Easy to build projects for everyone

Everyday ELECTRONICS

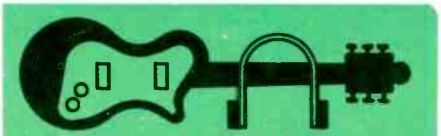
MAY 81
60p

FREE

GLOSSARY OF I.C. TERMS

PRESENTED FREE WITH EVERYDAY ELECTRONICS MAY 1981 ISSUE

INSIDE



GUITAR HEADPHONE AMPLIFIER

BABY ALARM

SOIL METER

LIGHTS REMINDER
IGNITION LOCATOR

TV Interference FILTERS

AUDIO TEST SET
for Hi-Fi Enthusiasts

PART ONE

NEW SERIES
Introduction to LOGIC

Australia $1·00 New Zealand $1·10 Malaysia $4·50

- ORDER BY POST OR TELEPHONE WITH BARCLAYCARD/ACCESS
- ELECTRONIC TEST EQUIPMENT SPECIALISTS
- ALL PRICES INCLUDE VAT

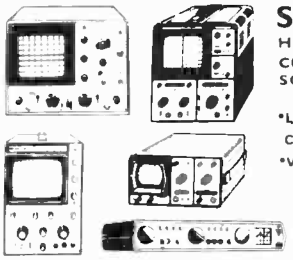
AUDIO ELECTRONICS

- ALL MODELS ON DISPLAY
- RETAIL – MAIL ORDER – EXPORT – INDUSTRIAL
- OPEN SIX DAYS A WEEK
- CALL IN AND SEE FOR YOURSELF

ALL PRICES INCLUDE VAT

SCOPES

A range of Scopes in stock from 5mHZ Single Trace to 50mHZ Dual Trace. Mains and Battery/Mains Portables. Many on demonstration.



HAMEG ● TRIO ● LEADER ● SINCLAIR ● HITACHI

SINGLE TRACE (UK c/p etc £2·50)

Hm 307-3 10mHZ, 5mV, 6 × 7cm display plus component Test	£158·78
C01303D 5mHZ, 10mHZ, 7 × 7cm display	£109·25
SC110 10mHZ Battery portable, 10mV, 3·2 × 2·6cm display (Optional case **£8·86**, Nicads **£8·63**, Mains unit **£4·00**)	£158·95
•LB0512A 10mHZ, 10mV, 5″ display	£195·50
CS1559A 10mHZ, 10mV, 5″ display	£232·00
•V151 15mHZ, 1mV, 5″ display	£241·50

OPTIONAL PROBES (ALL MODELS)

X1 £6·50, X10 £8·50, X100 £12·95, X1-X10 £10·95

SAFGAN DUAL TRACE

10MHZ-£194·35, 12MHZ-£201·25, 15MHZ-£216·20.

•PRICES INCLUDE FREE PROBE(S)

DUAL TRACE (UK c/p etc £3·50)

CS1562A 10mHZ, 10mV, 5″ display	£267·00
CS1575 5mHZ, 1mV, 5″ display	£284·00
Hm 312-8 20mHZ, 5mV, 8 × 10cm display	£253·00
CS1566A 20mHZ, 5mV, 5″ display	£339·00
•LBO3085 70mHZ, 2mV, 5 × 6·3cm display, Battery/Mains portable, built in Nicads	£482·00
Hm 412-4 20mHZ, 5mV, 8 × 10cm display plus Sweep Delay	£399·50
CS1577A 35mHZ, 2mV, 5″ display	£478·00
CS1830 30mHZ, 2mV, 5″ display plus Sweep Delay Line/New Model	£569·00
Hm 512-8 50mHZ, 5mV, 10 × 8cm display, Delay Sweep	£667·00
•LB0514 10mHZ, 1mV (5mV), 5″ display	£294.00
•V152 15mHZ 1mV 5″ display	£326·60
•V302 30mHZ 1mV 5″ display	£447·35
•V550 50mHZ 1mV 10 × 8cm Delay sweep + 3 channel display	£799·25

(UK C-P £1.75)

GENERATORS

TRIO ● LEADER ● CSC
SINCLAIR ● LEVELL

RF

A range of signal generators to cover audio RF and pulsing. Mains operated (TG series battery).

SG402 100KHZ-30mHZ with AM modulation	£68·00
LSG16 100KHZ-100mHZ (300mHZ on Harmonics)	£63·25
SG2030 250KHZ-100mHZ low cost range	£46·95
ARF300 18HZ-200mHZ Low cost range	£76·95

PULSE

2001 1HZ-100KHZ (Function)	£89.70
TG105 5HZ-5mHZ	£92.50
4001 0·5HZ-5mHZ	£109.25
TG100 (Function 100KHZ)	£90·85

AUDIO (All sine/square)

AG202A 20HZ-200KHZ	£69.00
LAG26 20HZ-200KHZ	£73.60
AG203 10HZ-1mHZ Sine/Square	£126.75
LAG120A 10HZ-1mHZ	£146.00

LOGIC PROBES/ MONITORS

Logic probes indicating high/low, etc, states that scopes can miss. All circuit powered for all IC's.

LP3 50 mHZ logic probe	£55·95
LP1 10 mHZ logic probe	£35·50
LP2 1½ mHZ logic probe	£19·95
LM1 Logic monitor	£33·00
LDP 50 mHZ Logic probe with case	£51·00

Also in stock range of Protoboard kits and breadboards.

PRO MULTIMETERS

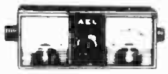
M1200 100K/Volt 30 range plus AC/DC 15 amp	£67·00
K1400 20K/Volt 23 range large scale	£79·95
M1500 20K/Volt 42 range plus AC/DC 10 amp	£53·50

(UK c/p **£1·20**)

K200 38 range FET 10m ohm input 20Hz to 30 MHz	£95·00

(UK c/p **£1·50**)

SWR/FS AND POWER METERS



Range in stock covering up to 150mHZ and up to 1K watt power. PL259 sockets. 250UHZ Grid Dip.

SWR9 SWR/S 3-150mHZ	£9·50
SWR50 SWR/Power meter 3½-150mHZ 0-1000 watts	£13·95
110 SWR/Power 1½-144mHZ 0/10/100 watts	£11·50
171 As 110 Twin meter plus F/S	£14·50

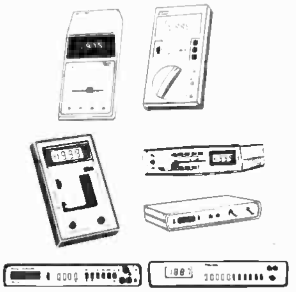
Plus large range of BNC/PL259/etc leads / plugs / adaptors / connectors always in stock.

176 SWR Power FS 1½-144mHZ, 5-50 watt	£16·60
KDM6 Grid Dip 1½-250mH7	£38·50

DIGITAL MULTIMETERS

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors—some with optional Nicads. All supplied with batteries and leads.

KAISE ● SINCLAIR ● LASCAR ● THURLBY



HAND HELD

(UK post etc 85p)

TM352 3½ Digit LCD plus 10ADC and Hfe checker	£54·95
TM354 3½ digit LCD 2A AC/DC	£45·94
ME502 3½ Digit LED plus 10A DC and Hfe checker	£43·95
LM2001 3½ Digit LCD 2 amp AC/DC 0·1%	£51·70
6200 3½ Digit LCD 0·2A AC/DC, Auto range	£45·95
6220 As 6200 plus 10A AC/DC	£55·95
6100 As 6200 plus Cont. test/range hold	£69·95
6110 As 6100 plus 10A AC/DC	£85·95
GL35C 3½ digit LCD 1A AC/DC	£37·50

BENCH PORTABLES

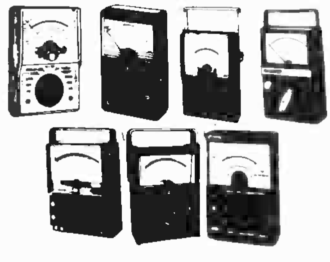
(UK c/p £1·00)

DM235 3½ Digit LED 21 ranges, 0·5% AC/DC 2A	£60·38
DM350 3½ Digit LED 34 ranges, AC/DC 10A	£83.38
TM353 3½ Digit LCD AC/DC 2 amp	£96·60
TM351 3½ Digit LCD AC/DC 10 amp	£113·85
LM100 3½ Digit LCD AC/DC 2 amp	£86·50
DM450 4½ Digit LED 34 ranges, AC/DC 10 amp	£113·85

(DM series options: Carry case **£8·86**, Nicads **£8·63**, Mains adaptor **£4·00**.)

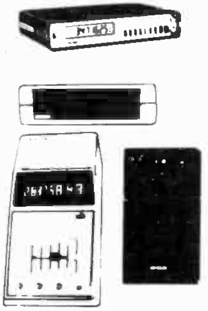
MULTIMETERS

(UK post etc 75p)



KRT101 1K/Volt 10 range pocket	£4·60
ATM1/LT1 1K/Volt 12 range pocket	£5·98
NH55 2K/Volt 10 range pocket	£6·50
AT1 2K/Volt 12 range pocket de luxe	£7·75
NH56 20K/Volt 22 range pocket	£11·95
YN360TR 20K/Volt 19 range pocket plus hfe test	£13·50
AT1020 20K/Volt 19 range de luxe plus hfe test	£16·95
7081 50K/Volt 36 range plus 10 amp DC	£20·80
TR303TR 20K/Volt + 12A DC + HFE test	£15·95
AT20 20K/Volt 21 range de luxe plus 10A DC and 5KV DC	£21.95
AT205 50K/Volt 21 range de luxe plus 10A DC	£24·95
7080 20K/Volt 26 range large scale. 10A DC plus 5KV AC/DC	£26·95
AT2050 50K/Volt 18 range de luxe plus hfe test	£28·50
AT210 100K/Volt 21 range de luxe 12A AC/DC	£29·95
360TR 100K/Volt 23 range plus hfe checker and AC/DC 10 amps	£34·95

FREQUENCY COUNTERS



Portable and Bench LCD and LED Counters up to 600mHZ. Prices include batteries and leads.

HAND HELD (UK post etc 85p)

PFM200 20HZ to 200mHZ 8 Digit LED	£52·27
MAX50 100HZ to 50mHZ 6 Digit LED	£56·35
MAX550 30KHZ to 550mHZ 6 Digit LED	£97·75

BENCH PORTABLES

(UK c/p £1·00)

MAX100 8 Digit LED 5 HZ to 100mHZ	£89·00
TF200 8 Digit LCD 10HZ to 200mHZ	£166·75
7010A 9 Digit LED 10HZ to 600mHZ	£169·00
200SPC 6 Digit 100mHZ LED built into 0·002HZ to 5·5mHZ pulse generator	£437·00
TP600 600mHZ Prescaler for TF200	£43.13
TF040 8 digit LCD 20 MHz	£126·50

CSC ● SINCLAIR ● SPC ● OPTO ELECTRONICS

SOLDERLESS BREADBOARD AND KITS

EXP350	£3·45
EXP300	£5·95
EXP650	£3·95
EXP600	£6.50
KITS	
PB6	£9·95
PB100	£12·95
PB101	£17.95

(UK c/p – EXP's **30p.** KITS **55p**)

MINI DRILLS AND KITS

(9-12 Volt ¼″ chucks)

Small Drill plus 3 collets	£7·25
Medium Drill plus 3 collets	£10·50
Small Drill plus 20 tools	£14·95
Medium Drill plus 20 tools	£17·95
Mains Drill	£13·95
Mains Drill plus 20 tools	£21·50

CHOOSE FROM THE UK's LARGEST SELECTION

Stockists of electronic equipment, speakers/kits, PA equipment plus huge range of accessories ● UK carriage/packing as indicated ● Export – prices on request ● All prices correct at 1/3/81 E & OE ● All prices include VAT.

AUDIO ELECTRONICS Cubegate Limited

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Send large SAE (20p UK) Schools, Companies, etc. free on request.

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**; **250V**: 100 **65p**; **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.

500 Ω,1 K & 2K (Lin. only) Single	29p
5K-2 M Ω single gang	29p
5K-2 M Ω single with DP switch	78p
5K-2 M Ω double gang	68p

SLIDER POTENTIOMETER
0·25W log and linear values 60mm

5K Ω-500K Ω single gang	70p
10K Ω-500K Ω dual gang	110p
Self Stick Graduated Bezels	36p

PRESET POTENTIOMETERS
Vertical & Horizontal

0-1W 50 Ω—5MΩ Miniature	7p
0-25W 100 Ω—3·3M Ω Horiz	10p
0-25W 200 Ω—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		6p	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	86
ORP61	85
2N5777	45
7 Seg Displays	
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DL704 C Cth ·3"	99
DL707 C.A. ·3"	99
DL747 C.A. ·6"	180
FND357 or 500	120
MAN3640	178
·3" Green C.A.	180
TIL32 Inf. Red	58
TIL78 detector	70
Bargraph Red.	
Ten segment	225p

LCD DISPLAYS

3½ Digit	675p
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
LM300H	170	LM327N	270	595
LM305H	140	LM723	39	78HG 5A +5V
LM309K	135	TAA550	50	to +25V 600
LM317K	350	TBA625B	95	79HG 5A −2·25
LM323K	625	TDA1412	150	to −24V 650p

SLIDE 250V:

1A DPDT	14p
1A DP c/off.	15p
½A DPDT	13p
4 pole c/over	24p

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	89p
SPST on/off	84p
DPDT 6 tags	75p
DPDT c/off	88p
DPDT Biased	148p

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 10p; 14 pin 10p; 16 pin 10p; 18 pin 43p; 20 pin 22p; 24 pin 30p; 28 pin 35p; 40 pin 40p.

JACKSONS VARIABLE CAPACITORS

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

DENCO COILS

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

VEROBOARDS ·1"

	clad	plain
2½ × 3½"	66p	47p
2½ × 5"	75p	—
3¾ × 3½"	75p	—
3¾ × 5"	86p	72p
3¾ × 17"	296p	192p
4¾ × 17"	387p	—
Pkt. of 36 pins	20p	
Spot Face Cutter	107p	
Pin Insertion Tool	147p	

COPPER
clad boards
Fibreglass

6 × 6"	90p
6 × 12"	150p
S.R.B.P.	
9·5 × 8	95p

Ferric Chloride 1 lb. Anhydr. 225p

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	16
3A/400V	16
3A/600V	17
3A/1000V	30
6A/400V	50p

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range 2V7 to 39V 400mW **6p each**
Range 3V3 to 33V. 1·3W **15p each**

NOISE

Z5J	180

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
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	48
8A/300V	60
8A/400V	75
8A/600V	98
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	205
25A/1000V	480
30A/400V	525
T28000D	120

TTL 74 (TEXAS)

7400	11	123	65	LS54	30	LS367	65	4086	90
7401	12	125	50	LS55	30	LS368	90	4089	150
7402	11	126	45	LS73	45	LS373	150	4093	89
03	14	128	65	LS74	35	LS375	150	4094	240
04	14	132	55	LS75	45	LS374	180	4095	95
05	18	136	65	LS76	45	LS377	199	4096	95
06	36	141	75	LS78	50	LS378	140	4097	340
07	36	142	185	LS83	105	LS390	140	4098	115
08	17	143	350	LS85	80	LS393	140	4099	190
09	20	144	350	LS86	38	LS399	230	4161	115
10	17	145	90	LS90	50	LS668	105	4410	750
11	25	147	150	LS91	125	LS670	270	4411	950
12	20	148	125	LS92	75	**CMOS**		4422	320
13	32	150	130	LS93	60	4000	18	4433	570
14	38	151	70	LS95	115	4001	18	4501	750
16	30	153	70	LS96	120	4002	24	4502	28
17	30	154	120	LS107	45	4006	86	4503	125
20	19	155	75	LS109	75	4007	22	4507	60
21	38	156	75	LS112	40	4008	82	4508	325
22	25	157	70	LS113	75	4009	40	4510	99
23	28	159	165	LS114	40	4010	48	4511	150
25	28	160	99	LS122	70	4011	24	4512	98
26	43	161	99	LS123	75	4012	24	4514	265
27	32	162	99	LS124	180	4013	45	4515	299
28	35	163	99	LS125	45	4014	80	4516	120
30	19	164	120	LS126	45	4015	85	4518	105
32	27	165	120	LS132	60	4016	42	4519	70
33	36	166	130	LS136	35	4017	82	4520	115
37	35	167	205	LS138	70	4018	88	**LINEAR IC's**	
38	32	170	205	LS139	70	4019	48	702	75
40	20	172	375	LS151	90	4020	99	709C 8 pin	35
41	68	173	110	LS153	85	4021	90	710*	67
42	58	174	100	LS155	75	4022	95	733	75
43	120	175	82	LS157	70	4023	25	741 8 pin	17
44	116	176	80	LS158	70	4024	60	747C 14 pin	78
45	105	177	85	LS160	90	4025	25	748C 8 pin	36
46	132	178	110	LS161	98	4026	180	753 8 pin	185
47	72	180	90	LS162	110	4027	48	810	159
48	75	181	280	LS163	95	4028	82	2114-300n	175
50	20	182	85	LS164	115	4029	105	2114-200n	225
51	20	184	130	LS165	145	4030	55	2708	350
53	20	185	130	LS166	175	4031	185	2716-5V	450
54	20	188	310	LS168	210	4032	125	AY-1-0212	595
60	20	190	130	LS169	210	4034	213	AY-1-1313A	660
70	40	191	120	LS170	288	4035	125	AY-1-1320	225
72	30	192	120	LS173	105	4036	275	AY-1-5050	99
73	35	193	120	LS174	110	4037	115	AY-1-5051	160
74	34	194	102	LS175	110	4038	118	AY-3-1270	840
75	56	195	75	LS181	295	4039	299	AY-3-8500	390
76	40	196	99	LS183	298	4040	105	AY-3-8910	850
80	52	197	88	LS191	120	4041	80	AY-5-1224A	235
81	120	**74LS**		LS192	95	4042	80	AY-5-1230	450
82	75	LS00	13	LS193	95	4043	95	AY-5-1317A	639
83	90	LS01	13	LS194	125	4044	95	CA3011	110
84	99	LS02	15	LS195	130	4046	130	CA3014	157
85	105	LS03	15	LS196	120	4047	98	CA3018	68
86	33	LS04	20	LS197	85	4048	65	CA3020	186
89	205	LS05	23	LS200	345	4049	45	CA3023	191
90	42	LS08	22	LS221	120	4050	48	CA3028A	80
91	84	LS09	23	LS240	225	4051	80	CA3035	235
92	50	LS10	20	LS243	165	4052	80	CA3036	115
93	57	LS11	32	LS244	195	4053	80	CA3043	275
94	85	LS12	32	LS245	190	4054	130	CA3045	365
95	70	LS13	40	LS251	130	4055	130	CA3046	71
96	80	LS14	60	LS253	95	4056	135	CA3048	214
97	176	LS15	40	LS257	95	4059	575	CA3059	195
100	130	LS20	21	LS258	120	4060	110	CA3075	213
104	62	LS21	32	LS259	160	4063	120	CA3080E	65
105	62	LS22	35	LS261	450	4066	58	CA3081	190
107	34	LS26	44	LS266	75	4067	430	CA3089E	215
109	60	LS27	35	LS273	180	4068	26	CA3090AQ	375
110	54	LS28	35	LS279	88	4069	26	CA3123	150
111	68	LS30	20	LS280	250	4070	30	CA3130	90
112	70	LS32	25	LS283	90	4071	25	CA3140	48
116	180	LS33	35	LS290	130	4072	25	ICL7106	795
118	85	LS37	30	LS293	130	4073	25	ICL7107	975
119	120	LS38	35	LS295	215	4075	25	ICL8038CC	340
120	105	LS40	28	LS298	215	4076	99	ICM7205	1150
121	35	LS42	66	LS299	420	4081	28	ICM7215	1050
122	50	LS47	85	LS323	450	4082	25	ICM7216A	1950
		LS51	25	LS365	65	4085	90	ICM7216	1950
				LS366	65				

ICM7216C	1950
ICM7217A	790
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
LM379	375
LM380	80
LM381N	145
LM382	125
LM386	99
LM387	120
LM389	99
LM733	75
LM1458	45
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM3915	240
LM3916	255
LM13600	135
M252AA	625
M253AA	1150
MC1303	88
MC1304P	260
MC1310P	150
MC1494	694
MC1495	350
MC1496L	92
MC1596	225
MC3302	150
MC3340	120
MC3360	120
MC3403	135
MM57160	520
NE543	210
NE544	165
NE555	22
NE556	55
NE560	325
NE561	395
NE566	180
NE567	170
NE570	450
NE571	420
RC4136D	40
S566B	275
SAB3209	425
SAB3210	275
SN76013	170
SN76023N	170
SN76477	175
TAA621	250
TBA120	70
TBA800	90
TBA810	95
TDA1022	575
TDA1024	105
TDA2020	320
TL061CP	48
TL071CP	48
TL074CN	140
TL081CP	42
TL083CN	92
TL084CN	120
UAA170	170
UAA180	170
XR2206	350
ZN414	95
ZN423	195
ZN424	130
ZN1034	200

Transistors		BC182	10	BF194	12	MPF104	36	TIP142	120	2N3663	15
AC125	35	BC183	10	BF195	12	MPF105	36	TIP147	120	2N3702	10
AC126	25	BC184	10	BF196	12	MPF106	40	TIP2955	60	2N3703	10
AC127	25	BC182L	10	BF197	12	MPSA05	25	TIP3055	60	2N3704	10
AC128	25	BC183L	10	BF198	16	MPSA06	25	TIS43	32	2N3705	10
AC141	30	BC184L	10	BF199	18	MPSA12	32	TIS44	45	2N3706	10
AC142	30	BC187	26	BF200	30	MPSA55	30	TIS45	45	2N3707	10
AC176	28	BC212	10	BF224	24	MPSA56	30	TIS88A	50	2N3708	10
ACY17	70	BC212L	10	BF244	28	MPSA70	25	TIS90	30	2N3709	10
ACY18	70	BC213	10	BF245	28	MPSU06	55	TIS91	32	2N3710	10
ACY19	75	BC213L	10	BF244B	30	OC26	170	ZTX107	11	2N3711	10
ACY20	75	BC214	10	BF256	35	PC28	130	ZTX109	12	2N3771	179
ACY21	75	BC214L	10	BF257	32	OC35	125	ZTX109	11	2N3772	195
ACY22	60	BC236	10	BF258	32	OC36	120	ZTX300	13	2N3773	270
ACY28	75	BC237	14	BF259	35	OC41	120	ZTX301	16	2N3819	22
ACY39	85	BC307B	15	BF274	42	OC42	120	ZTX302	16	2N3820	45
AD149	79	BC308B	16	BF336	40	OC43	55	ZTX303	25	2N3822	65
AD161	42	BC327	15	BF451	35	OC44	120	ZTX304	17	2N3823	65
AD162	42	BC238	14	BF594	30	OC45	40	ZTX314	25	2N3866	90
AF118	95	BC338	15	BF595	39	OC70	40	ZTX326	30	2N3903	18
AF139	40	BC441	34	BFR39	23	OC71	35	ZTX341	30	2N3904	18
AF178	75	BC461	34	BFR40	23	OC72	40	ZTX500	14	2N3905	15
AF239	78	BC477	40	BFR41	23	OC74	50	ZTX501	15	2N3906	17
BC107	10	BC516	40	BFR79	23	OC76	50	ZTX502	15	2N4037	46
BC107B	12	BC517	40	BFR80	24	OC81	50	ZTX503	18	2N4058	10
BC108	10	BC547	14	BFR81	25	OC82	130	ZTX504	25	2N4061	10
BC108B	12	BC548	14	BFR98	105	OC83	40	ZTX531	25	2N4062	10
BC108C	12	BC549C	14	BFX29	28	OC84	40	ZTX550	25	2N4427	80
BC109	10	BC557	15	BFX84	26	OC140	110	2N697	23	2N3859	78
BC109B	12	BC558	15	BFX85	28	OC170	85	2N698	40	2N4871	55
BC109C	12	BC559	15	BFX86	28	OC171	85	2N699	35	2N5172	18
BC140	30	BCY70	16	BFX87	28	OC200	85	2N706A	19	2N5179	45
BC142	30	BCY71	18	BFX88	28	TIP29	34	2N708	19	2N5191	75
BC143	30	BCY72	20	BFY50	23	TIP29A	36	2N918	33	2N5305	24
BC147	9	BD131	48	BFY51	23	TIP29B	56	2N1131	24	2N5457	36
BC147B	10	BO132	48	BFY52	23	TIP29C	60	2N1132	24	2N5458	36
BC148	9	BD133	60	BFY56	32	TIP30	48	2N1303	60	2N5485	36
BC148B	10	BD135	45	BFY64	35	TIP30C	56	2N1304	65	2N5642	750
BC148C	10	BD136	40	BFY81	120	TIP31A	45	2N1305	60	2N5777	45
BC149	9	BD137	40	BRY39	40	TIP31C	55	2N1671B	215	2N6027	32
BC149C	10	BD138	40	BSX20	20	TIP32A	48	2N2219A	28	3N128	112
BC153	27	BD139	40	BSY95A	25	TIP32C	60	2N2220A	26	3N140	112
BC154	27	BD140	40	BU105	170	TIP33A	65	2N2221A	25	40311	60
BC157	10	BD144	198	BU205	190	TIP33C	78	2N2222A	25	40313	125
BC158	10	BD145	198	BU208	200	TIP34A	74	2N2369A	17	40315	68
BC159	11	BD205	110	E421	250	TIP34C	88	2N2646	48	40316	85
BC160	45	BD214	115	MD8001	250	TIP35A	160	2N2904	28	40361	50
BC167	10	BD245	45	MJ400	150	TIP35C	185	2N2905A	26	40362	50
BC168C	10	BD378	70	MJ491	175	TIP36A	170	2N2906	26	40408	95
BC169C	10	BD434	55	MJ2955	90	TIP36C	199	2N2907A	26	40411	280
BC170	15	BD517	75	MJE340	54	TIP41A	60	2N2926G	10	40467	95
BC172	11	BD695A	85	MJE370	100	TIP41B	68	2N3053	26	40468	60
BC173	11	BD696A	85	MJE371	100	TIP42A	60	2N3054	58	40594	90
BC177	20	BDY56	180	MJE2955	99	TIP42B	75	2N3055	48	40595	98
BC178	20	BF115	35	MJE3055	70	TIP120	90	2N3442	140	40603	90
BC179	20	BF167	29	MPF102	66	TIP121	99			40673	95
BC181	20	BF180	38	MPF103	36						

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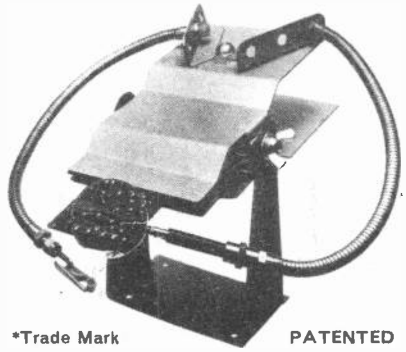

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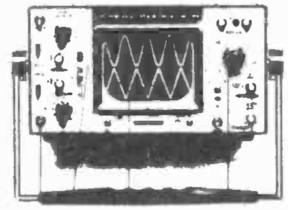

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Simple T.R.F. Design. Covering most Amateur Bands and Short Wave Broadcast Bands. Five controls, Bandset, Bandspread Reaction, Wavechange and Attenuator. Coil section is by Wavechange Switch. Use with Headphones or a Crystal earpiece. Kit contains all the components required including the P.C. Board and Case. Instructions are included with this kit. KIT **£18·97**. Headphone extra **£2·98.**

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EJ28, 98 CALAIS ROAD, BURTON-ON-TRENT, STAFFS., DE13 0UL. 0283-65435. 9-12, 2-4 MON.-FRI. ADD 40p P. & P. TO ALL ORDERS. Callers by appointment only.

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TEACH-IN-80

E.E. 12 part series. Oct '79-Sept '80. Covers the basics of electronics—lots of practical work. Circuits are built on a plug-in Eurobreadboard, which is built into a wooden console which houses the power supplies, speaker, meter, pots and LED indicators. The series uses a range of electronic components in the experimental work including a photocell, I.C.s, transistors, etc.

Wooden Console (Tutor Deck) kit **£5·98** extra. Includes all the wood, glue, feet and strap handle.

Electronic components, including Eurobreadboard, for the console and the experiments **£25·40** (called list A + B + C by E.E.). Reprints available—Parts 1-12, 45p each.

List 'C' only **£2·45.**

C106D	56p	2N5457	58p	BFY51	24p
TIC46	49p	2N5484	63p	BFY52	23p
OA47	11p	40673	98p	BFX88	32p
OA90	9p	AC128	29p	BRY39	48p
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IN4001	5½p	BC182L	11p	TIP33A	94p
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VN67AF	£1·21	BC214L	11p	2N3055	59p
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E12 SERIES. 1R-10M	1½p each
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10nF; 15nF; 22nF; 33nF; 47nF 7p each. 68nF; 100nF 8p. 150nF; 220nF 12p. 330nF 15p. 470nF 20p. 680nF 28p. 1µF 33p. 1·5µF 49p. 2·2µF 65p.

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Values in pF: 2·2; 3·3; 4·7; 5·6; 6·8; 8·2, 10; 15; 22; 33; 47 & 56pF 7p each. 68pF; 100pF 7p each. 150pF; 220pF, 330pF 11p each. 390pF, 470pF, 1000pF 5p each. 2200pF 6p each. 3300pF, 4700pF 7p each. 10nF 13p. 100nF 22p. 47nF 14p.

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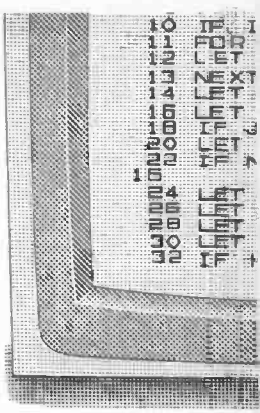
New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete



```
10 IF I
11 FOR
12 LET
13 NEXT
14 LET
16 LET
18 IF J
20 LET
22 IF N
16
24 LET
26 LET
28 LET
30 LET
32 IF +
```

Reach advanced computer comprehension in a few absorbing hours

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!

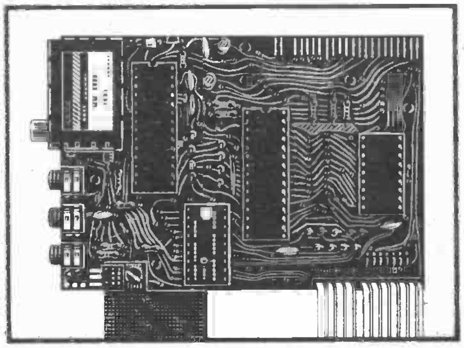
The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Built: £69.95 complete

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).

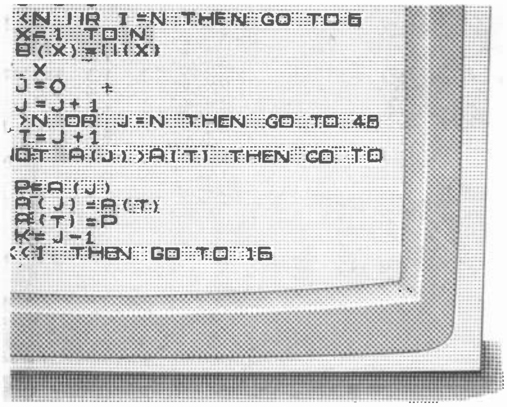
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual

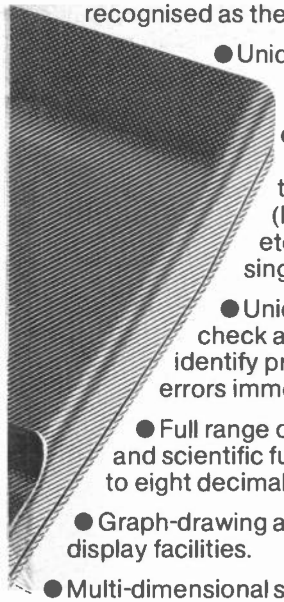
Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



```
<N IIR I=N THEN GO TO 6
X=1 TO N
B(X)=I(X)
 X
J=0
J=J+1
>N OR J=N THEN GO TO 48
T=J+1
IOT A(J)>A(T) THEN GO TO

P=A(J)
A(J)=A(T)
A(T)=P
K=J-1
<1 THEN GO TO 16
```

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!)
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

sinclair
ZX81

Sinclair Research Ltd,
6 Kings Parade, Cambridge, Cambs.,
CB2 1SN. Tel: 0276 66104.
Reg. no: 214 4630 00

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.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

TOTAL £ ______

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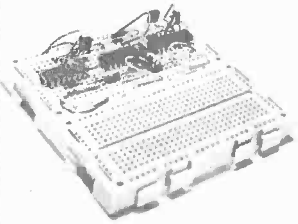
New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs and be joined together. Bus strips on X & X axis—total 360 connexion points for just **£4·15.**

(Photo shows 2 blocs)



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Z529 74 Series ICs—Gates and complex logic. 20 asstd. ICs on panels **£1**; 100 ICs **£4.**

Z527 2 × 6V reed relays, 6 × 2S030 or 2S230 6 × 400V rects, + R's. Only **50p.**

IN4006 DIODES

Special purchase of 1A rects, Russian made. Packed in boxes of 300, **£8·50** per box; 4 boxes **£30·00**; 10 boxes **£75·00.**

DISC CERAMICS

0·22µF 12V 9mm dia. Ideal for decoupling. 100 for **£2·75**; 1000 **£20·00.**

0·05µF 12V 15mm dia. 100 **£1·50**; 1000 **£12·00.**

TRANSISTOR PACK K516

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!!!

New full spec, supplied with data. Type MK50321—full function inc memory. Only **60p.**

741 — 7 for £1
555 — 5 for £1

DISPLAYS

8 and 9 digit 7-segment bubble type for above chips—most have minor faults dud segment etc. Mixture of 2 or 3 different types with data. 5 for **£1·00.**

REGULATED PSU PANEL

Exclusive Greenweld design, fully variable 0-28V & 20mA-2A. Board contains all components except pots and transformer. Only **£7·75.** Suitable transformer and pots **£6·00.** Send SAE for fuller details.

P.C. ETCHING KIT Mk V

The best value in etching kits on the market—contains 100 sq ins copper clad board, Ferric Chloride, Etch resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. All for **£4·95.**

SLIDER POT SCOOP!!!

Made by Piher, types PL40CP. Silly prices for superb goods!!

PL40CP—69 × 16 × 9mm, 40mm slide length. 220R, 2k2 or 10k lin only. Prices (any mix): 1-24 **20p**; 25-99 **17p**; 100+ **14p.**

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K503 150 wirewound resistors, 1W-12W. Wide range of values. **£2·00.**

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K518 200 disc ceramic caps. Big variety of values and voltages. **£1·00.**

BARGAIN LIST 13

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.

