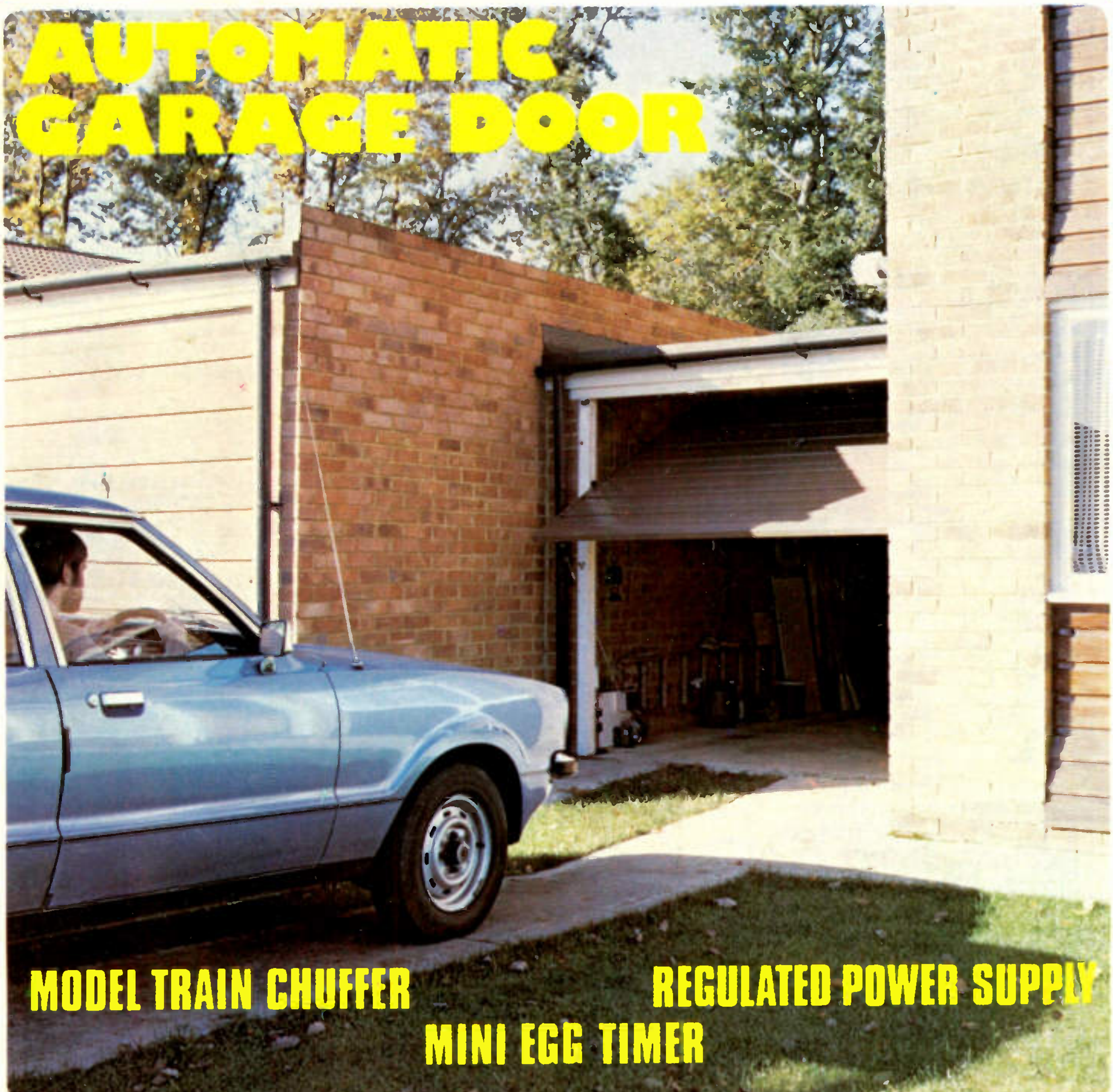
Easy to build projects for everyone

Everyday ELECTRONICS

JAN. 82
70p



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VOL. 11 NO. 1 JANUARY 1982

Everyday ELECTRONICS

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

Seasonal Greetings to all our readers

Our February issue will be published on Friday, January 15. See page 43 for details.

PROJECTS

SERIES

FEATURES

ELECTRONI-KIT

DENSHI KITS—

Final offer on kit type SR-3A

". . . . fun and entertainment as well as education" — **(EVERYDAY ELECTRONICS** mag.)

This is the final opportunity to obtain this first-class multi-project kit at little more than its 1977 price! **(Current value over £40).**

Circuits are constructed by plugging the encapsulated components into the boards provided, following the instruction manual. Technical details are also given concerning each project. The components are used over and over again and you can design your own circuits too, or use the kit as a useful testing board. No previous experience of electronics is required but you learn as you build—and have a lot of fun too. The kits are **safe for anyone.**

SR-3A KIT (16½″ 10″ 2½″) **£29·95**

Build over 100 projects including 3-TR reflex radio receiver, 3-TR radio receiver with RF amplifier, 2-TR reflex radio receiver, 3-TR amplifier for crystal mike, 3-TR amplifier for speaker/mike, 3-TR signal tracer, Morse Code trainer, 2-TR electronic organ, electronic metronome, electronic bird, electronic cat, electronic siren, electronic gun, 2-TR sleeping aid, high voltage generator, discontinuity warning device, water supply warning device, photoelectric alarming device, 3-TR burglar alarm, 3-TR water supply warning device, 3-TR water level warning device, 3-TR photoelectric alarming device, Morse Code trainer with sound & light, discontinuity warning device with sound & light, water level warning device with sound & light, electronic metronome with sound & light, buzzer with sound & light, wireless mike, wireless telegraph set, wireless discontinuity warning device, wireless water level warning device, wireless water supply warning device, wireless photoelectric warning device, etc.

All kits are guaranteed and supplied complete with extensive construction manual **PLUS** Hamlyn's "All Colour" 160 page book "Electronics" (free of charge whilst stocks last).

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AC126 25
AC127 25
★AC128 16
AC176 25
AC187 22
AC188 22
AD142 120
AD149 80
AD161 40
AD162 40
AF124 60
AF126 50
AF139 40
AF186 70
AF239 75
BC107 10
BC107B 12
★BC108 8
BC108B 12
BC108C 12
★BC109 8
BC109C 12
BC114 22
BC115 22
BC117 22
BC119 35
BC137 40
BC139 40
BC140 30
BC141 30
BC142 25
BC143 25
BC147 8
BC148 8
BC149 9

★BC157 8
BC158 10
★BC159 8
BC160 45
BC168C 10
BC169C 10
BC170 8
BC171 10
BC172 8
BC177 18
BC178 18
BC179 18
BC182 10
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BC184 10
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BC237 8
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BC308 15
BC327 14
BC328 14
BC337 14
BC338 14
BC477 30
BC478 30
BC479 30
BC517 40
★BC547 7

BC548 10
BC549 10
BCY70 18
BCY71 18
BCY72 18
BD115 80
BD131 35
BD132 35
BD133 50
BD135 50
BD136 30
BD137 30
BD138 30
BD139 35
BD140 35
BD204 110
BD206 110
BD222 85
BF180 35
BF182 35
BF184 25
BF185 25
BF194 12
BF195 12
BF196 12
BF197 12
BF198 10
BF199 18
BF200 30
★BF244B 18
BF245 30
BF256B 45
BF257 32
BF258 25
BF259 35
BF337 40
BFR40 23

BFR80 25
BFX29 25
BFX84 25
BFX85 25
BFX86 28
BFX87 25
BFX88 25
BFY50 23
BFY51 23
BFY52 23
BFY53 32
BFY55 32
BFY56 32
BRY39 40
BSX20 20
BSX29 35
BSY95A 25
BU205 160
BY206 200
BU208 170
MJ2955 99
MJE340 50
MJE520 65
MJE521 95
MJE3055 70
MPF102 40
MPF104 40
MPSA05 22
MPSA06 25
MPSA12 30
MPSA55 30
MPSA56 30
MPSU05 55
MPSU55 60
MPSU56 60
TIP29 35
TIP29A 40
TIP29B 55

TIP29C 60
TIP30 45
TIP30A 40
TIP30B 50
TIP30C 60
TIP31A 45
TIP31B 45
TIP31C 55
TIP32A 45
TIP32B 55
TIP32C 60
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TIP33C 75
TIP34A 60
TIP34C 85
TIP35A 160
TIP35C 180
TIP36A 170
TIP36C 195
TIP41A 60
TIP42A 60
TIP120 90
TIP121 90
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TIP141 120
TIP142 120
TIP147 120
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TIP3055 55
TIS43 40
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TIS45 45
TIS90 30
TIS91 30
★VN10KM 45
VN46AF 75
VN66AF 85

VN88AF 95
★ZTX107 8
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ZTX109 12
ZTX300 14
ZTX301 16
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ZTX304 17
ZTX341 30
ZTX500 15
ZTX501 15
ZTX502 15
ZTX503 18
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2N706A 20
2N708 20
2N918 35
2N1132 22
2N1613 30
2N2218A 45
2N2219A 25
2N2221A 25
2N2222A 20
2N2368 25
★2N2369 11
2N2484 25
2N2646 45
2N2904 20
2N2904A 20
2N2905 22
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2N2907 25
2N2907A 25
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★2N3053 20
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2N5458 36
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2N5485 36
2N5777 45
2N6027 30
40360 40
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40362 50
40408 70
40594 100

CMOS

4000 14
★4001 12
4002 14
4006 65
4007 17
4008 58
4009 30
4010 35
★4011 13
4012 17
★4013 22
4014 60
4015 50
★4016 22

★4017 43
4018 60
4019 35
★4020 55
4021 65
4022 70
4023 18
4024 40
4025 18
★4026 96
4027 30
4028 55
4029 75
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4034 170

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4055 115
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4063 90
4066 35
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★4093 33
4094 140
4095 90
4097 340
4098 85
4099 95
40106 50
40109 100
40163 100
40173 100
40175 100
40193 120

4502 70
4503 50
4507 38
4508 200
4510 65
★4511 50
4512 70
4514 180
4515 180
4516 75
★4518 45
4520 70
4521 200
4526 80
4527 90
★4528 65

4529 150
4532 95
4534 495
4538 110
4543 110
4549 380
4553 295
4555 45
4556 48
4559 390
4560 180
4584 45
4585 99
4724 140

TTL

★7400 11
7401 11
7402 12
7403 14
7404 14
7405 17
7406 26
7407 26
7408 15
7409 16
7410 14
7411 20
7412 20

★7413 24
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7497 120
74100 80

74107 30
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74123 45
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74126 40
74132 40
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74148 75
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74153 45
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74180 65
74181 135
74182 75
74190 70
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74192 70
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74194 70
74195 63
74196 63
74197 63
74198 95
74199 95

LS TTL

LS00 13
LS01 14
LS02 14
LS03 14
LS04 15
LS05 15
LS08 16
LS09 16
LS10 16
LS11 16
LS12 15
LS13 25
LS14 48
LS15 15
LS20 15

LS21 15
LS22 16
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LS37 16
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LS47 40
LS48 70
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LS75 27

LS76 20
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LS273 90
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LS283 45
LS353 100

LS365 38
LS366 38
LS367 38
LS368 50
LS373 80
LS374 80
LS375 50
LS377 90
LS378 70
LS390 75
LS393 75
LS399 220
LS541 135
LS670 175

LINEAR

★709 25
★741 14
748 35
AY-3-1270 840
AY-3-8910 700
AY-3-8912 625
CA3046 60
★CA3080 55
CA3089 214
CA3090AQ 375
CA3130E 95

CA3140E 45
CA3160E 100
CA3162E 450
CA3189E 290
ICL7106 790
ICL8038 320
ICM7555 80
★LF351 40
LF353 85
LF356 85
LM10 359
★LM301A 25
LM311 70
LM318 85

★LM324 40
LM339 50
LM348 90
LM358 90
LM377 150
★LM380 65
★LM381 100
LM382 120
★LM386 65
LM387 120
LM393 100
LM709 40
LM710 50
LM725 350

LM733 75
★LM741 14
LM747 75
LM748 35
LM1458 40
LM2917 200
LM3900 50
LM3909 70
LM3911 120
LM3914 200
LM3915 200
LM13600 120
MC1310 150
MC3302 150
MC3340 135
NE515 270
NE529 225
NE531 150

NE544 185
★NE555 16
★NE556 45
NE565 120
NE566 150
★NE567 100
NE571 425
RC4136 90
SN76018 170
SN76018 150
SN76477 150
TBA641B11 250
TBA800 80
TBA810 95
TBA820 80
TBA950 290
TCA940 140
TDA1004 300

TDA1008 320
TDA1010 225
★TDA1022 560
TDA1024 125
TLO71 45
TLO72 75
★TLO81 30
TLO82 70
★TLO84 90
★XR2206 300
ZN414 100
ZN423 195
ZN424 135
ZN425E 390
ZN426E 330
ZN427E 650
ZN428E 480
ZN1034E 200

CONNECTORS

DIN	Plug	Socket
2 pin	9p	9p
3 pin	12p	10p
5 pin	13p	11p
Phono	10p	12p
1mm	13p	13p

Jack	Plug	Socket
2.5mm	10p	10p
★3.5mm	★7p	★7p
Std.	16p	20p
Stereo	24p	25p
4mm	18p	17p

UHF (CB) Connectors
PL259 Plug 40p — Reducer 14p
SO239 Square chassis socket 38p
SO239S Round chassis socket 40p

IEC 3 pin 250V/6A
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2 metre lead 120p

HARDWARE

PP3 Battery clips 6p
Red or Black crocodile clips 6p
Black pointer control knob 15p
Pair ultrasonic transducers 350p
4mm terminals (various colours) 33p
64mm 64 ohms min. speaker 70p

BOXES

Dimensions in inches. Aluminium.

3 × 2 × 1	70p	6 × 4 × 2	120p
4 × 3 × 1½	85p	6 × 4 × 3	150p
4 × 3 × 2	100p	8 × 6 × 3	180p

COMPONENT KITS

An ideal opportunity for the beginner or the more experienced constructor to obtain a wide range of components at reduced prices.

¼W 5% Resistor Kit. Contains 10 of each value form 4·7Ω to 1M (650 resistors) 480p.
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Nut and Bolt Kit. Total 300 items 140p

25	6BA ½" bolts	25	4BA ½" bolts
25	6BA ¼" bolts	25	4BA ¼" bolts
50	6BA washers	50	4BA washers
50	6BA nuts	50	4BA nuts

PANEL METERS

Size 60 × 46 × 35mm.

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

450p each.

VERO

Verobloc 350p
Size 0·1 matrix
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
Double sided 60p
Spot face cutter 105p

TRANSFORMERS

Miniature mains.
606V, 909V, 12012V all @ 100mA — 100p each
High quality. Split bobbin construction.
6VA 0-6, 0-6V @ 0·5A; 0-9, 0-9V @ 0·4A; 0-12, 0-12V @ 0·3A — 220p each
12VA 0-6, 0-6V @ 1A; 0-9, 0-9V @ 0·6A; 0-12, 0-12V @ 0·5A; 0-15, 0-15V @ 0·4A — 275p each (plus 40p carriage)
24VA 0-6, 0-6V @ 1·5A; 0-9, 0-9V @ 1·2A; 0-12, 0-12V @ 1A; 0-15, 0-15V @ 0-8A — 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A; 0-15, 0-15 @ 1·6A — 400p each (plus 70p carriage)
100VA 0-30, 0-30V @ 1·6A 920p each (plus 80p carriage)
Please add carriage charges to our normal postage charge.

CABLES

20 metre pack single core connecting cable, ten different colours 65p
Speaker cable 10p/m
Standard screened 16p/m
Twin screened 24p/m
2·5A 3 core mains 23p/m
10 way ribbon 65p/m
20 way ribbon 120p/m

OPTO

★3mm red	7p	★5mm red	8p
★3mm green	12p	★5mm green	12p
★3mm yellow	12p	★5mm yellow	12p

Clips to suit 3p each.

Rectangular		TIL32	40p
★Red	12p	TIL78	40p
Green	17p	TIL111	60p
Yellow	17p	ORP12	85p

Seven Segment Displays

Com. cathode			Com. anode		
DL704	0·3in	95p	DL707	0·3in	95p
★FND500	0·5in	65p	FND507	0·5in	90p
TIL313	0·3in	105p	TIL312	0·3in	105p
TIL322	0·5in	115p	TIL321	0·5in	115p

All seven segment displays are supplied with connection details.
2N5777 45p — Dual colour LED 65p

PCB MATERIALS

Alfac transfer sheets 45p
Dalo etch resist pen 100p
Fibre glass board 3·75 × 8" 70p
Ferric Chloride 250ml bottle 100p

CRYSTALS

100KHz	290p	6·144M	180p
200KHz	370p	7·00M	250p
1MHz	300p	8·0M	170p
1·008M	370p	10·0M	180p
1·8432M	300p	12·0M	290p
2·0M	270p	16·0M	240p
2·4576M	220p	18·0M	240p
3·276M	240p	18·432M	220p
3·579M	120p	19·968M	300p
4·0M	150p	26·69M	300p
4·194M	150p	27·145M	240p
4·43M	125p	38·6667M	320p
5·0M	240p	48·0M	220p
6·0M	200p	116M	300p

SOLDERING IRONS

Antex CX 17W Soldering iron 420p
2·3mm and 4·7mm bits to suit 55p
CX 17W element 190p
Antex X25 25W soldering iron 440p
3·3mm and 4·7mm bits to suit 55p
X25 25W element 190p
Solder pump desoldering tool 480p
Spare nozzle for above 70p
10 metres 22 swg. solder 100p

DIODES

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

POTENTIOMETERS

Rotary. Carbon Log or Lin 5K-1M. Single 32p. Stereo 85p.
Slide. 60mm travel single Log or Lin. Vales 5K-500K 63p.
Preset. Submin. horizontal values 100Ω-1M.

SOCKETS

★8 pin	7p	22 pin	20p
★14 pin	9p	24 pin	22p
★16 pin	10p	28 pin	26p
18 pin	15p	40 pin	32p
20 pin	18p		

Soldercon pins 60p/100.

REGULATORS

Positive		Negative	
★78L05	25p	79LO5	65p
78L12	30p	79L12	65p
78L15	30p	79L15	65p
★7805	45p	★7905	45p
★7812	45p	★7912	45p
7815	60p	7915	60p
LM309K	130p	★LM323K	350p
★LM317T	120p	LM723	40p

CAPACITORS

Polyester. Radial leads. 250V C280 type.
0·01, 0·015, 0·022, 0·033, 6p; 0·047, 0·068, 0·1, 7p; 0·22, 9p; 0·22 13p; 0·47 13p; 0·68 20p; 1·0 23p.

Electroytic. Radial leads or Axial leads.
0·47/63V, 1/63V, 2·2/63V, 4·7/63V, 10/25V, 7p; 22/25V, 27/25V, 8p; 100/25V, 9p; 220/25V, 14p; 470/25V, 20p; 1000/25V, 30p.

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.

Polystyrene. 5% tolerance.
10p–1000p 6p. 1500p–4700p 8p. 6800p–0·012 10p.

Ceramic.
22p–0·01u. 50V type. 3p each.

Trimmers. Mullard 808 series.
2–10pF 22p. 2–22pF 30p. 5·5–65pF 35p.

RESISTORS

¼W 5% Carbon film E12 series 4·7Ω-10M 1p each.
⅛W 5% Carbon film E12 series 4·7Ω-4M7 2p each.
¼W 1% Metal film. E24 series 10Ω-1M. 6p each.

BRIDGE RECTIFIERS

1A	50V	22p	4A	400V	95p
1A	400V	35p	6A	100V	80p
2A	200V	40p	6A	200V	9p0
2A	400V	45p	6A	400V	95p
4A	200V	90p			

TRIACS + SCRS

SCRs			TRIACS		
★C106D		30p	400V	4A	60p
400V	8A	70p	400V	8A	70p
400V	12A	99p	400V	16A	105p

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Everyday ELECTRONICS

VOL. 11 NO. 1 JANUARY 1982

INFORMATION YEAR

The start of a new year offers an excuse for recalling the past and anticipating the future. When our ruminations involve electronics we quickly come to realise that much has happened to justify earlier predictions and that today we live in a society very dependent both for work and pleasure upon the products created by this technology. A world without electronics is simply not imaginable to anyone under around forty. And it is a fair bet that even those whose memories can take them back to the days before electronics entered the vocabulary would be reluctant to do without their TV or hi-fi, or maybe personal computer, to say nothing of the countless less obvious but very important electronic appurtenances that contribute "behind the scenes" to the higher standard of living we enjoy today.

A notable development over the past few years has been the bringing together of different branches of applied electronics to form comprehensive systems where, for example, vision and sound are complementary to computing, and where distance between equipments has become no object thanks to flexible telecommunications networks, which may include space satellites.

This kind of integration of electronic functions is well illustrated by Information Technology. The purpose of this newly created, or rather newly labelled, technology is to exploit computing and other data processing techniques by co-ordinating them with the latest methods for communicating and interfacing with people or other machines. The ability to have immediate access to vast stores of facts and figures with computing capabilities also on hand is bound to transform the running of businesses, industries and large administration centres like governmental departments. Eventually similar facilities will be available in the home, Prestel viewdata and Teletext being a taste of what is to come.

There are, of course, social as well as economic implications in the large scale use of Information Technology. Will we be able to make sensible use of all the data and information likely to be instantly available? How secure will these information sources be; will it be possible to ensure that private and confidential information does not get into the wrong hands—or onto the wrong VDU screen?

But whatever forebodings there may be, there can be no doubt about the coming of the "information revolution." For vested commercial interests have a powerful ally in the Government. Information has become the in-thing, a vital aid to economic recovery, no less. To ram this fact home, the Minister of State appointed to watch over this young technology announced recently that 1982 has been designated Information Technology Year. So everyone should get the message during the coming months, even though it's via the old fashioned printed word in newspaper or magazine.

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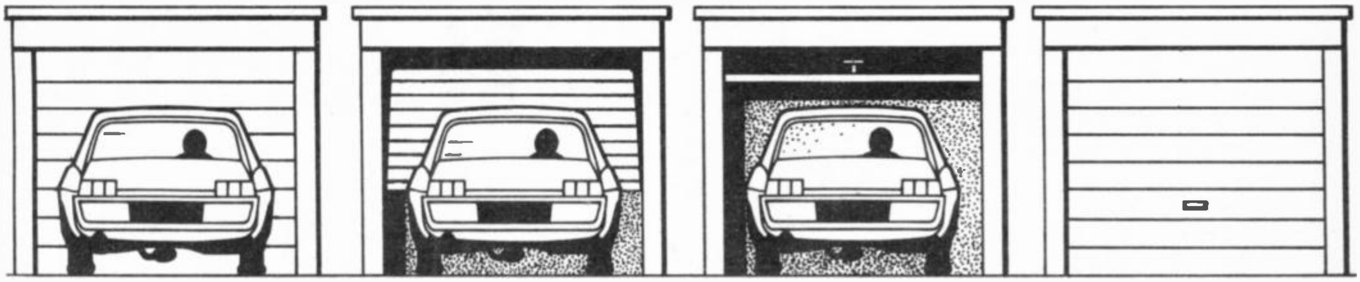


GARAGE DOOR

PART ONE

BY P. HORSEY

IN THIS age of automation surprisingly few people are able to enjoy the benefits of an automatic garage door. Yet what could be more luxurious, on those cold, wet and windy days, than driving towards a door which obediently opens before you at the press of a button.

Commercially available automatic doors can be very expensive, so it was decided to design a system which would operate on an existing up-and-over door. The result may not be as neat as a professional assembly, but the cost can be reduced by a substantial amount depending upon the type of motor selected.

To the electronics enthusiast, the circuits required to receive the ultrasonic signals from the car, process them, and start and stop the motor at the correct times are reasonably straightforward. The mechanics involved may seem complicated at first sight, but in fact, little specialised skill is required, and any person who is capable of fixing a shelf could tackle this project with confidence.

ULTRASONIC REMOTE CONTROL

The system to be described is intended for use on the rigid up-and-over type garage door and is based on having the door counterbalanced so as to be slightly biased towards opening.

An electric motor and gearbox combination then either permits the door to open by gradually releasing a cord or closes the door by winding the cord up again.

A solenoid is also incorporated to unlock the door.

The door can now be remotely operated from the driving seat of the approaching car with the use of an ultrasonic transmitter, the receiver mounted into the garage door frame. A push-button switch on the inside of the garage will close the door (or open it, should the motorist be taking the car out from the garage) once the car has been put away.

Various fail-safe mechanisms are included to prevent damage to the car should the door close prematurely and to protect the motor in the event of the door being unable to close fully.

A block diagram of the electronic control is shown in Fig. 1.

SUITABILITY

The basic mechanics of automating a garage door are to be outlined first, since it is essential to establish the feasibility of the project, before building the circuits required. The whole project comprises of four main sections; the ultrasonic transmitter (fitted into the car); the ultrasonic receiver; the logic control circuit and the mechanics, including the door micro-switches and "safety cut-out circuit".

Each section is complete in itself, and some readers may find other applications for parts of the project. The logic circuit for example, is appropriate for any open/close, or up/down system from lifts to automated curtains!

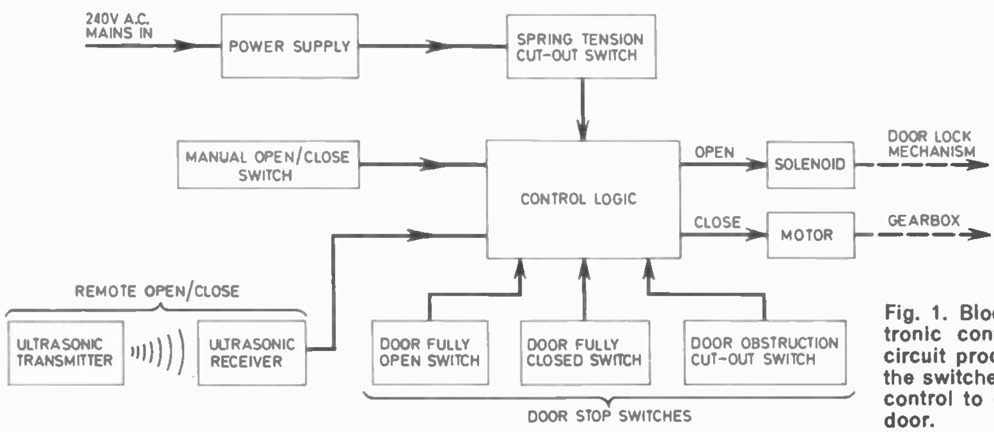


Fig. 1. Block diagram of the electronic control system. The logic circuit processes information from the switches and ultrasonic remote control to open, close or stop the door.

GARAGE DOOR

It is essential at this stage to check that the garage door can be closed and opened in the following way: (see Fig. 2). Unlock the door and pull gently in direction A. The door should begin to open, and it may rise under its counterbalance weights or springs. If it tends to stick, a vertical force in direction B should open it fully.

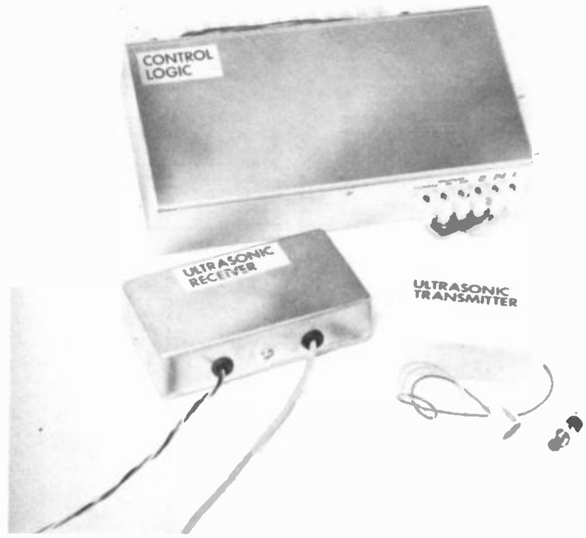
Now fix a cord to point P (to one side of the door) and pull down towards C, in direction of arrow. It should be possible to close the door fully, pulling only from point C.

If the door works in this way, it will be noted that only three forces are required to open and close the door. Force C is provided by the motor winding up a cord, force A is provided by a spring, and force B (if necessary) by a weight and two pulleys as shown in Fig. 2(d).

The actual arrangement will vary according to the geometry of the garage, and detailed measurements will not therefore be provided. Before starting work, check that the door operates freely, and does not stick at any point. The importance of this cannot be over stressed.

CONTROL ELECTRONICS FOR THE GARAGE DOOR SYSTEM

Electronics Approx. Cost £42



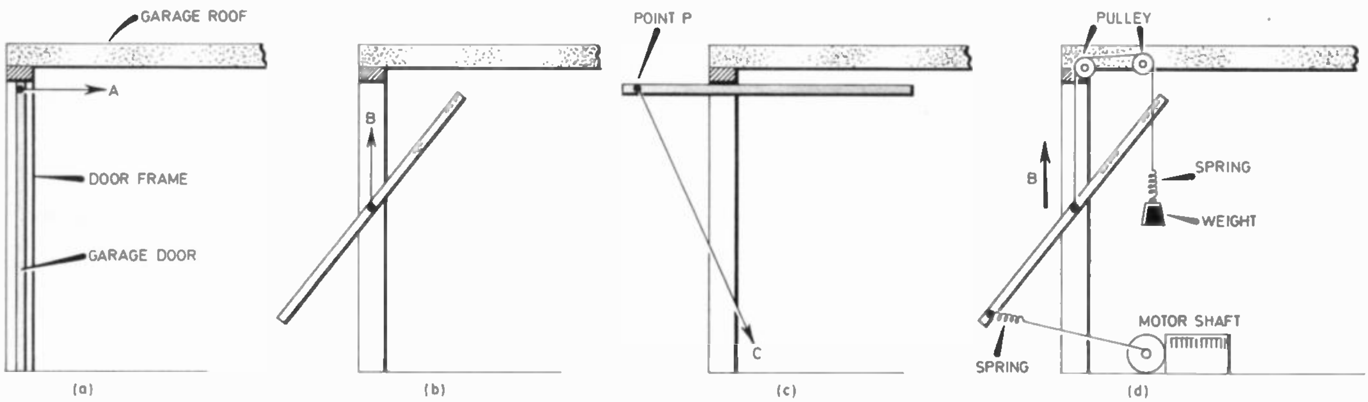


Fig. 2. (a), (b) and (c) show the forces required, and the directions in which they act, to open and close an up-and-over garage door (d) Shows the way in which two of these forces are achieved.

MECHANICAL ASSEMBLY

The actual construction and installation of the mechanics involved will be discussed in depth in Part Two of this article next month. The majority of the mechanical components, with perhaps the exception of the motor, should be readily available from builders merchants or hardware stores, or even scrounged from old scrap.

The ultrasonic receiver and transmitter circuits will be detailed first, each being treated as a separate unit. Part Two will deal with the Control Logic circuit construction, the mechanical modification and, finally, the fitting of the system as a whole to fully automate the up-and-over type garage door.

ULTRASONIC TRANSMITTER

The finished Ultrasonic Transmitter with remotely wired transducer and switch.

HAVING experimented with optical and infra red systems, an ultrasonic remote control system operating at 40kHz was chosen for its overall effectiveness regarding cost and operating distance. Ultrasonic transducers are available in pairs (which in most cases means that either unit may be the transmitter or receiver) or sold as individual units, where the transmitting and receiving units are different.

Both combinations of these devices have been tried in the transmitter and the receiver, and little difference in performance was observed.

CIRCUIT DESCRIPTION

The circuit (see Fig. 3) is designed for operation from a nine volt battery. While the car battery supply could be used, the saving made hardly justifies the extra components required, especially when the life of the battery will probably approach the life of the car battery!

The transmitter is activated by pressing push button switch, S1, which must be held down for a few

ULTRASONIC TRANSMITTER

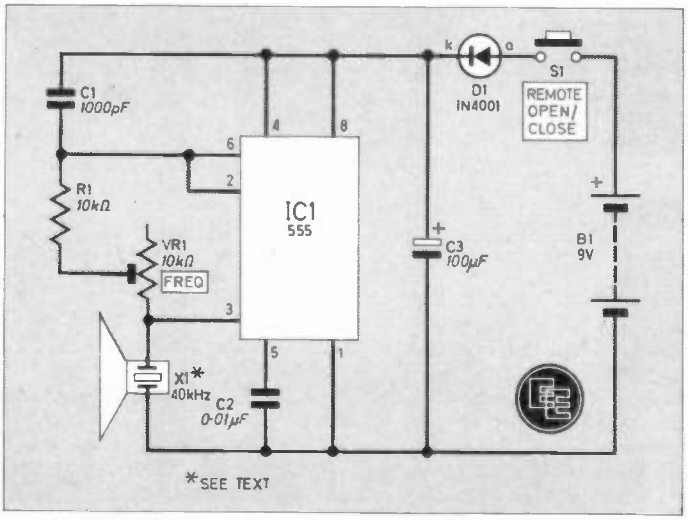
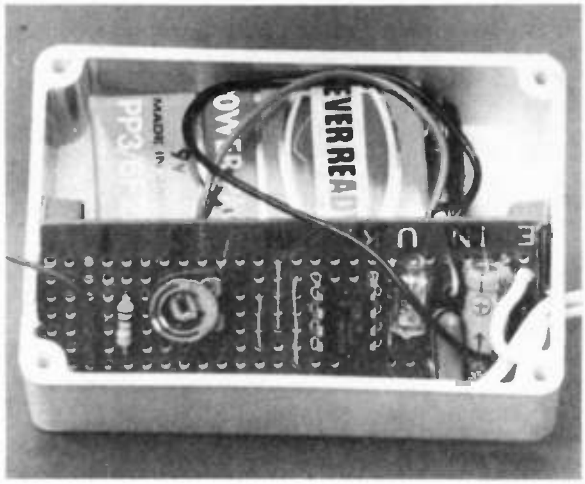


Fig. 3. Circuit diagram of the Ultrasonic Transmitter.



Transmitter with lid removed to show the way in which the board and PP3 battery are mounted.

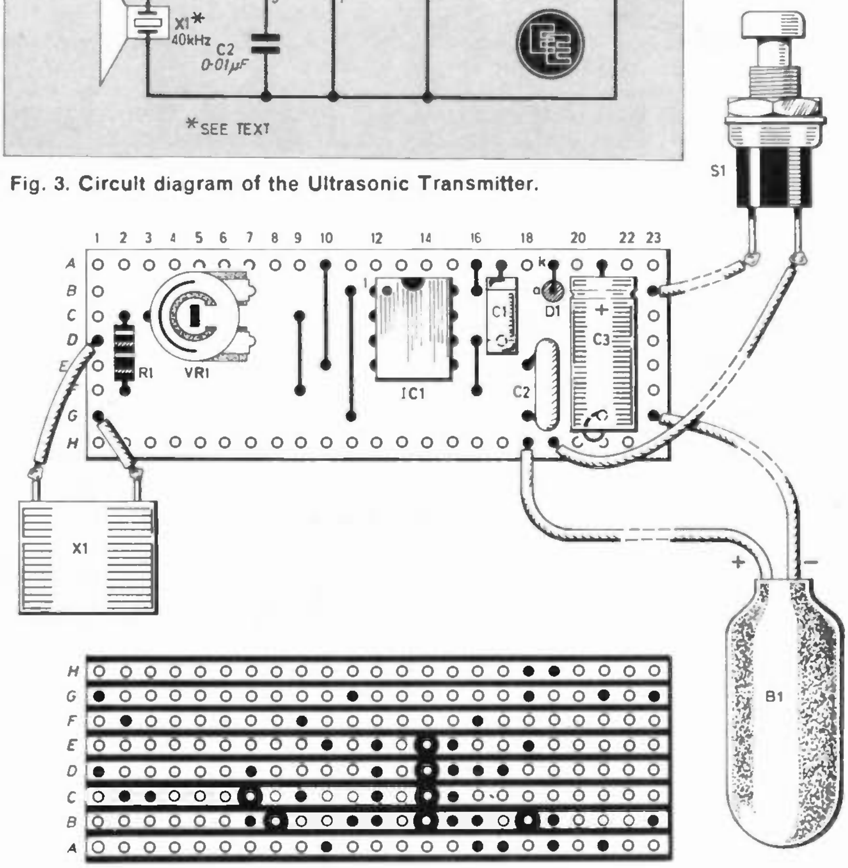
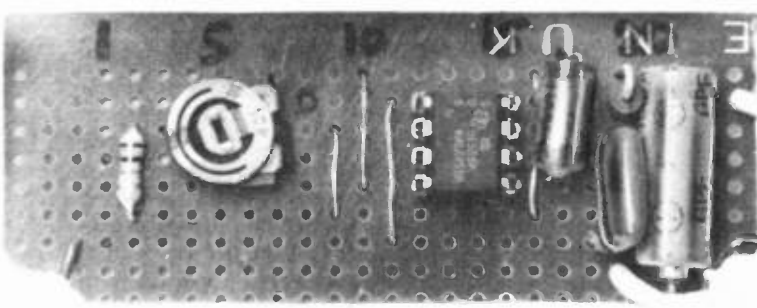


Fig. 4. Stripboard layout of the Transmitter, showing track breaks on the underside.



