Easy to build projects for everyone

Everyday ELECTRONICS

JULY 81
60p

ELECTRONIC MULTIMETER

COMBINATION LOCK

XENON STROBE LAMP

TOUCH SWITCH with VOLTAGE-CONTROLLED CUT-OUT

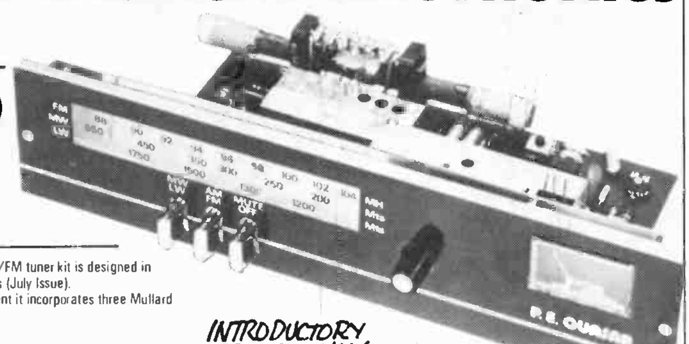
MORSE PRACTISE OSCILLATOR

Australia $1·20 . New Zealand $1·30 Malaysia $4·50 IR 84p (inc. V.A.T.)

NEW

PRACTICAL ELECTRONICS

STEREO TUNER KIT

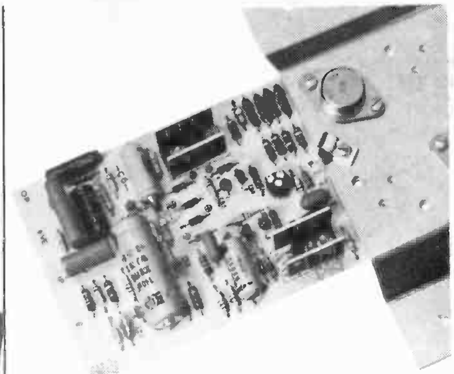


This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July Issue).
For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

Features
VHF - M.W. - L.W. Bands. Interstation muting and A.F.C. on VHF.
Tuning Meter. Two back printed P.C.B's. Ready made chassis and scale.
Aerial: AM - Ferrite Rod, FM - 75 or 300 ohms.
Stabilized 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 circuit diagrams and instructions.

INTRODUCTORY PRICE - ONLY
£17.95
plus £2.50 p&p

HIGH POWER MODULE KITS



125 WATT MODEL £10.50
plus £1.15 p&p (Illus)

200 WATT MODEL £14.95
plus £1.15 p&p

SPECIFICATIONS

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

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 backprinted, etched and ready to drill for ease of construction, and the aluminium chasis 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

MULLARD LP1183 STEREO PREAMP

FREE!

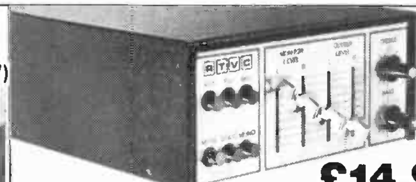
Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.

PRACTICAL ELECTRONICS CAR RADIO KIT (Constructors pack 7)

2 WAVE BAND MW LW
* Easy to build * 5 push button tuning
* Modern styling design * All new unused components
* 6 watt output * Ready etched & punched P.C.B.
* Incorporates suppression circuits * Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts 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. The radio fits easily in or under dashboards.
Complete with instructions. **£10.50** plus £2.00 p&p

CONSTRUCTORS PACK 7A
Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack, p&p £1.15



£14.95
plus £2.90 p&p

10+10 WATT STEREO AMPLIFIER KIT

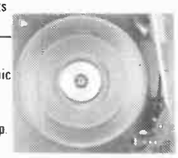
- Featuring latest SGS/ATES TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier module.
- Attractive black vinyl finish cabinet. Size 9" x 8⅜" x 3⅝" approx.
- Converts to a 20 watt Disco amplifier.

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 disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

SPECIFICATIONS

Suitable for 4 to 8 ohms speakers

Frequency responce	40Hz — 20KHz
Input Sensitivity	P.U. 150mV Aux. 200mV Mic. 1.5mV
Tone controls	Bass ± 12db @ 60Hz
	Treble ± 12db @ 10KHz
Distortion	1% typically @ 4 watts
Mains supply	220-250 volts 50Hz



BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £3.15 p&p when purchased with amplifier.
Available separately **£10.50** plus £3.16 p&p.

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

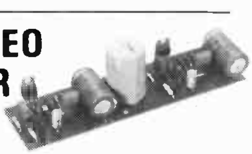
STEREO MAGNETIC PRE-AMP CONVERSION KIT. All components including P.C.B. to convert your ceramic input on the 10+10 amp to magnetic. **£2.00** when purchased with kit featured above. **£4.00** separately inc. p&p.

30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red 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 14¾" x 10" approx.

READY TO PLAY £32.90 plus £3.80 p&p

HI FI STEREO AMPLIFIER MODULES



- Mullard LP1183 built preamplifier suitable for ceramic and auxiliary inputs. £1.95 plus 70p p&p.
- Mullard LP1184 built preamplifier suitable for magnetic/ceramic and auxiliary inputs. £4.95 plus 80p p&p
- Matching I.C. 10 + 10 Stereo Power amplifier kit. £3.95 plus £1.15 p&p
- Matching power supply kit with transformer. £3.00 plus £1.96 p&p
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes. £1.70 plus 80p p&p.
- Complete with application notes.

R T V C

323 EDGWARE ROAD, LONDON W2
21A HIGH STREET, ACTON W3 6NG

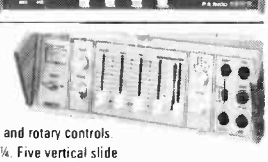
ACTON: Mail Order only. No callers
ALL PRICES INCLUDE VAT AT 15%
All items subject to availability. Price correct at 1.5.81 and subject to change without notice.
For further information send for instructions 20p plus stamped addressed envelope.
NOTE: Goods despatched to mainland and N. Ireland only.
Persons under 16 years not served without parent's authorisation.
R TVC LTD. reserve the right to alter, update or improve their products without notice.

50 WATT MONO MIXER AMPLIFIER

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.
Power output 50 watt R.M.S. (continuous) for use with 4 to 8 ohms speakers. Finish: Attractively styled black vinyl case, with matching fascia and knobs. Complete and ready for use.

£39.95
plus £3.70 p&p

100 WATT MONO DISCO AMPLIFIER



Brushed aluminium fascia and rotary controls.
Size approx 14" x 4" x 10¼. Five vertical slide controls, master volume, tape leverl, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

£76.00 plus £4.60 p&p

Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-5.30pm. Closed all day Thursday. ACTON: Mail Order only. No callers GOODS DESPATCHED TO MAINLAND AND N. IRELAND ONLY

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/ P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 50p TO ALL ORDERS UNDER £10·00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. (ACCESS orders by telephone welcome).

VAT Export orders no V.A.T. Applicable to U.K. Customers only. Unless stated otherwise all prices are exclusive of V.A.T. Please add 15% to total cost including P & P.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am–6.00 pm. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in nAF)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 100n, 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n **60p**; 1µF **68p**; 2µ2 **82p**; 4µ7 **85p**.
160V: 10nF, 12n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1µF **42p**; 1µ5 **45p**; 2µ2 **48p**; 4µ7 **58p**.

POLYESTER RADIAL LEAD CAPACITORS (250V)
10nF, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **17p**; 680n **19p**; 1µF **23p**; 1µ5 **40p**; 2µ2 **46p**.

We stock most of the parts for projects in this magazine.

ELECTROLYTIC CAPACITORS: (Values are in µF) **500V**: 10 **52p**; 47 **78p**; **63V**: 0·47, 1·0, 1·5, 2·2, 3·3 **8p**; 4·7 **9p**; 6·8, 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 100 **19p**; 1000 **70p**. **50V**: 47 **12p**; 68 **20p**; 220 **24p**; 470 **32p**; 2200 **90p**. **40V**; 4·7, 15, 22 **9p**; 3300 **90p**; 4700 **120p**. **25V**: 1·5, 6·8, 10, 22 **8p**; 33 **9p**; 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 2200 **50p**; 3300 **76p**; 4700 **92p**. **16V**; 40, 47, 100 **9p**; 125 **12p**; 220 **13p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 3300 **74p**; 4700 **79p**.
TAG-END TYPE: 450V: 100µ **65p**. 70V ;4700µ **245p**. 64V; 3300 **198p**; 2200 **139p**. **50V**: 3300 **154p**; 2200 **110p**. **40V**: 4700µ **160p**. **25V**: 4000 **92p**; 3300 **98p**; 2500, 2200 **90p**. 15,000 **345p**

TANTALUM Bead Capacitors
35V: 0·1µ, 0·22, 0·33 **15p**; 0·47, 0·68, 1·0, 1·5 **16p**; 2·2, 3·3 **18p**; 4·7, 6·8 **22p**; 10 **28p**. **16V**; 2·2, 3·3 **16p**; 4·7, 6·8, 10 **18p**; 15 **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**. **10V**; 15, 22 **26p**; 33, 47 **35p**; 100 **55p**.

MYLAR FILM CAPACITORS
100V: 1nF, 2n, 4n, 4n7, 10n **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**. 470n/50V **12p**.

MINIATURE TYPE TRIMMERS
4-6pF, 2-10pF **22p**; 2-25pF, 5-65pF **30p**; 10-88pF **35p**.

COMPRESSION TRIMMERS
3-40pF, 10-80pF **20p**; 20-250pF **28p**; 100-580pF **39p**; 400-1250pF **48p**.

POLYSTYRENE CAPACITORS
10pF to 1nF **8p**; 1·5nF to 12nF **10p**.

SILVER MICA: 2pF, 3·3, 4·7, 6·8, 8·2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 **15p**. 200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **21p**. 1000, 1200, 1800, 2000 **30p**. 3300, 4700 **60p**.

CERAMIC CAPACITORS: 50V
0·5pF to 10nF **4p**; 22n to 100n **7p**.

EURO BREADBOARD £5·20.

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.
500Ω,1 K & 2K (Lin. only) Single **29p**
5K-2 MΩ single gang **28p**
5K-2 MΩ single with DP switch **78p**
5K-2 MΩ double gang **88p**

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **110p**
Self Stick Graduated Bezels **36p**

PRESET POTENTIOMETERS
Vertical & Horizontal
0-1W 50Ω—5MΩ Miniature **7p**
0-25W 100Ω—3·3MΩ Horiz **10p**
0-25W 200Ω—4·7MΩ Vert **10p**

RESISTORS: Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

Range	Val.	1–99	100+
¼W 2Ω2–4M7	E24	2p	1p
½W 2Ω2–4M7	E12	2p	1p
1W 2Ω2–10M	E12	5p	4p
2% Metal Film 10Ω–1M		8p	4p
1% Metal Film 51Ω–1M		8p	6p

100+ price applies to Resistors of each value not mixed.

TGS 812 or 813 gas and smoke detector **415p**. Socket for above **30p**.

OPTO ELECTRONICS
LEDs plus clips
TIL209 Red **13**
TIL211 Grn **18**
TIL212 Yellow **18**
·2" Red **14**
2" Yellow Green **18**
Square LED **29**
OCP71 **120**
ORP12 **80**
ORP61 **85**
2N5777 **45**
7 Seg Displays
TIL321 C An 5" **115**
TIL322 C Cth 5" **115**
DL704 C Cth 3" **80**
DL707 C.A. ·3" **90**
DL747 C.A. ·6" **180**
FND357 or 500 **120**
MAN3640 **175**
·3" Green C.A. **180**
TIL32 Inf. Red **52**
TIL78 detector **54**
Bargraph Red. Ten segment **225p**

LCD DISPLAYS
3½ Digit **625p**
4 Digit **750p**
6 Digit **850p**

VOLTAGE REGULATORS*

1A	**TO3**	**+ve**	**—ve**	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	145p	—	
1A	**TO220 Plastic Casing**			
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p
100mA	**TO92 Plastic Casing**			
5V	78L05	30p	79L05	65p
6V	78L62	30p	—	
8V	78L82	30p	—	
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085 95	LM326N	240	78H05+5V/5A	550
LM300H 170	LM327N	270		
LM305H 140	LM723	35	78HG 5A +5V	
LM309K 135	TAA550	50	to +25V	600
LM317K 350	TBA625B	75	79HG 5A −2·25	
LM323K 625	TDA1412	150	to −24V	850p

SLIDE 250V:
1A DPDT **14p**
1A DP c/off. **15p**
½A DPDT **13p**

PUSH BUTTON
Latching or Momentary.
SPST C/Over **99p**
DPDT C/Over **145p**

SWITCHES
TOGGLE 2A 250V
SPST **33p**
DPDT **44p**
SUB-MIN TOGGLE
SP changeover **59p**
SPST on/off **54p**
DPDT 6 tags **75p**
DPDT c/off **88p**
DPDT Biased **145p**

SWITCHES Miniature Non-Locking
Push to Make **15p** Push to Break **20p**
ROCKER: SPST on/off 10A 250V **28p**
ROCKER: Illuminated DPST
Lights when on: 10A 240V **85p**
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. **45p**
ROTARY: Mains 250V AC, 4 Amp **56p**

DIL SOCKETS (Low Profile – Texas)
8 pin **8p**; 14 pin **10p**; 16 pin **10p**; 18 pin **16p**; 20 pin **22p**; 24 pin **25p**; 28 pin **30p**; 40 pin **30p**.

JACKSONS VARIABLE CAPACITORS
Dilicon 100/300pF **195p**
500pF **250p**
6 1 Ball Drive 4511/DAF **160p**
Dial Drive 4103 6 1/36 1 **775p**
Drum 54mm **59p**
0-1·365pF **325p**
00 2 365pF **395p**
0 2 365pF with slow motion Drive **450p**
00 208/176 **395p**
" " with slow motion drive **450p**
C804-5pF 10 15 25 50 pF **278p**
100, 150pF **352p**
'L' 3 x 310pF **725p**
00·3 x 25pF **550p**

DENCO COILS
'DP' VALVETYPE
Range 1 to 5 Bl., Rd., Yl. Wht. **106p**
6–7 B.Y.R. **95p**
1·5 Green **130p**
'T' 1 to 5 Bl., Yl., Rd., Wht. **140p**
B9A Valve Holder **38p**
RDT2 **120p**
RFC 5 **120p**
RFC 7 (19mH) **135p**
IFT 13; 14; 15; 16; 17 **110p**
IFT 18/1·6 **120p**
IFT 18/465 **135p**
TOC 1 **110p**
MW5FR **112p**
MW/LW 5FR **136p**

VEROBOARDS ·1"

	clad	plain
2½ × 3¾"	73p	52p
2½ × 5"	83p	—
3¾ × 3¾"	83p	—
3¾ × 5"	95p	79p
3¾ × 17"	326p	211p
4¾ × 17"	426p	—

Pkt. of 100 pins **50p**
Spot Face Cutter **118p**
Pin insertion Tool **162p**

COPPER clad boards
Fibreglass
6 × 6" **90p**
6 × 12" **150p**
S.R.B.P.
9·5 × 8 **95p**
Ferric Chloride 1 lb. Anhydr. **195p**
Dalo Pen **90p**

DIODES
AA129 22
BA100 15
BY126 12
BY127 12
CRO33 250
OA9 40
OA47 12
OA70 12
OA79 15
OA81 15
OA85 15
OA90 8
OA91 8
OA95 8
OA200 8
OA202 8
IN914 4
IN916 5
IN4001/2 5
IN4003 6
IN4004/5 6
IN4006/7 7
IN4148 4
IS44 9
3A/100V 15
3A/400V 16
3A/600V 17
3A/1000V 30
6A/400V 50p

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ZENERS
Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V. 1·3W **15p each**

NOISE
Diode **195**

BRIDGE RECTIFIERS
(plastic case)
1A/50V 20
1A/100V 22
1A/200V 25
1A/400V 28
1A/600V 34
2A/50V 35
2A/200V 40
2A/400V 46
2A/600V 85
6A/100V 83
6A/400V 95
10A/200V 215
10A/600V 315
25A/200V 215
25A/600V 395
BY164 56
VM18 DIL 55

DIAC
ST2 **25**

SCRs Thyristors
1A/100V 42
5A/400V 40
5A/600V 43
8A/300V 60
8A/400V 75
8A/600V 95
12A/400V 95
12A/800V 188
15A/700V 180
2N4444 140
2N5062 32
2N5064 35
BT106 150
C106D 38
TIC44 24
TIC45 29

TRIACS
3A/100V 48
3A/400V 56
8A/100V 60
8A/400V 69
8A/800V 115
12A/100V 78
12A/400V 82
12A/800V 135
16A/100V 103
16A/400V 105
25A/400V 185
25A/800V 295
25A/1000V 480
30A/400V 525
T28000D 120

TTL 74 (TEXAS)

7400	11
7401	12
7402	11
03	14
04	14
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07	36
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173	110
174	100
175	82
176	80
177	85
178	110
180	90
181	280
182	85
184	130
185	130
188	310
190	130
191	120
192	120
193	120
194	102
195	75
196	99
197	88

74LS

LS00	13
LS01	13
LS02	15
LS03	15
LS04	20
LS05	23
LS08	22
LS09	23
LS10	20
LS11	32
LS12	32
LS13	40
LS14	60
LS15	40
LS20	21
LS21	32
LS22	35
LS26	44
LS27	35
LS28	35
LS30	20
LS32	25
LS33	35
LS37	30
LS38	35
LS40	28
LS42	66
LS47	85
LS51	25
LS54	30
LS55	30
LS73	35
LS74	35
LS75	45
LS76	45
LS78	50
LS83	105
LS85	80
LS86	38
LS90	50
LS91	125
LS92	75
LS93	60
LS95	115
LS96	120
LS107	45
LS109	75
LS112	40
LS113	75
LS114	40
LS122	70
LS123	75
LS124	180
LS125	45
LS126	45
LS132	35
LS136	35
LS138	62
LS139	70
LS151	90
LS153	85
LS155	75
LS157	70
LS158	70
LS160	90
LS161	98
LS162	110
LS163	95
LS164	115
LS165	145
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	110
LS175	110
LS181	295
LS183	298
LS191	120
LS192	95
LS193	95
LS194	125
LS195	130
LS196	120
LS197	85
LS200	345
LS221	120
LS240	225
LS243	165
LS244	150
LS245	145
LS251	130
LS253	95
LS257	95
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS279	88
LS280	250
LS283	90
LS290	130
LS293	130
LS295	215
LS298	215
LS299	420
LS323	450
LS365	65
LS366	65
LS367	65
LS368	90
LS373	150
LS375	150
LS374	180
LS377	199
LS378	140
LS390	140
LS393	140
LS399	230
LS668	105
LS670	270

CMOS

4000	18
4001	18
4002	24
4006	86
4007	22
4008	82
4009	40
4010	48
4011	24
4012	24
4013	45
4014	80
4015	85
4016	42
4017	82
4018	88
4019	48
4020	99
4021	90
4022	95
4023	25
4024	60
4025	25
4026	180
4027	48
4028	82
4029	105
4030	55
4031	185
4032	125
4034	213
4035	125
4036	275
4037	115
4038	118
4039	299
4040	105
4041	80
4042	80
4043	95
4044	95
4046	130
4047	98
4048	65
4049	45
4050	48
4051	80
4052	80
4053	80
4054	130
4055	130
4056	135
4059	575
4060	110
4063	120
4066	58
4067	430
4068	26
4069	26
4070	30
4071	25
4072	25
4073	25
4075	25
4076	99
4081	28
4082	25
4085	90
4086	90
4089	150
4093	89
4094	240
4095	95
4096	95
4097	340
4098	115
4099	190
4161	115
4410	750
4411	950
4422	320
4433	570
4501	750
4502	28
4503	125
4507	60
4508	325
4510	99
4511	150
4512	93
4514	265
4515	299
4516	120
4518	105
4519	70
4520	115

LINEAR IC's

702	75
709C 8 pin	35
710*	48
733	75
741 8 pin	14
747C 14 pin	78
748C 8 pin	36
753 8 pin	185
810	159
2114L-300N	99
2114L-200	150
2114-450N	99
4116-200N	150
2708	250
2716-5V	275
9400CJ	350
AY-1-0212	675
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-3-1270	840
AY-3-8500	390
AY-3-8910	770
AY-5-1224A	235
AY-5-1230	450
AY-5-1317A	639
CA3011	110
CA3012	175
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	71
CA3048	214
CA3059	195
CA3075	213
CA3080E	65
CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8038CC	340
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	1950
ICM7217A	790
ICM7224	785
ICM7555	80
LD130	452
LF351	48
LF356	90
LM10	395
LM301A	26
LM308T	95
LM311H	70
LM318	240
LM324	50
LM339	70
LM348	90
LM349	125
LM358	50
LM379	375
LM380	80
LM381N	145
LM382	125
LM384	140
LM386	99
LM387	120
LM389	99
LM1458	45
LM2917	195
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM3915	240
LM3916	255
LM13600	135
M252AA	625
M253AA	1150
MC1303	88
MC1304P	260
MC1310P	150
MC1488	90
MC1489	90
MC1494	694
MC1495	350
MC1496L	92
MC1596	225
MC1709	90
MC3302	150
MC3340	120
MC3360	120
MC3401	52
MC3403	135
MC3405	150
MCF6040	97
MK50398	635
MM5303	635
MM57160	576
NE529	225
NE543	210
NE544	185
NE555	17
NE556	55
NE560	325
NE561	395
NE562	410
NE564	435
NE565	120
NE566	180
NE567	170
NE570	450
NE571	420
RC4136D	40
S566B	275
SAB3209	425
SAB3210	275
SG3402	295
SN76013	170
SN76023N	170
SN76477	175
SP8629	299
TAA621	250
TAD100	159
TBA120	70
TBA550Q	330
TBA641	250
TBA651	190
TBA800	90
TBA810	95
TBA820	70
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TDA2030	300
TL061CP	46
TL064	159
TL071CP	46
TL074CN	140
TL081CP	42
TL083CN	92
TL084CN	105
UAA170	170
UAA180	170
XR2206	320
Z80CPU	525
ZN414	95
ZN423	195
ZN424	130
ZN1034	200
ZN425E	350
ZN426E	300
ZN1040E	685

Transistors

AC125	35	BC212	10	BF257/8	32	OC41/42	120	ZTX301/2	16	2N3906	17
AC126/7	25	BC212L	10	BF259	35	OC43	55	ZTX303	25	2N4037	46
AC128	25	BC213	10	BF274	42	OC44	120	ZTX304	17	2N4058	10
AC141/2	30	BC213L	10	BF336	40	OC45	40	ZTX314	25	2N4061/2	10
AC176	28	BC214	10	BF451	35	OC70/71	40	ZTX326	30	2N4427	80
ACY17/18	70	BC214L	10	BF594	30	OC72	40	ZTX341	30	2N3859	78
ACY19/20	75	BC236	10	BF595	39	OC74/75	50	ZTX500	14	2N4871	55
ACY21/22	75	BC237	14	BFR30/40	23	OC76	50	ZTX501/502	15	2N5172	18
ACY28	75	BC307B	15	BFR41	23	OC81	50	ZTX503	18	2N5179	45
ACY39	85	BC308B	16	BFR79	23	OC82	130	ZTX504	25	2N5191	75
AD149	79	BC327	15	BFR80/81	24	OC83/84	40	ZTX531	25	2N5305	24
AD161/2	45	BC238	14	BFR98	105	OC140	110	ZTX550	25	2N547/8	36
AF118	95	BC338	15	BFX29	28	OC170/1	85	2N697	23	2N5485	36
AF139	40	BC441	34	BFX84	26	OC200	85	2N698	40	2N5642	750
AF178	75	BC461	34	BFX85/86	28	TIP29	34	2N699	35	2N5777	45
AF239	78	BC477	40	BFX87/8	28	TIP29A	36	2N706A	19	2N6027	32
BC107	10	BC516/7	40	BFY50	23	TIP29B	56	2N708	19	2SA715	60
BC107B	12	BC547/8	14	BFY51/52	23	TIP29C	60	2N918	33	2SC495/6	70
BC108	10	BC549C	14	BFY56	32	TIP30	48	2N1131/2	24	2SC1096	85
BC108B	12	BC557/8	15	BFY64	35	TIP30C	56	2N1303	60	2SC1173	125
BC108C	12	BC559	15	BFY81	120	TIP31A	45	2N1304/5	65	2SC1306	150
BC109	10	BCY70/71	16	BRY39	40	TIP31C	55	2N1671B	215	2SC1307	220
BC109B	10	BCY72	20	BSX20	20	TIP32A	48	2N2219A	28	2SC1449	85
BC109C	12	BD131/2	48	BSY95A	25	TIP32C	60	2N2220A	25	2SC1678	140
BC140	30	BD133	60	BU105	170	TIP33A	65	2N2221A	25	2SC1923	50
BC142/3	30	BD135	45	BU205	190	TIP33C	78	2N2222A	25	2SC1945	225
BC147	9	BD136/7	40	BU208	200	TIP34A	74	2N2369A	17	2SC1953	80
BC147B	10	BD138/9	40	E421	250	TIP34C	88	2N2646	48	2SC1957	90
BC148	9	BD140	40	MD8001	250	TIP35A	160	2N2904/5	28	2SC1969	198
BC148B	10	BD144/5	198	MJ400	150	TIP35C	185	2N2905A	26	2SC2028	85
BC148C	10	BD205	110	MJ491	175	TIP36A	170	2N2906/7	26	2SC2029	180
BC149	9	BD214	115	MJ2955	90	TIP36C	199	2N2926G	10	2SC2078	155
BC149C	10	BD245	198	MJE340	54	TIP41A	60	2N3053	26	2SC2091	85
BC153/4	27	BD378	70	MJE370/71	100	TIP41B	68	2N3054	58	2SC2314	85
BC157/8	10	BD434	55	MJE2955	99	TIP42A	60	2N3055	48	2SC2166	165
BC159	11	BD517	75	MJE3055	70	TIP42B	75	2N3442	140	2SC1679	190
BC160	45	BD695A	85	MPF102	66	TIP120	90	2N3663	15	2SD234	75
BC167	10	BD696A	85	MPF103/104	36	TIP121	99	2N3702/3	10	3N128	112
BC168C	10	BDY56	180	MPF105	36	TIP142	120	2N3704/5	10	3N140	112
BC169C	10	BF115	35	MPF106	40	TIP147	120	2N3706/7	10	40311	60
BC170	15	BF167	28	MPSA05	25	TIP2955	60	2N308/9	10	40313	125
BC172/3	11	BF180	38	MPSA06	25	TIP3055	60	2N3710/1	10	40315	68
BC177/8	120	BF194/5	12	MPSA12	32	TIS43	32	2N3771	179	40316	85
BC179/81	20	BF196/7	12	MPSA55	30	TIS44/45	45	2N3772	195	40361/2	50
BC182/3	10	BF198	16	MPSA56	30	TIS88A	50	2N3773	270	40408	95
BC184	10	BF199	18	MPSA70	25	TIS90	30	2N3819	22	40411	280
BC182L	10	BF200	30	MPSU06	55	TIS91	32	2N3820	45	40467	95
BC183L	10	BF224	20	OC26	170	ZTX107	11	2N3822/3	65	40468	60
BC184L	10	BF244/5	28	OC28	130	ZTX109	12	2N3866	90	40594/5	90
BC187	26	BF244B	30	OC35	125	ZTX109	11	2N3903/4	1-	40603	90
		BF256	35	OC36	125	ZTX300	13	2N3905	15	40673	95

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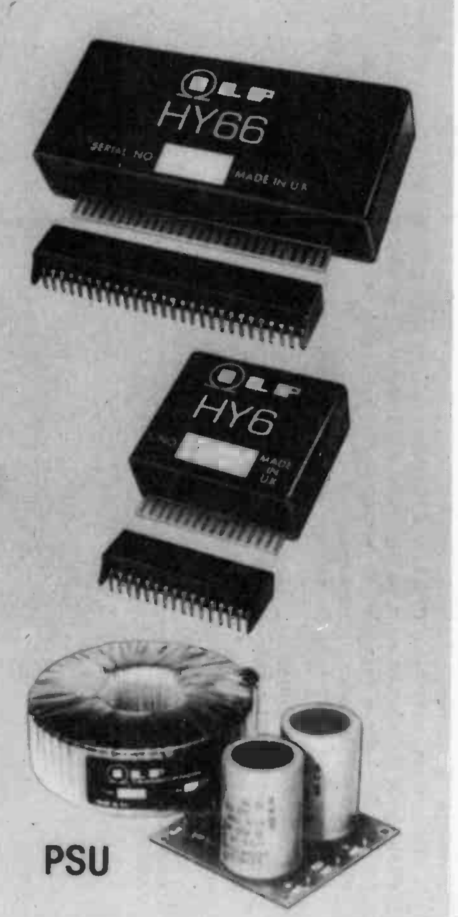

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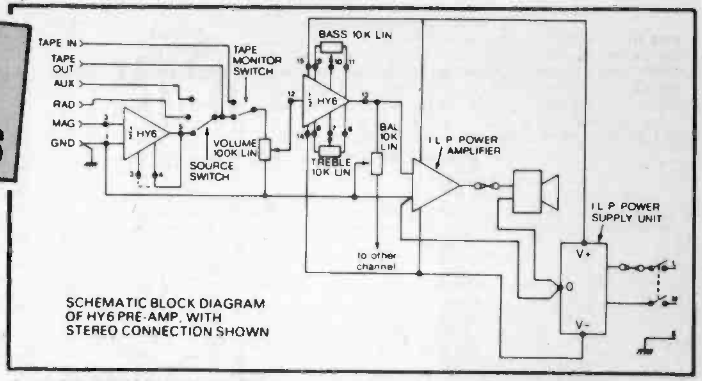

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NOT BY CHIPS ALONE

What's in a name. Quite a lot it seems. The term "microprocessor" never caught the imagination of the media and the public at large and has now been abandoned in favour of "microchip". Yet it is really just *one* particular kind of microchip, a microprocessor, that is the true basis of much comment in the media today.

As a marketing operation to stimulate general interest in the technology the use of "microchip" has proved effective. It is easy to remember and it rolls off the tongue freely. Its frequent inclusion into conversations can help convey an impression of deep understanding of technical matters and appreciation of the true import of microelectronics in our advancing world. It has become, in short, a "buzz word".

Not that there is anything wrong in popularising electronics and bringing it into everyday conversation. Quite the contrary. Yet there is a danger that by concentrating on "the chip" an unnecessary and unwarranted aura is being created around this particular kind of device. The notion that a microchip is a magic box possessing most extraordinary powers and that it performs in splendid isolation is nonsense and the proliferation of such an idea in the public mind can only be detrimental to a proper intelligent understanding of electronics.

Such misunderstanding can lead to serious consequences if it diverts attention from the continuing need for skilled persons to design circuits and systems. These traditional skills are going to be as much in demand in future as they were before the integrated circuit appeared on the scene.

So despite all the wonders attributed to the microchip (actually, the microprocessor) the human element is likely to remain a vital factor in the world of electronics for many years to come. At this precise moment the need is for more technical education for young people so that we have adequate properly trained manpower to exploit fully the microchips that are already, and will continue to be, in abundance.

The principles of electronic circuit theory and the practical aspects of circuit design based on both discrete and i.c. devices—with special attention to the interfacing of these components—are key subjects for serious and urgent consideration by our educationalists when planning curricula for the eighties.

Fred Bennett

Our August issue will be published on Friday, July 17. See page 473 for details.

Everyday ELECTRONICS

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Circuit EXCHANGE IS NO ROBBERY
See Page 501

ELECTRONIC

BY G. HALLAM

MULTIMETER

THE NEWCOMER to electronics is soon faced with the problem of buying a multimeter. But what kind of multimeter should be bought and how much will it cost? The cost of a good instrument can bring one out in a cold sweat for £40 is not too much to pay for an analogue meter while digital types are often twice this amount.

ELECTRONIC INSTRUMENTS

Such would be the cost of the so-called "electronic" instruments which make use of solid-state components to obtain sensitivities of the order of 500 kilohm/volt and more. Multimeters costing less than £10 should be avoided for they are often fragile, difficult to read and of low sensitivity.

While moving coil meters are still generally available, there is a lot to be said for building a multimeter, especially if its specifications are competitive with the electronic analogue types costing twice as much.

CIRCUIT DESCRIPTION

The design of the multimeter is based on four integrated circuits, as shown in the circuit diagram of Fig. 1.

The first of these, IC1, is a programmable current source which, on selection of one of the resistors R1 to R5 by means of switch S1, enables the value of a resistor placed across the input sockets SK1 and SK2 to be measured when the function switch S2 is in the OHMS position and S3 is pressed.

IC2 is wired as a unity-gain buffer amplifier which passes on the voltage developed across the resistor under test to the third i.c.

This component, IC3, is wired as a times-ten non-inverting amplifier which amplifies a 50mV signal at its pin 3 to provide a full scale reading on the meter ME1. This meter in association with the series resistor R24, gives an approximate 0·5V f.s.d. reading and the meter is calibrated by adjustment of VR1 as explained later.

The final i.c., IC4, is wired as a precision full-wave rectifier which enables the meter to record a.c. currents and voltages when S6 is in the A.C. position and VR3 is adjusted for calibration.

VOLTAGE MEASUREMENT

The measurement of voltage requires the function switch S2 to be set to VOLTS, S6 in the D.C. position and S5 and S1 to be in the OFF position. The ON/OFF switch S7 must, of course, be on.

The voltage to be measured, applied across SK1 and SK2, appears across the voltage divider resistors R8 to R12. Suppose S4, the voltage range switch, is in position 2. If a 50mV d.c. signal is applied to the inputs, this voltage appears at the non-inverting input of IC3 and is amplified to give a full scale deflection on the meter as required. But if S4 is in position 5, say, a 50V signal across the input terminals is reduced by the voltage divider action of resistors R8 to R12 so that once again a 50mV signal is applied to the input terminals of IC3 which again gives a full scale deflection on the meter, but this time corresponding to an input of 50V.

Similarly, 50mV appears at the input of IC3 for the other positions of S4 when the appropriate maximum d.c. voltage is being measured.

If a.c. voltages are being measured, S6 needs to be in the A.C. position so that full-wave rectified signals from IC4 are presented to the meter, VR3 being used to set the full scale deflection on the meter in this case.

RESISTANCE MEASUREMENT

The measurement of resistance requires the function switch S2 to be in the OHMS position, S6 set to D.C. and S5 and S4 in the OFF position.

SPECIFICATION

Voltage Range
0 to 500V in five ranges: 50mV, 500mV, 5V, 50V, 500V, a.c. and d.c.

Current Range
0 to 500mA in five ranges: 50μA, 500μA, 5mA, 50mA, 500mA, a.c. and d.c.

Resistance Range
0 to 5MΩ in five linear scales, calibrated left to right

Display Format
Analogue moving coil meter with integrated circuit input and range control

Accuracy
Better than 2 per cent

Input Inpedance
20MΩ on all voltage ranges

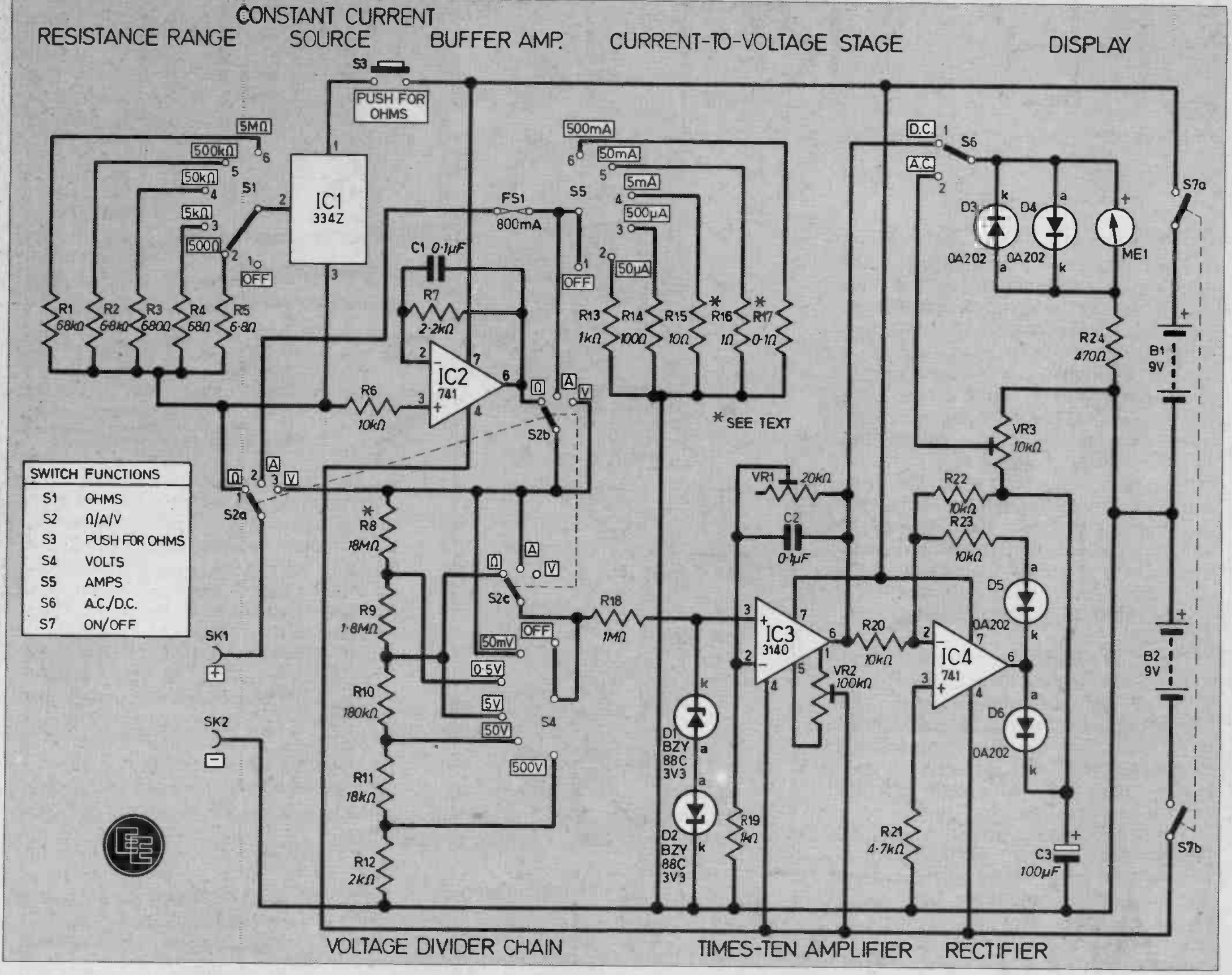


Fig. 1. Full circuit diagram for the Electronic Multimeter. Note that the meter ME1 is a 1mA f.s.d. type.