£1 BARGAIN PACKS

Each pack £1 ; any 25 packs £22

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K102	15	BC349A transistors
K103	10	BC546B transistors
K104	18	BC182B transistors
K105	50	1N4148 diodes
K106	18	BC184L transistors
K107	18	BC2131 transistors
K108	8	2N5060 thyristors, 30V 0·8A T092 case
K109	15	BC114 transistors
K110	4	BD131 transistors
K111	4	BD132 transistors
K112	12	3A 100V rects, wire ended
K113	30	DA002 rects 150V 0·5A
K114	15	XK6116 (BF241) transistors
K115	18	SP1218 (2N3702) transistors
K116	10	MPSL01 NPN 140V T092
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K118	16	ME4101 NPN 60V AF low noise
K119	10	2N5401 NPN 160V T092
K120	6	prs 2SD96/2SB496 AF O/P sim to AC128/176
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K122	10	VR525 5·25V 2·2W zener
K123	10	56V 1W zener
K124	50	·02µF disc ceramic
K125	200	1k 5% ¼W carbon film resistors
K126	100	3000pF 63V polystyrene preformed caps
K127	25	47µF 25V axial lead caps
K128	25	15µF 40V do
K129	8	AA113 diodes
K130	25	470R V 0·1W presets
K131	10	VA1086 thermistor
K133	20	3 way 5A term blocks
K134	50	unmarked untested OC71 type transistors
K135	30	4·7µF 10V radial elecs
K136	4	AC187k transistors
K137	5	18µF 100V non-polarised caps
K138	30	¼" coil former with slug
K139	40	·025µF 50V mylar caps
K140	30	·05 do
K141	40	0·01µF 400V axial caps (C296)
K142	25	wire ended neons std size, 90V
K143	200	squares mica insulation 25mm sq.
K144	30	IR5 3W wirewound resistors
K145	10	1500µF 16V caps—radial PC mntg
K146	25	330µF 4V axial caps
K147	3	150µF 350V caps—radial PC mntg
K148	30	transformer former type X228
K149	12	Ferrite rod type X036
K150	10	switches type W430
K151	12	0·125" red LED's
K152	10	0·2" red LED's
K153	30	T05 heat sinks, same as G104
K154	15	5 pin 180° Din socket, clip fix
K155	100	metres thin flex (50 × 2m lengths)
K156	15	1¼" chassis mntg fuseholder
K157	12	16 pin QIL-QIL IC sockets
K158	6	SPCO centre off white rocker switches
K159	20	0·3W presets 500k V with knurled knob
K161	20	0·3W presets 2k5 V
K162	20	0·3W presets 2M5 V with knurled knob
K163	400	15R ¼W 5% preformed vert mntg resistors
K164	50	22pF 2% silver mica caps
K165	20	Sub-min reed switch, body 20mm long
K166	100	3300pF 630V polyester PC mntg caps
K168	50	AA144 diode preformed as above
K169	30	8V2 400mW zener as K167
K171	25	11V do
K173	12	1·5µF 25V tant bead caps
K174	12	0·47µF 25V tant bead caps
K175	100	2000pF 2½% 125V p/s caps
K176	24	150R 0·1W vert presets
K177	24	470R 0·1W horiz presets
K178	24	470R 0·1W vert presets
K179	24	2k 0·1W horiz presets
K180	24	2k 0·1W vert presets
K181	24	2k2 0·1W horiz presets
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K187	18	PE5030 NPN SI T092 transistors. Vce 35V, Hfe 75
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K189	30	1N649 600V 0·4A diodes, preformed for H mntg.

ELECTRONICS

A NEW AND EXCITING HOBBY!!

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Ideal for beginners – gives lots of general information – explains how to build lots of projects : Intercom, Rain Alarm, Radios, Organ, Parking Light etc. All parts supplied and can be re-used on special deck provided, so NO SOLDERING is required. Just needs 4½V battery.

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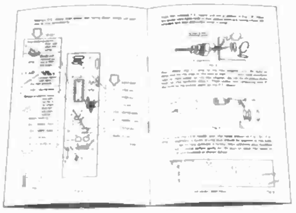

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Projects... Theory... and Popular Features...

THAT'S LOGIC

This month's free gift will round off nicely our eight-part series explaining i.c.s., which concludes in this issue.

An examination of this 24-page glossary will show, amongst other things, how much of the special vocabulary of electronics is directly attributable to integrated circuits. Clearly these devices are now pillars of the electronic establishment.

Integrated circuits themselves are divided into two main classes, ,commonly known as linear and digital devices, respectively. The latter class brings us into the field of logic. This is the stuff computers thrive on; but not only computers, for digital techniques are now employed extensively in a vast number of circuits, many of them quite uncomplicated and commonplace. It follows therefore that an understanding of digital counting methods and the manner in which electronic gates (switches) are deployed to process streams of digits is necessary for all who wish to maximise their appreciation and practical use of electronics.

This is where our new series *Introduction To Logic* comes in. It will provide a clear-cut guide for the newcomer to this subject, and at the same time be a useful refresher course and handy source of reference for others. Remember though that every instalment is vital to the whole, so don't miss out on a single issue of EE—that's logic, isn't it?

F.M. FOR THE CITIZENS

The Home Secretary's announcement that a Citizens Band radio service will be authorised sometime in the autumn has been greeted with qualified rejoicing by the champions of this form of personal two-way communications.

The snag for those who have beaten the gun, is that their a.m. equipment will remain illegal in the UK. For while the Home Office has been forced to bow to the popular demand for a frequency of 27MHz, it has taken into account the real dangers of interference to television reception created by amplitude modulated signals on this frequency, and has therefore plumped for frequency modulation as being the lesser of the two evils from the TVI point of view.

The threat of this nuisance is not going to disappear for a very long time—if at all. Viewers who suffer from picture break-up or interference on sound caused by transmissions from either licensed amateurs or illegal CB operators could find an answer to the problem in this month's article *TVI Filters*.

Fred Bennett

Our June issue will be published on Friday, May 15. See page 331 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 10 NO. 5 MAY 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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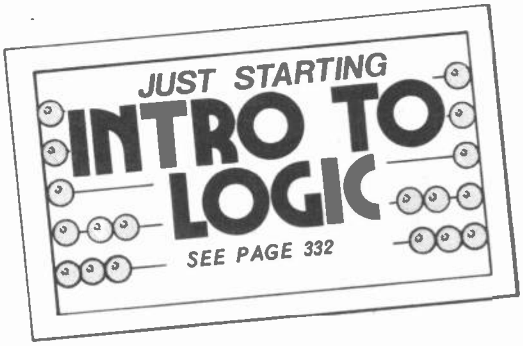
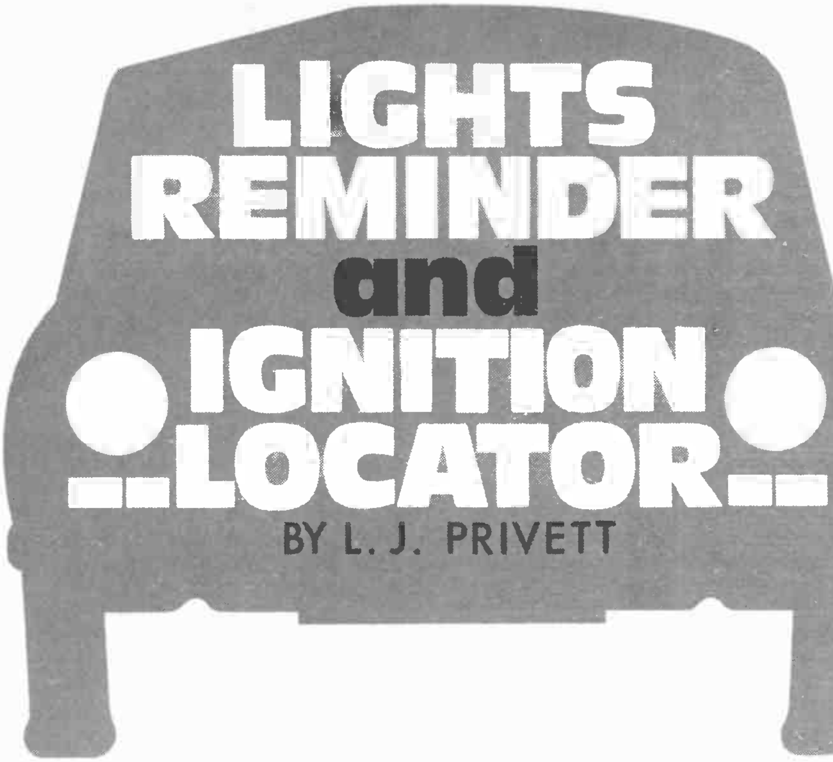




LIGHTS REMINDER and IGNITION LOCATOR

BY L. J. PRIVETT

THERE have been many circuits published in the past for reminding the driver that the car lights have been inadvertently left on, so the author decided to incorporate in his version an extra facility at minimal extra cost and complexity, to make the project a little different.

This unit will give an audible warning if the car lights are on and one or other of the doors that operate the car courtesy light are opened. What also happens whenever the car door is opened and then closed (conditions for one entering the car) is that a cluster of l.e.d.s light up showing the position of the ignition switch. This is most useful in dark ambient conditions.

The l.e.d.s stay illuminated for a period of time and then switch off automatically. This operates regardless of whether or not the ignition switch is on or off. **The circuit to be described here is suitable only for negative earth vehicles.**

CIRCUIT DESCRIPTION

The circuit diagram of the Lights Reminder is seen in Fig. 1 together with relevant car wiring. The system is based on a CMOS integrated circuit, the 4011, a quad 2-input NAND gate, a common and inexpensive i.c.

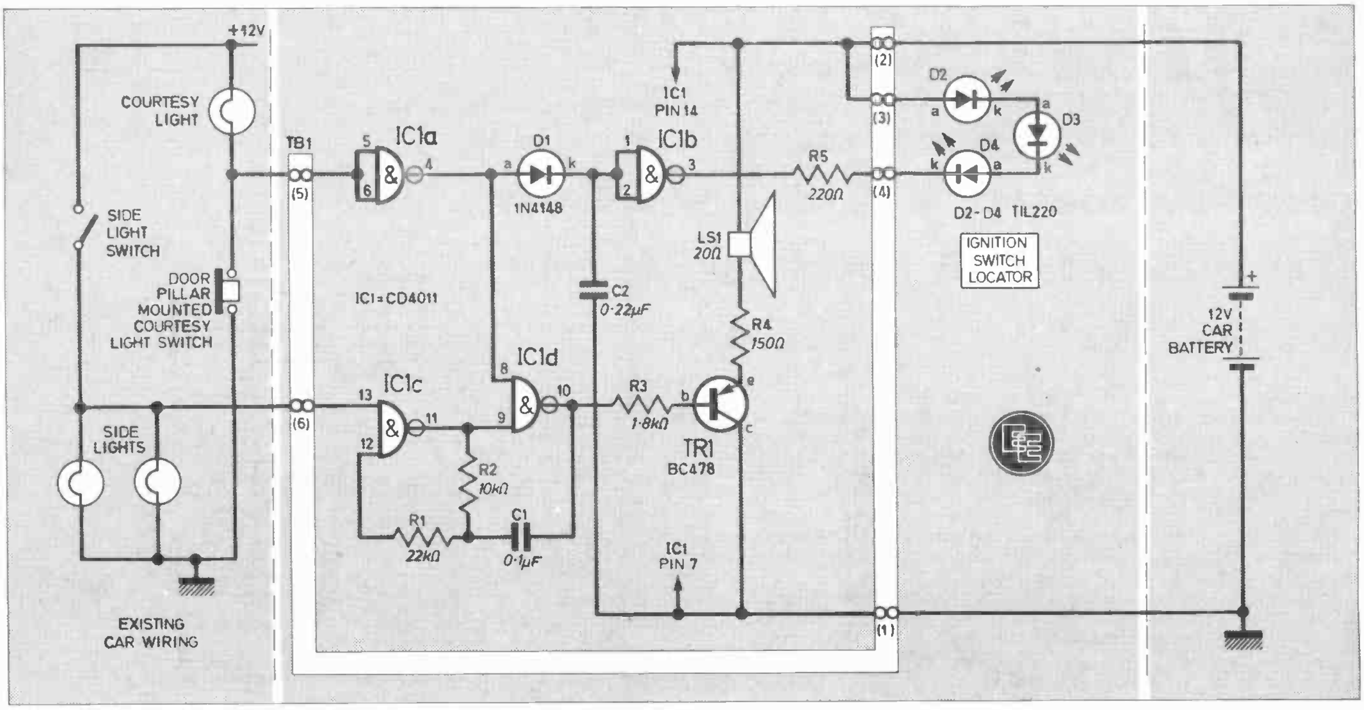
Two of these gates, IC1c and IC1d are connected to form an astable multivibrator which has the feature of being controlled, turned on or off, by an input to each gate, pins 13 and 8 going high or low respectively.

The output of this oscillator is fed through R3 to the base of TR1. This drives a moderately high impedance speaker. R4 is included to limit the power dissipation in TR1 whilst maintaining adequate output volume. Alternatively, R4 can be omitted if a more powerful transistor, such as a BFX87, is used to replace the BC478.

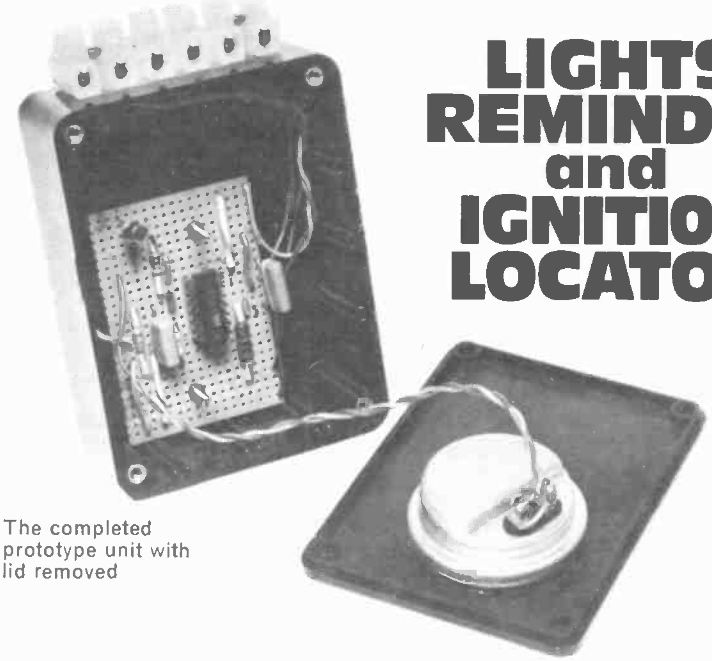
One input to IC1c is held low through the sidelights in the car and the input to IC1d is controlled by the courtesy light circuit via the inverter formed by IC1a. Both inputs have to be maintained at logic 1 for sustained oscillator output.

Gates IC1a and IC1b form a short duration timing circuit that is triggered by the courtesy light switch. The input to IC1a is held high from the 12 volt supply through the courtesy filament lamp. This produces a low output to feed IC1d pin 8 to inhibit the oscillator. When the courtesy switch is made, this output changes to a low producing a high at pin 8. If the sidelights are also on pin 13 is also high resulting in the oscillator producing its tone in the loudspeaker.

Fig. 1. The circuit diagram for the Lights Reminder and Ignition Locator with relevant car wiring.



LIGHTS REMINDER and IGNITION LOCATOR



The completed prototype unit with lid removed

£4·50
approx. cost

COMPONENTS

See **Shop Talk** page 334

Resistors

R1	22kΩ
R2	10kΩ
R3	1·8kΩ
R4	150Ω
R5	220Ω

All ¼W carbon ± 5%

Capacitors

C1	0·01μF polyester
C2	0·22μF polyester

Semiconductors

D1	1N4148
D2-D4	TIL220 red l.e.d. (3 off)
TR1	BC478 *pnp* silicon
IC1	4011 CMOS Quad 2-input NAND gates

Miscellaneous

LS1	miniature loudspeaker 20 to 80 ohms
TB1	6-way screw terminal block

Stripboard: 0·1 inch matrix, 26 strips × 17 holes; 14-pin d.i.l. socket for IC1; stranded p.v.c. covered wire; plastics case, size 100 × 80 × 40mm; 6BA fixings including 5mm long spacers and shakeporof washers (5 sets); piggy-back crimp connectors (2 off); eyelet crimp connector (1 off).

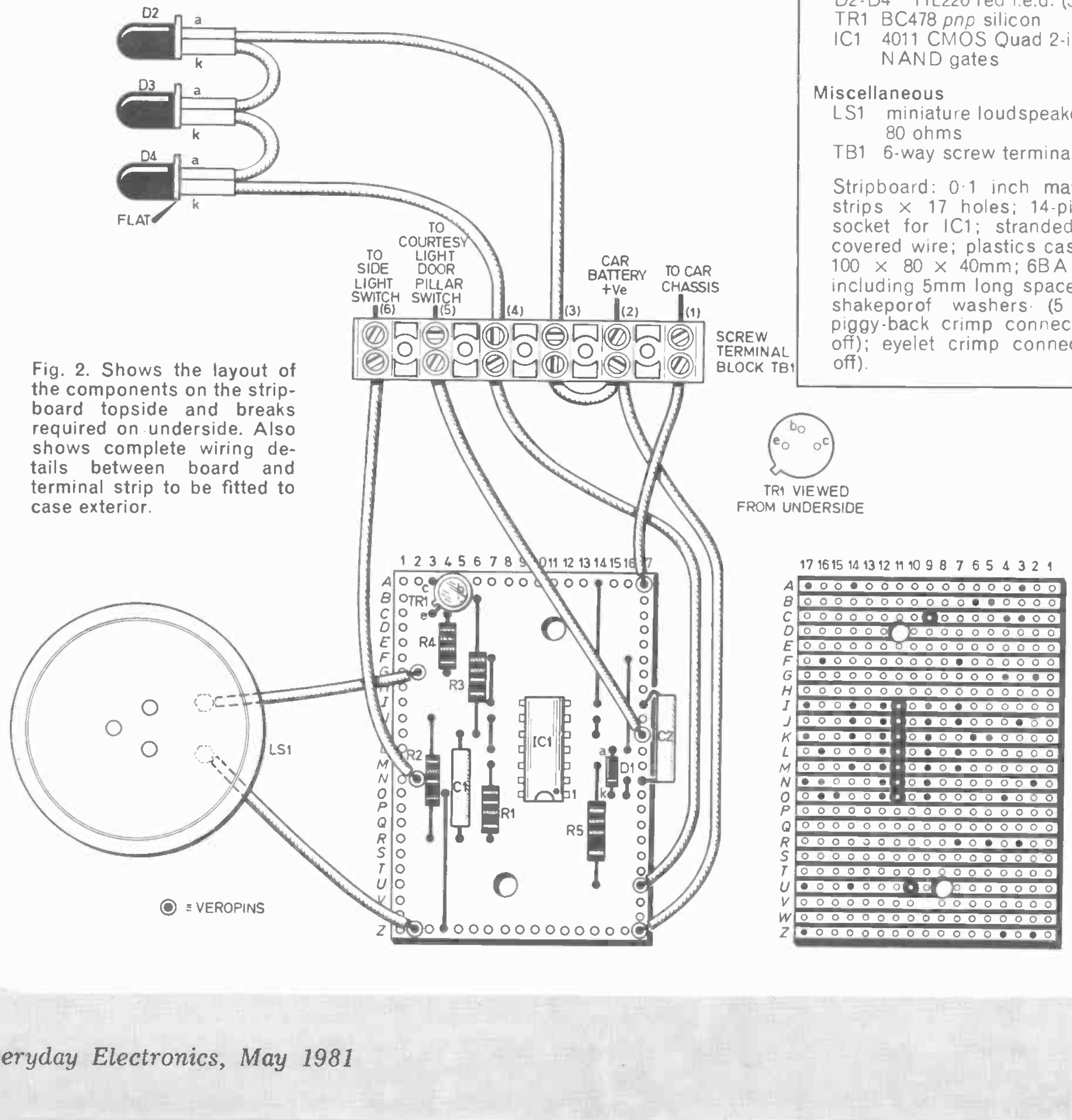
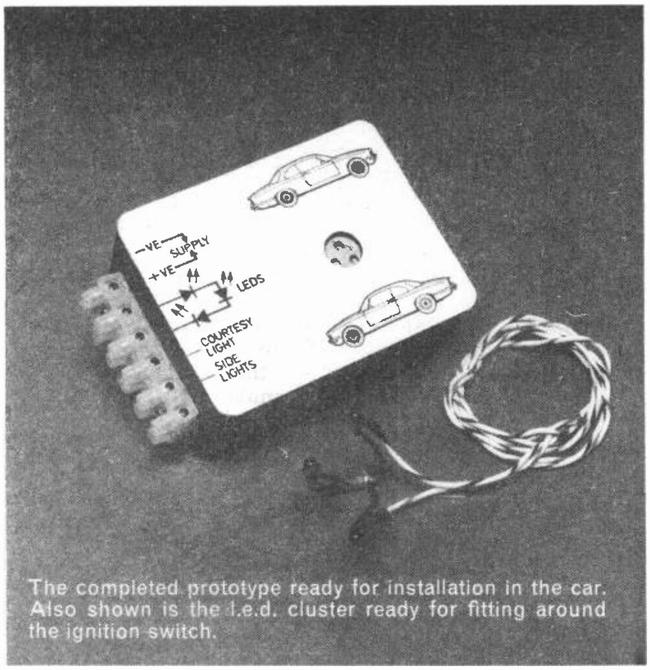


Fig. 2. Shows the layout of the components on the stripboard topside and breaks required on underside. Also shows complete wiring details between board and terminal strip to be fitted to case exterior.



The completed prototype ready for installation in the car. Also shown is the l.e.d. cluster ready for fitting around the ignition switch.

The output from IC1a also feeds IC1b input (connected as an inverter) via D1. Normally pin 4 will be low so IC1b output will be high. The l.e.d.s D2 to D4 will thus be off. When the door is opened, pin 4 goes high and C2 charges up quickly. IC1b follows by going low resulting in the l.e.d.s turning on. When the door is next closed, pin 4 returns to low and C2 begins to discharge through IC1b input. After a time set by the value of C2, the voltage across this capacitor drops below the logic high threshold and pin 3 reverts to a high extinguishing the l.e.d. cluster.

The value chosen for C2 produces an l.e.d. on-time of approximately 30 seconds. This should be more than enough time to sort out the right key and insert it into the ignition switch.

D1 is included for two reasons: (1) to limit C2 discharge path to input of IC1b only, and (2) to prevent C2 voltage levels from interfering with oscillator action.

CONSTRUCTION starts here

ASSEMBLY

The position of the components on the topside of the 0·1 inch matrix stripboard is seen in Fig. 2 together with the breaks to be made on the underside. Make the required breaks using the special spot-face cutting tool or a small drill bit. Make sure that any swarf produced is cleaned off. Next insert the Veropins followed by the i.c. socket. These will aid the positioning of the remainder of the components.

LINK WIRES

Now connect the link wires followed by resistors, capacitors and semiconductors in this order paying special attention to the polarities of the latter. Do not insert the i.c. in its socket at this stage. In the prototype sleeving was fitted over the link wires as can be seen in the photograph, but this is not essential.

Connect up the off-board wiring using stranded wire—not the solid core type, as this has a tendency to break with vibration as will be experienced in the car. Make secure mechanical joints at the Veropins before soldering.

LOUDSPEAKER

The speaker can be any value between 20 and 80 ohms. The one used in the prototype was the earpiece from an old telephone which gave satisfactory results.

In the prototype this was glued to the lid of the case which had a matrix of holes drilled to allow the sound to escape and be heard. It may be a better idea however to make a small bracket to hold the speaker in place as the vibration it is likely to receive could easily disturb an adhesive connection.

Screw fix the board and the terminal block to the case using shakeproof washers as well. Drill some small holes alongside the terminal block to allow the cables to come through from the board. Take off any rough edges with a larger drill bit by slightly countersinking the holes. Finally connect the wires as shown in Fig. 3 not forgetting the link wire on the terminal block.

Fit the i.c. into the socket the right way round. This is a CMOS device so please take the standard precautions. The pins of the i.c. when first purchased are normally slightly out of true and need to be bent inwards to fit the socket easily. Do this on a metal tray or similar connected to earth. Another quick way of earthing yourself is to run a cable from earth to your watch if it has a metal strap as this gives a good connection. Once completed the board is ready for testing.

TESTING

It is as well to test the unit before installing in the car and tapping into the wiring system. A couple of bulbs and switches and a 12 volt d.c. supply will be required. If no bulbs are available, 1 kilohm resistors could be used in their place.

Connect up according to Fig. 3 and check out its operation for combinations of the two switches. The l.e.d. on-time may be increased by increasing the value of C2 or vice versa if this is not entirely to your satisfaction. When satisfied that the unit is functioning correctly, it may be installed in the car.

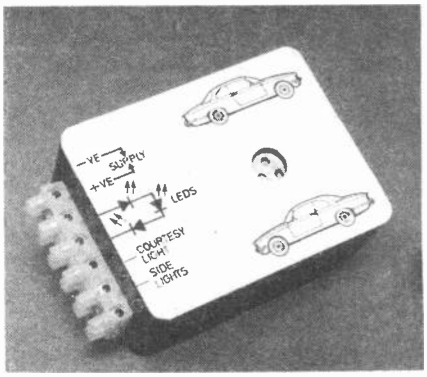
No details for fixing the l.e.d. cluster around the ignition switch have been given as this will vary according to the car model and make.

The unit should be positioned in a convenient place inside the car so that the tone can be heard clearly when activated. It is advised that a position not subject to large temperature changes be found, in other words away from the heater fan area and other draughty positions.

Insulated crimp connection will be required to connect to the car wiring system, and the "piggy-back" type will be most convenient allowing two wires to be connected to a terminal without cutting the resident wiring in any way.

Probably the most convenient point to pick up the 12 volt supply is the ignition switch, and of course the sidelight connection to the dash mounted light switch. Piggy-back connectors are required for these.

A "eyelet" connector for connection to the chassis (battery −ve) is also required. The connector type for connecting to the courtesy light switch will be determined after consulting the car wiring diagram for the most convenient take-off point. Use stranded wire for these connections. ⌑



GUITAR HEADPHONE AMPLIFIER

BY P. BAILEY

THE market today offers a huge selection of different amplifiers and "combos" for the electric guitarist, but there seem to be fewer amplifiers that have a headphone facility. Practice amplifiers can be bought with powers of about 5 to 15 watts, and these normally have a socket for headphones, but even these practice amplifiers can be quite expensive.

The author has seen a make of headphone amplifier for guitar practice, but this was retailing at around £30 and this was felt to be too high a price for those simply wanting to be able to practice without disturbing others.

The unit to be described here uses only a few, easily-obtained, components and satisfies the above requirements. It is truly pocket sized, and is battery operated and so is completely portable. It can drive an ordinary pair of stereo headphones to more than adequate volume for practice purposes.

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1 and can be seen to be a simple circuit. The signal from the guitar enters the circuit via SK1 and C1. SK1, as well as being the input socket is also the on/off switch since it has been wired so that the battery is only connected when the guitar jack-plug is inserted. This avoids a flat battery due to forgetting to switch the unit off after use, or inadvertently knocking the on/off switch on.

The signal is fed directly into the 741 op-amp i.c. which in this case has been connected as a non-inverting amplifier, the basic circuit for which is shown in Fig. 2.

Non-inverting simply means that the output signal is in phase with the input signal, that is if the input voltage is positive then the output voltage will be positive too, and the same goes for a negative input voltage. The circuit in Fig. 2 is of a d.c. amplifier of this type, and its gain is dependent on the values of R_A and R_B by the formula:

$$\text{Gain} = \frac{R_B}{R_A + R_B}$$

So if R_A is made very small with respect to R_B then the gain will fall until it is unity, when R_A is zero. Similarly if R_B is made very small with respect to R_A then the gain will rise until it is the open loop again of the op-amp (usually around 100,000 for a typical 741). Therefore by substituting a potentiometer in place of R_A and R_B, with its wiper connected to the inverting input of the op-amp, the gain can be made variable.

But this circuit, being a d.c. amplifier, must be coupled by capacitors

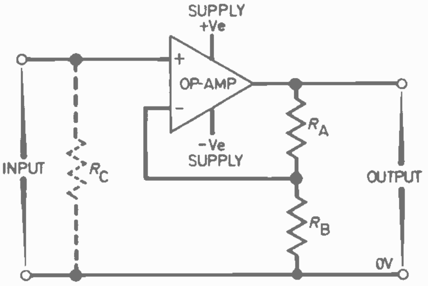


Fig. 2. A basic non-inverting op-amp circuit on which the design is based.

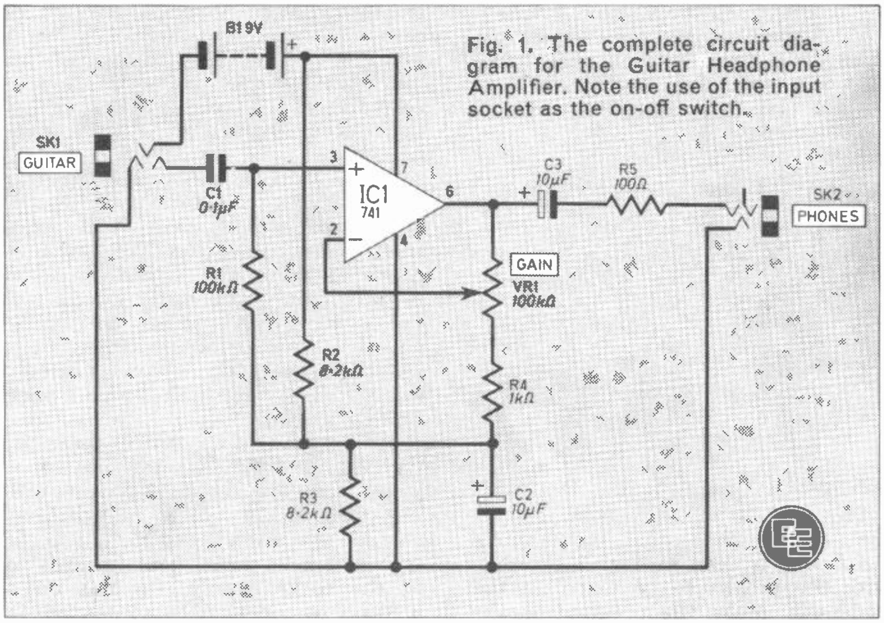
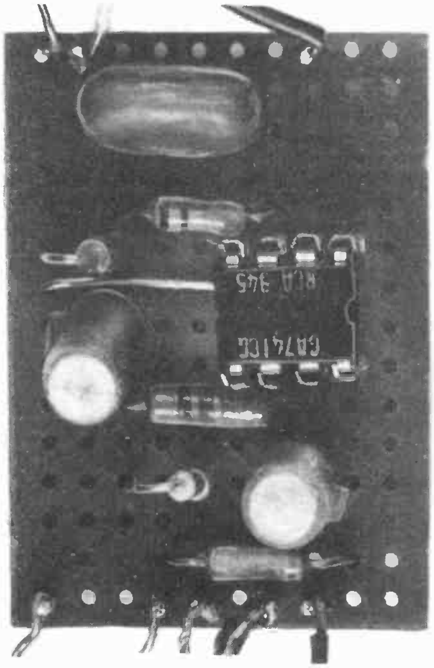
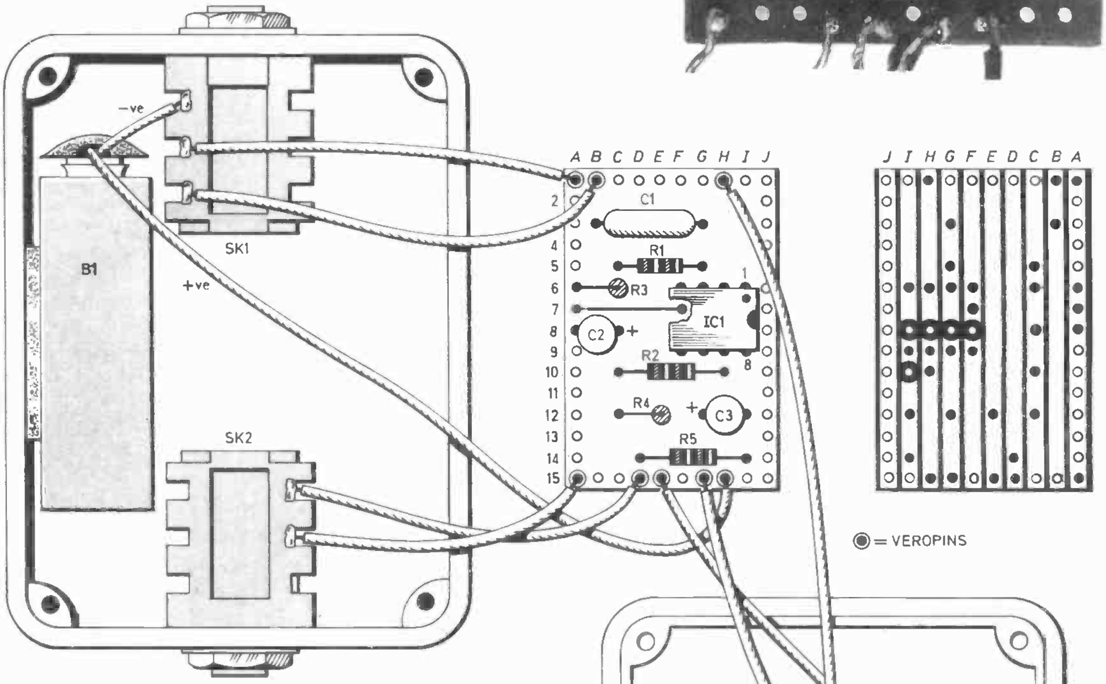


Fig. 1. The complete circuit diagram for the Guitar Headphone Amplifier. Note the use of the input socket as the on-off switch.

The completed prototype amplifier (left) ready for use.



Close up view (right) showing the construction of the prototype circuit board



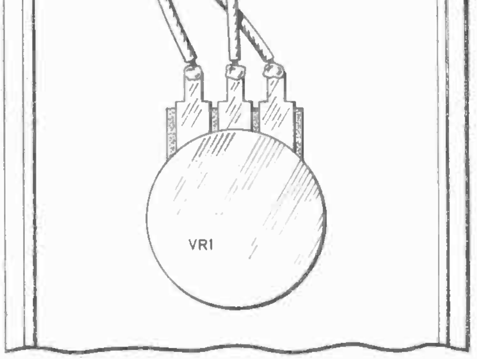
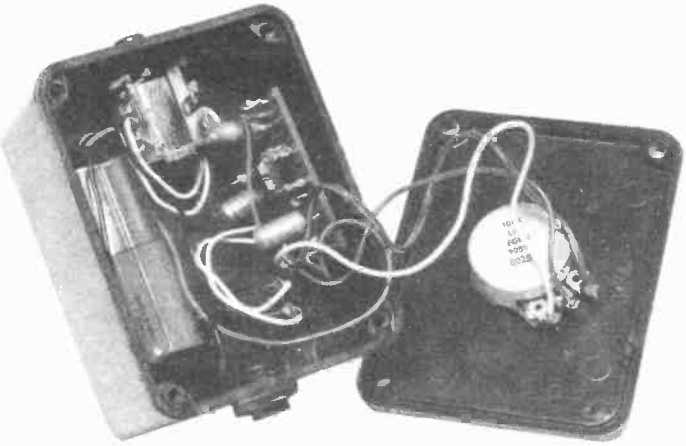


Fig. 3. Complete interwiring details between board and case mounted components. Also shows the layout of the components on the top-side of the board and the breaks required on the underside. Self adhesive foam hold the battery securely in position.



Near-completed prototype unit showing board in its position in the case.

at the input and at the output, when it is required to be used in a.c. applications such as this, and when this is done a resistor R_C (shown dotted) must be included to d.c. stabilise the amplifier, otherwise it would quickly saturate, that is, the output would become locked hard positive or negative.

