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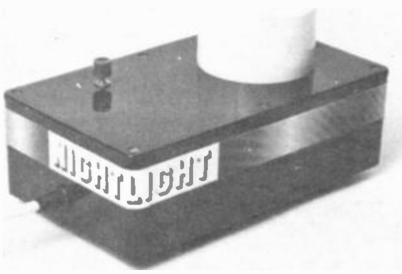

PROJECTS

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Our July issue will be published on Friday, June 18. See page 391 for details.

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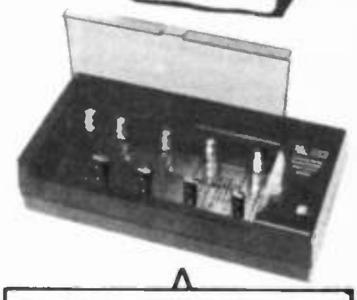

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9400CJ 350	ICL7622 180	LM384 130	MC1310 150	NE571 425	★TLO81 30
AY-3-1270 840	ICL8038 320	LM386 65	MC3302 150	RC4136 68	TLO82 50
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CA3046 60	LF353 85	LM710 50	ML925 210	SN76477 250	ZN414 100
CA3080 65	LF356 90	LM711 60	ML926 140	TBA120S 70	ZN423 125
CA3089 215	LM10 395	LM725 350	ML927 140	TBA800 80	ZN424 135
CA3090AQ	LM301A 25	LM733 75	ML928 140	TBA810 96	ZN425E 390
375	LM311 70	★LM741 14	ML929 140	TBA820 80	ZN426E 330
CA3130E 90	LM318 120	LM747 75	NE515 270	TBA950 290	ZN427E 650
CA3140E 45	★LM324 40	LM748 35	NE529 225	TCA940 170	ZN428E 480
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TRANSISTORS		BC548 10	BFR40 23	TIP29A 40	★ZTX107 8	2N3053 23
AC125 35	BC157 10	BC549 10	BFR80 25	TIP29B 55	★ZTX108 8	2N3054 55
AC126 25	BC158 10	BC558 10	BFX29 25	TIP29C 60	ZTX109 12	2N3055 50
AC127 25	BC159 6	BCY70 18	BFX84 25	TIP30A 45	ZTX300 14	2N3442 120
★AC128 20	BC160 45	BCY71 18	BFX85 25	TIP30B 50	ZTX301 16	★2N3702 6
AC176 25	BC168C 10	BCY72 18	BFX86 28	TIP30C 60	ZTX302 15	2N3703 9
AC187 22	BC169C 10	BD115 80	BFX87 25	TIP31A 45	ZTX303 15	★2N3704 6
AC188 22	BC170 8	BD131 35	BFX88 25	TIP31C 55	ZTX341 30	2N3705 9
AD142 120	BC171 10	BD132 35	BFY50 23	TIP32A 45	ZTX500 15	2N3706 9
AD149 80	BC172 8	BD133 50	BFY51 23	TIP32C 60	ZTX501 15	2N3707 10
AD161 40	BC177 18	BD135 50	BFY52 23	TIP33A 50	ZTX502 15	2N3708 10
AD162 40	BC178 18	BD136 30	BFY53 32	TIP33C 75	ZTX503 18	2N3709 10
AF124 60	BC179 18	BD137 30	BFY55 32	TIP34A 60	ZTX504 25	2N3772 190
AF126 50	BC182 10	BD138 30	BFY56 32	TIP34C 85	2N697 20	2N3773 210
AF139 40	★BC182L 8	BD139 35	BRY39 40	TIP35A 160	2N698 40	★2N3819 18
AF186 70	BC183 10	BD140 35	BSX20 20	TIP35C 180	2N706A 20	2N3820 40
AF239 75	BC183L 10	BD204 110	BSX29 35	TIP36A 170	2N708 20	2N3823 65
BC107 10	BC184 10	BD206 110	BSY95A 25	TIP36C 195	2N198 35	2N3866 90
BC107B 12	★BC184L 7	BD222 85	BU205 160	TIP41A 60	2N1132 22	2N3903 10
★BC108 9	BC212 10	BF180 35	BU206 200	TIP42A 60	2N1613 30	2N3904 10
BC108B 12	BC212L 10	BF182 35	BU208 170	TIP120 90	2N2218A 45	2N3905 6
BC108C 12	BC213 10	BF184 25	MJ2955 99	TIP121 90	2N2219A 25	2N3906 10
★BC109 6	BC213L 10	BF185 25	MJE340 50	TIP122 90	2N2221A 25	2N4037 45
BC109C 12	BC214 10	BF194 12	MJE520 65	TIP141 120	2N2222A 20	2N4058 10
BC114 22	★BC214L 8	BF195 12	MJE521 95	TIP142 120	2N2368 25	2N4060 10
BC115 22	BC237 8	BF196 12	MJE3055 70	TIP147 120	2N2369 16	2N4061 10
BC117 22	BC238 14	BF197 12	MPF102 40	TIP2955 60	2N2484 25	2N4062 10
BC119 35	BC308 15	BF198 10	MPF104 40	TIP3055 55	★2N2646 45	2N5457 36
BC137 40	BC237 14	BF199 18	MPSA05 22	TIS43 40	2N2904 20	2N5458 38
BC139 40	BC328 14	BF200 30	MPSA06 25	TIS44 45	2N2904A 20	2N5459 30
BC140 30	BC337 14	★BF244B 22	MPSA12 30	TIS45 45	2N2905 22	2N5485 36
BC141 30	BC338 14	BF245 30	MPSA55 30	TIS90 30	2N2905A 22	2N5777 45
BC142 25	BC477 30	BF256B 45	MPSA56 30	TIS91 30	2N2906 25	2N6027 30
BC143 25	BC478 30	BR257 32	MPSU05 55	★VN10KM 45	2N2906A 25	40360 40
BC147 8	BC479 30	BF258 25	MPSU06 55	VN46AF 75	2N2907 25	40361 50
BC148 8	BC517 40	BF259 35	MPSU55 60	VN66AF 85	2N2907A 25	40362 50
BC149 9	BC547 8	BF337 40	MPSU56 60	VN88AF 95	2N2926 9	40408 70

CMOS

CMOS	★4017 43	4034 170	4054 110	4081 18	40193 120	4528 75
	4018 60	4036 285	4055 115	4082 20	4502 70	4529 150
4000 14	4019 35	4039 295	4059 480	4085 65	4503 50	4532 95
★4001 12	4020 55	4040 55	4060 85	4086 65	4507 38	4534 495
4002 14	4021 65	4041 75	4063 90	4089 140	4508 200	4538 110
4006 65	4022 70	4042 55	★4066 35	★4093 33	4510 65	4543 110
4007 17	4023 18	4043 60	4067 395	4094 140	★4511 50	4549 380
4008 58	4024 40	4044 65	4068 15	4095 90	4512 70	4553 295
4009 30	4025 18	4046 70	4069 18	4097 340	4514 180	4555 45
4010 35	★4026 96	4047 70	4070 18	4098 85	4515 180	4556 48
★4011 13	4027 30	4048 55	4071 18	4099 95	4516 75	4559 390
4012 17	4028 55	★4049 28	4072 18	40106 50	★4518 45	4560 180
★4013 25	4029 75	★4050 28	4073 20	40109 100	4520 70	4584 45
4014 60	4030 35	4051 60	4075 20	40163 100	4521 200	4585 99
4015 60	4031 170	4052 70	4076 60	40173 100	4526 80	4724 140
★4016 26		4053 60	4077 25	40175 100	4527 90	

TTL

TTL	7413 24	7442 40	7480 45	74107 30	74155 60	74177 75
	7414 35	7444 85	7482 70	74109 32	74156 60	74179 65
7400 11	7416 25	7446 60	7483 50	74121 28	74157 43	74180 65
7401 11	7417 25	7447 40	7485 70	74122 45	74160 60	74181 135
7402 12	7420 15	7448 50	7486 25	74123 48	74161 60	74182 75
7403 14	7421 20	7450 16	7489 180	74125 40	74162 60	74190 70
7404 14	7422 20	7451 16	7490 28	74126 40	74163 60	74191 70
7405 17	7427 28	7453 16	7491 45	74132 40	74164 60	74192 70
7406 26	7428 28	7454 16	7492 40	74141 65	74165 60	74193 65
7407 26	7430 15	7460 16	7493 35	74145 65	74167 180	74194 70
7408 15	7432 25	7472 25	7494 35	74147 100	74170 165	74195 63
7409 15	7433 27	7473 28	7495 35	74148 75	74173 60	74196 63
7410 15	7438 27	7474 25	7496 45	74150 75	74174 65	74197 63
7411 20	7437 27	7475 38	7497 120	74153 45	74175 70	74198 95
7412 20	7440 17	7476 30	74100 80	74154 75	74176 55	74199 95

LS TTL

LS TTL	LS21 15	LS76 20	LS125 30	LS161 42	LS221 60	LS365 38
	LS22 16	LS78 24	LS126 30	LS162 42	LS240 90	LS366 38
LS00 13	LS26 16	LS83 50	LS132 45	LS163 42	LS241 80	LS367 38
LS01 14	LS27 15	LS85 70	LS136 30	LS164 50	LS242 80	LS368 50
LS02 14	LS30 16	LS86 25	LS138 35	LS165 120	LS243 85	LS373 80
LS03 14	LS32 16	LS90 25	LS139 35	LS166 85	LS244 80	LS374 80
LS04 15	LS37 16	LS92 38	LS145 75	LS170 175	LS245 120	LS375 50
LS05 15	LS38 16	LS93 35	LS147 160	LS173 70	LS247 75	LS377 90
LS08 16	LS40 16	LS95 45	LS148 95	LS174 60	LS251 40	LS378 70
LS09 16	LS42 38	LS96 110	LS151 40	LS175 60	LS257 48	LS390 75
LS10 16	LS47 40	LS107 45	LS153 40	LS190 55	LS258 45	LS393 75
LS11 16	LS48 80	LS109 30	LS154 120	LS191 55	LS259 95	LS399 220
LS12 15	LS51 16	LS112 30	LS155 45	LS192 55	LS266 25	LS541 135
LS13 25	LS55 16	LS113 30	LS156 45	LS193 60	LS273 90	LS670 175
LS14 48	LS73 25	LS114 30	LS157 35	LS195 50	LS279 50	
LS15 15	LS74 25	LS122 42	LS158 38	LS196 60	LS283 45	
LS20 15	LS75 27	LS123 55	LS160 42	LS197 68	LS353 100	

SWITCHES

Submin toggle
SPST 55p. SPDT 60p. ★DPDT 50p
Miniature toggle
SPDT 80p. SPDT centre off 90p
DPDT 90p. DPDT centre off 100p
Standard toggle SPST 35p. DPDT 48p
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★Push to make 12p. Push to break 22p
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Heavy Duty Footswitch 170p

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★3mm red	8	★5mm red	8
★3mm green	12	★5mm green	12
★3m yellow	12	★5mm yellow	12

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Rectangular		TIL32	40
★red	12	TIL78	40
green	17	TIL111	60
yellow	17	ORP12	85
TIL38	40	TIL100	90
SN5777	45	Dual colour	60

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DL704 0·3"	95	DL707 0·3"	95
★FND500 0·5"	80	FND507 0·5"	90
TIL313 0·3"	105	TIL312 0·3"	105
TIL322 0·5"	115	TIL321 0·5"	115

All displays are supplied with pinouts.

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2·5mm	10p	10p
3 pin	12p	10p	3·5mm	9p	8p
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
SO 239S round chassis socket 40p
IEC 3 pin 250V/6A
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2m lead 120p

SCRS		TRIACS	
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C106D	30	400V 8A	65
400V 8A	70	400V 16A	95
400V 12A	99	BR100	25

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★64mm 8 ohm speaker	70p
20mm panel fuseholder	25p

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50 6BA washers	50 6BA washers

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0-50µA	0-500mA
0-100µA	0-1A
0-500µA	0-50V AC
0-1mA	VU
0-10mA	0-300V AC
0-50mA	0-25V
0-100mA	0-30V DC

495p each.

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Standard screened	16p/m
Twin screened	24p/m
2·5A 3 core mains	23p/m
10 way rainbow ribbon	65/m
20 way rainbow ribbon	120p/m

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Special prices on popular regulators. Prices valid to 30th June 82.

		Volts	Amps	1+	10+
78L05	T092	5	100mA	25p	23p
78L12	T092	12	100mA	25p	23p
7805	Plastic	5	1	38p	34p
7812	Plastic	12	1	38p	34p
7905	Plastic	5	1	45p	42p

SOCKETS

★ 8 pin	7p
★14 pin	9p
★16 pin	10p
★18 pin	15p
20 pin	18p
22 pin	20p
24 pin	22p
28 pin	26p
40 pin	32p
Soldercon pins	50p/100.

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Verobloc	350p
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2·5 × 1	22p
2·5 × 3·75	75p
2·5 × 5	85p
3·75 × 5	95p
VQ board	160p
Veropins per 100	
Single sided	50p
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1A 50V	22	6A 100V	80
1A 400V	35	6A 400V	95
2A 200V	40	VM18 DIL	
2A 400V	45	0·9A 200V	50

RESISTORS

¼W 5% Carbon film E12 series 4·7-10M. 1p each
¼W 5% Carbon film E12 series 4·7 to 4M7. 2p each
¼W 1% Metal film E24 series 10-1M. 6p each

CRYSTALS

100KHz	290	6·0M	200
200KHz	370	6·144M	180
1MHz	300	7·0M	250
1·008M	370	8·0M	170
1·8432	300	10·0M	180
2·0M	270	12·0M	290
2·4576M	220	16·0M	240
3·276M	240	18·0M	240
3·579M	120	18·432	220
4·0M	150	19·968	300
4·194M	150	38·667	320
4·43M	125	48·0M	220
5·0M	240	116M	300

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	45	7905	45
7812	45	7912	45
7815	50	7915	55
LM309K	130	LM723	40
LM317K	350	LM338K	475
LM317T	120	78H05	
LM323K	350	5A 5V	550

DIODES

BY127	12	★1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
★1N4148	2	400mW zen.	6

BZX61 Series Zeners, 1·3W 4V7-39V. 15p each.

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; 1µ 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.

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; 1µ, 33p; 2µ2, 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.

Ceramic disc. 22p-0·01µ 50V, 3p each.
Mullard miniature ceramic plate.
1·8pF to 100pF 6p each.
Polystyrene. 5% tolerance.
10p-1000p 6p. 1500-4700p 8p. 6800-0·12µ 10p.
Trimmers. Mullard 808 Series.
2-10pF 22p. 2-22pF 30p. 5·5-65pF 35p.

BOXES

Aluminium		Plastic With lid + screws	
3 × 2 × 1in	70p	3 × 2 × 1in	55p
4 × 3 × 1½in	85p	4½ × 3 × 1½in	88p
4 × 3 × 2in	100p	7 × 4 × 2in	160p
6 × 4 × 2in	120p		
6 × 4 × 3in	180p		

PCB MATERIALS

Alfac transfer sheets—please state type (e.g. DIL pads etc)	45p
Dalo etch resist pen	100p
Fibre glass board 3·75 × 8"	75p
Ferric Chloride 250ml bottle	100p

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 3/4in 100 ohms to 100K, 88p each.

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VOL. 11 NO. 6 JUNE 1982

Everyday ELECTRONICS

THE END IS NOT NIGH

Every so often we hear of dismal forecasts from supposedly knowledgeable persons to the effect that the home construction side of electronics will be played out within five, ten or twenty (or is it more?) years. These Jeremiahs usually base their opinions on the fact that more and more sophisticated and attractive electronic equipments are becoming available on the consumer market and the new interests created, such as computing, running CB rigs and video recording, require no technical knowledge or involvement with the inside works. One consequence of this, the pessimists believe, is that keen interest in the technical aspect of electronics will wane.

We are sure this is a wholly mistaken view, which ignores all past experience and present day evidence. New avenues have indeed been opened up by the arrival of these more recent additions to the electronic scene. The operative words are "new" and "additions". But none of this, in our view, implies a threat to home construction activities—rather quite the reverse.

Every new avenue opened up by applied electronics furnishes new opportunities for individual enterprise and ingenuity in devising ancillary units to extend or improve the facilities provided by consumer equipments, or to permit interfacing between various equipments. The electronics enthusiast is constantly being offered fresh challenges to his ability to design and build circuits.

This is borne out in this month's issue by two constructional projects aimed specifically at enhancing the usefulness of commercial equipments. One is a worthwhile modification for the well known ZX81 microcomputer that provides an audible indication each time a key is pressed; the other is a power unit specially designed to operate a mobile transceiver from the mains thus allowing a mobile set to double as a base station as required.

Indulging in a little speculation on our own part, it is obvious that the one thing that *could* threaten home construction would be the drying up of component supplies. Luckily this catastrophe cannot be envisaged for the foreseeable future. The trend towards total integration of circuitry by commercial equipment makers may affect the variety of "conventional" components manufactured, and so in turn restrict the choice available to constructors through retail outlets. However, any such deficiencies will be well compensated for by the introduction of new components related to emerging technologies closely related to electronics, like optical fibres or "Photonics." Above all, one thing is sure: commercial equipment production techniques will have to undergo drastic changes before all the basic parts for circuit building cease to be available to amateur designers and constructors.

Fred Bennett

CB POWER SUPPLY

BY R.A PENFOLD

Allows a mobile unit to be used as a home base station

ALTHOUGH citizens band (CB) base stations are now available, there are relatively few to choose from and prices are generally much higher than for mobile transceivers. It is therefore not surprising that many CB users who require a base station actually use a mobile transceiver plus a mains power supply. Such an arrangement is comparatively inexpensive and seems to have no major disadvantages.

This power supply was specifically designed to enable a legal 27MHz mobile CB transceiver to be mains powered, but it could obviously be used to operate any other in-car equipment from the mains supply provided the current requirement is not too high. The maximum current available is either 1·5 amps or 2 amps depending on the mains transformer used in the unit.

CURRENT RATINGS

It is worth mentioning here that although manufacturers' specifications for legal CB transceivers often give quite high maximum current consumption figures, with 2·5 amps being quite normal, measurements on a few CB transceivers show a current consumption of around 1 amp. Bearing in mind the power restrictions on CB equipment this is about the current drain that one would expect, and presumably the figures given in manufacturers' specifications are some sort of peak level and not a continuous one.

Thus the 2 amp version of the power supply should be adequate for any legal (British standard) CB transceiver, and if it is possible to measure the current consumption of the transceiver with which the power supply will be employed it will probably be found that the 1·5 amp version is adequate.

The output of the supply is well smoothed and regulated, and problems with the mains hum modulating the transmitter or breaking through on receive should not be experienced.

I.C. REGULATOR

The circuit is based on an L200 integrated circuit voltage regulator, and the block diagram of Fig. 1 shows in slightly simplified form the internal arrangement of this device and the way in which it is used. The simplifications mainly concern the omission of the sophisticated protection circuits of this device which prevent damage due to overheating or unacceptably high combinations of input current and voltage.

In this particular application the device is used with only a fairly modest input voltage and dissipates only a few watts so that these protection circuits are not of great importance.

REGULATOR OPERATION

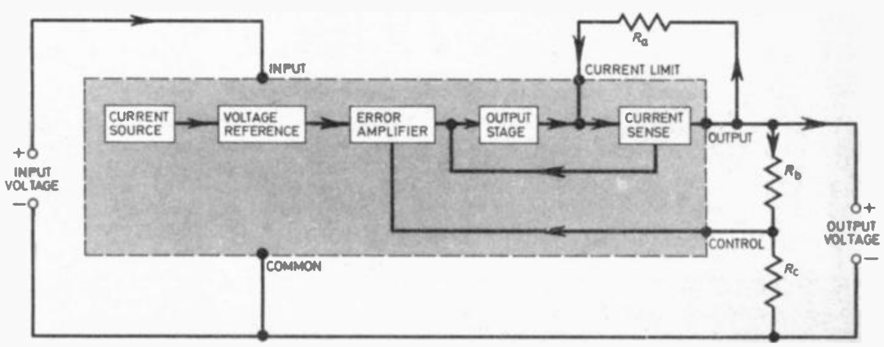
A voltage reference is fed from a constant current source so that a highly stable output potential is produced. This reference voltage is fed to one input of a differential error amplifier, and the other input is fed from the output of the device via the potential divider formed by R_b and R_c.

The error amplifier drives the output terminal of the device by way of an output stage which enables very high output currents to be handled but provides no voltage amplification, and a circuit which prevents an excessive output current from flowing.

By a negative feedback action the circuit maintains the voltage at the control terminal at the same potential as the voltage from the reference source. Thus an increase in output voltage, for example, unbalances the input voltages to the error amplifier so that its output goes negative and largely counteracts the increase in output voltage. A reduction in output voltage reduces the input voltage to the control terminal and produces a compensating increase in output potential.

Obviously the output is stabilised at a certain voltage, as well as the control terminal being stabilised at the same potential as the reference voltage. The output must be at a higher potential than that produced by the reference source due to the voltage drop produced by R_b and R_c, and the output can therefore be set at any

Fig. 1. Block diagram of the L200 voltage regulator i.c. illustrating its principle of operation.



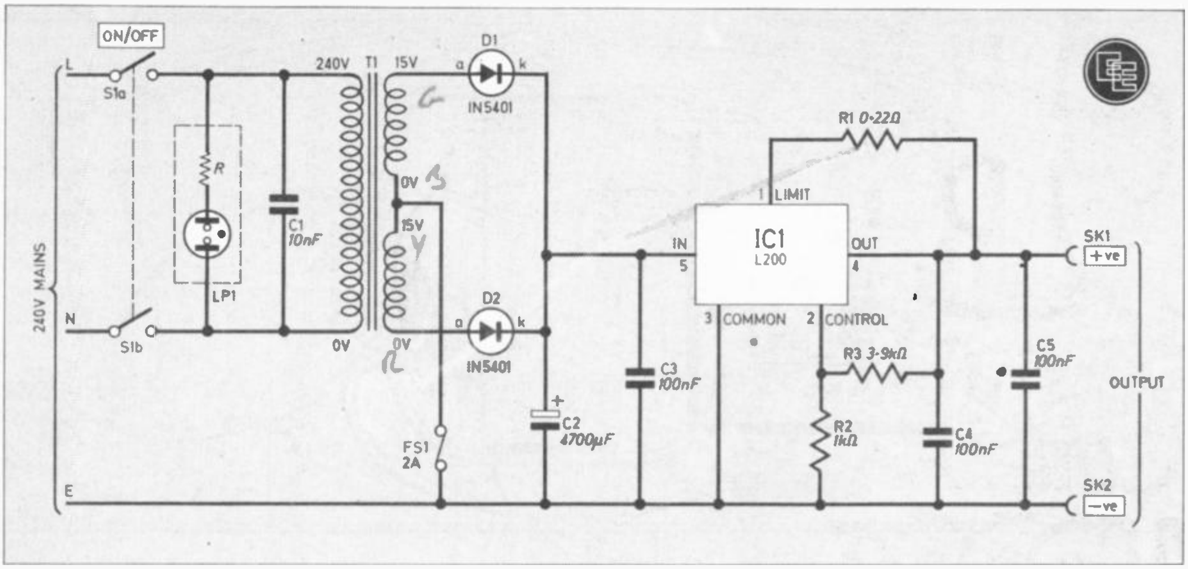


Fig. 2. The complete circuit diagram of the CB Power Supply.

voltage (within reason) that is higher than the reference voltage.

The reference voltage of the L200 is nominally 2·77 volts. The output voltage is nominally equal to R_b plus R_c divided by R_c, and then this is multiplied by the 2·77 volts reference potential.

Resistor R_a is used to set the threshold level of the current limiting circuit, and this circuit comes into operation when the voltage across discrete resistor R_a reaches 0·45 volts. The value for R_a is therefore equal to 0·45 divided by the required maximum output current (in amps).

The current limiting is of the foldback type and this simply means that attempting to draw a current in excess of the current limit threshold level actually gives an output current which is lower than the limiting threshold. With ordinary current limiting the overload output current is slightly in excess of theshold level at which the current limiting circuit starts to operate.

COMPONENTS

Resistors
- R1 0·22Ω 3 watt 5%
- R2 1kΩ ¼ watt 1%
- R3 3·9kΩ ¼ watt 1%

See **Shop Talk** page 381

Capacitors
- C1 10nF 250V a.c.
- C2 4700µF 25V elect.
- C3 100nF polyester (C280)
- C4 100nF polyester (C280)
- C5 100nF ceramic

Semiconductors
- IC1 L200 adjustable voltage regulator
- D1, D2 1N5401 3A rectifier diode (2 off)

Miscellaneous
- T1 Standard mains primary 0–15V, 0–15V 1·7 amp secondaries (see text)
- S1 d.p.s.t. rotary mains switch
- FS1 2 amp 20mm quick-blow fuse
- LP1 Panel neon indicator with integral series resistor
- SK1/2 two-way spring terminal panel

Metal case, type AB31 or similar, size 152 × 114 × 76mm approximately—see text; control knob; printed circuit board size 70 × 60mm; length of 3-core mains cable; chassis mounting 20mm fuseholder; rubber grommet (for mains cable inlet); fixing hardware for p.c.b. and IC1; solder tag.

Guidance only Approx. cost £11 excluding case

CIRCUIT DESCRIPTION

The complete circuit diagram of the CB Power Supply is shown in Fig. 2, and a certain amount of circuitry is needed in addition to the voltage regulator.

T1 is used to step down the 240 volt mains supply to a much lower voltage that can be applied safely to the regulator, and it also isolates the output of the supply from the dangerous mains supply. The output from T1 is an alternating current (a.c.) but a direct current (d.c.) is needed to operate a mobile CB transceiver. The output of T1 is therefore fed to a full-wave push-pull type rectifier which consists of D1 and D2, and this pulsating d.c. signal is then given a high degree of smoothing by C2.

C3 and C4 are supply decoupling capacitors which are needed to prevent IC1 from becoming unstable. R1 is the resistor that sets the maximum output current of the unit, and the specified value gives a maximum current of about 2 amps.

R2 and R3 set the output voltage of the supply at a nominal level of fractionally under 13·6 volts. This may seem to be too high since a car battery has a nominal potential of 12 volts, but a car supply is normally somewhat in excess of 12 volts, and most in-car equipment is designed for optimum results with a 13·8 volt supply. A nominal output potential of 13·6 volts is therefore perfectly satisfactory.

R2 and R3 are precision (1 per cent) components so that the actual ouput voltage is very close to the calculated figure.

C1 and C5 are r.f. filter capacitors which prevent the strong r.f. field from the transmitter from coupling signals into the unit due to pick-up in the input and output wiring. They also help to prevent stray coupling from the transmitter into the mains power supply through the power supply.

S1 is a straightforward on/off switch and LP1 is the on/off indicator neon. LP1 must be a type that has an integral series resistor for use with the 240 volt UK mains supply.

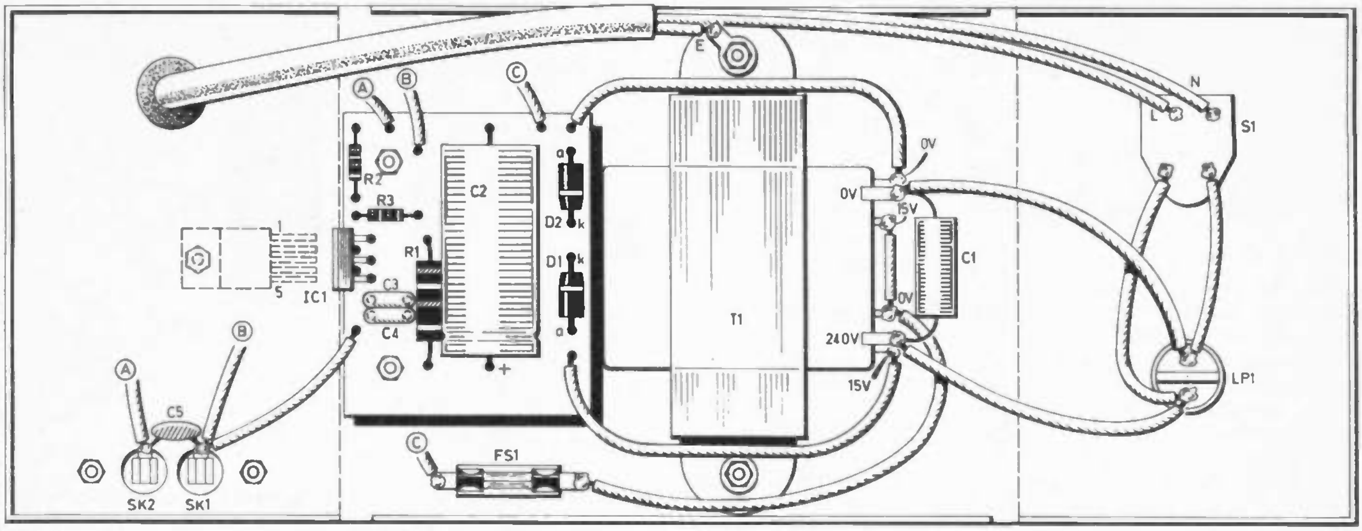


Fig. 4. Component layout on the topside of the p.c.b. with full interwiring details. As shown, SK1 and SK2 are spring loaded terminals.

CB POWER SUPPLY

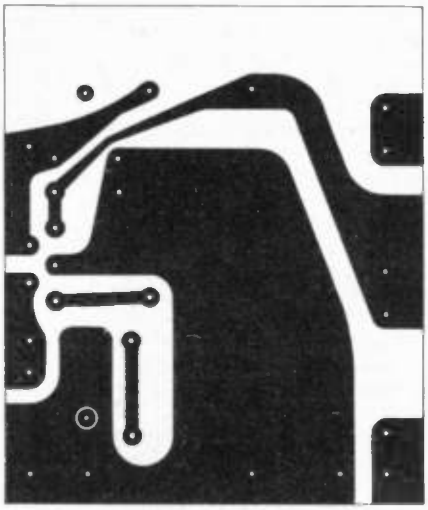
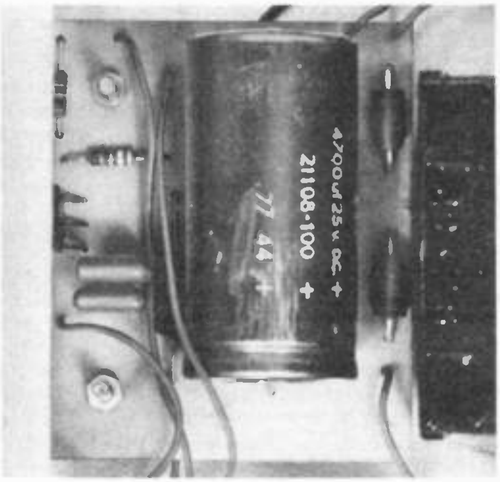
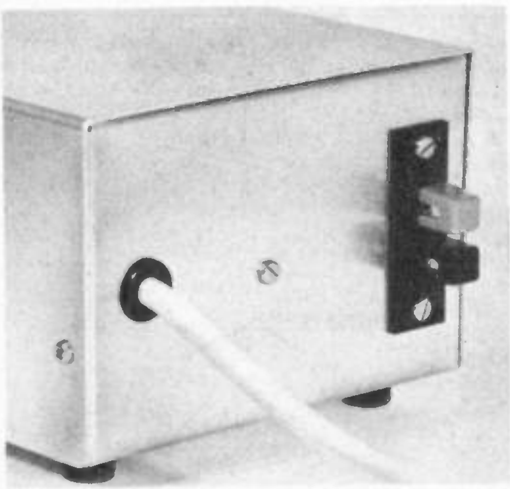


Fig. 3. The full-size master pattern to be etched on the p.c.b. The black areas represent the copper tracks.

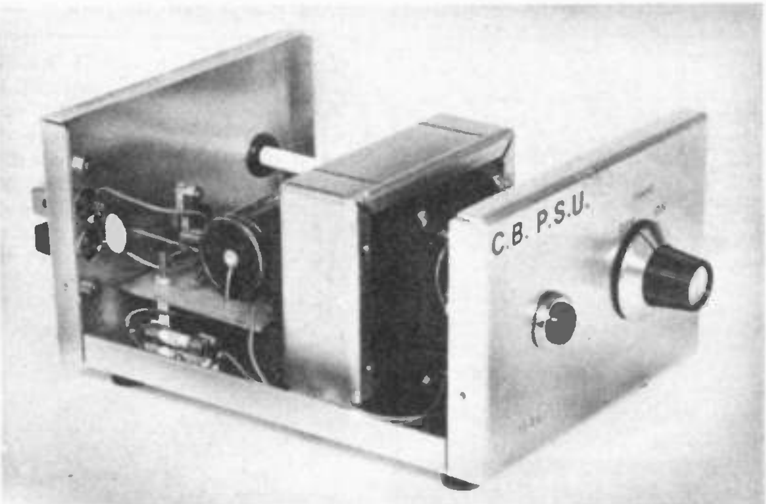


Close-up view of the prototype p.c.b.

Shows the cable leaving the case through a protective grommet. Fitted with a spring-loaded terminal pair.



The completed CB Power Supply with case top half removed.



CONSTRUCTION starts here

METAL CASE

An aluminium box having approximate dimensions of 152×114×76mm was used as the case for the prototype power supply, but it is advisable to obtain the mains transformer T1 before obtaining a case so that you can be certain that there will be sufficient space for the transformer and other components.

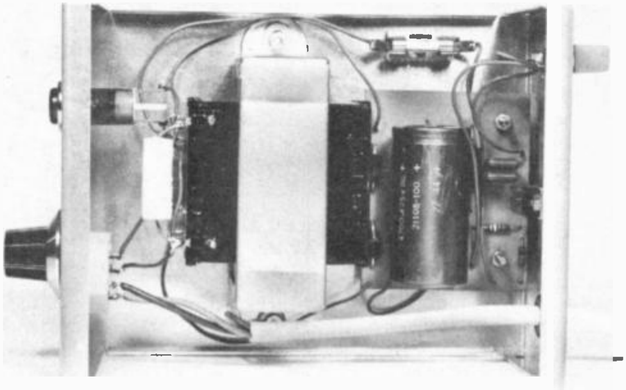
For a 1·5 amp maximum output T1 can be a type having twin 15 volt secondary windings rated at 1·7 amps or more, or twin 17 volt windings rated at 1·5 amps or more. For a 2 amp maximum output the secondary current rating needs to be higher, the minimum acceptable figures being 2·5 amps and 2 amps respectively.