S1 selects the resistance range on the meter by placing one of the resistors R1 to R5 into the circuit based on IC1.

This three terminal device produces a constant current which is variable over the range 1μA to 10mA. Thus a 6·8 kilohm resistor gives a constant current of about 10mA and a 68 ohm resistor a constant current of 1mA, and so on.

One of these currents flows through the resistance placed between the terminals of the multimeter. For example, suppose S1 is in position 6 and selects the 68 kilohm resistor. IC1 is now able to source a current of 1μA which flows through the test resistor when S3 is closed. If this resistor has a value of 5 megohm, the voltage developed across the resistor is 5V.

This voltage is presented to the input of the buffer amplifier IC2 and appears at the "top end" of the voltage divider chain R8 to R12 via the function switch S2. Now S2c connects pin 3 of IC3 to the 5V position on the divider and so the actual voltage presented to pin 3 is 50mV which is the voltage required to provide a full scale deflection on the meter indicating a resistance of 5 megohms.

A resistor of lower value than 5 megohm has the same current (1μA) flowing through it and therefore produces a deflection on the meter which is proportional to this resistance.

If S1 is in position 5, a 10mA current flows through the resistor connected between the sockets so that a 500 kilohm resistor produces a 5V at the "top end" of the resistor chain and once again the meter shows a full scale deflection corresponding to 500 kilohms.

CURRENT MEASUREMENT

The measurement of current requires S1 and S4 to be set to OFF and the function switch S2 set to AMPS. S5 now selects one of the resistors R13 to R17 to enable current to be measured.

Current flowing into SK1 passes through the fuse FS1 and then through one of these resistors say R17, to 0V. The voltage drop across this resistor when a current of 500mA flows through it is 50mV. This voltage is passed on to IC3 by means of S2b and S2c and is amplified by IC3 to produce a full scale deflection on the meter corresponding to 500mA.

Similarly, a full scale deflection corresponding to a current of 5mA occurs when S5 is in position 4 and a current of 5mA flows through R15 and so on for the other current ranges.

LINEAR SCALE READINGS

Note that the scale readings on the meter for amps, ohms and volts are linear for the following reasons. First, the meter itself is a linear transducer producing a deflection proportional to the voltage across its input terminals. Second, Ohm's law applies to any one of the range resistors through which current is flowing. Third, op-amps IC3 and IC4 are wired as linear voltage amplifiers.

CONSTRUCTION starts here

PRINTED CIRCUIT BOARDS

Most of the components for the multimeter are assembled on two p.c.b.s as can be seen in the accompanying photographs. The foil layouts of the two boards are shown in Fig. 2 and you can either prepare these separately or on a single piece of copper-clad board to be split into two when the etching process has been finished.

In the completed unit the two boards are mounted back to back, the one nearest the case front (board A) carrying the range switches and resistors plus a few other odds and ends, and the other (board B) the integrated circuits and associated components.

Board B should be assembled first and the layout is shown in Fig. 3. This is quite straightforward and should present few problems. Make sure that the tantalum capacitors, diodes and IC1 are all inserted correctly. The d.i.l. integrated circuits are mounted in sockets.

The other p.c.b., board A can be tackled next. The layout is shown in Fig. 4. The four rotary switches, S1, S2, S4 and S5, together with associated resistors plus the resistance test switch, S3, and fuseholder are mounted on this board. The orientation of these switches is important and this is shown clearly in the diagram.

RESISTANCE WIRE

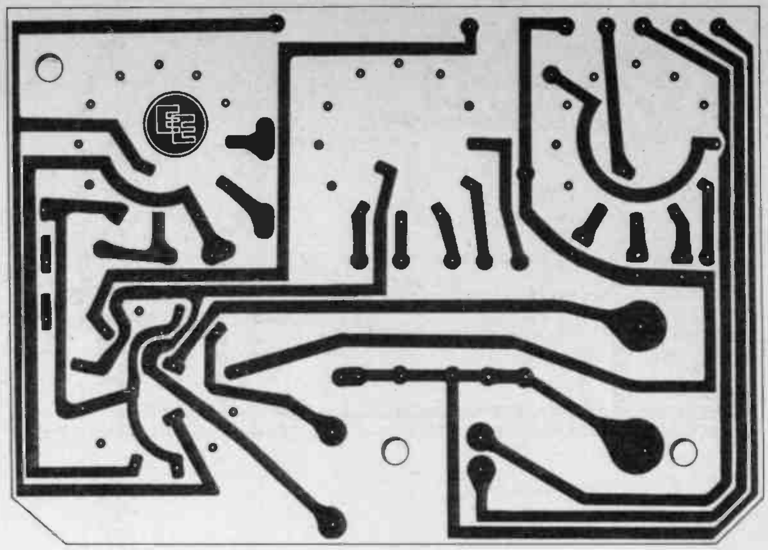
Because resistors R16 and R17 are very low in value, they each consist of a length of resistance wire mounted between the terminals of a p.c.b. terminal block which has been cut in half.

Suitable resistance wires should be selected for these resistors to give 1 ohm and 0·1 ohm respectively. As a guide, 50mm of 32 s.w.g. nichrome wire will give a resistance of about 1 ohm, and 40mm of 22 s.w.g. nichrome wire will give 0·1 ohm.

Clamp the wires between the p.c.b. terminal blocks and if an accurate ohmmeter is available adjust these wire lengths to obtain the required resistances. Otherwise wait and adjust these lengths after the multimeter has been initially calibrated.

RESISTORS

Accuracy is also essential for resistors R1 to R5 and it will be necessary



Resistors

R1	68kΩ		R13	1kΩ	metal oxide
R2	6·8kΩ		R14	100Ω	metal oxide
R3	680Ω		R15	10Ω	metal oxide
R4	68Ω		R16	1Ω	wire **
R5	6·8Ω		R17	0·1Ω	wire **
R6	10kΩ		R18	1MΩ	
R7	2·2kΩ	metal oxide	R19	1kΩ	
R8	18MΩ	high stability carbon film*	R20	10kΩ	
R9	1·8MΩ	high stability carbon film	R21	4·7kΩ	
R10	180kΩ	metal oxide	R22	10kΩ	
R11	18kΩ	metal oxide	R23	10kΩ	
R12	2kΩ	metal oxide	R24	470Ω	

All ½W carbon ± 5% except where stated otherwise
* Made up of 10MΩ + 6·8MΩ + 1·2MΩ
** See text

Potentiometers

VR1	20kΩ	20-turn cermet trimmer
VR2	100kΩ	20-turn cermet trimmer
VR3	20Ω	20-turn cermet trimmer

COMPONENTS approximate cost £30

Capacitors

C1	0·1µF	polyester
C2	0·1µF	polyester
C3	100µF	16V tantalum

Semiconductors

IC1	LM334Z programmable current source
IC2	741 op-amp 8-pin d.i.l.
IC3	3140 MOSFET op-amp 8-pin d.i.l.
IC4	741 op-amp 8-pin d.i.l.
D1, 2	BZY88 Zener 3·3V 400mW (2 off)
D3-6	OA202 small signal silicon diode (4 off)

Switches

S1	miniature wafer 1-pole 6-way (use 1-pole 12-way)*
S2	miniature wafer 3-pole 3-way (use 3-pole 4-way)*
S3	miniature push to-make, release-to-break
S4	miniature wafer 1-pole 6-way (use 1-pole 12-way)*
S5	miniature wafer 1-pole 6-way (use 1-pole 12-way)*
S6	s.p.d.t. miniature slide switch
S7	d.p.s.t. miniature slide switch

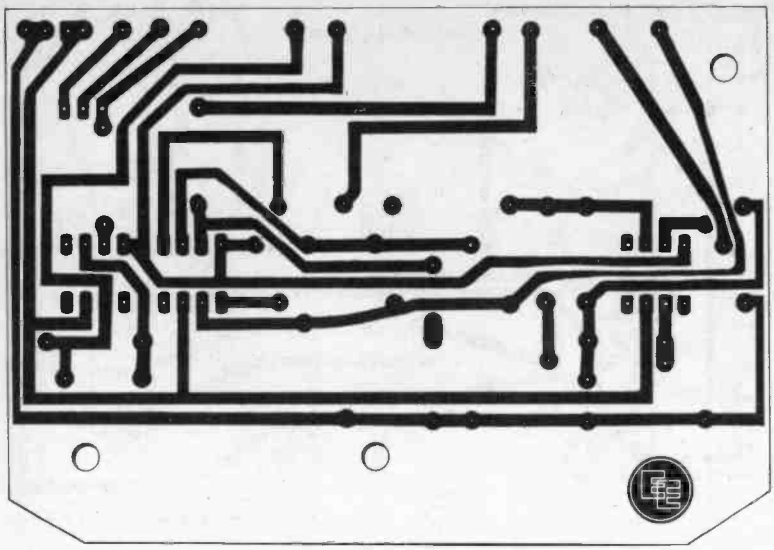
*Use p.c.b. mounting type.

See Shop Talk page 472

Miscellaneous

B1, 2	9V, PP6 type (2 off)
FS1	800mA cartridge fuse and p.c.b. fuseholder
ME1	1mA f.s.d. moving coil meter
SK1, 2	4mm socket with 3mm thick spacers (one red, one black)

Four knobs; two press connectors for batteries; three 8-pin d.i.l. sockets; copper wire, p.v.c. covered size 7/0·2 mm; 18 s.w.g. tinned copper wire; 22 s.w.g. and 32 s.w.g. nichrome resistance wire for 1 ohm and 0·1 ohm resistors; four-way p.c.b. terminal block; plastics case 190 × 110 × 60mm; tinplate for screen, 190mm × 70mm; p.c.b, 100 × 70mm (2 off)



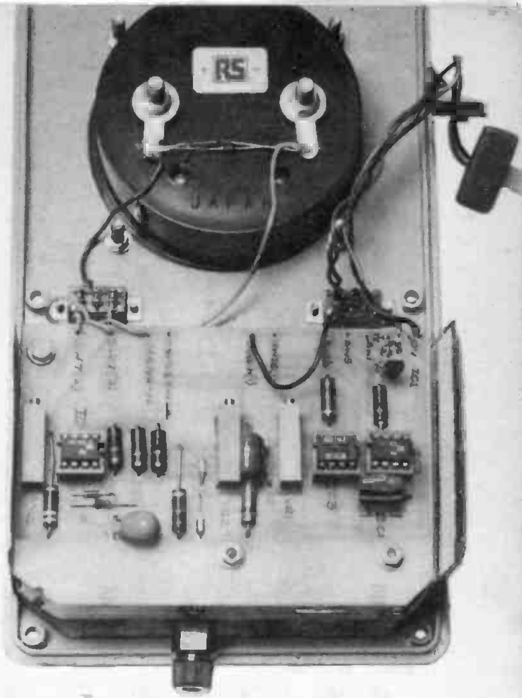
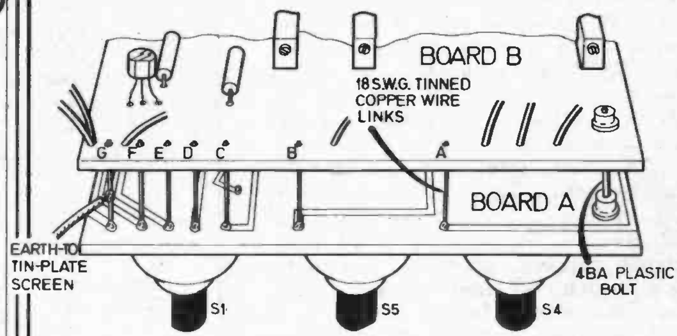


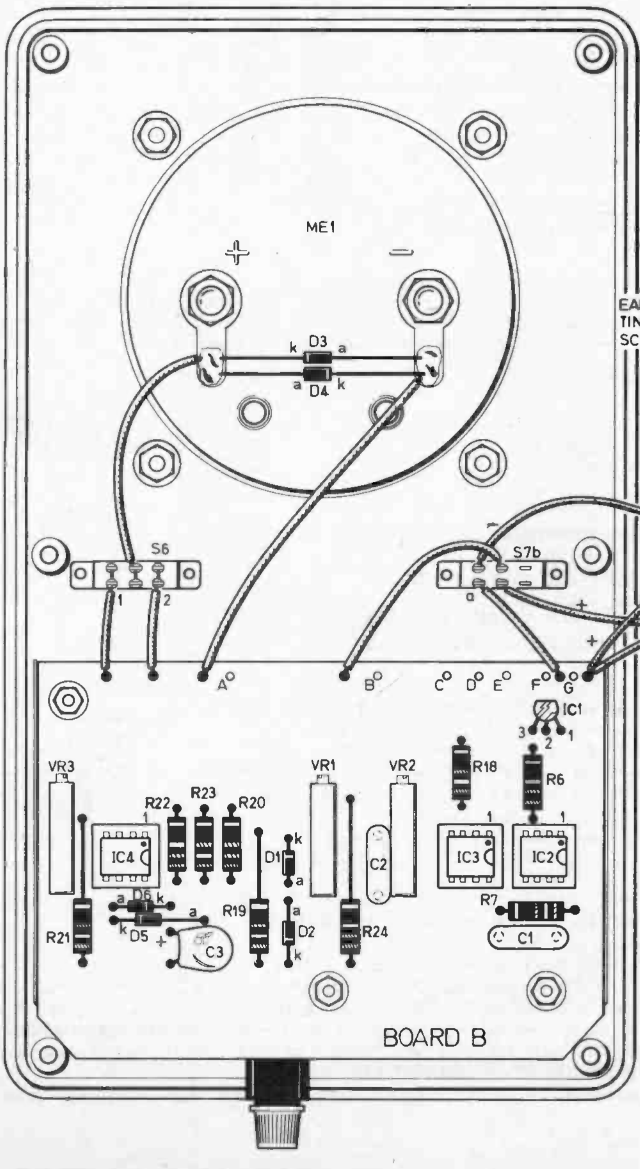
Fig. 2. (above) Foil pattern for board B full size. Foil pattern for board A is shown to the left on the facing page, also full size.

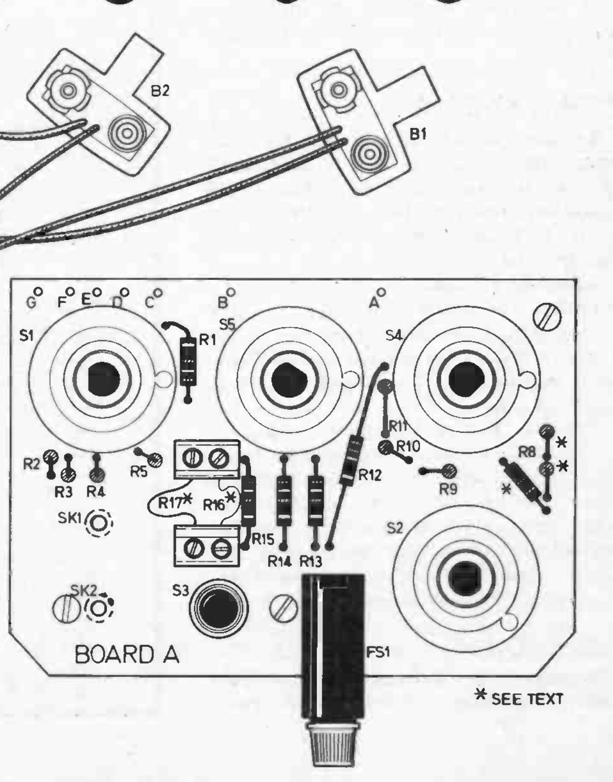
Fig. 3. (below) Component layout for board B and interwiring to certain off-board components.

Fig. 4. (bottom right) Component layout for board. A Note that resistors R17 and R16 are made of lengths of resistance wire, as explained in the text, and R8 is made up of three resistors in series. The four rotary switches S1, S2, S4 and S5 must be orientated as shown.

Fig. 6. (below) This shows the two p.c.b.s joined together electrically with 18 s.w.g. wire links. The actual physical mounting is done using 4BA plastic nuts, bolts, and spacers.







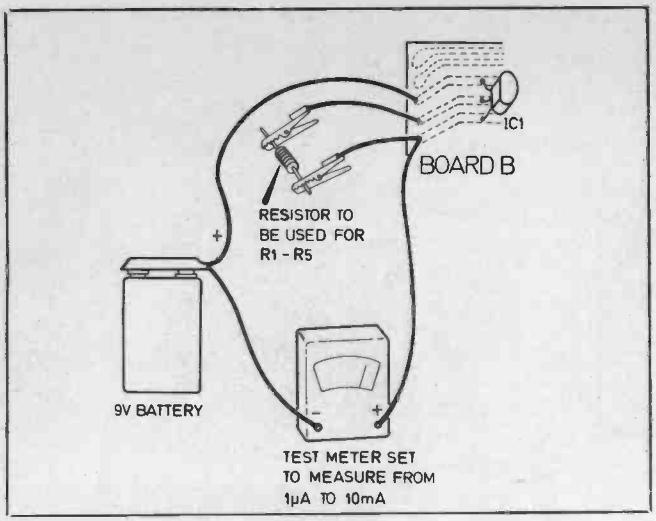
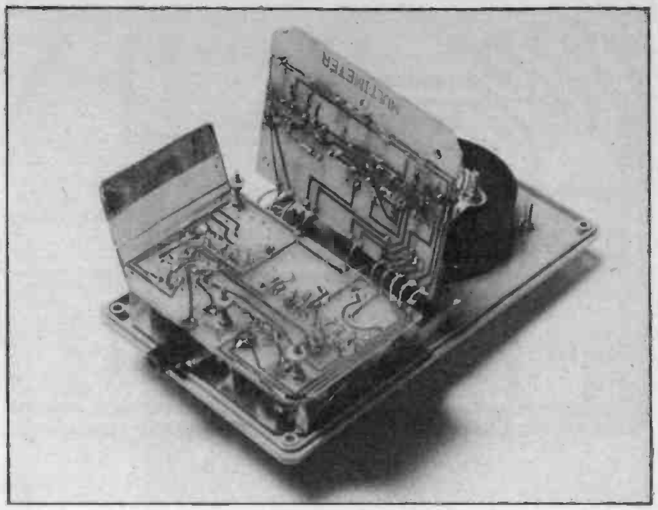


Fig. 5. Temporary circuit for selecting R1 to R5.



Board A is shown fixed in position mounted on the front panel, and board B is shown hinged back to reveal the wire links.

to select the most suitable resistor for each value from a selection of resistors with the same nominal value.

In order to do this a temporary circuit should be wired to board B as shown in Fig. 5. Resistors should be chosen from nominal values of 68 kilohm, 6·8 kilohm, 680 ohm, 68 ohm and 6·8 ohm to give 1µA, 10µA, 100µA, 1mA and 10mA respectively when measured with the test meter. These resistors correspond to R1 to R5 and should be soldered in their correct position on board A. The wires to the temporary circuit can then be removed.

At this stage the wire links between the two boards can be inserted according to Fig. 6. These are made of lengths of 18 s.w.g. tinned copper wire 15mm long.

CASE

The whole unit is mounted in a plastics box size 190 x 110 x 60mm. Cut and drill the front panel and tinplate screen according to the dimensions shown in Fig. 7, and label the front panel as illustrated in the accompanying photographs. You can do this using rub-down transfers which may be protected by a clear varnish or fixing spray.

Fix the moving coil meter, ME1 and switches S6 and S7 to the front panel. Before fixing the 4mm sockets, raise the head of each socket with a 3mm spacer.

The two p.c.b.s can be temporarily secured to the front panel using the mounting nut of S3. The two sockets, SK1 and SK2, are designed to be soldered directly to board A but for the time being are connected up using lengths of insulated wire.

At this stage the other p.c.b., board B, can be mounted above board A using 4BA plastic nuts and bolts. The accompanying photographs should make this clear.

Final assembly can now go ahead according to Fig. 3. When this has been completed make a thorough visual check and then insert the three i.c.s. into their sockets making sure that they are the correct way round.

Make sure that all the switches are in their off positions and then connect the two 9V batteries to the circuit. Carefully and firmly support the panel and boards and make sure that you can gain access to the adjustment screws of the trimmers VR1, VR2 and VR3.

Incidently you will find it much easier to adjust these multi-turn presets if you use a special adjusting screwdriver. The unit is now ready for calibration.

CALIBRATION

The following sequence of adjustments must be carried out in order to calibrate the multimeter ranges:

1. Switch S2 the function switch, to VOLTS and S4, the volts range switch, to 50mV. Ensure that S1 and S5 are OFF. Switch S6 to D.C. and

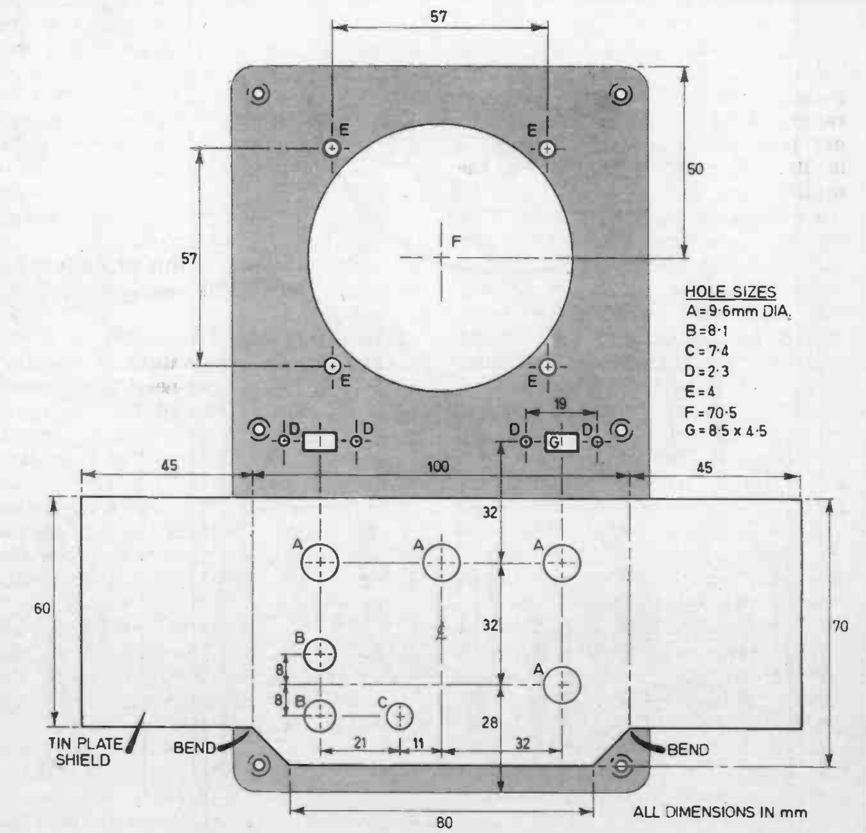


Fig. 7. Front panel and tin-plate screen drilling dimensions.

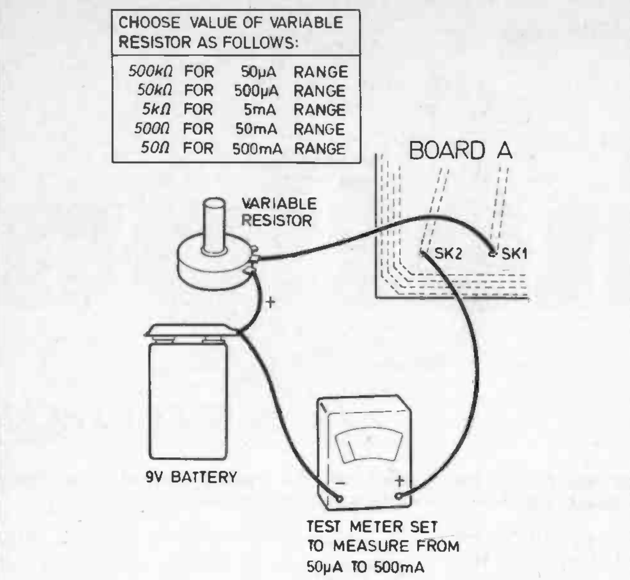
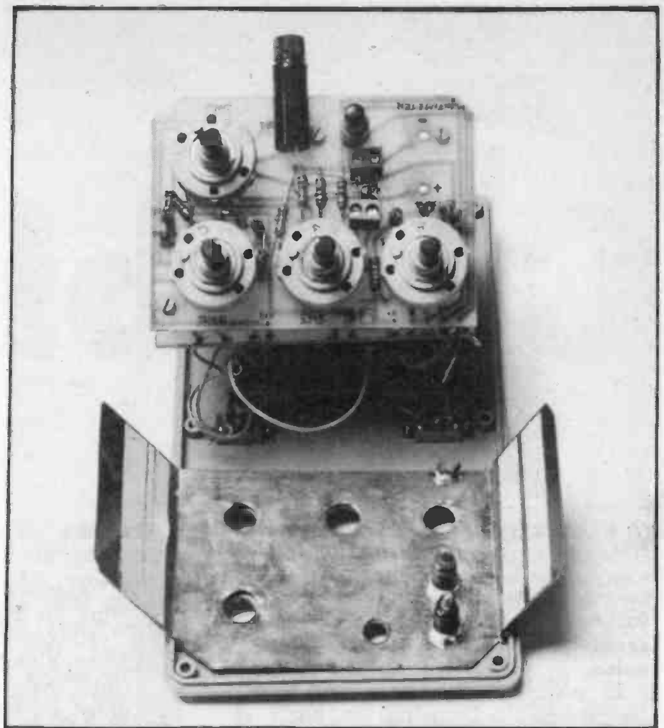


Fig. 8. Temporary circuit for calibrating current ranges.



View of the rear of the front panel. The tinplate screen is shown mounted in position and the component side of board A is also shown. Note that the input sockets, SK1 and SK2 are still mounted in place on the front panel. When the circuit board is in position these solder directly into board A.

link sockets SK1 and SK2 together. The inputs to IC3 are now effectively grounded. Switch power to the multimeter by means of S7 and adjust trimmer VR2 until the meter reads zero. Switch off the multimeter, remove the short from the input sockets and return the range switches to OFF.

2. Apply an accurately known 5V d.c. supply to the input sockets of the multimeter. Switch S4 to its 5V position and S2 to VOLTS. Leave range switches S1 and S5 in their OFF positions and ensure that S6 is in its D.C. position. Switch on the multimeter and adjust VR1 until the meter reads full scale deflection. At this stage linearity of the scales may be checked by using other values of d.c. input voltage. If any d.c. volts scale is not accurate, a change in the value of one of the resistors in the voltage divider chain may need to be made.
3. Similarly, the A.C. VOLTS range can be checked. Set S6 to A.C. S1 and S5 remaining OFF. Apply a known a.c. voltage to the input sockets. Switch S4 to an appropriate range and S2 to VOLTS. Adjust VR3 until the meter reads full scale deflection corresponding to the input voltage. Having already checked the d.c. volts ranges, the rest of the a.c. volts ranges will automatically be correct. Remove the a.c. input voltage and return all switches to OFF.
4. Connect a known resistor across the input terminals and switch S1 to an appropriate resistance range. Ensure that S4 and S5 are OFF and switch S2 is set to OHMS. S6 should be set to D.C. for resistance measurements. Switch on the multimeter by means of S7 and check the value of the resistance.

   It is unlikely that any changes are required to the values of resistors R1 to R5 since these have already been selected to provide the correct constant currents. Check the other resistance ranges, though, while you are about it. Return all switches to OFF and remove the test resistor. Note the necessity to press switch S3 when taking resistant measurements.

   The purpose of this procedure has been explained earlier in this article.
5. In order to calibrate the five current ranges, the values of resistors R13 to R17 might need adjustment, particularly R16 and R17 for these determine the two upper current ranges, 50mA and 500mA, respectively. Set up the temporary circuit shown in Fig. 8 which will enable a variable current to be passed through the multimeter by the variable resistor. Set S1 and S4 to OFF and the function switch S2 to AMPS. S6 should be set to D.C. Set S5 to the low current range and adjust the variable resistor in the temporary circuit so that the external test meter reads 50μA.

   Check that the multimeter reads full scale deflection to within a tolerable scale division. If not, replace R13 on the board A until the required accuracy is obtained. Note that if the reading is too low the value of R13 should be increased. Repeat these checks on resistors R14 and R15.

   The lengths of the two wires comprising R16 and R17 might need adjustment when calibrating the two higher current ranges. Their lengths will need shortening if the reading is too high and vice versa.

When all the ranges have been calibrated, remove the temporary wires connecting the terminals of the sockets to board A. Fit the p.c.b.s to the front panel using all the nuts to the switches and solder the terminals of the sockets to the board A. After a final check that all the leads are in place and that the two batteries are firmly positioned inside the case using pieces of foam, or better, aluminium brackets, the panel of the multimeter can be screwed down to the base of the box and the multimeter is then ready to use.

It should not be necessary to recalibrate the multimeter except that you should avoid mistreating it by exposing it to dampness or liquids or letting it become too warm (or cold). Good quality components have been suggested for the circuit and normal everyday changes of temperature should not cause any noticeable changes in reading. Note, finally that you might like to use a 1A fuse in the current circuit if the fuse blows too frequently on slight current overload and the meter movement is protected by diodes D3 and D4. ☐

FIVE DIGIT DESIGN FOR ELECTRONIC SECURITY
EASY TO CHANGE NUMBER COMBINATION

Combination Lock

By G. SOUTHERN

An electronic lock has several advantages over a standard mechanical lock. No more is it necessary to fumble for door keys on a dark wet night, nor does the problem of lost keys arise.

This particular lock is operated by a five figure combination which is entered into the system by means of a push-button key pad.

Changing the number combination is also simple as this involves no more work than removing a plug from the circuit board, altering several connections and replacing.

In fact several plugs could be kept available for easy alteration of numbers. The number of combinations is enormous.

The lock cannot be operated by depressing all the keys at once for a number of times, because all unused keys are used to reset the system timer. When the system timer is reset, the outputs of all the bistable stages are also set to zero.

In order to simplify the design, no facility has been included to eliminate keyboard contact bounce. Consequently, consecutive numbers must not be the same, otherwise contact bounce will increment the register by two positions instead of only one.

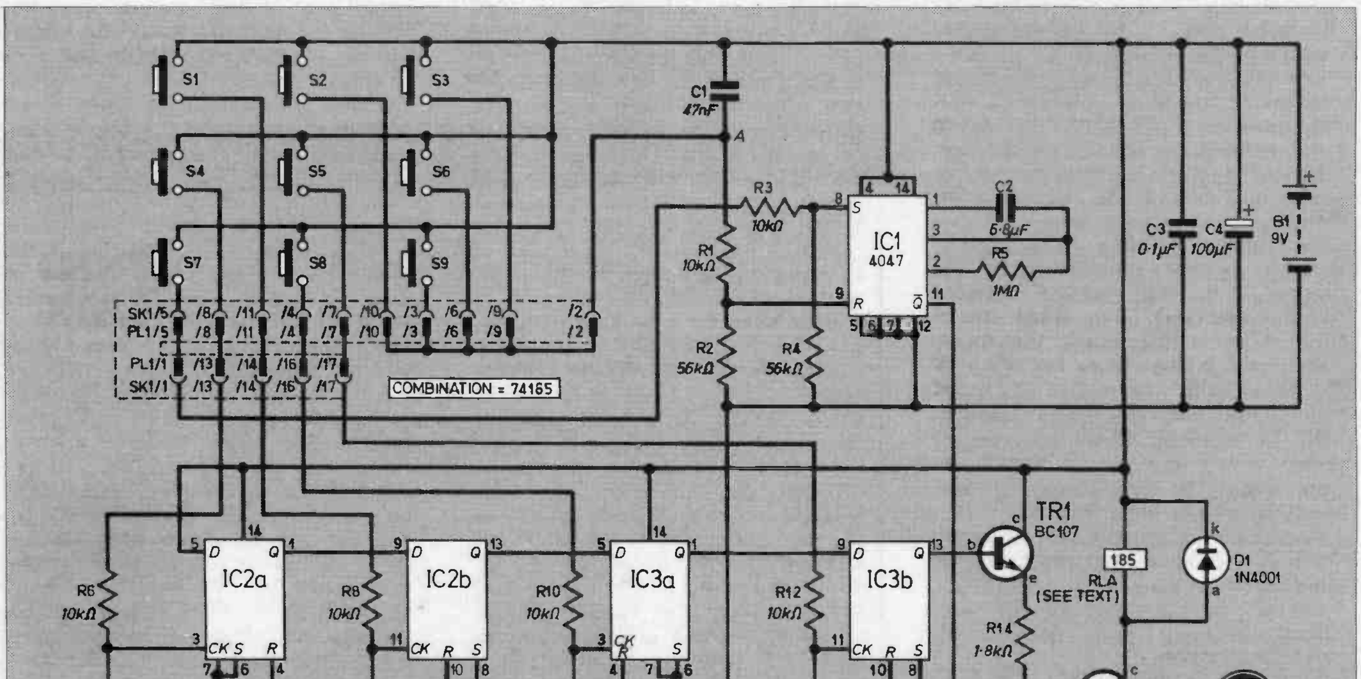
Another facility is that once the first digit has been entered, only a set time is then available to key in the remainder of the combination number and open the lock. At the end of the timed period, the timer will reset the internal logic.

CIRCUIT

The circuit diagram is shown in Fig. 1. Integrated circuit IC1 is connected as a monostable, which is triggered by the positive going edge of a pulse on pin 8. The quiescent voltage on pin 8 can be considered to be equal to V_{SS} (0 volts). When push-button S7 is depressed, the voltage on pin 8 will rise to a value near to V_{DD} (9 volts), limited by the values of the potential divider network resistors R3 and R4.

The rise in voltage will trigger the monostable, starting the internal

Fig. 1. Full circuit diagram of the Combination Lock. Note that the switches S1 to S9 are arranged in the form of a keypad.



oscillator in the chip and setting the $\overline{Q}$ output to zero. The internal bistable will count two oscillator pulses and then set the $\overline{Q}$ output to logic level 1 (approximately equal to V_{DD}). The frequency of the oscillator is set by the value of capacitor C2 and resistor R4, and this is directly related to the period of the monostable.

When the bistables (IC2, IC3) reset, lines are switched from logic "0" to logic "1" level, all Q outputs will be switched to logic "0" level (V_{SS}). The bistables used are D-type versions, that is to say if the D input is at logic "1" level, the positive edge of the clock pulse, will clock the Q output to logic "1" level.

If the D input is now changed to logic "0" level, the Q output will remain unchanged at logic "1" level until the next clock pulse arrives.

RESET LINE

The condition of the Q output depends on the D input and data on the D input is only clocked to the Q output when the clock changes state from logic "0" to logic "1". So when the bistable reset lines are held at logic "1" level, if pushbutton S4 is depressed the voltage on pin 3 of IC2a rises from logic "0" to logic "1" level.

As the D input pin 5 of IC2a is already at V_{DD} (logic "1" level) the Q output pin 1 of IC2a will be clocked to logic "1" level. When the Q output of IC2a rises to logic "1" level, the D input of IC2b (pin 9) will also rise to logic "1" level, thus allowing the third digit of the combination number to be "keyed in".

Bistables IC2b, IC3a, IC3b are clocked in the same way as IC2a. It can be seen that the combination number must be entered in the correct order, that is, the monostable must be triggered first and then the bistables in order.

The bistables are a form of individually clocked shift register. All unused keys are connected between point A and V_{DD}. Thus when one of these keys is depressed, the monostable will be reset, so resetting all the bistables At the end of the timed period, which is typically 15 seconds, with the values of C2 and R4 as shown, the $\overline{Q}$ output of IC1 will rise from logic "0" to logic "1" thus resetting all the bistables.

