounted on an "L" shaped aluminium bracket made from 16 or 18 s.w.g. aluminium, and this is detailed in Fig. 4. The lower part of the bracket is fixed to the base panel of the case using 6BA fixings, and a B9A valve holder (SK3) is mounted on the upper part of the bracket, again using 6BA fixings. The positions of the two small mounting holes for the valve holder can be marked on the bracket using the holder as a template, once the main 19mm diameter hole has been made using a chassis punch.

The coils have a base which plugs into the B9A valve holder, and the bracket is mounted in a position that enables the coils to be plugged into the holder through a 19mm diameter hole punched in the rear panel of the case. This enables the coils to be changed over without having to remove the outer cover of the case.

COMPONENT BOARD

The component panel is a 0·1 inch matrix stripboard having 31 holes by 16 copper strips, and this is illustrated in Fig. 2. First cut out a board of the specified size using a hacksaw, and then drill the two 6BA clearance (3·3mm diameter) mounting holes. Then make the single break in the copper strips before fitting and soldering the components into place, leaving the semiconductors until the end.

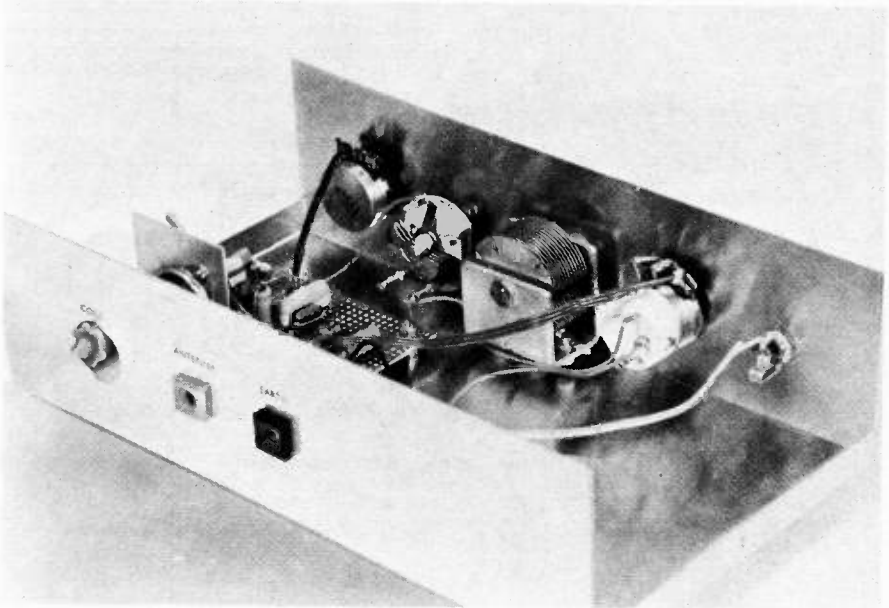
Veropins are used at points where off-board components will be connected, and these are tinned with solder. The finished board is then mounted on the base panel of the case between T1 and VR1. Use spacers over the 6BA mounting screws to hold the connections on the underside of the board clear of the metal case.

Fig. 3 shows the wiring needed to complete the receiver, and this is all done using ordinary 7/0·2mm, p.v.c. insulated connecting wire. The leads carrying r.f. signals, particularly those connecting to C1, C2, and T1 should be kept as short as possible, but in other respects this wiring is straightforward.

AERIAL AND EARTH

A long-wire aerial is required, and this is simply a length of aerial wire connected to SK1. Ideally, an outdoor aerial about 10 or 20 metres long should be used, and the wire should be mounted as high as possible, well clear of buildings or other large obstructions. It should also be insulated from the aerial supports to prevent the signals received from being leaked away to earth.

View inside the chassis showing the general layout of components and the method of inserting the tuning coils through a hole in the rear panel.



SHORT WAVE RADIO

COMPONENTS approximate cost £27

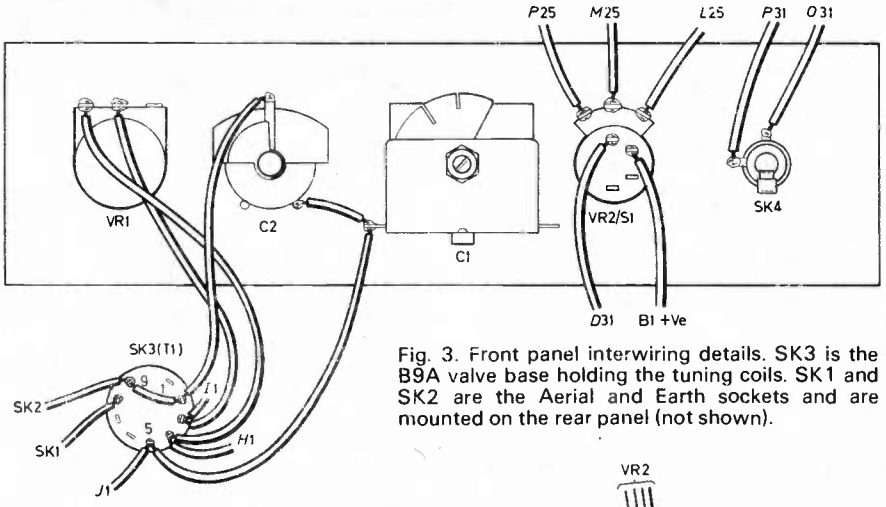


Fig. 3. Front panel interwiring details. SK3 is the B9A valve base holding the tuning coils. SK1 and SK2 are the Aerial and Earth sockets and are mounted on the rear panel (not shown).

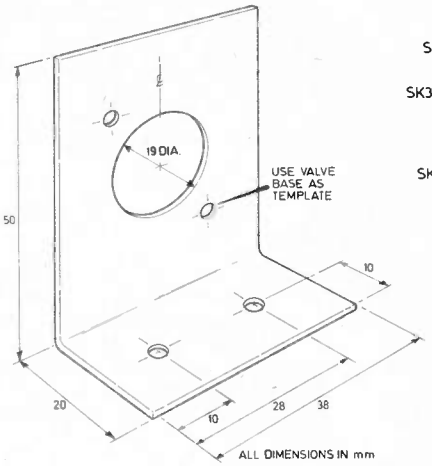
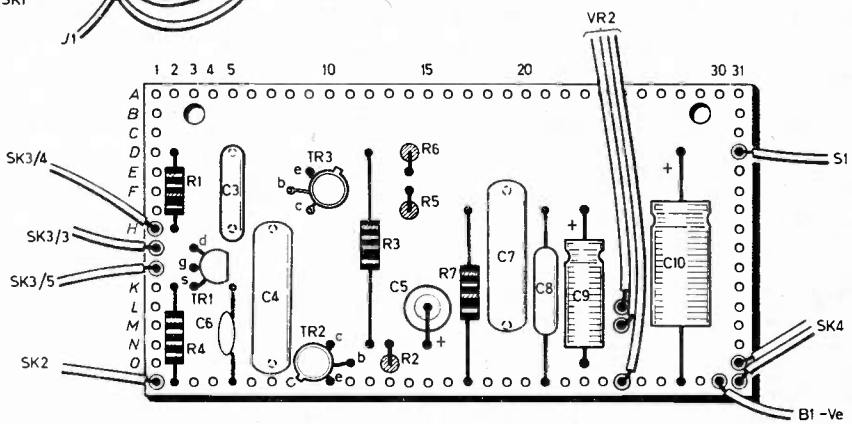


Fig. 4. The coil mounting bracket for holding the valve base (SK3) parallel to the rear panel.



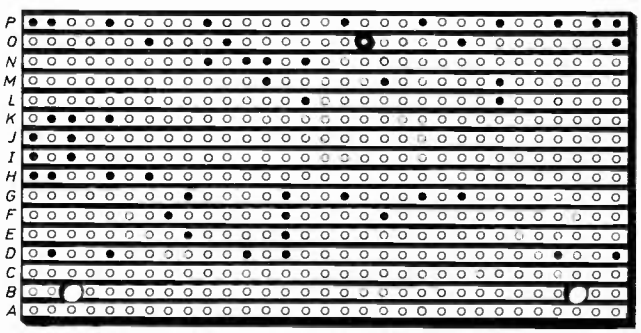


Fig. 2. The component layout of the Short Wave Radio circuit board.

COMPONENTS

See Shop Talk page 629

Resistors

R1	1·5kΩ
R2	1·8MΩ
R3	4·7kΩ
R4,7	2·2kΩ (2 off)
R5	1MΩ
R6	100Ω

All ¼W carbon ±5%

Capacitors

C1	365pF Jackson type O air spaced variable capacitor
C2	25pF Jackson type C804 air spaced variable capacitor
C3	22nF polyester
C4	470nF polyester
C5,9	1µF 63V elect. (2 off)
C6	3·3nF ceramic
C7	330nF polyester
C8	10nF polyester
C10	100µF 10V elect.

Semiconductors

TR1	BF244B *n*-channel j.f.e.t.
TR2	BC109 *npn* silicon
TR3	BC179 *pnp* silicon

Miscellaneous

VR1	1kΩ linear carbon potentiometer
VR2/S1	10kΩ log. carbon potentiometer with s.p.s.t. switch
SK1,2	4mm banana socket (2 off)
SK3	B9A 9-pin valve holder
SK4	3·5mm jack socket
T1	Denco Green D.P. coils (3 off, ranges 3, 4, 5)
B1	9V PP3 battery

Stripboard, 0·1in matrix, 31 holes by 16 strips; metal case 230 x 130 x 64mm; 18 s.w.g. aluminium 70 x 40mm; high impedance headphones with 3·5mm jack plug; 4mm banana plug (2 off, for earth and aerial); 7/0·2mm connecting wire; 6BA and 4BA mounting hardware; battery clip; control knob (4 off).

It is not essential to use an outdoor antenna though, and about 10 metres of aerial wire strung around a room or in a loft will give quite good results, although a proper outdoor aerial will give significantly better reception when propagation conditions are poor.

An earth connection will improve matters, especially on the low frequency bands (that is, when using the range 3 coil). An earth connection can be made to a metal plate or pipe buried in the ground, and the plate or pipe should preferably have an area of about 0·25 square metres or more. The lead which connects it to SK2 can be made from aerial wire and should be no longer than necessary.

USING THE SET

VR2/S1 is a combined on/off switch and volume control, and in normal use it is best to advance VR2 to maximum, with this control only being backed-off if a strong station produces excessive volume. C1 is used to tune the set to the band which is to be searched for stations, but fine tuning is accomplished using C2. This covers only a small part of each tuning range, and consequently tuning is much easier using this control.

VR1 is the regeneration control, and it is essential to use this control properly if good results are to be achieved. With this control fully backed-off (set in a fully anticlockwise direction) it is likely that few, if any, stations will be received. Advancing VR1 should result in improved results with greater sensitivity and selectivity, but if it is advanced too far, the set will go into oscillation.

