EVERYDAY ELECTRONICS and computer PROJECTS

MAY 1983 85p

FREE TRANSISTORS

Apple II and BBC Micro REAL-TIME CLOCK

TEST GEAR 83 LAB AMPLIFIER

TRAIN CONTROLLER

PLUS TWO DESIGNS FOR YOUR FREE TRANSISTORS

Microboards SPECIAL OFFER

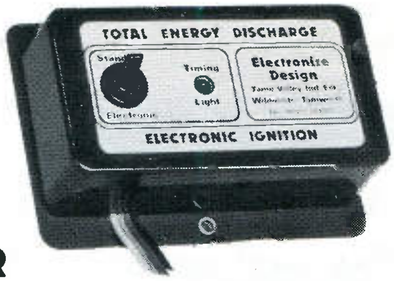
Australia $1.50 Malaysia $4.95 IR £1.26 (inc V.A.T.)

electronize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

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 max. (even with 8 cylinders).

★ 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.

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

Most **NEW CARS** already have **ELECTRONIC IGNITION**. Update **YOUR CAR** with the most powerful system on the market - 3½ times more spark power than inductive systems - 3½ times the spark energy of ordinary capacitive systems, 3 times the spark duration.

Total Energy Discharge also features:
EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, LED STATIC TIMING LIGHT, LOW RADIO INTERFERENCE, CORRECT SPARK POLARITY and DESIGNED IN RELIABILITY.

★ **IN KIT FORM** it provides a top performance system at less than half the price of competing 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.

FITS ALL NEGATIVE EARTH VEHICLES
6 or 12 volt, with or without ballast.

OPERATES ALL VOLTAGE IMPULSE TACHOMETERS:
(Older current impulse types need an adaptor).

STANDARD CAR KIT	**£15·90**	PLUS P. & P. £1 (U.K.)
Assembled and Tested	**£26·70**	
TWIN OUTPUT KIT	**£24·55**	Prices include VAT
For Motor Cycles and Cars with twin ignition systems		
Assembled and Tested	**£36·45**	

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM

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

★ **2000 COMBINATIONS** provided by an electronic key - a minature 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

CAR ALARM KIT	**£24·95**	PLUS P. & P. £1 (U.K.)
ASSEMBLED AND TESTED	**£37·95**	Prices include VAT

VISA — Buy it with Access

Access and Visa Welcome. Write or Phone Quoting Number

Goods normally despatched within 7 days

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

EVERYDAY
ELECTRONICS
and computer PROJECTS

VOL. 12 NO. 5 MAY 1983

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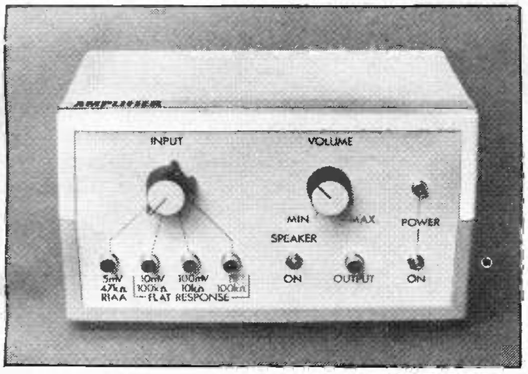
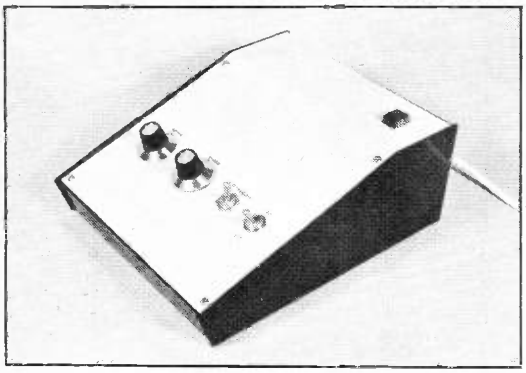
COMMENT . . . POPULAR FEATURES . . .

FOR YOUR FREE TRANSISTORS

See pages 282 and 286





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—NO. 1 IN THE UK—

The latest certificated ABC* figures show that Everyday Electronics is not only the largest selling electronic constructors' magazine in the United Kingdom, but has increased its lead by a very significant margin.
*Audit Bureau of Circulations.

Our June 1983 issue will be published on Friday, May 20. See page 303 for details.

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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

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

TRANSISTORS

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

CABLES

20 metre pack single core connecting cable ten different colours 65p
Speaker cable . . . 10p/m
Standard screened . . . 16p/m
Twin screened . . . 24p/m
2.5A 3 core mains . . . 23p/m
10 way rainbow ribbon . . . 65p/m
20 way rainbow ribbon . . . 120p/m
10 way grey ribbon . . . 38p/m
20 way grey ribbon . . . 80p/m

HARDWARE

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

CAPACITORS

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

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	▶5V	550

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 BR100	25

DIODES

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

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv
Highly sensitive 19 range multimeter including transistor tester. Overload protection. DC volts – 1000, AC volts – 1000; DC current 0.25A. 4 resistance ranges. Complete with batteries, leads, etc. 1395p

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	TIL312 0.3"	115
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

BRIDGE RECTIFIERS

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

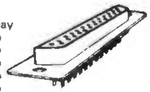
TRANSFORMERS

Please add carriage charges to our normal post charges.

Miniature mains:
606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature:
3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200p each.
6VA 0-6, 0-6 @ 0.5A; 0-9, 0-9 @ 0.3A; 0-12, 0-12 @ 0.25A 270p each.
High quality. Split bobbin construction
6VA 0-6, 0-6 @ 0.5A; 0-9, 0-9 @ 0.4A; 0-12, 0-12V @ 0.3A 220p each.
12VA 0-6, 0-6 @ 1A; 0-9, 0-9 @ 0.8A, 0-12, 0-12 @ 0.5A; 0-15, 0-15 @ 0.4A 295p (plus 40p carriage).
25VA 0-6, 0-6 @ 1.5A; 0-9, 0-9 @ 1.2A; 0-12, 0-12 @ 1A; 0-15, 0-15 @ 0.8A 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1.5A. 440p each (plus 75p carriage)

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 460
2.3 and 4.7mm bits to suit . 65
CS 17W iron: 450, element: 210
Antex XS 25W . . . 480
3.3 and 4.7mm bits to suit . 65
Solder pump desoldering tool. 480
Spare nozzle for above . . 70
10 metres 22swg solder . . 100

CONNECTORS

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

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . . 120p

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

TOOLS

Small trimming tool . . . 22
Small pocket screwdriver . . . 16
Large pocket screwdriver . . . 13
6 piece precision screwdriver set in plastic case . . . 170
Low cost side cutters . . . 160
High quality side cutters . . . 650
Low cost pliers . . . 160
High quality pliers . . . 650
Wire strippers . . . 120
Expo reliant drill . . . 695
Expo Titan drill . . . 1025
Drill stand . . . 1200

VERO

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

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 12p.
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

MICRO

		6116P3	365	6852	240	8228	220
		6502CPU	325	6875	495	8251	250
		6522VIA	295	6880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551 ACIA	650	81LS96	85	8259	390
2114L2	75	6800CPU	220	81LS97	85	MC1488	55
2716	205	6802CPU	250	8080A	250	MC1489	55
2532	290	6809CPU	620	8085AC	340	Z80ACPU	290
2732	290	6810RAM	115	8156	350	Z80APIO	260
2764	540	6821 PIA	110	8212	110	Z80ACTC	260
4116P20	70	6840	360	8216	100	Z80ASIO	900
5101L-1	220	6850	110	8224	120	Z80ADMA	1150

SOCKETS

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

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . . . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts — 50 6BA washers — 50 6BA nuts
25 6BA ½" bolts — 25 4BA ¼" bolts — 50 6BA washers
50 6BA nuts — 25 6BA ½" bolts

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 1M. . . . 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		4 x 2¾ x 1½"	95
& screws		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
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	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
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		

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1 OFF	10 OFF	50 OFF	100 OFF
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60p	£5.75	£27.50	£50.00

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SX66 5 x 22k Log — SX70 5 x 1 meg Lin

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5 pieces	£3	(60p each)
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*Quantities approximate, count by weight

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SX18	100	Mixed Ceramics 1pf-56pf	£1
SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics	£1

*Quantities approximate, count by weight

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The lowest price ever.
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Positive +	Negative +
7805 – 50p	7905 – 55p
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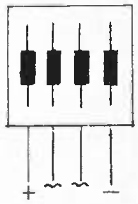

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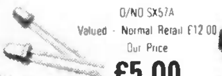

O/NO SX57A
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Glass Type similar IN4000 SERIES IN4001-IN4004
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SX52 6 Black Heatsink will fit TO-3 and TO-220. Ready drilled. Half price value. £1
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SX54 TO-66 size 35mm x 30mm x 12mm 35p
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DOUBLE SIDED FIBREGLASS BOARD

FB4	2	14 x 4"	110	£2.00

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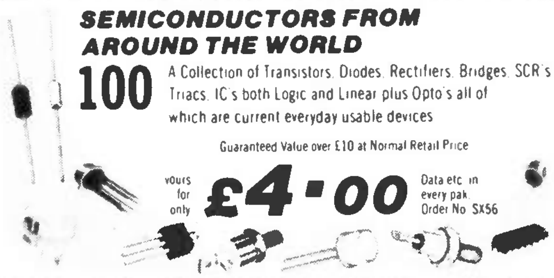

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REGULATED VARIABLE *Stabilised* POWER SUPPLY

Variable from 2-30 volts and 0-2 Amps. Kit includes – 1 – VPS30 Module, 1 – 25 volt 2 amp transformer, 1 – 0-50v 2" Panel Meter, 1 – 0-2 amp 2" Panel Meter, 1 – 470 ohm wirewound potentiometer, 1 – 4K7 ohm wirebound potentiometer, Wiring Diagram, included. Order No. VPS30 KIT **£20**

MINIATURE FM TRANSMITTER

Freq: 95-106MHz. Range: ½ mile
Size: 45 × 20mm. Add: 9v batt.
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Ideal for: 007-MI5-FBI-CIA-KGB etc.

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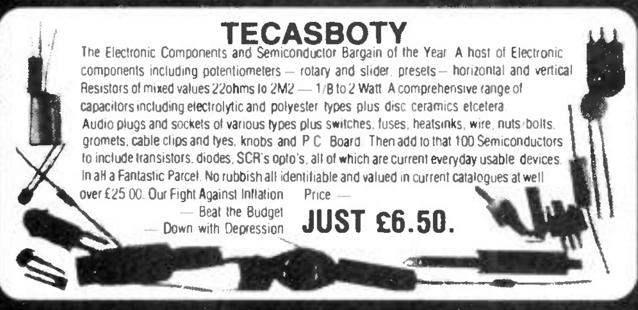

The Electronic Components and Semiconductor Bargain of the Year. A host of Electronic components including potentiometers — rotary and slider, presets — horizontal and vertical. Resistors of mixed values 22ohms to 2M2 — 1/8 to 2 Watt. A comprehensive range of capacitors including electrolytic and polyester types plus disc ceramics etcetera. Audio plugs and sockets of various types plus switches, fuses, heatsinks, wire, nuts/bolts, gromets, cable clips and tyes, knobs and P.C. Board. Then add to that 100 Semiconductors to include transistors, diodes, SCR's opto's, all of which are current everyday usable devices. In all a Fantastic Parcel. No rubbish all identifiable and valued in current catalogues at well over £25.00. Our Fight Against Inflation — Beat the Budget — Down with Depression. Price — **JUST £6.50.**

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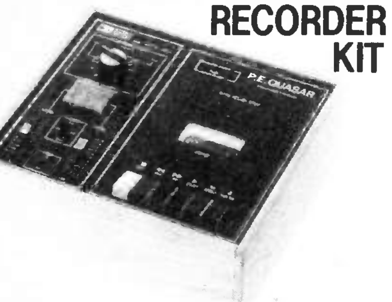
T.V. SOUND TUNER BUILT AND TESTED

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".

£22.95 + £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 cabinet - £4.50 + £1.50 p&p.

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

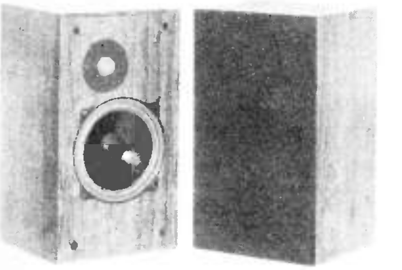
BSR RECORD DECK

Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco.
13"x11" approx. **£12.95** + £1.75 p&p.

SPECIAL OFFER! Replacement stereo cassette tape heads – £1.80 ea. Mono £1.50 ea. Erase 70p ea. Add 50p p&p to order.

Special Offer! AUDAX 45 WATT TWO WAY SPEAKERS £36.95 a pair

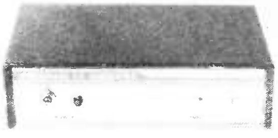
Plus £7.00 p&p



Originally made to sell for over £70. Unit comprises 8" bass/mid range and 4" soft dome tweeter and a 6 element crossover. Mirror image. Finished in rosewood. Size: 470mm high x 264mm wide x 225mm deep. Empty cabinets available separately if required. £9.95 pair + £4.75 p&p.

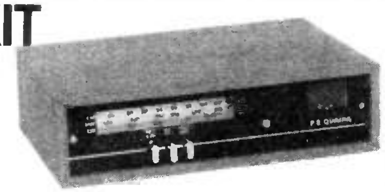
PERSONAL LS AMP KIT

Amplifier for your personal stereo cassette player as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.



Parts: Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit, £1.95 + £1.50 p&p. Pair of 4½" eliptical speakers, £1.50 the pair, + £1.00 p&p. Input & output sockets & plugs, £1.50. Recommended case (for the power supply and amp only), £2.95 + 80p p&p.
P&P inclusive price of £1.75 for two or more articles.

P.E. STEREO TUNER KIT



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

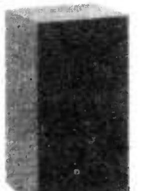
£17.95 Plus £2.50 p&p.

Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x 8½"x 3¼". **£3.50** Plus £1.50 p&p.

SPEAKER KIT

2 WAY 10 WATT

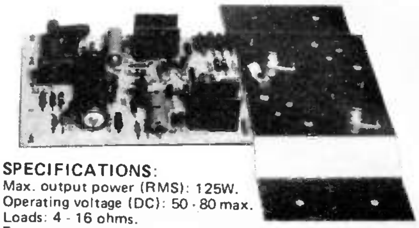
8" bass/mid range and 3¼" tweeter. Complete with screws, wire, crossover components and cabinet. All wood pre-cut – no cutting required. Finish - chipboard covered wood simulate. size 14½"x 8¾"x 4". PAIR for ONLY
£12.50 plus £1.75 p&p.



125W HIGH POWER AMP MODULES

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

The power amp kit is a module for high power applications – disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use.
Supplied with all parts, circuit diagrams and instructions.
ACCESSORIES: Suitable mains power supply kit with transformer: £8.50 plus £2.00 p&p.
Suitable LS coupling electrolytic: £1.00 plus 25p p&p.



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

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Model No. GP-397 III.
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EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 5 MAY 1983

COMPUTER ADD-ON'S

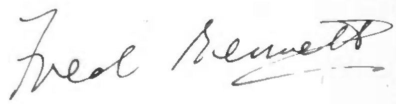
THE development of electronic hardware add-on's for personal computers has opened up new areas and opportunities for the electronics constructor. Computer users with little or no experience of the practical work involved in our hobby may feel all this activity beyond them. They should not balk at the task: the rewards will greatly outweigh the time and effort spent in acquiring the necessary skills and expertise to build projects. Our constructional articles make everything crystal clear and back-up information concerning sources of supply for unusual or "difficult" components is given in *Shop Talk* every month. Features for the newcomer to electronics form an on-going part of our contents.

Add-on's and other units tailored to suit individual machines, or groups of machines, are already written into our publishing program. These designs are appearing on a regular basis now, and by judiciously ringing the changes we shall endeavour to keep all personal computer users happy, whether they be Apple, BBC, Genie, Pet or ZX aficionados. For no matter what machine is specifically catered for, many of these designs will be capable of wider application; furthermore, they will keep all computer users up to date with regard to the attractive propositions developing in the hardware region. Remember one good idea usually gives rise to many others . . . so if you have a personal computer you owe it to yourself to watch our pages regularly.

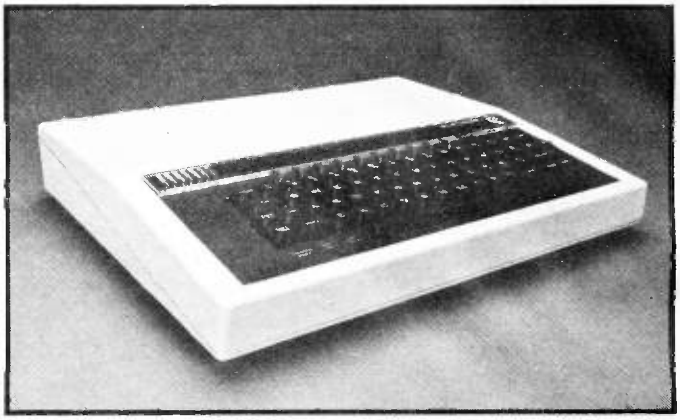
Electronic hardware is our business, however in the case of many computer add-on's it is not possible to escape the need for software. Providing that the essential listings are not of inordinate length they will be published in the text. Larger listings will be available directly from EE on cassette. Details of our newly opened Software Service appear elsewhere within this issue.

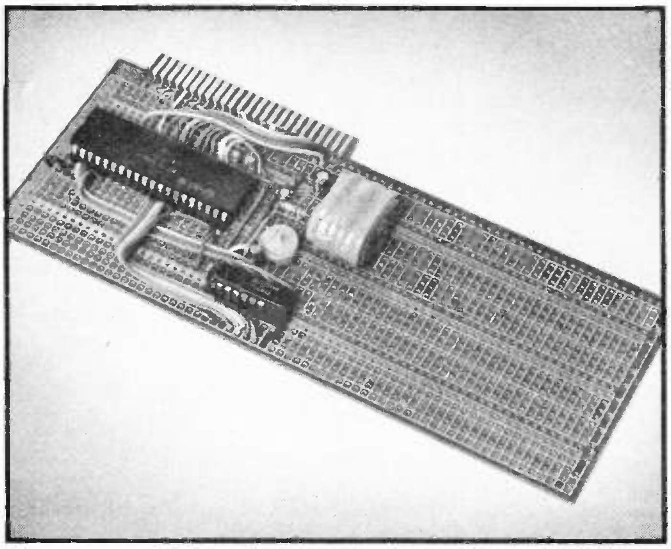
Computers are important. But they are only part of the electronic scene, as is borne out by this month's project repertoire. Apart from our Apple,BBC and Vic20,Pet projects we also cover such diverse interests as pop music (Guitar Headphone Amplifier) and model railways (Train Controller); then there's a small Personal Radio, a Moisture Detector and number three in our Test Gear 83 series. What is more, we go even further than just providing design information, for attached to the front cover is a pair of transistors which can be used in either of two particular projects.

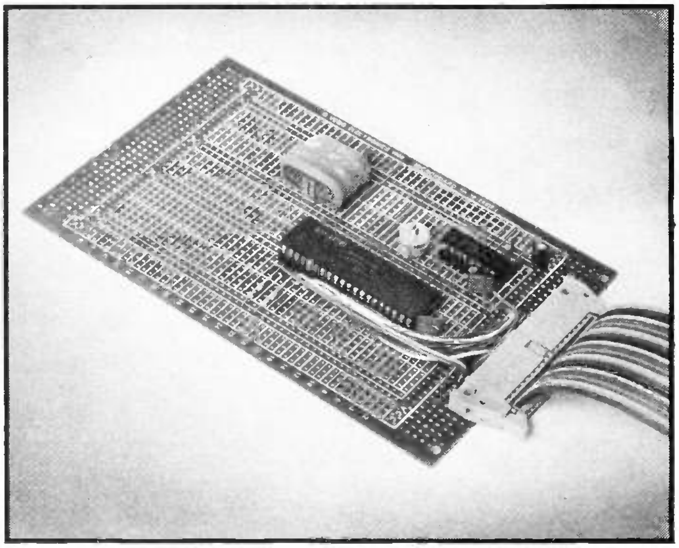
Finally, just a hint about next month. For those who use a TRS-80, a Video Genie or a Caravan—there's something of special interest in our June issue. For further details please refer to page 303.



REAL-TIME CLOCK APPLE II & BBC MICRO







Useful hardware add-ons for two popular micros. Capable of displaying day and time of day (hours, minutes and seconds).

BY O.N. BISHOP

WHEN you first hear someone refer to "real time" you may wonder why they bother to say "real". There is no doubt that time is real. Why the emphasis on its reality?

Real-time is a phrase used in the world of computers to distinguish between the actual time of day, as can be shown on the dial of any ordinary clock, and the various other kinds of time that mainly concern the computer itself. Ordinary clocks tell us the real time (half-past three, for example). The other clocks (or oscillators) in the computer are used for telling it which stage it has reached in its cycle of operations.

Egg-timers and oven-timers are clocks which can be classed with the other clocks of the computer. They tell you what stage has been reached in the cycle of operations involved in boiling an egg or cooking a joint. Usually they tell you when the cycle is complete and the egg or joint is ready to eat.

It is not easy to use this kind of clock to tell you the real time, such as when you should switch on the TV to view your favourite programme.

SOFTWARE CLOCKS

All computers, even the simplest of micros, need a clock to time the operation of the system. Usually this is a high-frequency crystal oscillator, wired to the microprocessor. Few microcomputers have real-time clocks, although some such as the BBC Microcomputer allow you to make use of the system clock to control a special "clock program" which displays real time. This is a *software* clock, for it is not a physical part of the computer and must be loaded into memory from a cassette tape (or keyboard) on every occasion that you use it.

HARDWARE CLOCK

The Real-Time Clock described here is a *hardware* clock, consisting of a special clock i.c. with another i.c. to interface it to the computer. The clock i.c. has many of the characteristics of the i.c. in a digital watch. The main difference is that the i.c. in a watch is designed to drive a 7-segment display. The outputs required for this are very different from those which a microprocessor requires. A microprocessor could be programmed to read the output intended for a 7-segment display, but the program required to do this would be unnecessarily complicated.

This project is designed specially for the Apple II personal computer *and* the BBC Micro. Owners of the Apple are fortunate in having a set of "slots" (sockets) on the circuit board of the micro into which they can plug circuit boards (or "cards") carrying interface circuits of various kinds.

Having made up the circuit as described, you simply open the case of the Apple, plug in the card, and the real-time clock is ready for use.

The socket which takes the card has been provided with connections to the data bus, the address bus and several control lines. By using these we are able to make use of the on-board address-decoding facilities of the Apple, and so simplify circuit construction a great deal.

For the BBC Micro, a socket is required to be fitted to the circuit board and a cable to connect to the BBC 1MHz Bus (PL11).

Readers will be able to adapt this design to suit other micros. The main difference is that you will have to provide an address-decoding circuit. This is already provided by the Apple and the BBC Micro.

REAL-TIME CLOCK I.C.

The main sections of the clock i.c., an MM58174, are shown in Fig. 1. The crystal oscillator runs at 32·768kHz. Its frequency is first divided by 16/15 to give 30·720kHz and is then divided 9 times by a series of binary counters to give 60Hz. This is further divided by 6 to give the fundamental timing frequency of 10Hz, or tenths of a second.

The fundamental frequency is then fed to counters which register tenths, units and tens of seconds, units and tens of minutes, units and tens of hours, units and tens of day, day of the week, day of the month, and units and tens of years. The "year" register holds a value which depends on the position of the current year in the leap-year cycle.

Any of these registers (except the three "seconds" registers) may be written into to set the time of the clock when we first begin to run it. Any register (except the year register) can be read from when we want to know the time.

Register 14 is used to stop and start the clock. Register 15 is for interrupt status. This is for using the clock as an elapsed-time clock. It can be set to interrupt the micro once after a given period (which may be 0·5s, 5s or 60s), or repeatedly every 0·5s, 5s or 60s, as explained later.

Register 1 is used when testing the i.c. in the factory and must always be set to "0" before the clock is started, and *every time the computer is switched on.*

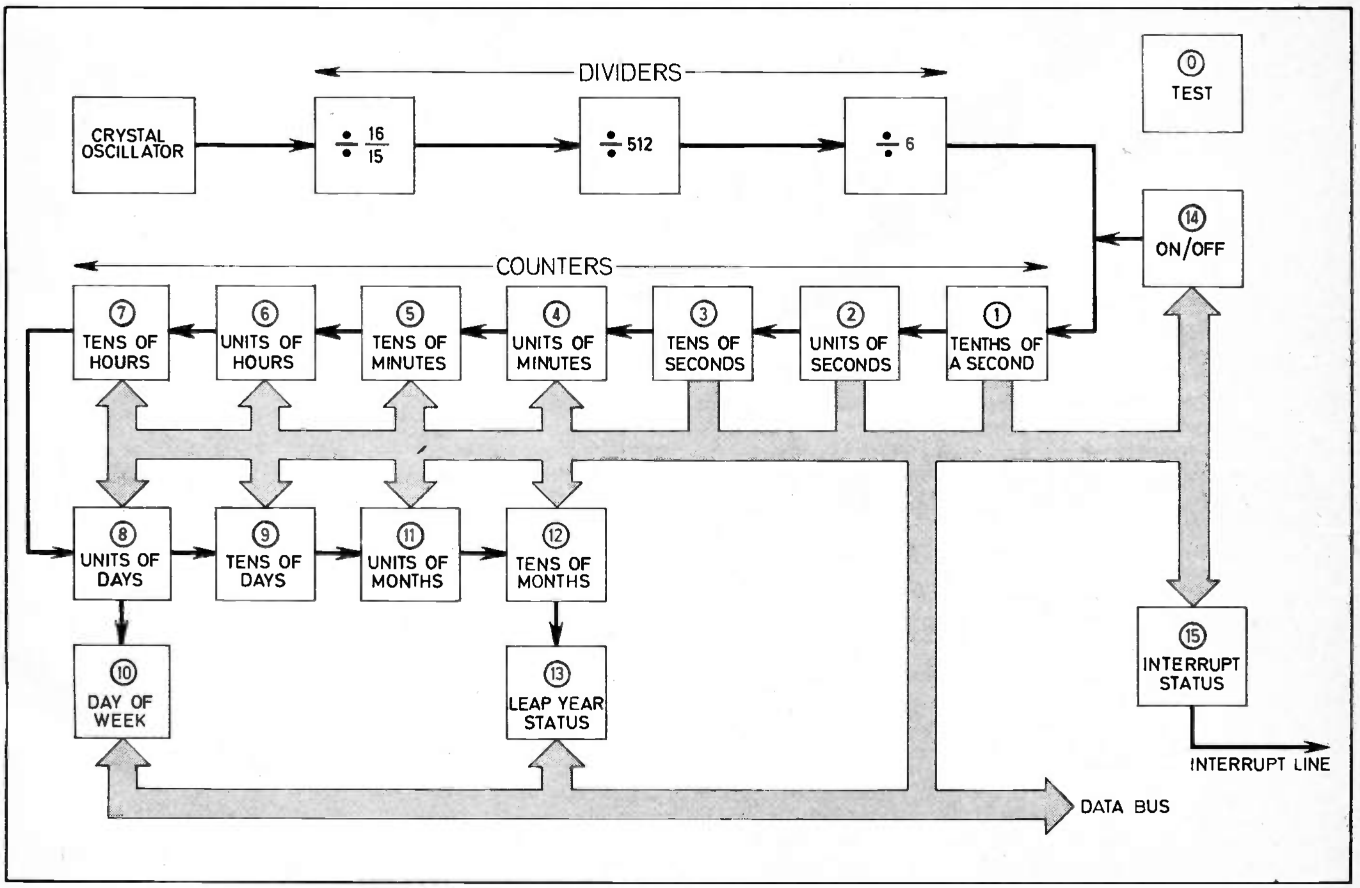
CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 2. This has been drawn for the BBC Micro, with the different pinning connections to suit the Apple.

The circuit shows that the clock i.c. has a back-up battery. This is a big advantage, for the clock continues to run while the micro is switched off and if the board is unplugged from the computer.

Unlike a software clock, it does not need resetting every time the micro is turned on. When the micro is running and the i.c. is being powered by the +5V supply of the micro, it takes about 4mA, but

Fig. 1. Block diagram of the MM58174 Real-Time Clock i.c. The encircled numbers are the address within the clock of each of its registers.



when the micro is switched off and the clock is running from the battery, it takes only 4μA. The recommended nickel-cadmium battery has a capacity of 10mAh, so the clock will run for many months on the battery alone. When the micro is on, the battery is trickle-charged with a current of about 1mA.

PERIPHERAL INTERFACE ADAPTOR

In order to be able to use the clock i.c., we must look into the details of how the MC6821 (IC1) Peripheral Interface Adaptor (or PIA) works. One of the problems of using the clock i.c. is that the exact times at which data may be exchanged between the clock i.c. and the microprocessor inside the computer are very limited in extent and are determined by the cycle of operation of the micro.

It makes programming less complicated if we use a PIA. Data from the MPU which is intended for the clock i.c. may be fed to the PIA, which holds it ready for when the clock is able to read it.

The PIA is essential in transfer of data in the other direction, too. The clock can be made to send data to the PIA, but at that stage it is not placed on the data bus. To put data on to the bus at the wrong time would certainly upset the operation of the computer. Once in the PIA, the data can be read by the MPU at a time convenient to itself.

It is apparent from the description above that the PIA is capable of sending data in either direction: micro-to-clock (output) or clock-to-micro (input).

TWO EIGHT-BIT PORTS

The PIA has a set of eight terminals to connect it to the MPU through the data bus. It has two sets of lines (called Port A and Port B), for communicating with the clock. Each port has eight lines, though we use only the lower four lines of each port (PA0 to PA3 and PB0 to PB3) in this circuit. The lines can pass data in either direction, but we must first decide upon which direction. This is done by setting the Data Direction Registers in IC1 for each port (DDRA and DDRB). The DDRs have eight locations (or bits), one corresponding to each line of the port. If a bit is set to "0", the corresponding line is defined as an *input*; if it is set to "1" it becomes an *output*.

In this circuit we define the four lower lines of Port A as outputs. These are used to output an address (in the range 0 to 15) to IC2, the clock i.c., this address being a number in the range 0 to 15, to select which register is to be read from or written to.

The four lines of Port B are used for sending data in either direction. They are defined as outputs when we are setting the clock and as inputs when we want to know the time.

CONTROL REGISTERS

The operation of each port is controlled by a control register (CRA, CRB). One of the uses of this register is to put us into communication with DDRA and DDRB, or with the registers which are used in transferring data between the micro and the clock. Table 1 shows the settings.

Table 1 also shows how the control registers are used to operate the control outputs CA2 and CB2. These lines are normally kept at high level (+5V), but CA2 is made low when we want to make the $\overline{RD}$ input of the clock low so as to be able to read data from it. CB2 is made low to make the $\overline{WR}$ input low when we want to write to the clock.

The $\overline{RD}$ input is held high by pull-up resistor R3 wired to the back-up battery. This holds $\overline{RD}$ high while the power supply is off. A low $\overline{RD}$ halts the counting process, so if R3 was not present, the clock time would not advance while power is off. The $\overline{WR}$ input has an internal pull-up resistor.

Fig. 2. Lower right shows the circuit diagram for the Real-Time Clock with connection details to the 1MHz bus of the BBC Micro; lower left shows the connections between circuit and the Apple II (slot 3).

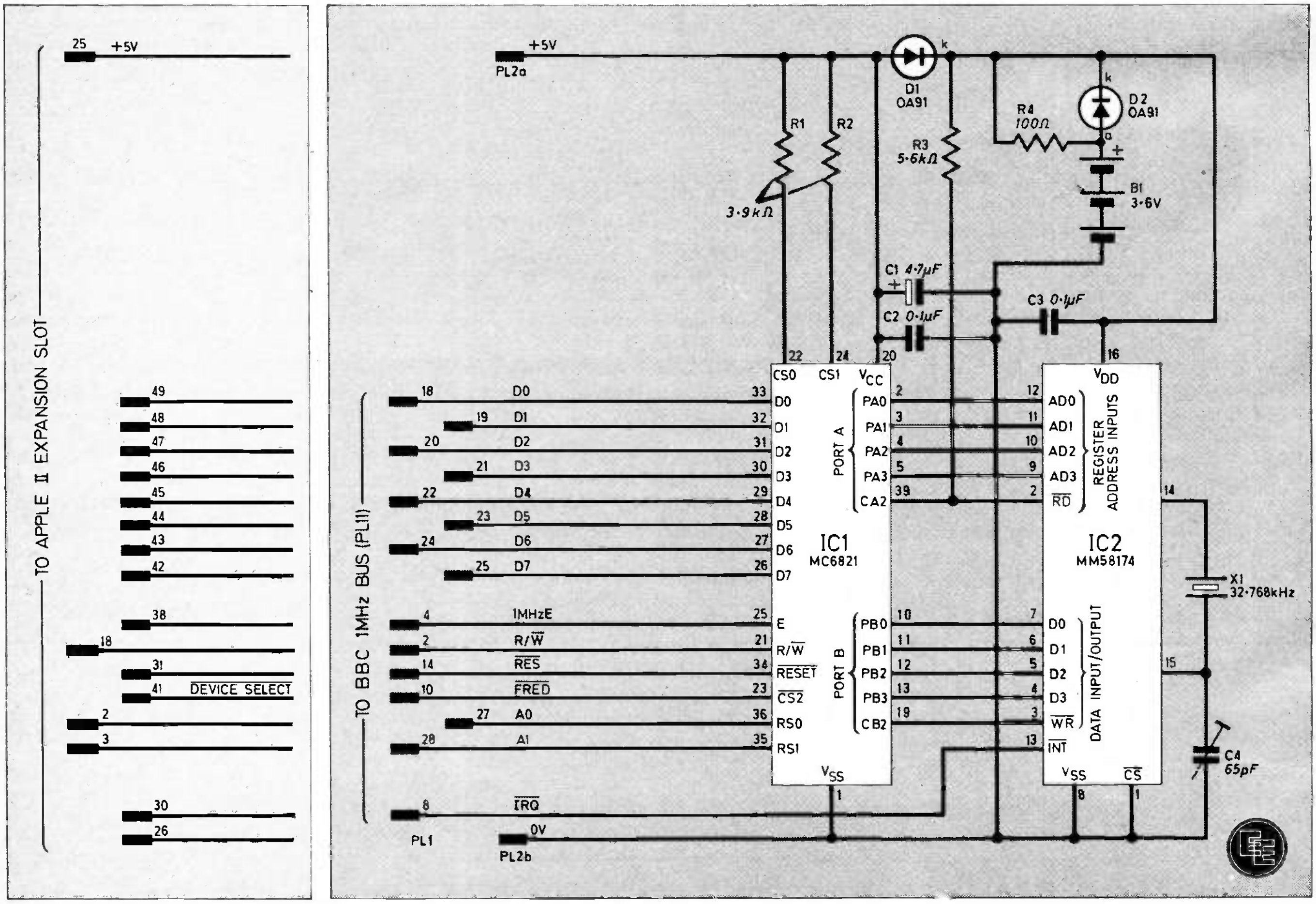


Table 1. Using the Control Registers of the PIA

Bit	7	6	5	4	3	2	1	0
Function	Not applicable		Controls output CA2			DDRA	Not applicable	
CA2 high with access to DDRA	0	0	1	1	1	0	0	0
			(Equivalent to 56 in decimal)					
CA2 high with access to Port A	0	0	1	1	1	1	0	0
			(Equivalent to 60 in decimal)					
CA2 low with access to Port A	0	0	1	1	0	1	0	0
			(Equivalent to 52 in decimal)					

The table refers to CRA, but the same coding applies to CRB.

DEVICE SELECT

In order to alter any of the registers in the PIA, the chip must be selected. In the Apple, this is done by using the $\overline{\text{DEVICE SELECT}}$ line of its slot. This line goes low whenever any address in the Peripheral I/O space of the slot is addressed. The programs given here assume that the clock card is in slot 3.

The Peripheral I/O space for this slot consists of the sixteen addresses $C0A0 to $C0AF (the "$" indicates a hexadecimal number). $\overline{\text{DEVICE SELECT}}$ is wired to a "Chip Select" input ($\overline{\text{CS2}}$) of the PIA. We need only four addresses ($C0A0 to $C0A3) to address the PIA, as shown in Table 2. The lower two address lines (A0 and A1) are wired to the "Register Select" inputs, RS0 and RS1. When one of the addresses is on the bus, $\overline{\text{CS}}$ is made low and the levels at RS0 and RS1 determine which register is put in communication with the data bus.

The other connections to the PIA are:

CS0 and CS1: alternative "Chip Select" inputs, which require a high input to make the chip active, and are held high permanently by R1 and R2.

E: the Enable input is connected to the ϕ1 clock line in the Apple; R/$\overline{\text{W}}$: the read/write line is connected to the R/W line of the Apple; $\overline{\text{RESET}}$: a low level on this line (as when the micro is first switched on or the Reset key is pressed) clears all registers of the PIA to zero (but not those of IC2).

In the Apple, the clock uses the +5V regulated supply which is provided at the slot. Your micro may be able to provide the current (about 100mA) from its own supply. You should check in the manual of your computer to ascertain how much current it can supply without overloading. If it cannot supply enough you will need to add a +5V regulator circuit to your clock board.

THE BBC MICRO

The BBC Microcomputer has the same MPU as Apple II (a 6502) which provides the same signals for controlling the clock. Table 3 shows which pins of the 1MHz bus connector to use.

The 1MHz bus is available on both Model A and Model B micros, so the clock circuitry can be used with either model.