COMPONENTS

TRANSMITTER

Resistors

R1	10kΩ
¼W carbon ± 5%	

Capacitors

C1	1000pF polystyrene
C2	0·01μF polyester
C3	100μF 25V elect.

See **Shop Talk** page 30

Semiconductors

IC1	555 timer
D1	1N4001

Miscellaneous

B1	9V battery (PP3)
S1	push-to-make, non-latching
VR1	10kΩ miniature horizontal preset
X1	40kHz ultrasonic transducer

Stripboard, 0·1 inch matrix, 8 strips by 23 holes; case size 72 × 50 × 25mm (Vero type 75-1469L); wire; battery clip; 8 pin d.i.l. i.c. holder.

COMPONENTS approximate cost £5·50

seconds (as determined by the preset VR2 in the receiver). The 40kHz signal required to drive the transducer, X1, is obtained from IC1, the popular 555 timer, in the astable multivibrator configuration functioning as an oscillator. The values of C1, R1 and VR1 are chosen to provide this frequency, VR1 being adjusted to ensure the maximum output is obtained from the transducer. Capacitor C2 also aids decoupling, and enhances stability. Capacitor C3 decouples the supply.

CONSTRUCTION starts here

CONSTRUCTION

A piece of 0·1 inch stripboard measuring 8 strips by 23 holes is used. In practice the size should be chosen to achieve a good fit in the case. See Fig. 4.

Break the tracks as shown (seven breaks altogether) and assemble the components, starting with the i.c. socket, wire links, and preset VR1. The other components should be added, checking the polarity of C3 and D1.

Decide at this stage where and how the device will fit inside the engine compartment of the car, and whether the transducer will be fixed by itself, or attached to the case of the transmitter unit. The transducer should be mounted in a position where it can directly face the receiver, DO NOT FIT THE DEVICE TO THE CAR AT THIS STAGE, but establish the lengths of wire required to link the stripboard with the transducer and the push-button switch, S1.

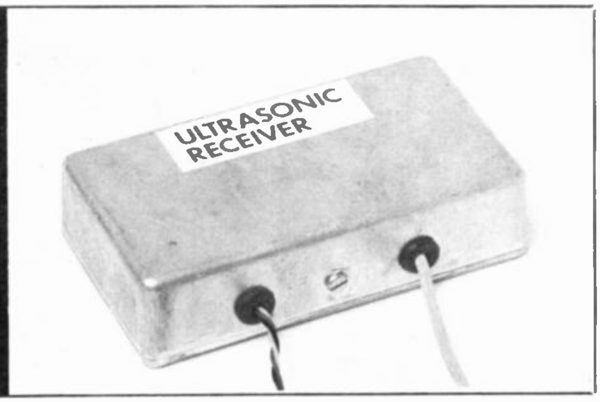
Remember that this switch will be fitted below the dashboard and the wires must be long enough to reach the transmitter unit inside the car. Finally insert IC1 into its holder observing the correct orientation.

TRANSMITTER CASE

A small plastic case 72 x 50 x 25mm was used. Two holes, one for the transducer wires and the other for the push-button switch wires were drilled. The stripboard may be secured by means of self-adhesive foam rubber pads, and likewise the PP3 battery may be fitted. Holes for mounting the completed transmitter must also be drilled in the case.

The transmitter should be kept on the workbench ready for testing and tuning when the receiver has been constructed.

ULTRASONIC RECEIVER



THE ultrasonic receiver is housed in a separate case to the power supply and control logic circuits. This reduces the chance of noise being picked up from the transformer, relays and motor, and allows the receiver to be placed near the receiving transducer thus avoiding the use of long connecting wires in this very sensitive area.

RECEIVER CIRCUIT DESCRIPTION

This circuit is based on an operational amplifier type 748, see Fig. 5. This is similar to the popular 741, but offers external frequency compensation, so with a suitable capacitor (C4) across pins 1 and 8, provides improved high frequency gain.

The signal from the transmitter is received by the transducer X1, is amplified by transistor TR1, and then the output is applied to IC1 via coupling capacitor C2, the GAIN CONTROL pot, VR1, and capacitor C3. Resistors R5 and R6, and capacitors C5 and C6 form a filter which produces maximum gain at about 40kHz. This, together with the low values of C2 and C3 limits the sensitivity of the circuit at audio frequencies.

The output from IC1 is coupled via d.c. blocking capacitor C7 to the voltage doubler and detector diodes D1 and D2. When a 40kHz signal is received by the transducer, a steady voltage develops across capacitor C8. Resistor R8 is for discharging C8 under a no-signal condition.

When the signal is received, transistor TR2 switches on, its collector voltage falling almost to zero. Transistor TR3 is turned off, and the current flowing through VR2 and R10 flows via R11 to charge up capacitor C9.

COMPONENTS

RECEIVER

COMPONENTS approximate cost £7·80

Resistors

R1	6·2MΩ
R2	100kΩ
R3, 4, 5	1MΩ (3 off)
R6, 7	1kΩ (2 off)
R8	82kΩ
R9	4·7MΩ
R10, 11	22kΩ (2 off)

All ¼W carbon ± 5%

Capacitors

C1	100μF 25V elect.
C2, 3, 5, 6	100pF ceramic (4 off)
C4	3·3pF ceramic
C7, 8, 10	0·1μF polystyrene (3 off)
C9	22μF 25V elect.

Semiconductors

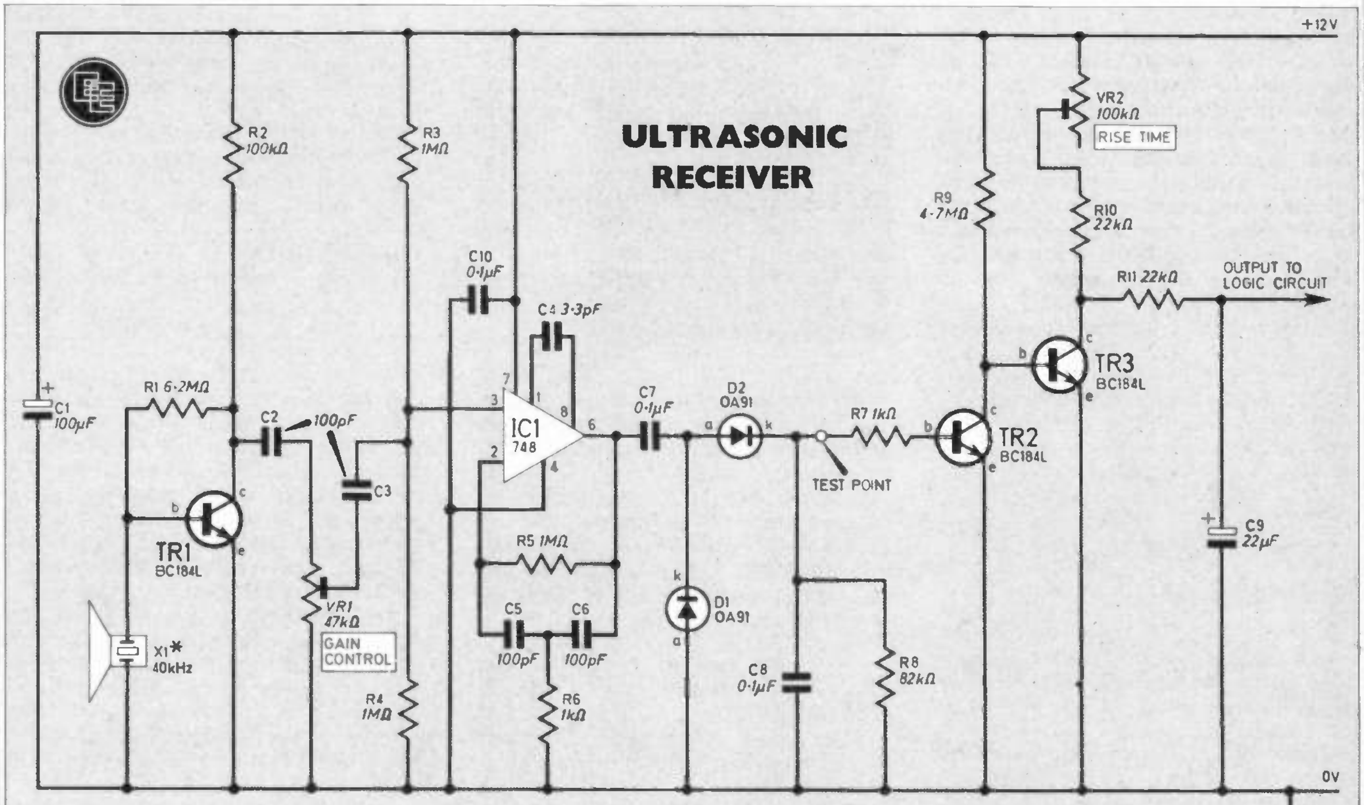
IC1	748 operational amplifier 8 pin d.i.l.
D1, 2	OA91 germanium signal (2 off)
TR1, 2, 3	BC184L silicon *npn* (3 off)

See Shop Talk page 30

Miscellaneous

VR1	47kΩ miniature horizontal preset
VR2	100kΩ miniature horizontal preset
X1	40kHz ultrasonic transducer

Stripboard, 0·1 inch matrix, 14 strips by 42 holes; diecast box size 113 × 63 × 31mm; small grommets (2 off); wire; screened cable; 8 pin d.i.l. i.c. holder; board mounting hardware.



*SEE TEXT

Fig. 5. Circuit diagram of the Ultrasonic Receiver.

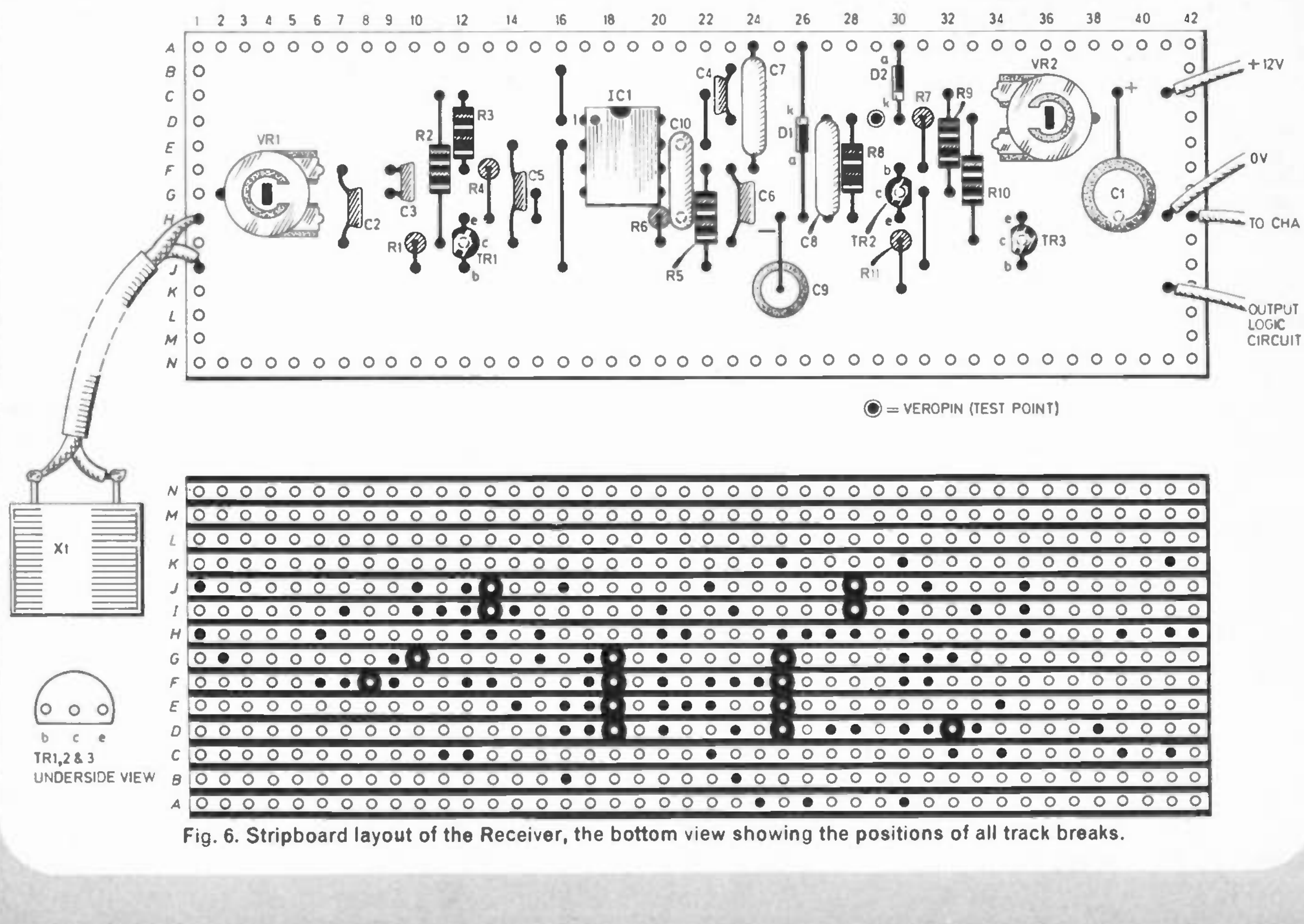


Fig. 6. Stripboard layout of the Receiver, the bottom view showing the positions of all track breaks.

Hence the voltage on C9 slowly rises, its charge rate determined to a large extent by VR2. Thus a steady signal lasting for a preset time must be received before the logic circuit of the next stage is triggered. This, together with the narrow band frequency selectivity of the amplifying stage makes the unit very insensitive to stray noise.

Under no signal conditions transistor TR2 is cut off, and enough current flows via resistor R9 into the base of TR3, turning it on, maintaining its collector at nearly zero volts, hence the current flowing via preset VR2 and R10 now sinks through TR3.

C9 will also be discharged through TR3, therefore no output is present under these conditions. Decoupling is provided by capacitors C1 and C10.

CONSTRUCTION starts here

CONSTRUCTING THE RECEIVER

The receiver is constructed on 0·1 inch matrix stripboard measuring 42 holes by 14 strips (see Fig. 6).

Break the tracks where shown (15 in all) and solder in the wire links, i.c. socket, presets VR1 and VR2, and resistors. The diodes, electrolytic capacitors and transistors must be fitted the correct way round, the non-polarised capacitors can be fitted either way. The i.c. may now be inserted, again observing the correct orientation.

Finally solder the connecting wires and screened cable to the ultrasonic detector, ensuring that the screen connects the case pin of the detector with the 0V track on the circuit board. Note also that this lead will have to be threaded through the case of the receiver, and through the hole in the garage door frame (yet to be drilled).

DIECAST CASE

In order to provide electrical screening, a diecast box should be used to house the receiver circuit. The box used in the prototype measured 113 x 63 x 31mm.

Begin by drilling holes for the earthing screw, securing screws, transducer lead and output/power leads. Rubber grommets should be fitted where any leads pass through the case, and the stripboard may be mounted by any convenient method, taking care not to allow the case to cause a short circuit.

Finally the lead from the 0V track (marked CHASSIS on Fig. 6) should be fixed to the case by means of a solder tag connection.

TESTING THE ULTRASONIC SYSTEM

A 12V power source is necessary to test the receiver as the power supply on the control logic circuit has yet to be built.

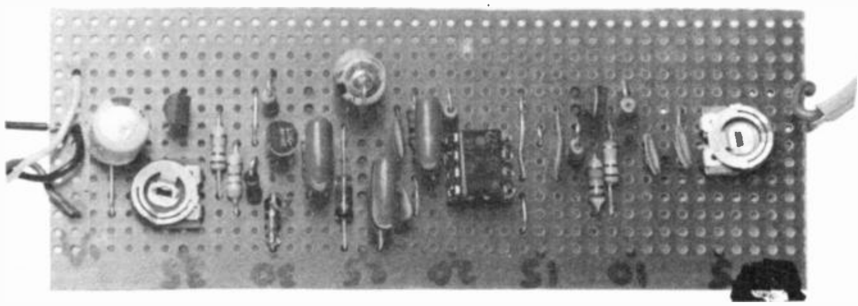
Connect a voltmeter set to read about 5 volts between the TEST POINT at D2 "k" and 0 volts on the receiver. Set up the transmitter and the receiver with the two transducers facing each other, a few centimetres apart.

Adjust the transmitter preset, VR1, to about the half way point, and set the receiver preset VR1, GAIN CONTROL, to full gain, that is fully clockwise.

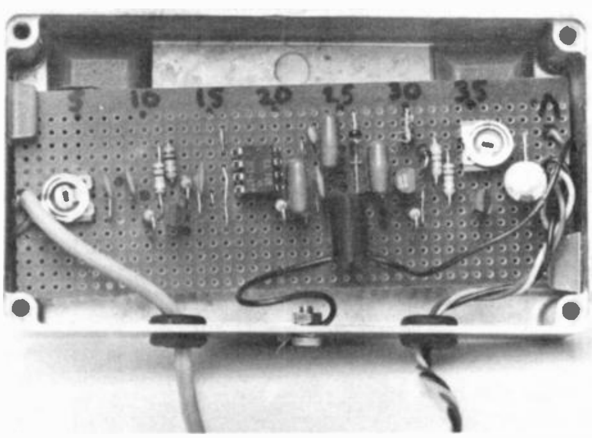
Switch on the receiver 12V power supply, and observe the voltmeter. It should read zero. Connect the transmitter power supply (PP3 battery) and check that the voltmeter now gives a reading when transmitter switch, S1, is made. Adjust the transmitter preset, VR1, if necessary to obtain a maximum reading.

Move the transducers much further apart (up to 10 metres), and again adjust the transmitter preset for a maximum reading.

Reset the voltmeter to read 12V, equal to the power supply, and connect the positive meter terminal to the "output" lead from the receiver. Set VR2, RISE TIME control, to a midway position, and switch on the transmitter. The voltmeter reading should slowly rise to nearly the supply voltage, and fall to zero when the transmitter is turned off. Adjusting VR2, will alter the time taken for the voltage to rise, thus setting the delay time before the control logic is activated.

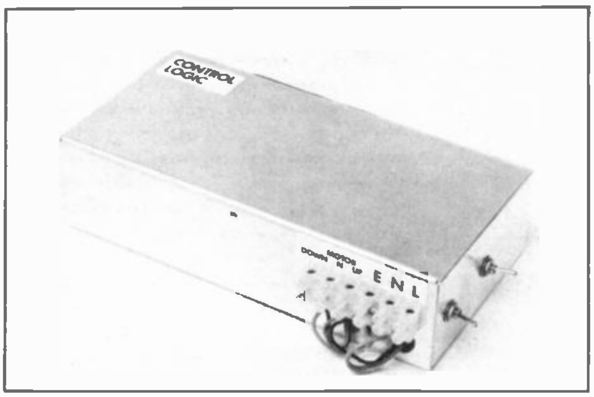


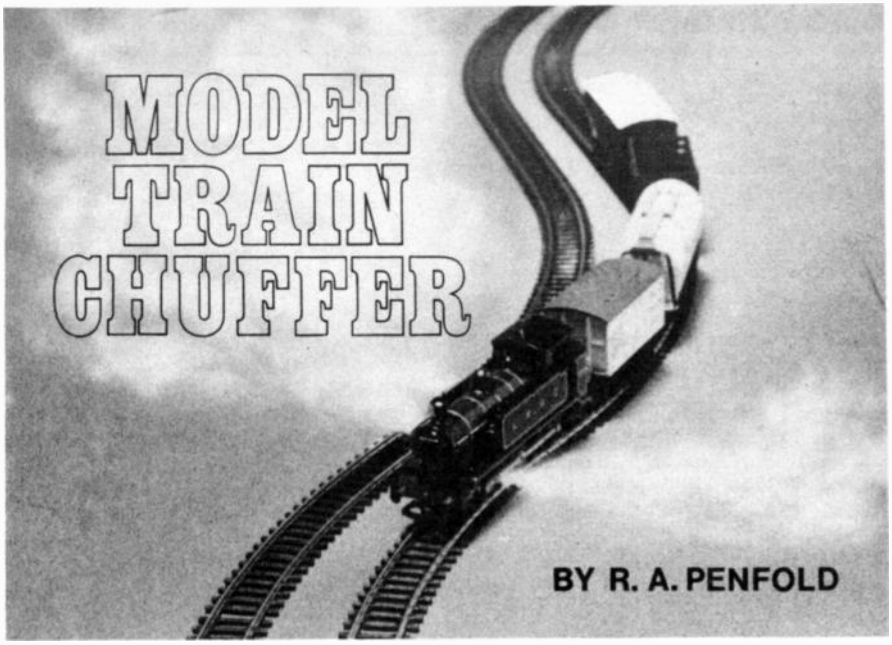
Finished Receiver board assembly.



View inside the Receiver case showing the component board with screened cable to the transducer.

NEXT MONTH: LOGIC CONTROL AND MECHANICAL ASSEMBLY





MODEL railway layouts can be fitted with numerous accessories to give greater realism, and this does not just include items which give improved realism visually. Various sound effects units for model railways can be produced, and the "chuffer" unit described here is an example of such a unit.

When the model train is stationary the unit produces a "hissing" sound (to feed on amp/speaker) which simulates the sound of a steady stream of steam escaping from a stationary locomotive. When the train starts to move, the "chuffing" sounds are produced, and the unit responds to the track voltage so that as the speed of the train increases and decreases, so does the "chuffing" rate.

The unit can be adjusted so that the "chuff" sounds commence as the train starts to move.

The unit does not have an integral amplifier or loudspeaker, and is intended to feed into a hi fi system, record player, or any suitable amplifier. Best results seem to be obtained with a fairly high power amplifier and a large speaker, but quite good results can be obtained using a simple battery powered amplifier having an internal miniature speaker if preferred.

This chuffer unit should work with any normal type of train controller without any modifications being required. It will operate with types that have an unsmoothed or pulsed output just as well as with types having a smoothed output.

SYSTEM PRINCIPLES

Consider the block diagram of Fig. 1.

The voltage across the track is fed to the control input of a voltage controlled oscillator, and the latter is designed so that it fails to operate with a low input voltage, and has an operating frequency that rises steadily as the input voltage is increased above a certain threshold level. It is this oscillator that sets the "chuff" rate.

With many controllers the voltage on the track is not a steady d.c., but is simply a rectified a.c. signal, or a series of pulses. In either case the motor responds to the average d.c. potential across the tracks, and the voltage controlled oscillator must also be designed to respond to the average level, rather than the level present from one instant to the next.

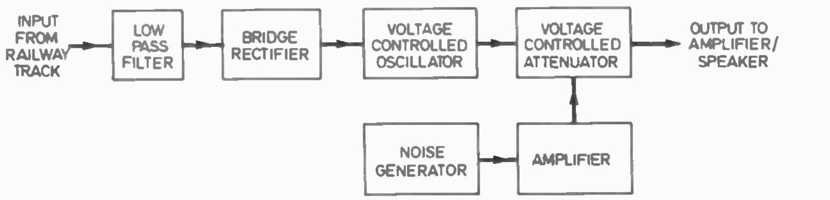


Fig. 1. Block diagram of the Model Train Chuffer showing principle of operation.

This is achieved simply by adding a low pass filter at the input to integrate the pulses and give a reasonably smooth d.c. output. This also filters out any noise spikes placed on the track supply by the electric motor in the locomotive.

BRIDGE CIRCUIT

The voltage controlled oscillator must also respond properly to an input voltage of either polarity since the direction of the train is controlled by switching the polarity of the track supply, and both polarities will be used. This problem is easily overcome by adding a bridge rectifier at the input so that the polarity of the signal fed to the control input of the voltage controlled input is always the same, regardless of the track supply polarity.

A white noise generator produces a "hissing" sound which is very similar to the sound of escaping steam, and a noise generator is therefore used to produce the basic signal of the chuffer. The output of the noise generator is quite weak and it is therefore amplified before being applied to a voltage controlled attenuator. From here the signal is fed to the output.

HISS AND CHUFF

The voltage controlled attenuator is controlled by the output signal of the voltage controlled oscillator. The circuit is arranged so that with the voltage controlled oscillator not operating, the noise signal is moderately attenuated, and produces a reasonably strong output signal. This is the required steady "hissing" sound of a stationary steam locomotive. When the voltage controlled oscillator starts to operate it switches the voltage controlled attenuator between full output and zero output, so that bursts of noise are produced at the output and the desired "chuffing" sound is generated.

CIRCUIT DESCRIPTION

Now consider the circuit diagram, Fig. 2. R1 and C1 form the low pass filter at the input and D1 to D4 form the bridge rectifier. The voltage controlled oscillator is based on TR1 and IC1, the latter being a CMOS 555 timer i.c. (the ICM7555) used in the astable mode. The CMOS version is used here merely because it gives the circuit a much lower current consumption (around 2mA instead of 10mA).

With no input voltage to the unit TR1 will be switched off and there is no charge path for timing capacitor C3. The oscillator therefore fails to operate. With a track voltage of reasonable proportions present, TR1 is biased into conduction by way of R2 and oscillations are produced. The higher the track voltage, the more heavily TR1 conducts, and the higher the frequency of oscillation. VR1 is adjusted so that oscillation commences at the appropriate track voltage.

R5 is included in the circuit to prevent the oscillator from operating at a very low frequency due to possible leakage through TR1, which could produce the occasional "chuff" while the train was stationary.

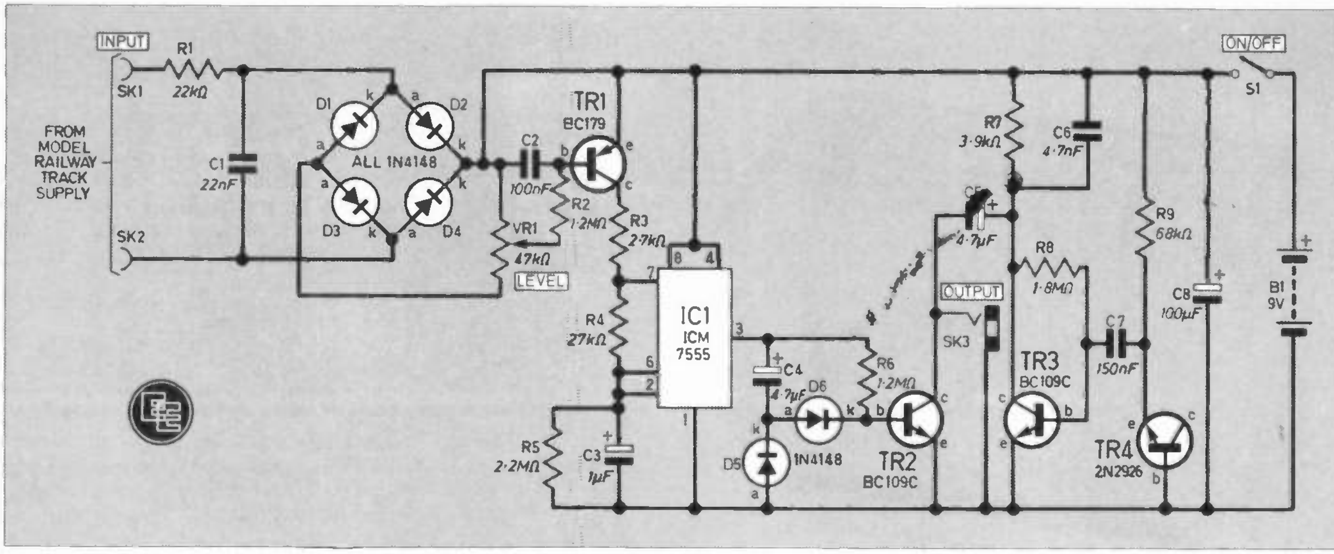
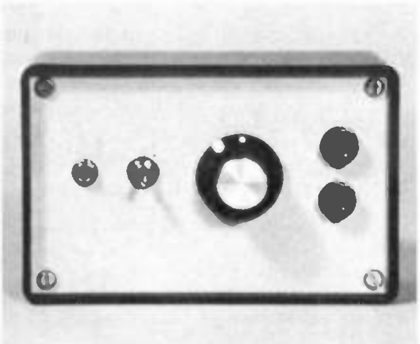


Fig. 2. The circuit diagram of the Model Train Chuffer. An amplifier/speaker is required.



The prototype Chuffer before labelling of control panel functions.

WHITE NOISE

The noise signal is generated by R9 and TR4. The base-emitter junction of TR4 is reverse biased and acts rather like a low voltage Zener diode. Like a Zener diode it produces noise spikes which collectively give the required white noise signal, but this signal is only a few millivolts r.m.s. in amplitude and must be considerably amplified in order to give a high enough output level to drive most amplifiers. The necessary amplification is provided by TR3 which is used as a straightforward high gain common emitter amplifier. C6 rolls off the upper audio response of this stage slightly. This is necessary because the pitch of the noise signal is slightly too high to give a realistic effect. C5 couples the amplified noise signal to the output socket.

TR2 has its collector to emitter impedance shunted across the output of the unit, and the output signal level can be controlled by means of a signal to the base of TR2. With zero base current, TR2 is switched off and has such a high collector to emitter impedance that it has no significant effect.

If it is steadily biased more heavily into conduction it gradually loads the output more heavily, thus reducing the output level. When biased hard into conduction the output level is insignificant.

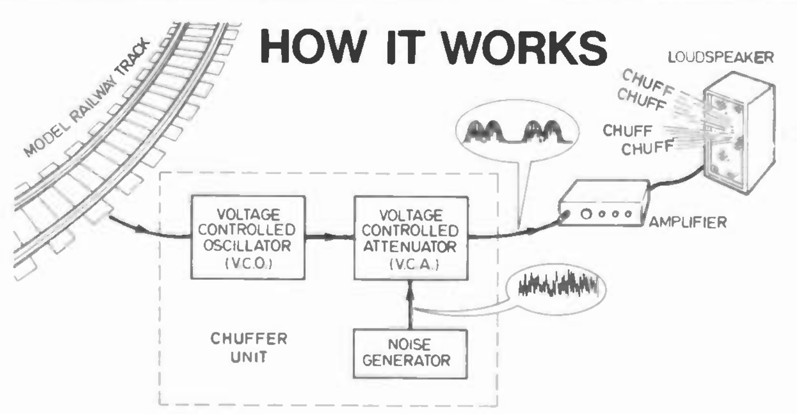
Of course, a simple voltage controlled attenuator of this type would not be acceptable in most applications as it generates significant amounts of distortion, but here it is only being used to control a noise signal and quite high levels of distortion are of no consequence.

When IC1 is not oscillating, its output assumes the high state. TR2 is then biased into conduction from the output of IC1 via R6, but it does not conduct very heavily and there is a reasonably strong noise signal at the output.

When IC1 is oscillating, on positive output pulses a strong base signal is applied to TR2 by way of C4, D5, and D6. This reduces the amplitude of the output signal to practically zero.

When the output is negative, TR2 does not receive any significant bias current through R6, or C4, D5, and D6, so that it switches off and the output is at full amplitude. Thus the required modulation of the output signal and the "chuffing" sound is produced.

The circuit gives an output signal level of sound around 1 volt r.m.s. from a 3·9kΩ source impedance, and this is sufficient to drive any normal audio amplifier.



A voltage controlled oscillator (v.c.o.) receives its control voltage from the track, and has a frequency of operation that varies from zero with a low track voltage to several pulses per second at maximum track voltage.

A noise generator has its output fed to a voltage controlled attenuator (v.c.a.) and then to an external amplifier and speaker. With the oscillator not operating this gives a steady, steam-like "hissing" sound from the speaker. When the oscillator operates, via the v.c.a., it gives bursts of noise signal that produce the "chuffing" sound.

The "chuff" rate is controlled by the frequency of the v.c.o. which is in turn controlled by the track voltage (and the speed of the train), so that the train speed and "chuff" rate match one another.

View of the Chuffer with lid raised showing board mounted on rear of case.

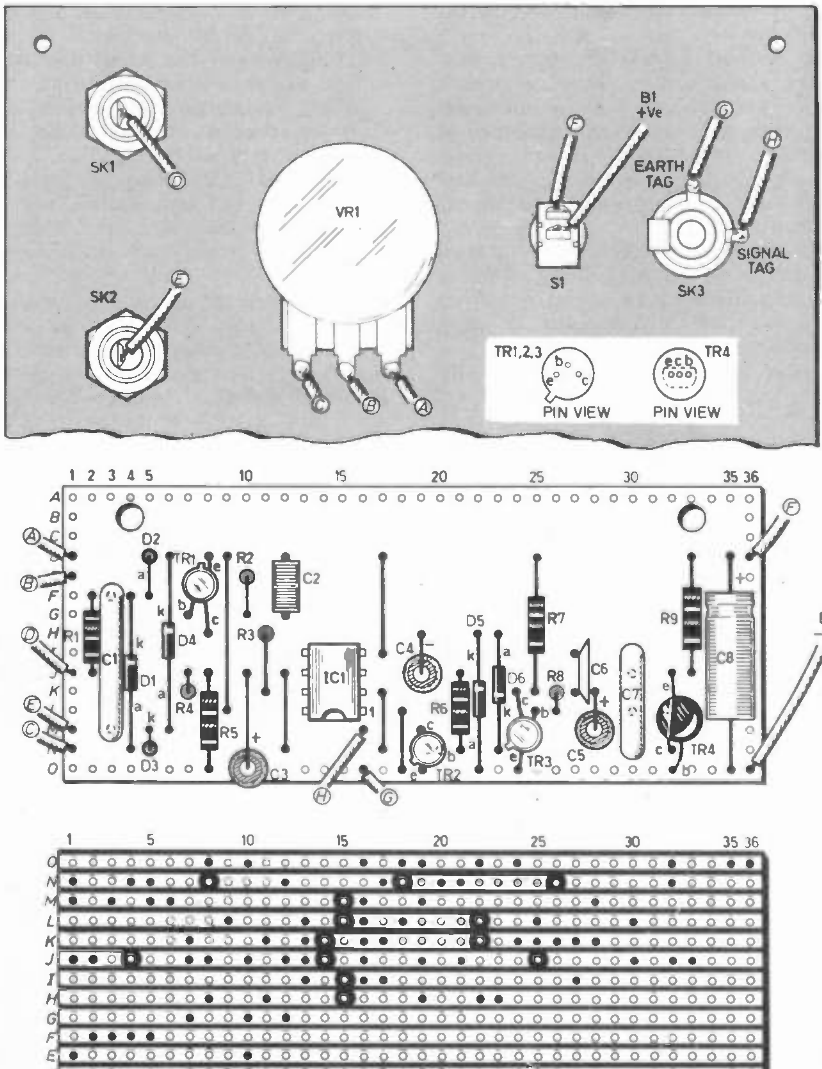


Fig. 3. Layout of the components on the stripboard with breaks to be made on the underside. Also shows wiring between board and case mounted components.

COMPONENTS

See Shop Talk page 30

Resistors
- R1 22kΩ
- R2 1·2MΩ
- R3 2·7kΩ
- R4 27kΩ
- R5 2·2MΩ
- R6 1·2MΩ
- R7 3·9kΩ
- R8 1·8MΩ
- R9 68kΩ

All ¼ watt carbon ± 5%

Capacitors
- C1 22nF polyester (C280)
- C2 100nF polycarbonate
- C3 1μF 25V elect.
- C4 4·7μF 25V elect.
- C5 4·7μF 25V elect.
- C6 4·7nF ceramic plate
- C7 150nF polyester (C280)
- C8 100μF 10V elect.

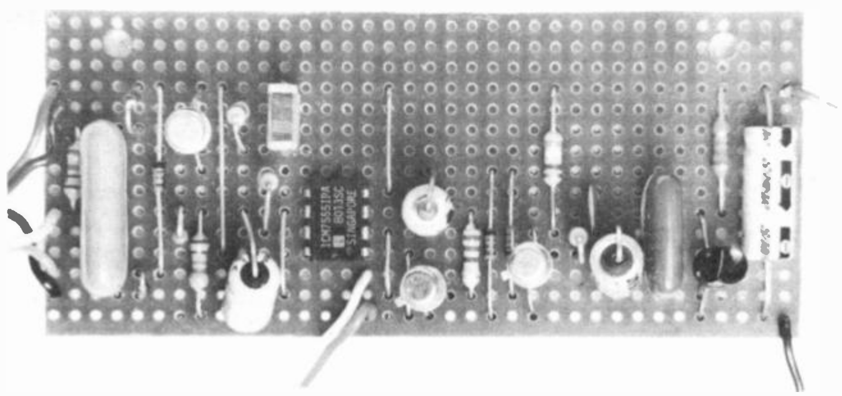
Semiconductors
- IC1 ICM7555 CMOS timer i.c.
- TR1 BC179 silicon *pnp*
- TR2, 3 BC109C silicon *npn* (2 off)
- TR4 2N2926 silicon *npn* (see text)
- D1 to D6 1N4148 small signal silicon (6 off)

Miscellaneous
- VR1 47kΩ carbon lin. law potentiometer
- S1 s.p.s.t. miniature toggle
- SK1, 2 Wander sockets (2 off)
- SK3 3·5mm jack socket
- B1 9V type PP3

Stripboard: 0·1in matrix, 15 strips × 36 holes; case type BIM4004 or similar; control knob; p.v.c. covered stranded wire; output leads, 3·5mm jack plug to connectors to suit amplifier.