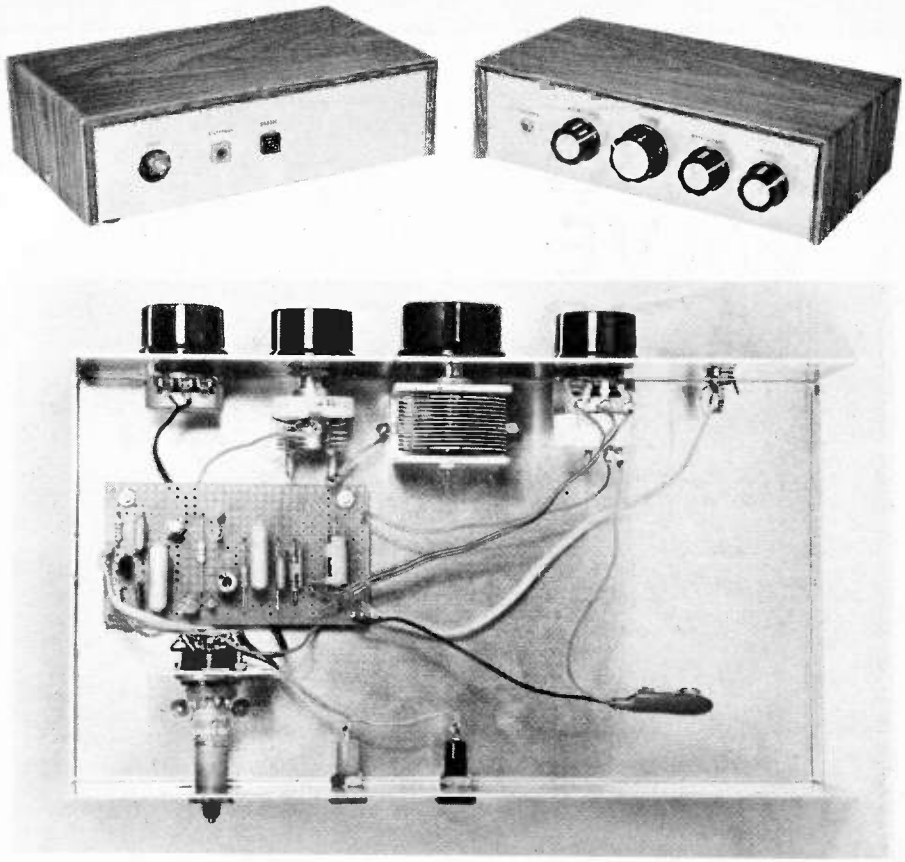
With the set in this state, received stations will be accompanied by an audio tone which will vary in pitch as the tuning is adjusted, and it will be impossible to receive stations properly. For best results, VR1 must be carefully set just below the point at which oscillation occurs and it may be necessary to slightly reset VR1 each time the tuning controls are shifted by more than a small amount.

When first trying out the set, it is probably best to use the range 4 coil as several of the popular broadcast bands are within the frequency coverage of this range, and these will usually provide a great many strong stations at any time of the day or night. The high frequency bands are included in the coverage of the range 5 coil, and are excellent for long distance reception. However, these are mainly daytime bands, and normally fade-out during the hours of darkness.

There is only one main broadcast band within the coverage of the range 3 coil, and this is quite small. The 160-metre amateur band will be found towards the low frequency end, and this may provide a.m. transmissions from local "hams".

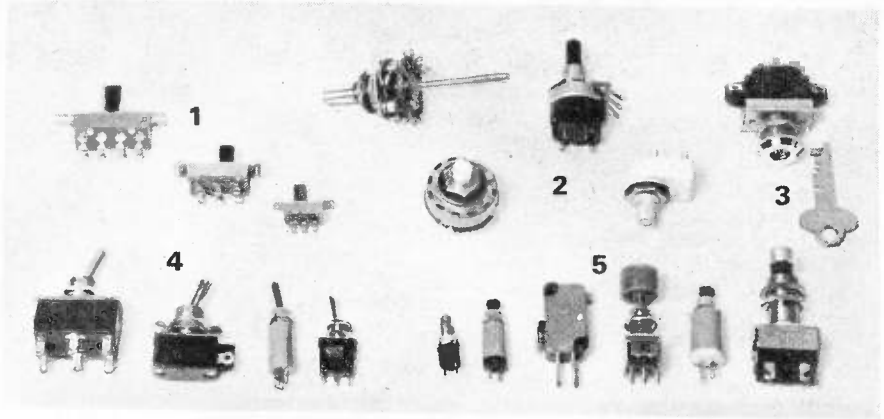
Single sideband (s.s.b.) and Morse (c.w.) are commonly used on the amateur short-wave bands in preference to ordinary a.m., and the receiver can resolve this type of transmission if VR1 is advanced slightly beyond the threshold of oscillation. However, the tuning controls must be adjusted very carefully in order to give a proper audio output from an s.s.b. transmission.

The three coils are supplied with their adjustable cores fully screwed down into the coil former, and it will probably be found that correct coverage is obtained with the cores in this position. If the coverage is found to be incorrect, the cores can be adjusted to rectify this. □



A plan view of the prototype Short Wave Radio showing the routing of the wiring. Connections to the tuning coils and variable capacitors should be kept as short and direct as possible.

SQUARE one FOR BEGINNERS



Photograph above shows groups of various types of switches, including: (1) slide switches; (2) rotary switches, including the wafer type and a control potentiometer with integral switch; (3) key operated on/off switch; (4) four different sizes of toggle switch; (5) a selection of push-button switches with momentary action types, a microswitch and left, a latching version.

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

SWITCH CONFIGURATIONS

The simplest switch form is the **Single Pole Single Throw** (abbreviated to s.p.s.t.) and this type has a single "pole" with one other terminal, connection being made between the two when the switch is operated. Some examples of these simple on/off switches are given in Fig. 2.

The **Single Pole Double Throw** switch (s.p.d.t.) has only one "pole" but with two other terminals and activating will switch the connection to the pole from one terminal to the other. For this reason it is also known as a *Single Pole Change-Over* switch.

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

In similar fashion, the **Double Pole Double Throw** (d.p.d.t.) switch is two change-over switches mechanically linked and operated by the same mechanism. Also referred to as a *Double Pole Change-Over* switch. See Fig. 1.

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

Alternatively, the non-latching or momentary action switch will change its state when depressed but return to its original state when the actuating force is removed.

Miniature push-button switches are examples of non-latching (see Fig. 4) and fit into a further two categories: the *push-to-make* switch, being off in the natural state and on when pressed (*normally open* contacts); and the *push-to-break* switch, being on in the normal state and off when pressed (*normally closed* contacts).

OTHER SWITCHES

The rotary wafer switch (see Fig. 3) consists of a rotating mechanism onto the spindle of which is placed wafer switch elements. The pole of the switch is connected to a wiper contact which sweeps around the wafer making contact with the terminals of the switch. Each position is latched and an adjustable stop enables the switch to be custom designed for any number of "ways".

The microswitch is a useful device (see Fig. 2) usually being a single pole change-over switch operated by a very small push-button and requiring very little actuating force.

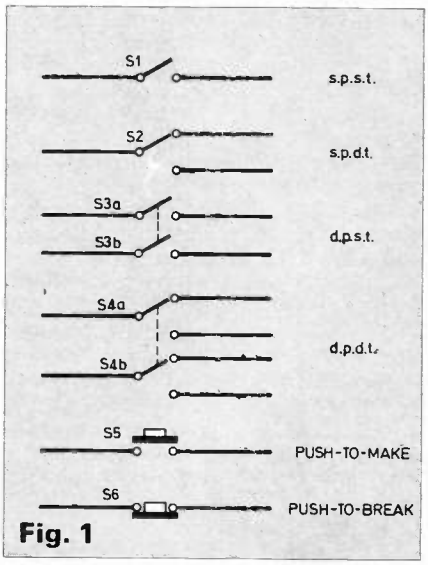


Fig. 1. The circuit symbols of the four basic switch configurations plus the two types of simple push-button switch.

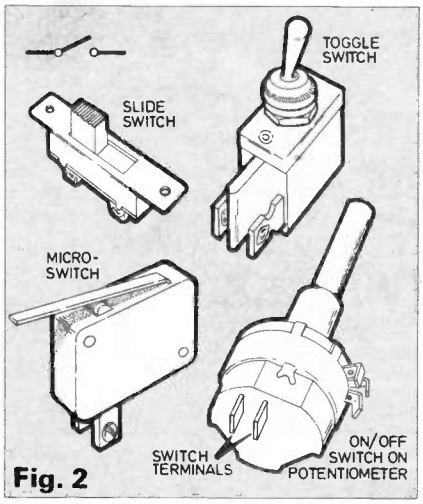


Fig. 2. Four types of s.p.s.t. (on/off) switch, one of which is mechanically coupled to a control potentiometer. A microswitch is also shown.

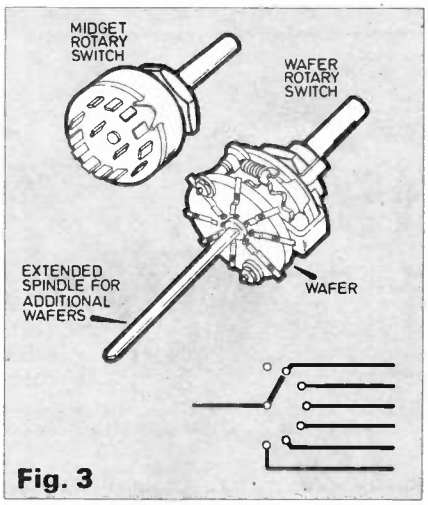


Fig. 3. Two rotary switches and the typical circuit symbol. The wafer switch can be extended by adding more wafers. The maximum number of "ways" for both types is usually 12.

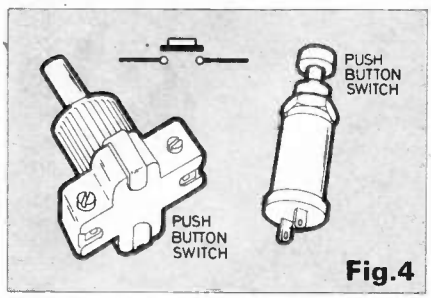


Fig. 4. Two push-button switches, one with screw terminals (for table lamps and so on), and a miniature non-latching switch.

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.

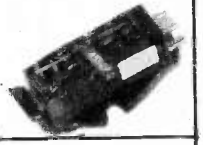
• NOISE REDUCTION SYSTEM • AUTO STOP • TAPE COUNTER • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS • TWIN V.U. METER • WOW & FLUTTER 0.1% • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TAPES.

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.