Pin 4 (1MHzE) gives a clocking pulse which is used instead of ϕ1 of the Apple. Pin 10 gives a signal called $\overline{\text{FRED}}$, which is the equivalent of the $\overline{\text{DEVICE SELECT}}$ used on the Apple.

The power supply is taken from the power outlet on the underside of the BBC Micro, PL10.

The $\overline{\text{FRED}}$ output is normally high, but goes low when any address in the range &FC00 to &FCFF is used ("&" represents a hexadecimal number follows). Thus without further address decoding we can use &FC00 as the base address of the clock (equivalent to address 3000 of Table 2, or 16205 in the Apple listings).

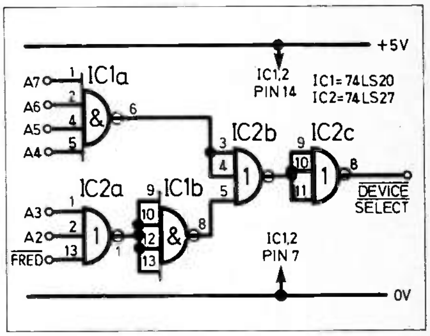


Fig. 3. Decoder circuit for use with the BBC Micro to place the Real-Time Clock at address &FCFO.

FURTHER DECODING

The snag about this system is that you will not be able to attach anything else to the bus at the same time. If you want to have more than one device attached, you must provide further address decoding. The built-in decoder of the BBC Micro takes care of the upper eight address lines, and the lower two go directly to IC1, so only the six lines A2 to A7 need decoding. Fig. 3 shows a circuit which gives the base address &FCFO.

Table 2. Addresses used by the PIA (assuming the base address is 3000)

Address	Register accessed
3000	Port A input/output OR* DDRA
3001	Control Register A (CRA)
3002	Port B input/output OR* DDRB
3003	Control Register B (CRB)

*Depends on the setting of bit 2 in the Control Register for the Port (see Table 1).

Table 3. Connections to the 1MHz Bus of the BBC Microcomputer

Pin No.	Name of line
2	R/$\overline{\text{W}}$
4	1MHzE
10	$\overline{\text{FRED}}$
14	$\overline{\text{RESET}}$
18–25	D0–D7 (data bus)
27–34	A0–A7 (address bus)

APPLE II REAL-TIME CLOCK CONSTRUCTION

APPLE MICROBOARD

For use with the Apple II personal computer the circuitry is built on an Apple Compatible Microboard. This has been specially designed to plug directly into the extension "slots" on-board the Apple. It has a gold-plated finger set, and this design is intended to plug directly into slot 3. The board has a unique feature of a Colander Ground Plane for maximum screening purposes, and has solder mask protection.

The layout of the components is not critical and may be changed to suit requirements. Our layout design has been accommodated on one half of the board to allow other user-designed circuitry to be added at any time.

The layout of the components on the topside of the board is shown in Fig. 4, including link wires. There are no breaks to be made on the underside. Note that there is a through-the-board link to be made at the bottom right-hand corner of the board as drawn.

Two underside link wires are to be connected. There is one to join D1(k) to D2(k), and a second adjacent to this to connect IC1 pin 39 to IC2 pin 2.

Begin construction by soldering in both i.c. sockets followed by the shorter link wires and the remainder of the components in any order. Pay attention to the polarities of B1, D1, D2 and C1. The "leads" on B1 and C4 will need to be "thinned" using a small file so that they comfortably fit the hole size on the board. Do not enlarge the hole size, as this may scratch the resist from the Ground Plane and make an unwanted connection between the lead and 0V. An eye-glass will be found very useful for inspecting connections as they are made, and ensure no unwanted connection is made.

The prototype unit as seen was built using stranded insulated wiring with its ends suitably trimmed and tinned before connection. However, solid core wiring may be a better alternative here.

With all the components in position, carry out the interwiring as shown in Fig. 4. The encircled numerals on some leads refer to the edge connector fingers they are to connect to. Note that some leads need to be soldered to the board topside.

The socket (slot 3) on board the Apple micro to accommodate the circuitry is shown in Fig. 5.

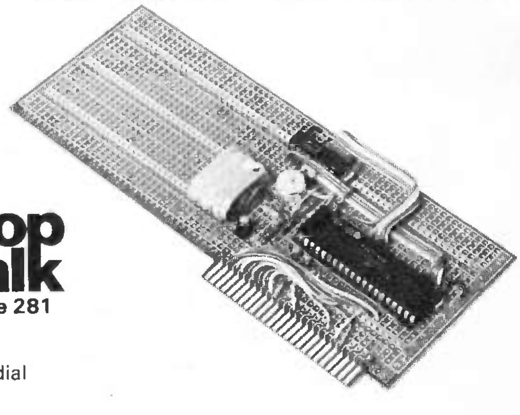
INSERTING CHIPS

When completely satisfied that the assembly is complete and correct, insert the i.c.s in their sockets, paying particular attention to their orientation. If these devices are inserted and powered up the "wrong way round", they will undoubtedly be destined for the dustbin.

Initially, set C4 to a mid-way position. It can be set on test if necessary according to results.

COMPONENTS

For Apple II



Resistors

R1	3·9kΩ
R2	3·9kΩ
R3	10kΩ
R4	100Ω

All $\frac{1}{4}$W carbon ±5%

See Shop Talk page 281

Capacitors

C1	4·7μF 6V elect. radial leads
C2, C3	0·1μF ceramic or plastic
C4	65pF beehive trimmer capacitor, p.c.b. type

Semiconductors

D1, D2	OA91 or similar germanium diode (2 off)
IC1	MC6821 Peripheral Interface Adaptor (PIA)
IC2	MM58174 microprocessor real-time clock

Miscellaneous

B1	3·6V rechargeable Ni-Cad battery
X1	32·768kHz crystal

40-pin d.i.l. socket; 16-pin d.i.l. socket.

COMPONENTS approximate cost £26 excluding software

Apple compatible Microboard, Vero type 200–22266B, see Special Offer Coupon on page 304; p.v.c. insulated connecting wire.

Software

T002 cassette: Real-Time Clock (Apple II).

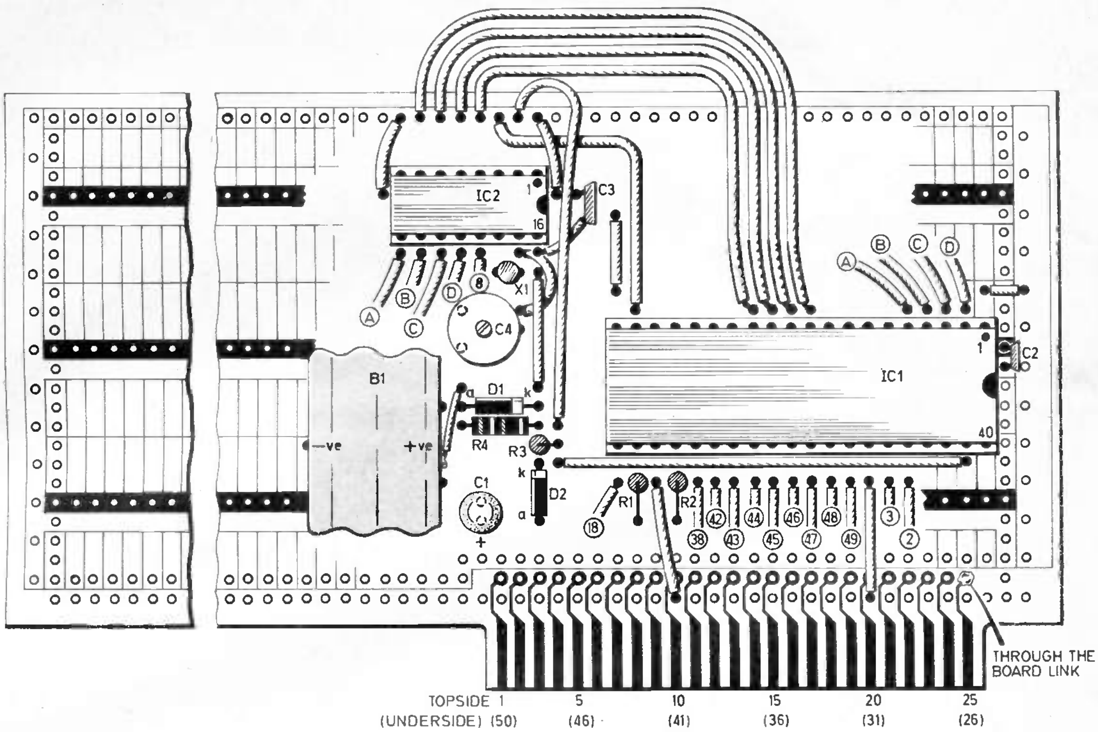


Fig. 4. Topside view of the Apple Compatible Microboard showing component layout and full interwiring. There are no breaks to be made on the underside. Two link wires need to be added on the underside: (1) to connect D1(k) to D2(k) and (2) adjacent to (1) to connect the lead from IC1 pin 39 to the lead from IC2 pin 2. The encircled numbers on each lead refers to the edge connector "finger" they are to connect to.

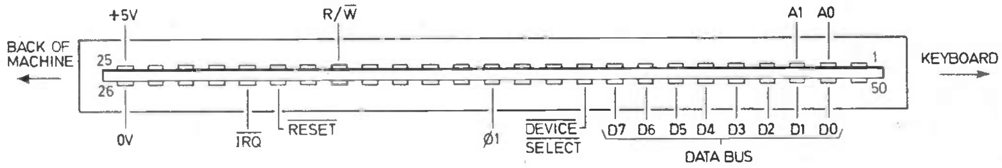
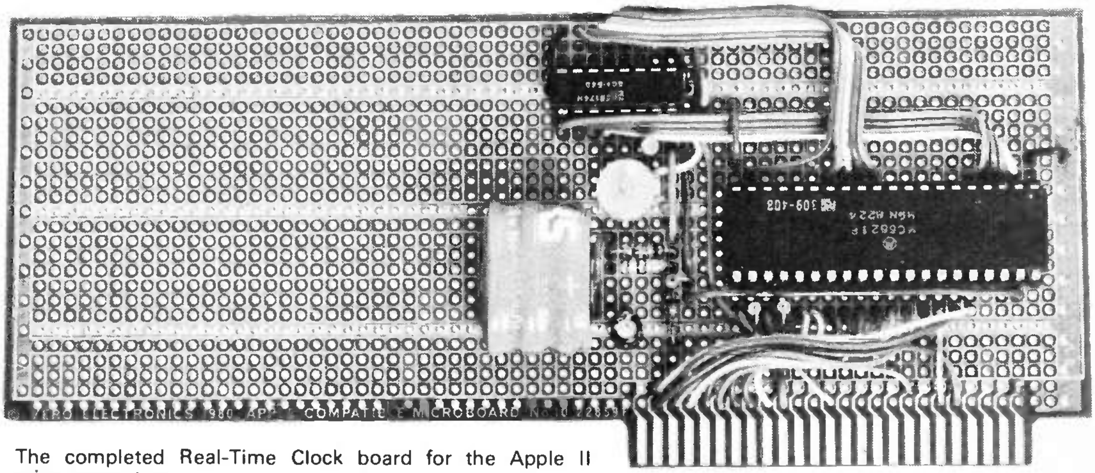
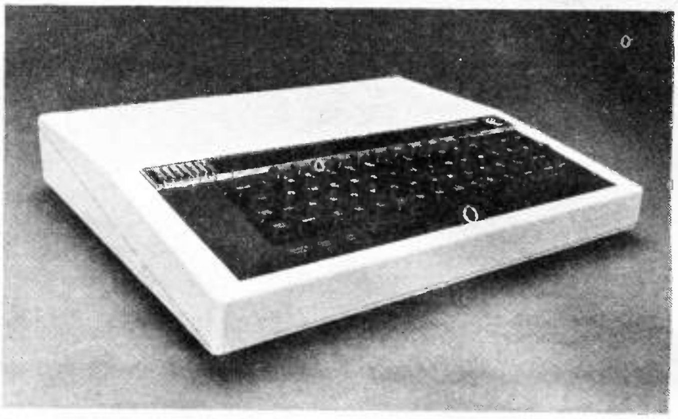


Fig. 5. A "slot" in the Apple II showing the pins required for the Real-Time Clock.



The completed Real-Time Clock board for the Apple II microcomputer.

BBC MICRO REAL-TIME CLOCK CONSTRUCTION



BBC MICRO-BOARD

For use with the BBC Microcomputer, the circuitry is assembled on a single-height Micro-Board. This has a particular arrangement of tracks and supply rails on its underside. This board is to be fitted with a 34-pin plug to allow connection to the BBC 1MHz bus by means of a suitably terminated length of 34-way ribbon cable.

The layout of the components on the topside of the board is shown in Fig. 6. The layout is not critical and may be changed to suit. Sufficient space exists on the board for further user designed circuitry to be added if and when required.

Two breaks are required to be made on the underside of the board, one immediately beneath D1, the other below C1. Make these breaks using a small drill bit and then insert the i.c. sockets. There are numerous link wires required. Some of these were made using tinned copper wire. It was only found necessary to use sleeving in two places, where one wire perpendicularly crosses another, but sleeving could be added at certain places on some wires to prevent the possibility of adjacent wires shorting.

Make all the links and then position and solder the remainder of the components, paying attention to the polarities of B1, D1, D2 and C1. The holes accommodating the leads of B1 and C4 will need to be slightly enlarged to comfortably accept these leads.

It will be found useful to prepare a label to attach to the board immediately behind PL1, containing pin numbering information. This will allow the remaining interwiring to be carried out more easily (and correctly). The wires to reach these locations are marked with an encircled numerals representing their pin destination.

Finally, wire up PL2 and connect its lead to the board. Pinning details for the power outlet into which PL2 is to connect are given in Fig. 7 which also contains the pin numbering for the 1MHz bus.

34-WAY RIBBON CABLE

The geometry of the 34-way ribbon cable/connectors to comply with the Micro-Board layout in Fig. 6, needs to be as shown in Fig. 8. This configuration must be used. If you already have a cable, but it is wired differently, then to use this cable the wiring to the two rows on the board from PL1 will need to be modified accordingly.

Set C4 to its mid-way position. After thoroughly inspecting the assembly, and when satisfied that it is correct, the i.c.s may be inserted. Make sure you insert them the right way round, otherwise they will be destroyed when powered up.

COMPONENTS

For BBC Micro

Resistors

See **Shop Talk** page 281

R1	3·9kΩ
R2	3·9kΩ
R3	10kΩ
R4	100Ω

All $\frac{1}{4}$W carbon ±5%

Capacitors

C1	4·7µF 6V elect. radial leads
C2, C3	0·1µF ceramic or plastic
C4	65pF beehive trimmer capacitor, p.c.b. type

Semiconductors

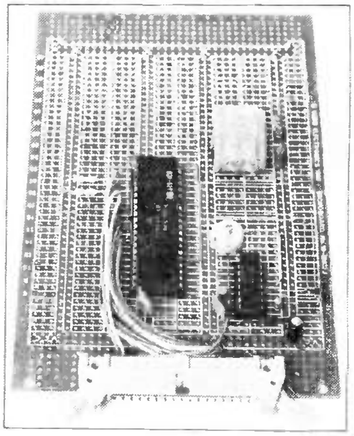
D1, D2	OA91 or similar germanium diode (2 off)
IC1	MC6821 Peripheral Interface Adaptor (PIA)
IC2	MM58174 microprocessor real-time clock

Miscellaneous

B1	3·6V rechargeable Ni-Cad battery
X1	32·768kHz crystal

40-pin d.i.l. socket; 16-pin d.i.l. socket

PL1	34-way p.c.b. mounting plug with right-angle pins
PL2	6-way plug to suit power outlet on BBC Micro



COMPONENTS approximate cost £26 excluding software

34-way ribbon cable (approx. 50cm) fitted with in-line sockets to mate with PL1 and PL11 on BBC Micro (1MHz bus outlet); tinned copper wire; twin insulated wire for PL2 connection. Microboard, Vero type 200-22271B see Special Offer Coupon, page 304.

Software

T003 cassette: Real-Time Clock (BBC Micro).

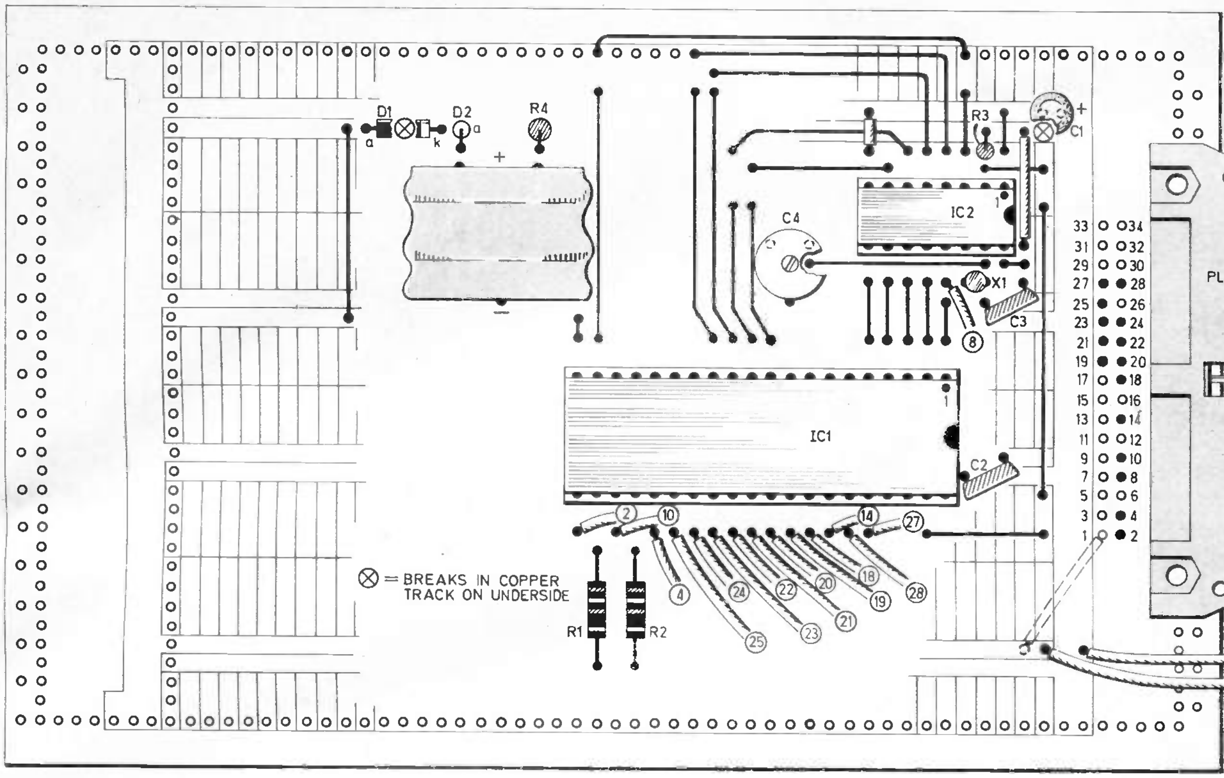


Fig. 6. Topside view of the Micro-Board showing component layout and complete interwiring for the BBC Micro version. The encircled numbers on the leads refer to the 1MHz bus pin no. they are to connect to. The link wire (shown dotted) from PL1 pin 1 to the 0V rail needs to be made if an external power supply (such as the one shown in Figs. 10 and 11), instead of the supply on board the BBC Micro.

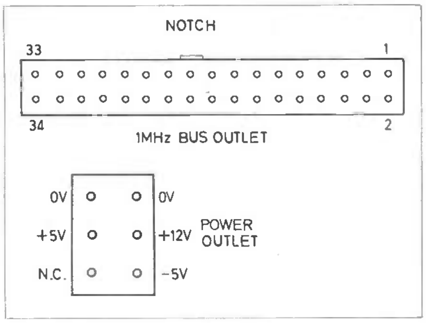


Fig. 7. Socket orientation and pinning information on the BBC Micro as seen when the front of the machine is tipped up and the sockets viewed from the front (keyboard uppermost).

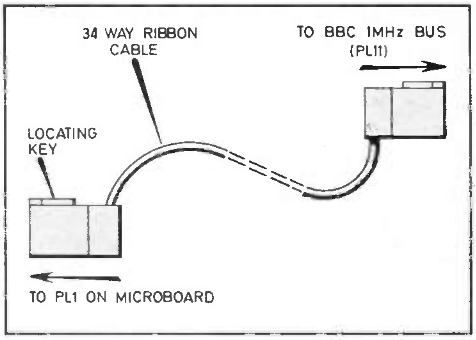
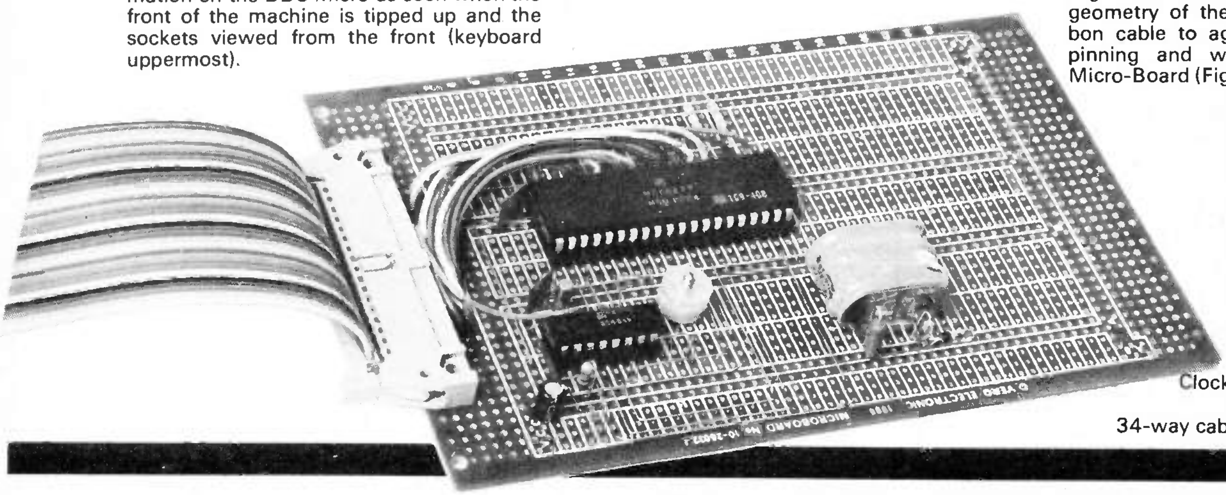
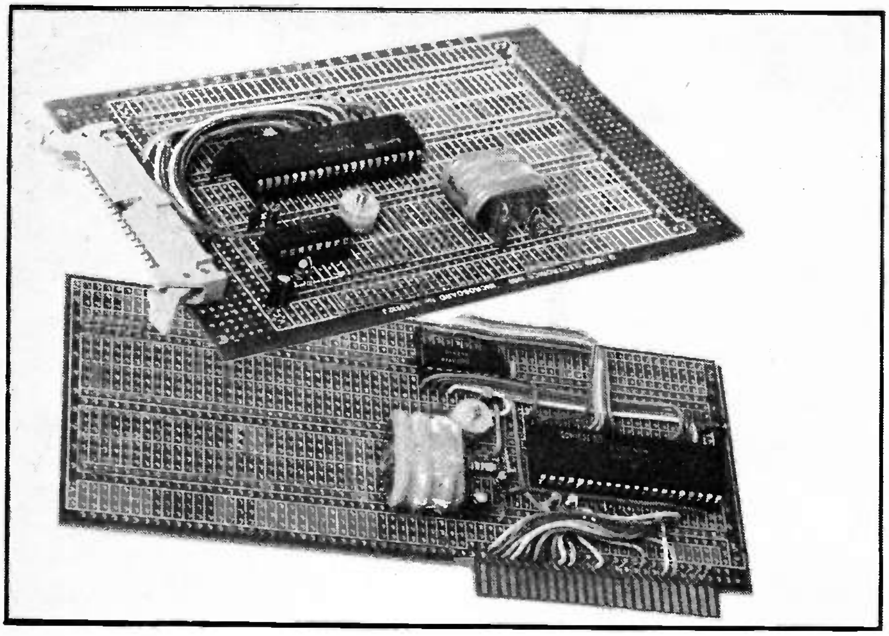


Fig. 8 (above). Required geometry of the 34-way ribbon cable to agree with the pinning and wiring on the Micro-Board (Fig. 6).



The completed Real-Time Clock circuit board Micro with 34-way cable plugged in.



TESTING

The only practicable way of testing it is to plug the circuit board into the computer: into slot 3 on the Apple, or via a 34-way cable/connector into PL11 on the BBC Micro. Switch on the micro, and load in the software.

Since the resetting at power-up causes all registers of the PIA to be set to zero, all lines of the PIA are defined as inputs to begin with. This is a standard safety feature for PIAs, since it prevents the operation of a peripheral such as the clock i.c. from being upset by random output commands at power-up time. In this state, all outputs from Ports A and B and the two Control outputs should be at +5V.

The unused outputs of Port A (pins 6 to 9) remain at +5V throughout, but the unused outputs of Port B (pins 14 to 17) are at 0V since they have no pull-up resistors.

PROGRAMS

The REM statements in the programs indicate what levels to expect on the four used lines of each port and on the control lines.

The INITIALISATION program is used for getting the clock ready for action. It first defines Ports A and B as outputs, then sets register 1 (test) and register 14 (start/stop) to zero. The clock is now ready to be set to the correct time and date.

The TESTING program simply allows you to examine the contents of any clock register, to see if it is behaving as expected. It begins by starting the clock, converts Port B to input function, and then asks you which register you want to examine. You will note that, before it prints the data it has read, it checks to see if it is "15". A reading of "15" is obviously nonsense as far as times and dates are concerned, and its appearance is a warning from the clock that its registers have been updated since the last reading.

For example, suppose the time is read just before 4 o'clock. The micro might read 59·9 seconds and 59 minutes, but before it can read the hours the clock changes to 4 hours 0 mins 00 seconds. The micro will read the hours as 4, and print out the time as 4 hours 59 minutes 59·9 seconds, an error of almost 1 hour! Updating of any register causes it to output "15", which means that you should begin the process of reading the registers again. There is plenty of time to read them all in a tenth of a second.

If you run the program and answer <3> in response to the query, you should see a column of single digits scrolling up the screen, incrementing by 1 every second. If you select register <4> instead, they should increment every ten seconds.

The SETTING program allows you to set the time while the clock is stopped. Set it for a few minutes ahead of the actual time. Wait when the message "Ready?" is printed. As soon as the time is exactly that which you have set, press <Y>. This starts the clock at precisely the right instant.

When you have tried the TESTING program and examined the way it works, you will be ready to write your own program for reading the time.

READING shows you how to read hours and minutes and the day of the week. You can extend the program to take in seconds, and the date.

Having read the data, there are all kinds of ways of displaying it, from a straightforward text display to a simulation of an analogue clock dial, with moving seconds hand. There is quite a lot of programming fun to be had from the real-time clock.

INTERRUPTING

The "Interrupt" facility needs a machine code program. If you do not wish to become involved in machine code programming you may leave out the signal line connecting the interrupt output of the clock (pin 13) to the $\overline{IRQ}$ line of the computer.

Normally the $\overline{IRQ}$ line is held at high level, but the clock can bring it low to cause an Interrupt ReQuest. When this happens, and provided that the microprocessor has been enabled to respond to such a request, it completes the operation it is engaged in, then stores the contents of its registers in a safe place, the "Stack".

It then goes to addresses 1022 and 1023 in RAM, where it expects to find the starting address of its Interrupt Service Routine. The Interrupt Service Routine (ISR) tells the MPU what to do next.

If, for example, the clock is being used in conjunction with a games program to limit the length of time each player is allowed to take for each move, the ISR might cause the message "Time up! Next player's move" to be displayed. When the ISR is completed, the microprocessor jumps back to the point it had reached in the main program, retrieves the original contents of its registers from the Stack and continues with the main program.

An interrupt does not *necessarily* have any apparent effect on the program which is being run. An egg-timer program could

Table 4. Interrupts: data to be placed in Register 15

Function		Bit 3210	Decimal equivalent
No interrupt		0000	0
Single interrupt	after 60s	0100	4
	after 5s	0010	2
	after 0·5s	0001	1
Repeated interrupts	every 60s	1100	12
	every 5s	1010	10
	every 0·5s	1001	9

be run at the same time as any other program. If the clock is set to interrupt at 1-minute intervals, the microprocessor is interrupted, jumps to a routine to count the number of times it has been interrupted and returns to the main program. It happens so quickly that you would not notice the interruption.

On, say, the fifth interruption, when the egg is ready for eating, a message "Egg ready now" is flashed on the screen, before the main program is resumed.

INTERRUPT FLAG

$\overline{IRQ}$ is enabled if the Interrupt Flag in the Status Register of the microprocessor if "0", and disabled if it is "1". When the computer is first switched on, this Flag is set to "0". Unless you deliberately set the flat to "1" by using SEI in machine code, it remains at "0" so that there is no need to take special action to enable it.

The only time it goes to "1" of its own accord is when the microprocessor is servicing an interrupt and does not want to be interrupted while doing so. When it has finished it makes the flag "0" again.

To tell the microprocessor where to find the start of the ISR, you place the starting address in locations 1022 and 1023. The low byte of the address goes in 1022, the high byte in 1023.

The address can be changed from time to time during the course of a program so that the interrupt sends the microprocessor to different ISRs which cause different things to happen on at different stages of the program. This can be done simply from a basic program by POKEing the new addresses to 1022 and 1023.

The interrupt output of the clock is controlled by Register 15. The settings are shown in Table 4. The procedure for setting the register is exactly the same as that used in the SETTING program for the other registers. Having set Register 15 to the required interval, read the Register three times in succession. This starts the interrupt timer.

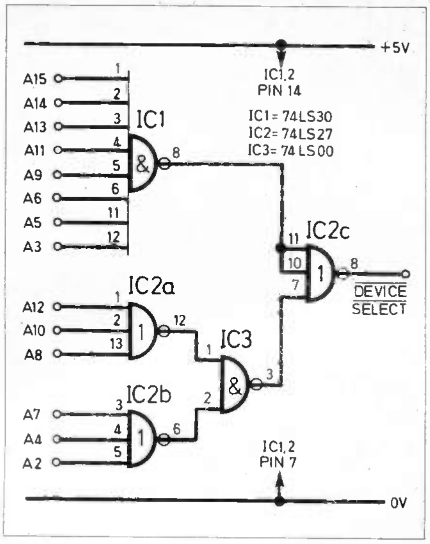


Fig. 9. Address decoder for the addresses 60008 to 60011. Lines A0 and A1 go to RS0 and RS1 of IC1 in Fig. 2.

OTHER MICROS

Unless your micro has "slots" or a built-in I/O port, you will need to provide an address decoder for the clock. You can choose any address you like, but take care that it is not one which is already allocated for use by the micro itself.

For example, it must not be in the range used by RAM, ROM, the Keyboard or the Video monitor. Consult your manual for details. Having found a vacant address, an address decoder can be built up on the model of that shown in Fig. 9. □

5V POWER SUPPLY

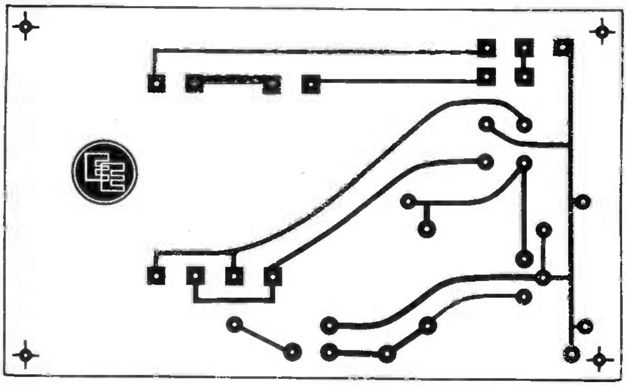
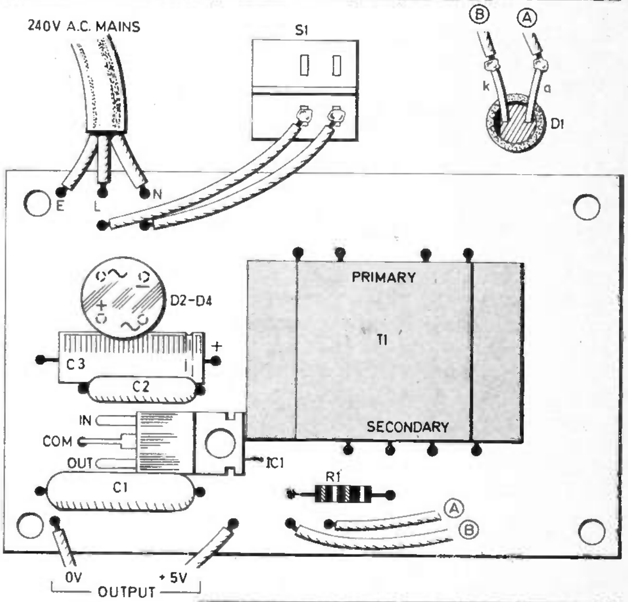


Fig. 11. The 5V Regulated Power Supply is assembled on one p.c.b., the full size artwork of which is shown here. It must be housed in a suitable case and the output taken to a pair of sockets mounted alongside the switch and l.e.d.



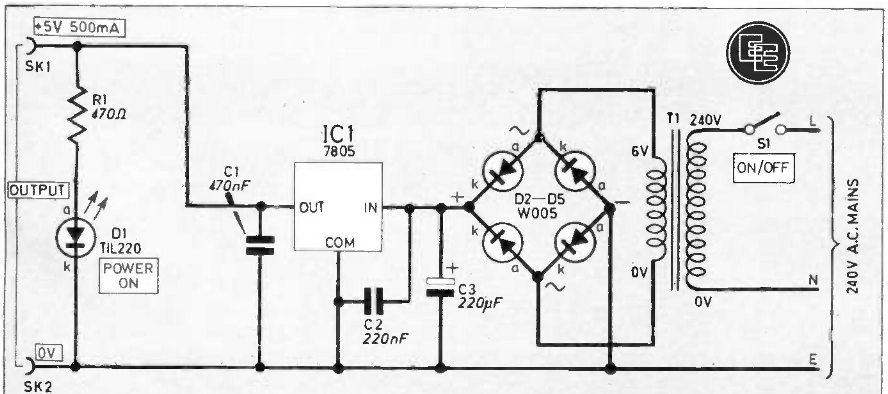
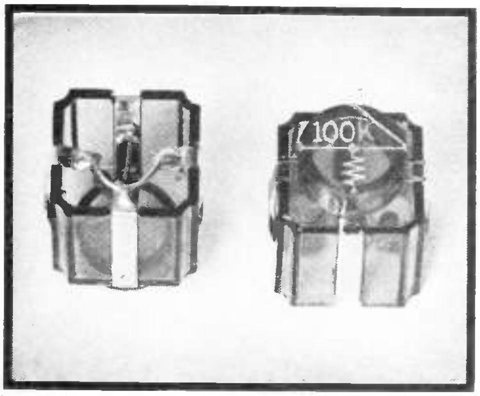


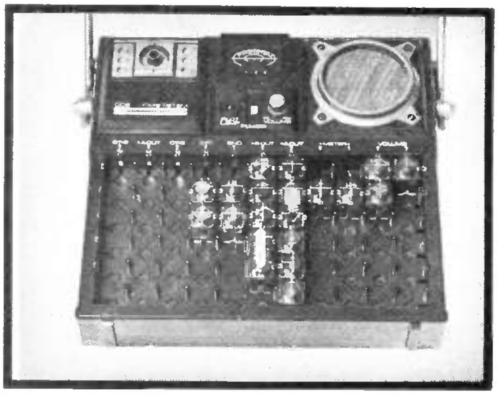
Fig. 10. Circuit diagram of the 5V Regulated Power Supply.

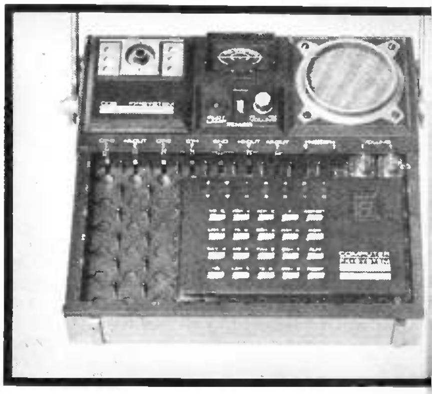
COMPONENTS

R1	470Ω ¼W carbon ±5%
C1	470nF polyester C280
C2	220nF polyester C280
C3	220µF 10V elect.
D1	TIL220 0·2in red l.e.d.
D2–5	W005 50V, 1A bridge
IC1	7805 5V, 1A regulator
S1	s.p.s.t. mains switch
SK1,2	4mm banana socket (2 off)
T1	mains transformer with 0–6V, 0–6V 250mA secondaries, p.c.b. mounting (RS 207–829)

Single-sided p.c.b. 80 x 50mm; case to suit; wire; mains lead.







SPECIAL REPORT

FX – COMP

FIRST impressions of the FX Computer are that it is a very deceptive piece of equipment. It may look like a cheap toy but neither is it cheap nor is it a toy.

Built by Gakken Corporation Limited, this educational kit retails at £69.95 plus £3.00 for p & p, available from Electroni-Kit Limited, Dept. EE, 388 St. John Street, London, EC1V 4NN.

The case is made from robust plastic and forms the experimenters "test-bed". The top section of the case near the carrying handle contains the supply on/off switch, the amplifier module, volume control and light sensitive cell (CDS). The CDS module may be interchanged for an l.e.d. clock and timer.