Approx. cost Guidance only £7

CONSTRUCTION starts here



Close up of the prototype Chuffer circuit board.

STRIPBOARD LAYOUT

The chuffer unit can be made quite compact and it will readily fit into a case measuring about 110×70×50mm. The controls and sockets are mounted on the front panel, and any sensible layout can be employed as the layout is not critical from the electronic point of view.

The stripboard layout for the circuit is shown in Fig. 3. and uses 0·1 inch matrix board having 15 strips by 36 holes. There are thirteen breaks in the copper strips plus the two 6BA or M3 clearance mounting holes to be made before soldering in the components and link wires.

IC1 is a CMOS device, but it has an internal protection circuit that eliminates the need for any of the usual CMOS handling precautions. It can therefore be soldered direct to the board and it is by no means essential to use an i.c. socket.

TR4 is a 2N2926 device in the prototype, but any silicon *npn* device having a low base/emitter reverse breakdown voltage should work just as well. Devices such as a 2N2924, 2N3711, 2N3708, BC184, and a BC238 all worked well in the circuit, and it is likely that most constructors will be able to find a suitable device in their spares box.

Devices having a comparatively high reverse base/emitter breakdown voltage will not work properly in the circuit as the battery voltage might be inadequate to produce breakdown and generate the noise spikes, especially as the battery voltage starts to fall.

The completed component board is wired to the rest of the components once fitted on the front panel using ordinary multistrand p.v.c. insulated wire, and the board is then mounted on the rear panel of the case, towards the top, using M3 or 6BA fixings. This will leave ample space for a PP3 size 9 volt battery on the base of the case, and a piece of foam material can be used to keep the battery in position here.

USING THE UNIT

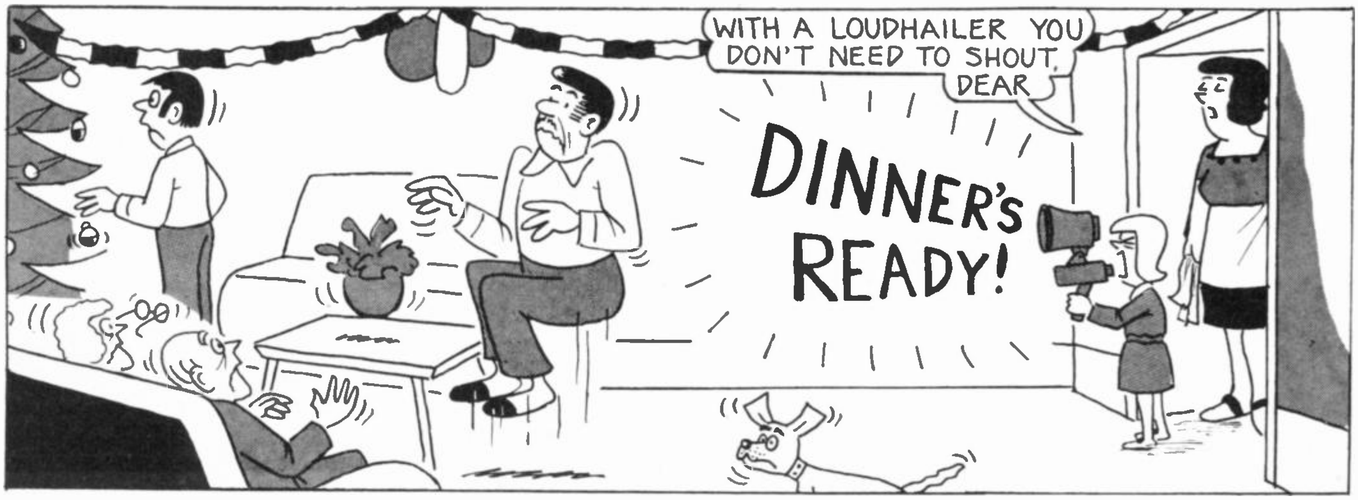
A screened lead fitted with plugs of the appropriate type is used to connect the output of the chuffer unit to the input of the amplifier. An ordinary twin lead is used to take the voltage from the track to SK1 and SK2, and an extra power rail can be included in the layout to provide a convenient take-off point for the track voltage.

Probably the easiest way of giving VR1 the correct setting is to adjust the train controller so that the train is moving as slowly as possible, and then adjust VR1 for the lowest possible "chuff" rate. After using the unit for a while, any fine trimming of VR1 can then be carried out if it should prove necessary.

VR1 has been made a panel control rather than an internal preset component so that it can easily be readjusted to suit a different locomotive.

If the amplifier has tone controls it is worthwhile experimenting a little with the settings of these to try to obtain optimum realism. A certain amount of bass boost, for example, can give a very good effect. ⌑

JACK PLUG & FAMILY... BY DOUG BAKER



EE TEACH-IN 82

PART 4

BY O.N. BISHOP

BASIC ELECTRONIC THEORY WITH EXPERIMENTS

SWITCHING CIRCUITS WITH TRANSISTORS AND INTEGRATED CIRCUITS

So far we have studied the action of three kinds of electronic component:

(1) **Resistors** reduce the flow of electric current by a greater or lesser amount, depending on their resistance.

(2) **Diodes** allow current to flow freely in one direction but allow virtually no current to flow in the opposite direction.

(3) **Transistors** have two actions: (i) they act as switches, allowing a current to flow or not to flow, (ii) they act as variable resistors allowing different amounts of current to flow. The varying flow of current is itself controlled by a much smaller current, so transistors acting in the second way are amplifiers.

Components such as transistors and diodes, which give a gain in current or voltage, or which have directional properties, are called **active components**. Components such as resistors, which do not have these effects, are called **passive components.**

This month we shall follow one important way of using the switching property of transistors.

EXPERIMENT 4.1

The action of a switching transistor

Fig. 4.1 shows a transistor (TR1) connected so as to switch an l.e.d. (D1) on or off. The Verobloc layout for this Experiment is shown in Fig. 4.2.

Touch flying lead X to strip A (+6V). This turns TR1 on. It now has very low resistance between d and s (about 5 Ω). If we think of TR1 and R4 as parts of a potential divider, we can calculate that the voltage at point Z is about $6 \times (5/185) = 0{\cdot}16$V. This is close to 0V, and certainly not high enough to cause a current to flow through the l.e.d. and light it.

Touch X to strip M (0V). This turns TR1 off and its resistance is several million ohms. The voltage at Z becomes almost +6V. A current can now flow through D1.

Check the truth of the statements above by connecting the meter to Z (location F18).

EXPERIMENT 4.1

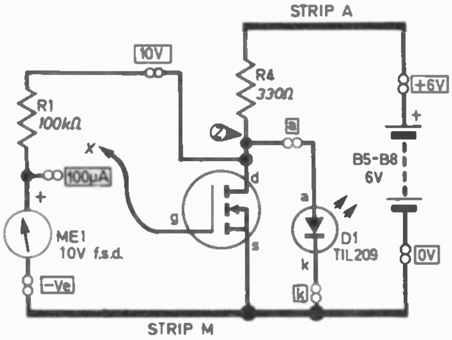
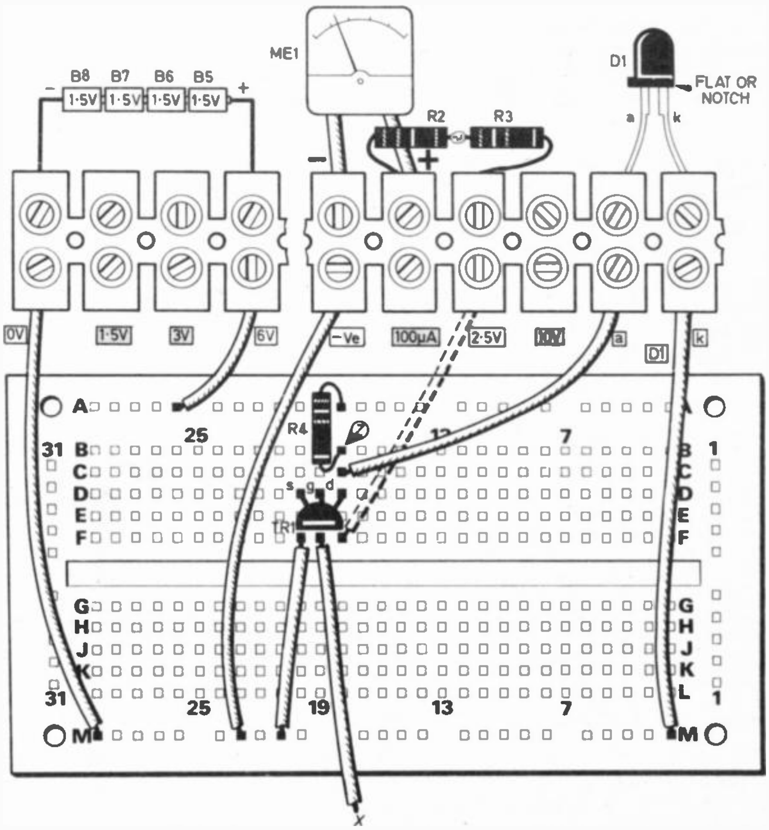


Fig. 4.1. Circuit diagram for investigating the switching action of a VMOS transistor.

Fig. 4.2. The layout of Fig. 4.1 on the Verobloc. The dotted leads show the connections for measuring the voltage at Z.



TRUTH TABLES

We can summarise the results of Experiment 4.1 in a table. In this table (Table 4.1) the word "low" means 0V or as close to 0V as makes no difference. The word "high" means the supply voltage (+6V in this experiment) or close to it. The second column shows the voltage at Z that corresponds to any given voltage at X. This table is a **truth table** because it tells us what is true about the logic of the circuit.

Table 4.1

X	Z
Low	High
High	Low

Table 4.2

X	Z
0	1
1	0

Table 4.2 shows exactly the same thing, but represents low by "0" and high by "1". It is a little quicker to write Table 4.2 and to read from it.

Notice that X and Z can have only two states—low or high, 0 or 1 respectively. This is because the transistor is either on or off. We do not allow in-between states.

If X is 0, Z is 1. We could also say that if X is 0, Z is NOT 0. Or if X is 1, Z is NOT 1. This circuit performs a simple logical operation. Z is always the opposite of X. Z is NOT X. The logical operation is therefore called NOT. Sometimes it is called INVERT.

A circuit which performs a logical operation is called a **logic gate.** Note that this use of the word "gate" is different from its use for the gate electrode of an f.e.t.

Fig. 4.1 thus shows the circuit of a NOT gate, with input X and output Z. The l.e.d. is not part of the gate; it is there simply to show the state of the output of the gate.

EXPERIMENT 4.2
Diode gates investigated

Two diodes are used in the logic gate shown in Fig. 4.3. As before, the l.e.d. (D1) indicates the state of the output (Z). Inputs X and Y can each be made 1 (=6V) or 0 (=0V). Since there are two inputs, each with two possible states, there are four possible combinations of inputs. The truth table for this gate needs four lines:

Table 4.3

Inputs		Output
X	Y	Z
0	0	
0	1	
1	0	
1	1	

The output column has been left blank, for you to fill in the results of your experiment. The layout for this is shown in Fig. 4.4. The results appear on p.29.

When you have finished the above test, work out the behaviour of the gate in Fig. 4.5, Verobloc layout Fig. 4.6.

The input columns of the truth table are the same as in Table 4.3, but the outputs are different (see p.29 for answer).

AND and OR

The output of the gate in Fig. 4.3 can be high only if both X AND Y are connected to 6V. If either X or Y are connected to the 0V rail, current flows through D4 or D5, which act as resistors of low value. The voltage at Z becomes close to 0V.

Since both X AND Y must be 1 to obtain an output of 1, we call this an AND gate. Z is true ($Z=1$) only when X is true ($X=1$) AND Y is true ($Y=1$).

In Fig. 4.5 the output is 1 whenever X OR Y are connected to +6V. Connecting either to 0V has no effect, since the diodes do not allow current to flow from Z to the 0V line. Since Z is true ($Z=1$) when X is true ($X=1$) OR when Y is true ($Y=1$), OR when both are true, we call this an OR gate.

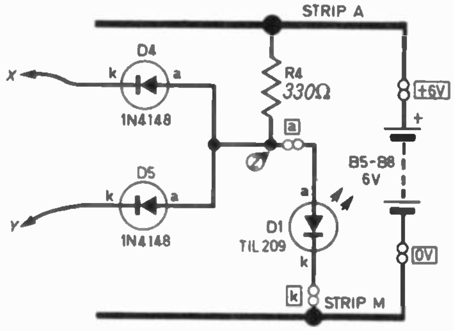
EXPERIMENT 4.3
Combining two logic gates

Fig. 4.7 shows the AND gate with its output fed to the NOT gate. Wire up this gate according to Fig. 4.8 and work out its truth table.

As might be expected, column Z of this table has the opposite values to column Z of the AND truth table. Since this gate performs a NOT-AND operation, we call it a NAND gate.

Wire up the OR gate again (Fig. 4.5) and feed its output to the NOT gate (Fig. 4.1). This makes up a NOT-OR gate, or NOR gate as it is known. Use it to find the NOR truth table. You will need to devise a Verobloc layout for this.

EXPERIMENT 4.2



You will notice in this and the remainder of the Experiments this month, that no current limit resistor appears in series with the l.e.d. This is in order when operating from a low supply voltage but one must be included when the supply voltage is greater than 6V.

Fig. 4.3. Circuit diagram for investigating diode gates.

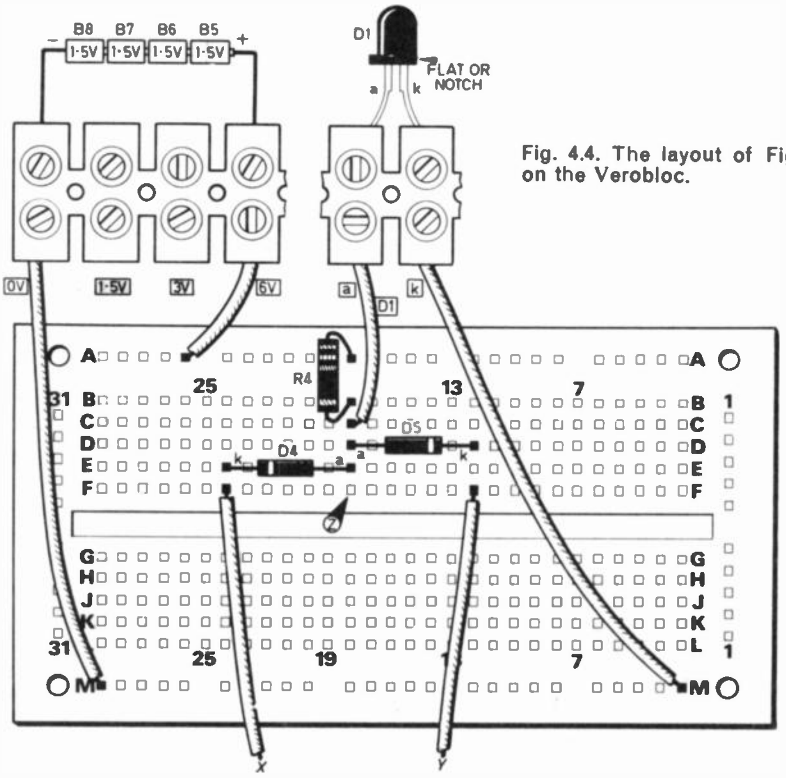


Fig. 4.4. The layout of Fig. 4.3 on the Verobloc.

EXPERIMENT 4.2

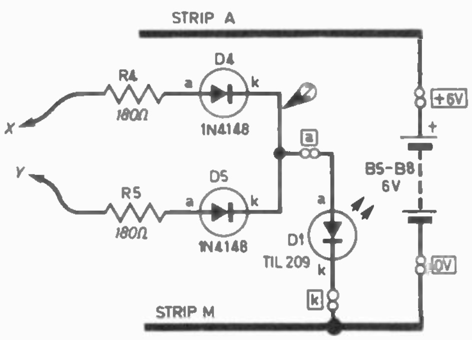


Fig. 4.5. Another circuit for investigating diode gates. Compare orientation of D4 and D5 with those in Fig. 4.3.

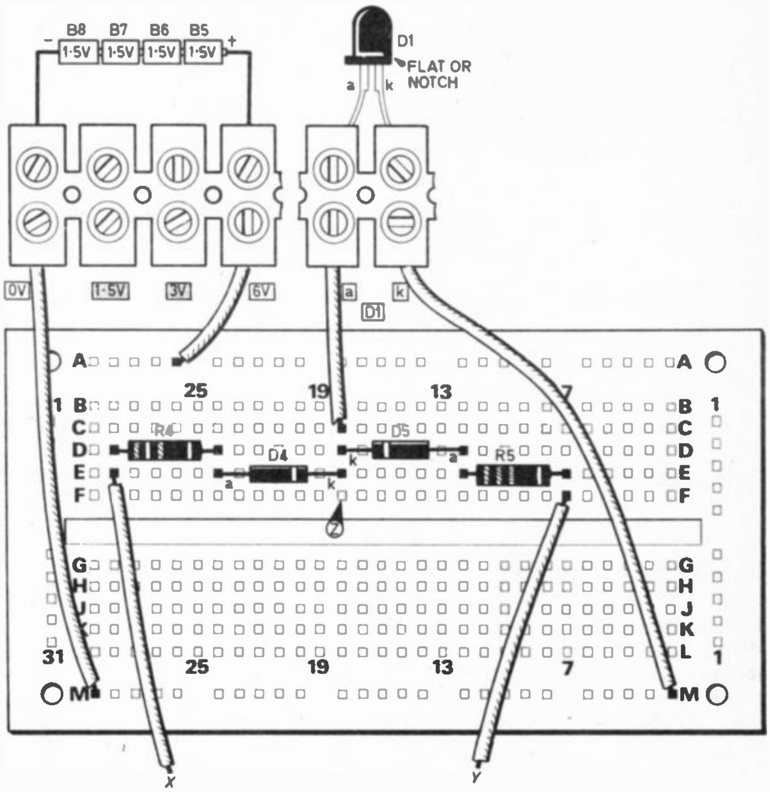


Fig. 4.6. The layout of Fig. 4.5 on the Verobloc. Take care to orien'ate the diodes correctly.

EXPERIMENT 4.3

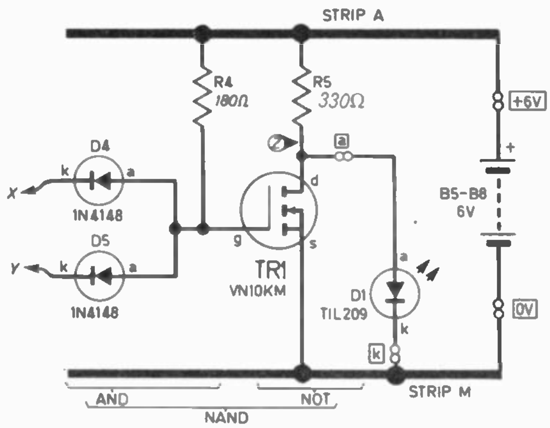


Fig. 4.7. Circuit in which a AND gate and a NOT gate are cascaded to form a third type of logic gate.

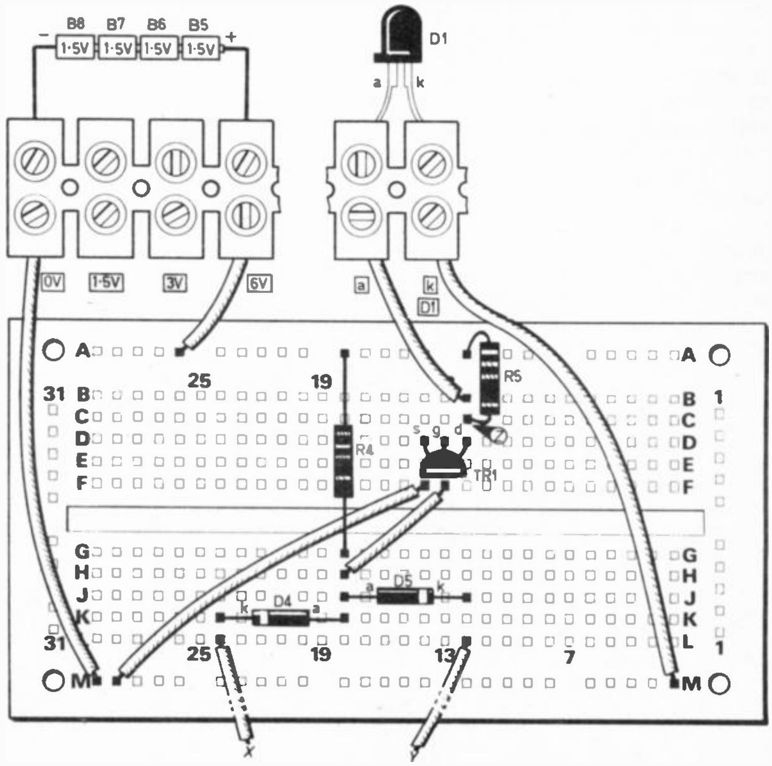


Fig. 4.8. The circuit of Fig. 4.7 wired up on the Verobloc.

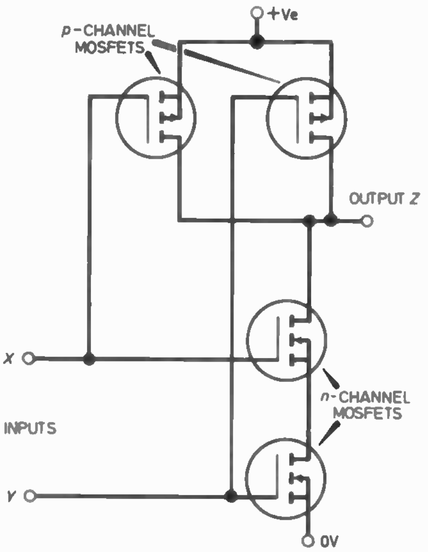


Fig. 4.9. Making a NAND gate from four mosfets.

INTEGRATED CIRCUITS

Another way of making a NAND gate is shown in Fig. 4.9. It is made from four MOSFETS. Two of these are *n*-channel MOSFETS, such as we described in Part 2. They are switched on when their gate electrodes are made high. The other two transistors are *p*-channel MOSFETS, which are switched off by a high input, but turned on by a low one.

To give a low output at *Z* we need to turn both *n*-channel transistors on (connecting *Z* to the 0V rail), and turn both *p*-channel transistors off (isolating *Z* from the +6V rail). In other words, inputs *X* and *Y* must both be high. With any other combination of inputs, *Z* is connected to the 6V rail through one or both of the *p*-channel transistors: also, one of the *n*-channel transistors is off, disconnecting *Z* from the 0V rail. In all these cases, output is 0.

Such a gate has a much faster and more reliable action than the simple gates used in the experiments. We could make such a gate by wiring up four MOSFETS on the breadboard, but there is no need to go to this trouble and expense, for the gates can be bought ready-made.

When manufacturing MOSFETS it is easy to produce several on a single slice of silicon complete with the connections needed make up the logic gate. This is what is called an **integrated circuit.**

In this example, we find four NAND gates on a single chip, as shown in Fig. 4.10. Each gate has two input terminals and one output terminal. They share a common power supply. The package is described as a quad 2-input NAND.

When we are building logic circuits it is not necessary to know exactly how each gate is constructed. All we need to know is *what it does*. Consequently it is much simpler and a good deal more informative if we represent gates by special symbols, see Fig. 4.11.

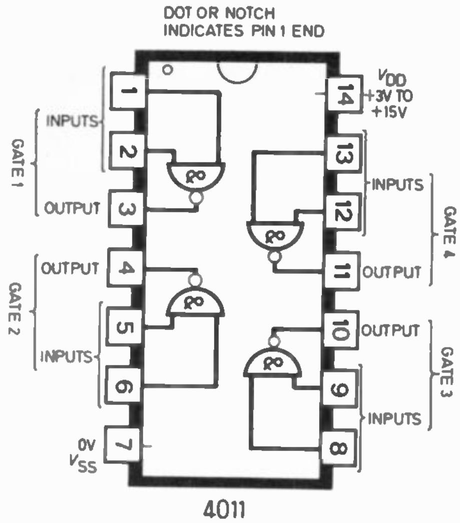


Fig. 4.10. Pinning details for the CMOS Quad-2-input NAND gate i.c., 4011. Viewed from above.

Note that some kinds of gate may have more than two inputs; NOT gates always have one input and EXCLUSIVE-OR gates always have two.

EXPERIMENT 4.4
Logic with integrated circuits

Fig. 4.12 shows how to test one of the gates of the 4011 i.c. The unused inputs of the other gates are connected to +6V; if this is not done the i.c. does not work properly. Run through the input combinations of Table 4.3 and check that the gate performs the NAND function properly. The layout for this experiment is shown in Fig. 4.13.

Next wire both inputs of the gate together (connect *Y* to *J20*). This makes the gate into a one-input gate. What logical operation does it perform now? (see p29).

Wire up the circuits of Fig. 4.14a and b. The numbers indicate the pins to be used, the pins being numbered as in Fig. 4.10. Run through the usual four input combinations for each circuit. What logical operations do these circuits perform? It appears that NAND gates can be made to do many different jobs.

Remove the +6V battery lead from the Verobloc, and replace the 4011 by the 4070 i.c. and then re-connect the +6V supply

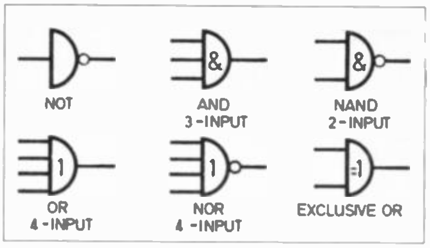
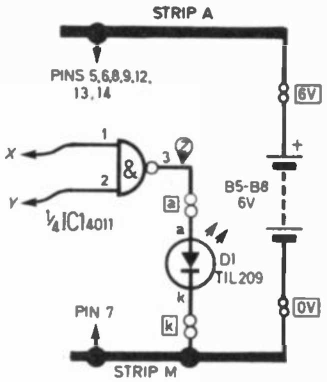


Fig. 4.11. Symbols for logic gates.

EXPERIMENT 4.4

Fig. 4.12. Circuit for investigating the action of a 2-input NAND gate, one of the four contained in a 4011.



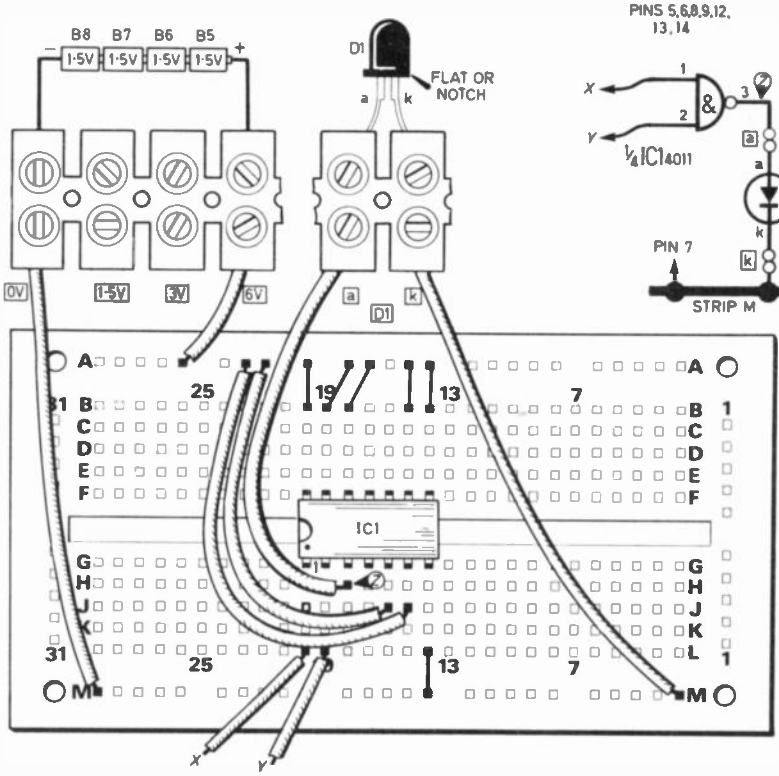
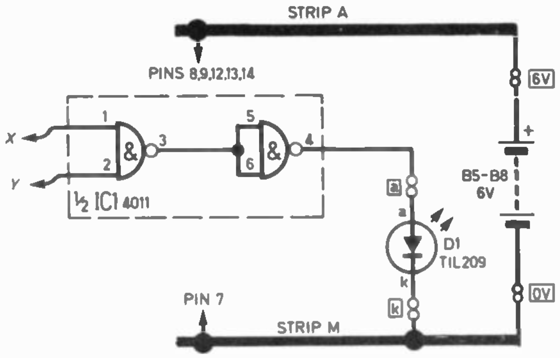


Fig. 4.13. The layout of Fig. 4.12 on the Verobloc. Note that unused inputs are strapped to +6V.



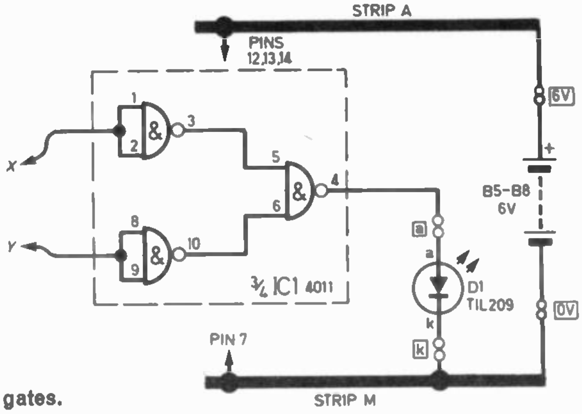


Fig. 4.14 (a) and (b) (right). Making logic modules from NAND gates.

EXPERIMENT 4.5

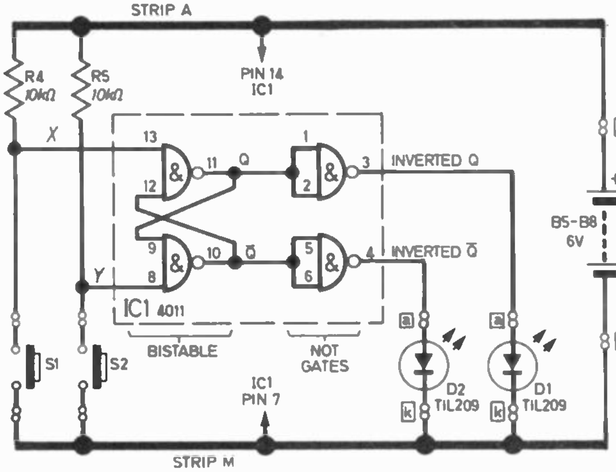


Fig. 4.15. Making up a bistable from two NAND gates. The other two gates are used as buffers.

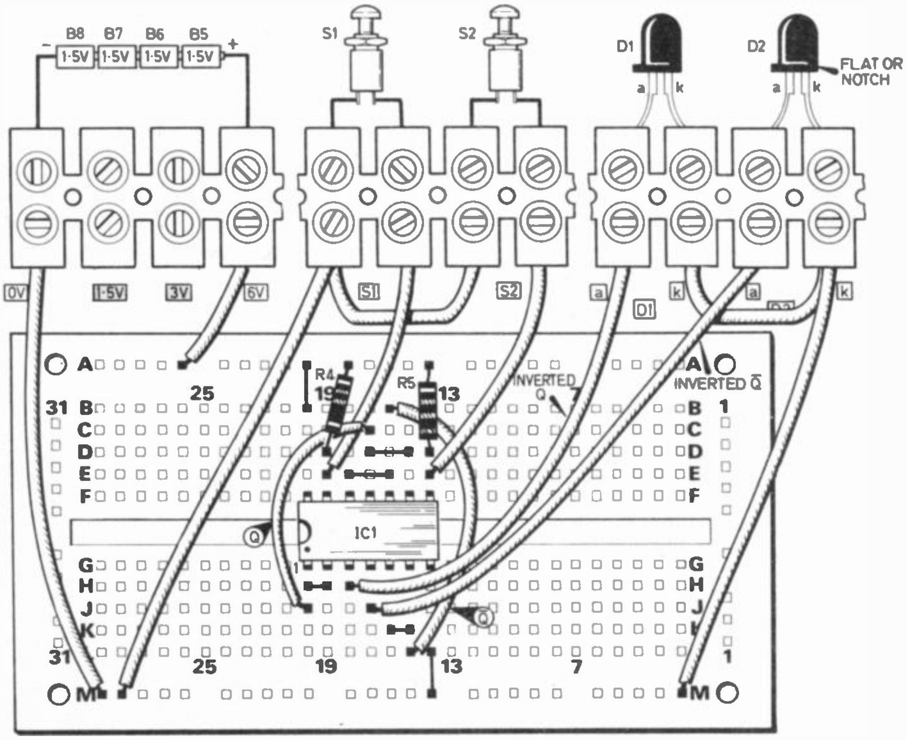


Fig. 4.16 (below). The Verobloc layout for the circuit in Fig. 4.15.

lead. This i.c. has four EXCLUSIVE-OR gates. Each has two inputs, the pin connections are the same as those of the 4011, but the logic function is different. Find its truth table (see p29 for answer).

COMPUTER LOGIC

Logic gates are the basis of the action of many kinds of device, from the pocket calculator and electronic door-chime to the most elaborate of mainframe computers. Mathematics operates by logical rules so we use logic circuits for all kinds of calculations. There is more to say about this in Part 12 of the Series.

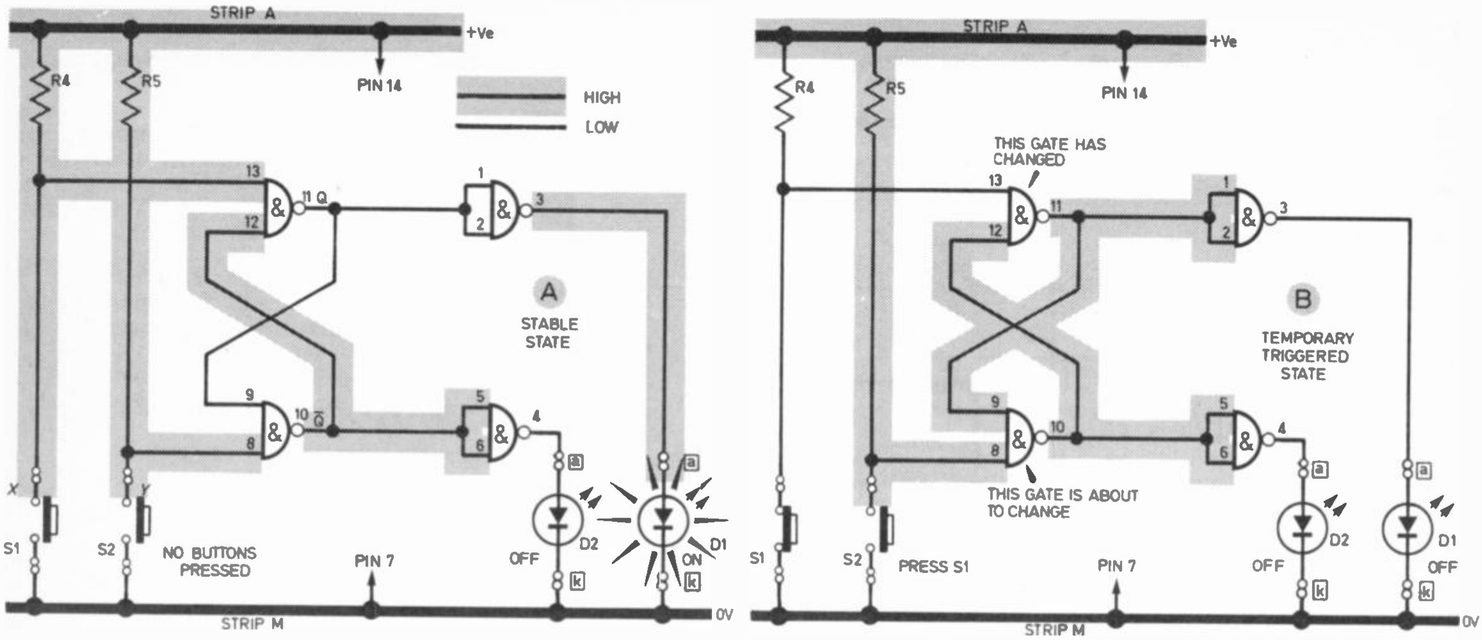
EXPERIMENT 4.5
A memory circuit

Two NAND gates can be cross-connected (Fig. 4.15) to form a **bistable** circuit. It gets its name because it has *two* stable states. We cannot connect l.e.d.s directly to the outputs of this circuit for they take so much current that the bistable does not operate. So we feed the outputs to two NOT gates and use these to drive the l.e.d.s, D1 and D2. The inputs are normally held high by the pull-up resistors R4 and R5. They can be made low by pressing S1 or S2.