S1 and LP1 are mounted on the front panel of the case and T1 is bolted to the base panel of the case just to the rear of these. An entrance hole for the mains lead is drilled on one side of the rear panel and the output sockets (SK1 and SK2) are mounted on the opposite side. On the prototype the output sockets were actually a couple of spring loaded terminals mounted on a small paxolin strip, and these provide a very quick and simple way of connecting the output of the unit to the supply leads of the transceiver. However, terminal posts, wander sockets, or any similar type of connector can be used if preferred.

CIRCUIT BOARD

A printed circuit board is used in the construction of this project. A suitable printed circuit design is shown actual size in Fig. 3. This is a very simple design and can easily be produced using normal home-constructor printed circuit techniques.

Note that D1 and D2 have much thicker leadout wires than normal components, and require holes in the printed circuit about 1·5mm in diameter. Also, the cathode (k) leadout wire of the 1N5401 device is indicated by a narrowing of the component's body at the end from which this leadout emanates, rather than the usual coloured band around the body of the component.


Plan view of the completed prototype.

The completed printed circuit board is mounted at the rear of the case with the heat-tab of IC1 flat against the rear panel of the case. Use long 6BA or M3 mounting bolts with spacers about 12·5mm long so that the underside of the board is held well clear of the metal case.

REGULATOR MOUNTING

IC1 is bolted to the rear panel of the case (which acts as the heatsink for IC1) and with the printed circuit bolted in place the position of the mounting hole on the rear panel can be marked through the mounting hole in the heat-tab on IC1. It is not necessary to insulate IC1 from the case. The printed circuit board is then removed and the M3 or 6BA clearance mounting hole is drilled.

FS1 is fitted in a chassis mounting fuseholder which is mounted at any convenient place on the base panel of the case.

Finally, C1 and C5 are soldered into place, and the other wiring is completed before the printed circuit is bolted in place. The mains earth lead must connect to the metal case for reasons of safety, and a solder tag can be fitted on one of the mounting bolts of T1 if no other suitable earthing point can be found.

The wires to the printed circuit board must be made using a heavy duty hook-up wire capable of taking at least 2 amps safely.

TESTING

Give all the wiring a couple of very thorough checks before plugging the unit into the mains supply and switching on. If possible use a multimeter to check that the output voltage is correct before connecting the transceiver to the output of the power supply. Be careful to connect the transceiver supply leads to the output of the power supply with the correct polarity—not all CB transceivers have reverse polarity protection.

In use the microphone should be kept a reasonable distance (about half a meter or so) away from the power supply or inductive coupling from the mains transformer to the microphone might give problems with mains hum on the transmitted signal. ⌑

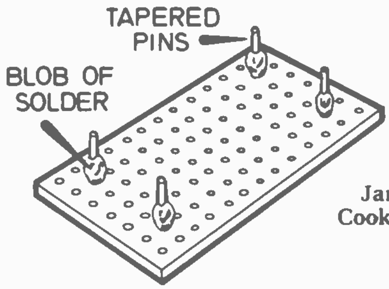
MATRIX BOARD JIG

When making an electronic project, I always try to hold my circuit board in a vice, for ease of soldering. The only drawback is that a small vice, like I and fellow constructors use, has a small jaw opening.

I have overcome this problem by designing a useful little piece of equipment for holding outsize circuit boards.

This easy to build device is pushed into the holes of the Vero or matrix board being worked upon and then is clamped in the vice. If the pins are slightly too fat to be pushed into the small board, so much the better. The blob of solder is to prevent the pins from being moved while the circuit board is fitted.

I find this holds the board very firmly, and is well worth its cost of a few pence.



James Bentley,
Cookbury, Devon

NIGHTLIGHT

BY C. LARE

Many people, particularly children, do not like going to sleep in a dark room and often request that a light be left on. However, such a light may well disturb sleep patterns by its presence and in many cases the ideal night light is one which slowly dims over a long period of time.

The design presented here is for such a light. When it is first switched on the bulb slowly illuminates over a period of a minute and then gradually dims out over the following three-quarters of an hour. When the brightness reaches a preset minimum the night light switches itself off and consumes no more power. Children are generally fascinated by the action of the light and this fact alone can be useful when that troublesome bedtime comes around again!

The light is mains powered but the bulb and circuits are totally isolated by a transformer. The prototype was housed in a plastic box, and since six screws need removing to gain access to the mains it may be considered fairly safe.

CIRCUIT PHILOSOPHY

The main element in this circuit is the means of controlling the current passing through the bulb and hence varying its brightness. A power transistor could be used and as the control voltage increases, the current flowing into the base of the transistor will increase, and so the transistor will turn on more allowing more current to pass through the bulb.

This will indeed work, but the drawback is that the base draws a considerable amount of current, typically 10mA for a 2 watt bulb and to understand why this base current is a problem it is necessary to examine the easiest way of obtaining a slowly varying control voltage, that is the simple RC network. However, a typical RC network using a 47μF capacitor and a 2·2 megohm resistor has a time constant of about 100 seconds, but *only* if no other current is drawn from the capacitor. So it is out of the question to drive the base of a normal transistor with such an RC network.

A solution to this problem is available in the form of a VMOS transistor (a specialised form of MOSFET which can carry high currents). Unlike the normal transistor the VMOS transistor is voltage driven and as such the control input (gate) draws virtually no current and it is therefore possible to connect this directly to the RC network. Note that the capacitor must be charged up to turn the bulb on.

To generate a delay of nearly one hour from an RC network is not practical due to component limitations. The system derived for use in this project uses a very basic digital to analogue converter fed from a 4-bit binary counter. The counter produces a binary sequency (0000 0001 0010 0011 . . . 1110 1111) at its four outputs and each output is fed to a resistor with a value chosen to reflect the "importance" of the output. As such, the 4-bit output is connected to a 10 kilohm resistor, the 3-bit to a 22 kilohm resistor, the 2-bit to a 39 kilohm resistor and the least significant bit to an 82 kilohm resistor so that it has the least effect. See Fig. 1.

As the count proceeds, the voltage at the junction of these resistors will be affected by the counter output in the same ratios as the count. Thus as the count proceeds from 0000 to 1111 the output voltage will increase in 15 steps reaching a maximum voltage as a count of 1111 is reached. This maximum voltage will depend on the supply voltage to the counter itself.

Since this scheme converts a digital number into an analogue voltage is termed a Digital to Analogue converter or DAC. The DAC will also work in reverse and count down from 1111 to 0000 to produce a decreasing voltage.

With these concepts in mind it is possible to consider the actual circuit.

THE CIRCUIT

See Fig. 2 for the full circuit diagram. When S1 is pressed (ignore the RLA1 switch for the moment) mains power is applied to the transformer, giving just over 12V at the bridge rectifier and 470μF smoothing capacitor C7. A 9 volt supply for the i.c.s is derived from this by means of a Zener diode D4 and resistor R12. C5 decouples this supply.

Once power is applied, an oscillator built around IC1 will start to run, and quite slowly because of the high value resistances employed in the timing part of the circuit. It should take about three minutes to complete one timing cycle. The oscillator is based on the 7555 timer i.c., a CMOS version of the very well known 555.

The output from the 7555 is connected directly to a CMOS 4-bit logic counter, the 4029. This counter is wired in count down mode, and will count down one binary number every time it receives a clock pulse from the oscillator. In this application it

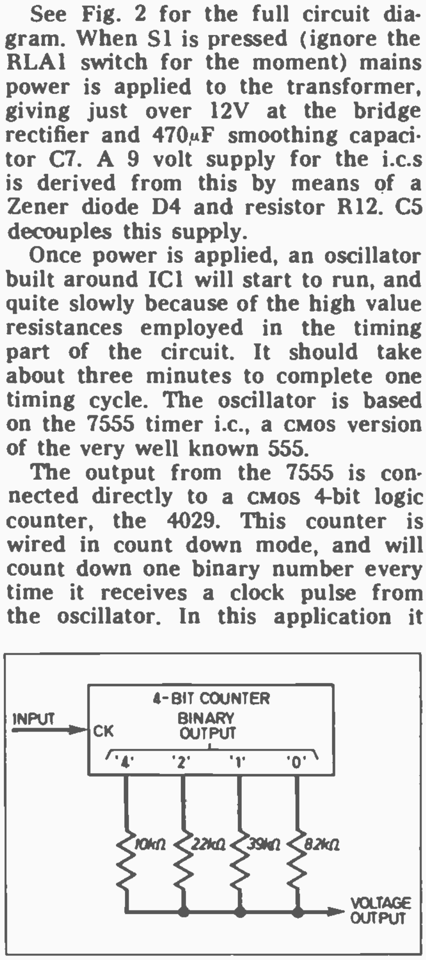


Fig. 1. The basic digital to analogue converter using a 4-bit binary counter.

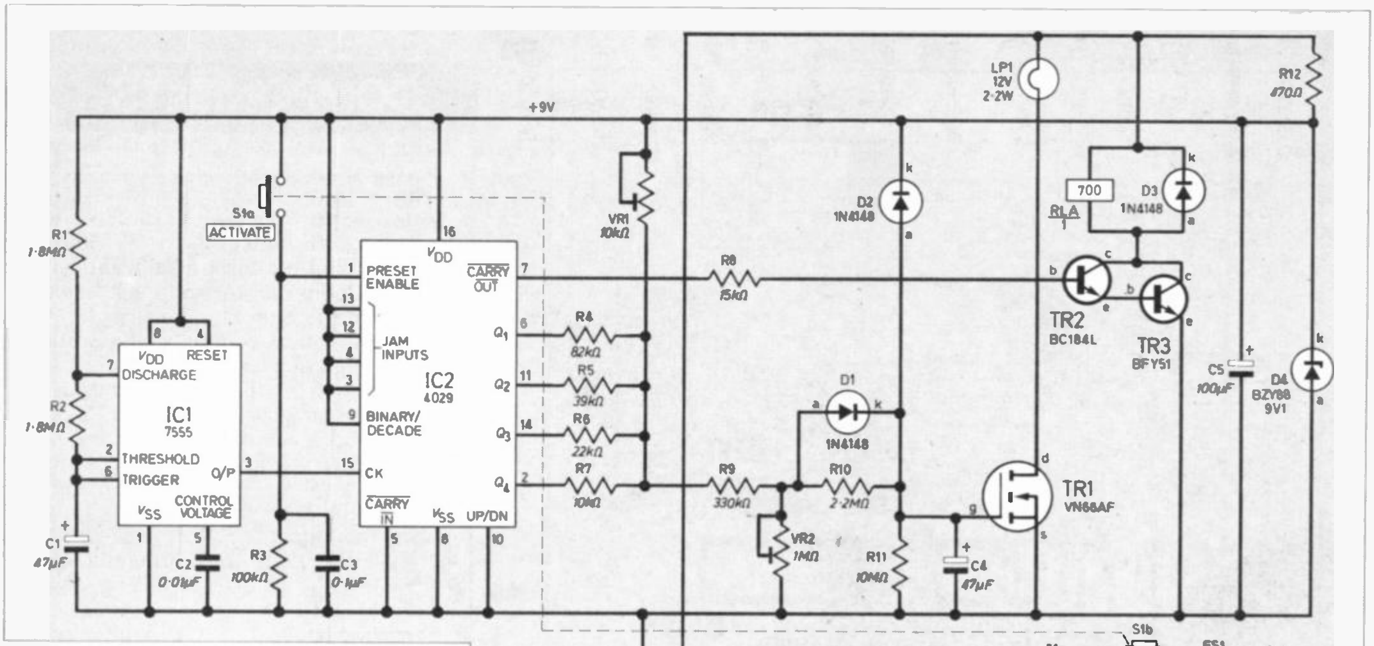
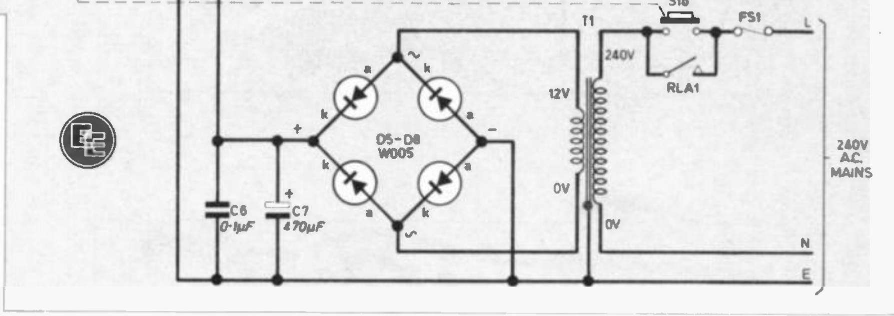



Fig. 2. The complete circuit diagram of the Nightlight. IC2 is the 4-bit binary counter that forms the DAC along with resistors R4 to R7. Note that both the lamp and the relay are run from the unregulated supply.

must count down from 1111, and so a form of loading is used.

When the PRESET ENABLE input, pin 1, of the counter i.c. is taken high, the information on the JAM inputs, pins 4, 12, 13, and 3 is transferred to the *Q* outputs, pins 6, 11, 14 and 2 respectively. So to produce 1111 at the output, all four JAM inputs must be taken to $+V_{DD}$ and the preset enable input must be switched to allow it to be taken high momentarily. This is done with the other half of S1.

Thus once power is applied, the counter will be set to 1111. Pin 7 of the counter also goes to a high voltage when the counter is loaded with 1111 and this high voltage is used to drive a Darlington pair, consisting of TR2 and TR3, which activates the relay. D4 protects the circuit from the back e.m.f. caused by the relay coil. Once the relay closes the press switch can be released because the relay contacts remain closed and keep supplying power to the circuit.

SET COUNT

So once S1 is pressed, the counter loads with 1111 the relay latches and S1 can be released. This process happens very quickly indeed and as soon as S1 is released the counter will start to slowly count down from 1111. When it reaches 0000, pin 7 drops to 0 volts. This facility is provided to enable two of these counters to be connected together and for this reason is called the CARRY output. In this application as pin 7 goes low, the transistors TR2 and TR3 stop conducting and the relay opens, disconnecting the circuit from the mains until S1 is pressed again.

The outputs from the counter are fed to a DAC as described earlier and resistors R4 to R7 are connected together and the junction is fed via R8 and D1 into an RC network consisting of C4 and R11. However, it should be noted that R11 plays little part in the circuit and the main part of the time constant to smooth out the voltage change from the output of the DAC. D1 allows the bulb to come on quickly when S1 is pressed and the counter outputs go to 1111 as it effectively shorts out R10 during the charge time and thus R10 does not affect the initial charge rate of C4.

Once the RC network has fully charged and the counter started clocking down, D1 plays no further part in the circuit. D2 ensures that the capacitor will discharge quickly when power is removed. Two preset potentiometers VR2 and VR1 are included. These are used to set the maximum and minimum brightness respectively by adjusting the output voltage from the DAC by assisting the high level or pulling down the low level. The voltage on C4 is then fed directly to the gate of the VMOS lamp driver, TR1.

As a result once the circuit is set the voltage on the capacitor rises and the lamp comes on. Over the next 15 cycles from the counter, at about 5 minutes each, the voltage output from the DAC will fall in 15 stages. This decline is smoothed by the RC network and the effect is one of gradual dimming.

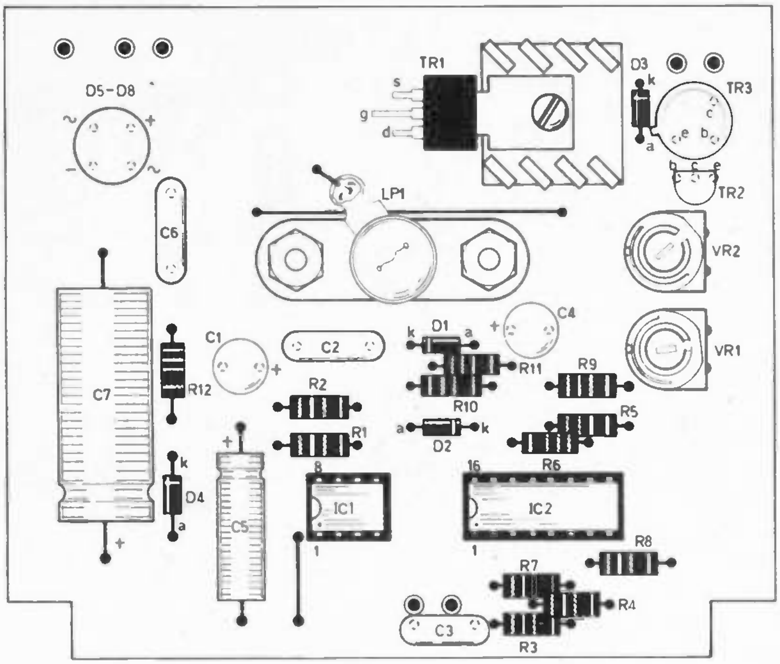
On the 16th cycle the counter reaches zero and pin 7 goes low opening the relay and switching the unit off as required.

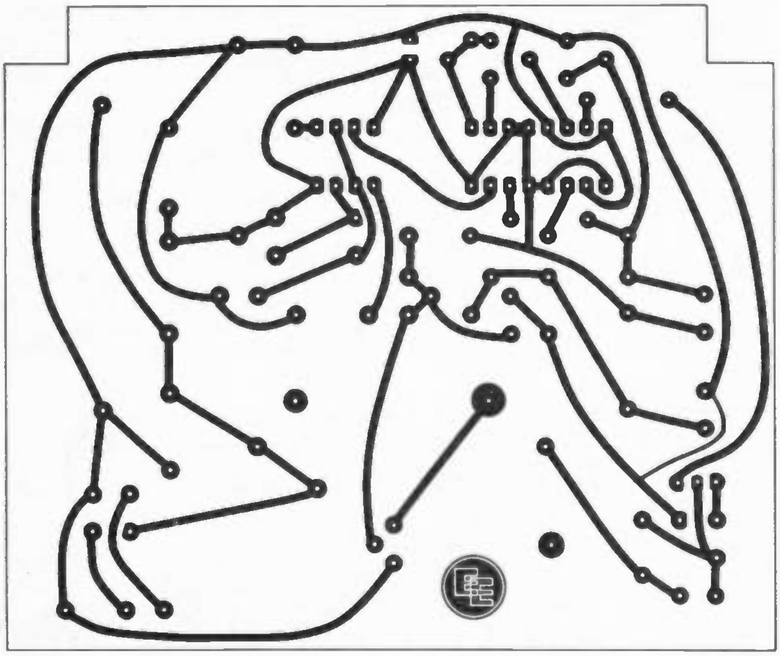
CONSTRUCTION starts here

P.C.B. CONSTRUCTION

All the components except the relay, transformer and switch are mounted on a printed circuit board, and this was produced with an etch resist pen on a single sided copper clad board. The foil pattern and component layout is shown in Fig. 3.

Start assembly of the board by inserting the seven terminal pins in the





COMPONENTS

Resistors
R1, 2 1·8MΩ (2 off)
R3 100kΩ
R4 82kΩ
R5 39kΩ
R6 22kΩ
R7 10kΩ
R8 15kΩ
R9 330kΩ
R10 2·2MΩ
R11 100MΩ
R12 470Ω
All ¼W carbon ±5%

See **Shop Talk** page 381

Capacitors
C1, 4 47μF 10V tantalum (2 off)
C2 0·01μF C280 polyester
C3, 6 0·1μF C280 polyester (2 off)
C5 100μF 10V elect.
C7 470μF 10V elect.
C_x 0·1μF (see text)

Semiconductors
D1-3 1N4148 silicon diode (3 off)
D4 BZY88 C9V1 9·1V, 400mW Zener
D5-8 1A, 50V bridge rectifier
TR1 VN66AF *n-channel* VMOS
TR2 BC184L *npn* silicon
TR3 BFY51 *npn* silicon
IC1 7555 CMOS timer
IC2 4029B CMOS presettable binary/b.c.d. up/down counter

Miscellaneous
S1 d.p.d.t. push-to-make momentary action switch
T1 Mains transformer, 12V, 1A secondary
LP1 12V, 2·2W filament lamp
VR1 10kΩ miniature horizontal preset
VR2 1MΩ miniature horizontal preset
RLA 12V 700Ω relay with one normally open contact
FS1 2A, 20mm mains fuse
P.c.b., 102 × 84mm; plastic case, 190 × 60 × 100mm; 4 × p.c.b. guide adaptors; lamp holder (for LP1); 4BA studding, 4 × 4BA nuts and spring washers, 2 × 4BA screws 13mm long, solder tag (for the mounting of LP1 holder); TV5 heatsink (for TO-220 device, TR1); heatsink compound; 6BA screw and nut; 7 × terminal pin; 8 pin i.c. holder; 16 pin i.c. holder; grommet; mains cable; cable tie; 7/0·2 equipment wire; fuse holder.

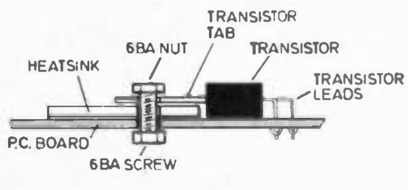
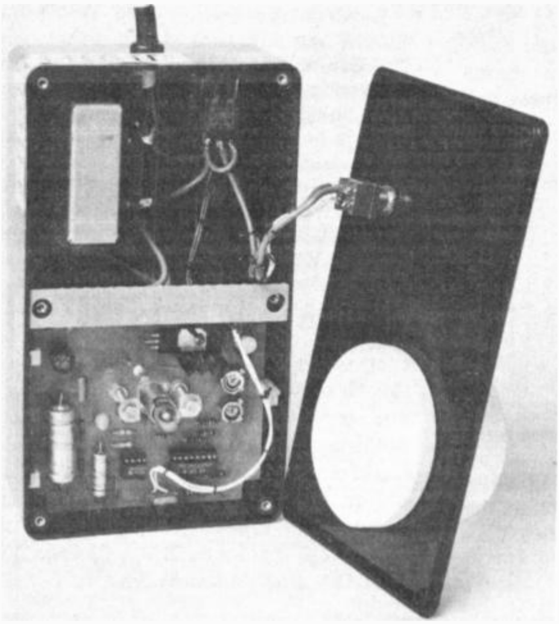


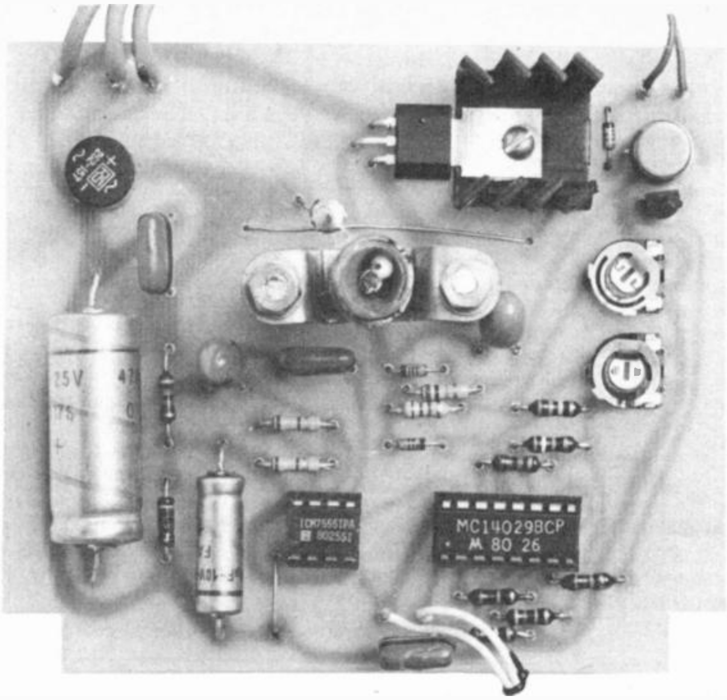
Fig. 3. (above) Nightlight p.c.b. foil pattern shown actual size. Top view shows the component layout.

Fig. 4. (left) Mounting of the VMOS transistor, TR1, to its heatsink.

COMPONENTS approximate cost £20



The finished unit with the lid removed clearly showing the aerosol cap "shade" and all major components.



Finished circuit board.

appropriate positions. The resistors should be inserted next, together with the links, bridge rectifier, two preset resistors and the i.c. holders. Add the power supply smoothing electrolytic capacitors C5 and 7, taking care with the polarity, and the three C280 style capacitors C2, 3 and 6, but do not add the two tantalum capacitors C1 and 4 at this stage because the board will be initially tested without them. Insert the diodes and the transistors, again checking the orientation of each. The VMOS transistor TR1 needs a small heatsink; this should be fitted by preforming the leads, and positioning it on the board. A dab of heatsink compound should be added to the heatsink which is then slipped under the tab of the transistor and the assembly screwed together with the 6BA fixings (see Fig. 4) after which the transistor may be soldered in. Check that the chamfer has been correctly aligned so that it is on the top side.

LAMP HOLDER

Next assemble the lamp holder as shown in Fig. 5. If a holder of a different type is used two wires from the p.c.b. to this holder will be required. Two 1·25in 4BA screwed rods (studding) were used to fasten the lamp holder on to the board and the rods are held to the holder and board by the 4BA nut and spring washers. Note that one of these screwed rods acts as a connection from the p.c.b. to the bulb and care should be taken to ensure that everything is clean and good contact is obtained.

Add the wire from the bulb holder to the board. Finally place the two i.c.s in their holders. The board is now complete apart from C1 and C4.

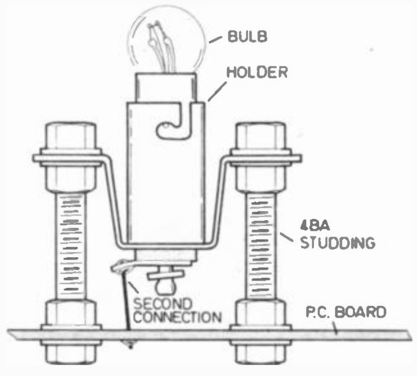


Fig. 5. The method of mounting the lamp holder with the 4BA studding. Note that one of these fixings forms one of the electrical connections.

CASE

The prototype p.c.b. was mounted in the plastic case using the special board guides for this purpose. These are clipped on the board and then the board and guides are slipped into the box. The height of the board in the box should be chosen so that the heatsink clears the lid, but the lamp stands proud.

Mount the transformer in the box using two 4BA screws and nuts, adding a solder tag to one of the screws. Drill the entry hole for the mains wire and insert a grommet in it. Feed in the mains wire and fasten a ratchet cable tie on the inside of the box so that the cable can't be pulled out. The relay can be secured with double-sided sticky tape as per the prototype.

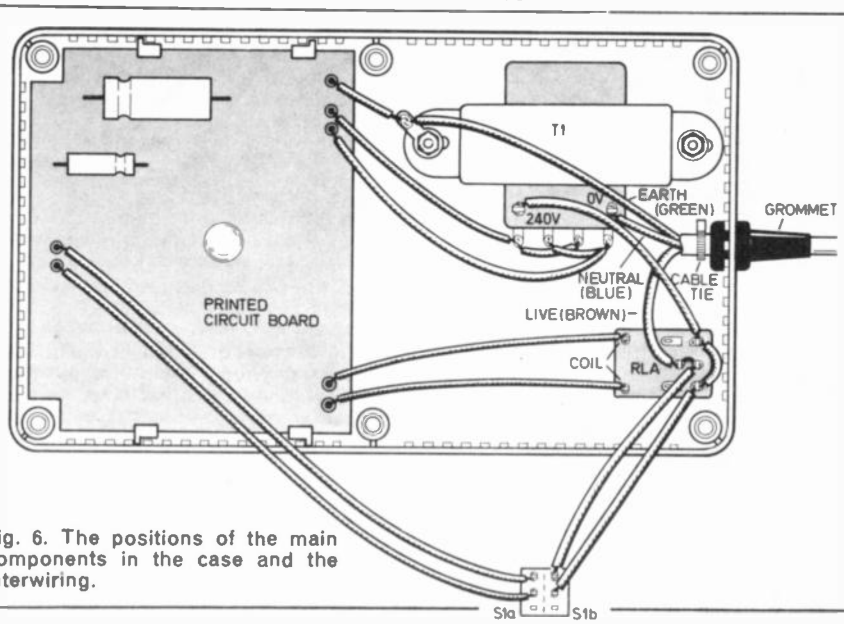


Fig. 6. The positions of the main components in the case and the interwiring.

A shade for the bulb in the prototype was made out of an aerosol cap and to fit it, a large hole was cut in the lid of the box above the position of the lamp and then filed to size. The aerosol top was then inserted from under the lid to fill the hole and the lip on the cap prevents it from being pulled out. An alternative might be to use a flexible car map light with the added advantage that the direction of the light can be moved around.

The push switch was also mounted on the top. Note that the button on this sort of switch can be removed for easy mounting.

Wire up the unit as shown in Fig. 6. Take great care to wire the push-switch correctly since a mistake here could ruin the entire circuit board as well as being very dangerous. Ideally a meter should be used to check the connections, but a lamp bulb and battery circuit will do just as well.

Remember that this unit is mains powered and as such potentially lethal. Check that the 3 pin mains plug fitted contains a 2A fuse and cover *all* the exposed mains terminals, including those on the switch, with insulating tape or rubber sleeves.

TESTING

Temporarily connect Cx, a 0·1μF capacitor in place of C1 to make the oscillator run much faster. Press S1 and check the relay closes. While holding the switch in check the 9 volt supply is correct, and then adjust VR2 until the lamp just reaches maximum brightness. Check the voltage across the bulb; it should be about 12 volts, but if it is slightly above reduce the voltage to 12 volts by adjusting VR1. It does not matter if the voltage is slightly below 12 volts.

Release the switch and the lamp should quickly dim down in clearly visible stages. When it reaches the lowest brightness the relay should click out, but do not worry if it doesn't because the system is running very quickly and it might not have time to do so before the counter rolls round from 0000 to 1111, at which point the bulb will come on again. Adjust VR1 to set the brightness at the minimum point.

Disconnect the power and replace the 0·1μF test capacitor with the correct value for C1 and insert C4 for the first time. Reconnect the power and press the start switch. Initially nothing should happen apart from the relay closing but after a short period the bulb should start to light up and will gradually increase to full brightness after which it will fade out over the next 40 minutes or so. ⌑

LETTERS

Whoops!

Tut, tut, tut *Square One* author! Why did you teach *me* to form leads as per example *C* in the March *Square One*? It should be:—

(1) Gauge the point of the bend.
(2) Grip the lead firmly at that point with the pliers, with the plier jaws on the component body side of the point of bend.
(3) Bend the "flying" end of the lead with one finger to form a neat right angle.

I had one occasion to try to locate an open circuit which turned out to be a cracked resistor/lead joint. Never again!

I feel it is even more important when forming semiconductor leads. I still have your magazine though.

J Austin,
Clapton, E5.

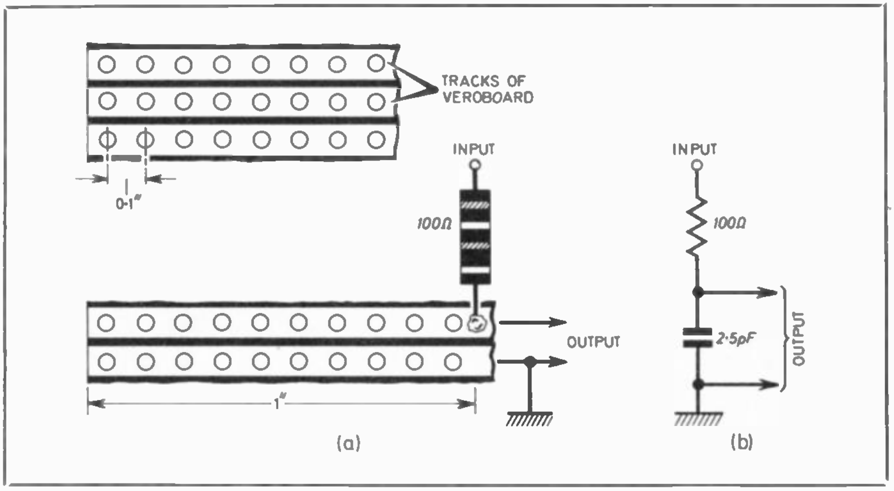
Mr Austin is of course, absolutely right, and this method of preforming leads puts less strain on the component body, thus greatly reducing the risk of failure. And I'm glad to see you're still with us!

Stray Capacitance

The use of 0·1in. Veroboard for building projects is popular, and effective for most circuits. However, this board has a "stray" capacitance, between neighbouring tracks, of about 2·5pF per inch. This is indicated in Fig. 1.

Stray capacitance can affect the speed of response and maximum frequency of a circuit. If a resistance of 100ohm is placed in series with a one inch length of track (see Fig. 2), an *RC* time constant of 0·25nS is obtained.

Thus a pulse passing through this circuit would require this time to equilibrate. This corresponds to a frequency of around 1000MHz. If lower power circuits are used



this effect is enhanced and the maximum frequency may be reduced by a factor of greater than 100.

From this it is apparent that special precautions must be taken if Veroboard is to be used at high frequencies. These would involve reducing the track lengths as much as possible and where feasible, using only alternate tracks.

Andrew Marshall,
Nottingham.

Take Note

With reference to the *Micro Music Box*, EVERYDAY ELECTRONICS February 1980.

The project requires an i.c. reference number, TMS100N MP0027A (CS107-01) MICROCOMPUTER (CHROMATRONICS). I am unable to obtain this i.c. and would be grateful if you could put me in touch with a supplier of this i.c.

P Weatherburn,
Blyth,
Northumberland.

The TMS100N MP0027A musical microcomputer chip is still available from Chromatronics, Coachworks House, River Way, Harlow, Essex (See Shop Talk *of the same issue).*

PLEASE TAKE NOTE

0-12V Power Supply With Overload Alarm *(Sept. 81)*

Page 627. In the components list, resistors R10, 11 and 12 should be 8·2 kilohms, 1 kilohm and 120 ohms respectively and not 120 ohms, 8·2 ohms and 1 kilohm as shown. The values given on the circuit diagram (page 626) are correct.

2K RAM PACK *(April 1982)*

In Fig. 1, page 235, A14 on the ZX81 finger set has incorrectly been labelled 14b. It should read 12b.

The constructional diagrams Figs. 2 and 3 are correct.

By Dave Barrington

Catalogues Received

Only two catalogues have been received in the office this month, although some of our advertisers are carrying details of their latest additions in their ads.

The 60-page Greenweld Electronic Components 1982/3 components catalogue lists an excellent selection of semiconductors and i.c.s and costs 50p plus 25p postage. Included with the catalogue is a bargain list and a pre-paid envelope for your first order.

Five 12p discount vouchers are printed on the inside back cover. These vouchers are valid against purchases provided certain conditions are meet. One voucher will be accepted with the first cash with order over £4 and thereafter one voucher for every £3 worth of goods ordered up to a maximum of five vouchers.

Apart from containing such items as bench tools, wirewrapping kits, i.c. tools, p.c.b.s and cases, the latest 38-page Electroware catalogue from OK Machine & Tool also includes NiCad battery chargers, multimeters, pH meters and capacitance meters.