Capacitor C1 is included to ensure that IC1 is held at reset during initial power switch-on.

OUTPUT CIRCUIT

When the Q output of IC3b (pin 13) rises to logic "1" level, the base emitter junction of transistor TR1 will be forward biased. This causes transistor TR2 to saturate via resistor R14 thus switching on the relay RLA.

The operating current of RLA should be less than 1 amp and with the relay used was about 50mA. It should be remembered that this unit is battery powered so any large current drain, such as a high power relay, will drain the battery very quickly.

A separate power supply to the solenoid or whatever is connected to the relay contacts will also be required. This will depend entirely on the nature of the solenoid, be it mains voltage or otherwise. Diode D1 is included to minimise the effect of the back e.m.f. generated by the switch off of RLA.

The relay or solenoid will be de-energised at the end of the monostable period or when the monostable is reset.

CONSTRUCTION starts here

CIRCUIT BOARD

The main part of the circuit is assembled on a printed circuit board and its pattern can be seen in Fig. 2. The three logic i.c.s are not soldered direct to the board but located in sockets. Start off by soldering in the resistors and i.c. sockets followed by the capacitors and finally the transistors and diode.

The off-board connections are made via connector pins soldered into the appropriate positions and ten-way ribbon cable is used to connect up the keyboard. This can be salvaged from an old calculator as in the prototype, although all the keys must be made to operate independently and not in matrix fashion.

An alternative would be to use separate push-to-make, release-to-break push-button switches.

One novel feature is the method of combination selection. Here the appropriate inputs to the various logic stages and the connector pins to each of the ten keyboard switches are all terminated at a twenty way socket. By means of links in a matching twenty way plug, the required combination can be connected to the appropriate switches. This is explained in detail later on.

RELAY

The output of the final bistable is taken via a buffer amplifier to a relay. The most appropriate type would be a "Continental" relay and you should choose the contact ratings according to the sort of equipment you wish to control with the lock. For example if you are going to use a mains operated solenoid, the contacts will have to be mains rated.

INSTALLATION

It can be seen that this particular unit is not housed in any specified case. This is simply because every installation is different, and so will require different housing. The keypad should be installed outside the door or whatever is being controlled, suit-

COMPONENTS

Resistors

R1, 3, 6, 8, 10, 12 10kΩ (6 off)
R2, 4, 7, 9, 11, 13 56kΩ (6 off)
R5 1MΩ
R14 1·8kΩ
All ¼W carbon ±5%

See **Shop Talk** page 472

Capacitors

C1 47nF polyester
C2 6·8µF non-polarised plastic
C3 0·1µF polyester
C4 100µF 25V elect.

Semiconductors

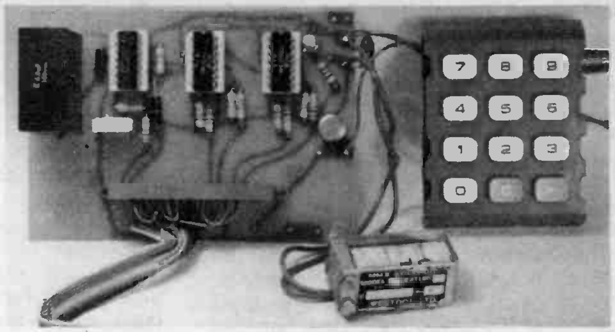
IC1 CD4047 CMOS mono/astable multivibrator
IC2, 3 CD4013 CMOS dual D-type flip-flop (2 off)
TR1 BC107 *npn* silicon
TR2 BFY50 *npn* silicon
D1 1N4001 50V 1A silicon diode

COMPONENTS approximate cost £12 excluding keyboard & case

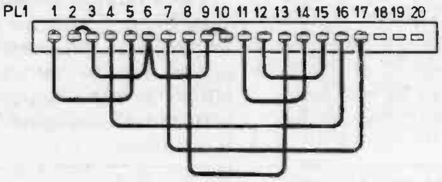
Miscellaneous

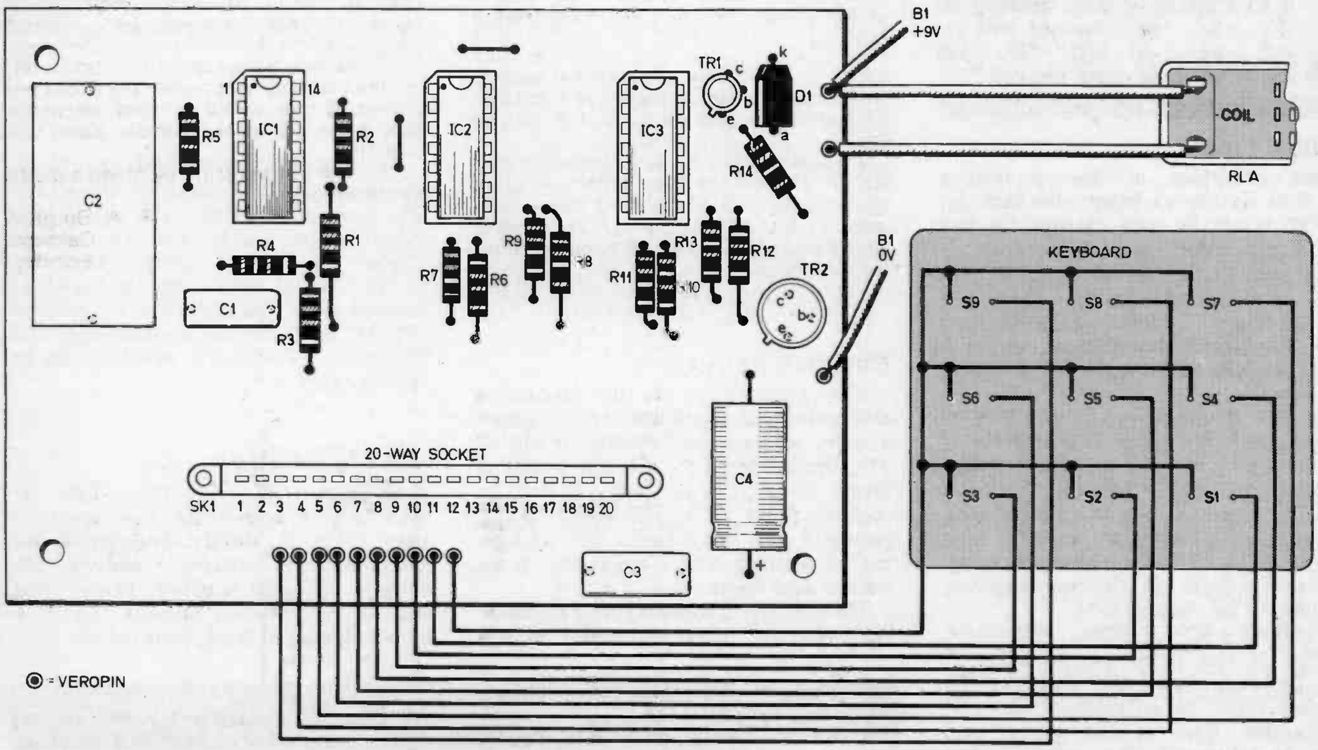
S1-S9 nine-way calculator type keyboard with separate normally open switches *or* nine push-to-make, release-to-break single push button switches (9 off)
RLA Continental type relay, 185 ohm coil resistance, with contacts to suit load being switched (see text)
B1 9V PP7 type
PL1/SK1 Twenty-way plug and socket for combination setting.
printed circuit board, 110 × 75mm; ten-way ribbon cable; battery connectors; p.c.b. wiring pins; suitable case; p.c.b. mounting hardware; interconnecting wire.

Combination Lock



Completed circuit board with the keypad salvaged from an old calculator and a solenoid instead of a relay.





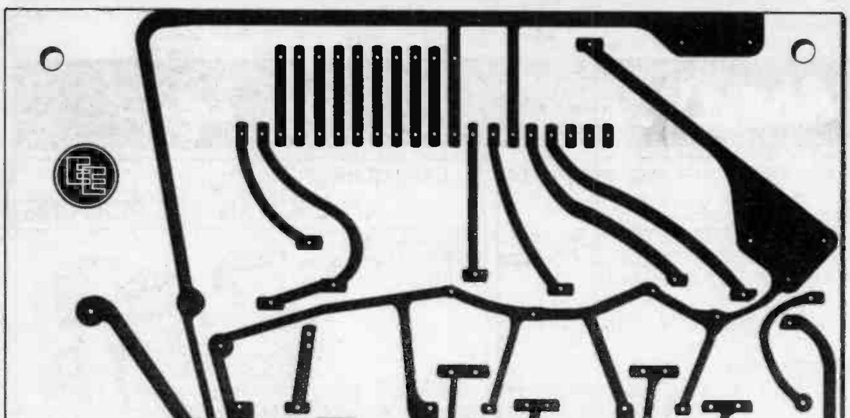


Fig. 2. Printed circuit board pattern and component layout. Note the 20-way socket on the circuit board. The corresponding 20-way plug is shown top left wired for the combination 74185.

Table I. PLI Connections.

Socket Pin	Connection
1	IC1 set
2	IC1 reset
3	keyboard 9
4	keyboard 8
5	keyboard 7
6	keyboard 6
7	keyboard 5
8	keyboard 4
9	keyboard 3
10	keyboard 2
11	keyboard 1
13	IC2a *CK*
14	IC2b *CK*
16	IC3a *CK*
17	IC3b *CK*
18–20, 12, 15	no connection

ably weatherproofed, and the main circuit board should be positioned in some secure place where it cannot be tampered with.

COMBINATION

The combination that operates the lock can be set as follows. On the circuit board is a twenty-way socket. Each pin of that socket corresponds to the connections listed in Table 1. In other words each of the switch outputs from the keypad has a pin connection, and each of the *CK* inputs to the i.c.s, and the set and reset inputs to IC1 have pin connections.

To set the combination, you should take a corresponding 20-way plug and link pin 1 (Set of IC1), to the pin that corresponds to the first number in the combination. Then link pin 13 (*CK* of IC2a), to the pin of the second number of the combination, pin 14 to the pin for the third number, pin 16 to the pin of the fourth number and pin 17 to the pin of the fifth number.

All the remaining number pins are connected to pin 2 (reset of IC1). The 0 key of the keypad is not used and consecutive numbers cannot be the same.

Once the combination has been set up on a twenty way plug, this can be inserted into the socket on the p.c.b. and the lock is ready for operation. It now becomes very easy to change the combination as this can be done by simply replacing the plug with another, wired up with a different combination.

For example to set up the combination 74185, the following links should be made on the twentyway plug:

Link pin 5 to pin 1, pin 8 to pin 13. pin 11 to pin 14, pin 4 to pin 16, pin 7 to pin 17 and pins 3, 6, 9, 10, to pin 2. ☒

LETTERS

School for thought

I am writing to you in disgust on reading Mr. S. A. Courtney's letter in the May 1981 edition where he said "school children are abusing the use of CB radio".

Nothing could be further from the truth, in Manchester anyway. I do not know of any school children in Manchester who abuse CB. I do not think that Mr. Courtney knows what CB can and is used for.

But don't get me wrong, it can and is used extensively in emergency situations and for giving 10-13's (weather/road conditions). Take for example an accident in the Peak District of Derbyshire where a taxi with five people onboard suddenly collided with a van. As a result of this accident one man died and seven other people were seriously injured.

Following shortly behind was another CB'er "Flying Horse" who immediately put out a 10-33 (emergency) and another CB'er relayed the message to the ambulance service. The taxi driver was seriously injured and at one point close to death. but through the use of CB his life was saved.

However, the main use of CB is to make friends with people. One trucker put it all succinctly when he said "CB radio is a friendship-maker, bringing the world a little step closer together".

I have heard of many people who were lonely for one reason or another and have bought a CB "rig" and have said that they are lonely no more because at the press of a button they have hundreds of friends who are willing to talk or give help.

I would like Mr. S. A. Courtney to give us an example of how school children are abusing CB (if he can) taking into account that it is better for us to make new friends rather than to become mindless vandals.

The Prophet (aged 15),
Rainy City.

Neutralise

In the *Letters* column (March 1981) a Mr. J. G. Burch asked for information on a ferric chloride neutraliser. You stated that there were none commercially available.

May I suggest that you first well dilute the solution with water, then slowly adding Calcium Carbonate. This is available as crushed lime stone, sold as garden lime, to reduce soil acidity.

Because of this ability to neutralise ferric chloride, it is inadvisable to use *hardwater* to make up a ferric chloride solution for etching. Partial neutralisation will reduce its effectiveness. Try using rain water if this is the problem.

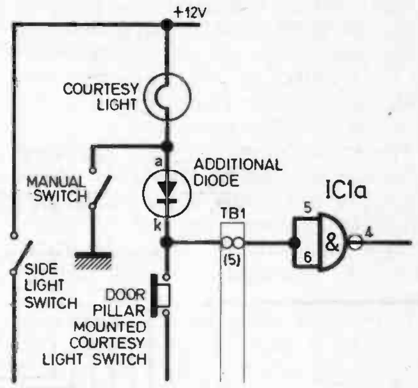
K. H. Young,
Victoria,
Australia.

Light Reminder

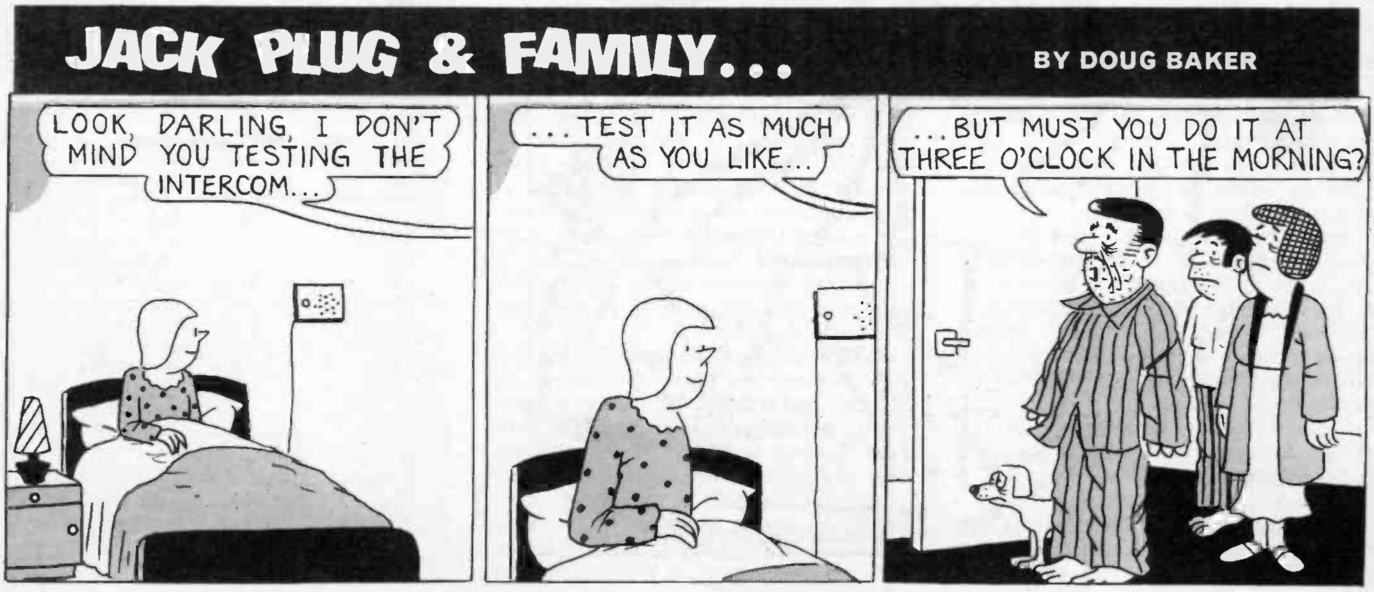
In Mr. L. J. Privett's design for a *Lights Reminder and Ignition Locator* (May issue) he did not consider the many cars that have a manual switch for operating the courtesy lights when the doors are closed. If this switch is used when the side lights are on the audible alarm will operate.

This can be overcome by fitting a diode as shown below.

F. A. Burgess
Oakham,
Leicester.



Mr. Burgess's suggestion for modifying the Lights Reminder and Ignition Locator for vehicles with a manual courtesy light switch. This has not been tested by us.



DISCRETE SEMICONDUCTORS EXPLAINED

PART TWO

BY J.B.DANCE

OUR DISCUSSION about diodes last month is naturally followed by a consideration of the various types of transistor. Diodes have only two connections, contain a single *pn* junction and cannot amplify. However, transistors have three main connections, may contain one or two *pn* junctions and can be employed to amplify signals.

The name **transistor** is derived from the words **transfer** and **resistor,** since the device effectively operates by the transfer of current from a low resistance emitter circuit to a high resistance collector circuit.

The most commonly used types of transistor are the **bipolar** types which are given this name because the output current flows through semiconductor materials of both polarities, that is, through *p* and *n*-type materials.

In the **field effect transistor** the output current flows only through one channel of either *p*-type or *n*-type material but not through both types, so these devices are sometimes called **unipolar** transistors. **Unijunction transistors** operate in a different way to bipolar or unipolar types.

BIPOLAR TRANSISTORS

Almost all modern bipolar transistors employ silicon as the semiconductor material, although some germanium types are still manufactured. Gallium arsenide devices are also used for special purposes.

Any bipolar transistor has one of the two possible polarities, namely *npn* or *pnp*. The *npn* type consists of a single crystal of the semiconductor material in which a thin, lightly doped *p* layer is sandwiched between two more heavily doped *n* layers as shown in Fig. 2.1a.

Similarly a *pnp* transistor contains a lightly doped *n* layer sandwiched between two more heavily doped *p* layers as shown in Fig. 2.1b.

In both *npn* and *pnp* transistors the thin central layer is known as the **base,** while the other two electrodes are known as the **emitter** and **collector.** In most circuits the base is the input electrode and the current fed to or taken from this electrode controls a much larger current flowing between the collector and the emitter.

It may seem from Fig. 2.1 that the collector and emitter would be interchangeable, but in almost all transistors there is a considerable difference in construction between these electrodes and they are seldom interchangeable.

TRANSISTOR FUNCTION

Let us consider how an *npn* transistor functions. For normal operation the base is biased positively with respect to the emitter and the collector receives a positive bias too, but the collector potential is usually greater than that of the base, see Fig. 2.2.

Thus the base-emitter junction is forward biased (*p*-type material positive) and the collector-base junction is reverse biased (*p*-type material negative). A **depletion region** forms around the collector-base junction as in any reverse biased diode, so one would expect little current to flow across this junction.

FREE ELECTRONS

As indicated in Fig. 2.2, conduction in the forward biased base-emitter diode is mainly by means of free electrons passing from the emitter material into the base, since there are relatively few positive holes in the *p*-type material of the base which can pass into the emitter as the base is lightly doped.

When an electron from the emitter has entered the base, the chance of it being neutralised by a hole is small partly because the base region is very thin (about 0·025mm in thickness) and partly because the hole concentration in the base is quite low. Most of the electrons which enter the base from the emitter are therefore drawn through the depletion region into the collector by the electric field which exists across the collector-base junction.

The negative electrons which move from the emitter through the base into the collector are equivalent to a flow of a conventional current in the opposite direction from the collector to the emitter. However, this collector current will flow only when a much smaller current flows in the base circuit.

When electrons move to the collector, they are quickly replaced by others which enter the base from the

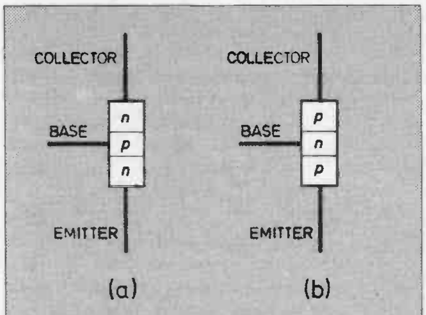


Fig. 2.1. The electrodes and structure of (a) an *npn* and (b) a *pnp* junction transistor.

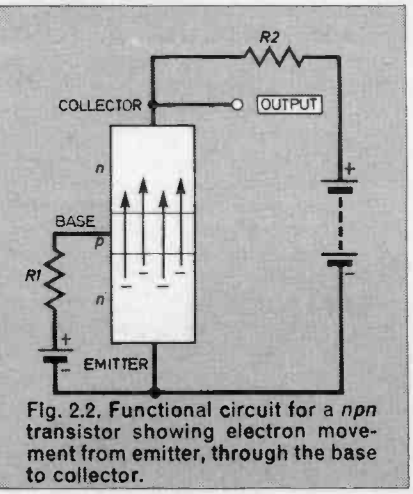


Fig. 2.2. Functional circuit for a *npn* transistor showing electron movement from emitter, through the base to collector.

emitter. In many transistors about 99 per cent of the electrons from the emitter reach the collector, the other 1 per cent giving rise to the external current in the base circuit.

The value of the current from the emitter to the base determines the electron density in the base region and this controls the number of electrons reaching the collector and hence the collector current.

Thus as the base current increases the collector current increases in proportion to it, so this simple transistor circuit provides current amplification. The collector current in Fig. 2.2 passes through *R2* and, if this resistor has a relatively high value, the output from the collector shows a fairly large voltage change. Thus voltage amplification can be obtained.

In the case of a silicon *npn* transistor biased as in Fig. 2.2, the base will automatically take up a potential of about +0·65V relative to the emitter. The voltage applied to the collector is normally larger than this and should be adequate to create a suitable electric field to attract electrons from the base region, but not large enough to produce collector-base junction breakdown.

CIRCUIT SYMBOL

The circuit of Fig. 2.2 may be drawn using the conventional circuit symbol for an *npn* transistor as shown in Fig. 2.3. In an *npn* transistor the direction of the conventional current is from the collector through the base and out of the emitter.

The arrow in the circuit symbol thus shows the direction of this conventional current—which is opposite to the direction of electron flow. The base current also flows in the direction shown by this arrow.

PNP TRANSISTORS

The operation of a *pnp* transistor is exactly similar to that of an *npn* device, except that all polarities are reversed. Thus in a *pnp* device holes pass from the *p*-type emitter to the lightly doped *n*-type base and hence into the *p*-type collector.

A negative voltage applied to the *n*-type base forward biases the base-emitter junction. A negative voltage is also applied to the collector so that the collector-base junction is reverse biased and a depletion region is created.

The circuit of Fig. 2.4 shows a *pnp* transistor circuit analogous to the *pnp* circuit of Fig. 2.3. It should be noted carefully that a negative bias is applied to the base and a negative bias to the collector—the opposite to that used in Fig. 2.3.

In a *pnp* transistor the main current from the emitter to collector is carried by positively charged holes, so the conventional current flows in the same direction as these holes. The arrow on the emitter symbol is therefore pointing towards the base and collector. It is only the direction of this arrow which distinguishes the *pnp* transistor symbol from that of an *npn* transistor.

As the bias required by a *pnp* transistor is opposite to that required by an *npn* transistor, it follows that different external circuits must be used for the two types of device.

High performance silicon transistors are available in both the *npn* and in the *pnp* polarities, but *npn* types are more commonly used. Transistors for the very highest power levels and for the highest frequencies tend to be available only as *npn* devices. Some circuit designs require *pnp* and *npn* transistors with a similar performance. Such similar transistors of opposite polarities are known as **complementary** types.

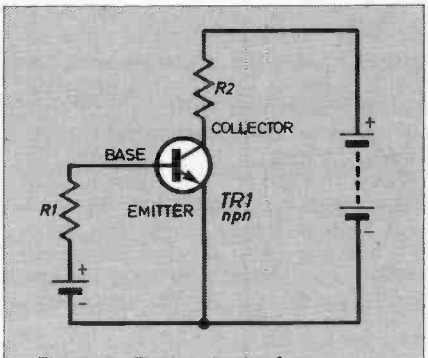


Fig. 2.3. Basic circuit for an *npn* transistor

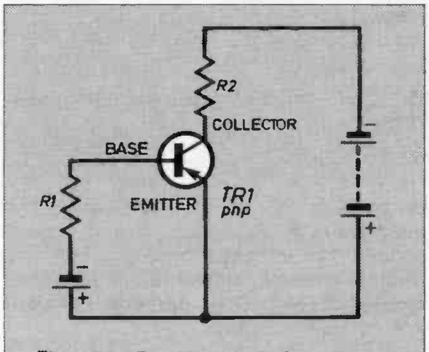


Fig. 2.4. Basic circuit for a *pnp* transistor

PRACTICAL CIRCUITS

The circuits of Figs. 2.3 and 2.4 require two batteries each and are obviously very inconvenient. The circuit of Fig. 2.5 shows a practical *npn* audio-amplifier circuit in which bias for the base is derived from the positive supply line using the two resistors R1 and R2. The capacitor C1 prevents any steady voltage at the base from reaching the previous circuit from which the signal is derived.

The optimum values of the components in the circuit of Fig. 2.5 depend somewhat on the positive supply voltage and on the input and output impedances, but the values shown are fairly typical for a circuit operating from a 9V supply.

The use of a circuit biased in this way keeps the operating point relatively constant, that is, the steady collector current passing through the transistor and other parameters remain fairly constant as the temperature and supply voltage change. This is a most important consideration.

The circuit of Fig. 2.5 uses the base as the input electrode and the collector as the output electrode with the emitter as the common electrode for both the input and output circuits. However, two other electrode configurations are used.

EMITTER FOLLOWER

In Fig. 2.6 the circuit of an **emitter follower** is shown which is used to convert a high input impedance signal into a low output impedance. In the emitter follower the signal is applied to the base and the output is taken from the emitter with the collector as the common electrode.

The emitter follower derives its name from the fact that the emitter voltage "follows" any change in the

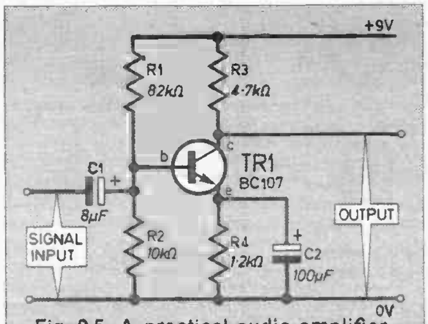


Fig. 2.5. A practical audio amplifier circuit using an *npn* transistor in a common emitter configuration.

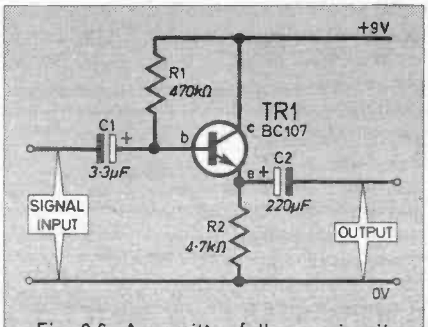


Fig. 2.6. An emitter follower circuit for providing low output impedance.

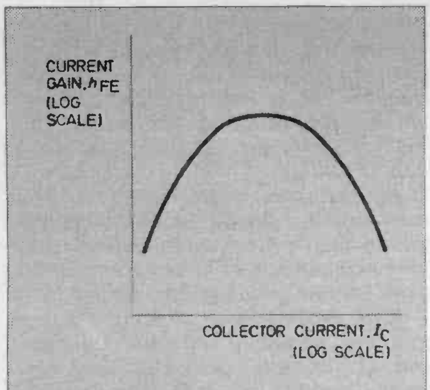


Fig. 2.7. Variation of d.c. current gain with collector current.

base voltage. Input and output capacitors are required to prevent steady voltages at the base and emitter from reaching other circuits to which the input and output of Fig. 2.6 are connected.

The circuit of Fig. 2.6 (unlike that of Fig. 2.5) cannot provide voltage amplification. Indeed, the output voltage is very slightly less than the input voltage, but the circuit can provide current amplification. The emitter follower is often used as an output stage to provide a low impedance output signal.

It is also possible to use the emitter as the input electrode, the collector as the output electrode and the base as the common electrode. Such **grounded base** circuits can sometimes be useful for the amplification of high frequencies.

CURRENT GAIN

One of the most important characteristics of any transistor is that it can provide a current gain. Let us consider the **grounded emitter** or **common emitter** circuit. The **current** gain in such a circuit is the collector current divided by the base current and is given the symbol h_{FE}.

If one plots values of h_{FE} against the collector current, I_C, one obtains a graph of the general form shown in Fig. 2.7. Some transistors, such as the well-known BC109, are designed for use at values of collector current mainly in the range 0·1 to 10mA and give a maximum current gain somewhere in this range.

Other devices, such as the BFY50, are designed to operate at medium currents from about 10mA to about 1A. They are useful in such applications as audio driver devices, since they can provide the moderately high current required by an audio output transistor of a high power amplifier. These transistors are usually mounted in small circular metal packages or in plastic packages such as those shown in Figs. 2.8a and b.

High current transistors for high power work (such as the common 2N3055 which can operate at collector currents of up to 15A) have internal junctions of greater area. They are manufactured in metal packages, which can be bolted to a heat sink or in a plastic package with a metal face piece which can be bolted to a heat sink as in Figs. 2.9a and b.

Low current transistors do not require a heat sink, but a small heat sink can be fitted to those medium current transistors which are supplied in metal packages.

The collector electrode of medium and high current transistors is connected to the metal case of the device, since most of the heat is developed in this electrode. The heat sink connected to such a transistor will therefore be at the collector potential unless arrangements are made to insulate the heat sink from the metal case or the metal insert of a plastic encapsulated device.

TRANSISTOR CHOICE

Our choice of a transistor for a particular purpose will thus be partly determined by current carrying capacity, but we shall soon see that various other considerations may be important in many cases.

As h_{FE} varies with I_C, when quoting a value of h_{FE} for a device, the value of I_C should also be stated. In addition, the value of the collector-to-emitter voltage V_{CE}, should really be stated, since h_{FE} varies with this too.

The value of h_{FE} is known as the **d.c. current gain.** It is used for designing a circuit from the steady current aspects. For audio and other alternating signal design aspects, another form of current gain is most important. This is designated h_{fe} (or β) and is equal to a small change in the collector current divided by the change in the base current which produced it, all measurements being made at specified values of I_C, V_{BE}, and so on.

It may be noted that h_{FE} is not equal to h_{fe} and that care is needed to use lower case letters in their correct places both in the quantity symbol and in the subscript concerned. For those who wish to study it, Table 2.1 gives the basic rules on the symbols used.

OTHER PARAMETERS

Apart from current gain, other parameters are important in selecting a transistor for a particular application. For example, the maximum current which the transistor can safely handle without being damaged is important.

The maximum power a transistor can dissipate internally is another important factor, but it varies with the temperature of the transistor case. Manufacturers normally specify this power for a case temperature of 25 degrees Celsius.

Yet a further factor influencing the selection of a tranisistor is the maximum voltage which can be applied to its collector without the danger of breakdown. There are two ratings. The V_{CEO} value is the maximum

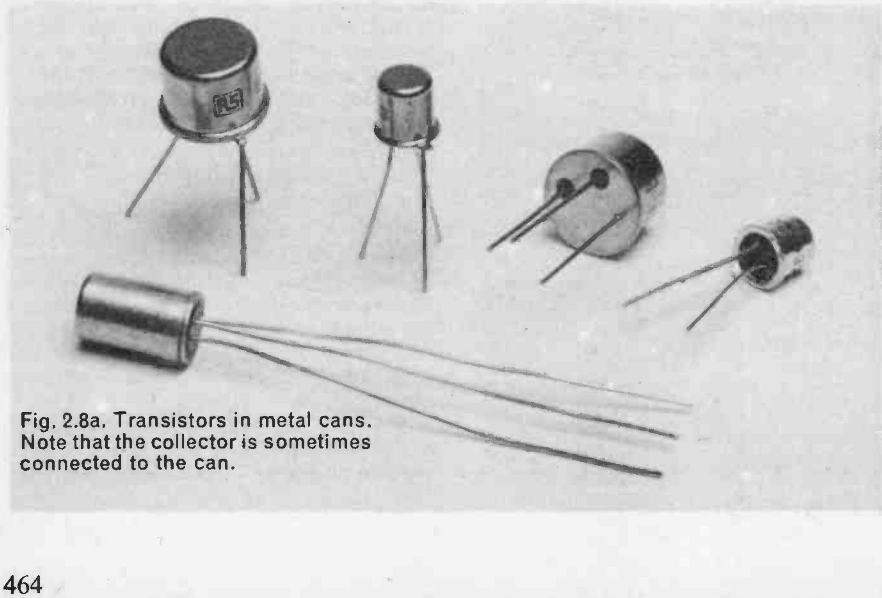


Fig. 2.8a. Transistors in metal cans. Note that the collector is sometimes connected to the can.

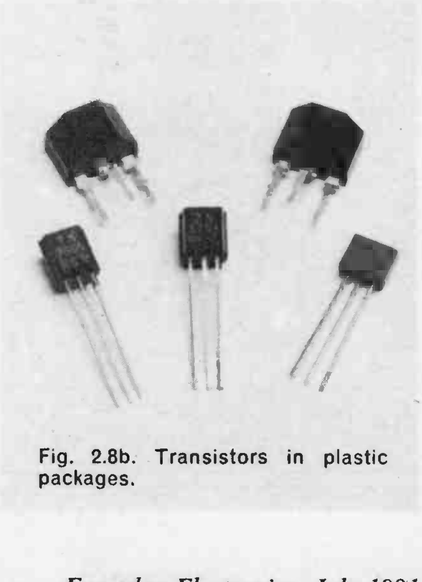


Fig. 2.8b. Transistors in plastic packages.

Table 2.1. Upper and lower case characters in symbols for semiconductor parameters

SYMBOL	MEANING
Upper case quantity symbol plus upper case subscript *Example* I_C	The steady current value under no signal conditions. The subscript (AV) may be added to indicate the total average value with signal or (M) for the total peak value.
Upper case quantity symbol plus lower case subscript *Example* V_{be}	The r.m.s. value of the alternating signal component. The subscript (av) may be added to indicate the average value of the varying signal component or (m) to indicate the peak value of this component.
Lower case quantity symbol plus upper case subscript *Example* i_B	The instantaneous total value of the quantity concerned.
Lower case quantity symbol plus lower case subscript *Example* v_b	The instantaneous value of the varying signal component.

collector-to-emitter voltage with the base open circuited and V_{CBO} the maximum collector-to-base voltage with the emitter open circuited.

All transistors have a current gain which will fall off at very high frequencies. The f_T value is the product of the gain and the bandwidth measured at some high frequency. It may be thought of as the frequency at which the gain falls to unity in the common emitter circuit and is known as the **transition frequency.**

Typical values of some of these parameters are given in Table 2.2 for some well-known transistors of various types.