TEST-BED

The test-bed is located in the lower section of the case and is designed around a rectangular well which accepts the various component cubes. The base of the well is marked up into a matrix of squares. The component cubes are located in these squares, held in position by small plastic locating pillars at the corners of the squares.

The sides of the well connect to the component cubes via sprung metal connecting lugs. The contacts on the sides of the well are wired to various modules mounted in the top section of the case. These well contacts are clearly marked, so no mistakes should be made when constructing the electronic circuits.

COMPONENT CUBES

The kit provides 29 component cubes made from preformed plastic. The various components are mounted in the centres of the cubes which are clearly marked with the component symbol and value. The cubes also have sprung connecting lugs on their sides which in turn are wired to the components. Cubes without components are used as interwiring links.

Far left shows the component cubes with symbol and component mounting. (Centre) The test-bed with an experimental Gun Sound circuit. (Left) Test-bed showing the computer keyboard ready for use.

KEYBOARD

The computing circuitry of the kit is contained in the keyboard, which in turn slots into the test-bed. The keyboard is then able to draw power via connecting lugs. The keyboard uses a custom designed chip to provide the program memory, data memory and registers. The keyboard is a standard hexadecimal key located board and is neat and attractive. Both binary and hexadecimal displays are located on the board, and these provide clear viewing when programming.

Certain keys are designated a musical note and a full range musical scale is available. The unit provides reasonable sound and the notes are of good clarity.

Various games are already stored permanently in the memory and are used in conjunction with the binary display.

INSTRUCTION MANUALS

Provided with the kit are two instruction manuals. One manual deals with the computing side of the kit and lists 100 example programs. The second manual handles the electronic projects and provides 65 example circuits.

The electronic projects manual is excellently illustrated and each project has its own circuit diagram and easy to follow "building block" component layout. A brief introduction to each circuit is also provided.

The computer manual is not as clear as might be expected, especially when dealing with computing in Machine Code. The manual is also confusingly ordered and it lacks any real continuity.

CIRCUIT AND PROGRAM TEST

All 165 computer and electronic projects were carried out.

We found the electronic circuits easy to set up and nearly all the circuits were successful. Those that failed were due to an error on our part. The Steam Boat Sound circuit provided the first failure but after re-checking the circuit, it was found to be due to a component cube making an unnecessary connection with the wall of the well.

We found that it was possible to make a bad connection when using a small amount of component cubes. This was because the cubes lacked any pressure to push them together. It may be a good idea to push each of the cubes firmly down once the circuit has been built.

The computer programs of which there are 100 examples proved to be just as successful. Few mistakes were made when operating the keyboard, which proved to be very fast and reliable.

Any mistakes that were made when programming were easily edited, although at times it was easier to "reset" and start again.

KIT CONTENTS

1	Test Bed
1	Computer Console
1	Light Sensitive Cell
1	Speaker
29	Component Cubes
2	Test Probes
1	Manual containing 65 electronic projects
1	Manual containing 100 computer projects

CONCLUSION

The kit is very well made and the layout of the unit is excellent, the idea of a test-bed may not be new but it provides an easy circuit set-up.

Electronic projects are easily set up in the test-bed and if successful the circuit may then be drawn from the symbols printed on the cubes. This application is extremely useful, even to an experienced electronics engineer.

The kit has good educational value and the electronic project manual provides a first class introduction for the beginner. The computer manual provides a good introduction to computing, but then tends to lose its way and is difficult to follow.

The components in the cubes are easily interchangeable, so that the kit may be easily expanded, to a limitless number of projects.

Overall a good educational kit, although the price is a bit questionable. □

PUTER KIT

BY R. HOOPER

TEMPERATURE SENSOR FOR PET & VIC 20 COMPUTERS

BY J. ADLINGTON, L. CHAPMAN AND J. MONK

THIS project has been specifically designed for use with the A–D Converter which appeared in EE January, 1983. When attached it will allow precision temperature readings to be made and displayed on the PET and Vic 20. Suitable software for these two machines is included later in the article.

The temperature sensor may also find applications as a "stand-alone" unit or when equipped with a suitable connector to feed other A–D Converters with other computers. Software will in these cases need to be developed by the user.

Some computers are already equipped with on-board A–D Converter circuitry. In such cases the temperature sensor could plug directly into the computer "analogue input". However, the user is advised to check with the manual before doing so. The important parameter to look for is the analogue reference voltage. In the BBC Micro for example, a suitable "reference voltage" is generated and available and should be incorporated in the circuitry.

TEMPERATURE SENSOR

The circuit diagram of a Remote Temperature Sensor circuit providing 10mV per K (0 to 100 degrees Celsius on the 1 volt range is shown in Fig. 1).

IC1 is a precision temperature sensor whose operation is similar to that of a Zener diode—hence its symbol. It has a breakdown voltage whose magnitude is directly proportional to, and bears a linear relationship with its temperature.

The device provides an output of 10mV per Kelvin. For a Celsius output an off-set voltage of 2·73V is necessary. This equals the voltage across IC1 at 0 degrees Celsius (=273K).

The reference voltage is derived from the battery supply by the potential divide action of R3, R4 and VR1. VR1 is adjusted so that the voltage at its wiper equals 2·73 volts.

Zener diode D1 together with R5 provides a stable supply to the circuitry.

The l.e.d. D2 acts as a power-on indicator and lights up when S1 is closed.

The voltage difference between the two poles of PL1 is proportional to the temperature of the sensor and forms the analogue input to the A–D Converter.

CONSTRUCTION

The components are assembled on a small p.c.b. size 51 × 30mm single-sided. The pattern to be etched is shown full size in Fig. 2.

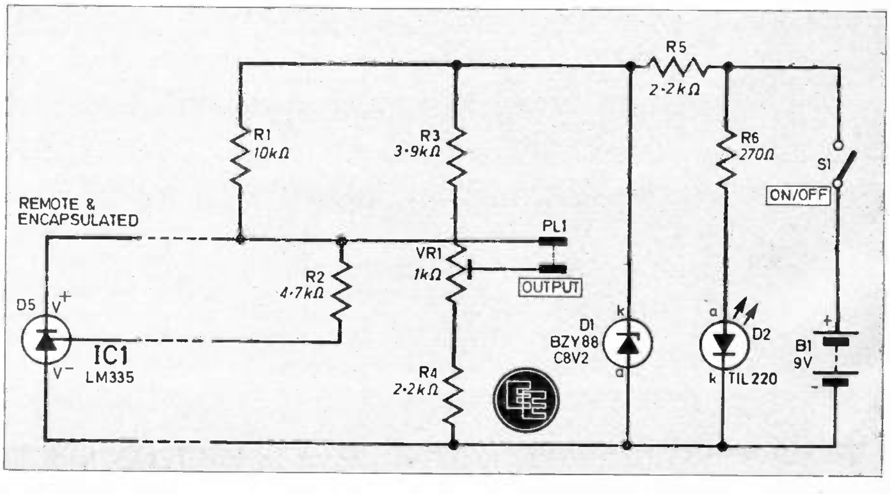
The p.c.b. fits inside a small diecast aluminium box measuring approximately 90 × 35 × 30mm with a PP3 battery. Assemble the components as shown in Fig. 3, and attach suitable lengths of flying leads to reach the case mounted components.

In the prototype, the lead running to the sensor was a length of 3-core mains cable. It should be passed through a grommet lined hole in the case end after being soldered to the assembled p.c.b.

Double-sided adhesive foam was positioned on the case inside where the board was to sit. This prevents the tracks from shorting out on the metal case.

The prototype sensor i.c. was glued using Araldite into the end of a short length of 5mm diameter plastic tubing after having its leads extended using stranded lightweight wire soldered to its leads. The junctions were sleeved for protection. These leads were soldered to the ends of the 3-core cable which was

Fig. 1. Circuit diagram of the Remote Temperature Sensor.



previously passed through a longer piece of plastic tube. The joints were sleeved. The two parts of plastic tubing clipped together.

The LM335 can be mounted in a thin metal tube to provide protection for it. The metal cases often used for clinical thermometers are ideal, although some heatsink compound should be used to improve *thermal* contact between sensor and casing avoiding *electrical* contact between the two.

Connect the battery, insert in the case and fit the case lid to complete the unit.

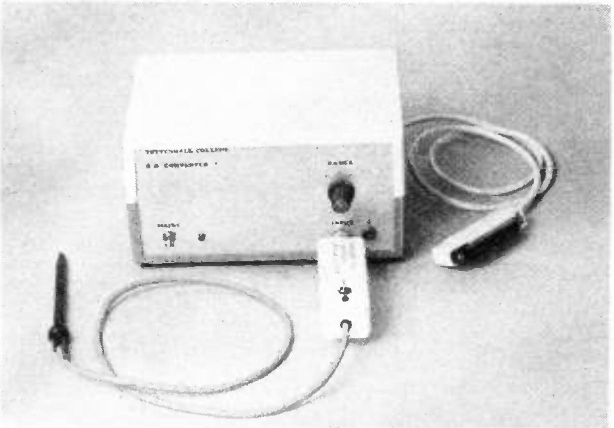
A digital voltmeter is required for accurate calibration. With the LM335 at 0 degrees Celsius, connect a voltmeter across the output (PL1) and adjust VR1 for ZERO output. The unit is then ready for use with the A–D Converter.

SOFTWARE

High level languages are not generally well suited to input/output (I/O) control applications: writing a peripheral interfacing program in Basic can be likened to attempting to eat an apple through the strings of a tennis racket.

It is possible, however, to marry the convenience of Basic with the efficiency of machine code by patching a machine code program into the PET Basic character fetch routine (CHRGET) in page zero. This enables the programmer to utilise the inherent benefits of a machine code subroutine to control the operation of the A–D Converter without sacrificing the advantages of Basic.

The fact that the entire operation of such a converter can be controlled by a



The completed prototype sensor plugged into the A–D Converter. The latter is suitable for use with PET and Vic 20.

A view inside the completed prototype sensor. The board is held securely by double-sided foam on its underside (see below).

COMPONENTS

See Shop Talk page 281

Resistors

R1	10kΩ
R2	4·7kΩ
R3	3·9kΩ
R4	2·2kΩ
R5	2·2kΩ
R6	270Ω

All ¼W carbon ±5%

Semiconductors

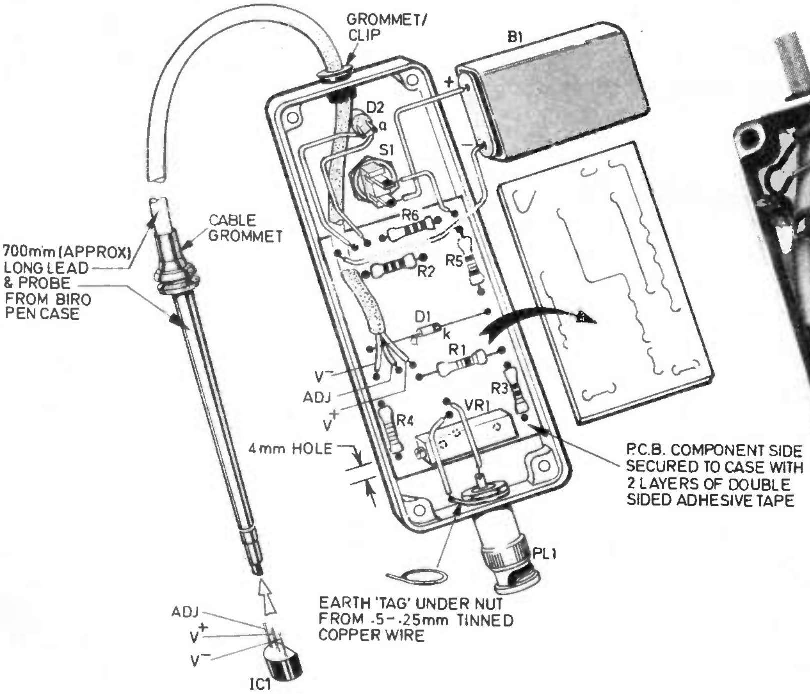
IC1	LM335Z precision temperature sensor
D1	BZY88C8V2 8·2V 400mW Zener diode
D2	TIL220 0·2 inch red l.e.d.

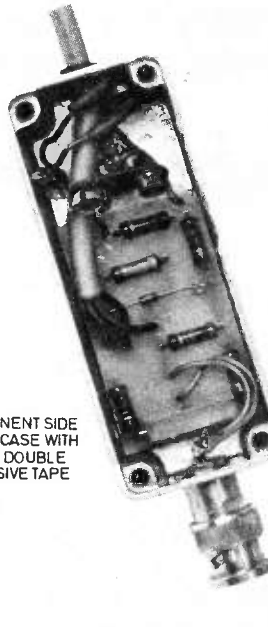
Miscellaneous

S1	miniature on-off toggle
PL1	b.n.c. plug
B1	PP3 9 volt
VR1	1kΩ ¾ inch multiturn cermet preset

Printed circuit board, single-sided size 51 × 30mm; 3-core cable; diecast aluminium box, size 90 × 35 × 30mm; PP3 battery clip; sleeving; rubber grommet.

Approx. cost Guidance only £6





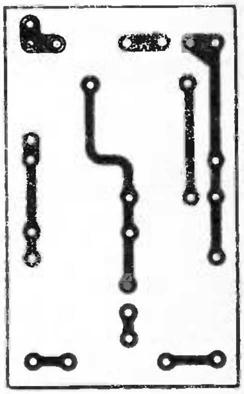


Fig. 2. Full-size master p.c.b. pattern. The black areas represent the copper to remain after etching.

Fig. 3. Layout of the components on the p.c.b. topside with full assembly and interwiring details.

single command in a Basic program means that experimental results are easily obtainable for use within that program.

APPLICATIONS

Some applications in the chemistry laboratory are outlined below. In each case a temperature probe is attached to the converter.

1—DIRECT MEASUREMENT

The FETCH command, !T, instructs the converter to change the analogue input into a digital value which is passed to the Basic program as variable T.

```
10  !T
20  PRINT "PROBE TEMPERATURE IS"; T+273; "KELVIN"
```

2—DATA LOGGING

The FETCH command, !T, can be placed in a timed program loop. Temperature readings can thus be stored at regular intervals in a dimensioned array. One such sampling program is listed below.

```
10  DIM T(100)
20  DELAY = 600: REM 10 SECONDS
30  FOR N = 1 TO 100
40  S = TI
50  IF TI < S + DELAY THEN 50
60  !T
70  T(N) = T
80  NEXT N
```

3—DIGITAL DISPLAY

The temperature obtained using the FETCH command, !T, can be passed to a number plotting sub-routines: the large digits so displayed can be seen by all pupils in the laboratory.

```
10  !T
20  GOSUB 10000: REM NUMBER PLOTTING ROUTINE
```

4—GRAPH PLOTTING

A number of different graphical formats are possible. If quarter character graphics are used in place of the normal full character graphics a reasonable 80×50 screen resolution can be obtained. A direct graphical representation of a temperature/time curve during the cooling of naphthalene is one such application of this technique.

5—DECISION MAKING

The use of FETCH commands and IF . . . THEN statements in a program allow decisions to be made. One obvious application is in boiling point determination—is the temperature increasing or has it reached a constant value?

6—COMPUTER SIMULATION

A stainless steel probe containing a platinum resistance thermometer and hydrogen gas can be interfaced via the converter to the microcomputer. The temperature of the gas is monitored and a bar chart of the Maxwellian distribution of molecular velocities at different temperatures is plotted during immersion in various liquids.

TRANSDUCERS

As previously mentioned, existing laboratory measuring instruments which have an "external meter" connection can be interfaced with the microcomputer using the Converter. The 100mV range is often useful here although the instrument should be provided with a "dummy" load resistor of value equal to the resistance of the meter with which it is normally intended to be used. (Many such meters are 100Ω, 1mA f.s.d. types and a resistor of this value is thus suitable.)

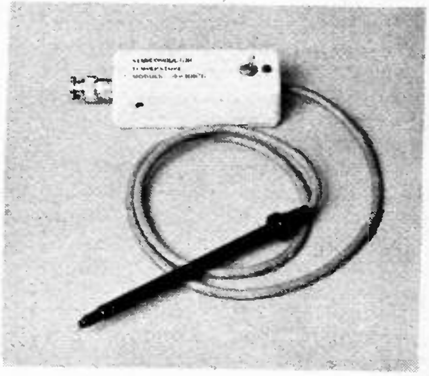
Tailor made transducers are under development by the designers and include the following: temperature (semiconductor), temperature (platinum resistance), pH value, luminous intensity, sound level and these designs will be published in EE in due course. □

PROGRAM A **FOR PET COMPUTER**

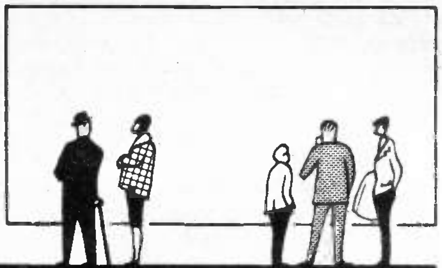
```
5 REM TEMPERATURE/PET/ZN427E
9 REM INITIALISATION ROUTINE
10 POKE 59468,PEEK(59468)OR192:REM CB2 ENABLE
20 POKE 59468,PEEK(59468)AND223:REM TRI-STATE DISABLE
30 POKE 59456,PEEK(59456)OR8:REM START CONVERSION HIGH
40 POKE 59459,0:REM PORT A INPUT
50 GOSUB 2000
60 PRINT "TEMPERATURE";TC%
70 GOTO 50
1999 REM CONVERSION ROUTINE
2000 POKE 59456,PEEK(59456)AND247:REM START CONVERSION LOW
2010 POKE 59456,PEEK(59456)OR8:REM START CONVERSION HIGH
2020 POKE 59468,PEEK(59468)OR32:REM TRI-STATE ENABLE
2030 TC%=INT(PEEK(59471)*.4+.5):REM FETCH TEMPERATURE
2040 POKE 59468,PEEK(59468)AND223:REM TRI-STATE DISABLE
2050 RETURN
```

PROGRAM B **FOR VIC 20 COMPUTER**

```
5 REM TEMPERATURE/VIC-20/ZN427E
9 REM INITIALISATION ROUTINE
10 POKE 37147,PEEK(37147)AND227:REM DISABLE SHIFT REGISTER
20 POKE 37148,PEEK(37148)OR192:REM CB2 MANUAL OUTPUT
30 POKE 37148,PEEK(37148)AND223:REM TRI-STATE DISABLE
40 POKE 37139,PEEK(37139)OR32:REM DDRA BIT 5 OUTPUT
50 POKE 37151,PEEK(37151)OR32:REM START CONVERSION HIGH
60 POKE 37138,0:REM DDRB INPUT
70 GOSUB 2000
80 PRINT"TEMPERATURE";TC%
90 GOTO 70
1999 REM CONVERSION ROUTINE
2000 POKE 37151,PEEK(37151)AND223:REM START CONVERSION LOW
2010 POKE 37151,PEEK(37151)OR32:REM START CONVERSION HIGH
2020 POKE 37148,PEEK(37148)OR32:REM TRI-STATE  ENABLE
2030 TC%=INT(PEEK(37136)*.4+.5):REM FETCH TEMPERATURE
2040 POKE 37148,PEEK(37148)AND223:REM TRI-STATE DISABLE
2050 RETURN
```



SHOP TALK



BY DAVE BARRINGTON

Catalogues

This month we have received two new mail order catalogues from firms which, until now, are new to us.

The 132-page Electronic Components Catalogue from **MS Components** is lavishly illustrated and every item is priced under each entry. Over 1800 new items have been added to their already vast stock of components.

Components held range from resistors and capacitors to computer keyboard and printer mechanisms. A new 33-page section features a broad range of discrete components, logic, linear, hybrid, microprocessor, interface and memory integrated circuits.

Although supplying mainly to the trade, MS Components do *not* levy a minimum order charge and prices include postal charges. Also, it states under their conditions of sale that they "will despatch to any type of customer or private individual provided that the terms of our trading conditions are compiled with".

The MS Components catalogue is well worth adding to readers' libraries and further details and copies may be obtained from **MS Components Ltd., Dept EE, Zephyr House, Waring Street, West Norwood, London, SE27 9LH.**

Two items that caught the eye whilst browsing through the new 176-page **JEE Distribution** Catalogue were a range of board and cable fasteners and a range of pinout labels for the popular 7400 and 4000 series of integrated circuits. The catalogue is issued with a separate price list which is updated throughout the year.

The full-size self-adhesive labels have the relevant pinning details, including type number, printed on them and are stuck on top of the i.c. to give at-a-glance information of the internal make-up of the device.

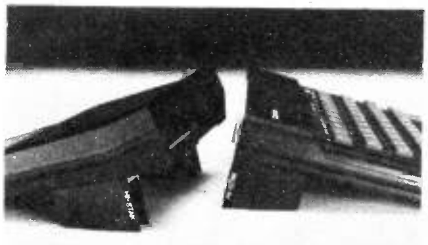
Coinciding with the release of the JEE catalogue is the announcement of the opening of their new shop premises in Southfields, London.

Copies of the JEE Distribution Catalogue can be obtained from **JEE Distribution Ltd., Dept EE, 43 Strathville Road, London, SW18 4QX.**

Home Computer Feet

Claiming to make keyboards more comfortable to use and their printed surfaces easier to read, **Warp Factor Eight** have introduced plastics "ramps" for raising home computers at a more inclined angle.

Known as Hi-Stak they are moulded plastics ramps with built-in rubber feet and self-adhesive tops which are stuck to the rear of machines to raise the rear-end from the resting surface. The additional "feet" are suitable for Sinclair, VIC20, Atom, Jupiter Ace, Lynx and Oric 1.



Warp Factor Eight Hi-Stak home computer feet.

The Hi-Stak is available, by mail order, from **Warp Factor Eight, 6 Pelham Road, Braughing, Ware, Herts.** Price £3.95 including VAT and postage.

Spectrum Sounds

Three months ago **Bi-Pak Semiconductors** marketed a sound generator for use with the Sinclair ZX81 (See *Shoptalk,* February issue). So successful has this been that they have now introduced a new modified version for all the Sinclair range of home computers.

Designated ZON X, the unit is self-contained in a black plastics case with a loudspeaker and volume control. For use with the Sinclair Spectrum, there is a further plug-in adaptor which houses a crystal and other components needed to give unlimited sound facilities.

The ZON X for use with ZX81 and Timex 1000 cost £25.95, The ZON X plus special adaptor for the Spectrum cost £32.75. All prices include VAT and postage.

Further details may be obtained from: **Bi-Pak Semiconductors, Dept EE, The Maltings, 63a High Street, Ware, Herts, SG12 9AG.**

CONSTRUCTIONAL PROJECTS

Headphone Amplifier

When ordering the input jack socket SK1 for the *Headphone Amplifier,* be sure to specify a d.p.d.t. switched type. These are stocked by most of our advertisers.

MW Radio/Tuner

The ferrite aerial for the *MW Radio/Tuner* is available direct from Denco (Clacton) Ltd., Dept EE, 355 Old Road, Clacton-on-Sea, Essex. Other suitable aerials are stocked by Ambit and Maplin.

Model Train Controller

The case used in the prototype model of the *Model Train Controller* was obtained from Maplin and can be ordered as: LH67X (ABS Console M6007). Most of our advertisers stock sloping front cases and any of these may be used, provided they are of similar dimensions.

Real-time Clock

Quite a large saving on the circuit boards for the Real-time Clock projects can be obtained by using the special coupon on page 304. The coupon should be presented to your local BICC-Vero stockist.

The only stockist we have been able to locate for the 6-way plug to suit power outlet on the BBC Micro (PL) is Watford Electronics, Dept EE, 34 Cardiff Road, Watford, Herts, WD1 8ED. We understand that they are able to supply all components for this project.

The semiconductors, crystal, d.i.l. sockets and connectors (except the 6-way plug) are available from Cricklewood Electronics.

EVERYDAY ELECTRONICS SOFTWARE SERVICE

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

All prices include VAT, postage and packing. Remittances should be sent to Everyday Electronics Software Service, Editorial Offices, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

PROJECT TITLE	CODE	COST
ZX81 SPEED COMPUTING SYSTEM (Feb 83)	T001	£2.95
REAL-TIME CLOCK (Apple) (May 83)	T002	£2.95
REAL-TIME CLOCK (BBC) (May 83)	T003	£2.95

GUITAR HEADPHONE AMPLIFIER

A SIMPLE PROJECT FOR YOUR FREE TRANSISTORS

BCY65EP—2N4123

It is possible to practice playing the electric guitar without causing any disturbance or annoyance to others by simply relying on the acoustic output of the instrument, but this has the drawback of very low volume and it is obviously impossible to practice using any guitar effect units.

A much better alternative is to use a practice amplifier having a headphone output, or a headphone amplifier such as the simple and inexpensive design featured here.

The circuit is primarily intended for use with high or medium impedance headphones, but it also seems to give quite good results when used with low cost 8 ohm impedance headphones. The sensitivity of the amplifier is high enough for use with low output guitar pick-ups, but a volume control at the input of the circuit enables the sensitivity to be reduced so that overloading can be avoided if a high output pick-up is used. The unit also has proper bass and treble tone controls.

CIRCUIT DESCRIPTION

The circuit has just two stages; a preamplifier built around TR1 and an active tone control stage based on TR2. The full circuit diagram of the unit is shown in Fig. 1.

TR1 is used as a common emitter amplifier with R2 as the collector load resistor and R1 providing base biasing. R3 is used to provide negative feedback which boosts the input impedance of the circuit slightly, as well as giving lower noise and distortion levels. C3 reduces the response of the preamplifier at frequencies above the audio range, and this helps to avoid instability and breakthrough of radio frequency interference. The input signal is coupled to TR1 via volume control VR1 and d.c. blocking capacitor C2.

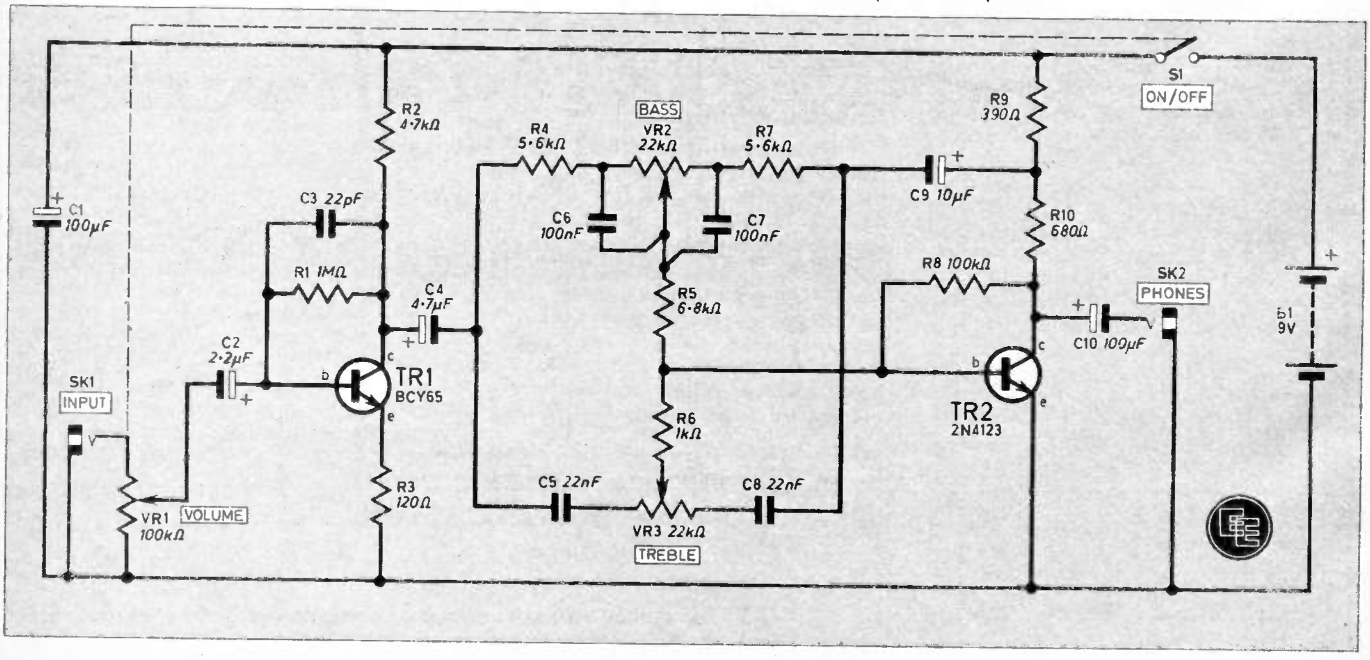
The tone control circuit uses TR2 as a common emitter amplifier with frequency selective negative feedback provided via the tone control networks. The circuit operates in a similar manner to an inverting mode operational amplifier circuit, and the voltage gain of TR2 is roughly equal to the impedance from C9 to the base of TR2 divided by the impedance from C4 to the base of TR2.

TREBLE CONTROL

If we consider the treble control circuit first, the relevant feedback components are C5, C8 and VR3. At low frequencies C5 and C8 will have impedances that are high in comparison to the track impedance of VR3, and while adjustment of VR3 will obviously have some effect on the gain of the circuit, the degree of control available is insignificant.

The situation is very different at high frequencies where C5 and C8 have a very low impedance. With the wiper of VR3 towards the C5 end of its track there is a low impedance from C4 to the base of

Fig. 1. Complete circuit diagram of the Guitar Headphone Amplifier.



TR2, and a much higher impedance from C9 to the base of TR2.

The circuit consequently provides a reasonable voltage gain at these frequencies. With the slider of VR3 towards the C8 end of its track there is a low impedance from C9 to TR2's base, and a high impedance from C4 to TR2's base. The circuit consequently provides less than unity voltage gain.

Thus VR3 provides the required effect by providing boost and cut at treble frequencies, but having no significant effect at bass and middle frequencies.

BASS CONTROL

The bass control (VR2) operates in a similar fashion. At high frequencies C6 and C7 place what is effectively a short circuit across VR2 so that it can have no significant influence on the gain of the circuit. At low frequencies the impedance of C6 and C7 is much higher and VR2 is then able to exercise considerable control over the gain of the circuit. R4 and R7 are included to prevent excessive bass boost and cut being provided by the circuit. R5 and R6 help to minimise interaction between the bass and treble tone control networks.

In this explanation it has been assumed that the feedback is taken direct from the output of TR2 (collector terminal), but it is in fact taken from a tapping on the collector load resistance. This does not fundamentally affect the operation of the tone controls, and merely results in a small voltage gain through TR2, rather than a nominal unity voltage gain.

This small additional voltage gain is needed to ensure that the amplifier has adequate gain for use with low output guitar pick-ups which provide an output signal of only about 20 or 30mV r.m.s. in amplitude.

S1 is the on/off switch and is a set of make contacts on the input socket, SK1. The unit is therefore automatically switched on when the guitar is connected to SK1, and switched off again when it is disconnected. A separate on/off switch can obviously be used if preferred. The current consumption of the circuit is about 5mA, and power is provided by a 9-volt battery.

CONSTRUCTION starts here

CASE

An aluminium box measuring about 133 × 102 × 38mm provides a housing for the unit which is reasonably compact but does not complicate construction. The three controls and the input socket are mounted on the front panel, and wiring the unit will be more straightforward if the panel layout used on the prototype is copied. In other words these components should be mounted in a single row

COMPONENTS

Resistors

R1	1MΩ
R2	4·7kΩ
R3	120Ω
R4,7	5·6kΩ (2 off)
R5	6·8kΩ
R6	1kΩ
R8	100kΩ
R9	390Ω
R10	680Ω

All ¼W carbon ±5%

Capacitors

C1	100μF 10V axial elect.
C2	2·2μF 63V radial elect.
C3	22pF ceramic
C4	4·7μF 63V axial elect.
C5,8	22nF polyester (2 off)
C6,7	100nF mylar (2 off)
C9	10μF 25V axial elect.
C10	100μF 10V radial elect.

Semiconductors

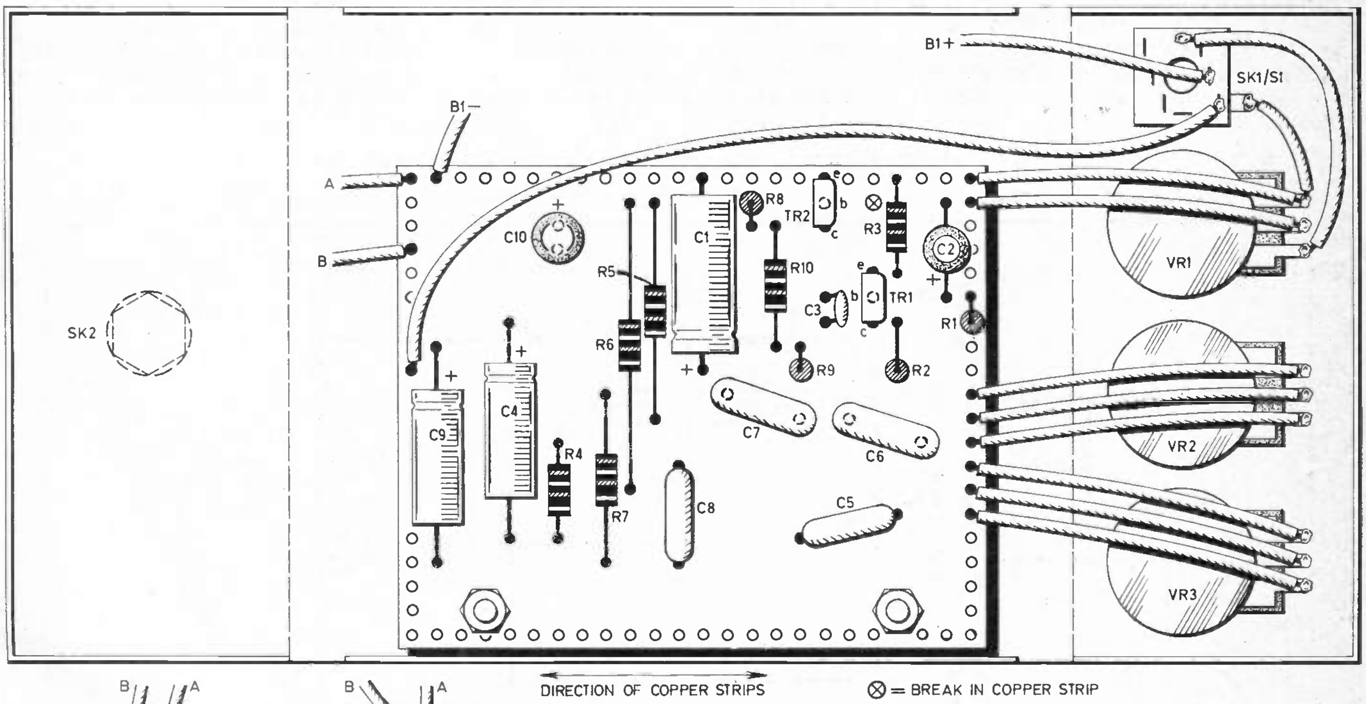
TR1	BCY65EP *npn* silicon
TR2	2N4123 *npn* silicon

Miscellaneous

VR1	100kΩ log carbon potentiometer
VR2,3	22kΩ lin carbon potentiometer (2 off)
S1	Part of SK1
SK1	Standard jack with d.p.d.t. contacts
SK2	Standard stereo jack
B1	9 volt (PP3 or PP6 size)

0·1in matrix stripboard, 20 strips by 24 holes; aluminium case, 133 × 102 × 38mm (type AB10); three control knobs; battery connector; wire; 6BA fixings.

Approx. cost Guidance only £5.00



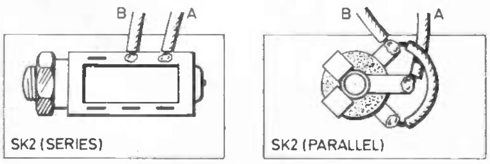
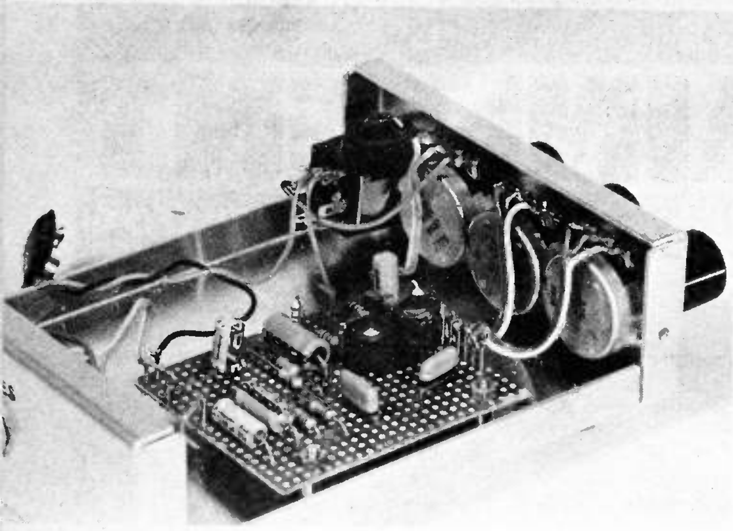
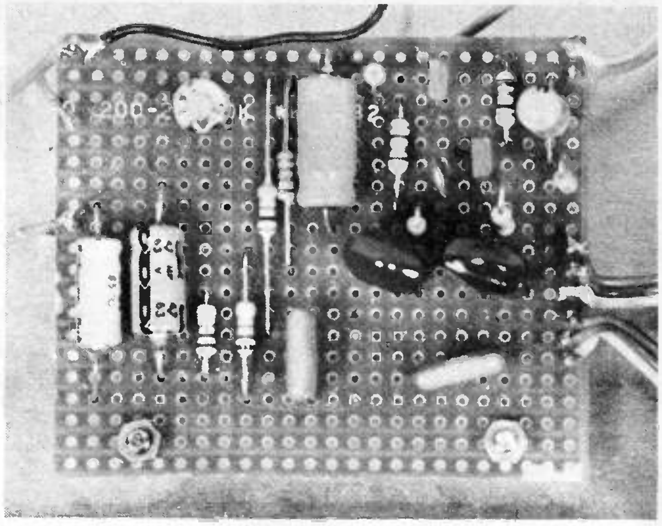


Fig. 2. Full component and off-board wiring details. The series and parallel wiring to the output socket is shown on the left.