Copies of the catalogues are available for the sum of 30p (for postage) from Electroware, Dept EE, Dutton Lane, Eastleigh, Hants SO5 4AA.

Kits

This month we have received two kits that we hope, space permitting, to eventually do in-depth evaluations under our *Special Report* page in future issues. In the meantime, as they appear excellent value-for-money, we feel that a brief description of the items would not be amiss.

For the beginner, it is now essential learning that a grasp of digital logic is undertaken if he intends making a future for himself in electronics. The new "Superkit" self-instruction courses from Cambridge Learning would seem a step in the right direction.

Packed in a neat pocket-sized plastic wallet, the Digital Electronic kit is based around a 171-page instruction manual and a Euroboard, used for solderless experiments. The complete kit consists: Instruction manual, 7 TTL i.c.s, 4 l.e.d.s, a 4-pole 2-way d.i.l. switch, 16 resistors, 3 capacitors, EuroBreadboard, battery connectors (not battery) and all necessary connecting wires.

It is claimed that after completing the course, the beginner will have a basic understanding of the meaning of current, voltage, resistance and various types of voltage source. The practical use of R-S flip-flops, J-K flip-flops, clock generator circuits, counters and shift registers should also be understood.

Questions and answers problems are set for most chapters and sections. This also includes using truth tables.

The Digital Electronic Superkit costs £19·90, including VAT and packing, and is available from Cambridge Learning Ltd., Dept EE, Rivermill Lodge, St Ives, Huntingdon, Cambs PE17 4EP.

Back to basics or the fun-side of electronic construction and learning could be used to describe the new Radionic 140 kit from Radionic Products.

Once again, a 40-page well illustrated handbook forms the basis of over 140 simple projects. These range from demonstrating the use of an op-amp to building a radio receiver, light operated switch and a burglar alarm.

All experiments are carried out on a robust "experimenters deck", component connections being made by numbered spring-terminal posts. No soldering is required.

The Radionic 140 cost £47·75, including VAT and p&p, and is available direct from Radionic Products Ltd., Dept EE, Waverley Road, Yate, Bristol BS17 5RB.

Superkit from Cambridge Learning.

Rapid Move

After only about 18 month of trading at their Eynsford, Kent premises, Chris Parker of Rapid Electronics informs us that they have just moved into "tailored" premises at Colchester, Essex.

One of the reasons given for the move has been the growth of their Mail Order service.

The address for the new premises is: Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex, CO4 5RD. This is just off the A12 and callers will be most welcome.

Another supplier of components who has moved premises is Home Radio. Their postal address for mail order remains unchanged at P.O. Box 92, 215 London Road, Mitcham, Surrey.

However, their address for personal callers is now 169 London Road, Mitcham, Surrey. Alan Sproxton of Home Radio emphasises that it would be appreciated if readers wishing to call-in could phone first, on 01 648 3077, stating their requirements before starting their journey.

Yet another move underway is the announcement from Lascar Electronics of the occupation of premises in Chelmsford, Essex. The new building will be their head office and house the sales and design departments. The old premises will be used as the manufacturing base.

The expansion programme is well underway and already a new digital capacitance meter and mains powered panel meters have been introduced. This will be followed, over the next twelve months, by a series of handheld instruments, including thermometers, pH meters and a 4½digit bench multimeter.

The 1982 shortform catalogue is now available from the new offices at Lascar Electronics Ltd., Dept EE, Oakland House, Reeves Way, South Woodham Ferrers, Chelmsford, Essex CM3 5XQ.

2K RAM Pack

Recently we had great difficulty in locating a "ready-made" 2×23-way 0·1in. pitch wirewrap edge connector for our *2K RAM Pack* project for the Sinclair ZX81. (See April 1982 issue).

We have since learnt that Watford Electronics produce a wirewrap edge connector specially for the ZX81 for the sum of £2·99 inclusive. We have tested a sample and found that by using a pair of thin long-nosed pliers it was fairly simple to remove the pins and insert the polarising key.

CONSTRUCTIONAL PROJECTS

Night Light

Items that are likely to cause buying problems in the *Night Light* project are; the *n*-channel VMOS, 4-bit logic counter and the CMOS timer devices.

The VN66AF, ICM7555 and the 4029B devices used in the prototype were purchased from Watford Electronics. These are also listed by Rapid Electronics and Benning Cross Electronics.

When specifying the 4029B logic counter, the **"B"** type *must* be used rather than the older *A* type.

CB Power Supply

The voltage regulator, type L200, for the *CB Power Supply* could prove difficult to locate. It is a five terminal regulator whose voltage and current are programmable. The device features current limiting, thermal shutdown and input overvoltage protection.

The only sources of supply we have been able to locate is from Ambit International and Maplin Electronic Supplies.

Keyboard Sounder

Only the capacitors and sound source for the *Keyboard Sounder* may be troublesome to track down.

The ceramic, resin dipped monolithic capacitors are available from Ambit International. These should be ordered as stock number 04-10404.

The piezo electric resonators used in our model were also obtainable from Ambit, stock number 43-27201. These devices are also listed in the Greenweld catalogue. A printed circuit board is available from Proto Design, price £2·10 including VAT and p&p.

Public Address System

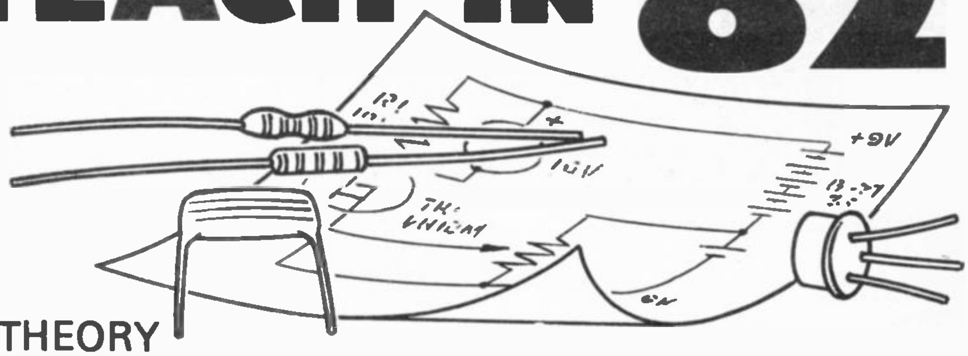
The *Power Amplifier* output transformer T1 is the same as the mains transformer T2, except that it has a centre-tapped primary. Both transformers are obtainable from ILP Electronics Ltd., Dept EE, Graham Bell House, Roper Close, Canterbury, Kent. Quote the two type numbers given in the components list.

The meter ME1 is obtainable from Maplin Electronic Supplies.

EE TEACH-IN 82

PART 9

BY O.N. BISHOP



BASIC ELECTRONIC THEORY WITH EXPERIMENTS

FREQUENCY RESPONSE

WE BEGIN this month with a very simple but fundamental experiment.

EXPERIMENT 9.1
Charging and discharging a capacitor

The circuit for Expt. 9.1 is shown in Fig. 9.1 when S4 is at RED a current flows through R23 and charges C8. The p.d. across C8 is read on ME1. C8 can be instantly discharged by pressing S1.

The recommended Verobloc layout is shown in Fig. 9.2. Begin with power switched off (S4 to GREEN position), and press S1 for an instant. The meter should read 0V. With the selector switch (S6) of the oscillator set to 1Hz, D1 flashes on and off once a second. Count down in step with the flashes from 5 like this: "5, 4, 3, 2, 1, zero". At "zero" turn S4 to RED and continue counting up. Record the meter reading every 5 seconds. Continue until the meter needle does not move. You may need a few practice runs or someone to assist you. Alternatively, you could use a stopwatch or wristwatch. The results are discussed later.

To investigate discharging, begin with C8 fully charged to 9V. Then switch S4 to GREEN. This provides a discharge path for C8 through R23. The first reading is 9V (before you switch S4 to GREEN). Count as before. Take readings every 5 seconds until C8 is fully discharged to 0V.

EXPERIMENT 9.1

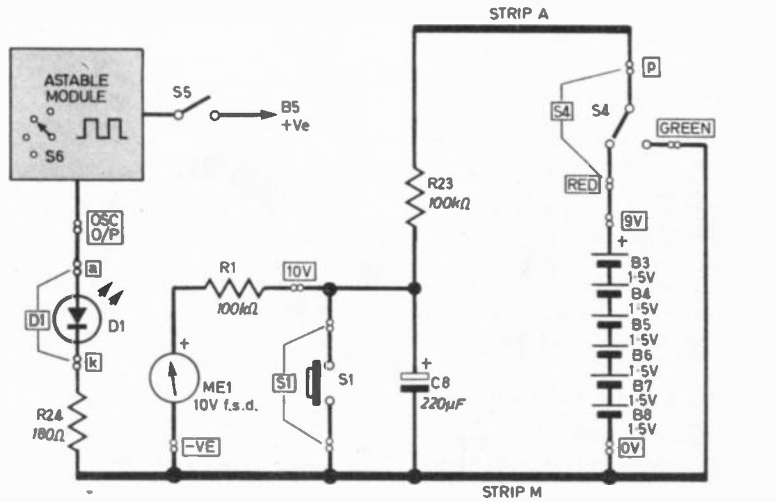


Fig. 9.1. Circuit diagram for investigating charging and discharging of a capacitor. The l.e.d./oscillator arrangement is for timing purposes and is optional—see text.

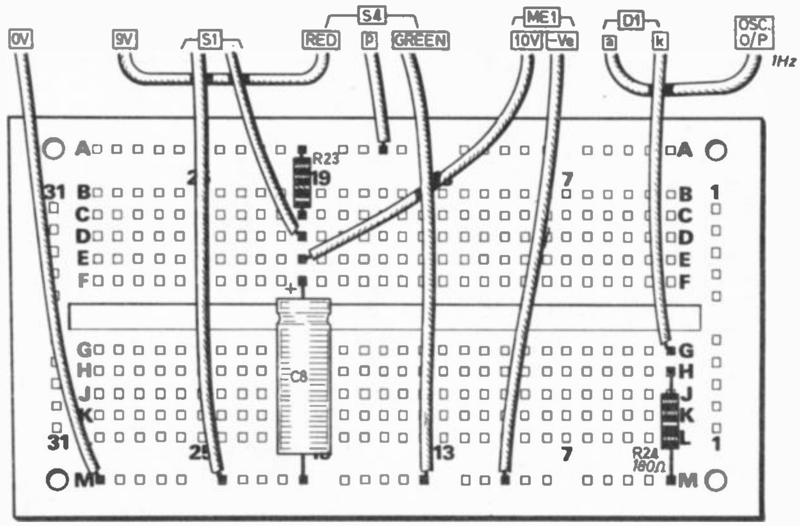


Fig. 9.2. Layout of the circuit in Fig. 9.1 on the Verobloc.

CHARGING A CAPACITOR

A graph of your charging results should be something like the solid line of Fig. 9.3. During this time the current flowing to the capacitor decreases as shown by the dashed line. At any given instant we can say that:

> *I* is proportional to the *rate of change* of *V*

The rate of change of *V* is the gradient or slope of the *V*-curve. You can see that *I* is greatest when the *V*-curve slopes most steeply upward. As the *V*-curve gradually levels off, the value of *I* gradually decreases.

At the end, the V-curve is level, its slope is zero and I is zero too.

It can be shown that for any given combination of resistor (R) and capacitor (C), V rises to 63 per cent of its final value in a definite time t, where the value of t is:

$$t = RC$$

The product RC is known as the **time constant** of the circuit. The time constant of your experiment was $100 \times 10^3 \times 220 \times 10^{-6} = 22$ seconds. In this time V should have risen to 63 per cent of 9V, or 5·7V. Leakage through the meter may have affected the actual result obtained.

DISCHARGING A CAPACITOR

Your discharge results should be like the curve in Fig. 9.4. The V-curve falls steeply at first, gradually levelling off. I is greatest at first and gradually falls to zero. V falls to 37 per cent of its initial value when $t = RC$.

DECIBELS AND POWER

Before we go further we need to understand the **decibel** scale. The decibel (symbol dB) is a unit used to express the ratio between two powers. If one power is P_1 and the other is P_2, the ratio between them is $n = 10\log_{10}(P_1/P_2)$ decibels. You can see from this that if $P_2 = 1$ and $P_1 = 100$ (a hundred times bigger), $P_1/P_2 = 100$, and $n = 10\log_{10} 100 = 10 \times 2 = 20$dB. If P_1 is a thousand times P_2, their power ratio is 30dB. If P_1 is twice as great as P_2, their power ratio is $10\log_{10} 2 = 10 \times 0{\cdot}3010 = 3$dB. If P_1 is one-half of P_2, their power ratio is $10\log_{10} 0{\cdot}5 = 10 \times (-0{\cdot}3010) = -3$dB. The important points to remember are:

A doubling of power gives a ratio of 3dB.
A halving of power gives a ratio of −3dB.

IMPEDANCE

Impedance is a term we use to describe anything which tends to impede or oppose the flow of a current in a circuit or device. Resistance is a kind of impedance with which we are familiar already.

When a capacitor is partly or fully charged, the charge on the plates opposes the flow of current which might increase the charge. We have seen this already: the current falls as charging proceeds. We call this effect its **reactance**, which is another kind of impedance.

Impedance has the symbol Z and is expressed in ohms. A resistor has constant impedance:

$$Z_R = R$$

With a capacitor the current is proportional to the *rate of change* of V. If a capacitor is being charged by an alternating current (for example, an audio signal from a microphone), the rate of change of V depends on the frequency of the signal:

High frequency gives high rate of change, which gives high currents, so impedance is low.

Low frequency gives low rate of change, which gives low currents, so impedance is high.

The impedance (or reactance) of a capacitor (Z_C) depends on frequency. We can think of a capacitor as a *frequency-dependent resistor*.

The impedance of a capacitor is given by:

$$Z_C = \frac{1}{2\pi fC} \text{ ohms}$$

where C is the capacitance in farads, and f the frequency in Hz.

RC NETWORK

In Fig. 9.5a, a signal (V_{IN}) is fed to a resistor and capacitor which are in series. A signal (V_{OUT}) is taken from the junction between them. This network takes on a more familiar appearance if we re-draw it as in Fig. 9.5b. It is a potential divider. The equation for a potential divider tells us that:

$$V_{OUT} = V_{IN} \times \frac{Z_C}{Z_R + Z_C}$$

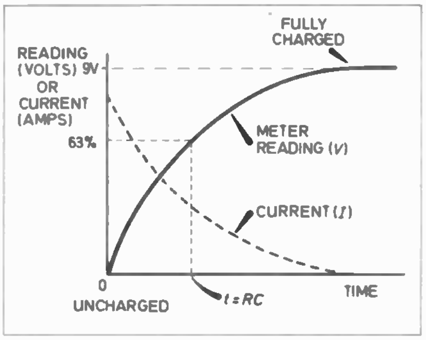
Z_R is a resistance, so this remains constant at all frequencies, but Z_C varies with frequency.

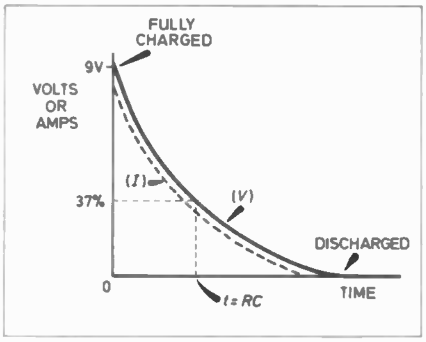
At low frequency, Z_C is high. For example, if f is 100Hz, and C is 0·1μF, $Z = 1/(2\pi \times 100 \times 0{\cdot}1 \times 10^{-6}) = 15915\Omega$, or approximately 16k$\Omega$. If R also has the value 16kΩ, then V_{OUT} is half of V_{IN} at any instant.

At high frequency, Z_C is low. For example if f is 10kHz, then with the same values for R and C, Z falls to 160Ω. V_{OUT} becomes only 0·01 times V_{IN}.

This network allows signals of low frequency to pass, but signals of high frequency are very much reduced in power. It is called a **low-pass filter.** Fig. 9.6 shows its effect.

Output power falls to half of the input power (the −3dB point) when $f = (1/2\pi RC)$. This is when $Z_R = Z_C$ as in the first example above. Beyond that point, power output falls by 6dB for every doubling in frequency (every octave). Note how the time constant comes into this calculation.





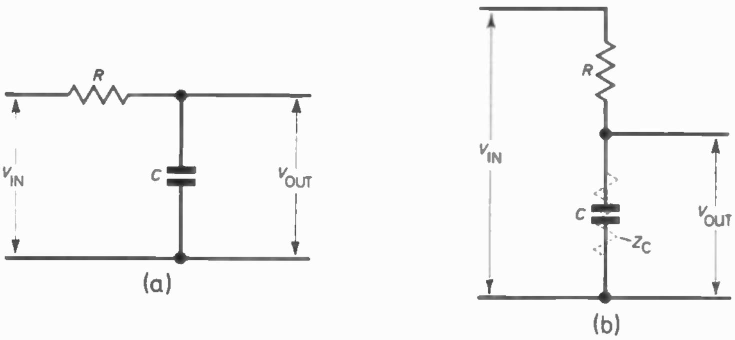
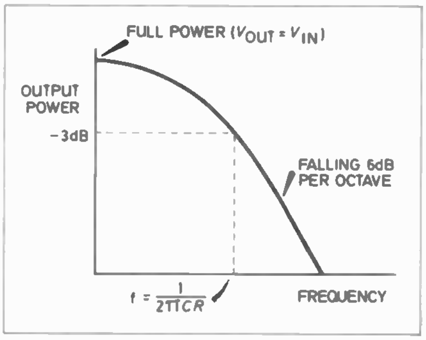


Fig. 9.3 (top left). The changes in voltage and current as a capacitor is charged from a constant voltage source of 9V.

Fig. 9.4 (top right). The changes in voltage and current as a capacitor is discharged through a resistor.

Fig. 9.5 (above). Resistor/capacitor *(RC)* network (b) same network as in (a) redrawn as a potential divider. The resistor in dotted lines represents the impedance of the capacitor.

Fig. 9.6 (right). The output response of a low-pass filter.



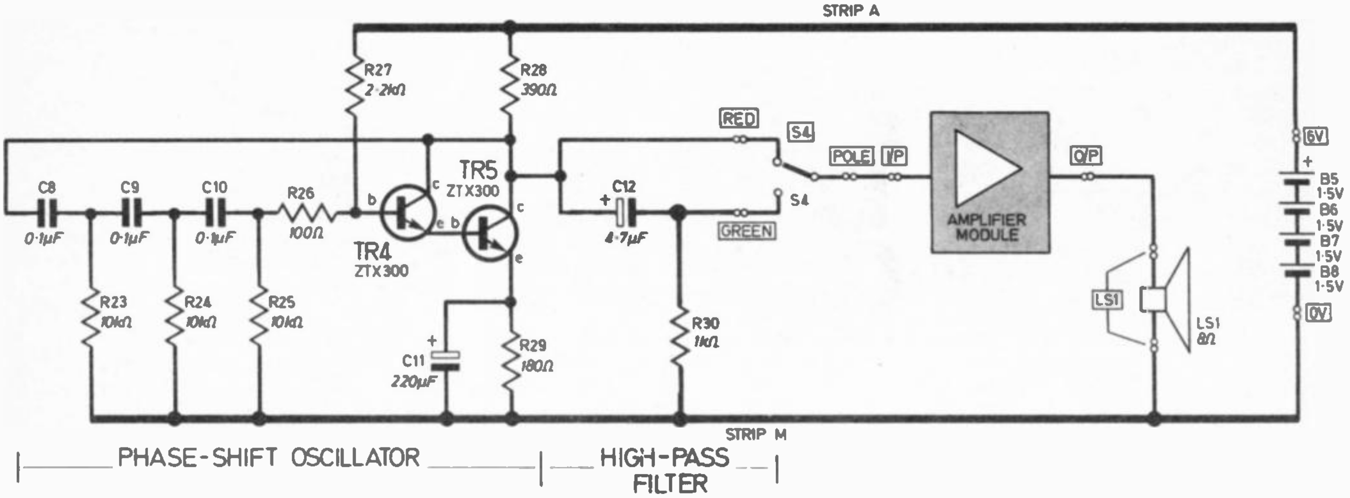


Fig. 9.7. Circuit for investigating the action of a low-pass filter. The phase-shift oscillator provides a sinewave source.

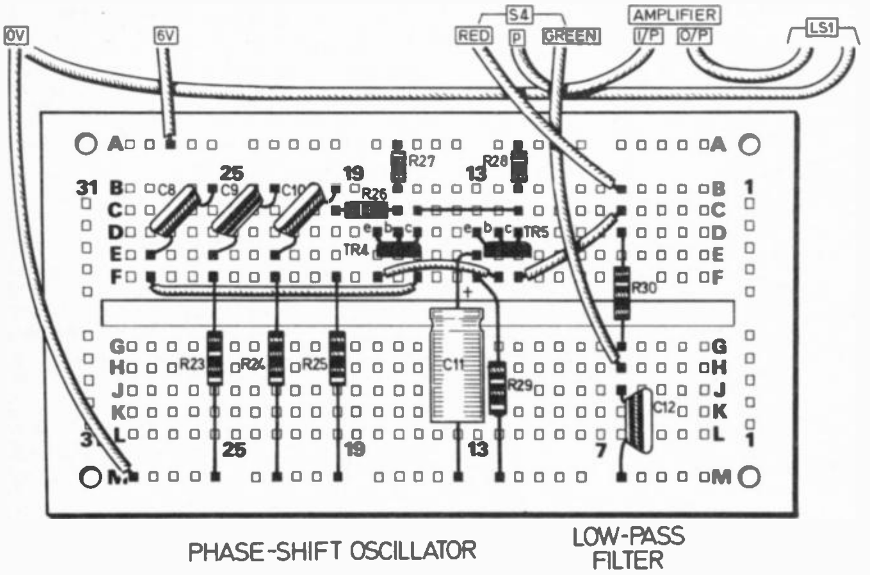


Fig. 9.8. Layout on the Verobloc for the circuit of Fig. 9.7.

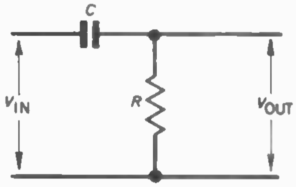


Fig. 9.9. A resistor and capacitor connected as a high-pass filter.

Test the action of the filter by connecting the amplifier first to the input side of the filter (S4 to RED) and then to the output side (S4 to GREEN) and compare the loudness of the sounds. This is a very rough way of working but is good enough to show the effect.

Replace C12 with a 0·1μF capacitor. Whereas Z_C at 100Hz is 339kΩ for a 4·7nF capacitor, it is only 16kΩ for a 0·1μF capacitor, as was calculated earlier. A potential divider with 100kΩ in series with 16kΩ should give a relatively low output. Try it and hear the effect.

Finally use a 4·7μF capacitor as C12. At 100Hz, $Z_C = 1/2\pi fC = 1/(2\pi \times 100 \times 4{\cdot}7 \times 10^{-6}) = 339\Omega$. This is *much* smaller than 100kΩ. Output is so low that it is unlikely to be heard. The −3dB point is 0·34Hz: only signals well below the audio frequencies are transmitted at full power.

EXPERIMENT 9.2
The action of a low-pass filter

The source of the signal is a **phase-shift oscillator** which gives a fairly pure sinewave (see Fig. 9.7. This feeds a low pass filter composed of R30 and C12. The way the oscillator works will be described next month.

Left to themselves, systems tend to oscillate with simple harmonic motion, which produces a sinewave output. A pendulum is one example. There is only one frequency in its motion. The oscillator used here has only one frequency. The squarewave oscillator which you built earlier is not suitable for use here.

Though a square wave may seem to be very simple, it really is a rather unnatural kind of wave, forcibly produced by the switching action of the transistors. A square wave is considered to be a sinewave of the fundamental frequency with several sinewaves of higher frequencies added to it to produce the unnaturally square shape.

The layout of the components on the Verobloc for this experiement is shown in Fig. 9.8.

The frequency of the oscillator is about 100Hz. The filter is like the one we have already described, but its −3dB point is $1/(2\pi \times 4{\cdot}7 \times 10^{-9} \times 100 \times 10^{3}) = 339$Hz. It passes a signal at 100Hz without appreciable reduction in power.

HIGH PASS FILTERS

If we now arrange the resistor and capacitor in an *RC* network, as in Fig. 9.9, the equation for the network becomes:

$$V_{OUT} = V_{IN} \times \frac{Z_R}{Z_R + Z_C}$$

At low frequencies, when Z_C becomes very large, the fraction on the right becomes very small making V_{OUT} much less than V_{IN} The network absorbs low frequencies, but passes high ones. It is known as a **high-pass filter.**

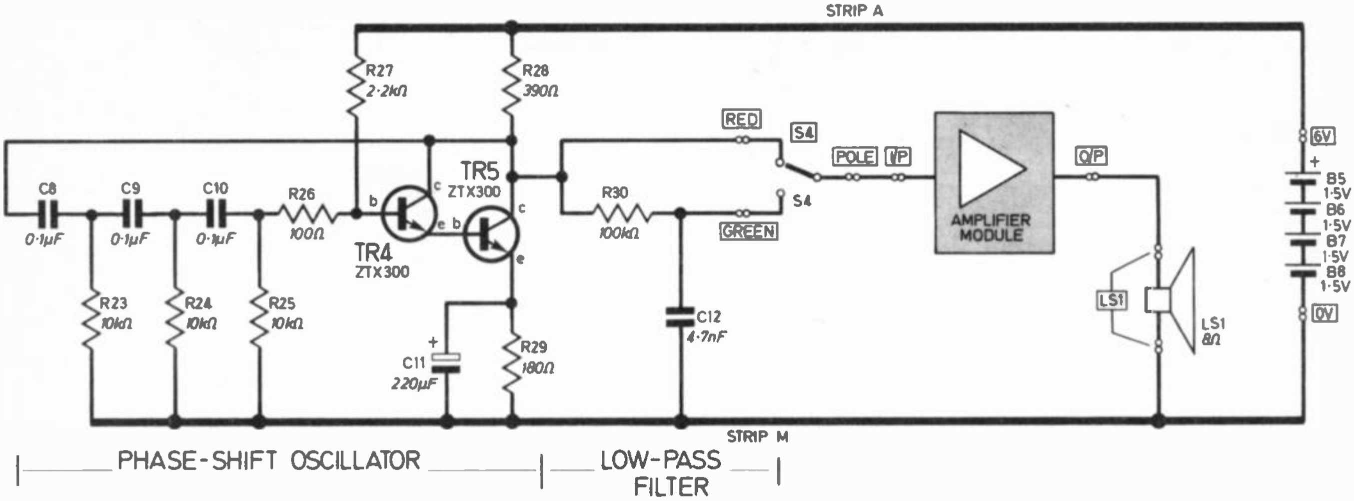


Fig. 9.11. Circuit for investigating the action of a high-pass filter. Use the layout in Fig. 9·8, but interchange R30 and C12.

EXPERIMENT 9.3
The action of a high-pass filter

The circuit for this experiment is similar to that in Fig. 9.7 except that the positions of R30 and C12 are exchanged, and the value of R30 is now 1kΩ as can be seen in Fig. 9.11.

Begin with C12 = 4·7µF. As calculated earlier, its impedance at 100Hz is only 339Ω, so when it is at the positive end of the potential-divider we shall expect it to have little effect. The −3dB point is 0·34Hz as before. It passes all signals above 0·34Hz. There is little reduction in power of all audio signals.

Now make C12=0·1µF. The −3dB point is 1·6kHz, so some reduction in power is to be expected. If you use a 4·7nF capacitor, the signal is only just audible from the loudspeaker. If you are doubting that the signal is actually being transmitted across the capacitor, remove R10. Volume is restored immediately.

In effect, by removing R31, you have placed an infinitely high resistor between C and the 0V rail. If Z_R in the equation is very large, the value of Z_C makes little difference and $V_{OUT} = V_{IN}$.

Replace R30, then make C12= 6·8pF.

At 100Hz its impedance is $Z_C = 1/(2\pi \times 100 \times 6{\cdot}8 \times 10^{-12}) = 234$MΩ.

The −3dB point is $1/(2\pi \times 6{\cdot}8 \times 10^{-12} \times 1 \times 10^{3}) = 23$MHz, so it is not surprising that no signal reaches the amplifier. Remove R31 again, just to prove that it really is getting through the capacitor.

INDUCTORS

An **inductor** is a coil of wire wound on a former of magnetic material. A current produces a magnetic field when it passes through the coil. Because of the nature of electromagnetism, any change in the magnetic field is opposed. If current is suddenly increased, a reverse e.m.f. is generated which opposes that increase. If current is suddenly decreased the decrease is likewise opposed. The more rapid the change of current, the stronger the effect.

This is the basis of the use of the induction coil in a car. When the contact breaker abruptly turns off the low voltage (12V) supply to the coil, the induced e.m.f. is so high (several thousand volts) that it can be used to generate sparks at the sparking plug.

If the effect depends on the *rate of change* of current, we have a device which, like the capacitor, is *frequency dependent*. But the inductor operates in the reverse manner, having greatest impedance at high frequencies (most rapid change of current):

Inductor impedance, $Z_L = 2\pi fL$

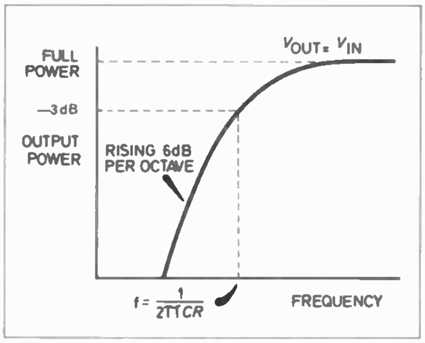


Fig. 9.10. The output response of a high-pass filter.

In this expression, L is the **inductance** of the inductor, expressed in henries. Because their impedance is dependent on frequency, inductors can be used in filters. In practice, they are not used as often as capacitors because, to obtain sufficiently large values of L, we need coils with many turns and bulky metal formers. Also they readily pick up magnetic interference such as mains hum. They were more widely used in valve-based equipment, but are out of place in today's portable transistorised circuits.

However, there is one practical example of their use. In Fig. 9.12 we have an inductor in parallel with a capacitor. At (a) the input signal has low frequency, Z_C is high, but Z_L is low. Most of the signal passes through the inductor to ground. At high frequency (b) the reverse occurs. Z_C is low and Z_L is high, and the capacitor lets the signal pass

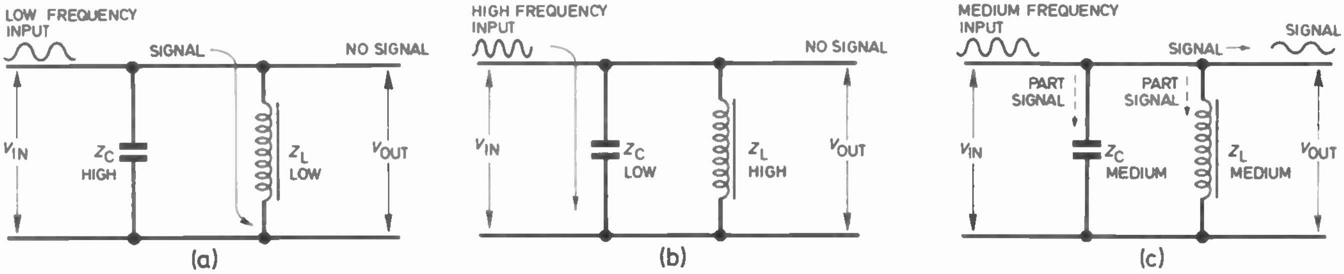


Fig. 9.12. An inductor and capacitor in parallel arrangement forming a tuned *LC* network.

to ground. If we choose suitable values for C and L it is possible for there to be a frequency which is not fully passed by either component (see Fig. 9.12 and Fig. 9.13).

If signals with various frequencies are fed to this network, those of low and high frequency are lost, but those of the central frequency are passed to the output. This circuit is called a **tuned circuit.** It picks out signals of one frequency from a mixture of frequencies; it is a **band-pass filter.** If C is variable, we can tune the circuit to one of a range of frequencies. This circuit is used in radio sets.

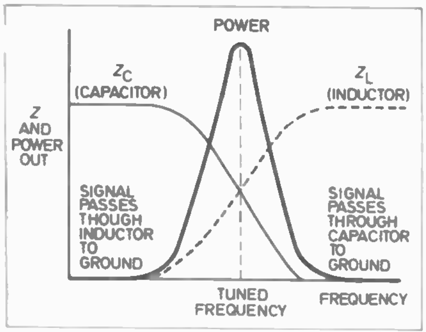


Fig. 9.13. Shows how L and C combine to give a tuned circuit (a band-pass filter).

RADIO

A radio station radiates electromagnetic waves from its aerial. These have a frequency greater than 30kHz (radio frequency or r.f.). In amplitude-modulated (a.m.) radio, the amplitude of this **carrier wave** is modulated by the audio frequency of the sound signals which are to be carried (Fig. 9.14).

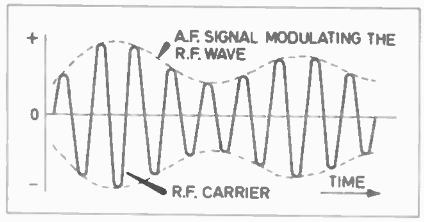


Fig. 9.14. Amplitude modulation (a.m.) of a radio carrier wave.

The radiation induces corresponding currents in the aerial of the receiver. Signals of different frequencies arrive from innumerable radio stations. Using the circuit of Fig. 9.15, most of these signals can be lost to ground. The circuit is tuned to pass the r.f. of one particular transmitter. The signal then passes through a diode which rectifies it, see Fig. 9.17.

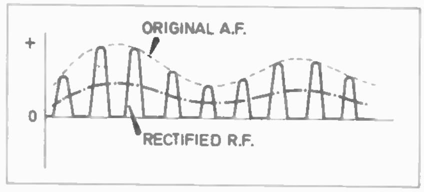


Fig. 9.17. Rectified r.f. signal. The amplifier receives the average of this (dot/dash line) which has the same form as the original audio signal.

It is still an r.f. signal, but the stray capacitance between the diode and ground creates a low-pass filter, removing the r.f., and leaving only the audio frequency signal. This is amplified to drive a loudspeaker.