Although simple, this type of circuit can drive a pair of headphones to quite high volumes. The gain control allows the unit to be used with all different kinds of electric guitar, since some pick-ups have lower level output signals than others, and these require a higher gain. Resistor R4 simply stops the gain from being too high at its maximum setting since this would cause very severe distortion.

SUPPLY LINES

The positive and negative supplies necessary for this i.c. have been derived from the 9V battery using the potential divider formed by R2 and R3. This arrangement alone would be unsatisfactory in this application due to the internal circuitry in the i.c. The fact that only a small current is flowing in the divider means that very little current would be available to drive the headphones. This problem is overcome by inserting C2 which makes the divider invisible as far as a.c. signals are concerned.

R5 limits the current drawn from the i.c. thus protecting it, and also limits the voltage swing present across the output when using low impedance headphones thus protecting the headphones.

COMPONENTS

Resistors
- R1 100kΩ
- R2 8·2kΩ
- R3 8·2kΩ
- R4 1kΩ
- R5 100Ω
- All ¼W carbon ± 5%

Capacitors
- C1 0·1μF polyester
- C2, 3 10μF 10V elect. radial lead type (2 off)

Integrated Circuit
- IC1 741 op-amp 8-pin d.i.l.

Miscellaneous
- VR1 100kΩ carbon lin.
- SK1, 2 standard stereo jack socket (2 off)
- B1 9V type PP3
- Stripboard: 0·1 inch matrix, 10 strips × 15 holes; 8-pin d.i.l. socket; insulated stranded wire and single core stiff wire; knob; plastics case approx. 80 × 60 × 40mm.

Guidance only Approx cost **£3·50 complete**

Finally the amplified signal passes out through SK2, a stereo jack socket which has been wired so that when stereo headphones are used they are connected in series. This also has the advantage that headphones terminated in a mono jack plug can also be directly plugged in and used.

CONSTRUCTION starts here

BOARD AND COMPONENTS

The circuit is a simple one and so construction should be straightforward. Since the unit is required to be truly pocket-sized, the circuit board is by necessity fairly small, and while the components are not closely packed in, it should be borne in mind when buying the parts that oversize components may not fit the circuit layout shown. For this reason it is recommended that the two 10μF capacitors be single ended p.c.b. types or similar rather than large axial electrolytics. If the size of the case being used is unimportant then the layout may be redesigned to accommodate any size of components desired, using a larger circuit board.

The circuit board layout is shown in Fig. 3. First mount the i.c. socket. It is best to use one since this will avoid any damage to the i.c. during soldering due to overheating, and this will make it easier to see where the other components should go. Resistors and capacitors should be mounted next, with particular attention being paid to mounting the polarised capacitors the correct way round. Finally the i.c. can be mounted into its socket.

In the prototype Veropins were used for all flying leads and these made their connection considerably easier. Since the circuit board is small and light no mounting bolts have been used, the board being secured by stiff wire leading to the input and output sockets. If a larger case is used fixing of the circuit board by means of nuts, bolts and stand-offs may be required.

Also, where the input lead length (SK1 to board) is increased beyond a few centimetres screened lead will become necessary, and care should be taken when using unscreened lead to keep the input and output leads apart, thus eliminating any possibility of instability and oscillation.

Sticky pads such as "Sticky Fixers" or "Velcromounts" can be used to hold the battery in position, or else double-sided Sellotape could be used.

CHECKING AND USE

Check all the wiring and also check that the breaks in the copper strips have been correctly made. Then if all seems well the battery can be connected, headphones plugged in, and the unit switched on by inserting a jack plug at the input.

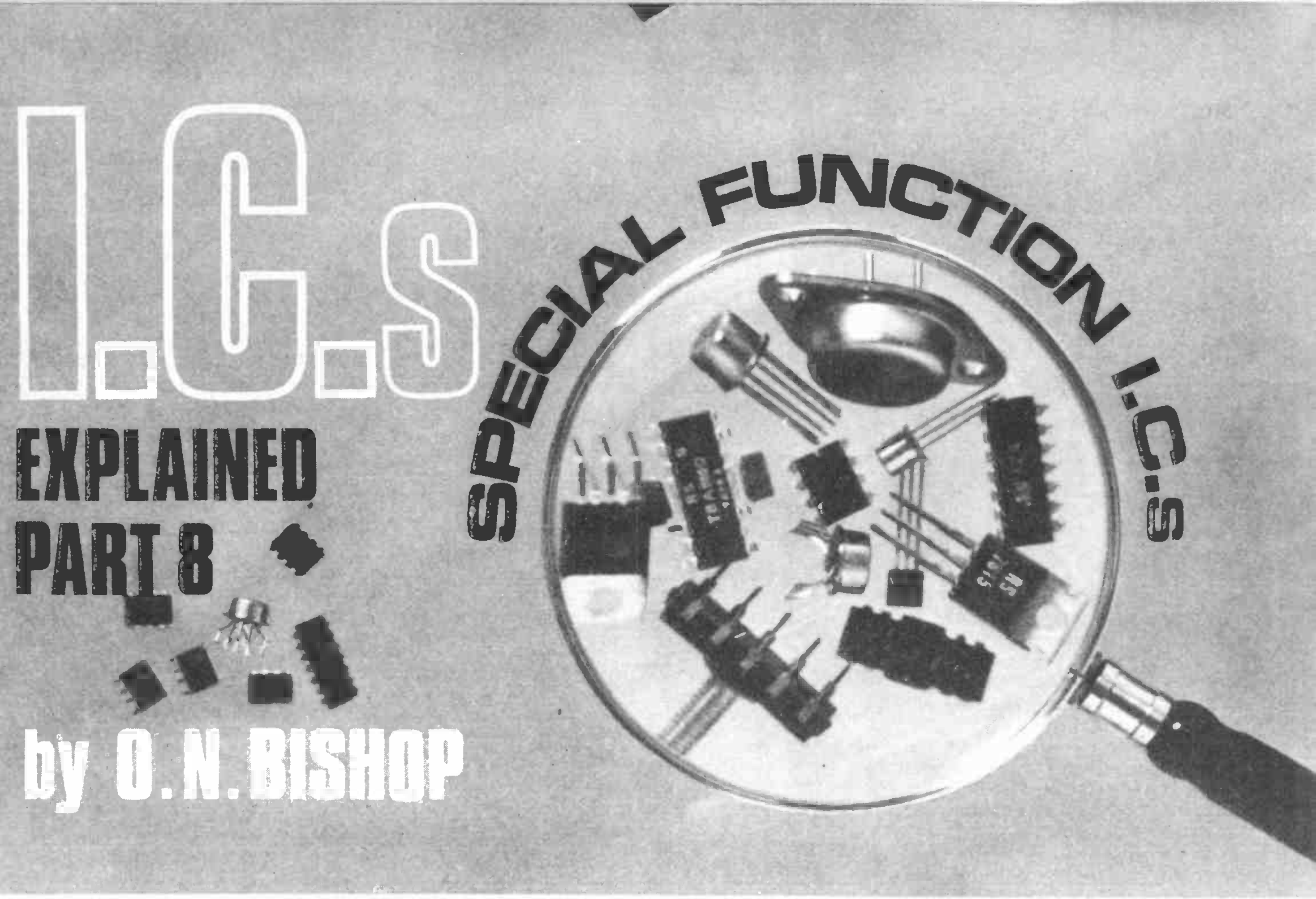
With the gain control advanced slightly a hum should be heard when touching the input with a finger. This should get louder as the gain control is advanced. If this is not so switch off and check all wiring and also check that IC1 has been inserted the correct way round. It is worth noting that due to the output socket contact arrangement, if headphones with a mono/stereo switch are used, the unit will only function when the switch is in the stereo position.

With the unit working, a guitar should now be plugged into it and its volume control turned full on. By increasing the gain the guitar should become audible, getting louder until it becomes distorted when the gain is at maximum. To remove the distortion the gain should be decreased until the signal is fairly clean, then the volume control on the guitar should be reduced to a setting giving maximum volume with minimum distortion. Many guitarists will find the distortion facility desirable especially for use in lead guitar practice.

If there is not found to be enough gain for the guitar being used then a small single transistor pre-amp could be inserted before the i.c. Normally this would not be necessary and the prototype worked well with many different guitars. Alternatively R4 could be reduced in value.

Of course the unit is not limited to use with guitars and could be used with an organ or synthesiser for instance, which had a low-level signal output but no headphone socket. It could even be used between a guitar or other instrument and amplifier (amplifier volume low) to act as a pre-amp or to produce distortion. In either of these cases the lead to the amplifier would be inserted into the headphone socket on the unit. ⌑

I.C.s EXPLAINED
PART 8
SPECIAL FUNCTION I.C.S
by O.N.BISHOP



IN THIS concluding article of the series we survey a wide range of digital i.c.s, from the most complex to the simplest of all.

REMOTE CONTROL

Whether we are controlling a television set from the comfort of an armchair, or are controlling the Voyager II fly-by of Saturn from the Jet Propulsion Laboratory, Pasadena, a digital signal stands more chance of being accurately received than an analogue signal.

The all-or-nothing nature of digital signals can survive the rigours of distortion and noise inherent in transmission across the living room or across deep space. Even though the signal may be mis-shapen on arrival it is usually easy to square it up before passing it to the logic circuits in the receiver.

CODING AND DECODING SYSTEMS

Various systems are in use for coding the commands before transmission and decoding them after reception. In the simplest form a series of pulses is sent, usually preceded by a "start" pulse. Subsequent pulses are either "0" or "1", so conveying a binary-coded message. The digital proportional control commonly used for model radio-control conveys analogue information (for example, required engine speed, or position of rudder) by transmitting pulses of varying length (pulse width modulation, p.w.m.). Naturally, any distortion of the pulses during transmission is liable to distort the pulse length. Fortunately, the operator can usually see the actual response of the model and make compensating adjustments.

PULSE POSITION MODULATION

A more recently invented system is pulse position modulation (p.p.m.) and a small family of digital i.c.s has been developed to code and decode the commands. In p.p.m. all pulses are of equal duration. The spacing between pulses is of three fixed and distinctive lengths, see Fig. 8.1. The fact that all lengths are standard makes it simple to reconstitute a distorted pulse train sufficiently well to allow the command to be decoded.

The SL490 i.c. (Fig. 8.2) is able to generate a carrier frequency (for an ultrasonic oscillator, for example) and to modulate this signal with a train of pulses (5 *intervals*). It can also produce a signal without a carrier for use with infra-red or radio-control systems.

The i.c. is operated by pressing one of up to 21 push-buttons. Ten of these cause the production of 10 different "program codes." These are decoded by the ML922 decoder causing its four program outputs to go to the corresponding binary coded state. These can be further decoded, for example by the 4028 b.c.d. to decimal decoder that was mentioned last month, to switch on any one of 10 electronic circuits or devices.

Analogue information is not transmitted as such. The i.c. controls up to 3 analogue circuits by transmitting either an "analogue +" or "analogue −" signal for each. At the decoder the effect of these signals is to increase or decrease the voltage appearing at the corresponding three "analogue output" pins. Voltages range from 0V to a preset maximum, in 32 steps. The analogue voltages may be fed to an operational amplifier for example, or perhaps to an electronic attenuator i.c. (MC3340P) to control the volume from a radio or TV set.

In addition to this function the system has a number of other useful switching actions. One of the chief error-avoiding features of the system is that the SL490 repeatedly sends out code groups for as long as the button is pressed. The ML922 checks each group as it is received and only when two consecutive received groups are identical does it respond. The SL490 can also be used with two simpler decoder i.c.s, the ML928 and

ML929. These respond to codes 00000 to 01111 and 10000 to 11111 respectively, and have 4-bit binary outputs.

These outputs are latched, like those of the ML922, and change only when a new command is received. The ML926 has unlatched outputs; the outputs are active only for as long as one of the 15 codes 00001 to 11111 is being received.

Table 8.1 Truth table for required output from three independent inputs

Inputs			Outputs
C	B	A	Z
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

COMPLEX LOGIC

Sometimes we want to perform a complex logical operation, such as that shown in Table 8.1. To do this with logic gates requires a lot of working out and, when it has been done, we need several logic gates with some fairly elaborate wiring. A much simpler solution is to use a *data selector* i.c.

The 4512 can cope with the problem very easily and you have no need to become mentally tangled with OR, NOR, AND and NAND. Fig. 8.3 shows the connections needed. Think of the

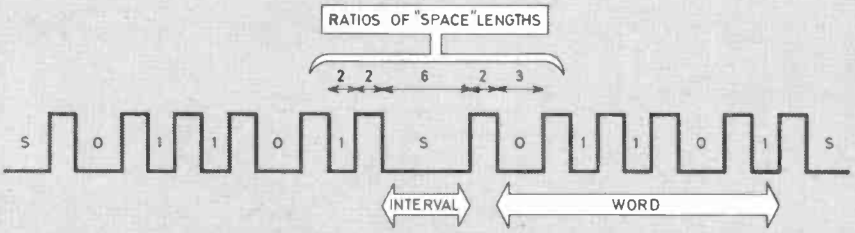


Fig. 8.1. Pulse code modulation: the coded word is 10110. Pulses are all of equal length at intervals of three related lengths.

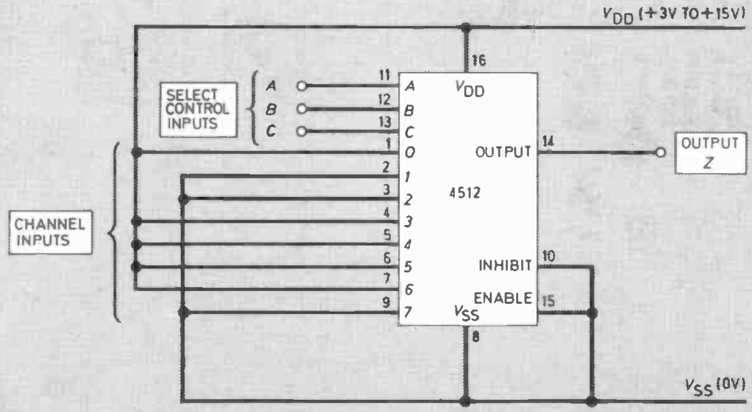


Fig. 8.3. Using the 4512 data selector as a complex logic generator.

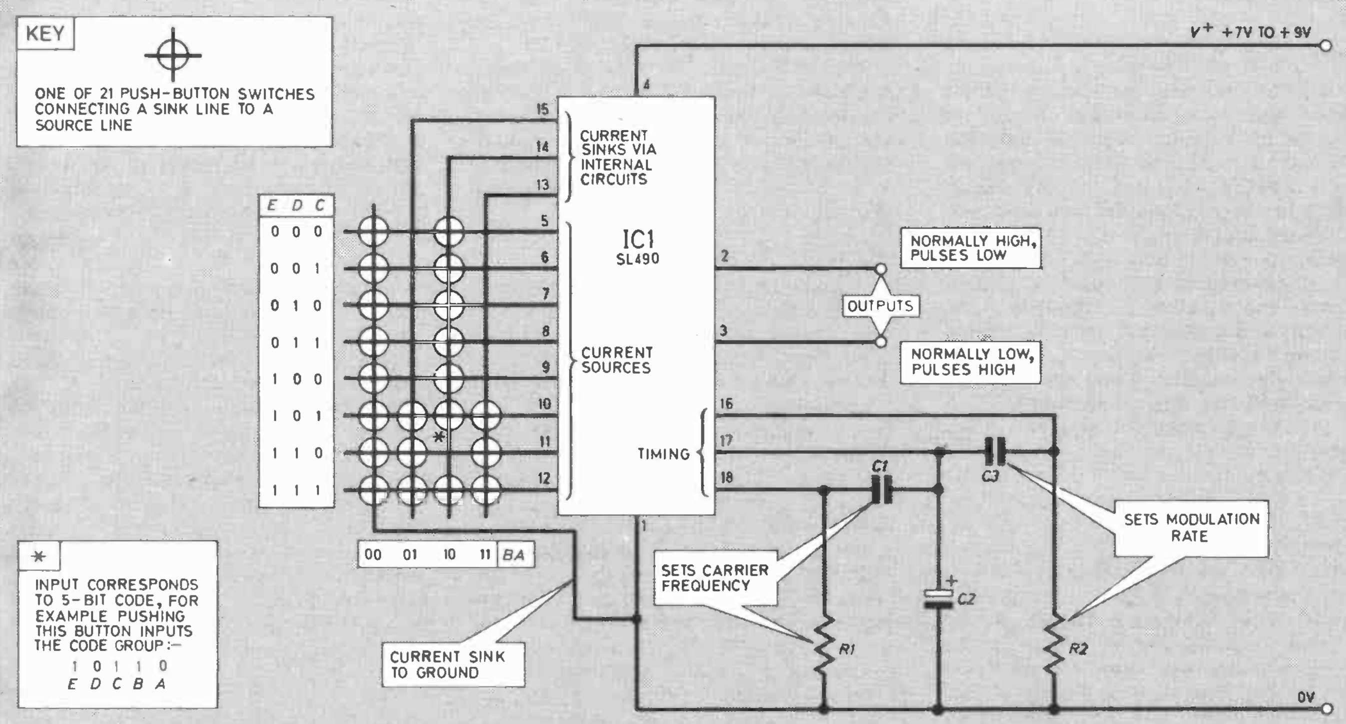


Fig. 8.2. The SL490, an i.c. which generates p.p.m. groups when a selected push button is pressed.

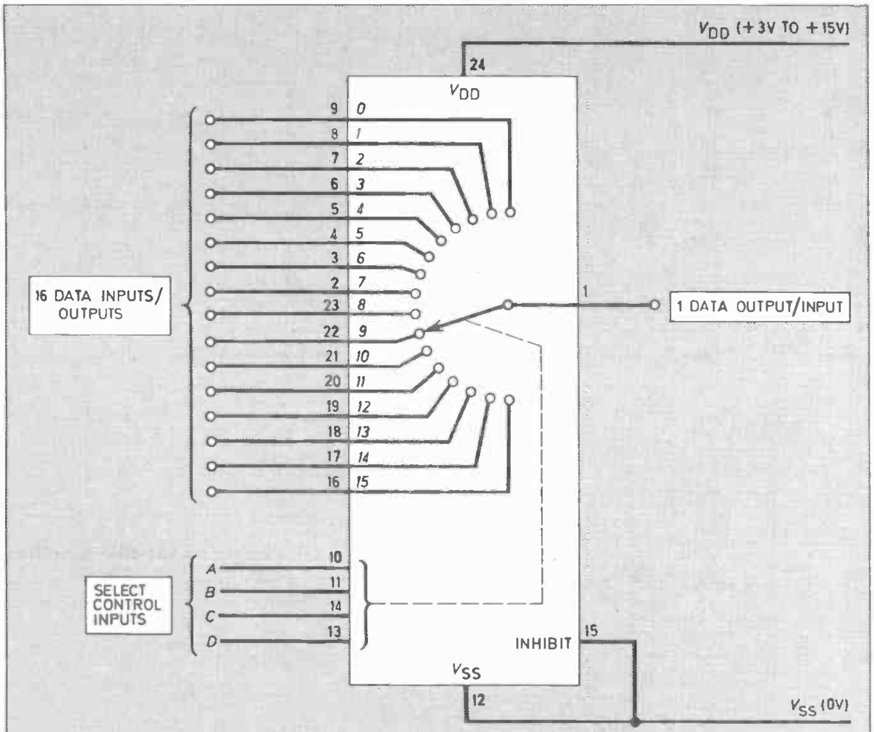


Fig. 8.4. The scheme of the 4067 analogue switch. This is a 24-pin package.

inputs to *C*, *B*, and *A* as a 3-bit binary number; these are used to select one of the data inputs 0 to 7.

For example 011 selects the third data input. Since this is connected to V_{DD}, the output takes the value 1. This is the logic for the fourth line of the truth table. Similarly 010 selects input 2, giving a low output, 0. Instead of working out complex, logic, we simply look at the truth table and connect inputs 0 to 7 to V_{SS} or to V_{DD}, as required. Incidentally, the 4515 has tri-state outputs (see Part 5, February 1981) which allow it to be connected to a data bus.

If we need logic involving four variables, we can use the 4515 and the technique of *logic folding*, which there is not room to describe here. Alternatively, there is the 4067 which has four "select" inputs (*ABCD*) to select 1 of 16 data lines, see Fig. 8.4.

There are two fundamental differences between the 4067 and 4515. The first is that the 4067 can operate either as a data selector *or* as a data distributor. The 16 selected lines can be inputs (as in the 4515) *or outputs*. The selected one of these is switched to a single pin which may be an output (as in the 4515), but can instead be an input. In short, signals can be passed through the 4067 in either direction. A signal on the single line can be distributed to any selected one of the 16 outputs, or the other way about.

The second feature of the 4067 is that it transmits analogue signals just as easily as digital ones. For the 4515, outputs and inputs are either 0 or 1. The 4067 can handle these too but can also transmit signals at any other voltage in the range V_{SS} to V_{DD}. It acts as a 1-pole, 16-way *switch*. This and similar i.c.s which will be described later are known as analogue switches.

Before leaving the topic of complex logic there is one more kind of digital i.c. that should be considered. This is the ROM, or read-only-memory. A microcomputer uses very complex logic. It needs a store of instructions telling it what to do at each stage. These instructions may be stored in coded form (machine code) in its ROM and will have been programmed, either during manufacture or subsequently by the user, to give the required combination of outputs for each of the 256 possible inputs. It is as if Table 8.1 had 256 lines, and a 4-bit output column. Although we normally think of a ROM as providing the data for controlling microprocessors there is no reason why they should not be employed for complex logical operations in other types of circuit.

TRANSMISSION GATES

One of the features of CMOS that distinguishes it from TTL is the transmission gate, see Fig. 8.5. The gate consists or two CMOS transistors, one *p*-channel and one *n*-channel. When the control input is low, the *n*-channel transistor becomes non-conducting. At the same time, the gate of the *p*-channel transistor is made high by the inverted control input, so this transistor too becomes non-conducting. The resistance between input and output is exceedingly high, being about 10TΩ(10^{13}Ω), which for all practical purposes is the equivalent of off. When the control input goes high the transistors become conducting and the switch is on. Now the path between input and output has low resistance, between 80Ω and 300Ω depending on the i.c. concerned and the voltage at which it is operating.

An analogue signal applied to either side of this switch appears virtually unchanged at the other side. Here we have a way of switching digital or analogue signals under digital control. Transmission gates are used instead of the conventional logic gates in several logic circuits. For analogue operation $V+$ is usually +5V and $V-$ is −5V. Their use in the 4027 *J-K* flip-flop was described in Part 6.

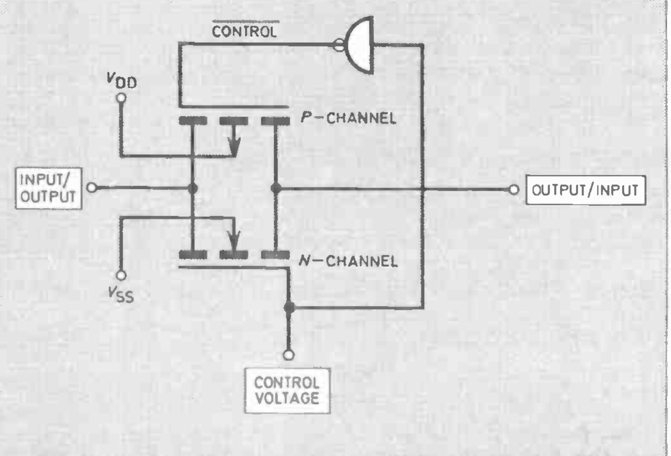


Fig. 8.5. Basics of a CMOS transmission gate.

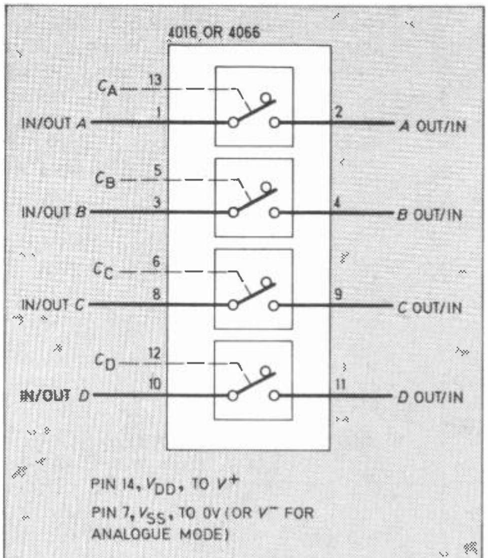


Fig. 8.6. The 4016 and 4066 quadruple analogue switch i.c. pinouts.

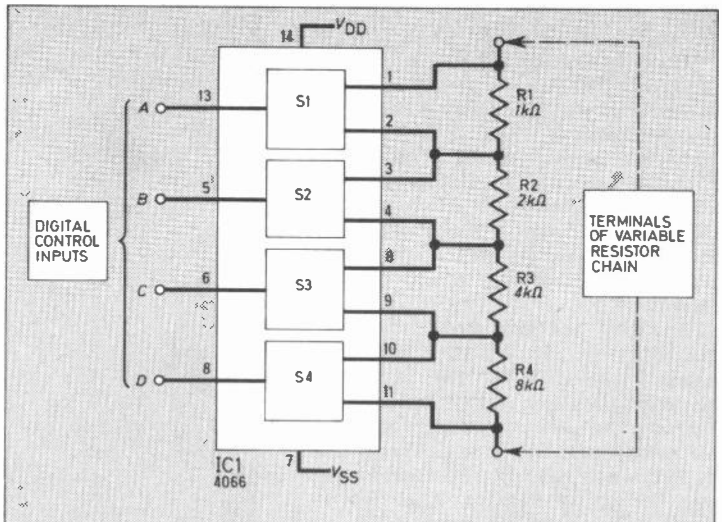


Fig. 8.7. Using the 4066 to make a digitally controlled variable resistor.

Table 8.2 Analogue switches

Device Type No.	No. of Inputs	Select Inputs	No. of channels	Equivalent mechanical switch
4051	1	*ABC*	8	1-pole 8-way
4052	2	*AB*: controls both units	4	2-pole 4-way
4053	3	*A1, A2, A3*; one per unit	2	three independent s.p.d.t.

A set of four transmission gates is available as the 4016 and the 4066 (with lower gate resistance). Each gate has its own control input, and can be considered as a s.p.s.t. switch (Fig. 8.6).

Apart from simple switching operations these i.c.s can be used to build a number of useful sub-circuits. In Fig. 8.7 we see how the 4066 can be used to make a digitally controlled variable resistor. As each control voltage goes high the switch is "closed' so short-circuiting the corresponding resistor. The gate resistances are low compared with the external resistors so the effective resistance of the chain can be varied from zero (about) up to 16kΩ in steps of 1kΩ.

Coupled analogue switches are used in the 4051 to 4053 i.c.s. These are analogue data selectors or distributors (often called demultiplexers or multiplexers). Table 8.2 compares their features. The 4051 is used in the project described at the end of this article.

SPECIAL FUNCTIONS

Apart from the remote control i.c.s described above, all the digital i.c.s mentioned so far in this series have been suitable for a wide range of functions. They have comprised logic gates, flip-flops, counters, registers, latches, decoders and several types of data-switching circuit.

In addition to these there is an equally large range of i.c.s each dedicated to one particular function. The advent of the CMOS transistor with its small size and very low power requirements has made it possible to pack thousands of transistors on one chip. Most of the devices mentioned in this section are examples of the complexity of function that can be realised as the result of such large scale integration (LSI).

PARITY I.C.

An example of one of the least complex of the special-purpose i.c.s is the 4063 magnitude comparator. This accepts two 4-bit binary numbers *A* and *B* as its input and has three inputs, one of which goes high for each of the three possible events, *A*<*B*, *A* = *B* or *A*>*B*.

The 4531 parity generator is used to add the extra parity bit to a data word as a check against errors during transmission. It has 12 input pins to receive a data word up to 12-bits long. Its output is low if the number of "1"s in the word is even, or high if the number of bits is odd. Whatever the number of "1"s in the data, the parity bit makes the total number of bits *even*.

The parity bit is transmitted as part of the data word. At the receiving end, another 4531 is used to check that the number of bits is even. If not, an error must have occurred; the state of the output of the 4531 indicates this fact. The 4531 can also generate *odd* parity bits.

Many examples of LSI are pulse generators of one kind or another. There are the top octave generators used in electronic organs, pianos and synthesisers, the multitude of clock and watch i.c.s and various forms of timer controllers, and the complex sound generators used for sound effects for TV games or for producing the tunes of musical doorbells.

This catalogue of the most elaborate of digital i.c.s leads us naturally to the most complex of all, the microprocessor. In some ways this is not as specialised as the others for, with appropriate programming, it can be made to perform many of the tasks performed by the others. It can handle the flow of data, act as an alarm clock, generate music and sound effects, perform all the most complex of logical operations, including numerical calculations, to mention only a fraction of its abilities. It can be made to *appear* to do all these things simultaneously!

Yet, in spite of the wonderful things these i.c.s can do, we must not be overawed by them. They all make use of the same basic units—gates, counters, flip-flops and the like—that we have studied in the course of this series. Complex they may be but nothing new by way of electronics or logic is inherent in their make-up or action.

THE 4007

From the heights of LSI and VLSI we turn to the most humble of i.c.s which, besides being a useful one, has (in contrast to the synthesisers and microprocessors) the merit that we can easily memorise its circuit diagram and can readily understand how it works. If you follow what goes on inside the 4007, it will give you insight into the behaviour (and occasional misbehaviour) of its more complicated brethren.

The 4007 contains only six CMOS transistors. In Fig. 8.8 they are numbered TR1 to TR6 for ease of reference. Two are paired to make an inverter; the other four are joined as two complementary pairs. These are the building-blocks of an astonishingly wide variety of circuits. The 4007 is often called the "do-it-yourself" i.c. for, within limits, you can make it do more-or-less what you want.

The action of the inverter is easy to understand. Pin 11 is connected to V_{DD}, and pin 9 to V_{SS}. **A high input** to pin 10 turns TR6 on, and TR5 off. Pin 12 is thus isolated from V_{DD}, but not from V_{SS}. Potential at pin 12 is pulled down—the output at pin 12 is low.

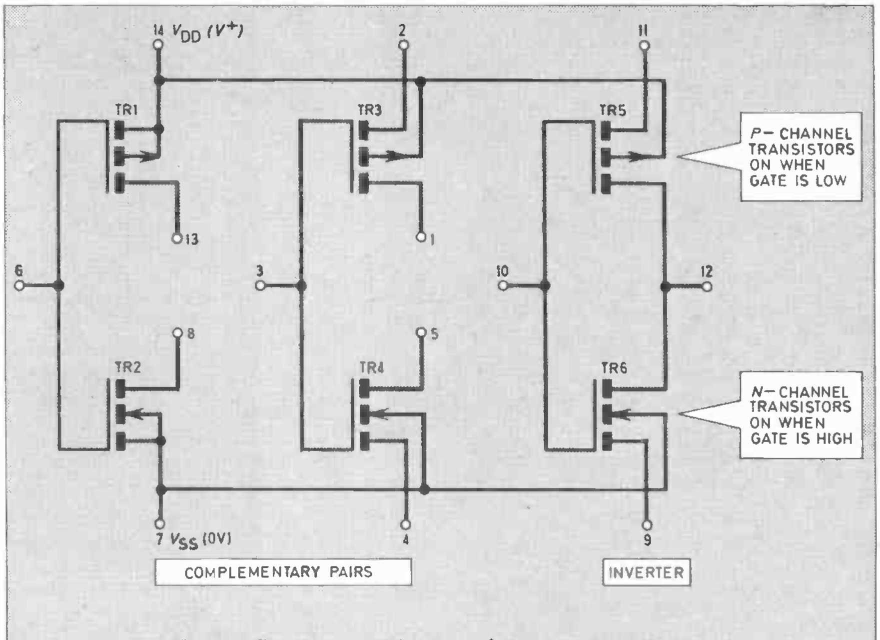


Fig. 8.8. The internal circuitry of the versatile 4007 i.c.

The gates of the other pairs of transistors are similarly connected, but the other terminals of these transistors are individually accessible. If we need two more inverters, we simply join pin 8 to 13 and pin 5 to 1, and take our outputs from pin 8 (or 13) and pin 5 (or 1).

Fig. 8.9 shows how we make up a 2-input NAND gate. The terminal connections are 14 to 2, 13 to 1 to 5, and 8 to 4. When both inputs (pins 6 and 3) are low TR1 and TR3 are on, connecting output (pin 1) to V_{DD} (high).

If only one input is low we still get one connection to V_{DD} so output remains high. The connection to V_{ss} is broken at one or other of TR2 and TR4. Only when *both* p-channel transistors are off and *both* n-channel transistors are on do we get a complete connection to V_{ss} together with isolation from V_{DD}. This occurs only when both inputs are high.

Fig 8.10 shows the same connections between gates, but they are laid out to show more clearly how TR2 and TR4 are in series. This circuit has not used the inverter, so when wired like this the 4007 provides both an inverter and a 2-input NAND gate. To obtain a 3-input NAND gate (but no inverter) we join 1 to 12 to 13, 2 to 14 to 11, 4 to 8 and 5 to 9. Readers may care to draw this out, using simplified outlines as in Fig. 8.9, and check that it produces the required function.

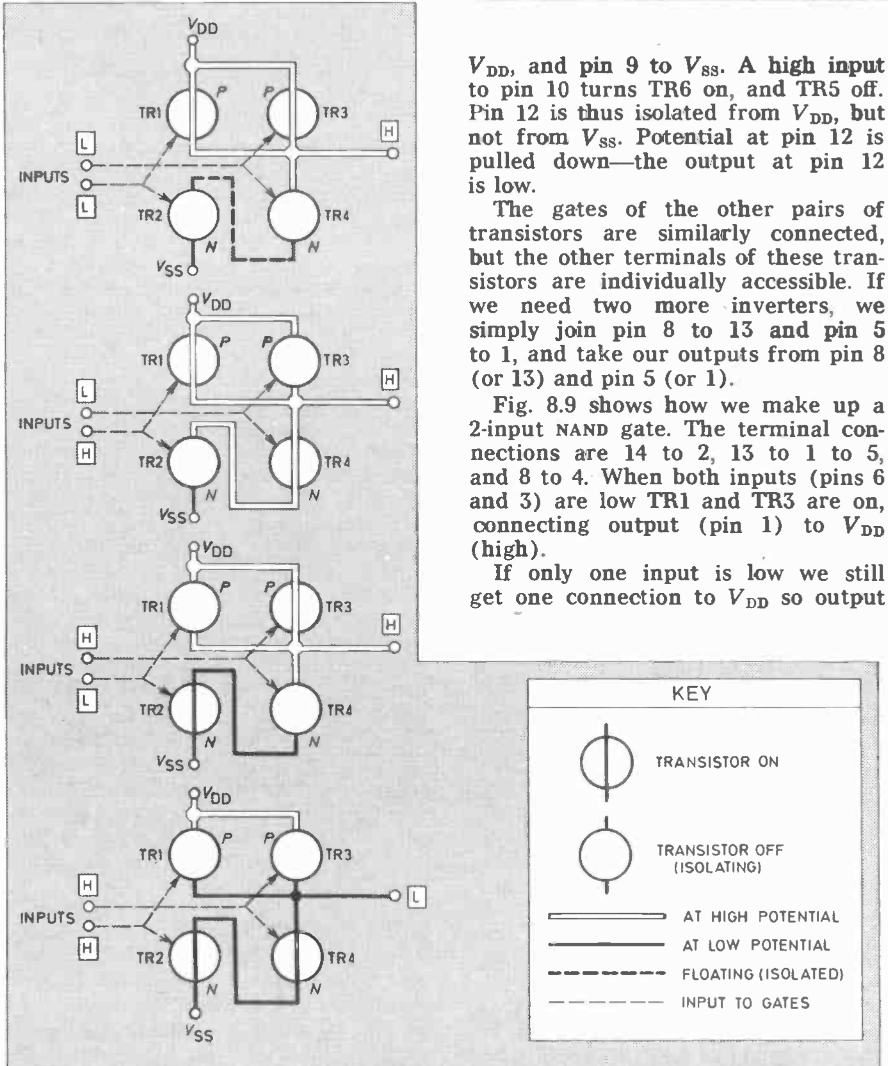


Fig. 8.9. Making a 2-input NAND gate using the 4007 i.c. For simplicity the permanent connections to the substrate of each transistor have been omitted.