Picture showing layout of components inside the case.



Component board layout.

with VR3 on the left, then VR2, next VR1 and SK1 on the right. SK2 is fitted on the rear panel of the amplifier.

COMPONENT BOARD

The component panel is a 0·1 inch matrix stripboard panel which measures 20 copper strips by 24 holes. Details of the component board are provided in Fig. 2. After a board of the required size has been cut out using a hacksaw the two 6BA clearance mounting holes should be drilled and the single break in the copper strips should be made before soldering the components into place.

Be careful to connect the electrolytic capacitors and the two transistors the right way round. Veropins are used at points on the board where connections to off-board components will be made.

Next the component panel is mounted on the base panel of the case using 12mm 6BA bolts with 6mm spacers to hold the underside of the board clear of the metal case so that short circuits are avoided. The board is mounted so that the end of the board at which R1 and C2 are mounted is next to VR1 to VR3. The final wiring of the unit is then perfectly straightforward, and this is shown in Fig. 2.

If the unit is to be used with medium or high impedance headphones, results will almost certainly be best with the two phones wired in parallel, and this is achieved using the method of connection shown in Fig. 2 (assuming that the headphones are connected to an ordinary stereo jack plug).

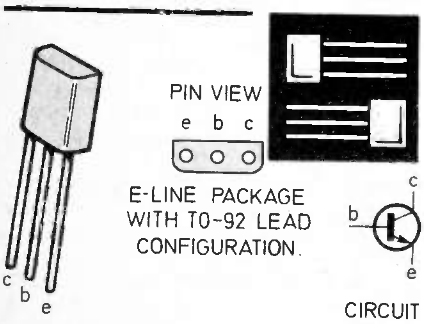
With low impedance types it is better to have the phones connected in series across the output of the amplifier, and an insulated stereo socket must then be used for SK2, otherwise an unwanted connection to the chassis tag of the socket will be made via the metal case and SK1. Fig. 2 shows the appropriate method of connection for this type of socket.

IN USE

The guitar lead connects to SK1, and the amplifier is automatically switched on and off when the jack plug is inserted and removed from SK1. Results will probably be best with any volume or tone control fitted to the guitar set at maximum, with the volume and tone then adjusted using the controls on the amplifier.

However, if desired, any tone controls fitted to the guitar can be used in addition to those on the amplifier to give greater control over the tone. □

2 FREE TRANSISTORS



The 2N4123 and BCY65EP are both *npn* silicon planar general purpose transistors. The BCY65EP is particularly suited for low noise a.f. amplifier input and driver stages and both types have been designed for use in general purpose amplifiers, oscillators, and switching applications. They are identically cased in Ferranti E-Line plastic packages with TO-92 lead-out.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	BCY65EP	2N4123	UNIT
Collector-Base voltage	V_{CB}	60	40	V
Collector-Emitter voltage	V_{CE}	60	30	V
Emitter-Base voltage	V_{EB}	7	5	V
Continuous Collector current	I_C	100	200	mA
Power dissipation @ $T_{amb} = 25°C$	P_{TOT}	400	500	mW
Power dissipation @ $T_{case} = 25°C$	P_{TOT}	–	1·2	W
Power dissipation @ $T_{case} = 45°C$	P_{TOT}	1	–	W

ELECTRICAL CHARACTERISTICS

Transition frequency (min)	f_T	125	250	MHz
Static gain* ($V_{CE} = 1V, I_C = 10mA$)	h_{FE}	80–190	–	–
Static gain* ($V_{CE} = 1V, I_C = 2mA$)	h_{FE}	–	50–150	–
Dynamic gain* @ 1kHz ($V_{CE} = 5V, I_C = 2mA$)	h_{fe}	125–250	–	–
Dynamic gain* @ 1kHz ($V_{CE} = 1V, I_C = 2mA$)	h_{fe}	–	50–200	–

**Forward current transfer ratio.*

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Sounds Of Video

In just five years video recording has become a way of domestic life. In Britain there are around 20 million homes and three million now have video recorders.

We have become blasé about the extraordinary trick performed by every one of these machines. It squeezes colour TV bandwidth, over 3MHz, out of half-inch tape running at less than one inch per second. This is half the running speed of audio cassette tape.

Because we take the pictures for granted, we've now started to listen to the sound. Unfortunately it doesn't bear close listening. Although the video signals are recorded by rapidly rotating heads, which scan the tape at around 10 miles an hour, the sound still has to be recorded in conventional linear fashion, at under one inch per second.

To make matters worse the audio tracks are very narrow, and when they are split into stereo with a guard band in between, they become absurdly tiny. The audio tracks on a V2000 video recorder, for instance, are just 0·65mm wide in mono. In stereo, each half track is just 0·25mm wide, with a guard band of 0·15mm in between. Although noise reduction systems can reduce hiss, there is no getting away from the fact that the sound of video is severely handicapped.

New Approach

This is why the firms behind both the Japanese formats, Beta and VHS, have developed a completely new type of sound recording system for video. Instead of recording the sound linearly, it is f.m. encoded and interlaced with the video waveform so that it is laid down by the video heads as part of the video tracks.

To make this possible a completely new type of recording technology is used. This is depth or vertical recording. It takes advantage of a natural recording phenomenon, whereby different frequencies record at different depths in a magnetic coating, with higher frequencies nearest the surface. So although the f.m. sound carrier and f.m. video carrier are recorded at the same time, by the same heads, on the same tracks, they are physically separated because they lie in different layers of the tape coating.

The Beta and VHS hi-fi sound systems won't be available for a year or so. When they do come on the market they will be compatible with existing VHS and Beta machines, because the same sound will also be recorded linearly, conventionally.

Calculating Time

Last year I wrote a short item bewailing the fact that there isn't a calculator on the market that easily computes time. You would use such a calculator to tot up the total length of several different music or speech recording segments, and then subtract them from a total available time, to see how much is left over. It would obviously be a boon for broadcast and tape editors.

After publication I immediately received a flood of letters from readers who very helpfully told me that it *was* possible to buy reasonably priced calculators which add time without special programming. Most are budget scientifics made by Casio. My thanks to everyone who wrote in pointing this out, but I still feel there would be a market for a calculator that did the trick more easily.

To add time with a scientific calculator you have to enter hours, minutes and seconds by keying in time as degrees and then using the sexagesimal instruction key. The display shows the times in decimal equivalents.

You then do the sum and convert decimals back into hours, minutes and seconds by using the inversion and sexagesimal keys. The sequence works perfectly well, but it's hardly a simple, everyday approach to totting up time!

My point was, and still remains, that the calculator manufacturers seem to be missing out on a useful feature that could be easily offered, simply by relabelling and dedicating a few keys, and combining the unit with a clock and stopwatch timer. We've already got calculators with clocks and stopwatch timers, and we have already got scientifics with sexagesimal arithmetic.

So why not package these features together for people who are more interested in adding time, than making science calculations. It's always been my sneaking suspicion that only a relatively few people who buy scientific calculators ever fully understand their functions, let alone exploit them.

Record Spoiler

You'll probably have seen reports in the popular press that CBS has developed a spoiler system to prevent unauthorised taping of records. Actually it's *not* a spoiler system and CBS is the first to admit it. But it could, in theory, prevent unauthorised taping.

A so-called spoiler signal is supposed to stop people taping records, by interfering with some vital circuit in the tape-recorder when illegal copying takes place. But if the record is to sound all right for normal listening, which is, of course, legal, the spoiler must be of too high or too low a pitch to be heard. As such it is all too easily filtered off, either deliberately or by budget equipment.

The CBS system doesn't add anything to the music signal. Instead it takes something away. A very narrow notch is filtered out of the music signal, in the mid-frequency range of around 3 or 4kHz.

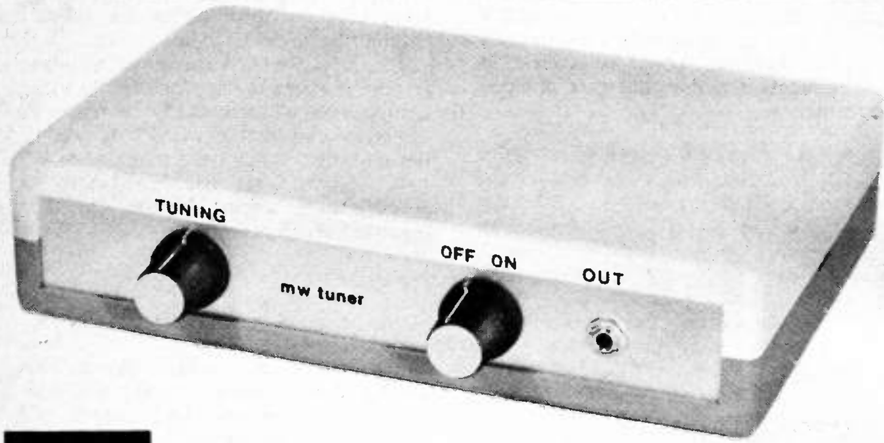
This notch isn't normally audible. It's like a crack in the piano keyboard. But if a tape-recorder has a sensor circuit which can detect the notch, and switch off some vital circuit like the bias, then it will refuse to record a notched disc.

Although CBS has proved that the system can work well, it relies on legislation to make tape-recorder manufacturers build in the necessary sensor and switch circuits. Realistically it's a non-starter, because there are now so many recorders without switches and discs without notches that it's too late to make the system a legal requirement.

The real irony is that the idea of marking music with an identifying notch, rather than adding a trigger signal, is at least ten years old. In the USA, radio pioneer, Murray Crosby patented something very similar for keeping tabs on the number of times radio commercials are broadcast. Other radio stations, like the British Forces Broadcasting Service, use notched trigger signals to control its tape recorders.

The record industry knew all about these notch systems back in the mid '70s but did nothing about using them to curb home taping. But, of course, at that time record sales were booming, and no-one bothered about home taping. Now, with the recession and interest in video cutting into record sales, the record industry is looking for someone or something to blame.

MW PERSONAL RADIO



A SIMPLE PROJECT FOR YOUR FREE TRANSISTORS

BCY65EP—2N4123

Although based on just two transistors this simple design provides good reception over the medium-wave broadcast band and gives more than adequate volume from any station that is received at reasonable strength.

The output is suitable to drive a crystal earphone, high impedance headphones, or virtually any amplifier. The unit has also been tried with a pair of medium impedance hi fi headphones and these gave excellent results.

Apart from the use of headphones, an earphone, or whatever, the unit is completely self-contained as it has an internal ferrite aerial and does not need any additional (external) aerial to give good results. Power is provided by a 9-volt battery, and many hours of use are available from each battery as the current consumption of the circuit is only about 3·5mA.

The unit is very easy to construct and it should be well within the capabilities of a beginner if reasonable care is taken during construction.

CIRCUIT DESCRIPTION

Most radio receivers use a superheterodyne (*superhet*) circuit, but while circuits of this type admittedly give excellent performance, they are relatively complex and expensive to build, and they can also be awkward to set up ready for use once completed. In this design the much more simple tuned radio frequency (t.r.f.) type of circuit has been used, and although this does not give results that are comparable to a *superhet* circuit, a perfectly adequate level of performance can be achieved. Fig. 1 shows the circuit diagram of the set.

TR1 and TR2 are used in a two-stage direct coupled amplifier, and both devices are used in the common emitter mode so that the circuit as a whole has a very high level of gain. The circuit is biased so that there is approximately 1·45 volts at the collector of TR1 and about 0·7 volts at the emitter of TR2, and negative feedback through bias resistor R2 helps to stabilise these bias levels.

For example, if the collector of TR1 should go more positive for some reason, the emitter of TR2 would go positive by a similar amount, a higher base current would be fed to TR1 via R2, and TR1's collector voltage would therefore be reduced. The collector and emitter currents of TR2 are virtually identical, and as collector resistor R3 is about six times higher in value than emitter resistor R4, the voltage developed across R3 is about six times higher than that present across R4.

With 0·7 volt developed across R4 this gives about 4·2 volts across R3, and the output of the amplifier is therefore biased to a potential that enables a high peak-to-peak output voltage to be obtained without clipping and serious distortion of the signal.

C7 is used to decouple R4 so that the negative feedback that this resistor would otherwise introduce is eliminated and TR2 is able to provide a high level of voltage gain. With only two stages of amplification in the circuit it is essential that they both provide high gain if acceptable results are to be obtained.

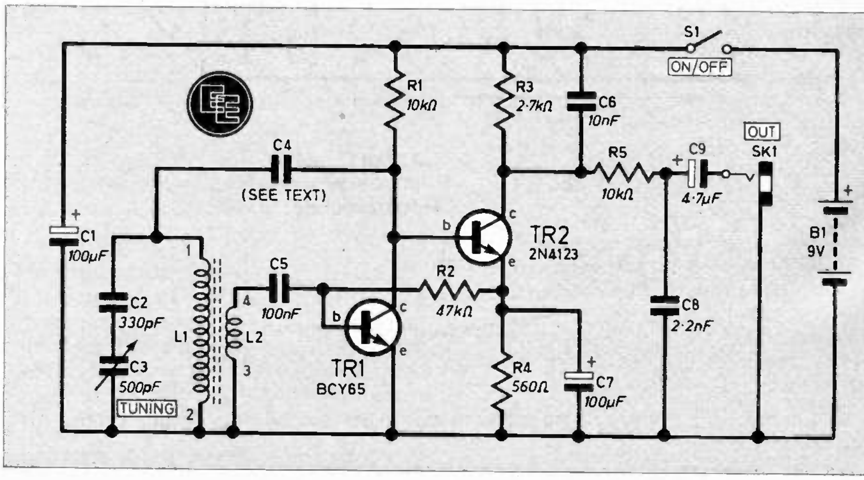
FERRITE AERIAL

The input signal for the amplifier is provided by ferrite aerial L1/2, and C3 is the tuning capacitor for the latter. The component used in the C3 position was chosen because it is small and inexpensive, but it has a somewhat higher maximum capacitance than is really needed. C2 is therefore used in series with C3 to effectively reduce its maximum value to a suitable figure. The output of the aerial is coupled to the input of the amplifier via a low impedance coupling winding (which ensures an efficient signal transfer) and d.c. blocking capacitor C5.

Filtering (r.f.) is provided at the output of the amplifier by C6, R5 and C8, and the remaining audio frequency signal is coupled to output socket SK1 by C9. Of course, r.f. filtering alone is not sufficient to produce a.m. demodulation, and rectification of the signal is also needed. This rectification is actually an inherent feature of the amplifier, and it occurs due to the variation in gain that occurs with changes in the collector current of a transistor.

On one set of half-cycles the current through TR2 increases and produces a

Fig. 1. Complete circuit diagram of the MW Personal Radio.



consequent increase in gain, while on the other set of half-cycles the collector current and gain of TR2 both reduce. As TR2 is handling a fairly high signal level the gain difference on the two sets of half-cycles is quite large, and reasonably efficient rectification and detection is produced.

STATION SELECTION

Tuned radio frequency receivers have two main deficiencies; a lack of sensitivity and a lack of selectivity. A receiver which has good selectivity can pick-up just a small part of the frequency range covered by the set so that it can pick out just one station even though the band may contain numerous strong stations with crowding in places. A simple t.r.f. circuit such as this one has all the selectivity provided by a single-tuned circuit (ferrite aerial L1/2 in this case), and it is this that gives mediocre results in this respect.

A simple way of improving both sensitivity and selectivity is to use positive feedback, or regeneration as it is often termed in this context. This simply entails coupling some of the radio frequency signals from the output of the amplifier and feeding it back into the ferrite aerial so that a boost in gain is provided.

There will be more feedback (and thus a greater boost in gain) near the centre of the receiver's passband, and this effect produces the improved selectivity.

In this circuit the feedback is from the collector of TR1 to the ferrite aerial via capacitor C4. The latter has a very low value, and is in fact made from a couple of small pieces of insulated wire. The circuit is arranged so that the feedback is of the positive type so that the feedback signal is added to the input signal and a boost in gain and selectivity are obtained. Negative feedback would be useless in this application and would give reduced performance.

CONSTRUCTION starts here

COMPONENT BOARD

A 0·1 inch matrix stripboard panel measuring 12 copper strips by 23 holes accommodates most of the components. Details of this board and the wiring of the receiver are illustrated in Fig. 2. There are no breaks in any of the copper strips.

Construction of the board starts by cutting out a board of the specified size using a hacksaw, and any rough edges are then smoothed using a file. Next the two 6BA clearance holes are drilled and the components are soldered into place leaving TR1 and TR2 until last. Be careful to fit C1, C9, C7, TR1 and TR2 the right way round, and make sure that none of the copper strips are shorted together by solder splashes.

It is helpful to fit Veropins to the board at points where connections to off-board components will eventually be made as the board can then be wired to the rest of the unit after it has been mounted in the case. Alternatively the board can be wired into the circuit and then bolted in place in the cabinet.

CASE

The case used for the prototype is a Verobox having approximate outside dimensions of 180 × 120 × 40mm. This gives a smart appearance and makes construction of the unit very simple and straightforward, but any case of largely non-metallic construction and about the same dimensions should be suitable, and with a little ingenuity it should be possible to use a much smaller case if desired.

Note that it is important that the case is largely of non-metallic construction

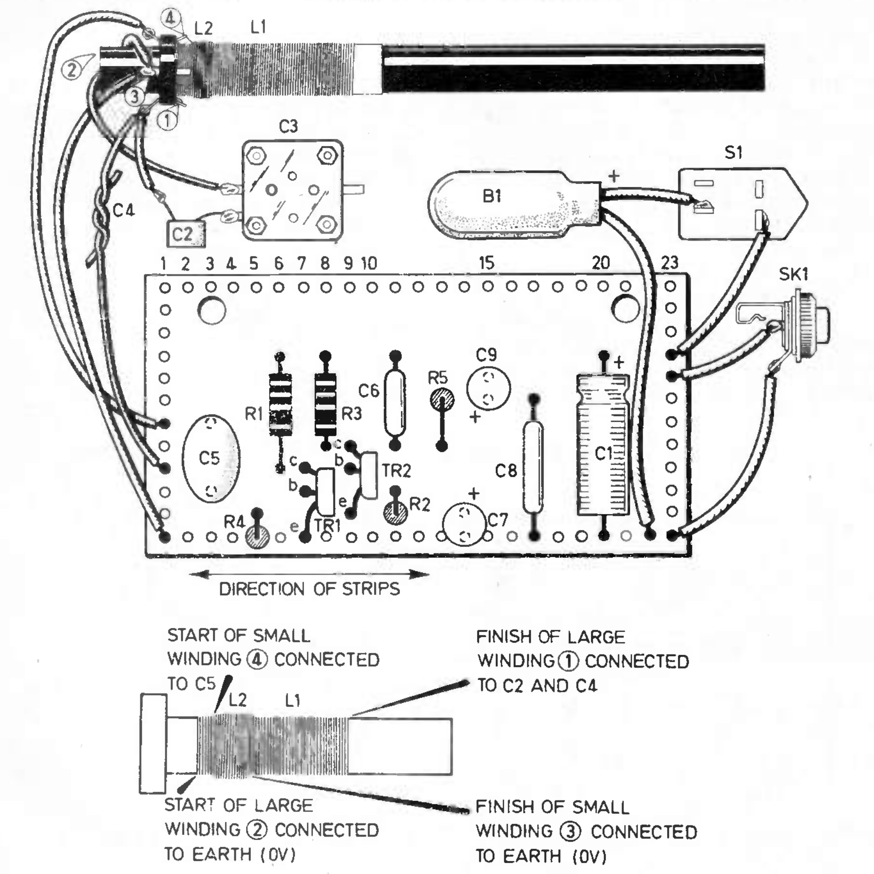


Fig. 2. Layout of component board with complete interwiring details of the off-board components.

COMPONENTS

Resistors

R1,5	10kΩ (2 off)
R2	47kΩ
R3	2·7kΩ
R4	560Ω

All ¼W carbon ±5%

See Shop Talk page 281

Capacitors

C1	100µF axial elect.
C2	330pF ceramic plate
C3	500pF variable
C4	see text
C5	100nF mylar
C6	10nF mylar
C7	100µF 10V radial elect.
C8	2·2nF mylar
C9	4·7µF 63V radial elect.

Semiconductors

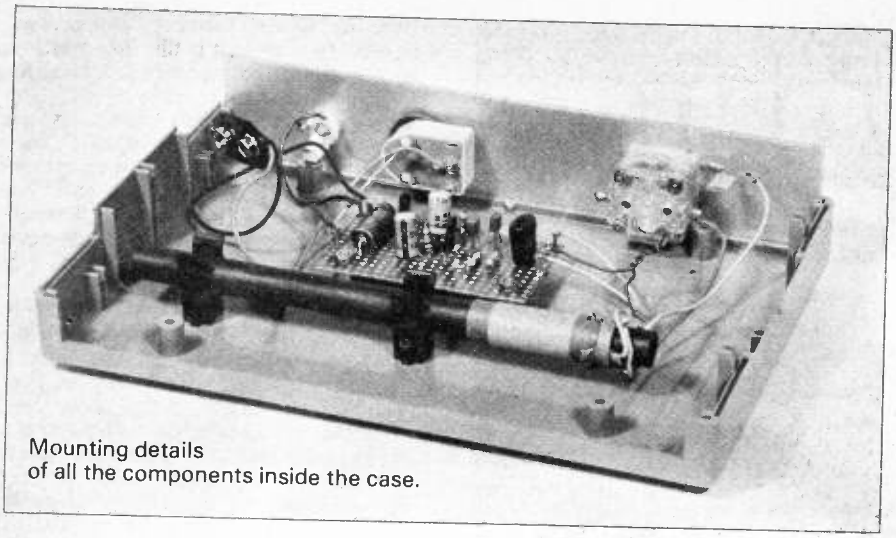
TR1	BCY65EP *npn* silicon
TR2	2N4123 *npn* silicon

Miscellaneous

L1	medium-wave ferrite aerial (Denco 5FR)
S1	rotary on/off switch
B1	9 volt (PP3 or PP6)
SK1	3·5mm jack socket

Verobox 75-3007C size 180 × 120 × 40mm; 0·1 inch matrix stripboard, 23 holes by 12 strips; two control knobs; battery connector; 6BA fixings.

Approx. cost Guidance only £7·00



Mounting details
of all the components inside the case.

since metal would have the effect of screening the ferrite aerial so that it would be unable to pick-up any significant signal, and the unit would obviously fail to work at all. Although the Verocase used for the prototype does have aluminium front and rear panels, these are quite small and do not have any significant screening effect on the aerial.

The two controls and the output socket are mounted on the front panel. The component specified for C3 has provision for screw mounting, but it may be easier to glue it in place using a good quality general purpose adhesive.

The ferrite aerial used in the prototype is an Ambit aerial coil type MWC2 mounted on a 140 × 9·5mm ferrite rod type FRA, which is in turn mounted on the base panel of the case towards the rear of the unit using two 6·35mm 6BA bolts and two mounting clips type FRPC. However, the circuit has been found to work well using a Denco type MW5FR aerial which is supplied complete with a 140 × 9·5mm ferrite rod. This aerial can be mounted using a couple of large P-grips.

The circuit should work using a normal medium-wave ferrite aerial having a small coupling winding. It is essential for the aerial to be connected correctly, and reference to Fig. 3 plus a close inspection of the aerial coil should clarify matters.

Once all the components have been mounted in the case the final wiring of the unit can be completed. This includes the fitting of C2 which is mounted direct on C3, as shown in Fig. 2. Capacitor C4 just consists of two pieces of insulated wire about 75mm long and connected to the appropriate points in the circuit.

Single-strand wire is better than the multi-strand type since single-strand wire will not tend to spring apart and unwind itself. Initially these two wires should not be twisted together and should just be positioned close to one another.

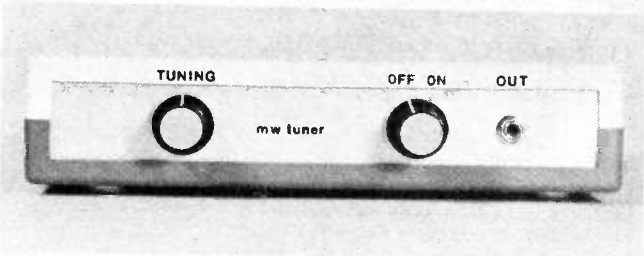
TUNING ADJUSTMENT

To an extent the coverage of the receiver is controlled by the position of the aerial coil on the ferrite rod. The aerial coil can be left at any position on the ferrite rod that provides full coverage of the medium-wave band, and its exact position should not be very critical since C3 gives slightly more than complete coverage of the band.

In order to obtain good results from the circuit it is essential to have C4 set correctly. With the two wires forming C4 a little way apart it will probably be possible to receive a few stations at moderate volume, but the set will probably lack reasonable selectivity. Twisting the two wires together should improve both sensitivity and selectivity, but if they are twisted together over too great a length oscillation will occur at certain settings of C3.

This will be heard as a tone of varying pitch as the set is tuned through a station, and proper reception is not possible with oscillation present. The two wires forming C4 should be twisted together as much as possible without oscillation being evident at any setting of C3. The receiver will then have optimum performance and should provide good reception.

Remember that the ferrite aerial is directional, and if necessary the unit can be turned to peak the wanted station and to null any interfering transmission. It is possible that slight overloading could occur in strong reception areas, and the set can then be turned to reduce the strength of the received signal to a satisfactory level. □



Picture showing the front panel of the finished article.

BOOK REVIEWS

AN INTRODUCTION TO VIDEO

Author	D. K. Matthewson
Price	£1.95 Limp edition
Size	180 × 110mm 87 pages
Publisher	Bernard Babani Ltd
ISBN	0-85934-075-9

For those who are relative newcomers to home video this book will provide some very useful information and answers. In some cases it could possibly save you money.

The book deals with the circuitry and mechanical features of typical recorders with Beta and VHS format. The book contains helpful hints on tape editing, copying and the use of video cameras.

R.A.H.

THE ART OF PROGRAMMING THE ZX SPECTRUM

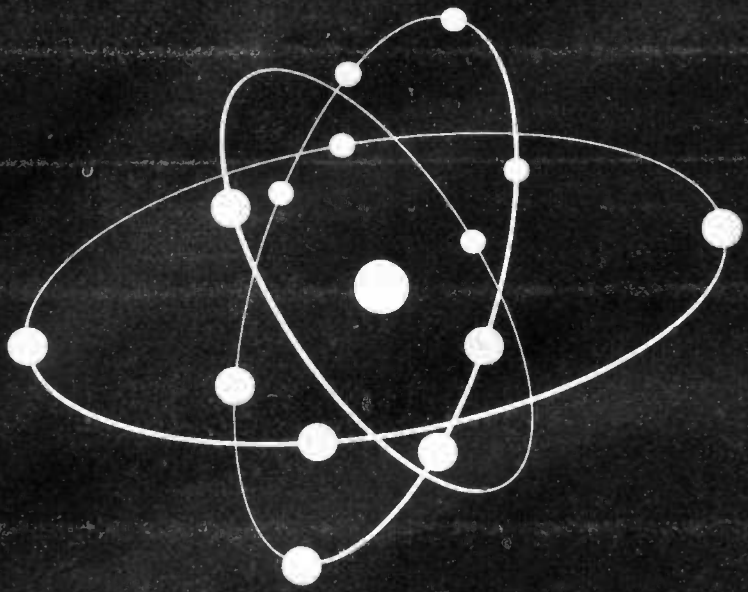
Author	M. James
Price	£2.50 limp edition
Size	180 × 110mm. 138 pages
Publisher	Bernard Babani Ltd
ISBN	0-85934-094-5

This book provides a very detailed and comprehensive guide to programming the Sinclair ZX Spectrum. Each area of programming is explained in easy language and each example program is accompanied by a program listing.

Not only is this book useful for an experienced programmer but it will also provide the beginner with a useful introduction to computing.

R.A.H.

ELECTRONICS and the ELECTRON



Part 1 INTRODUCING THE ELECTRON

BY J. B. DANCE

WHAT is this peculiar particle, the electron, from which our hobby of electronics has derived its name? An electron is an extremely minute object weighing less than one thousand million million million millionth of a gramme; such an object is quite beyond our imagination. To add to our confusion an electron may behave as a particle or as a wave, depending on the particular experiment one performs!

THE UBIQUITOUS ELECTRON

Electrons are found in enormous numbers in all types of matter. When chemical changes occur (such as the burning of coal or the use of food in our bodies), it is the electrons in the matter undergoing the change which alter their orbital positions and so produce new chemicals.

If one combs one's hair or rubs a piece of plastic to generate electric charges, one merely removes an extremely minute fraction of the electrons present in a material and transfers them to another material, thus creating very high voltages.

Electrons are therefore, to all intents and purposes, responsible for almost all of the phenomena of everyday life. Indeed, it is only the electrostatic repulsion between the electrons of our bodies and those of other materials, which prevents us from sinking rapidly into the ground towards the centre of the earth under the force of gravity, since all matter is almost entirely empty space (except possibly the extremely dense matter of neutron stars).

The compressed air inside a vehicle tyre supports the weight of the vehicle as a result of the bombardment of huge numbers of air molecules on the inside of the tyre. However, if we look at the molecules of air more closely, we find it is the repulsion between the electrons of the air and of the car tyre which supports the vehicle. Similarly the braking force of a car is essentially provided by inter-actions between the electrons of the tyre and electrons of the road surface.

ELECTRONICS

However, in this article we shall be mainly concerned with the flow of electrons in various materials and in electronic tubes, since it is this flow which is an electric current and which makes our hobby of electronics possible. Initially electronics was a term applied to the use of vacuum tubes (valves) in which electrons flowed. In the early years of this century, electronics was a term exclusively reserved for what we now call nuclear instrumentation (that is, the use of electronic devices for nuclear particle detection and measurement).

The term electronics subsequently underwent some change in use with the rapid developments in radio communication. In the 1950s and 1960s the term electronics gradually became the science of using semiconductor materials and devices rather than vacuum tubes. However, one still meets the vacuum tube in the cathode ray tubes of the television receiver, in certain microwave electronic tubes and in a few other applications where no semiconductor device has yet been found to replace the electronic tube both for performance and economy.

The flow of electrons is responsible for all aspects of electronics. It would seem equally reasonable to call the whole of chemistry (or perhaps even the whole of science) "electronics". However, the name "chemistry" and the names of most of the other sciences had become firmly established even before the electron had been discovered.

HISTORY

The discovery of the electron was one of the most important of a number of discoveries made near the turn of the century which completely revolutionised our fundamental ideas of physics. In 1895 Röntgen discovered X-rays using discharge tubes and in the following year Becquerel found radioactivity using photographic techniques.

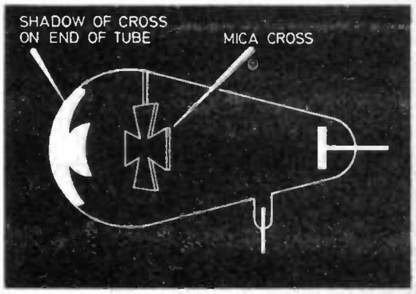


Fig. 1.1. A typical Maltese Cross tube for demonstrating the emission of cathode rays.

In 1897 J. J. Thomson discovered the electron and this greatly assisted our understanding of the constitution of matter. Important discoveries in the nuclear field soon followed together with Einstein's *Special Theory of Relativity*.

It was known that if a high potential was applied to an evacuated tube, such as that shown in Fig. 1.1, the glass of the tube glowed with a green light. If an object such as a mica cross is placed in the position shown, a shadow of this cross is thrown onto the end of the tube. This is known as the Maltese Cross Experiment.

It seemed that something was being emitted from the negative electrode (the cathode) and was travelling more or less in straight lines towards the glass at the end of the tube. What was this "something"? Initially it was assumed that some form of ray was given out by the cathode and these rays were therefore called "cathode rays"—a name which still persists in our cathode ray tubes.

German scientists of that time believed that the rays were some form of invisible light, whereas English scientists felt that they were minute particles of negative electricity. The latter proved correct.

It was found that cathode rays could penetrate a thin sheet of aluminium. If allowed to fall onto a light paddle wheel made of mica, they would cause the wheel to rotate on its axis. In 1895 J. Perrin collected cathode rays in a cylinder and used an electroscope to show they have a negative charge.

We now believe that cathode rays consist of a beam of electrons. Apparently the name "electron" was first suggested by Stoney in 1894 for the particles of cathode rays, but it was not clear at that time whether the rays consisted of a continuous flow of some material or whether individual particles were really present.

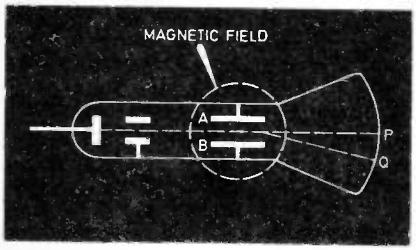


Fig. 1.2. The vacuum tube used by J. J. Thomson.

THOMSON'S EXPERIMENT

In 1897, J. J. Thomson measured the ratio of the charge of the particles to their mass and this enabled scientists to conclude that individual electrons were present in the cathode rays. The type of tube used by Thomson is shown in Fig. 1.2.

A narrow beam of cathode rays is produced by an arrangement known as an electron gun. The beam passes through a region in which either an electric field or a magnetic field or both can be applied to the rays, the direction of the two fields being perpendicular to one another.

The electric field is induced by applying a voltage to the electrodes marked A and B, whilst the magnetic field is produced by a coil outside the tube in the region indicated by the dotted circle of Fig. 1.2.

Thomson applied a magnetic field which caused the electrons to be deflected from P to Q. The position where the beam met the end of the tube was made visible as a green glow, as in the modern cathode ray tube. Thomson then applied an electric field between the plates which was just sufficient to return the beam to its former position at P.

The magnetic and electric fields were now producing equal and opposite effects. Thomson now entered values for the field strengths into suitable equations in order to obtain a value for the ratio of the charge/mass for the particles of the beam. He was also able to show that the velocity of the particles was about 10 per cent of that of light.

The important discovery made by Thomson was that the charge/mass ratio of cathode rays was always the same no matter what material was used for the cathode. This strongly implied that all electrons are alike and that they are universal constituents of all matter.

The charge of an electron (given the symbol *e*) was measured by J. J. Thomson and by Townsend independently in 1897–98, but Milikan developed a more accurate technique during the period 1909–1916. This charge was found to be the same as that carried by the hydrogen ion (or any other monovalent ion) in solution and is now taken as the fundamental unit of electric charge. No particle has yet been found which has a charge which is not equal to *e* or some whole number multiple of *e*.

As the charge/mass ratio, e/m and the charge *e* were both known, the mass of the electron, *m*, could be found. Electrons are one of the lightest known particles, having a mass of only about 1/1840 of that of the hydrogen atom, this being the lightest known atom.

Sir William Bragg has said that Sir J. J. Thomson (1856–1940) "more than any other man was responsible for the fundamental change in outlook which distinguished the physics of this century from that of the last." He led a team at the Cavendish Laboratory, Cambridge, where he was professor of experimental physics. He was succeeded by his pupil, Rutherford.

THE CATHODE RAY TUBE

Thomson's tube of Fig. 1.2 was the forerunner of the modern cathode ray tube. A typical c.r.t. is shown in Fig. 1.3.

Hot objects emit electrons and therefore a heater is used at the end of the tube. This has the advantage that a much lower voltage is adequate to operate the tube than in heater-less tubes in which the electrons had to be torn out of the cathode by the high electric field produced by a high operating voltage. In addition, the use of a relatively low operating voltage, not exceeding a few kilovolts, removes the danger of X-rays being formed. When cathode rays (that is, electrons) strike a surface, they lose their velocity and X-rays are formed.

The grid or modulator electrode controls the number of electrons which pass along the tube through a hole in the anode. They then pass through two sets of deflector plates; one set of plates can deflect them vertically and the other set horizontally. Finally, they strike the fluorescent screen where a part of their energy is converted into light.

The cathode ray tubes used in television receivers are somewhat similar to the oscilloscope type of tube shown in Fig. 1.3, but the electron beam is deflected by means of a magnetic field generated by coils placed around the neck of the tube.

A FUNDAMENTAL PARTICLE

The electron is one of the fundamental particles of nature. The other two fundamental particles found in atoms are the proton and the neutron. These last two particles are found in nuclei, a typical nucleus being about 10^{-13}cm in diameter.

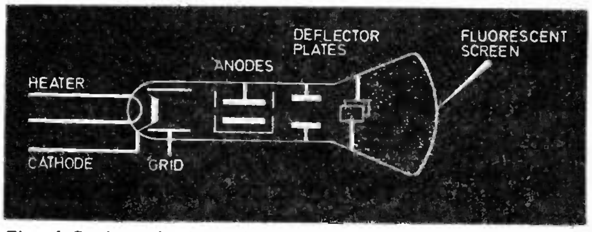


Fig. 1.3. A typical modern cathode ray tube as used in oscilloscopes.

The electrons are said to be in orbits around nuclei, but whether they actually circle around the nucleus according to Bohr's theory will not be discussed here.

The particles emitted in a type of radioactive decay known as beta decay are electrons. Beta particles are identical to electrons. Many other types of nuclear particles are known, such as neutrinos, muons and kaons, but they need not concern us.

Next month: Conduction and how electrons flow in various materials.