EXPERIMENT 9.4

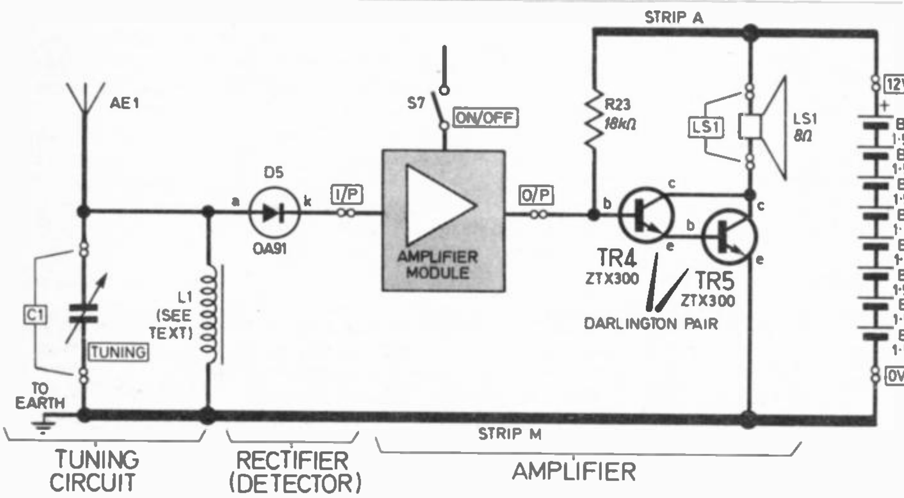


Fig. 9.15. Circuit for a simple radio receiver.

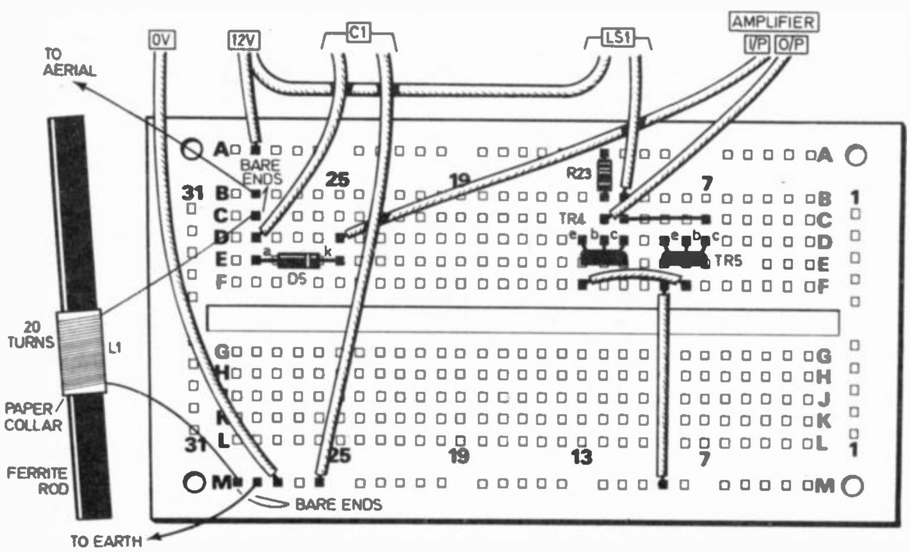


Fig. 9.16. The layout of the radio receiver experiment on the Verobloc.

EXPERIMENT 9·4
A simple radio receiver

The circuit diagram of the simple radio receiver experiment is shown in Fig. 9.15 and the recommended Verobloc layout in Fig. 9.16.

The inductor is wound around a rod of ferrite, which is a magnetic material able to reverse its magnetic state at high frequency.

Cut a rectangle of thin paper, wind it round the centre of the rod and fix it with sticky tape to make a collar. On this collar wind 20 turns of 28 s.w.g. enamelled copper wire and fix it in place with sticky tape. Scrape the ends of the wire with a knife to remove the insulation before plugging them into the Verobloc.

The aerial is a length of insulated wire, 20 metres or more long. If possible, lead this out of a window and suspend it as high as you can, and as far from buildings as can be managed. If you cannot take it outdoors, fix it as high as possible, zig-zagging it across the room. The Earth wire goes to a metal rod or similar metal object buried outdoors in damp soil, or it may be wound around a tap or the metal piping of the *cold*-water system.

If you are close to a transmitter, you may hear a signal by connecting an earphone directly to *D*24 and the grouna rail. No other source of power is needed. Most situations call for an amplifier, possibly with extra amplification, as provided by the Darlington pair in Fig. 9.15.

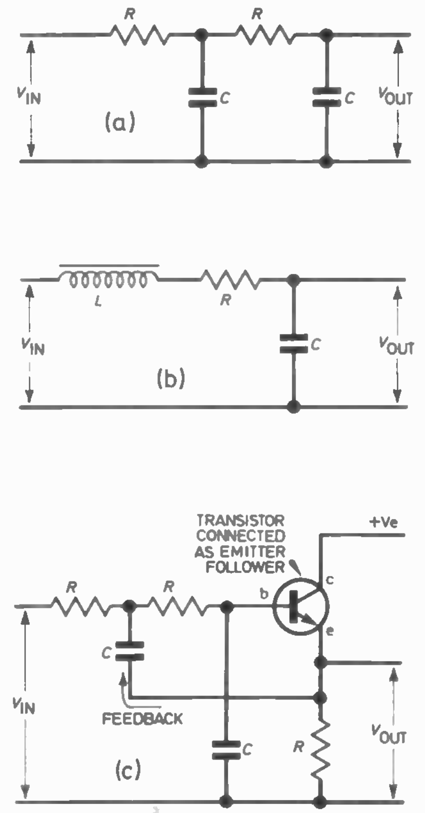


Fig. 9.18. Improving on the simple low-pass filter: (a) two-stage passive *RC* filter (−6dB per octave) (b) *LCR* passive filter (−12dB per octave) (c) active filter (−12dB per octave); this uses a single emitter follower transistor stage.

PART 8 ANSWERS

8.1. 0001, 0011, 1001.
8.2. Input is b.c.d. for 9; all outputs high except pin 9 (segment e).
8.3. The l.d.r. does not produce an e.m.f. when light falls on it.
8.4. The l.e.d. would turn on and off gradually as you cover or uncover the l.d.r. with no "snap" action (try it!).
8.5. The l.e.d. is off when the l.d.r. is covered; comes on when it is uncovered.
8.6. Photoconductive cell.
8.7. From the R25/TR5 point (V_D), back through the emitter-base junction of TR4 and the base of TR4 to the PCC1/VR1 point (V_A). Change in V_D is in the same direction as the change in V_A, so feedback is positive.

It should be possible to hear several different stations. At night, there may be too many to pick out any one clearly. Try putting the 180pF capacitor in parallel with C1 to give a different tuning range.

ACTIVE FILTERS

Components such as resistors, capacitors and inductors have no gain and their action is not affected by the direction of current. We call them **passive devices**. Transistors and diodes are **active devices** in that they have gain or at least are affected by the direction of current. Fig. 9.18 (c) shows a typical low-pass active filter.

QUESTION TIME

9.1. A charged capacitor is discharged through a resistor. At what instant is the current greatest?
9.2. In Q9.1, at what instant is the voltage changing most rapidly?
9.3. What do we mean by *time constant*?
9.4. If a charged 22μF capacitor is discharged through a 15kΩ resistor, what is the time constant, *t*?
9.5. If in Q9.4 the capacitor was charged to 12V, what would be its charge at time *t*?
9.6. If the output power of an *RC* network is 6dB below the input power, what fraction of input power appears at the output?
9.7. Calculate the impedance of a 470nF capacitor at 200Hz, and at 200MHz.
9.8. Calculate the −3dB point for a high-pass filter in which *R*= 1·5kΩ and *C*1=1nF.

Its performance is equal to that of the *LCR* filter shown in Fig.9.18b but it is smaller, lighter, and cheaper and does not pick up magnetic interference. The amplifier can be anything from a single transistor to an op-amp i.c.

A well-designed active filter has a constant response up to the cut-off point, above which power is reduced by 12dB (that is, to about one sixteenth) per octave. This is a much sharper cut-off than with the *RC* filter in Fig.9.18(a).

To be continued

COUNTER INTELLIGENCE

By PAUL YOUNG

Electronic Phenomenon

In the last few years, Electronics have advanced at such a phenomenally rapid rate, that we can be forgiven for being unable to keep up with them. This state of affairs is particularly noticeable in the field of computers.

Christopher Evans put this in a rather telling way in his book, *The Mighty Micro* published by Victor Gollanz. I quote, "Suppose the motor industry had developed at the same rate as computers and over the same period. Today you would be able to buy a Rolls-Royce for £1·35, it would do three million miles to the gallon, and it would deliver enough power to drive the Queen Elizabeth II. And if you are interested in miniaturisation, you could place half a dozen of them on a pins head".

It is one of statements that stick in the mind, although I would be rather diffident about trotting it out too often, in case I was asked to prove it!

Sound Economics

I remember many years ago my friend Norman Jones a Director of the Butterfly Brand Envelope firm telling me, that at the end of every year they throw away 50 per cent of their slow selling or unsaleable stock. This is obviously sound economics, because you can reach a stage where the space is more valuable than the goods it is housing.

It happens in our trade as well of course, although I think most of us would rather dispose of it to the enthusiasts at a give away price than see it destroyed. What is rather heart breaking, is when a firm comes begging to buy off you the very goods you put on the tip the previous day. Believe me, it does happen!

Day of Leisure

Today, no one would argue against the fact that the most agonising problem any Government has to face is unemployment. Unfortunately in this respect, electronics is a two edged weapon. On the one hand the new technology creates jobs and at the same time it produces machines making it possible for one man to do the work of fifty!

Naturally, any Government has to deal with it on a day to day basis, but do any of them engage on any long term plans?

It must be apparent to the meanest intellect, that there is not enough work to go round and what there is must be shared. This should be a cause for rejoicing and not the reverse, provided, and here is the rub, that people can be taught how to enjoy their leisure and lead a full and rewarding life. All hobbies are going to play an important part and magazines like EVERYDAY ELECTRONICS might well become a part of every school curriculum.

Breaking the Rules

Now that my interest in CB has been aroused, I am always on the lookout for snippets of information on the subject.

I'm sure our readers have noticed that in the majority of Sunday papers, on one of the pages there is always a well endowed leggy girl. She is always photographed on the wing of an aircraft, the bonnet of a racing car, a racing boat or sitting on a steam shovel.

This time it was CB that received the treatment. As I expect you already know, those who use CB are called "Breakers" and chose their own Code name.

So here we have a picture of the usual girl, talking into her microphone and the caption went something like this. "Here is Miss Dee Lightful who is a "Breaker". The code name she uses is "Beautiful Eyes". She tells us she makes many friends by using her CB Radio.

Looking once more at her parameters, I don't find that statement at all hard to believe!

SEAT BELT REMINDER

By T. R. de Vaux-Balbirnie

The proposed laws making the wearing of safety belts in cars compulsory are to be upon us very soon so there is a good case for acquiring the habit *now*, in the interests of safety.

Car users are often heard to say that they would *always* wear their seat belts—*if only they could remember!* This project has been designed to give the driver a visual reminder each time he starts the engine.

It would be extremely unwise, and could be very dangerous, to interfere with the seat belt mechanism in an attempt to make a direct warning system so in a home-made project it is necessary to use an indirect method.

REMINDER

The Seat Belt Reminder consists of a circuit which alternately flashes two red lights on a small sign with the word "BELTS" printed on it. The lights will start to flash as soon as the ignition is turned on. When the engine is started, the oil pressure warning light goes off and a control wire from the oil pressure switch causes the sign to stop flashing; not straight away but after a delay of about 15 seconds. This gives the occupants of the car ample time to take notice.

If the engine is in good condition, it will not switch on the oil pressure warning light in the normal course of running. If it did, the "trigger" from the oil pressure switch would cause the lights to start flashing.

It could be argued that the car occupants would become accustomed to the device so that, after a time, they would disregard it. This may be true but it is hoped that the seat belt habit will have become firmly established by this time then the project may be dismantled and the components used for something else!

The prototype was tested on an Austin Maxi (fitted with an alternator) and an old BL Mini (fitted with a dynamo) with complete satisfaction. Both test cars were of the negative-earth type. Certain modifications will be needed to make the circuit suitable for positive-earth cars and these are outlined later.

Before starting to build the circuit, check that the car is fitted with the usual oil pressure warning light controlled by a pressure operated switch on the engine block.

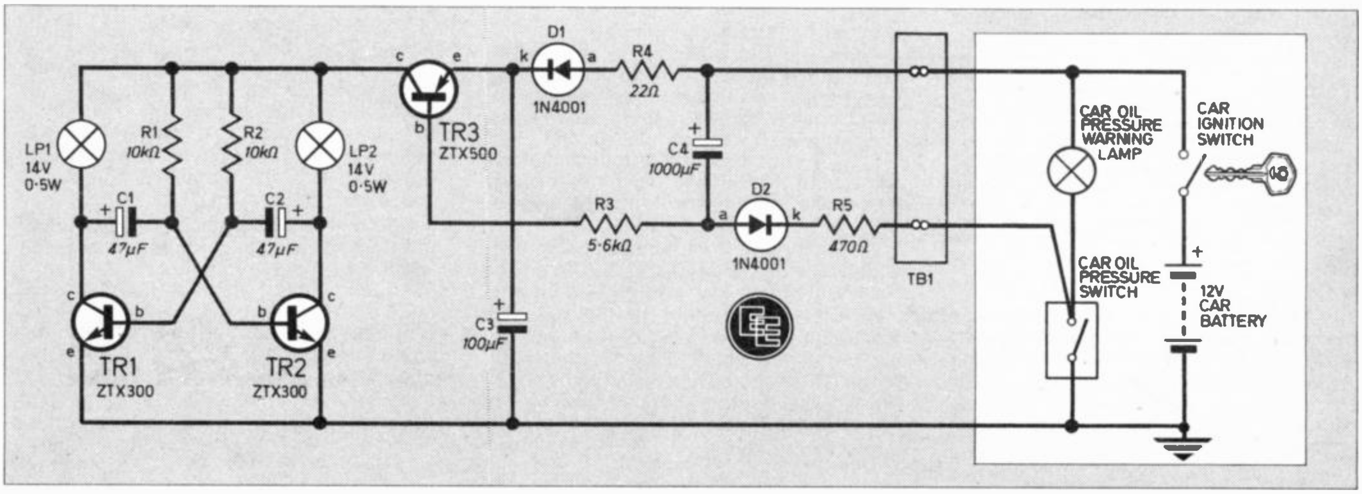
CIRCUIT OPERATION

See Fig. 1 for the full circuit diagram. When the ignition is switched on, the circuit is connected to the positive battery terminal. Since the engine is not yet running, the oil pressure switch contacts will be closed and the oil pressure warning light will be on. C4 charges rapidly through D2 and R5 and the negative polarity on the base of *pnp* transistor, TR3, switches it on therefore acting as a switch and allowing current to flow to the next part of the circuit. This is an astable multivibrator consisting of TR1, TR2 and associated components and causes the indicators LP1 and LP2 to flash in turn.

When the engine has started, oil pressure builds up and the contacts of the pressure switch open. However, there will be sufficient charge stored in C4, to hold TR1 on for several seconds longer. This capacitor eventually discharges through R3 and the base/emitter junction of TR3. Thus, TR3 switches off and the lamps stop flashing. C4 is prevented from discharging through the oil pressure warning lamp by means of the diode D2.

Using the component values given, LP1 and LP2 will flash at a rate of about twice per second and due to

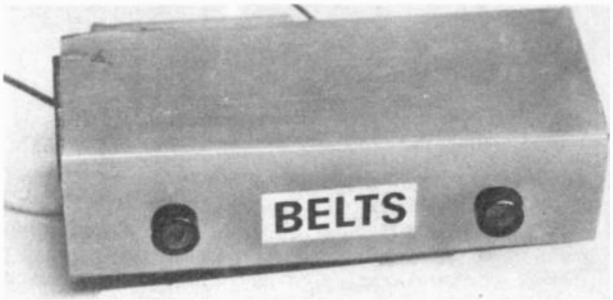
Fig. 1. The complete circuit diagram of the Seat Belt Reminder shown here for negative earth wired cars. Note that the section of the diagram showing the host car's 12V battery circuit is a representation only and omits details like the regulator and fuse box.



component tolerances, the finished project may well operate at a slightly different rate. To change the flash rate raising the values of C1 and C2 would slow it down and vice-versa.

The time for which LP1 and LP2 continue to flash after the oil pressure light has gone out depends on the value of C4 and in the prototype, this was about 15 seconds. Again, this could be increased by raising the value of C4.

C3 and diode D1 are necessary to smooth the supply to the circuit because without these components, the rather "spiky" output from the charging system could cause erratic flashing when the engine is running. R4 protects C3 from excessive charging current.



The finished unit prior to installation. This picture clearly shows the lettering between the lamps and the brushed aluminium effect on the front panel.

CONSTRUCTION starts here

STRIPBOARD

The circuit panel is built on a piece of 0·1 inch matrix stripboard, 11 strips by 30 holes and the layout is shown in Fig. 2. When constructing the circuit, care must be taken to avoid "bridging" adjacent copper tracks and the strips must be broken in the positions indicated using a spot face cutter or a small twist drill.

The polarities of all electrolytic capacitors and diodes must be carefully observed, they are shown on the circuit diagram for negative-earth cars and would need to be reversed for the positive-earth version. The wire connections for C1 and C2 deserve special mention and on no account must these leads touch one another. Their natural stiffness should prevent this from happening but short pieces of sleeving could be used if needed. Pieces of insulation stripped from connecting wire makes suitable sleeving.

The flying earth lead on the circuit panel must be made of stranded rather than solid connecting wire. The seemingly awkward position of the terminal block TB1 is so as to avoid the rear parts of LP1 and LP2.

It would be possible to avoid the block connector altogether and to use flying leads for all external connections but this would be a false economy, making subsequent fitting and removal from the car more difficult. The circuit should first be assembled without the connections to LP1 and LP2. These will be made at the end.

FRONT PANEL

The front panel is made from thin aluminium about 75 × 50mm bent as shown in Fig. 3. Holes are drilled

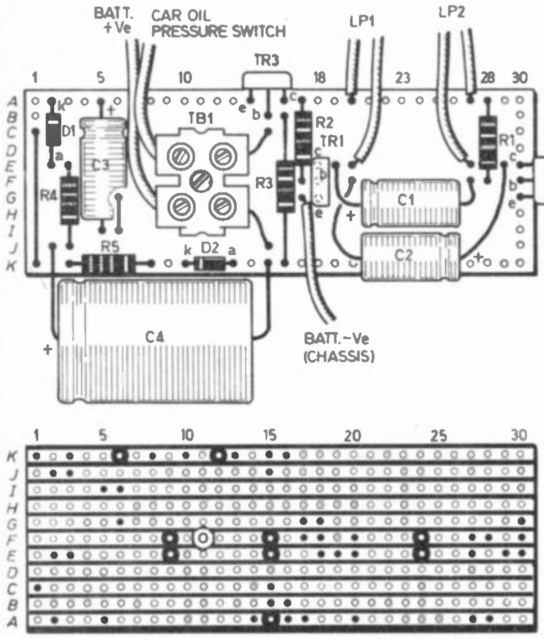


Fig. 2. Stripboard layout for the negative earth version. Bottom view shows the track breaks on the underside. The leads from C1 and C2 must not touch and should be sleeved.

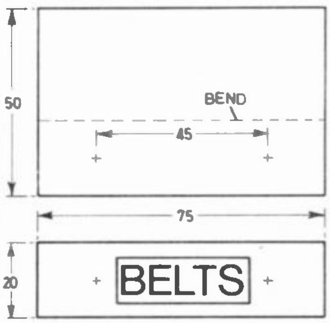


Fig. 3. Drilling and folding details for the front panel.

COMPONENTS

Resistors
R1, 2 10kΩ (2 off)
R3 5·6kΩ
R4 22Ω
R5 470Ω
All ¼W carbon ±5%

Capacitors
C1, 2 47μF 16V elect. (2 off)
C3 100μF 16V elect.
C4 1000μF 16V elect.

Semiconductors
D1, 2 1N4001 silicon (2 off)
TR1, 2 ZTX300 silicon *npn* (2 off)
TR3 ZTX500 silicon *pnp*

Miscellaneous
LP1, 2 Sub-miniature panel mounting filament lamp, 14V, 40mA (2 off)
TB1 5A terminal block, 2-way
0·1 inch matrix stripboard, 30 holes by 11 strips; aluminium sheet, 75 × 50mm; "piggy-back" automotive connectors (2 off); stranded equipment wire; solid wire (for links).

Approx. cost Guidance only £4·20

for LP1 and LP2 and a small card with the word "BELTS" prepared by "Letraset" dry print lettering gives a very professional appearance. Before securing the card, the aluminium panel may be gently rubbed in one direction with fine carborundum paper to give a "brushed" effect. A layer of "Sellotape" over the front panel will provide a very neat finish and protection from fingermarks. The indicator lamps may be secured, the leads shortened as necessary, and soldered to the circuit panel.

TESTING

At this stage it is a good plan to test the circuit using a 9 volt battery remembering that the lamps will not glow as brightly as they will from a 12 volt supply. First make sure that the underside of the circuit panel is kept clear of the aluminium panel. There must be no possibility of short circuits at the copper strips. Connect the positive terminal on the block connector to the positive terminal of the battery and the flying earth lead to the negative. Connect a length of wire to the input terminal and touch the other end to the negative battery terminal. The lamps should begin to flash. When the input wire is removed, the lamps should continue to flash for about 15 seconds after which they should fade and gradually stop flashing altogether. If the electrolytic capacitors have been in stock for some time, it may take several trials for them to reform and for the rate of flashing to stabilise.

When the circuit is operating correctly, it may be mounted on the aluminium panel. This must be done in such a way that the copper strips are properly insulated from the aluminium. One simple and effective way of doing this is to use double sided adhesive fixing pads available from stationers.

INSTALLATION

A suitable location in the car must now be chosen for the unit. It should be placed so as to catch the driver's attention yet, if possible, be shaded from bright light.

Using proper auto-type stranded wire, run a lead from the input terminal on the block connector to the oil pressure unit on the engine. There will already be a wire for the warning light so a "piggyback" connector, available from motor accessory shops, may be used to enable the additional connection to be made. Twisted connections are unsatisfactory and will fail in service.

Where the wire runs through metal from the interior of the car to the engine compartment it is essential to use a rubber grommet. It is very likely that there will be an existing one nearby which will accept an additional wire.

FUSE

The fuse box should now be located and a fuse found which is "live" *only* when the ignition is switched on. A 12 volt bulb with one side "earthed" will soon locate a suitable fuse. Make certain that the side of the fuse receiving the new connection is correct by checking that the light goes off when the fuse is removed. Run a lead from the fuse to the positive terminal (+12V) TB1. If all available connectors to the fuse have been used then another "piggyback" connector will be needed. Again, the wire must pass through a grommet wherever metal is involved.

The flying earth lead must now be connected to the body of the car. If there is no existing earth point nearby, a small hole will need to be drilled in a metal part and an eyelet used. This may be secured with a self tapping screw.

FINAL TEST

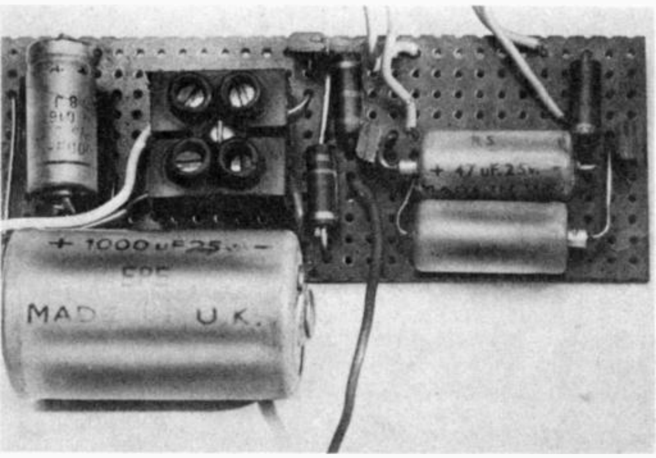
The unit should now receive its final test. With the ignition switched on, the lights should begin to flash and continue to do so. The engine should now be started. It is quite normal for the flashes to become a little erratic while the starter motor operates but when the engine "fires" the lamps should flash regularly again. The oil pressure warning light should soon go off and the lamps should continue to flash after a short time, the lamps will flash more dimly and in a few more seconds go out altogether. During the final few seconds the flashes will probably become much more rapid and, perhaps, slightly erratic. Again, this is quite normal.

If all is well, the unit may be secured using the adhesive pads mentioned previously.

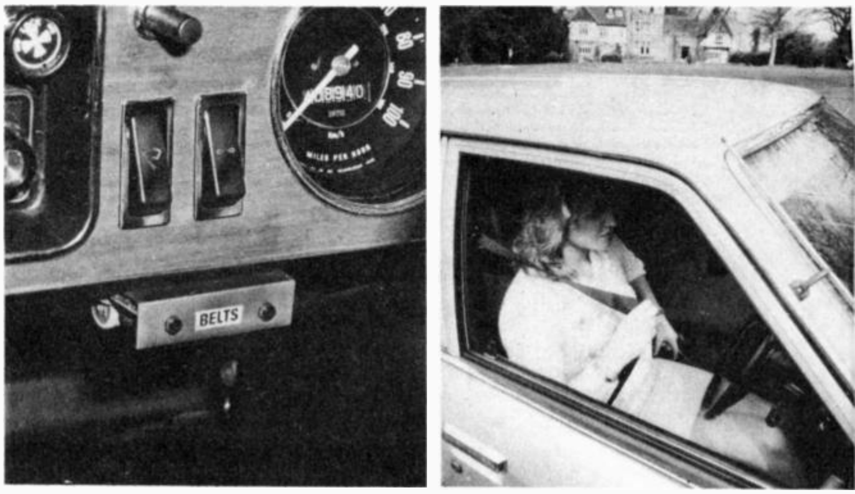
You don't have to heed the warning flashes but they will help you to gain the habit and avoid prosecution when the law is passed.

POSITIVE EARTH

For positive earth wired cars the following modifications must be made. First, transistors TR1 and 2 must be substituted with the ZTX500 *pnp* devices and TR3 changed for a ZTX300 *npn* transistor. Secondly, the polarities of both the electrolytic capacitors and the diodes must be reversed. All other components remain the same and the connections to the car will also be unchanged, noting that the wire from hole G17 will of course be connected to the chassis and the lead from TB1 goes to the fuse box. ⌘



Completed circuit board showing the careful positioning of the large electrolytic capacitors and terminal block.



The Seat Belt Reminder mounted beneath the dashboard of the authors car, where it can be seen by both driver and passenger but is not too obtrusive.

Everyday ELECTRONICS

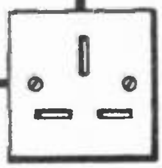
July Attractions

BRAKE LIGHT RELAY for TRAILER or CARAVAN

Negligible load on existing car brake light system

New Series
A.C. Mains Explained

A short series of articles dealing with the generation and distribution of power to homes and industry, and mains powered equipment.



COMPARATOR VOLTMETER

Measures voltage without an analogue or digital meter using a nulling technique. Voltage read from calibrated scale.

LAP COUNTER and JUDGE

Lap counter displayed on two digit read-out. Passing car detected by opto-transistor.

PITCH PIPE

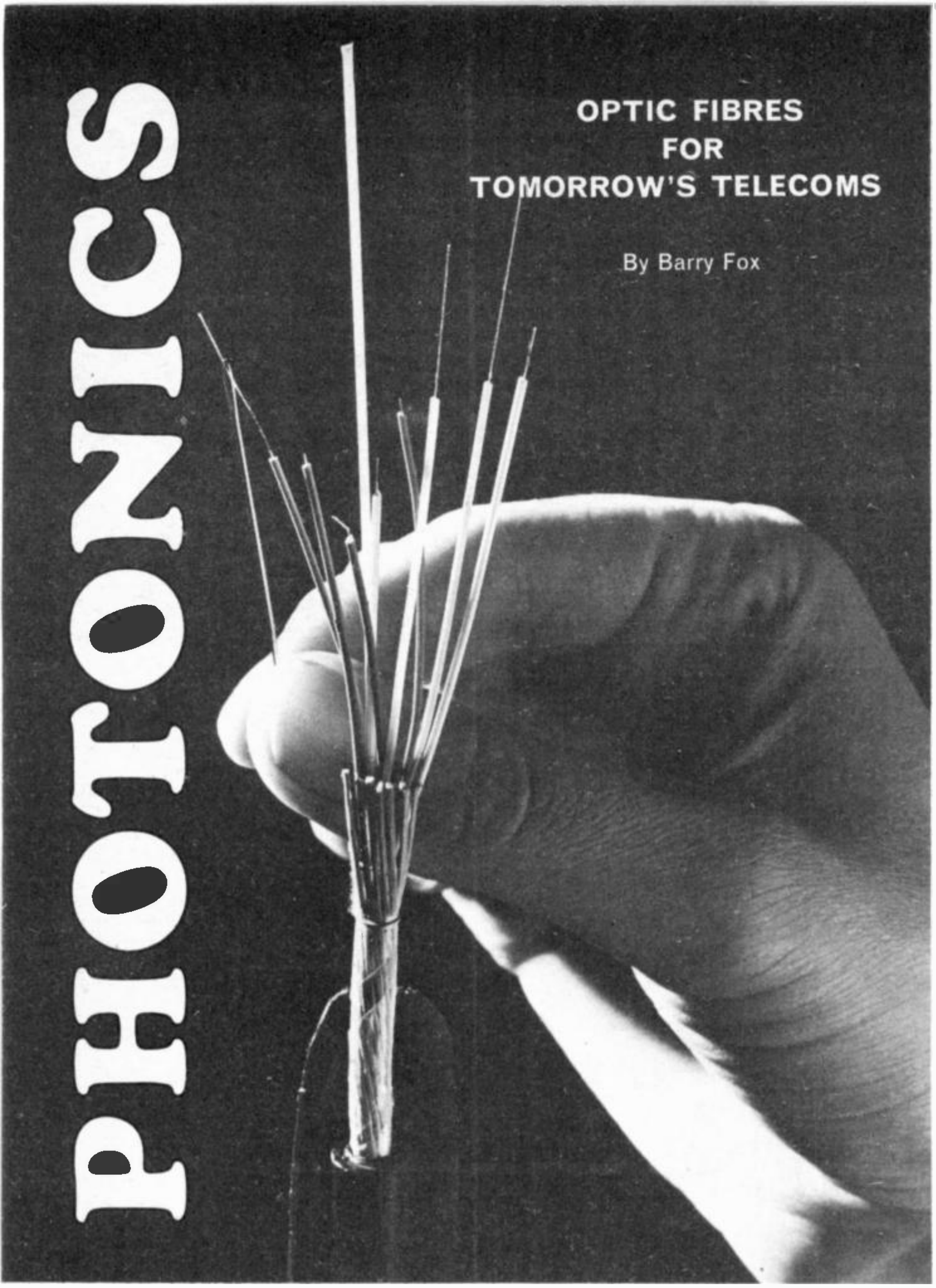
A compact pocket-sized tuning aid. Produces note *A* above middle *C*. Ideal for the violin player and others.

JULY 1982 ISSUE ON SALE FRIDAY, JUNE 18

PHOTONICS

OPTIC FIBRES FOR TOMORROW'S TELECOMS

By Barry Fox



WHAT is described as a "major breakthrough" in optical fibre transmission was recently announced by British Telecom. BT's Martlesham Heath research laboratory had produced a sample batch of optical fibres so pure that they can carry a digital data stream of 140 million pulses a second over 100 kilometres without intermediate amplification.

This is equivalent to 2,000 simultaneous telephone calls, several hundred hi-fi audio channels and several video picture links. When further tests have been carried out British Telecom will license outside contractors, including GEC, to produce the new fibre on a commercial scale.

IMPROVED TECHNIQUE

To make the fibre British Telecom is using a technique called Modified Chemical Vapour Deposition (MCVD) which was developed by Bell Labs in the US, nearly 10 years ago. Bell went on to patent the process in Britain, Canada, France, USA, Germany, Japan and the Netherlands.

British Telecom says it has improved the original Bell Labs process, and filed patents on these improvements. So a complicated legal situation is likely to arise when the British Telecom fibres are put into production.

They acknowledge this as unfortunate but unavoidable because the future of optical fibre technology lies with MCVD techniques. Previously they used a quite different technique involving crucibles to produce the short experimental optical fibre telephone links which have been carrying calls under British soil since 1977.

The publicity created by British Telecom's announcement has stirred up wide interest in optical fibres as a transmission link. But because the technology is new, few people understand what optical fibres can offer; simply that a single cable made out of flexible, hair-thin glass, can carry many times the number of hi-fi, video or telephone channels that a conventional wire or coaxial cable of similar size can carry.

Conventionally, sound and television signals are carried either along wires as electrical currents or in space as radio waves. It is however also possible to carry the same signals in the form of light waves.

This isn't so surprising when you bear in mind that light and radio waves differ only in their frequency and wavelength. Light has a much higher frequency, and shorter wavelength, than radio. Last year I visited Bell Labs in New Jersey and learned first hand about their work on MCVD fibres.

EARLY DEVELOPMENTS

Transmission of information by light is by no means a new idea. In August 1880, Alexander Graham Bell, the Scotsman who emigrated to North America and invented the telephone, filed a patent application on an "apparatus for signalling and communicating called Photophone". The patent, which issued as US number 235 199, describes a primitive system of optical communication and laid the foundations for today's revolution in light fibre technology.

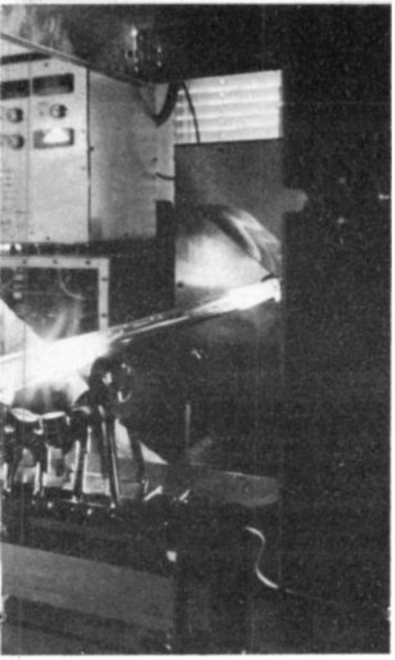
Bell took light from the sun, a lamp or even a candle, and used a lens to focus it into a beam. This beam was then passed through a rotating wheel, or oscillating miniature venetian blind, to chop it up or "modulate" it. This was Bell's "photophonic transmitter".

His "photophonic receiver" was a lens which focused the modulated light beam onto a very thin, hard rubber diaphragm mounted in a telephone earpiece. According to the Bell patent, when the chopped light beam was focused onto the diaphragm it created sympathetic movements which could be heard as sound.