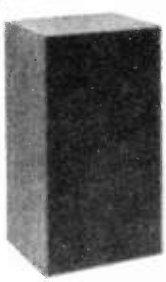
STEREO CARTRIDGES

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.

SPEAKER KIT 2 WAY 10 WATT



8" bass/mid range and 3¼" 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.

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: 13¾"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

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.

*** SPECIAL OFFER! ***
£13.95 (w/out case)
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Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x 8½"x 3¼".
£3.50 Plus £1.50 p&p.

HI-FI TWEETER BARGAIN

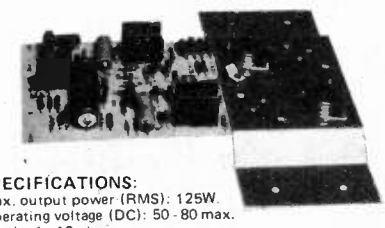
GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3¾"sq.) for use in up to 40W systems; with 2 element crossover.
£3.95 each (p&p £1) or
£6.95 pair (p&p £1.50)

125W HIGH POWER AMP MODULES

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

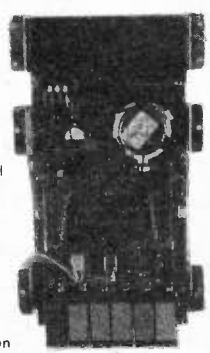
The power amp kit is a module for high power applications – disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously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

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 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.

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 30/7/83 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)
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Telephone or mail orders by ACCESS welcome.

RTVC

ELECTRONIC PENDULUM

BY MARTIN CRAGG

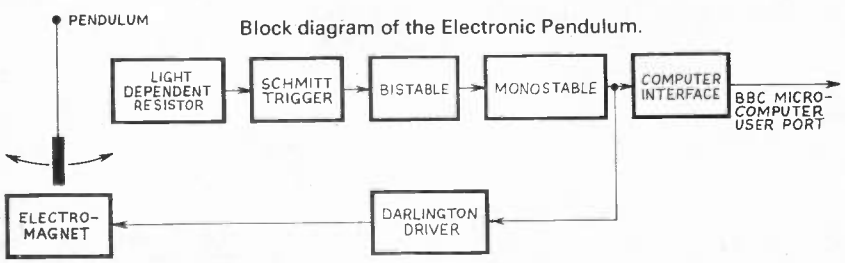
IN "O" and "A" level physics it is often necessary to demonstrate the use of a simple pendulum for determining the acceleration due to gravity. Normal methods, using a retort stand and clamp, cotton suspension, metal "bob", and a stopwatch for timing, are both tedious and time consuming.

This project will enable the physics teacher to set-up and easily demonstrate the principle of a simple pendulum, whilst removing a large proportion of the time consuming element. Using the apparatus it is possible to show that the period of the pendulum is directly proportional to the square root of its length and that the period remains constant, irrespective of the amplitude of the swing, providing amplitude does not exceed 10 degrees of arc.

It may also be shown that by increasing the number of timed swings increases the accuracy of the result and that a moving body will come to rest due to air resistance unless an external force acts upon it.

UNIT DESCRIPTION

A mild steel bob and cotton suspension pendulum are kept swinging at a constant amplitude by an electromagnet sited below the pendulum. Every time the bob passes over the apparatus the electromagnet gives a kick to the pendulum inputting a small amount of energy. The amount of energy is precisely controlled by the circuitry and a constant amplitude of swing results.



Block diagram of the Electronic Pendulum.

A BBC Microcomputer is linked to the pendulum by a simple interface. A pulse from the interface is fed into the user port of the computer every swing of the pendulum. The computer counts the swings and works out the period. Then, using the formula:

$$g = \frac{(2\pi)^2 l}{t^2}$$

the computer calculates a value for "g"

COMPONENTS

Resistors

R1,11,12,13	4·7kΩ (4 off)
R2,3,5	1·2kΩ (3 off)
R4	2·7kΩ
R6	1kΩ
R7,8,14	10kΩ (3 off)
R9,10	68kΩ (2 off)
R15	330Ω

All ¼W carbon ±5%

See Shop Talk page 629

Capacitors

C1,2	0·01μF polyester (2 off)
C3	1000μF 40V elect. axial leads
C4	0·047μF polyester

Semiconductors

D1	1N4148 silicon
D2	TIL220 0·2in red l.e.d.
TR1,2,4,6,7	2N3904 silicon *npn* (5 off)
TR3	2N3906 silicon *pnp*
TR5	2N3053 silicon *npn*
IC1	4001 CMOS quad 2-input NOR gate

Miscellaneous

S1,2	s.p.s.t. toggle (2 off)
VR1	100kΩ lin. control potentiometer
VR2	1MΩ lin. control potentiometer
PCC1	ORP12 light dependent resistor
SK1,2	4mm banana socket red (2 off)
SK3	4mm banana socket white
SK4,5	4mm banana socket black (2 off)

Printed circuit board: single-sided size, 170 x 95mm, *EE PCB Service* Order code 8310-03; case, 193 x 158 x 58 (rear) x 34mm (front), (RS type 508-188); 14-pin d.i.l. holder; 30mm of 12·8mm internal diameter mild steel tubing; 7/0·2mm wire; 36 s.w.g. enamelled copper wire.

Approx. cost Guidance only **£19.00**

the acceleration due to gravity.

Where l = length (metres) of the pendulum and t = the periodic time in seconds.

CIRCUIT DESCRIPTION

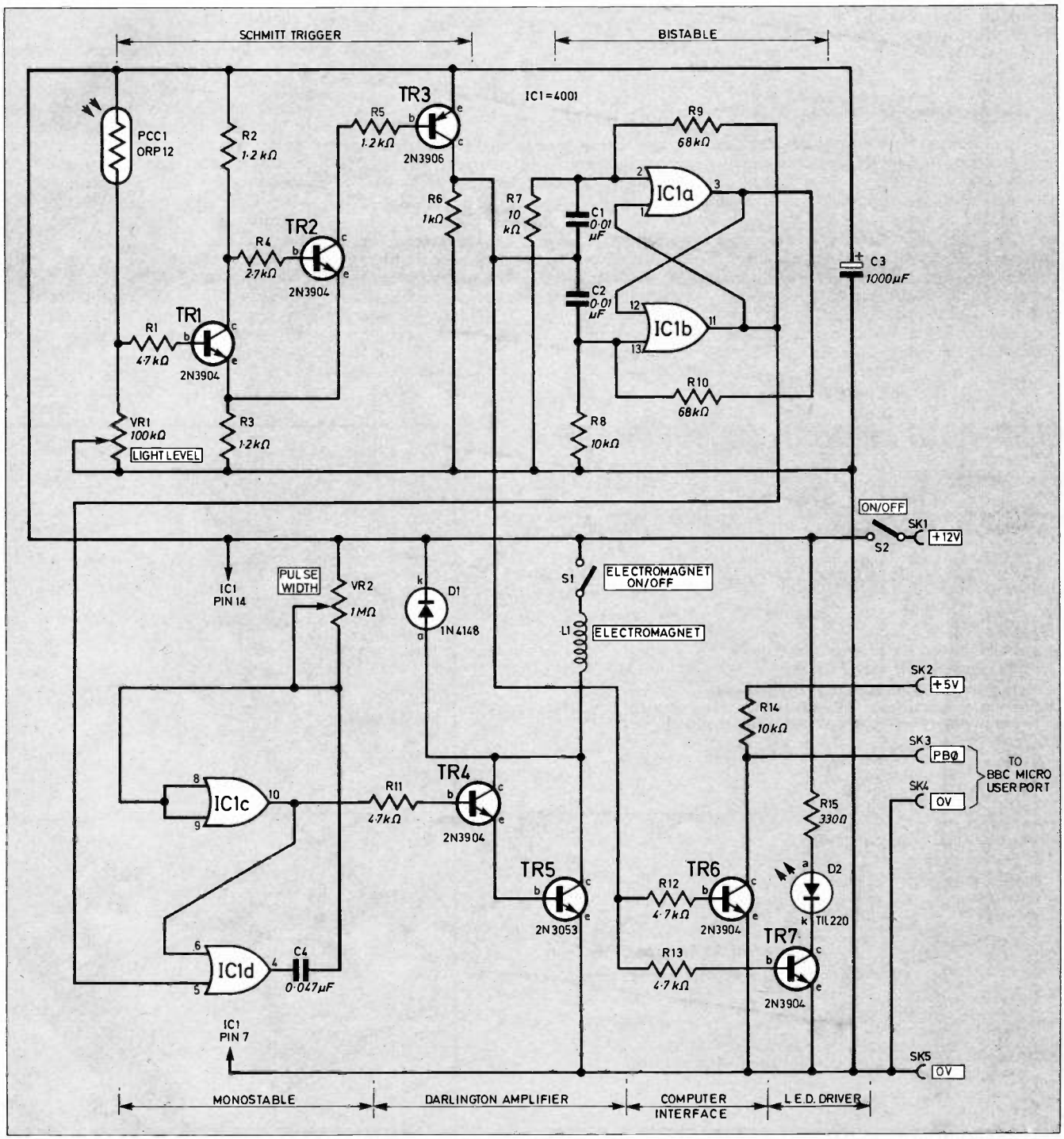
The potentiometer VR1 and the light dependent resistor (PCC1) form a potential divider at the base of TR1. As the pendulum bob passes over the l.d.r. the voltage at the base of TR1 increases. Transistors TR1–TR3 form a Schmitt trigger which provides a good square-wave pulse for the bistable and VR1 is used to compensate the changing light conditions found in the laboratory. The circuit diagram is shown in Fig. 1.

One half of the 4001, a quad 2-input NOR gate (IC1a and IC1b) forms a basic set/reset bistable latch. Resistors R7–R10 and C1, C2 form the necessary a.c. coupling to enable triggering by the pulses received from the Schmitt trigger.

The other two gates in the 4001 (IC1c and IC1d) package are used in a monostable circuit which is triggered by the bistable. The monostable will stay on for a set amount of time determined by the values of VR2 and C4. VR2 is mounted on the front panel of the unit and enables the pulse width to be controlled.

The output from the monostable drives a Darlington pair amplifier (TR4 and TR5). The Darlington pair energises the electromagnet (L1) and gives the bob a

Fig. 1. The complete circuit diagram for the Electronic Pendulum.



sufficient "kick" to maintain a constant amplitude. Switch S1 is incorporated so that the electromagnet can be disconnected to allow free swinging of the pendulum.

The input to the interface circuit (TR6) is connected to the output of the Schmitt trigger, thus TR6 is switched on every time the pendulum bob passes over the l.d.r. The 5-volt supply for TR6 (SK2) is derived from the computer power supply available at the user port.

For connection to the user port consult the BBC user guide. Note that if a separate power supply is used for TR6 it must not exceed 5V as damage to the computer may result. The output from TR6 (SK3) is connected to PBØ of the user port.