The layout of the components on the Verobloc for this experiment is seen in Fig. 4.16. When the battery is first connected, one, *but not both*, of D1 and D2 will light. Find out which button you have to press to make the bistable change state. How do you make it change back again? If you press the same button again, what happens? Figs. 4.17 a, b and c explain this.

If the buttons are pressed alternately the bistable repeatedly changes from one state to the other and back again. On a low input at *X* it flips from one state to the other, then on the next low input at *Y* it flops back again. This type of bistable is often called a **flip-flop.**

The state it is in at any moment is determined solely by which input was the last one to be made low. It can "remember" what has happened to it in the past. The flip-flop is used in calculators and computers as a way of storing information—a unit of memory.



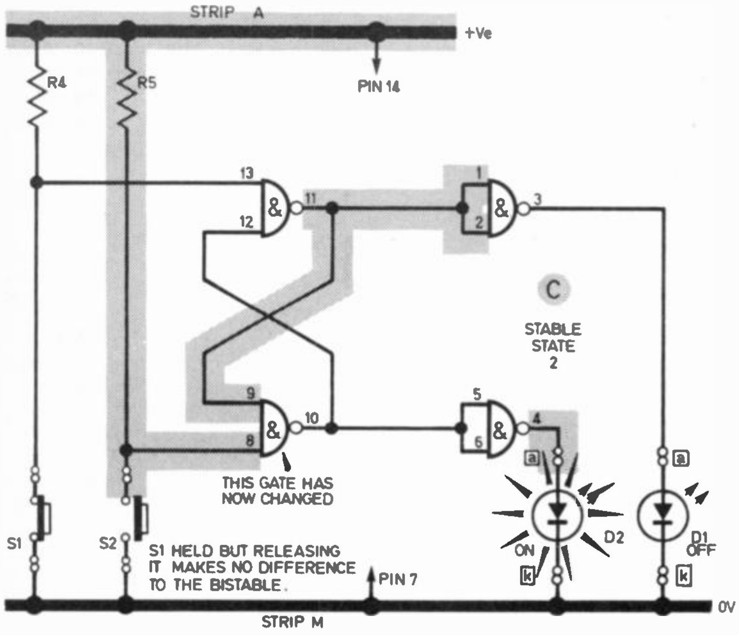


Fig. 4.17 (a) (b) and (c). Stages of action when a bistable changes state. Check the logic using your NAND truth table.

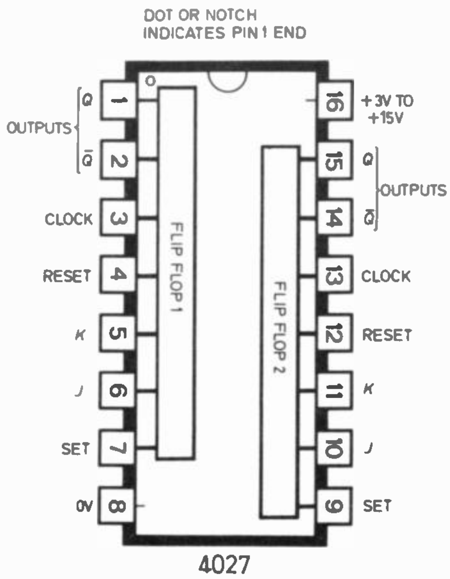


Fig. 4.18. The pinning details for the 4027 i.c. viewed from above. This is used in the next experiment.

THE J-K FLIP-FLOP

The 4027 i.c. gives you the convenience of two ready-made flips-flops without the need to assemble them from individual gates. Each has a clock input. The flip-flop changes state whenever the clock input changes from low to high. A change from high to low has no effect. See Fig. 4.18.

There are two more inputs, called *J* and *K*. These control what happens when the clock input changes. If *J* and *K* are both low, nothing happens. If one of the *J-K* inputs is high and the other is low, the *Q* output takes up the state of the *J* input and the $\overline{Q}$ output takes up the state of the *K* input. If both *J* and *K* are high, the outputs change state every time the clock input goes high.

The *Set* and *Reset* inputs are normally held low. If *Set* is made high, the *Q* output goes high ($\overline{Q}$ goes low) *immediately*, without waiting for a change of clock input. Reset has the opposite effect.

EXPERIMENT 4.6
Using the J-K flip-flop

Fig. 4.19 shows two flip-flops with their *J-K* inputs high. They change state every time their clock inputs go high. We can not simply use a push-button at the clock input. When you press a button, it does not make a good contact at first. Contact is made and broken a dozen or more times before final good contact is made. The flip-flop would respond as if its input had changed many times and its final state is unpredictable. Here we use our earlier flip-flop to provide a clean change-over from high to low or low to high. Wire up the components on the Verobloc according to Fig. 4.20.

Press S1 to give a high-to-low change at point *X* (does not affect the *J-K* flip-flop) or

EXPERIMENT 4.6

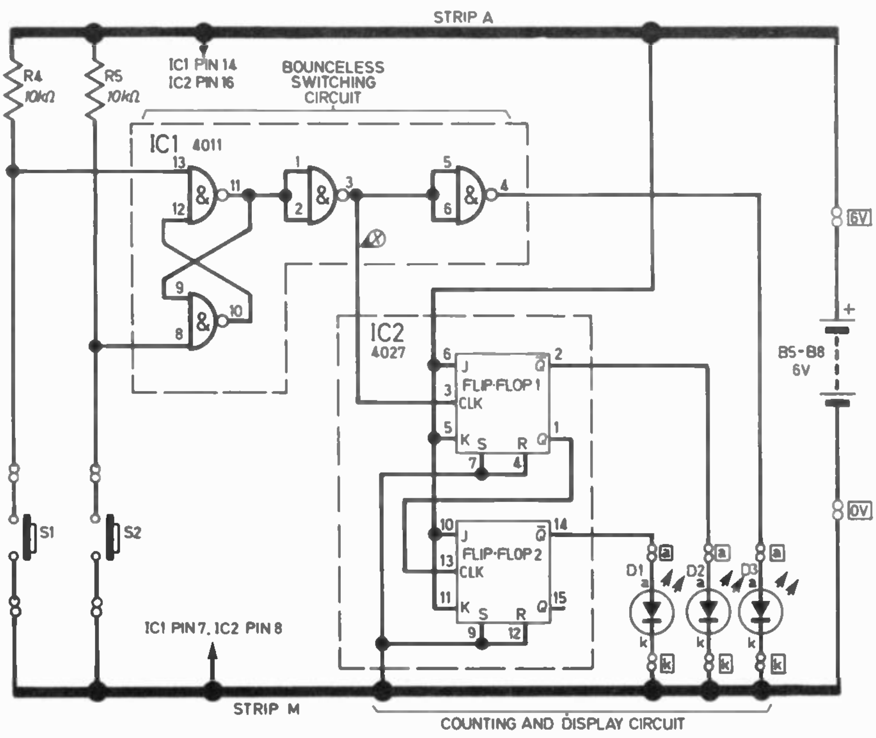


Fig. 4.19. A counting circuit using two *J-K* flip-flops, a bistable and two NOT gates.

press S2 to give a low-to-high change (changes the *J-K* flip-flop). Press S1 and S2 alternately until all l.e.d.s are out. Now we are ready to start.

Press S1, making D3 light. The high-to-low change at *X* does not affect the *J-K* flip-flops. Press S2, making D3 go out. The low-to-high change at *X* makes FF1 (flip-flop number one) change state and D2 lights. The *Q* output of FF1 changes from high to low, so it has no effect on FF2 and D1 stays out. Now press S1 again. D3 lights, but there are no other changes, so both D2 and D3 are now lit.

At the next press of S2, D3 goes out and so does D2, for there is a low-to-high change at *X*. As *Q* of FF1 goes low, *Q* goes high; this triggers FF2 to change state. D1 comes on for the first time.

The changes so far can be set out in a table:

Table 4.4.

Step No.	Press	D3	D2	D1
0 (start)	—	0	0	0
1	S1	0	0	1
2	S2	0	1	0
3	S1	0	1	1
4	S2	1	0	0

0 = unlit; 1 = lit

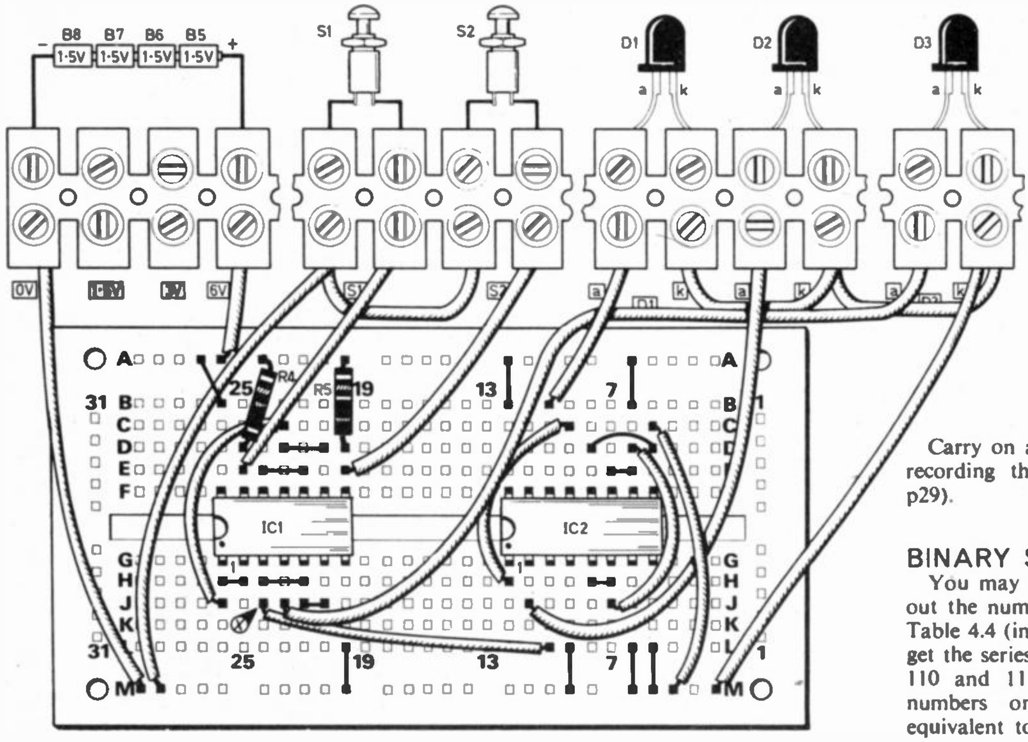


Fig. 4.20. The layout of Fig. 4.19 on the Verobloc.

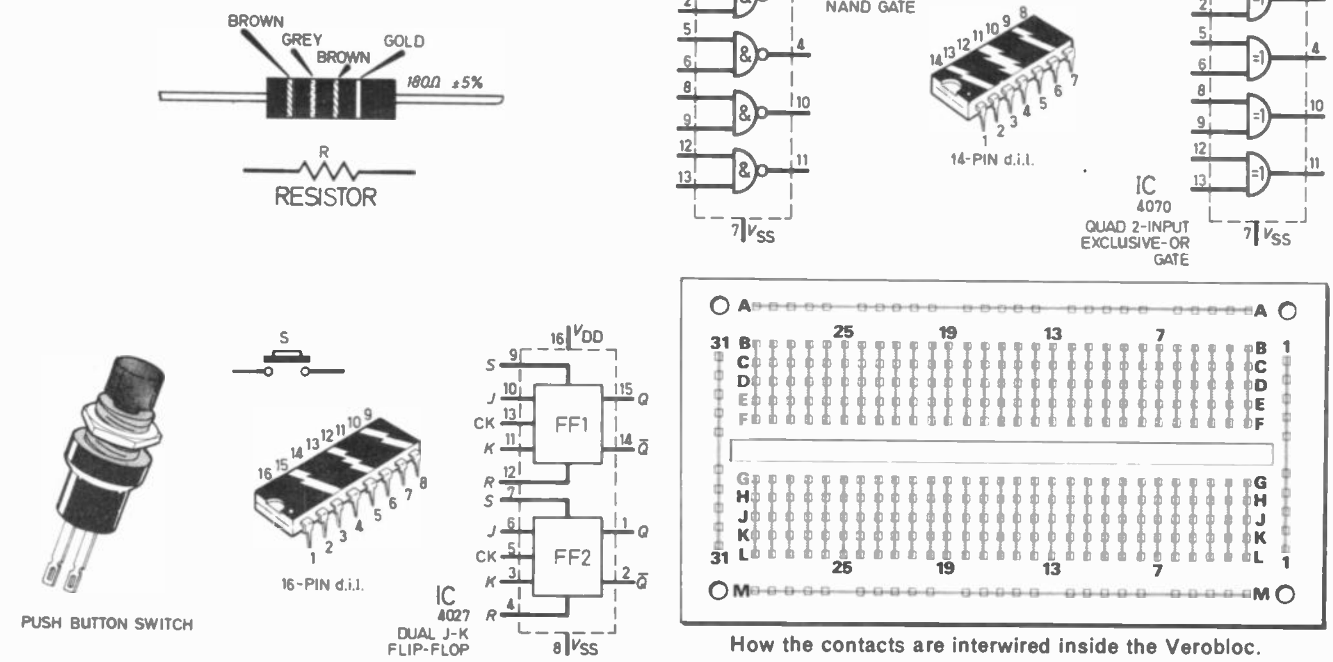
Carry on as above for four more steps, recording the results as above (answers p29).

BINARY SCALE

You may have noticed that if we write out the numbers in the diode columns of Table 4.4 (including your own results), we get the series 000, 001, 010, 011, 100, 101, 110 and 111. These are the first eight numbers on the binary scale, being equivalent to counting from 0 to 7 in the decimal scale. On the eigth press the lamps all go out, returning the count to 0.

This circuit demonstrates how flip-flops can be used to count. It counts the number of presses on the buttons. Similar circuits can be used to count electrical pulses from other sources. If the pulses are produced by cars going into a car-park, we can use such

TEACH-IN 82 COMPONENTS IDENTIFIED



How the contacts are interwired inside the Verobloc.

a circuit to count the cars, and to trip a flip-flop to switch on a 'Park Full' sign when the maximum number is reached. Counting circuits are widely used in all kinds of situations and most of them are based on chains of flip-flops.

Since there have been so many questions in the Experiments there is no *Question Time* this month. Next month we look at some other kinds of transistor and see what they can do.

Answers to this month's Experimental Exercises.

EXPERIMENT 4.2

Truth table for AND

Inputs		Output
X	*Y*	*Z*
0	0	0
0	1	1
1	0	1
1	1	1

Truth table for OR

Inputs		Output
X	*Y*	*Z*
0	0	0
0	1	0
1	0	0
1	1	1

EXPERIMENT 4.4

When the two inputs of a NAND gate are wired together, it functions as a NOT gate (see 1st and 4th lines of your NAND table).

Fig. 4.14a. Inverting the output from a NAND gives NOT-NOT-AND, which gives AND.

Fig. 4.14b. Inverting the inputs to a NAND gives OR.

Truth table for EXCLUSIVE-OR

Inputs		Output
X	*Y*	*Z*
0	0	0
0	1	1
1	0	1
1	0	0

Z is high when one of *X* or *Y* (but *not both*) are high.

EXPERIMENT 4.6

The remaining stages are:

Step No.	Press	D3	D2	D1
5	S1	1	0	1
6	S2	1	1	0
7	S1	1	1	1
8 (=0)	S2	0	0	0

ERRATA

Further to the correction last month concerning Fig. 1.3, on p660 lines 13 and 21: change *X to Y*.
In Question 1.10, "R1 = 150kΩ and R2 = 150Ω" should read "R4 = 150Ω and R5 = 15Ω.

PART 3 ANSWERS

3.1. *n*-type.
3.2. Cathode.
3.3. Holes (and positive ions in solution).
3.4. 0·6V.
3.5. No.
3.6. By the depletion region.
3.7. Out.
3.8. It draws virtually no current from the circuit under test.
3.9. 2·7V.
3.10. 1·72V.

By Dave Barrington

Component Packs

The recommendation of bargain packs of components is very subjective and really a case of ones own personal experience as to whether they are "value for money". Our own experience has been that certainly for such items as resistors, capacitors, diodes and mixed semiconductors buying packs is cost saving and to be recommended.

When you consider that resistors can cost from 1 to 3p each and that you can purchase packs of 100 to 600 resistors, of varied values, from the sum of 90p to under £6 this is quite a saving. On the other hand, the purchase of a mixed selection of "untested" semiconductors has been known to show a 30 per cent failure rate.

Two kits worthy of closer investigation are the E12 series of resistor packs from Home Radio and Rapid Electronics.

A feature of the Home Radio SP22 Resistor Pack is the method of packing the resistors in compartmented cardboard trays with their values indicated on label strips. This makes for easy selection.

With 10 each of the popular values and 5 each of the less popular, the pack contains approximately 400 resistors and costs £5 including VAT and postage.

The Rapid kit contains 650 ¼W 5 per cent carbon film resistors banded together in groups of ten. The values range from 4·7 ohms to 1 megohm.

The cost of the Rapid Electronics kit is £4·80 plus VAT and 50p postage and packing.

Pocket Music Tutor

Of the thousands of electronic organs and pianos sold every year, it is claimed that three quarters are bought by people with no knowledge of music. However, they've all got something in common: they all want to get recognisable tunes out of their instruments as soon as possible.

Budding organists and pianists struggling through the first stages of learning to play will welcome the pocket electronic chord and scale tutor from Speedyplain.

Called Prelude, it gives an instant visual guide to more than 600 chords as well as all major and minor scales. It's a hand-held device, similar to a pocket calculator, with keys for the musical notes, chords and inversions, and a liquid crystal keyboard display.

The unit is designed to help tutored or self-taught students learn the basic "alphabet" of music; to teach classically trained musicians modern harmony and to help string or wind players to convert to keyboards.

Two professional organ teachers who helped in Prelude's design claim it is far easier and quicker to use than a printed tutor. Not only does it show notes making up the basic chord, but the user can add progressively more complex components, such as sixths, sevenths, ninths, minors and diminisheds.

The Prelude tutor is available direct from Speedyplain Ltd., Dept EE, 120 Marsh Lane, Longton, Preston, PR4 5YL, and cost £19·95 including VAT (without batteries), plus 40 pence post and packing.

The Prelude electronic chord and scale tutor from Speedyplain.

Project Kits

After a successful campaign in Europe, Velleman electronic kits are now available in this country through Velleman UK Ltd.

Ranging in price from £4 to about £250, a fairly wide selection of kits are offered to satisfy the beginner and the advanced constructor. They range from a simple three-tone bell to a microprocessor controlled Eprom programmer.

Each kit is given a "degree of difficulty" grading to help would-be constructors to select kits within their capability. All kits are built on printed circuit boards with component designations printed on the topside.

Copies of a free illustrated catalogue containing details of the range of Velleman electronic kits is obtainable from Velleman UK Ltd., Dept EE, P.O. Box 30, St Leonards on Sea, East Sussex, TN37 7NL. A stamped addressed envelope would be appreciated.

Catalogue

The new Tandy 1981/2 catalogue is now available in all 300 Tandy stores throughout Britain. Issued free to all Tandy customers, the 140 page catalogue contains over 2200 exclusive own brand products.

The catalogue also includes a ten page section on all hardware, software, peripherals and for the TRS-80 microcomputer, Models I, II and III, the TRS-80 pocket computer and the very latest Colour Computer.

CONSTRUCTIONAL PROJECTS

Automatic Garage Doors

The 40kHz transducers used in the transmitter and receiver units for the *Automatic Garage Door* are fairly common items and now stocked by most component suppliers. These are usually sold in pairs and may be supplied with two-pin or phono plug connections. Either type may be used but the latter will require altering the wiring to the transducers.

The motor used in the designers set-up was a Fracmo type, currently stocked by Service Trading Co, Dept EE, of 57 Bridgman Road, Chiswick, London, W4 5BB, with an output shaft running at approximately 56r.p.m. and a more than adequate torque of 50lbs/in. We understand that they have only a limited stock, but are able to supply a near equivalent type in their Parvalux range with 42 or 30 r.p.m. at 50lbs/in. torque.

The author informs us that a cheaper alternative would be two one-way motors fixed together in such a way as to enable reverse operation.

Most of the hardware for the door gear should be available from local builders merchants or hardware stores.

Mini Egg Timer

Because of the close packing of components within the small case for the *Mini Egg Timer*, the audible warning device WD1 specified should be used.

This is available from Ambit International as stock number 43-27201. However, any low voltage (6V) solid state buzzer could be used here but would necessitate a larger case or be mounted on the exterior of the case.

Model Train Chuffer

The *Model Train Chuffer* uses a CMOS equivalent to the renowned 555 timer i.c. This is designated ICM7555 and appears to be available from most advertisers, at a price varying from 80p to just over £1.

Siren Module

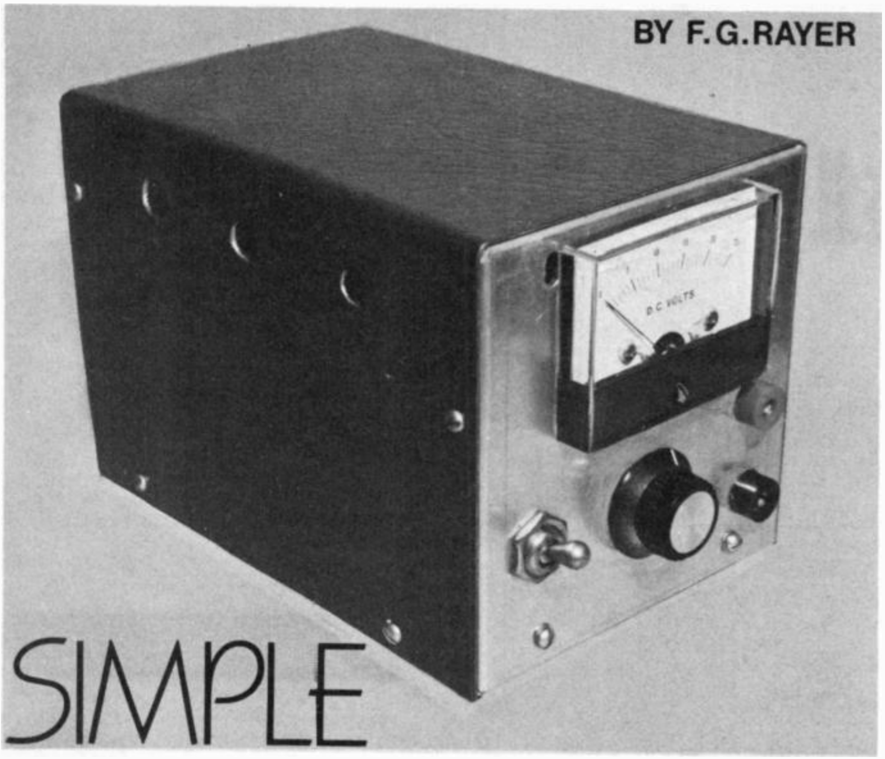
Once again it may be wise to browse through the advertisements when looking for a particular component for the *Siren Module*. The transistor type TIP31A is listed from 40p to 52p each.

Simple Stabilised P.S.U.

No problems should be encountered when purchasing components for the *Simple Stabilised P.S.U.* The bolt together Universal Chassis appears to be only available from Home Radio.

Electroplating

Any readers who are contemplating building or attempting to undertake their own electroplating should pay heed to the warning contained in the *Electroplating* article. This applies particularly to the handling of chemicals.



BY F.G.RAYER

SIMPLE STABILISED P.S.U.

THERE is no doubt that a regulated and adjustable power supply unit is of immense utility to the constructor and experimenter of electronic projects. Some thought has been given to easing constructional work to make this project suitable for the beginner. Regulation is so good that if wished the cost can be reduced by omitting the meter—but more about this later. Output voltage is 1·2V to 20V at currents up to 1 ampere, adequate for very many purposes.

CIRCUIT DESCRIPTION

The mains transformer T1 has a 20-0-20V 1A secondary, with full-wave rectification by silicon diodes D1 and D2. The peak voltage across the reservoir capacitor C1 is about 28V, and this is the input to the LM317K regulator.

The LM317K has internal stabilising, feedback, regulating and current passing devices. The output voltage is a function of VR1 value between 0V and ADJUST and is given by:

Output voltage = 1·2 (1 + VR1/R1)

The LM317K can handle 1·5 amps but T1 rating limits the p.s.u. output to 1 amp. C2 and C3 effectively suppress transients, or instantaneous mains voltage spikes which would otherwise reach the output.

To use the unit, it is only necessary to switch on by S1, set VR1 so that the voltmeter ME1 shows the wanted voltage, and plug in the apparatus to be operated, not forgetting to observe the correct polarity.

If the p.s.u. output leads are shorted, the end of R1 normally at positive potential becomes negative, and thus also the ADJUST input of the i.c. This protects the circuit, though naturally one would not leave the p.s.u. output shorted in this way.

NO METER

Changes in input voltage to the LM317K, or to output load current (within the normal limits) results in no visible change to the reading shown by the panel meter ME1. It is of course useful to have this meter to show the voltage at all times.

It can, however, be eliminated by fitting a pointer knob to VR1, with a scale glued to the panel behind this control. Connect a general purpose test meter set to its 0-20V or similar d.c. range, to the p.s.u. output sockets. The scale for VR1 can then be calibrated at 1·5, 2, 2·5, 3V and so on.

Subsequently you simply set VR1 to the wanted voltage before connecting any item of equipment to be run from the unit.

CONSTRUCTION starts here

CASE

The case is built up from Universal Chassis members and is based upon 101×101mm flanged members for back and front, with a 152×101mm flanged member for the bottom, see Fig. 2. The top/side section is made from a piece of thin sheet metal or perforated metal 152×304mm, bent into a 101×101×152mm open box.

BACK PANEL

Prepare the back panel by drilling the four holes for mounting the LM317K. You must use a TO-3 power transistor type insulation set (mica washer and two plastic bushes).

The mica can be used as a template to mark out the drilling positions for the required holes. Take care not to distort the back, and remove any

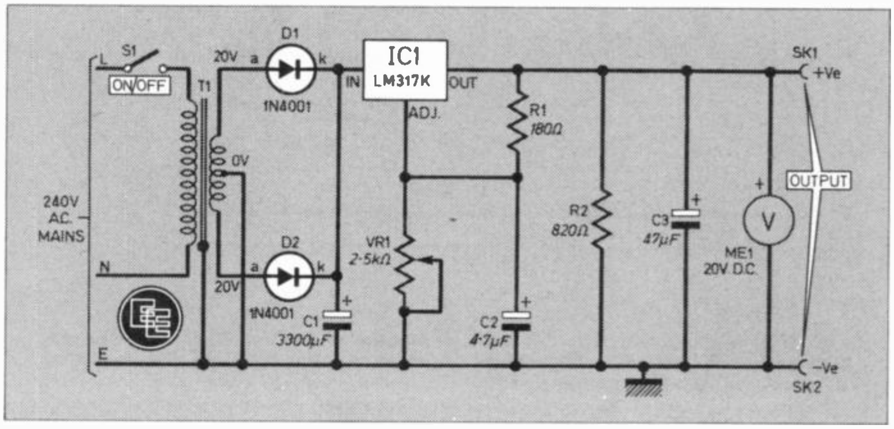
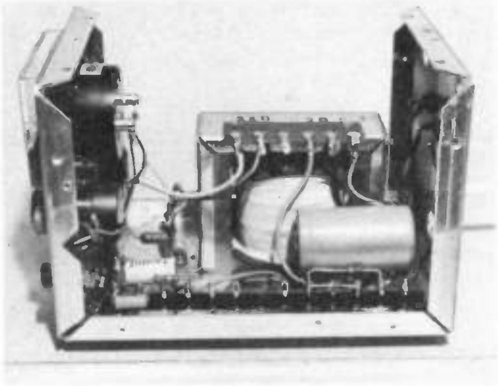


Fig. 1. The complete circuit diagram of the Simple Stabilised P.S.U.

SIMPLE

STABILISED P.S.U.

COMPONENTS approximate cost £18 excluding case



Interior view of the finished prototype showing how the case is constructed from Universal Chassis parts.

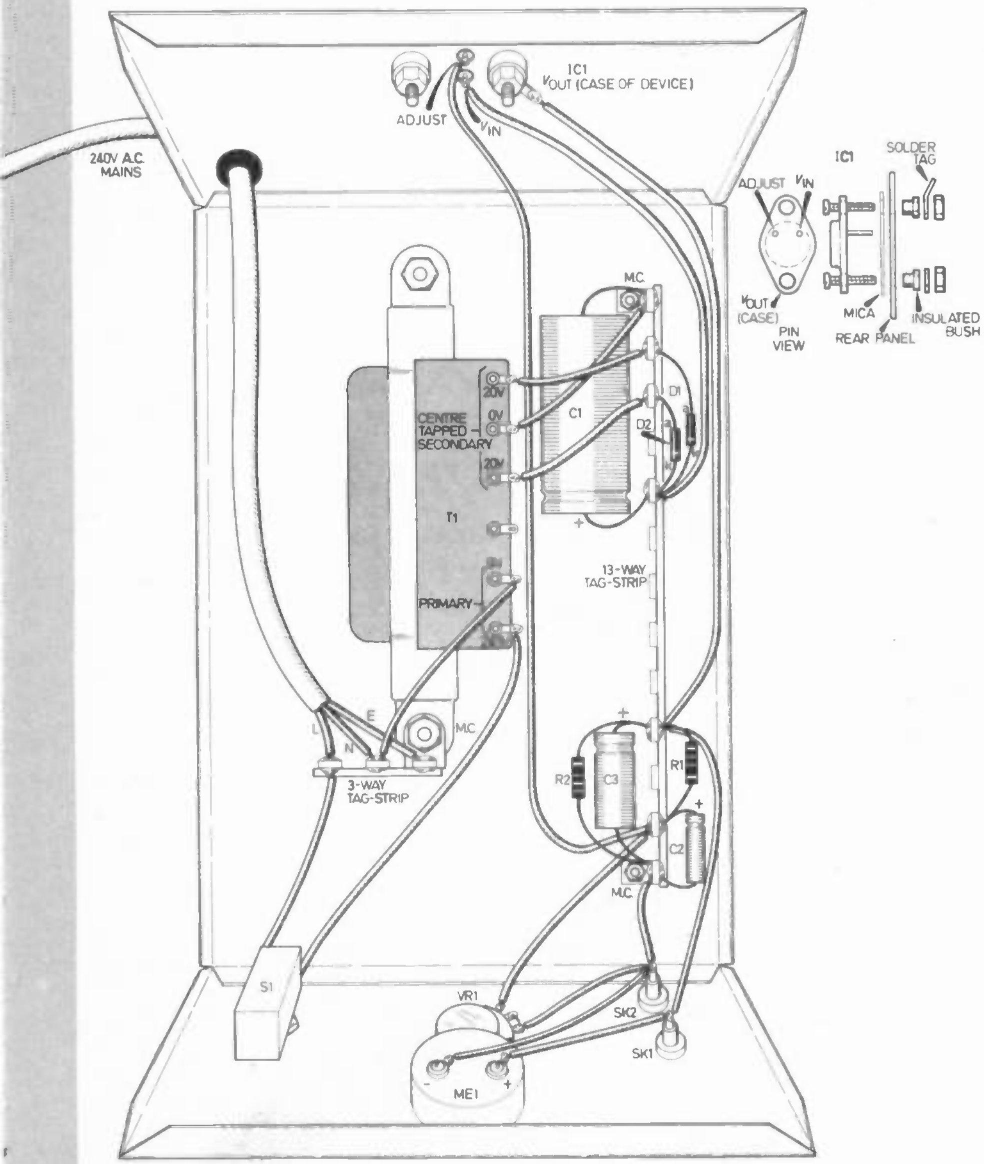


Fig. 2. Recommended layout of the components on the Universal Chassis members with full interwiring details. Also shown top right are the mounting details for IC1 and its insulation set.

COMPONENTS

Resistors
R1 180Ω ½W carbon ±5%
R2 820Ω 1W carbon ±5%

Capacitors
C1 3300μF 30V elect.
C2 4·7μF 30V elect.
C3 47μF 30V elect.

See **Shop Talk** page 30

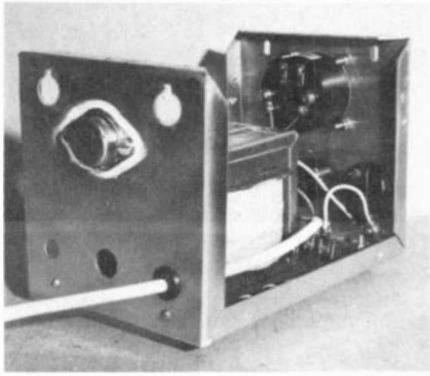
Semiconductors
IC1 LM317K adjustable voltage regulator i.c.
D1, D2 1N4001 1A 50V silicon rectifier (2 off)

Miscellaneous
VR1 2·5kΩ carbon or wirewound linear potentiometer
S1 s.p. on/off toggle mains
ME1 20V or 25V d.c. panel meter
SK1, SK2 4mm insulated sockets (1 red, 1 black)
T1 mains primary/ 20-0-20V 1A secondary
Standard tagstrip, 13-way and 3-way; Universal Chassis members: 101 × 101mm flanged members (2 off), 152 × 101mm flanged member; sheet aluminium or perforated metal size 152 × 304mm (case lid); insulation set (mica washer and 2 insulating bushes) for IC1; rubber grommet for mains cable; suitable length of 3-core mains cable; rubber feet (4 off); fixing hardware for transformer, IC1, case and tagstrips; 1A insulated connecting wire.

burrs from around the holes. Fit the mica washer between i.c. and back, with the insulated bushes in the holes in the latter, and fit a solder tag for the OUTPUT connection. One of the thermal greases can be smeared on the meeting surfaces before fitting the i.c. to ensure good thermal contact. Check that case and pins are all isolated from the metal back panel.

FRONT PANEL

Drill fixing holes for S1, VR1, and the two output sockets, as shown. An opening for the meter can be made with an adjustable tank cutter, or with one of the screw-up type punches, or by drilling a ring of small holes closely together, so that a piece can be removed and the hole completed with half-round file.



Shows the back panel with the i.c. mounted and ventilation holes.

VENTILATION

Several 9mm or similar holes should be punched or drilled in the bottom panel (which is raised by the feet) and also low down and high up on the back panel. If the cover is sheet metal, a row of holes can also be punched in each side of this.

BOTTOM PANEL

Drill fixing holes for the transformer and long tag strip. When front, back and bottom are assembled, secure four rubber feet with bolts and nuts, using the holes already present.

WIRING

With all parts fitted as in Fig. 2, wiring should now be carried out as shown. In the prototype blue was used for i.c. INPUT, green for ADJUST, and red for OUTPUT and positive, for ease of identification.

Note how Live, Neutral and Earth of the mains cord are anchored. Fit a 3-pin mains plug correctly, with 2A or 3A fuse. Those points marked MC are firmly bolted to the metal chassis or box.

TESTING

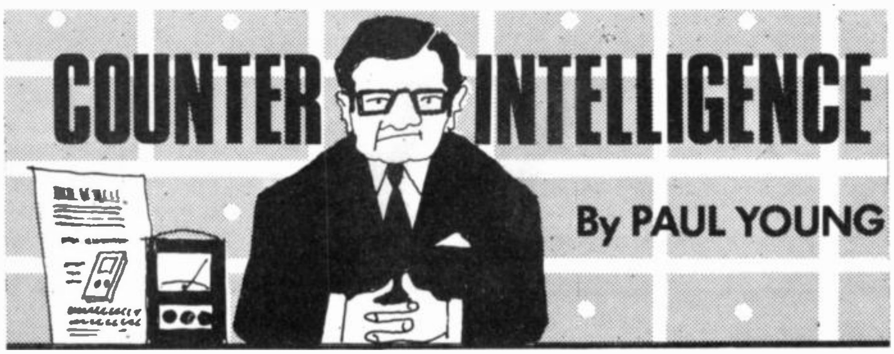
You should measure nearly 29V across C1, but this will fall as current is drawn, though this does not influence the output voltage.

It is essential D1 and D2, and electrolytic capacitors, are wired with correct polarity. Check these before switching on.

Output should be absolutely stable, free of hum, and remain unchanged despite any changes in current drawn with in the p.s.u. rating.

Check the short-circuit protection network by placing a heavy gauge wire link across the output sockets for a *short time*. ME1 reading should drop to 0V, but return to previous level when link is removed.