As a more sophisticated approach Bell used a diaphragm in the transmitter, connected to the beam modulator. The transmitter diaphragm was part of a telephone handset so that when someone spoke, the diaphragm vibrated in sympathy and modulated the light beam accordingly.

In this way the light link could transmit speech signals. But clearly the attempt to convert light energy direct into acoustic energy at the receiver was impractical.

Bell replaced the diaphragm with a piece of light-sensitive selenium connected in series with a battery and telephone ear-



(above) BT's record breaking research team Dr David Newman, Dr John Midwinter and Dr Roger Heckingbottom.

(left) Optical fibres in the making at Martlesham Heath.—BT.

(right) The equivalent of a million telephone calls are possible using the necklace around this model's neck.—BT.

(heading picture) Eye of needle gives idea of the scale in this picture of a typical optical fibre cable to be used in project Mercury.——courtesy BP.

piece. The incoming light beam was focused onto the selenium which changed its resistance in dependence on the strength of the beam. So a fluctuating beam created a fluctuating resistance in the telephone circuit and this produced a fluctuating current in the earpiece which in turn produced sound.

BELL'S PHOTOPHONE

The system was, of course, unreliable. Although Bell spoke in the patent about using a candle as the light source, it is clear that the system had the best chance of working when powered by sunlight. The system couldn't work at night or on dull days, and stopped working when the sun went behind a cloud.

It wasn't just an armchair idea—Bell certainly made a prototype of the system described in his patent. It was recently discovered in the Smithsonion Institution in Washington DC; the curious gadget had lain for 100 years in a wooden box with no one realising what it was.

The Bell Laboratories research division recently made a mockup re-creation of the original photophone. This was a logical move because Bell, like telephone organisations all round the world, is now replacing conventional metal cables with the modern equivalent of Bell's Photophone.

LIGHT PIPE

Optical communications have several advantages over electrical or radio communication; but several disadvantages as well. It's essential to concentrate the light into a very narrow beam, because if the light spreads it can't provide a useful link over a long distance—Just as a torch is less effective over a long distance if its beam is wide.

Also if the beam is travelling through the atmosphere, it will be attenuated (reduced in power) by rain, fog, snow, smoke or pollution. A major advantage is that because light waves have a much higher frequency than radio waves, it is possible to modulate them with a much wider bandwidth.

By using multiplex techniques (which slot separate signals into separate slices of the bandwidth spectrum) it is possible to carry a large number of separate audio, video or telephone channels on the transmitted light wave. Because telephone channels have a much narrower bandwidth than audio or video channels, a light link can carry many more telephone calls than radio or TV programmes. As an added bonus, light links are not affected by electrical interference.

It soon became clear that the only way to communicate with light waves was down an optical pipe of optimum transparency. This way the light rays are unaffected by atmospheric conditions.

It also provides a way of making the light go around corners, or follow curves, without the use of expensive and cumbersome mirrors or prisms. The light source is modulated with the signal to be carried, the light is formed into a beam and injected into one end of the light fibre, the beam is extracted at the other end and demodulated to provide a replica of the original.

TOTAL INTERNAL REFLECTION

Optical fibre communication relies on the natural phenomenon called total internal reflection, and the use of an optically pure fibre.

If you swim under water it's usually impossible to see the sky above. This is because the light rays reflect off the boundary between water and air; each has a different refractive index and the light rays have difficulty crossing the boundary.

Light fed into one end of a rod of transparent material will emerge from the other end for exactly the same reasons. The light cannot escape from the walls of the rod because it cannot cross its boundary with the air. A light fibre is a very tiny fibre thread of glass which, because of its small size, is both strong and flexible.

Most people will have seen ornaments which rely on a "mare's tail" of light fibres. Individual fibres are bunched together at one end, close to a source of light. The other ends of the fibres fan out freely, like the spray from a fountain, and at the tip of each free fibre there is a spot of escaping light. Imagine a modulated light source and a receiver at the ends of each fibre and you have an optical fibre communication link.

Bell Telephones now group togethe twelve individual light fibres, each slightly thicker than a human hair to make a ribbon. Twelve ribbons are then grouped to make a total of 144 individual fibres inside a half inch sheath. This can carry over 40,000 two-way telephone conversations at the same time, using either analogue or digital transmission techniques.

The technology has been daunting. One main problem has been finding a way of injecting the modulated light into the fibres; another has been making the fibres pure enough to carry the light over a long distance.

LASER INJECTION

The key to injection was invention of the laser (or more accurately construction of a working laser on previously proposed principles) just 20 years ago. A laser produces an intensely bright beam of coherent, monochromatic light; in other words the light rays in the laser beam are all in phase, or in step, and of almost a single frequency or colour.

Because it is monochromatic and coherent a laser beam can be focused into a very narrow pencil of light which is ideal for injection into one end of a light fibre. It can also be modulated, by switching it on and off, very rapidly (tens of millions of times a second).

Although early lasers, and modern powerful lasers, rely on the optical stimulation of gas, it is obviously impractical to use a bulky gas laser in a light link. An alternative is to use a high intensity Light Emitting Diode, similar to the l.e.d.s used in watch and clock displays, but with much greater light output.

Ten years ago Bell Labs succeeded in producing a solid state version of a laser, using a combination of gallium and arsenide. Initially solid state lasers had a very short life; they would burn out after just a few minutes use. But by the mid 70's solid state lasers with virtually infinite life expectancy had been developed and these are now the lynch pin of optical fibre communication technology.

A tiny solid state laser at one end of the fibre injects modulated light which is received at the other end of the link by an equally tiny semiconductor diode. Provided the fibre is of sufficient optical purity

(above) Comparing the new with the old. BT technician, Jane Harrison holds the new optical fibre cable and millwright Fred Walker holds the old style metal cable.

(left) A technician joining optical fibres at Martlesham Heath research laboratory —BT.

it can transmit light more efficiently than metallic wire can transmit electricity—with less attenuation of the signal level. And, of course, the raw material for glass fibre is far cheaper than for metallic wire.

BOOSTERS

With modern systems the light frequency used is often in the infra-red spectrum, which is just outside the frequencies visible to the human eye.

By the early 80's light loss had been reduced to around 3dB per kilometre, in other words the light intensity dropped by only one half after one kilometre of travel.

As this effect is cumulative, repeater stations or boosters must be used. These are expensive and inelegant, because the light has to be tapped off from the fibre, converted into electricity, amplified, reconverted back into light and fed back into the fibre again.

Current British Telecom fibres, for instance, need boosters at intervals of between 7 and 10 kilometres. The new breakthrough, achieved by British Telecom at Martlesham, is to produce a fibre from glass so pure that it can carry digital pulses for up to 102 kilometres without the need for a booster.

Light loss on the new fibre can be as low as 0·25dB per kilometre. This can put the total loss over the full 102 kilometre length, including 11 fibre joints, at only 33dB. In practice the distances between boosters will be around 30 kilometres.

OPTICAL BOUNDARY

Early attempts at making glass fibres failed because metal ions (vanadium, cobalt, iron and manganese) were always present as pollutants and absorbed the light. The problem of metal ion pollution has now been largely cured, and the industry is turning its attention to the elimination of *OH* impurities which absorb light at some wavelengths.

Various techniques for purification exist and these relate to the need for a fibre with an optical boundary across its width to cause total internal reflection. It is in theory possible to use a pure glass fibre with the glass/air boundary causing the total internal reflection.

However, the moment the outside surface of such a fibre is touched or dirtied, the light streams out. So modern fibres have a central core of high refractive index which is surrounded by material of lower refractive index; and usually the finished fibre is externally clad with a protective sheath of plastics.

The central core of high refractive index can be very small, so that little more than a single ray of light can travel in a very tight path down the fibre centre. This is called a "single-mode" or "monomode" fibre, see Fig. 1.

It is difficult to inject the beam into the fibre because there is no margin for error in positioning the light source at the fibre end. A laser is usually needed for successful injection.

STEPPED INDEX

The obvious alternative is to make the central core larger. This is called a "stepped-index" fibre. Many rays can now travel down the central core but they will bounce off the refractive boundary at slightly different places and times, so the light which emerges at the far end will be slightly dispersed.

If modulation of the light is analogue dispersion of the light by multiple refractions will distort the waveform. If modulation is digital one pulse runs into the next.

A third possibility is to make a gradual transition between the central core and outer jacket so that there is an internal focusing effect. This is a "graded index" fibre, see Fig. 1. The disadvantage here is that the fibre can only cope with a smaller bandwidth.

MAKING A FIBRE

So optical fibres are chosen on a "horses for courses" basis; a choice is made between the three types in dependence on the type of signal they are to carry. The new British Telecom fibre is of the single mode or mono mode type.

There are various techniques to purify the glass to create the necessary optical boundaries, and keep attenuation to a minimum. The technique originally used by British Telecom involved drawing molten silica out of a platinum crucible.

The Mechanical Chemical Vapour Deposition technique developed by Bell Labs, and now adopted and modified by British Telecom, starts with a hollow tube of fused silica, about a metre long and as thick as a finger. This tube is rotated in a lathe while heated by a moving blow torch to around 1700°C. See Fig. 2.

Chloride chemicals, in an oxygen carrier, are fed through the tube and the resultant chemical reactions deposit a very thin layer of oxides onto the inner surface of the tube. The process is repeated around 50 times, with a 10 or 20 micron layer built up on each occasion. The result is a silica tube with an internal cladding of optically pure glass with a high refractive index.

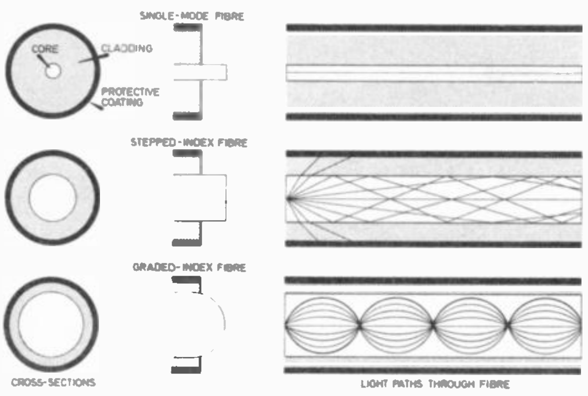


Fig. 1. The various grades of optical fibres. The structure of the fibre determines how the light signal is affected. A single-mode fibre permits light to travel along only one path. By contrast the stepped-index fibre provides a number of pathways of different lengths. A graded-index fibre has many layers and cuts down modal disperison to a minimum.—Bell Labs.

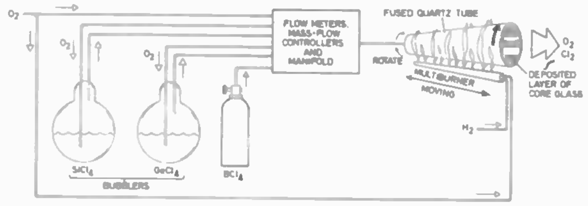


Fig. 2. The Modified Chemical Vapour Deposition (MCVD) process for making a fibre—Bell Labs.

OPTO PULSES

Optical Record

Another world record in optical fibre transmission has been claimed by British Telecom's fibre research team, in cooperation with UK industry.

Laser light pulses have been sent along 31·5km of continuous fibre at a rate of 650 million a second—a digital signal of 650Mbit/s, equivalent to nearly 8,000 simultaneous telephone calls.

The fibre was incorporated in a trial cable installed between British Telecom's Martlesham Heath Research Laboratories and its new System X telephone exchange at Woodbridge, Suffolk.

The pulse rate of 650Mbit/s is the highest achieved and is four times greater than that currently used for long distance (trunk) telephone call transmission.

FIBRE LINKS

A complete range of optical fibres, previously only available from Corning Glass Works, USA, is now being marketed in the UK by Optical Fibres; a new British company.

Under terms of an agency agreement they have been appointed sole UK distributor.

The McMichael 2000 series fibre optic "extender unit" enables up to 24 extra channels to be transmitted down one fibre optic when used in conjunction with a "master unit". This brings the total system capacity up to 32 channels.

Mercury Go-Ahead

Project Mercury is all set to go ahead as a competitor to British Telecom, having been granted a 25-year licence.

The consortium of Cable & Wireless, BP and Barclays Merchant Bank will lay 1,000km of optical fibre along railway tracks linking British cities. Capacity will be 8,000 simultaneous telephone calls.

The service should start operating next year.

This tube is now heated and shrunk down to form a solid glass rod, which has a core of high refractive index surrounded by glass of lower index. All impurities have been carried away by the vapour reaction and the result is a solid rod of purity better than 10 parts per billion, or 160 grains of sand in a railway container or truck-full of sugar!

The solid rod is now heated to 2500°C in a radio frequency furnace and pulled into tiny, flexible glass fibres. Around 10 miles of fibre can be pulled from the original 1 metre tube.

An alternative approach is to heat the tube and blow the modifying chemical gases onto the outer surface. This builds up a skin which has a different refractive index from the main tube material.

Other techniques involve depositing the modifying materials at one end of the rod and then drawing it into fibre. But all techniques have in common two aims; to achieve optical purity and optical boundaries.

OPTICAL TRIALS

Optical links provide an answer to the prospect of overloaded telephone lines in the future. Bell use 144 individual hair-fine fibres (in 12 groups of 12) which can simultaneously carry over 40,000 two-way voice conversations, and are the equivalent of four-and-a-half heavy, bulky copper wire cables each containing 900 pairs of wires.

By replacing the copper cables which now lie in underground conduits with new half inch light fibre links, it will be possible to increase the 'phone system capacity many times over without any extra tunnelling or digging operation.

Bell, who has been commercially testing light fibre links since 1977 (in Chicago), announced an 80 million dollar project to link Washington, Philadelphia, New York and Boston with half-inch light fibre cables capable of carrying 80,000 simultaneous telephone calls. The first leg of this 611 mile project, between Washington and New York, will be in operation by 1983.

Tests are under way to see if optical fibres can be used for undersea cables, as a cheaper alternative to satellite communications. Similar research and development is being carried out all over the world. British Telecom for instance, already has a five mile optical fibre link in active everyday service in the UK.

Germany is just now on the point of using fibre cables and the German Post Office staged a major demonstration of fibre links at the 1981 Berlin Radio Show.

MAKING A CONNECTION

Until recently one of the main practical problems with optical fibres has been the difficulty of joining separate lengths, end to end, with efficient light transmission across the joint. Conventionally fibres now come ready-equipped from the factory with screw sockets at each end, like coaxial plugs. But now there are splicing techniques available which enable individual fibres to be joined end-to-end, and even broken fibres to be repaired by a worker in a man-hole.

Bell use a silicon wafer with *V* grooves etched accurately in its surface. The engineer uses a diamond scribe to clean-cut the ends of the fibres to be joined. The prepared ends are then lined up in the silicon wafer groove and clamped with pins; light loss is minimal.

British Telecom has built a prototype joining block which can make joints with a loss of only 0·1dB. The fibres to be joined are aligned on a jig with the aid of a microscope. Under computer control an arc is struck between electrodes and this cleans the ends to make an invisible weld joint.

OPTICAL PROCESSING

Bell Labs have shown that it is now even possible to push enough optical power down a fibre line to ring an electric bell at the passive end. (The light energy is, of course, converted into electricity.) So this opens up the long term possibility of fibre telephone links direct into the home.

Perhaps the most exciting work is the integration of optical circuits, and direct optical processing. At the moment the signals are in optical form only as they travel down the light fibre. But there is no reason why a signal should not be processed in optical state; with photons of light performing the functions now performed by electrons.

PHOTONICS

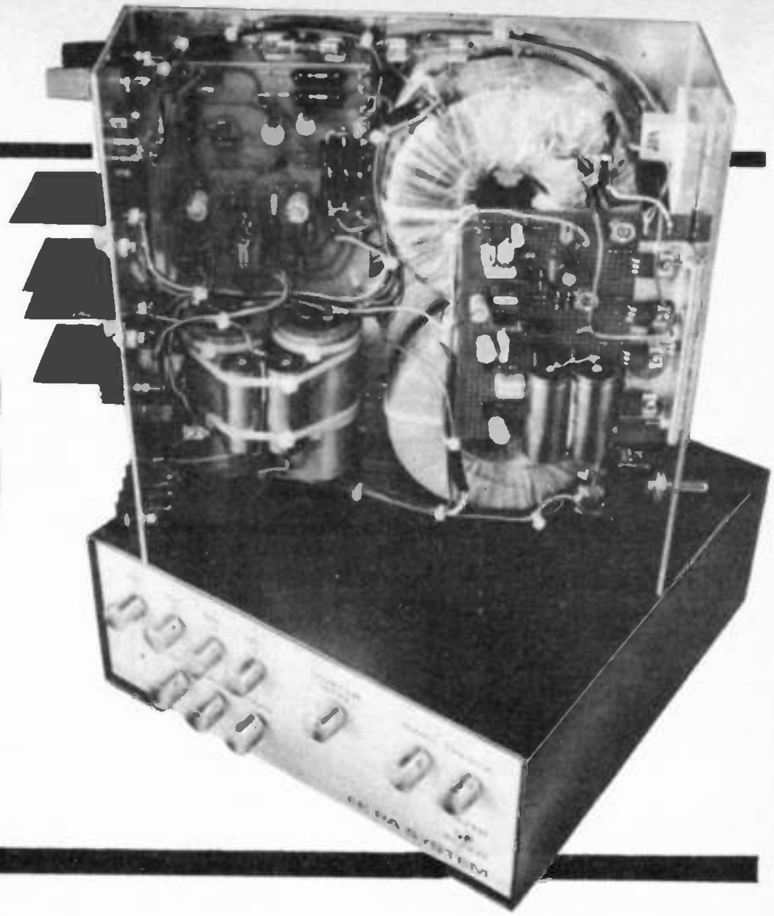
A new word *Photonics*, has been coined and already integrated optic circuits, comparable to solid state electronic i.c.s, have been developed. In these circuits the light beam is moved, and switched, under the effect of a magnetic field which affects its polarisation. Soundwaves can be used to create a diffraction grating which directly influences a light beam, or an electric field can be used to alter the refractive index of a material set in the light path.

Within a few years we could well be seeing *photonic* hobby magazines. ☐

PUBLIC ADDRESS SYSTEM

PART 2

By E.A.Rule



THIS month we continue with the construction of the control unit. Then follows the circuit diagram and technical description of the second unit of this P.A. System—the power amplifier, which includes the power supplies for the complete system.

CHASSIS AND CASE

Each chassis is made in the form of an inverted "U" from aluminium sheet and the overall size of sheet required for each is 418×240mm.

The author used sheet which was 2mm thick as it was felt that these units could be called upon to take a fair number of hard knocks, but unless proper bending equipment is available it is suggested that 1·2mm thick sheet be used. You will also need two sheets cut to 500×250mm for the two covers which make the cases. Most D.I.Y. shops will cut to required size.

This month full details are given for making the Control Unit chassis and case. (Details of the power amplifier's metalwork will appear in Part 3.)

Mark the chassis out as shown in Fig. 2.1. All holes should be centre punched to prevent the drill from wandering and a small pilot hole drilled first (the writer used a 1·2mm drill for this).

After drilling, all the holes should have any burrs removed. The cut-outs for the meter and mains socket can be made using an Abrafile blade fitted to a standard hacksaw and any burrs finally removed with a suitable file.

After all the holes and cut-outs have been made and checked for correct measurements and positions the chassis can be bent up. Be very careful to bend the correct way!

The two covers are made in a similar way but although a measurement is given for the width, the height of the sides is not. After bending the chassis, its actual overall height should be measured and this measurement used to determine the height required for the cover sides. This will allow for variations in bending and sheet thickness and ensure that the chassis is a sliding fit within the cover.

The bottom flanges of the cover each consist of half the remaining metal. The width of the cover should be measured from a centre line (not shown on drawing Fig. 2.4) after checking the actual width of the cut sheet.

Note that although screw fixing holes are shown in the covers they are not shown on the chassis drawing. Again this is to allow for bending variations; once the chassis has been fitted into the cover these holes can be marked in their correct positions.

SUB PANEL

Dimensions and drilling details for the control unit sub panel are given in Fig. 2.2.

FINISHING OFF

Note that certain holes on the two chassis are countersunk from the *outside*, this can best be carried out after the chassis have been bent and will avoid countersinking the wrong side.

If possible purchase aluminium which has a protective plastic backing on one side. Use this side as the "outside" of the chassis and covers. This will avoid unsightly scratches on the finished chassis front panels and covers—these could be sprayed to any suitable finish without further preparation.

As an alternative finish the front panels and covers could be covered with one of the plastic self adhesive materials. A very wide choice of these is available and most D.I.Y. shops will have a range to pick from.

ASSEMBLY AND WIRING

Mount the eight d.i.n. sockets onto the back panel. Use 6BA screws and nuts. See Fig. 2.3.

Fit S1 and D1 onto the front panel.

Fit the ten potentiometers to the sub panel. Mount this assembly onto the rear of the front panel and secure with two 6BA screws fitted with ¼in spacers.

The completed printed circuit board can now be placed in position mounted on four p.c.b. stand-offs which are secured by screws at the underside of the chassis.

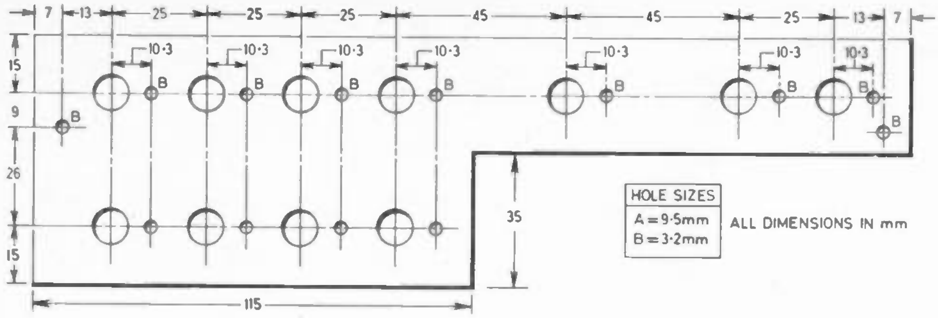


Fig. 2.2. Public Address System: Control Unit sub panel details.

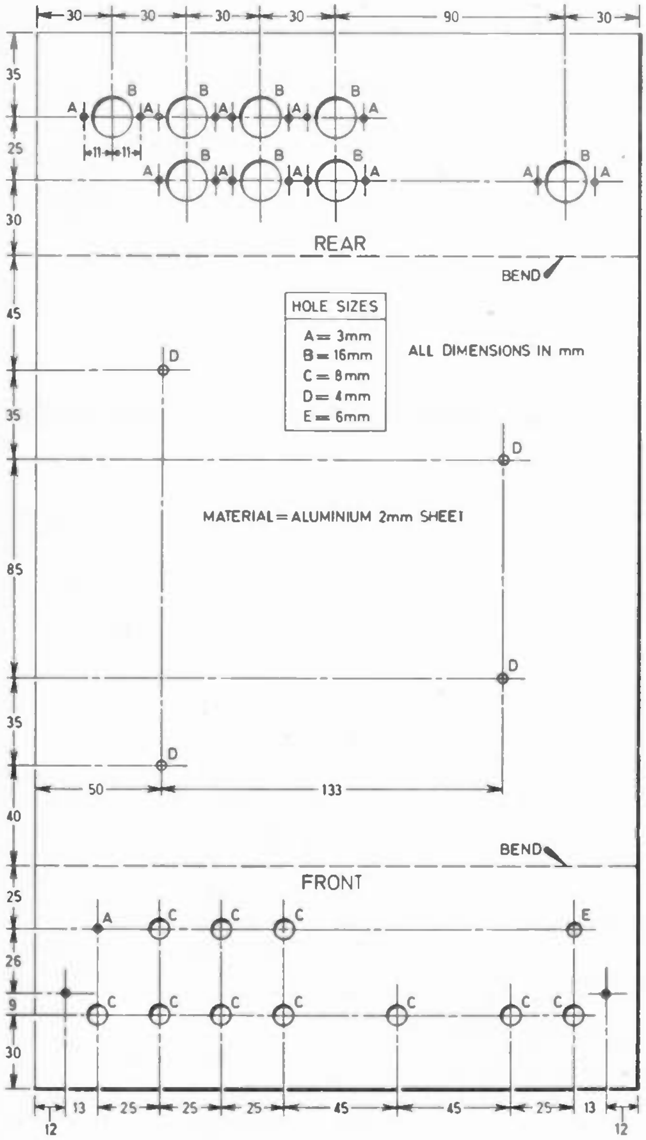
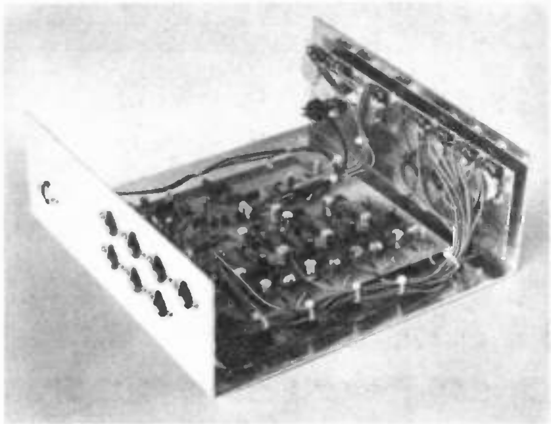


Fig. 2.1. Public Address System: Control Unit chassis drilling and bending details.



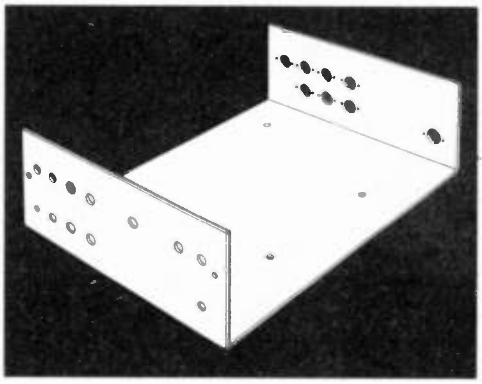


Fig. 2.3. Completed chassis.

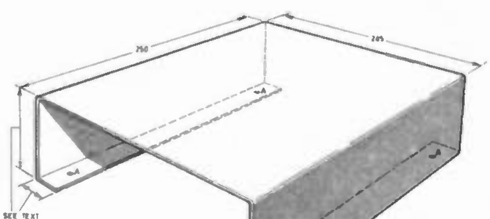


Fig. 2.4. Public Address System: Control Unit cover.

The wiring-up can now be commenced. See Fig. 2.5 for details of connections. For the 13 unscreened leads use tinned copper stranded 7/0·2mm p.v.c. covered equipment wire. Other connections are made with lightweight screened cable: single core of 7/0·1mm plain copper stranded conductors, lap screened and p.v.c. sheathed.

The leads and cables should be neatly dressed and made up into "cable forms" with cable ties, as shown in the photographs.

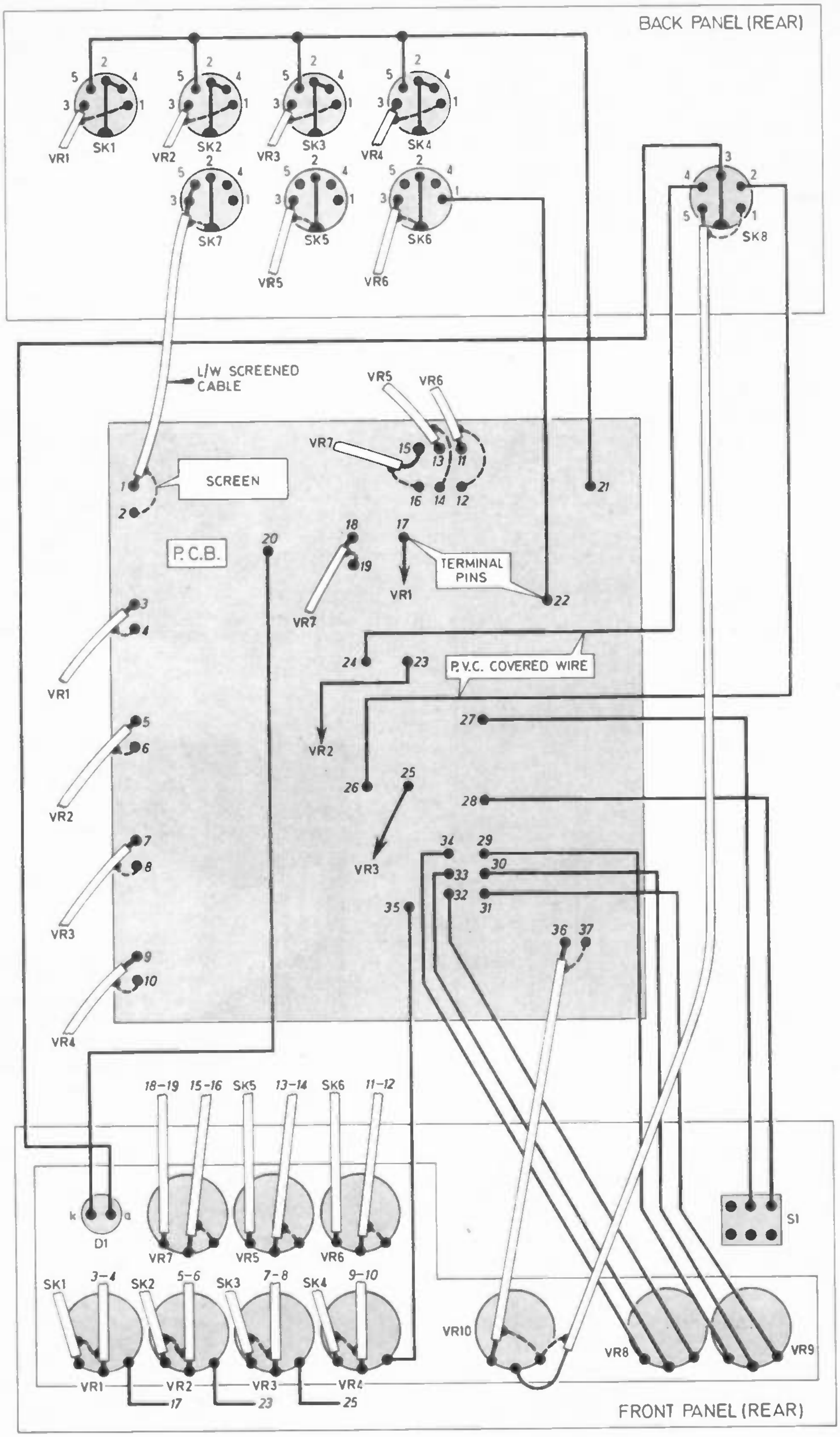
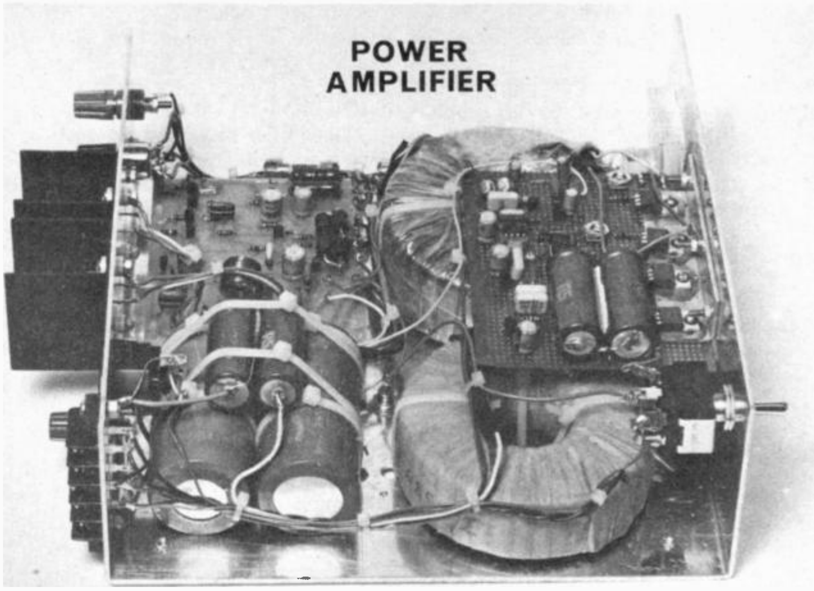


Fig. 2.5. Public Address System: Control Unit final assembly and wiring details.



CIRCUIT DESCRIPTION

The complete circuit for the power amplifier unit is shown in Fig. 2·6. (The full specification appeared in Part 1.)

The power amplifier is based on a well proved and tested design which uses MOSFETS in the output stage. These devices have a very high reliability and are almost indestructable, a very desirable feature in an amplifier which may be used at public events under all sorts of adverse conditions.

Input is via a 240 degree 5-pin DIN socket SK1 and passes to the base of TR1 via a d.c. blocking capacitor C2. R4 and C3 from an r.f. filter. Transistors TR1, TR2 are used as a differential pair and these in turn drive the second differential pair TR3, TR4. This second pair has an active collector load (current mirror formed by TR5 and D3) to maintain the pushpull action. The power MOSFETS TR8, TR9 are driven directly from this pair.

FEEDBACK

Due to the very low harmonic distortion obtained with MOSFETS only 45dB of negative feedback is used. The use of less feedback (compared with bipolar designs) results in a less severe distortion occurring at the clipping point when maximum output is reached.

The Zener diodes D5, D6 prevent the MOSFETS receiving excessive drive in the event of fault conditions.

HIGH FREQUENCY PERFORMANCE

Due to the excellent high frequency performance of the amplifier only a small amount of phase correction is needed in the feedback loop and this is provided by C5, L1, R23 and C13.

The amplifier is unconditionally stable and can be used to drive any type of load. As the *full* 50 watts can be obtained right up to 100kHz care is needed if the amplifier is used with other signal sources which may contain frequencies of this nature as tweeter loudspeakers can be easily damaged. No such problem arises with our own control unit as these excessive frequencies have been restricted.

The quiescent current is fixed at around 50/100 milliamps and no adjustment is required as thermal runaway is impossible with power MOSFETS due to their negative temperature coefficient.

Electronic decoupling on the supply rails is used for the early stages to ensure the minimum of hum and to remove the possibility of signals fed back via the supply rails which would otherwise get into the early stages and cause distortion. TR6, TR7 provide this decoupling.

OUTPUT

The output from the amplifier is fed to the 8 ohm output terminal and also to the primary of the 100 volt line transformer T1. This transformer is in fact the same type as the mains transformer T2 but with a centre-tapped 240 volt winding which is used here as the secondary to provide either a balanced or unbalanced 100 volt line output. D.C. blocking capacitors C16, C17 must be used, as due to the very low resistance windings the small amount of d.c. off-set voltage at the output can cause quite large currents to pass. The amount of d.c. present is less than 50 millivolts but with a resistance of only 0·01 ohms this produces a current of 1 amp and this has to pass through either one of the output devices (depending on polarity) causing an unbalanced condition and distortion. C16, C17 prevent this and they are polarised by connecting their positive ends to a 25 volt supply obtained via R24, R25 which form a potentiometer across the h.t. supply.