Table 2.2. Performance parameters for some typical transistors

Transistor Type	Polarity	P_T* (W)	I_C* (A)	V_{CEO}* (V)	h_{FE}	f_T (MHz)	Comments Devices are silicon unless otherwise stated.
AC127	npn	0·34	0·5	12	50	2·5	Germanium audio output
AC128	pnp	0·7	−1·0	−16	60–175	1·5	Germanium audio output
AC176	npn	1·0	1·0	18	50–250	3·0	Germanium audio output
AF139	pnp	0·06	−0·01	−15	55	550	Germanium mixer/oscillator
AF239	pnp	0·06	−0·01	−15	50	700	Germanium for TV tuners
BC107	npn	0·36	0·1	45	110–450	250	Audio driver
BC108	npn	0·36	0·1	20	100–800	250	General purpose low current
BC109	npn	0·36	0·1	20	200–800	250	Low-noise audio
BC142	npn	0·8	0·8	60	over 20	80	Audio driver device
BC147	npn	0·35	0·1	45	110–450	300	Audio driver device
BC148	npn	0·35	0·1	20	100–800	300	General purpose
BC149	npn	0·35	0·1	20	200–800	300	Low-noise audio device
BC182L	npn	0·3	0·2	50	100–480	150	General purpose device
BC183L	npn	0·3	0·2	30	100–850	280	General purpose device
BC184L	npn	0·3	0·2	30	over 250	150	Low noise audio
BC212L	pnp	0·3	−0·2	−50	60–300	200	General purpose device
BC213L	pnp	0·3	−0·2	−30	80–400	350	General purpose device
BC214L	pnp	0·3	−0·2	−30	140–600	200	General purpose device
BC477	pnp	0·36	−0·15	−80	110–950	150	Audio driver device
BC478	pnp	0·36	−0·15	−40	110–800	150	General purpose device
BC479	pnp	0·36	−0·15	−40	110–800	150	Low-noise audio device
BC547	npn	0·5	0·2	45	110–800	300	General purpose device
BC548	npn	0·5	0·2	30	110–800	300	General purpose device
BC557	pnp	0·5	−0·2	−45	75–475	150	General purpose device
BC558	pnp	0·5	−0·2	−30	75–850	150	General purpose service
BD115	npn	0·8	0·15	180	60	145	High voltage power amp
BD131	npn	15**	3·0	45	over 20	60	Small power device
BD132	pnp	15**	−3·0	−45	over 20	60	Small power device
BDX32	npn	12**	5·0	1700	—	—	TV time base
BF173	npn	0·175	0·025	25	—	1000	I.F. amplifier
BF180	npn	0·15	0·02	20	—	675	TV tuner r.f. amplifier
BF181	npn	0·15	0·02	20	—	600	TV tuner mixer/oscillator
BFY50	npn	0·8	1·0	35	30	60	General purpose device
MJE340	npn	20**	0·5	300	over 30	—	Small power service
TIP33A	npn	80	10·0	60	20–100	3	Audio output
TIP34A	pnp	80	−10·0	−60	20–100	3	Audio output
TIP2955	pnp	90	−15·0	−60	5–30	8	Plastic audio output
TIP3055	npn	90	15·0	60	5·30	8	Plastic audio output
TPSA13	npn	0·6	0·3	30	10,000	200	Darlington device
ZTX300	npn	0·3	0·5	25	50–300	150	General purpose device
ZTX500	pnp	0·3	−0·5	−25	50–300	150	General purpose device
2N697	npn	0·6	1·0	40	50–120	50	General purpose device
2N3053	npn	0·8	1·0	40	50–250	100	General purpose device
2N3054	npn	25	4·0	55	25–100	1	Power device
PNP3054	pnp	25	−4·0	−55	25–100	100	Power device
2N3055	npn	115	15·0	60	20–70	1	High power device
PNP3055	pnp	115	−15·0	−60	0–70	0·8	High power device
2N3703	pnp	0·3	−0·5	−30	30–150	100	General purpose device
2N3705	npn	0·36	0·5	30	50–150	100	General purpose device
2N3706	npn	0·36	0·5	20	30–600	100	General purpose device
2N3771	npn	150	30·0	40	15–60	0·8	High power device
2N3772	npn	150	20·0	60	15–60	0·8	High power device
2N3773	npn	150	16·0	140	15–60	0·8	High power, high voltage
2N3904	npn	0·31	0·2	40	100–300	300	Fast switch
2N3906	pnp	0·31	−0·2	−40	100–300	250	Fast switch

* *Maximum ratings at 25°C (except where marked* ***)*

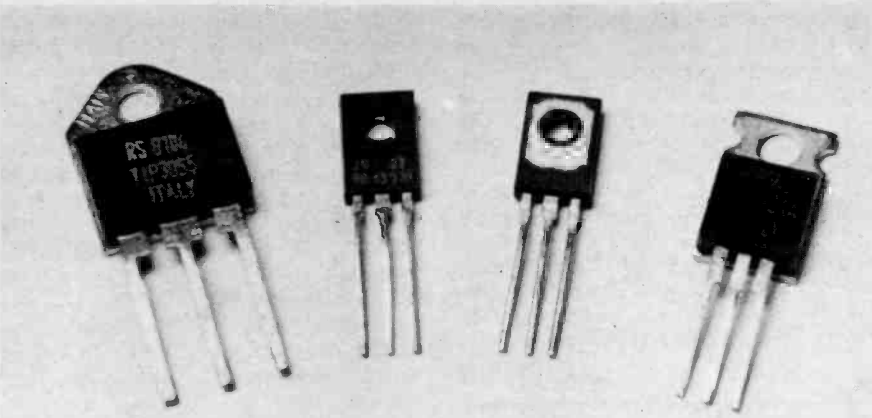


Fig. 2.9a. Plastic package power transistors. The two devices in the centre are in fact the two sides of the same package. The metal plate attached to the collector, designed to be bolted onto a heat-sink can be clearly seen.

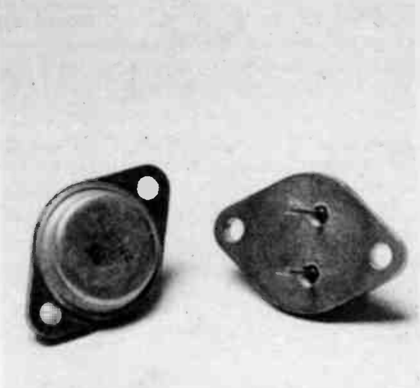


Fig. 2.9b. Power transistor in metal package. The collector is directly connected to the can and connection is made to it via the package.

TESTING TRANSISTORS

Most normal *npn* transistors can be tested with a multimeter switched to a resistance range using the method shown in Fig. 2.10a. The emitter should be connected to the meter terminal marked positive and the collector is connected to the terminal marked negative. In the case of a silicon transistor, the meter should indicate a very high resistance until the resistor R1 (about 47 kilohm for a typical transistor) is touched on the base lead whereupon the meter needle should move across a substantial part of the scale.

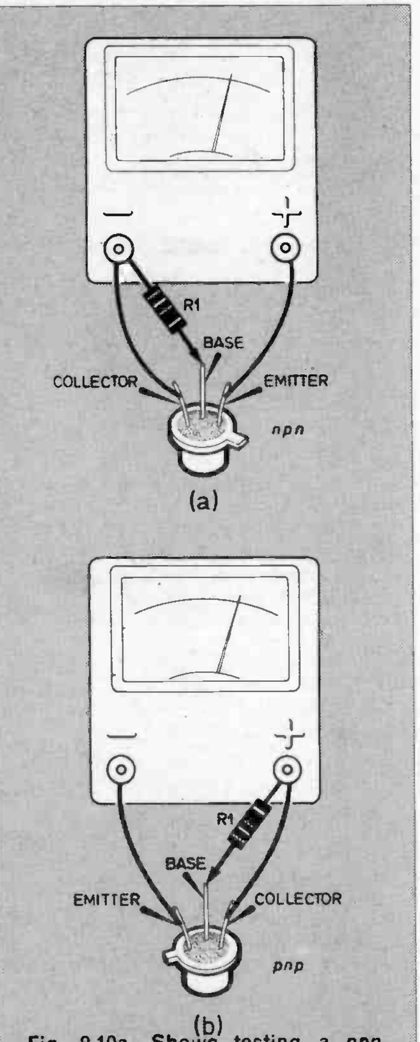


Fig. 2.10a. Shows testing a *npn* transistor with a multimeter turned to the resistance range. (b) Shows similar testing of a *pnp* transistor.

This is a quick test for current gain, but is not intended to be a perfect test for all transistors. Of course *pnp* devices may be tested similarly if the connections are all changed as shown in Fig. 2.10b.

This test can be performed even if one does not know the connections of the transistor. If one uses a low resistance range to find two electrodes which do not conduct in either direction, these are the emitter and collector.

If conduction occurs when the base is positive (the negative meter terminal) to either of the other electrodes, the device is *npn* and vice versa. The device is then tested as in Fig. 2.9, the collector and emitter being distinguished by the configuration which provides the greater current gain (meter deflection when R1 is touched on the base).

DARLINGTON DEVICES

Modern silicon bipolar transistors have current gain values ranging from about 5 to 2,000, the gain generally being smaller in high current devices.

If this is inadequate, a greater current gain can be obtained by the use of the **Darlington circuit**. One can make a Darlington circuit using two separate transistors, but it is often more convenient to use a single Darlington device which contains two transistors suitably connected.

The internal circuit of an *npn* power Darlington device is shown in Fig. 2.11a and a similar *pnp* device is shown in Fig. 2.11b. In addition to the two transistors in each package, there are two stabilising resistors which help to prevent the operating point from changing adversely.

The input signal is fed to the base of the smaller transistor which amplifies the signal by an emitter follower action and drives the larger output device. The total current gain ranges from about 20 (in high power devices) to over 100,000.

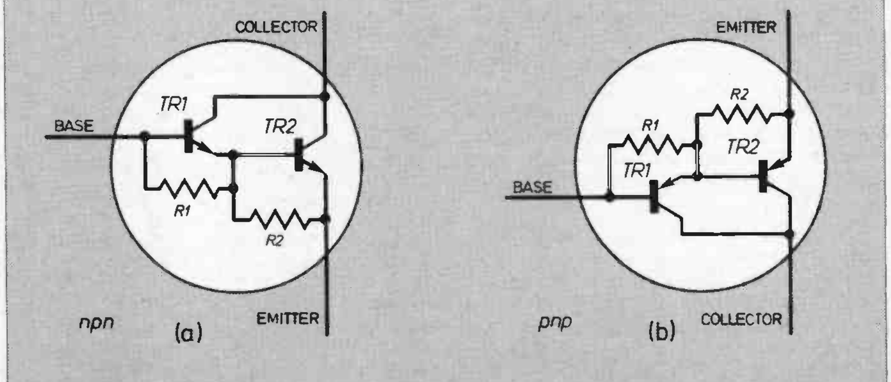


Fig. 2.11. Circuit of (a) *npn* and (b) *pnp* Darlington devices.

JFETS

Field effect or **unipolar transistors** may be divided into two main types, JFETS and MOSFETS. The junction field effect transistor (JFET) has either a channel of n-type or of p-type silicon with a gate of the opposite type of silicon formed as a junction as shown in Fig. 2.12.

A JFET may be used in the type of circuit shown in Fig. 2.13. In the case of the n-channel device shown, a negative potential is applied to the p-type gate so that the gate-to-channel diode is biased into the non-conducting state.

As the negative gate potential is made more negative, the depletion region extends further into the channel until eventually it spreads right across the channel and no current can flow from the drain to the source (V_p in Fig. 2.14).

A bipolar transistor is a current amplifier, but the JFET is a voltage amplifier like a thermionic valve. Like the valve the input impedance of the gate circuit of a JFET is very high, since the gate is reverse biased.

The drain current is plotted against the gate-to-source voltage for an n-channel JFET in Fig. 2.14, the drain to-source voltage being held constant. The drain current which flows when the gate and source are connected together is designated I_{DSS}.

A p-channel JFET can be used in the type of circuit shown in Fig. 2.15 which is similar to that of Fig. 2.13, but with the polarities reversed. The n-type gate electrode is made positive with respect to the channel so that it is reverse biased. Note the arrow of the p-channel device of Fig. 2.15 points in the opposite direction to that of the n-channel device in the circuit symbol of Fig. 2.13.

Both n-channel and p-channel JFET devices are readily available, but the n-channel types are more common. The plastic encapsulated types 2N3819 (n-channel) and 2N3820 (p-channel) are two of the best known JFET products for general purpose applications.

MOSFET DEVICES

A **Metal Oxide Semiconductor field effect transistor** (MOSFET) is somewhat similar to a JFET except that the gate electrode consists of a small piece of metal electrically insulated from the channel by a very thin layer of silicon dioxide. Thus the gate impedance is very high irrespective of the polarity of the bias.

An enhancement MOSFET passes little drain current if the gate is connected to the source, but the drain current increases with the gate voltage. A depletion type MOSFET passes a drain current even when the gate is connected to the source. However, the drain current varies with the voltage applied between the gate and the source. The diagram in Fig. 2.16 shows the internal structure of an enhancement MOSFET.

Unfortunately the thin layer of silicon dioxide in a MOSFET is easily damaged by stray electrostatic voltages. The gate electrode of a MOSFET device should therefore be shorted to one of the other electrodes at all times before the device has been soldered into a circuit, after which the circuit impedance provides protection against the accumulation of electrostatic charges.

Next month: Unijunctions, thyristors, triacs, thermistors.

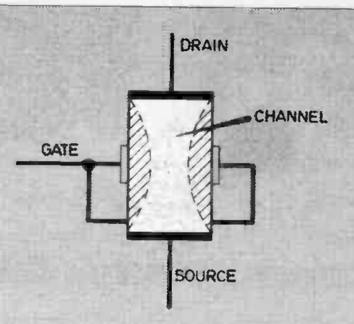


Fig. 2.12. Structure of a JFET device.

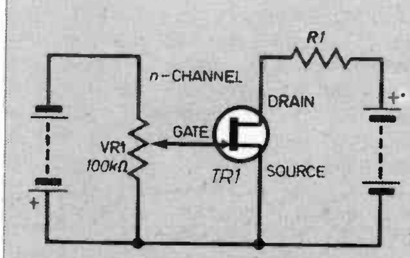


Fig. 2.13. Basic circuit for using or testing a n-channel JFET.

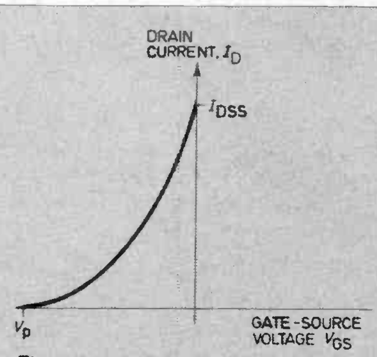


Fig. 2.14. Variation of drain current with gate-to-source voltage in a n-channel JFET.

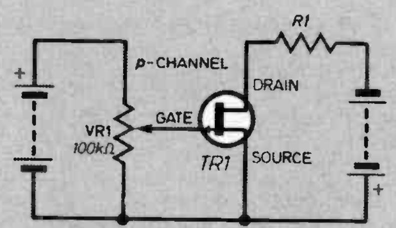


Fig. 2.15. Basic circuit for using or testing a p-channel JFET.

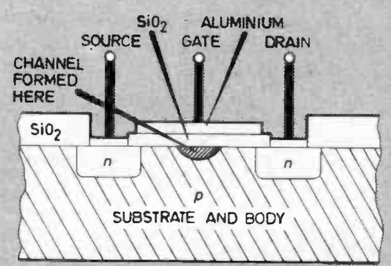
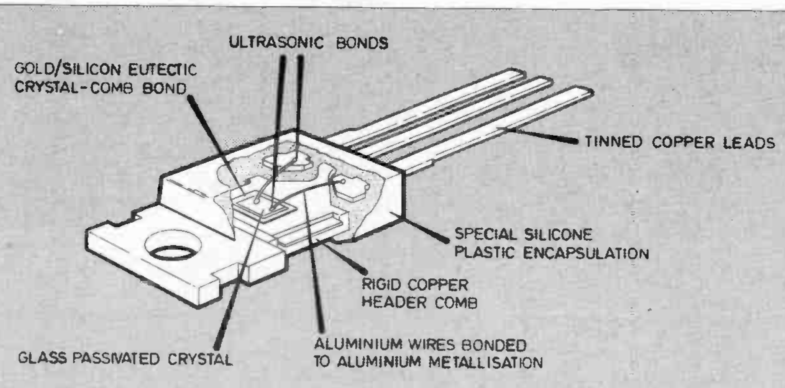
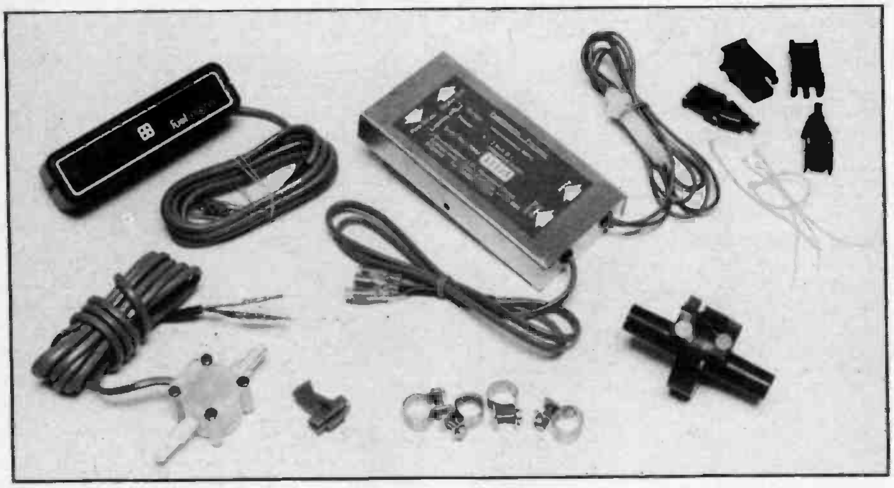


Fig. 2.16. Structure of a low-power enhancement MOSFET.



Internal structure of a Mullard plastic encapsulated power transistor.

FUEL STRETCHER



THIS article describes a fuel consumption monitor for in-car use, designed to fit most vehicles with a carburetter fuel system and cable driven speedometer.

The Fuel Stretcher gives instantaneous read-out of miles per gallon (m.p.g.), with a frequency of update determined by fuel flow rate; for example high flow rate gives high frequency of change and low flow rate gives low frequency of change (update), thus providing another indication of fuel economy.

Normally frequency of update is between one and four seconds, but the fuel consumption monitor has a switch-to-half or -double this frequency facility to suit individual driving conditions. Furthermore, there is a built-in zeroing which automatically changes the readout to ·0 when the car stops, that is when no speed pulses are produced.

The fuel monitor can be easily changed to give litres per 100km. This is the continental unit for fuel consumption, and most likely will be introduced into UK when the petrol pumps start to dispense in litres by the end of 1981. The m.p.g. to 1/100km change is affected by changing two links on the processor circuit board.

The electronics can also be used for a variety of other applications, such as measurement of r.p.m., flow ratio, g per hr and 1 per hr, simply by changing transducer inputs or introducing a time base.

This design is based on a well proven, proprietary fuel consumption monitor supplied by EnviroSystems Ltd, Grange-over-Sands, Cumbria and available through a nationwide dealer network. The complete fuel consumption monitor, and also a kit and components are available from Marshalls, Kingsgate House, Kingsgate Place, London NW6 4AT.

MAIN FEATURES

The main features of the system are:

a. Four-digit display on its own p.c.b. with the counter/driver.
b. Processor board to process the signals from the road speed and fuel flow sensors and feed this information to the display unit. This board contains the speed pulse calibration switch and rate of update switch.

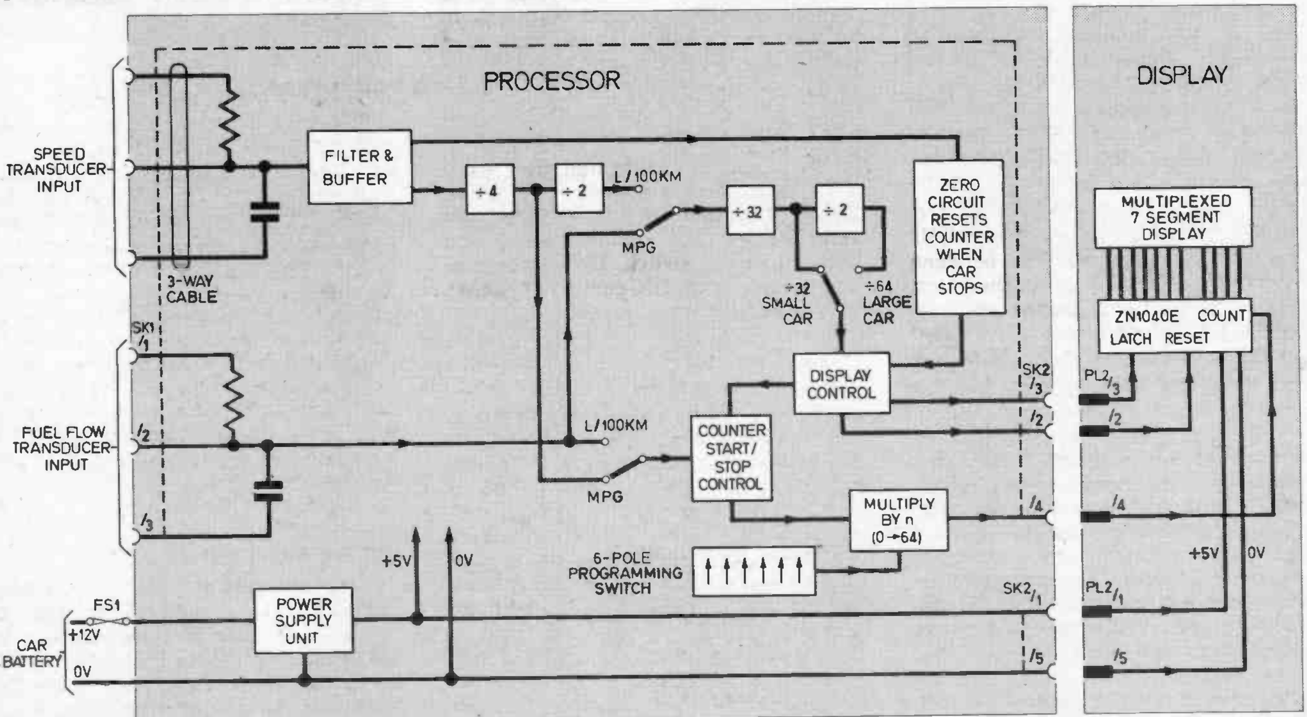


Fig. 1. Block diagram of the Fuel Stretcher. This shows the overall system and how it is arranged within the two units—the Processor and the Display.

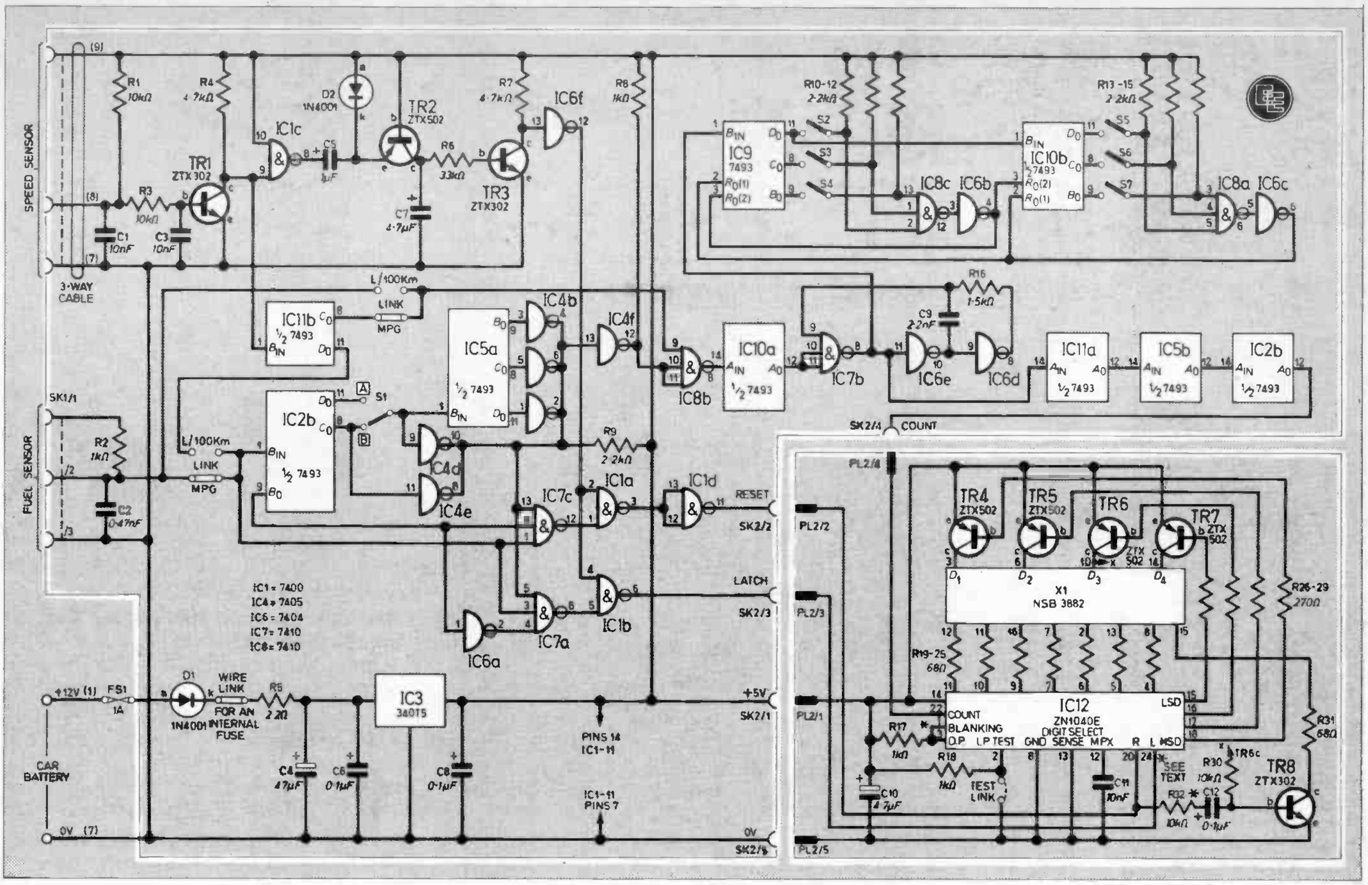


Fig. 2. Circuit diagram of the Fuel Stretcher. The Display Unit circuitry occupies the lower r.h. corner. Clarification of the connections to IC12 is given in Table 1.

Table 1

CONNECTIONS BETWEEN R17 AND IC12

IC12 PIN	FUNCTION
1	BLANKING
3	DECIMAL POINT
21	COUNT DIRECTION
23	INHIBIT

N.B. PINS 21 AND 23 NOT SHOWN ON CIRCUIT DIAGRAM

c. The system uses mainly low priced TTL.
d. Fuel flow related pulses are provided by a flow sensor, normally installed in the fuel line between the fuel pump and the carburetter.
e. Speed proportional pulses are provided by a speed sensor mounted in the speedometer cable. This sensor is independent of cable fittings.

PRINCIPLE OF OPERATION

Basically the road speed sensor counts pulses derived from the speedometer cable, while pulses from the flow sensor cause the generation of a series of internal control pulses which halt the speedometer cable rotation counting process, store and display the count to date, and reset the counter.

This will, therefore, give effectively a unit of distance covered over a number of units of flow, which with the proper calibration factors and division factors will be m.p.g., and with another calibration factor km/l. For l/100km two small linkages have to be changed on the processor p.c.b. and the counting process will work in reverse, giving a unit of flow used over a unit of distance.

CALIBRATION

The unit is calibrated for each vehicle using its speedo calibration figure (number of revolutions per mile for the speedometer cable) and the calibration switch. The calibration switch for most UK cars is available from Marshalls.

CIRCUIT DESCRIPTION

The overall system arrangement is indicated in the block diagram, Fig. 1, while the complete circuit is given in Fig. 2. In practice, the circuitry is divided into two units:

(1) The Processor Unit including all the TTL circuitry and the power supply circuit, and embracing transistors TR1, TR2 and TR3; and integrated circuits IC1 to IC11.

(2) The Display Unit which incorporates the integrated counter/driver IC12 and the four-digit display X1 and the driver transistors TR4 to TR7. Also TR8.

Interconnections between these two units are made via SK2 and PL2.

The speed sensor is connected to the Processor Unit via a 3-way cable. The fuel sensor is connected via PL1/SK1.

SPEED SENSOR SIGNALS

The speed sensor signal (10 pulses per cable revolution) is applied to input buffer transistor TR1 via filter components R1, C1, R3, C3. The buffered, TTL compatible, signal then goes to IC11b, a 7493 binary counter.

Here, depending on the m.p.g./l per 100km function link setting, it is divided by 4 (at pin 8, IC11b) for m.p.g. and then used to control the display counter (IC12) via the counter start/stop control IC8b; or for l per 100km divided by a further factor of 2 (÷ 8 total from pin 11, IC11b) and used to control the display LATCH and RESET controls.

FLOW SENSOR SIGNALS

Flow sensor signals enter via filter network R2, C2 and (following the m.p.g. case through) are divided by 32 or 64 (selectable by S1 for small/large car respectively) by IC2b and IC5a, which together with IC4a, b, c, d (this constitutes a 5-input NOR gate) and dual 3-input NAND gate IC7, form

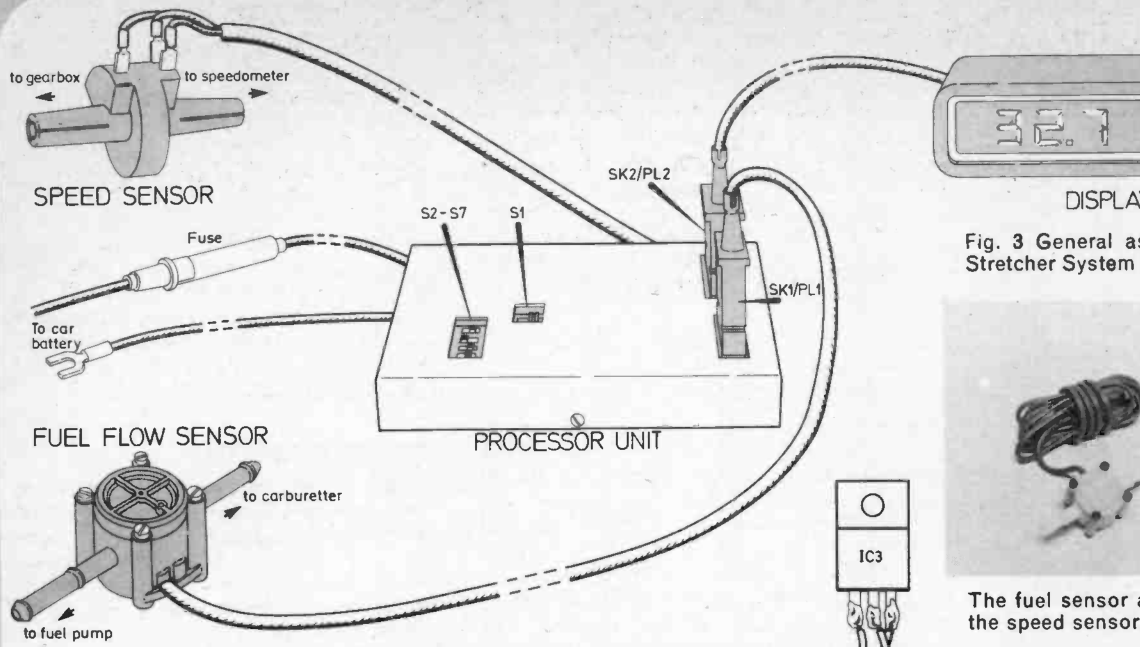
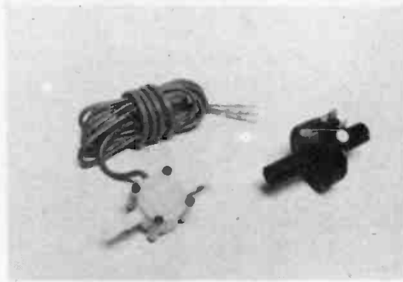


Fig. 3 General assembly of the Fuel Stretcher System Equipment.



The fuel sensor and cable and (right) the speed sensor.

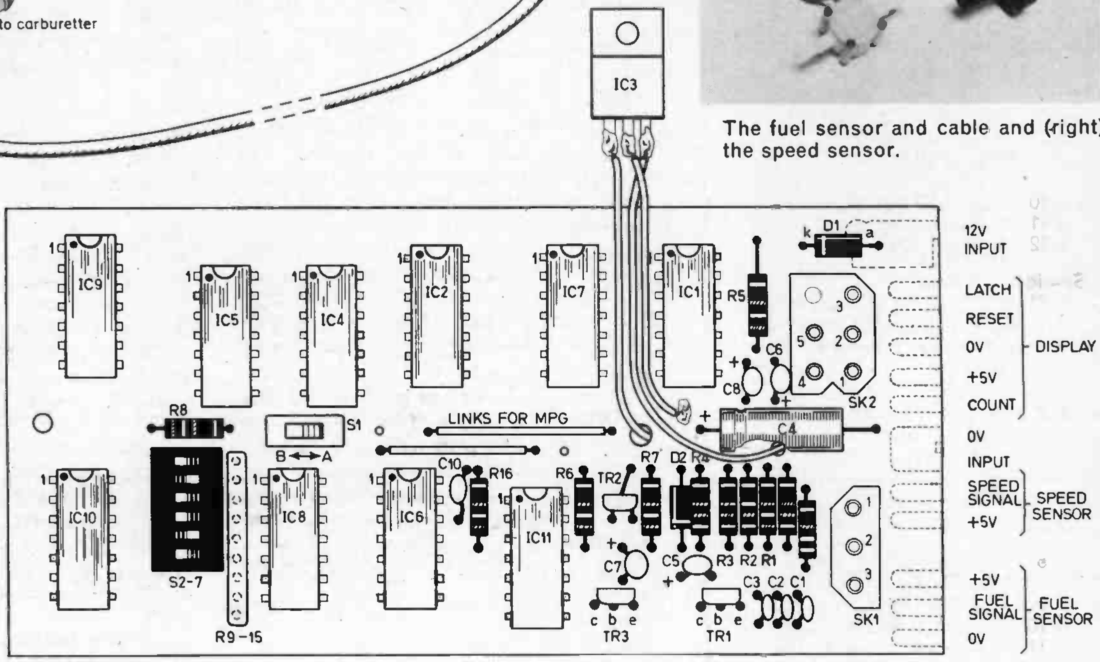


Fig. 4 The Processor Unit p.c.b. viewed from component side. The external-connection solder pads at r.h. edge are on the underside of the board. This is a double-sided circuit board. Note that some semiconductor pins are soldered to pads on the top side.

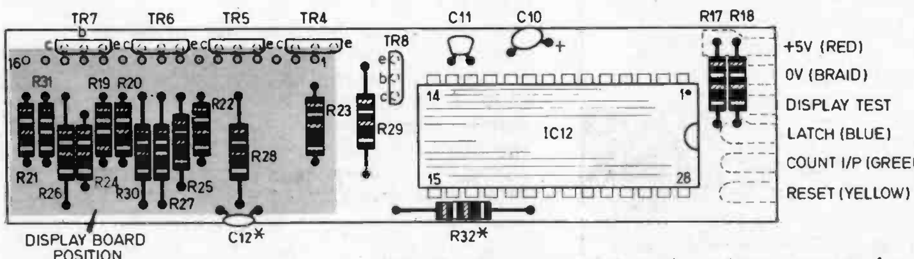
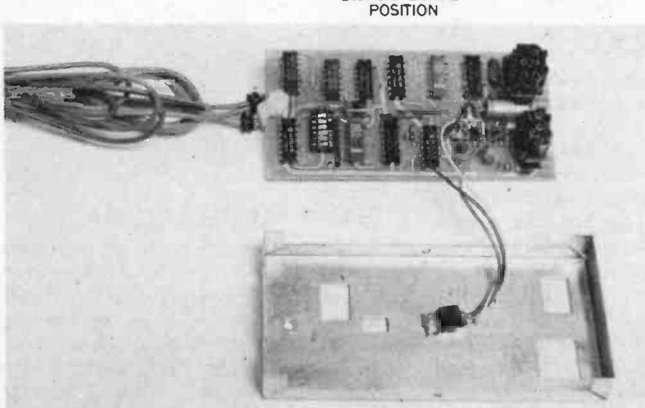
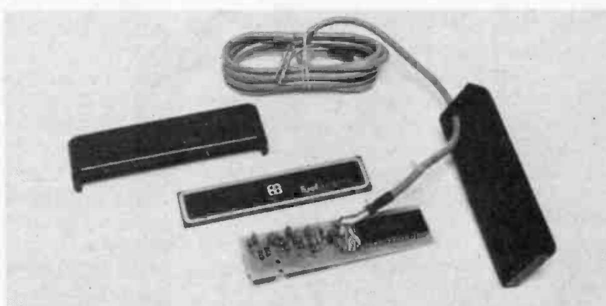


Fig. 5 The Display Unit p.c.b. viewed from component side. The external-connection solder pads at r.h. edge are on the underside of the board.



(left) The Processor Unit p.c.b. and top section of case with voltage regulator IC3 in position.

(below) The Display Unit prior to final assembly.



COMPONENTS

Resistors

R1	10kΩ	R16	1·5kΩ
R2	1kΩ	R17	1kΩ
R3	10kΩ	R18	1kΩ
R4	4·7kΩ	R19-25	68Ω (7 off)
R5	2·2Ω wire wound 2·5W	R26	270Ω
R6	33kΩ	R27	270Ω
R7	4·7kΩ	R28	270Ω
R8	1kΩ	R29	270Ω
R9-15 (7 off)	2·2kΩ s.i.l. 8-resistor package (one not used)	R30	10kΩ
		R31	68Ω
		R32	10kΩ

All ¼W carbon film ± 5% except where otherwise stated

Capacitors

C1 10nF plate ceramic
C2 470pF plate ceramic
C3 10nF plate ceramic
C4 47μF 25V elect.
C5 1μF 10V tantalum
C6 0·1μF 25V tantalum
C7 4·7μF 10V tantalum
C8 0·1μF 25V tantalum
C9 2·2nF plate ceramic
C10 4·7μF 10V tantalum
C11 10nF plate ceramic
C12 0·1μF 25V tantalum

Semiconductors

TR1, 3, 8 ZTX 302 *npn* silicon
TR2, 4, 5 6, 7 ZTX 502 *pnp* silicon
IC1 7400 quad 2-input NAND gate
IC2 7493 4-bit binary counter
IC3 LM340T5 voltage regulator 5V 1A
IC4 7405 hex inverter o.c.
IC5 7493 4-bit binary counter
IC6 7404 hex inverter
IC7 7410 triple 3-input NAND gate
IC8 7410 triple 3-input NAND gate
IC9 7493 4-bit binary counter
IC10 7493 4-bit binary counter
IC11 7493 4-bit binary counter
IC12 ZN1040E 4-decade counter/driver
D1 1N4001 1A 50V silicon diode
D2 1N4001 1A 50V silicon diode
X1 NSB 3882 4-digit display

See Shop Talk page 472

Switches

S1 single pole 2-way
S2-7 6-way d.i.l. package

Connectors

PL1, SK1 3-way plug and p.c.b. mounting socket
PL2, SK2 6-way plug and p.c.b. mounting socket

Miscellaneous

FS1 1A cartridge fuse and cable type holder
X2 Speed sensor
X3 Fuel sensor with 3-way cable
Processor p.c.b; display p.c.b. CB8200, wire for battery supply; metal case for processor, plastics case for display; screen, p.c.b. pillar. 4-way cable with screen, 3-way cable with plug p.c.b.
All parts and installation instructions are obtainable from Marshalls, Kingsgate House, Kingsgate Place, London NW6

a rather complex circuit which produces the timing pulses which are to be the main DISPLAY CONTROL pulses controlling LATCH and RESET on IC12 in a manner rather like a stop-watch.