ELECTRON DATA

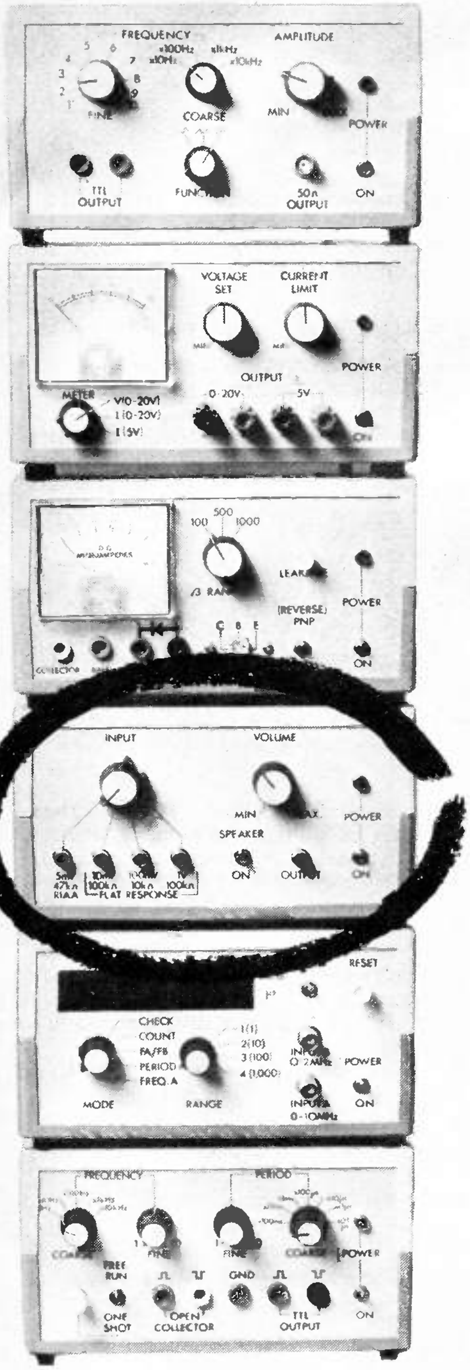
e = negative charge of an electron = $1{\cdot}6021892 \times 10^{-19}$ coulomb.
m = mass of the electron = $9{\cdot}109534 \times 10^{-28}$ gramme.
(The mass of the electron can also be expressed in terms of energy, using Einstein's equivalence of mass and energy; it is equal to 0·5110034MeV where 1MeV = 1 million electron volts.)

As far as is known, the electron is stable indefinitely; it has been shown to have a half-life of over 10^{21} years.

TEST GEAR 83 LABORATORY AMPLIFIER

UNIT THREE **BY J. R. W. BARNES**

THE TEST GEAR 83 SERIES CONSISTS OF:
DUAL POWER SUPPLY ● FUNCTION GENERATOR ● TRANSISTOR TESTER
PULSE GENERATOR ● LABORATORY AMPLIFIER ● FREQUENCY METER



PROJECTS which involve sounds of one kind or another are both popular and common among hobbyists. They range from radios and musical instruments to alarms and special effects generators. In all cases some form of amplifier and loudspeaker must be used to convert the electrical signals to sound waves.

The unit described here is a small half watt amplifier, with a pre-amplifier section designed to accept a very wide range of inputs. It has a small internal speaker which produces acceptable results, but better fidelity is obtained with an external speaker.

In line with the other units in the series the amplifier is mains powered and housed in a matching case.

FOUR INPUTS

The amplifier has four inputs. Three of these have a flat response, that is, provide the same degree of amplification across the audio band. The fourth input has RIAA magnetic pick-up equalisation.

A few words of explanation may be needed here. When records are recorded, the bass end of the spectrum is attenuated and the high frequencies boosted. There are many reasons for this, the most important being to improve the signal-to-noise ratio and to prevent the stylus bouncing out of the tracks with heavy bass.

To obtain the correct sound on playback, the frequency response of the amplifier must boost the bass and reduce the treble. To ensure compatability, a standard frequency response has been adopted called RIAA. This facility will enable record decks with magnetic cartridges to be tested without the need for a complete hi fi in the workshop.

The Laboratory Amplifier is only single channel (mono) but two could be used for stereo. The instrument case is not an ideal loudspeaker enclosure and better reproduction is obtained using an external speaker. Tone controls were thought to be unnecessary and as a consequence have been omitted.

The amplifier has a very wide bandwidth, the high frequency breakpoint being at around 200kHz, whilst this does not conform to the normal practice of audio amplifier design, it allows the unit to be used with confidence as a preamplifier to an oscilloscope or an a.c. voltmeter.

CIRCUIT DESCRIPTION

The circuit is designed around a monolithic audio amplifier integrated circuit, the LM386 (IC2). Intended for a wide range of consumer products including radios, tape recorders and televisions, this i.c. was designed to operate from a single supply and with minimum external components. These features make it ideal for this application. The circuit diagram is given in Fig. 1.

The amplifier gain is set internally to 20 (26dB). For those unfamiliar with the system of measuring gain in decibels remember that multiplication of two numbers can be carried out by adding the logarithm of each number and taking the antilog of the result. Decibels are conveniently a logarithmic scale, so if the gain of two stages of an amplifier are known in decibels, the combined gain is simply the sum. The gain in dB is obtained by:

$$\text{Gain in decibels} = 20 \times \log_{10} \text{gain}$$

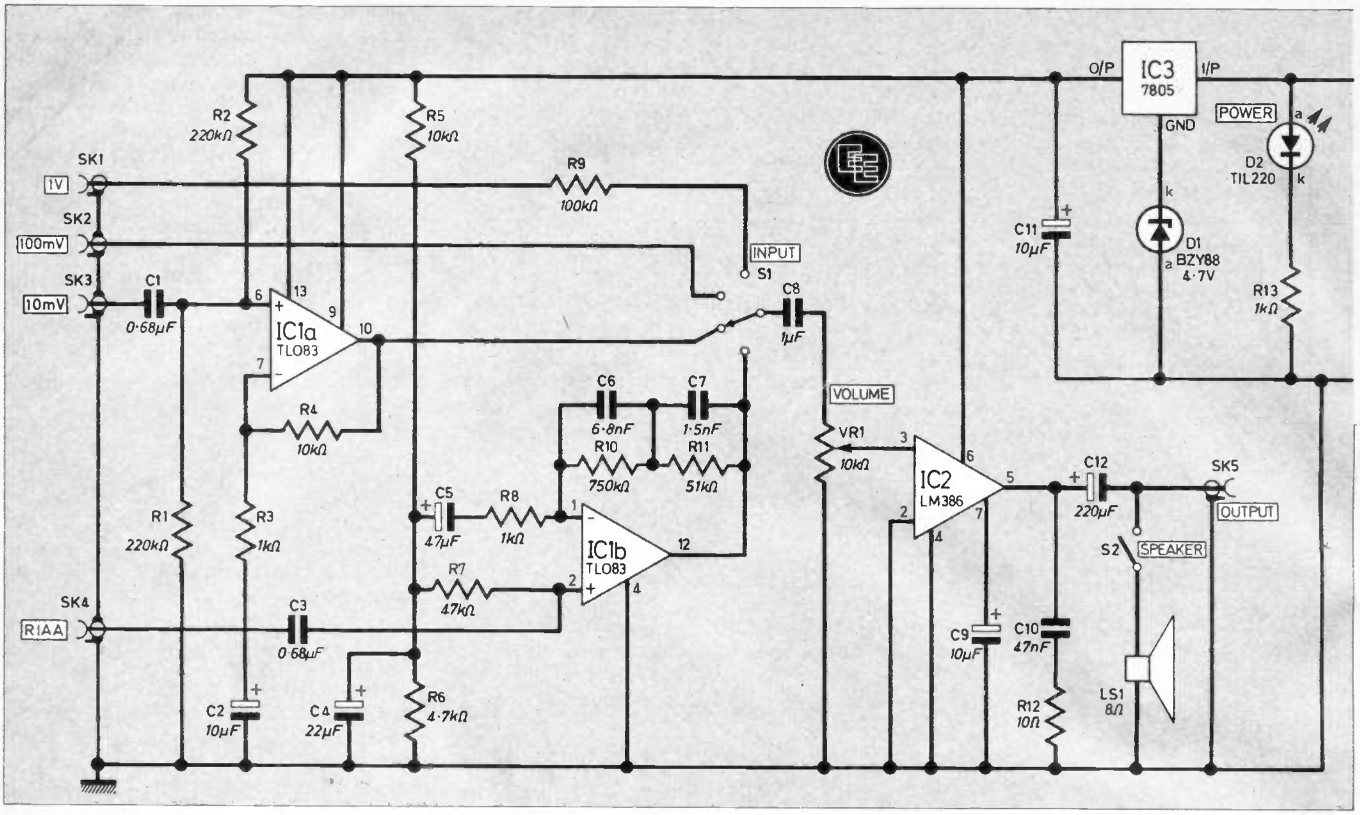
For example, a gain of 2 is equivalent to 6dB. Attenuation can also be expressed in decibels, a division by a factor of 2 is equivalent to −6dB.

Using the formula: $power = \frac{V^2}{R}$

for the required output of half a watt with an 8 ohm loudspeaker, an output voltage of 2V r.m.s. is required. Since the amplifier has a gain of 20, the corresponding input signal (for full output) is 100mV.

SPECIFICATION

Output power:	0·5W	**Bandwidth:**	20Hz–200kHz
Input (RIAA):	5mV, 47kΩ	**Output:**	Internal speaker or via phono socket
Inputs (flat):	10mV, 100kΩ		
	100mV, 10kΩ	**Controls:**	Input select, volume, speaker on
	1V, 100kΩ		



The input selector switch S1 allows the LM386 to be driven directly from the 100mV socket. The less sensitive, 1V input is implemented in the form of a resistive attenuator formed by R7 and the volume control potentiometer VR1.

The active components for the preamplifier are contained in the dual op-amp, IC1. One half of this is configured as an amplifier with a gain of 10 and a flat frequency response. This is the 10mV input into IC1a. The other half, IC1b, is configured as a RIAA equalised amplifier.

This amplifier has a gain of around 36dB at 1kHz. The frequency response of the amplifier is shown in Fig. 2. Notice how the gain changes with frequency. This type of graph, showing the relationship between gain and frequency, is commonly called the transfer function.

The power supply is a mains derived 10V d.c. supply regulated by IC3, a 5V regulator and D1, a 4·7V Zener diode in the common line of IC3.

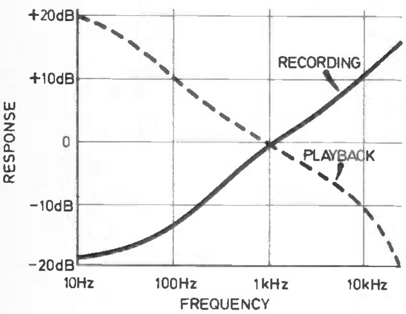


Fig. 2. The record characteristics for an RIAA equalised amplifier.

COMPONENTS

Resistors

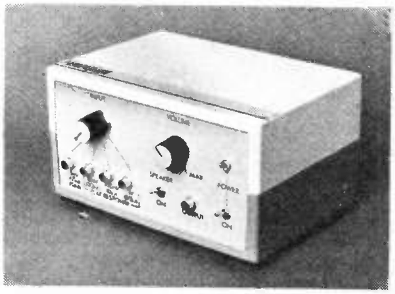
R1,2	220kΩ (2 off)	R6	4·7kΩ	R10	750kΩ ±2%
R3,8,13	1kΩ (3 off)	R7	100kΩ	R11	51kΩ ±2%
R4,5	10kΩ (2 off)	R9	47kΩ	R12	10Ω

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

See Shop Talk page 281

Capacitors

C1,3	0·68µF Siemens (2 off)
C2	10µF, 10V tantalum
C4	22µF, 40V elect. radial lead
C5	47µF, 10V tantalum
C6	6·8nF Siemens
C7	1·5nF Siemens
C8	1µF polyester
C9	10µF, 25V elect. radial lead
C10	47nF Siemens
C11	220µF, 16V elect. radial lead
C12	10µF, 16V elect. radial lead
C13	470µF, 25V elect. radial lead



Semiconductors

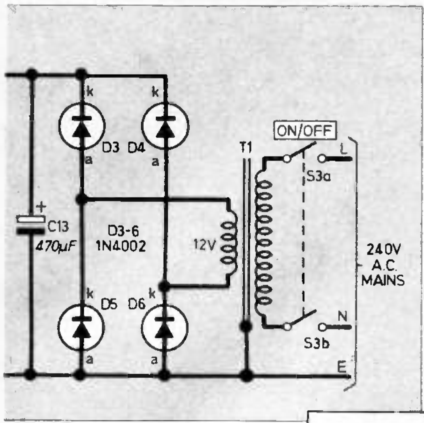
D1	BZY88 C4V7 4·7V Zener
D2	TIL220 0·2in red l.e.d.
D3-6	1N4002 silicon rectifier (4 off)
IC1	TL083 dual op-amp
IC2	LM386 op-amp
IC3	7805 5V, 1A regulator

COMPONENTS approximate cost £22

Miscellaneous

VR1	10kΩ log potentiometer
S1	3-pole, 4-way midget rotary
S2	s.p.s.t. miniature toggle
S3	d.p.d.t. miniature mains
SK1-5	phono socket (5 off)
LS1	8Ω, 500mW loudspeaker
T1	miniature mains transformer with 12V, 500mA secondary

Single-sided p.c.b. 140 x 90mm; Verocase type 202 21036C; control knob with pointer (2 off); 7/0·2mm wire; mains lead; P-clip; l.e.d. mounting clip; 14-pin i.c. holder; 8-pin i.c. holder; Veropins; mounting hardware.



CONSTRUCTION

CIRCUIT BOARD

The majority of the circuit is mounted on a single-sided printed circuit board, 140 × 90mm. The track layout is shown in Fig. 3. The prototype board was made using etch-resistant transfers and it is recommended that this method is used if constructors choose to make their own p.c.b. Veropins should be used where flying leads leave the board.

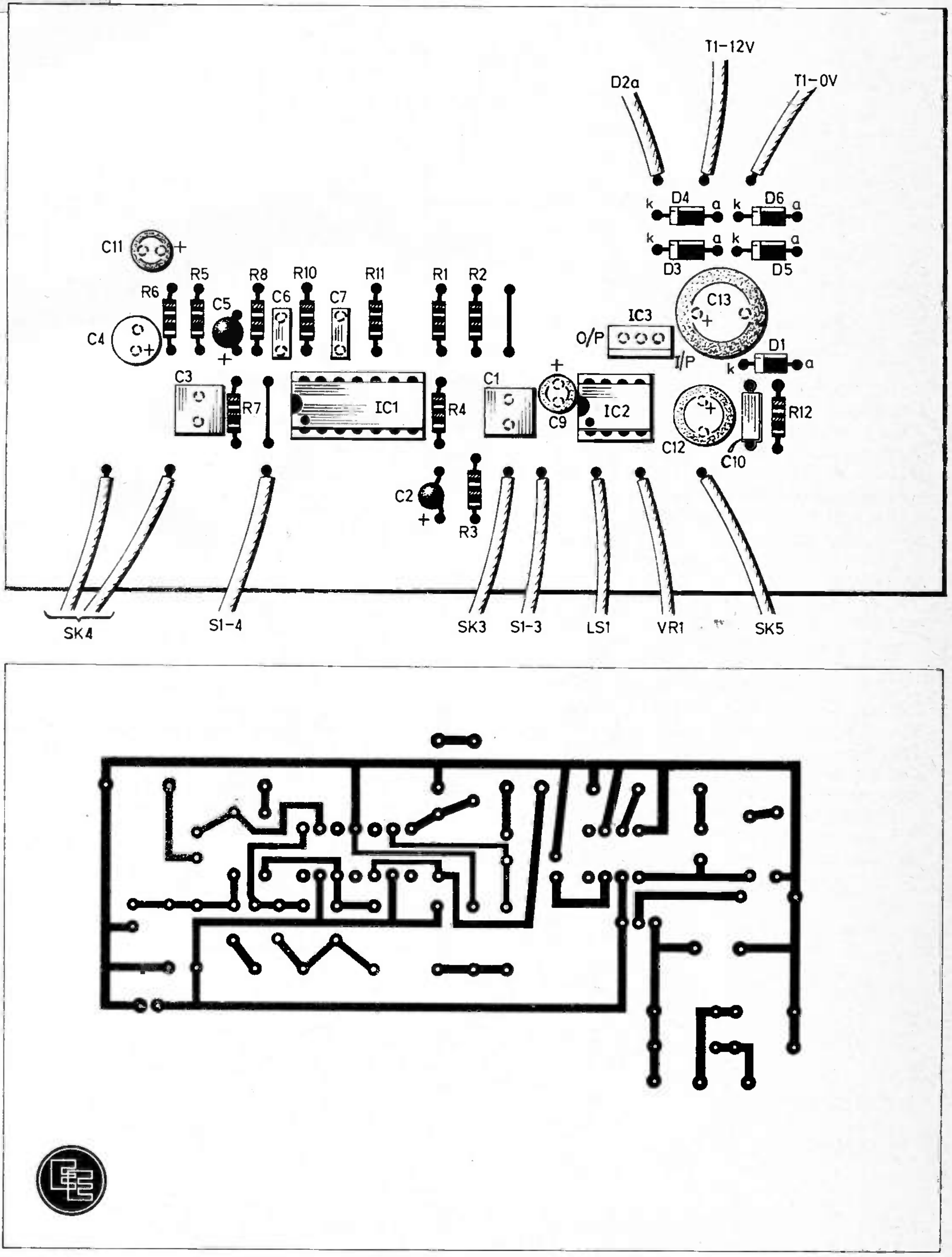
The order of construction is not critical, but a systematic approach is best. Either work from left to right or solder in the components sequentially, working down the components list. It is suggested that holders are used for the integrated circuits as this will facilitate substitution should they become damaged through mis-use of the unit.

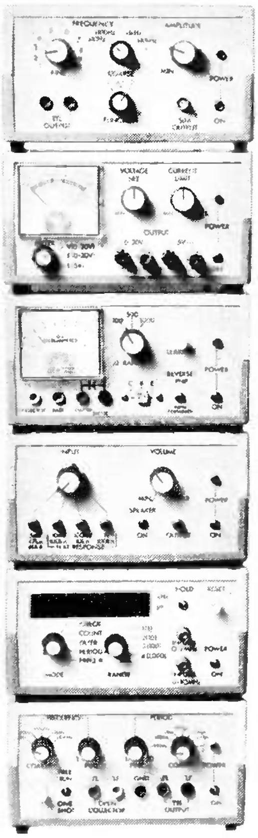
Before switching the unit on check the polarity of the electrolytic capacitors and diodes, the orientation of the integrated circuits, and the mains wiring for mistakes.

For safety reasons the front and rear panels should be connected to mains earth.

Fig. 1 (left and above). The complete circuit diagram of the Laboratory Amplifier. The labelling of the input select switch, S1, is as for the input connectors.

Fig. 3. The full size p.c.b. artwork and component layout of the Laboratory Amplifier. Four mounting holes are required and these are positioned to suit the threaded pillars in the Verobox.





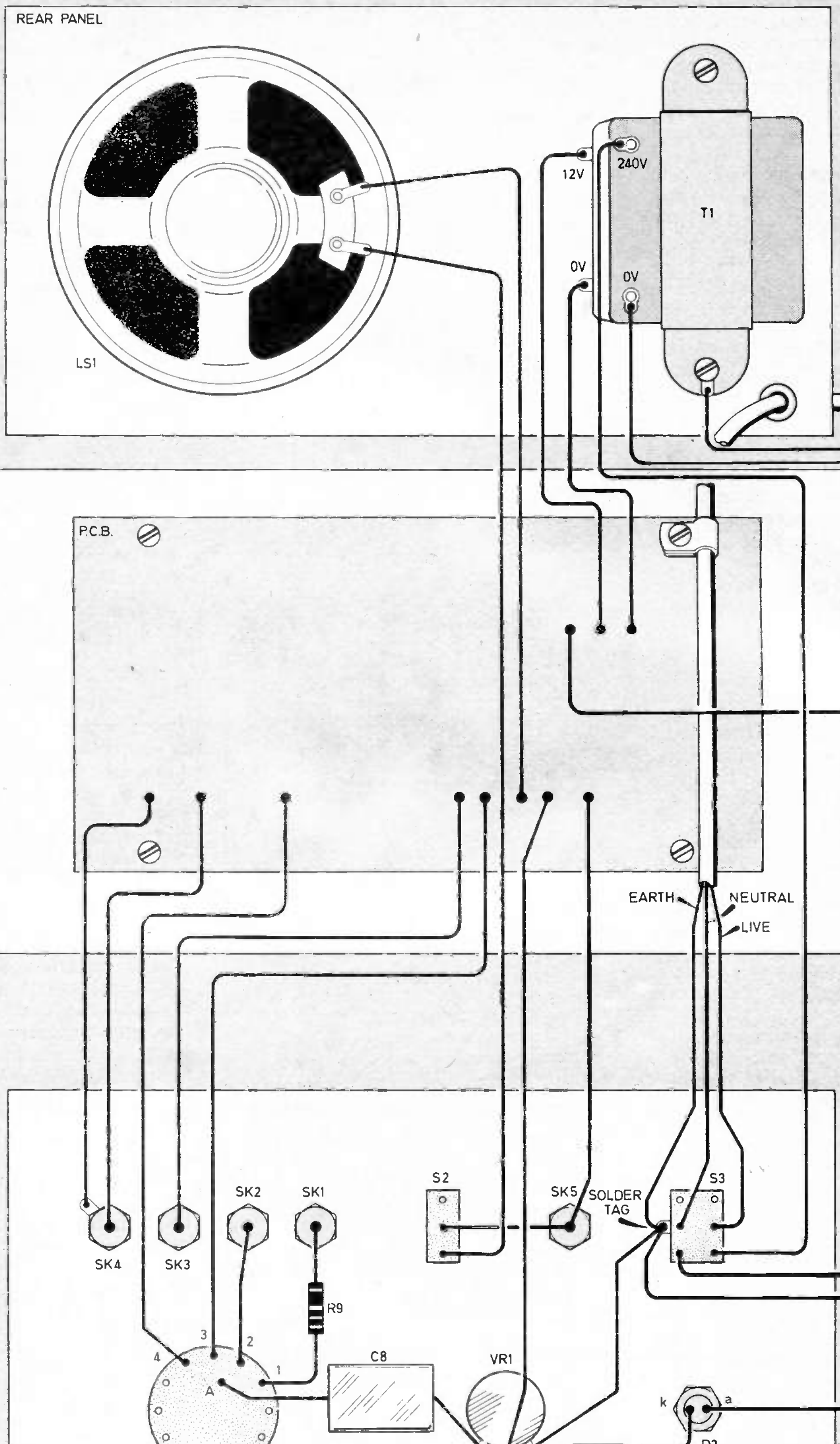


Fig. 5. Front panel layout and interwiring diagram.

CASE

The unit is built in a Verocase type 202 21036C. Begin construction with the preparation of the front and rear panels. The front panel drilling is shown in Fig. 4. On the prototype the controls were positioned to line up with the controls on other units in the series.

The rear panel must be rendered acoustically transparent to allow the sound from the loudspeaker to escape. Several options are available; a large hole covered in speaker cloth or as used on the prototype, a pattern of small holes drilled in the aluminium.

It is advisable to check the actual components before drilling any holes, because hole sizes can vary considerably.

Single hole mounting phono sockets were used on the prototype, but there is no reason why other types such as DIN style or jack sockets could not be used, depending on the constructors requirements. The l.e.d. POWER indicator used was the type enclosed in a metal housing, as these are smarter and more robust than the small plastic clips.

The final point-to-point wiring is carried out following the diagram shown in Fig. 5.

TESTING

A signal source is required for testing. Those who built the Function Generator (EE, April 1983) can use that. Constructors without a signal generator can use the earphone output of cassette player or a radio.

Connect the signal source to the 1V input socket, set the VOLUME control to about a quarter clockwise, make sure the speaker switch is in the ON position and then turn the mains on. If all is well, the sound should be heard.

Turn the signal source down and try the 100mV input. Because the other two inputs are very sensitive, a potential divider made from two resistors, should be positioned between the input and the signal source, see Fig. 6. The 10mV input should have normal balanced sound due to its flat response. However, due to the effects of the equalisation circuit, the RIAA input will have a "bassy" sound and very little treble.

IN USE

There are many uses for a small amplifier in the workshop. If you are repairing a fault on a tape deck it will enable it to be tested without the need for a full hi fi set up. The amplifier can be used as a signal tracer to isolate faulty components in audio amplifiers. The sound effects circuits which are published from time to time can be tested on a breadboard without having to build the audio amplifier section.

The unit has also been used in conjunction with an oscilloscope to examine voltages too small to be viewed directly, and it is for this reason the bandwidth has been extended to 200kHz. □

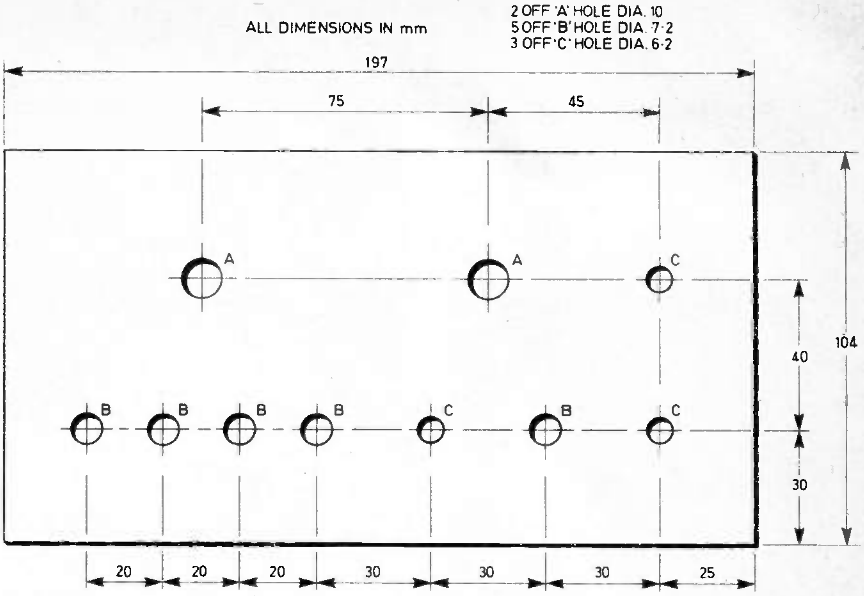


Fig. 4. Front panel drilling details.

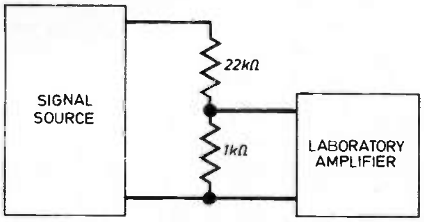
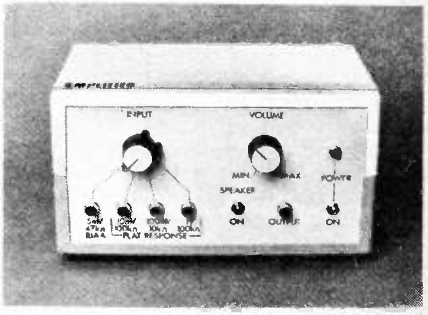
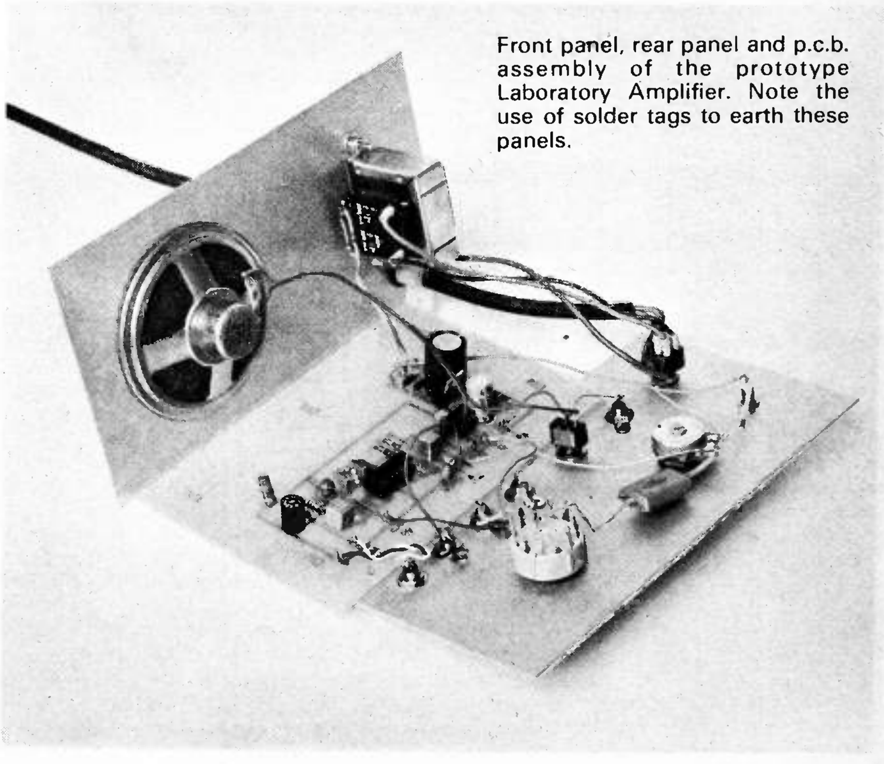


Fig. 6. Test set-up for the 10mV and RIAA inputs.





Front panel, rear panel and p.c.b. assembly of the prototype Laboratory Amplifier. Note the use of solder tags to earth these panels.

COUNTER INTELLIGENCE

By PAUL YOUNG

Behind The Counter

The term *Counter Intelligence* in the context of these articles should lead one to assume a close proximity to a sales counter, and not being associated with "Smiley's People". This is correct, but if a business is reasonably successful, the owner of that business will be pushed further and further away from the aforesaid counter. He will be called in only during those odd occasions, and sadly today they are very few.

During these last few months, having offered to help a friend of mine I have been thrown in at the deep end again, and found myself in intimate contact with the counter. It has made me realise that the lot of a shop assistant is a hard one.

My friend cannot afford more staff, and being a fairly busy shop, we are on our feet almost continuously for eight hours. Lunch consists of coffee and a sandwich, with bites taken out of the sandwich between customers. No-one is to blame, because there is no other way it could be made to work. I am lucky because I only do five days, whereas my friend invariably does seven.

Customers on the whole are friendly and understanding which eases our burden. The good ones know exactly what they want and describe it accurately or give you a clearly written list. The more inept ones will go on describing an object for five minutes after you have told them you don't stock it even though there may be several other customers waiting to be served.

It is not difficult to spot the old hand. If he asks you for six items and you have four, he will take them, while the inexperienced customer will politely tell you that he will go to a shop that stocks the lot, not realising that such a shop may not even exist.

I had an extreme example of this a few days ago when a customer asked me for three integrated circuits. I had two of them and bought them to the counter. He then asked me where he could purchase the third and I directed him to another retailer in the vicinity. To show his gratitude he said, "I will buy all three from him" and walked out. Luckily for him I am of a passive nature otherwise an incident might have occurred.

About two weeks ago, my friend took on some casual labour. A lad living on social security. He told us if it wasn't for his video recorder he would be awfully bored with life. My friend said wistfully that he wasn't even able to afford a colour television.

When asked if he would do two days the following week, he replied, "Sorry mate, I'm off to Italy tomorrow for a fortnight's holiday". My friend who hasn't been able to afford a holiday for several years looked at me and said, "I wish I knew the secret of how it's done".

Fresh Air

Ionisers having now found favour with the medical profession seem to be an acceptable accessory in the home. I built one about two years ago and though it appears to work successfully it has posed one or two questions.

Meeting a friendly electronics boffin in the Rose and Crown the other night, I tackled him on the subject. "Supposing," I said, "I had wired up all the diodes the wrong way round would I get positive Ions instead of negative ones?" This particular model works on the Cockcroft Walton voltage doubling circuit. My friendly boffin frowned, and said he would give it some thought and I said I would return later.

When I returned three hours later, he was deep in thought and knee deep in empty glasses. "You see," I told him, "Although my wife finds it makes breathing easier, it might be all in the mind, in other words, an electronic placebo." I well remember a cousin of mine who had to take a spoonful of medicine each day and got it mixed with my aunt's shampoo. She swore it cured her and we never told her the truth, though my aunt did experience difficulty in trying to wash her hair with the medicament.

The second question is this; my Ioniser is working on a low mantelpiece made of ceramic tiles and just under the discharge point, after a few weeks black lines appear which look like a river depicted on a map, thin lines joining thicker ones and finally joining one thicker still. My friend looked alarmed, and hinted that double scotch might help clear his brain. This I provided and finally asked him, would there be a simple way I could test to see if the Ions were negative or positive?

His face brightened, "Oh! yes, use an electroscope". I pointed out that the objection to that was that I didn't have one handy. "Oh! in that case you could comb your hair and produce some static electricity. At this juncture I cut him short, "My dear David, after worrying about writing articles for ten years, I haven't enough hair left to comb!!

That is how the matter stands at the moment, I can only hope that some kind knowledgeable reader will come up with some answers.

Winds Of Time

One interesting little sidelight on this electronic age came to my attention recently. A teacher who was trying to describe the motion of the wind in a high pressure area said, "It goes in a clockwise direction", Rows of blank faces greeted her remark.

She tried again, "Well look at your watches". The class did this and were still nonplussed. I need hardly tell you that they all wore digital watches.

JACK PLUG & FAMILY...

BY DOUG BAKER

LETTERS

Anti-Phase Phones

Sir—On page 161 of the March 1983 issue of EE (*Test Gear 83—Dual Power Supply*), the labels of the resistors R9 and R13 seem to have wandered on to the wrong components.

In Fig. 1c on page 116 of your February 1983 issue (*Square One*), the two halves of a stereo headphone are shown in series to produce a 16 ohm mono instrument by the expedient of connecting to the tip and ring of the jack plug whilst leaving the sleeve unconnected.

Whilst certainly presenting the drive-source with a 16 ohm load, this arrangement will result in the listener's ears being presented with two anti-phase signals which will sound "not right". If the two earpieces are to be run in series, the connections to one of them should be interchanged, and this will entail the opening of one of them—not to be recommended.

Personally I have fitted a cheap stereo set with a d.p.d.t. switch so wired that the two sides may either run normally as a stereo set or put in series whilst retaining correct phasing but presenting a 16 ohm mono load, and the result is pleasing.

One final point is that a growing number of your contributors seem to be specifying scarce and/or special components with RS code-numbers. Now this firm (as you yourselves confirm from time to time) simply will not deign to deal with members of the public (even with chartered electrical engineers like myself), so that the obtaining of specified parts becomes very difficult.

There is the further point that RS are quite merciless so far as continuity of availability is concerned, and are quite likely to drop an item from their list with very little notice. I see their local "rep" every four months or so, and have frequently made this point to him.

For myself, I will not use their products unless they are of simple types available from other sources as well. Perhaps your contributors should be discouraged from specifying parts which are not readily available from genuine retailers.

James W. Robson,
Newcastle Upon Tyne.

Thank you for pointing out the error on the Dual Power Supply *project. The values of resistors R9 and R13 were inadvertently transposed on both the circuit diagram and the components' list. It should be R9–24 kilohms and R13–430 ohms. (See* Please Take Note, *page 304.)*

In all fairness to RS Components, it has never been their policy to supply direct to the public, but genuine component distributors and suppliers can usually obtain their product, particularly if a part number is supplied.

As for RS dropping items from their list with little notice, the catalogue does indicate if a particular item is subject to design change or only available until stocks are exhausted and this is always checked before a stock number is quoted.

Any other reader experiencing difficulty obtaining components from suppliers? Comments welcome.

Temperature Sensor

Sir—I read with interest your article "Car Thermometer" by M. Plant in the March issue, and was a little surprised to see such an expensive, precision device as the RS Components 308-809 temperature sensor, at £5.28 trade price, specified in such a design. Then I read the piece in *Shop Talk*.

I feel sure that the National LM334 would be quite as suitable for this thermometer, although it might mean a little redesign. I enclose a brief data sheet on this device, which we do not stock at the moment, but would be prepared to stock for your readers at a price of £2.50 including VAT and postage.

Geoffrey Hillier,
Midland Electronics,
Nottingham.

Interested parties should contact Mr. Hillier at Midland Electronics, Department EE, 5a Gregory Street, Lenton, Nottingham NG7 2LR. We stress that we have not tried this alternative and that some circuit modification is required. A data sheet is available.

A.C. Alternators

Sir—In your series *A.C. Mains Explained* (Part One, page 475, July 1982), Mr. A. Kenyon shows a diagram (Fig. 1.3) of a single phase a.c. alternator with a single conductor rotated in a magnetic field.

I was asked to draw a single phase a.c. generator showing the basic principles and I reproduced, from memory (and it was *very* close), Mr. Kenyon's drawing and was told that it was completely wrong!

Apparently it should be a loop of rotating conducting material to produce the sinusoidal waveform shown. Could you please explain why Mr. Kenyon shows the conductor as a single conductor passing through the magnetic field when in fact I am told by my instructor that a loop would passably generate "something like two phase a.c." I hope you can help.

Also, why does he show one end to be positive (+) and the other end to be negative (—).

The series generally has helped me a lot. Thank you.

J. Tustin,
Skillcentre Hostel,
Slough,
Berks.

In order to answer your first enquiry concerning the single conductor rotating in a magnetic field, it is necessary to return to first principles.