The 100 volt line can be loaded to the full 50 watts.

POWER SUPPLY

Dual purpose power supply circuits are incorporated so that the equipment can be run either from the normal 240 volt mains supply or from a 12 volt car battery.

MAINS OPERATION

Mains is applied via socket SK2, switch S1, and fuse FS2 to the primary winding of the mains transformer T2. Output from the centre-tapped secondary feeds the four silicon diodes, D8, D9, D10, D11 which make up a bridge rectifier. The output from the bridge is split into equal positive and negative supply rails (+42·5V and −42·5V) with C14 and C15 acting as smoothing capacitors. The centre tap of the secondary winding is earthed.

The switch S1 has three positions: Mains, Off, Battery. Only one lead of the mains supply is switched as this makes the changeover switching from mains to battery easier, so the mains should always be disconnected when changing fuses or working on the wiring for any reason.

BATTERY OPERATION

The 12 volt d.c. supply is connected to the circuit via fuse FS1 and S1. This d.c. input is decoupled by two capacitors C31, C32, both 2,200μF. Two individual capacitors are used here, in order to keep the ripple current down and to permit standard type capacitors to be used without overheating under full power conditions.

The 12 volt d.c. supply is fed to the d.c./a.c. inverter section via an electronic decoupling transistor TR14.

TR10 and TR11 form a multivibrator which produces square waves at a frequency of 14kHz. These square waves are differentiated and the resulting narrow pulse is used to trigger the pulse-width modulator, IC1. The output pulses from IC1 are fed into the driver transistor TR15 which in turn drives four Darlingtons in parallel, TR16-TR19. The output pulses from these transistors are fed into two extra windings on T2 which act as a centre-tapped primary when working from a battery supply.

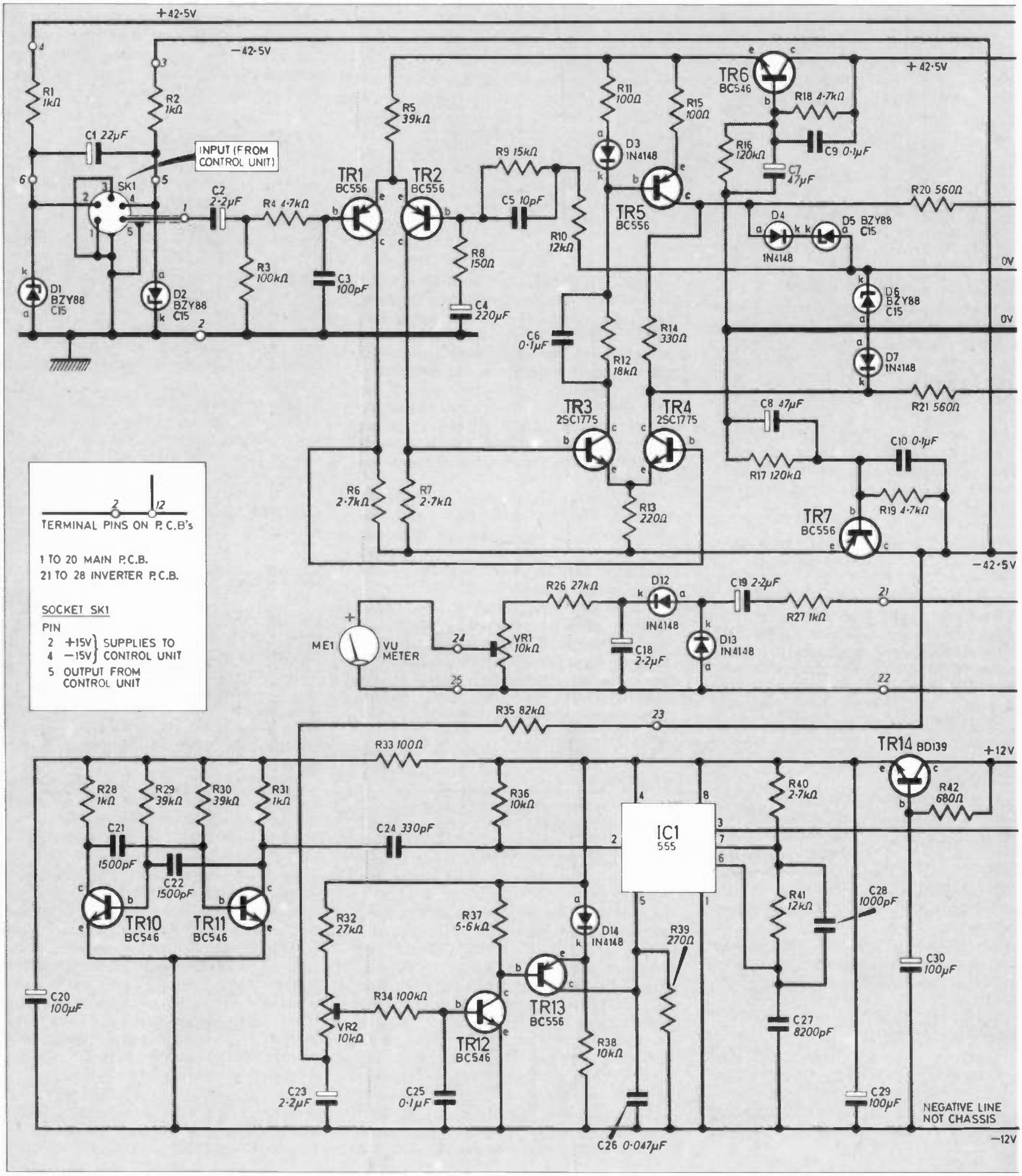
The output from transformer T2 secondary is rectified as before. Some of the negative voltage produced is fed back to TR12 and TR13 via R35 and used to pulse-width modulate the output of IC1. When only low power is being drawn from the supply the pulse width is narrow and under full power conditions it is wide. This means that power is supplied according to the demand and also provides a degree of regulation similar to that obtained from the normal mains supply.

The inverter circuit is capable of supplying enough power to let the power amplifier meet its full output of 50 watts. Diode D15 protects the circuit in the event of the battery being connected up with its polarity reversed, by blowing fuse FS1. Note that A POSITIVE EARTH is used.

R. F. RADIATION

Pulses of a square wave nature are very rich in harmonics and when used for a power supply such as here, there is a considerable amount of

Fig. 2.6. Public Address System: Power amplifier circuit diagram.

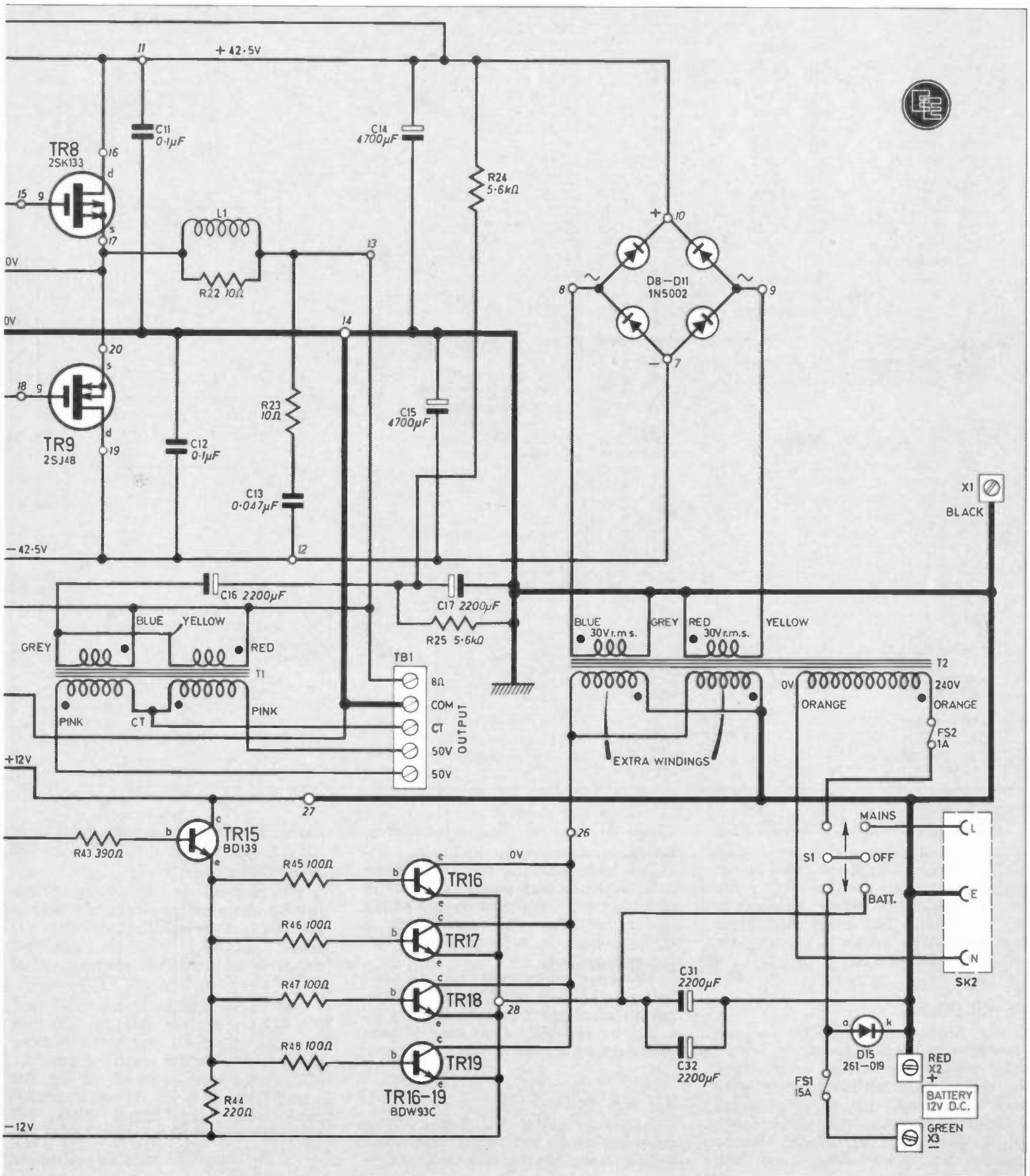


energy radiated from the transformer. (The effect is similar to that from a TV receiver.) As a result of this, interference can be caused to transistor radios over a distance.

Normally this type of supply would only be used for outdoor events when no mains supply is available, and no serious practical problems should result. However if used in the battery mode indoors, the radiation can cause radio frequency interference several metres away, particularly in the long wave band. The interference falls off rapidly as the frequency gets higher.

Do NOT fit any form of capacitor across the transformer windings in an attempt to supress the interference as it may cause the destruction of the Darlingtons TR16-TR19.

The mains lead should be removed when operating from batteries to avoid its acting as an "aerial".



COMPONENTS

Approx cost Guidance only **£60** excluding case

Resistors

R1 1kΩ 3W w.w.
R2 1kΩ 3W w.w.
R3 100kΩ
R4 4·7kΩ
R5 39kΩ
R6 2·7kΩ
R7 2·7kΩ
R8 150Ω
R9 15kΩ
R10 12kΩ
R11 100Ω
R12 18kΩ
R13 220Ω
R14 330Ω
R15 100Ω
R16 120kΩ
R17 120kΩ
R18 4·7kΩ
R19 4·7kΩ
R20 560Ω
R21 560Ω
R22 10Ω 2W carbon film 5%
R23 10Ω
R24 5·6kΩ
R25 5·6kΩ
R26 27kΩ
R27 1kΩ
R28 1kΩ
R29 39kΩ
R30 39kΩ
R31 1kΩ
R32 27kΩ
R33 100Ω
R34 100kΩ
R35 82kΩ
R36 10kΩ
R37 5·6kΩ
R38 10kΩ
R39 270Ω
R40 2·7kΩ
R41 12kΩ
R42 680Ω
R43 390Ω
R44 220Ω
R45 100Ω
R46 100Ω
R47 100Ω
R48 100Ω
All ¼W high stab. carbon film 5%, except where otherwise stated

Potentiometers

VR1 10kΩ skeleton preset, linear
VR2 10kΩ skeleton preset, linear

Capacitors

C1 22μF elect. 35V
C2 2·2μF elect. 16V
C3 100pF polystyrene 10%
C4 220μF elect. 16V
C5 10pF polystyrene 10%
C6 0·1μF polyester 10%
C7 47μF elect. 63V
C8 47μF elect. 63V
C9 0·1μF polyester 10%
C10 0·1μF polyester 10%
C11 0·1μF polyester 10%
C12 0·1μF polyester 10%
C13 0·047μF polyester 10%
C14 4,700μF elect. 63V 7A ripple @ 70°c
C15 4,700μF elect. 63V 7A ripple @ 70°c
C16 2,200μF elect. 200V
C17 2,200μF elect. 200V
C18 2·2μF elect. 16V
C19 2·2μF elect. 16V
C20 100μF elect. 16V
C21 1,500pF polystyrene 5%
C22 1,500pF polystyrene 5%
C23 2·2μF elect. 16V
C24 330pF polystyrene 5%
C25 0·1μF polyester 10%
C26 0·047μF polyester 10%
C27 8,200pF polystyrene 5%
C28 1,000pF polystyrene 5%
C29 100μF elect. 16V
C30 100μF elect. 16V
C31 2,200μF elect. 25V 2·6A ripple @ 40°c
C32 2,200μF elect. 25V 2·6A ripple @ 40°c

Semiconductors

IC1 555 timer
TR1 BC556 *pnp* transistor
TR2 BC556 *pnp* transistor
TR3 2SC1775 *npn* transistor
TR4 BC556 *pnp* transistor
TR5 2SC1775 *npn* transistor
TR6 BC546 *npn* transistor
TR7 BC556 *pnp* transistor
TR8 2SK133 *n*-channel power f.e.t.
TR9 2SJ48 *p*-channel power f.e.t.
TR10 BC546 *npn* transistor
TR11 BC546 *npn* transistor
TR12 BC546 *npn* transistor
TR13 BC556 *pnp* transistor
TR14 BD139 *npn* transistor
TR15 BD139 *npn* transistor
TR16-19 BDW93C Darlington-pair transistor (4 off)
D1 BZY88C15 Zener, 15V 500mW
D2 BZY88C15 Zener, 15V 500mW
D3 1N4148 silicon signal diode
D4 1N4148 silicon signal diode
D5 BZY88C15 Zener, 15V 500mW
D6 BZY88C15 Zener, 15V 500mW
D7 1N4148 silicon signal diode
D8-11 1N5002 silicon rectifier 3A (4 off)
D12 1N4148 silicon signal diode
D13 1N4148 silicon signal diode
D14 1N4148 silicon signal diode
D15 RS 261-019 silicon rectifier 13A

Transformers

T1 Mains primary 0–240V centre tapped (120 + 120V). Two secondaries each 0–30V r.m.s 2·66A. ILP type 53017.
T2 Mains primary 0–240V. Two secondaries each 0–30V r.m.s 2·66A. ILP type 52017.

See Shop Talk page 381

Inductor

L1 see text

Fuses

FS1 Battery fuse 15A 1¼in.
FS2 Mains fuse 1A slo-blow 1¼in.

Sockets

SK1 5-way 240 degree d.i.n. chassis mounting
SK2 Mains socket chassis mounting RS type 488-191

Terminals

TB1 5-way terminal block
X1 black, X2 red, X3 green — screw terminals 4mm (3 off)

Switch

S1 d.p.d.t. with centre "off" position 15A d.c.

Meter

ME1 VU scale, 200μA f.s.d. Maplin type RW73Q.

Miscellaneous

Printed circuit boards: "power amplifier", inverter/VU meter". P.C.B. stand-offs (4 off). Terminal pins. Sheet aluminium for chassis and cover. Screws, nuts, washers. Wire: heavy gauge and normal connecting wire. Fuse holders 1¼in. (2 off). Cable ties. Socket for IC1. Plug for SK2, RS type 488-208.

The problem will be appreciated when it is considered that under full audio power conditions the power supply is producing around 120 watts of square wave at 14kHz! In practice the problem is not much more than that caused by colour TV receivers, but should be born in mine.

HEAT SINKS

The heat sinks provided for the MOSFETS are large enough to permit full power operation over long periods of time. Although there is no risk of damage due to overheating with power MOSFETS the actual power output can fall if the devices become unduly hot. The sinks used will enable at least 50 watts minimum to be obtained under all conditions.

The heat sink for the Darlingtons used in the battery power supply is in fact the front panel and chassis of the power amplifier unit and again is large enough in area to permit full power operation.

All heat sinks will become hot under full power conditions and temperatures of around 60 to 65 degrees C can be expected after long periods of operation at high power.

VU METER

A peak reading VU meter M1 is provided as an aid to setting output levels. Some of the output signal is passed via R27 into a voltage doubler circuit and the resulting d.c. is fed to the meter via VR1.

The amplifier is first set up for the full 50 watts output, and then VR1 is set for a 0dB reading on the VU scale. Accuracy with the specified meter is arround 2dB over its range of VU readings.

The meter will be found most useful when operating into the 100 volt line system where loudspeakers tend to be remote to the amplifier position. The meter can be used to set the sound level to peak 50 watts output even when the sound from the speakers cannot be heard.

To be continued

RADIO WORLD

By Pat Hawker, G3VA

Licensing radio amateurs

Over many years of involvement with amateur radio in the U.K., I have felt that the licensing authority (originally the Post Office, then the shortlived Ministry of Posts and Telecommunications and more recently the Home Office Radio Regulatory Department) have always been reasonably well-disposed, if at times in a rather unimaginative way, towards the radio amateur. The licensing conditions may have been rather more restrictive than in some countries, but one has felt that the service has been efficiently and effectively run—and newcomers could depend on getting a fair deal, if little positive encouragement. So what has gone wrong?

First, perhaps the gradual change of attitude from the days when it was recognised that amateur radio was more than just a "fun thing". That the service was contributing to the development of radio and also provided serious "self-training" that could be useful to the country.

It gave, at no cost to the Government, useful training in electronics and radio communication and a valuable reserve of skilled radio operators. That, despite modern high-speed data communication systems, such operators might one day be needed again, as they were in 1939-46, and in the meantime were providing useful emergency facilities.

It has been clear for some years that the licensing authority now sets little value on such considerations, if they add even a jot to administrative burdens. Consider the long delays in introducing any form of British "novice" licence or (more debatable) any form of incentive licensing. Or the growing schism between the licence regulations (and current equipment) and the Radio Amateurs' Examinations set by the City & Guilds of London Institute.

Far from encouraging more youngsters to enter, at low cost, the world of electronics and communications technology, the costs of licences and the examinations creep ever higher—£15 and travelling costs for a Morse Test these days, and the need to apply months in advance to take the RAE which is held only twice a year. The final straw must be reckoned the confusion over the needless changes introduced this year with the new "schedule" of frequencies, transmission modes and power limitations.

Why on earth change from the easily measured and universally understood "150 watts d.c. power input" to the confusing and, virtually unmeasurable "20 dBW carrier power supplied to the aerial"? How many amateurs can accurately measure the output power of their transmitters?

Why should it be necessary for them to do so? And why on earth introduce decibel notation when this is not even part of the syllabus for the R.A.E.? And is the power to be measured that supplied to the transmission line or the radiating element itself? This can make a big difference at v.h.f. and u.h.f.!

To change from the simple, meaningful and easily measured d.c. input is rather like changing the vehicle speed limits to kilometres per hour in decibels relative to 1km/h. I cannot see the public ever standing for that, and I must admit to being surprised that the R.S.G.B. has apparently agreed to dBW carrier power in the licence schedule.

Swedish way

Far from leading the way in Europe, the British way of amateur licensing now lags well behind that found in many other countries. Take for example Sweden, where there are some 8,500 licensed amateurs in a population of under 8-million a significantly higher percentage than in the U.K.

There are four classes of licence: "*T*" or technician licences permits the use of 75 watts on 144MHz or above (no Morse test); "*C*" licences limited to 10 watts cw on h.f. bands with 8 w.p.m. Morse test; "*B*" licences 75 watts, including s.s.b. on h.f. (12 w.p.m. Morse test); and "*A*" licences permitting 500 watts input, all bands, all modes (16 w.p.m. Morse test).

The technical examination, like the present R.A.E., is based on a "multiple choice" paper (you have only to select the right answer among a number provided). But this examination can be taken on *any* working day and candidates are told immediately whether they have passed or failed. The licence and callsign is sent soon afterwards through the post.

The Morse test is based on machine generated code. How different from the long months it takes to acquire a British licence!

The "pirates"

For years the British licensing authorities tried to stiffle the natural demand for CB. All sorts of hell would be let loose if the natives were allowed even regulated access to 27MHz.

Five years ago it was clear that unless the Wireless Telegraphy Acts were changed to make it illegal to *sell* (not just import in working order) CB equipment there was no way of stopping CB, and if at that stage they had decided to legalise 27MHz f.m. the interference problems would never have got out of hand.

And what about the 49MHz hand-held units? Or the 1·9MHz portable and cordless telephones? Offered openly for sale in most High Streets, while British Telecom earnestly strive to develop more expensive 900MHz units.

Shades of new technology!

As consumers, most of us have reason to be grateful for the many years of electrical recording that have created an enormous reserve of musical talent. Radio programmes of golden oldies, all-time greats, jazz record requests all feature artists of the 1920s, 1930s and 1940s. Louis, "Bix", Billie Holiday, "Fats", Bessie Smith still set the standards for the jazz enthusiasts, "Bing", Nat King Cole, and the young Sinatra represent the first decade of "crooners"; Glen Miller big band swing.

But one must feel sympathy for the young hopefuls, the would-be recording stars of tomorrow. With such established competition it is not enough for them to have talent, they must also develop some entirely new approach that the earlier stars never used—one reason I suspect for some current pop styles.

Clever frequency-selective electronic processing can take away much of the scratch and hiss and high-frequency fall-off of even the oldest discs and can turn them from mono into pseudo-stereo. But I was a little surprised the other day to hear a newly released record featuring a pop duet by two long-dead artists who, in life, never even met but who happened to have recorded the same tune in more or less the same key. Electronic wizardry brought them together. This clearly opens up all sorts of possibilities in drawing on the vast reserve of recordings but is hardly a development that will be welcome to those struggling to be the stars of tomorrow.

It is just one aspect of the way in which we seem prepared to let technology eliminate the living human artist or operator, and their skills and crafts. In the amateur radio field, for example, there are more and more "intelligent receivers" with microprocessors doing all the work. This led, a year or two ago, to an Australian amateur Roy Hartkopt, VK3AOH, putting his fears into a doggerel warning:

I've got a new transceiver,
It's synthesized of course,
It sends all modes and rtty*
And generates good morse.

It's got a micro in it,
Which calls and logs them too
It prints the QSL cards,
There's nothing left to do.

And so I'll lock the shack up,
And let it have a ball.
While I'll go weed the garden,
It won't need ME at all!

(* radio teletype often pronounced ritty.)

Everyday News

TELEX TECHNOLOGY

The world's largest computer-controlled telex exchange, sited at British Telecom's Keybridge House in London, is due to start handling international traffic this month (May). The £8 million gateway exchange was officially handed over on February 24 to Mr Jim Hodgson, managing director of British Telecom International (BTI) by Plessey Controls, who successfully developed and installed the system.

With its computer based "Stored Program Control" (SPC), this latest addition to BTI's telex network provides a 30 per cent increase in available lines to Europe and beyond to transmit messages to over one million telex users worldwide.

Mr Jim Hodgson, managing director British Telecom International (right) discussing the equipment's computer supervising system with one of Telecom's engineers.

Store and Forward

The facilities the SPC system provides for Britain's 90,000 subscribers include the storing of telex messages which cannot be transmitted on demand and automatically re-transmitting them later, thus overcoming congestion on overseas networks and intercontinental time differences. A multi-address feature is also accessible, whereby the exchange automatically sends the same message to more than one customer.

Calls are much faster and if at the first try the call does not get through, the exchange will make further attempts without the caller having to re-dial.

The system itself, the latest in a proven line of telex and data switching systems from Plessey and designated the 4660/90, is an advanced multiple-processor exchange similar to the smaller gateway exchange brought into service at St Botolphs House, London in 1978.

All main control elements are duplicated and operate in "hot standby" and powerful on-line diagnostic programmes constantly monitor performance and can execute automatic changeover of control elements without loss of service if failure is detected.

Plessey have already won considerable foreign orders against fierce Japanese and German competition and amongst the countries to have similar systems installed are Egypt, Malta and Thailand.

The Future

With the advancement of new methods of data transmission, electronic mail and teletex being in the forefront, the long term future of telex looks to be in doubt. However, telex in its present form will still take a large slice of the business message market at least up until the end of the century and in fact last year, in spite of the recession, European calls increased by two per cent and intercontinental traffic by 13 per cent.

Although the Keybridge exchange will probably be the last international gateway to be built in Britain, it has the capability to expand its present capacity by up to two-and-a-half times to enable it to keep pace with the current growth in telex calls in and out of the country.

CHEETAH

Following in the wake of the computer controlled Keybridge telex exchange, British Telecom unveiled the "Cheetah", a new microprocessor based electronic telex terminal.

Such is its quiet operation (just a little noisier than a standard typewriter) and modern appearance that the Cheetah brings the telex machine out of the back room and into the general office and the simplicity and effectiveness of its operation enables secretary and director alike to send word-perfect messages.

The terminal, developed by ITT Creed, consists of a teleprinter, visual display unit, alpha-numeric keyboard and an electronic memory. This memory, of either 16K or 32K, can store up to 2,250 or 4,500 words respectively and has a back-up battery as protection against mains failure.

Facilities offered by the Cheetah include off line message preparation whereby outgoing messages are typed into the memory and displayed on the screen, while the teleprinter can still receive or transmit other messages without interrupting the operator. This also permits the operator to edit a message prior to transmission.

Automatic operation permits stored messages to be sent at pre-set times and the terminal will even remake the call up to five more times if necessary due to the called number being busy. Extra use of the memory is made with the short code calling facility and up to 16 frequently used telex numbers can be stored and called automatically in response to a one key code.

Additional features are automatic fault diagnosis, automatic date and time insertion, justifying of text to avoid word splits, logging of all calls and attempted calls and the refusal to accept an incoming message if both the memory and the paper roll are used up.

The Cheetah is initially being supplied to subscribers in London and the Midlands.

—ANALYSIS

THE ROBOT RACE

The narrow strip of land in Japan known as the Tokaido Strip is packed with 50 million people, one of the highest densities of population in the world. Devoted to industry it also has the densest population of industrial robots, the great majority of the 75,000 estimated to be in service in Japan and increasing daily.

Robot-like machines are nothing new. Fifty years ago the technique was called mechanisation and thirty years ago we started to call it automation which, with the addition of electronic control, started the process of de-skilling so that even the most complex fabrications could be supervised by machine-minders rather than highly-trained operators.

The industrial robot is the logical extension of automation. It is no different in principle but is more man-like in having fingers and one, if not two, arms. Cheap microelectronics have provided it with a low-grade brain competent enough to cope with repetetive tasks. First-generation robots relieved human workers from having to do dangerous, dirty or boring jobs.

Today robots of greater capability are taking over a much wider spectrum of jobs and in high-wage countries are now more cost-effective to employ than people. In Japan they have not, so far, displaced many people. Rather they have been used to achieve more massive production of cheaper goods with the same workforce. The Japanese drive for efficiency and domination of world markets is an increasing threat to other industrial nations who, willy-nilly, are forced to follow Japan's example if they are to stay in business just as, in the past, those who lagged in mechanisation or automation had to modernise or die.

New generation robots of remarkable virtuosity are now appearing. One will respond to a voice command from a vocabulary of 100 words. Another is able to recognise, through its TV eye, the orientation of a workpiece and dispose its fingers accordingly. A third is touch-sensitive through strain gauges in its fingers. In fact all the human senses are available including taste and smell through automatic chemical analysis of solids, liquids and gases.

Imitating humanity we now have a labouring class of robots doing heavy or unpleasant work and a higher educated class, more sensitive and intelligent, devoted to precision fabrication, assembly and test.

The social implications are difficult to forecast but even in Japan it is acknowledged that the cherished job-for-life tradition is under threat.

Brian G. Peck

In a joint team effort in association with General Electric of America, Plessey Marine has just been awarded a competitive development contract from the US Government for a new mine hunting sonar system.

LASER CHECKOUT

A point-of-sale terminal for supermarkets using a holographic laser scanner for reading the bar codes now printed on most products has been developed by ICL.

VIDEO DISC FIRST FOR UK

The first market to sell the VHD video disc system will not, as expected, be Japan but is likely to be the UK. This is the result of JVCs decision to postpone its launch in Japan.

The company is blaming the depressed economic conditions in Japan and the small sales of video disc systems so far. Sales of the PAL format in the UK will be under licence to the Thorn EMI Ferguson brand.

Talking Computer

The Open University is to develop a cheap talking computer for use by blind people. It will speak out information normally displayed on the screen.

The project has been funded with a £25,000 grant from the Microelectronics Education Programme and the Department of Industry.

Making a million

Dynamic Clive Sinclair whose ZX81 personal computer has topped the quarter million sales is expected to become a millionaire if, as anticipated, he places up to 20 per cent of Sinclair Research shares on the market later this year.

Wired cities

Cable TV and other services could be available to most households in the UK by 1986 if recommendations by the Government information technology advisers are followed. Industry has already agreed to fund the re-cabling programme at an estimated cost of £2·5 billion.

A powerful incentive for the Government to lift the present restrictions on cable TV is the preservation and possible increase in employment in the cable and TV set manufacturing industries.

Following the success of Compec exhibition in London, a similar computer and computer software show is to be staged in Scotland in September.

Compec Scotland is to be staged from September 7 to 9 in the City Hall, Glasgow.

The Department of Industry's "micro-van project" has overtaken the "micro-train" in the number of visitors who have seen the exhibits.

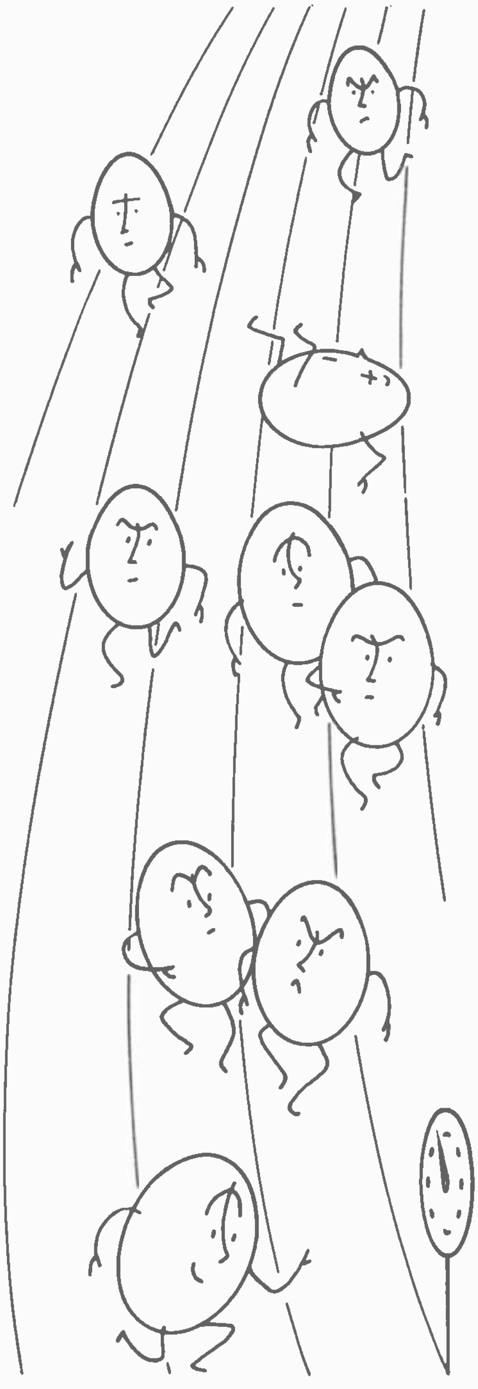
A satellite earth station antenna has been mounted on the roof of University College, London, in preparation for "Project Universe", an experiment in computer communications via satellite.

An experimental amorphus solar cell has been successfully developed by Mitsubishi Electric. This solar cell, with a 9·0mm² element size, offers an energy conversion efficiency of 8·5 per cent. Claimed to be the world's highest.

The ZX Spectrum, a new advanced personal colour computer, was unveiled by Sinclair Research at the Computer Fair, April 23. Enhanced Sinclair Basic is contained in a 16K ROM with options of 16K or 48K internal RAM. The 16K model can be upgraded to 48K later by Sinclair. In the high resolution graphics mode (256×192) there is still 9K of the 16K user RAM available! Other features include an on-board sound generator, standard typewriter sized 40 push-key ASCII keyboard with upper and lower case characters. Programs may be loaded/saved on cassette at six times the speed of the ZX81. The expansion port allows the existing ZX printer to be used but later when the RS232/Network Interface Board becomes available, other printers may be linked to the Spectrum. This will also allow a number of Spectrums to be bus-linked. Coming later this year will be the ZX Microdrives—micro floppy discs—to hold up to 100K bytes; up to 8 of these can be linked.

EGG TIMER

BY M.P. HORSEY



THE GOOD old sand operated egg timer has one or two advantages over its electronic counterparts. Namely, it is portable, virtually everlasting, easily reset, and does not need to be switched off at the end of the timing cycle. However, its main disadvantages are that it produces no audible indication that it has reached the end of the period and its duration cannot be varied to suit the user.

In desperation at having cooked yet another hard boiled egg through forgetting to watch the sand, the decision was made to design an electronic egg timer, combining simplicity of operation with the bonus of a "bleep" at the end of the time period.

CIRCUIT DESCRIPTION

The circuit is based on a CMOS 4001 quad 2-input NOR gate, and is shown in Fig. 1. Gates IC1a and IC1b form a monostable multivibrator with a time period dependent upon the values of C2 and VR1. Whilst the accuracy of this type of circuit may not quite equal that of specialised timing i.c.s, it can match the sand egg timer, and combines low cost with low current consumption.

Diode D2 protects the circuit from the battery being connected in reverse; an easy mistake to make and especially necessary since no on/off switch is incorporated. Capacitor C4 decouples the supply.

Resistor R1 maintains pin 1 of IC1a at logic 0 and capacitor C1 suppresses any stray voltage spikes, especially in the vicinity of an electric cooker. Since pin 10 of IC1c is also at logic 0, pins 2, 5, 6, and 12 will be as well. Therefore with both pins 1 and 2 of IC1a at zero, the output, pin 3, will be at logic 1. This means pins 8 and 9 will also be logic 1, thus maintaining pin 10 at zero and transistor TR1 will be off, and the l.e.d. will not light.