In this way the fuel pulses are "gating" the display counter so that it displays speed pulses per fuel pulse (which coupled with the various adjustment factors gives miles per gallon or km per litre. The inversion links then provide for 1/100km).

PROGRAMMABLE MULTIPLICATION CIRCUIT

In order to cater for all speed ratios, the COUNT signal coming from counter start/stop control IC8b is passed to the counter input via MULTIPLY BY *n* circuit which is programmable from 0—64 by a 6 pole switch, S2—S7.

A pulse arriving at IC7b via resettable flip/flop IC10a enables (on LOW to HIGH transition) an oscillator comprising IC7b, IC6e, R16, C9. The pulse train from the oscillator is counted by programmable divider IC9, IC10b and when the number set on the 6-pole switch is reached the flip/flop IC10a is reset (since it is a part of IC10b which is reset via IC6c along with IC9). So 1 pulse creates *n* pulses.

The times *n* output is then fed into divider chain IC11a, IC5b, IC2b, and is divided by 8; and although this reduces the range of the times *n* circuit, it allows multiplication factors other than integer or whole numbers, that is times $\frac{1}{8}$ to times 8 in steps of $\frac{1}{8}$ to give a "fine tune" capability to the circuit.

IDLING RESET TO ZERO

When the car is idling and no distance speed pulses are produced and fuel pulses are few and far between, both 1/100km and m.p.g. readings can be misleading. To prevent this, the display counter is caused to reset to zero by a charge-pump circuit comprising C5, D2, TR2, C7.

Pulses from speed buffer TR1 via IC1c are used to charge C5 on the falling edge of the pulse and on the rising edge the emitter of TR2 is taken positive of the +5V rail and turns TR2 on.

In this way each consecutive charge pulse charges C7 a little more as pulse repitation rate increases from zero. At a few m.p.h. the voltage across C7 is high enough to turn TR3 on hence IC6b pin 13 is low and pin 12 high; this enables LATCH and RESET pulses to occur normally through gates IC1a and b but as car stops C7 discharges via R6 into base of TR3 and TR3 turns off, IC6f pin 13 goes low therefore inhibiting LATCH and RESET and counter displays zero.

OPTIONAL AID

An optional service aid is provided by R32 and C12 in the Display Unit. These components cause all decimal points to flash very briefly every reset pulse. This verifies correct operation of fuel sensor.

CONSTRUCTION

Component layouts for the two p.c.b.s are given in Fig. 4 and Fig. 5. The accompanying photographs provide additional details of the general asembly of the Processor Unit and the Display Unit.

PROCESSOR UNIT

After the components (including SK1 and SK2) have been mounted on the p.c.b., solder the battery leads (red and blue) and the speed sensor leads (blue, yellow and red of 3-core cable) to the underside of the p.c.b., as indicated in Fig. 4.

Solder three leads (black, yellow, red) to the voltage regulator IC3 and their other ends to the p.c.b. Secure IC3 to the top section of the case with screw and nut.

Fit a plastic p.c.b. pillar to the hole at one end of the p.c.b.

Place the p.c.b. into the case, allowing the sockets SK1 and SK2 to pass through the rectangular holes provided.

Secure the board in position by means of a No. 6 self-tapping screw fitted into the p.c.b. pillar.

Fit grommets to the battery and speed sensor leads so that they fit into the slots at one end of the case when the leads are dressed over the p.c.b.

Fit the bottom section of the case and secure with two screws.

DISPLAY UNIT

After components have been assembled on the p.c.b., feed the 5-core cable through the hole in the corner of the plastic case and then solder the leads (red, yellow, blue, green and metal braid) to the solder pads, as indicated in Fig. 5.

The p.c.b. assembly is held in position by the tongues and posts moulded in the case.

The plastic screen slots into the foremost groove, and the top section of the case is then snapped into position.

INSTALLATION

Detailed instructions for fitting the sensors into a car and for calibrating the complete system can be obtained from Marshalls. See components list.

Certain miscellaneous items such as spade terminals, nuts and bolts and snap-on connectors are available from car accessory shops.

By Dave Barrington

New technology is in the forefront this month and includes a unique innovation from a British manufacturer.

Battery Saver Radio

A portable radio that will virtually "pay for tself" is the claim for the latest model from Fidelity Radio.

Although the battery manufacturers will not be over the moon about this latest British designed set, the consumer will certainly welcome the Battery Saver portable radio which recharges ordinary—yes ordinary—batteries when plugged into the mains.

Powered by a standard PP9 or equivalent battery, circuitry is incorporated which automatically recharges the battery when the radio is plugged into the mains. Recharging can take place up to four times and can be carried out whether or not the radio is switched on. A red l.e.d. shows when the battery is being charged.

The claim is based on current prices, taking the average life of a radio as being five years and each battery having a life of three months. It is estimated that batteries will cost the owner of an ordinary radio about £24, assuming future price rises are similar to those over the last few years.

The Battery Saver will cost about £6 to run over the same period. This saving of £18 can be compared to the expected retail cost of the new radio of around £20.

Talking Time

With the latest talking watch now being marketed by Trafalgar Watch Company Ltd., that old catch phrase of "if you want to know the time ask a policeman" will have to be updated to "...ask your watch".

Using the very latest in microprocessor technology, the Tel-Time actually "speaks" the time and can even be programmed, before it leaves the factory, to tell it in one of three languages—English, French, and German.

The Tel-Time is expected to sell for around £59. Addresses of nearest stockists can be obtained from Trafalgar Watch Company Ltd., Dept EE, Trafalgar House, Grenville Place, Hale Lane, London, N.W.7.

The versatility of the recent crop of new generation timepieces is illustrated by the latest Casio CA90 wristwatch. Not only is it a good timekeeper, accuracy of ±15 seconds a month, but it also incorporates a four function 8-digit calculator and a space invader game.

The watch function includes such features as: 12 or 24 hour format; auto calendar giving day, date, month and year preprogrammed until 2002; a 24 hour alarm and a hourly chime signal setting. There is also a professional stopwatch facility capable of 1/100 second to 24 hours measuring net, lap and first and second place times.

The calculator has the four basic functions of addition, subtraction, multiplication and division.

For the game the keyboard is divided in half, the left hand keys become aim and the right hand keys the fire controls. The random digital invaders "attack" from the bottom right and move across the display. Apart from the attacks speeding up as the game is in progress, it also has sound effects and scoring.

For the person on the move, particularly during the holiday period, the Casio MA-1 quartz digital battery alarm clock, measuring only 1¾ × 4½ × 3in, has some useful features. These include hourly time signals, a symphonic alarm or buzzer, snooze facility and an integral amplifier with speaker and volume control.

During the snooze setting, the melody sounds for about 30 seconds and subsequently the buzzer sounds seven times for 60 seconds at intervals of four minutes at and after the preset time. A large push "button" on top of the clock functions as an alarm stop button and also as a night time illumination button.

Both the Casio CA-90 wristwatch (£24·95) and the MA-1 Quartz battery alarm clock (£9·95) are available from Tempus, Dept EE, Freepost, 164-167 East Road, Cambridge, CB1 1DB.

Trafalgar "talking" watch

Casio CA-90 watch

Fidelity Battery Saver Radio

CONSTRUCTIONAL PROJECTS

Xenon Strobe Lamp

Very high voltages are present in the *Xenon Strobe Lamp* and we strongly advise readers to use only those components specified.

The xenon flash tube and trigger coil used are available from any Tandy Store stock numbers 272-1145 and 272-1146.

The transformer T2 is a RS type 196-268 and the printed circuit board has been designed to accommodate the transformer pinning. Other similar types with a secondary rating of 3–0–3V at 200mA may be used but its location on the board, and in the case, may need to be changed.

It is important to pay special attention to the working voltages of the capacitors used and ones with lower ratings must NOT be used. Higher rating working voltages are quite acceptable.

Pay particular attention to C7 which must NOT be an electrolytic type. A mixed dielectric type was found to be suitable.

The bridge rectifier is available from Watford Electronics. A plastics case for housing the components should be used.

The rotary switch is available in metal or plastics construction. We strongly recommend that readers use the plastics encapsulated type, with plastics spindle.

A ready-made p.c.b. is available from Proto Design, 14 Downham Rd., Ramsden Heath, Billericay, Essex at a cost of £3·10 incl. P/P.

Combination Lock

Only two parts look like being problem items in the *Combination Lock*. These are the keyboard and the 20-way connector.

The 20-way connector used in the author's model is a RS printed circuit board connector; order as stock number 488-365.

Many advertisers now sell off old disused calculators and their keyboards could be salvaged for use here. Alternatively several printed circuit board push switches could be grouped together and used for the keyboard.

Any relay or solenoid with a coil rating greater than 185 ohms, with contacts to suit may be used. Also, ribbon cable is now generally available from most suppliers.

Electronic Multimeter

The only item that may cause buying problems in the *Electronic Multimeter* is likely to be IC1, the LM334Z programmable current source device. This is available from RS Components stockists and is listed as stock number 308-540.

Multiturn cermet trimmer potentiometers are fairly expensive components but, in the interest of accuracy, we suggest they are used. These can be either 20 or 15-turn types.

Fuel Stretcher

Although it is not in the full constructional class, all components for the *Fuel Stretcher* project are available from A. Marshall (London) Ltd. They issue a complete price list and are able to supply complete kits.

As the sensor items are special to the system they are only available from Marshalls. Also, they are supplying all the necessary literature for installing the system in the vehicle.

The fuel line hose should be obtainable from any good car accessory shop.

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AUGUST 1981
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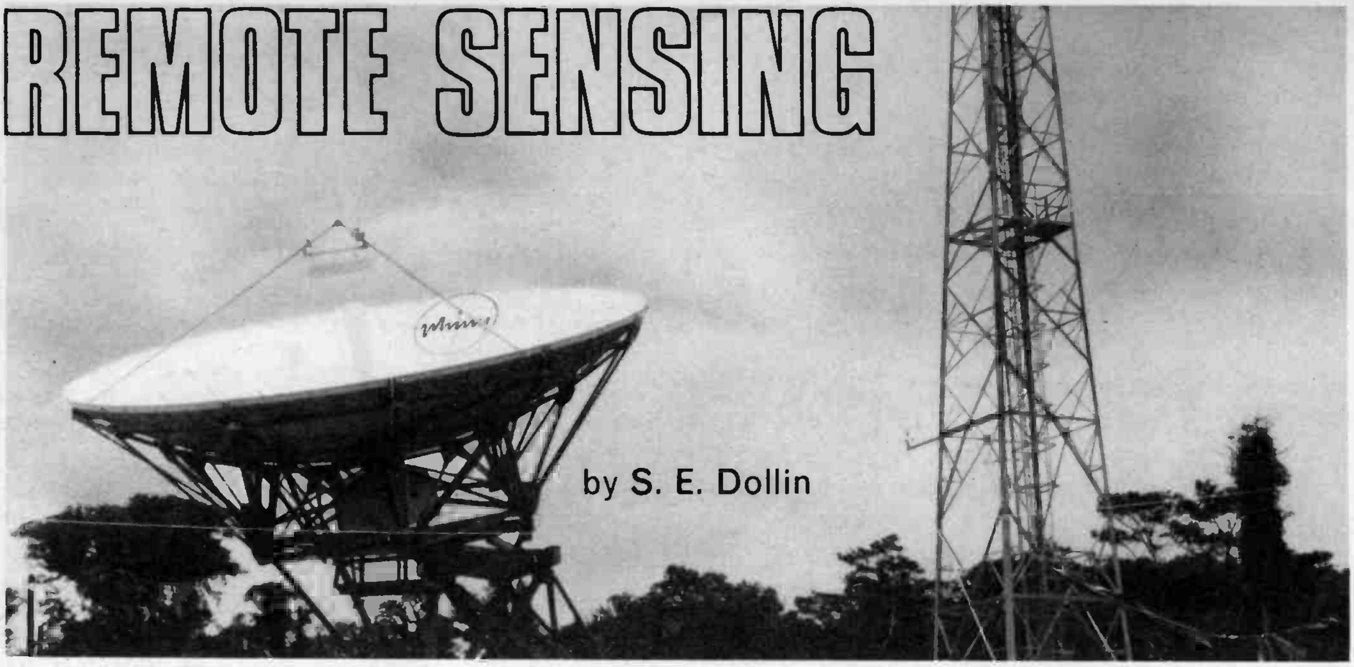
REMOTE SENSING



by S. E. Dollin

Confusion reigns in the US while UK develops new picture analysis technique

REMOTE SENSING, or the use of satellites in earth orbit to detect conditions on the earth's surface, has been with us for about nine years and in that time has been used to collect useful data on such things as mineral resources, crop growth, water flow and so on.

This has been based largely on the Landsat series of satellites, a project run by NASA in the United States, and to date three satellites have been launched.

Landsat 1 was launched in 1972 and continued transmitting way beyond its one year design life until 1978 when it was shut down. Landsat 2 was launched in 1975 and operated for a similar period. The craft currently in use is Landsat 3. This was put into orbit in 1978.

EQUIPMENT

All three satellites carry a wide variety of equipment including a multi-spectral scanner (MSS), return beam vidicon (RBV), and a data collection system (DCS). By orbiting the earth every 103 minutes, the satellite can scan a strip on the surface 100km wide. The satellite shifts westwards on every orbit and so can scan adjacent strips, eventually building up a complete picture of the earth's surface. This takes 18 days.

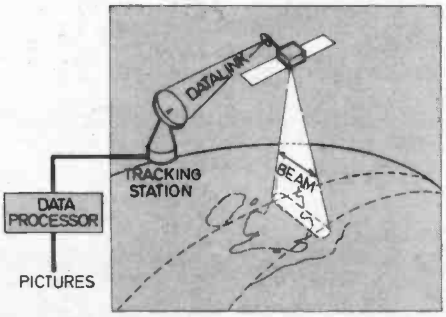
The MSS detects sunlight that has been reflected from the surface. Different rock formations, vegetation, water and so on reflect light of different wavelengths in different strengths and this enables the MSS to distinguish them apart. The equipment is designed so that the sunlight can be broken into five spectral bands and these are broken down into individual picture elements or "pixels" before being transmitted down to earth in digital form.

The RBV equipment uses high resolution TV cameras to pick up information from the earth's surface. Landsats 1 and 2 have three cameras and Landsat 3 has two, each operating in a different part of the visible spectrum.

The DCS is something of a side-line as this picks up data transmitted from over 1000 land stations and retransmits it back to ground stations in the USA.

In addition to the Landsat series, information is also used from Seasat satellites and weather satellities such as the GOES and TIROS series.

In Europe, remote sensing is handled by the European Space Agency (ESA), who operate two ground receiving stations for the Landsat programme as part of the Earthnet remote sensing network. One of these is at Fucino in Italy, the other at Kiruna in Sweden. From here information is sent to the UK point of contact at RAE Farnborough for processing.



Landsat's scanner sweeps across a 100km wide strip of the earth's surface for every orbit. The information gathered is then transmitted back to a receiving station on earth in digital form where it is then processed and turned into meaningful pictures.

COMPUTER PRODUCED MOSAIC

As it stands, the data is in digital form and must be processed before it is of any use. At the National Remote Sensing Centre based at RAE Farnborough computer specialists have developed a technique for producing a mosaic picture from the raw data that is more accurate than anything ever produced before and which could bring real benefits to the third world.

The mosaic is formed by taking separate 185 by 185km scenes from the MSS and combining them with the same scenes shot with the RBV. This gives additional density information. The combined signals are then fed through a computer which joins the edges so that a continuous picture emerges. This is possible because there is some overlap in each shot and this information can be used by the computer program to arrive at an average signal level. This can then be processed to give the continuous image.

The final picture can then be matched to a map using prominent landmarks to give a cartographically correct image.

CLAIM AND COUNTER-CLAIM

Taking the Landsat project as a whole, processing of the information is almost as important as the actual satellites themselves and here Britain is in a leading position. However, with the gathering uncertainty about the future of Landsat, this advantage may be short lived. There have been problems with the satellites themselves. For instance Landsat 3 is only partly operational with a broken multi-spectral scanner.

To counteract this, the scientists at NASA have been forced to restart Landsat 2 even though it is well beyond its intended life span. In addition to this, the launch of Landsat 4 has been put back until 1982 so there is little room for further unforeseen difficulties.

The problem is further complicated by the fact that there are moves to transfer responsibility for Landsat from NASA to NOAA (the National Oceanographic and Atmospheric Administration), a process destined to take several years.

By doing this it is hoped to speed up the turn-round time on data input. Add to this the scientists' scepticism about the value of the work they are producing, and the optimism of the politicians' hype, and the real benefits of remotely sensed data become buried in a confusion of claim and counter claim.

Returning to the UK for the moment, the benefits of remote sensing can be immediate and lasting. For example the Bristol Channel is notorious for its sandbanks, yet it is impossible to survey the channel month by month as the sandbanks shift and change. Remote sensing makes this immediately possible. Other examples include crop and water management.

Perhaps the most dramatic examples of the benefits of remote sensing can be seen in such schemes as a hydrology project in Botswana undertaken by the NRSC where detailed cartographic information has been provided where maps were either very sketchy or didn't exist at all.

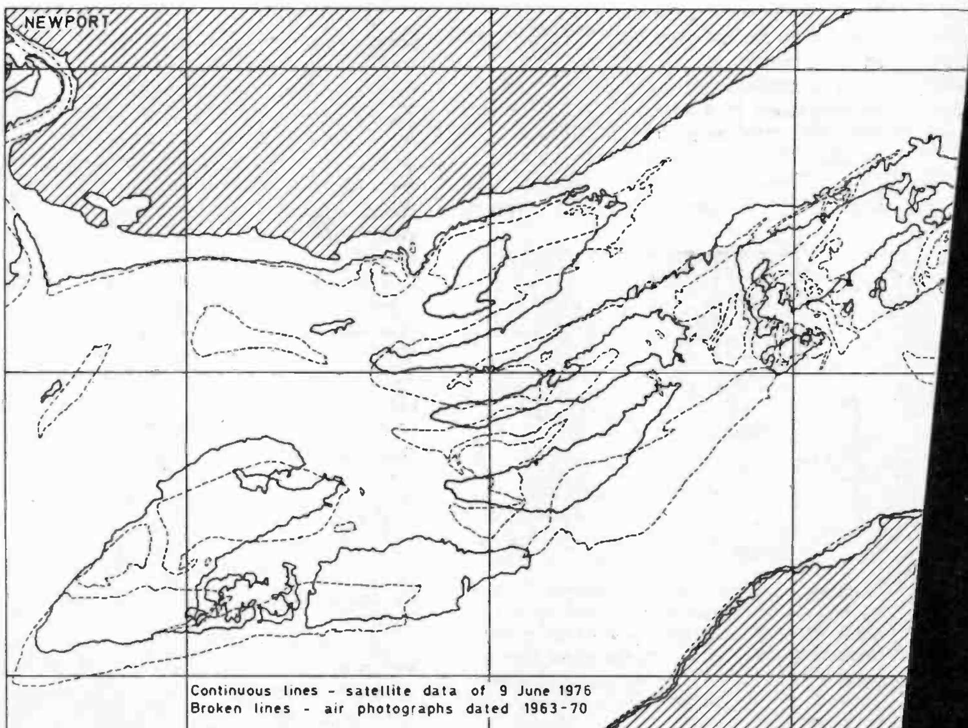
THE FUTURE OF LANDSAT

The future of Landsat and remote sensing generally will ultimately depend on the system getting off on a commercial footing. At present this system is little more than an elaborate experiment. The demand for information exists and an infrastructure for the dissemination of the information also exists. Indeed the NRSC is already geared to providing a service to all sorts of industries and users including forestry, mining, agriculture as well as research and higher education. The centre is also concerned with research into techniques of remote sensing, data processing analysis and interpretation for a wide variety of applications on behalf of or in conjunction with users.

Further afield, third world countries are falling over themselves to invest in sophisticated remote sensing satellite equipment and data, often for very dubious reasons. Local politics, high pressure American sales talk and a desire to safeguard valuable mineral resources are all too often responsible for these countries investing in expensive equipment rather than any altruistic motives to help local agriculture and living standards.

However, all eyes will be on the Americans. As much as two years ago two senators tabled bills to make Landsat a commercial service and the proposal that NOAA should administer an operational land, sea and air remote sensing system called Stereostat was approved some 18 months ago. Let us hope that the future of remote sensing is not jeopardised by President Reagan's proposed budget cuts now before the American government. ⌑

Map below shows the positions of sandbanks in the Bristol Channel plotted both by satellite and by conventional means. The disparity between the two can be clearly seen. The three photos to the right show part of the Wash and were produced using data from Landsat 1. The top photograph is an original image in the red end of the spectrum. Below that is a computer processed picture of the same area with enhanced density to show water depths and below that is a cleaned up version.



INTRODUCTION TO LOGIC

PART 3 BY J. CROWTHER

BINARY ARITHMETIC

(b) Subtraction

Binary subtraction is similar to decimal subtraction but anything borrowed from the next column becomes a two instead of a ten.

example

Subtract 18 from 25.

decimal	binary	
1	*22*	*borrow*
25	11001	
18 —	10010 —	
7	111	equivalent to 7_{10}.

As there is no facility on a computer to represent two, this method cannot be used. Subtraction is carried out by a process known as **complementary addition.**

Two's Complement

The complement of a number means changing all the 0's to 1's and all the 1's to 0's. This is known as **1's complement.** However this has limitations and in computers **2's complement** is used. The latter is formed by adding 1 to the 1's complement.

In the method of complementary addition, the number to be subtracted is transformed to its 2's complement and then added to the other number. Any overflow is ignored.

example

Subtract 18 from 25.

Take the 1's complement of 18 (10010), 01101
add 1   1
to give 2's complement 1110

decimal		binary	
25		11001	
18 —		01110 —	(add 2's complement)
7	1	00111	= 7_{10} when overflow is ignored
	overflow—↑		

Negative Numbers

In computers it is necessary to be able to represent both negative and positive numbers in binary. The complementary addition method of subtraction gives a clue to how this is achieved.

In mathematics the statement 25 − 18 can be written as 25 + (−18), and since in complementary addition we subtract by adding the 2's complement it follows that the latter must represent the negative number.

example

+18 = 00010010
therefore −18 = 11101101 + 1 = 11101110

An alternative method which some people find easier is to write down the positive number, then starting from the right hand side, copy up to and including the first 1 that you come to, and then invert the rest.

example

To form −8, write down +8 in binary = 00001000.
Then using the above rule, −8 = 11111000.

Exercises

3.1. Write down the binary for the following decimal numbers: (*a*) +3 (*b*) −3 (*c*) +16 (*d*) −16 (*e*) +127 (*f*) −1.

Sign Bit

Using the 2's complement method of representing negative numbers raises an obvious problem.

We have just seen that −18 is represented by the binary string 11101110, but this string also represents the positive number 238. The problem that now arises is how does the computer know whether 11101110 represents −18 or +238.

In computers and microprocessors numbers are stored in registers of a certain length, for example 8 or 16 bits long (or more) depending on the particular computer.

To distinguish between a positive and negative number in a register, the extreme left hand bit, known as the most significant bit (m.s.b.) is the sign bit, and is used to determine if the number is positive or negative using the following code:

If the sign bit is 0, the number is positive.
If the sign bit is 1, the number is negative.

The remaining bits in the register represent the magnitude of the number as illustrated in Fig. 3.1.

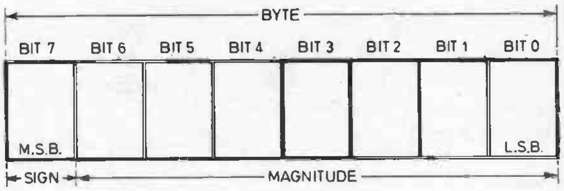


Fig. 3.1. Arrangement of the sign and magnitude bits in a computer 8-bit register.

Range of Numbers that can be held in a register

For simplicity suppose the register was four bits in length. Since the most significant bit cannot be a 1 if the number is to be positive the highest positive number possible in a four-bit register is 0111 (= 7). As a 1 can appear in the m.s.b. for a negative number, the highest negative number possible in a four-bit register is 1000 (= −8). It will be seen that there is always one more negative number that can be stored than positive numbers.

The full range of numbers that can be stored in any register is given by the formula:

Highest negative number $= 2^{(n-1)}$

Highest positive number $= 2^{(n-1)} - 1$

where n is the number of bits in the register.

In an 8-bit register:

Highest negative number $= 2^{(8-1)} = 128$

Highest positive number $= 2^{(8-1)} - 1$

$= 127$

(c) Multiplication

Binary multiplication is the same as decimal multiplication, that is, multiplying by each digit in turn, moving to the left each time and then adding.

example

Multiply 12 by 13.

decimal	binary
12	1100
13 ×	1101 ×
36	1100
12	0000
156	1100
	1100
	10011100 $= 156_{10}$

As the computer can basically only do additions, it multiplies by a process of repeated addition.

example

To multiply 9 by 3, the computer would add 9 together three times, thus:

$9 + 9 + 9 = 27.$

(d) Division

The computer does division by repeated subtraction, takes the 2's complement and adds, until there is no remainder. It then adds together the number of processes carried out to reach this condition and this is the answer.

decimal	binary
13	0001101
5) 65	101) 1000001
5	101
15	110
15	101
00	101
	101
	000

example

To divide 9 by 3.

```
         9 }   1 )
subtract 3 }     )
         6 }   1 }  3 processes so answer is 3.
subtract 3 }     )
         3 }   1 )
subtract 3 }
         0
```

Advantages

Whilst counting in binary is very slow and cumbersome for human use, it has many advantages in electronics:

(1) Binary only has two states, 1 and 0 (on and off) and is therefore very reliable.

(2) Electrical energy moves at 3×10^8 metres per second, therefore any slowness due to long trains of additions is removed. A computer can carry out about 500,000 additions per second.

(3) It makes subtraction using an addition process very easy.

LOGIC

Logic can be described as arriving at a reliable result by placing the correct information in the right order.

BINARY LOGIC

Binary logic is easier than most human logic since each decision has only one of two possibilities. A clear yes/no answer is given, there is no "maybe", "nearly", or "could be" as in human logic. Since switches are used for either of the two states, if they are set in the correct order a reliable result is obtained.

example

An automatic gas central heating system, see Fig. 3.2.

A result will not be obtained, that is no heat, unless:

(1) Pilot light is on.

(2) Temperature of the room drops below a certain predetermined value.

(3) The time is set correctly.

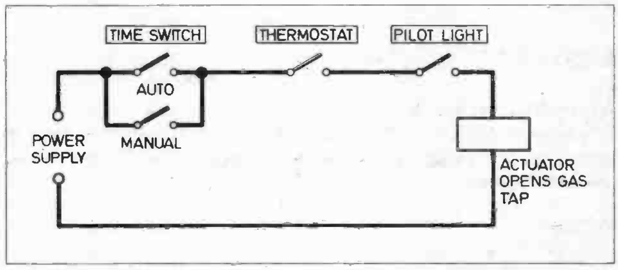


Fig. 3.2. Simplified circuit for an automatic gas central heating system.

GATES

As can be seen from the previous example a result can be obtained by a number of switching circuits. In logic circuits these switches are known as gates. These may be connected in series or parallel, or in complex systems, a combination of both. To use mechanical switches, such as relays for example, would be bulky, slow, and less reliable, so the transistor is used as a switch in logic circuits.

Answers to Exercises in Part 2

2.1. (*a*) 524 (*b*) 3640 (*c*) 751.

2.2. (*a*) 001010110011 (*b*) 11010101000111 (*c*) 100010110 (*d*) 101110010101 (*e*) 011010111

2.3. (*a*) 1001,0100 (*b*) 0100,0010,1001 (*c*) 0010,1001,0100,0111 (*d*) 0001,0111,0011,0110 (*e*) 0101,0011,1000 (*f*) 0111,0011,0101

2.4. (*a*) 95 (*b*) 709 (*c*) 364

2.5. (*a*) E1 (*b*) B8F (*c*) FC (*d*) 13

2.6. (*a*) 0100,1111 (*b*) 0001,1010,1100 (*c*) 0110,0111 (*d*) 0010,1010,1000 (*e*) 1110,1111 (*f*) 1010,0001,1011

2.7. (*a*) 45 (*b*) 431 (*c*) 538 (*d*) 430 (*e*) 251 (*f*) 87

2.8. (*a*) 660 (*b*) 1EE (*c*) 1436 (*d*) 43 (*e*) 7B.

2.9. (*a*) 1000 (*b*) 0001,0101 (*c*) 0001,1000 (*d*) 0001,0000,0000.

TO BE CONTINUED

BACK TO BASICS
Amplification

IN its earlier days the telephone was an upright instrument. Still to be seen in old films, a key feature was that the mouthpiece and earpiece were separate. The mouthpiece (containing the microphone or transmitter) was mounted on a thing like a candlestick. The earpiece or receiver was a bell-shaped device on the end of a flexible cable. To use it you held the earpiece to your ear and bent down to speak into the mouthpiece.

It didn't take the public long to discover that a trick could be played with the "candlestick" telephone. You called up a number (via an operator, of course) and on getting an answer you held the earpiece against the mouthpiece. The person you called then got a piercing howl into his ear. Great fun . . . for the caller.

FEEDBACK

The effect was very like what happens with present-day audio systems when a microphone is placed too close to a loudspeaker.

The resulting howl or whistle is usually called **positive feedback** because it is caused by sound being produced by the loudspeaker, fed back to the microphone, going through the amplifier, out again at the speaker, back to the microphone, and so on for ever—or until somebody turns down the volume.

TELEPHONE CIRCUIT

In the case of the howling telephone, there is just one problem. When the basic circuit is inspected (**Fig. 2.1**) there is no amplifier to be found. What there is consists of the two microphones (one at each end of the line), the two earphones and a battery.

Amplification implies an increase in energy. So where does this come from?

The answer is, the battery.

But a battery isn't an amplifier either, and the energy it normally gives out on demand is a steady **direct current,** not the rapidly-varying current needed to create a howl. Somehow, the energy of the battery is being converted into the sort of **audio-frequency alternating currents** which cause the howl.

The arrow from microphone to earphone at one end of the line indicates that these are coupled together (by holding them together, in this case).

This provides feedback, since sound from the earphone goes straight into the microphone and the resulting current from the microphone must flow right round the whole circuit and therefore through the same earphone again, making more sound, and so on.

What we have to explain is how the volume gets greater as the sound signals go round and round the circuit.

CARBON MICROPHONE

The key component is the microphone. If you were to obtain an early telephone microphone and take it to bits you'd find a cone-shaped piece of thin aluminium. The tip of the cone presses against a little box or bag full of shiny black dust. It looks like coal dust, but is really a collection of tiny polished granules of a form of carbon.

Carbon is an **electrical conductor,** and current from the battery flows through the granules. But they are packed rather loosely, and held in place by gentle pressure from the aluminium cone. Increase the pressure and the little granules make better contact with one another, allowing current to flow more freely. Reduce pressure and less current flows.

The microphone is therefore capable of turning pressure variations on the aluminium cone into current variations. The trick is to make it respond to the variations in **air** pressure caused by the speaking voice. This is what the cone is for.

Its real name is the **diaphragm** and it is mounted so that it vibrates in sympathy with the sound waves from the voice (which are just rapid changes in air pressure).

As it vibrates it compresses or relaxes pressure on the granules, depending on whether the diaphragm is moving inwards or outwards at a particular instant.

The sound variations make the resistance of the carbon granules vary in sympathy, so producing corresponding changes in the amount of current drawn from the battery.

In the receiver, the current flows through the coil of an electromagnet. This produces changes in magnetic field strength. These changes vary the pull of the magnet on an iron diaphragm, which moves to and fro in sympathy, reproducing the original sounds, as air waves again.

EQUIVALENT CIRCUIT

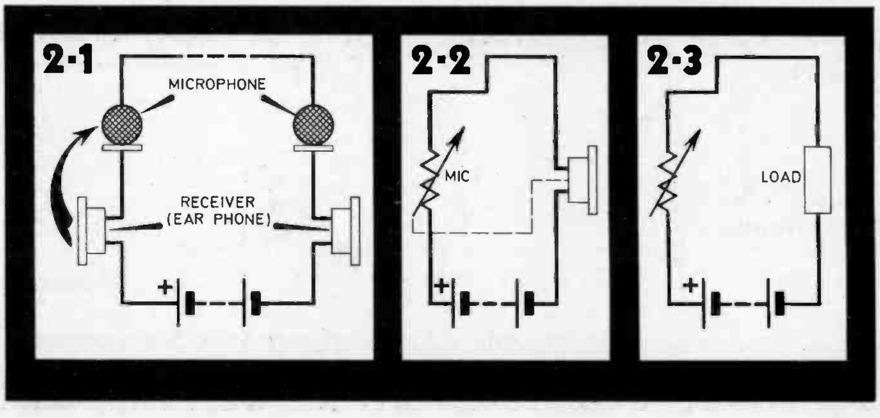
Evidently it is the microphone and earphone at one end of the line which create the howl. The ones at the receiving end are merely part of the circuit which is inactive in howl-production.

Let's forget about the far end and rewire the circuit using just the active, near-end devices (**Fig. 2.2.**). The microphone is now shown as a **variable resistance** operated by the earphone. For the circuit to **oscillate** (howl) the microphone must generate more sound-producing current at each pass round the circuit, so that the volume builds up.

Fig. 2.1. Basic telephone circuit.

Fig. 2.2. Equivalent circuit with microphone and earphone.

Fig. 2.3. Resistance-variation generator.



A FOUR-PART INITIATION COURSE FOR NEWCOMERS

By George Hylton 2

RESISTANCE-VARIATION GENERATORS

The microphone acts as a sort of tap to turn the current on harder or softer. The howling telephone demonstrates an important class of electrically active devices. Forget about *sound* and think only of the *variations in resistance.*

In principle, anything that varies can be made to vary a resistance. The general idea simplifies itself to **Fig. 2.3.** Here there is just a variable resistance, a battery, and a mysterious box marked **Load.**

A "load", in electrical terms, is anything driven by energy from some sort of generator. An electric lamp is a load on the mains. A loudspeaker is a load on an amplifier . . . and so on.

In this circuit, so long as the resistance is not being varied but is just left at some fixed value, a steady (direct) current flows whose value depends on the total resistance in the circuit, that is the load resistance plus the "variable". If the variable resistance is now altered the current changes.

Since the load is traversed by the current it, too, experiences a change, and absorbs more energy or less energy as the current increases or decreases.

In this way the battery and the variable resistance act together to form a sort of generator of varying current. If the variations go on at audio frequency then the load receives audio energy mixed up with steady "**d.c.**" energy from the battery.

AMPLIFICATION

What produces the variations in resistance? In the case of the howling telephone it was sound waves, but it could be other things.

Some substances change resistance according to how much light falls on them, for instance, so that could be a possibility. However, the most important class of devices in electronics are those which are controlled not by sound waves or light, but by **voltages** and **currents.**

Imagine that somehow a current produces variations in the resistance. The resistance, in its turn, produces variations in the current of the battery circuit. If these secondary variations are greater than the ones which cause the change of resistance then the circuit is **amplifying.** "Amplifying" merely means, "making larger".

The earliest kind of **transistors** behaved rather like the variable resistance in **Fig. 2.3.** A small **input current** controlled a larger **output current,** by changing the resistance of the device. The name "transistor" (from '*transfer resistor*') suggests this form of action.

ACTIVE DEVICES

Transistors and other amplifying devices are examples of **active devices. Fig. 2.4** shows how active devices are used, in general terms, without going into the complexities of complete amplifier circuitry.

The active device is controlled by a small input current, or input voltage in some cases. This control input, known in electronics as the **input signal,** whether or not it has anything to do with conveying messages, turns the active device on or off and so governs the amount of energy from the battery which reaches the load.

Note that the battery must be there. It is the real source of energy.

Fig. 2.4 doesn't say where the input is coming from. It could be a radio aerial, a microphone, a gramophone pickup or many other things. Also, the current path of the input signal is incomplete.

Fig. 2.4 shows one input terminal, but there ought to be two, because the input current must flow in at one terminal and out at another if it is to have its own complete circuit. And without a complete circuit no input current can flow.

Most practical amplifiers use active devices in which the missing signal terminal is at the same time one of the device's other terminals, that is the one at the bottom, where the battery is connected in **Fig. 2.4,** or the one at the top where the load is connected.

This shared terminal is called the **common terminal,** and since it is very often connected to the earth, or something equivalent to the earth, it is also called the **earth terminal** ("ground" terminal in America).

TRANSISTORS

Fig. 2.5 illustrates the point with two kinds of transistor.

The **bipolar transistor (a)** is controlled by an input current flowing between its **base** terminal and its **emitter** terminal. The emitter terminal is here the common terminal since the main current from the battery also flows through it.