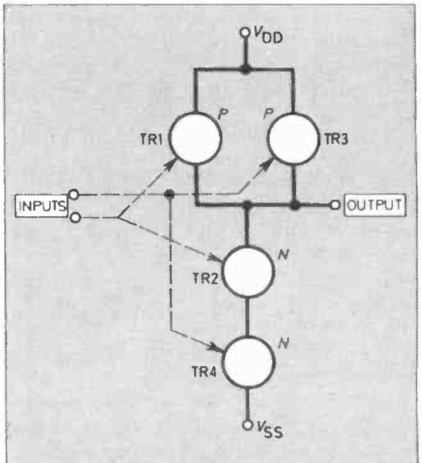


Fig. 8.10. The 2-input NAND gate of Fig. 8.9 re-arranged.

The arrangement of Fig. 8.11 puts TR1 and TR3 in series; TR2 and TR4 are in parallel. The result of this is a 2-input NOR gate. We get a high output only when both *p*-channel transistors are on, that is when both inputs are low. If an OR gate or an AND gate is required, the inverter is used to invert the output from the NOR or NAND gates described above

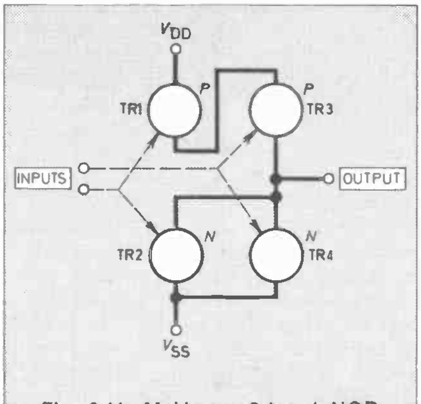


Fig. 8.11. Making a 2-input NOR gate, from the 4007 for example.

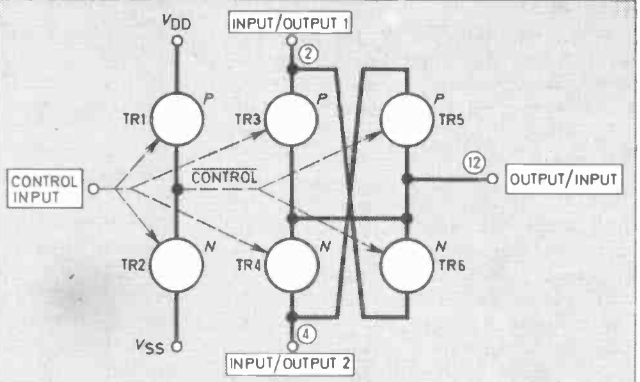


Fig. 8.12. Making a transmission gate using the elements available in a 4007 i.c.

If an inverter buffer is required, we connect each pair of transistors as an inverter (8, 13, 1, 5, and 12) and then wire them in parallel with each other.

As a final example Fig. 8.12 shows how to build a transmission gate. Join pins 1 to 5 to 12; 2 to 9; 11 to 14; 6 to 8; 8 to 13 to 10. TR1 and TR2 provide the inverted control input (see Fig. 8.5). If the control input is high, TR4 and TR5 are on and in parallel. They provide a path between pin 4 and pin 12 in either direction. At the same time TR3 and TR6 are off, isolating pin 2. The reverse occurs with a low control input. This circuit functions as a s.p.d.t. switch. Thus this simple i.c. can often provide that extra gate which is so often unexpectedly required as the design of a logic circuit nears completion. It is perhaps the least complex integrated i.c. of all those described in this series but this does not make it any the less useful. It helps to remind us that i.c.s are not magic. They are just highly complex arrangements of the very simple electronic devices with which we are all familiar.

MUSICAL BOX

The novelty circuit shown in Fig. 8.13 makes use of the 4051 1-to-8-channel analogue switch i.c. described earlier. We use it to switch various resistors into the timing circuit of a 555 timer i.c. (IC4) which is running in the astable mode. The result is that eight different frequencies are obtainable. By suitable choice of resistors an eight-note tune may be played. Pin 7 should be connected to −5V in the analogue mode, but in this circuit it may be grounded, as shown.

Switching is performed by feeding a 3-bit binary count from the counter (IC2) to the "select" inputs of the switch (IC3). The counter is advanced at the rate of about 1Hz by the other 555 timer, IC1.

The output from IC4 goes to a crystal earphone; for the benefit of the rest of the family it is advisable to use this while composing tunes. Later, when all is sounding perfect, the output may be connected to an amplifier and loudspeaker.

The values of R3 to R10 should be between about 200Ω and 100kΩ. To obtain a precise value for fine tuning, it may be necessary to substitute two

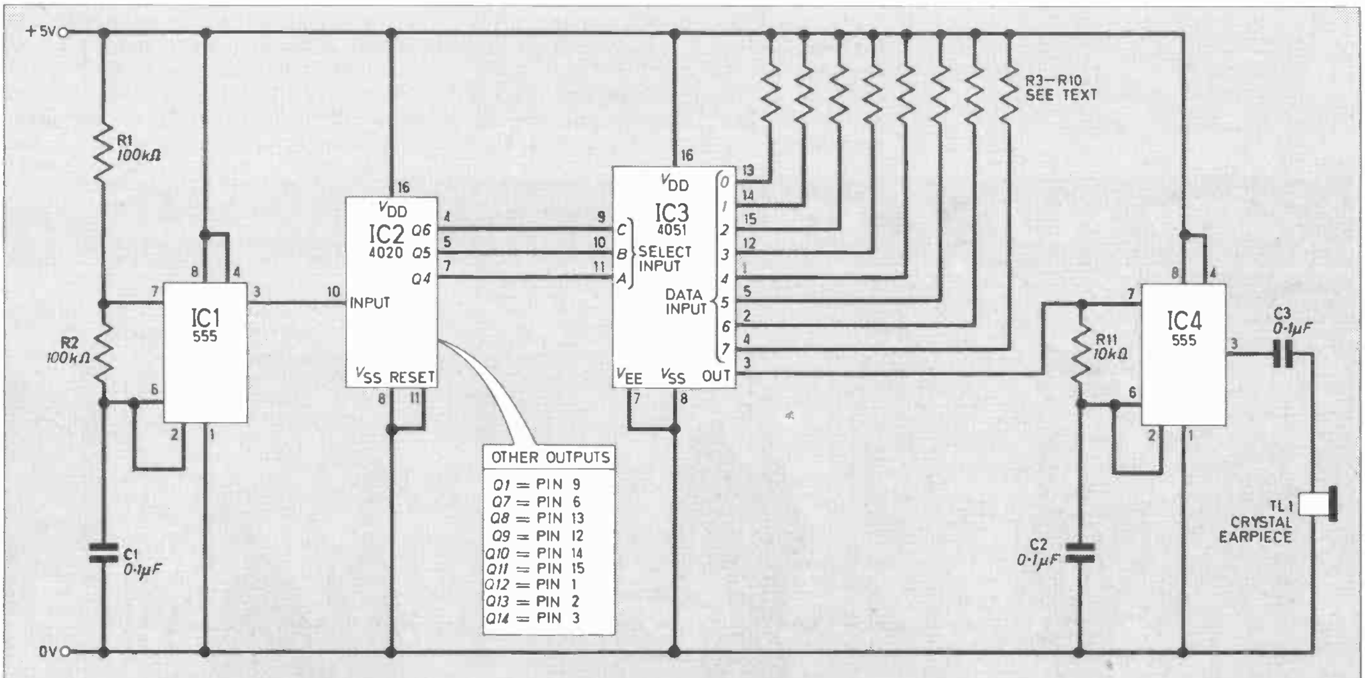


Fig. 8.13. The circuit for a CMOS music box.

or more resistors in series for the single resistors shown. Omitting a resistor provides a silent interval. The speed at which the tune is played depends on the values of R1 or C1. The order in which the notes are played depends on the wiring between IC2 and IC3.

As shown in Fig. 8.13 the circuit runs through the notes from 0 to 7 in order, playing each one for an equal length of time, and repeating indefinitely. Crossing the wires between these three sets of pins plays the notes in a different order. Using other outputs gives quite different effects—trills and warbles—particularly if output 1 is used instead of one of the three shown. The result would make a distinctive door alert. This is intended to be a fun circuit and to give scope for experimenting. One could even try omitting IC1 and driving IC2 (pin 10) from the output of IC4 instead!

INTEGRATED CIRCUITS

When building circuits such as the one described above we play with a few i.c.s, trying the effects of connecting them together in various ways.

Each time we bring an i.c. into use we casually add a dozen or even several hundred transistors to our circuit. It is done with no more effort than was made by the early electronics enthusiasts when they added a single valve to their radio sets.

It has been said that the development of integrated circuits has taken the fun out of electronics as a hobby. This series should have demonstrated that such an idea is false. Maybe we no longer *need* to build an amplifier from discrete components when we can get one on a chip ready-made and working perfectly. But nowadays the amplifier or the digital counter is the building-block of circuits far more complex and interesting than those that earlier enthusiasts could ever have aspired to build.

Instead of a few basic units—diode, triode, pentode, transistor, resistor or capacitor—we now have literally hundreds of different i.c.s that can be put together in so many fascinating yet purposeful ways.

A second aim of this series has been to conduct the reader through the realms of the i.c. and to explain the properties and potentialities of each of the main types in use today. It is hoped that we have been successful in this attempt.

PLEASE TAKE NOTE

Three Channel Stereo Mixer
(February 1981)

Electrolytic capacitors C1, C2, C3, C4, C7 and C10 as shown in Figs. 1 and 2 are connected the wrong way round and should be reversed. However, the circuit may well function satisfactorily as shown, as did the prototype, although component life could be shortened. The labelling for SK1 and SK3 should be transposed. (It relates to incoming signal levels).

Signal Tracer
(February 1981)

Electrolytic capacitor C8 has been drawn incorrectly and should be reversed, the positive going to the emitter of TR3. (This also applies to the circuit shown in *Square One*, March 1981).

Car Actuated Driveway Light
(February 1981)

An error occurred in the component list regarding the working voltage of capacitor C1 which should have been specified as having a working voltage of 25V and not 16V.

There is also a discrepancy between the value of this capacitor shown in the circuit diagram, Fig. 1, and that in the component list. Either value will give satisfactory results but the higher value is preferred

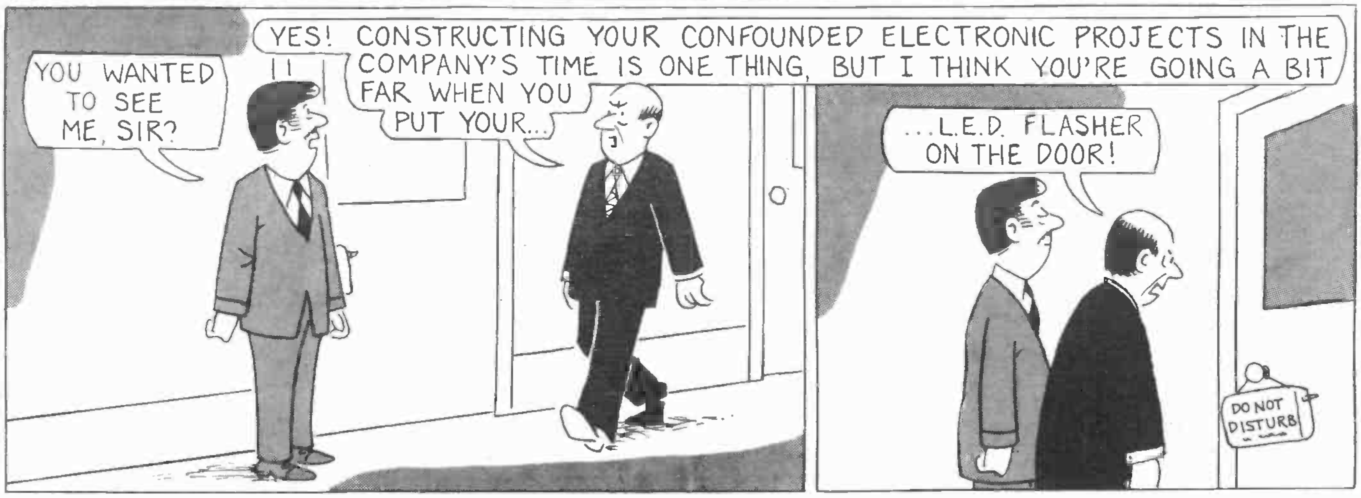
4-Band Radio
(February 1981)

The ceramic filter X1 was incorrectly specified and should read type CFM2455B and replaces the type SFM455B used in the prototype which is now unavailable. The CFM type only has three pins (instead of five as shown).

With this filter C13 is not neccessary and R10 should be reduced to 1·5 kilohm. It is not a symmetrical type and should be fitted into the board so that the end with the cut-away is nearest to TR3 collector.

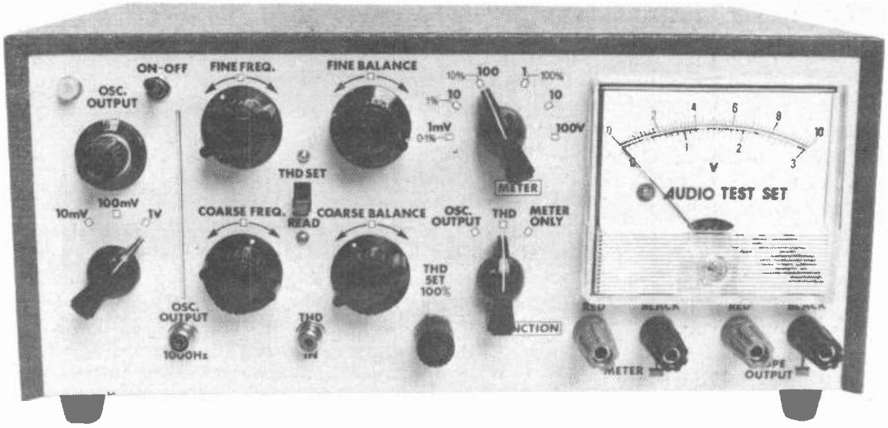
JACK PLUG & FAMILY...

BY DOUG BAKER



AUDIO TEST SET PART 1

F.C.Judd



Measurement of frequency response and power output alone do not tell the whole story regarding the performance of an audio amplifier. Measurement of total harmonic distortion (t.h.d.) is also highly desirable and in fact essential if one is to be assured that an amplifier is functioning satisfactorily.

Even quite high levels of harmonic distortion are not easily detectable by ear and it is quite possible to construct an audio amplifier which although having the requisite frequency response and power output, may be generating unnecessary distortion because of a wrong value component or a defective transistor or even poor design.

The Audio Test Set described in this article provides facilities for checking total harmonic distortion to at least 0·1 per cent at 1kHz, as well as power output, signal voltage output, signal-to-noise performance, frequency response (with a suitable wide range audio signal generator), amplifier input sensitivity and the gain of separate amplifier stages. *The use of an oscilloscope is essential for all these measurements.*

The unit incorporates a stable 1kHz low distortion oscillator, a harmonic

COMPONENTS

Resistors

R1	2·7kΩ	R24	820kΩ	R47	12kΩ
R2	22kΩ	R25	100kΩ	R48	10kΩ
R3	6·8kΩ	R26	150kΩ	R49	1·2kΩ
R4	3·9kΩ	R27	10kΩ	R50	390Ω*
R5	1·5kΩ	R28	10kΩ	R51	15kΩ
R6	68Ω	R29	1kΩ	R52	47kΩ
R7	100Ω	R30	1kΩ	R53	680Ω
R8	2·2kΩ	R31	100Ω	R54	10kΩ
R9	120Ω	R32	10Ω	R55	22kΩ
R10	10kΩ	R33	4·7kΩ	R56	680Ω
R11	120kΩ	R34	470kΩ	R57	17·2kΩ**
R12	12kΩ	R35	150kΩ	R58	17·2kΩ**
R13	10kΩ	R36	220kΩ	R59	2·2kΩ
R14	1·2kΩ	R37	22kΩ	R60	1·8kΩ
R15	5·6kΩ	R38	22kΩ	R61	100Ω
R16	10kΩ	R39	680Ω	R62	150Ω
R17	100kΩ	R40	27kΩ	R63	1·2kΩ
R18	10kΩ	R41	12kΩ	R64	10kΩ
R19	1·2kΩ	R42	100kΩ	R65	12kΩ
R20	68kΩ	R43	1·2kΩ	R66	100kΩ
R21	68kΩ	R44	100Ω	R67	270Ω*
R22	68kΩ	R45	10kΩ		
R23	100Ω	R46	120kΩ		

All ½W carbon film high stability ±5%

* See text

**Made up of 15kΩ and 2·2kΩ resistors in series (see text)

Potentiometers

VR1	25kΩ log. carbon
VR2	1kΩ lin. carbon
VR3	10kΩ lin. carbon
VR4	1kΩ lin. carbon
VR5	10kΩ lin. dual-gang carbon
VR6	2·2kΩ miniature horizontal preset
VR7	1kΩ lin. carbon

Semiconductors

TR1-TR8	BC109 *npn* silicon (8 off)
TR9	OC41 *pnp* germanium
TR10	BC109 *npn* silicon
D1-D4	OA90 small signal germanium (4 off)
D5-D8	W005 50V, 1A bridge rectifier

Capacitors

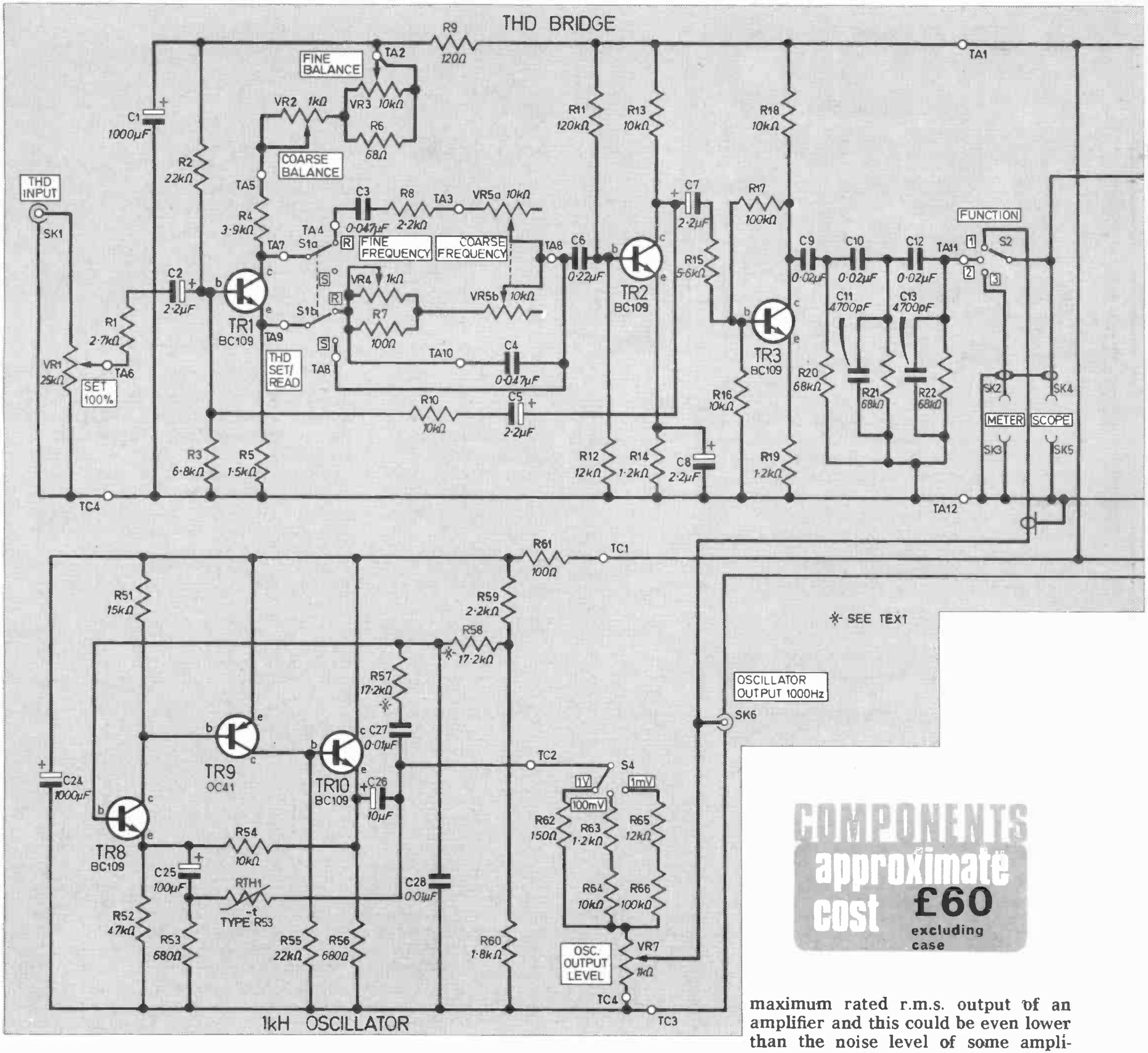
C1	1000µF 40V elect.	C16	220µF 40V elect.
C2	2·2µF 40V elect.	C17	1000µF 40V elect.
C3	0·047µF C280 polyester	C18	100µF 40V elect.
C4	0·047µF C280 polyester	C19	750µF 40V elect.
C5	2·2µF 40V elect.	C20	10µF 40V elect.
C6	0·22µF C280 polyester	C21	10µF 40V elect.
C7	2·2µF 40V elect.	C22	22µF 40V elect.
C8	2·2µF 40V elect.	C23	0·1µF C280 polyester
C9	0·02µF polyester	C24	1000µF 40V elect.
C10	0·02µF polyester	C25	100µF 40V elect.
C11	4700pF polystyrene	C26	10µF 40V elect.
C12	0·02µF polyester	C27	0·01µF C280 polyester
C13	4700pF polystyrene	C28	0·01µF C208 polyester
C14	2·2µF non-polarised polycarbonate	C29	1000µF 40V elect.
C15	10µF 40V elect.	C30	2200µF 40V elect.

See Shop Talk page 334

Miscellaneous

S1	d.p.d.t. slider
S2	one-pole, three-way rotary
S3	one-pole, six-way rotary
S4	one-pole, three-way rotary
S5	s.p.s.t. mains toggle
SK1	chassis mounting phono
SK2-SK5	insulated screw terminals (2 off red, 2 off black)
SK6	chassis mounting phono
ME1	moving coil panel meter, 100µA f.s.d. (see text)
T1	mains primary/24V, 150mA secondary
RTH1	glass encapsulated thermistor, type R53
LP1	mains panel neon with integral resistor
CB1	two-way plastic connector block

Metal case, 300 × 165 × 125mm, Bamber Electronics type BC7, or similar; 0·1inch matrix perforated s.r.b.p. board, one piece 46× 34 holes, one piece 43 × 34 holes, one piece 42 × 34 holes and one piece 44 × 34 holes; screened cable for internal interwiring; connecting wire; eight knobs (see photographs for style); mounting brackets; 6BA nuts and bolts for mounting boards; grommet; twin-core mains cable; Veropins.



COMPONENTS

approximate cost £60

excluding case

distortion bridge for 1kHz and an audio millivoltmeter with an audio frequency range 10Hz to 100kHz and an input range up to 100V. The set is mains powered. This first part deals with constructing the test set and in the second part, next month, we deal with the procedures for measuring harmonic distortion and include oscillograms of actual examples.

PERFORMANCE PARAMETERS

Before dealing with the circuitry and construction it is important that the performance parameters of the test set itself are understood. These will, of course, set the limits of measurements. For instance, many modern and usually expensive high fidelity amplifiers have a total harmonic distortion factor often less than 0·01 per cent. The test set is not suitable for checking t.h.d. at less than about 0·05 per cent. To measure to levels much below this, far more sophisticated and costly professional equipment would be necessary. However, a limit of 0·1 per cent is quite adequate for home constructors and at least sufficient to ensure that amplifier performance is adequate in this respect.

It would be as well to remember that total harmonic distortion at 0·1 per cent is 60dB below the normal maximum rated r.m.s. output of an amplifier and this could be even lower than the noise level of some amplifiers.

However, in order to measure distortion to 0·1 per cent the oscillator used for the test signal must itself have a very low distortion, well below the level of measurement limit, otherwise one would be measuring the distortion of the amplifier plus the distortion of the oscillator. The full system specification is set out in the adjoining table.

FOUR SECTIONS

The full circuit diagram of the Audio Test Set is shown in Fig. 1 and it can be seen that the unit consists of four sections—t.h.d. bridge, audio millivoltmeter, 1kHz oscillator and power supply.

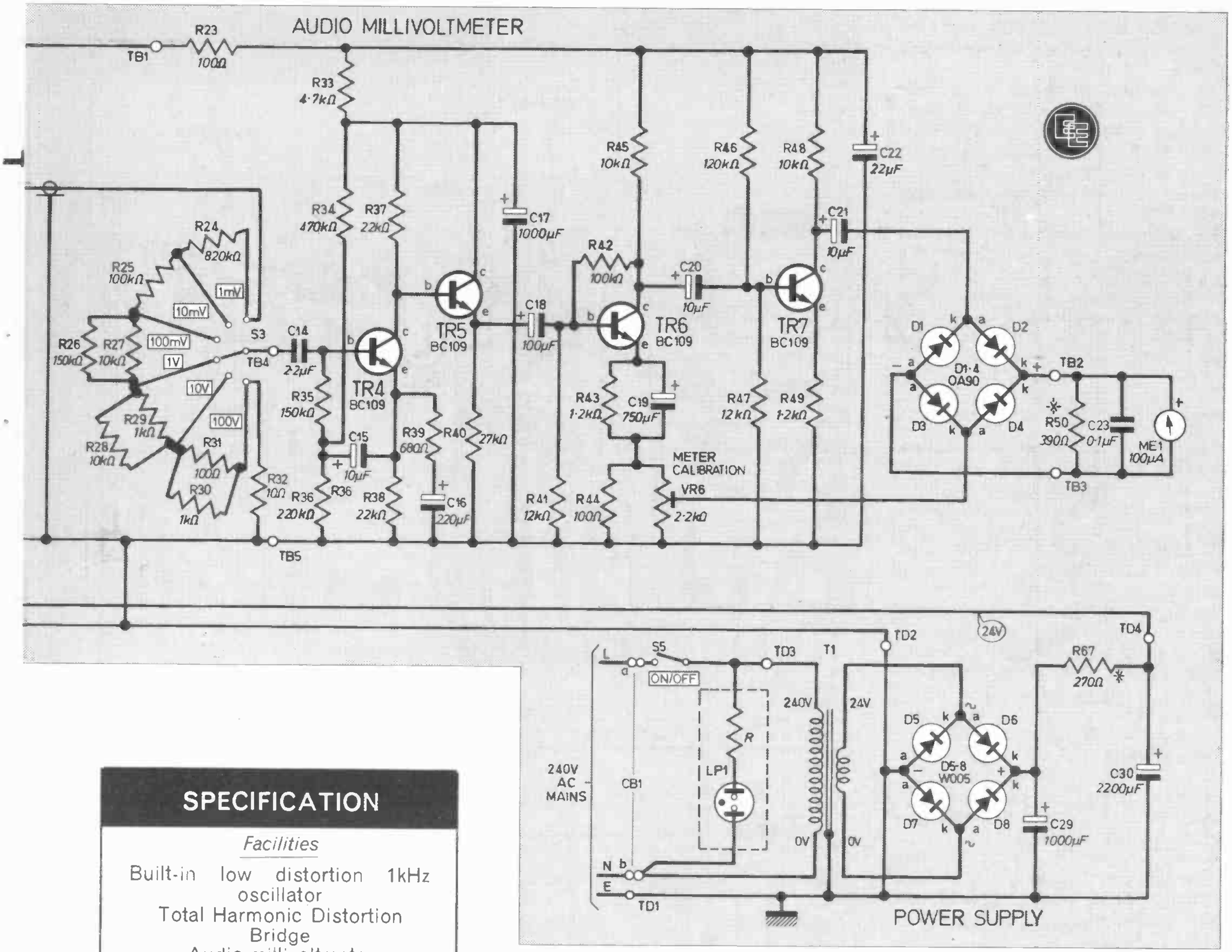


Fig. 1. Full circuit diagram of the Audio Test Set. The separate sections of the circuit are clearly marked.

SPECIFICATION

Facilities

Built-in low distortion 1kHz oscillator
Total Harmonic Distortion Bridge
Audio millivoltmeter

System Parameters

Oscillator
Fixed 1kHz frequency ± 10Hz, drift <1Hz
Total harmonic distortion 0·02%
Maximum output 1V r.m.s. in 0-10mV, 0-100mV and 0-1V steps

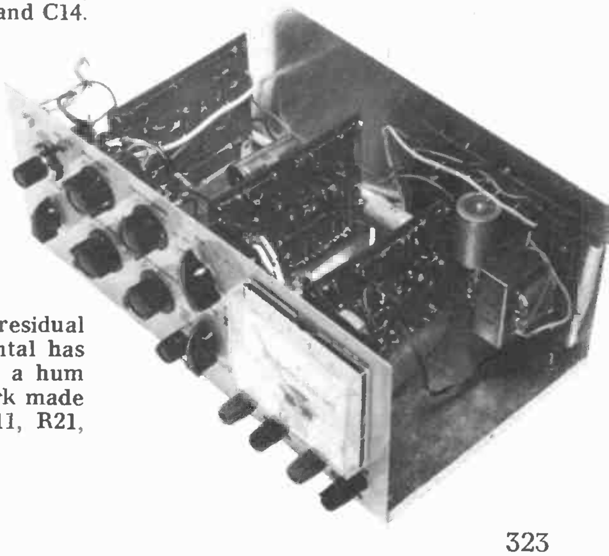
T.H.D. Bridge
Minimum input 200mV
Minimum t.h.d. detectable 0·05%
Mains-hum rejection 26dB at 50Hz
Circuit distortion compensation 0·5dB per 1kHz above 1kHz
Noise factor $50\mu V$

Audio Millivoltmeter
Six ranges, 0 to 1mV, 10mV, 100mV, 1V, 10V, 100V
Accuracy >1% of calibration
Input impedance 1MΩ
Frequency range
10Hz to 100kHz ± 0·5dB

Note: an oscilloscope and dummy load are needed to measure t.h.d. and amplifier output. A wide range audio oscillator is also required for checking overall frequency response of audio equipment.

The first section, the t.h.d. bridge and amplifier, consists of TR1, TR2 and TR3 with a Wien bridge feedback network that is used to null out the fundamental frequency of 1kHz when measuring harmonic distortion. The bridge itself consists of the transistor TR1, the variable controls VR2, VR3, VR5 and components C3, R8 and C14.

However, the input signal to the bridge must not exceed 1V r.m.s. so an input attenuator VR1 (SET 100 PER CENT) is provided. The minimum input signal that can be used for measurement of t.h.d. is 200mV. Transistors TR2 and TR3 which follow the bridge circuit are fairly conventional amplifiers and the output from these, which will normally be the residual distortion after the fundamental has been nulled out, is taken via a hum filter and compensator network made up of C9, C10, C12, R20, C11, R21, C13 and R22.



From here signals are taken for measurement of amplitude via S2 to the audio millivoltmeter section. The variable controls VR3 and VR2 in the t.h.d. bridge network are FINE BALANCE and COARSE BALANCE respectively and the controls VR4 and VR5 are FINE FREQUENCY and COARSE FREQUENCY respectively.

The function of these is to completely remove the fundamental 1kHz test signal produced by the oscillator section to leave only the distortion content for measurement. Operation of these controls will be explained later.

The FUNCTION switch S2 in position 1 selects the oscillator output for checking level, in position 2 selects the output from the t.h.d. bridge when measuring distortion and in position 3 connects the panel terminals to the meter circuit for external use.

AUDIO MILLIVOLTMETER

The audio millivoltmeter section will cater for inputs from less than 1mV up to a maximum of 100V (essential for checking high power outputs). The input attenuator network around S3 provides 20dB steps downward from 100V as in the specification.

The input impedance of the millivoltmeter is approximately equal to the total attenuation resistance which is just under 1 megohm. The first transistor TR4 is in a boot strap circuit to maintain a high input impedance for the attenuator network.

Signals then go via TR5 as an emitter follower to drive the bridge rectifier amplifier TR6 and TR7. The bridge rectifier consists of four germanium diodes D1 to D4 and has a feed-back path to TR6 to set linearity and calibration via the pre-set, VR6. The meter, ME1, calibrated 0-10 has a 100μA movement.

METER

The type of meter used in the prototype was the RS Components type 259-634 with an internal resistance of 1,300 ohm. The value of the shunt resistor R50 was accordingly chosen so that the meter would show the voltages required and any fine setting could be done with VR6.

However, other types of meter can be used. It would be preferable if one was chosen with an internal resistance as near to 1,300 ohms as possible because this would mean that there would be no need to change any component values.

If you do have to use a meter which has a significantly different internal resistance you may find that you cannot set up the meter reading as described later. In this case you will have to change the value of R50 until full adjustment can be made with VR6.

In this case the easiest method is to replace R50 with a 500 ohm preset and adjust this until the meter performs as it should.