With both pins 5 and 6 of IC1b at zero, the output at pin 4 will be logic 1, capacitor C3 will be charged and pin 13 of IC1d will be logic 1. Since an input to either pin of a NOR gate will switch the output to zero, pin 11 will be logic 0, and transistor TR2 will be non-conducting. Thus the circuit is in the standby mode, and so little current is used that the battery will last for virtually its "shell life".

TOUCH CONTACTS

If the touch contacts are bridged with one finger, enough current will flow to raise the input at pin 1 of IC1b to logic 1. This will cause the output at pin 3 to fall to zero, taking pins 8 and 9 to zero also. Pin 10 will now become logic 1, turning on transistor TR1 and the l.e.d. will light up, current limited by R3.

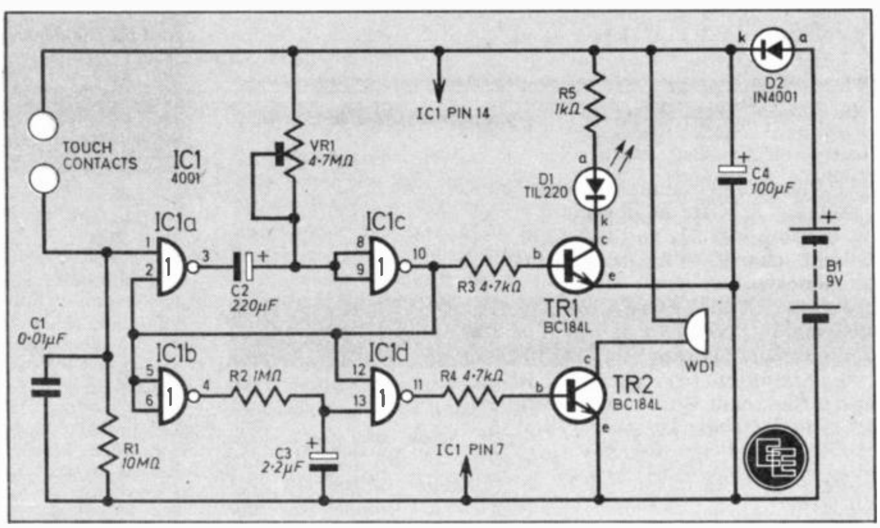
Meanwhile pins 2, 5, 6 and 12 will have changed state to logic 1 due to the output from pin 10. Thus IC1a will remain active even when the finger is removed from the touch contacts, and pin 3 will remain at logic 0.

With pins 5 and 6 at logic 1, the output from IC1b will fall to zero, discharging C3, and reducing the voltage at pin 13 of IC1d to zero and output from this gate will remain at zero, due to the input at pin 12 now being logic 1.

This state will be maintained for a period preset by C2, and VR1. Current will flow through VR1, slowly charging C2, and after the required time period, the input pins 8 and 9 will flip the output of IC1c to zero. The l.e.d. will be extinguished and IC1a will return to its original state.

However, IC1d now finds that both pins 12 and 13 are at logic 0, and its output will switch on, in turn switching on transistor TR2 via R5. The solid state bleeper WD1 will now sound.

Fig. 1. The complete circuit diagram of the Egg Timer. Note that if the touch contacts are to be replaced with a push-button, a 100 kilohm resistor must be added in series with it.



COMPONENTS

Resistors
- R1 10MΩ
- R2 1MΩ
- R3, 4 4·7kΩ (2 off)
- R5 1kΩ
- All ¼W carbon ±5%

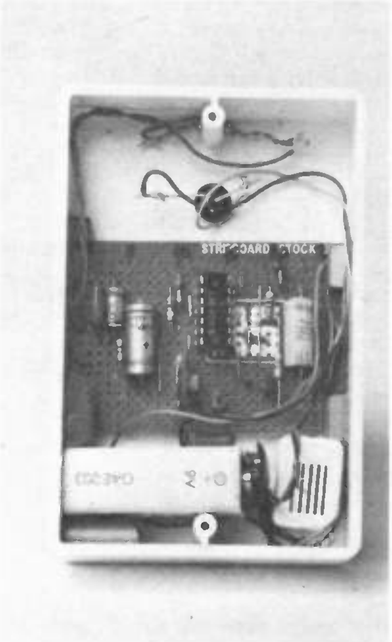
Capacitors
- C1 0·01μF polyester
- C2 220μF 10V elect
- C3 2·2μF 10V elect
- C4 100μF 10V elect

Semiconductors
- D1 TIL220 red l.e.d.
- D2 1N4001 silicon rectifier
- TR1, 2 BC184L *npn* silicon
- IC1 4001 CMOS quad 2-input NOR gate

Miscellaneous
- VR1 4·7MΩ vertical preset
- WD1 Solid state buzzer, 6 to 9V operation
- B1 9V PP3 battery

Stripboard, 0·1 in. matrix, 16 strips by 25 holes; plastic case, 115 × 80 × 35mm; 14 pin d.i.l. holder; l.e.d. mounting clip; battery clip; 7/0·2 equipment wire; solid wire (for touch contacts).

Approx. cost Guidance only £4·95 excluding battery



Photographs showing the unit with the case lid removed, and right, the finished Egg Timer with the touch contacts on the top corner.

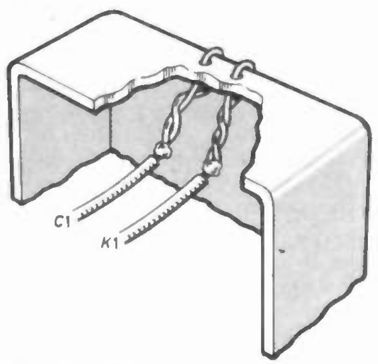


Fig. 3. Method of constructing the touch contacts from solid tinned copper wire.

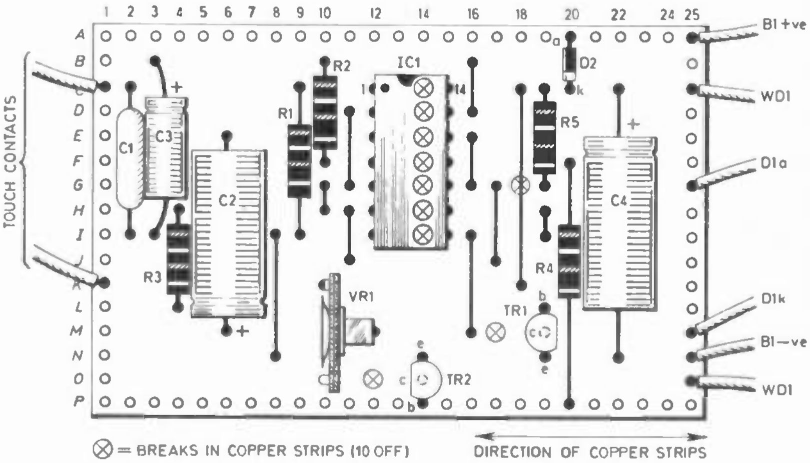


Fig. 2. Stripboard layout for the Timer circuit. Make special note of the breaks in the copper tracks.

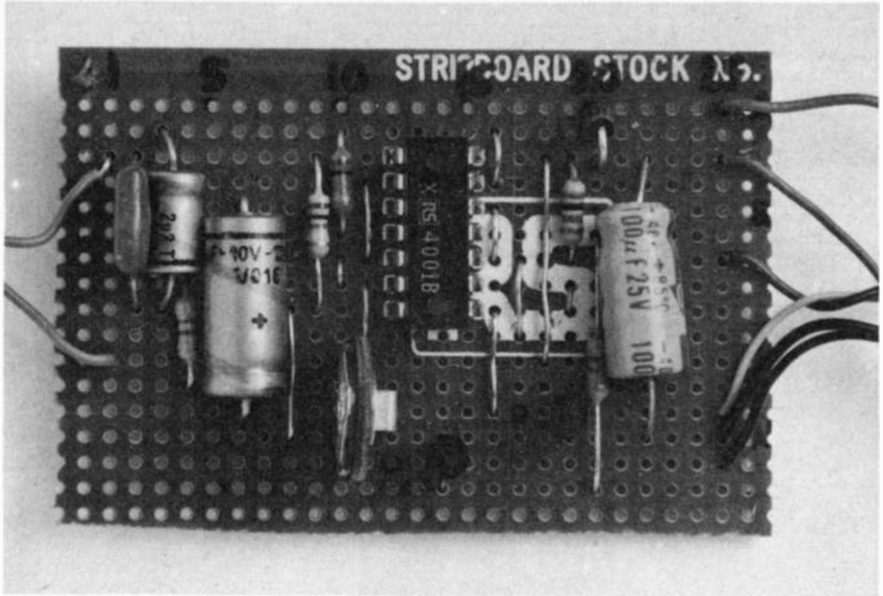
At the same moment, with pins 5 and 6 of IC1b at logic 0, pin 4 will become logic 1, and the capacitor C3 will charge. The time constant dependent upon the value of this capacitor and that of resistor R4. The constructor can therefore select values to suit his requirements. Those given maintain pin 13 of IC1d at logic 0 for about 2 to 3 seconds, after which pin 13 becomes logic 1, and the output at pin 11 switches off. The bleeper therefore stops sounding, and the circuit is returned to standby mode.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is built on a 0·1 inch matrix stripboard measuring 16 strips by 25 holes. Break the tracks where shown in Fig. 2 and carefully mark out the board to avoid errors. An i.c. holder is desirable, and this should be soldered into place, followed by the wire links, the preset, fixed resistors and capacitors, ensuring that the electrolytic capacitors are placed the correct way round.

Take care to solder the diode and transistors correctly, ensuring that transistor types BC184L are used with the layout shown, as BC184 types have a different lead configuration. Finally, connect flexible wires to link the battery clip, bleeper WD1, touch



Close-up of the finished circuit board.

switch and l.e.d., ensuring again that these are connected with the correct polarity. IC1 can now be inserted.

CASE PREPARATION

A plastic case measuring 115 × 80 × 35mm was used and four very small holes must be drilled at the top corned for the touch contacts, and ordinary tinned copper wire can be used as shown in Fig. 3. Twist the wires firmly inside the case, and leave the ends long so that the leads from the circuit board may be soldered well away from the plastic case to prevent it melting.

The l.e.d. requires a 6·4mm hole on the centre line, about 25mm from the top of the case. The mounting clip may now be fitted with l.e.d. Next connect the circuit board to the touch contacts, and mount the board, bleeper and battery using small self adhesive pads.

SETTING UP

It is helpful if the time-period is quite short when testing, and to facilitate this, VR1 must be turned so that the sliding contact is quite near (but not touching) the end connected to track *K*.

Connect the battery and this may sound the bleeper for a few seconds. Wait for the sound to stop, and check that the l.e.d. is off. Now firmly touch the wire "touch switch" and the l.e.d. should light up. A short time later, as determined by VR1, it will extinguish, and the bleeper should sound for a few seconds. The timer must now be set, by trial and error, to provide the required time.

Note that when adjusting the timer, it is necessary to make repeated timings, and when used in this way the time period may be as much as 20 seconds or so shorter than normal. Make allowance for this when initially setting up. In normal use, the timer should be accurate to within a second or so.

FAULT FINDING

Should the timer fail to work, simple tests with a voltmeter may be made to establish the fault. With the negative probe of the voltmeter connected to the 0V line of the circuit, check that about 8 to 9 volts is present at pin 14 of IC1. With the timer in its standby state, high readings (7 or more volts) should be present on pins 3, 4, 8, 9, and 13 of the i.c. Pins 1, 2, 5, 6, 10, 11, and 12 should all be low (less than 3 volts).

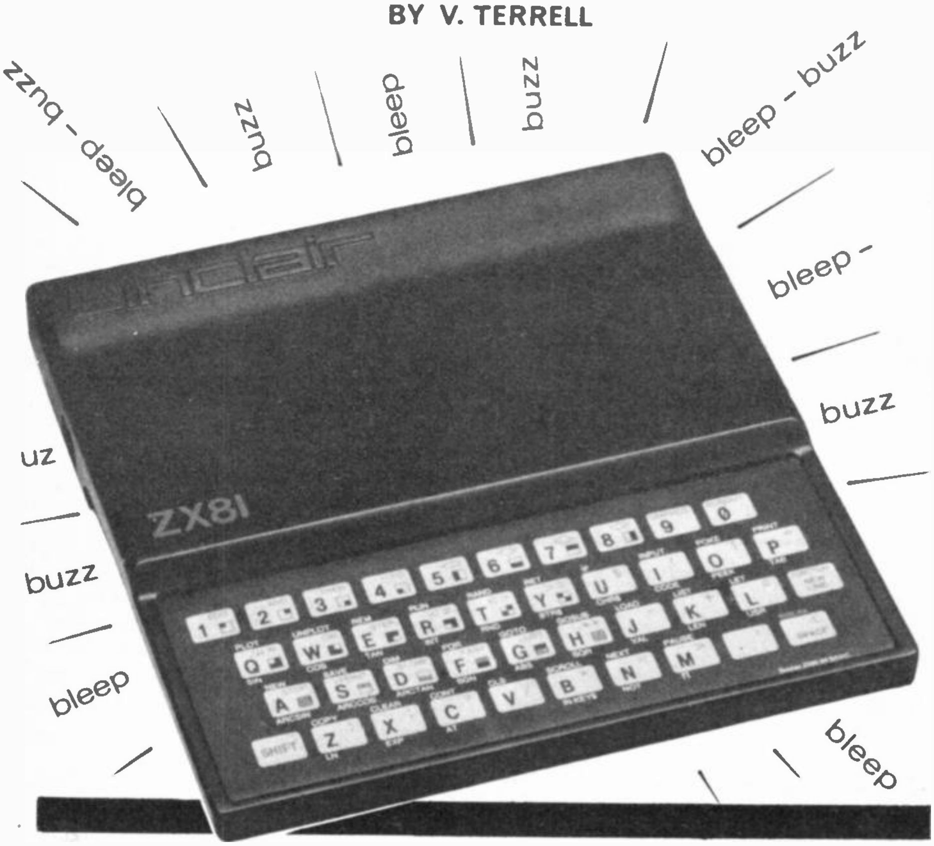
When the touch contacts are activated, pin 3 should go "low" and pin 10 "high". By following the circuit description and taking voltmeter readings in this way, the fault should become evident.

The prototype has proved reliable and consistent for many months. Grease in the kitchen could prove troublesome, if allowed to coat the touch contacts, and it should be removed carefully with a soft cloth. In very dirty environments the touch contacts could be replaced with a small button switch, and in this instance a resistor of about 100 kilohms should be connected in series with the switch. ⌑

JACK PLUG & FAMILY... BY DOUG BAKER

KEYBOARD SOUNDER FOR THE SINCLAIR ZX81

BY V. TERRELL



SINCE the launch of the ZX81 last year the popularity for this unit has been amazing. One has only to flick through any of the computer magazines and "ZX81" seems to be on virtually every page.

The ZX81 keyboard is a touch entry type, and the only means of feedback one has is to look up at the screen whenever pressure is applied to a key (to check that it has been entered). To avoid this constant checking it was decided to generate a tone, whenever a key is pressed and thereby enable the user to type in up to a line or more of programme without the need to look at the screen.

This method saves considerable time especially when typing in long programmes.

Also required is some means of knowing when the shift key is being pressed *together* with any of the other keys. This was accomplished by generating two tones, a low pitch tone for <SHIFT> and a high pitch tone for every other key. Consideration was given to the fact that the shift key has to be held down continuously whilst editing a line, and a lower buzz-like tone was thought to be more pleasing to the ear. Furthermore its volume level was reduced.

KEYBOARD

The ZX81 keyboard schematic is shown in Fig. 1. The take off points to the sounder are also included in the diagram but for the moment consider only the keyboard itself.

The keyboard is wired in a matrix format, the five resistors each feed two columns of keys, for example resistor R_A is connected to keys V G T 5 and 6 Y H B. The eight diodes D_A to D_H which carry information to the computer circuitry are wired to the eight rows of keys, for example, the line to diode D_A runs underneath keys 1 2 3 4 5 and only connects to the appropriate key when the key is pressed.

The matrix is therefore five columns by eight rows which is equal to 40, this being the number of keys on the ZX81 keyboard.

The fourteen take off points are required to provide the necessary information to produce the two tones that are generated by the Keyboard Sounder. Two of these points are the 0V and 5V supplies to the sounder, the other twelve are for voltage level sensing by the sounder whenever a key is pressed.

PRINCIPLE OF OPERATION

Consider for example that <D> is pressed. The voltage at resistor R_C is routed via the D key and feeds the line to the keyboard diode D_C. The computer detects this voltage level, generates the character D and displays it on the screen. The computer also detects a change in voltage across resistor R_C (the wiring for this has been omitted to avoid any confusion), to enable it to distinguish between keys A S F G on the same row but not connected to the same resistor. This also applies to the other seven rows of keys.

The sounder has been designed to detect any change in voltage level from the keyboard side of the eight diodes D_A-D_H and from four of the resistors R_A-R_D. The four resistor take off points are required to produce a hight tone when keys Z X C V are pressed at the same time as <SHIFT>. When these keys are pressed without <SHIFT> being pressed, the sounder produces both tones simultaneously. All other keys with the exception of <SHIFT> produce a high tone.

CIRCUIT DESCRIPTION

The two 556 dual timers IC2, 3 are each connected up as voltage triggered astables, where one timer in each package is a voltage sensing switch controlling the other timer in its package which is wired up as an oscillator. The oscillator is on or off depending on the voltage level reaching its reset, pin 10. The frequencies at which they run are determined by the values of R4, C4 and R8, C7 respectively. IC2 generates the high tone, IC3 the low tone. The frequencies at which each astable runs

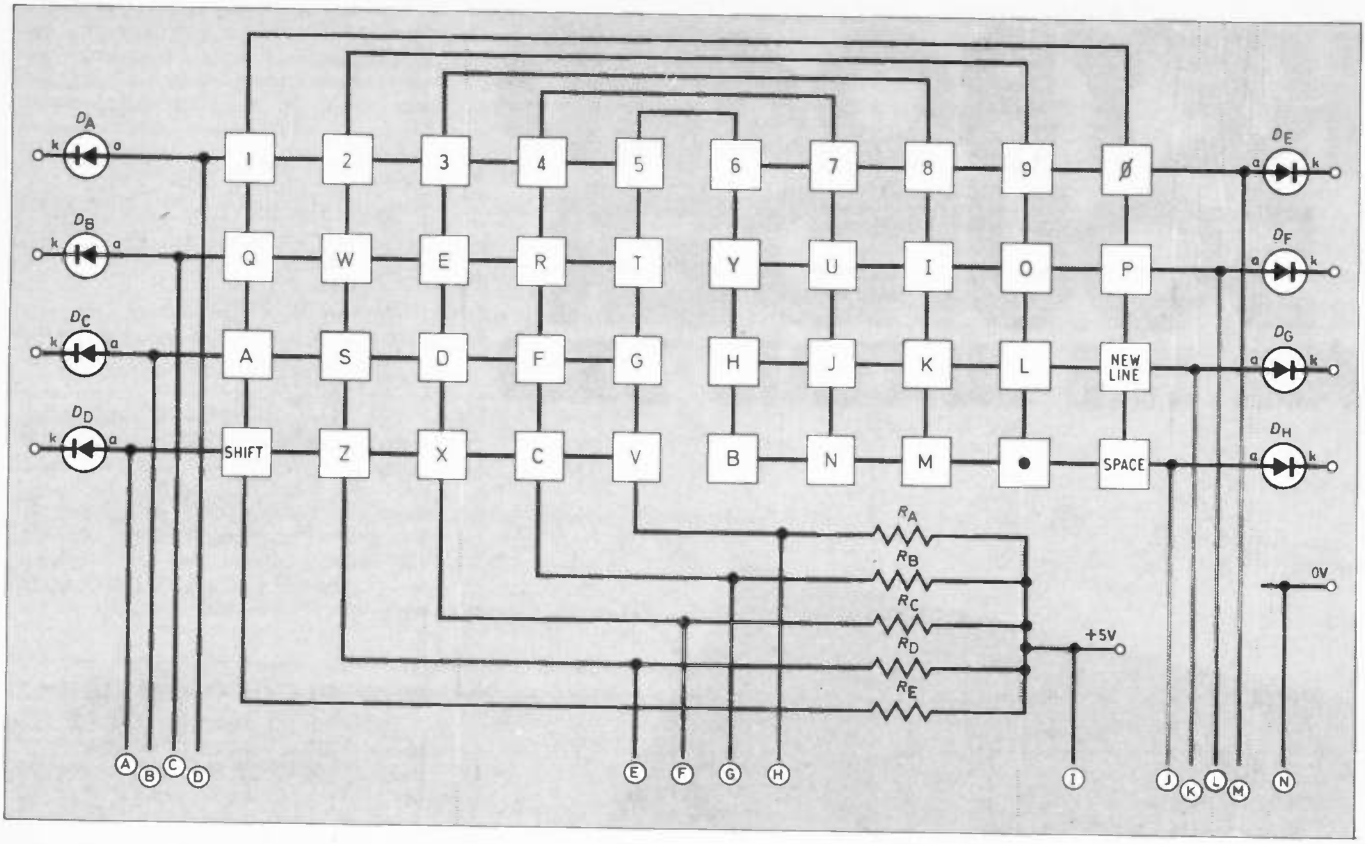


Fig. 1. Schematic diagram of the ZX81 keyboard showing how the keys lay on a 5 × 8 matrix.

COMPONENTS

Resistors

R1	100kΩ
R2	150Ω
R3	10kΩ
R4	4·7kΩ
R5	100kΩ
R6	150Ω
R7	10kΩ
R8	68kΩ
R9	3·9kΩ

All ¼W carbon ±5%

See **Shop Talk** page 381

Capacitors

C1 to C7 0·1μF resin dipped monolithic ceramic—0·1 inch pin spacing (7 off)

Semiconductors

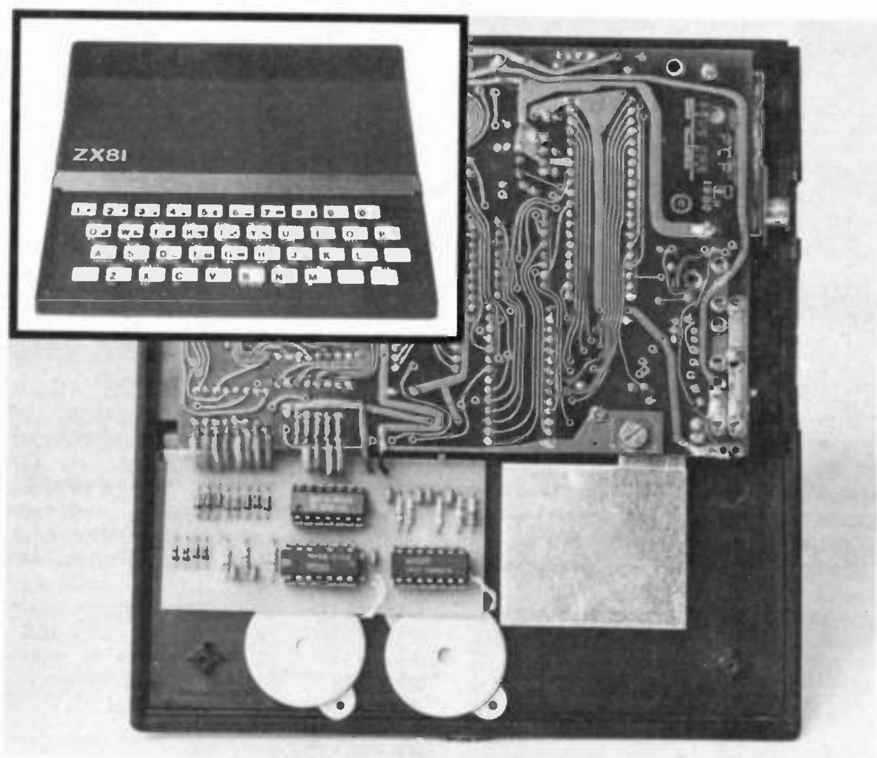
D1-D12	1N4148 (12 off)
IC1	74LS04 TTL lower power Schottky hex inverter
IC2, 3	556 dual timer i.c. (2 off)

Miscellaneous

WD1, 2 PB2720 piezo ceramic transducer (2 off) (Ambit 43-27201)

14 pin d.i.l. sockets (3 off); single sided p.c.b. size 80×40mm; double sided adhesive foam strip (10cm); equipment wire 7/0·2mm (30cm); solder.

Approx. cost Guidance only £7



View inside the ZX81 with the Keyboard Sounder installed. The two transducers are held in place by means of double-sided Sellotape. Double-sided adhesive foam secures the sounder board to the ZX81 case. Top left shows the ZX81 keyboard.

Rear view of the ZX81 showing its bus outlet, a double-sided p.c.b. finger set. This was used in our 2K Ram Pack article published in April '82.

can be calculated by the formula: $f = \frac{1}{1{\cdot}4 \times CR}$. IC2 and IC3 resistor and capacitor were calculated to give tones of approximately 1,500Hz and 100Hz respectively.

Consider IC2, where the input to the trigger is at pin 6. Its output is at pin 5. With no input to the trigger, the output is at a high level (+5V). Resistor R2 sets pin 3 to just above 0V, which sets up a threshold voltage level for the trigger.

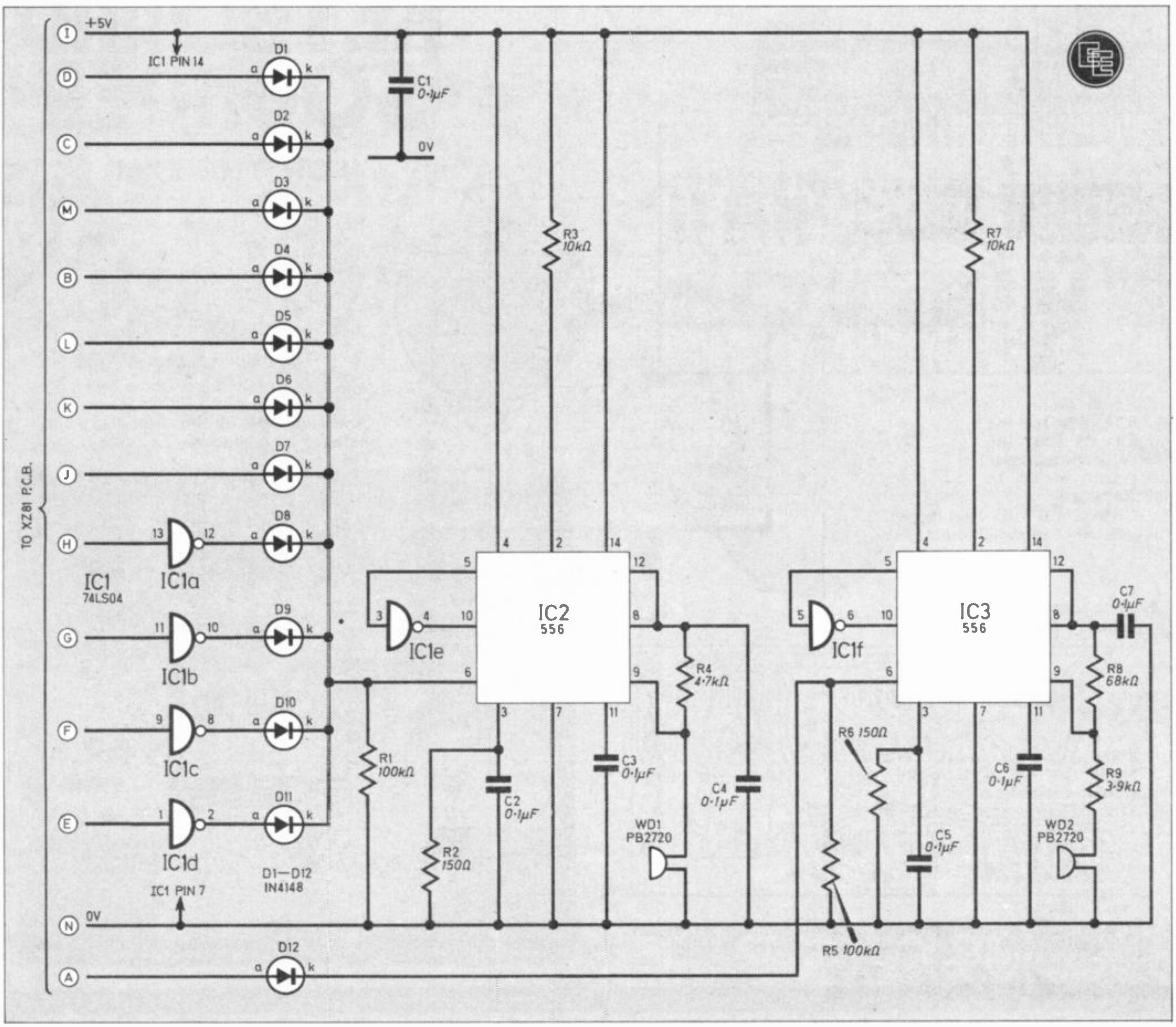
If the input to pin 6 exceeds this level the output changes state—it becomes low (0V). Gate IC1e inverts this low and puts a high on the astable reset, pin 10, enabling it to oscillate and produce a tone in the piezo transducer WD1. R1 holds pin 6 below the threshold level for no input from the keyboard. Capacitors C2, C3 provide decoupling and prevent instability.

IC3 functions identically to IC2, the only difference is R9 which is in series with WD2, this reduces the voltage to it and therefore its volume level. Capacitor C1 decouples the supply rail.

The twelve diodes D1-D12 are necessary to prevent interaction between the keys. The four inverters IC1a, b, c, d, invert the high levels that are on the four keyboard resistors before a key is pressed.

With no keys pressed the output from the diodes can be considered as an open circuit. As soon as a key is pressed the appropriate trigger input receives a voltage above its threshold level and is turned on and produces the required tone—or tones in the case of keys Z X C V or any key that is shifted, for as long as the key is depressed.

Fig. 2. The complete circuit diagram of the Keyboard Sounder.



CONSTRUCTION starts here

CONSTRUCTION AND FITTING

Because the space available inside the computer is limited it was decided to construct the sounder on a small printed circuit board. The full-size master for this is shown in Fig. 3. The component layout on the board topside is shown in Fig. 4, which also includes wiring up details to the ZX81 p.c.b.

Start by fitting the three i.c. sockets, next solder the nine resistors into their correct positions, followed by the 12 diodes and the seven capacitors and short lengths of insulated wire. Once this stage is reached the board should be positioned inside the computer alongside the resident p.c.b. as shown in Fig. 3 and the photograph.

To remove the base from the computer peel off the rubber feet and unscrew the five fixing screws, note that two of them are shorter than the others. The inter-connecting wires are now cut to the correct lengths, stripped and tinned, and the piezo transducers attached. Referring to Fig. 4, solder the board in position. The 5V and 0V connection points on the computer are lacquered and need scraping to show the copper track before soldering.

The three i.c.s. may now be plugged in, and the unit is now ready to test.

Finally stick double-sided adhesive foam strip underneath both the board and transducers to securely hold them in position.

The circuit is powered up when the ZX81 is turned on. Press <SHIFT> to hear a low frequency "buzz" tone. Press in turn each key. A higher pitched tone should be heard. You will hear the buzz-tone as well when keys Z X C V are pressed. This is unfortunate but could not be avoided with this design. This was not found to be a problem or cause confusion in use. Hold <SHIFT> down and press all other keys in turn. The buzz will be heard all the time, and be accompanied by the higher tone when each key is pressed. These results indicate the sounder is functioning satisfactorily. ⌑

KEYBOARD SOUNDER

FOR THE ZX81

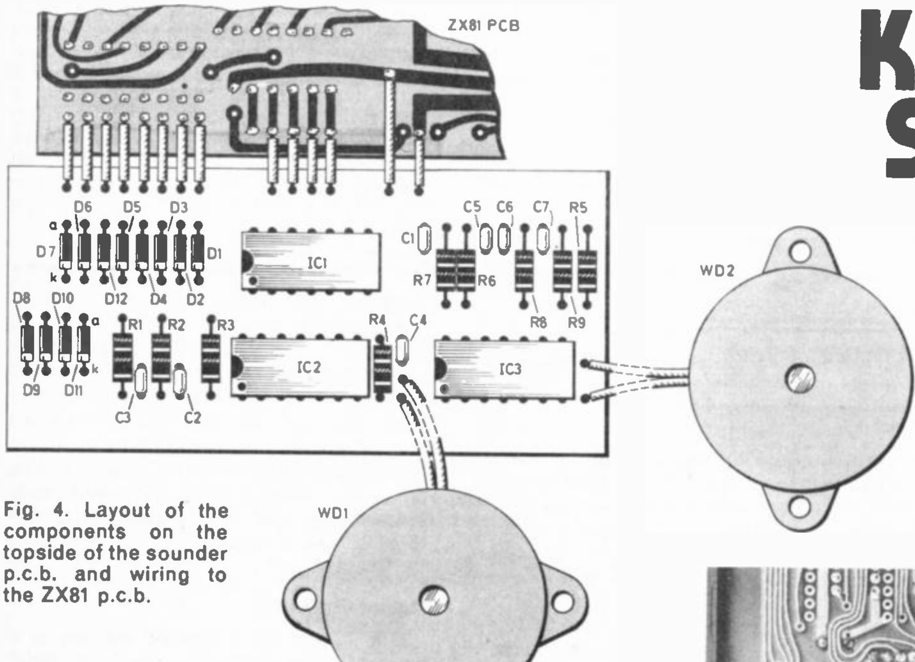
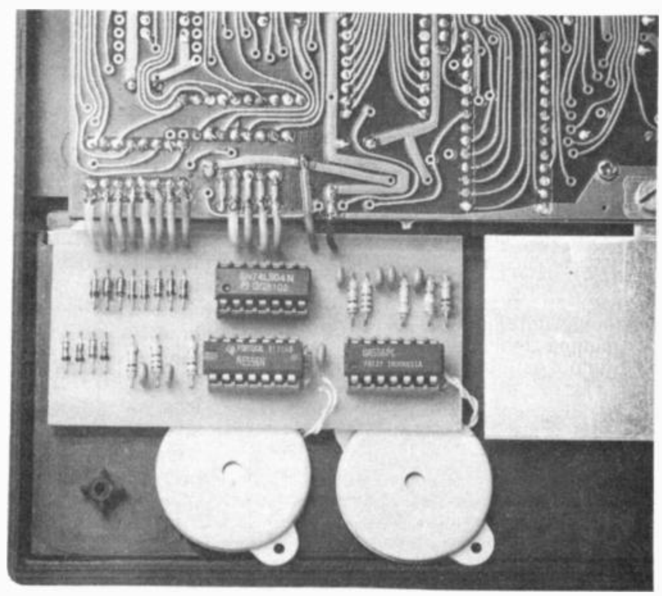


Fig. 4. Layout of the components on the topside of the sounder p.c.b. and wiring to the ZX81 p.c.b.