The **field effect transistor (b)** is controlled by a voltage applied between **gate** and **source.** The source is here the common terminal. In principle, however, any one terminal can be common.

Continued next month

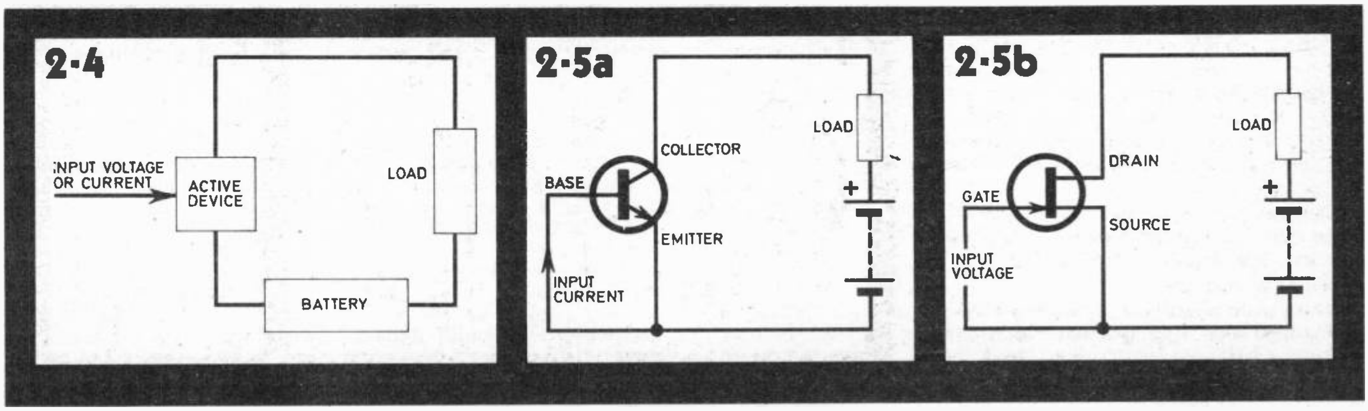


Fig. 2.4. Essentials of an amplifier.

Fig. 2.5. (a) Bipolar Transistor current-controlled amplifier. (b) Field-effect transistor voltage-controlled amplifier.

Everyday News

INTER-CITY SPECIAL

A novel way of publicising a novel industry is one way of describing the Microelectronics Applications Project's latest venture. This is the MAP Microtrain, a roving exhibition destined to visit 22 towns and cities before its run ends early in November.

This specially fitted out train was inaugurated on May 6 at Marylebone Station, London by Mr Kenneth Baker, minister for Information Technology and its purpose was spelled out when he said;

"We are taking the Microtrain all over the country to show people what can be achieved with microelectronics and help them get started. Microelectronics is going to affect all of our lives and if Britain is to reap the benefits, we have to begin taking our opportunities.

"Much has been achieved in the first phase of the Microelectronics Applications Project (MAP) in encouraging British companies to take up the challenge but too many, around 50 per cent, still have not appreciated that microelectronics is relevant to their business."

The exhibition features examples of micro-computers currently available, industrial applications and office equipment including word processors and Prestel equipment and a very full programme of seminars and lectures has been arranged on a wide variety of topics for a wide range of people.

In fact the major target of this exhibition is on the one hand industrialists and on the other schools and other educational establishments although the train will also be open to the public free of charge at certain times and organised parties will be particularly welcome.

One particular aspect of the exhibits are the opportunities to actually operate the equipment and gain some idea of how it actually feels to be faced with, say, a word processor, whilst at the same time representatives from both manufacturers and the Department of Industry will be on hand to answer questions and talk in some depth about their various responsibilities.

At present the MAP Microtrain is at the Reading Motorail dock where it will stay until June 26, after that it moves on to Plymouth, Gloucester, Cardiff and Wrexham, stopping for a week at each place and opening from Monday to Friday. After a summer break the exhibition re-opens on August 31 at Glasgow High Street, and then visits Aberdeen, Dundee, Newcastle-upon-Tyne, Middlesborough, Birmingham International, Liverpool Lime Street, Manchester Piccadilly, Hull and finishing in Sheffield on November 2.

Kenneth Baker M.P. aboard the MAP Microtrain.

Inmos Comes to Market

NEB-sponsored Inmos has appointed two distributors in the UK to handle v.l.s.i. devices now coming off production lines in the USA. They are Rapid Recall, High Wycombe, and Hawke Cramer, Sunbury. European distributors are also being appointed.

First product is a 16K x 1 static r.a.m. to be followed by a 64K x 1 dynamic RAM and a 4K x 4 static RAM.

WORLD SERVICE

Fears that the BBC World Service would be severely cut appear to be ill-founded. Marconi has won substantial contracts for antenna systems for the relay stations in Cyprus and at Orfordness in Suffolk.

It is estimated that the BBC has over 40 million regular listeners overseas plus an even greater number who casually listen.

Avionics Takes a Dive

Electronic fail - safe techniques developed for civil and military aircraft have been adapted by Marconi Avionics for use in remote control systems for oil wells on the sea bed.

First major installation in conjunction with NL Shaffer of Houston, Texas, is now in operation in the BP Magnus oil field.

Mobile Question

The Mobile Radio Committee is reviewing the spectrum requirements for land mobile terrestrial services up to 1000MHz in the United Kingdom up to the end of the century in the light of the outcome of WARC 1979.

Questionnaires will be distributed to representative organisations and individual users about their present and future use of radio channels, but any further contributions will be welcome before the end of June.

They should be addressed to Room 708, Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London, SE1 8UA.

TV/DX Group

A national DXTV (long distance) reception group has been formed mainly under the instigation of George Grzebieniak (RS 41733) from Chiswick, West London. The group has held regular meetings in the London area since February.

Several of the members have already acquired and used a large range of various pieces of TV equipment, ranging from a 5 inch multi-band B/W TV set to a 27 inch full colour model, which incorporates provision for satellite reception. Anyone wishing to contact this group should write to George Grzebieniak, c/o 185 Fleet Street, London EC4A 2HS, enclosing a self addressed stamped envelope.

—ANALYSIS

A BURNING IDEA

Once in a while an idea burns itself into the mind so compulsively it can't be resisted. This was the experience of Paul Galvin just 50 years ago. He had recently set up the Galvin Manufacturing Corporation in Chicago with five employees, hardly any capital and little previous business success. His trade was in radio sets and battery eliminators.

His inspiration was to make the world's first mass-produced car radio. In another brilliant flash, which came to him one morning while shaving, he conceived the name for the product, Motorola, with its subtle suggestion of motion coupled with radio.

Working in an entirely new field, mistakes were bound to be made both in the product and in installation with the result that the burning idea, now converted into hardware, had a habit of catching fire and burning all around it. While Galvin was arranging a loan to finance the venture with a friendly banker, his engineers fitted a radio to the banker,s new Packard car. A nice gesture designed to convince the banker of his sound business judgement. Within half an hour the Packard was a burnt out shell.

Another early user was a Chicago undertaker who had a set fitted in his hearse. On the way to the cemetery one day the hearse caught fire and to the horror of the mourners the intended burial became a cremation.

Despite these and other tragi-comic episodes, Galvin and his small team persisted and eventually overcame the technical problems, establishing Motorola as the number one name in car radio. They even recalled the entire production of one model, salvaged only the valves and speakers and smashed the rest with sledgehammers to preserve the integrity of the name.

In the mid-50s Motorola, by now a great company bearing the name of its first product, had a second testing period. A decision had to be made whether to stay in the semiconductor business with the huge risks involved, or to play safe and get out. The Motorola directors decided to "go for broke" and poured money into the plant at Phoenix, Arizona, with the result we see and admire today.

Paul Galvin, whose first exercise in free enterprise was selling Popcorn from a stall, died in 1959. His story has special significance today because his burning idea and his faith in its success came not in a boom time but in 1931 when the United States was in deep recession with bread lines and soup kitchens a common sight.

Given the idea, the man, and the will to succeed, there is no bad time to start a business.

Brian G. Peck

Changeover from old Strowger to new electronic telephone exchanges is accelerating. Some 2½ million of Britain's 18 million telephones are now coupled via electronic exchanges and present projections are 5 million by 1985 and 15 million by 1990.

Following a partnership agreement with Corning Glass, BICC is to spend £11·5 million on setting up an optical fibre manufacturing plant in the UK, most probably at Shotton on Teesside. Production of 50,000km of fibre per year is planned for 1984.

CB Assault

A major assault on the CB market is being planned by Binatone when citizens band is finally legalised in the autumn (see Radio World).

They plan to launch two models in September and these will be on sale through their usual High Street outlets.

A compact mobile set called "Breaker" will be sold at £59·95 excluding aerial, while a larger mains model will retail at £99.

JAPAN-UK LINK-UP

Britain's Department of Industry and Japan's Ministry of International Trade and Industry have started exploratory talks on joint projects for the future.

Among projects under discussion are computer-aided design and manufacturing equipment, computers, telecommunications and robotics.

Logic in UK

A top figure in world semiconductors and formerly chairman of Fairchild, Wilf Corrigan, is planning to have a UK subsidiary of his new company LSI Logic. Corrigan, British-born and educated, expects to have a UK design centre and manufacturing unit in operation sometime in 1982.

Main manufacturing base for high speed integrated circuits is now being established near Santa Clara in "Silicon Valley". The operation, supported by US and British backers, has recruited top men from the semiconductor industry and has a high prospect of success.

Digital Discs

Philips and Sony will market digital audio disc players by the end of 1982.

The format has been jointly developed from the Philips Compact Disc first demonstrated two years ago, following the cross-licensing agreement between the two companies on video and audio technology. The Compact Disc system finally decided upon uses 16-bit linear coding and like the Philips video disc is laser read.

National Semiconductors has announced a 32-bit MPU hard on the heels of Intel's 32-bit project. Samples should be available to the trade by mid-summer.

The Home Secretary has appointed the Baroness Pike of Melton to be Chairman of the Broadcasting Complaints Commission from June 1, 1981.

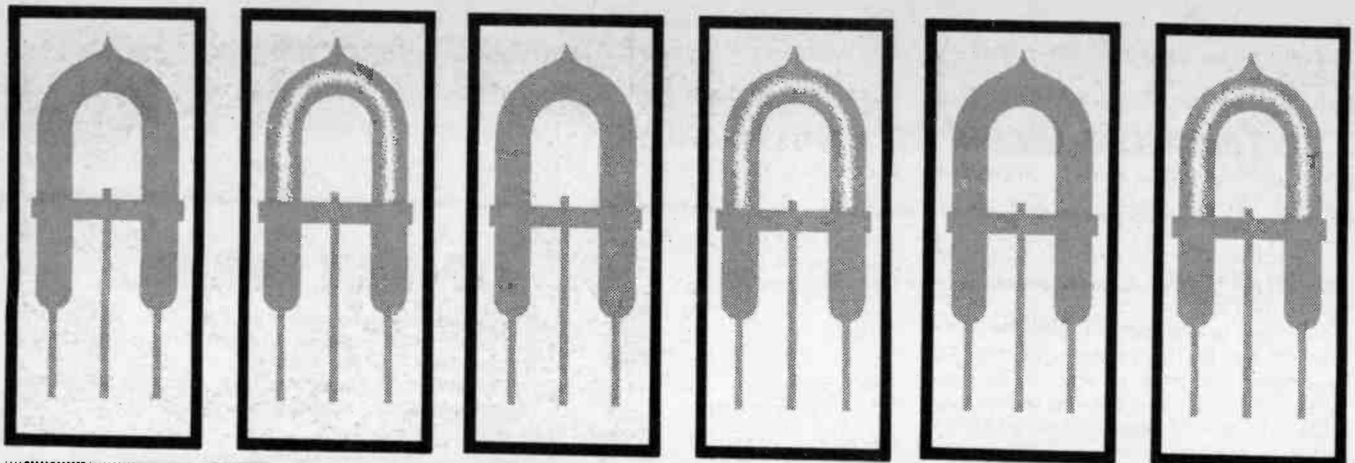
Vertical Player

The first machine in the world to be able to play both sides of a record without it being turned over is the claim for the Sharp VZ3000 Bi-Play Disc Compo System.

The system comprises of a fully automatic 2-speed belt driven vertical 12 inch turntable that detects the size and required speed of the record, and its two linear tracking arms with VM cartridges allow both sides of a record to be played automatically without turning it over.

The VZ3000 unit also incorporates a l.w./m.w./f.m. stereo radio with a 4-track 2-channel stereo cassette deck, featuring the Sharp APSS (Auto Program Search System) that automatically finds the start of a piece of music, and a Dolby noise reduction system with metal tape capability.

The complete system, including speakers, is expected to retail at about £325 and will be introduced in the autumn.



XENON STROBE LAMP

BY J. C. MAY

THE unit described in this article was designed to be used in the workshop, laboratory and garage where timing measurements and observations are to be made on rotating, vibrating and other repetitive motion machinery and apparatus.

The effect of a strobe unit such as this is to "freeze the motion" making it appear stationary when its flashing rate is in sync with the speed of the machinery. Also it will make the machinery appear to be moving very slowly when near-synchronised. With a knowledge of the flashing rate the rotational speed of a motor shaft or pulley for example may be calculated in revs per minute (r.p.m.).

FACILITIES

The xenon strobe can be set to flash at a rate between about 180 and 1,800 f.p.m. (3 to 30Hz). This is accomplished by means of a stable internal adjustable oscillator.

The device is also equipped with an external trigger facility. Maximum external trigger rate must be limited to about 30Hz for regular consecutive flashes. This facility is useful for positional alignment and deviation measurements. This input is also thought to be useful for photographic purposes to serve as an electronic flash although no tests have been carried out to verify this. A short is required between the two poles of EXT. TRIG. to trigger in this mode.

CAR TRIGGER

A further special external trigger is included for use in car timing adjustment. The pick-up for this is from the No. 1 spark plug in the car and this is fed directly to the trigger electrode of the xenon tube. On no account should the previously mentioned external trigger input be used for this purpose.

To make the unit portable and convenient to use, the power supply is derived from four dry cells (total 6V) contained in the case with the high d.c. voltage required being derived from an integral inverter.

Rechargeable cells, type AA, can also be used in this unit and are more suitable for prolonged use. Also, an external power source may be employed via a case mounted socket.

Although the unit could be used for local lighting effects by DJs in discos and by pop groups, it is not suitable for large area illumination due to the limited output power capability.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Xenon Strobe Lamp is shown in Fig. 1. The internal oscillator is formed by IC1, a 555 timer and local components. A train of square waves is produced at its output. The frequency of this train is continuously variable from about 3 to 30Hz by means of VR1.

A second 555 timer i.c. IC2, is connected as a monostable multivibrator. By grounding its trigger input, pin 2, via C2, a single output pulse is produced at pin 3. R4 discharges C2 when not grounded. S1 selects internal or external triggering. The chosen output is differentiated by C4/R6 to produce a positive going short duration spike to reach the gate of CSR1 in the high voltage part of the circuitry.

WARNING

Very high voltages, 400V d.c. and a 4 kilovolt trigger pulse are generated in some parts of the circuitry. If touched a severe electric shock could be received so extreme care should be exercised during the testing of this project. For this reason we feel that this project should only be tackled by the more experienced constructor and beginners are urged to seek the help and advice from such a person before contemplating construction.

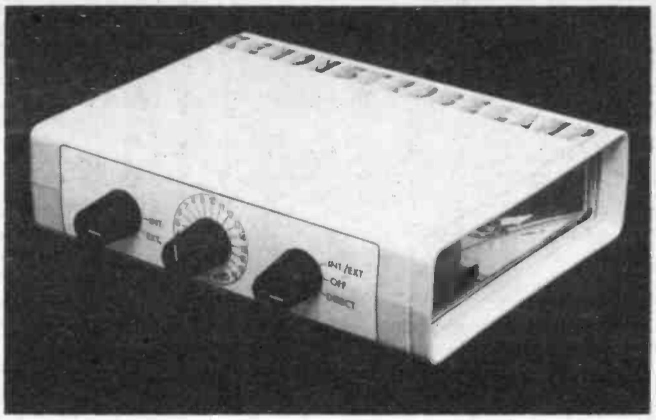
HIGH VOLTAGE CIRCUITRY

The inverter/diode bridge (described below) produces pulsed d.c. about 400V peak across *XY*. C5 charges up to this peak and acts as the smoothing capacitor to maintain a d.c. level of approximately 400 volts.

Capacitor C6 charges towards this value through R7 and T1 primary (CSR1 assumed off at this stage). The charge time is proportional to the values of C6 and R7 and these have been chosen to make this time very much shorter than the internal oscillator maximum frequency, that is $\ll$ 33 milliseconds.

This state of affairs is demanded by the xenon lamp, as a primary voltage pulse on voltage step-up transformer T1 of between 200 and 300 volts is needed to induce the required 4kV pulse across T1 secondary to reach the lamp trigger electrode. On receipt of a positive pulse at CSR1 gate, CSR1 turns on pulling one side of C6, which has been charged to about 300V, down to 0V. The result of this is to cause C6 to rapidly discharge through T1 primary producing the trigger voltage across its secondary winding.

While C6 is charging up, so is C7 through R9 to about 400V and this is applied across the two extreme electrodes of LP1. The 4kV trigger pulse ionises the xenon gas in the tube and current flows through the gas causing brief but intense illumination. CSR1 turns off as C6 discharges allowing C6 to recharge and be ready for the next trigger signal to CSR1 gate terminal.



The energy for each flash was contained in C7 and all is spent when the tube is activated. This energy is given by $(\frac{1}{2})CV^2$ joules, where C is the value of C7 in farads and V is the voltage it has charged up to at the instant of triggering. For values shown, energy equals 45 millijoules.

R9 prevents continued discharge in the lamp between trigger pulses and serves to limit recharging rate of C7. Thus the brightness of the flash is determined by the value of C7 and its maximum repeat rate set by R9 and in this instance by the output impedance of the inverter circuitry. The latter is dominant.

Under no circumstances should an electrolytic capacitor be used for C7 as the high discharge rate could destroy it.

INVERTER

The inverter first stage consists of two gates from IC3, a CMOS hex inverter, cross coupled with C8 and R12 to form a square wave generator. There are two antiphase outputs available at pin 12 and pin 10 and these are buffered by IC3a and b to feed the bases of TR1 and TR2. The outputs are such that TR1 is on while TR2 is off and vice versa.

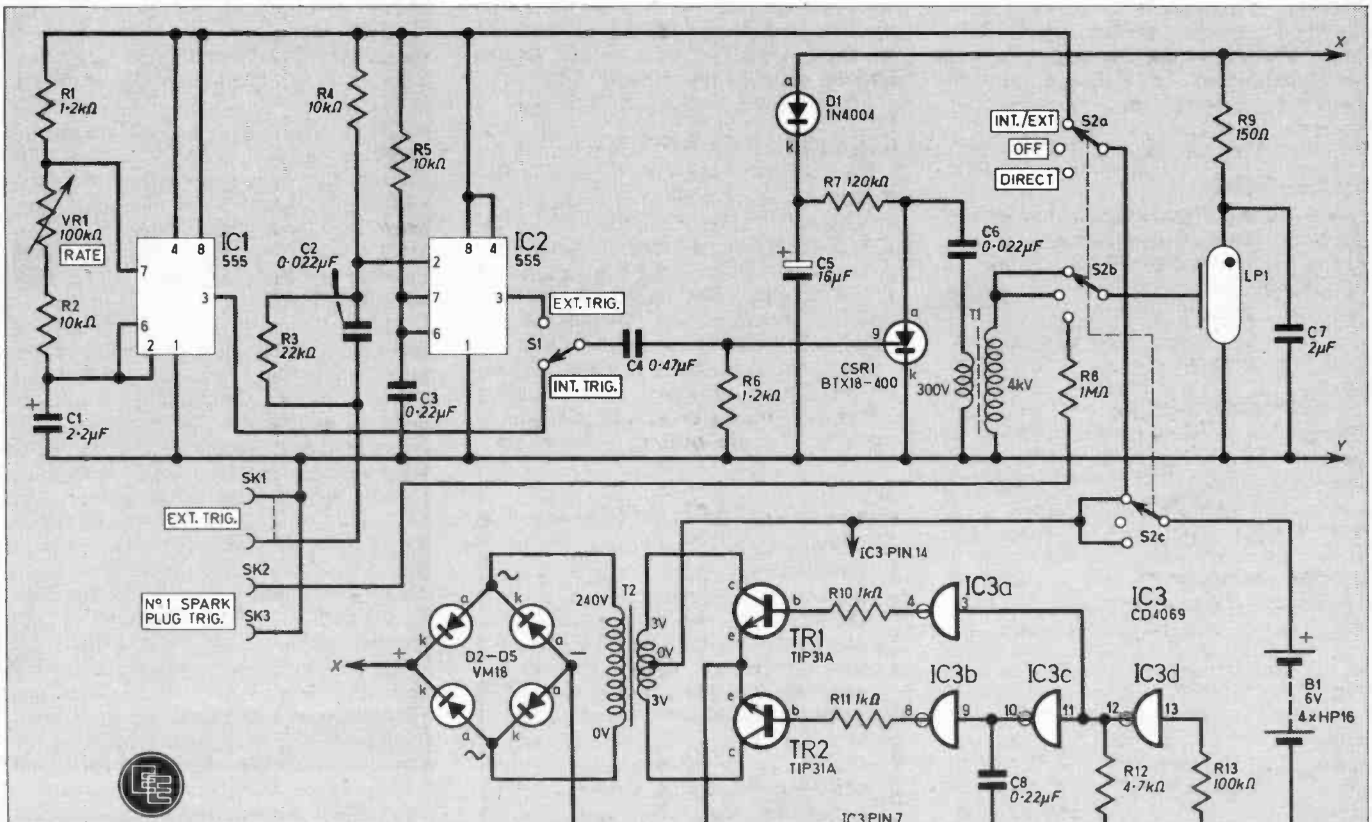
The two 3V windings of T2 form the collector loads of TR1 and TR2 wired as common emitter amplifiers. The flux change in these windings as TR1 and TR2 are alternatively switching on and off causes a much higher voltage to be induced across T2 secondary.

In fact T2 is a low voltage mains transformer being used in reverse. This is fairly inefficient and a switching d.c. supply of 6 volts is required to produce 280 volts r.m.s. across T2 secondary. This is full-wave rectified by D2-D5 to produce pulsed d.c. of about 400V peak and this is fed to the xenon lamp and associated circuitry.

PRINTED CIRCUIT BOARD

Nearly all the components are mounted on a single fibreglass p.c.b., size 160×100mm. The remainder of the components are mounted on the case. The case used in the prototype was a Vero type which has an integral battery compartment to hold four HP7 batteries. HP16 batteries can be accommodated if the connector clips are suitably bent. These are capable of supplying up to 1 amp (according to manufacturer's data sheet) and are therefore able to handle the requirements of the circuit here. Current consumption rises with flashing rate and reaches a maximum of about 500mA for the highest rate.

Fig. 1. The complete circuit diagram for the Xenon Strobe Lamp. Type AA rechargeable cells may be used as the power source.



CONSTRUCTION starts here

CIRCUIT BOARD

The full-size master p.c.b. pattern is seen in Fig. 2; the components mounted on the topside of the board can be seen in Fig. 3, together with wiring to the case mounted controls and sockets.

Sockets have not been used to hold the 555 i.c.s, but for safety in construction, a 14-pin d.i.l. was thought wise for the CMOS i.c.

Order of construction is not critical but it is advised that the four distinct sections of the circuit are assembled and tested separately during construction: (1) internal oscillator, (2) monostable, (3) inverter, (4) high voltage circuitry.

ASSEMBLY

Assemble the components of the oscillator section and connect all flying leads. Solder the appropriate leads to VR1, S1, SK1, and SK2 after they are fitted to the case. Connect a 6V d.c. supply between the appropriate +ve lead and 0V. Observe on an oscilloscope or an l.e.d. with series resistor that a square wave is being obtained from IC1 pin 3 and that this is reaching S1 pole for one of its positions. This will be INT. TRIG. The frequency should increase for clockwise rotation of VR1.

Next assemble the monostable circuit. A scope or l.e.d. at IC2 pin 3 should show a short duration pulse when a wire is touched across the contacts of SK1. Check now that with S1 in its other position, EXT. TRIG., this output reaches S1 pole. Solder C4 and R6 in place and observe that each of these pulses is being transformed to a spike across R6.

These can be seen as kicks on a voltimeter needle. A diode should be temporarily wired across R6, cathode to +ve probe to absorb the negative spikes generated by overshoot from the falling edge of the input pulse to the differentiator, C4/R6.

The p.c.b. has been made to suit a particular make of inverter mains-transformer which had pins suitable for direct insertion into the board when mounted upside down. Alternative fixing and connection arrangements will need to be devised for other transformers. Assemble the remainder of the inverter components.

COMPONENTS approximate cost £12·50 excluding case

For instant observation when the inverter is being tested, a mains neon can be connected to T2 secondary on the underside of the p.c.b. Connect +6V to the inverter positive supply lead on the board and the supply negative to board or terminal. The

COMPONENTS

Resistors

R1	1·2kΩ 2%	R7	120kΩ
R2	10kΩ 2%	R8	1MΩ ½W
R3	22kΩ	R9	150Ω 2W
R4	10kΩ	R10	1kΩ
R5	10kΩ	R11	1kΩ
R6	1·2kΩ	R12	4·7kΩ
		R13	100kΩ

All ¼W carbon ±5% except where stated otherwise

Capacitors

C1	2·2μF 6V tantalum
C2	0·022μF ceramic
C3	0·22μF polyester
C4	0·47μF polyester
C5	16μF 400V elect.
C6	0·022μF 400V polyester
C7	1μF 400V mixed dielectric
C8	0·22μF polyester

See Shop Talk page 472

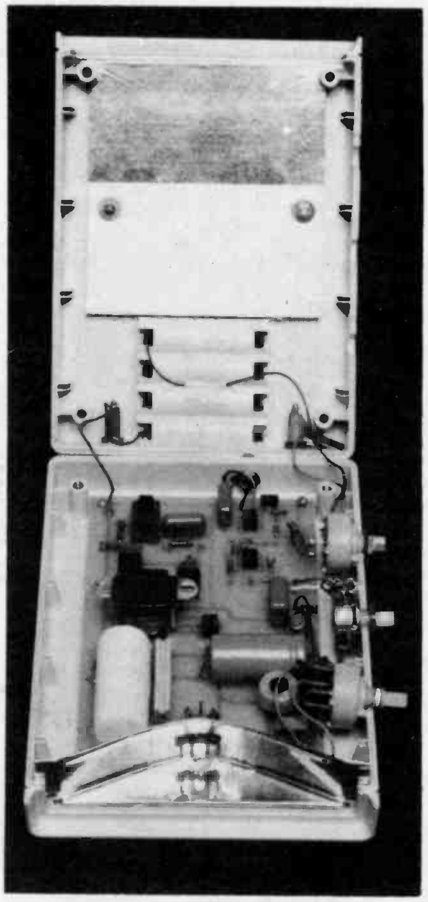
Semiconductors

D1	1N4004 1A 400V rectifier diode
D2-D5	VM18 1A 400V bridge rectifier 4-pin d.i.l.
TR1, TR2	TIP31A silicon *npn* (2 off)
IC1, 2	555 timer i.c. (2 off)
IC3	CD4069 CMOS hex inverter
CSR1	BTX18-400 1A 400V thyristor

Miscellaneous

VR1	100 kΩ carbon potentiometer lin. law
SK1	panel mounting phono socket
SK2, 3	4mm insulated panel socket (1 red, 1 black)
LP1	Xenon flash tube (Tandy No. 272-1145)
T1	High voltage trigger transformer (Tandy No. 272-1146)
T2	Mains primary/200mA 6V centre tapped secondary (used in reverse) (RS 196-268)
S1	Single-pole, two-way rotary switch
S2	Three-pole, three-way plastic rotary switch
B1	HP16 1·5 volt cells or type AA rechargeable cells (4 off)

Printed circuit board, fibreglass size 160 × 100mm; control knobs (3 off); case, Vero plastic box Series II size 190 × 138 × 45mm with integral battery compartment (65-2072D); p.v.c. covered connecting wire.



The completed prototype showing reflector in position and the controls seated in one section of the case. Note that SK2 and SK3 are mounted in the top half of the case as seen.

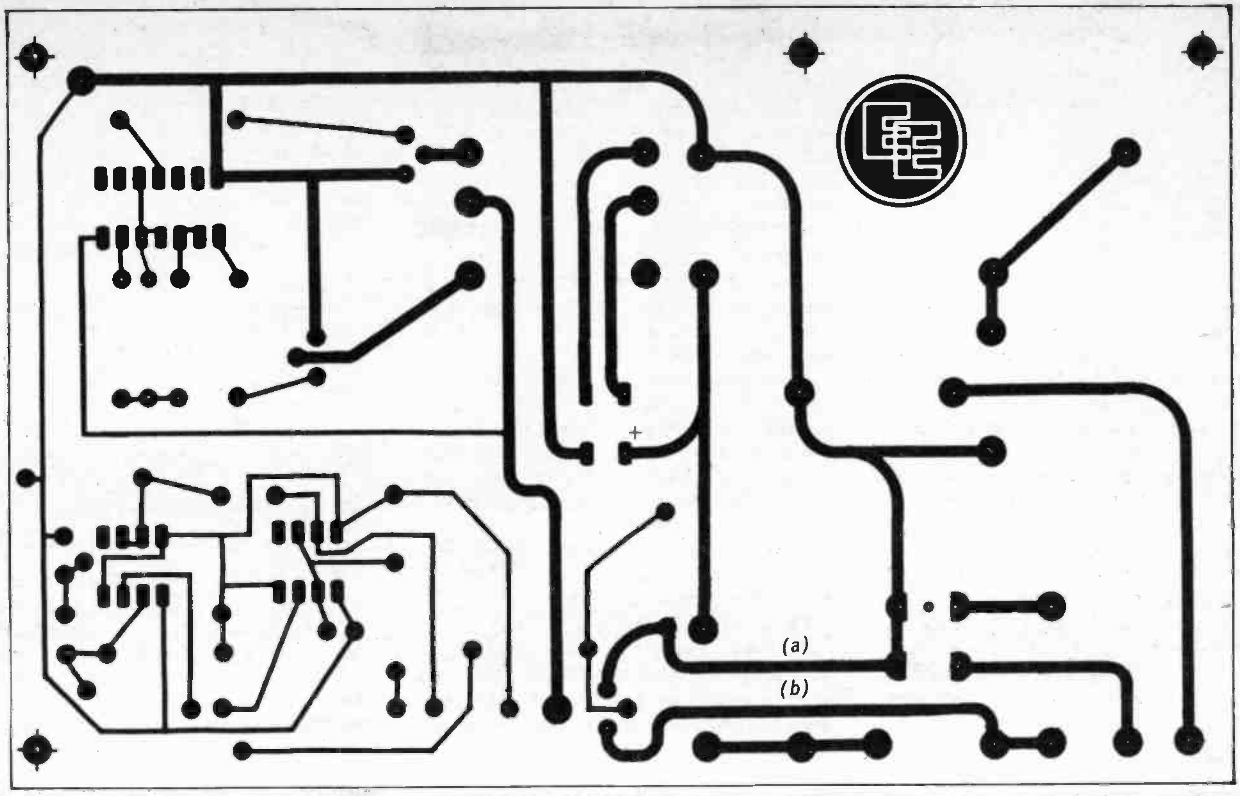


Fig. 2. The printed circuit pattern (actual size) to be etched on the p.c.b.

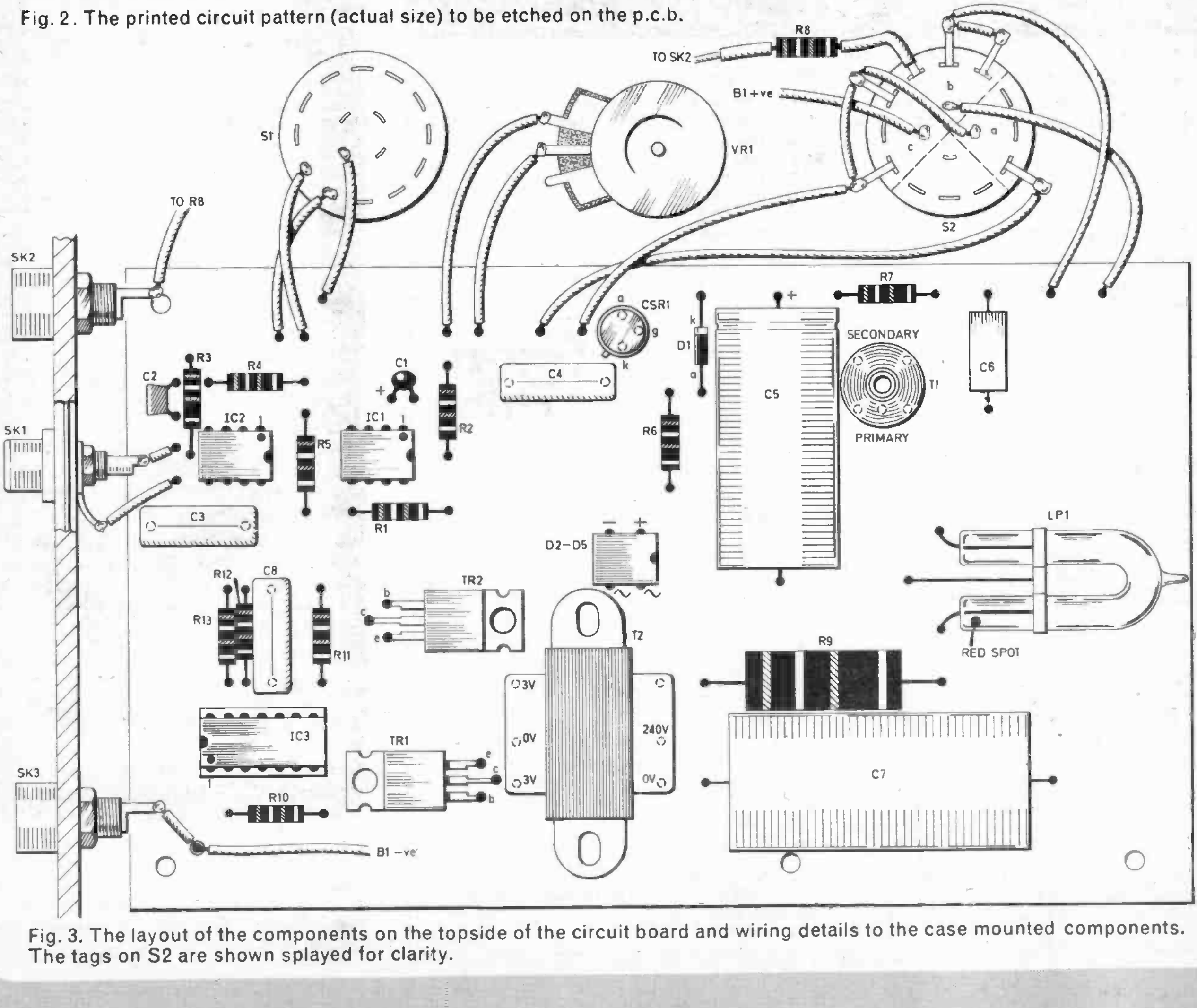
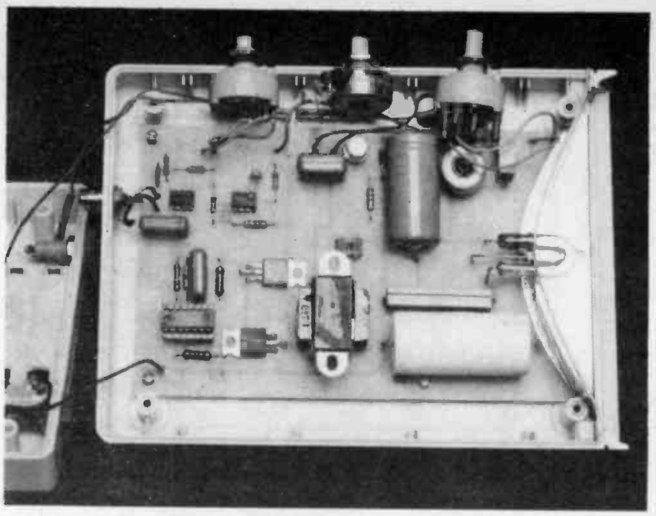


Fig. 3. The layout of the components on the topside of the circuit board and wiring details to the case mounted components. The tags on S2 are shown splayed for clarity.

View of the rear face of the case showing the external trigger sockets clearly labelled.



Plan view of the section of the case which holds the circuit board and emphasises the need for sleeving the tags on S2.

NOTE. The Strobe will work satisfactorily when constructed as shown. However, to keep within the specifications of T1, an additional resistor (330 kilohm ¼W) should be fitted across CSR1 anode and cathode. This will ensure that T1 primary voltage does not exceed 300V. The resistor may be soldered directly to the copper tracks (a) and (b) on the p.c.b. underside. Circuit description voltages assume this resistor is in circuit.

neon should glow brightly and the voltage across this should be about 280 volts r.m.s.