Finally fix the cover in place with self-tapping screws which run into the flanges of back, bottom and front panels. ⌑



I am greatly cheered by the large number of youngsters who take up electronics as a hobby, and undoubtedly many will want to adopt it as a career. Although these are hard pressed times, I think they have made a good choice, because there are openings at all levels with the really brilliant ones finishing up as designers.

At a slightly less elevated echelon, there are vacancies for electronic engineers on board ships. On a modern tanker or container vessel, the electronic engineering officer is almost as important as the captain.

In the next five years every garage worth its name will need an electronics expert. Those of you who saw "Tomorrow's World" recently probably were intrigued by the new cars coming on the market shortly, where the computer works out the exact speed at which the gear should be changed, and then proceeds to do it. Needless to say I know instinctively what would happen if I owned one. Going downhill it would decide to change into bottom and the engine would race away sounding like an angry hornet, and going uphill it would change into top and promptly stall.

Mind you it is hard to think of anything today from washing machines to cookers that doesn't rely heavily on electronics, so in the service industries there must always be a demand for recruits, even though the time may come when they invent machines that service themselves. I don't object to any of this, provided that complication is not introduced without noticeable advantage.

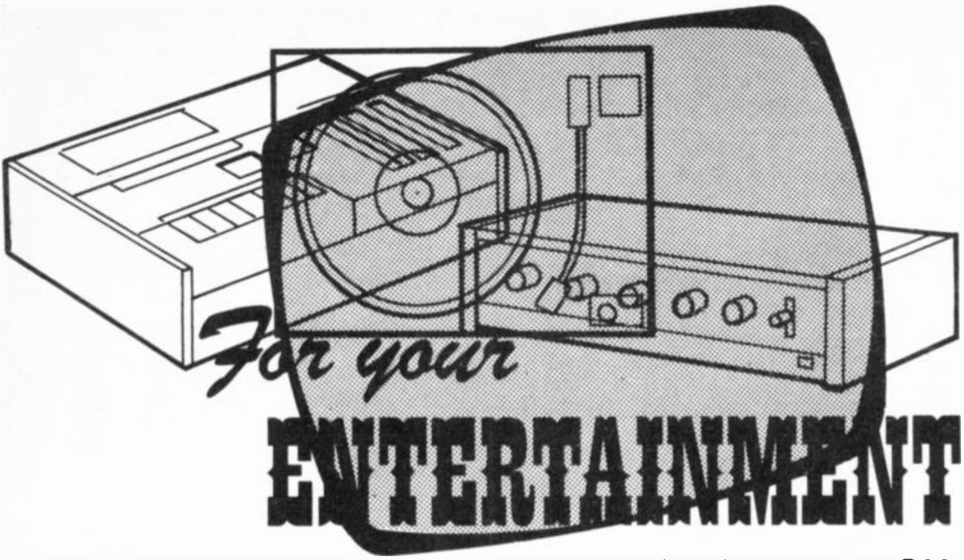
Safety in Simplicity

James Watt had the problem of converting a reciprocating motion into a rotary one and he solved it very neatly by inventing the crank. One of his workmen pinched the idea and patented it, preventing Watt from using it. Watt then invented a dozen different ways of obtaining the same result, but none so simple or effective as his original. The simpler a thing is the less likelihood of failure. As the late E. F. Schumacher said, "Any third rate engineer can make a complicated apparatus more complicated but it takes a touch of genius to find one's way back to basic principles. The more complex a thing is, the more it tends to break down and you can't repair it yourself."

If you take a simple thing like a spade, it can't go wrong! Make it mechanical and up go the chances of failure. Put an engine on it, the failure rate increases, and finally put an electronic control on it and it's a wonder if it ever works at all! And yet having said all that, take a piece of apparatus as complicated as a colour television set and they work for years without any trouble. Come to think, the handle of my spade broke in half this morning!

I suppose one day a mains plug and socket that is standard all over the world will be in general use and what a boon that will be to travellers. I expect many of you use electric razors and if you go abroad you are confronted with continental sockets which will only accept a continental plug. It is no good switching to a safety razor temporarily, because the electric shaver's beard is too soft.

I get round this problem by taking my clockwork razor with me when travelling. (Looks of incredulity on the faces of my readers!) No really, the one used by the man in the moon. (Ah! now we know old Young is pulling our leg!) Let me explain, this type of razor was used by the astronauts to conserve their battery supply. It has a small rotary head rather like a Philips, and with three complete winds I can get a perfect shave.



By BARRY FOX

Break Up

It has been fascinating to watch the British Post Office react over the last year or so to the reality of commercial competition. The PO's original attitude clearly reflected its position of total security, with a monopoly on everything connected with and to the British telephone system. Arrogant would not be too strong a word to use.

Now, progressive break up of the PO's power and demonopolisation by the Telecommunications Bill has brought a corresponding change of face by the Post Office. There's even been a change of name, to British Telecom.

Time Delay

British subscribers don't need reminding how bad it used to be just a couple of years ago. Long delays in installing new lines, a pathetically small choice of ancient technology dial phones and the compulsion to rent everything at high prices from either the Post Office or Post Office-approved suppliers. The Area offices, responsible for "selling" extra telephones knew little or nothing about what was available, and appeared to care even less.

Long distance phone calls were all too often hampered by the dreaded "all lines are engaged, please try later" and anyone trying to route a Trans-Atlantic call through a British operator had to wait an inordinate length of time. Worse still you had to join the same long queue for an operator even if you only wanted foreign directory help. And long distance multi-digit calls that failed had to be laboriously re-dialled because the Post Office didn't offer push button 'phones with the last number recall facility, whereby an entire string of digits can be re-called by the push of a single button.

Liberation

But meanwhile, in America, libralisation of the similar monopoly held by the Bell Telephone Company filled the shops with exciting telephone equipment. Push button phones, answering machines, recorders; all could be bought outright for private installation.

Inevitably some of this equipment started to reach Britain, either as private imports in the suitcases of those who had taken their holidays abroad, or as bulk imports from Far Eastern manufacturers. Magazines and newspapers started to publish articles about what British subscribers were missing.

Dissatisfaction

Dissatisfaction grew and the Post Office added fuel to the fire by condemning foreign equipment out of hand and threatening to diconnect the phone lines of any British subscriber who dared to install it. Some of this criticism was in fact wholly justified.

Equipment designed for foreign use is often unsuitable for Britain. The US telephone network is for instance "gainy". Most lines are amplified whereas in the UK lines are often passive because we have a tradition of using low-loss copper.

So a telephone that produces acceptable levels of sound in the US may well be unusable in some parts of Britain. Also the ringer circuits of foreign phones may not match the British network. You can install an imported telephone and then find that some incoming calls don't ring your bell.

In Britain, where two extension phones are connected to the same line, the sound and ringer circuits are connected in a hybrid series/parallel circuit. This ensures a standard impedance across the line and prevents the bell of one phone from jangling while calls are made on the other. Many foreign phones don't offer the option of series/parallel connection.

Guidance Needed

Most important of all, anyone buying an unauthorised telephone, and trying to install it themselves, can't seek guidance and help from the Post Office engineers to get it right. This has dangerous implications. Any amateur trying to install a mains-powered gadget, for instance a memory telephone or automatic answering machine, could end up putting mains voltage on the phone lines if they get the connections wrong or have bought a cheap unit without adequate isolation.

The idea of an amnesty, whereby owners of unauthorised 'phones could pay the Post Office to help then get it properly installed, was poo-pood. But the Post Office has already encountered a case where someone bought a mains-powered cordless telephone, which uses the mains wiring as aerial, and connected it up incorrectly so that mains power burned out his entire home 'phone system.

Incidentally, (and it's a topic we'll return to in future months), do bear in mind that liberalisation of the phone system will *not* affect the question of cordless phones. They use a radio link between a base station and hand set and they will remain illegal because they contravene the Wireless Telegraphy Act. Anyone caught using one is liable for heavy fines and/or imprisonment.

Phone-In

At the end of June the London radio station, LBC, held an hour-long *Phone-In* on "What kind of telephone service does the public want".

Calls poured in from listeners who wanted to know what kind of special phones and services are available, and what we are likely to see in the future. There was a clear groundswell of resentment and confusion over what British Telecom does and does not have to offer a subscriber. (Incidentally it's clear that everyone still calls The Post Office "the Post Office"; the title British Telecom certainly hasn't yet stuck).

I was in the studio and did my best to answer the questions that came through from listeners. Why, you may well ask, should a journalist be speaking on behalf of the Post Office The answer is quite simply that although the Post Office were asked, literally days in advance, to send someone along to the studio they thought it wasn't necessary.

This decision was doubtless not unconnected with the fact that the LBC programme went out late on a Saturday night, rather than during weekday working hours. If British Telecom, nee The Post Office, can't muster a spokesman for an hour long live radio phone-in programme on a Saturday night in London, then what price Sir George Jefferson's brave promise that "We must be market responsive when we are competing with others".

The sad irony is that several Post Office engineers, and ex-Post Office engineers, had sufficient loyalty to their employer to phone in and try and defend the Post Office against callers' attacks. But there were no calls from Post Office management. They should be thoroughly ashamed of themselves. Do you suppose they are?

SCHOOLS
Electronic Design Award
COMPETITION

over £1,000 IN PRIZES

Mullard Ltd—the largest electronic components Company in the UK—and EVERYDAY ELECTRONICS join forces to present this rewarding challenge to Secondary Schools.

DESIGN A PIECE OF ELECTRONIC EQUIPMENT HAVING A DIRECT PRACTICAL APPLICATION IN A SCHOOLS SCIENCE LABORATORY

This competition is open to any United Kingdom Secondary School, State or Independent. Pupils of either sex in the age group 11-18 are eligible to participate in a team representing their school.
The competition will be conducted in two stages.

STAGE 1
Submission of Papers describing the proposed project with full circuit details.
Papers will be judged for novelty, ingenuity and viability. Particular attention will be given to originality and good circuit design technique.
Schools whose designs are adjudged to be the most promising will be asked to produce a working model of their designs.

STAGE 2
Models will be examined and prize winners selected on the basis of mechanical design, neatness of wiring and general assembly, plus operational performance.

All models will be exhibited at Mullard House, London, where the official presentation of prizes will be made.

FIRST PRIZE	**£150**	**plus a selection of components valued at £100**
SECOND PRIZE	**£100**	
THIRD PRIZE	**£50**	
NINE RUNNERS UP		**a selection of components valued at £50**

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

Write to: Schools Competition
Room 2130
Kings Reach Tower
Stamford Street
London
SE1 9LS

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

Closing date for Registration: December 31 1981

Closing date for submission of Papers: February 16 1982

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

INTRODUCTION TO LOGIC

PART 8 BY J. CROWTHER

LOGIC MODULES (continued)

Example

To derive the Boolean expression and switching circuit for the module shown in Fig. 9.1.

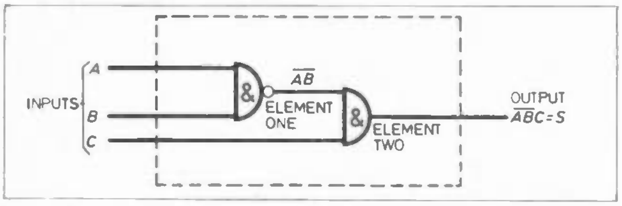


Fig. 9.1. Logic module to be translated to a switch arrangement.

The output from the NAND gate is of the form $\overline{AB}$, and this is fed to the input of an AND gate, with C to the other input. As the output of an AND gate is the product of the inputs:

$$\overline{AB}C = S$$

In order to convert this equation into one representing switching arrangements, we must apply Demorgan's Theorem, and get the "bars" over a single letter to represent normally closed switches.

$$\overline{AB}C = (\bar{A} + \bar{B})C = S$$

The equation $(\bar{A} + \bar{B})C = S$, represents the switch arrangement in Fig. 9.2.

Truth Table

The truth table for the module in Fig. 9.1 is shown below:

Input to element 1		Input to element 2		Output
A	B	C	$\overline{AB}$	$\overline{AB}C = S$
0	0	0	1	0
0	0	1	1	1
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	0	0
1	1	1	0	0

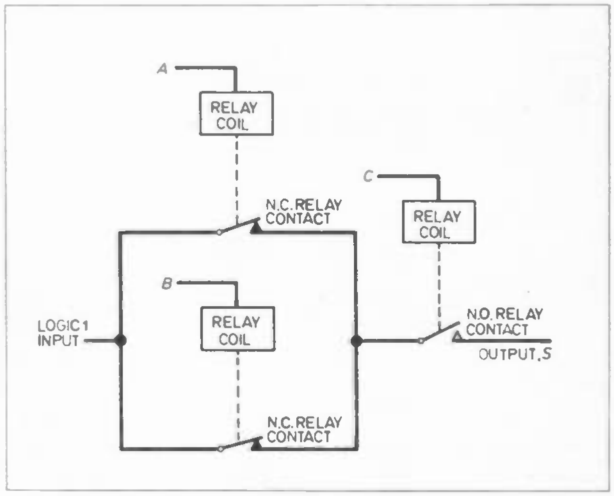


Fig. 9.2. Switch version of the module in Fig. 9.1.

FINDING GATES FROM EQUATIONS AND SWITCH ARRANGEMENTS

Example

Design a Logic Module to represent the switch arrangement in Fig. 9.3.

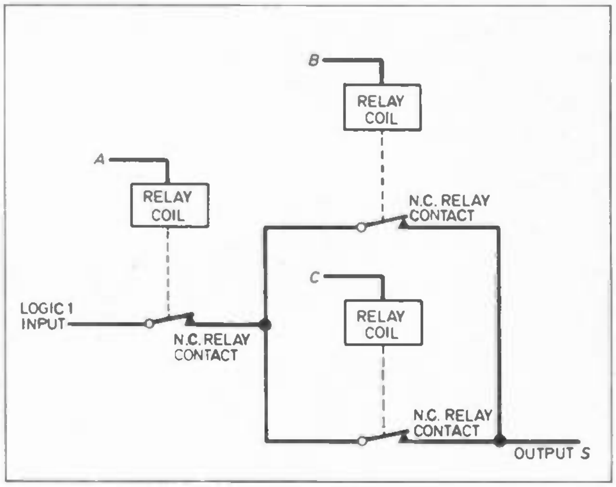


Fig. 9.3. Switch arrangement to be converted to a logic gate module.

Equation

$A(B+C)=S$

Since this equation is A, times $(B+C)$, and the output from an AND gate is the product of the two inputs, the last gate must be an AND gate fed with A and $(B+C)$, as shown in Fig. 9.4.

To get $(B+C)$, we must have an OR gate fed with B, and C, so the final module is as seen in Fig. 9.5.

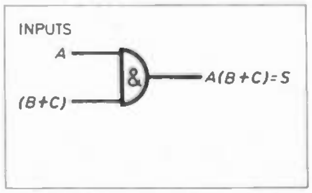


Fig. 9.4. First stage of conversion for Fig. 9.3.

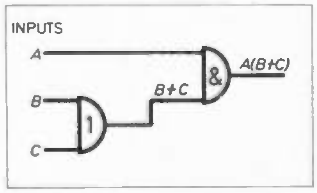


Fig. 9.5. Logic module for Fig. 9.3.

Example

Design a Logic Module to represent the switch arrangement in Fig. 9.6.

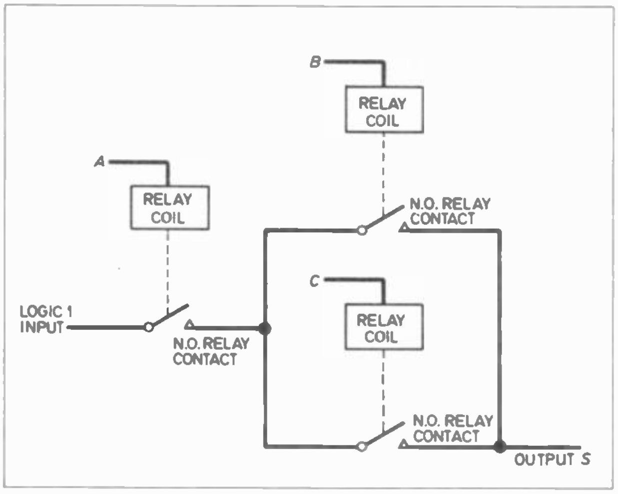


Fig. 9.6. Switch arrangement to be translated to a logic gate module.

Equation

$\bar{A}(\bar{B}+\bar{C})=S$

Apply Demorgan's Theorem to convert the above equation into an expression representing gates, that is, join the "bars" to form a complete "bar" as shown:

$\bar{A}(\bar{B}+\bar{C})=\bar{A}(\overline{BC})=\overline{A+BC}=S$

$\overline{A+BC}$ is the equation for a NOR gate fed with A, and BC, as shown in Fig. 9.7.

To obtain BC, we require an AND gate fed with B, and C, so the final module would be as seen in Fig. 9.8.

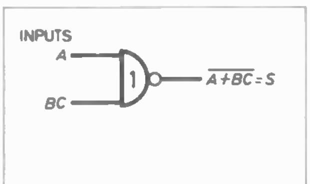


Fig. 9.7. First stage of translation for Fig. 9.6.

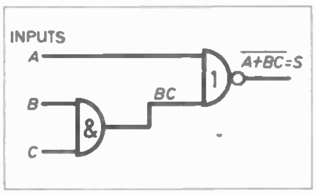


Fig. 9.8. Logic module for Fig. 9.6.

BOOLEAN IDENTITIES

In algebra and trignometry, identities are used to simplify equations.

For example, in trignometry $\sin^2\theta + \cos^2\theta = 1$

The same applies to Boolean Algebra where identities are used to simplify equations to see if it is possible to reduce the number of switches required.

Boolean Identities

(1) $AA=A$ also $\bar{A}\bar{A}=\bar{A}$
(2) $A\bar{A}=0$
(3) $A1=A$ also $\bar{A}1=\bar{A}$.
(4) $A0=0$ also $\bar{A}0=0$
(5) $A+A=A$ also $\bar{A}+\bar{A}=\bar{A}$
(6) $A+1=1$ also $\bar{A}+1=1$
(7) $A+0=A$ also $\bar{A}+0=\bar{A}$
(8) $A+\bar{A}=1$
(9) $A+\bar{A}B=A+B$
$\bar{A}+AB=\bar{A}+B$
$A+\bar{A}\bar{B}=A+\bar{B}$
$\bar{A}+A\bar{B}=\bar{A}+\bar{B}$

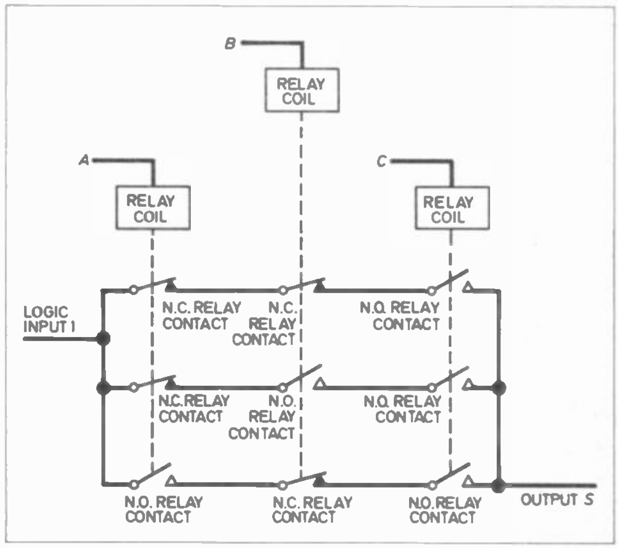


Fig. 9.9. Switching arrangement to be investigated by Boolean rules and identities.

example

$\bar{A}\bar{B}C+\bar{A}BC+A\bar{B}C=S$

This equation represents the circuit in Fig. 9.9, containing nine switch contacts.

Use the Boolean Rules and Identities, to simplify this equation and reduce the number of switches.

First of all, simplify the equation.

C is common to all terms, and can be put outside the bracket (see Rule 3 in Part 5):

$C(\bar{A}\bar{B}+\bar{A}B+A\bar{B})=S$

A is common to the first two terms in the bracket, and can be brought outside using the same rule:

$C[\bar{A}(\bar{B}+B)+A\bar{B}]=S$

But $(\bar{B}+B)=1$ (Identity 8)

$\therefore C(\bar{A}1+A\bar{B})=S$

But $\bar{A}1=\bar{A}$ (Identity 3)

$\therefore C(\bar{A}+A\bar{B})=S$

But $(\bar{A}+A\bar{B})=\bar{A}+\bar{B}$ (Identity 9)

$\therefore C(\bar{A}+\bar{B})=S$

This last equation represents the switch circuit in Fig. 9.10.

It can be seen that the original circuit has been reduced from nine to three switch contacts to give the same result.

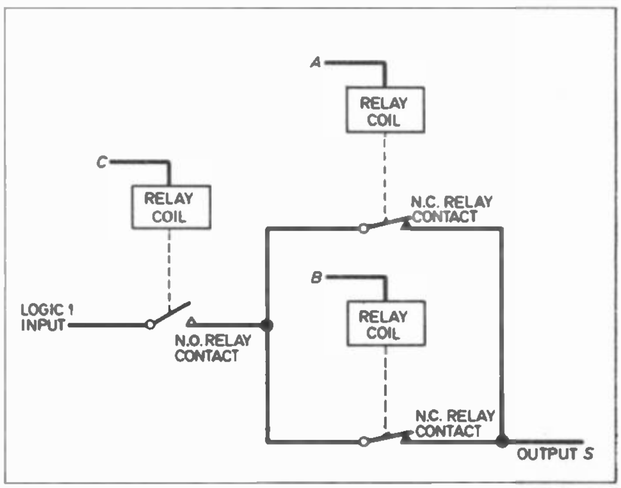


Fig. 9.10. Simplification of Fig. 9.9 after applying Boolean rules and identities.

TO BE CONTINUED

Everyday News

INFORMATION TECHNOLOGY 82

AN EXCITING ERA

A nation-wide campaign has been launched to make everyone aware of the information revolution and 1982 has been designated "Information Technology Year" by the Government.

A full programme has been planned for 1982 to help improve understanding amongst the general public, as well as in business and public administration. Leading figures from the fields of health, education, the arts, leisure, industry and commerce, the media, finance, Government and the Information Technology industry itself, are promoting IT in their own particular sphere.

Speaking at the launch of IT 82, Kenneth Baker MP Minister for Information Technology said *"we are entering an exciting era, we are seeing the home of the future, the office of the future and the factory of the future emerge from the realms of science fiction and become reality. This is happening through the application of microelectronics to control of machines, to computing, to communications and to entertainment."*

University Chips

University research departments throughout the UK are now able to design their own silicon microcircuits using the Racal silicon gate CMOS uncommitted logic array (ULA) system.

The scheme, under the auspices of the Science and Engineering Research Council (SERC), is being coordinated by the Department of Electrical Engineering at Edinburgh University which has a £1 million silicon fabrication facility.

Contracts worth more than £700,000 have been placed with Sony Broadcast for Electronic News Gathering (ENG) equipment to be used in both East and West Germany.

Distance Links

Despite world recession international telecommunication links are scheduled for major expansion. In ocean cables a new 8,000 mile route will link Australia, New Zealand, Fiji, Hawaii and Canada.

Called ANZCAN, it comes into service in 1984, will carry twenty times the traffic of the existing COMPAC system and will cost £200 million.

As well as a new Europe-America cable planned for service in 1983 an additional link is now planned for 1988. The latter is expected to be engineered with optical fibres.

Aids for Disabled

Among the special equipment for the disabled demonstrated recently by British Telecom were a talking switchboard for blind telephone operators, and communications terminals for deaf people with moving strip visual display.

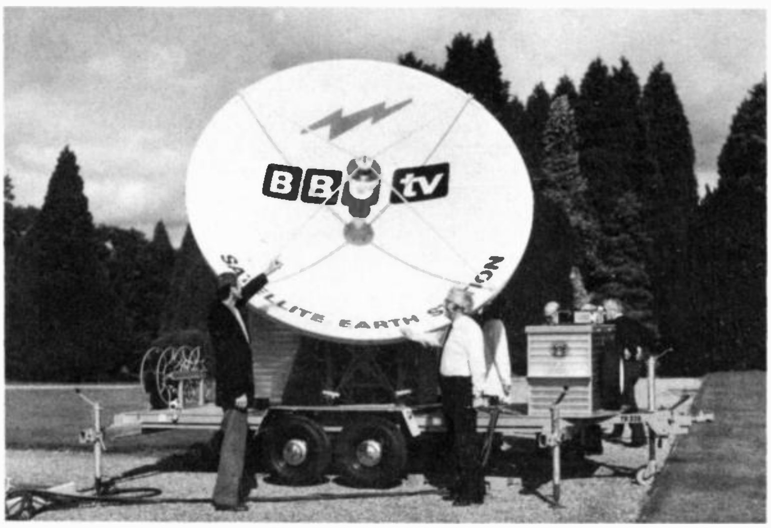
Also demonstrated was a Prestel model for the blind or deaf, the former using a braille character generator in place of the TV screen, the latter using the moving strip visual display terminal and keyboard as used for deaf conversations.

One of Britain's leading exhibitions organisers in the computer field, IPC Exhibitions, is to run a show covering the field of personal computers, home computing, small business systems and associated software.

The "Computer Fair," as the show will be named, will be held at Earls Court from April 23 to April 25, 1982.

Plessey Avionics and Communications have announced a £750,000 improvement programme for the restructuring of manufacturing facilities at their Vicarage Lane, Ilford, site.

This new and sophisticated area will be used to manufacture part of the Ptarmigan battlefield trunk communications system for the British Army.



BBC DESIGN SATELLITE TERMINAL

The BBC demonstrated its new mobile satellite link terminal to BBC Management and Senior Engineers at a recent Conference at the Institute of Electrical Engineers in London. The mobile setellite link terminal commissioned for Television Outside Broadcasts has just been completed by the BBC Engineering Research Department, and is undergoing pre-operational trials.

The first field trials included a "Morning Service" programme on BBC1, a contribution to the South West "Opt-Out" in the "Nationwide" programme and an edition of "Multicoloured Swap Shop". All these programmes originated in Guernsey in the Channel Islands and used the new satellite link.

Under normal conditions it is intended that the satellite link will be used over difficult transmission paths and not where conventional radio link circuits can be used.

The transmitter is very flexible and may operate on any of the available channels through the Orbital Test Satellite (OTS) or future European Communications Satellites.

Incredible as it sounds, French scientists have developed an ordinary standard sized credit card which houses a microprocessor and memory.

The user can use it in place of a cheque book, cash credit being inserted at the bank and purchases at shops deducted by placing the card in a counter-top terminal at which the user can also see how much cash balance remains.

Enhanced Teletext

In a programme of work supported by the UK Department of Industry, BBC Research Department has produced equipment to be used to study enhancement to the British teletext system.

One of the early uses of this equipment has been to produce a teletext decoder capable of displaying the normal pages as broadcast now, but with a much better quality of character generation than is found in the first generation mass-produced teletext decoder designs.

Fly-by-TV

The mass of instruments in airliner cockpits could soon largely be replaced by colour TV screens.

The idea is to call up on the screen only the data required for any particular phase of flight in respect of management and safety. A prototype system is now flying in a Royal Aircraft Establishment One-eleven aircraft

Demonstration flights have been made in Europe and the United States in the expectation that such systems will be used in the next generation of airliners still at the drawing-board stage of design.

WORLD VIEW

A world-wide viewdata service is rapidly becoming a reality following a series of recent agreements announced by European and other countries to take the initial steps towards the interconnection of their national viewdata systems in 1982/83.

Following its success in West Germany, the gateway facility (which allows viewdata customers to get easy access to a wide range of existing, non-viewdata computers) is to be implemented in the Netherlands and Italy, as well as the UK.

In addition to allowing the connection of non-viewdata computer systems, gateway will result in the interconnection of national viewdata systems. This means, for example, that a Prestel user in the UK will be able to access the Bildschirmtext service in Germany and vice versa.

The Department of Transport is taking no chances in the event of a decline in petrol supply. It has commissioned the consultancy firm EASAMS to study all the requirements of a nationwide network of battery recharging points for electric vehicles. These could be at conventional garages, in parking lots or on the kerb side.

Custom Metalworking

The Card Frames Division of Vero Electronics has issued a new colour brochure detailing the comprehensive custom metalworking service offered by the company.

Using the latest machinery, the Card Frame Division is able to undertake DNC punching, forming, guillotining, engraving, component printing, anodising, painting and assembly work.

The Scottish Development Agency is to seek planning permission to set up a Science Park in Glasgow.

Hazard-proof Radar

The remarkable ability of lifeboats to capsize in mountainous seas and survive still has the handicap that the radar goes out of action after the rotating scanner has been immersed in sea water.

The problem has now been overcome with the development of a completely waterproof radar by Racal-Decca in consultation with the Royal National Lifeboat Institution.

All radars in RNLI lifeboats are now being modified to waterproof standard, including those with open cockpits or wheelhouses.

In Agreement

The Scottish Development Agency have just revealed details of the financial assistance it has given to Inmap, the joint venture by Edinburgh and Herriot Watt Universities to promote the industrial application of microelectronics.

The Agency has reached an agreement with Inmap under which it will provide up to £380,000 over the next three years to encourage the introduction of microelectronics technology into small and medium-scale companies.

One of Scotland's best-known industrialists, Peter Carmichael, CBE, Joint Managing Director of Hewlett-Packard, has been appointed Director, Small Business and Electronics, of the Scottish Development Agency.

—ANALYSIS

THE ELECTRONIC CHURCH

On first thought, religious institutions founded on ancient tradition would seem to have little need or use for electronics. Yet, if we accept that a principal activity of all religions is to propagate the Word it is clearly their duty that it should reach all peoples.

Facing such logic the normally ultra-conservative Roman Catholic Church was first in the field with high-powered world-wide broadcasts from Vatican Radio. The example was quickly followed by other denominations and sects and today there are scores of radio and TV stations round the world devoted entirely to religious worship and instruction and many organisations generating multi-lingual religious programmes.

At local level most religious buildings have electronic sound reinforcement and ancient cathedrals have inductive-loop-audio guided tours for pilgrims and tourists. The traditional harmonium in the chapel has long since been ousted by the electronic organ.

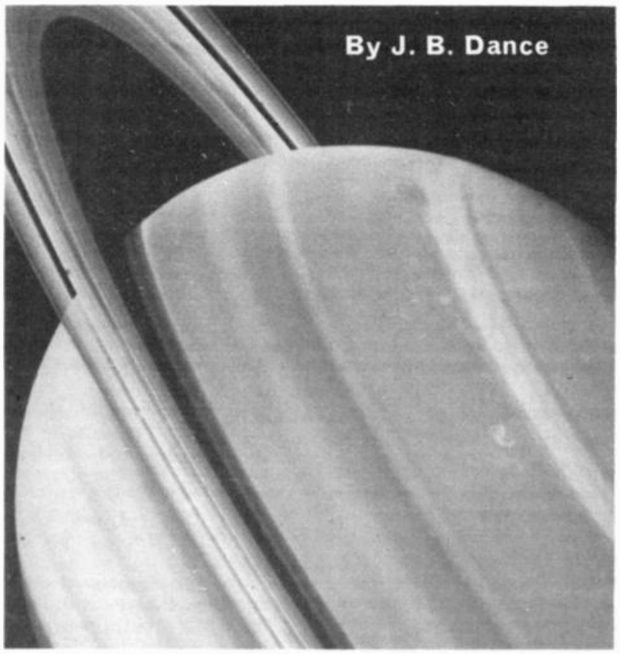
Loudspeakers in the belfry, tape-activated, are less expensive than bells and bell-ringers and, in Islam, the muezzin calling the faithful to prayer from the minaret is likewise tape-recorded. Along the Via Dolorosa in Jerusalem no self-repecting monk guiding pilgrims is now properly equipped without his shoulder-slung portable public address system.

The Mormon Church, whose faith embraces retroactive baptism, operates one of the largest computer systems in the world. Its giant data bank, protected from all hazards including nuclear war, records all traceable ancestors of today's three million living Mormons.

But while electronics is a powerful tool in promoting and aiding religious practices and, on a wider front, has enabled us to explore in detail physical quantities and qualities from the smallest atom to the immensities of outer space, no electronic instrumentation, however sensitive, has yet been able to measure or explain any spiritual, psychic or other paranormal phenomena. They remain eternal mysteries and perhaps better so.

Brian G. Peck.

VOYAGER 2 ENCOUNTERS SATURN



Our heading photo shows an image of Saturn and its rings returned by Voyager 2 from a distance of 13.9 million km from the planet. Note the shadow of the rings on Saturn and the banding marks on the surface.

ONE of man's greatest achievements in the last decade has been the sending of highly instrumented electronic robots to explore the more distant parts of the solar system. These spacecraft not only transmit signals back to earth from which high resolution photographs can be re-constituted, but also send us a great deal of other data which will keep scientists busy for years to come.

Sometime ago the *Pioneer* spacecraft sent us useful images of the enormous planet Jupiter and one of these craft returned images of Saturn, but these images were much inferior to those returned by the later *Voyager* craft. These craft were launched in August and September 1977. *Voyager 1* reached Jupiter on March 5, 1979, Saturn on November 12, 1980 and is continuing to return highly valuable data as it moves out of the solar system without making any further planetary encounters.

The *Voyager 2* spacecraft passed by Jupiter during July 1979 and reached the region of Saturn in late August/early September 1981. It is this *Voyager 2* encounter with Saturn which is the subject of this article, but it is interesting to note that the huge gravitational field of Saturn has been used to sling the spacecraft on towards an encounter with Uranus in January 1986 and hopefully with Neptune in August 1989.

Rings of Saturn

Saturn is one of the most beautiful objects in the heavens which can be seen by a telescope, but earth-based telescopes can capture only a little of the wealth of detail revealed by the *Voyager* spacecraft's imaging systems. *Voyager 2* came closer to Saturn than *Voyager 1* and carried better Vidicon camera tubes, so it provided rather better images.

Two rings are easily observed from the earth around Saturn separated by the well-known Cassini Division. *Voyager 1* showed that there are hundreds of rings around the planet, whilst *Voyager 2* (with its electronic memories specially programmed using the results of the *Voyager 1* encounter) has shown that the number rings amounts to thousands or perhaps tens of thousands. Even the divisions between the rings themselves contain fairly faint rings, yet the thickness of the ring system is only about 2km!

It is believed that the rings consist essentially of small lumps of ice and rock individually orbiting the planet like tiny moons. The ring systems casts clear shadows on the surface of the planet itself.

Markings radiating outwards rather like the spokes of a wheel were detected in the B-ring by *Voyager 1*. One theory proposed that the spokes consist of dust particles levitated by the electric fields of the planet, but careful experiments with *Voyager 2* did not find evidence to support this.

Further work with *Voyager 2* examined the light of a star which had to pass through the rings before reaching the spacecraft. As *Voyager 2* passed behind the rings, the effect of the rings on its radio transmissions enabled some estimate to be made of the size of the particles of the rings.

Lightning discharges in the vicinity of the planet which appeared to come from within the B-ring were detected. Measurements indicated that these lightning flashes were thousands of times more powerful than the lightning we experience on earth.

Scientists are very puzzled as to how the rings maintain their mechanical stability. It may be that moons of the planet help to keep the system stable, but there is still much to be discovered even though the spacecraft have sent us far more information than we had previously accumulated through centuries of viewing the planet.

Sphere of Gas

Saturn itself is believed to be mainly a huge sphere of gas kept together by gravitational attraction. Its markings are similar but less prominent than those on Jupiter. Very high wind speeds of more than 1,000 miles per hour have been found above Saturn.

Saturn consists mainly of hydrogen and helium gases and has a very low density. The temperature of its clouds is of the order of −190°C and it is not known whether there is any surface to the planet, as no light can penetrate the thick clouds.

Moons of Saturn

Apart from Saturn itself and its ring system, one of the main objectives of the Saturn encounters was an investigation of the numerous moons which circle the planet.

Titan

Titan is not only the largest, but also the most interesting of these moons and was viewed by *Voyager 1*; unfortunately nothing could be seen through the dense cloud cover of the surface of the satellite.

Voyager 1 passed a hundred times closer to Titan than *Voyager 2*, since the trajectory of the latter was programmed to enable it to travel on to Uranus and Neptune and this would not have been possible if it had passed close to Titan. Indeed, Titan is of such importance that had *Voyager 1* failed to return data on this moon, *Voyager 2* would have been sent to encounter it and the future Uranus and Neptune encounters would have been lost.

Nevertheless, *Voyager 2* returned valuable data on Titan and showed that some considerable changes had occurred since the first encounter. In particular, an instrument on board *Voyager 2* looked at the polarised light scattered by particles in the atmosphere of Titan; this could not be done by *Voyager 1*, since its instruments had failed.

Titan is of particular interest, since it has a dense atmosphere (82 per cent nitrogen, 6 per cent methane and other gases) and molecules detected in this atmosphere are those which could give rise to life.