T.H.D. BRIDGE

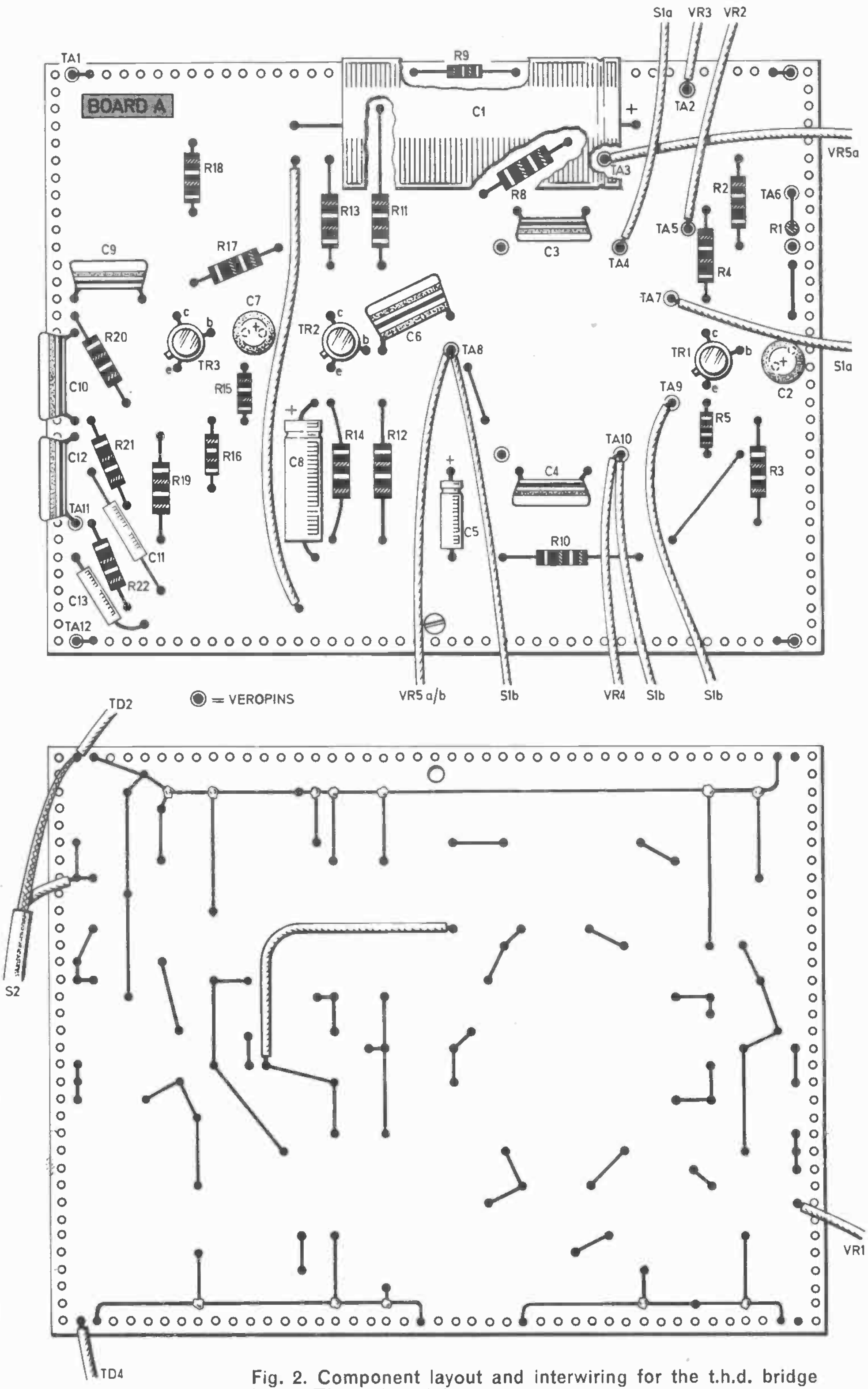


Fig. 2. Component layout and interwiring for the t.h.d. bridge board. This is board A.

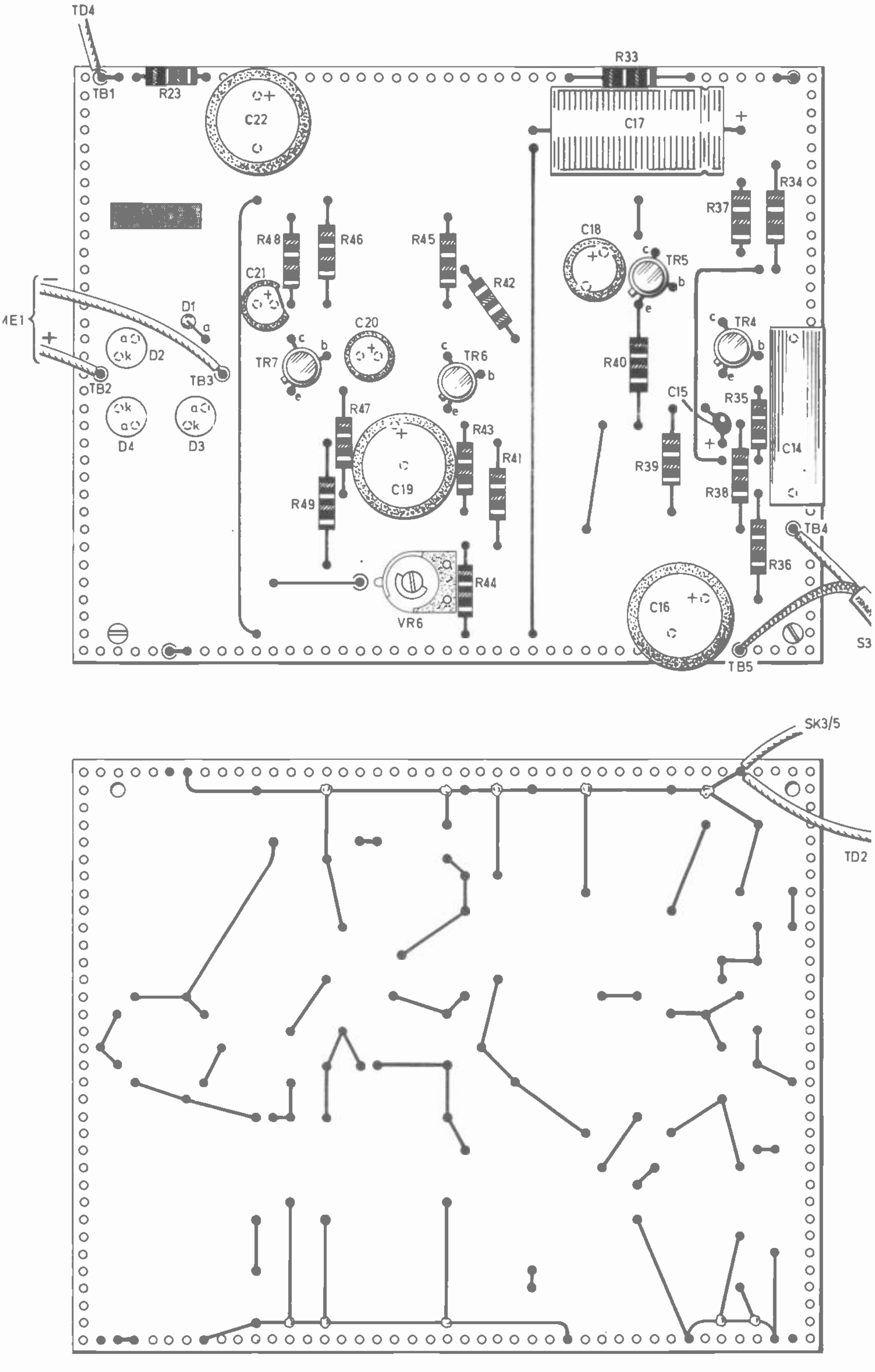


Fig. 3. Component layout and interwiring for the audio millivoltmeter board. This is board B.

OSCILLATOR AND POWER SUPPLY

The 1kHz reference oscillator section consists of TR8, TR9, TR10 and associated components which together form a low distortion Wien bridge oscillator with a maximum r.m.s. output of 1V. The output is maintained at constant level by the use of the thermistor RTH1 in the feedback path between TR10 and TR8.

Resistors R58 and R59 are made up of a 15 kilohm and a 2·2 kilohm resistor connected in series. This is essential to make sure that the frequency of the oscillator is within 10Hz of 1kHz. More is said of this when we come to describe the construction of the unit.

The final section consists of the power supply which is quite simple and consists of the transformer T1 with a 24V secondary (or two 12V secondary windings wired in series), a bridge rectifier, D5-D8, and reservoir and smoothing capacitors C29 and C30.

The resistor R67 may have to be adjusted to obtain between 23 and 24V on the positive rail but this will again be dealt with later. There are other points in the circuitry that are marked "see text" and these will also be dealt with in due course.

Because this unit is meant to be an accurate piece of test equipment, it would be inappropriate to use out of spec or surplus devices in its construction. This goes for such things as switches and potentiometers as well as semiconductors.

CIRCUIT BOARDS

Before starting construction it would be a very good idea to study all the diagrams and photographs very thoroughly and familiarise yourself with the front panel layout and controls, and the positioning of the four circuit boards within the cabinet.

The separate circuit boards can be tackled first. Start with the power supply board (board D), then the t.h.d. bridge board (board A), then the audio millivoltmeter board (board B), and finally the 1kHz oscillator board (board C). Detailed layouts are shown in Figs. 5, 2, 3 and 4, respectively.

On this latter board there are two sets of resistors marked "see text". This concerns R58 and R57. There are two resistors wired in series for each of these circuit references and as explained earlier this is necessary in order to achieve the correct operating frequency.

Each circuit board is built up on 0·1 inch matrix perforated s.r.b.p. board and the component leads are taken off to their respective destinations on the reverse of the board.

Board A is 46 x 34 holes; board B, 43 x 34 holes; board C, 42 x 34 holes, and board D, 44 x 34 holes.

TERMINAL PINS

To make interwiring easier to follow, all off-board connection Vero-pins are given a reference. For example, the Veropins on board A are given references TA so the third connection on board A for example would be TA3. This method is followed throughout all the circuit and wiring diagrams.

It may be found easier in final assembly and wiring to have flying leads ready on the circuit boards to reach the appropriate panel components, or vice versa, as the main circuit boards and the controls are quite close together. It is important to use screened leads where shown and to keep all other connecting leads as short as possible. Do not change the position of any of the circuit boards or panel components.

FRONT PANEL

The next job to tackle is the metalwork. The unit is housed in a metal case 300×165×125mm and the front panel should be drilled and cut according to Fig. 6. Likewise the chassis and rear panel should be drilled to take the circuit board mounting brackets.

Use the specified case if possible or at least one that will allow you to follow the panel component layout and circuit board layouts that we have shown, reasonably closely. The whole case must be metal to ensure complete screening.

The hole through which the mains cable passes *must* have a rubber grommet fitted.

The front panel wiring can now be dealt with. A full interwiring plan is shown in Fig. 7. Note that several of the screened leads are connected such that only their inner core is actually wired up at the front panel. This is essential so that earth loops and hence unwanted mains hum is minimised, but at the same time the case is earthed as a safety precaution.

Construction is finished off by interconnecting boards and panel mounted components according to Fig. 2, 3, 4, 5 and 7. Leads must be kept short and the layout should not be rearranged so some judicious fiddling may be involved here.

SUPPLY RAIL

Before applying voltage to the circuits make sure that R67 (board D) is in fact 270 ohms. This may need to be changed slightly in value to obtain a positive rail voltage when all the circuits are operating of not less than 23V and more than 24V.

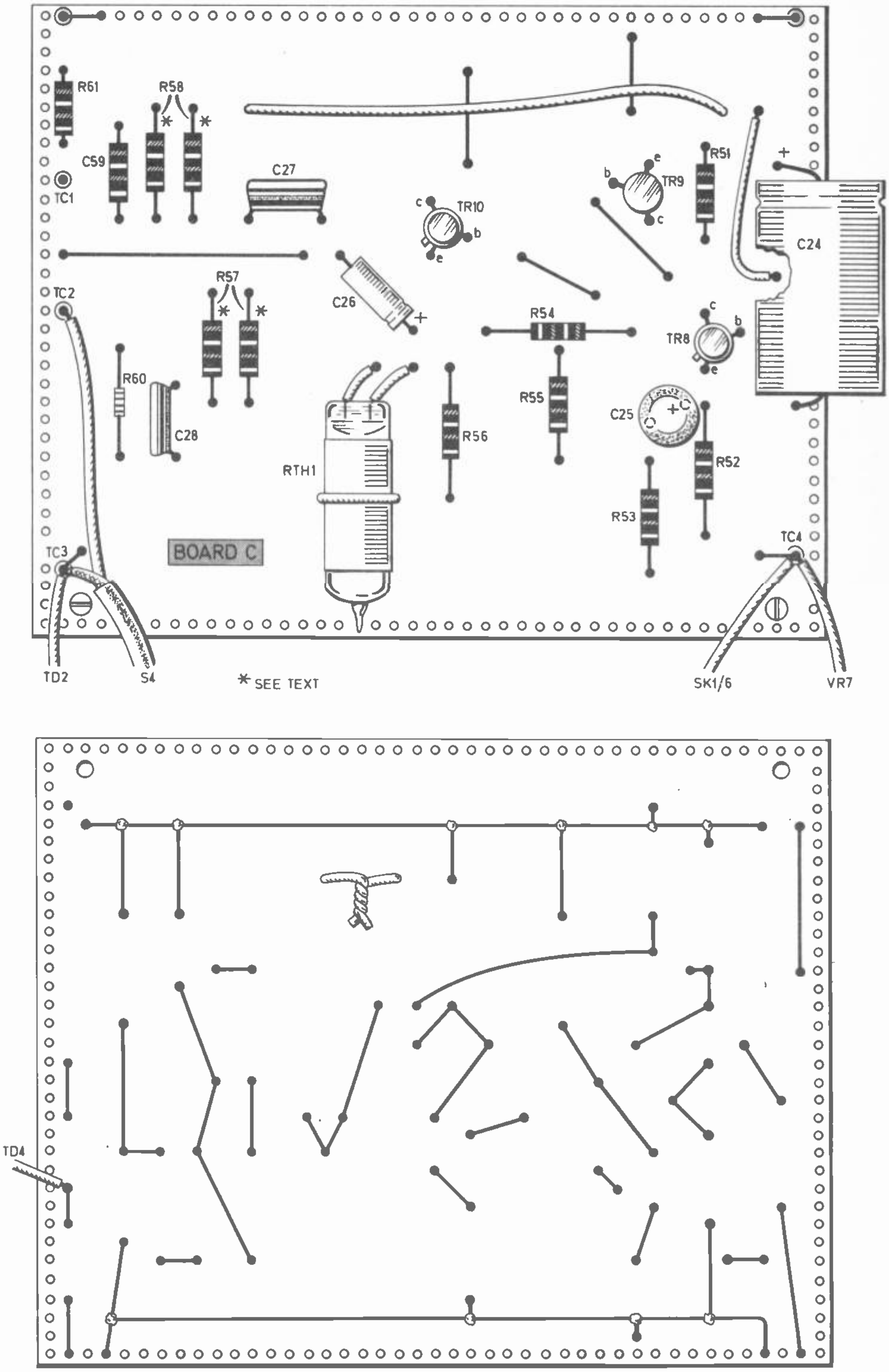


Fig. 4. Component layout and interwiring for the oscillator board. This is board C.

POWER SUPPLY

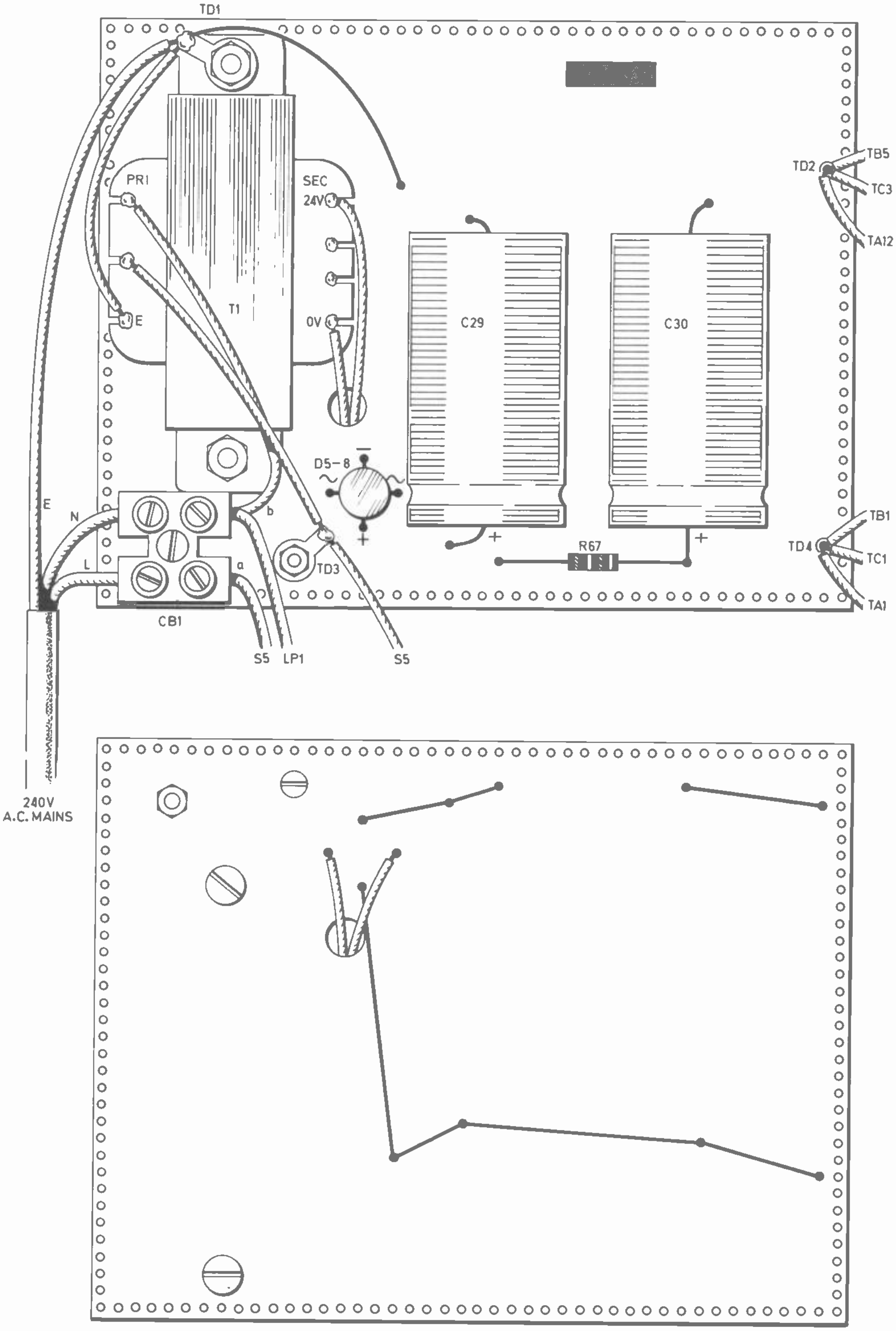


Fig. 5. Component layout and interwiring for the power supply board. This is board D.

If the voltage is a little too low, a resistor of between 1·2 kilohms and 4·7 kilohms can be connected in parallel with R67. If the voltage is too high then the value of R67 may have to be changed to 330 ohms, or 270 ohms plus a small value like 33 or 47 ohms in series. The total current drawn from the supply should be 32mA. The current drawn by each circuit is 22mA for the oscillator circuit (board C) 6·5mA for the t.h.d. bridge circuit (board A) and 3·5mA for the audio millivoltmeter circuit (board B).

SETTING UP

First it is essential to ensure that the 1kHz oscillator is operating correctly. Set the FUNCTION switch S2 to position 1. Set the METER switch (S3) to the 1V range. Set the OSCILLATOR OUTPUT LEVEL switch (S4) to 1V and VR7 at maximum. If the oscillator is operating correctly the meter will be reading either just more or less than full scale.

Now adjust the pre-set VR6 until the meter reads exactly full scale or 10. Connect an oscilloscope to the oscillator output socket SK6 and check that the wave form is perfectly sinusoidal. The slightest visible distortion of the waveform would indicate faulty operation of the oscillator.

If all appears well then check the positive voltage rail at terminal pin TD4 which must be between 23 and 24V. If not, adjust the resistance of R67 as previously described. Check also the total current from TD4 to all the circuit boards which should be 32mA plus or minus 1mA.

METER READING

Check once again the meter reading of the oscillator output which should be 1V r.m.s. but if this has changed due to any re-adjustment of the positive rail voltage, then further adjustment of VR6 may be necessary. If the oscilloscope is calibrated the peak to peak oscillator output voltage of 1V r.m.s. should be 2 x 1·414 or 2·828V.

Next set the OSCILLATOR OUTPUT LEVEL switch S4 to 100mV, still with VR7 at maximum, turn the METER switch, S3, also to 100mV, upon which the meter should once again read full scale or 10. Repeat this procedure for an oscillator output of 10mV with the S3 set to 10mV to obtain once again full scale deflection or 10.

Very minor adjustment of VR6 may be necessary to obtain full scale meter readings on the three oscillator output ranges or at least to within one small division of the meter which represents only a very marginal error in readout.

Next month: Measuring harmonic distortion of voltage and power amplifiers.

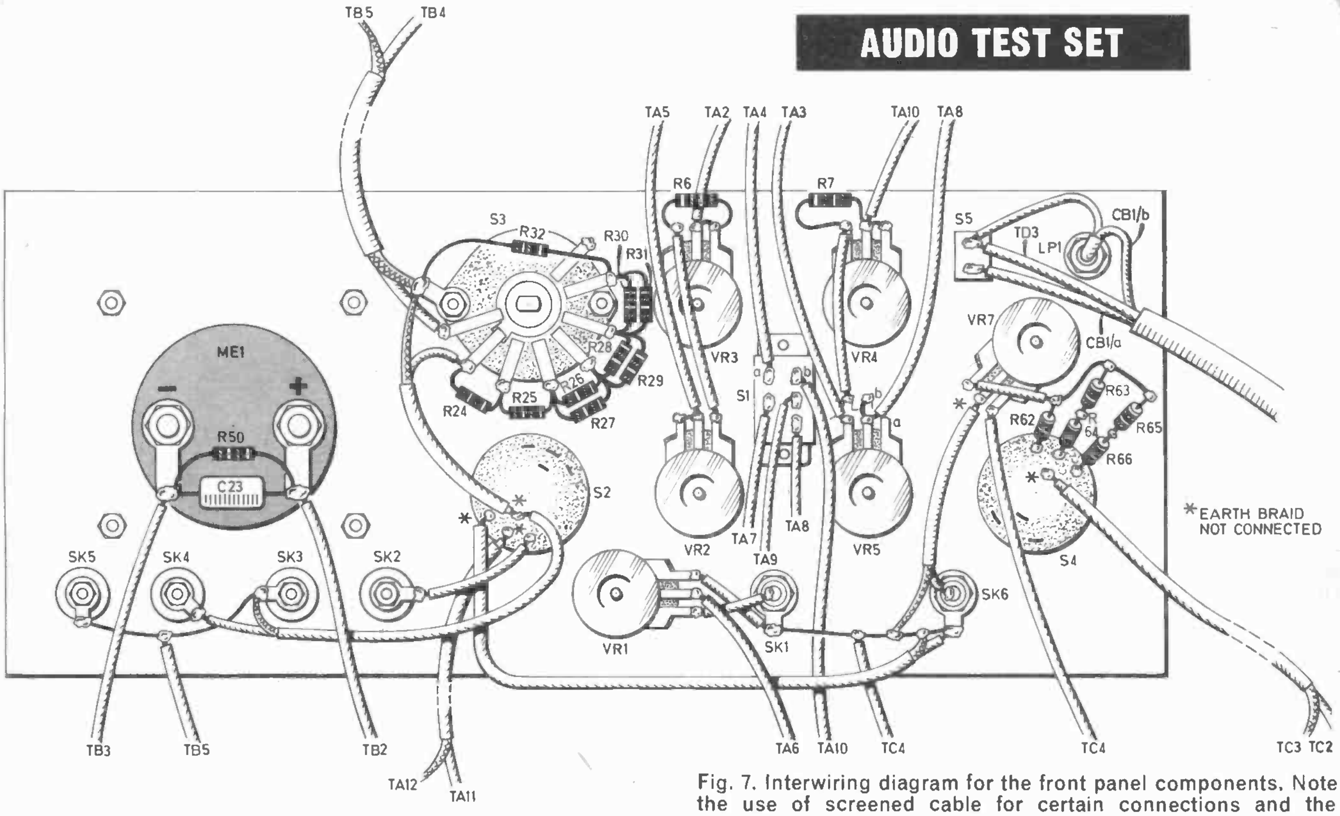
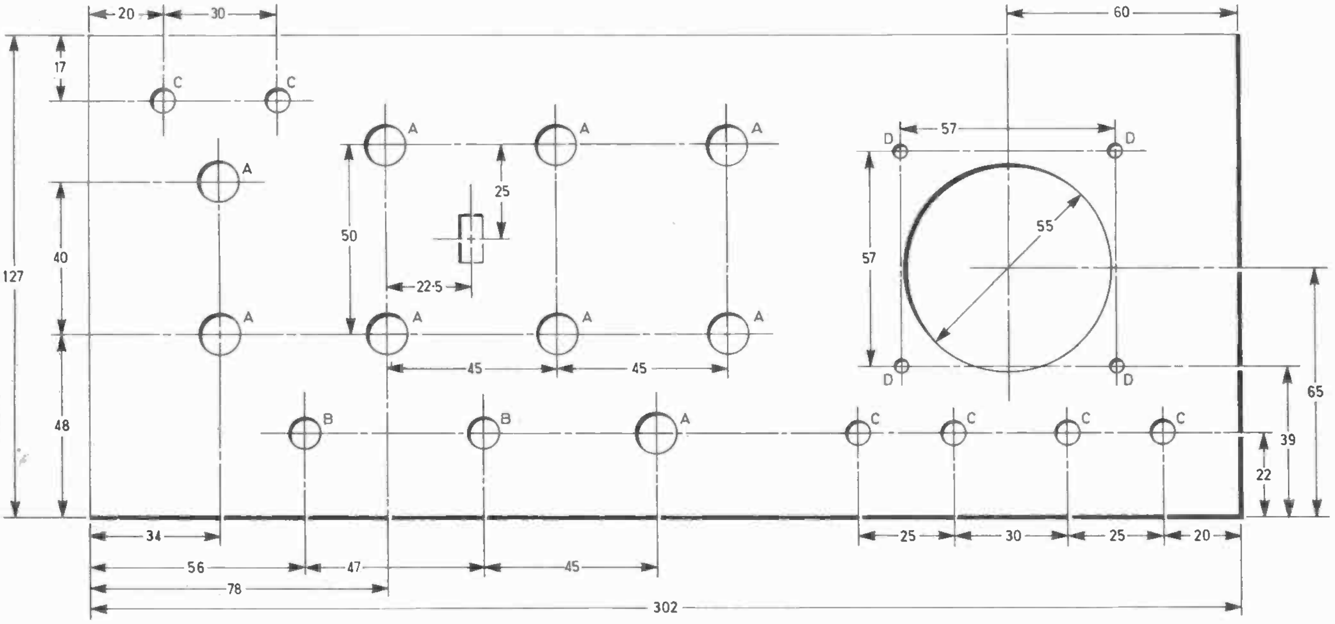


Fig. 7. Interwiring diagram for the front panel components. Note the use of screened cable for certain connections and the arrangements for connecting up the earth braids.



DIAMETERS OF HOLES

A = 10
B = 7
C = 6
D = 3

ALL DIMENSIONS IN mm

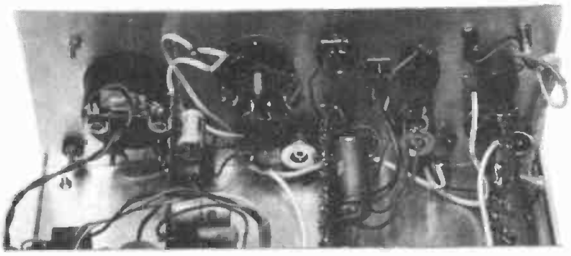


Fig. 6. Drilling plan for the front panel. If you are using different components to the ones specified then you should check their dimensions before drilling mounting holes.

SQUARE one FOR BEGINNERS

SOME form of "circuit board" is required to hold together all the components in a circuit. This can take many forms from the very simple tag strip approach to the dedicated board known as a printed circuit board (p.c.b.).

The most common circuit board to be found in the pages of EVERYDAY ELECTRONICS is stripboard which is also known as Veroboard and referred to as such in component catalogues.

This consists of a perforated board with holes punched on a matrix of 0·1 inch, and 0·15 inch, with strips of copper bonded to one side.

The strips are used as anchorage points (after soldering) for the component leads, and the strips are cut and interconnected to produce a physical interconnection of the components according to the circuit diagram.

A
Top row shows the two matrix sizes from the copper side of virgin stripboard; the top (unclad) side; breaks made along the strips. Lower row shows both sides of 0·1 inch matrix board when fitted with push-fit double-sided Veropins.

B
Other circuit boards available to the constructor. Top left to bottom right shows: three sizes of group board; two versions of tag strip; plain copper clad board for making p.c.b.s; plain insulated board; plain matrix board (unclad) available in matrix sizes 0·1 and 0·15 inch.

C
Projects usually specify a particular size of board, number of strips by number of holes. This will in most cases require cutting from a larger standard size board.

D
After cutting, all swarf must be cleared away otherwise bridges across tracks will almost certainly result, causing the completed unit to malfunction. This can be cleaned away using a file or sandpaper.

E
Breaks along the copper strips being made with a tool designed for the job—a spot face cutter. Alternatively a small drill bit may be used. Remove any swarf with sand paper before proceeding.

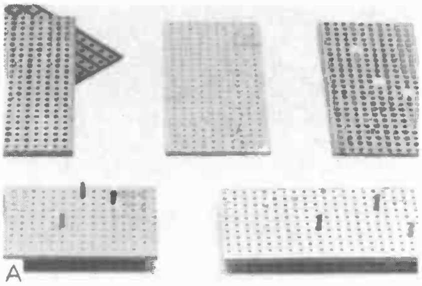
F
Components are mounted on the top (unclad) side of the board such that component bodies are close to the board. Axial components (resistor and diode shown) should have their leads bent to exactly span their allotted holes.

G
Pushing a component, in this case a diode, into its allotted holes in the board after the leads have been bent. Trim the leads before soldering.

H
The solder is taken to the joint being heated by the iron and should be melted around the contact between lead and strip. Both halves of the joint must be heated before applying the solder.

I
After all the components have been connected, lead out wires (flying leads) can be attached. Tin the ends of stranded wire to produce the equivalent of a solid wire, and then treat as a component lead.

J
Veropins allow a good mechanical joint prior to soldering. Wrap the tinned lead around the pin before soldering. These pins allow off-board components to be connected after the board has been secured in position.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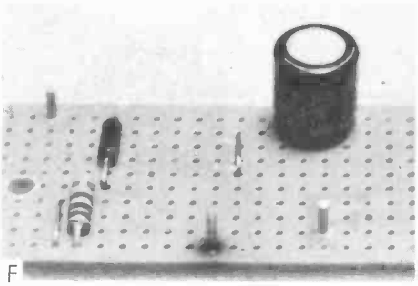
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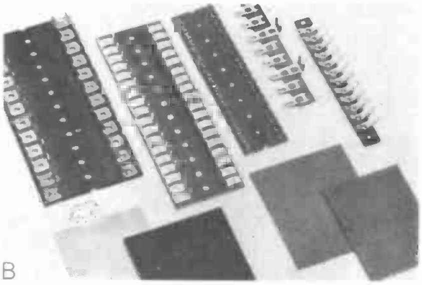
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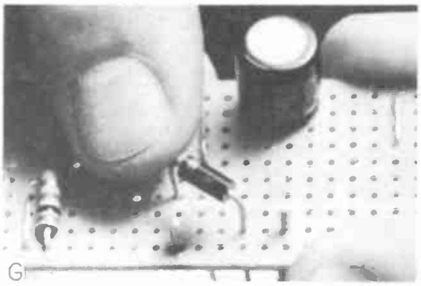
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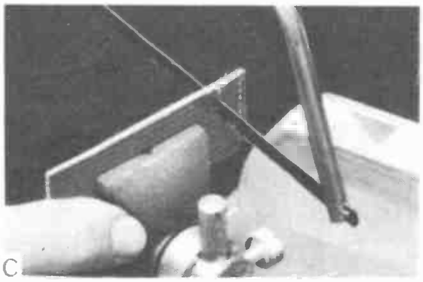
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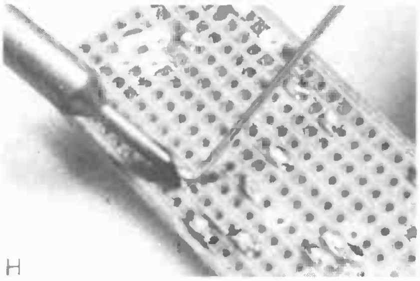
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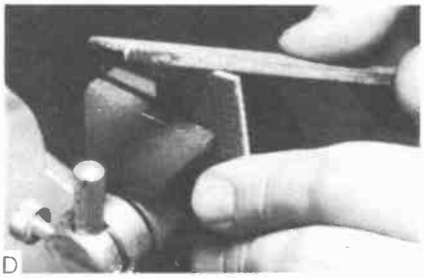
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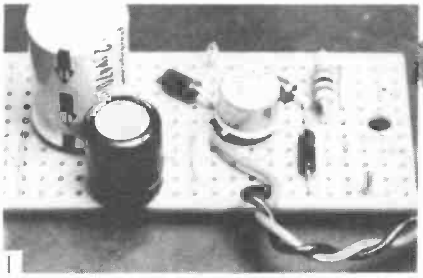
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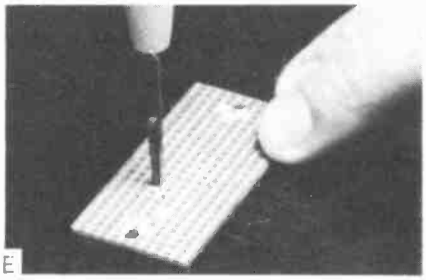
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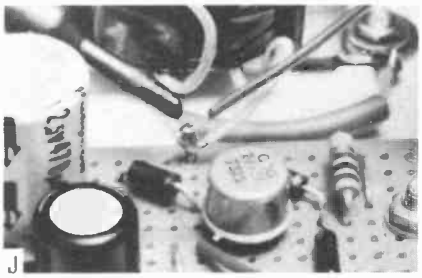
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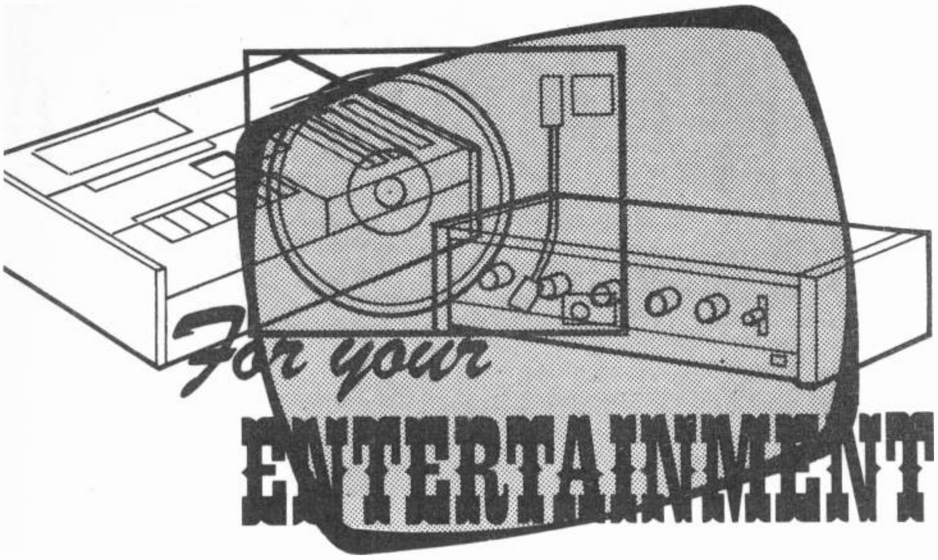


For your ENTERTAINMENT

By BARRY FOX

Cautionary Tale

The sad story of Garrard makes a cautionary tale for the British electronics industry, or any sector of British industry for that matter.

Founded in 1915 and independent until a takeover by Plessey in 1960, they were once the jewel of British audio. The company started to fail while under the wing of Plessey. It was progressively reduced in size and finally sold in November 1979 to the Brazilian electronics empire, Gradiente.

It's impossible to say where and when the final rot set in but the whole business of splitting Garrard up, selling off some of its factories and leaving the remaining production lines dependent on outside contractors clearly contributed to their eventual downfall and take over by the Brazilians.