CONSTRUCTION

The electronic circuitry is built into an RS Components console case measuring 193 × 158 × 58 (rear) × 34mm (front), although any case of approximately this size should be suitable. VR1, VR2, the light emitting diode (D2) and the electromagnet assembly are mounted on top of the case. The l.d.r. is mounted inside the core of the electromagnet as shown in Fig. 2 and all the connections to the console are made via 4mm banana sockets mounted at the rear of the case.

ELECTROMAGNET

The core of the magnet is made from 12·8mm (internal diameter) mild steel tubing which will accept the l.d.r. as a comfortable fit. The coil of the electromagnet uses 800 turns of 36 s.w.g. enamelled copper wire.

The components are mounted on a printed circuit board (shown in Fig. 3) measuring 170 × 95mm. This is large for such a simple circuit and could be reduced in size considerably. One advantage of such a large board is that various parts of the circuit can be easily identified and fault finding is made simple.

The board is available from the *EE Printed Circuit Board Service*, Order code 8310-03.

PENDULUM

The bob is made of mild steel (soft iron would be better) and measures 30mm in length by 20mm in diameter. A piece of black card is attached to the bottom of the bob and is approximately 35mm in diameter. This disc of card is essential for the operation of the system since it causes the electromagnet to be energised just before the bob reaches the electromagnet as shown in Fig. 4. This gives the necessary kick to the pendulum to keep it swinging.

The support for the pendulum is not critical and is left to personal choice.

The unit is easy to use with the program listed. Set the bob swinging and adjust VR1 until D2 is reliably pulsed on every time the bob passes over PCC1. Adjust VR2 until the amplitude of the pendulum is less than 10 degrees of arc.

This will require patience as the bob will react slowly to pulse width changes. Once the amplitude is correct VR2 will need very little adjustment unless the length of the suspension is changed dramatically. One setting will work for suspension lengths between 0·5 and 1m.

OPERATION

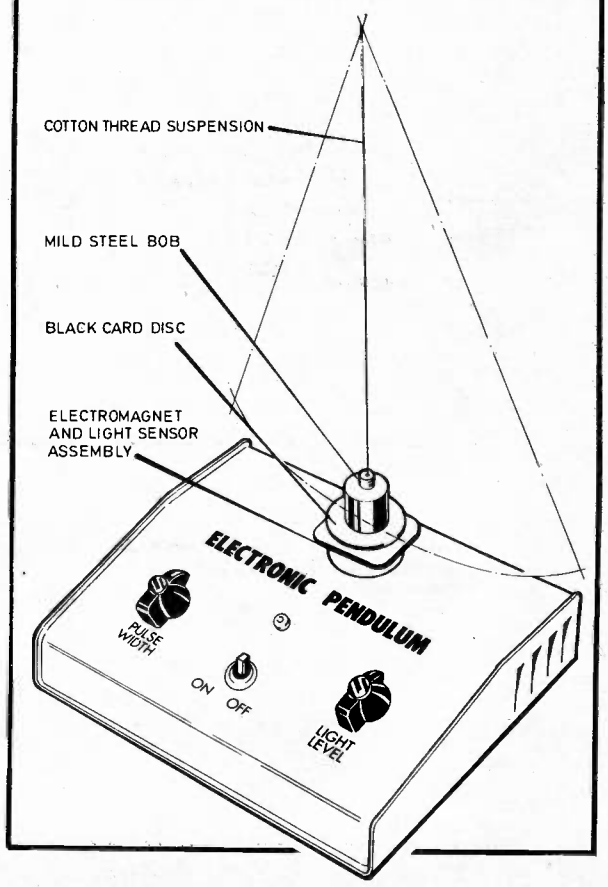
Run the program and enter the length of the pendulum, and remember, the length of the pendulum is measured from the centre of the bob to the pivot. When the computer is counting the swings, the elapsed time will be displayed in the centre of the visual display unit. Fairly accurate results are obtained with ten swings although accuracy will increase by increasing the number of swings to be timed.

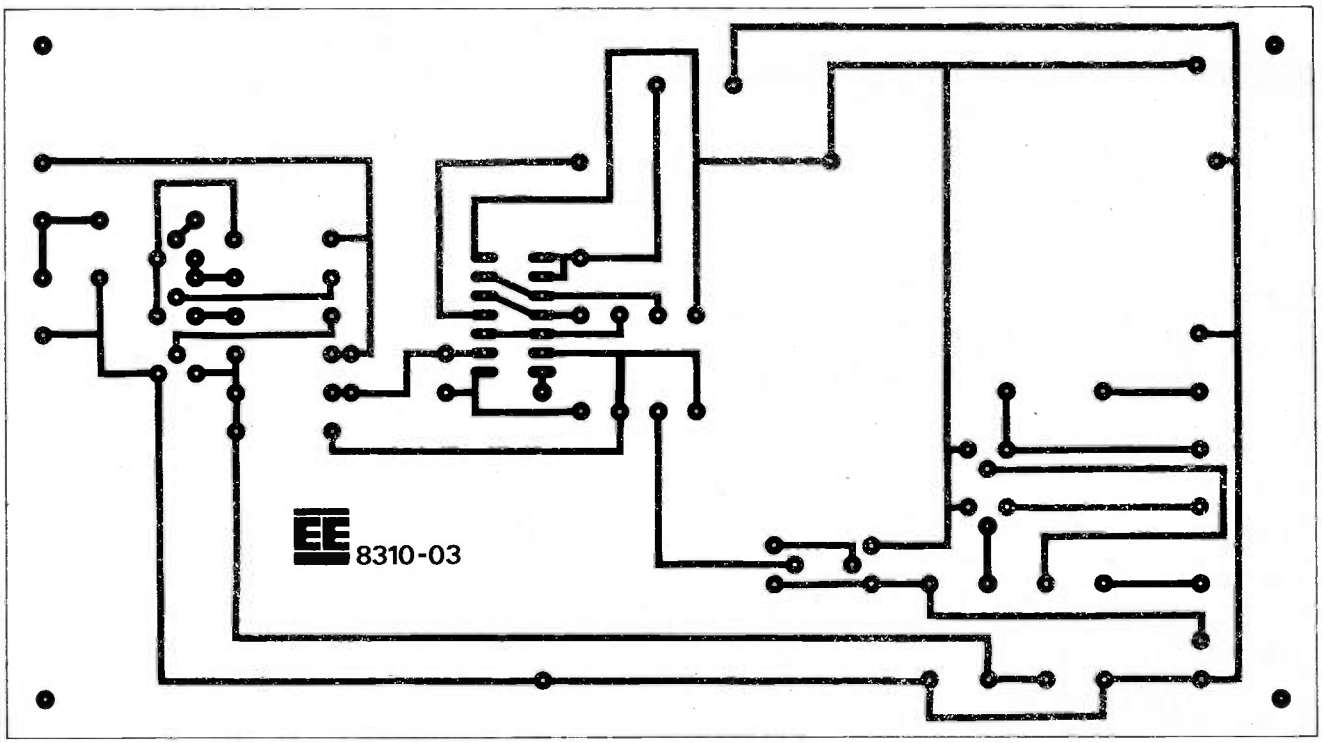
Although this project is used with a BBC Microcomputer it could be used with virtually any microcomputer with a user port. The program listing given is very simple and could be easily adapted to other machines. □

ELECTRONIC PENDULUM SOFTWARE

```
  2 REM Electronic Pendulum
  4 REM October 1983
  6 REM <c> Everyday Electronics
 10CLS
 20 MODE 5
 30PRINT TAB(1,10);"E L E C T R O N I C"
 40PRINT TAB(3,15);"P E N D U L U M"
 45 LET A$=GET$
 60 MODE 7
 70 CLS
 75 PRINT:PRINT
 80 PRINT" PROGRAM TO DETERMINE g. ACCELERATION          DUE TO GRAVITY"
 90 PRINT:PRINT
100 INPUT "INPUT THE LENGTH OF THE PENDULUM IN          METRES",L
110 PRINT:INPUT "HOW MANY SWINGS DO YOU REQUIRE",K
120 PRINT:PRINT:PRINT"PRESS ANY KEY TO CONTINUE"
130 ?&FE62=0
140 A=-1
150 A$=GET$
160 CLS
170 IF ?&FE60 =254 THEN 180 ELSE 170
180TIME =0
190 T=TIME
200 PRINT TAB(14,12);(TIME-T)/100
210X=?&FE60
220IF X=254THEN240
230 GOTO 200
240A=A+1
250 IF A = K*2 THEN 280
260IF?&FE60=255THEN230
270GOTO250
280T1=(TIME-T)/100
290P=T1/(A/2)
300G=((2*PI)^2)*L/P^2
305 LET G=INT(G*100)/100
310 PRINT"LENGTH OF PENDULUM=";L "m."
312 PRINT"NUMBER OF SWINGS=";K
314 PRINT:PRINT"g.ACCELERATION DUE TO GRAVITY=";G;" m/s^2"
320 PRINT:PRINT:PRINT"DO YOU WISH TO RUN AGAIN <Y OR N> "
330 IF GET$="Y" THEN GOTO 70
340 END
```

Fig. 4. Black card disc shown mounted on the mild steel bob.