Other Moons

Apart from Titan, *Voyager 2* came closer to the moons Enceladus, Tethys, Hyperion, Iapetus and Phoebe than the first mission. Enceladus has a surface which shows a great deal of past geological activity. Part of its surface is heavily cratered by bombardments a very long time ago, but other parts are relatively smooth, indicating that material has been ejected (possibly by volcanic activity) and has settled onto the original cratered surface. Strangely enough any volcanoes would be water volcanoes, since Enceladus is mainly ice!

The moon Tethys has a chasm groove several kilometers deep around nearly three-quarters of its circumference; it is 100km wide and some 2,000km in length. *Voyager 2* also found a crater 400km in diameter with a central peak and some concentric rings. The surface of this moon is heavily cratered.

Hyperion is a strange moon, a disk-shaped elongated object of dimensions about 400 × 250 × 200km, which is battered and scarred with craters. Iapetus is another strange moon, since it has a dark side facing forward in its orbit around Saturn and a bright side facing backward.

The dark side is as black as asphalt and has given rise to much speculation as to its composition, since it has one of the darkest surfaces in the solar system.

The first images of the outermost satellite, Phoebe, were captured by *Voyager 2*. This orbits in the opposite direction to the other moons and may possibly be a captured asteroid rather than a normal Saturnian moon.

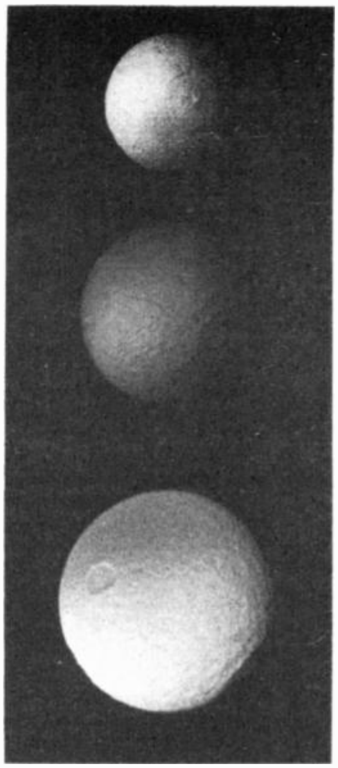
Radio Signals

All of this work (and many other projects) would not have been possible without the US Deep Space Network for receiving the extremely weak radio signals from the spacecraft. The Deep Space Network has stations in Goldstone, California, near Madrid, Spain and near Canberra, Australia. These stations have been deliberately spread out around the surface of the earth so that no spacecraft can be out of sight of all three of the stations at any time unless the craft is in the radio shadow of a huge object such as Saturn.

Spacecraft going towards the Sun can use solar panels to convert the energy of the Sun into the electric power they need. However, *Voyager* was designed to travel to the outermost parts of the solar system where the intensity of sunlight is very small, so it had to be provided with radiosotope thermoelectric generators to provide the power required by the radio transmitters and instruments.

Both *Voyager* craft receive signals from earth at a frequency in the S band (over 2,000MHz). Signals sent from earth programme their onboard memories so that they make the desired observations at the right time and so that their small gas jets put them into the required trajectory and enable course correcting trajectory changes to be made. *Voyager 2* had its main receiver fail, so it has operated on a duplicate receiver.

The spacecraft transmits at a maximum power of just over 28W in the S-band



A series of views of the moon Tethys taken at 4 hour intervals shows its 400km crater rotating towards the limb of this satellite. Note the central peak and the circles around the crater.

(about 2,300MHz), but can also transmit in the X-band at about 8,400MHz at a power level of up to about 21W.

The *Voyager* craft have a 3·7m diameter reflector dish which can be pointed towards the earth to provide good communications facilities with high data return rates at the great distance of Saturn. However, a low-gain antenna is also incorporated in the craft so that if the high-gain dish antenna happens to be facing away from the earth, a command signal can be sent to the low-gain antenna to cause the large dish to face the earth again.

The signals reaching the earth are so weak that the Deep Space Network stations have 64m diameter dish aerials to receive them together with smaller 34m and 26m diameter dish aerials for reception when conditions are not so critical. In addition, the smaller aerials can provide signals which can be fed to a computer together with the signals from the larger aerials to provide optimum reception.

Bad weather conditions (such as heavy rain or snow) at an earth receiving station can cause loss of the X-band signal. Some of the most important data was therefore recorded on the spacecraft's instruments and re-transmitted later to other earth stations to provide a form of insurance against partial loss of the information which has been so costly to obtain.

Jammed Platform

When *Voyager 2* was in the shadow of Saturn and out of radio communication with the earth stations, a moving platform which carries the cameras and certain other instruments became jammed in position. Although it could still be moved in the vertical direction, it could not be moved horizontally.

Engineers immediately set about investigating the problem, but any command signal they sent to the craft took about 1 hour 25 minutes to reach the craft and a similar time had to pass before the engineers could receive a signal back from the craft to ascertain whether the command had been effective. This long delay, due to the immense distance involved, made the investigations far more difficult.

The platform mechanism was finally freed after a few days and, although initially stiff, the performance of the movement has steadily improved. Thus the workers are anticipating there will be no problem at Uranus encounter.

As the sticking of the platform occurred shortly after the spacecraft had passed through the plane of the rings of Saturn, it was initially thought that the problem could have been due to particle bombardment of the mechanism with minute, very high velocity particles. Further investigation has shown that the problem was apparently caused by worn gear mechanisms, close clearances between gears and lubrication problems in the low-temperature, high vacuum conditions near Saturn.

Conclusions

The *Voyager* craft (and other planetary missions) are one of the marvels of modern electronics which has been able to answer quesions over which man has pondered for centuries. Unfortunately even the USA is having to cut its expenditure on its space programme, but some projects will be going ahead during the early 1980's. ☐

The writer is indebted to Don Bane, Jet Propulsion Laboratory, California for providing information and photographs used in this article.

RADIO WORLD

By Pat Hawker, G3VA

FM or SSB

In the political rather than technological arguments about FM and AM for CB operation, there has been a tendency to knock unduly the performance that can be achieved with narrow-band FM. But it was a little surprising to find Dr. William Gosling, technical director of Plessey Electronic Systems Ltd, writing in "The Guardian" newspaper: "I am well-known as an opponent of the use of f.m.—for anything—on the grounds that it wastes valuable space in the radio bands. For CB radio I would have preferred the UK to adopt the more advanced s.s.b. system, now rapidly becoming dominant in the US".

Apart from the fact that use was being made of s.s.b. techniques as early as 1915 whereas we owe practical f.m. to Howard Armstrong's work in the 1930s, there remains many doubts about the effectiveness of s.s.b. for mobile operation; none about f.m.

Even Dr. Gosling's strong support for s.s.b. was less evident only a few years ago when he strongly advocated the alternative system of double-sideband a.m. with diminished carrier for private mobile radio. A system which indeed can be shown to have considerable advantages over s.s.b. for many applications but requires the use of fully synchronous detectors in the receivers.

Inconclusive trials

More recently the Home Office and Pye Telecommunications have carried out many tests on the use of s.s.b. systems (to which Dr. Gosling later turned) but these have proved far from conclusive. Indeed at distances or more than a very few miles, 25kHz channelling f.m. appears to have consistently outperformed s.s.b. (though it must be added that s.s.b. might permit 5kHz channelling).

For mobile operation to make full use of the narrow channels calls for a very high standard of sideband suppression and extremely good and complex automatic gain control in receivers. Also, there is an increasing problem of Doppler frequency shift when vehicles are travelling at speed when using the higher frequencies.

Broadcasters use wideband f.m. with around 200kHz channel spacing but can claim that for national coverage this is actually less extravagant in radio spectrum utilization than a.m. This is because the "capture effect" of f.m. permits the same frequency to be used many times over even in a relatively small area such as the UK whereas a.m. or s.s.b. require a much greater "protection ratio", that is to say an interfering signal has to be much stronger with wideband f.m. before it becomes objectionable.

So although for some purposes s.s.b. is definitely superior to FM or AM, it would not only result in unnecessarily complex (and more costly) equipment for CB it is doubtful whether it would have any significant advantage.

CB licences

The actual conditions of the CB licence seem an odd mixture of an easy-going approach interspersed with tough technical conditions. For example there is not much that you cannot do, except to make grossly offensive or obscene remarks or speak in code. Likewise it is possible to use selective calling systems which are apparently not permitted by the amateur radio licence.

On the other hand, it is a condition of the licence that the aerial should not be more than 1·4 metre long with base loading, which is less efficient than a loading coil two-thirds of the way up or with top capacitance loading. On 27MHz unloaded quarter-wave ground planes, monopoles or half-wave dipoles are all well over 1·4 metres long and thus illegal.

One can see reasons for limiting the length of the aerial on a mobile unit, but one would have expected that for base stations at least the classic ground-plane aerial (originally devised in the 1930s by Dr George Brown of RCA for American police communications) would have been permitted. Perhaps it is all just to make it easier to spot "illegal" operators, though that may prove unfortunate for licensed amateurs with full-size aerials!

Brass pounders

For many years Morse operators have been called "brass pounders" although very few modern Morse keys are made of brass—more's the pity. Recently I spotted a collector offering (for about £60) an 1898 brass key claimed to be in vintage condition.

This caught my eye since for many years I have used one of the classic double-current brass keys made by Griffin, London (No. 432 Mk. III 1914) with its massive brass terminals and gleaming "send/receive" switch. I have to admit that mine is not in "vintage" condition, cost me a princely half-a-crown in 1938, and is much more of a working tool than a collector's item.

In the interim period I have learned to use and tried out many other forms of Morse key: the sideswiper, the semi-automatic "bug" key, the popular electronic keyer and the modern dual-paddle "squeeze" keyer. My conclusion is that there is no single "best" type of key but that individual operators gravitate towards the type that suits them best: in my case the large but elegant double-current brass key.

I also suspect that this once popular type of key has an advantage in that unlike most up-and-down manual keys the downward motion is not suddenly halted by the silvered electric contacts which are on springy metal but against a pliable washer. But also because, with the aid of metal polish and a rag, they become laboratory instruments with all the aesthetic appeal of gleaming brass—vintage Bentley's of an almost bygone era of telegraphy.

This feeling is clearly shared by others and I note that in New Zealand replica keys based on a once standard British Post Office key are now on the market.

Manual speed

According to the Guinness Book of World Records, Harry Turner, W9YZE is credited as holding the record for fast sending on a purely manual key, having clocked up 175 characters per minute (35 words per minute) in November 1942 at the US Army Signal Corps School at Camp Crowder, Missouri—and he still pounds brass on the amateur bands.

To reach 35 wpm is no mean achievement although I have come across operators capable of reaching about 30 wpm on good straight keys. The real beauty of such sending is not usually the speed but good letter formation and the absence of errors that tend to mar the "perfect" sending of electronic keyers.

Reliability

The strong emphasis put by consumers on "reliability" as the most desirable characteristic of any complex electronic equipment is increasingly recognized by industry in Europe and North America and has long been exploited by Japanese industry.

A recent special issue of the professional IEEE "Spectrum" journal is largely devoted to reliability and also sheds some light on the rising cost of repairs. It is pointed out that a good 19-inch colour television set in the USA retails for about $400 while a typical service call to the home costs from $35 to $100 for labour and replacement parts.

If only one in a hundred receivers requires a service call during the warranty period, and taking an average of $50 per call, the cost of unreliability to the manufacturer is 50-cents per set. But if one in ten sets requires servicing it amounts to $5 per set.

Next month

Everyday ELECTRONICS

FEBRUARY 1982 ISSUE
ON SALE
FRIDAY, JANUARY 15

February 1982

M.W. SUPERHET RECEIVER

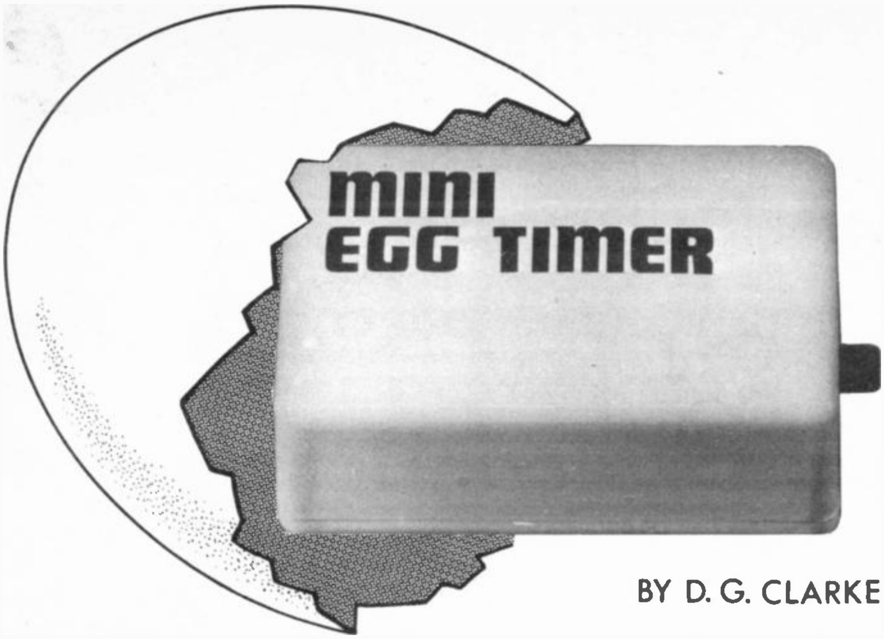
STEREO RECORD PLAYER

CAR OVERHEATING ALERT

CINE FRAME COUNTER & INTERVAL TIMER

**Part 2 of
Auto Garage Door
and all
the Regulars, of course!**

MINI EGG TIMER



BY D. G. CLARKE

WHILST electronic timers are by no means uncommon as constructional projects, this design has the merits of being compact, economical on batteries and cheap to build. Operation of the device could not be simpler, being activated by means of a solitary ON/OFF slide switch and commences to bleep at the expiration of the preset timing period. Switching off the unit also resets the timer in readiness for a further cycle.

The prototype has amply repaid its construction in use not only as an egg timer but also for timing telephone calls and turns at Scrabble and should be well within the competence of the beginner in electronics.

CIRCUIT DESCRIPTION

The unit is built around the 555 timer i.c., two of which are employed in the astable (free-running) mode. Referring to the circuit diagram, Fig. 1, IC2 both sets the initial timing period and, at its conclusion, produces an audible signal via the transducer, a piezo-ceramic device.

The timer could in fact be constructed using only IC2 and its associated components whereby a continuous note would be emitted. IC1 serves to modulate IC2 thus producing an intermittent bleep which, at the expense of a little more current consumption, is more compelling as an alarm.

The operating cycles of both i.c.s are governed by the time taken to charge a capacitor via a resistor chain. In the case of IC1, the relative timing components are R1, R2 and C1 which produce a bleep modulation frequency of about 2·5Hz.

IC2 functions in a similar fashion, although with a significant difference. In this instance C2 forms the initial charging capacitor (C3 being negligible by comparison), the rate of charge being governed by R4, R5, R6 and VR1. At switch on, C2 begins to charge and after 3 minutes (using the components specified) IC2 would normally initiate a discharge cycle. However, the inclusion of D2 prevents C2 from discharging and it effectively drops out of circuit. C3, which is already charged, is nevertheless free to discharge and it therefore controls the timing cycle, continuing to charge and discharge at an audible frequency of around 2kHz.

When the device is switched off, the spare contacts on S1 are used to ensure that C2 is fully discharged through R3, thereby eliminating any risk of variations in the timing cycle.

CASE

Start by cutting an aperture in the case to house the slide-switch, S1. As indicated in the photograph, the switch is mounted as close as possible to the corner of the case on one of its short sides. Drill two adjacent holes about 5mm diameter and open these out with a needle file to a suitably sized rectangle. After checking that the switch can be freely operated within

COMPONENTS

See Shop Talk page 30

Resistors
R1 10kΩ
R2 120kΩ
R3 1kΩ
R4 120kΩ (see text)
R5 1·2MΩ
R6 120kΩ
All ¼W carbon ± 5%

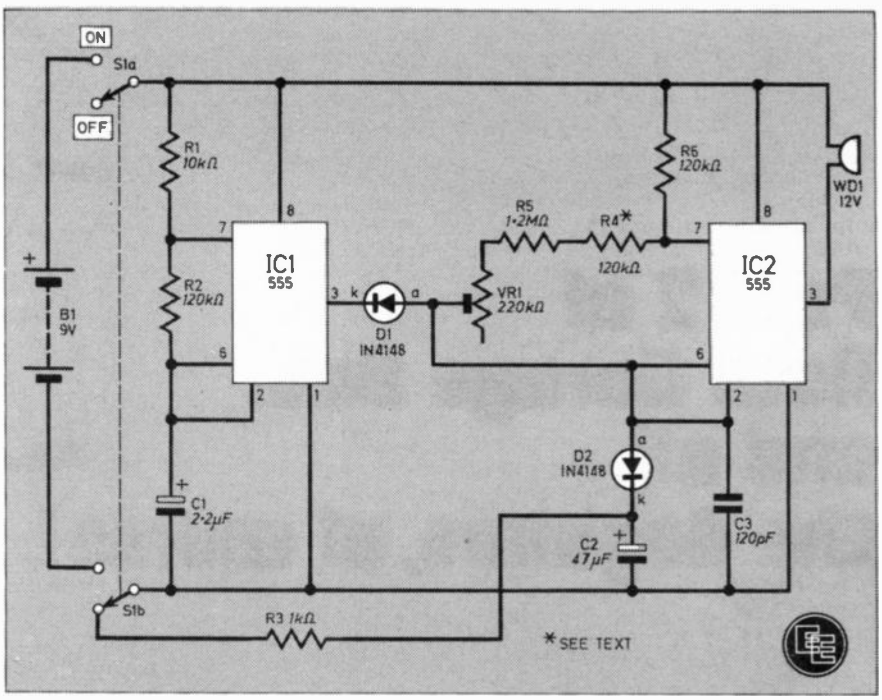
Capacitors
C1 2·2μF 10V tantalum or elect.
C2 47μF 10V tantalum or elect.
C3 120pF min. ceramic

Semiconductors
D1, 2 1N4148 (2 off)
IC1, 2 555 timer (2 off)

Miscellaneous
VR1 220kΩ sub-miniature vertical preset
S1 Sub-miniature d.p.d.t. slide
WD1 PB2720 Piezo-ceramic transducer
B1 9V battery (PP3)
Stripboard, 0·1 inch matrix, 24 holes by 7 strips; battery clip; Verobox type 202-21025K, 72 × 50 × 25mm; Veropins (5 off); equipment wire.

Approx. cost Guidance only £2·50 excluding case

Fig. 1. Circuit diagram of the Mini Egg Timer.



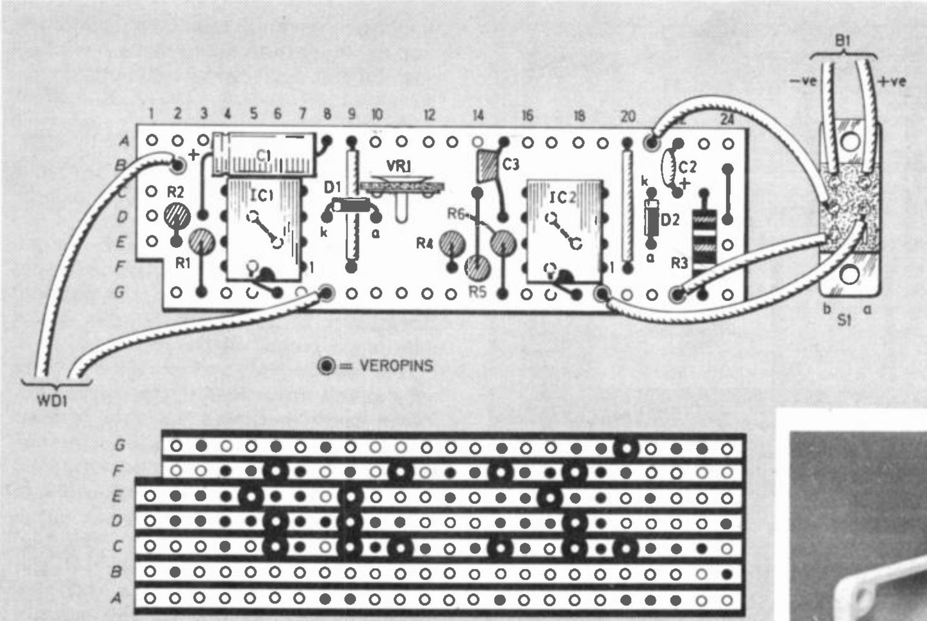


Fig. 2. Stripboard layout of the egg timer showing the track breaks on the underside of the board.

The sound transducer mounted on the lid and the close packing of the circuit board and battery.

the aperture, two small holes can be drilled for the fixing screws.

Finally drill a 3mm hole in the centre of the case lid for the sound from the transducer.

CIRCUIT BOARD

First, cut the Veroboard to the size indicated in Fig. 2 noting the rebate required to fit round the corner pillar of the case. Then, using a hand-held 3mm drill or Vero track cutting tool, cut the copper strips in the positions shown.

Soldering should commence with the wire links indicated in Fig. 2. Note the two small diagonal links positioned under each of the i.c.s. Check the position of these links carefully; mistakes will be difficult to rectify once the i.c.s have been soldered into position.

Normal practice is to leave the installation of "active" components such as the i.c.s until last but in this instance there is some merit in reversing the procedure to assist the physical location of other components. Start, therefore, with IC2 taking care to ensure that it is correctly orientated by referring to Fig. 2. Continue by installing R3, 5 and 6, preset VR1, C1 and D2 (observing the polarity of the latter two components). Clip off surplus leads close to the soldered joint.

The value of R4 depends on the tolerance of the other timing components and may need to be changed to achieve the desired preset time period. At this stage temporarily fit a 120kΩ resistor.

Now wire the piezo-ceramic transducer, the slide switch and the battery clip taking great care in the case of the last two items to observe correct orientation. Connect a PP3 battery and switch on whereby a continuous note should be emitted.

If all is well, disconnect the battery and proceed with the installation of IC1 and all remaining components except C2. Reconnect the battery when this time a modulated bleep should be produced.

The final step is to install the main timing capacitor, C2. The preferred choice here is a tantalum capacitor which is less likely than an electrolytic capacitor to deteriorate with age thereby affecting the timing cycle but a small electrolytic capacitor (10V working) can be physically accommodated, however, and will give acceptable results with probably some saving in cost.

ADJUSTMENT

The final, if somewhat tedious, operation is to adjust the preset resistor VR1 to give an accurate timing period, the duration of which depends on the constructor's personal preferences as to the consistency of their boiled eggs! The author enjoys a three-minute egg, so we shall describe the setting up procdure for such. Rotate the preset to its mid-point position, reconnect the battery and switch on, timing the period before the alarm sounds and repeat this process as necessary, each time adjusting VR1 to obtain a duration of exactly three minutes.

If it transpires that this interval is not within the range of VR1 it will be necessary to increase R4 for longer intervals or reduce its value to shorten the period.

It may be, of course, that the constructor prefers his eggs cooked for four minutes or wishes to set up for some other timing function. In that event it would be desirable to vary R5 at the outset and a four minute timer would require about 1·5MΩ in this position.

FINAL ASSEMBLY

When all adjustments have been completed, wire in R4 permanently and attach the transducer to the underside of the lid with a couple of dabs of adhesive, taking care to line up its centre hole with that drilled in the lid. Insert the circuit board in its case and screw the slide switch into position. No other fixing is necessary as the battery will hold the board neatly in place.

Screw the lid to the case, and finally, attach a label indicating the preset timing period of the unit. ⌑

SIREN MODULE

BY A.R. WINSTANLEY

THE device described in this article generates a US police-car type "whooping" tone and is suitable for many medium-power alarm applications. The tone is sounded over a 5 watt loudspeaker and in fact the level of output available is quite startling. The module can be used with burglar alarms, fire alarms or in fact in any unit requiring a distinctive audible alarm and which is capable of supplying 12 volts at about 500mA.

It is possible to incorporate a small modification which permits the module to imitate the familiar two-tone sequence of many British police cars.

THE 555 TIMER I.C.

The circuit employs two 555 timer i.c.s, both of which are operated in the astable mode. This is illustrated in Fig. 1.

An astable multivibrator possesses no stable state, and continues to offer a steady stream of pulses at its output without the need for triggering. In the case of a 555 astable, a constant square wave (Fig. 2) appears at the output terminal. The frequency, or number of pulses per second (measured in hertz), is dependent upon the values of three external timing components, namely R_a, R_b and C. Fig. 2 illustrates how the frequency is controlled by these three components.

The other interesting features depicted in Fig. 1 are the "reset" and "control voltage" facilities. The reset pin, if grounded, will halt the output, that is the output will go low and remain like this until the reset signal is removed. It is customary to connect the reset pin to $+V_{cc}$ (the positive supply rail) if it is not required.

CONTROL VOLTAGE

The "control voltage" pin provides another means of adjusting the frequency of the output. Apart from altering the values of R_a, R_b and C, a control voltage may be applied to pin 5 to vary the output frequency independently of the "RC network".

By applying a voltage to pin 5, it is possible to modulate the frequency of the square wave output in sympathy with the amplitude of the control voltage. This method is employed in the Siren Module where the applied voltage has a sawtooth waveform.

If the control voltage terminal is unused, normally it is connected to 0V via a 0·01μF capacitor, although for a minimum component count it can be left entirely unconnected.

CIRCUIT DESCRIPTION

The circuit diagram of the Siren Module is shown in Fig. 3. It can be seen that two 555 astable circuits are employed, IC1 and IC2 with associated timing components. IC1 produces a square wave operating at a nominal frequency of about 500Hz; this forms the basic "tone" of the system.

IC2 produces another square wave of a much lower frequency, about 3Hz. Note however that a variable resistor VR1 is incorporated so this frequency is adjustable to a certain extent. VR1 was in fact eventually incorporated in the design to compensate for large tolerances which affect the value of C3.

The output of IC2 is coupled through R4 and R5 to the control voltage terminal of IC1. C2 is a large-value electrolytic capacitor whose presence converts the square wave produced by IC2 into a sawtooth waveform.

The square wave from IC2 causes C2 to constantly charge up and discharge, and so the smooth sawtooth waveform produced by this is used to modulate the output of IC1; the frequency of operation of IC1 is altered rhythmically to produce a "whooping" tone instead of a continuous 500Hz note.

As a basis for experimentation, readers may wish to note that by omitting C2, a "two-tone" effect will

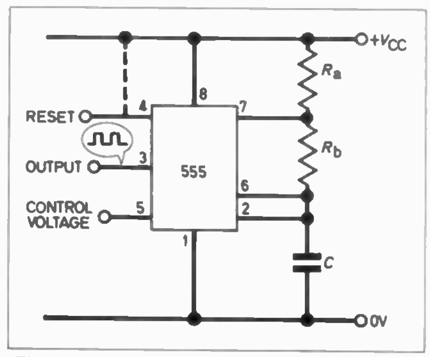


Fig. 1. Basic arrangement of a 555 timer i.c. to function as an astable multivibrator.

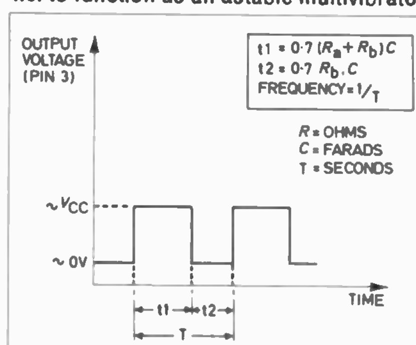


Fig. 2. Output waveform and frequency calculation for 555 astable.

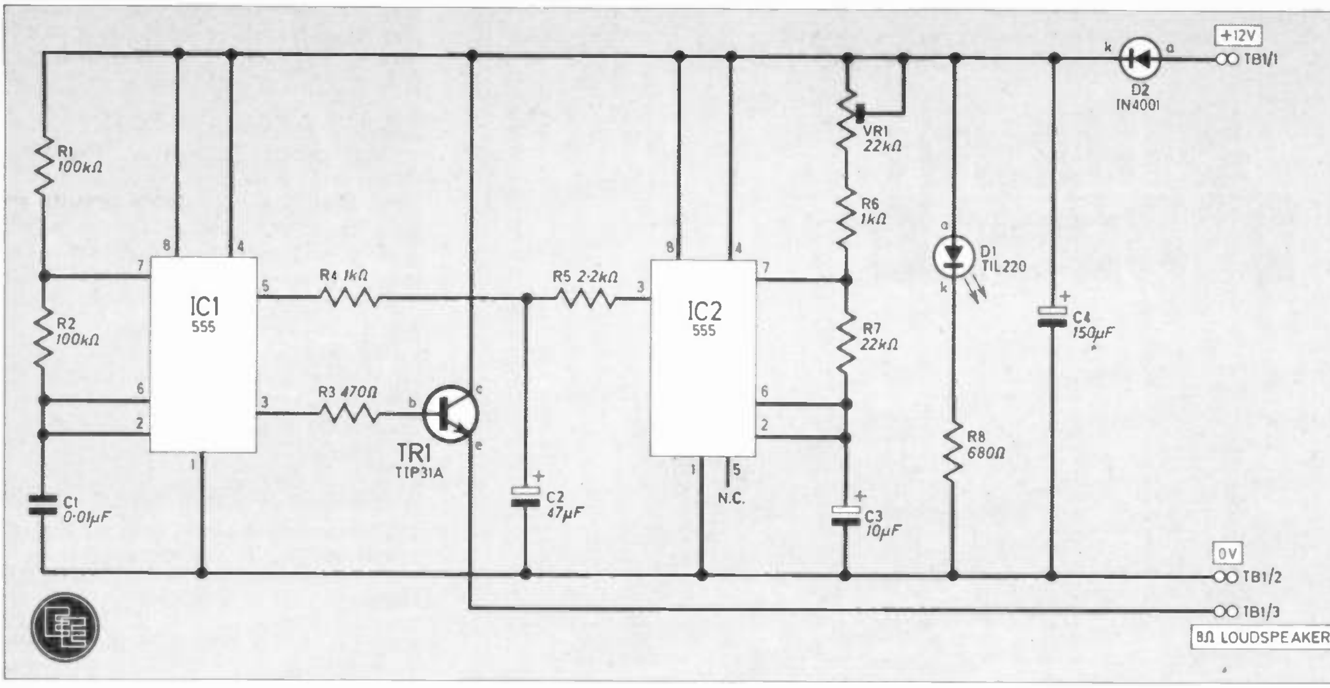


Fig. 3. The complete circuit diagram for the Siren Module.

COMPONENTS

Resistors
- R1 100kΩ
- R2 100kΩ
- R3 470Ω
- R4 1kΩ
- R5 2·2kΩ
- R6 1kΩ
- R7 22kΩ
- R8 680Ω

All ¼ watt carbon ± 5%

See **Shop Talk** page 30

Capacitors
- C1 0·01μF polyester (C280)
- C2 47μF 12V elect. radial leads
- C3 10μF 12V elec. radial leads
- C4 150μF 12V elect.

Semiconductors
- IC1, 2 555 timer i.c. 8-pin d.i.l.
- TR1 TIP31A *npn* silicon
- D1 TIL220 0·2 inch red l.e.d.
- D2 1N4001 1A silicon

Miscellaneous
- VR1 22kΩ sub-miniature horizontal preset
- TB1 3-way 2A screw terminal strip

Stripboard: 0·1 inch matrix 18 strips × 37 holes; 8-pin d.i.l. sockets (2 off); clip/bush for D1; TO-220 insulating kit for TR1; rubber grommet; metal case size 100 × 70 × 40mm; Veropins (5 off); p.v.c. covered stranded wire; 6BA fixing hardware; 2mm diameter sleeving; 22 s.w.g. tinned copper wire; Loudspeaker and enclosure—see text.

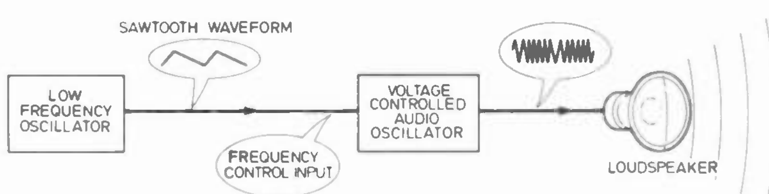
Approx. cost Guidance only £4 excluding speaker

be produced. This is because a square wave is being used directly as a modulating signal for IC1, so that the 500Hz tone is suddenly increased and then decreased again, producing two separate notes.

The final "whooping" tone is available at pin 3 of IC1, but the maximum current that can be supplied is only 200mA. This is insufficient for the required 5 watts power output. TR1 functions as a current amplifier to realise 5 watts into an 8 ohm speaker.

An 8-ohm loudspeaker (minimum) should be used, with a minimum power rating of 5 watts r.m.s. An ex-music-centre loudspeaker mounted in an enclosure has been used with the prototype with very great effect. Note however that the loudspeaker is connected to the Siren Module through a terminal block, but it will be possible to mount an unhoused Siren Module in the loudspeaker enclosure itself.

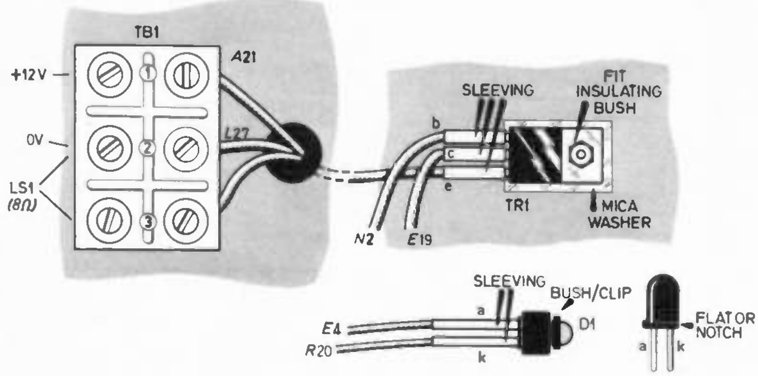
The circuit requires a 12V supply maximum at 500mA maximum, 300mA minimum. D2 protects the circuit from damage which could occur if the power supply happened to be accidentally reversed upon initial switching on. Finally, D1 is a light-emitting diode which glows when the power is on, and C4 serves to decouple the power supply and prevents unwanted interaction between the two oscillators.



HOW IT WORKS

A low frequency oscillator has its output "shaped" to provide a sawtooth waveform. The second audio frequency oscillator, without any signal fed to its control input produces a tone of about 500Hz. The effect of the sawtooth voltage is to cause this tone to vary in pitch about 500Hz, the shape of the sawtooth producing a "whooping" tone. This is heard in a loudspeaker via a current booster amplifier (not shown).

SIREN MODULE



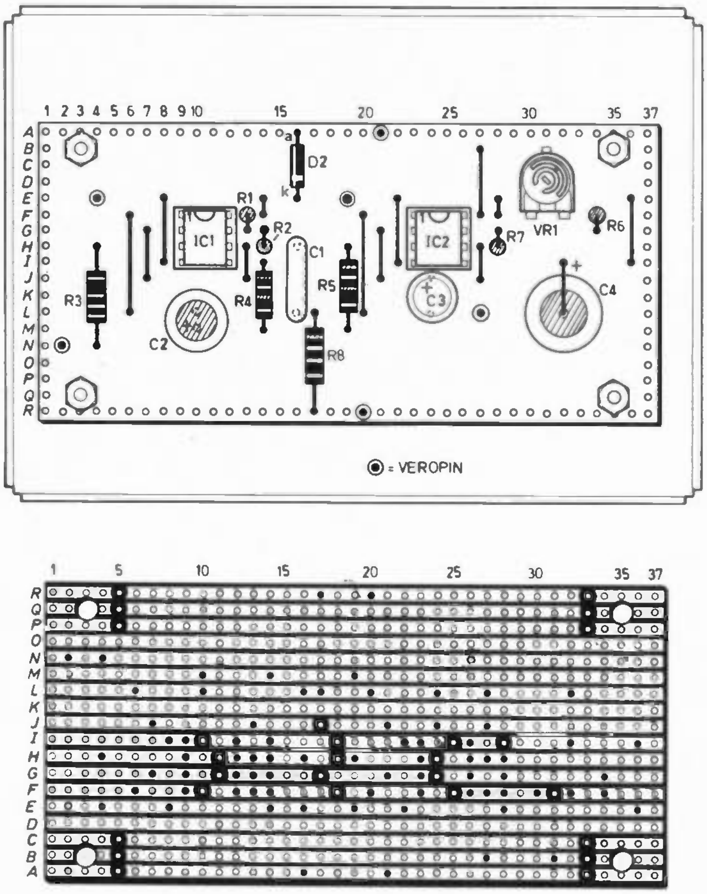


Fig. 4. Layout of the components on the stripboard and breaks to be made in the tracks on the underside. Veropins are used as anchorage points for wiring the remote components to the circuit board. Sockets are advised for both i.c.s.

The completed siren showing the mounting of the supply and loudspeaker connecting terminal block on the side of the case.