In the nineteenth century Michael Faraday discovered the effect of ***electromagnetic induction,*** *that is, an e.m.f. (electro-motive force) is induced in a wire when it cuts through a magnetic field.*

As Mr. Kenyon stated in his article, the amount of e.m.f. depends on three factors; the strength of the magnetic field, the speed at which the wire moves through the magnetic field and the length of the wire.

If the two ends of the wire are connected so as to make a complete circuit (as in the case of Fig. 1.3, via the slip rings, carbon brushes and the oscilloscope) then the induced e.m.f. will cause a current to flow in the wire. The direction of this current flow (the polarity of the e.m.f.) will depend upon the direction that the wire cuts through the magnetic field. This is known as the ***Generator Principle.***

To return to the example shown in Figs. 1.2 and 1.3, we must think of the magnetic field between the two poles of a permanent magnet as ***magnetic lines of flux*** *and these are represented on the diagrams as equally spaced parallel lines running from the north pole to the south pole.*

If we look at the end-on view shown in Fig. 1.2 with the conductor at point A. *At this instant, the conductor is travelling parallel to the flux lines and as such, is not cutting through the magnetic field therefore the e.m.f. is zero.*

However, in traversing from point A *to* B*, the conductor starts to cut through the magnetic lines of flux and so generates an e.m.f. At point* B *it is perpendicular to the field and is therefore cutting through the maximum number of lines and the e.m.f. reaches its peak value.*

Continuing its rotation to point C*, the e.m.f. falls back to zero as the conductor is once again travelling in the same direction as the lines of flux. At this moment, the conductor reverses its direction through the magnetic field and so as previously stated, the polarity of the induced e.m.f. and hence the direction of current flow, is reversed.*

So as the conductor rotates from point C*, through* D *and back to* A*, the same e.m.f. is generated as in the first half of its rotation but with the opposite polarity. In this way, a sinusoidal waveform is generated.*

So the simple a.c. alternator shown in Fig. 1.3 is in theory correct. However, in practice this arrangement is inadequate to obtain the large amounts of e.m.f. needed for power generation and the practical solution is to rotate a coil of wire (remembering that a "loop" is in fact, just a single-turn coil) in the magnetic field.

In doing this, the length of the conductor is simply being increased, this being the third factor governing the amount of e.m.f. induced.

As to your second question regarding the polarity, by fixing one end of the wire (or loop) at earth potential and calling it OV, the potential at the other end of the wire (with respect to OV) will alternate between a positive peak and a negative peak for each revolution.

Calling these peaks positive and negative simply indicates that the polarity of the e.m.f. has been reversed.

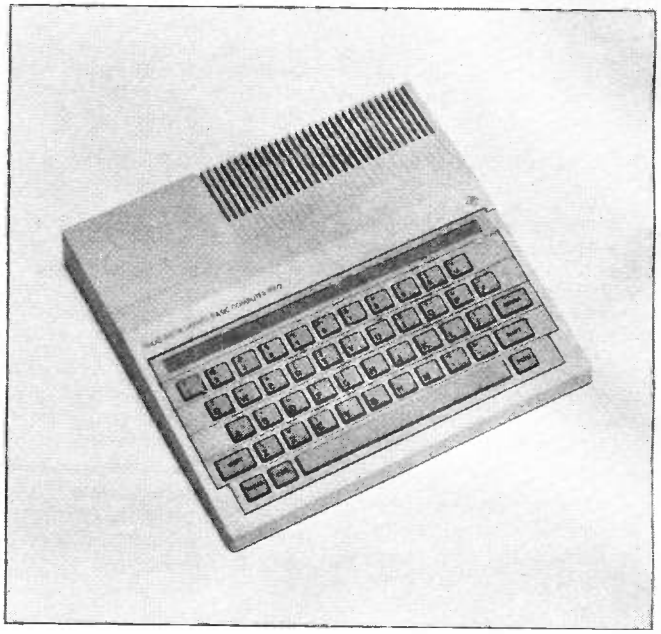
EVERYDAY news ... from the world of

TEXAS DRIVE FOR HOME COMPUTER MARKET

JUST launched in America by Texas Instruments is a new 16-bit Home Computer that is expected to sell for around £75. Unlike most computers in this price bracket, the TI–99/2 Basic Computer can use software on solid-state cartridges as well as on cassettes.

The TI–99/2 is equipped with a staggered QWERTY arrangement, the space bar forming one of the 48 function/operation keys. The computer has 4·2K bytes of random access memory (RAM), of which 4K bytes is user accessible, and can be expanded to a total of 36·2K bytes of RAM.

Most peripherals for the new system will plug into a Hex-bus peripheral interface connector in the rear of the case. The Hex-bus port allows users to connect any peripheral developed for TI's Compact Computer family.



Software

Twenty software programs will be available on cassettes initially but more will be added as they become available. Educational programs include: Picomath-80, Math I and II, Statistics I and II, Sunrise Time, Datetimer and Civil Engineering.

Programs for personal management are: Household formulas, chequebook manager, purchase decisions and general finance. Entertainment cassettes include: Lunar Landing Bioplot, The Minotaur, TI Trek, and Mind Games I, II, III and IV.

A built-in r.f. modulator allows connection to any television. A cassette interface cable is also included to interface directly to the new TI program recorder or many of the ordinary tape cassette players on the market.

Availablility of the Texas TI–99/2 Basic Computer in Europe is planned for the third quarter of this year. *"The TI–99/2 is designed to allow computer novices to learn to program a computer in TI Basic and Basic-supported assembly language," said William Turner, President of the Consumer Group.*

COMING EVENTS

A working conference on "Prototyping", sponsored by the Commission of the European Communities will be held in Brussels on 25 to 28 October.

The conference, organised by the National Computing Centre and Gesellschaft für Mathematik and Datenverarbeitung (GMD), Bonn, aims at bridging the gap between researchers and practitioners in the field of software engineering and information systems development.

★ ★ ★ ★ ★

The Essex University "1983 Electronic Systems Summer School for Teachers" will be held from Sunday July 10 to Friday July 15. This year they are offering two revised courses: Feedback and Communication Systems and Digital and Computer Systems.

The Summer School courses have been structured to assist teachers of Electronics within the School environment. In particular, the courses complement the AEB "A" level in Electronic Systems.

However, it is emphasised that both courses have sufficient breadth to be of relevance to similar "A", "O" and CSE curricula.

The first distributor to offer the complete range of Mullard/Signetics "Micromin" components is to be Swift-Sasco. These include ranges of i.c.s, transistors and diodes, all in S.O. packages for surface mounting on printed circuit boards.

The IBA have negotiated a non-exclusive know-how and patent-licensing agreement for the use of its MAC satellite transmission system with the United States Satellite Broadcasting Corporation (USSBC), a firm linked with Hubbard Broadcasting Inc. of Minnesota.

US FAVOURS UK

The UK has consolidated its position as the most favoured overseas location for US electronics investments. As much as 27 per cent of those US electronics companies which plan to set up foreign operations within the next three years have either chosen or shortlisted the UK as their preferred European base—*as long as it remains a member of the European Economic Community.*

This is one of the findings from the second American Electronics Survey undertaken by "The Electronics Location File". A representative sample of 662 electronics companies were interviewed during November and December 1982 to allow company executives to air their views on issues affecting the US electronics industry and to predict its future performance and domestic and foreign investments for the coming year.

One result to emerge is the almost unanimous belief that the US electronics sector will improve in 1983. More than 80 per cent of the companies surveyed foresaw an improvement and nearly 90 per cent expected their own companies to perform better than in 1982.

Space Communications

State-of-the-Art microwave equipment for use at Goonhilly Downs global satellite communications centre in Cornwall has been supplied by Siemens. The equipment, comprising two high-power amplifiers, automatic carrier level control and a signal routing and switching system, was developed at Siemens engineering laboratory in Congleton, Cheshire.

The two high-power amplifiers are installed in Aerial 2 at Goonhilly and use the Siemens YH 1045 A3 travelling-wave tube, which is also used in high-power amplifiers installed in Hong Kong and Bahrain. Travelling-wave tubes (t.w.t.s) are a wideband alternative to using klystrons for microwave power amplification.

Using t.w.t.s, the carrier signals are combined at low power levels prior to being fed into the t.w.t. for power amplification. Using relatively narrow-band klystrons, on the other hand, carrier signals are amplified individually and then combined at high-power.

Travelling-wave tube high-power amplifiers are, therefore, the last stage in the transmitter immediately prior to the aerial feeder circuits.

FREE SHOPPING BY PRESTEL

Customers of the Nottingham Building Society are being offered *free* conversion of their television sets to connect with Britian's first electronic banking system. The adaptor and keyboard enables customers of the Nottingham to connect with the Scottish Bank involved in the system, and for the cost of a local telephone call they can check their account, transfer monies as well as being able to perform other financial actions.

The conversion enables customers to use the Prestel computerised system and it is hoped retailers will soon be connected to extend the service with "Home Shopping". The consortium hopes to attract 100,000 customers by 1986 and sees this scheme as the first major competition for the clearing banks when the "Home Shopping" service enables customers to order, and pay for goods, debiting their accounts with the Nottingham by computer.

Prestel are financing half the cost of each installation which is expected to total £100 per household.

Despite a loss of $1·6M in absorbing the Stromberg-Carlson acquisition, Plessey has reported an 18 per cent increase in third-quarter profits to £29M.

This means that for its first nine months Plessey has increased its profits by 14 per cent to $102M and is well on target to surpass the 1982 end-of-year figure of $111·4M.

Power Approval

The first UK power supply manufacturer to gain the critical UL, CSA and VDE approvals on a standard catalogue range of switch mode power supplies has been awarded to Gould's of Bishop Stortford.

The approvals, which are accepted internationally as guaranteeing the electrical safety of sub assemblies designed to be included in business machines or consumer equipment, apply to all units in Gould's Simflex open-frame range, which is aimed at the microcomputer and business system market.

Transatlantic Lightlines

Tenders are now being invited for the world's first intercontinental optical fibre undersea cable. It will be able to carry many thousands of phone calls across the Atlantic as pulses of laser light in strands of glass no thicker than a human hair.

The new cable, due to start service in 1988, is expected to cost more than £250 million. British Telecom will contribute the second largest share of this sum.

Cable TV Has Little to Offer

Delegates to a recent NCC Workshop on the business applications of Cable TV Systems concluded that cable systems had little to offer the business users.

With the high speed 2Mbit/s and 8Mbit/s digital circuits becoming available from British Telecom and Mercury, little need was seen for the still higher capacity of cable systems.

Business users generally require a large number of incoming and outgoing circuits and this need is not compatible with cable systems, where incoming circuits predominate. Nevertheless, delegates did feel that to cater for possible future business needs, there should be a unified national addressing scheme for terminals on cable systems to give every terminal a unique address.

BREAKFAST IN TIME

To accommodate the launching of "Breakfast Time TV", the BBC Topical Production Centre at Lime Grove underwent a major facelift in record time. The major change being the construction of a new three-storey technical area and production offices within a former film studio.

Production Area

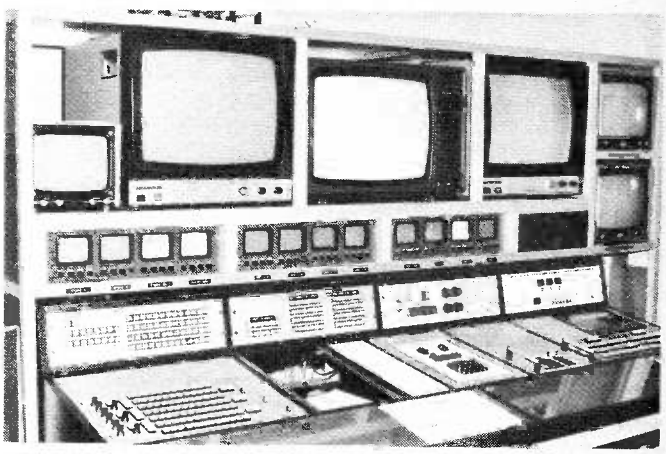
The "Breakfast Time" production offices incorporate a Hewlett Packard 3000 computer, which is used to assist the production staff in the preparation of stories, scripts and running orders. The majority of the hardware is located in an old dressing room, with groups of terminals connected to it via fibre optic cables; fibre optics were used to avoid electrical interference to data signals, and to simplify cable runs.

The 40 terminals can be used as word processors to prepare new material or may have news agency wire services outputs displayed direct on the screen. When stories have been prepared they can be sent out automatically to the programme editor; details such as the presenter's name, the running time, and notes of any videotape or telecine inserts can be added. The final script is then available to the studio director on a VDU in the studio control room, or can be printed out for use by the presenters. The computer project has been made possible by a grant of £250,000 from the Department of Industry during the 1982 Information Technology year.

Technical Base

The new technical area combines videotape (VT), telecine (TK) and electronics graphics equipment in a coherent group, and is adjacent to the Central Vision Apparatus Room (CVAR). Equipment recently added in the CVAR has included video, audio and d.c. matrices. The five matrices allow outside sources to be connected to the VT area, VT and TK to be fed to the studio mixers and out-going lines, monitoring of Network and Test Signals, cue and talkback routing, and connections to and from the electronics graphics area.

The electronics graphics area is next to the new VT area. It has been equipped with a Quantel 6001 Stills-Store (which has four 180M byte disc packs to enable over 700 stills to be stored), a Quantel 7001 paint box computer graphics system as well as a two-channel Chyron IV caption generator, and a simple video rostrum equipped with an Ikegami HL79D camera. A control desk contains an effects mixer to combine the outputs of the various graphics devices, the matrix controls to route the graphics devices to either studio or to VTR machines, and comprehensive monitoring.

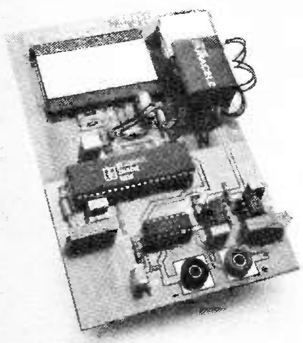


New facilities at the BBC's Topical Production Centre at Lime Grove include an electronic graphic artists area. Control of the Quantel paint box and Stills-Store is via this effects mixer and matrix.

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

DVM EVALUATION KIT

An evaluation kit for the recently released *Ferranti* ZN451 Digital Voltmeter is now available. It is claimed that the customer can evaluate the capabilities of this $3\frac{1}{2}$ digit monolithic DVM without the need to resort to designing and constructing a system from scratch.



One of the features of the ZN451 is the facility whereby external circuits may be included in the auto zero loop: output signals are provided to control external auto zero switches so that op. amps or other signal conditioning circuits can be included in the loop to boost input impedances and/or improve sensitivity to as low as 1·999mV full scale. Thus it is possible to measure low voltages without any "zero error".

Full details of both the Evaluation Kit, which is priced at £29.50 and the ZN451 are available from:

Ferranti Electronics Ltd.,
Dept EE, Fields New Road,
Chadderton, Oldham,
Lancs OL9 8NP.

TALKING COMPUTERS

A new speech synthesiser device that allows computers to speak whatever is typed-in on a keyboard, is now available from **Intelligent Artefacts,** a division of Sands Whiteley of Orwell, Royston, Herts. Known as the Votrax Type-n-Talk, it can be used with practically any available computer. It is claimed to have unlimited vocabulary and allows computers to talk with a reasonably clear "voice".

It is operated by simply typing English text and a talk command. Typewritten words are automatically translated into electronic speech or code by the unit's microprocessor-based text-to-speech algorithm.

It is possible to program verbal reminders to prompt you after a lengthy routine and make your computer announce events. Computer games can be made to speak of dangers, give reminders, and praise the contestant.

In teaching, the computer with Type-n-Talk can be used in spelling tests. For the blind it allows them to undertake computer studies and it can help the dumb with speech output. For example: by typing in the characters representing "h-e-l-l-o", the spoken word "hello" is generated.

The synthesiser was developed and produced by Votrax of Detroit, USA, for whom Sands Whiteley are exclusive European distributors. It is available for £275 plus VAT.

SOLDERING STYLUS

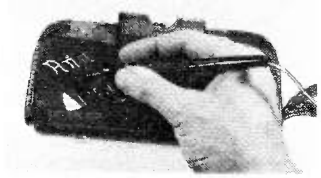
A novel and useful marking tool has just been marketed by ***Light Soldering Developments.*** The Admin Electric Stylus is about the size of a ballpoint pen, and operates at $4\frac{1}{2}$ volts from its own mains plug/isolation transformer, which fits a standard 13A socket.

The silver-alloy writing tip heats in about 30 seconds to a temperature (sufficient to activate the special blocking foil supplied), to allow writing in a choice of metallic and coloured finishes on surfaces such as paper, card, plastics, leather and paint. This makes it ideal for modelling and for lettering front fascia panels on equipment.

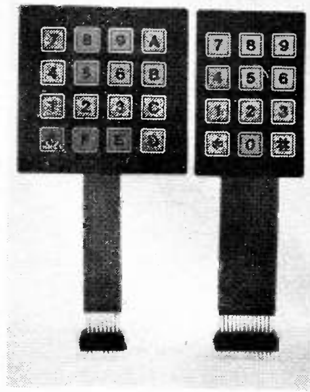
The Admin Stylus comes complete with plug/transformer, 9 lengths of foil (gold, silver, copper and six colours) and full operating instructions. The recommended retail price is £15.04, including postage and VAT.

For more details and addresses of local stockists contact:

Light Soldering
Developments Ltd.,
Dept EE, 97/99 Gloucester
Road, Croydon
CR0 2DN.



KEYBOARDS



A new range of membrane keypads, available with 12 or 16 keys, has just been announced by ***Velleman (UK) Ltd.***

Both versions, type KB12 and KB16, are offered with standard legend or blank keys, to enable the user to make up their own legend. Insulated flat ribbon cable is used to connect the keyboard to a 0.1in. spacing p.c.b. connector. Ratings are 24V and 25mA maximum.

Price including VAT and postage is £8.44 for both versions, on one off quantites, with discounts available on large orders. They will also manufacture keyboards to customers' own design.

A data sheet with full technical specification is available on request.

Velleman (UK) Ltd.,
Dept EE, P.O. Box 30,
St. Leonards-on-Sea,
Sussex TN37 7NL.

TRANSFORMERS FOR DESIGNERS

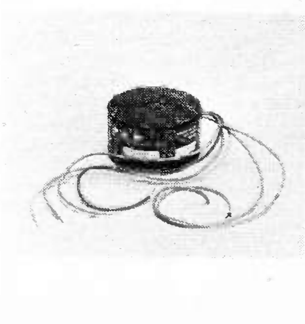
A new customer design facility aimed at the circuit designer has been set up by ***ILP Electronics,*** the audio power amplifier module people, for the supply of "special one-off" toriodal transformers.

They offer a seven day design and prototype service, for which they charge a nominal £20 on top of the one off price. All custom design transformers are allocated a part number upon manufacture of the prototype.

ILP have also appointed ***Barrie Electronics Ltd.,*** of 3 The Minories, London EC3, as one of their distributors and stockists of the new toriodal transformers.

For details of the new service readers should write to:

ILP Electronics Ltd.,
Dept EE, Graham Bell House,
Roper Close, Canterbury,
Kent CT2 7EP.



SOLAR SCIENTIFIC CALCULATOR

EXPERTISE in calculator miniaturisation and solar cells have been brought together in the new ***Casio*** FX98, a no batteries credit card sized calculator with 42 scientific functions.

A bank of solar cells located in the top corner power unit from sunrise to sunset. The liquid crystal display gives an eight-digit mantissa and two-digit exponent readout. A full set of log, trig, power and root functions are possible, plus statistical analysis, ability to handle fractions, polar-rectangular and sexagesimal conversion.

The Casio FX98 solar scientific calculator has a recommended retail price of £16.95 and addresses of local stockists can be obtained from:

Casio Electronics Ltd., Dept EE, Unit 6, 1000 North Circular Road, London NW2 7JD.

A LOGICAL KIT

AIMED originally at school pupils studying for 'O' and 'A' levels, the Digital And Logical Electronics Circuit Kit from Carter-Richardson is equally suitable for anyone looking for a "starter" course in logic and digital electronics.

Claimed to be designed by practising teachers of electronics, the Daleck kit consists of eight interlinking modules together with a progressive guide to experiments. These circuit modules are also available separately.

Standard TTL 74 series integrated circuits are used to teach the properties of the standard gates and combinational circuits. The properties of the different flip-flops are demonstrated and sequential circuits for serial and parallel registers and accumulators are developed. Indications are also given on how to extend the system into other areas.

Carter-Richardson Electronic Systems, Dept EE, Greta Side, Keswick, Cumbria CA12 5LG.

TEMPERATURE INTERFACE FOR DVM

ANYONE who has access to a digital multimeter can now use it as a wide range temperature measuring instrument using standard type K thermocouples, by adding the DVM/TC Interface Unit from ***Graham Bell Instrumentation.***

This new product has a temperature range of −50°C to +1100°C and incorporates automatic cold junction compensation. The output of 1mV per degree Centigrade is via a coiled lead fitted with 4mm plugs.

Since the accuracy is claimed to be unaffected by the output loading, it may also be used to interface low output impedance instruments such as chart recorders.

Further information can be obtained from:

Graham Bell Instrumentation, Dept EE, P.O. Box 230, 39 Derbyshire Lane, Sheffield S8 0TH.

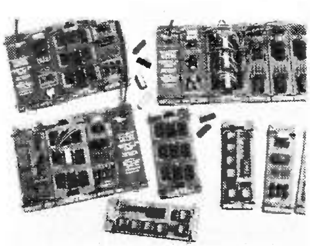
ON FILE

A SELECTION of needle files has just been announced by Neill Tools and should prove invaluable additions to the tool box.

A set of six 16mm files in a plastics wallet consist of one each: hand, flat, round, half-round, square and three square.

These files are ideal for clearing copper burrs across pads on p.c.b.s and solder "whiskers" between stripboard tracks. The recommended retail selling price is £8.22, excluding VAT.

Neill Tools Ltd., Dept EE, Napier Street, Sheffield S11 8HB.

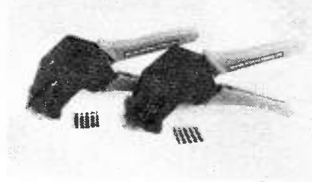


RIBBON CABLE STRIPPER

OVER the last few months we have published several projects that have called for the use of ribbon cable for interwiring boards, controls and interface connectors. The stripping or baring the ends of this type of cable can be fairly tricky and any tool which aids this delicate operation is most welcome.

Just such a tool has come to our notice with the announcement from ***Eraser International*** of two new ribbon cable stripping pliers to their range of production equipment.

The models RTS1 and RTS2 both have an adjustable strip length incorporated and are adjustable for different cable sizes



and self-adjusting for cable widths.

The model RTS1 will remove the insulation completely from the end of a cable but the RTS2 is designed to give only a partial strip, thus leaving the strands intact until they are required for termination purposes.

The recommended retail price is £95 and further information is available from:

Eraser International Ltd., Dept EE, Unit M, Portway Industrial Estate, Andover, Hants SP10 3LU.

EVERYDAY ELECTRONICS

COMPUTER PROJECTS

Published over the last 12 months

2K RAM PACK FOR SINCLAIR ZX81 *April 82*
KEYBOARD SOUNDER FOR SINCLAIR ZX81 *June 82*
TEMPERATURE INTERFACE FOR TANDY TRS-80 *Aug/Sept 82*
EXPANSION SYSTEM FOR SINCLAIR ZX81 *October 82*
TAPE CONTROLLER FOR SINCLAIR ZX81 & SPECTRUM *November 82*
EXTRA RAM FOR SINCLAIR ZX81 *December 82*
A TO D CONVERTER FOR PET *January 83*
SPEED COMPUTING SYSTEM FOR SINCLAIR ZX81 *February 83*
EPROM PROGRAMMER FOR ACORN ATOM *Feb/March 83*
EXPANDED ADD-ON KEYBOARD FOR SINCLAIR ZX81 *March/April 83*
AMPLIFIER FOR SINCLAIR SPECTRUM *April 83*

All the above are fully illustrated, detailed constructional articles. Back numbers £1.00 (inclusive of p & p) per copy currently available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

Please enclose appropriate remittance.

Stocks of back issues are limited. In the event of non-availability a photocopy of the relevant article will be supplied.

Software Service

This new EE Software Service starts this month. It provides the user with a quality copy of the master operating program for our computer based projects. Programs are available on cassette tape. See page 281 for further details.

THE ELECTRONICS OF IT INFORMATION TECHNOLOGY

PART SEVEN

BY T.E. IVALL C.Eng., M.I.E.R.E

In the first article of this series a fundamental question was posed about information technology: is **IT** a genuinely separate engineering activity which we shall continue to recognise as such long after 1982's *Information Technology Year* is over? And after looking at some of the activities and products involved we asked a subsidiary question: is there really something essential which holds all these disparate elements together in some kind of natural unity?

The time has come to round off the series by summing-up and offering answers to these questions—or perhaps by admitting that no satisfactory answers can be found.

PUBLIC AWARENESS

Well, if public events and the mere repetition of the name are anything to go by, it certainly seems that **IT** exists. At the end of the government's IT82 public awareness campaign the Prime Minister announced at a London conference that "according to the results of an opinion poll I've just received, six out of ten people have heard of **IT.** At the beginning of the year fewer than two in ten had heard of **IT.**"

Of course, this proves nothing beyond the effectiveness of a publicity campaign. The reaction of many intelligent citizens seems to be: "Yes, I've now heard of information technology but I still don't know what it really is". At one point the advertising campaign was implying that **IT** was just a new name for computers. Those hoping for enlightenment must have been confused.

More down to earth were the various comments coming from the industrial world. In October 1982, for example, a government appointed committee chaired by Mr J. A. Alvey of British Telecom reported on "A Programme for Advanced Information Technology". In response to Japanese competition they had been asked to advise on a British programme of collaborative research and development into **IT.** The report said there was a need for such a national effort and identified four areas which were felt to be very important: software engineering; v.l.s.i. (very large scale integration); man-machine interfaces; and "intelligent knowledge-based systems" (using inference in the performance of industrial tasks).

Then in February of 1983 the National Economic Development Office made parallel recommendations, for production rather than R&D, in a report entitled: "A Policy for the United Kingdom Information Technology Industry". As far as the UK is concerned NEDO says that **IT** is alive but not at all well. We have a trade deficit of £150M a year which may grow to £1000M a year by 1990 if we don't do something about it.

AN AREA FOR STUDY

But more pertinent to our questions, perhaps, is the news that academia is recognising **IT** as an identifiable area for study. For example, the University of Surrey has just established a Chair of Information Technology, sponsored jointly by Racal Electronics and the Department of Industry. And the universities of Aston and York are developing new degree courses, with the help of British Telecom, for training electronics engineers to become skilled in both telecommunications and computers—the two main arms of **IT** (see *Everyday News,* March issue).

So it looks as though the academic world has found **IT** real enough to be worth teaching as a distinct, if not entirely separate, subject. This follows a pattern of increasing specialisation which has already given us new university departments for such things as Cybernetics and Computer Science.

THE BINARY CHOICE

All this is really too recent to allow us to digest it properly and perhaps find some answers in it. Meanwhile, as far as the present author is concerned, it still seems that any unity to be found in information technology must depend on the fundamental principle of the binary choice. In technological terms this comes down to digital electronics.

The binary choice is common to the binary logic of digital computers (Part 6) and the binary coded information transmitted in digital telecommunication systems (Parts 2 and 4). Electronic logic is concerned with the information of states; digital transmission systems with the information of coded numbers and characters.

If history is anything to judge by, these two methods go back a very long way. Deductive logic with its "true" and "false" statements, as we saw in Part 6, has been practised for many centuries, perhaps originating with Aristotle. Binary coding of characters, as George Hylton showed in the March issue (p. 146), goes back at least as far as Francis Bacon, the Elizabethan philosopher and man of affairs. It's probably a very ancient principle indeed if we also think of smoke signals or the high and low pitch drumbeats of the bush telegraph.

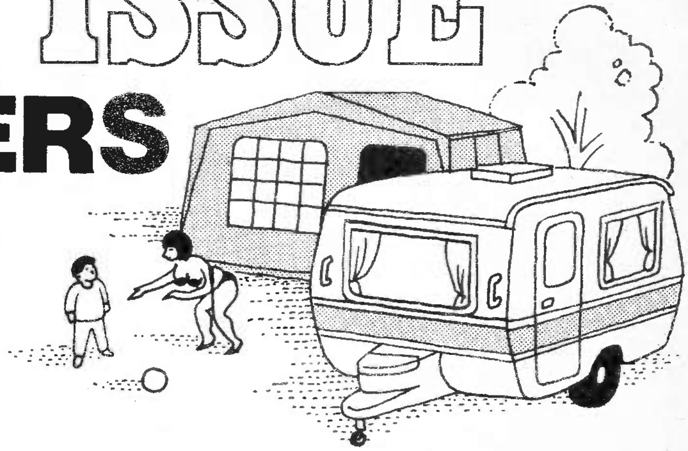
DEEPLY ROOTED

So history shows the basic concept of the binary choice to be deeply rooted in human thinking. Thoughts often lead to deeds. What we are now doing in information technology is just a mechanisation of this fundamental idea for useful purposes. The significant fact, mentioned in Part 1, that the binary digits of transmitted codes are sometimes generated as the binary states of electronic logic, linking telecommunications with computers, is one technological example of how central is this principle of two-state representation.

● But what do *you* think? EVERYDAY ELECTRONICS would be glad to hear your views on **IT** and the Editor would certainly be happy to publish any letters with interesting contributions to this discussion. □

JUNE ISSUE

CARAVANNERS & CAMPERS



HERE ARE TWO SIMPLE YET EXTREMELY VALUABLE UNITS THAT WILL HELP ENSURE MAINTENANCE OF AMENITIES CONSIDERED NORMAL NOWADAYS AND EXPECTED WHEN ON TOUR OR LOCATED AT A HOLIDAY SITE.

CARAVAN POWER SUPPLY

A simple and effective unit to enable an auxiliary battery in the caravan to be re-charged on a touring holiday thus enabling interior accessories to be used independently of the towing vehicle. Not designed for long-stay holidays at fixed locations but invaluable to the tourist.

CARAVAN FRIDGE ALARM

For use with absorption fridges of the type used in caravans and for camping. Gives audible or visible early warning of fridge failure. Fully effective when towing or at a fixed site. Independently powered from PP3 battery.

TRS-80 & VIDEO GENIE MICRO USERS

EPROM PROGRAMMER

A PORT-BASED SYSTEM (THREE 8-BIT OUT PORTS, ONE 8-BIT IN PORT) DESIGNED FOR USE WITH A HOST COMPUTER TO PROGRAM 1K, 2K AND 4K +5V RAIL EPROMS. SOFTWARE DEVELOPED FOR USE WITH THE TRS-80 MODEL I LEVEL II AND VIDEO GENIE MICROCOMPUTERS, BUT MAY BE USED WITH OTHER MACHINES PROVIDING THAT SUITABLE SOFTWARE IS DEVELOPED AND CERTAIN SYSTEM SIGNALS ARE ACCESSIBLE.

GUITAR EFFECTS UNIT

PUSH BUTTON COMBINATION LOCK

PLUS ALL THE REGULAR FEATURES

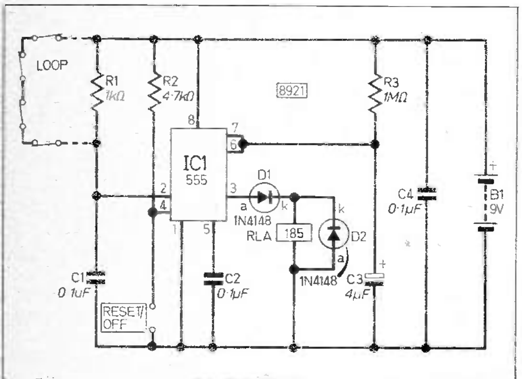
EVERYDAY ELECTRONICS and computer PROJECTS

JUNE 1983 ISSUE ON SALE FRIDAY, MAY 20

CIRCUIT EXCHANGE

BURGLAR ALARM

THE heart of the circuit lies around the 555 timer i.c. Once the alarm has been triggered it will latch on even if the loop is remade. If the alarm has been triggered and the loop remade, it will turn off automatically after a preset period depending on the value of R3. The value specified was 1 megohm which gives a delay of about one minute and six seconds.



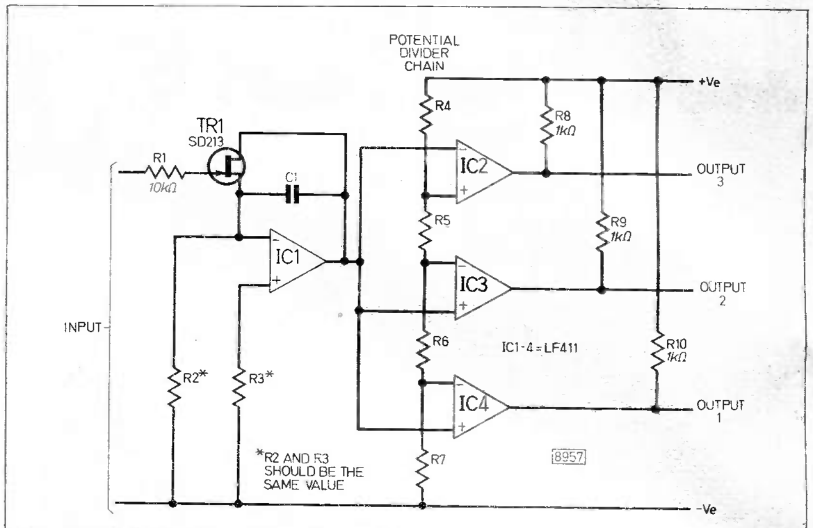
The 555 is triggered by pin 2 of the i.c. being held positive when the loop is made. When it is broken pin 2 becomes negative thus triggering off the 555.

It was found that C1 and C4 were necessary as these supressed any interference picked up by the loop which might accidentally trigger the alarm. The circuit will run from 5V to 15V d.c. depending on which kind of relay is used.

S. Currell,
Hoveton,
Norwich.

VARIABLE SEQUENTIAL SWITCH

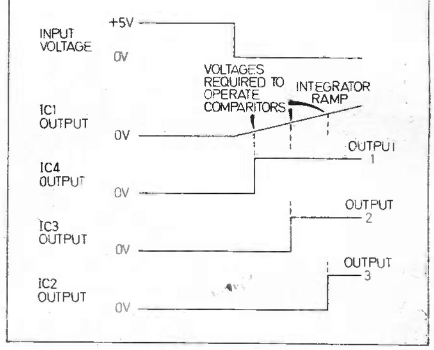
A POSITIVE voltage is applied to the input and therefore also the gate of TR1, the f.e.t. TR1 is turned on and C1 appears to be short circuit. When the input voltage is reduced to 0 the short is removed and IC1 acts as an integrator.



An enhancement mode insulated gate f.e.t. (TR1) is used to ensure that when the input is 0 there is no leakage, that is no parallel path across C1.

The integrator ramp rate = (–ve/R2 C1) volts per second. Operational amplifiers IC2, IC3, IC4 are comparators. When the ramp voltage on the non-inverting input exceeds the voltage on the inverting input the comparators change state and an output is generated. The voltage at the inverting input is derived from the potential divider chain. As each position on the divider chain will have a different voltage available, so each comparator will operate in sequence but for different levels of ramp input voltage. Because of the resistors connected to the output of each comparator, once the comparators have toggled they will generate the same output voltage.

D. A. Fownes,
Pendeford,
Wolverhampton.



PLEASE TAKE NOTE

Test Gear 83—Dual Power Supply *(March 1983)*

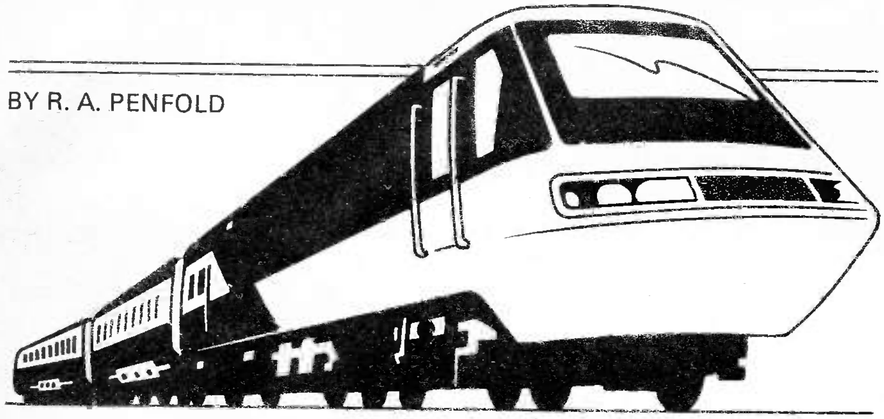
The circuit diagram (Fig. 1, page 160) and the Components' List (page 161) show the values of resistors R9 and R13 transposed.

They should read R9 as 24kΩ and R13 as 430Ω. The positions of these two components on the circuit board layout (Fig. 3, page 162) are correct.

Test Gear 83—Function Generator *(April 1983)*

Note: R11 on the circuit diagram should be 470Ω. Fig. 2. Lead marked SK4 should read VR4.

BY R. A. PENFOLD



MODEL TRAIN CONTROLLER

VERY simple train controllers are attractive if a low cost controller is required, but they suffer from some drawbacks. One of these is simply that they are rather unrealistic in that the train tends to respond instantly to changes in the speed control setting.

Real trains start much more sluggishly due to inertia, and once underway tend to coast for some distance if the throttle is cut back to zero, due to the momentum of the train. Brakes are needed in order to bring the train to a halt fairly rapidly.

These effects can be simulated electronically by having a speed control that has delays which permit only a relatively gradual increase in output power, and an even slower decay in the output power. A second control which enables the decay time to be shortened gives the simulated braking action.