Close-up view of the sounder p.c.b. installed alongside the ZX81 p.c.b.



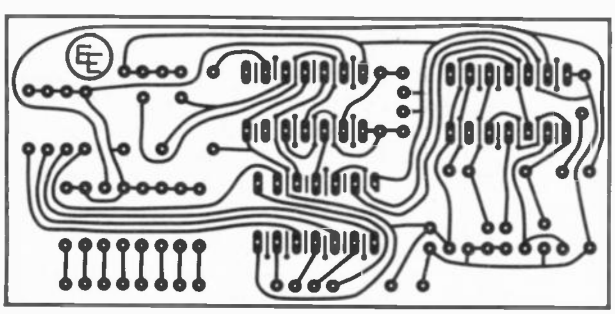
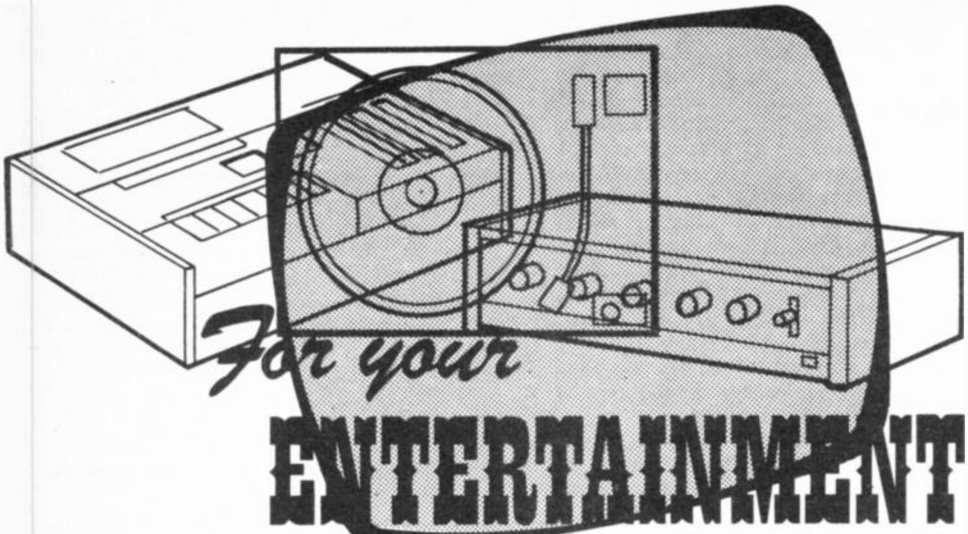


Fig. 3. Full size master pattern to be etched on the p.c.b. The black areas indicate the copper to remain after etching.



For your ENTERTAINMENT

By BARRY FOX

Question of Time

A casual question by a BBC radio producer proved much more difficult to answer than anyone first expected. "What we need here in the studio" he said "is a calculator that adds time. Where can we buy one?"

When a radio programme is put together the producer has to tot up the total time of pre-recorded interviews, taped jingles, and disc records. You can't conveniently do this with an ordinary calculator, because it won't add minutes and seconds unless they are first converted into decimal numbers.

Although there used to be a calculator that added minutes and seconds as well as decimals, it is no longer available. I couldn't find a single calculator in the shops that does the trick, even though it would be a best seller to the radio and TV broadcasting industry.

What I did find, however, was a way of adding time. You do it with a Texas Instruments programmable calculator (either 58, 58C or 59).

These calculators come with a "Master Library" of pre-programmed memories. The Master Library has 25 programmes and one of these, the DMS operations program, number ML23, can be used to add time.

The program is primarily intended for the addition or subtraction of numbers in Degree, Minutes, and Second format. But the program can equally well be used for time calculations using hour, minute, and second format.

So any broadcaster interested in totting up time with a calculator need look no further than a TI programmable and program ML23 of the Master Library. But it's an expensive answer to the problem (programmables cost much more than simple dedicated calculators) and I can't help a nagging suspicion that somewhere, someone must be marketing a simple calculator that does the same job.

Does anyone know of one?

On Change

The British company Fidelity Radio has bought the HMV Nipper trademark. At the trade shows held in London last Spring I chanced on the new Fidelity "Battery Saver" portable radio. It's such a clever idea, and all-British (developed by Fidelity in conjunction with a British university) that I couldn't help wondering why Fidelity had made so little noise about it.

The "Battery Saver" achieves the apparently impossible; it re-charges ordinary dry cell batteries. Not only are dry cells normally regarded as impossible to charge, they often carry a warning telling users not to try.

It is in fact true to say that a dry cell can't be re-charged, once it has died. The electrode converts to a chloride compound and it's impossible to reverse the chemical chain of events. There is a risk of explosion due to the formation of gas inside the sealed case if the charge is anything higher than a trickle of milliamps.

The Fidelity radio which can extend battery life by up to four times, works by putting the batteries on trickle charge very early in their life cycle. Whenever the radio is plugged into the mains the charger feeds a current of around 23 or 24 milliamps into the 9 volt battery as soon as its voltage starts to fall. As charging continues the current is reduced until it reaches zero when the battery has reached a nominal level of 8·7 volts.

This isn't the whole story. If d.c is fed to a dry cell, the zinc tends to reform on the electrode as dendrites. These then flake off, almost immediately. But by superimposing an a.c. signal on the d.c. charge it is possible to prevent the formation of dendrites. So the Fidelity radio charging current is really an a.c. wave which has more positive-going power than negative-going power.

It's an interesting idea because although more and more people are now turning to the use of re-chargeable nickel cadmium batteries, these are expensive and need a separate and expensive charger with current control. Also nickel cadmium cells can be very unpredictable. Some will go on providing years of hard use, others seem to give up the ghost and refuse to hold a charge very early in their working life. Indeed one school of thought says that nickel cadmium cells work best when they are worked hard with plenty of charging and discharging under a demanding load.

Flying Saucer

Philips virtually owns the town of Eindhoven in Holland, made famous by the Arnhem parachute battles in 1944 for bridges across the Rhine.

Frankly there's not much to see in the town except Philips buildings. But one of these is the Evoluon. This is a giant museum of technology and science, shaped like a flying saucer, because the lights round its rim are flashed in sequence to make the whole building look as if it is revolving.

The Evoluon opened in 1966, to mark the 75th anniversary of Philips, and it's very much a "hand-on" museum. There's all manner of electronic gadgetry like that found in the London Science Museum, and the Museum of Technology in Chicago.

Almost every exhibit does something. There's a Meccano machine for drawing rose designs, like those used on bank notes. It draws a different picture every time and there are 10 million possibilities.

There are TV games, explanations of how TV sets work and various opportunities for children to see themselves on a TV screen. Through a powerful magnifying lens you can see how the colour on a TV screen is built up from phosphor dots. On a large domestic TV set there are 1,200,000 or 1·2 million dots; 400,000 of each of the three primary colours, red, green and blue.

The colour balance of different types of lighting is demonstrated by allowing visitors to vary the colour balance of different lamps for themselves. There's a display of 3-D photography and countless film and video shows.

Concern for the environment is a common theme. One exhibit is a pigeon's nest, complete with eggs, formed entirely from short ends of wire. The pigeons had been living in an airport hangar, where packing cases were wrapped with wire. The floor was littered with the short ends snipped off and the pigeons collected them instead of twigs.

Pedal Power

One of the most popular exhibits is a bicycle with a dynamo in the back wheel that provides just enough power for a TV set and camera focused on the bicycle. To produce a picture of yourself on the TV screen you have to pedal hard enough to produce 75 watts.

You'd be surprised how hard it is. It's a useful reminder of how much energy we take for granted at the turn of a switch.

A human being can develop around 75 watts which is around one tenth of a horse power. In practice a horse delivers only around one half this amount of energy over a prolonged period. But it eats food that we won't touch.

So to power a modern house we'd need around 100 human beings pedalling a giant dynamo treadmill, or around 20 horses in the garden tethered to an enormous gear system driving a dynamo. And think of all the hay you'd have to give them every day.

SQUARE **one** FOR BEGINNERS

THIS month, *Square One* is dedicated to the fixed value resistor. This, the most commonplace of components, is the basic building block of many a circuit so an understanding of how to use and identify them is very important.

The unit of resistance is the ohm and is given the symbol omega (Ω).

The normal practice to identify the resistance of a resistor is by means of a colour code, whereby the body of the component has four (and possibly five) coloured "bands" around it. Usually these bands are closer to one end of the resistor and it is from that end that the code starts. Table 1 gives the meaning of each particular band and so, for example, a resistor coded red-red-orange-gold has the value 22×1,000 =22,000 ohms or 22 kilohms (as the prefix "k" or "kilo" means multiples of 1,000). The fourth, gold band indicates a tolerance of plus or minus 5 per cent. A resistor coded blue-grey-green has the value 68×100,000= 6,800,000 ohms or 6·8 megohms (in this case the prefix "M" or "mega" means multiples of 1,000,000). Note that the absence of a fourth band shows this resistor has a tolerance of plus or minus 20 per cent.

Generally available resistors do not come in all possible numerical values but in what is known as "preferred values" and the three most common series of preferred values (E6, E12 and E24) are listed in Table 2. Note decadal multiples and sub-multiples are also to be included, for example, 4·7, 470, 4700 and so on.

Apart from the different tolerances and values, resistors also come in a range of wattages or power ratings, and this will largely determine the physical size of the component. Power is expressed in watts (W) and is equal to the voltage across the resistor multiplied by the current through it.

TABLE 2 PREFERRED VALUES

VALUE	SERIES E6	SERIES E12	SERIES E24
10	●	●	●
11			●
12		●	●
13			●
15	●	●	●
16			●
18		●	●
20			●
22	●	●	●
24			●
27		●	●
30			●
33	●	●	●
36			●
39		●	●
43			●
47	●	●	●
51			●
56		●	●
62			●
68	●	●	●
75			●
82		●	●
91			●

Table 3 lists the most common types of resistor available and gives typical data for each to assist in the selection of the right component.

TABLE 1 RESISTOR COLOUR CODE

Band colour	1st & 2nd bands (1st & 2nd figures)	3rd band (Multiplier)	4th band (Tolerances)
Black	0	×1	—
Brown	1	×10	±1%
Red	2	×100	±2%
Orange	3	×1,000	±3%
Yellow	4	×10,000	±4%
Green	5	×100,000	—
Blue	6	×1,000,000	—
Violet	7	×10,000,000	—
Grey	8	×100,000,000	—
White	9	×1,000,000,000	—
Gold	—	×0·1	±5%
Silver	—	×0·01	±10%
No band	—	—	±20%

A fifth, pink band indicates a high stability resistor.

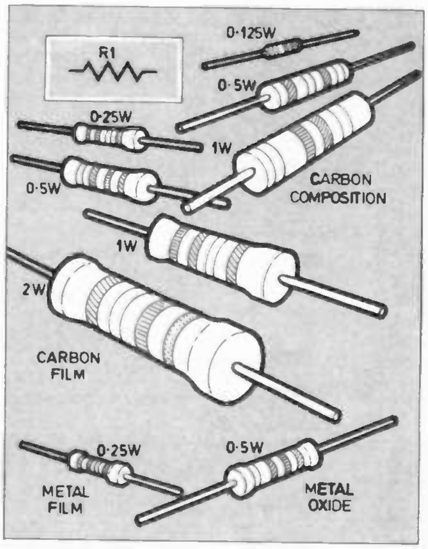


Fig. 1 (right). Shown here is a selection of fixed value resistors, drawn approximately to size. All of those given in Table 3 (with the exception of the wire wound types) are represented. Inset shows the most commonly used circuit symbol.

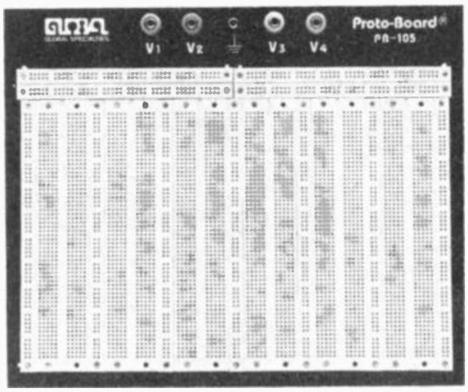
TABLE 3 DISCRETE RESISTOR DATA

TYPE	POWER RATING	TOLERANCE	PREFERRED SERIES		BODY SIZE (mm)	TYPICAL APPLICATION
Carbon film	0·25W	±5%	E12	10Ω to 1MΩ	8 × 2·5 dia.	High stability
	0·5W	±5%	E24	10Ω to 1MΩ	10·5 × 4 dia.	
	1W	±5%	E12	10Ω to 1MΩ	16 × 7 dia.	
	2W	±5%	E12	10Ω to 1MΩ	24 × 9 dia.	
Carbon composition	0·125W	±10%	E6	10Ω to 1MΩ	4·1 × 1·7 dia.	General purpose
	0·5W	±10%	E6	3·3Ω to 10MΩ	10 × 3·5 dia.	
	1W	±10%	E6	2·2Ω to 10MΩ	14·2 × 5·7 dia.	
Metal film	0·4W	±1%	E24	10Ω to 1MΩ	6·5 × 2·5 dia.	Precision
Metal oxide	0·5W	±2%	E24	10Ω to 1MΩ	10 × 4·8 dia.	
Wirewound	2·5W	±5%	E12	0·22Ω to 270Ω	13 × 5·5 dia.	High power
Vitreous wirewound	2·5W	±5%	E6	1Ω to 10kΩ	13 × 5·6 dia.	
Ceramic clad	4W	±5%	E6	1Ω to 10kΩ	6·5 × 8 × 18	
	7W	±5%	E6	0·47Ω to 22kΩ	6·5 × 8 × 38	
	11W	±5%	E6	1Ω to 22kΩ	9 × 10 × 50	
	17W	±5%	E6	1Ω to 22kΩ	9 × 10 × 75	
Aluminium clad	12W (25W)*	±5%	E6	0·47Ω to 470Ω	27 × 28 × 12	Very high power
	25W (50W)*	±5%	E6	0·47Ω to 470Ω	51 × 29 × 15	

* *Power rating given in parentheses for the aluminium clad resistors are for heatsink mounted resistors. All other power ratings are in free air at 70°C max.*

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

SUPERBOARD



New from GSC, the "Superboard" PB-105 is a large area solderless breadboard specially suited to microprocessor based projects and other applications involving large numbers of i.c.s.

It can carry up to 48 14-pin dual-in-line packages, and also incorporates five dual purpose terminals for supplies and/or input and output junctions. It is also possible to accommodate up to 18 distribution busses—enough to satisfy even the most complex of circuits.

From the Proto-Board family, the 105 is based on standard breadboard sockets and bus strips and is claimed to be able to provide 912 terminals and over 4000 tie points. The contact strips have a claimed internal resistance of less than 0·5 milliohms.

Mounted on a robust base plate, the PB-105 Superboard costs £83·95 including VAT, postage and packing.

Global Specialities Corporation, Dept EE, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

BRIGHT LIGHTS

A new family of multi-shaped l.e.d.s suitable for a multitude of diverse indicator applications are now being marketed by Zaerix Electronics Ltd.

Including not only 3mm and 5mm standard devices but also rectangular, square, domed, dot and arrow shapes, almost any design of bargraph and arrowed "null indicators" can be produced.

Comprising 30 lens shapes, 3 lead frame designs and 7 basic diffused or transparent colours these GaAsP/GaP and GaP devices have a claimed power dissipation figure of 105mW and luminous intensity capabilities of up to 20mcd at 20mA—fairly bright!

Zaerix Electronics Ltd, Dept EE, Electron House, Cray Avenue, St Mary Cray, Orpington, Kent BR5 3QJ.

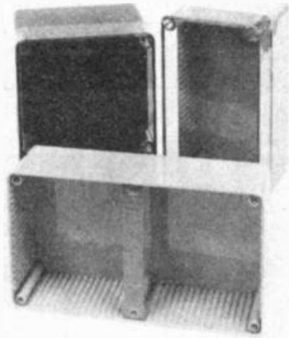
SEE-THROUGH LID

Suitable for use in a variety of applications, such as timers and controllers, where viewing of, but not necessarily access to internal components is required, Boss Industrial Mouldings have added a deep profile clear lid to their BIM2000 range of Bimboxes. Coloured versions of the lid are also available.

Designed to fit on the 2006 case, the transparent lid is designated BIM2006/26 and measures 190 x 110 x 90mm high.

The lids incorporate small flanges, which sit recessed into the base and help to prevent the ingress of moisture.

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



HOME BASE

Complementing its successful portable in-car CB rigs, Fidelity Radio have just announced the introduction of a new home base station. The mains operated CB3000-FM meets all the required UK specifications.

Features of the base station, suitable for the lounge or bedroom shelf, include a 40 channel selector with l.e.d. indicator and separate Channel Nine selection for the emergency frequency. There are rotary front panel controls for r.f. gain, calibration, tone, squelch and volume on/off.

An SWR and level meter is included as are PA or CB, calibrate, reflected power, and power/signal selection push "tabs". Input and output sockets are provided for headphone, external speaker, PA speaker, tape recording and microphone.

The CB3000FM home base station is supplied complete with microphone and holder.

Fidelity Radio Ltd, Dept EE, Victoria Road, London NW10 6ND.

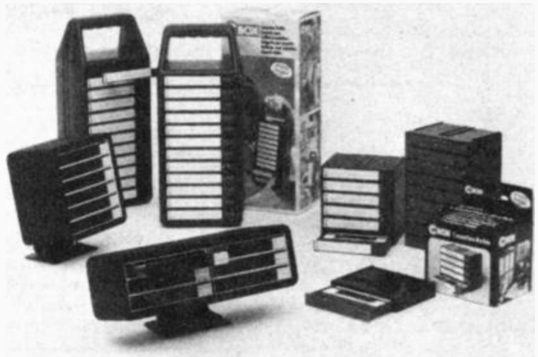
CASSETTE STORE

A range of versatile cassette storage units, with spring loaded drawers, have just been launched by Artur Fisher (UK) Ltd. They offer versions for vehicles, portable packs and for building up a home library.

The individual Fisher C-Box consists of a moulded case containing a spring-loaded drawer, that is opened by pressing a release button to one side of the case. The cassette sits on two pins designed to hold the spools firmly in place so that the tape cannot unravel.

An interlocking facility is included on the top and bottom of the boxes to allow vertical stacking if required.

Artur Fisher (UK) Ltd, Dept EE, Ficher House, 25 Newton Road, Marlow, Bucks SL7 1JY.



CIRCUIT EXCHANGE

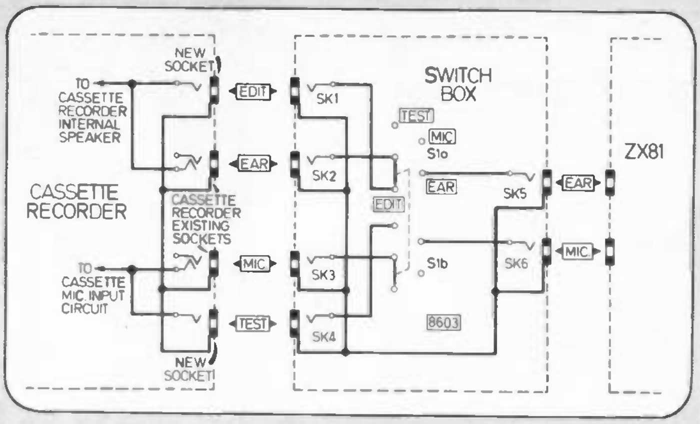
CONTINUITY AND POLARITY TESTER

This circuit is for a simple and inexpensive audible continuity and polarity tester. T1 (half of a miniature audio output transformer), R1 C1 and TR1 are wired as a simple oscillator which forms the basis of the unit.

The continuity tester is operated by switching S1 to the CONTINUITY position so that R1 is connected to SK1. A probe is then plugged into this socket, and S2 is switched to connect the battery to the circuit. The unit produces a continuous tone to indicate continuity.

The polarity tester is operated by connecting R1 to TR1 base and C1 via S1 in the POLARITY position and then S2 is switched to disconnect the battery from the circuit. The probe is plugged into SK2 and the power supply of the circuit under test is connected to the unit. A tone will now be heard. When the probe from SK2 is placed on a point with a positive potential, the tone will cease and a negative potential causes the tone to lower. The unit must *not* be used for high voltages or mains testing.

Christopher Wheattey,
Havant,
Hants.

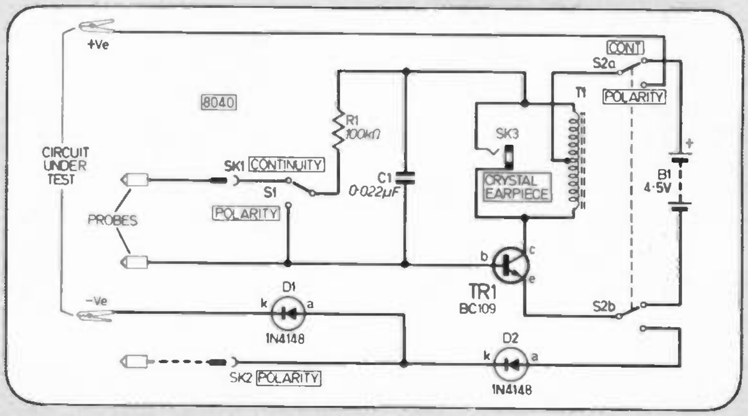


ZX81 SWITCH BOX

Users of the ZX81 will be well aware of the necessity to unplug their cassette recorder "ear" and "mic." plugs if they wish to add a voice lead in circuit or listen to a programme; or unplug the "ear" plug whilst saving, in order to prevent feedback.

To overcome this chore, which has the danger of crossing over connections, I have built a matching switch box according to the enclosed circuit. The cost is approximately £5, but can be reduced by wiring direct to the switch S1, thus saving six plugs and sockets.

M. J. Brady,
Nottingham.



CYCLE LAMP BACK-UP CIRCUIT

If your bicycle is equipped with dynamo type lighting, then the lights will of course turn off at a road junction. It goes without saying that this is very dangerous because other road users will no longer be able to see you and you are likely to be hit by cars from all directions.

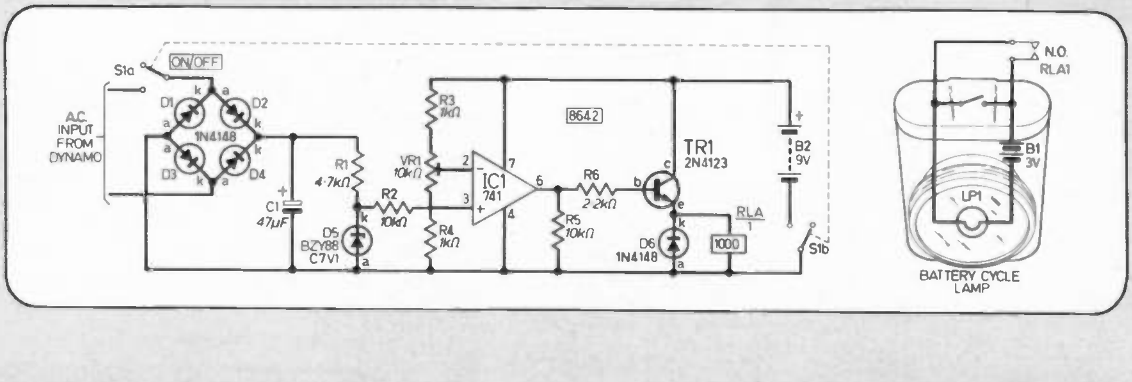
This circuit detects when the voltage produced by the dynamo is insufficient to adequately power the lamps and then turns on a relay to switch on an additional battery operated lamp. The relay will automatically switch off when the dynamo output has once again reached the correct level. Thus combining the economy of a dynamo with the safety of battery operated lights.

The a.c. from the dynamo is rectified and smoothed by D1 to D4 and C1, and then coupled to one input of IC1, a 741 op-amp, with Zener diode D5 preventing the input voltage exceeding the op-amp supply voltage. RV1 is adjusted so that TR1 just switches on the relay RLA at the desired level, and the normally open contacts are then wired in parallel with the switch on the battery lamp.

The finished unit can easily be tucked beneath the saddle.

Use a double-pole relay if rear light back-up is also required.

Hugh Falkner, Kenilworth, Warks.



NEW AND FREE FROM GSC.

NEW an exciting range of projects to build on the EXP300 breadboards.
NOW anybody can build electronic projects using "Electronics-by-numbers", its as "Easy as A, B, C with G.S.C!"

FREE project

MUSICAL DOORBELL OF THE 3RD KIND

You've seen the film, now haunt your visitors with the tune!
Each time the doorbell is pushed the eerie tune plays out, then switches off to conserve battery power.

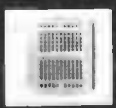
HOW DO YOU MAKE IT.

Our **FREE** project gives you clear "step-by-step" instructions. For example "take Resistor No.1 and plug it into hole numbers B45 and B47".
"Take IC No.1 and plug it into hole numbers E35 to E42 and F35 to F42, (pin 1 on the IC goes into F35)"
"Take. . ." Welll why not "clip-the-coupon" and get your **FREE** step-by-step instruction sheet and your **FREE** 12 projects with each **EXP300** bought and your **FREE** catalogue and. . . . .

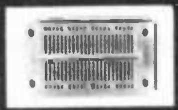
EXPERIMENTOR BREADBOARDS

The largest range of breadboards from GSC.
Each hole is identified by a letter/number system
EACH NICKEL SILVER CONTACT CARRIES A LIFE-TIME GUARANTEE.

All modular construction means that any Experimentor breadboard can be 'snap-locked' together to build breadboards of any size.



EXP325
The 'one-chip' breadboard
Takes 8, 14, 16 and up to 22 pin IC's
Has 130 contact points including 2 bus bars.



EXP350
The 'beginners-breadboard'
For limited period you can have **FREE** 12 'Electronics by Numbers' **PROJECTS**

EXP300

The most 'widely-bought' breadboard
Don't miss out on our **'NEW AND FREE'** projects
They can be built on the **EXP300**.

EXP600
The Hobbyist microprocessor' board

EXP650
The 'one chip microprocessor' board

EXP4B
'Snaps-on' four extra bus bars

PB6
The ultimate breadboard kit

PB100
The most kit for the least money

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Goods despatched within 48 hours.
TO ORDER JUST CLIP THE COUPON.

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Exp 350	£ 4.48	
Exp 300	£ 7.76	
Exp 600	£ 8.39	
Exp 650	£ 5.00	
Exp 4B	£ 3.50	
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Sinclair ZX81 Personal Comp
the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

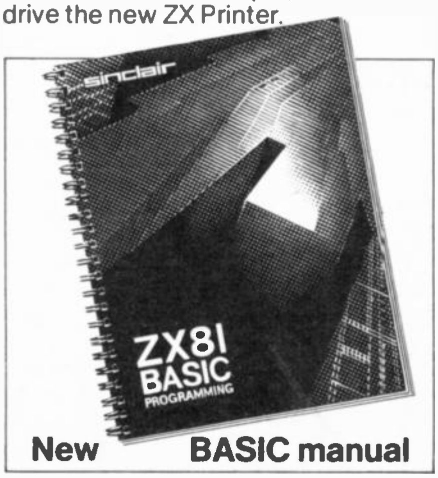
In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.



New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 700 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

uter-

Available now- the ZX Printer for only £59.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81
BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.
BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.
EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST , Camberley, Surrey, GU15 3BR. Order

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (700 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	29.95	
	Sinclair ZX Printer.	27	59.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

☐ Please tick If you require a VAT receipt TOTAL £

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Please print.

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FREEPOST – no stamp needed. Offer applies to UK only. EVE06

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ZX81

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SUPER HI-FI SPEAKER CABINETS

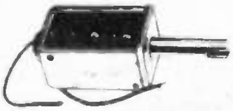
Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

GOODMANS SPEAKERS

6½" 8 ohm 25 watt £4.50. 2½" 8 ohm tweeter. £2.50. No extra for postage if ordered with cabinets. Xover £1.50.

UNIVAC KEYBOARD BARGAIN

50 keys, together with 5 miniature toggle switches all mounted on a p.c.b. together with 12 i.c.'s, many transistors and other parts.
£13.50 + £2.00 post.
This is far less than the value of the switches alone. Diagram of this keyboard is available separately for £1.



SOLENOID WITH PLUNGER

Mains operated £1.99
10 – 12 volts DC operated £1.50.

POPULAR KITS

3 - 30v VARIABLE VOLTAGE POWER SUPPLY UNIT
With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit £13.80

IONISER KIT
Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — complete mains operated kit, case included £11.95 plus £2.00 post.

MORSE TRAINER
Complete kit £2.99.

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Complete kit £3.95.

MAINS POWER SUPPLY
Gives any voltage from 3v to 16v at up to 300mA. Complete kit less case £1.95. Case 90p.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage whichever suits you best. Price £12.50 + £3.00 post.

CHANCE OF A LIFETIME

We have to clear a big store. 100 tons of stock must go. 10 kilo parcel of unused parts. Minimum 1,000 items includes panel meters, timers, thermal trips, relays, switches, motors, drills, taps and dies, tools, thermostats, coils, variable condensers, variable resistors, etc. etc. Individually these must cost in excess of £100. YOURS FOR ONLY £11.50 plus £3.00 post.

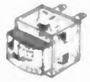
MILLIONS OF HOMES WILL BE BURGLED THIS SUMMER — SAY THE EXPERTS

Don't let yours be one of them. Install our burgar alarm. Install our burglar alarm. Complete kit includes 6" external alarm bell, mains power unit control box with key switch 10 window/door switches 100 yards of wire. With Instructions £29.50.

TINIEST MICROPHONE

Not much bigger than a pea, 600 ohm condenser type. Ideal for bugging and similar applications. 50p each or 10 for £4.50.

LEVEL METER

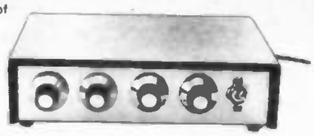


Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. 75p.

THERMOSTAT ASSORTMENT

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

3 CHANNEL SOUND TO LIGHT KIT



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

STANDARD RELAYS

3 changeover 10 amp contacts, single screw fixing, mains operated. £1.25. 12 volt operated £1.50. 6 volt model 99p.
Other coil voltages — please enquire.

ULTRA SMALL 12v RELAYS

Single pole gold plated contacts. Tubular construction, 17mm long 10mm dia. Ideal for models. PCB or freemounting. £2.30 ea.

MINAITURE PLUG IN RELAYS

12v operated. 3 changeover. £2.45, base 45p.
12v operated. 2 changeover. £1.87, base 35p.

THIS MONTH'S SNIP

0 - 100 MICRO AMP PANEL METER

Japanese made, flush mounting, size approximately 45mm x 50mm x 30mm deep.
PRICE £2.95.

ROTARY WAFER SWITCHES

5 amp silver plated contacts. ¼" shaft. 1" dia. wafer.

Single wafer types, 29p each, as follows:

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

Two wafer type, 59p each, as follows

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

3 wafer types 99p each,

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

EXTRACTOR FAN

Mains operated — ex-computer
5" Woods extractor £5.75, Post £1.25.
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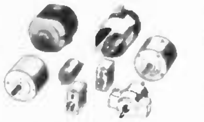
4" x 4" Muffin 115v. £4.50. Post 75p.
4" x 4" Muffin 230v. £5.75. Post 75p.



8 POWERFUL BATTERY MOTORS

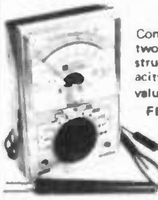
For models, maccanos, drills, remote control planes, boats, etc. £2.95.

TAPE PUNCH & READER

For controlling machine tools, etc, motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. £17.50 pair. Post £4.00.

MINI-MULTI TESTER

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



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 60p post and insurance.

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

12V FLUORESCENT LIGHTING

For camping — car repairing — emergeny lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an Inverter for 21" 13 watt miniature fluorescent tube. £3.45. (tube not supplied).

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

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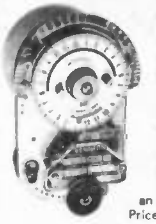
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30. (not licenceable in the U.K.)

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit. (not licenceable in the U.K.).

FM RECEIVER

Made up and working, complete with scale and pointer needs only headphones, ideal for use with our surveillance transmitter or radio mike. £5.85. or kit of parts £3.95.



VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case but we can supply a plastic base £1.75 or metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controllerfor the immersion heater. Price of adaptor kit is £2.30.

STEREO HEADPHONES

Very good quality, 8 ohm impedance, padded, terminating with standard ¼" jack-plug £2.99 post 60p.

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

ZX81 OWNERS

Make yourself a full size keyboard! Key switches complete with plain caps. 6 for £1.15.

RESISTORS

Carbon film, 1/4 or 1/3 watt, standard leads, not pre-formed, all 5% values: 1p each 100's. 2p each 10. 5p each less than 10 per value. OR — INVENTOR'S PACK, containing 10 of each of 60 different values from 1 ohm to 10 megohm, packed separately, £5.75.

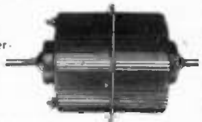
DELAY SWITCH

Mains operated — delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps — second contact opens a few minutes after 1st contact. £1.95.

MOTORS FOR ROBOTICS

If its a toy robot you are making then one of our eight battery motors (see centre column) may do. If its a bigger one, however, then see below If still not big enough then enquire — we have larger motors but these are usually mains driven.

12v MOTOR BY SMITHS



Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45.
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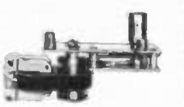

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See below for ordering information.

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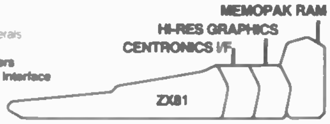

All these products are designed to fit 'piggy-back' fashion on to each other, and use the Sinclair power supply. WATCH THIS SPACE for further details. We regret we are as yet unable to accept orders or enquiries concerning these products – but we'll let you know as soon as they become available.

How to order your Memopak.

By Post: Fill in the coupon below and enclose your cheque/P.O./Access or Barclaycard number.

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8–16K . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programmes, and can be used to run assembly language routines.
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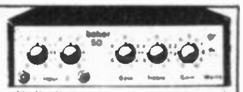

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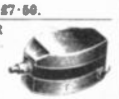

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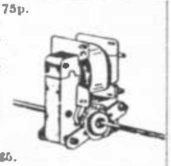

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