CONSTRUCTION starts here

CASE

The Siren Module can be built into a standard aluminium box measuring 100×70×40mm and the circuit itself—with the exception of TR1—can be constructed on 0·1inch stripboard, 18 strips×37 holes.

Any other metal case can be used providing that it is of a size suitable for carrying the completed circuit board.

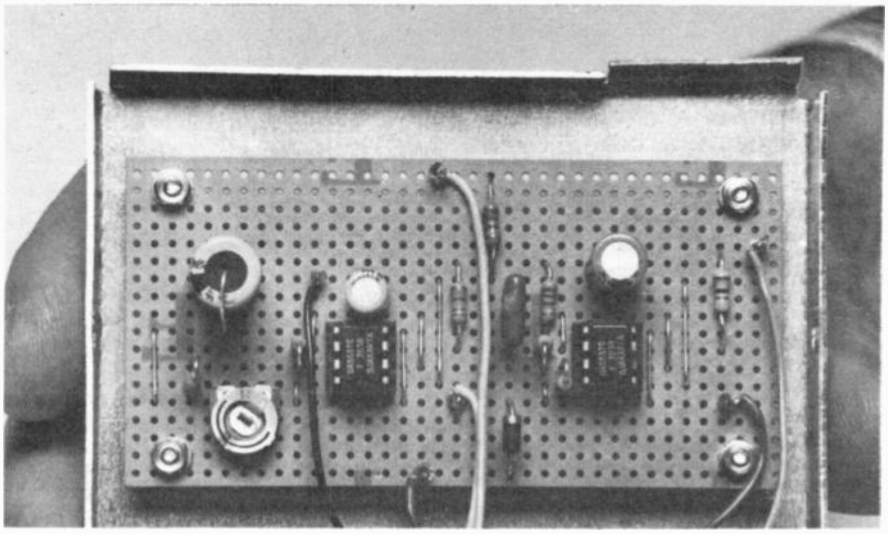
CIRCUIT BOARD

Fig. 4 illustrates the suggested stripboard layout. Having cut the stripboard to size, drill four 6BA clearance holes in each corner as shown to take the necessary mounting hardware. Take care when drilling to make sure that the circuit board is not fractured due to excess pressure.

Then all the breaks in the copper strips are made, using either a hand-held twist drill or the proper spot face cutter. The Veropins may then be inserted and soldered in the positions indicated.

At this stage it may be best to solder in the two 8-pin d.i.l. sockets which carry the i.c.s. These serve as a good reference when locating and soldering the 22 s.w.g. tinned copper link wires.

The recommended order of construction continues with the soldering in of the miniature resistors and the electrolytic capacitors.



The completed circuit board mounted in position on the base of the case. The cutaway in the lip to avoid obstructing the terminal block can be seen top right.

HEATSINK FOR TRANSISTOR

During normal operation, the temperature of TR1 will rise noticeably, and so the aluminium box is used as a heatsink to dissipate some of this heat, the reason for specifying a metal box to house this project.

TR1 is mounted on one wall of the aluminium box with 6BA hardware, using a TO-220 mica washer and insulating bush to isolate the transistor tab (which is internally connected to the collector) from the box. A smear of silicon grease or similar heatsink compound on both sides of the mica washer will assist in heat transfer from the transistor to the heatsink.

Note that it will be easier to solder a flying lead to each of the terminals before fixing in place.

TERMINAL BLOCK

Mounted externally on the case is a 3-way screw terminal block which carries the connections for the positive supply rail and also one terminal of the loudspeaker; the third screw terminal forms a combined connector both the 0V and remaining loudspeaker terminal. Bear in mind that the lip of the lid overlaps about 6mm when positioning the terminal block on the outside of the case.

A small hole must be drilled next to the terminal block and this hole should be fitted with a small grommet. Flying leads are then taken from the appropriate Veropins on the circuit board, through the hole to the terminal block as shown.

The light-emitting diode can be mounted on the front of the box using and l.e.d. bush-clip. The l.e.d. must be positioned such that its leadouts will not interfere with the circuit board inside once the completed module is closed up—in fact the leads will probably need cutting back a little. Cut the anode shorter than the cathode so that you can easily identify the leadouts.

Standard multicored hook-up wire can be used throughout as flying leads, with 2mm diameter p.v.c. sleeving pushed over the leads of the l.e.d. and TR1 to ensure that short-circuiting will not occur.

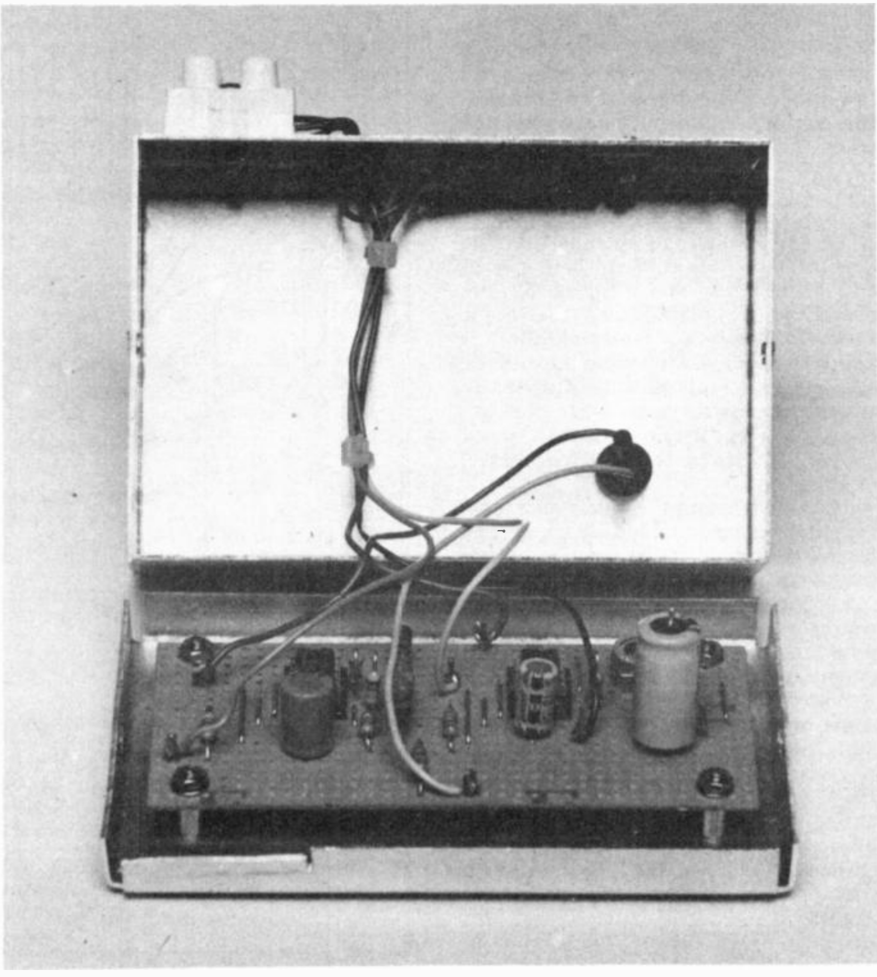
TESTING AND SETTING UP

Once construction is complete, check out the finished unit carefully. In particular inspect the circuit board closely, and fit the i.c.s correctly into their sockets if you have not already done so. Set VR1 to middle position.

Connect a suitable loudspeaker to the 0v and LS terminals of the module, and then apply 12V (500mA maximum) to the +12v and 0v terminals.

Switch the power on: the l.e.d. should illuminate and the Siren Module should drive the speaker, but the "whooping" tones may not be perfectly formed. By adjusting VR1 it should be possible to produce the desired effect. ⌑

The "lid" or base of the siren removed showing clearly how the circuit board is mounted on spacers. The l.e.d. is seen on the right of the case with insulating sleeving over the pins. Take care that the l.e.d. does not foul on the circuit board.



ELECTROPLATING

OF NON-CONDUCTIVE OBJECTS

by R. M. Henderson

THERE ARE many objects whose appearance can be enhanced by electroplating. The drawback is that many of them are non-conductors; for example, leaves and leaf skeletons and plastic models.

The methods involved are quite easy to follow and require no specialist equipment.

FIRST STEPS

The first step is to obtain a bottle of "Aquadag". This is a colloidal suspension of graphite and may be bought at a good chemist or photographic dealer. If any difficulty arises then you may have to resort to a scientific equipment dealer (look in Yellow Pages).

The object to be plated must be perfectly clean, dry and free from grease. A good wash in detergent followed by a rinse in distilled water will ensure this. Handle with tongs or tweezers at this stage as fingers are naturally greasy.

The object is then left to dry and then painted all over with Aquadag using a soft brush to ensure that all the detail of the object shows through the coating. A second coat is applied when the first is dry.

THE CELL

An electroplating cell must now be constructed. This consists basically of two electrodes, one formed by the object to be plated and the other formed from the material that is going to be deposited onto our object, and an electrolyte, or solution in which the two electrodes are immersed. The whole system is, of course, contained in a tank or vessel of some sort.

The ideal vessel would be a rectangular glass tank. However, any large container such as a plastic bucket or bowl would do just as well.

For obvious reasons, a metal tank would not be suitable as it would bypass the action of the cell.

An electrical connection is made to a part of the object which will not show or may be cut off when finished and this connection is taken to the negative side of the battery or power supply. This should be well smoothed and give at least 6V d.c. The object becomes the negative electrode or cathode.

A positive electrode or anode should also be constructed and this should consist of a thick rod or preferably plate of the metal to be deposited onto the cathode. Needless to say this is connected to the positive terminal of the battery.

The anode should, if at all possible, be of greater surface area than the cathode and if metal plate or foil is not available, rod or wire can be heated and beaten flat. Several interconnected pieces may be needed.

PLATING CURRENT

The best plating is done when the current is 10mA per square centimetre of cathode, although areas need not be exact. If you were plating plastic chessmen for example, you could regard them as cylinders and calculate the surface area from the usual formula; Area equals $2\pi rh + 2\pi r^2$, where h is the height and r the radius in centimetres.

The area of a leaf can be found by drawing round it on centimetre graph paper and counting complete centimetre squares then adding half the number of incomplete squares before doubling.

Ideally the cathode should revolve slowly all the time (the method is outside the scope of this article), but a turn through ninety degrees each quarter of the total plating time will do. In fact this can take up to 48 hours depending on "plate" thickness.

Do not try to hurry the plating by increasing the current as this causes the result to be very granular and the plated metal does not adhere properly to the object.

The choice of electrolyte and operating temperature depend on the metal being plated and Table 1 summarises the best solutions and working temperatures.

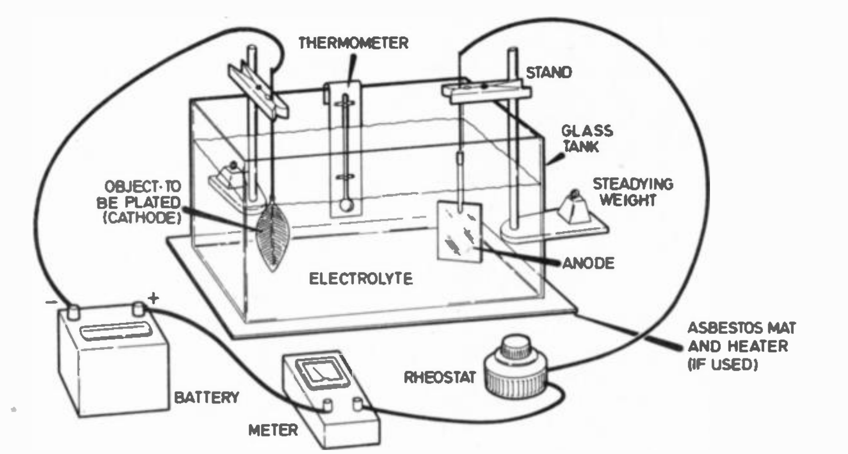


Fig. 1. A practical electroplating set-up.

Table 1: Electrolytes for different metals

Metal to be plated	Electrolyte details	Comments
Copper	12·5g copper sulphate crystals and 12 drops of battery acid in one litre of water.	Strong coat of copper at 38°C; softer coat which polishes easily at 50°C; adequate plating at room temperature.
Zinc	50ml of saturated zinc sulphate solution with an equal volume of water. Add 4 drops of battery acid and a teaspoon of Borax.	Temperatuie makes little difference.
Nickel	50g of nickel ammonium sulphate in one litre of water.	Temperature makes little difference.

Note that a saturated solution is made by warming water and dissolving as many crystals as possible. When allowed to cool to room temperature, crystals appear at the bottom of the vessel and the liquid above these crystals is the saturated solution.

FINISHING OFF

If a leaf or other organic object is plated, a small hole must be made through the plating in an inconspicuous place or the stem cut off revealing the interior. The leaf is then gently warmed at first and then more strongly until it carbonises leaving an empty shell of plated metal.

The melting points of copper, zinc and nickel are 1083, 420 and 1453 degrees Celsius respectively, so a little care is necessary here, especially with zinc. Any discolouration due to the heating can be removed with metal polish. If the leaf is not totally destroyed, gases from its decomposition may damage the plating.

This small hole can be sealed when the heating process is completed using Araldite mixed with filings of the appropriate metal and carefully ground level with carborundum paper.

SOME PRACTICALITIES

A suitable practical set-up for electroplating is shown in Fig. 1. The stands are made from half-inch dowel inserted and glued into pre-drilled holes in a wooden base approximately 100×150mm in size. A clothes peg is then glued onto the rod in the position shown in the diagram. Two of these are required.

A weight placed on the base of the stand may be necessary to prevent it overbalancing.

The tank containing the solution (electrolyte) rests on an asbestos mat. If an electric heater is available so much the better. **However only use heaters that have been specifically designed for this sort of work (for example photographic tray heaters) as a mixture of water and electricity can be very dangerous. This rules out home-made contraptions.**

The electrical circuit consists of a battery, meter and variable resistor or rheostat. The rating of these particular items will depend on the job in hand but, bearing in mind that you require 10mA per square centimetre you should plan for about a maximum of 100 to 150 square centimetres. This means that your ammeter should be capable of measuring 1·5A and the battery should be capable of delivering a continuous current of 1·5A for an appreciable time. In practice this will mean using an accumulator such as a car battery.

The rheostat should again be adequately rated so you will probably need a wire-wound type rated at 20W for 12V working or 10W for 6V working.

The time taken to plate an object can vary and the surest way of working this out is by experience and a sharp eye. Although the time required depends largely on how thick the coating is going to be, you are going to need several hours to complete the process.

MAINS POWER

As an alternative to using a battery, you could try using a mains power supply. This has several advantages especially if you have access to a stabilised supply where all the control is built in. This would enable you to dispense with the rheostat and separate meter.

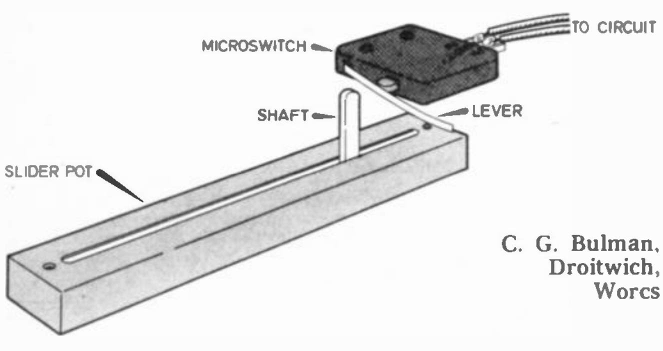
The main requirement is that the supply is well regulated and smoothed and once again able to supply the current demanded for the process. ¤

Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

SWITCHES FOR SLIDER POTS

It is possible to obtain rotary potentiometers with a switch incorporated which turns off at one end of the travel. However, slider pots never have this. Therefore I have thought up a simple method of adding a switch.

A lever operated microswitch is mounted at one end of the slider so that at the extreme end of its travel, the shaft presses against the lever and opens the normally closed contacts.



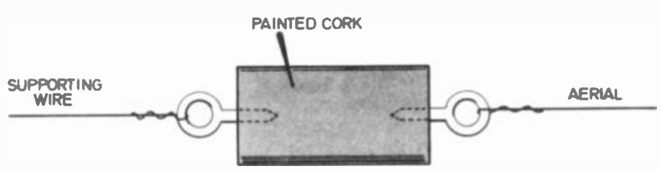
C. G. Bulman,
Droitwich,
Worcs

BALANCING AMPLIFIER CHANNELS

The balancing of the output of multiple channel audio amplifiers can be performed by connecting a speaker across the two non-common terminals (sometimes marked "output" or "+", in other words those not connected to earth or the chassis) of the channels to be balanced. With the same signal to both inputs of the amplifier channels (or the amp switched to mono) and the volume or gain turned up, the balance and/or tone controls are adjusted until there is as near to no volume as is possible. The amplifier is now balanced.

This method may be used for balancing low output a.f. amps or r.f. amps provided an a.c. voltmeter or oscilloscope is connected in place of the speaker.

C. M. Rogers,
Wooton-under-Edge, Glos



CHEAP AERIAL INSULATOR

Porcelain or glass aerial insulators can often be costly items to buy in the shops but there is a simple and cheap alternative (see diagram).

First of all take a cork and put a small screw eye in both ends. No holes need to be drilled because the cork is soft and they can just be screwed straight in.

The supporting wire is attached to one screw eye and the aerial to the other. Before it can be used it must be water-proofed with paint or varnish.

If a heavier duty or better quality insulator is required then the cork can be replaced by a piece of pine.

John Hickson,
Bexley, Kent

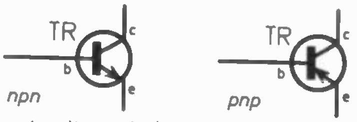
SQUARE one FOR BEGINNERS

TRANSISTORS come in a variety of shapes and sizes, the type of encapsulation often depending on the function it performs in a circuit. For example, a power transistor needs to be fairly substantial to dissipate unwanted heat whereas a high frequency device will require a metal can for screening.

Detailed here are the physical outlines and lead configurations, along with important electrical parameters.

TRANSISTOR PARAMETERS

I_C (max): maximum collector current.
v_{CE} (max): maximum voltage allowed across the emitter and collector terminals.
h_{FE}: d.c. current gain (large signal gain).
p_{TOT}: maximum permissible power dissipation in the device.
f_T: the frequency at which the current gain (h_{FE}) drops to unity.



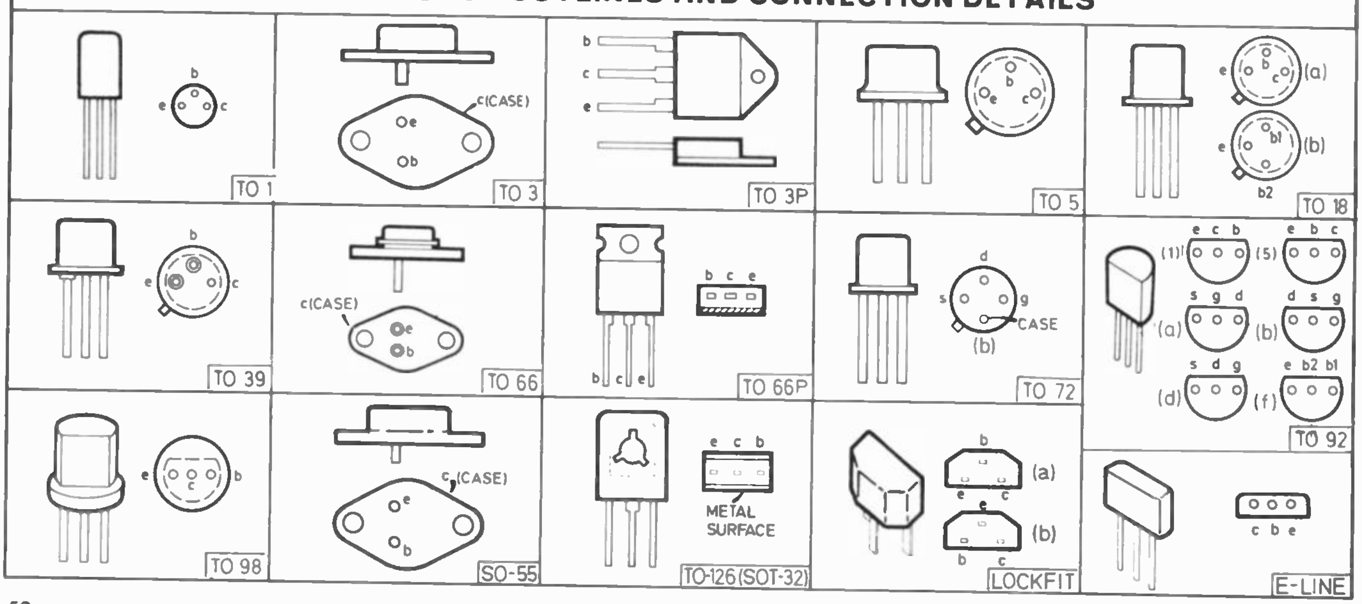
The circuit symbols representing the two types of bipolar transistor.

BIPOLAR TRANSISTORS

Device	Case	Material	V_{CE} (max) (V)	I_C (max) (mA)	h_{FE} (min/max)	P_{TOT} (mW)	f_T (MHz)
AC127	TO-1	nG	12	500	50	340	2.5
AC128	TO-1	pG	16	1A	60/175	700	1.5
AD142	TO-3	nG	50	10A	30/-	30W	0.5
AD149	TO-3	pG	50	3.5A	30/100	22W	0.5
AD161	SO-55	ng	20	3A	80/320	4W	3
AD162	SO-55	pG	20	3A	80/320	4W	1.5
BC107	TO-18(a)	nS	45	100	110/450	360	250
BC108	TO-18(a)	nS	20	100	110/800	360	250
BC109	TO-18(a)	nS	20	100	200/800	360	250
BC147	LOCKFIT	nS	45	100	110/450	350	300
BC148	LOCKFIT	nS	20	100	110/800	350	300
BC149	LOCKFIT	nS	20	100	200/800	350	300
BC182L	TO-92(1)	nS	50	200	100/480	300	150
BC184L	TO-92(1)	nS	30	200	250/-	300	150
BC212L	TO-92(1)	pS	50	200	60/300	300	200
BC214L	TO-92(1)	pS	30	200	140/600	300	200
BC477	TO-18(a)	pS	80	150	110/950	360	150
BC478	TO-18(a)	pS	40	150	110/800	260	150
BC479	TO-18(a)	pS	40	150	110/800	360	150
BD131	TO-126	nS	45	3A	20/-	15W	60
BD132	TO-126	pS	45	3A	20/-	15W	60
BD237	TO-126	nS	100	2A	25/-	25W	3
BD238	TO-126	pS	100	2A	25/-	25W	3
BFY50	TO-5	nS	35	1A	30 typ.	800	60
BFY51	TO-5	nS	30	1A	40 typ.	800	50
BFY52	TO-5	nS	20	1A	60 typ.	800	50
TIP31A	TO-66P	nS	60	3A	10/60	40W	8
TIP32A	TO-66P	pS	60	3A	10/40	40W	8
TIP41A	TO-66P	nS	60	6A	15/-	65W	3
TIP42A	TO-66P	pS	60	6A	15/-	65W	3
TIP2955	TO-3P	pS	60	15A	5/30	90W	8
TIP 3055	TO-3P	nS	60	15A	5/30	90W	8
ZTX300	E-LINE	nS	25	500	50/500	300	150
ZTX500	E-LINE	pS	25	500	50/300	300	150
2N697	TO-5	nS	40	1A	40/120	600	50
2N2926G	TO-98	nS	25	100	235	360	100
2N3053	TO-39	nS	40	1A	50/250	800	100
2N3054	TO-66	nS	55	4A	25/100	25W	1
2N3055	TO-3	nS	60	15A	20/70	115W	1
2N3702	TO-92(1)	pS	25	200	60/-	360	100
2N3704	TO-92(1)	nS	30	800	100/-	360	100
2N3904	TO-92(5)	nS	40	200	100/300	310	300
2N3906	TO-92(5)	pS	40	200	100/300	310	250

p—*pnp*, n—*npn*, G—germanium, S—silicon

TRANSISTOR OUTLINES AND CONNECTION DETAILS



Semiconductor News

OPTO-ELECTRONICS

Seven segment displays designed for viewing up to 30 feet away are now available from **Litronix**. These 20mm displays, the **DL-3400** series, are pin for pin compatible with the HP 508 23400 series and are designed for use in such applications as clocks, point of sale equipment, and other similar systems.

The latest idea in seven segment display counter-decoder-drivers has just been introduced by **Intersil**. This is the **ICM7208** and is manufactured using a low voltage metal gate CMOS process.

The most interesting feature of this new device is the fact that not only does it feature low power consumption (10mW maximum) and combine counting, decoding, and display driving circuits, but it also runs no less than seven separate seven segment displays. This means that such functions as multiplexing, display blanking, reset, input inhibit and so on are also included on the chip.

For simple counter unit applications the chip requires only the addition of displays and a handful of resistors and capacitors to build a fully operational system.

A new departure in panel lamps has just been introduced by **Hewlett-Packard** and consists of an l.e.d. with a reverse current protection diode and series resistor contained in a single package.

Two versions are available—the **HLMP-3105** designed for 5V operation and **HLMP-3112** designed for 12V operation.

Both lamps use l.e.d. chips made from Gallium Arsenic Phosphide on a Gallium Phosphide substrate and emit red light (yellow and green devices are also available) and the wide 90 degree viewing angle allows them to be used in many display and control panels without the operator position relative to the panel being too critical.

CRYSTAL DATA

A **M-Tron** data sheet which includes a cross reference chart for Microprocessor Quartz Crystals is available from **MCP Electronics Ltd.**, Dept EE, 38 Rosemont Road, Alperton, Wembley, Middlesex, HA0 4PE.

MCP is sole UK agent for the M-Tron range of quartz crystals which encompasses a group of commonly used microprocessor clock crystals, as well as the facility to produce to specification any crystal within the range 1 to 170MHz.

SERVO AMPLIFIER

Electronic control in industry is an expanding market and **Ferranti Electronics** have just extended their product range with a new low cost servo amplifier i.c.

This is the **ZN409CE** and is offered in a standard 14-pin d.i.l. package. The company already manufactures the well known ZN419 but this suffers from "over the odds" pricing because of its non-standard miniature packaging. The new i.c. is identical in specification to the ZN419 but 25 per cent cheaper.

DYNAMIC MEMORY

Another new chip from **Intel** is the **2164**, a 64K by 1-bit dynamic RAM. It is manufactured using the company's well proven HMOS process and comes in an industry standard 16-pin d.i.l. package. Maximum access time is 200ns and the device is pin compatible with the earlier 2118 16K bit RAM.

This allows memory upgrade to 64K merely by substituting the new chip and adding one additional multiplexed address line.

According to Intel, "The advent of the 64K dynamic RAM device will allow system designers to incorporate more memory into a system without increasing its physical size".

NEW PRODUCTS

CLEAN CAR

Recognising the number of car cassette players now in use, Bib Audio/Video Products have recently introduced a useful car cassette head cleaning system, which is suitable for use on all cassette players.

The Bib cleaning system comprises a non abrasive cleaning tape, housed in a standard cassette, together with tape head cleaning fluid in a spray can.

The recommended retail price is £4·99, including VAT, and the items are conveniently packed in a handy storage wallet which can be kept in the car glove compartment.

Bib Audio Video Products Ltd, Dept EE, Kelsey House, Wood Lane End, Hemel Hempstead, Herts HP2 4RQ.

ELECTRONIC DOORMAN

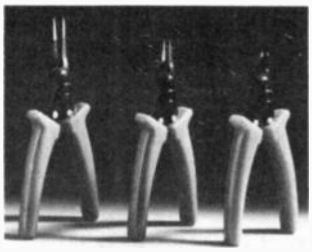
Available in several versions, The Electronic Doorman entry phone from Barkway Electronics is an ideal security system for offices, flats, houses and other buildings.

For flats and offices the equipment can operate via a porter's or receptionist's control panel, catering for an unlimited number of units. At the other end of the scale there is a "mini" system specially designed for houses. It is supplied as a complete individual kit which, it is claimed, is easy to install and operate.

Barkway Electronics Ltd, Dept EE, Barkway, Royston, Herts SG8 8EE.

GETTING A GRIP

A set of three small handtools fitted with cushion-grip handles have been added to the range of tools offered by Tele-Production Tools.



The set consists of a flush cutting side cutter, with the cutting head angled at 45 degrees, and two fine nosed pliers. The tools are available at a cost of £10 per set or £3·75 each, inclusive of post and packing and VAT.

Tele-Production Tools Ltd, Dept EE, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW.

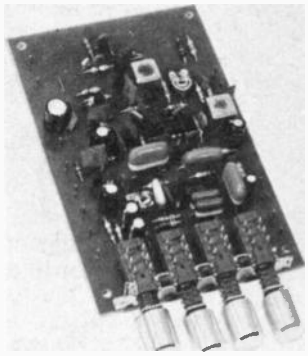
SERVICE WALLET

The new service wallet from Toolmail is designed for work on all electronic equipment including computers, video and audio units.

The zipper wallet contains 25 branded miniature tools made up of: miniature soldering iron, desolder braid, solder, soldering tools, range of screwdrivers, pliers, cutters, wire stripper, i.c. extractor and scissors.

The kit costs £39·50 including VAT with free postage anywhere in the UK.

Toolmail Ltd, Dept EE, Parkwood Industrial Estate, Sutton Road, Maidstone, Kent ME15 9LZ.



STEREO FM TUNER

The latest Bi-Kit Stereo FM Tuner module board from Bi-Pak Semiconductors comprises varicap tuning and a phase locked loop decoder for the reception of mono or stereo broadcasts.

Pushbutton switches enable the selection of four pretuned frequencies or stations, the selected frequencies being tuned by multiturn potentiometers. Provision exists for the addition of an l.e.d. stereo indicator, a centre zero tuning meter and a mono/stereo switch.

The ready built S.453 module is supplied complete with installation instructions and costs £22·35 including VAT and post and packing.

Bi-Pak Semiconductors, Dept EE, PO Box 6, Ware, Herts SG12 9AG.

CHARGE-UP COST DOWN

Now available in the UK is the Gould "Again & Again" rechargeable battery system, claimed to offer a low cost, re-usable alternative to expensive alkaline batteries.

The Gould nickel cadmium battery system includes all the popular battery sizes and an easy-to-use battery charger. The charger will take all the batteries in the "Again & Again" range, including the PP3 type.

It is claimed that for an outlay of around £15, a consumer can buy a set of batteries and a charger which will typically provide power for up to five years.

Gould Battery Division, Dept EE, Raynham Road, Bishop's Stortford, Herts CM23 5PF.

Multicore makes soldering easy fast & reliable

Ersin Multicore
Ersin Multicore, solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.
Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.

Size 3 40/60 tin/lead
£4.37 Per reel 1 6mm dia

Size 10 60/40 tin/lead
£4.37 Per reel 0 71mm dia

Size PC115 60/40 tin/lead
£1.38 Handy pack 0 028mm dia

Size 19A 60/40 tin/lead
£1.15 Handy pack 1 22mm dia

Multicore Savbit
Multicore Savbit, solder contains 5 cores of copper erosion reducing flux, increases the life of your soldering bit by 10 times, for better soldering efficiency and economy.
Comes in two handy dispensers and tool box reels.

Size 12 Savbit
£4.37 Per reel 1 2mm dia

Size 5 Savbit
£1.15 Per pack 1 2mm dia

Size SV130 Savbit
£1.73 Per pack 0 048mm dia

Multicore Alu-Sol
Multicore Alu-Sol, solder contains 4 cores of flux, suitable for most metals especially aluminium.
Comes in handy dispensers on tool box reels.

Size AL150 Alu-Sol
£2.07 Per pack 048mm dia

Size 4 Alu-Sol
£7.82 Per reel 1 6mm dia

All prices inclusive of VAT.
Available from most electrical and DIYs stores. If you have difficulty in obtaining any of these products send direct with 50p for postage and packing. For free colour brochure send S.A.E.

Multicore Solder Wick
Multicore Solder Wick, absorbs solder instantly from tags and printed circuits with the use of a 40 to 50 watt soldering iron.
Quick and easy to use, desolders in seconds.

Size AB10 Solder Wick
£1.43 Per pack

Multicore Tip Kleen
Multicore Tip Kleen, soldering iron tip wiping pad. Replaces wet sponges.

Size 2 Tip Kleen
£0.92 Per pack

Bib Wire strippers and cutters
Wire strippers and cutters, with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking-catch and easy-grip plastic covered handles.

Size 9 Wire Strippers
£2.69 Per pair

Bib Audio/Video Products Limited
(Solder Division), Kelsey House,
Wood Lane End, Hemel Hempstead,
Hertfordshire, HP2 4RQ.
Telephone: (0442) 61291
Telex: 826437

TRULY PORTABLE

Hitachi claim, that never before have so many advances been made in a new video model than with the Hitachi VT6500 portable video system. "It's portable video, that's truly portable."

The new model will appeal to the enthusiastic cine user as now it is possible to electronically edit a recorded video tape. It has pulse control editing that ensures that scene changes and overlays are clean and in sync with no distortion or electronic "snow" at the critical points.

Besides clean picture editing, the sound can be varied too. Most video recorders provide an audio dub facility which replaces the original sound track with new sound, but the VT6500 goes a stage better by enabling the user to blend new sound material with the original sound track and not replace it, although this is still possible.

The VT6500 is supplied with remote control unit, r.f. cable, earphone, cassette tape, shoulder bag and battery for the sum of £677 including VAT.

Hitachi Sales (UK) Ltd, Dept EE, Hitachi House, Station Road, Hayes, Middlesex UB3 4DR.

PERSONAL COMPUTER

The new Atari 400 and Atari 800 personal computers are now on sale in the UK, under an exclusive franchise with Ingersoll Electronics.

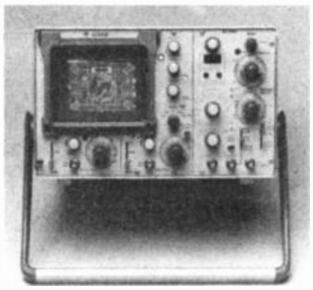
It is claimed that even those who are hesitant about owning a home computer can have these machines "humming" in minutes.

The suggested retail price for the Atari 800 is £645 including VAT and the Atari 400 £345, including VAT.

Ingersoll Electronics Ltd, Dept EE, 202 New North Road, London N1 7BL.

TV SCOPE

A 30MHz dual trace, TV monitoring oscilloscope, made under licence by Gould, incorporates a BBC-designed timebase module to provide a wide range of video triggering and display modes for the monitoring and measurement of broadcast television signals.



The OS3351 oscilloscope has a 16kV cathode ray tube to give a bright display of video waveforms, and the timebase generator allows the instrument to be used for the line-by-line examination of 625-line television waveforms or to display a complete TV picture. The line number selected for display is indicated on a 3-digit l.e.d. display on the front panel.

Gould Instruments Division, Dept EE, Roebuck Road, Hainault, Essex 1G6 3UE.

in My Class

by T.R. de Vaux-Balbirnie

We use a lot of single-strand connecting wire with p.v.c. insulation for circuit building. Gerald had an unhappy knack of breaking the core. On this occasion he was securing it under the terminal of a lampholder when the end fell off.

I decided to find out what he was doing wrong and discovered that he was stripping the insulation with ordinary side cutters. I must admit that I do this myself and he must have picked up the habit. I explained that when I do it I am careful to squeeze the handles only enough to cut the insulation and no more.

With experience this is possible. If any greater pressure is applied then a "nick" will be made in the core. If this is at all deep then the wire will break soon afterwards. If only slightly scored, the core will break later, probably at a very inconvenient time.

I told the whole class that it was far safer to use the special wire strippers which are adjustable for the type of wire. When correctly "set" they will cut the insulation but not the core.

I decided always to use the strippers myself when demonstrating to the class and to avoid also the habit of using my teeth!

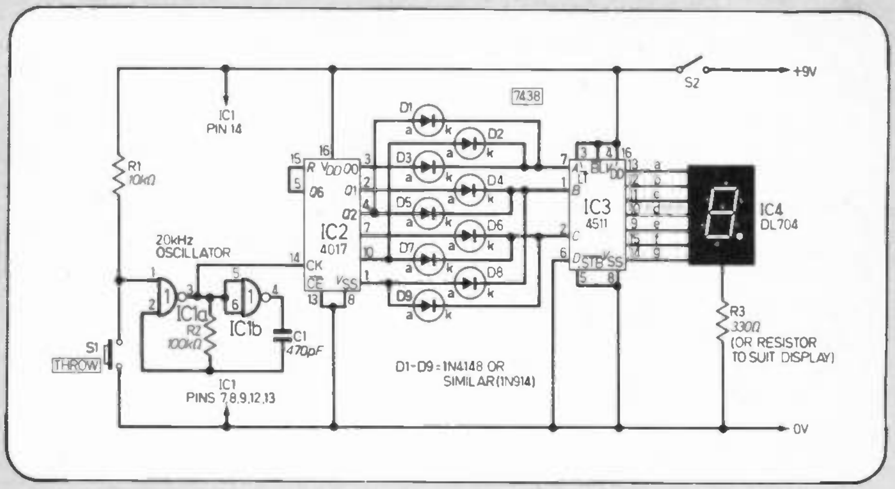
I explained to the class that one rather thick single core was very fragile and that stranded wire should always be used when the wire was subject to much bending. Wire made from many thin strands was flexible and could be used for headphone leads and the like where bending could be expected. On the other hand, stranded wire was very difficult to push into the holes of circuit boards unless twisted and tinned.