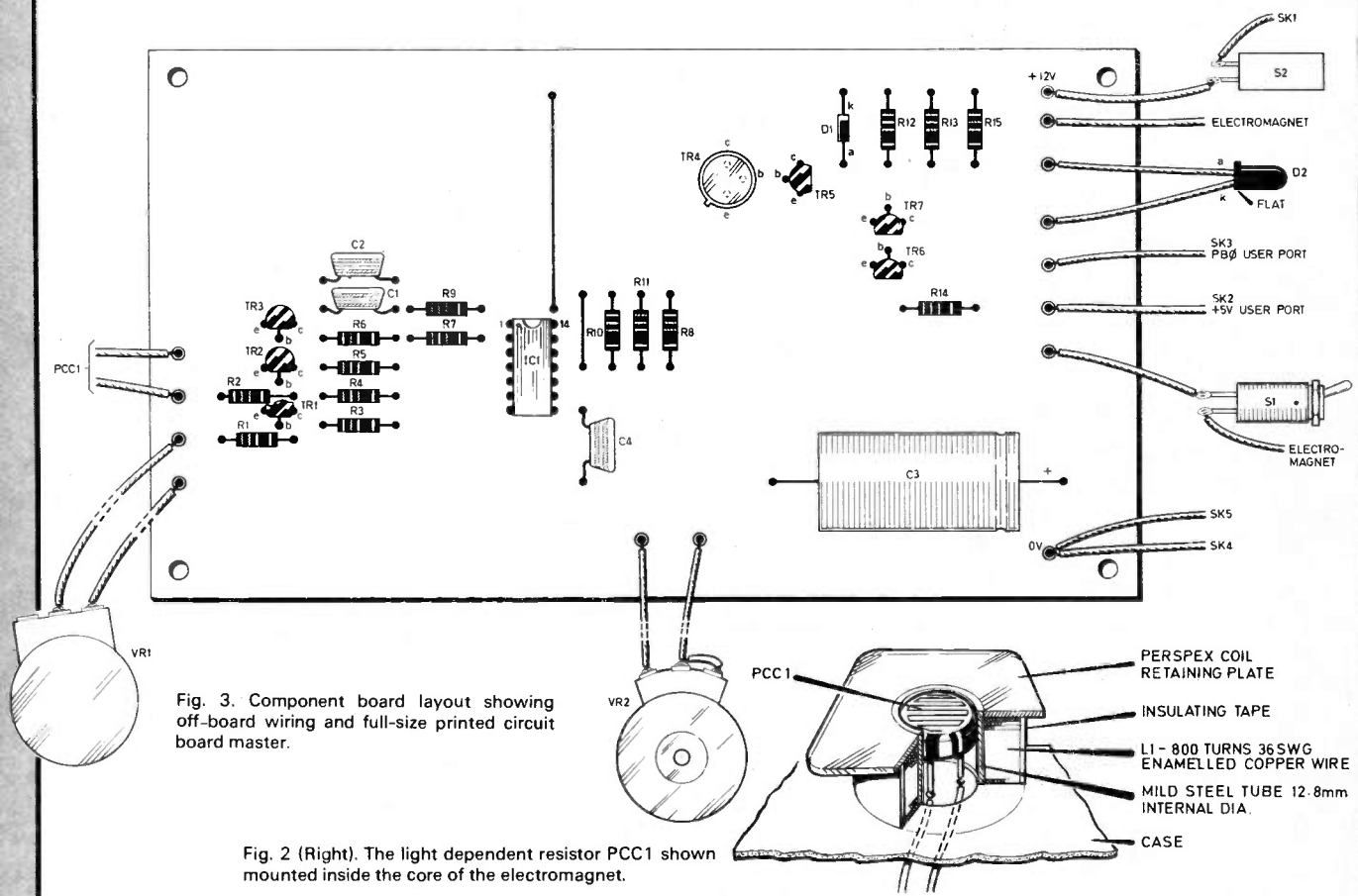


Fig. 3. Component board layout showing off-board wiring and full-size printed circuit board master.

Fig. 2 (Right). The light dependent resistor PCC1 shown mounted inside the core of the electromagnet.

COMPUTER AIDED EXPERIMENTS

USING THE RM380Z MICROCOMPUTER

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

2. NAPHTHALENE COOLING CHARACTERISTIC

THIS experiment uses the 590kH temperature sensor with its associated amplifier (see page 646) to feed an analogue-to-digital converter. The latter is connected to the user port of a 380Z microcomputer which allows the results to be stored and processed to produce a plot in real-time of the cooling curves of various substances.

In the following, naphthalene is the substance under investigation, and the ADC employed is the one featured in EE Sept '83.

Naphthalene is heated to 100 degrees C and the liquid naphthalene is then allowed to solidify and cool down to room temperature. The temperature transducer produces an amplified voltage output proportional to temperature in degrees C, and this analogue voltage is input directly to channel 0 of the ADC. Here the voltage is converted into an 8-bit binary format (byte), which the microcomputer continuously monitors, and plots on the VDU the temperature as a function of time, that is, a cooling curve. In effect, the microcomputer is acting as a voltmeter, which, at the same time plots the voltage variations across it, just as in last month's laser experiments, where the varying voltage was produced as a result of variations in light levels.

EXPERIMENT SET-UP

The experimental set up is shown in Fig. 2.1, and the resulting cooling-curve for naphthalene in Fig. 2.2.

The solid naphthalene is placed in a test tube which in turn is placed in a beaker of boiling water. After a few minutes the naphthalene melts and liquefies. Place the temperature sensor assembly in the 100 degree C liquid naphthalene and RUN the software on the RML 380Z microcomputer. The top right of the VDU should show a decimal number around 200. Our conversion equation is:

$$V = kN$$

$k = (10/255)$, and at 100 degrees C the value of the output voltage (V) should be 8 volts from our amplifier,
therefore

$$N = (V/k) = (8 \times 255/10) = 204$$

Lift out the test tube from the boiling water and allow the naphthalene to cool. As the temperature drops, the microcomputer will start to plot the variation of temperature with time. The curve will initially exhibit a steep drop, due to a large rate of heat loss, but then the curve will be seen to level out to a plateau as the naphthalene begins to solidify, at about 80 degrees C, and it will stay level until all the naphthalene is solid again, when the temperature will start to drop again and the curve will fall but much more gradually than before.

Best results were obtained with fresh samples of naphthalene. Candle wax was also used, but since this is a mixture of several waxes, each one solidified in turn, so the "plateau" had a definite gradient!

Cooling curves are extensively used in the steel industry as a means of determining the purity of molten metals.

The combination of Temperature Transducer/Amplifier/ADC/380Z can be put to less esoteric (but just as important) applications, as the measurement of one's own body temperature, with perhaps the microcomputer responding with a "go and see a doctor" diagnosis?!

Or, at a particular setting of temperature the microcomputer can activate an AUX output on the ADC unit with an appropriate POKE statement. For example if AUX1 is connected to an alarm circuit and if the temperature exceeds 50

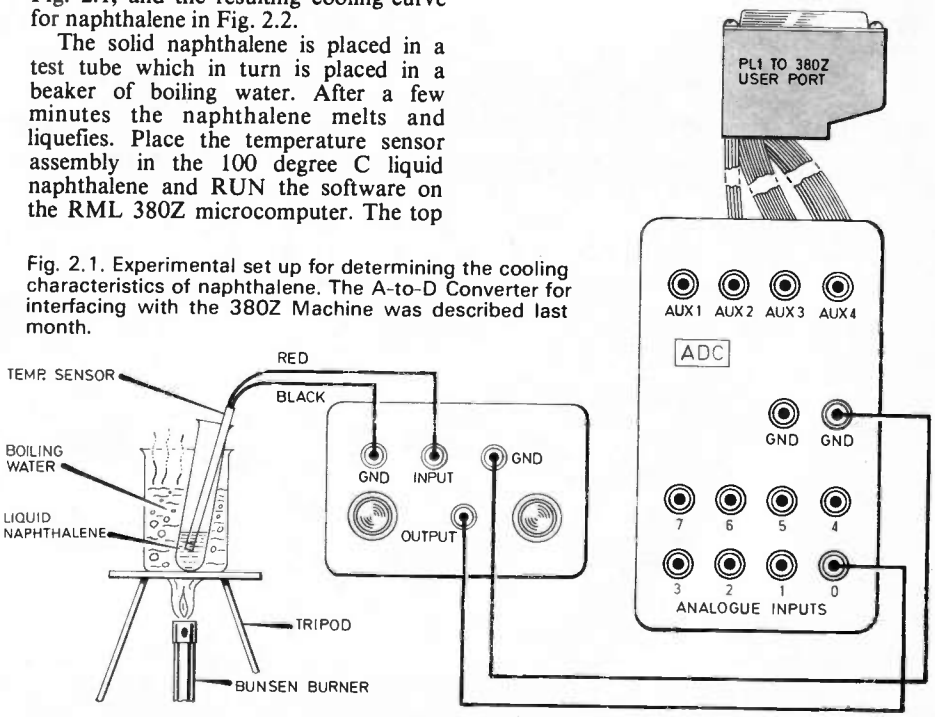


Fig. 2.1. Experimental set up for determining the cooling characteristics of naphthalene. The A-to-D Converter for interfacing with the 380Z Machine was described last month.

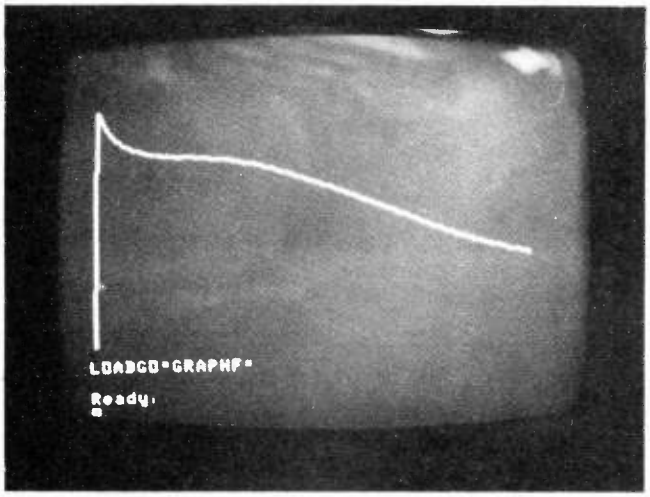
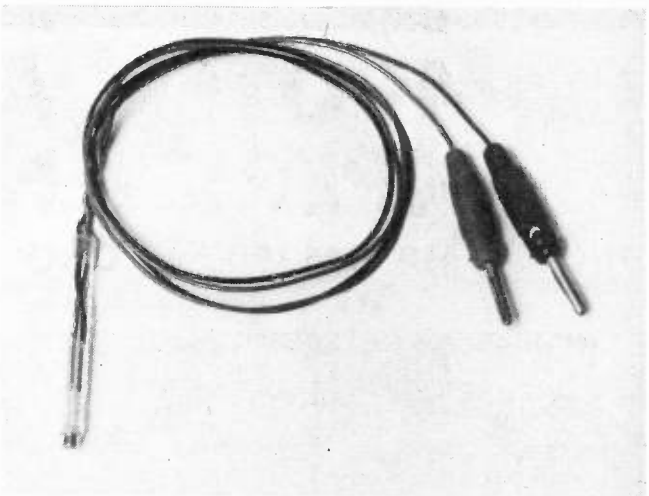


Fig. 2.2. Photograph of the cooling curve for the experiment shown in Fig. 2.1.



The temperature sensor used in this experiment. Full details of this sensor and associated amplifier can be found on page 646.

degrees C then the chances are a fire is starting somewhere. On reading this, the computer then responds with a POKE 64511,128, which makes pin 21 of the 380Z user port go high. This can be used to saturate a transistor, close a relay and turn on an alarm.

Similarly, last month's light sensor could, for example, be used as part of an intruder alarm system with the microcomputer monitoring the voltage output from the light transducer, which if low, could again signal the activation of an alarm.

THE A-TO-D CONVERTER

The ADC referred to is based around the 7581 analogue-to-digital converter chip, having eight separate analogue inputs (channels) each one capable of handling up to 10V maximum input.

Constructors need not confine themselves to this ADC, but can use this temperature transducer/amplifier with any ADC as long as its maximum input voltage is known so that the gain of the amplifier can be tailored to meet that maximum voltage. The same applies to last month's light sensor, where the maximum voltage would need to be divided in order to meet input requirements for other ADCs.