They suffered in the hands of outside suppliers and they found themselves committed to contracts which left them no option but to buy from outside contractors. Once they had to purchase 4,000 turntable platters from Japan at £5 a time because the local product was faulty and a deadline for orders had to be met. Then a batch of plinths needed re-working before they could be used.

Some firms find it dangerous to try and produce too many components for themselves. But Garrard suffered from relying too heavily on outside suppliers. This is why the company is now moving over to making its own printed circuit boards.

However, Garrard's new motor was designed in collaboration with JVC of Japan. JVC now sells it to Garrard at half the price it would cost to make in England.

Best Buy

Recently I wanted to buy a cheap and cheerful, but solid and reliable, mid-fi gramophone turntable for my teenage children to use. I went to a Comet store and found that by far the best buy was a Garrard SP25 turntable for around £35. It fitted the bill exactly.

Unfortunately there wasn't one in stock. The remaining choice was between a gaggle of Japanese decks, all aspiring to super-fi with very flimsy looking pickup arms. All these decks cost too much and looked as if they wouldn't last five minutes at the untender mercy of a bunch of teenage kids.

This prompted two questions. How come, if the SP25 still looked the best buy, could Garrard have got into such financial difficulties? And why couldn't I buy one? Talking with Garrards produced some interesting answers.

Since it was first introduced in 1965 they have sold 4 million SP25's. It went from Mark I to Mark VI and was rightly famous.

The jigs and tools for making the SP25 component parts had been repeatedly refurbished and when Plessey (Garrards owner until a few years ago) started selling off their factories, they somehow managed to sell off some of the tooling needed to produce the turntable. So Garrard found themselves buying in parts from a firm who were unfamiliar with how to make them.

This led to a situation where their staff had to teach their suppliers the know-how, for instance how to bake parts in ovens at exactly the right temperature. Faced with this problem and the need to refurbish the tools yet again, Garrard were in a predicament; either invest heavily in refurbishing the tools to produce yet another version or kill it off once and for all.

They knew that if they refurbished and relaunched with a Mark VII there would be a cry of "Oh not the SP25 again, can't you do anything new?" So they announced an end to the SP25. This provoked an outcry from people who said "Why are you killing it off?"

Nothing daunted, Garrard asked the trade for guarantees. If they were to invest in new tools, then they needed firm orders for enough turntables to cover the cost of tooling up.

Even the people in the trade who had cried so loudly about the end of the turntable wouldn't put their money where their mouth was and come up with firm, guaranteed orders. So in Spring 1980 they finally stopped all production of the SP25 and sold their remaining stock to Comet.

The remaining jigs and tools may well be sold to a firm in Yugoslavia that used to buy SP25's in bulk. So it is just possible that Yugoslavia may start exporting them back to the UK. But it's all very "iffy" and the long and short of it is that if you want to buy an SP25 you will have to find one sitting in a warehouse somewhere.

New Beginning

The end of the SP25 marks the end of an era. But on a more happy note, another Garrard era that ended back in 1977 will soon be re-born. There can hardly be a hi-fi enthusiast who hasn't heard of the old Garrard 401 turntable, and there are still large numbers of these still in use.

Like the SP25, production of the 401 began in 1965. It ceased in 1977 and this produced another outcry. But they were unable to respond.

Astonishingly, and no one is quite sure how it happened, half the original tooling for making the 401's was "lost" at the time of the big redundancies that hit Garrard in 1978. They hunted high and low for the tools because there were big orders from Japan. To this day no one has ever found the missing tools.

Was it deliberate sabotage, spite on the part of redundant management and workers or, most likely, was it a general "couldn't care less attitude" on the part of some of the people then in control? No one knows. But Garrard has now re-tooled and plans, before long, to launch a completely new version of the 401. This will be the flagship of the new Garrard line, costing under £200.

The company sees it as comparable with the best of British hi-fi. Only time will tell whether this enthusiasm is justified. But it would take a hard heart not to wish them luck with the new 401.

Images

A new type of TV camera made by the English Electric Valve Company of Chelmsford, Essex, literally "sees" with heat. With it firemen can search through a smoke-filled room or it can be used to provide a picture of a house or factory highlighting any escaping heat.

This new "thermal" camera has a TV picture tube which senses temperature instead of light. Objects at normal room temperature radiate in the 8 to 14 micron band and energy of this wavelength is imaged on a thin slice of crystal which develops a pattern of surface charges proportional to the heat radiation absorbed.

These charges are neutralised by a scanning electrode beam similar to that used in a conventional TV camera. The beam produces an output signal which can be used to generate a TV picture.

So far it all sounds straightforward, but the signal is proportional to the *rate* of temperature *change*, not the actual temperature registered. Normally such a camera can only produce an image on a TV monitor screen when either the object is moving or the camera is panned across a stationary object. Clearly this is of little practical value, especially for firemen or anyone trying to detect hot spots of heat which pinpoint areas of bad insulation in a building.

To produce a continuous image from a stationary object using a stationary camera, a rotating shutter is provided in front of the tube. This chops up the incoming radiation at a frequency of 25Hz to create a continually changing heat gradient. English Electric say that with an *f*/1 lens made from germanium it is possible to resolve images from temperature steps of only 0·15 degrees Celsius.

In some respects the system borrows from Baird's original 1920's idea for a mechanical TV system which used a rotating wheel to scan the image!

A Selection from our June issue

BURGLAR ALARM SYSTEM

A comprehensive alarm system with parallel and series loops, and an additional sonic detector channel.

INEXPENSIVE DARKROOM TIMER

Very simple mains powered circuit which gives visible counting signal for photographic processing. Can also be used for general purpose timing.

Another Great New Series! Gives you the bare facts on DIODES • TRANSISTORS • THYRISTORS • TRIACS • OPTO DEVICES... and all

This four-part series provides basic operating theory, information on construction and characteristics and extensive tabulated data for all common discrete semiconductors.

TREMOLO UNIT

Suitable for use with most electronic instruments including guitar and organ. Also useful in the recording studio for special effects.

TAPE AUTO START

A battery saving device designed for portable tape-recorders. May be used for dictation obviating the need to start and stop the recorder manually.

Everyday ELECTRONICS

JUNE 1981
ISSUE ON SALE
FRIDAY, MAY 15

INTRODUCTION TO LOGIC

PART 1

BY J. CROWTHER

ANALOGUE AND DIGITAL PROCESSES

Most technical processes use two ways of gathering information.

(a) Measuring or Analogue Process

In analogue processes measurements are compared with a standard or reference, and are continually changing, showing the state at that particular instant.

example

A car speedometer shows actual speed with reference to m.p.h. at that particular time.

A fuel gauge shows how much fuel is in the tank at that particular time.

(b) Counting or Digital Process

In digital processes separate discrete items or categories are counted, there need be no reference to time.

example

An odometer counts the total miles travelled, the time this was achieved in does not matter.

DIGITAL TECHNIQUES

Methods of Counting

The universally adopted counting system is the **decimal** system where we count in powers of ten. This number ten is called the **base**, or **radix**. There is no reason why we cannot count to the base, or radix of any number we wish, such as eight, six, or two.

Whichever base is used for counting, the same principle applies, that is they are all based on powers of the radix. The number of symbols used in the system is numerically equal to the radix.

examples

To the base of ten, (radix = 10) ten symbols are used 0 to 9.

To the base of eight, (radix = 8) eight symbols are used 0 to 7.

To the base of two (radix = 2) two symbols are used 0 and 1.

Since most of us deal exclusively in the decimal system, it seems superfluous to indicate that the number is in fact a decimal number. When dealing with several different counting systems however, as one is if involved with computers, the radix of the system must be clearly indicated to avoid confusion and errors. The way this is done is to spell out after the number the system name or more conveniently add a suffix to the number, equal to the radix.

example

The number 1981 in the decimal system would be written 1981 (decimal) or 1981_{10}. If the system has a radix of 8, then the number would be written 1981 (octal—see later) or 1981_8. In general, if the radix of this number is $_r$, then the number should be specified as 1981_r.

THE DECIMAL SYSTEM

In the decimal system of counting, ten symbols are used, 0 to 9. There is no new symbol for ten. If we wish to write ten we use the same symbols but start another column, for example ten is written as 10.

Since the radix is 10, and as all systems are based on powers of the radix, then decimal numbers can be arranged in columns of powers of the radix. Thus the number 1,234·56 can be represented as:

Power of 10	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}
Decimal No.	1,000	100	10	1	0·1	0·01
1,234·56	1	2	3	4	5	6

↑
decimal point

Thus the number 1,234·56 means
(1 × 1000) + (2 × 100) + (3 × 10) + (4 × 1) + (5 × 0·1) + (6 × 0·01)
= 1000 + 200 + 30 + 4 + 0·5 + 0·6
= 1234·56

Proof that any number to the power of "0" equals 1

Let n be the number raised to the power p.

Now $\frac{n^p}{n^p} = 1 = n^p \times n^{-p} = n^{p+(-p)} = n^{p-p} = n^0$

Counting in different bases

The same procedure as above applies if we use other numbers as bases for counting. Suppose we want to use a base of six. The number of symbols used would be six (0 to 5). There is no new symbol for six, we use the same symbols and start another column.

example

Six is written as 10.

Since the radix is now 6, counting to the base of six is therefore based on the powers of 6. The number 0124·30 can be represented as:

Powers of 6	6^3	6^2	6^1	6^0	6^{-1}	6^{-2}
Decimal No.	216	36	6	1	1/6	1/36
No. to base 6	0	1	2	4	3	0

↑
point

Thus the number 0124·30 to the base six ($124 \cdot 3_6$) is equal to the decimal number:

(0 × 216) + (1 × 36) + (2 × 6) + (4 × 1) + (3 × 1/6) + (0 × 1/36) = 36 + 12 + 4 + 0·5 = 52·5 (decimal) or $52 \cdot 5_{10}$.

Exercises

1.1. Convert the following numbers to decimal:

(*a*) $123 \cdot 2_4$ (*b*) $613 \cdot 1_8$ (*c*) 510_6.

Converting decimal to different bases

To convert decimal numbers to numbers of a different base, keep dividing by the base until there is nothing left, and then read the remainders from the bottom upwards as shown:

example

Convert 26_{10} to a number having a base of 4.

4) $\underline{26}$
4) $\underline{\ 6}$ and 2 over
4) $\underline{\ 1}$ and 2 over
4) $\underline{\ 0}$ and 1 over

Now read the remainder column, up from the bottom:

Thus 26_{10} is equivalent to 122_4

If the decimal number contains a fraction, treat the whole number as above, and then treat the fraction separately.

example

Convert $26{\cdot}734375_{10}$ to a number having a base of 4.

Treat the whole number first by dividing by the base until there is nothing left as above:

Thus 26_{10} is equivalent to 122_4.

Now deal with the fraction part by multiplying the fraction repeatedly by the base until it reads zero, recording the numbers that appear to the left of the decimal point. Note that *only* the fraction part each time is multiplied. Place the decimal point before the first digit obtained by this process as shown:

$$\left.\begin{array}{l}0{\cdot}734375 \times 4 = \overset{\downarrow}{2}{\cdot}937500\\ 0{\cdot}937500 \times 4 = 3{\cdot}750000\\ 0{\cdot}750000 \times 4 = 3{\cdot}000000\end{array}\right\}0{\cdot}233$$

Reading the numbers to the left of the decimal point from the top as they appear after multiplication shows:

$0{\cdot}734375_{10}$ is equivalent to $0{\cdot}233_4$.

Combining the two sections we get:

$26{\cdot}734375_{10}$ is equivalent to $122{\cdot}223_4$.

Exercises

1.2. Convert 125_{10} to the base of (*a*) 4 (*b*) 6 (*c*) 8.
1.3. Convert $72{\cdot}1875_{10}$ to the base of (*a*) 4 (*b*) 6 (*c*) 8.

Disadvantages of using decimal counting in electrical machines

Electrical machines could be designed to count in decimal.

For example:

10 volts represent ten, 9 volts could represent 9 and so on.

This has the disadvantage of involving too many symbols, so that it becomes unreliable for the following reasons:

(1) A variation of the power supply voltage would cause errors, therefore power supplies would need to be stabilised making them large and expensive.

(2) Components would have to be made very accurate, with very close tolerances.

(3) Components would have to have high stability, so they would not be affected by temperature variations and other such parameters.

(4) Component values could change due to ageing.

Any of the above would cause inaccuracy and unreliability.

If we reduce the number of symbols the system becomes more reliable.

example

If we had five symbols, so that 10 volts represented five, 8 volts represented 4 four, and so on, a variation of 1 volt would reduce the error from 1 to ½ in the final result.

From the electrical point of view the switch is the most reliable piece of equipment. Resistors, coils and transformers have a certain tolerance. A switch on the other hand has no tolerance, it is either ON or OFF with no in-between condition.

Since the switch has only two positions, we now have only two symbols, 1 for ON and 0 for OFF, therefore errors are reduced. As computers and logic circuits use switches (high-speed "electronic" versions) for speed and reliability they must count to the base of two, that means in the BINARY SYSTEM.

THE BINARY SYSTEM

Since we are only using two symbols 0 and 1, there is no new symbol for two; use the same symbols and start a new column.

example

Two is written as 10

Now the radix is 2, so the binary system is based on powers of 2 as shown:

Powers of 2	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
Decimal No	32	16	8	4	2	1	0·5	0·25
Binary No.	0	0	1	0	1	0	0	1

binary point ↲

Thus the binary number 001010·01 means:

$(0 \times 32) + (0 \times 16) + (1 \times 8) + (0 \times 4) + (1 \times 2) + (0 \times 1) + (0 \times 0{\cdot}5) + (1 \times 0{\cdot}25)$
$= 8 + 2 + 0{\cdot}25 = 10{\cdot}25$

So the binary number $001010{\cdot}01_2 = 10{\cdot}25_{10}$.

Powers of Two

$2^0 = 1$	$2^7 = 128$	$2^{14} = 16{,}384$
$2^1 = 2$	$2^8 = 256$	$2^{15} = 32{,}768$
$2^2 = 4$	$2^9 = 512$	$2^{16} = 65{,}536$
$2^3 = 8$	$2^{10} = 1{,}024$	$2^{17} = 131{,}072$
$2^4 = 16$	$2^{11} = 2{,}048$	$2^{18} = 262{,}144$
$2^5 = 32$	$2^{12} = 4{,}096$	$2^{19} = 524{,}288$
$2^6 = 64$	$2^{13} = 8{,}192$	$2^{20} = 1{,}048{,}576$

Exercises

1.4. Convert the following binary numbers to decimal:
(*a*) 1101·1 (*b*) 1001110·11 (*c*) 100100·1 (*d*) 11011101111

Converting decimal to binary

To convert decimal to binary, keep dividing by 2 until there is nothing left, and then read the remainder column, up from the bottom as shown:

2) $\underline{13}$
2) $\underline{\ 6}$ and 1 over
2) $\underline{\ 3}$ and 0 over
2) $\underline{\ 1}$ and 1 over
2) $\underline{\ 0}$ and 1 over

Now read the remainder column up from the bottom:

Thus 13_{10} is equivalent to 1101_2.

If the decimal number contains a fraction treat the whole number as above, and then treat the fraction separately.

example

Convert $10{\cdot}75_{10}$ to binary.

Treat the whole number first thus:

2) $\underline{10}$
2) $\underline{\ 5}$ and 0 over
2) $\underline{\ 2}$ and 1 over
2) $\underline{\ 1}$ and 0 over
2) $\underline{\ 0}$ and 1 over

Thus 10_{10} is equivalent to 1010_2.

Now deal with the fraction part by drawing columns thus:

Negative powers of 2	2^{-1}	2^{-2}	2^{-3}
Decimal number	0·5	0·25	0·125

Since $0{\cdot}75 = (1 \times 0{\cdot}5) + (1 \times 0{\cdot}25)$, then $0{\cdot}75_{10}$ is equivalent to $0{\cdot}11_2$, or by repeatedly multiplying fraction by 2 as shown earlier.

Combining the two together we get:

$10{\cdot}75_{10}$ is equivalent to 1010·11 binary.

Exercises

1.5. Convert the following decimal numbers to binary:
(*a*) 62 (*b*) 1024 (*c*) 42·25 (*b*) 51·125

TO BE CONTINUED

By Dave Barrington

Circuit Board Transfers

Catering for the amateur or professional who wishes to produce "one-off" p.c.b.s, Ace Mailtronix have been appointed stockists of the p.c.b. draughting transfers manufactured by Alfac and distributed in the UK by Pelltech Ltd.

The etch resist transfers offer a wide selection of symbols including terminals, solid, oval, square and offset pads, together with connectors, curved and straight tracks, transistor symbols and dual-in-line (d.i.l.) pads.

The transfers usually come packed in sheets (115 × 105mm) of five of similar type but Ace Mailtronix are able to offer a mixed pack of six sheets including intro sheet, pads, lines and d.i.l.

Being etch resistant, most amateur constructors will opt for the 1:1 scale for direct application on to the copper board. However, for those with photographic reduction facilities a range of 2:1 scale transfers are available.

For further information and free catalogue send a stamped addressed envelope (9 × 4 inches) to Ace Mailtronix Ltd., Dept EE, 3a Commercial Street, Batley, Yorks, WF17 5HJ.

LCD Panel Meter

Anyone looking for a small handheld instrument case, with a raised viewing window and a top panel to take range switches and sockets or even a small calculator keyboard, has only to purchase one of the new l.c.d. panel meters from Lascar Electronics to obtain one free.

LCD Panel Meter from Lascar.

The new meter is claimed to be the first of a new generation giving at least ten times the battery life of any existing type. A PP3 battery will power the meter for an estimated two years, if operated eight hours a day, seven days a week.

Using l.c.d. watch manufacturing techniques to reduce the meter depth to a minimum, its features include digit hold facility, auto zero, auto polarity and single rail supply of 5 to 15V d.c. drawing 200μA.

As an evaluation offer (valid until December 31) Lascar are giving away an instrument case with each meter sold. The case accepts the meter, a PP3 battery and allows space for a small circuit board.

The total cost of the meter is £23·51 including VAT and postage and packing. A data sheet with the meter gives details of ten handheld instruments, including multimeters, thermometer and pH meter.

The LCD Panel Meter is available from Lascar Electronics Ltd., Dept EE, Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex, SS13 1LH.

Bumper Sale

The latest news we have from Home Radio is that they are turning over the whole of their first floor to a giant component sale. The sale, a joint effort with Harversons and G. P. Transformers, will run from April 25 to May 2 at the Home Radio premises at 269a Haydons Road, London, SW19.

Portable Vice

A third hand is always handy in the workshop and the latest vice from Home Radio should be a useful acquisition.

The vice has a G-clamp base enabling it to be fixed to various surfaces. Made from cast metal the vice costs £2·50, plus 37p VAT and £1 postage and packing. Total £3·77.

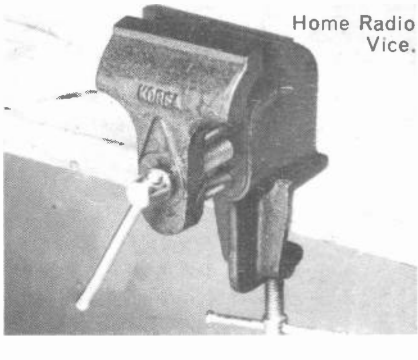
Talking of a third hand, we mentioned some time ago the Minibench from Absonglen and how we liked its general design.

Well, we have received a letter from a Scottish reader who thinks it is like growing six hands. The following is an extract from the letter.

"The Minibench that Eric got for Christmas has been tremendously useful and versatile. He would be totally lost without it now. As he says, it is like growing another six hands.

"The whole concept and design is great. We would be most grateful if somewhere in your magazine, you might find a small space for recommending it to other electronic folk.

"The only addition that it could perhaps have, though not essential, is a light incorporated on the bench close to where you work, for very fine, close-up detailed soldering."



Home Radio Vice.

Praise indeed. Further information on the Minibench can be obtained from Absonglen Ltd., Dept EE, The Forge, Staplow, Ledbury, Herefordshire HR8 1NP.

CONSTRUCTIONAL PROJECTS

Very few component purchasing problems should be encountered when seeking parts for this month's constructional projects. It is more likely to be one of personal preference than locating difficult components.

Audio Test Set

Although the construction of the *Audio Test Set* is quite a large undertaking only a couple of items could cause concern.

If possible the RS type meter called for should be used, but as this is a fairly expensive item any meter with an internal resistance as near to 1300 ohm as possible could be used. If a different meter is used it may be necessary to adjust the value of the meter resistor R50.

The germanium OC41 transistor would appear to be a rare specimen but is listed by some of the advertisers in this issue. The price seems to vary quite considerably. It is possible that the germanium OC44 or OC45 transistors could be used as replacements but they have not been tried in the model. Note that if these are used then the pin outlines will be different.

The case for the unit is not critical and the one used in our model is the BC7 from B. Bamber Electronics, Dept EE, 5 Station Road, Littleport, Cambs. CB6 1QE.

Phone Bell Repeater or Baby Alarm

The CMOS integrated circuit for the *Phone Bell Repeater or Baby Alarm* should be stocked by most advertisers and the usual precautions should be taken when handling this device.

If a small moving coil loudspeaker is used for the bell sensor then a step-up transformer with an approximate ratio of 1:40 to 1:80 should be used. The LT700 specified in the article is available from Watford, Maplin and Electrovalue.

Auto Lights Reminder and Ignition Locator

The loudspeaker warning device specified in the *Auto Lights Reminder and Ignition Locator* is a telephone earpiece insert.

Practically any small loudspeaker with an impedance of between 20 to 80 ohms could be used provided, of course, it will fit inside the case.

Soil Moisture Indicator

The choice of probe for the *Soil Moisture Indicator* is not critical and no doubt readers will use their own ingenuity. A pair of metal knitting needles would certainly make reasonable probes, but make sure you remove any protective coating on the needles with some emery cloth.

The suggested f.m. aerial socket for making up the probes should be available from any good audio shop although they seem to be in short supply. Alternatively a 2-pin 5A plug, sold through Woolworths stores, could easily be adapted.

By D.H.E. KING

PHONE BELL REPEATER or BABY ALARM

A RELATIVE with poor hearing first complained that the telephone bell was not as loud as it used to be when she was sitting in the room next to the hall in which the telephone was installed.

Then I was asked if a baby-alarm could be made more cheaply than the proprietary ones.

"After all", the mother said, "we want to know if the baby is yelling, not to listen to every little snuffle and burp!"

Urged on thus, this cheap circuit was designed to produce a tone in a distant loudspeaker in response to a reasonably loud noise input to the microphone—a telephone bell, a fretful infant or even your dog at the front door if there is a suitably placed microphone.

There is no chance of a complaint about eavesdropping on conversations since the circuit consists of a gated oscillator instead of an audio amplifier and an advantage of this circuit is that due to the use of a CMOS logic chip the standby or quiescent current is only about 0·5mA which makes for a very long battery life.

The whole circuit, with suitable adjustment of the sensitivity or threshold control will continue operating satisfactorily as the battery voltage drops during its life from 6V down to about 3V.

NAND GATES

The full circuit diagram of the Phone Bell Repeater is shown in Fig. 1. The first of the four NAND gates, IC1a, is biased by VR1 such that the output, pin 3, is on the verge of changing from a "high" or logic 1 down to a "low" or logic 0. Any positive-going increase in the input voltage causes the output of IC1a to change to a logic "low", driving the output of IC1b "high" (logic 1).

This only occurs for the brief positive peaks from the microphone and the output of IC1b is used to charge C1 via D1. This stored charge is used to enable the oscillator formed by gates IC1c and IC1d, causing it to oscillate.

If C1 were not discharged deliberately the tone would continue being generated for too long a time but R4 provides a reasonably swift discharge.

Thus the first peak of sound starts the tone and yet there will still be the typical pause in between the "rings" of a telephone (or the yells of a baby).

SQUARE WAVE

The square-wave output of IC1d provides pulses of base current for TR1 which in turn supplies the current drive to the distant loudspeaker. When the oscillator is turned off, the output of IC1d is at logic 0, which is virtually 0V and is less than the 0·6V required to turn on a base-emitter junction. Therefore TR1 draws zero standby current from the 6V supply.

The crystal microphone XI may be connected as shown in the circuit diagram as the crystal element is open-circuit to d.c. and does not shunt VR1 and R2. Virtually any crystal insert can be used here.

An alternative input device that might be more available is a small moving-coil loudspeaker used in conjunction with an output transformer from an old radio or TV perhaps. The primary winding is connected in *series* with the slider of VR1 as shown in Fig. 2. A suitable type of transformer if buying new would be the Eagle LT 700.

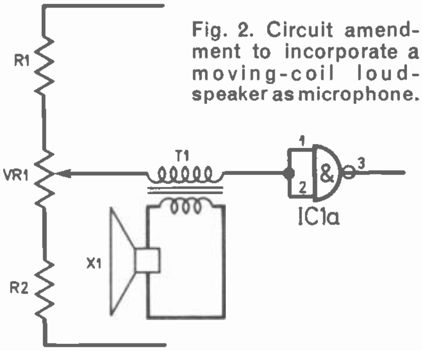
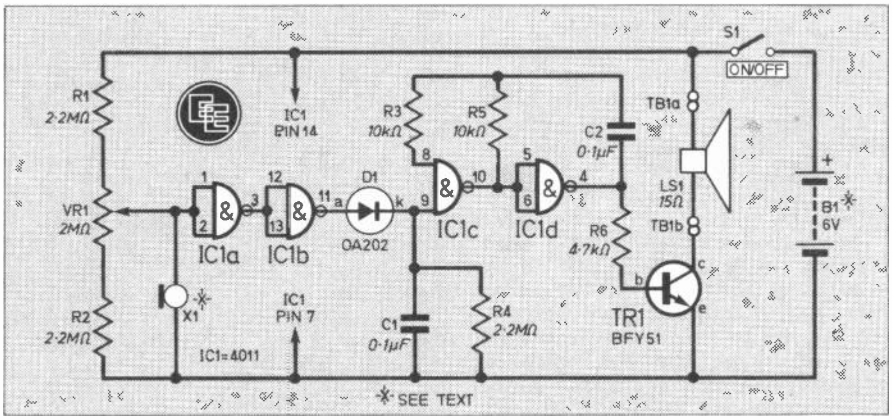


Fig. 2. Circuit amendment to incorporate a moving-coil loudspeaker as microphone.

Fig. 1. Complete circuit diagram of the Phone Bell Repeater.

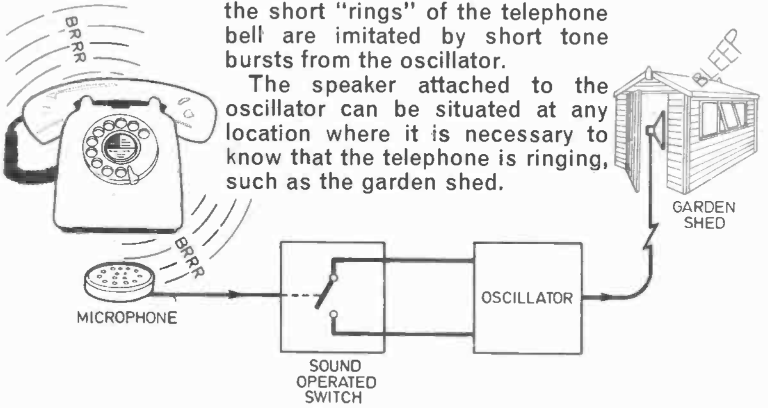


HOW IT WORKS

A microphone, connected to a sensitive sound operated switch, is situated close by the telephone. When the telephone rings, the microphone picks this up and switches on the oscillator.

The oscillator remains switched on until the sound ceases whereupon it also ceases to operate. So the short "rings" of the telephone bell are imitated by short tone bursts from the oscillator.

The speaker attached to the oscillator can be situated at any location where it is necessary to know that the telephone is ringing, such as the garden shed.



CONSTRUCTION starts here

STRIPBOARD

The components are laid out on a piece of 0·1 inch matrix stripboard size 16 strips by 15 holes and the layout is given in Fig. 3. The i.c. was mounted in a socket in the prototype and this is recommended although with the usual precautions a CMOS chip may be soldered directly into the board.

Veropins were used for the various input/output connections to allow some flexibility in fixing the circuit within its box.

Single core wires, if used, have a nasty habit of fracturing at inconvenient times when fitted and soldered direct into a circuit board but a pin may easily have its connection changed or renewed.

The board is secured to the baseboard with 6BA nuts and bolts as shown or with wire loops.

HOUSING

The completed circuit board is small and the thickness of a unit to fit beneath a telephone is therefore determined largely by the microphone unit and the batteries in their holder.

The prototype box was made of hardboard with soft wood supports, the on-off switch and threshold control being inset at one side. Full constructional details are shown in Fig. 4. No "on" indicator is fitted as this would draw many times more current than the rest of the circuit. The speaker is mounted in a separate enclosure.

BATTERY

The prototype unit was powered by four HP7 batteries wired in series in a special "flat-pack" holder. However the supply voltage for the CMOS i.c. is not critical and a PP3 battery could be used instead.

This gives a nominal 9V but is not able to supply a large current for quite so long as the HP7 combination and so may need more frequent replacement. On the other hand the 1289 flat torch battery could be used.

BABY ALARM

This design is equally suitable for use as a baby alarm. However certain small changes are necessary in the housing and positioning of the unit.

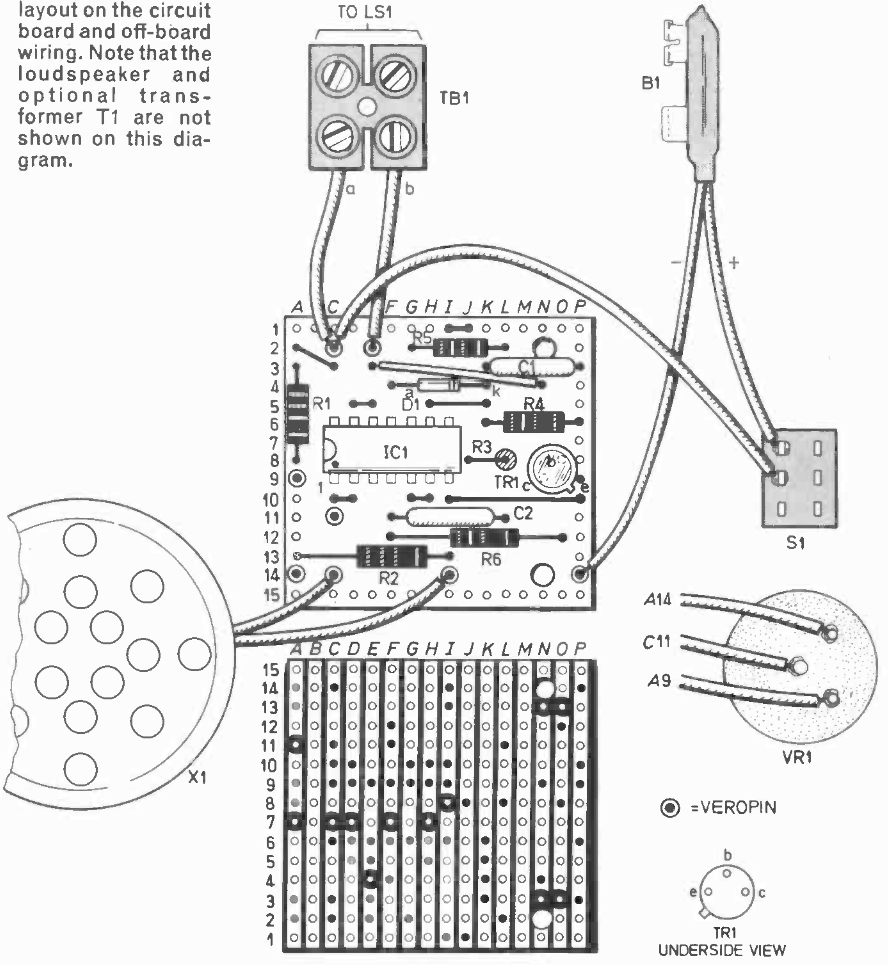


Fig. 3. Component layout on the circuit board and off-board wiring. Note that the loudspeaker and optional transformer T1 are not shown on this diagram.

COMPONENTS

Resistors

R1	2·2MΩ	R4	2·2MΩ
R2	2·2MΩ	R5	10kΩ
R3	10kΩ	R6	4·7kΩ

All ¼W carbon ± 5%

Capacitors

C1, C2 0·1μF C280 polyester (2 off)

Semiconductors

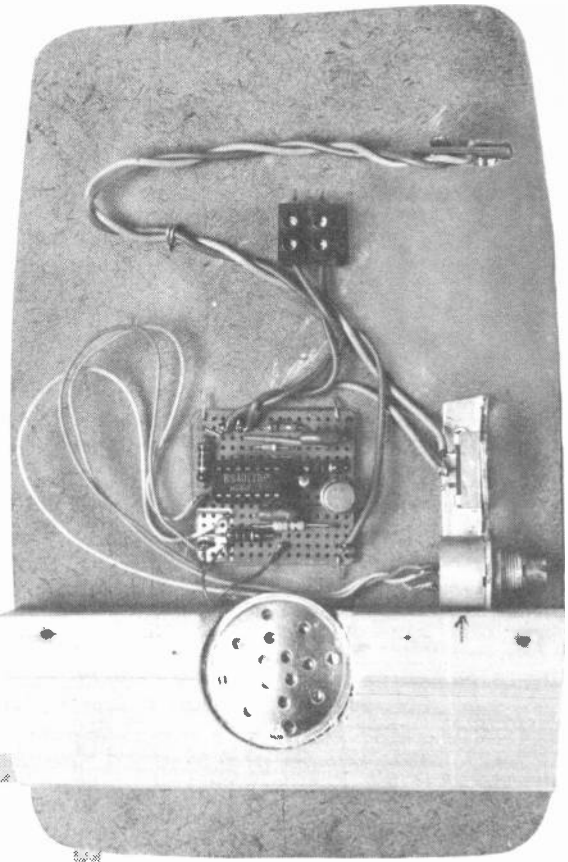
IC1	4011 CMOS quad 2-input NAND gates
TR1	BFY51 *npn* silicon
D1	OA202 general purpose silicon

Miscellaneous

S1	s.p.s.t. slider switch
VR1	2MΩ miniature linear carbon potentiometer
X1	crystal microphone (see text)
LS1	miniature loudspeaker, 15 ohms impedance
B1	6V battery, four HP7 types in series in special holder (see text)
T1	output transformer, Eagle type LT700 or similar (see text)

Stripboard: 0·1 inch matrix, size 16 strips by 15 holes; twin-core cable to connect loudspeaker; suitable housing for loudspeaker; hardboard and soft wood for main unit housing, or plastics box if building as baby-alarm; battery connector to fasten onto battery holder.

See **Shop Talk** page 334



Photograph right shows top view of the completed prototype.