Switch off and connect the bridge rectifier in circuit paying attention to polarity. A "+" is marked on the p.c.b. foil pattern to correspond with the same on the bridge. A d.c. voltimeter set to 400V d.c. or more will give a reading of about 380V across the bridge outputs. Current consumption will be about 100mA if all is well so far.

Finally, assemble the trigger and lamp components. T1 has a polarising leg fitted to one side and this has been accounted for on the p.c.b. so should be straightforward. Pay attention to polarity of the diode and more importantly, C5, the electrolytic capacitor.

XENON LAMP

There is a red spot on the glass tube to indicate its polarity, so pay special attention when fitting this component in place. A pair of pliers should be used when bending the leads on the tube to fit the board in a horizontal position. Place the pliers between the glass and wire bend position. Failure to do this may result in a broken tube.

Connect the remaining flying leads to S2, including the one to the battery compartment positive terminal according to Fig. 3.

All components to S2 must be made using p.v.c. covered wire, and although not shown in Fig. 3, all tags on S2b should be completely sleeved after soldering. Sleeves should also be fitted over the leadout wires of R8, and also its soldered connections to the lead from SK3, and SK3 tag itself. Finally, connect the battery −ve terminal lead to the Veropin on the board.

FINAL TESTS—BEWARE

You will next be testing the board with high voltages about so be especially careful. Keep your hands well away from the tube, trigger transformer S2 and the large capacitors in particular.

Before switching on make up a lead using insulated wire to contain within its length a 10 kilohm $\frac{1}{2}$W resistor. This will be used to discharge capacitors C5 and C7 after testing to make them safe to touch during the later stages of construction. Placing the two ends of the wire across each capacitor in turn will discharge them fully after a couple of seconds.

Set S1 to INT. TRIG. and VR1 fully anticlockwise and S2 to INT./EXT. The tube should flash at regular intervals; VR1 should increase flashing rate for clockwise rotation. If this does not happen switch off, discharge the capacitors as described above and investigate.

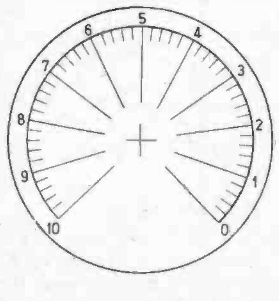


Fig. 4. Scale (actual size) for fitting around VR1, the rate control. This has been drawn to suit potentiometers with 270 degrees electrical rotation.

If all is well check the EXT. TRIG. facility. The trigger input for connection to the car ignition system is best tested in the garage with the unit fully assembled in its case. When doing this it is recommended that the connection between unit and car, and the appropriate settings, are made before the car is started up. Also, use of e.h.t. cable is advised.

CALIBRATION

With the circuit values shown, the theoretical frequency range of the internal oscillator should be from 3Hz to 30Hz (180 to 1,800 f.p.m.) and measurements on the prototype were extremely close to these theoretical values.

A linear scale can be made to encircle the control knob of VR1 over its electrical travel which for many potentiometers is 270 degrees. If this is the case with the potentiometer you have, then the scale shown in Fig. 4 may be used.

The relationship between flash rate and angular rotation of VR1 is given by:

$$f = k \frac{32 \cdot 48}{1 \cdot 06 + r} \text{ Hz}$$

where r is the reading from the scale and k is the correction coefficient to allow for the tolerance on the timing capacitor C1. A spot frequency check will need to be made to determine the value of k using the above formula.

f.p.m. $= 60 \times f$

Periodic time $= 1/f$ secs

Ideally an oscilloscope will be needed for this or a second accurately calibrated strobe could be used for a comparison check. Potentiometers with other angular rotations cannot use the scale in Fig. 4.

A calibrated knob is an alternative to the scale in Fig. 4.

REFLECTOR

For maximum forward transmission of the flash a reflector is needed behind the xenon tube. Ideally, this should be parabolic with the xenon tube at the focal point but this is not very easy to accomplish. Good results were obtained from the prototype which used curved cardboard covered with silvered "Contact" which is an insulator. The latter is self adhesive and is thus easily secured to the cardboard templates. On no account should metal be used for the reflector system shown.

A suitable reflector can be made to suit the specified case and dimensions of this are seen in Fig. 5. It consists of three sections: one is screwed to the inside of the case using the fixings available for a second board; another smaller flat section is glued to the circuit board beneath the xenon tube; the last section becomes curved when fitted in place and a little packing behind its extremes will hold it firmly in position.

The case comes complete with a metal front panel. This is not required and should be replaced with a piece of 1·5mm clear Perspex of the same size, 124×34mm.

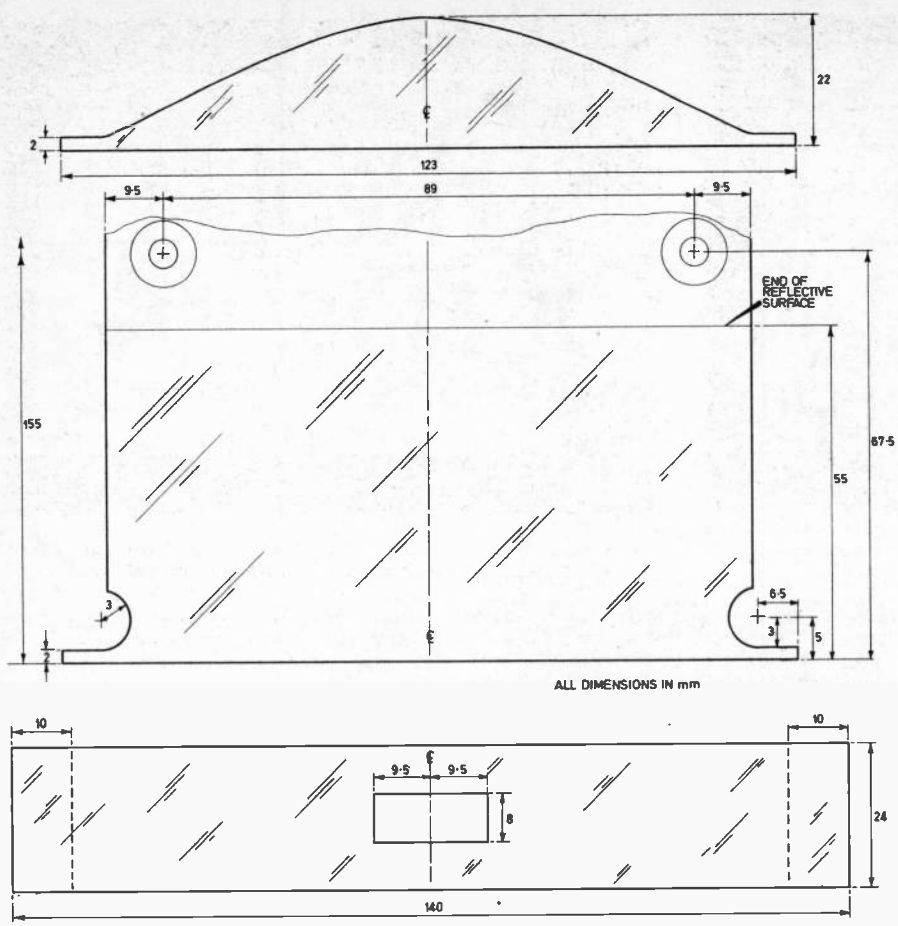
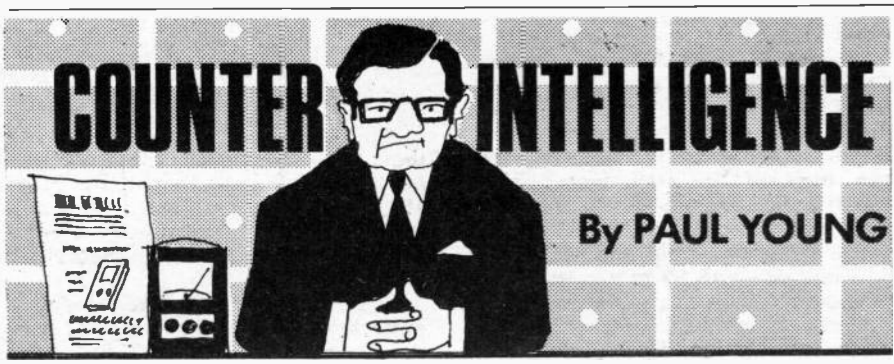


Fig. 5. Templates with dimensions marked for making a reflector to suit the specified case.



Thunder Struck

Regular readers may remember, that a short while ago, I was enquiring if any Doctors could throw any light on the phenomenon of people who suffer stomach upsets during thunderstorms. Imagine my delight when I received three letters, from Flight Lieutenant P. Joiner, Dr. D. G. Mayne and Mr. C. Stone, two of whom are Doctors.

I am still trying to digest all the interesting information they have given me on the subject. I read their letters with great enjoyment and the common factor in their remarks, seems to be, that the effect could be due to too many positive ions which are present in the atmosphere after a storm.

I cannot resist quoting from the delightful ending to Flight Lieutenant Joiner's letter. "Please keep up the good work on EE, I have enjoyed the magazine since day one, it has served as a good introduction to electronics which now involves most of my spare time and too much of my pocket money".

"Ion storms occur at home every time I order some bits, and their effect seems to be a constant vocal discharge of 'No'. Further, I can verify that these attacks are unrelated to weather, situation, time of year or time of day."

Great Achievement

The other day I read an account of a production engineer who was made redundant at sixty. To keep occupied, he made himself a lathe out of an old bedframe and started making bar billiard skittle sets.

These consist of nine small wooden skittles, a small wooden ball on a string, attached to a three foot pole. You throw the ball at the skittles in an attempt to knock down as many as possible.

Within a short while he had orders worth about £10,000. Asked to what he attributed his success he said he thought it partly due to a reaction against all these mechanical and electronic games that have taken over.

Still on the subject of electronics, what a triumph of electronic technology the space shuttle was, even if one computer did go wrong at the last moment and took two days to repair. The most exciting part was the landing, it had to be right first time there was no second chance. Anyone who has flown aeroplanes for any length of time, will at some time or other have been in that position and believe me it can be quite hair raising.

While we cannot help but admit that electronics have immeasurably increased the pleasure we obtain from life, television and music naturally spring to mind, it has not yet reached its full potential. It is bound eventually to lead to a shorter working day, working week, and finally, working life.

Provided those in power, realise in enough time, that this means a reappraisal of our life style, worldwide, and that teaching from an early age, must be orientated to showing the young how to enjoy their increased leisure, then all will be well.

Finally I think of all the applications of electronics, those that are used in the making of various prosthesis, must be accounted among the most praiseworthy. Prosthesis is the technical term for an electronic or mechanical substitute for a missing or defective part of the body.

TOUCH SWITCH WITH VOLTAGE~CONTROLLED CUT~OUT

FOR Ni–Cd POWERED EQUIPMENT

By C.J. Delmege

ELECTRONIC equipment gets smaller every year, bringing higher running costs due to the smaller batteries used. Thus a small radio can, in the author's estimation, easily cost about £7 p.a. to run.

Although expensive initially, rechargeable batteries cost virtually nothing to run and the equipment remains fully portable. The initial cost is recovered in about a year.

Nickel cadmium cells are the most common; direct replacements are available for most dry cells, but the voltage is 1·20 volts per cell (compared with 1·5 volts per cell) dropping to 1·1 volts when discharged. Because of this steady discharge characteristic, the reduced voltage is not a problem in practice. **The voltage, however, must never fall below 1·0 volts per cell, to avoid damage.**

The circuit to be described here prevents this by automatically disconnecting the batteries when the voltage falls below a preset level, while simultaneously functioning as an on-off touch switch. It thus greatly extends the life of the combined volume/on-off controls used in many small radios, where repeated switching on and off wears the carbon track.

CIRCUIT DESCRIPTION

The circuit, Fig. 1, comprises three transisors in cascade. TR1 controls TR2 and TR3, the output switching transistor; TR1 is itself controlled by TR2 via a positive feedback loop from TR2 collector ballast resistor, VR1, to TR1 base via R3.

Initially, all three transistors are off. When the ON plate is touched momentarily a few microamps flow across it to TR1 base and it turns on. The collector voltage falls causing TR2 and TR3 to turn on also. The voltage across VR1 now rises to 4·8V—0·7 volts (0·6 volts across TR1 base/emitter and about 0·1 volts across TR2 collector/emitter). About 0·7 volts (controlled by VR1 setting) is fed to TR1 base, sufficient to keep it conducting.

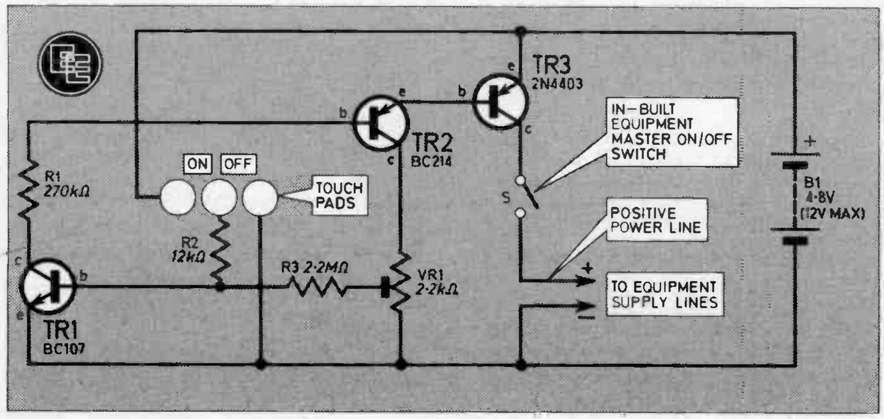
When the battery voltage falls so does the voltage across VR1 and the voltage fed to TR1 base. Eventually, this drops below 0·6 volts, and TR1 starts to turn off, reducing TR2 base and collector currents and further reducing the voltage across VR1. TR1 thus turns off even more and the whole process is rapidly repeated until all three transistors are fully off.

Preset VR1 controls the proportion of the battery voltage fed to TR1 and thus the cut-out voltage. The higher its setting the lower the battery voltage at which TR1 turns off and the circuit cuts out. The OFF plate works by diverting TR1 base current to ground, so turning it off followed by TR2 and TR3 turning off as described above.

Preset VR1 also limits TR3 base current and thus its maximum collector current. Small radios can draw up to 120 milliamps; TR3 minimum h_{FE} is 100, so the minimum required base current is 1·2 milliamp. With 4·1 volts (as would result from a bank of four cells as shown in the circuit) across it, VR1 must be 3·3 kilohm or less. If less, a slightly increased current is drawn from the batteries.

Resistor R3 acts as a buffer between TR1 and VR1, preventing current from the touch plates flowing into VR1 instead of to TR1 base; R2 protects TR1 if the ON plate is short circuited and R1 improves operation of the OFF plate by limiting TR1 collector current.

Fig. 1. The complete circuit diagram of the Touch Switch with Voltage Controlled Cut-Out.



CONSTRUCTION starts here

CIRCUIT BOARD

The unit does not have a separate case as it is intended to be incorporated in the equipment. So first decide where it will be mounted. Standard 0·1in pitch copper stripboard is used and the unit can be screwed in place, wedged with foam plastic, or glued. Component layout is not critical and may be altered to suit. The prototype layout is shown in Fig. 2.

Solder the three resistors in place first, then VR1 and finally the transistors. If the transistor leads are very short use a heat shunt on their leads to prevent thermal damage.

The prototype unit consumed less than 20 microamps when in the OFF state and so was connected direct to the batteries. The positive battery lead to the equipment should be disconnected from the batteries and joined to the "positive power line" in Fig. 2.

Drawing pins, or brass carpet tacks, make a neat form of touch plate. Drill three holes in the equipment case to suit the three drawing pins (or in a piece of insulating material, such as Formica). Then tin the stems of the tacks and push them into the holes. Now solder the touch plate wires to the tips of the stems protruding through the case. The pins can easily be made a tight fit by thickly tinning the whole stem, then filing to the required thickness. The head of the ON pin can also be tinned to distinguish it from the other two.

SETTING UP

Ideally, some form of variable voltage is required for setting up, otherwise a set of fully charged and a set of discharged cells will be needed.

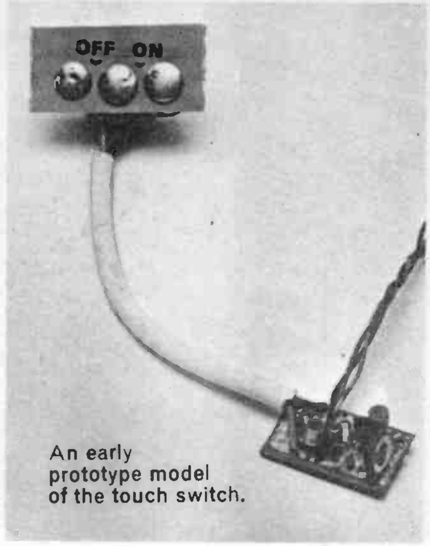
Set VR1 fully anti-clockwise then advance it about 20 per cent of its travel. Set the supply to the fully charged total cell voltage (1·2 volts/cell) and connect to the circuit board. Now check the touchplate operation.

If VR1 is set too low the circuit will only remain on with a finger held on the ON plate, while if it is too high the OFF plate will not work. Now set the battery voltage level to the total discharge value (1·1 volt/cell)—the cut-out level. Slowly reduce VR1 until the circuit cuts out. VR1 is very sensitive, so repeat the operation a few times.

Note that the circuit is sensitive to both electrical noise and moisture. When VR1 is correctly set, lock it with a little candle wax. Before final installation, cover the copper strips with masking tape.

MODIFICATIONS

The transistors listed will give the best performance. However, most high-gain silicon transistors will work well. To minimize leakage current when the circuit is off TR1 should be a really low-leakage type. If the equipment is left idle for a lengthy period put the in-built switch to off.



An early prototype model of the touch switch.

This will reduce current consumption.

The maximum recommended voltage is 12 volts. As voltage is increased the sensitivity of VR1 increases. This may be reduced by including a series resistor of not more than 3 times the value of VR1 between VR1 and TR2. So in Fig. 1 VR1 could be 1 kilohm in series with a 1·2 kilohm (so TR3 base current remains the same).

Many radios have a socket for an external power supply. This has an integral switch to disconnect the batteries when a plug is inserted. If it is to be used for recharging with batteries in situ the integral switch must be bypassed.

HIGHER CURRENT OPERATION

With the listed component values TR3 will supply about 150 milliamps at 4·4 volts, rising to almost 300 milliamps at 8·8 volts, which is a sensible limit for continuous operation. (I_C max is 600 milliamps). For currents up to 600 milliamps replace TR3 by a 2N2905 with a cooling clip, and reduce R1 and VR1 proportionately to increase base current to TR2 and TR3. Alternatively a suitable relay can be connected to TR3 if space permits.

When used with dry batteries set the cut-out voltage level to two-thirds of the nominal battery voltage.

If leakage current becomes a problem in very humid conditions, it may be virtually eliminated by connecting a 1 megohm resistor between TR1 collector and the positive rail.

If the touch switch is to be operated in a unit using a mains derived power supply, hum pick-up may sometimes cause erratic operation of the touch plates. This can be cured by connecting a 0·1 microfarad capacitor across the ON touch plate. It may be mounted either directly behind the touch plates, or on the board itself. ⌑

COMPONENTS

Resistors
R1 270kΩ
R2 12kΩ
R3 2·2MΩ
All ¼W carbon ± 5%

See Shop Talk page 472

Semiconductors
TR1 BC107 *npn* silicon
TR2 BC214 *npn* silicon
TR3 2N4403 *pnp* silicon

Miscellaneous
VR1 2·2 kilohm vertical miniature preset
Stripboard: 0·1 inch matrix, 7 strips × 10 holes; drawing pins (3 off); connecting wire.

Approx. cost Guidance only £1.00

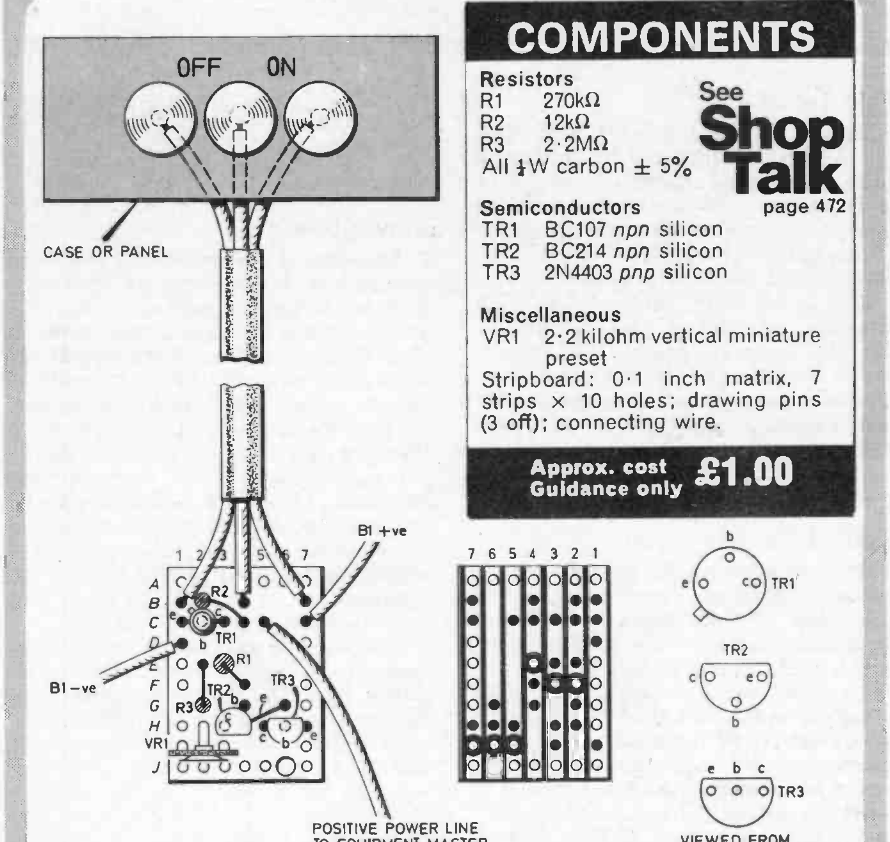
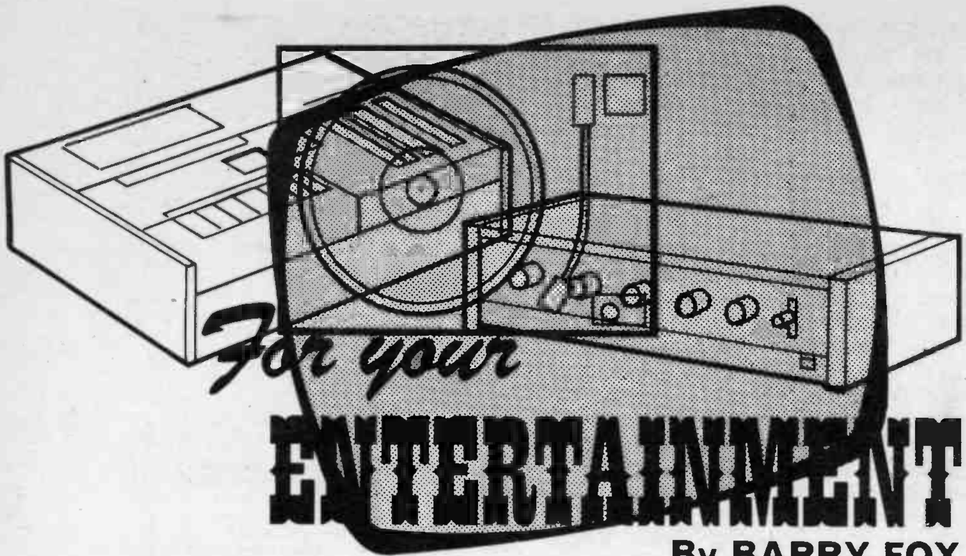


Fig. 2. Circuit board layout and interwiring of the unit.



By BARRY FOX

Keep Music Live

The Musicians' Union slogan is "Keep Music Live". Every time a club or pub plays tapes or discs instead of booking a band more work is lost to everyday working musicians.

Singers now often carry cassette tapes of pre-recorded backing tracks round with them. To perform live they sing into the microphone while the tape is replayed over the house sound system.

Although it costs the artist money to have the backing track tape professionally made, it guarantees a good backing wherever they go. And it also saves the promoter money.

In Japan, where almost everyone seems to fancy themselves as an amateur singer, domestic amplifiers are now on sale which incorporate a "voice cancelling" switch. This reverses the phase of one of the two stereo channels and subtracts it from the other. So any equal-level, in-phase material is eliminated.

On most commercially available recordings the solo voice is usually recorded at "centre front", and thus at equal-level and in-phase between channels. So the voice cancelling circuit usually removes the solo voice and leaves the backing. The proud owner of the amplifier can thus sing along with some of the world's best backing orchestras.

So far these amplifiers haven't yet appeared on the UK market. When they do they make the Musicians' Union job even more difficult.

Recently the Union had a dispute with the Royal Court Theatre management. The theatre was putting on a play about entertainment clubs and wanted to use a pre-recorded tape of musical accompaniment for the singers appearing in the club depicted in the play.

The theatre's argument was that because clubs so often use pre-recorded backing tapes it would be unrealistic for the theatre to employ a live band. The Union pressed its case but the Royal Court insisted on using the tape. Finally a compromise was reached; The theatre used the backing tape for the play but paid an equivalent number of musicians not to play.

It isn't only pre-recorded backing tracks that worry the Musicians' Union; it's also the replacement of live bands with discos. Although (speaking as an ex-musician and ex-MU member) I'm all for keeping musicians in work, the sad truth is that live music is all too often an anachronism.

There is just no way that a three or four piece band can replicate the sound of a multi-tracked studio recording. So a band is only better than a disco if it is playing fresh music, or well known music in a fresh style.

Unfortunately this happens only occasionally. All too often a tired and inappropriately small band churns out unenterprising and anaemic mock-ups of top twenty tunes. The best part of the evening may well be when the band takes a break and the management puts on records.

Also recorded music has the advantage that it always starts on time. How often have you arrived at a pub, club or show at the scheduled start time, and then had to wait for the musicians to arrive piecemeal and set up their equipment, while the manager bites his nails and worries himself sick?

Two items, adjacent on the agenda of a recent Musicians' Union meeting say it all. They also help explain why electronics and recorded music are taking over, and why live music is dying.

In the first motion the Central London Branch of the MU was asking to vote that "where musicians are engaged to fulfil casual dance engagements in the Greater London area and are called early for the purpose of setting up equipment or for other reasons, they shall be paid at the appropriate hourly rate from the time at which they are called irrespective of whether or not they are required to play". In other words a promoter, already hard pressed to pay for a live band instead of much cheaper electronic canned entertainment, would have to pay even more to ensure that the band started playing as promptly as a gramophone record!

Perhaps mischievously, the very next motion on the agenda called for "an open meeting" because "this Central London branch is concerned at the deterioration in the casual dance business". In other words there is concern that more and more promoters are abandoning live music and opting instead for pre-recorded music which is available, cheap and punctual, at the flick of a switch.

Fast Talker

Some of the more exotic JVC VHS video recorders now incorporate an interesting audio circuit. This enables the video tape to be run at twice the normal speed to produce twice normal speed pictures on the screen, and sound reproduced also at twice normal speed, but at *normal* pitch.

This is no mean technical task. The necessary audio circuit was developed in the USA by a company called Variable Speech Control and is being licensed to an increasing number of companies for incorporation in audio and video equipment.

Donald Duck

Normally when a video or audio tape is run at twice normal speed, the sound is reproduced at twice speed with all the frequencies doubled to raise its pitch by an octave. This creates a Donald Duck sound which renders speech virtually unintelligible.

Anyone with a two speed tape recorder will already know the effect well. But by making a fairly rough and ready conversion of the sound into digital code, it is possible to reduce all frequencies by a half. So the sound reproduces at twice normal speed with the pitch normal. The rough and ready digital conversion loses some quality but not enough to detract from intelligibility of the speech.

Slow Classic

According to the professional magazine, *International Broadcasting*, the VSC company has carried out research in the USA which suggests that the human brain is most comfortable when processing verbal information at around 250 to 300 words a minute, or twice the average speaking rate. At this speed, say VSC, comprehension increases since concentration improves.

I can vouch for this from personal experience. I've used a VHS machine with just such a circuit and found it very useful for scanning through video tape that I needed to watch for work, rather than entertainment for example, to cull a few facts from a televised interview.

However, I do have reservations over the suggestion, quoted by International Broadcasting that "Old movies are often quite slow paced, and viewers will find the show more lively if they increase the playback speed". I shudder to think of people watching classic movies like *Citizen Kane*, *The Maltese Falcon* and *Casablanca*, at twice normal speed. It's the slow pace of these classics that has made them classics.

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RADIO WORLD

By Pat Hawker, G3VA

The CB Proposals

This issue by the Home Office Radio Regulatory Department of draft "performance specifications" for equipment for what has now officially become "the Citizens Band Radio Service" ("Open Channel" is apparently now a closed bookl) has at last shown clearly what, unless there are yet further changes of mind, will be with us legally later this year.

Two separate specifications cover 27MHz "angle modulated" (frequency or phase modulated) equipment and 934MHz angle-modulated equipment. The onus is placed on the "manufacturer, assembler or importer" to ensure that the CB equipment he sells conforms with the specifications together with "any additional requirement imposed by regulations under the Wireless Telegraphy Act 1949".

Equipment will not have to be type-approved by the Home Office but the industry itself will be responsible for carrying out any measurements and tests to ensure compliance with the specification: such equipment can then be indicated by an authorised mark stamped or engraved on the front panel, including the letters CB in a circle.

All CB equipment—hand-held, mobile or "base" stations—must be covered by a licence and it will be a condition of this licence that "the apparatus fulfils, *and is maintained to,* the minimum technical standards of the specification." For the user, this could be an important condition since performance of mobile equipment can often degrade quite rapidly in the hostile environment of a vehicle.

Equipment

On 27MHz there will be 40 channels allocated each with 10kHz spacing: thus Channel 1 will have a nominal carrier frequency of 27·60125MHz; Channel 2 27·61125MHz; Channel 3 27·62125MHz and so on up to Channel 40 27·99125MHz. Output r.f. power is limited to 4 watts, which one would expect to be about equivalent to around 7 watts d.c. input.

It is worth noting that, in amateur radio practice, it is d.c. input power that is normally specified for f.m. transmitters. This power is intended to provide a limit of 2W effective radiated power with specified aerials.

However, if the aerial is mounted at a height exceeding 10 metres "the licence will require a reduction of transmitter power of 10dB". For this reason firms are expected to offer 10dB attenuators as a standard accessory.

UHF Equipment

The allocation at u.h.f. is now given as a full MHz at 934MHz with equipment expected to be sufficiently stable to permit working with 25kHz separation between adjacent channel carrier frequencies, although the draft specification shows 20 channels with 50kHz spacing. The Home Office people assure me that this was not a mistake but rather that it is hoped that it will prove possible eventually to operate this band as a 40-channel system if, in practice, stability of the equipment shows that this can be done.

In the draft specification, Channel 1 is 934·025MHz; Channel 2 934·075MHz and so on up to Channel 20 934·975MHz.

On this band r.f. output power is limited to 8 watts and the effective radiated power (ERP) limit is 25 watts, indicating that directional aerials of moderate gain will be permitted. For equipment with an integral aerial the ERP is limited to 3 watts; this provision is clearly intended to apply to hand-held equipment where it is sensible to protect the eyes against excessive radiation levels; the specified power seems a logical choice.

Range

On 27MHz an effective radiated power of 2 watts f.m. could, at certain times of the day, during certain seasons, and during years of high sunspot activity be capable of providing (in the absence of local interference) inter-continental communication, although clearly the Home Office proposals are designed to discourage rather than encourage this. Indeed, one feels that for those who seek long-distance communication, an amateur radio licence is the right answer. Additionally, on many summer days, it would be sometimes possible with this power to work over ranges of some hundreds of miles by taking advantage of the wafer-thin Sporadic-E ionic layers brought about by windshears high above the Earth.

In practice, both bands should be capable of providing useful communication ranges from and to mobile units; the main snag with 934MHz being the expense. A low-cost solid-state transmitter capable of providing 8 watts of r.f. output at this frequency would be quite a challenge, and one suspects that it will be some time before equipments of this power are marketed.

Other Provisions

Equipment need not, of course, be suitable for use on all allocated channels on either 27MHz or 934MHz and indeed hand-held equipment may make provision for transmission on a few, or even only one, channel.

No CB equipment will be permitted to contain facilities for transmission on frequencies other than those specified for CB, and this would thus seem to rule out any equipment in which transmission is also possible in the 28MHz amateur band. Another general point is that "controls which if maladjusted might increase the interfering potentialities of the equipment, shall not be easily accessible."

Most of the pages of the Home Office draft specifications are taken up with detailed information on how manufacturers can check that their equipment complies with the specifications. It perhaps needs to be emphasised that so far these specifications are still only "drafts "and may possibly be modified.

Critical Response

One notices that the response from the various organizations promoting CB has been in general critical, mainly because the 27MHz channels have been shifted up in frequency compared to those used in other countries. This will mean that even if modified for f.m. operation, existing "illegal" CB equipment will remain illegal. Whether it would be possible to further modify these for the proposed British channels and *also* meet the performance specifications probably depends on the equipment, but almost certainly would not often be possible.

Apart from the question of the "illegal" sets, the British channels will make it more difficult for sets carried in cars travelling overseas to make contact with "the natives" but this would probably be illegal anyway unless specifically permitted by the countries concerned. On the other hand it should decrease the chances of interference to radio-model controllers *(remember, only model aircraft are permitted to use the new allocation of 35MHz)* so they are likely to welcome this degree of protection.

Social Problem

On the other hand, the placing of CB channels right up to 27·99125MHz will bring them right alongside the amateur 28MHz band. This is bad news both for the amateurs and for the CB enthusiasts. In fact the amateurs, through the Radio Society of Great Britain, had specifically asked that CB should not be located too close to an amateur band.

The proposed arrangement seems certain to result in considerable mutual interference in those cases where a CB base station is located close to an amateur station legally using relatively high-power in the 28MHz band. Such transmissions seem bound to overload or swamp nearby CB equipment; further since the amateur may well be seeking very weak signals, the out-of-band radiation from even a low-power CB rig may affect his working. Taken together this adds up to all the elements of a considerable social problem, with both CBer and radio amateur operating within the terms of their licences, yet each interfering with the otherl

Workable Service

Apart from these frequency problems, I feel that the Home Office proposals provide a workable basis for what one hopes will be a useful, enjoyable and worthwhile CB service.

If only these proposals had been put forward in 1977 most potential users would have been very happy indeed! It has been the many delays and changes that have brought about so much hassle—and has also had the unfortunate effect of making it seem that if enough people break the law, then laws will be changed accordingly. So let us hope that no further time is lost.

CHIP SHOP KIT

MANY readers will already be familiar with the range of non-soldering plug-in electronic construction kits distributed in the UK by Electroni-Kit Ltd. Now in response to many requests, they have developed a new range of simple soldering type kits, known as CHIP SHOP KITS. These are inexpensive, the highest priced being only £5. We have seen them all and believe them to be good value for money.

Besides being useful, these projects would also serve as a good introduction for anyone wishing to embark on the hobby of electronics.

At present there are 20 different kits in the series, 18 of these being constructional projects and in some cases two projects in one kit. It is expected that the range will be expanded later and will include some i.c. based projects.

A soldering iron is a basic requirement for the assembly of each of these, so it seemed logical to include such a tool in the range. In this kit there is a British soldering iron, a 1 amp fuse, some solder and instructions on basic soldering techniques. The remaining kit contains some more tools: a pair of wire strippers/cutters, tweezers, magnifying glass and emery paper—other necessary tools for construction—together with instructions on their use and application. See page 444 for a list of the kits in the CHIP SHOP SERIES.

CONTENTS OF KIT

All projects are based on p.c.b. which is supplied ready etched and drilled. The kit contains all the components necessary to produce a working model, and including, where appropriate, loudspeaker(s), and in all but one kit a brightly coloured plastic case. All cases have an aperture for the loudspeaker which is "snapped" into position thereby eliminating the need for any form of hardware fixings, cutting or drilling thereby keeping construction as simple as possible. A neat solution!

Full step-by-step assembly instructions, a description of how the circuit works, circuit diagram, p.c.b. layout drawings and component list accompany each kit safely packaged in a polystyrene box. Resistor values are supplemented by their colour coding for easy identification—a most helpful addition especially for the beginner.

NO PROBLEMS

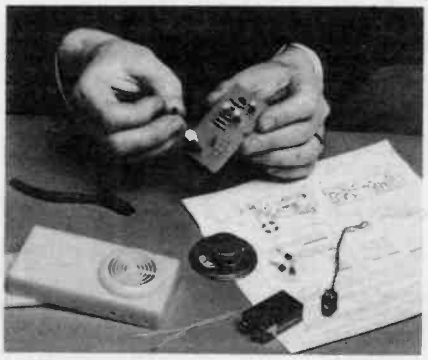
We chose a kit at random to build-up No. 16, American Police Siren. We followed the instructions and found no difficulties in understanding them or in the construction itself. Detailed help in identifying components is provided in the text which is especially useful for some of the small capacitors one obtains these days originating from foreign parts. Often the value is obscure being coded with other numbers on the body. This confusion has been eliminated here.