SOFTWARE

The software is almost the same as for Experiment 1 published last month on page 601. The following changes should be made in the main LASER program, and labelled TEMP.

Line 150 was originally

```
150  FOR Z=1 TO 200:NEXT Z
```

Change to:

```
150  FOR Z=1 TO 2000:NEXT Z
```

This is a time delay which needs increasing because of the length of time needed for the naphthalene to cool.

Line 130 was originally

```
130  CALL "LINE" ,I,Y*2,3
```

Change to:

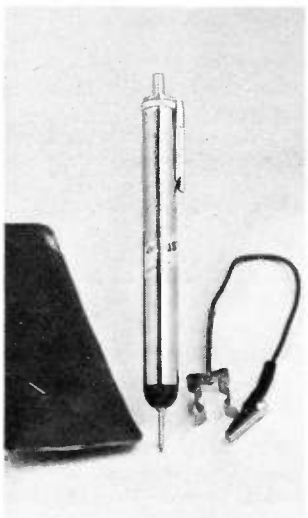
```
130  CALL "LINE" ,I,Y,3
```

This is a call to the plotting routine in the 380Z ROM, the *2 factor has been removed.

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

SIGNAL INJECTOR

A SMALL pocket-sized signal injector, designed as a pen-shaped signal probe, has just been marketed in the UK by **Alcon Instruments Ltd.**



The Chinaglia Usijet incorporates a blocking oscillator as the main signal generator, giving a basic 500kHz signal which is modulated at 1kHz for identification and demodulation check purposes. Because of the waveform used the equipment produces harmonics detectable up to 500MHz very useful for audio, radio and television servicing applications.

In use the probe case is merely connected via a fly-lead to the earth line of the item under test and the probe tip touched to whatever point the signal is required at. The probe can be used in "live" test conditions and it can also cope with circuit voltages up to 500V d.c.

Power consumption is 25mA from an internal 1·5V battery to give a 20V peak-to-peak output at the probe tip. The price of the Chinaglia Usijet Signal Injector, complete with earthing lead and instructions, is £11.55 inc. VAT.

Alcon Instruments Ltd., Dept EE, 19 Mulberry Walk, London, SW3 6DZ.

CONSOLE PROFILE

COMPLEMENTING their existing range of low-line Bimconsoles, **Boss Industrial Mouldings** have just introduced a deeper profile range of small and medium size sloping front cases. These are ideally suited for applications where meters, keyboards or switches are incorporated.

Available in four sizes ranging from 178 × 210 × 76 to 483 × 210 × 102mm, adequate space is also available on the side and rear panels for mains sockets and connectors.

The standard colour scheme is brown base and beige top panels, the units being held together by screws running through rubber feet into hank bushes on the base. Alternative colour schemes are available to special orders, these can have ventilation slots, keyboard cut-outs or switch punchings.

Further information on prices and local stockists can be obtained from:

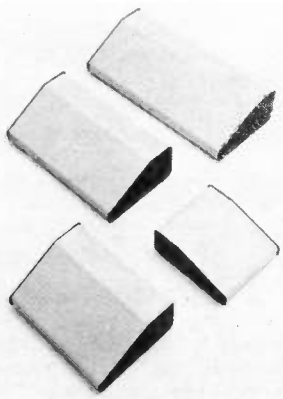
Boss Industrial Mouldings Ltd., Dept EE, James Carter Road, Mildenhall, Suffolk IP28 7DE.

PSEUDO-STEREO

THE first i.c. to combine stereo/pseudo-stereo/spatial stereo sound circuits is now being marketed by **Mullard**. Primarily for use in top-of-the-range TV and portable stereo radios, it can also be used in low-cost mono radios, where it makes possible the reproduction of the stereo effect without the need for expensive stereo decoder circuits.

The possibilities for stereo sound reproduction in the latest batch of TV sets which are coming on the market are, at present, being under-utilised because there are so few stereo TV broadcasts. The TDA3810 allows mono music to be converted into realistic-sounding pseudo stereo.

Basically, the pseudo-stereo circuit in the TDA3810 splits the incoming mono signal into two. One channel is presented straight to the output, while a delay is introduced into all frequencies of the second channel from 300Hz to 2kHz. The value of this delay depends on frequency, and is for example 500μs at 800Hz; this gives the illusion of stereo sound.



The frequencies of the second channel below 300Hz and above 2kHz are taken straight to the output to "fill-out" the sound between the speakers. The effect is, however, subjective, and low-pass filtering has been kept off the chip to allow manufacturers to customise the circuit.

The TDA3810 i.c. gives automatic switching between stereo and mono, with manual switching between stereo/spatial-stereo sound and mono/pseudo-stereo sound. It has outputs to directly drive l.e.d.s to indicate "spatial stereo" or "pseudo-stereo". The circuit operates from a supply voltage of 4·5V to 16V and has a supply current of typically 7mA.

Mullard Ltd., Dept EE, Mullard House, Torrington Place, London, WC1E 7HD.

EXPRESS HANDLES

THE latest edition of Imhof-Bedco Express Service catalogue contains a selection of enclosure handles.

Over 30 different handle styles are featured, many of them in a variety of sizes and fixings. Materials available include brass, chrome, steel, aluminium and plastics.

Styles range from simple bar handles to locking sets which come complete with mounting kit and keys.

Copies of the Imhof-Bedco Express Catalogue and addresses of nearest stockists are available from:

Imhof-Bedco Standard Products Ltd., Dept EE, Ashley Works, Ashley Road, Uxbridge, Middlesex UB8 2SQ.

PORTABLE SOUND AND VISION

THE latest in sound and vision is a portable stereo cassette recorder, m.w./f.m. radio incorporating a black and white TV from **Heron Electronics**, and being marketed under the Ingersoll brand.

The Ingersoll XK500 features a soft touch cassette deck with auto stop and soft eject, slide volume control, two built-in condenser microphones and a telescopic antenna. The TV has the usual brightness, contrast and vertical hold controls and a 4½ inch screen. Loudspeakers are included at each end of the unit.

The approximate retail price of the XK500 is £150 including VAT, and details of local stockists can be obtained from:

Heron Electronics Ltd., Dept EE, Heron House, 19 Marylebone Road, London, NW1 5JL.

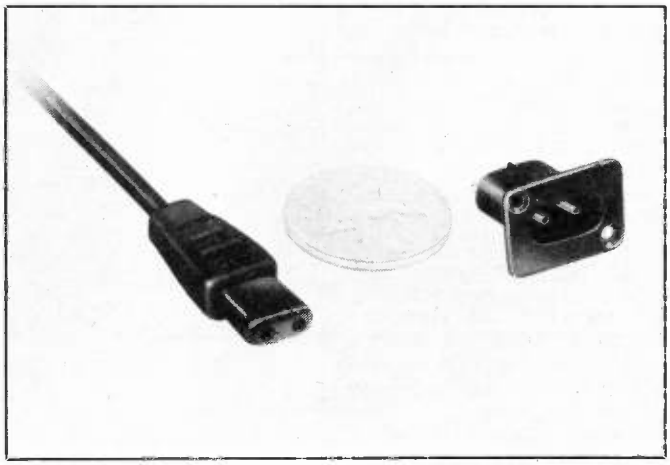
GOOD CONNECTION

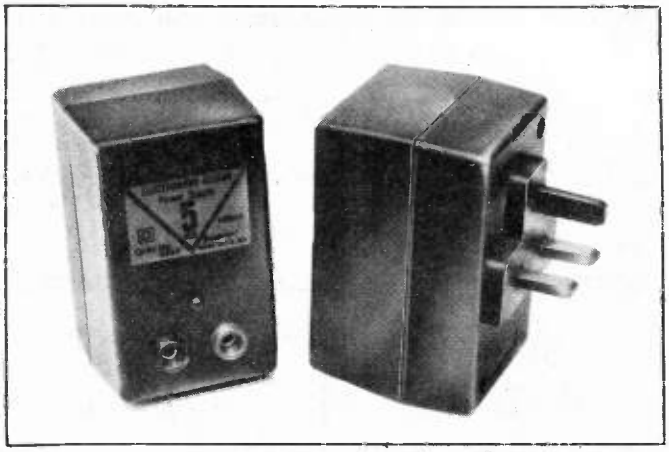
A MINIATURE, low voltage 2-pin connector set, originally designed for connecting batteries to Police Radios is now being marketed by A. F. Bulgin & Co. P.L.C.

The flex connector P750/2M has 2 metres of black 2-core cable terminated at one end with a moulded "female" plug. The chassis mounting inlet P755 is fitted with solder tags and fits a panel hole of approximately 9 × 5mm. The connector is rated at 3A 100V maximum.

Full details and stockists from:

A. F. Bulgin & Co. P.L.C.
Dept EE, Bypass Road,
Barking, Essex IG11 0AZ.





POWER SUPPLIES

A RANGE of low-cost d.c. power supplies suitable for powering logic, microprocessor and linear circuits are being produced by **Electronart Design.**

All units are housed in a 13A plug style case and feature thermal fuse protection and l.e.d. output indicators. The stabilised output is by way of 4mm sockets.

Models are available with single or twin outputs of 5, 12, 15 or 18V d.c. Other "extras" such as crowbar over-voltage protection, Power-on Reset and Power Down signals for microprocessor and memory applications are available.

Further information and prices are available from:

Electronart Design,
Dept EE, 78 Kimberley Avenue,
Ilford, Essex IG2 7AS.

HOME CONTROL SYSTEM

The new Aquarius home computer system from **Mattel Electronics,** has been specifically designed to have practical applications in the house. "Research has indicated that consumers are concerned that if they buy a computer it would be out-dated within three months of purchase," said Michael Lunch, Managing Director of Mattel UK.

In addition to the recent launch of the Aquarius home computer (a *Special Report* will be published shortly), they also demonstrated the prototype of a unique new home control system which is to be launched on the UK market very shortly.

The Home Control System (HCS) simply plugs into the Aquarius via one lead and into the mains via another. Using the computer you can program the system to control lights, electrical appliances, central heating, air-conditioning and any other electrically operated mains powered device.

The System

The system uses the mains wiring in your house, so no extra cabling or installation is required. Each selected light or appliance can be operated by the Home Control System by simply plugging it into a special "coding pod" which in turn plugs into standard 3-pin sockets. Equally, other modules can be attached to wall switches or thermostats, rather like adding a dimmer switch.

The HCS sends coded signals down the mains which are then received by the special modules which in turn activate the electrical appliances. Up to 256 separate items can be controlled and programmed in advance for a series of up to 32 individual on/off events in seven-day cycles.

Programming the system is made easy by the use of graphics indicating the type of room in the house and positions of appliances in the room. Only three keys on the Aquarius keyboard have to be used to carry out programming—from identification of light/appliances to setting the on/off timings and entering the final program.