CIRCUIT EXCHANGE

DIGITAL DIE

This die circuit provides a variation on a theme in that it uses a seven segment numeric display instead of a seven dot array to present its result.

The design is based around a decade counter i.c. which is clocked by a 20kHz oscillator consisting of two NOR gates and an R-C network. The counter output state when the "throw" switch is released is encoded into a binary input by the diode matrix D1-9 which is then converted to the seven segment display by the decoder/driver i.c., the 4511.



The brightness of the display may be varied by adjusting the value of R3 slightly.

When the "throw" button is depressed the display will appear as an "8" as the numbers change in rapid succession.

D. Butler,
Colchester,
Essex.

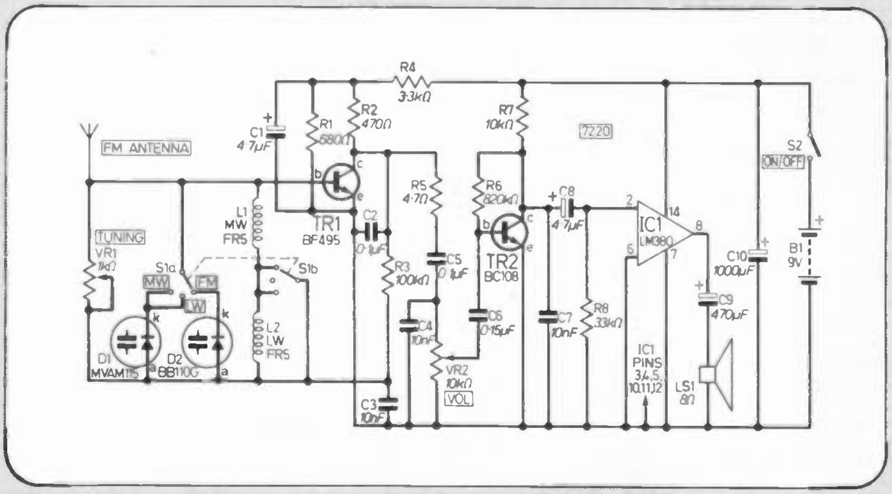
AM/FM VARICAP RADIO

The circuit shown here is for a basic varicap diode AM/FM tuner. Instead of using a variable capacitor in parallel with the tuning coils to pick up the radio signal, a capacitive semiconductor device known as a varicap diode is used in conjunction with a potentiometer.

The audio frequency end of the receiver utilises an LM380 i.c. amplifier and power is from a 9V battery.

This type of radio is simple to build as there are no complicated setting up procedures and tuning is easy and quite accurate.

R. Creed,
Ruislip,
Middlesex.

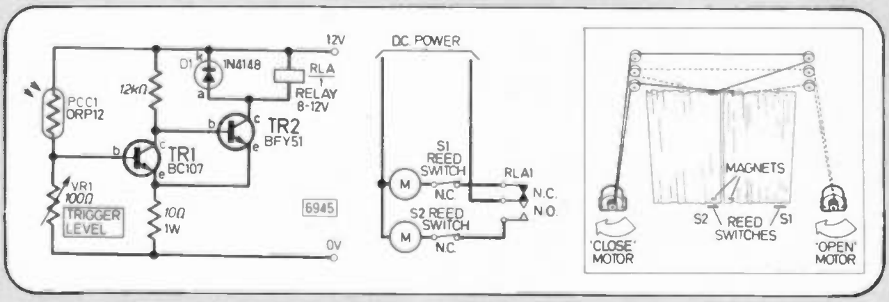


LIGHT OPERATED CURTAINS

Readers may be interested in my idea for a circuit for the use of opening and closing curtains when no one is at home.

The circuit is a light activated switch which operates a relay which switches on the curtain motors via reed switches S1, S2. The light dependent resistor PCC1 and VR1 provide the bias for the base of TR1 which triggers the transistor TR1 on at a predetermined level set by VR1. TR2 is switched on by the operation of TR1 and activates the relay RLA1.

The light dependent resistor should be placed close to the window glass, or even on an outside wall, so when darkness falls the relay can be operated. The motors are placed at the left and right of the curtain using fishing line and pulleys attached to the curtains. See sketch.



The reed switches S1, S2, and magnets are used to cut off the motors when the curtains are fully drawn back. The reed switches should be the changeover type wired in a normally closed position.

If mains is used, then the motors and switches must be changed to suit. A mains 12V transformer is advisable for prolonged use.

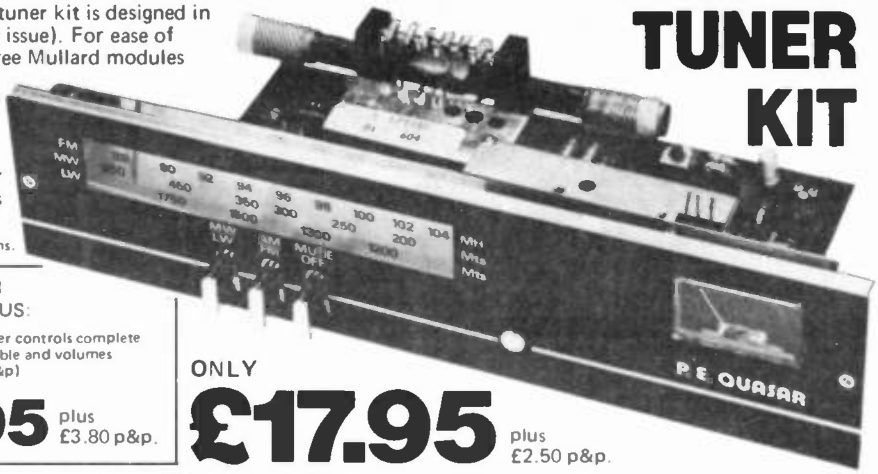
Michael Johnson,
Wilmslow, Cheshire.

CIRCUIT EXCHANGE

NEW PRACTICAL ELECTRONICS - STEREO TUNER KIT

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10½"x 2½" approx. Complete with diagrams and instructions.

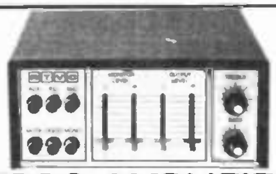


SPECIAL OFFER! TUNER KIT PLUS:

- Matching I.C. 10+10 Stereo Power amplifier kit (usually £3.95 + £1.15 p&p)
- Mullard LP1183 built preamp. suitable for ceramic and auxiliary inputs (usually £1.95 + 70p p&p)
- Matching power supply kit with transformer (usually £3.00 + £1.95 p&p)
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes (usually £1.70 + 80p p&p)

£21.95 plus £3.80 p&p.

ONLY **£17.95** plus £2.50 p&p.



STEREO AMPLIFIER KIT

- **Featuring latest SGS/ATES TDA 2006 10 watt output IC's with in-built thermal and short circuit protection.**
- **Mullard Stereo Preamplifier Module.**
- **Attractive black vinyl finish cabinet, 9"x 8¼"x 3⅜" (approx)**
- **10+10 Stereo converts to a 20 watt Disco amplifier.**

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amp assembly kit and mains power supply. Also features 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia with matching knobs and contrasting cabinet. Instructions available, price 50p. Supplied FREE with the kit.

£14.95 Plus £2.90 p&p.

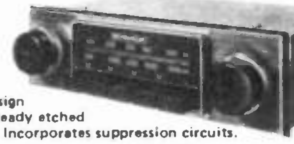
SPECIFICATIONS:	Suitable for 4 to 8 ohm speakers.
Frequency response	40Hz - 20KHz.
Input sensitivity	P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls	Bass ±12db @ 60Hz Treble ±12db @ 10KHz
Distortion	0.1% typically @ 8 watts
Mains supply	220 - 250 volts 50Hz.

STEREO MAGNETIC PRE-AMP CONVERSION KIT Includes FREE Magnetic cartridge with diamond styli. All components including p.c.b. to convert your ceramic input on the 10+10 to magnetic. Only available with 10+10 amp. **£2.00** includes p&p.

8" SPEAKER KIT Two 8" twin cone domestic speakers. £4.75 per stereo pair plus £1.70 p&p. when purchased with amplifier. Available separately £6.75 plus £1.70 p&p.

PRACTICAL ELECTRONICS CAR RADIO KIT SERIES II

2 WAVE BAND MW — LW



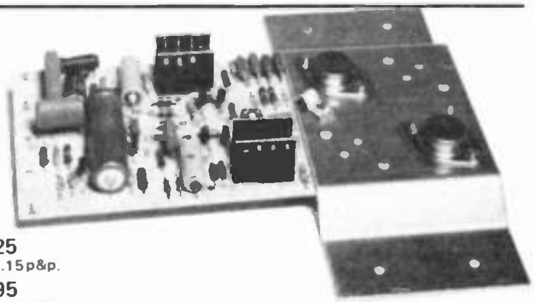
- Easy to build
- 5 push button tuning
- Modern design
- 6 watt output
- Ready etched and punched PCB
- Incorporates suppression circuits.

All the elect-onic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics March issue. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type pre-aligned and assembled, and a Bird pre-aligned push button tuning unit.

£10.50 Plus £2.00 p&p.

Suitable stainless steel fully retractable aerial (locking) and speaker (6"x 4" app.) available as a kit complete. **£1.95**/pack. Plus £1.15 p&p.

HIGH POWER AMPLIFIER MODULES



READY BUILT OR IN KIT FORM

	KIT	BUILT
125 WATT MODEL	£10.50 Plus £1.15 p&p	£14.25 Plus £1.15 p&p.
200 WATT MODEL	£14.95 Plus £1.15 p&p	£18.95 Plus £1.15 p&p.

SPECIFICATIONS:	125 W Model	200 W Model
Max. output power (RMS)	125 watts	200 watts
Operating voltage (DC)	50 - 80 max.	70 - 95 max.
Loads	4 - 16 ohms	4 - 16 ohms
Frequency response measured @ 100 watts	25Hz - 20KHz	25Hz - 20KHz
Sensitivity for 100 watts	400mV @ 47K	400mV @ 47K
Typical T.H.D. @ 50 watts, 4 ohms	0.1%	0.1%
Dimensions (both models)	205 x 90 and 190 x 36mm.	

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

ACCESSORIES:

Suitable LS coupling electrolytic for 125W model	£1.00 plus 25p p&p.
Suitable LS coupling electrolytic for 200W model	£1.25 plus 25p p&p.
Suitable mains power supply unit for 125W model	£7.50 plus £3.15 p&p.
Suitable Twin transformer power supply for 200W model	£13.95 plus £4.00 p&p.

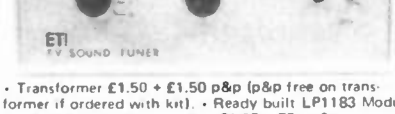
30+30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet, silver finished rotary controls and pushbuttons with matching fascia, mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30+30 watts RMS. 60+60 watts peak. For use with 4 to 8 ohm speakers. Size 14⅜"x 10" approx. **BUILT AND TESTED.**

£32.90 Plus £3.80 p&p.

TV SOUND TUNER KIT

as featured in E.T.I. December '81 issue. Kit of parts including PCB, UHF tuner, I.C.'s, all components excluding case, and selector switch. £11.45 + £1.50 p&p.



- Transformer £1.50 + £1.50 p&p (p&p free on transformer if ordered with kit).
- Ready built LP1183 Module for simulated stereo operation £1.95 + 75p p&p.

MONO MIXER AMPLIFIERS

50 WATT Six individually mixed inputs for two pick ups (Cer. or Mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic and aux inputs. Size: 13¾"x 6½"x 3¾" app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

£39.95 Plus £3.70 p&p.

100 WATT

Brushed Aluminium fascia and rotary controls. Size: approx. 14"x 4"x 10¼".

Five vertical slider controls, master volume, tape level, mic level, deck level, PLUS INTERDECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PFL) lets YOU hear the next disc before fading it In. VU meter monitors output. 100w RMS output (200w peak).

£76.00 Plus £4.60 p&p.

R T-V C

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Open 9.30am - 5.30pm. Closed all day Thursday.
Persons under 16 not served without parents authorisation.
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For further information send for instructions 20p plus stamped addressed envelope.

All items subject to availability. Prices correct at 1/10/80 and subject to change without notice. RTVC Limited reserve the right to update their products without notice.

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.

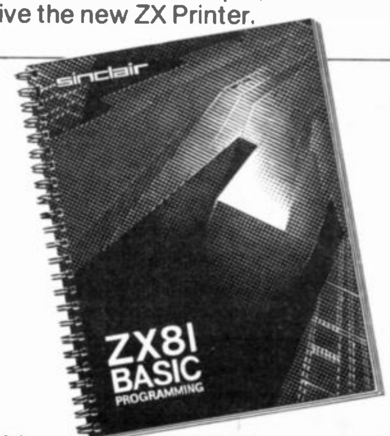
In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

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 – 600 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 £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alpha-numerics *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 7, Cambridge, CB2 1YY.

Qty	Item	Code	Item price £	Order 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) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

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EE Minilab £13·50
Kit of components for parts 1 to 6 £7·50
Special Price if above kits purchased together £19·00

The above kits include all the components specified in the Teach-In 82 projects parts 1-6 plus sockets for ICs specified. Don't forget to send the Vero £1 voucher for a further discount. Prices do not include VAT.

DISCO LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

DL1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimmer cont'l £14·00

DLZ1000K
A lower cost version of the above featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum £8·00
Opt'l Opto Input DLA1 60p

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Available in 5V, 12V & 15V versions.
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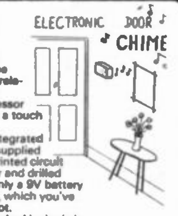
79L series 100mA neg. 60p
78 series 1A pos. 52p
79 series 1A neg. 5V 75p
LM317T adjustable 1·2V-37V 1·5A £1·80

ELECTRONIC DOOR CHIME



Fed up with your old doorbell? This KIT should cheer you up! Our latest kit gives you a pleasing three note harmonically related tone sequence (NOT a microprocessor controlled buzz) at a touch of a button.
Based on a new integrated circuit, this KIT is supplied complete with a printed circuit board, loudspeaker and drilled box and requires only a 9V battery and a push-button, which you've probably already got.
It may also be switched by logic in such applications as car alarms, clocks, toys, PA systems, etc. The unit produces a 150mW output and draws less than 1uA from a PP3 battery, when the tone ceases. Supplied complete with circuit and assembly instructions.

IDEAL PROJECT FOR BEGINNERS
ONLY £5.00 + V.A.T.

DVM/THERMOMETER KIT

NEW DESIGN

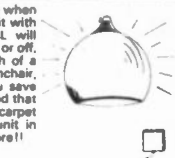
Based on the ICL7126 (a low power version of the ICL7106 chip) and a 3½" digit liquid crystal display, this kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (—50°C to +150°C) reading to 0·1°C. The basic kit has a sensitivity of 200mV for full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week. £15·50+VAT

TRIACS

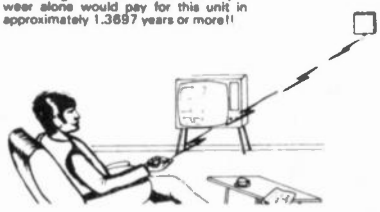
400V Plastic Case (Texas)
3A TIC206D 49p
8A TIC226D 58p
12A TIC236D 85p
16A TIC246D 96p
25A TIC263D 190p
6A with trigger Q4006LT 90p
8A isolated tab TXAL 226B 65p
Diac 13p
Opto isolated triac MOC3020 0·6A/400V 110p

YOU MUST HAVE BETTER THINGS TO DO

than getting up to switch lights on when it gets dark. Our Lamp Dimmer Kit with INFRA RED REMOTE CONTROL will enable you to switch the lights on or off, and set the brightness, at a push of a button without leaving your armchair, water-bed, etc. Not only will you save time but it has also been estimated that the savings in shoe leather and carpet wear alone would pay for this unit in approximately 1.3697 years or more!!



This unit has, of course, considerable practical uses, especially for the old, infirm and disabled. It works like a conventional dimmer, enabling you to switch the lights on or off, or to dim them to whatever brightness you require, by touch or remotely using the hand-held infra red transmitter. When assembled, it fits into a plaster depth box to replace your conventional switch or dimmer with no rewiring.



TDR300K Dimmer Kit £14.30 and MK6 Transmitter Kit £4.20. We also still sell our highly popular TD300K Touch Dimmer Kit at £7.00 and the LD300K rotary controlled Dimmer Kit at only £3.50 (plus VAT to above prices).
All kits contain all necessary components and full assembly instructions. You only need a soldering iron, cutters and a few hours.

MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. 1KW £4

MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc., from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. £2·50

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4·75

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on a new zero voltage switch IC, this kit may be wired to form a burst fire power controller, enabling the temperature of an enclosure to be maintained within 0·5°C. Thermistor failure causes output to switch off. Temperature range ambient to 90°C. 3KW. £5·55

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW. £4·50

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BURGLAR ALARM EQUIPMENT.

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British Standard panels to order

CABLE
3 4-core 100m £9·00
4 6-core 100m £14·00
5 Lacing wire 250m £3·90

CABLE FITTINGS
6 Clips 3·5mm 64p
7 Clips 5mm 64p

CONTACTS
8 Small flush 4-wire 79p
9 Flush ¾" quickfit 5 screw 95p
10 Surface 5 screw £1·09
11 Aluminiun (Patio) £1·81

PRESSURE MATS
12 Stair mat 22½" × 6½" £1·17
13 Standard mat £1·72

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17 Complete white or ivory 83p
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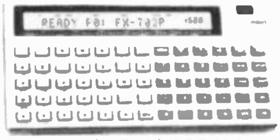
ONLY

£119.95



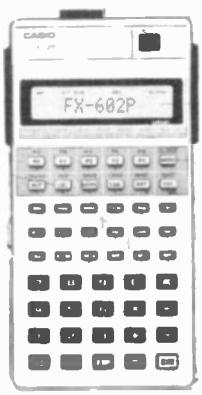
Plus FREE MiCROL Professional Programming Pack* (RRP £9.95).

Flattens the Sharp PC1211

Alpha/numeric dot matrix scrolling LCD. Variable input from 1680 steps, 26 memories, to 80 steps, 226 memories, all retained when switched off. Up to 10 programs. Subroutines; 10 levels. FOR:NEXT looping; 8 levels. Debugging and Editing. 55 built-in functions, including Regression and Correlation, all usable in programs. Program/Data storage on cassette via optional FA-2 adaptor (£19.95). Auto Power Off. 17x165x82mm. 176g.

World's Fastest Programmable?

FX-602P



- ★ LCD alpha/numeric (dot matrix) scrolling display.
- ★ Variable input from 32 program steps with 88 memories, to 512 steps with 22 memories.
- ★ Memory and program retention when switched off.
- ★ Up to 10 pairs unconditional jumps (GOTO).
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- ★ 50 scientific functions, all usable in programs.
- ★ PAM (Algebraic) with 33 brackets at 11 levels.
- ★ Program and data storage on cassette tape using optional FA-2 remote control adaptor, £19.95.
- ★ Compatible with the FX-501P and FX-502P.
- ★ 9.6x71x141.2mm. 100g.

ONLY £74.95

(RRP £84.95)

Plus FREE MiCROL Professional Programming Pack* (RRP £9.95).

FP-10 MINI PRINTER

For FX-702P, FX-602P, FX-502P, FX-501P.
Available soon. Price and delivery on application.

CASIO FX-702P SOFTWARE

Produced by MiCROL exclusively for Tempus
10% discount on software, if you purchase your hardware from us.

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Professional Programming Pack. Get the best from your FX-702P with: PROFESSIONAL PROGRAMMING – practical 702 programming from the ground up **plus** 702 REFERENCE MANUAL – definitive guide to every 702 program command – INVALUABLE! **MiCROL 702PPP. Price £9.95**

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MiCROL 702 Super:Calc. At last! The power of a VISICALC-type modelling system in a pocket computer! For all scientific, statistical, business and general computing users, SUPER:CALC has to be used to be believed – create powerful programs in minutes – answer 'what if' questions – analyse trends – cut programming time up to 95%. Full range easy-use commands; SAVE/LOAD/PRINT options. FA-2 recommended; FP-10 optional. Full detail User Manual plus Program List for direct entry.
Available December, 1981. **MiCROL 702 S:C. Price £14.95**

MiCROL 702 Basic:Plus. Add the power of up to 20 new commands to your programs! Custom-made to ease advanced programming – features include: String – number conversions; single-shot, await, timed KEY with user-controlled return values; programmable RAN # generator; DATA-PACKING – up to 2000 single digit, single name variables; INTEGRATED DISPLAY COMMANDS – display data and text with extra-low memory overheads. Modular design uses minimum memory; easy to customise. Full-detail User Manual plus Program List for direct entry.
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CASIO FX-3600P 10 digit LC display. 55 scientific functions including **INTEGRALS and REGRESSIONAL ANALYSIS. Up to 38 program** steps – 2 programs. One independent memory, 6 constant memories, all retained when switched off. 1,300 hour lithium battery. 9/32x2¾x5¼". Wallet. **ONLY £22.95**

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10 alternative displays; over 60 functions. LCD ANALOG display of time, plus: DIGITAL display of: Time (12 or 24 hour); Calendar; Full month calendar (this month and next month); Dual time (12 or 24 hour); Alarm time; Countdown alarm timer with memory function; Professional 1/100 second stopwatch with laps, etc. Hourly time signal. Alarm – electronic buzzer or 3 selectable melodies. Rapid forward/backward setting. 9.4x35.4x36mm.

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Displays hours, minutes and seconds (12 or 24 hours system), day and date. Auto calendar; calculator; professional 1/100 second stopwatch measuring net, laps and 1st and 2nd place times; **Pacer mode.** Can be used as a metronome to pace your running, or any other event.
Input data: Length of stride. Pacer signals, from 394 pips per minute to 63 pips per minute.
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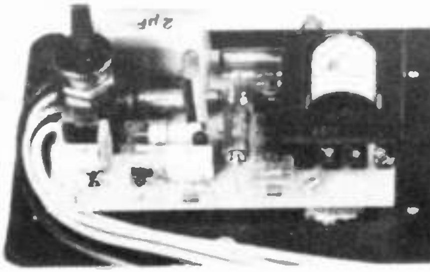
ELECTRONIC IGNITION KIT



TOTAL ENERGY DISCHARGE electronic ignition gives all the well known advantages of the best capacitive discharge systems.

PEAK PERFORMANCE ——— higher output voltage under all conditions.

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FIRES FOULED SPARK PLUGS no other system can better the capacitive discharge system's ability to fire fouled plugs.

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PLUS

SUPER POWER SPARK ——— 3½ times the energy of ordinary capacitive systems — 3½ times the power of inductive systems.

OPTIMUM SPARK DURATION 3 times the duration of ordinary capacitive systems — essential for use on modern cars with weak fuel mixtures.

BETTER STARTING ——— full spark power even with low battery.

CORRECT SPARK POLARITY unlike most ordinary C.D. systems the correct output polarity is maintained to avoid increased stress on the H.T. system and operate all voltage triggered tachometers.

L.E.D. STATIC TIMING LIGHT for accurate setting of the engine's most important adjustment.

LOW RADIO INTERFERENCE fully suppressed supply and absence of inverter 'spikes' on the output reduces interference to a minimal level.

DESIGNED IN RELIABILITY an inherently more reliable circuit combined with top quality components — plus the 'ultimate insurance' of a changeover switch to revert instantly back to standard ignition.

IN KIT FORM

it provides a top performance electronic ignition system at less than half the price of competing ready-built systems. The kit includes everything needed, even a length of solder and a tiny tube of heatsink compound. Detailed easy-to-follow instructions, complete with circuit diagram, are provided — all you need is a small soldering iron and a few basic tools.

AS REVIEWED IN ELECTRONICS TODAY MAGAZINE
JUNE '81 ISSUE
Quote "the kit is very impressive"
"well written instructions and a good performance".
"Exellent value for money. Highly recommended".

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

OPERATES ALL VOLTAGE IMPULSE TACHOMETERS
Some older current impulse types (Smiths pre '74) require an adaptor — PRICE £2.95

STANDARD CAR KIT £14.85 PLUS £1
TWIN OUTPUT KIT £22.94 U.K. P.&P.

For MOTOR CYCLES and CARS with twin ignition systems
Prices include V.A.T.

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DIMENSIONS:

Length	12.5 cm
Width	8.9 cm
Height	4.3 cm
Lead length	100.0 cm

TECHNICAL DETAILS

The basic function of a spark ignition system is often lost among claims for longer 'burn times' and other marketing fantasies. It is only necessary to consider that, even in a small engine, the burning fuel releases over 5000 times the energy of the spark, to realise that the spark is only a trigger for the combustion. Once the fuel is ignited the spark is insignificant and has no effect on the rate of combustion. The essential function of the spark is to start that combustion as quickly as possible and that requires a high power spark.

The traditional capacitive discharge system has this high power spark but, due to it's very short spark duration and consequential low spark energy, is incompatible with the weak air/fuel mixtures used in modern cars. Because of this most manufacturers have abandoned capacitive discharge in favour of the cheaper inductive system with it's low power but very long duration spark which guarantees that sooner or later the fuel will ignite. However, a spark lasting 2000µS at 2000 rev/min. spans 24 degrees and 'later' could mean the actual fuel ignition point is retarded by this amount.

The solution is a very high power, medium duration, spark generated by the TOTAL ENERGY DISCHARGE system. This gives ignition of the weakest mixtures with the minimum of timing delay and variation for a smooth efficient engine.

SUPER POWER DISCHARGE CIRCUIT A brand new technique prevents energy being reflected back to the storage capacitor, giving 3½ times the spark energy and 3 times the spark duration of ordinary C.D. systems, generating a spark powerful enough to cause rapid ignition of even the weakest fuel mixtures without the ignition delay associated with lower power 'long burn' inductive systems.

HIGH EFFICIENCY INVERTER A high power, regulated inverter provides a 370 volt energy source — powerful enough to store twice the energy of other designs and regulated to provide sufficient output even with a battery down to 4 volts.

PRECISION SPARK TIMING CIRCUIT This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level – just sufficient to keep the contacts clean.

TYPICAL SPECIFICATION

	TOTAL ENERGY DISCHARGE	ORDINARY CAPACITIVE DISCHARGE
SPARK POWER (PEAK)	140 W	90 W
SPARK ENERGY	36 mJ	10 mJ
(STORED ENERGY)	135 mJ	65 mJ
SPARK DURATION	500 µS	160 µS
OUTPUT VOLTAGE (LOAD 50pF EQUIVALENT TO CLEAN PLUGS)	38 KV	26 KV
OUTPUT VOLTAGE (LOAD 50pF + 500 KΩ EQUIVALENT TO DIRTY PLUGS)	26 KV	17 KV
VOLTAGE RISE TIME TO 20 KV (Load 50pF)	25 µS	30 µS

TOTAL ENERGY DISCHARGE should not be confused with low power inductive systems or hybrid so called reactive systems.

Goods normally despatched within 7 days

BI-PAK BARGAINS

"IRRESISTABLE RESISTOR BARGAINS"

Pak No.	Qty*	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ¼-½ watt Carbon Resistors	£1
SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.

*Quantities approximate, count by weight.

"CAPABLE CAPACITOR PAKS"

Pak No.	Qty*	Description	Price
SX16	250	Capacitors Mixed Types	£1
SX17	200	Ceramic Capacitors Miniature Mixed	£1
SX18	100	Mixed Ceramics 1pf-56pf	£1
SX19	100	Mixed Ceramics 68pf-0.5mf	£1
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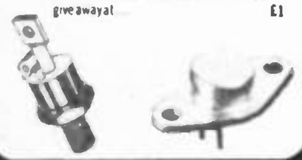

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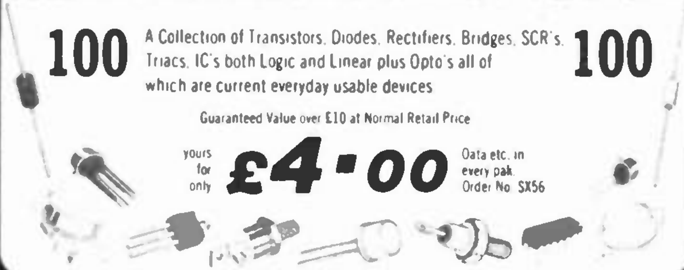

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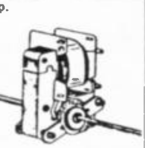
2 Pole, 240V, 2 Amp. Spindle—1·43 × 0·212in. £1·75. 2 Pole. 240V, 15 Amp Doubl spindle—1·75 × 0·16in. Each £1. 2 Pole. 120V, ·5 Amp Spindle—0·75 × 0·2in. Two in series — 240V. 50p each. Brush Motor. From a Food Mixer 240V, ·3 Amp High Speed and Powerful Spindle—0·5 × 0·25in. £2·95. B.S.R. Motor £4. Garrard Motor £5.



ALUMINIUM CHASSIS 18 s.w.g. Undrilled, 4 sides, riveted corners: 6 × 4 × 2½in. £1·44; 8 × 6 × 2½in. £1·80; 10 × 7 × 2½in. £2·30; 14 × 9 × 2½in. £3·00; 16 × 6 × 2½in. £2·90; 12 × 3 × 2½in. £1·80; 12 × 8 × 2½in. £2·60; 16 × 10 × 2½in. £3·20.
ALI ANGLE BRACKET 6 × ¾ × ¾in. 25p.
ALUMINIUM PANELS 18 s.w.g. 12 × 12in. £1·50; 14 × 9in. £1·44; 6 × 4in. 43p; 12 × 8in. £1·10; 10 × 7in. 96p; 8 × 6in. 72p; 14 × 3in. 72p; 12 × 5in. 72p; 16 × 10in. £1·68; 16 × 6in. £1·10.
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8/800V	£1·20	50/500V	£1·20	32+32/350V	50p
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32/500V	75p	8+16/450V	75p	32+32+32/352V	75p
				16+32+32/500V	£2

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Stereo Ceramic Cartridge
Plays 12in., 10in., or 7in. records Auto or Manual. A high quality unit 240V AC.
Size 13½ × 11¼in.
Above motor board 3¼in.
Below motor board 2½in.
£20 Post on All Decks £2.

RSR Single Player P207 cueing device, ceramic cartridge. **£15** post £2

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BSR C172 Slim arm. Metal Turntable. Ceramic Head. Cueing Device. Auto Stop. **£12** post £2

BSR Auto Changer. 11in. Turntable. Budget price. Stereo ceramic, reliable unit. 3-speed. **£17.50** post £2

ISKRA Disco Deck 3-speed stereo, 240V. £8 each, pst £2

Baker Disco Amplifier, 4 inputs, 150 watt. £89

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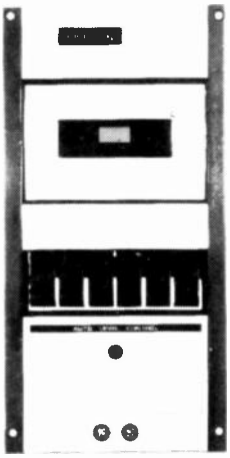
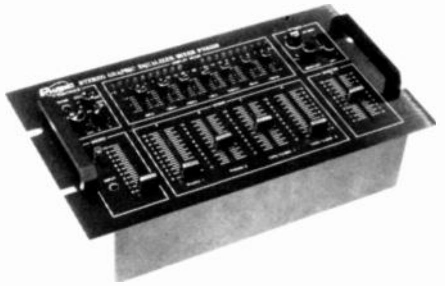


6 piano type keys

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.

STEREO MIXER—GRAPHIC EQUALISER



5 Channel stereo disco mixer with built in 7 band graphic equaliser. L.E.D. Vu Display. Monitored output. Fader mix and equaliser defeat button. Microphone talk over switch. Supplied complete and ready built. Ideal for incorporating into high quality disco public address consoles etc. or may be used free standing for hi-fi. (Inputs for dual turntables).

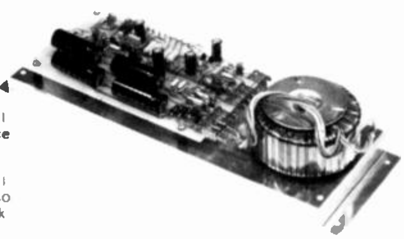
SPECIFICATION. **5 Inputs:—**
Microphone High 50K, Low 680ohm
Phono X2 50Kohm
Tape/Tuner X2 50Kohm
Frequency Response:—
Mic:— 10HZ—20K HZ
Phono X2 10HZ—20K HZ
Tape/Tuner X2 10HZ—80K HZ
Input Sensitivity:—
Mic. High 3mV, Low 0.3mV
Phono X2 Mag. 3mV, Cry. 150mV
Tape/Tuner X2 150mV
Output Impedance:—470 ohm
Talk Over:—Decrease 14db of the programme level
Headphone Output:—0.25W at 8 ohms
Equaliser Control Frequencies:—60HZ, 150HZ, 400HZ, 1K HZ, 2.5K HZ, 6K HZ, 15K HZ.
Control Range:—12 db Boost or Cut.
Power:—220—240v AC
Dimensions:—360 × 200 × 120mm
Price:—£85.00 + £2.50 P & P.

NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons. Specification and Price:—

15" 100 watt R.M.S. Impedance 8ohm. 59 oz. magnet. 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.50 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz Sensitivity 95dB **Price £23.70 each.** £2.50 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohm, 20 oz magnet 1" aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz Sensitivity 92dB Also available with black cone and black protective grill. **Price £8.90 each.** £1.25 Packing and Carriage each.

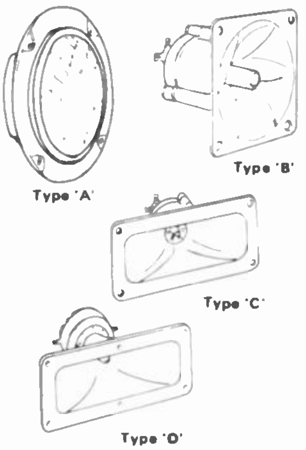


OMP POWER AMPLIFIER MODULES

100 and 150 WATTS R.M.S.
Power Amplifier Modules with integral toroidal transformer power supply and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. Auxilliary stabilised supply and drive circuit incorporated to power an L.E.D. Vu meter available as an optional extra.
SPECIFICATION:
Max. output power 100 watts R.M.S. (OMP 100)
150 watts R.M.S. (OMP 150)
Loads: (Open and short circuit proof) 4–16 ohms
Frequency Response: 20Hz—25KHz ±3dB
Sensitivity: for 100 watts 500mV at 10K
150 watts 500mV at 10K
T.H.D. 00.1%
Size: 360 × 115 × 80mm
Prices: OMP 100 £29.99 P & P £2.00
OMP 250 £39.99 P & P £2.00
V.u. Meter £6.60

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



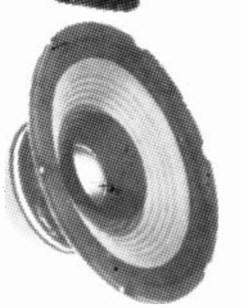
Type 'A' 3in round with removable wire mesh. Ideal for bookshelf hi-fi speakers. **Price (Type 'A') £3.45 each.**
Type 'B' 3½in super horn. For general purpose speakers disco and PA systems, etc. **Price £4.35 each.**
Type 'C' 2in x 5in wide dispersion horn. For hi-fi systems and quality disco etc. **Price £5.45 each.**
Type 'D' 2in x 6in wide dispersion horn. Frequency response extending down to mid-range (2000 c/s) suitable for hi-fi systems and quality disco. **Price £6.90 each.**
Post and Packing, all types, 15p each (or SAE for Piezo leaflets)

Piezo Level Control/Loudspeaker Terminals. Combines two spring loaded loudspeaker terminals, wire wound potentiometer and resister network. All mounted on a smart brushed aluminium plate. Fits neatly through a 3" x 3" cut out on rear of speaker cabinet. Price **£2.99** + 20p postage and packing

Matching 3-way loudspeakers and crossover
Build a quality 60 watt R.M.S. system
★ 10" Woofer
★ 3" Tweeter
★ 5" Mid Range
★ 3-way crossover

Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround. Crossover combines spring loaded loudspeaker terminals and recessed mounting panel.
Price £19.95 per kit - £2.50 postage and packing. Available separately, prices on request.

12" 80 watt R.M.S. loudspeaker.
A superb general purpose **twin cone** loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price £16.49 ea + £2.50 P&P



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