SPEED REGULATION

Another drawback of simple controllers is that they give only poor starting performance and speed regulation. This is due to the fairly high output impedance of these controllers, especially at low output power settings.

When an electric motor is stationary it has a very low impedance, and it virtually short circuits the output of the controller. Coupled with the rather high output impedance of the controller this gives very little voltage across the motor, and hence only a low power in the motor.

When an electric motor starts to operate, its impedance increases, and if it is fed from a rather high impedance source this results in the voltage and power fed to the motor suddenly rising by a considerable amount.

In practice this gives an undesirable effect in the form of the train almost instantly reaching a fairly high speed as it starts off, giving little realism. However carefully the speed control is adjusted, this sudden start is still obtained.

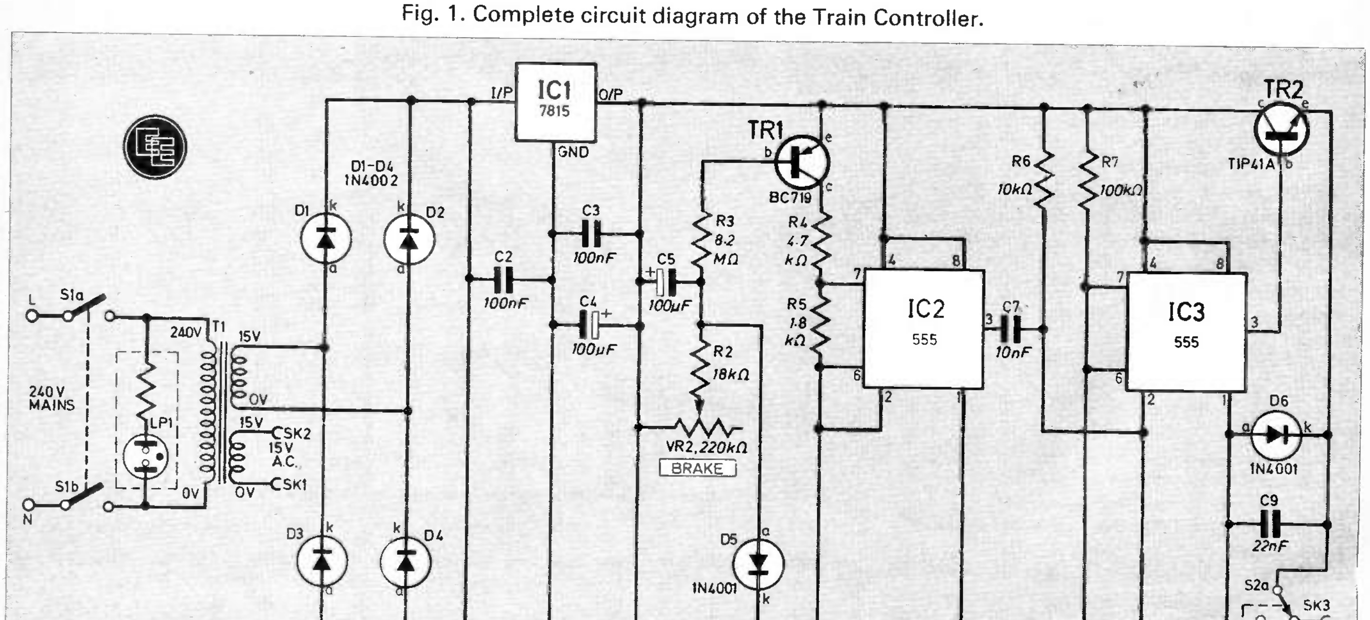
The poor speed regulation is caused in a similar way. The impedance of the motor tends to rise as the train runs down a gradient and the loading of the motor decreases, while the impedance reduces as the train goes up a gradient and the loading on the motor increases. This tends to give more voltage and power across the motor as the train goes downhill, and less voltage and power as the train goes uphill.

This is obviously the opposite of what is needed in order to give good speed stability, and when operating at low speeds the train accelerates down gradients and slows right down or stalls when climbing gradients.

IMPROVED PERFORMANCE

There are several ways of obtaining improved performance, and the most simple of these is to use a controller that has a low output impedance. This gives a stable voltage across the motor so that it draws more current and power when loading is increased, and less current and power when loading is decreased. This

Fig. 1. Complete circuit diagram of the Train Controller.



helps to combat speed fluctuations and stalling, but still gives less than perfect performance.

Even better performance can be obtained by using a circuit that actually gives slightly increased voltage when loading increases, and decreased voltage when loading reduces. In order to give really good results a circuit of this type needs to be matched to the motor it is powering, and this system is not often used in train controllers.

A system that is used a great deal in train controllers, and gives really excellent results is the pulsed controller system. The output voltage is either zero or maximum with this system, except for the very brief periods when the output signal is making the transition from one state to the other.

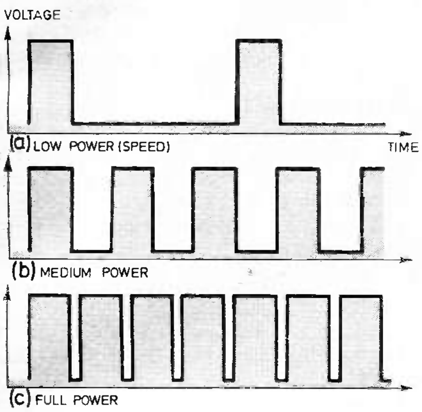


Fig. 2. Output waveform diagrams.

The effective output voltage is varied by altering the proportion of the time for which the output is at maximum. For example, if the controller has an output waveform of the type shown in Fig. 2(a) the output is at zero for a much longer time than it is at maximum. This gives a low average output voltage and thus low power from the motor. In the waveform of Fig. 2(b) the maximum and minimum output times are identical, and this gives half power from the motor. The waveform of Fig. 2(c) gives an output potential that is at maximum for by far the majority of the time, and therefore gives virtually full power from the motor.

PULSED CONTROLLER SYSTEM

The point of this system is that it gives short bursts of high power from the motor when set for low output powers. These bursts of maximum power give high torque from the motor while they are present, and this helps to give the "kicks" that are needed in order to get the train started. They also resist any tendency for the train to stall or run away down hills.

Ideally then, a train controller should provide simulated inertia, momentum, and braking, and should be a pulsed controller circuit. Few circuits of this type have been produced, and most are rather complex and expensive. The unit described here provides all the features mentioned above, gives very realistic results, but is nevertheless reasonably simple and inexpensive to construct.

There are two ways of generating the control pulses; one way is to have a monostable multivibrator which gives an output pulse of fixed duration each time it is triggered, and then trigger it from a variable frequency oscillator.

A low oscillator frequency gives few output pulses and low output power, a high oscillator frequency gives many output pulses and high power. The alternative method is to have a fixed oscillator frequency and vary the pulse length to control the output power.

VOLTAGE CONTROLLED

This unit uses the former method. The oscillator is a voltage controlled type, and the speed of the train is therefore altered by varying the control voltage fed to the v.c.o. (voltage controlled oscillator).

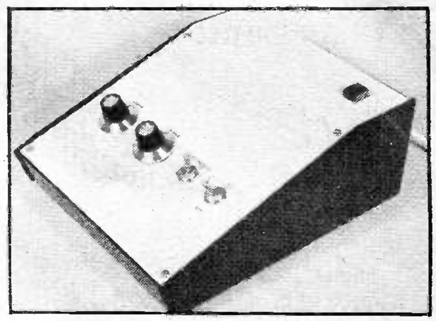
The control voltage is derived using a potentiometer, but the output of this is fed to the v.c.o. via a delay circuit. This gives the necessary short delay when the speed control is advanced, and longer delay time when it is backed-off. The brake control is also incorporated into this part of the circuit.

A buffer stage is needed at the output of the unit in order to provide the fairly high operating current of a model locomotive motor.

CIRCUIT DESCRIPTION

The relatively low cost of the unit is made possible by building the circuit round two 555 timer i.c.s. Fig. 1 shows the full circuit diagram of the unit.

The circuitry around T1 and IC1 forms a conventional stabilised supply capable of delivering up to 1A at 15 volts. IC1 incorporates current limiting circuitry which protects the unit against damage when the inevitable short circuits on the output occur. T1 has two secondary windings, one of which is used to power the controller circuitry, and the other is fed direct to a pair of output sockets. This gives a 15 volts 2A a.c. output which can be used to power points, controllers and other accessories.

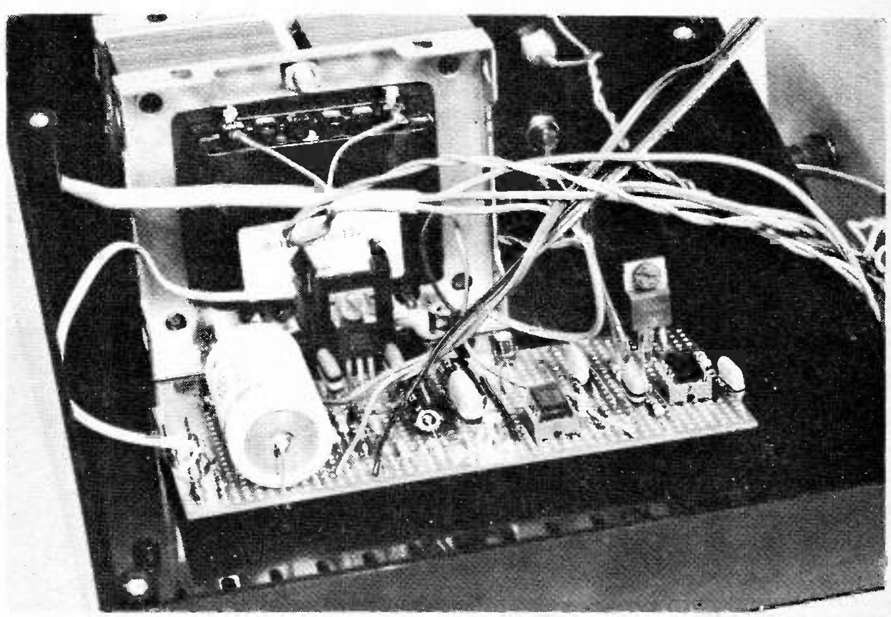


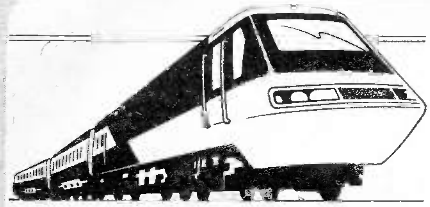
Front view of case showing controls.

The output pulses are generated by IC3 which is a straightforward 555 monostable circuit. TR2 is used as an emitter follower output stage which gives the unit a suitably low output impedance. R6 and R8 bias the trigger input of IC3 to about half the supply voltage, and the monostable can be triggered by reducing this voltage to less than one third of the supply potential. The trigger pulses must be very brief or they will significantly elongate the output pulses and adversely affect the performance of the circuit.

IC2 is a 555 device used in the astable (oscillator) mode. C7 couples the output of IC2 to the trigger input of IC3 and gives the required brief trigger pulses on the negative transitions of IC2's output. The operating frequency of IC2 is largely controlled by the emitter—collector resistance of TR1. This resistance can be

Complete wiring details of component board mounted inside the case.





MODEL TRAIN CONTROLLER

COMPONENTS

See Shop Talk page 281

Resistors

R1	27kΩ
R2	18kΩ
R3	8·2MΩ
R4	4·7kΩ
R5	1·8kΩ
R6	10kΩ
R7	100kΩ
R8	10kΩ

All $\frac{1}{4}$ watt carbon ±5%

Potentiometers

VR1	47kΩ linear carbon
VR2	220kΩ linear carbon

Capacitors

C1	1000μF 25V elect.
C2	100nF polyester (C280)
C3	100nF polyester (C280)
C4	100μF 16V elect.
C5	100μF 16V elect.
C6	220nF polyester (C280)
C7	10nF polyester (C280)
C8	22nF polyester (C280)
C9	22nF polyester (C280)

Semiconductors

IC1	7815 (15V 1A regulator)
IC2	555 timer i.c.
IC3	555 timer i.c.
TR1	BC179 *pnp* silicon
TR2	TIP41A *npn* silicon
D1,2,3,4	1N4002 (4 off)
D5,6	1N4001 (2 off)

Miscellaneous

T1	mains transformer having twin 15V 2A secondaries
S1	d.p.d.t. toggle switch
S2	d.p.s.t. toggle switch
LP1	mains neon indicator having integral series resistor
SK1,2,3,4	wander sockets (4 off)

Aluminium case type ABS M6007, 170 × 213 × 82mm (rear) × 31mm (front); 0·1 inch matrix stripboard, 20 holes by 50 strips; two control knobs; two heatsinks; mains lead; standard 3-pin mains plug.

Approx. cost Guidance only £13·00

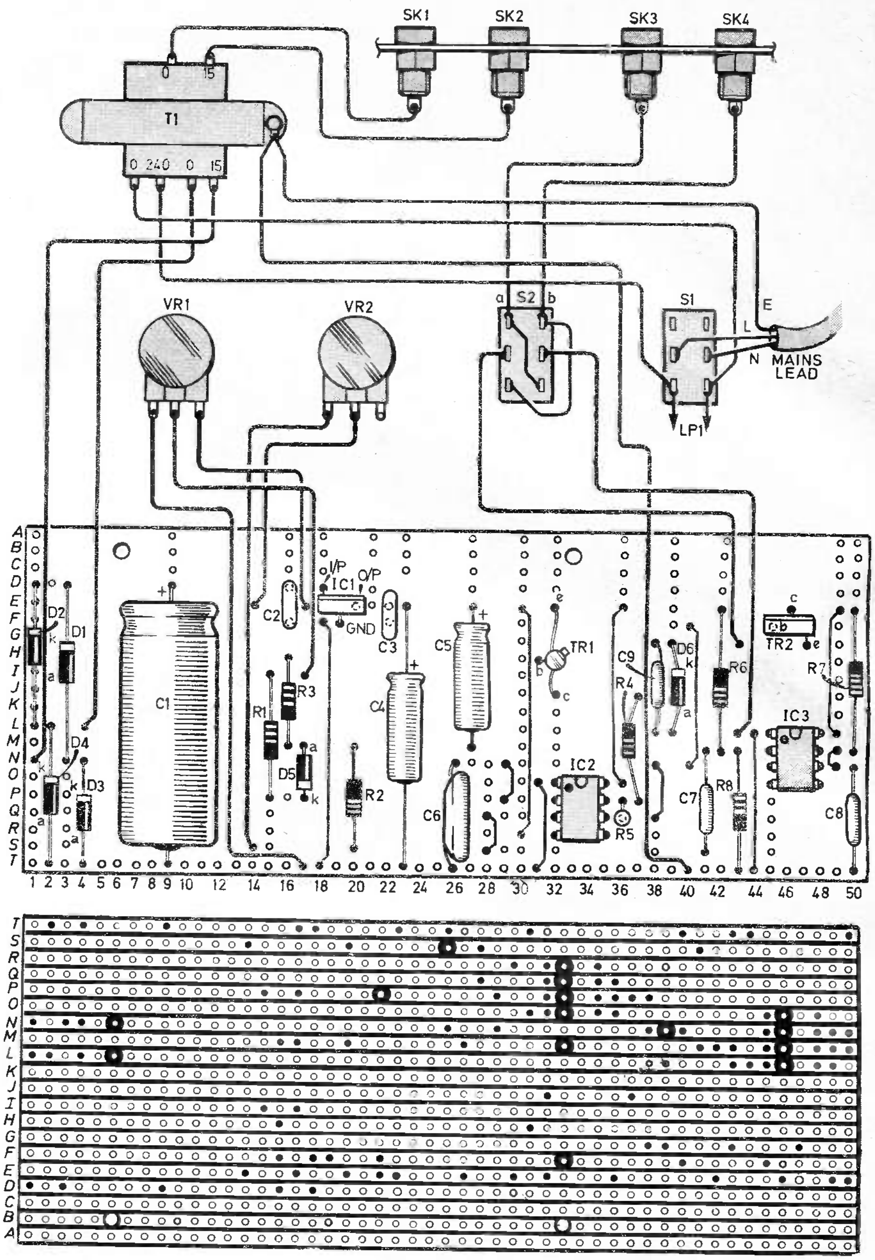
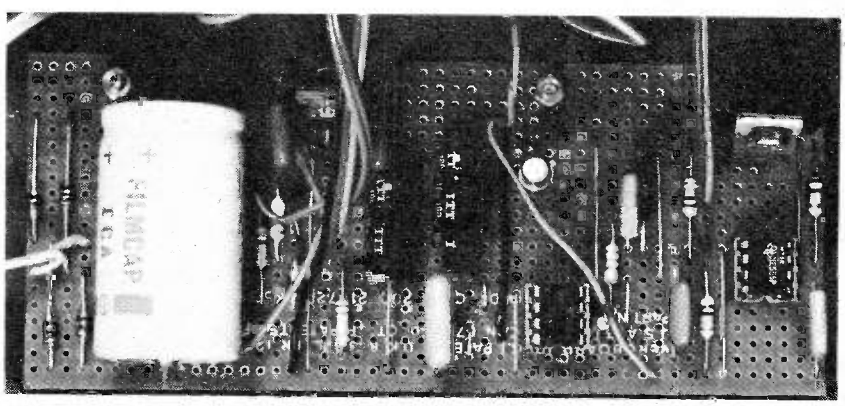


Fig. 3. Full component layout, interwiring and constructional details of the Train Controller.



The prototype component board.

controlled by a voltage applied to the junction of R2, R3. R3 is connected in the base circuit of TR1 to effectively convert TR1 to a voltage rather than current operated device, and it also greatly boosts the input impedance of TR1.

CONTROL VOLTAGE

If the base terminal of TR1 is at or near the positive supply potential, TR1 is cut off and supplies no current to the timing components of the oscillator. This prevents oscillation and gives no output pulses so that there is zero output power from the unit.

Taking the control voltage at the junction of R2 and R3 down towards the negative supply potential takes TR1 into conduction and activates the oscillator. The more negative the control voltage is taken, the heavier TR1 conducts, the higher the operating frequency of IC2, and the greater the output power of the circuit. Full output power is achieved when the control voltage is at nearly the negative supply rail voltage.

VR1 provides the control voltage and it therefore acts as the throttle, but the output from its slider is fed to the v.c.o. via R1 and D5. When the throttle is advanced by taking the slider of VR1 down towards the negative track connection this decrease in control voltage is coupled to R3 by way of R1 and D5, but there is a short delay while C5 charges up. This gives the simulated inertia.

If VR1 has its slider moved back up towards the positive track connection, D5 becomes reverse biased and blocks any significant discharge current through D5, R1 and VR1. A discharge current will flow through R2 and VR2 though, but there will be a substantial decay time if VR2 is at maximum resistance. This gives the simulated momentum.

The discharge time can be greatly reduced by setting VR2 for decreased resistance, and this produces the simulated braking.

The diode D6 is used to suppress any high voltage spikes which might otherwise be generated across the motor and which could damage the unit. C9 attenuates the high frequency components on the output of the unit, and this reduces the risk of the unit causing radio interference. S2 is a straightforward reversing switch.

COMPONENT BOARD

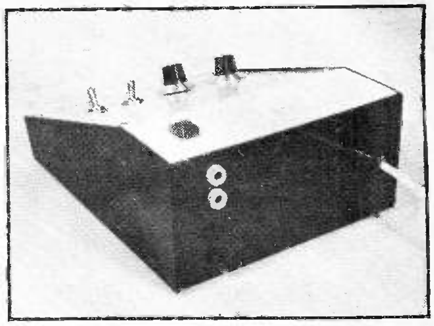
The positioning of the components on the topside of the 0·1in matrix stripboard can be seen in Fig. 3 together with the 15 breaks to be made in the copper strips on the underside of the board. Produce the breaks using either the special spot-face cutting tool or a small twist drill. Drill the two mounting holes for M3 fixings.

Next solder the components and link wires into place leaving the semiconductors until last. Be careful to connect the polarised capacitors and semiconductor devices the right way round.

CASE

A sloping front case is used as the housing for the prototype, however any case having approximate dimensions of 170 × 213 × 82mm will make a suitable housing for the controller. It is not essential to use a sloping front type. The four controls are mounted on the sloping part of the front panel leaving a space for the component board on the base of the case behind the controls.

LP1 is mounted on the horizontal part of the front panel so that there is sufficient space for the mains transformer to the left of this. The mains transformer can be any type capable of delivering 15 volts at 2A twice, and the component used in the prototype is a tapped type with the unwanted tappings being ignored. A solder tag is fitted on one of the fixing bolts of T1.



Rear view of case showing sockets.

The four output sockets are mounted on the rear panel of the case. Wander sockets are used on the prototype, but terminal posts can be used if preferred.

The off-board components are wired to the component panel using p.v.c. insulated multi-strand wire, and the other interconnections are completed in the same way. This wiring is shown in Fig. 4. An entrance hole for the mains lead must be drilled in the rear panel of the case, and the mains earth lead must connect to the solder tag fitted on one of the fixings of T1.

Finally, fit small finned heatsinks to TR2 and IC1 to prevent them from overheating in use, and bolt the component panel in place. It is advisable to place some insulation tape over any exposed mains connections to avoid the possibility of these coming into contact with anything.

It is strongly recommended that the wiring should be checked thoroughly several times before the unit is connected to the mains supply and switched on. T1 is capable of providing quite high currents, and wiring errors or solder blobs causing short circuits between copper strips on the component panel could easily cause damage to the unit. □

CIRCUIT EXCHANGE

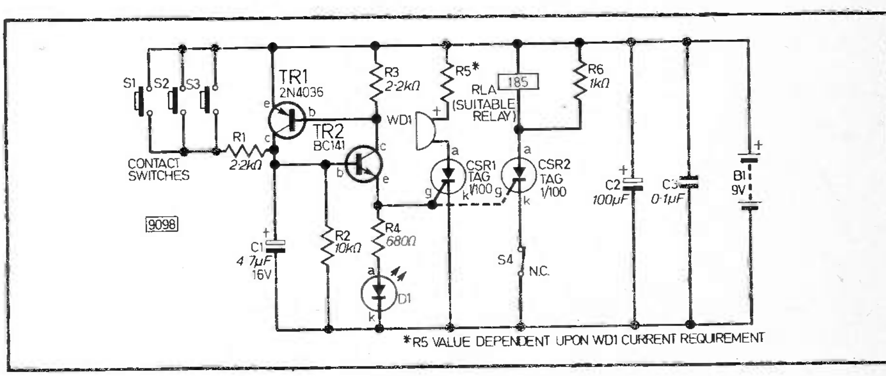
ELECTRONIC SWITCH/DOORBELL ALARM

This is a very versatile switching circuit whose output could be made to activate a buzzer or other audible device or any suitable relay or a silicon controlled rectifier. (RLA, CSR2 and associated circuitry illustrates the alternative version.) The contact switches shown could be several in a parallel arrangement, to short the circuit on and used as an anti-theft or other alarm system.

This type of transistor pair switch provides a more definite on-state and thence overcome false triggering, due to spurious voltages. The 1 kilohm resistor wired in parallel with the relay is to stabilise conduction of the silicon controlled rectifier CSR2 once it is being triggered on, and the normally closed switch S2 is meant to break the circuit, thus switching off the relay. D1 is an l.e.d. added in the emitter line of transistor TR2 to give on-state indication. (The same circuit could be modified to switch on a 23V a.c. mains line but a triac will have to be substituted for the s.c.r.)

Toh Eng Kiong,
Singapore.

MORE ON PAGE 317



RADIO WORLD

BY PAT HAWKER G3VA

Cost Of Quality

There is no doubt that new technology could give us all superior results to what we are used to with present-day domestic television, radio and audio equipment. The last few years have seen a great revival of development work in the field of high-definition television, in digital systems for radio broadcasting and for audio. The "compact" digital audio disc has reached the UK market—some six years after it was first publicly demonstrated.

Europe seems likely to opt for a fully digital system for some 6 to 8 high-quality sound channels to accompany each video channel on direct-broadcast-satellites (DBS). Indeed, the UK government has decided in favour of the IBA's C-MAC transmission system, one feature of which is a highly flexible all-digital structured system for sound. Initially, digital systems tend to add to the cost of domestic equipment although there are high hopes that costs, particularly of digital memory, will continue to fall.

However, not everybody is seeking higher quality. The video disc, for instance, is capable of providing better quality pictures than most domestic video cassette recorders—though the public appears to consider the "record" ability of tape machines for time-delayed viewing more attractive than the better quality of the video discs.

Laser Discs

For these reasons the whole industry is watching very carefully the publics response to the digital audio disc in the UK and the USA. More than 35 manufacturers are licensed to make laser-type players for the 4·7-inch "Compact Disc" format as developed by Sony and Philips.

The ability of the digital disc to provide virtually noise-free reproduction, with almost a (theoretical) 90dB dynamic range (compared with about 60dB for the best analogue recordings), free of wow-and-flutter and with no inherent reason for degradation of quality with frequent playing, represents a tremendous improvement. But, of course, not every existing hi fi installation comes near to providing a distortionless 90dB range which requires an instantaneous peak-power rating of hundreds of watts.

Digits do nothing to overcome deficiencies in loudspeakers or room acoustics, and a system capable of doing real justice to these discs might easily give you more problems with your neighbours than even an a.m. CB transceiver! Then again there will for many years be a need for a conventional disc player if only to play-out existing collections—and recordings that are not yet available in the Compact format.

For all these reasons the electronics consumer industry, the recording industry and the broadcasters will be watching intently to see just how many people invest in the new digital equipment, and whether this looks like rising steadily over the next few years.

Radio Data

The Compact disc results could, for example, influence decisions on the new "Radiodata" system, now close to European standardisation. Radiodata puts digital data signals onto v.h.f./f.m. radio broadcast transmissions which can be displayed on a suitable receiver in the form of an alpha-numerical display. This provides station identification, accurate time and—if there are sufficient display devices—a short programme-related message.

The data signals can also be used for several forms of automatic tuning or adjustment of controls. For example, a car radio could be made to follow a particular programme channel throughout a long journey.

It is all a technically elegant scheme. But at the moment the necessary alpha-numerical display devices and the associated electronics seem bound to add substantially to the cost of radio receivers even when special-purpose large-scale-integrated circuits become available. Some engineers believe that people would be prepared to pay for these facilities for "top-of-the-range" car models and possibly domestic hi fi tuners; others are not so sure.

The system is the outcome of European co-operation with the preferred system developed in Sweden and closely akin to a BBC-developed system. But its future depends on whether semiconductor manufacturers are willing to take the risk of investing a substantial sum in new LSI chips. Otherwise the system may never "take off".

A.M. and CB

Although the Citizen's Band licences introduced by the Home Office in November 1981 were quite specifically for "angle-modulation"—the rather fancy term that covers both frequency modulation (f.m.) and phase-modulation (p.m.)—a considerable number of amplitude-modulated (a.m.) signals can still be heard on 27MHz in the UK. A great deal of these signals on channels outside the official UK band.

While many of the users of a.m. are clearly those who bought equipment before UK licences were issued, there does seem to be a firmly-held view that a.m. is the "better" system and that the Home Office was just intent on making life difficult for the early birds in opting for f.m. One correspondent recently suggested to me that the Home Office had "conned" the public into believing that a.m. caused interference to television sets, whereas f.m. did not.

While I would agree that the whole protracted shambles over the introduction of CB licences in the UK did not reflect much credit on the licensing authorities, there really are solid technical reasons for asserting that f.m. is considerably less likely to cause interference to television, radio and audio domestic equipment than a.m. The fact is that a.m. signals are easily demodulated in any non-linear stage, whereas f.m. requires some form of off-resonant tuned circuit to convert it first into a.m. before it can be demodulated by any diode or other non-linear component.

That is not to say that consumer equipment should not be designed to cope with local low-power a.m. transmissions. This is usually possible without adding greatly to the cost. But the fact is that a great deal of domestic equipment in use today (and for the foreseeable future) cannot cope with local a.m. signals, and some of it does not even cope well with local f.m.

Although the interference statistics are gradually improving, there is no doubt that CB has in some regions overwhelmed the interference investigation teams and must be one of the reasons why British Telecom are hoping to divest themselves of responsibility for this work. The UK is not alone in opting for f.m.-only; this applies also in France, West Germany and Holland.

Teddy on the dole?

New electronics technology is often blamed for the loss of employment opportunities. Regretfully one has to admit that there appears to be a basis of truth in this, even though at one time it was claimed firmly that automation would create more jobs than it replaced.

The latest industry that seems to have been hit is traditional toy-making with the American demand slumping as video games take over. Even the video games industry has run into problems as profit margins are slashed and more and more production is being switched away from the USA to the Far East.

The distinction between video games and home computers is also becoming increasingly blurred in a way that never happened with teddy bears and model train sets!

TRANSISTOR DATA

BIPOLAR TRANSISTORS

Device	Construction	Case	$I_{C(max)}$ (mA)	V_{CE} (V)	V_{CB} (V)	P_{TOT} (mW)	h_{FE}	f_T (MHz)	Application
AC127	*npn* Germanium	TO-1	500	12		340	50	2·5	Audio output
AC128	*pnp* Germanium	TO-1	1 A	16		700	60-175	1·5	Audio output
AC141	*npn* Germanium	TO-1	1·2 A	18	32	720	40-160	1·5	Audio output
AC142	*pnp* Germanium	TO-1	1·2 A	20	32	720	40-160	1·5	Audio output
AC176	*npn* Germanium	TO-1	1 A	18	32	1 W	50-250	3	Audio output
AD142	*npn* Germanium	TO-3	10 A	50		30 W	30 min	0·5	Audio output
AD149	*pnp* Germanium	TO-3	3·5 A	50	50	22 W	30-100	0·5	Audio output
AD161	*npn* Germanium	SO-55	3 A	20	32	4 W	80-320	3	Audio output
AD162	*pnp* Germanium	SO-55	3 A	20	32	4 W	80-320	1·5	Audio output
BC107	*npn* Silicon	TO-18	100	45	50	360	110-450	250	Audio driver
BC108	*npn* Silicon	TO-18	100	20	30	360	110-800	250	General purpose
BC109	*npn* Silicon	TO-18	100	20	30	360	200-800	250	Low noise audio
BC142	*npn* Silicon	TO-39	800	60	80	800	20 min.	80	Audio driver
BC143	*pnp* Silicon	TO-39	800	60	60	800	25 min.	160	Audio driver
BC147	*npn* Silicon	Lockfit	100	45	—	350	110-450	300	Audio driver
BC148	*npn* Silicon	Lockfit	100	20	—	350	110-450	300	General purpose
BC149	*npn* Silicon	Lockfit	100	20	—	350	200-800	300	Low noise audio
BC159	*pnp* Silicon	Lockfit	100	30	30	350	500 typ.	150	Low noise audio
BC182L	*npn* Silicon	TO-92(1)	200	50	60	350	100-480	150	General purpose
BC183L	*npn* Silicon	TO-92(1)	200	30	45	300	100-850	280	General purpose
BC184L	*npn* Silicon	TO-92(1)	200	30	45	300	250 min.	150	General purpose
BC212L	*pnp* Silicon	TO-92(1)	200	50	60	300	60-300	200	General purpose
BC213L	*pnp* Silicon	TO-92(1)	200	30	45	300	80-400	350	General purpose
BC214L	*pnp* Silicon	TO-92(1)	200	30	45	300	140-600	200	General purpose
BC327	*pnp* Silicon	TO-92(2)	500	45	50	625	100-600	260	Driver
BC337	*npn* Silicon	TO-92(2)	500	45	50	625	100-600	200	Audio driver
BC441	*npn* Silicon	TO-39	2 A	60	75	1 W	40-250	50	General purpose
BC461	*pnp* Silicon	TO-39	2 A	60	75	1 W	40-250	50	General purpose
BC477	*pnp* Silicon	TO-18(1)	150	80	80	360	110-950	150	Audio driver
BC478	*pnp* Silicon	TO-18(1)	150	40	40	360	110-800	150	General purpose
BC479	*pnp* Silicon	TO-18(1)	150	40	40	360	110-800	150	Low noise audio
BC547	*npn* Silicon	TO-92(2)	200	45	50	500	110-800	300	General purpose
BC548	*npn* Silicon	TO-92(2)	200	30	30	500	110-800	300	General purpose
BC557	*pnp* Silicon	TO-92(2)	200	45	50	500	75-475	150	General purpose
BC558	*pnp* Silicon	TO-92(2)	200	30	30	500	75-850	150	General purpose
BCY71	*pnp* Silicon	TO-18(1)	200	45	45	360	100-400	200	Low noise, general purpose
BD115	*npn* Silicon	TO-39	150	180	245	800	60 typ.	145	Audio, high voltage
BD131	*npn* Silicon	TO-126	3 A	45	70	15 W	20 min.	60	General purpose, medium power
BD132	*pnp* Silicon	TO-126	3 A	45	45	15 W	20 min.	60	General purpose, medium power
BD135	*npn* Silicon	SOT-32	1·5 A	45	45	12·5 W	40-250	50	Audio driver
BD136	*pnp* Silicon	SOT-32	1·5 A	45	45	12·5 W	40-250	75	Audio driver
BD237	*npn* Silicon	TO-126	2 A	100	—	25 W	25 min.	3	Audio output
BD238	*pnp* Silicon	TO-126	2 A	100	—	25 W	25 min.	3	Audio output
BD437	*npn* Silicon	TO-126	4 A	45	45	36 W	40	3	Power switching
BFR40	*npn* Silicon	TO-92(1)	200	30	30	500	110-800	100	General purpose
BFR50	*npn* Silicon	TO-92(3)	1 A	60	80	1 W	15 typ.	50	—
BFR51	*npn* Silicon	TO-92(3)	1 A	40	60	1 W	15 typ.	50	—
BFR80	*pnp* Silicon	TO-92(1)	100	50	70	800	100	100	High voltage, general purpose
BFR87	*npn* Silicon	TO-92(1)	200	160	160	800	30	130	High voltage, general purpose
BFY50	*npn* Silicon	TO-39	1 A	35	80	800	30	60	High voltage, general purpose
BFY51	*npn* Silicon	TO-39	1 A	30	60	800	40	50	General purpose
BFY52	*npn* Silicon	TO-39	1 A	20	40	800	60	50	General purpose
BFX85	*npn* Silicon	TO-39	1 A	60	100	800	70 min.	50	General purpose
BFX88	*pnp* Silicon	TO-39	600	40	40	800	40 min.	100	General purpose
MJE340	*npn* Silicon	77-03	500	300	300	20 W	30 min.	15	High voltage, medium power
MJE520	*npn* Silicon	77-03	3 A	30	30	25 W	25 min.	3	General purpose
TIP31A	*npn* Silicon	TO-220	3 A	60	60	40 W	10-50	3	Audio output
TIP31C	*npn* Silicon	TO-220	3 A	100	100	40 W	10-50	3	Audio output
TIP32A	*pnp* Silicon	TO-220	3 A	60	60	40 W	10-25	3	Audio output
TIP32C	*pnp* Silicon	TO-220	3 A	100	100	40 W	10-25	3	Audio output
TIP33A	*npn* Silicon	TO-66P	10 A	60	60	80 W	20-100	3	Audio output
TIP33C	*npn* Silicon	TO-66P	10 A	100	100	8 W	20-100	3	Audio output
TIP34A	*pnp* Silicon	TO-66P	10 A	60	60	80 W	20-100	3	Audio output
TIP34C	*pnp* Silicon	TO-66P	10 A	100	100	80 W	20-100	3	Audio output
TIP41A	*npn* Silicon	TO-220	6 A	60	60	65 W	15-75	3	Audio output
TIP41C	*npn* Silicon	TO-220	6 A	100	100	65 W	15-75	3	Audio output
TIP42A	*pnp* Silicon	TO-220	6 A	60	60	65 W	15-75	3	Audio output
TIP47	*pnn* Silicon	TO-220	1 A	250	350	40 W	30-150	10	High voltage
TIP49	*npn* Silicon	TO-220	1 A	350	450	40 W	30-150	10	High voltage

Device	Construction	Case	$I_{C(max)}$ (A)	V_{CE} (V)	V_{CB} (V)	P_{TOT} (W)	h_{FE} (min)	f_T (MHz)	Application
TIP3055	*npn* Silicon	TO-3P	15 A	60	100	90 W	5-30	8	General purpose power
ZTX300	*npn* Silicon	E-Line	500	25	25	300	50-300	150	General purpose
ZTX500	*pnp* Silicon	E-Line	500	25	25	300	50-300	150	General purpose
2N697	*npn* Silicon	TO-5	1 A	40	60	600	40-120	50	Switching
2N2905	*pnp* Silicon	TO-5	600	40	60	600	100-300	200	Switching
2N2926G	*npn* Silicon	TO-98	100	25	25	360	235	100	General purpose
2N3053	*npn* Silicon	TO-39	1 A	40	60	800	50-250	100	General purpose
2N3054	*npn* Silicon	TO-66	4 A	55	90	25 W	25-100	1	Audio output
2N3055	*npn* Silicon	TO-3	15 A	60	100	115 W	20-70	1	High power
2N2222	*npn* Silicon	TO-18(1)	800	40	75	500	35 min.	250	High speed switching
2N3702	*pnp* Silicon	TO-92(1)	500	25	40	360	60 min.	100	General purpose
2N3703	*pnp* Silicon	TO-92(1)	500	30	50	360	30-150	100	General purpose
2N3704	*npn* Silicon	TO-92(1)	500	30	50	360	100 min.	100	General purpose
2N3705	*npn* Silicon	TO-92(1)	500	30	50	360	50-150	100	General purpose
2N3706	*npn* Silicon	TO-92(1)	500	20	40	360	30-600	100	General purpose
2N3771	*npn* Silicon	TO-3	30 A	40	50	150 W	15-60	0·8	High Power
2N3772	*npn* Silicon	TO-3	20 A	60	100	150 W	15-60	0·8	High Power
2N3773	*npn* Silicon	TO-3	16 A	140	160	150 W	15-60	0·7	High Power
2N3904	*npn* Silicon	TO-92(4)	200	40	60	310	100-300	300	Switching
2N3906	*pnp* Silicon	TO-92(4)	200	40	40	310	100-300	250	Switching

UNIJUNCTION TRANSISTORS

Device	Case	V_{b1b2} (V)	$I_{p(max)}$ (μA)	I_{pk} (A)	P_{TOT} (mW)	η (min-max)
BRY39	TO-72(4)	70	5	2·5	275	Programmable
TIS43	TO-92(9)	35	5	1·5	300	0·55–0·82
2N1671B	TO-5	65	2	–	450	0·47–0·62
2N2646	TO-18(2)	35	5	2	300	0·56–0·75
2N2647	TO-18(2)	35	2	2	300	0·68–0·82
2N4871	TO-92(8)	35	5	1	300	0·7–0·85

ABBREVIATIONS

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

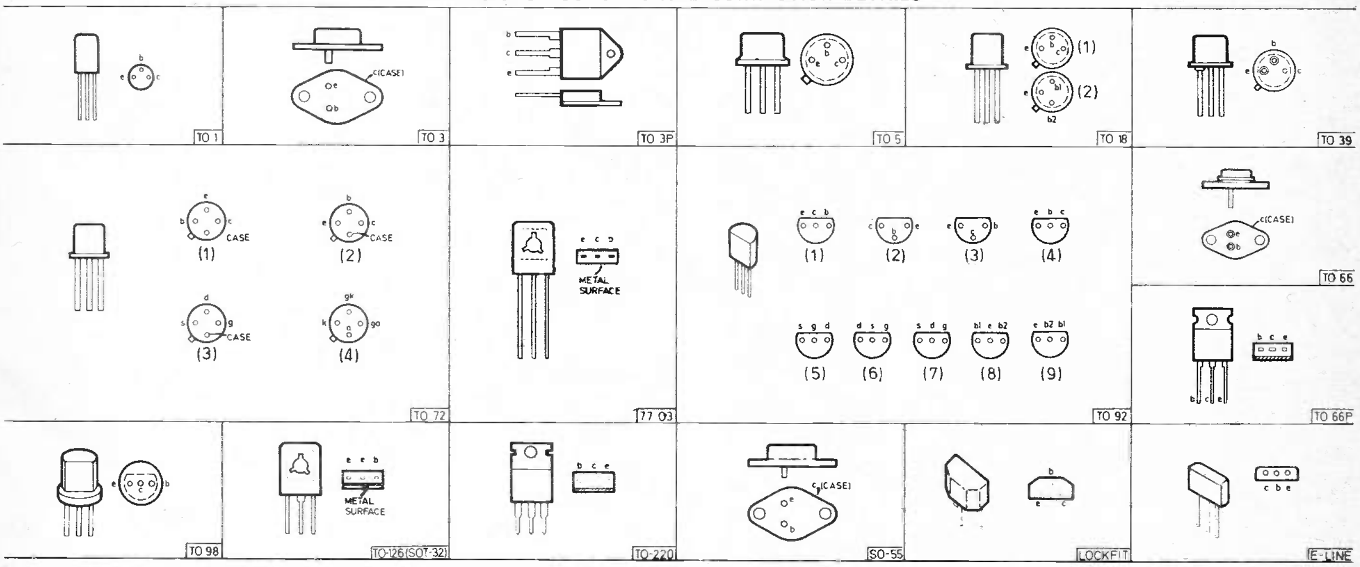
UNITS

V	volts	Ω	ohms
mV	millivolts (10^{-3}V)	kΩ	kilohms (10^3Ω)
µV	microvolts (10^{-6}V)	MΩ	megohms (10^6Ω)
A	amps	TΩ	teraohms (10^{12}Ω)
mA	milliamps (10^{-3}A)	kHz	kilohertz (10^3Hz)
µA	microamps (10^{-6}A)	MHz	megahertz (10^6Hz)
nA	nanoamps (10^{-9}A)	µs	microseconds (10^{-6}s)
W	watts	V/µs	volts/microsecond
mW	milliwatts (10^{-3}W)	dB	decibel

TRANSISTOR TYPES 2N4123 AND BCY65EP

For the data on these two free transistors see page 284

TRANSISTOR OUTLINES AND CONNECTION DETAILS



MOISTURE DETECTOR

BY N. KAY

THIS circuit was originally designed to give the alarm when the author's bath water reached a certain depth without having to check the bath every few seconds. However, since completing the unit, it became apparent that it has many other uses, for example, as a rain detector.