How It Works

The system works by giving each light or appliance module a code number and then sending signals automatically, via the mains, at the time you have programmed. The module then activates the appliance to turn on or off, in addition, the system is capable of dimming any light to a preset intensity.

For example, it is simple to set a porch light to come on at 8.30p.m. and off again at 12.30. This operation could be set either on a regular daily basis, separately timed for each day or in "security" mode. Security means that the computer will select random times to switch on or off at half an hour either side of the time input—a useful feature should you wish to deter burglars whilst you are on holiday.

The system could also be used to perform a "close down" function in the home or in a small office to make sure that items such as television, electric heaters, lights, and other appliances are not left on overnight.

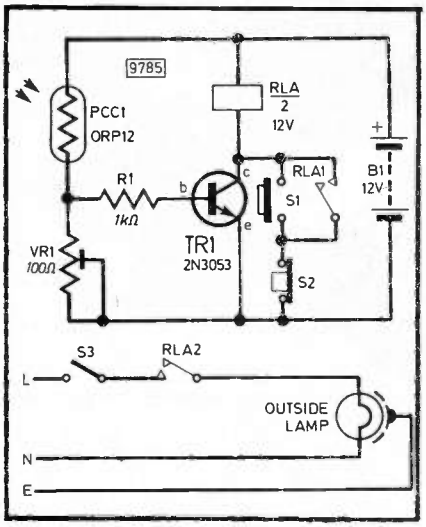
Mattel Electronics UK Ltd,
Dept EE, Mattel House,
North End Road,
Wembley,
Middlesex HA9 0AB.

CIRCUIT EXCHANGE

OUTSIDE LIGHT SWITCH

THIS circuit is for an Outside Light Switch, which can be activated by a car headlight beam. The relay is rated at 12V. The circuit is activated by S1 (push-to-make) and switched off by S2 (push-to-break).

Robin J. Clements,
Sheffield.

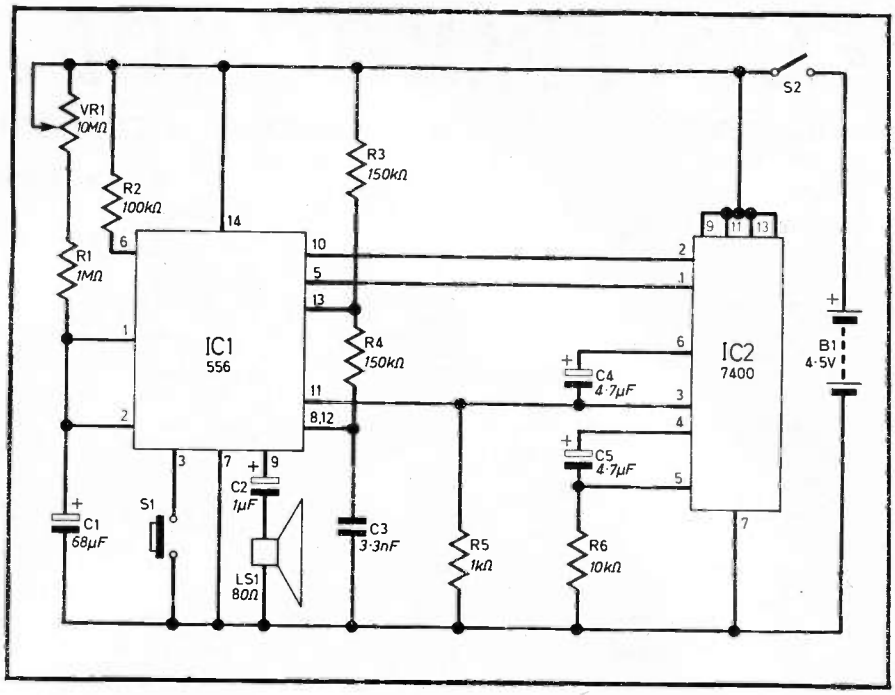


REACTION METER

WHEN the Reaction Meter is switched on each l.e.d. lights up in turn, the frequency at which each l.e.d. lights up can be varied by altering VR1. When S2 is depressed the l.e.d. which was on when S2 was depressed remains on until S2 is released. The idea of the reaction meter is to depress S2 when D6 the only green l.e.d. is lit so that D6 is the only l.e.d. alight. Altering VR1 makes it easier or harder.

IC1 acts as a voltage controlled oscillator. The frequency of the pulses depends on VR1 which acts as a potential divider. As IC2 receives each pulse the output is moved along one so the l.e.d.s light in turn. When S2 is depressed the "diode inhibit" (pin 13) goes high every time a pulse is produced, so IC2 stops counting and the l.e.d., which was lit when S2 is depressed, remains lit when S2 is released. Pin 13 is kept low by R3.

D. J. Sparkes,
Green Lane,
Coventry.

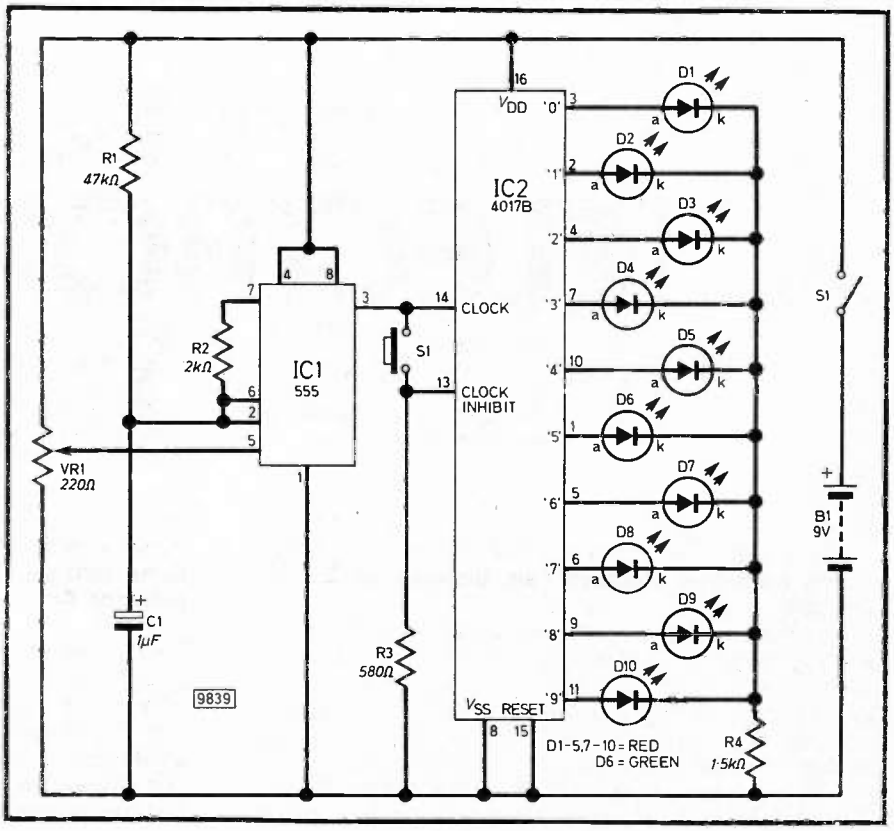


ELECTRONIC TIMER

THIS is an Electronic Timer with a timing range of one to eleven minutes. The lower half of IC1 is used as a standard monostable triggered by S1. This output is inverted by IC2 and fed to the reset pin (11) of the astable constructed from the other half of IC1.

The output from this astable is modulated by a further astable in IC2 and this produces a "whooping" note in the loudspeaker LS1.

Paul Dellar,
Harpenden,
Herts.



ELECTRONIC HOBBIES FAIR

We are sorry to announce the cancellation of this year's Electronic Hobbies Fair, planned for 27-30 October.

In spite of a significant success last year, the continuing recession is hitting the electronics hobby industry pretty hard. This has meant that many companies feel that this year they cannot sensibly allocate the resources of time, money and manpower involved in participation in exhibitions.

We feel that any exhibition sponsored by Everyday Electronics must offer the visitor a full range of components, equipment, projects and demonstrations from a wide selection of companies across the industry. As we cannot be absolutely sure of doing just this, we have decided with regret that we must disappoint our readers now rather than in October.

Everyday Electronics would like to thank those companies who had already given their support to the Electronic Hobbies Fair this year. With our apologies for the disruption of their plans we couple our hopes for a future event in a more buoyant business climate.

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VP6	200	Ceramic Caps Miniature – Mixed	£1.00
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VP9	100	Assorted Polyester/Polystyrene Caps	£1.00
VP10	60	C280 Type Caps Metal Foil Mixed	£1.00
VP11	100	Electrolytics – All Sorts	£1.00
VP12	60	Bead Type Polystyrene Min Caps	£1.00
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TEACHIN 84
Complete kit of component parts.
Price £21.50

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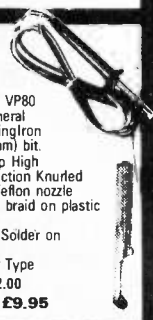

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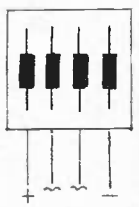

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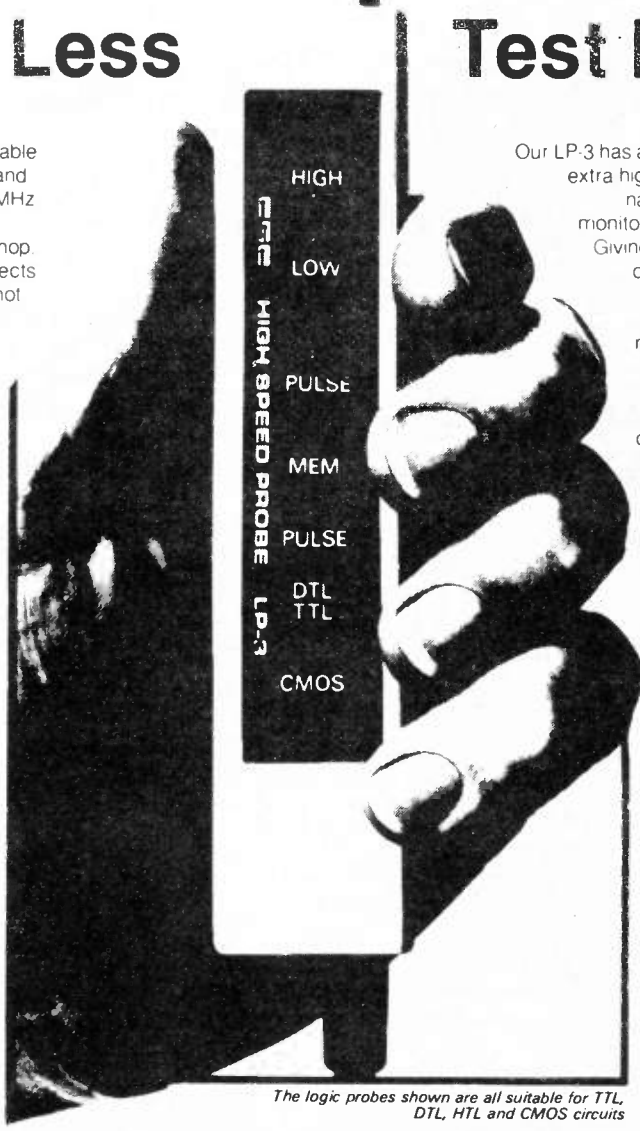