COMPONENTS approximate cost £5·00 excluding cases

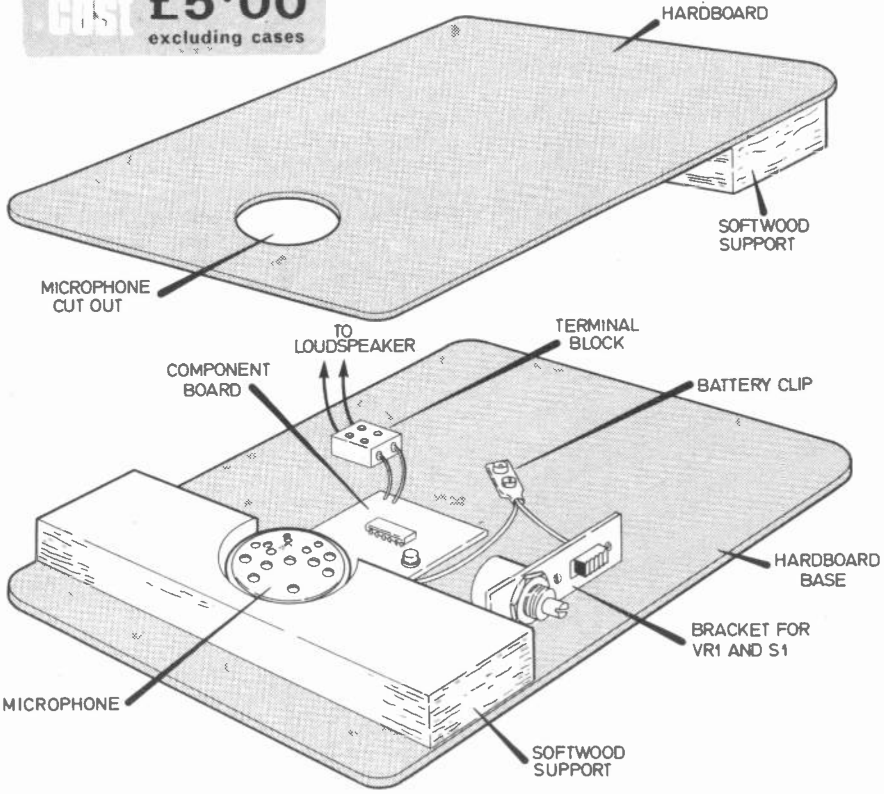


Fig. 4. A suggested housing for the unit to be located underneath the telephone. Note that this is designed to be used with a conventional "bell" telephone. It can be completely enclosed by fixing a strip around the edge of the base.

The microphone together with the rest of the circuitry and batteries can be housed in a proprietry plastics box and mounted in some convenient position near the baby.

The loudspeaker is housed separately and located near the parents. It is not really practical to have the microphone mounted alone with the circuit board and batteries at the loudspeaker end because of the long run of microphone cable that would be required to connect to the rest of the circuit.

SETTING UP

When completed and switched on, advance the slider of VR1 towards the positive (R1) end of the variable resistor and the tone will be heard in the speaker. Move the control in the opposite direction until the tone *just* ceases and the circuit is in its most sensitive state.

If the tone starts for too quiet or small a sound then move VR1 slider in the direction of R2 even more such that oscillations start reliably for the bell ringing or child crying.

FEEDBACK

When finally installing the system, care must be taken not to site the microphone and loudspeaker too close together otherwise a feedback loop will be set up.

This will mean that once the oscillator has started it will not shut off until the power is disconnected. ⌑

tvi FILTERS

BY E.A.RULE

Television reception can be marred by nearby transmitters (either licensed amateur or illegal C.B. stations) operating around 27—28MHz.
This article describes simple yet effective cures for such TV interference

THE problem of interference to television reception caused by nearby transmitters has become a very common one in the UK. It is unlikely at the present time if many homes are more than a matter of hundreds of yards away from a transmitter of one sort or another, either amateur, broadcast, police, taxi or even CB!

In many cases the distance may only be a matter of a few feet or so. The result is interference (TVI) of one sort or another to the reception of the UK u.h.f. TV service.

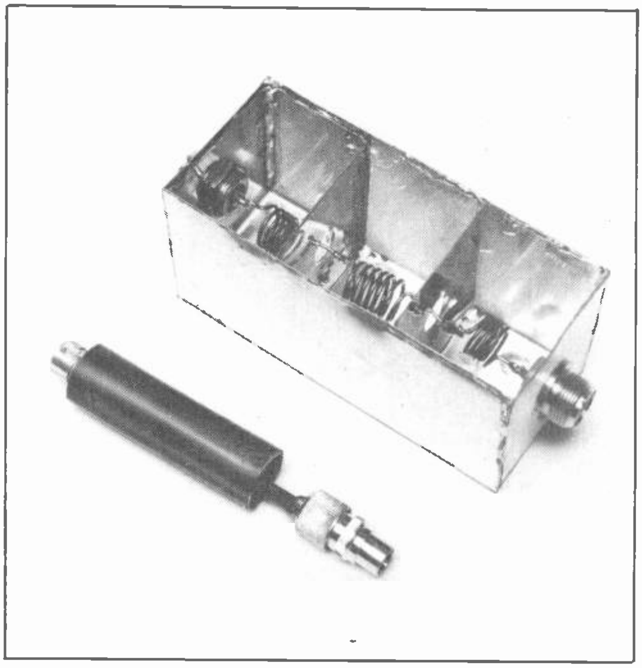
One way that this problem can be solved is for all television set manufacturers to make their receivers more selective, but this would result in the receivers becoming more expensive and in a price cutting market this could spell death to the manufacturer very quickly.

So receivers tend to get built down to a price and selectivity (as far as the r.f. circuits are concerned) is low on the list of priorities.

TWO SOURCES OF TROUBLE

In practice the problem is mostly due to two sources of interference: (*1*) harmonics from a nearby transmitter being on the actual TV frequency involved, (*2*) the fundamental transmitting frequency being of such a high strength that it simply "blocks" the TV signal due to an overloaded r.f. tuner unit in the TV receiver.

Both of these types of interference can be reduced or prevented with suitable filters added on external to the main equipment and not requiring any modifications to either transmitter or receiver. There are two types of filter that can be employed for this purpose: high-pass and low-pass.



HIGH-PASS AND LOW-PASS FILTERS

The difference between a high-pass and low-pass filter is this. A high-pass filter will pass all frequencies *above* its design frequency and attenuate the frequencies below. A low-pass filter will pass all frequencies *below* its design frequency and attenuate all frequencies above.

By using both types of filter it is possible to get a very high rejection of unwanted frequencies and prevent these causing interference to the required TV signals.

The low-pass filter is fitted between the transmitter and its aerial system and attenuates any harmonics that may be present in the transmitter output (there are always some).

The high-pass filter is connected into the TV receiver coaxial feeder (close to the actual set) and will prevent the transmitter fundamental frequency getting into the r.f. circuits of the receiver tuner unit. If allowed to get into this part of the receiver circuit the transmitter signal can overload it and "block" the circuits to the required TV signal.

This "blocking" signal could be very strong because the down-lead of the TV aerial makes a very good vertical aerial at the lower frequencies! Quite often, a high-pass filter is all that is needed to provide a cure, so this type of filter should be fitted before trying anything else. Details for the practical construction of both types will now be given.

PRACTICAL HIGH-PASS FILTER

As a high-pass filter will be needed for each TV receiver affected it should be of simple and cheap construction and the filter described here meets this requirement nicely. Fig. 1 shows the circuit of the filter and a typical frequency response is shown in Fig. 2.

Construction is very simple, a small piece of perforated s.r.b.p. board (no copper strips) measuring approximately 50×15mm is used for the base. The coils and capacitors are mounted as shown in Fig. 3, with a coaxial socket on one end and a short coaxial lead terminating in a coaxial plug at the other.

Keep the wires as short as practical. The resistor is to prevent static building-up on the aerial lead which could break down the capacitors under certain conditions (storm for example); its actual value is not critical. Anything between 220 kilohm and 1 megohm will do.

Once the filter has been made it should be housed in a piece of plastic tube (NOT METAL) and the ends sealed with Araldite, see photograph.

FILTERS IN SERIES

In cases where the interference is very severe, two of these filters could be used in series, but in this

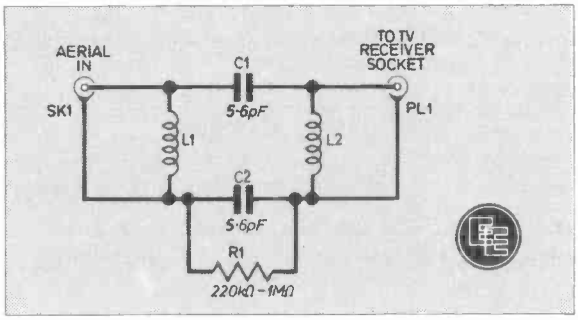


Fig. 1. Circuit of simple high-pass filter.

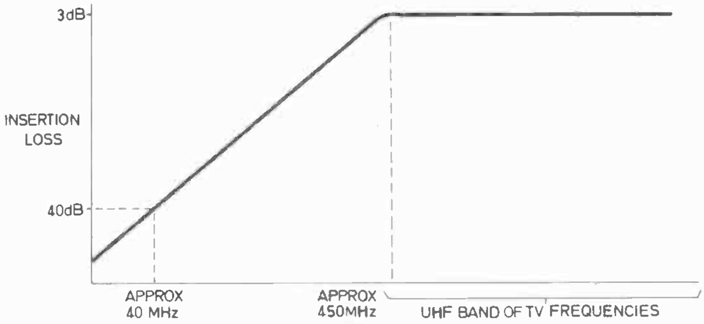
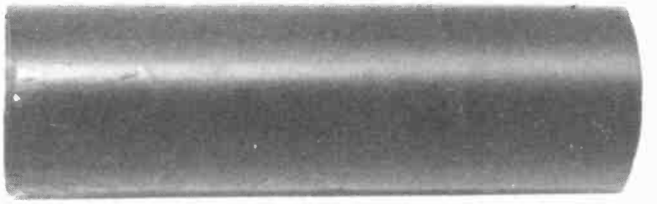
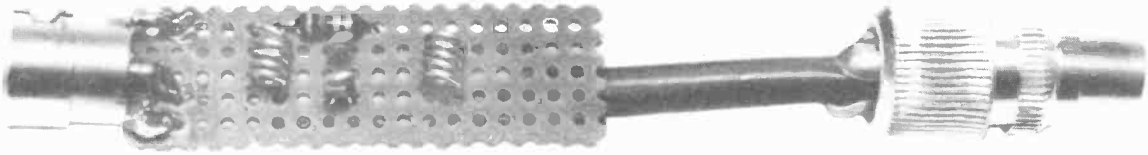
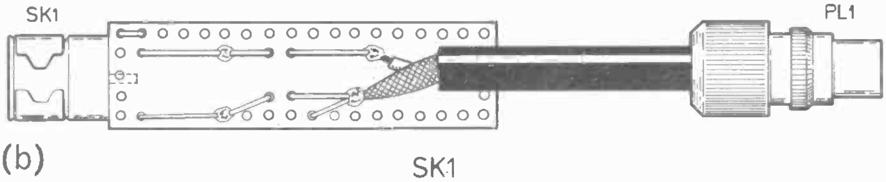


Fig. 2. Typical response of the circuit shown in Fig. 1.



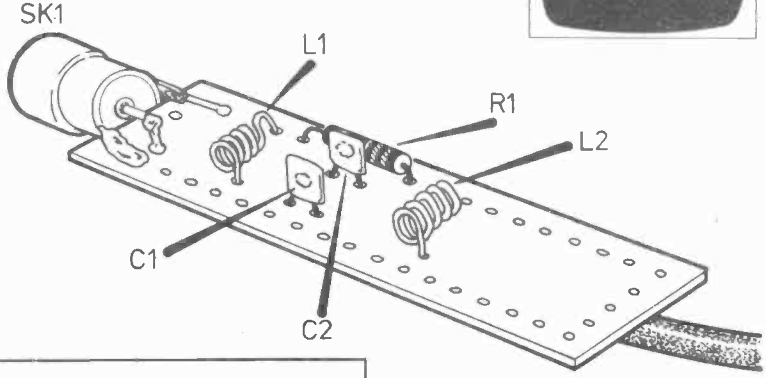
The completed high-pass filter with the plastic tube which is fitted over the assembly. The ends are then sealed with Araldite.





HIGH-PASS FILTER

Fig. 3. Construction of high-pass filter (a) top view of perforated s.r.b.p. board showing location of components, (b) underside of board showing wire links and connections to output plug.



(a)

COMPONENTS

HIGH-PASS FILTER

R1 220kΩ to 1MΩ $\frac{1}{8}$W carbon
C1, C2 5·6pF silver mica
L1, L2 see below
PL1, SK2 coaxial plug and socket

Miscellaneous

Perforated s.r.b.p. board 50×15mm. Short length of coaxial cable. Plastic tube (sleeve) 18mm internal diameter 65mm long.

COIL WINDING DETAILS

L1, L2 Five turns of 22 s.w.g. tinned copper wire wound over $\frac{1}{8}$ inch diameter former, the former is then removed leaving the coil self-supporting. The turns are spaced equal to the wire diameter.

COMPONENTS approximate cost £2·00 excluding case

case the total insertion loss may be too high in weak TV signal areas; however, it is worth a try.

If a masthead TV aerial amplifier is in use, it may require one of these filters at its input. In this case the filter must be made waterproof as it will be exposed to the weather. All external connections (plugs and sockets) must also be waterproof.

PRACTICAL LOW-PASS FILTER

The circuit of the low-pass filter is given in Fig. 4 and a typical frequency response is shown in Fig. 5.

The filter is built inside a metal box constructed as detailed in Fig. 7. The use of tin plate enables all joins to be soldered, thus making a completely sealed enclosure as far as r.f. leakage is concerned.

Two tin plate screens fitted internally divide the box into three equal sections. These screens are soldered on three sides where they make contact with the box sides, so making a complete seal between each section apart from the centre hole for the coil wire ends to pass through.

Standard SO239 coaxial sockets are used and it is probably best if these are fitted to the end panels before the sheet is bent.

COILS

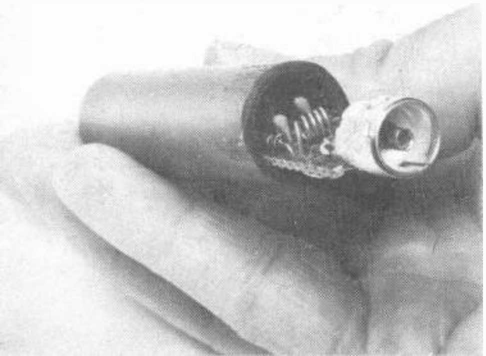
The details for constructing the coils are shown in Fig. 8 and should be followed exactly, for the coil dimensions are critical. The filter has been designed to start attenuating from approximately 32MHz and if the coils are not made as shown the cut-off frequency may become lower and start to attenuate the actual transmitter output. This might result in the filter being damaged due to the transmitter output being dissipated within the filter.

ASSEMBLY

The filter components are assembled as in Fig. 6.

First position L1 and L3 and solder their outer ends to the sockets. Then position L3 and secure the coil ends together by wrapping the capacitor lead around them, then solder.

The high-pass filter



The decoupling capacitors are all 82pF silver mica and one is placed each side of each screen. (In the prototype only a single capacitor of 180pF was used on one side of the screen, but two capacitors of half-value each side of the screen give better attenuation at u.h.f.).

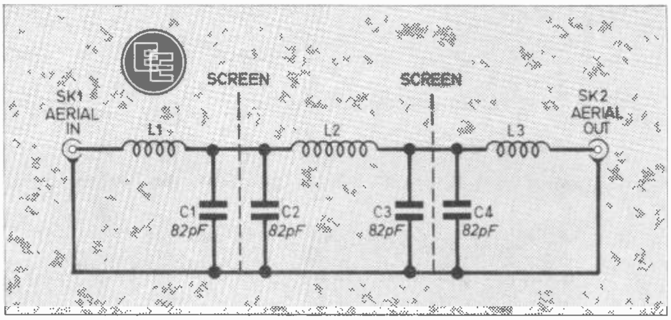


Fig. 4. Circuit of low-pass filter.

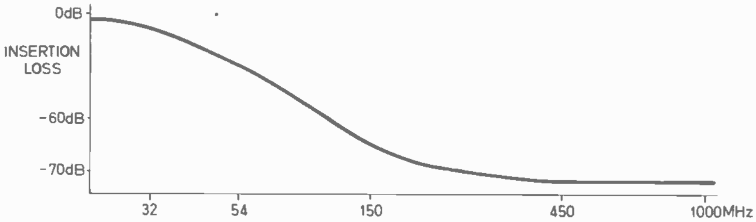


Fig. 5. Typical response of circuit shown in Fig. 4.

The earthy ends of all capacitors are soldered direct to the screens as shown. Keep the capacitor leads as short as possible otherwise the ultimate attenuation at u.h.f. will suffer.

Where the coils pass through the screens, make sure that the wire passes through the centre of the holes *without* touching the screen. The mica capacitors will hold the coils in position once they are soldered in place.

When satisfied that all coils and capacitors are soldered in the correct positions and that no unwanted shorts are present, the lid can be laid over the open side of the box and soldered into position, making a completely sealed unit.

However, until the unit has been tested on a transmitter it is suggested that the lid is held in place by soldering at the sides in three places only, this will enable it to be removed if something is found wrong.

USING THE FILTER

The filter can be used either way around with equal effect. With a correctly matched transmitter aerial system the filter should handle power outputs up to 1 kilowatt peak. However, a mis-matched aerial system could cause higher voltages to occur across the filter capacitors and break them down.

S.W.R. METERS

A brief word about the use of standing wave ratio (s.w.r.) meters is not out of place here, since it is not generally known that these instruments can, themselves, cause TVI.

This arises through the diodes used to provide the voltages for indicating the standing wave ratio on a meter. Harmonics of the transmitting frequency are generated by these diodes, and these can cause TVI.

After the aerial system has been checked out for s.w.r. the meter should be REMOVED from the system. If you must have the use of it as an output indicator, then fit it into the system *in front* of the low-pass filter so that the filter also removes any harmonics generated by the diodes. However, note that the meter cannot be used for s.w.r. measurement when connected in this way.

CONCLUSION

The filters described in this article will greatly reduce or prevent TVI from transmitters operating in the 1·5 to 30MHz band However, if after fitting them you still have TVI, don't jump to the conclusion that they don't work! It just means that you are getting the TVI from some other source as well. ⌑

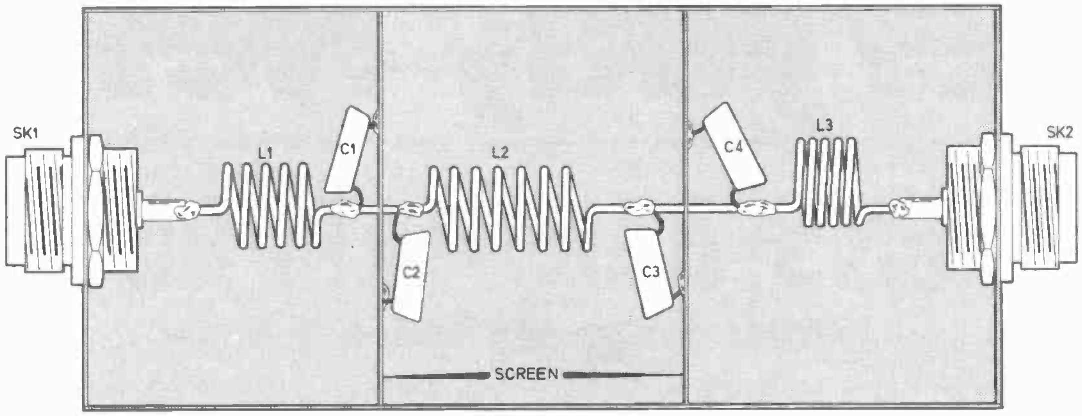


Fig. 6. The low-pass filter with lid removed. Note the positioning of the components and the soldering points.

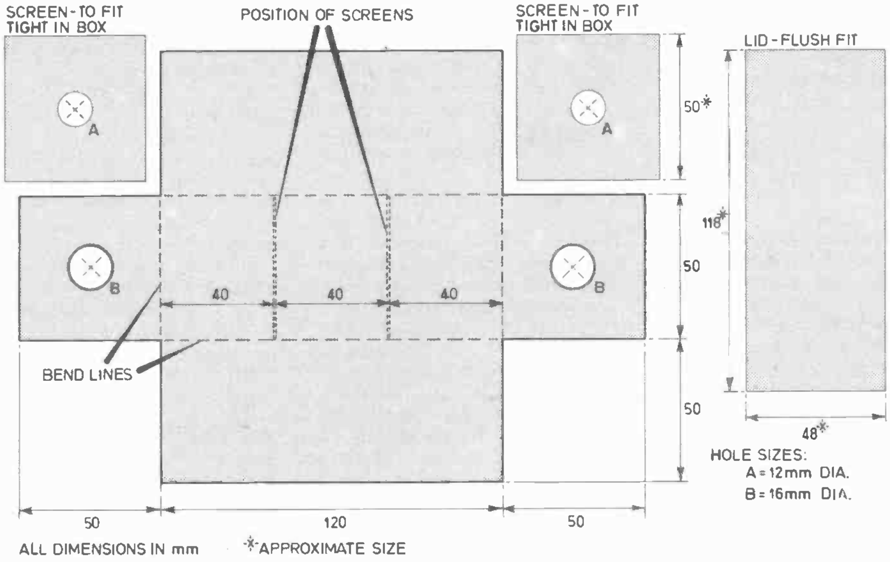


Fig. 7. Cutting, drilling and bending details for the sheet of tin plate from which the filter box is constructed.

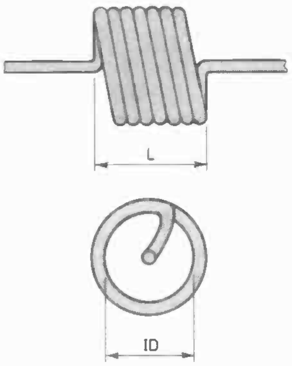
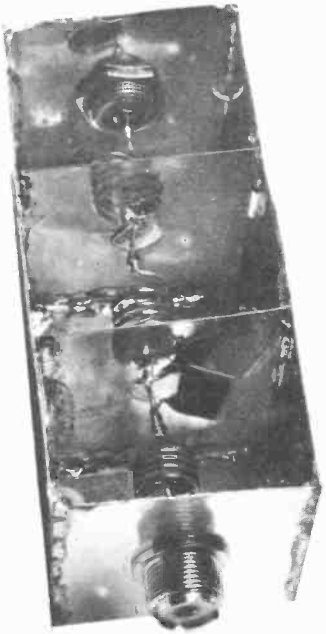


Fig. 8. Coils L1, L2 and L3. (See below for winding information).



COMPONENTS

LOW-PASS FILTER

C1-C4 82pF silver mica (4 off)
L1, L2, L3 see below
SK1, 2 SO239 coaxial sockets

Miscellanous
Tin plate for box, see Fig. 7.

COMPONENTS approximate cost £1·75

COIL WINDING DETAILS

Three coils required, made from 18 s.w.g. enamelled copper wire.
L1, L3, Five turns, close wound, 12·7mm internal diameter (2 off)
L2, Seven turns, close wound, 12·7mm internal diameter.

The coil ends are bent at right angles to the coils along the axis as shown (Fig. 8). The ends of the coil are cut to a suitable length for the box, each coil fits in the centre of its section of the box.

After winding, the coil length (L) is adjusted to 12mm (L1, L3) and 22mm (L2). This is done by carefully stretching the coil so that a gap exists between the turns, the gaps should be even all along the coil length.

Scrape the enamel from the ends of each coil, ensuring that a half-inch length of clean, bright copper is exposed at either end.

LOW-PASS FILTER

Everyday News

CITIZENS BAND APPROVED

— 27MHz F.M. and 930MHz F.M. —

Britain is to have a legal citizens band radio service. Mr William Whitelaw. the Home Secretary, announced this recently in a Parliamentary answer to Mr Patrick Wall MP.

It is hoped that the new service will be introduced in the autumn.

The new service will be authorised on 27MHz F.M. (frequency modulated), and a further frequency will be made available around 930MHz. Equipment will be required to meet a technical specification, and users will have to buy an annual operating licence.

The "pirate" 27MHz A.M. (amplitude modulated) equipment currently being used in this country is *illegal* and will remain so.

Choosing the Frequency

Announcing this new era in public radio communications the Home Secretary went on to say. "The final decision had to take into account the need to introduce a legalised service with the minimum of delay; the risk of interference to radio, TV and other authorised services both in the United Kingdom and in *neighbouring* countries; the availability of frequencies; and the desirability of adopting an international standard."

"The frequency selected—27MHz F.M.—should give CB enthusiasts the performance they want at about the same cost as illicit equipment but with far less interference to other users. France, the Netherlands and Germany are among those European countries who have legalised on 27MHz F.M. equipment and the Irish Republic has recently announced its intention to do the same."

"The other frequency proposed — around 930MHz — is going to be adopted in North America and some European countries, and is seen as being capable of giving a good quality service, especially in towns and cities, with the minimum of interference. It offers the prospects of an international market for British manufacturers."

"Other alternative frequencies, such as 41MHz and 450MHz, were reviewed but none was free of interference difficulties or met the other requirements. Existing authorised users of the 27MHz band, for example, hospital paging systems, may be affected by the Government's decision and the implications for them will be taken into account during the planning period."

Existing Equipment

"Existing illegal 27MHz A.M. (amplitude modulated) equipment will NOT be legalised. The volume of interference from CB sets using 27MHz A.M. equipment is increasing, in the last five months alone there were nearly 5,000 complaints of interference to radio, TV and hi-fi which were directly traced to the use of illegal 27MHz A.M. sets. This represents an increase of about one-third of all recorded complaints of interference from all sources. Emergency services have also been affected."

Equipment Specification

"Specifications for the new F.M. (frequency modulated) equipment will be drafted to ensure that it causes the minimum of interference to other radio users; standards will be set to which manufacturers, importers and assemblers will have to conform."

"The equipment will have to be permanently marked so that a purchaser knows the set he is buying meets these standards. Such specifications are vital to ensure that other radio services (police, fire, aviation) are not adversely affected."

Licensing

"Users of the new service will have to buy a licence, renewable annually, which will entitle them to use equipment on either frequency."

"Talks are taking place with the Post Office to see if they can issue licences on behalf of the Home Office. It is too early to say what the cost of a licence will be."

Finally a comment from the Minister of State for the Home Office: "*We are offering a new service which we hope will provide enjoyment for many people. It will give as good a service as the illegal A.M. equipment indeed some of this is already obsolete. It should soon cost about the same and should cause fewer problems for others.*"

"*The interference which illegal CB equipment is causing to TV reception and emergency services is giving rise to concern, and now that the Government has gone so far towards meeting the wishes of supporters of CB, I hope that we can rely on those with illegal equipment to act responsibly and stop using it*".

LONDON LIGHTS

A £1 million contract from the Greater London Council to update traffic lights at some 50 road junctions has been awarded to Plessey.

Traffic flow and control will be assisted by lights being linked via MPUs to a central control computer.

The first International Tape/Disc Association (ITA) European Home Video Seminar has been rescheduled for October 10 to 12, 1981 at the Palm Beach Club in Cannes, France during the Vidcom '81 exhibition.

The Maidstone YMCA Amateur Radio Society is holding a Hobby Electronics and Amateur Radio Mobile Rally on Sunday, May 3, 10 a.m. (admission 50p—free parking) at the Sportscentre, Melrose Close, Maidstone.

BLINDFIRE FOR USAF

Marconi Blindfire radar systems worth £20 million are included in the British Rapier low-level air defence missile installations to be introduced at USAF bases in East Anglia. This latest order is hard on the heels of a substantial order for Blindfire from the Swiss government.

Rapier air defence systems built by British Aerospace have achieved over £1,000 million of sales.

Wind Power

The site for Britain's first large scale wind turbine generator is to be Burgar Hill, Orkney.

It will develop three megawatts of power from a £5·6 million "windmill" to be supplied by The Wind Energy Group which is a consortium of Taylor Woodrow, British Aerospace and GEC. It should be in operation by 1983/84.

... from the World of Electronics

Scottish Recipe

Addressing 250 US company executives in San Francisco, David Simpson the President of Gould Inc, said "Scotland could produce fifty cents of every dollar earned by US Electronics companies in Europe by 1990."

"Within a decade, Europe's market for electronics will equal that of the US." "While Europe presently consumes 30 per cent of world production, £15,000 million, European-based companies produce only £5,200 million locally.

Speaking at a luncheon hosted by the Chairman of the Scottish Development Agency, he went on to say "US electronics firms which fail to set up an overseas manufacturing operation within the next five years will watch their friends gobble up the market".

ANALYSIS

SAFETY AT SEA

During World War 2 navies were quick to latch on to the advantages of radar to detect and home-on to enemy surface targets as well as to receive early warning of impending air attack. Radar could also be used as a navigation aid, the outlines of coasts and estuaries being made clearly visible in darkness or fog.

After the war marine radar was quickly introduced to merchant shipping. Its appeal was immediate for in-shore navigation and as an aid to collision avoidance.

Unhappily, early commercial marine radars were often built down to a price, shipowners being reluctant to indulge in what seemed an expensive luxury. Moreover, ships' navigators were inexperienced in the use of radar and often underestimated the limitations of what had been oversold as a solution to their problems.

The outcome of poor equipment reliability, failure to use it correctly, and over-reliance on this new wonder tool (with the result that visual look-outs became slack or non-existent) resulted in a series of spectacular and often tragic incidents. The radar-assisted collision became a standing though sick joke. This was rather unfair because although the radar-assisted collisions were well documented following courts of enquiry, nobody really knew how many potential collisions had in fact been avoided by radar.

Several attempts were made to improve marine radar performance and add facilities to make the navigator's task more simple. There were varying degrees of success in automating the radar and introducing prediction of a collision. Such sets were costly and generally fitted only to larger and expensive ships.

The microprocessor with its inexpensive yet powerful computing capacity has now produced an entirely new generation of marine radars providing comprehensive anti-collision facilities at an affordable price.

In this category is the Automatic Radar Plotting Aid (ARPA). By using several microprocessors they can keep the radar adjusted to optimum performance on every target whatever the target size and the conditions of rain-clutter or sea-clutter.

They can auto-track the movements of up to 20 other selected ships with their speeds and directions and warn the navigator when any target comes within a pre-set guard zone. They also allow the navigator to experiment with proposed manoeuvres to see how they would affect the situation before carrying them out, they will superimpose on the radar display a map of the approach to a port, and they monitor the whole system for faults.

The ARPA systems are to made a mandatory fit for all new ships of over 10,000 tons from July 1984 and retrofit on older vessels by January 1989.

Brian G. Peck

illicit telephones

With Government support, British Telecom is giving its customers new advice on the purchase and use of privately supplied attachments.

The message is: *Get the best use and value out of the telephone service. Avoid the risk of buying unauthorised instruments to connect to the public network.*

The Government's British Telecommunications Bill, now before Parliament, proposes certain changes, but Mr Peter Benton, Managing Director of British Telecom, stated in London recently: "We have a duty to tell customers that it is not the Government's intention to allow a free-for-all."

He said "The only equipment at present permitted is that certified by British Telecom as suitable for use as an attachment. Changes are proposed in this system, but the Government is as anxious as we are to ensure an orderly transition to the new arrangements. Regulations will still be necessary to ensure that the interests of customers are protected Only equipment which conforms to safety and technical standards established by a Government-approved body will be permissible."

John Chambers, of the BBC's Engineering Research Department, has won the American Institute of Electrical and Electronics Engineers (IEEE) "Outstanding Paper of 1980" award for his paper entitled "Enhanced UK Teletext Moves Towards Still Pictures".

Infrared intruder detection devices, components for TV night surveillance systems and pyroelectric fire alarm devices will all be on display on the Mullard stand at the "International Fire, Security and Safety Exhibition and Conference," Olympia, London, from April 21 to 24.

The postponement of the Audio, Video and TV Fair, which was to have been held at the National Exhibition Centre, at the beginning of May has just been announced.

Hitachi will start marketing VideoDisc players in the US in June. The players, based on the system developed by RCA, will retail for $499·95 (approx £230) and be built at Hitachi's Yokohama plant at the rate of 10,000 a month.

Hobbyists using Black & Decker "Workmate" portable workcentres will be interested to know that the 10 millionth to be manufactured was recently presented to Ron Hickman, the original designer.

Anglia Television is endowing a Chair in Electronics at the University of East Anglia, Norwich, It is expected that a professor of electronics will be appointed next year.

MAP for Success

The Government Microprocessor Applications Project (MAP) for British industry is enjoying continuing success. The free consultancy service had over 2,300 applications up to the end of last year of which more than 1,600 were approved with grants of up to £2,000 each.

New applications are running at a rate of 25 per week.

New Dish

British Telecom will start supplying customers with small dish satellite aerials for commercial trials this autumn.

To be supplied by Ferranti, the aerials will be used for testing new techniques, devices and for commercial trials in preparation for a new satellite communications service with Europe, planned to start in 1983.

As the service is aimed at closer links with Europe, who knows, perhaps the European Parliament would like to vote more funds to British Telecom on top of the recent £142 million donated by UK tax payers?

LOOK!

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.... the practical way.

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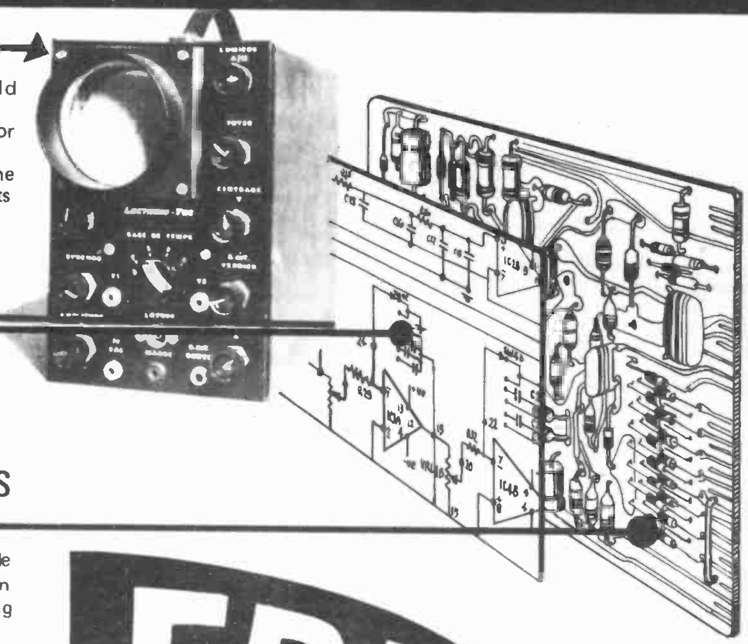
You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.

1. Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.



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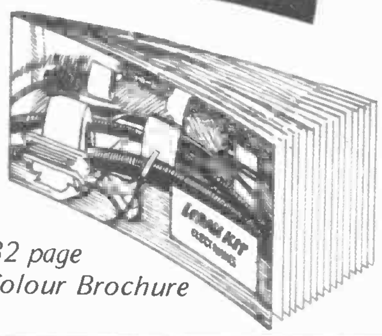
We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.

4. Free Gift.

All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

FREE



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RADIO WORLD

By Pat Hawker, G3VA

Break even!

So it will be 27MHz (legally) after all. But let us not rub the salt in too much or the Home Office RRD boys will think up a real joker to put into the technical specification for approved equipment. And despite what some of those who beat-the-gun are still saying, frequency-modulation is an entirely logical choice, providing virtually the same range as a.m. (though not as great as the equivalent power of s.s.b), need cost no more, and should generate far less interference.

Tests carried out by BBC Research Department in the 1960s showed clearly that domestic equipment is immune to local f.m. signals some 20-30dB stronger than a.m. signals.

Some manufacturers may be regretting the decision since it will be difficult for them to compete with the established Japanese firms already producing 27MHz equipment, both f.m. and a.m. But, for the enthusiasts, a 27MHz f.m. service should give them virtually everything they have asked for—except perhaps compatibility with some distant overseas CBers.