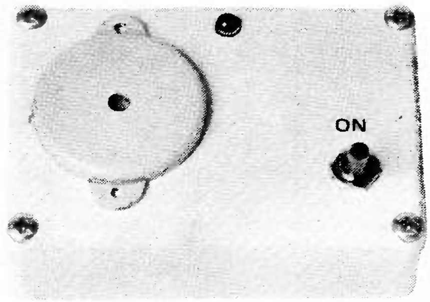
With a suitable sensor, the unit can give the alarm to prevent the weeks washing from getting "re-washed". The sensor could also be fixed in the cold-water tank in the loft to give the alarm should it begin to over fill.

CIRCUIT DESCRIPTION

Many readers may be familiar with the common alarm circuit which use an operational amplifier and detector. Such designs are acceptable but suffer from the drawback that they have a current drain of about 5mA and would quickly flatten a battery and when in constant use, the frequent battery replacement would be costly. The use of a mains powered supply is not recommended in applications involving water, *especially* in a bathroom.

The current consumption of this circuit is extremely low, on one prototype, it was measured to be a fraction of a microamp! The only time when a large current flows (about 8mA) is when the alarm is activated, so one battery should last a very long time.

In the detector circuit (see Fig. 1) an ordinary thyristor CSR1 has its gate terminal connected to the sensor, and R3 is included to limit the gate current and C2 prevents false triggering. The thyristor can be thought of as an electronic switch. When not triggered, it behaves like an open-circuit and no current can flow to the alarm. When triggered the "switch" is closed and the alarm sounds, alerting the user. A visual alarm is given by D1.



The alarm circuit is straightforward, VR1 alters the frequency of the alarm and should be adjusted to give a clearly audible, shrill note. The transformer used in the prototype came from a scrapped radio and almost any miniature audio output transformer with a centre tapped primary will do. C1 also governs the frequency and by changing its value, different pitched notes can be obtained.

Note that the tab of the thyristor has to be removed in order for it to fit the case. It can be cut with a pair of snips or some pliers, this inconvenience is justified by the fact that this type of device is commonly available from most suppliers.

TRANSDUCER

The Piezo ceramic transducer, WD1 gives a clear audible note and is ideally suited in this application as it is unaffected by steam and moisture and so can be used in the bathroom without damage, unlike an ordinary speaker with its delicate cone. It is not however suitable for use outdoors, and if used as a rain detector, the unit should be kept in the house, with the sensor connected by cable.

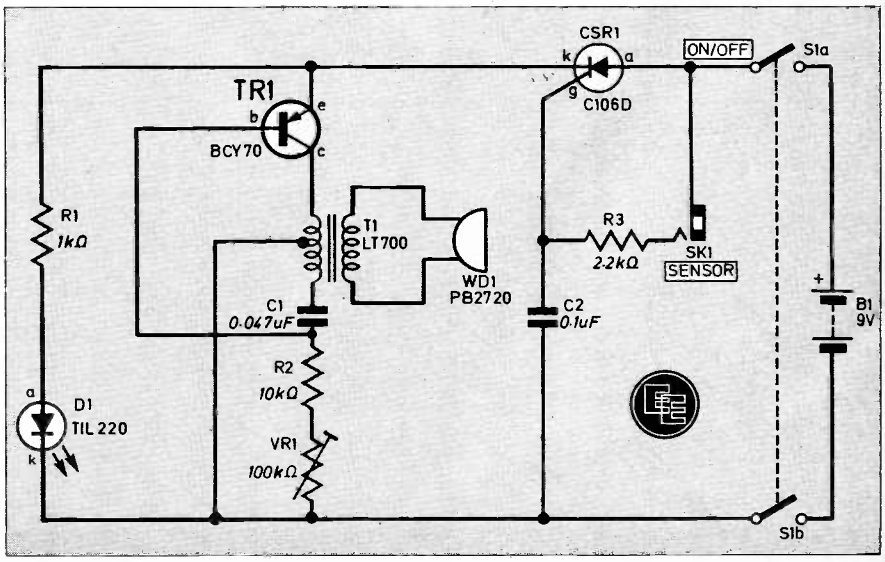
Two distinct advantages are gained by using a thyristor, apart from decreased current drain. Firstly, it is a very sensitive device and will be triggered by the smallest amount of moisture on the sensor and secondly, once triggered, it latches on and so it would, for example, require only one raindrop to bridge the sensor for a continuous alarm to be given.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit (see Fig. 2) is built on a piece of stripboard with a 0·1 inch matrix, 24 holes by 7 strips. The first thing to do after cutting the board to size,

Fig. 1. Circuit diagram of the Moisture Detector.



MOISTURE DETECTOR

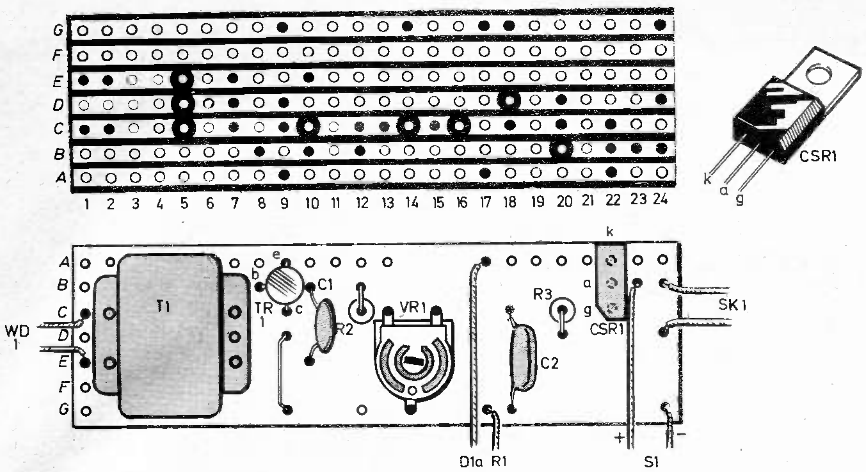
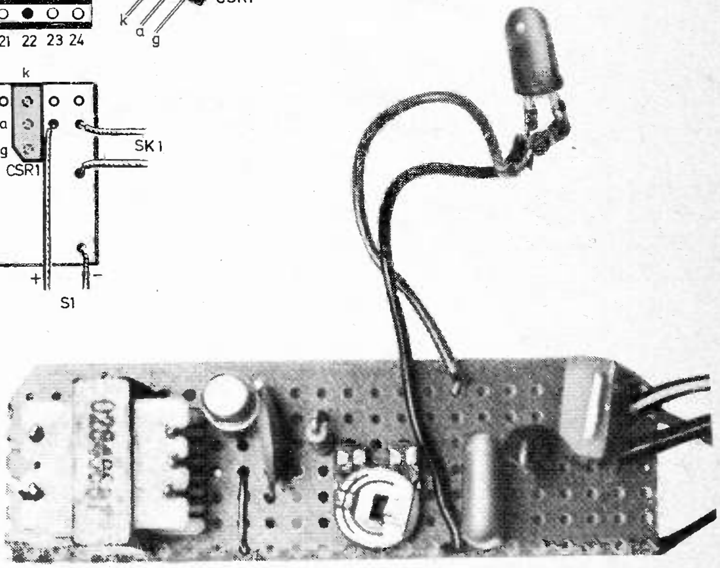
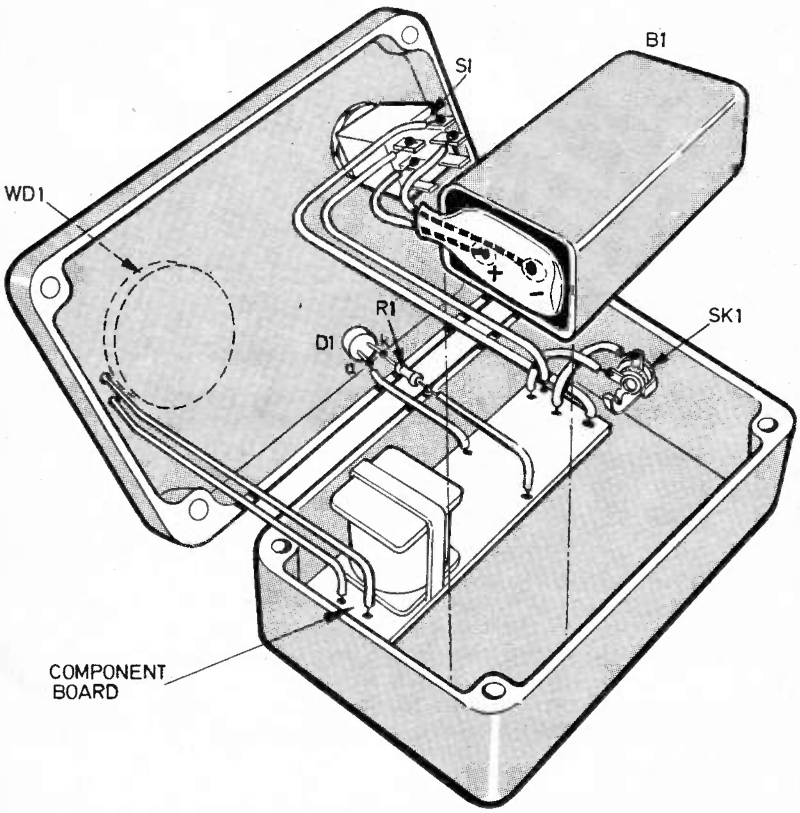


Fig. 2. Layout of the components on the top-side of the stripboard. Underside view shows the positions of the track breaks. Note that this layout is for the LT700 transformer (T1) and other types may have a different pin configuration.



Photograph (right) shows the prototype circuit board. The cropped tag of CSR1 is clearly visible.

Fig. 3 (below). Final assembly diagram. The transducer is glued to the top of the lid and the wires are fed through two small holes. Note that the cathode (k) of the l.e.d. is signified by a flat on the body.



COMPONENTS

See Shop Talk page 281

Resistors
- R1 1kΩ
- R2 10kΩ
- R3 2·2kΩ
- All ¼W carbon ±5%

Capacitors
- C1 0·047μF ceramic or polyester
- C2 0·1μF ceramic or polyester

Semiconductors
- D1 TIL220 0·2in. red l.e.d.
- TR1 BCY70 silicon *pnp*
- CSR1 C106D thyristor

Miscellaneous
- T1 LT700 audio transformer, 1·2Ω centre tapped primary, 3·2Ω secondary
- WD1 PB2720 piezo ceramic transducer
- VR1 100kΩ miniature horizontal preset
- S1 d.p.s.t. sub-miniature toggle
- SK1 2·5mm jack socket
- PL1 2·5mm jack plug
- B1 9V PP3

Case, 72 × 47 × 25 (Vero type 202–21025); 0·1in. matrix stripboard, 7 strips by 24 holes and 7 strips by 15 holes (for the sensor); battery clip; 7/0·2mm; wire; twin-core cable (approx. 2m); suction cup.

Approx. cost Guidance only £6.00

is to make the breaks in the tracks (there is a total of 8) and if the special cutter is not available, then a twist drill is ideal (3·5mm is best).

The order in which the components are soldered to the board is not important, however, do not forget to allow for different-sized transformers, depending on the type used.

Once the board is completed, check the wiring, track breaks and the orientation of the thyristor, l.e.d. and transistor. Connect up the battery as shown in Fig. 3 and short the two sensor terminals and the alarm should sound and the l.e.d. illuminate. Once it is certain that the board is correct, the type of sensor required can be decided, according to the unit's intended use.

SENSOR

Fig. 4 shows the sensor designed for the original circuit's use, in the bath. All that is needed is a piece of stripboard, about 7 strips by 15 holes, however any similar size will be suitable. The suction pad was obtained from a suction fixing hook and should be available from most hardware shops, the hook being removed and discarded. Following the diagram, it is a simple matter to construct the sensor.

There should be at least two unused strips between the two sensor contacts, so that they are not bridged by steam or moisture. The contacts should also be tinned to prevent them from tarnishing. In use the sensor should be "stuck" as far away from the taps to avoid splashes.

In the garden, the stripboard sensor would be unsuitable as a thin gap would be needed in order for the contacts to be bridged by a single raindrop and if two adjacent strips were used, there is the possibility they could be bridged by mist or damp. A better idea would be two tinned copper wires placed parallel to each other, separated by a thin gap and fixed a few centimetres above the ground, with no physical base under the wires on which moisture could collect.

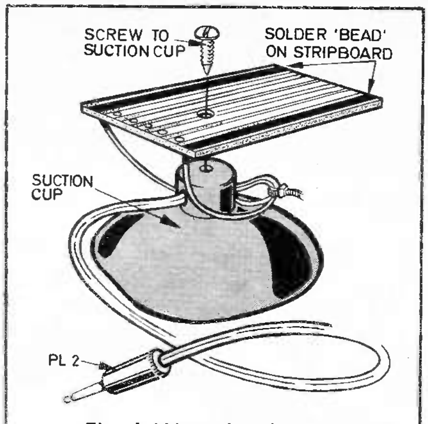


Fig. 4. Water level sensor.

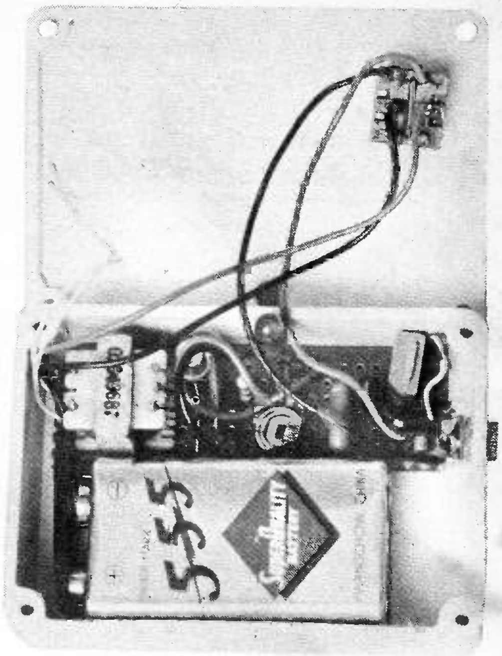
Alternatively, the reader could design and build his own, depending on how it is going to be used.

The sensor was connected to about 2 metres of twin-core cable such as the type used for loudspeaker connections. On the other end, a 2·5mm jack plug was connected, this allows the unit to be used with different type sensors.

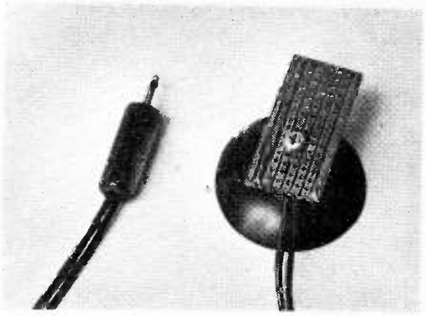
When changing the sensors, the unit should be switched off otherwise the alarm will sound each time a jack plug is inserted or withdrawn. To use the bath sensor, it should be affixed to the side of the bath at the opposite end to the taps, the unit should then be switched on. If the alarm immediately sounds, then there is probably some moisture on the sensor. If so, switch off and give it a wipe with a cloth and switch on again. If the unit persists in activating immediately, check to see if the connections to the jack plug and socket are shorting.

Once the sensor is in place, the unit can be switched on and the bath allowed to fill. If the sensor should become unstuck, the alarm will sound as it will fall into the water!

It may be a good idea to give the unit a test each time, before use, to check that the battery is still in a good condition. □


View inside the finished Moisture Detector unit. The circuit board is held in place with the PP3 battery and the switch is positioned on the lid so as to miss the battery.

The water level sensor made from a piece of stripboard and a suction cup.

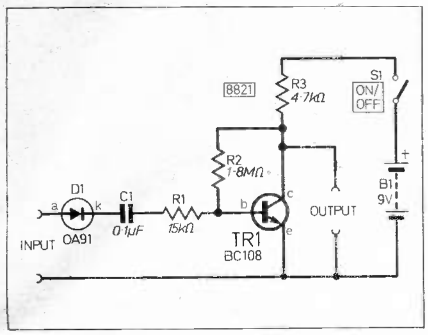


CIRCUIT EXCHANGE

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.

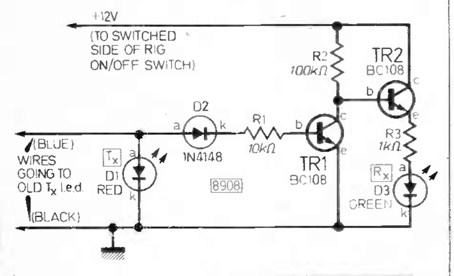
Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.



SOME TIME ago I built an effects unit for use with electrical musical instruments and I thought that I might pass this on. This fuzz box is very simple to construct on stripboard or tagstrip. The circuit relies on the fact that a diode will clip an a.c. signal, but because it crops it, an amplifier is necessary to boost the signal up to a suitable level. The amplifier will run from a PP3 battery and the output can drive either headphones or just go into the input of the power amplifier being used.

Robert Smith,
Sheffield.

CB RIG LIGHT ADD-ON



THIS circuit was designed to add a green Rx light to the front panel of a CB rig. I built it into a MAXCOM 4E by removing the small board containing the Tx light and placing the l.e.d. on the new board. I enlarged the screw hole for the Tx board, enough to allow the green l.e.d. through, and drilled a hole through the front panel the same size as the Tx hole.

To fit inside the Rig, the circuit had to be built on a small piece of plain 0·1 inch Veroboard with the l.e.d.s on the other side, and the right distance apart to suit the front panel holes.

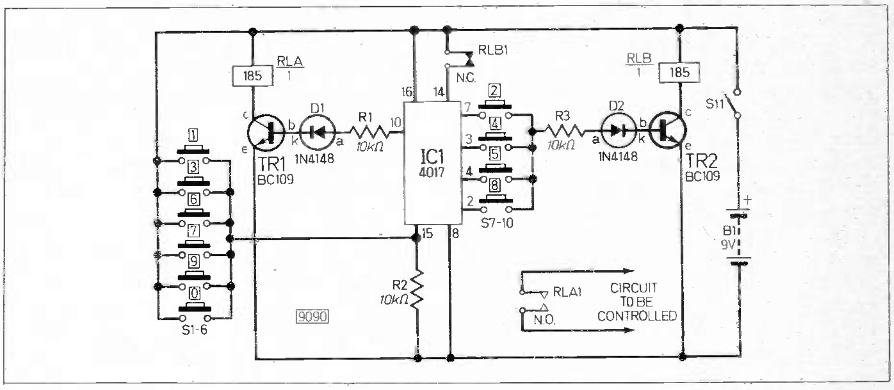
Finally, the old Tx wires are connected, then the board covered with insulating tape and then stuck in place.

Michael Palmer,
Havant,
Hants.

COMBINATION LOCK

WHEN power is applied to the circuit, the first output of the decade counter IC1, pin 3, goes high. If the switch S4 is pressed the base of TR2 goes high, energising the relay RLB. Contacts RLB1 are connected so that when RLB is energised pin 14 goes high, clocking on the counter. The cycle is repeated when switches 8, 5 and 2 are pressed in that order unless switches 1, 3, 6, 7, 9, or 0 are pressed. If they are, pin 15 goes high, resetting the counter. If the right combination, 4, 8, 5, 2, is pressed pin 10 goes high, energising RLA via TR1, R1 and D1. The contacts RLA1 are used to switch whatever is wanted.

Gideon Tearle,
Headington,
Oxford.



ELECTRONIC KEY

THE Electronic Key in this project is really a 3·5mm jack plug. When it is inserted into a socket an l.e.d., mounted in the jack plug, lights up.

While the plug is left in, the appliance, for example an electronic motor used for opening a door, is switched on. When the door is fully opened a reed switch is operated thus stopping the motor. When the "key" is removed the door automatically closes and another reed switch stops the motor.

The motor will stay in the open state only as long as the plug is inserted, so an "override" switch may be needed to keep the appliance on. The advantage of this system is that the socket can be easily hidden.

Circuit Description

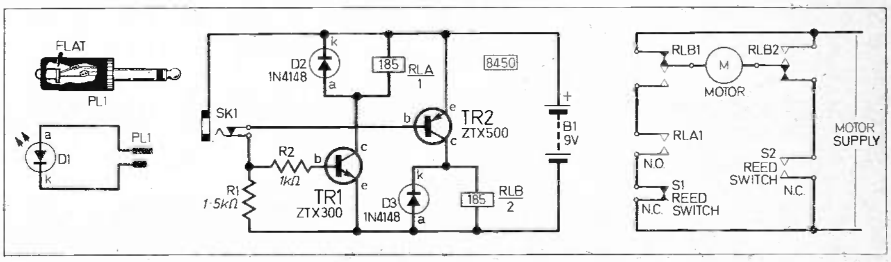
With the jack plug PL1 inserted the l.e.d. is supplied with a voltage to turn it on via the socket SK1 and R1. This also turns on TR1 to operate relay RLA which has a contact connected in the "motor" supply line.

When the plug is removed the contact in SK1 returns to its original position, thus "grounding" the ZTX500 transistor TR2. This operates relay RLB which changes over the polarity of the motor supply, causing the motor to rotate the other way, and the door, which is attached to the motor, to close.

When the door is fully closed the reed switch S2 is opened thus stopping the motor. This leaves the circuit ready for another operation by the insertion of a jack plug.

Another magnet is placed on the door to operate reed switch S1, the "open door" stop switch. The reed switches can be mounted in the door frame and perhaps, for reed switch S1, in a door stop.

Michael Taylor,
Windmillgreen,
Northampton.



SQUARE one FOR BEGINNERS

AFTER the resistor, the capacitor can be thought of as the next most important component in an electronic circuit. Available in a bewildering range of types, sizes and values, the beginner is often confused when it comes to making the right choice for a project.

Basically, a capacitor consists of two metal plates separated by an insulating material known as the **dielectric.** (With the exception of polarised electrolytic capacitors, see *Square One*, last month.) Usually the material used for the dielectric of the capacitor is also used to describe the type of capacitor.

For example, a **polystyrene** capacitor consists of two foil strips (the metal plates) with a layer of polystyrene (the dielectric) between them. This is usually rolled up into a tubular shape with two wire leads, one attached to each plate.

There are many different dielectric materials, including paper, polyester, ceramics and mica to name but a few, and each has different properties making the various capacitors suitable for particular applications. For instance, a silvered mica capacitor can be manufactured to close tolerances and will remain stable and therefore is ideally suited for timing and tuned circuits.

Compare this with the disc ceramic type which has a low tolerance specification, as much as +80% and −20% on the specified value. However, they are available at working voltages of up to 1000V and therefore find their application in power supply spike suppression and decoupling where the actual value is not so important.

The unit of capacitance is the **Farad** but as one farad represents a very high capacity, a more useful unit is the microfarad (µF) which is equal to one millionth ($\times 10^{-6}$) of a farad. Table 1 lists this and the other sub-multiples used for capacitance values.

As with resistors, capacitors are not available in all possible numerical values but in what is known as a **preferred series** of values. The E12 series is most commonly used for capacitors and this consists of the values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82 and their decadal multiples and sub-multiples (that is, 1·5, 150, 1500 and so on).

TABLE 1. CAPACITANCE SUB-MULTIPLES

picofarads (pF)	= 10^{-12} farads
nanofarads (nF)	= 10^{-9} farads
microfarads (µF)	= 10^{-6} farads
Therefore 1000pF	= 1nF
and 1000nF	= 1µF
For example 4700pF	= 4·7nF
and 4·7nF	= 0·0047µF

When describing a capacitor, the type of lead formation may also be given and will usually be either **axial** or **radial.** An **axial lead** capacitor will have its leads "sticking" out from each end of the component body (along its *axis*) like a resistor.

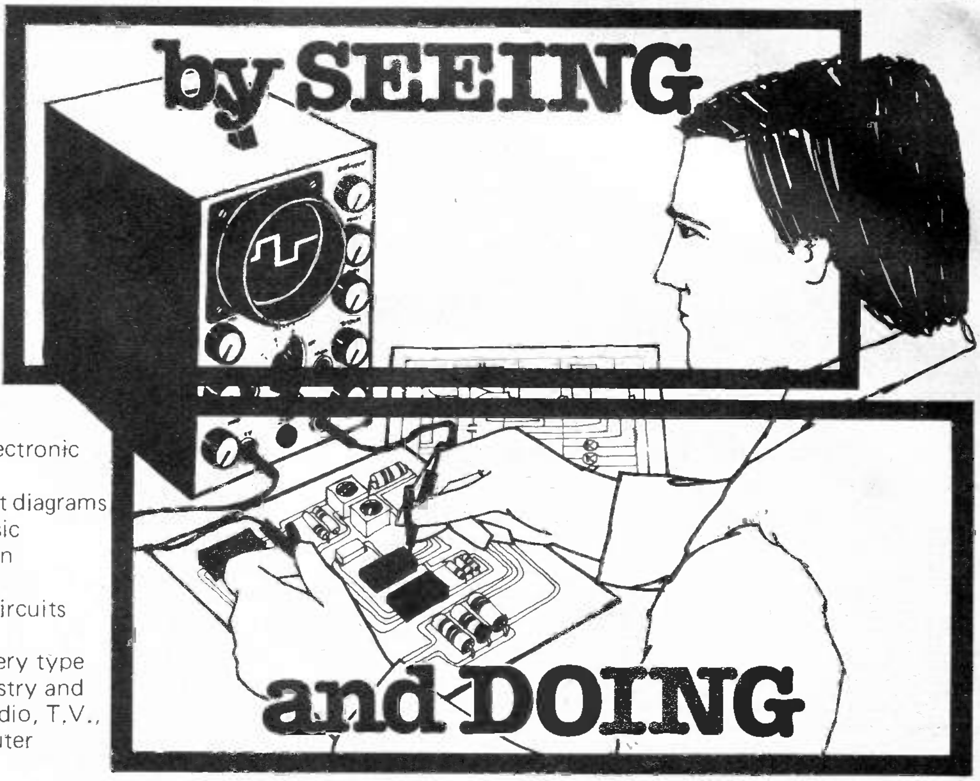
The **radial lead** capacitor has both leads *radiating* from one side of its body.

The types of capacitor listed in Table 2 are those most commonly found in the projects featured in EVERYDAY ELECTRONICS. All should be available from the regular component suppliers.

TABLE 2. FIXED VALUE CAPACITOR DATA

Dielectric type	Capacitance	Tolerance	Working voltage	Typical applications
ALUMINIUM ELECTROLYTIC				
Single ended (can)	100µF–68,000µF	+80% −20%	16V–100V	Power supplies, smoothing
Double ended (axial)	1µF–4700µF	+50% −10%	10V–450V	Smoothing, decoupling
Board mounting (radial)	0·1µF–2200µF	+50% −10%	6·3V–63V	Smoothing, decoupling
SOLID TANTALUM				
Miniature bead (radial)	0·1µF–100µF	±20%	6·3V–35V	Low leakage, timing circuits
FOIL AND PAPER				
High capacity (can)	2µF–10µF	±20%	600V d.c. (250V a.c.)	High voltage suppression
POLYPROPYLENE				
Epoxy encapsulated (axial)	0·001µF–0·47µF	±20%	1000V d.c. (350V a.c.)	Low loss, high voltage
METALLISED POLYCARBONATE				
Brass cased (axial)	1µF–10µF	±5%	63V d.c. (45V a.c.)	High stability, professional
Epoxy encapsulated (radial)	0·01µF–4·7µF	±20%	630V d.c. (300V a.c.)	High stability, professional
METALLISED POLYESTER				
Epoxy encapsulated	0·01µF–2·2µF	±20%	400V d.c. (200V a.c.)	General purpose
Miniature sleeved (radial)	0·001µF–0·047µF	±20%	750V d.c. (225V a.c.)	General purpose
Dipped case—C280 (radial)	0·01µF–2·2µF	±20% (±10%)	250V d.c. (160V a.c.)	General purpose
Moulded case (radial)	0·01µF–2·2µF	±20%	400V d.c. (200V a.c.)	General purpose
Miniature layer (radial)	0·01µF–2·2µF	±10%	400V d.c. (150V a.c.)	General purpose
POLYSTYRENE				
Foil tubular (axial)	10pF–0·022µF	±2½%	160V d.c. (40V a.c.)	High stability, filters
SILVERED MICA				
Wax impregnated (radial)	2·2pF–0·01µF	±1%	350V d.c.	High stability, tuned circuits
CERAMIC				
Monolithic resin dipped (radial)	10pF–1µF	±10%	100V d.c.	Decoupling
Sub-miniature plate (radial)	2·2pF–220pF	±2%	63V d.c.	Low loss, high stability
Disc (radial)	0·001µF–0·1µF	+80% −20%	1000V d.c. (300V a.c.)	Decoupling
Epoxy cased (radial)	10pF–0·1µF	±10%	100V d.c.	Filtering, coupling

The aluminium electrolytic and solid tantalum capacitors are polarised (that is, they have positive and negative terminals). All others are non-polarised.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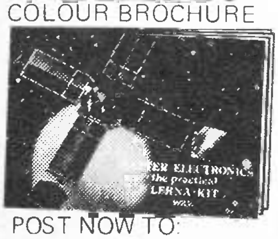
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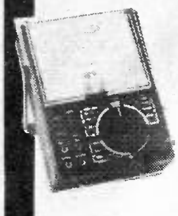

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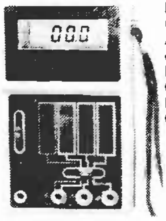

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AC Volts: 0-200V, 0-500V ±2% of full scale
DC Current: 0.2mA, 0-20mA, 0-200mA ±1.5% of reading
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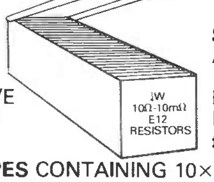

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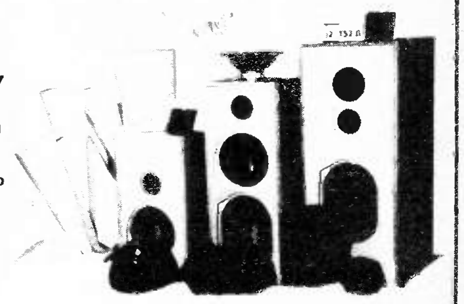

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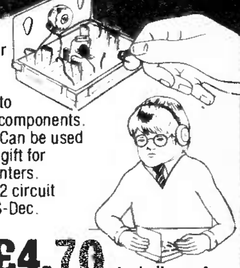

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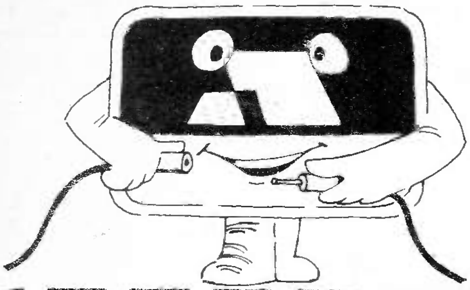

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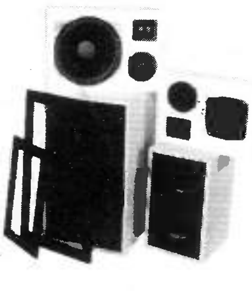

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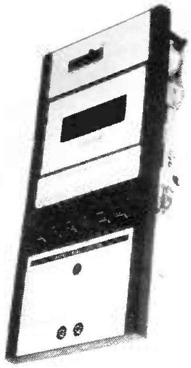

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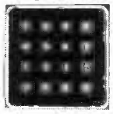

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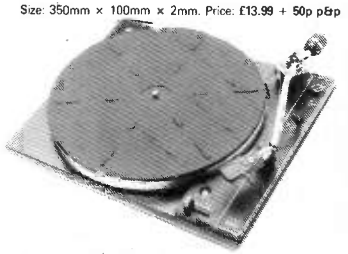

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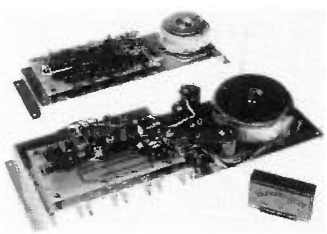

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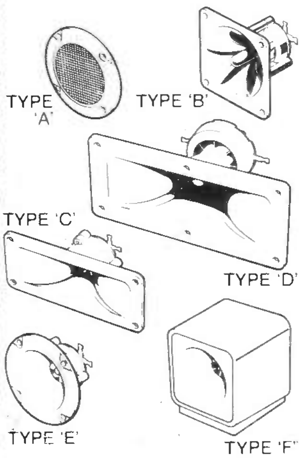

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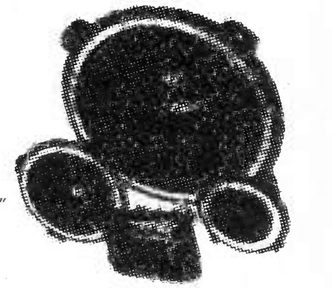

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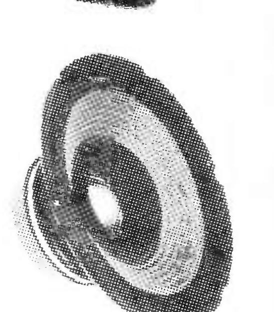

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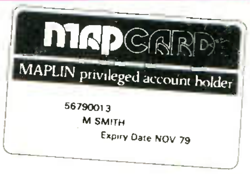

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