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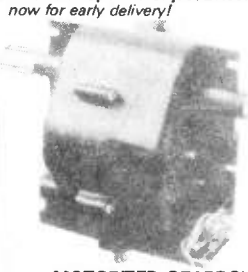

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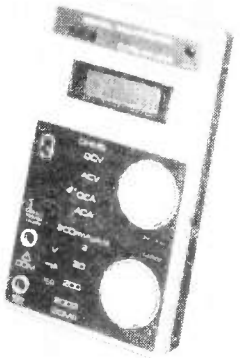

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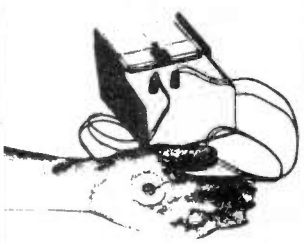

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Not a toy, this precision instrument was originally part of an "Open University" course, used to measure the change in emotional balance, or as a lie detector. Full details of how to use it are given and a circuit diagram. Supplied complete with probes, leads and conductive jelly. Needs 2 4½V batts. Overall size 155 × 100 × 100mm. Only **£9.95**–worth that for the case and meter alone!!

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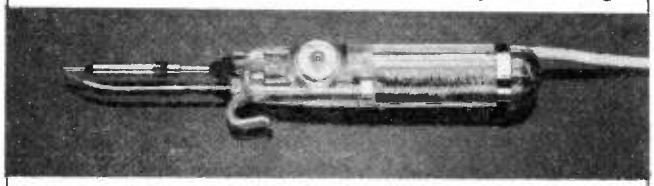
G.P.E. SELF-FEED SOLDERING IRON Patented

A new concept in miniature soldering iron design



This new development in Soldering Irons combines light weight (80g.) with unique one-handed operation. Solder is housed in the transparent handle and applied directly to the joint by turning the serrated wheel (located in the handle) with the index finger, allowing a clean, bright joint to be made every time. To renew the solder, the spring clip at the end of the handle is released, the cap is removed and a refill is inserted.

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IMPORTANT NOTE: The speaker prices above do not include postage but 10 or more speakers are post free – otherwise add £1.50 per order.

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By LAMDA (USA) – Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% – load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case – Models available: 5v - 6A £17.25. 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

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Buy these, they will save you time and money. Prices are for small quantities but if you are buying £100 lots or more – halve the prices. Twin circular, white .5mm length 54" – 23p; 3 core circular, white 99" – 1.25mm – 57p; Twin circular black 77", .5mm – 23p; 3 core circular, black 88" .5mm – 35p; 84" .5mm 46p; Twin circular black 114" 1.25mm – 69p. Twin circular white 200" .75 fitted 2 pin continental plug one end – 57p; 3 core circular white 54" .75mm core sizes fitted continental two pin and earth plug one end and new type 3 flat pin appliance connector at other end – 75p.

MINIATURE TOGGLE SWITCHES

As used on TV cameras and other lightweight equipment. American made by the Arrow Company.
Arrow ref. TCH3E Single pole changeover, centre off – 46p.
Arrow ref. TSH3PCL Single pole changeover PC8 mounting – 46p.
Arrow ref. TC6M Double pole changeover, centre off – 69p.

REED RELAY KIT

High inductance coil, moulded to take 4 reeds, operated by three volts DC or 12 ma. Could be used to close 4 circuits, or with the external magnets supplied, you could have two normally open, i.e. two changeovers. An exceptional bargain at 99p for the coil – 4 reeds and 2 magnets.

ROCKER SWITCHES

Standard size fit 11.5 x 28mm cut out. Single pole on/off – 23p; Single pole changeover 28p; Single pole changeover with centre off – 30p; Single pole on/off with neon – 46p. for double width cut out DpSt 36p, DpDT 46p.

NICAD BATTERY CHARGERS

This, although intended to charge button cells, bring leads from the contacts and then it will suit almost any Nicad battery, charge rate approximately 15mA but easy to vary.

MIXER MOTOR

If this had a case around it, it would be a complete mixer as it has a speed control switch giving three changes of main speed and it also has a gear box with two sockets for paddles. Three lower speeds are available from these sockets. £3.45 – post 60p.

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Approx 1½" diameter, the cover unscrews to enable the switch to be fixed and to keep the contacts covered, contacts look capable of up to 10 amps. 23p.

PILOT BULBS

Standard round 11mm 6.5v .3a by Philips. Box of 10 price 50p.

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).

MAINS MOTORS

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

CROSSOVER NETWORKS

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

– BARGAIN OF THE YEAR –

The AMSTRAD Stereo Tuner.

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

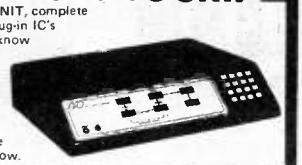
Other uses are as a "get you to sleep radio"; you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

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

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

THIS MONTH'S SNIP

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



VIEWDATA EQUIPMENT

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

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

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

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

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

X-RAY EQUIPMENT

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

MINI MONO AMP

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

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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.

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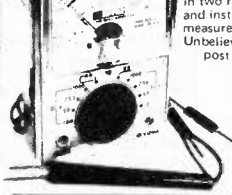
Deluxe pocket size precision moving coil instrument, jewelled bearings - 2000 o.p.v. mirrored scale. 11 instant range measures: DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0 – 100 mA.



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

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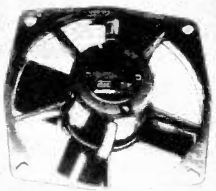
EXTRACTOR FANS



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12 volt 6½" extractor **£6.90,** post £1.50.

AUTO & ISOLATION TRANSFORMERS

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

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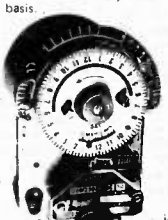
– send or receive a document in 4 minutes. This equipment is used for sending letters and almost any data through the telephone system – "Mail by Phone". The machines we have are the 3M 60088 with autofeed complete with ansafonettes and connector box. We have three sets of the equipment, it is not old, in fact it was used only for about a year (1980-81), believed to be in good order and certainly in a very good condition – cost new over £10,000. We will accept £500 the lot – buyer to examine and take away on an "as seen" basis.



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Mains operated with 20 amp switch, one on and one off per 24 hrs, repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** These are without case but we can supply a plastic case - £1.75.
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14 to 30	9.09	5.20	2.93	1.97
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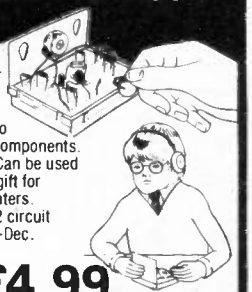

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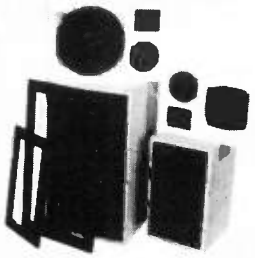
INDEX TO ADVERTISERS

Published approximately the third Friday of each month by IPC Magazines Ltd., Kings Reach Tower, Stamford St., London SE1 9LS. Printed in England by Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Subscriptions: Inland £12.00, Overseas £13.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise **Mullard** woofer (8" or 5") with foam surround and aluminium voice coil. **Mullard 3"** high power domed tweeter. **B.K.E.** built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.
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Price £14.90 each + £2.00 P & P.
5" 30W system — recommended cabinet size 160 x 175 x 295mm
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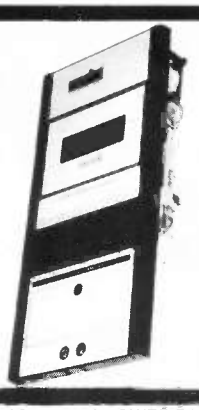
Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.
8" system cabinet kit **£8.00 each + £2.50 P & P.**
5" system cabinet kit **£7.00 each + £2.00 P & P.**

STEREO CASSETTE TAPE DECK MODULE



Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio: 45dB. Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5¼in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50**.

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THREE QUALITY POWER LOUDSPEAKERS (15", 12" and 8" See 'Photo). **Ideal for both Hi-Fi and Disco applications.** All units have attractive cast aluminium (ground finish) fixing escutcheons.
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12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm. imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £23** + £3 carriage.
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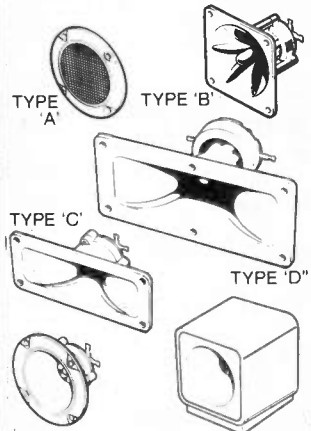

TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.29 each.**

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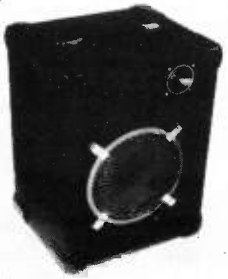

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The very best in quality and value.

Ported tuned cabinet in hard-wearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.

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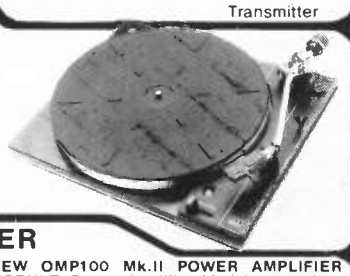
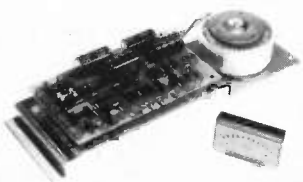


OMP POWER AMPLIFIER MODULE



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Improved specification

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Loads:— Open and short circuit proof 4/16 ohms.
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S.N.R. (Unweighted):— -118dB ±3.5dB.
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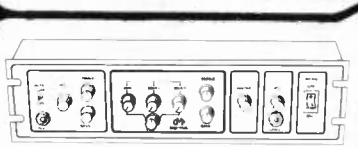

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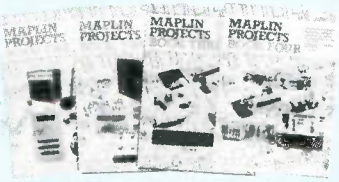

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*Projects for Book 8 were in an advanced state at the time of writing, but contents may change prior to publication (due 13th August 1983).

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