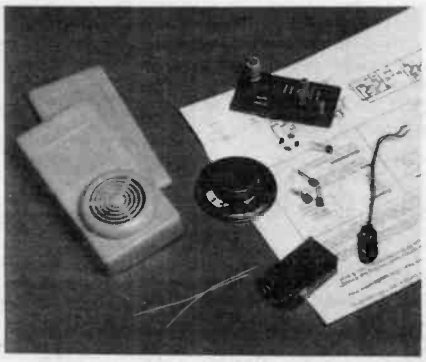
After making the final connection the battery was quickly connected and it worked—not an exact replica of the American Police Siren sound, but close enough to it nevertheless.

We were a little disappointed that the battery would not fit inside the case (with lid on) however we juggled with board position—and also that to turn the unit off the battery clip had to be disconnected. For some reason switches have not been made part of some kits including this one.

AVAILABILITY

CHIP SHOP KITS are not available by mail order from Electroni-Kit, but are being made available through Hobby Shops and Electronic Stores throughout the UK. If you find difficulty in locating a stockist in your area, contact Electroni-Kit Ltd, Rectory Court, Chalvington, Hailsham, East Sussex BN27 3TD.





SQUARE one

CAPACITORS come in a bewildering range of types and sizes mainly because, unlike resistors, it is impossible to devise a single method of construction that will yield a sufficiently wide range of values and working voltages.

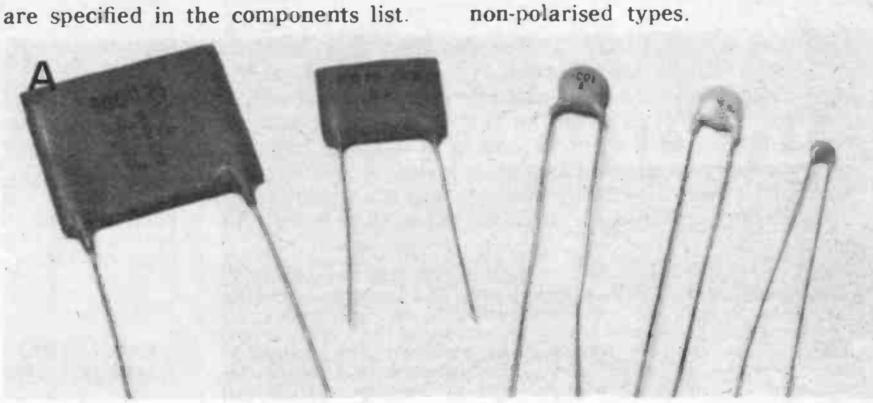
A capacitor consists of two plates of conductive material separated by an insulator or dielectric. It is the combination of materials for these two elements that causes the confusion.

Besides its value, a capacitor also has a working voltage and tolerance. If either of these are important, they are specified in the components list.

Another major division is polarised and non-polarised types. Generally the polarised types are large in value and must be connected up correctly. Variable capacitors form yet another class on their own.

Within the above parameters, a capacitor is often chosen because of its size and stability. This being the case, it means that virtually any capacitor with the same value and the same or a higher voltage rating will work in a given circuit and this should be borne in mind when experimenting with spare or surplus components.

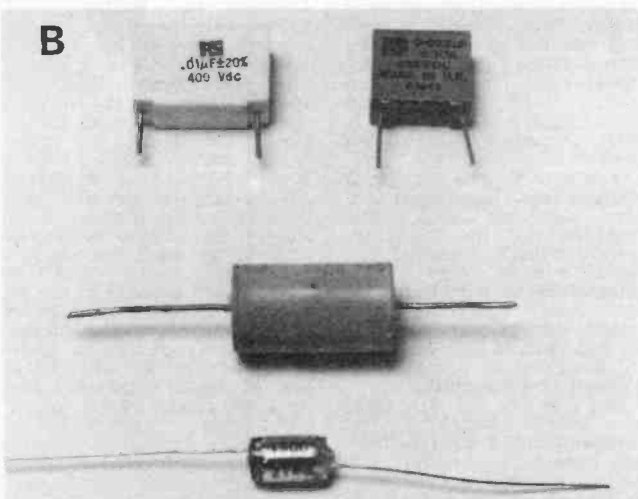
This month we look at the various non-polarised types.



A The two capacitors on the left are **silvered-mica** types. These are available in values up to about 10,000 picofarads and are used where high stability is required, such as in tuned circuits. Tolerance is very close, typically 1 per cent, and working voltage is typically 350V.

The next two along are **disc ceramics.** Although they are both similar in physical size, the one on the left is a 0·001μF, 750V type and the other a 0·1μF, 18V type. This shows clearly the trade off between value and voltage common with capacitors. Tolerance here is a very wide.

The capacitor far right is a **resin dipped ceramic** type for use where small size is mportant. Tolerance is 10 per cent.

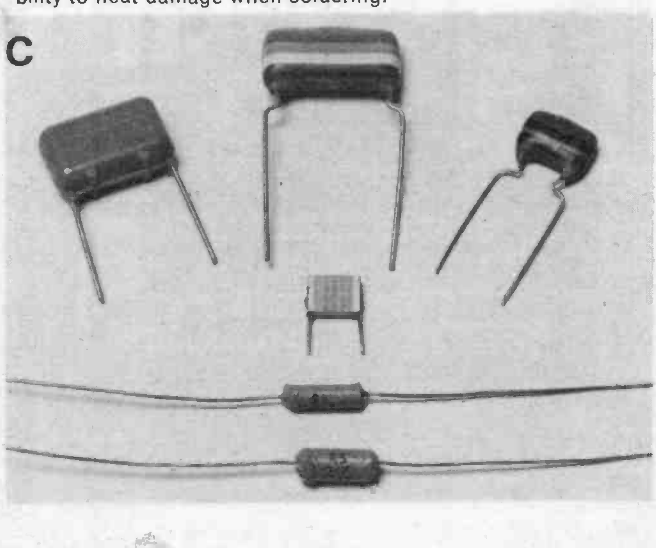


B A selection of different **plastic dielectric** capacitors. Top left is a **metallised polypropylene** film capacitor encapsulated in a flame retardent plastic case. This is a general purpose type of device, tolerance 20 per cent and voltage rating 400V d.c.

Next to this is a **polycarbonate** type. This has similar properties to the polypropylene types and also comes in a flame retardent case although some examples are available in cylindrical cases with axial leads. These capacitors are not recommended for continuous working on mains supply lines, but are particularly suitable for timing circuits.

Below these is a **mixed dielectric** capacitor. It is built from an impregnated paper/foil construction and can be used in a wide variety of applications. It is packaged in a polypropylene case and is physically larger than the metal film types. Working voltages can range up to 1000V d.c. and tolerance is 20 per cent.

The device at the bottom of the picture is a **plain foil tubular** capacitor with **polystyrene dielectric**—polystyrene for short. These can be used as a general purpose low value type where tolerance is not so important. They are physically smaller than mica types with much the same range but tend to be available only with low voltage ratings (160V d.c.). In fact tolerance is still very good at 2½ per cent and the only real drawback is a susceptibility to heat damage when soldering.



C Various forms of **polyester** capacitor. Top left is a moulded case metallised type with radial leads. This is a useful general purpose device with a tolerance of 20 per cent and working voltage up to 400V d.c. There are no problems in identifying the value as this is actually moulded into the case itself.

Next to this are two miniature dipped case types. They are wax treated and covered with a hard lacquer. The various coloured bands represent the value of the capacitor in nanofarads using a similar code to the resistor one. The two top bands give the first two digits, and the third the multiplier. The actual colours are identical to those used for resistors. A fourth band gives tolerance and the fifth the working voltage, red for 250V, yellow for 400V d.c. These capacitors are often referred to as C280 types and are designed for general purpose applications.

The small device in the centre is a miniature layer type. This gives a superior tolerance of 10 per cent as well as small physical size and an improved operating temperature range.

The two devices along the bottom are both miniature sleeved types. They are protected by a shrunk-on plastic sleeve and are designed to give rapid recovery from adverse environments. They are available in a small range of values with voltage ratings up to 750V d.c. Tolerance is 20 per cent.

Semiconductor News

LUCY—THE VIEWDATA SYSTEM OF THE 80s

A revolutionary new integrated circuit system has just been announced by **Mullard** and they describe it as "without doubt the definitive solution to viewdata problems for this decade".

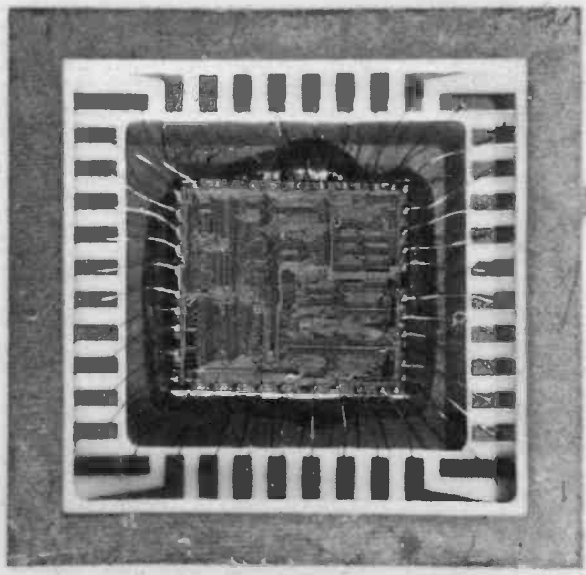
The heart of the system is the new **SAA5070** control chip code named LUCY. This is designed as a dedicated integrated circuit for viewdata-type applications and is intended specifically as a microprocessor peripheral. In previous viewdata systems the central processor was surrounded by a whole host of peripheral chips including information converters, UART type devices and other control chips. Even then software space has been limited and little has been spared for anything other than basic functions.

However, the LUCY chip combines most of these functions and is able to take the pressure off the processor in terms of time and software. It also provides other features not previously incorporated into viewdata decoders. In fact Lucy can be considered as an interface between the processor and the outside world.

One outstanding feature of this system is its compactness, so much so that the i.c. package count for basic viewdata acqusition is reduced to only four including the SAA5070 and the central processor, 8048. A further advantage comes from the fact that the accent is very much on the system software. The basic and optional features are all under the control of the microprocessor and are determined by the software that sits in the ROM so the same LUCY chip can be used for all systems.

Furthermore, a user who needs a simple system is not paying a loaded price for features he doesn't need, and the more sophisticated user gets the extra facilities at no extra cost.

The SAA5070 chip is in production now and already orders are being received. A three-module viewdata system based on the chip is in an advanced state of development and should be available next year.



A look inside LUCY—the Mullard SAA5070 i.c.

HIGH PERFORMANCE MPU

Following the success of their Z80 CPU, **Zilog** have now announced the **Z800**, a high performance 8-bit microprocessor, binary code compatible with the Z80.

Quite part from this compatibility, the Z800 features multiply and divide instructions, three times performance improvement over the Z80, 8 and 16-bit bus versions and on-board memory mapper for 4 megabyte address space. The Z800 will be available in this country from mid 1982.

CAR RADIO AMPLIFIERS

The monolithic i.c. power amplifier makes audio stage design very simple, a fact that has not been missed by manufacturers of consumer equipment. Not only are design and construction costs lower, but reliability is also increased—always a good selling point.

It is with this in mind that **Mullard** have introduced two new amplifier i.c.s, the **TDA1020** and the **TDA1510.** They are both designed for use in a wide range of car entertainment equipment and many different configurations are possible with the two circuits both of which are designed to run from a nominal 14·4V supply.

The first i.c., the TDA1020, is a single channel device incorporating a preamplifier and power amplifier. A simple control circuit may be placed either before or after the preamplifier and the overall voltage gain is 49dB. This means a power output of 12W into a 2 ohm load.

The other device, the TDA1510, is aimed at the up-market high quality equipment manufacturer. It comprises two power amplifiers delivering 12W each, which can be connected as a single channel circuit delivering 24W into a 4 ohm load.

This particular i.c. features variable gain, fixed by an external resistor and allows high quality control circuits to be connected in front of the device.

Both circuits are fully protected and are not sensitive to interference and car ignition signals. They also feature low output noise and distortion.

COMPUTER CHIPS

Another new product from **Zilog** is the **Z6132**, a high-density byte-wide quasi-static RAM. This new device has a 4K-bit capacity and conforms to the JEDEC 2716 28-pin package standard. Operating voltage is 5V and the chip consumes about one-sixteenth of the power needed by an equivalent type RAM array.

Although this device is a dynamic memory, it nevertheless behaves like a static device as far as the user is concerned. This is because all memory refresh control and implementation is carried out within the chip and is "transparent" to the user.

Still on the subject of low power, **Intersil** have just announced two new 256×4 CMOS 1K-bit static RAMS. These are designated **IM65X51** and **IM65X61** and differ only in their pin-out arrangements. The former comes in a 22-pin package with separate data input and output lines, and the former is an 18-pin chip with multiplexed data lines.

The new devices are manufactured using a selective oxidisation high density CMOS process called Selox-C and this provides better reliability and improved performance.

Many versions of these two devices are available all of which will retain data even when the power supply voltage drops down to as little as 2V d.c. and this allows the use of battery standby for long periods without losing information.

PLEASE TAKE NOTE

Digital Rule *(April 1981)*

There were three errors in the presentation of this project.

In Fig. 5, pin 1 of IC4 should be left unconnected. This can be achieved by removing the track from the pad at position 1 of IC4.

In Fig. 3, pin 15 of IC4 should be left unconnected. The p.c.b. layout of Fig. 5 is correct.

Also in Fig. 3, capacitor C15 should be connected between pin 3 of IC4 and +9V and not as shown. Once again the p.c.b. layout in Fig. 5 is correct.

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

TRANSMITTER SURVEILLANCE *
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30.

RADIO MIKE *
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

LIGHT CHASER
Gives a brilliant display — a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase patterns and a strobe effect. Total output power 750 watts per channel. Comlete kit. Price £16. Ready made up £4 extra.

FISH BITE INDICATOR
Enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. Price £4.90.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the arial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2.30

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1.85. Suitable 80ohm earpiece 69p.

NEW KIT THIS MONTH!
CB RADIO — Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller.
Complete kit with case and instructions only £5.99.

8 POWERFUL BATTERY MOTORS
For models, Meccanos, drills, remote control planes, boats etc. £2.50.

WATERPROOF HEATING WIRE
60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses — around water pipes, under grow boxes, in gloves and socks. 23p per metre.

COMPONENT BOARD Ref. W0998
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC107 and 2 type BFY-51 electrolytic condensers. SCR ref 2N 5062, 250uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95. + £4 carriage.

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

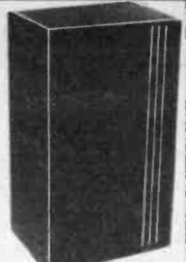
MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

EXTRACTOR FANS — Mains Voltage
Ex-computer, made by Woods of Colchester, ideal as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes, 5" £5.50. 6" £6.50. post £1 per fan.

KEYBOARD BARGAIN
50 computer type keys, together with 5 miniature toggle switches, all mounted on a p.c.b. together with 12 i.c.'s and many transistors and other parts, in a case but the case may be cracked or otherwise damaged.
£11.50 + £2 post. This is far less than the value of the switches alone. Diagram of this keyboard is included if you request it, or it is available separately. Price: £1.

*(Not licenceable in the U.K.)

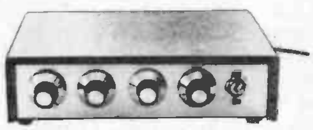
SUPER HI-FI SPEAKER CABINETS
Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.



Vu METER SNIP.
Approximately 1 5/8" square, suitable for use as a recording level meter power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1.00, or 10 for £9.00.

MOTORISED DISCO SWITCH
With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

3 CHANNEL SOUND TO LIGHT KIT
Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £19.95 assembled and tested.

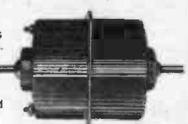


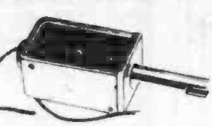
FLUORESCENT TUBE INVERTER
For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer Phillips inverter for 12" 8 watt miniature tube for only £5.25. (With tube and tube holders as well.

THIS MONTH'S SNIP
½ PRICE CABLES! Flat P.V.C. covered mains cables — for lighting and power instalations.

SIZE	TYPE	100 Mtres	CARRIAGE
1.5mm	Single	£ 3.95	£2.00
1.5mm	Flat twin	£ 6.50	£2.50
1.5mm	Flat three core & E	£ 9.85	£3.00
6mm	Single	£ 7.50	£2.50
4mm	Flat twim	£11.50	£3.50
6mm	Flat three core	£34.50	£4.50
16mm	Twin & E	£65 + £9.75	£10.00

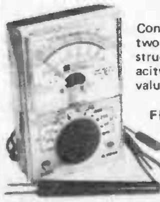
12v MOTOR BY SMITHS
Made for use in cars, these are series wound and they become more powerful as load increases - they will in fact burn themselves out if overloaded to stopping point. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45. Ditto, but double ended £4.25.





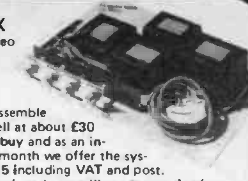
SOLENOID WITH PLUNGER
Mains operated £1.99
10 — 12 volts DC operated £1.50.

MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 — 100 mA.
Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 50p post and insurance.



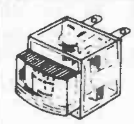
FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

MULLARD UNILEX
A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post.
FREE GIFT — buy this month and you will receive a pair of Goodman's elliptical 8"x5" speakers to match this amplifier.



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

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



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

STEREO HEADPHONES
Japanese made so very good quality. 8 ohm impedance. padded, terminating with standard ¼" jack-plug. £2.99 Post 60p.

BRIDGE RECIFIER
1 amp 400v 30p each.
10 for £2.50. 100 for £20.00

BURGLAR ALARM CONTROL PANEL
Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation, all you have to do is to take wires to pressure pads and to alarm bell. Price £7.95, with complete diagram.

PRECISION MAINS OPERATED CLOCK
For only £1.99. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with domestic cooker/switch, brand new and guaranteed.

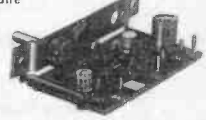
12V SUBMERSIBLE PUMP
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £8.50.

POPULAR SNIP — STILL AVAILABLE
And it still carries a free gift of a desoldering pump, which we are currently selling at £6.35p. The snip is perhaps the most useful breakdown parcel we have ever offered. It is a parcel of 50 nearly all different computer panels containing parts which must have cost at least £500. On these boards you will find over 300 IC's. Over 300 diodes, over 200 transistors and several thousand other parts, resistors, condensors, multi-turn pots, recifiers, SCR, etc. etc. If you act promptly, you can have this parcel for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. Surely this is a bargain you should not miss! When ordering please add £2.50 post and £1.27 VAT.

MAINS MOTORS Precision made as used in record players, blow heaters, etc. Speed usually 1,400. All have ample spindle length for coupling fan blade, pulley, etc. Power depends on stack size. 5/8" stack £2.00; ¾" stack £2.50; 7/8" stack £3.00; 1" stack £3.50; 1½" stack £4.50. Add 25% to motor cost to cover postage, and then add 15% VAT.

YOUR LAST CHANCE FOR THIS BARGAIN
100 twist drills, regular tool shop price over £50, yours for only £11.50. With these you will be able to drill metal, wood, plastic, etc. from the tiniest holes in P.C.B. right up to about ¼". Don't miss this snip — send your order today.

MINI MONO AMP on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 1 W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.



J. BULL (Electrical) Ltd.

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J. BULL (Electrical) Ltd — Established 25 years. MAIL ORDER TERMS: Cash with order -- please add 60p to all orders under £10, to offset packing, etc. ACCESS & BARCLAYCARD WELCOMED. Our shop is open to callers. BULK ENQUIRIES INVITED. Telephone: Haywards Heath (0444) 54563.

NOW **DOUGLAS** TRANSFORMERS FROM **TITAN**

NEW FRANCHISE AT FANTASTIC PRICES - EX STOCK

12/24V RANGE PRI 220/240V
SEC: 0 12V 0V 12V

TYPE	AMPS 12v	AMPS 24v	PRICE £	P/P £
242	0·3	0·15	1·70	0·40
213	1	0·50	2·32	0·70
71	2	1	2·51	0·90
18	4	2	3·24	1·43
68	3	1·5	3·15	1·43
85	5	2·5	5·52	1·43
70	6	3	6·26	1·43
108	8	4	7·36	1·73
72	10	5	8·05	1·65
116	12	6	8·57	1·90
17	16	8	10·53	2·05
187	30	15	17·62	2·45

15/30V RANGE PRI 220/240V
SEC: 0V 12V 15V 0V 5V 9V 15V
VOLTS AVAILABLE 3 ⇒ 15—0—15

TYPE	AMPS 15v	AMPS 30v	PRICE £	P/P £
112	1	0·50	2·47	0·95
79	2	1·0	3·16	0·95
3	4	2	5·64	1·43
20	6	3	6·59	1·73
21	8	4	7·80	1·73
51	10	5	9·68	1·90
117	12	6	10·97	2·05
88	16	8	14·65	2·20
89	20	10	16·93	2·35
90	24	12	18·84	2·55
91	30	15	21·56	2·65
92	40	20	30·08	3·50

25/50V RANGE PRI 120/220/240V
SEC: 0V 20V 25V 0V 8V 15V 25V
VOLTS OUT 5 ⇒ 25—0—25

TYPE	AMPS 24v	AMPS 50v	PRICE £	P/P £
102	1	0·50	2·88	1·43
103	2	1·0	3·60	1·43
104	4	2	7·04	1·73
105	6	3	8·33	1·90
106	8	4	11·18	1·90
107	12	6	14·79	2·20
118	16	8	20·49	2·55
119	20	10	24·52	2·55
109	24	12	29·39	3·50

30/60V RANGE PRI 120/220/240V
SEC: 0V 24V 30V 0V 10V 18V 30V
VOLTS 6 ⇒ 30—0—30

TYPE	AMPS 30v	AMPS 60v	PRICE £	P/P £
124	1	0·5	2·92	1·43
126	2	1	5·78	1·43
127	4	2	7·13	1·73
125	6	3	10·73	1·90
123	8	4	12·28	2·20
40	10	5	15·55	2·20
120	12	6	17·72	2·35
121	16	8	25·09	2·65
122	20	10	29·07	4·00
189	24	12	33·51	4·60

48/96V RANGE PRI 120/220/240V
SEC: 0V 36V 48V 0V 36V 48V
VOLTS 12 ⇒ 48—0—48

TYPE	AMPS 48v	AMPS 96v	PRICE £	P/P £
430	1	0·5	4·14	1·43
431	2	1	7·22	1·73
432	4	2	11·87	2·05
433	6	3	14·47	2·20
434	8	4	18·43	2·45
435	10	5	26·16	2·65
436	12	6	32·75	4·00
437	16	8	35·77	4·60

AUTOTRANSFORMERS 240/220—115V
65VA — 10KVA
0V 115V 220V 240V

TYPE	VA	PRICE £	P/P £
25	65	3·82	1·10
64	80	4·40	1·10
4	150	5·64	1·43
69	250	7·13	1·73
53	350	8·97	1·90
67	500	11·09	2·20
83	750	12·42	2·20
84	1000	16·88	2·65
95	2KVA	31·26	4·00
73	3	61·27	4·75
57	5	87·42	6·60
101	10	159·45	13·00

CASED AUTOTRANSFORMERS
240V LEAD IN: 115V 2PIN SOCKET OUT

TYPE	VA	PRICE £	P/P £
56W	20	5·52	0·58
64W	80	7·63	1·43
4W	150	9·63	1·73
69W	250	11·98	1·90
67W	500	18·67	2·20
84W	1000	26·90	2·65
95W	2000	48·45	7·00
73W	3000	69·18	8·00

LINE ADJUSTMENT AUTOTRANSFORMERS
0 200 210 220 230 240 250

TYPE	VA	PRICE £	P/P £
415C	50	2·13	0·58
416C	100	3·13	1·10
417C	200	3·65	1·43
418F	350	5·63	1·43
419F	500	6·13	1·73
420E	750	7·60	1·90
421F	1000	10·55	2·05

MAINS ISOLATORS (SAFETY SCREEN)
PRI 120/220/240V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	VA	PRICE £	P/P £
149F	60	7·35	1·73
150F	100	8·61	1·73
151F	200	12·15	2·05
152F	250	14·75	2·20
153F	350	18·22	2·55
154F	500	22·70	2·65
155F	750	32·08	7·00
156F	1000	41·26	7·00

MAINS ISOLATORS (SAFETY SCREEN)
PRI 380/416/440V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	VA	PRICE £	P/P £
243F	60	7·35	1·43
244F	100	8·61	1·73
245F	200	12·15	2·05
246F	250	14·75	2·20
247F	350	18·22	2·55
248F	500	27·70	2·65
249F	750	32·08	7·00
250F	1000	41·26	8·00

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INV. 2. Open frame for OEN. £39·95 p&p £2·35

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100	6-7·5-9v	250	3·85	58
	Regulated			
101	6-7·5-9v	300	4·70	58

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MN33. 20 coil formers, ceramic, plastic, reed relay etc.
MN34. 25 min. glass reed switch.
MN35. 10 asstd. switches, toggle, slide, micro, etc.
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MN40. 50 Polystyrene Capacitors.
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MN65. 3 BF 245-FETS.

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CIRCUIT EXCHANGE

RACING CARS

This circuit is a game for one player and is entitled Racing Cars.

If the player thinks the light emitting diode (l.e.d.) D2 will win, he turns the select switch S2 to position 2. He then presses the start switch S1 and the l.e.d.s D1 to D6 will start sequencing. Because they are sequencing too fast for the eye to see, it will appear that the l.e.d.s are all dimly lit.

When the player releases S1 one l.e.d. will remain lit. If it is the one he chose with S2 the win l.e.d. D7 will light up.

The l.e.d.s D1 to D6 are connected to IC2, a CMOS 4022 1-of 8-decoder. The outputs go from high to low in sequence; the first six outputs light D1 to D6, but the seventh output (pin 5) is connected to the reset pin which starts the output sequence again.

The enable pin 13 is connected to the start switch S1, and the clock will start counting/dividing only when this switch is pressed. The pulses are formed by IC1a and IC1b.

The integrated circuit IC1 can be a 4001 or a 4011, and is connected in a standard CMOS configuration for astable clocks. Some unused pins are connected to the negative supply to prevent damage or spurious operation.

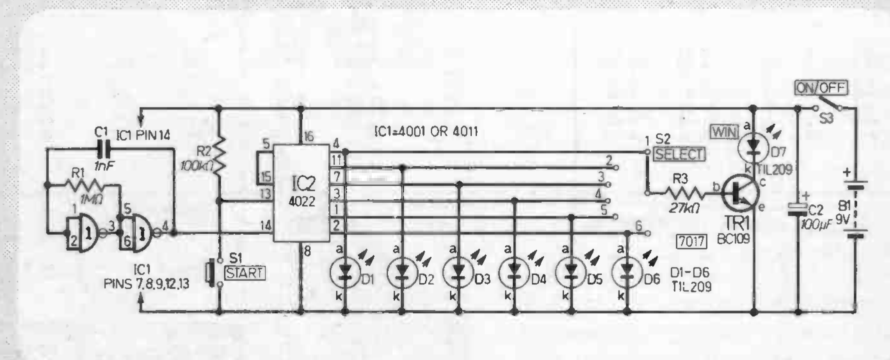
The win indication circuitry is formed by transistor TR1, S2, R3 and l.e.d. D7. It functions like a gate, and a light. So, when S2 is switched you are giving a chance of 1 in 6 for the appropriate l.e.d. to light D7 when S1 is released.

If the selected l.e.d. lights it will also provide an output to the win circuitry, via S2. If it does, it will turn on TR1 and will, therefore, light D7.

Capacitor C2 provides the power supply (PP7) decoupling that is required.

The start switch S1 must be a non-locking push-to-make type. The choice of switch for S2 will have to be made from a 2-pole 6-way or a 1-pole 12-way type. S3 is an on/off toggle switch.

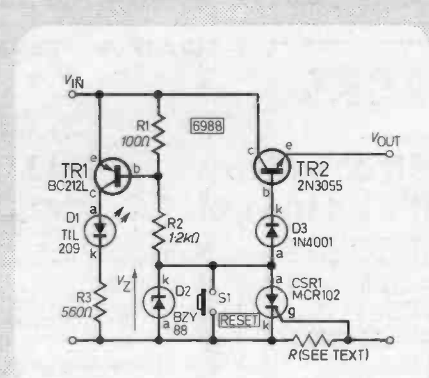
David Mullen
Morecambe,
Lancs.



ELECTRONIC FUSE

This circuit for an Electronic Fuse uses a cheap thyristor instead of expensive and difficult to obtain complementary germanium transistors and a lower trigger voltage (about 0·6V), which reduces the disturbance to the protected circuit.

Under normal conditions the thyristor is not conducting, the output voltage $V_{out} = V_z - 1{\cdot}2$, resistors R1 + R2 supply the Zener diode D2 current and TR2 base current, and the voltage across R1, about 0·6V, so that TR1 is off. When the load current increases beyond the "fused" value the thyristor switches to its conducting state causing V_{out} to fall to zero and the voltage across R1 to exceed 0·6V so that TR1 is turned on and the l.e.d. D1 lights.



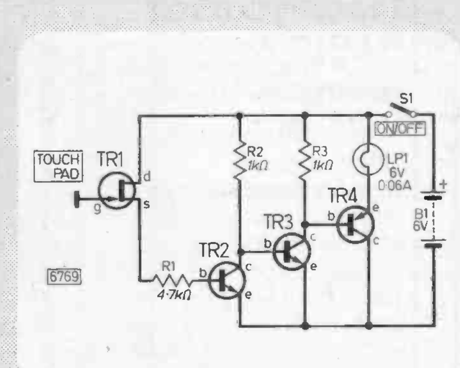
The thyristor will remain in the "on" state as long as its anode to cathode current exceeds the "holding value" I_H, ($I_H < 5$mA for the device used). Operating the push switch S1 turns the thyristor off and resets the circuit.

In the "on" state the voltage across the thyristor is of the order of one volt and so diode D1 is provided to ensure that TR2 is turned completely off.

To "fuse" at a load current I_f, resistor R is $0{\cdot}6/I_f$. Choose the voltage rating V_z of D2 to suit the maximum output voltage required.

J. Harrold,
Stoke Bishop,
Bristol.

F.E.T. TOUCH SWITCH



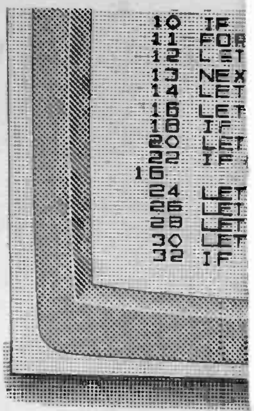
This circuit, which I thought of, uses an f.e.t. (field effect transistor) as a variable resistor. Depending on the amount of time that your finger is on the touch pad, this is the amount of time that the light, LP1, is on for. When the gate of TR1 is touched a few microamps flows into it and stops the flow of current from the drain to the source thus turning on the lamp. Transistors can be: TR1-2N3819; TR2, 3-BC107; and TR4-2N3702.

Colin Ellis (aged 13),
Sale Moor,
Greater Manchester

CIRCUIT EXCHANGE

New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete



Reach advanced computer comprehension in a few absorbing hours

Built: £69.95 complete

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability
With the ZX81, it's just as 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, or to select a program off a cassette through the keyboard.

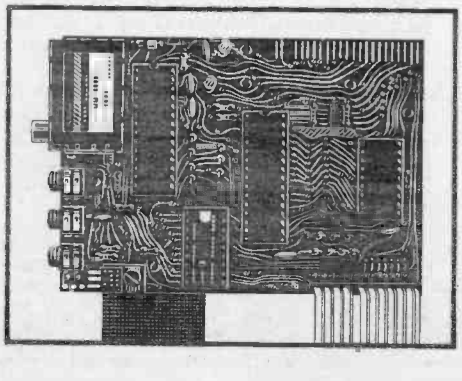
Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

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!

Kit or built – it's up to you!

The picture shows dramatically 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).

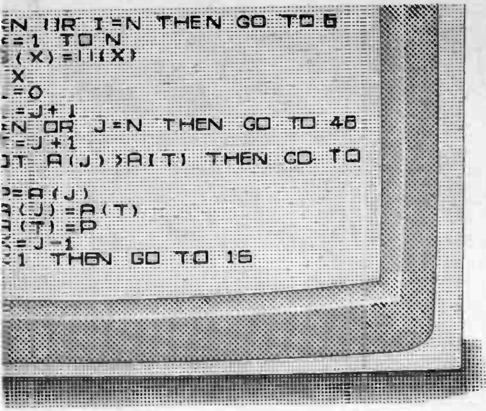
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

Coming soon – the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!

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.

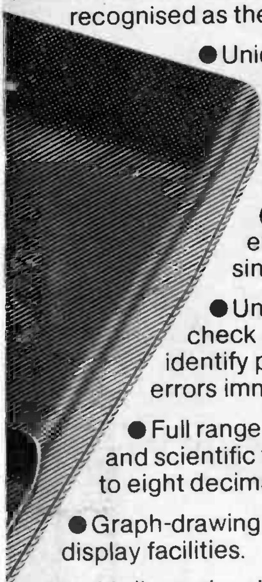
How to order your ZX81

BY PHONE – Access or Barclaycard 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 or Barclaycard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

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 (not available yet – but coming soon!)

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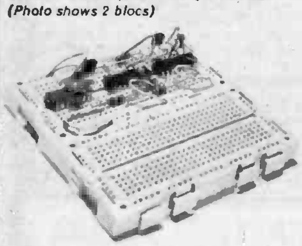
(Photo shows 2 blocs)



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0·5μF 12V 15mm dia. 100 £1·50; 1000 £12·00.

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Take advantage of this unbelievable offer!! Small signal NPN/PNP transistors in plastic package at an incredibly low, low price!! Almost all are marked with type number—almost all are full spec devices, some have bent leads. Over 30 different types have been found by us, including BC184/212/238/307/328; BF196/7; ZTX107 8/9/342/450/550 etc. Only available as a mixed pack at £3/100; £7/250; £25/1000.

CALC CHIPS 60p!!!

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K514 100 silver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10%. £2·00.
K516 Transistor Pack. Small signal NPN/PNP transistors in plastic package. Almost all are marked, full spec devices, but some have bent leads. Over 30 different types have been found by us, inc. BC184/212/238/307/328; BF196/7; ZTX107/8/9/342/450/550 etc. Look at the low price! 100 for £3·00; 250 for £7·00; 1000 for £25.
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10 page A4 list with 800 different items, many unusual, all at cut-price—switches, relays, pots, R's, C's, connectors, hardware, semiconductors, meters, displays, packs, panels, motors etc. etc. And its FREE!—just send 9 × 4 stamped SAE.

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Z521 Panel with 16236 (2N3442) on small heat sink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. 60p.
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Slide switches
Miniature 14p Standard DPDT 16p
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¼W Resistor kit. Contains 10 of each value from 4·7 to 1M (650 resistors). 480p each.
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25 6BA ¼" bolts	25 4BA ¼" bolts
25 6BA ⅛" bolts	25 4BA ⅛" bolts
50 6BA washers	50 4BA washers
50 6BA nuts	50 4BA nuts

CAPACITORS

Polyester. Radial leads. C280 type. 0·01, 0·015, 0·022, 0·033, 6p; 0·047, 0·1, 7p; 0·15, 0·22, 9p; 0·33, 0·47, 13p; 1·0, 23p.
Electrolytic. Radial leads.
1/63V, 2·2/63V, 4·7/63V, 10/25V, 7p; 22/25V, 47/25V, 8p; 100/25V, 9p; 220/25V, 14p; 1000/25V, 30p.

TRANSISTORS

AC128	25	BC178	18	BD131	35
AC176	25	BC182L	10	BD139	35
AD161	40	BC184L	10	BD140	35
AD162	40	BC212L	10	BFY51	23
BC107	10	BC214L	10	MJ2955	100
BC108	10	BC547	10	TIP2955	60
BC108C	12	BC548	10	TIP3055	55
BC109	10	BD131	35	ZTX107	12

CONNECTORS

Jack	Plug	skt.	DIN	Plug	skt.
2·5mm	10p	10p	2 pin	9p	9p
3·5mm	10p	9p	3 pin	12p	10p
Stand'd	16p	20p	5 pin 180	13p	11p

LINEAR

741	18	LM380	80	NE555	23
CA3046	60	LM381	120	NE556	55
CA3080	70	LM382	120	SN76477	170
CA3130	90	LM1458	40	TL081	40
CA3140	45	LM3900	50	TL084	110
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Published approximately the third Friday of each month by IPC Magazines Ltd., Kings Reach Tower, Stamford St., London SE1 9LS. Printed in England by Index Printers, Dunstable, Beds. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Subscriptions: Inland £9.00, Overseas £10.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

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