But then, not even in North America, has CB ever been intended for international communication; even if, in sunspot maxima years, 27MHz signals can wing their way across the oceans. Class B licensed amateurs feel they have a genuine grievance in that the RAE examination still limits them to speech operation on 144MHz and above, at least until they also pass a Morse test.

All cabled up

Those who have recently returned from visiting the USA tend to come back full of stories about the explosive growth of cable TV "subscription" services. For the payment of about $8 per month, the viewer receives not only the many network and independent broadcast transmissions available in the region, but also large numbers of extra channels carrying a variety of movie films and specialised programme and information services.

Some of the cable systems now being put in are designed to carry anything up to about 100 or so channels and the programmes are often distributed to the cable operators by means of geostationary satellites incorporating up to about 27 transponders.

Each of these transponders can carry one or (by using digital techniques) two or possibly even three programmes, capable of being picked up by the cable operators on fairly large, but inexpensive, dish aerials (viewers themselves can pick up these transmissions direct if they are prepared to spend about $5,000 for the 4GHz receivers and dishes). Names like Home Box Office and Ted Turner's super-satellite WTBS, Atlanta are becoming well-known throughout North America.

By the end of last year, well over 17 million American homes (approaching a quarter of the total) were linked to cable, and in Canada the percentage was even higher. The WTBS programmes, including the first-ever "all-news" TV service, is reaching some 10 million homes, thanks to the low cost of American satellite distribution circuits.

Since of the $8 monthly subscription charge, the average cable operator pays, to the programme makers, a copyright fee amounting to only about 3 cents per subscriber (less than the cost of mailing out the accounts) the cable systems have become big business—both for cable operators and for programme makers. The *New York Times* has described the scramble for local cable franchises as "the last great gold rush".

Yet, curiously, figures produced by the industry do present something of a paradox. For although American viewers seem keen on receiving very large numbers of channels, and willingly pay the monthly subscriptions (of course they do not have any TV licence to pay for unlike most European viewers), they tend on the whole to make surprisingly little use of these extra channels; ratings of the Network shows have on average declined remarkable little—and this has been largely offset by the still growing number of TV homes.

And even with so many channels, it appears that British viewers still tend to spend more time, on average, glued to the box. Perhaps the American viewers find it enormously difficult to decide which of all those channels they want to watch—or reach a consensus family decision.

Very h.f. extraordinary!

Radio amateurs are continuing to uncover some remarkable facets of long-distance radio propagation at v.h.f. On February 16, the Greek amateur SV1DH in Athens heard signals on both 50 and 144MHz coming from Zimbabwe (Rhodesia) and at the same time was able to receive for the first time a South African amateur beacon station on 50MHz—clearly all remarkable but not entirely unexpected examples of "transequatorial" propagation.

But wait, there are further twists to this feat—for the Greek amateur discovered that these signals were audible only when his beam aerial was pointing towards the north!

This would suggest that the signals were coming via the "long path" from southern Africa, passing fairly close to both the South and North Poles while almost certainly entrapped between ionospheric layers: possibly the most remarkable instance of v.h.f. chordal hop propagation yet recorded.

What is more, on the same day, amateur stations in Ascension Island (ZD8TC) and Puerto Rico (KP4EOR) spanned the South Atlantic on 144 MHz, apparently by some form of East/West transequatorial propagation.

Too-complex weapon systems

For several decades, the industry has been fighting against a common belief that electronics equipment is often unreliable, difficult to use and difficult to repair. The position today is that very often in electro-mechanical equipment, such as office copiers, computer peripherals and the like, it is the mechanical parts that give the most trouble.

Semiconductors, large-scale integration, low operating voltages and less heat have all helped to minimise the number of true electronic faults. On average, even a complex colour TV set is unlikely to require servicing more than about once a year, often less, compared to an average of around four to six visits per year in the early days of colour (it was said in the very early days of American colour that the service technician became virtually a house guest).

But all is not plain sailing in some areas: and the prime reason for this is the staggering complexity of some of the more advanced systems.

In the USA, "horror story" reports have been issued recently about some of the latest weapons systems that seem to have become too complex for the military to use effectively or to maintain in good shape.

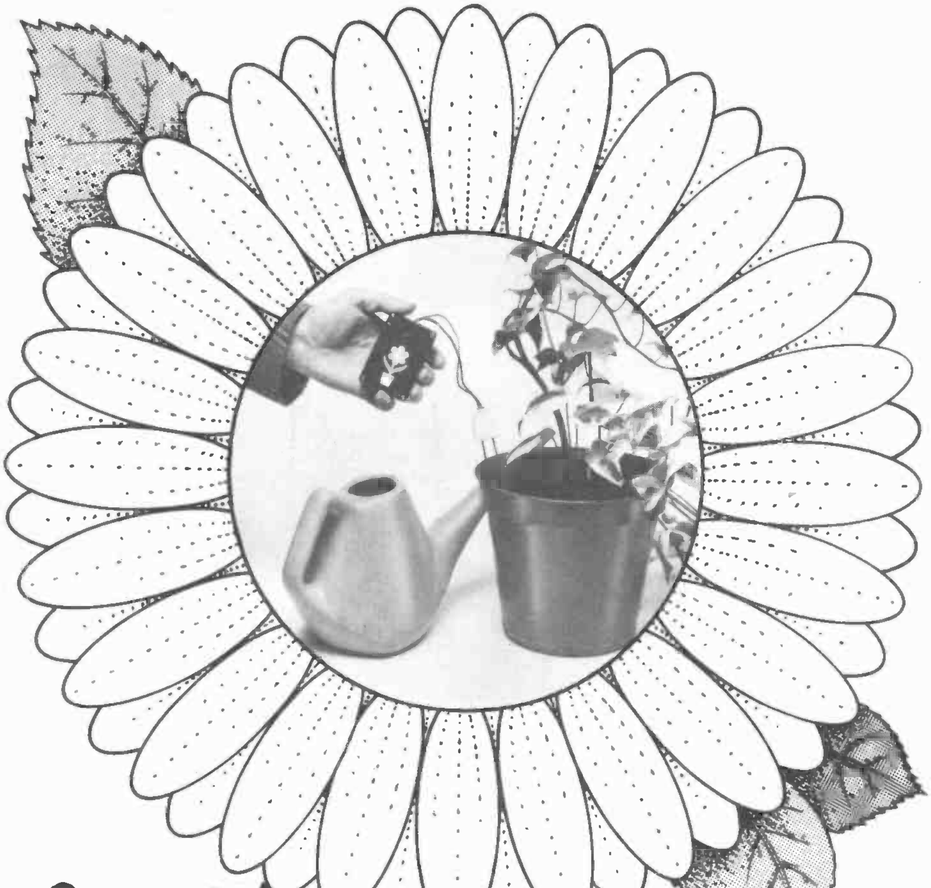
"Down time" (the time during which equipment is non-operational) can be alarmingly high and performance in field conditions is often very different from what can be achieved by highly skilled engineers during carefully staged demonstrations—and does not take into account combat stress, fatigue and the fact that service users need so many other skills that they cannot be expected to acquire detailed technical knowledge of the equipment.

Automatic test equipment, nowadays, is often supposed to take all the hassles out of maintaining "modular" equipment—but the American reports show that the ATEs similarly often suffer from excessive down-time and, even when functional, quite often fail to recognise and identify faults in the equipment they are meant to check.

Small is beautiful

The answer to over-automated, over-complex technology can be found in the writings of that great advocate of alternative technology, the late E. F. Schumacher of "Small is beautiful" fame. He wrote: *"Any third-rate engineer can make a complicated apparatus more complicated, but it takes a touch of genius to find one's way back to basic principles . . . complexity is a kind of disease . . . the more complex a thing is the more it tends to break down and you can't repair it yourself . . . is that a price worth paying so you don't have to turn a handle?"*

And the Americans themselves have a telling expression: "KISS—keep it simple, stupid!"



Soil Moisture Indicator

By J. Blundell

Many moisture detectors give a vague indication of moisture content by either a varying audio or visual output, and as such it is difficult to determine whether or not the plant requires more or less moisture.

TIMER CHIP

This circuit however overcomes the above disadvantages and a full circuit diagram is shown in Fig. 1. The 555 timer chip, IC1, is operated in the astable mode running at a frequency of approximately 2Hz. This is determined by R2, R3, and C1. The two probes are connected to pin 4 of IC1 and the 0V rail of the supply.

As pin 4 is the reset pin, a low (0V) potential applied to this pin will reset the circuit thereby ceasing oscillations. However a potential just greater than that required to reset the circuit will either cease oscillations, but still allow the l.e.d. to glow, or enable the circuit to function normally, that is to oscillate.

Therefore the circuit is ideally suited as a soil moisture indicator.

RESISTANCE

When the probes are inserted into the soil the resistance between them and hence between pin 4 of IC1 and 0V will be in one of three possible states. If the resistance is high, the l.e.d. will flash on and off as IC1 oscillates.

If the resistance drops, the l.e.d. will either stop flashing altogether or remain on all the time. These three states indicate the moisture content of the soil and may be summarised as follows:

l.e.d. flashes—soil dry
l.e.d. glows—soil moist
l.e.d. off — soil wet

Therefore in use, the plant should be watered only when the l.e.d. flashes or glows and never when the l.e.d. is extinguished.

POWER

The circuit is powered by a 9V PP3 battery and current consumption is in the region of 15mA when used. This is reduced to about 6mA when the soil is wet and D1 is not illuminated giving an extremely long battery life, typically several months.

STRIPBOARD

The prototype model was built on a small piece of 0·1 inch matrix stripboard size 6 strips by 16 holes. The breaks on the underside are made first.

The resistors and capacitors can be mounted next followed by the i.c.

A socket can be used for this if preferred although it should be a low profile type so as to fit comfortably onto the circuit board. The capacitor

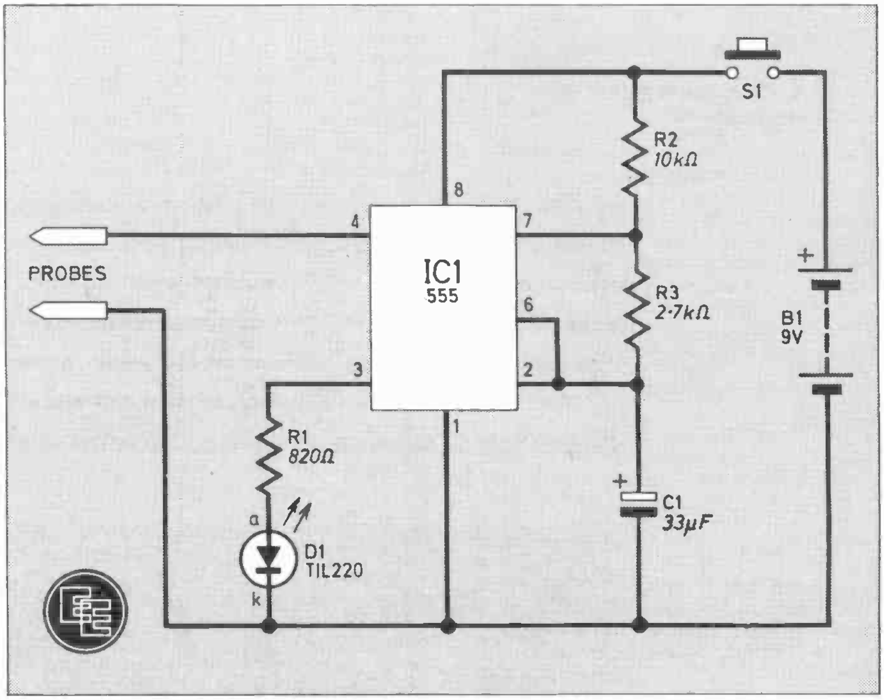
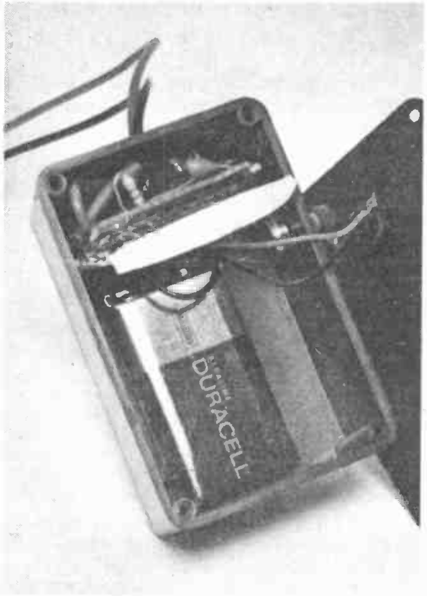


Fig. 1. Complete circuit diagram of the Soil Moisture Indicator.



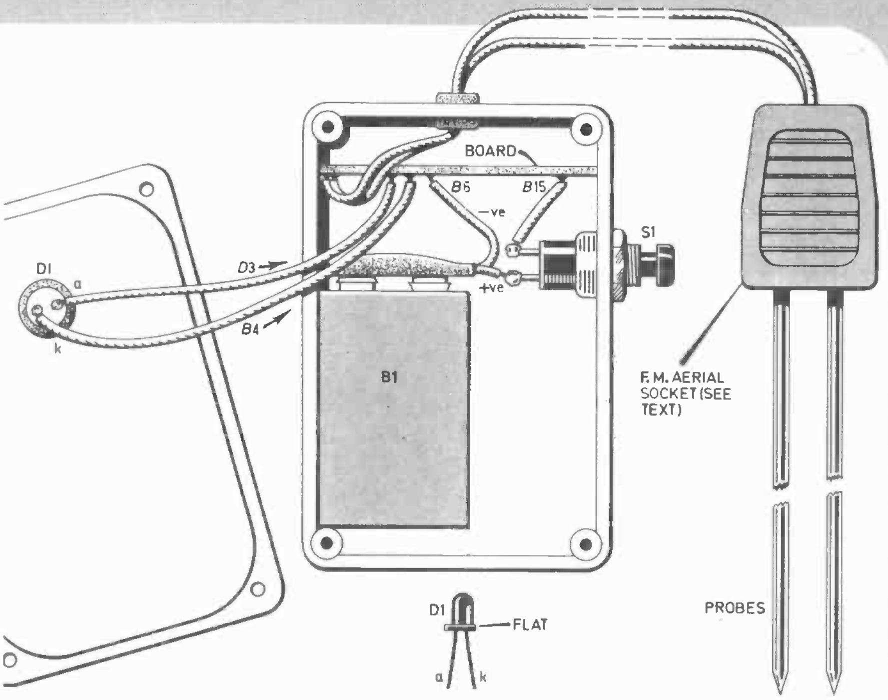


Fig. 3. Interior layout of the case and off-board interconnections. Make sure that the battery is positioned such that it does not foul the l.e.d. when the lid is screwed down.

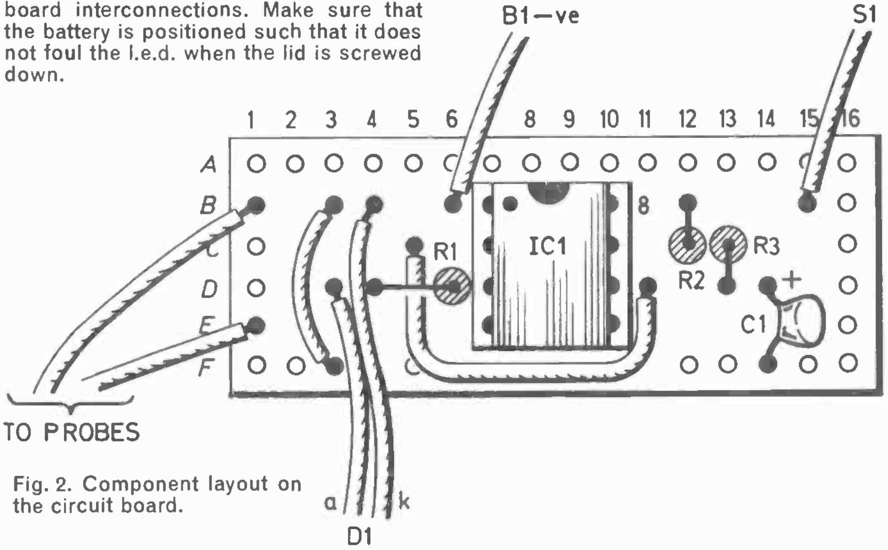
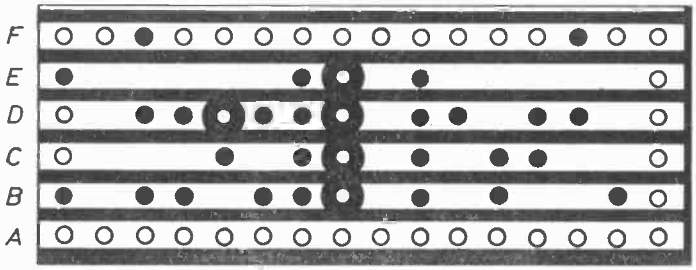
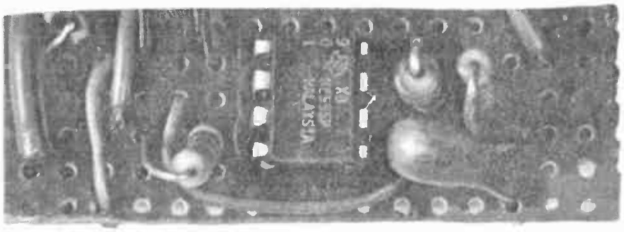


Fig. 2. Component layout on the circuit board.





Photograph right shows top view of prototype circuit board.

Soil Moisture Indicator

See **Shop Talk** page 334

Resistors

R1	820Ω
R2	10kΩ
R3	2·7kΩ

All $\frac{1}{4}$W carbon ±5%

Capacitor

C1	33μF 16V tantalum bead

Semiconductors

IC1	555 timer i.c.
D1	TIL220 red l.e.d.

Miscellaneous

S1	push-to-make, release-to-break switch
B1	9V, PP3 type

Stripboard: 0·1 inch matrix, size 6 strips × 16 holes; plastics case, size 72 × 47 × 26mm; battery clip; flexible wire for probes; brass rod, 2·5mm diameter; f.m. aerial socket for probes (see text).

The completed Soil Moisture Indicator showing interior of case and the two probes mounted in an f.m. aerial socket.

C1 is a tantalum bead type and is necessary because of the restricted space on the board. The full layout is shown in Fig. 2.

CASE

The circuit board together with the battery, l.e.d. and switch are all mounted in a small plastics box size 72×47×26mm. This is clearly shown in Fig. 3. As this particular case does not have moulded slots on the interior the circuit board must be held in place with "superglue."

Of course all off-board connections must be made before the board is finally glued in position. The wires leading out to the probes pass through a hole in the side of the case which has a grommet fitted. It would be a good idea to make these wires out of extra-flexible wire such as that used for the test instrument leads as these will be less prone to breakage in use.

Connections to S1 should pose no problems. Take care when connecting the diode to the circuit board, refer to the lead polarity diagram in Fig. 3.

PROBES

The probes themselves are made out of two 100mm lengths of 2·5mm brass rod. These are mounted in a standard f.m. aerial socket. This socket can be prized open using a screwdriver and the rods inserted in place. The wires are then soldered directly onto the top of the rods.

WET OR DRY

To use the unit push the probes deep into the soil. Press the button, S1, and the l.e.d. will light up or not according to the moisture present. Only if you get no response from the l.e.d. should you water the plant.

The prototype has been in constant use for over a wide range of plants for the past 12 months with absolutely no problems whatsoever. Prior to the building of the unit quite a number of plants were lost due simply to overwatering.

Many people water their plants when the top of the soil feels dry, not realising that it is not the top of the soil that should be moist but the soil at root level.

To test if the unit is working prior to insertion in the soil, press S1 whereupon the l.e.d. should flash. ⌑

BOOK REVIEWS

TEXAS INSTRUMENTS LEARNING CENTER
UNDERSTANDING SERIES
Understanding Calculator Math
Authors Ralph A. Oliva, et al
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Understanding Solid State Electronics
Authors William E. Hafford, Gene McWhorter, et al
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Understanding Digital Electronics
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Understanding Communications Systems
Author Don L. Cannon and Gerald Luecke
ISBN 0 89512 035 6
Understanding Microprocessors
Authors Don L. Cannon and Gerald Luecke
ISBN 0 89512 021 6
Price £3·50
Size 210 × 132mm, approx 280 pages each
Publisher Texas Instruments Inc.

THE YEAR is 1840. You're on horseback and you are travelling through this wide plain forming a valley between high hills on each side. Scanning the scene you notice large puffs of smoke rising from one of the highest points on one of the hills. . . .

No, it isn't the intro to a spaghetti western but the start of the first chapter of the Understanding Communications Systems book in this set from Texas Instruments.

You may ask, what have the wide open prairies got to do with modern electronics? More than you would suppose, because smoke-signals, like it or not, are a primitive form of communications system and are used here to illustrate basic principles before passing on to modern concepts.

In fact this low-key, humorous approach is used throughout the series often to great effect and it makes the whole business of learning so much more interesting.

Best of the lot in terms of graphics and pretty pictures is the Calculator Math book. You could be forgiven for thinking it was a superior sort of operator's manual for the Texas TI-30 calculator as all the key-strokes refer to this device. However, with a bit of thought you can adapt things to your own two pound Wooley's Wonder!

The rest of the books in the series are a little more serious in approach although an opportunity to drop in the odd cartoon is rarely overlooked.

Understanding Solid State Electronics is adapted from a 12-hour videotape course and was "created for the reader who wants to understand electronics but can't devote years to study". It concentrates very largely on practical applications rather than the finer points of theory and includes sections on virtually all fields of electronics.

A self-test quiz appears at the end of each chapter so you can see if you really did take in all the points you have just read through. This feature also appears in the other three books.

Understanding Digital Electronics, Communications Systems, and Microprocessors all demand a bit more background knowledge and a modicum of patience in sorting out the American terminology. In most cases this is little more than a minor irritation—after all didn't the Americans invent solid state electronics way back in 1948?

Communications systems are more of a problem because virtually everything from telephones to TV runs on different standards to the UK so this may limit the usefulness of this particular volume. Still, this doesn't really detract from what is an entertaining and informative series of books.

SED

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

DL1000K

This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.00**

DLZ1000K

A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**

Optional Opto Input
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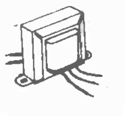
MINI TRANSFORMERS



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0·2″ Green	12p
0·2″ Yellow	12p
0·2″ clips	3p
Rectangular Red	16p
Rectangular Green	17p
Rectangular Yellow	17p
Flat Face rectangular, Triangular, Arrowhead, Square	
Red	17p
Green	20p
Rec. Yellow	20p

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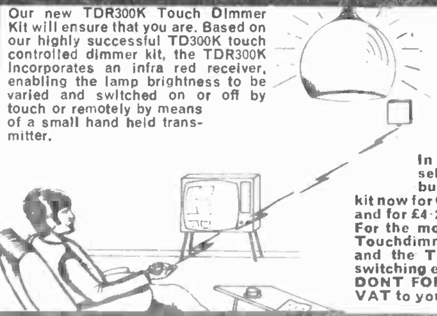
Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter.



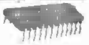
The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.

In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY £14·30 for the dimmer unit and for £4·20 for the transmitter.

For the more athletic of you, the TD300K Touchdimmer kit is still available at £6·50 and the TDE/K Extension kit, for 2-way switching etc., is £2·00.

DONT FORGET to add 50p P&P and 15% VAT to your total purchase.

INTEGRATED CIRCUITS



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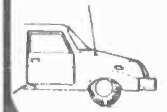
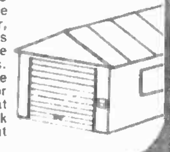
EVERY DOOR SHOULD HAVE ONE

As featured in E.E. May '81

Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered 8 digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code. The complete kit measures 7 × 6 × 3 cms. deep and consumes a mere 40mA when not in use and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for **ONLY £10·50** and think about all the keys you can lose or forget without ever locking yourself out.



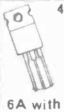


24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to IkW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0·5″ LED display, mains supply, display drivers, switches, LEDs triac, PCBs & full instructions.

CT1000K Basic Kit	£14·90
CT1000KB with white box (56/131 × 71mm)	£17·40
Ready Built	£22·50

TRIACS



400V Plastic Case (Texas)	
3A TIC206D	49p
8A TIC226D	58p
8A TIC225D Sensitive gate	66p
12A TIC236D	85p
16A TIC246D	95p
25A TIC263D	190p
6A with trigger Q4006LT	80p
8A isolated tab TXAL226B	65p
Diac	18p

CMOS

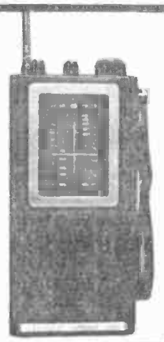
4000	17p	4017	70p	4050	40p
4001	18p	4019	42p	4060	£1·08
4002	18p	4023	22p	4069	19p
4007	17p	4025	21p	4070	19p
4011	19p	4026	£1·30	4071	18p
4012	17p	4027	40p	4077	26p
4013	38p	4028	50p	4081	20p
4015	75p	4040	80p	4093	54p
4016	35p	4049	38p	4501	24p

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P and 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1·50 (Europe) £4 (elsewhere) for P&P.
Send sae for price list and with all enquiries. Callers welcome 9.30-5.00 (Mon-Fri) 10·00-4·00 (Sat.)

TK Electronics

(EE), 11 BOSTON ROAD,
LONDON W7 3SJ. TEL. 01-579 9794

MULTIBAND RECEIVER WITH 27MHz



Frequency Range:

AIR	108–145 MHz
PB	145–176 MHz
WB	162·5 MHz
TV_1	54–87 MHz
FM	88–108 MHz
CB	1–40 Channels

Output 280mW ● 6v D.C. ● 3″ 8ohm Spk. 24″ Telescopic Ant ● I.F. 465KHz CB 10·7 MHz others.

£21.95 Inclusive

N.I.C

UNIT 3, 61 BROAD LANE, LONDON N.15 4DJ
Day 01-808 0377; Eve 01-889 9736

(EE)

OHIO SCIENTIFIC COMPUTERS new series 2 Challenger CIP Cheapo 4K version £202. Ohio 8K version £259. Special offer:-Superboard 3 with free power supply and modulator kit and guard band kit (gives 32 × 32 extended display, 1200 and 300 baud tape speeds, 50% higher computing speed and 50Hz conversion) £159 the lot. Guard band kit also sold separately £10. 4K extra ram £16·95. Case £27. Cassette recorder £17. Cegmon improved monitor rom £29·50. Assembler/Editor £25. Word processor £10. Display expansion kit 30 lines × 54 characters for superboard TWO £20.

PRINTERS supplied with free interface and word processor for Superboard and UK101. Seikosha GP80 £225. Oki Microline 80 £329. Base 2 800MST £299.

***SINCLAIR PRODUCTS** only are post free. SC110 oscilloscope £139, adaptor £4, rechargeable batteries £7·95, x1 probe £8·05, x10 probe £8·86, carry case £8·80. pfm200 £54·50, adaptor £4, case £1·73, connector kit £11·27. PDM35 £32·95, adaptor £4, case £1·73. dm235 £56·50, dm350 £78·50, dm450 £107·95, adaptor £4, case £8·80, rechargeable batts £7·95. Microvision TV £69. Adaptor £6·88.

MEMORIES 2114 450ns £2·15. 4116 200ns £2·83. 4027 £1·30. All low current.

***BATTERY ELIMINATOR KITS** 100ma radio types with press studs 9v £1·79, 9+9v £2·50. Stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma £3·12, 1 Amp £8·30. Stabilized power kits 2-18v 100ma £3·12, 1-30v 1A £8·50, 1-30V 2A £15·30. TTL and computer supplies 5V stabilized 1½A £9, 3A £14, 6A £20. 12v car convertor 6/7½/9v 1A £1·62.

***T-DEC AND S-DEC BREADBOARDS** s-dec £3·79. t-dec £4·59. exp4b £2·64. exp300 £6·61.

***BATTERY ELIMINATORS** 3-way type 6/7½/9v 300ma £3·50. 100ma radio types with press studs 9v £4·95, 9+9v £6·25. Car convertor 12v input, output 4½/6/7½/9v 800ma £3·04.

***TV GAMES** AY-3-8600 + kit £12·98. AY-3-8550 + kit £9·26.

SWANLEY ELECTRONICS
Dept. EE, 32 Goldsel Rd., Swanley, Kent

Post 45p extra. Add VAT except on sections marked *. Lists 27p post free. Official and overseas orders welcome.

TOP PRIORITY for every constructor...

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- About 2,000 items clearly listed.
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LETTERS

Over Complex?

I am surprised at the sophistication of some of the circuits published in E.E. these days. I refer in particular to the capacitor discharge unit, *Model Railway Points Controller* published recently. When one considers the requirements of the unit all that appears to be required is a means of discharging the capacitor without putting a short circuit across the supply, and this can be accomplished very simply by a series resistor in the supply line. The size of the resistor, of course, depends on the optimum load on the supply, and of course, on the acceptable delay in reaching full charge on the capacitor.

I have been using a simple circuit for some time where a capacitor of 5000µF charges through a resistor of 220Ω. Charging time is approximately two seconds. This circuit can operate four points simultaneously. The charging current is limited to 75mA on a 16V uncontrolled d.c. supply and of course this is the load taken from the supply when the points are operated.

The only sophistication I have found acceptable is the insertion of two l.e.ds, with their appropriate series resistors. One, a red one, is put in parallel with the series resistor and glows whilst the capacitor is charging, indicating "not ready". The other, a green one, is connected across the capacitor and glows with increasing brilliance until the fully charged state is reached indicating "ready". The l.e.d. resistors of course must be of different values, the green one being larger than the red one.

N. Bushell,
Pantmawr, Cardiff

The "sophistication" of our circuit allows rapid successive operation of a number of point motors. Mr. Bushell's circuit requires a two-second interval between successive operations. Also, our circuit only applies a short duration pulse per switch operation irrespective of the length of time that the switch is held on whereas Mr. Bushell's circuit applies a similar pulse, but also contains a d.c. component which is applied to the point motor for as long as the switch is held on. However, this is small, 75mA, and is unlikely to damage the point motor. Mr. Bushell's circuit requires a compromise between recharge time and standing current in the point motor. If this order of delay and standing current is acceptable then the unit will be that much cheaper and easier to build.

Blowing a Fuse

I have read the article about the fuse (*In My Class* by T. R. de Vaux-Balbirnie). Good information, but my problem is a little bit different. I have a stereo amplifier. It is a good amplifier but it eats fuses.

It is always the fuse for the loudspeakers that blows. The original fuse was a 400mA (quick blow). I changed it to a 500mA anti-surge, but it didn't help. What can I do? I know I have the right impedance on the speakers, and I don't touch the speaker selector, and the volume control is always point zero when I switch it on. What's wrong, and what can I do to make it alright again?

D. Agnani,
Dalby, Sweden

Are you certain that your speakers have the correct impedance and that there is no possibility of an intermittent short circuit between speaker leads or between one lead and a metal part of the amplifier. Short circuits like this frequently occur in plugs and sockets where twisting of leads is possible.

We suggest a double-check by borrowing some suitable speakers from a friend. If the fault persisted then substitute a fuse of value 1A—firstly "quick-blow" then, if necessary "anti-surge". Do not use a fuse with a higher rating than this without checking with the manufacturer since the output stage of the amplifier could be damaged.

No Reply

I am writing to you on account of seeing Mr. Andrew Lord's letter in the February issue of EVERYDAY ELECTRONICS in which he said he could not locate the ZN458T reference diode. I also had problems in obtaining the components. I wrote to the address you gave in the February issue and also in an earlier one enclosing an S.A.E. but even though I wrote quite a few times I still have received no reply.

So, I did a bit of investigating around other sources and eventually found a stockist, the address of whom is given below. Why I received no reply from the address you gave us I do not know. I thought that the address of the firm to which I have managed to obtain the components may be useful to other readers: Davian Electronics, 13 Deepdale Avenue, Royton, Oldham, Lancs, OLX 6XD

B. Harris,
Ladywood, Birmingham

Excellent Idea

While reading the February 1981 issue of your magazine I noticed a new feature called *Circuit Exchange*.

This I thought was an excellent idea, but reading deeper into the "Ultrasonic Transmitter-Receiver" article submitted by K. K. Gandaa, I found the equation of the resonant frequency of a parallel tuned circuit as:

$$f=2\pi\sqrt{L1 \times C2}.$$

Should this not read:

$$f=\frac{1}{2\pi\sqrt{L1 \times C2}}$$

I have been interested in electronics for several years now and EE was the first electronics magazine I bought regularly. Since my first issue of EE I have left school and gone into the electronics industry with a well known radar company.

Thanks EE for many projects, ideas and inspirations.

K. Harris,
Walton-on-Thames, Surrey

You are quite correct, of course, concerning the formula given in the Circuit Exchange *article. I apologise for this mistake.*

It is always very gratifying to hear from readers (or may be past readers) to learn of the value our contents has been to them in their early days in electronics.—Ed.

Neutralising Solution

With reference to the "P.C.B. Solution" letter in your March issue written by J. G. Burch from Southampton. I would point out that it is illegal to dispose of acids and corrosive liquids into domestic drains, even if they are diluted.

Being a photographer (amateur) who processes his own colour prints, I am aware that the bleaching solutions have to be neutralised before being disposed of. The Ilford Cibachrome System supplies a neutralizer in the processing kit, and it is also available separately at a modest price of about £1·05 which will deal with 5 litres of corrosive solution.

The other substance I believe you could use is ordinary bi-carb. Place just a spoonful in a plastic container large enough to take the used solution, pour the ferric chloride into it and then pour it away.

K. H. Bacon,
South Ockendon, Essex

Disposing of chemical wastes is always a problem but in this case we stand by what we said earlier that it is in order to dispose of highly diluted ferric chloride down what is known as the "foul" drain, that is, the drain into which sink and toilet waste flows. Surface drains, that is drains that dispose of rain water usually found by the sides of roads and paths must not be used.

As to neutralisers, it would be very unwise to mix undiluted ferric chloride with an unknown chemical or even sodium bicarbonate. The resulting chemical reaction would be unpredictable and may well be rather more violent than expected. We do not recommend this course of action.

Who-was-First

I read the article *I.C.s. Explained* in your February 1981 edition and made the "Who-was-first monitor". However, I found that the indicators took so much power from the outputs (IC2 pins 3 and 4) that there was no power left to power gates "b" and "d" causing malfunctions.

The solution was to connect two 180 ohm resistors, one in each of the leads of the l.e.ds, to reduce the current consumed.

I am twelve years old and probably one of your youngest readers and I much prefer matrix-board and Veroboard designs to p.c.b. designs.

Wishing you great success,

Philip Summers,
Haywards Heath, Sussex

Now that C.B.'s here

I breathed a sigh of relief when the Home Office at last announced that they would legalise C.B. by about August, on 27MHz FM. But at the same time I couldn't help wondering what we are letting ourselves in for.

Although I don't own a "rig" myself (yet), I live in an area where there are at least 200 in a 10 mile radius and many of these are finding their way to school children and are being extensively abused. Let's just hope that the Home Office will propose a licensing system and perhaps even a minimum age of about 16.

S. A. Courtney,
Chipping Campden, Glos.

ADVANCE ADVERTISING BARGAINS LIST!

Our FREE Bi-monthly list gives details of bargains arriving or just arrived – often bargains which sell out before our advertisement can appear – it's an interesting list and it's free – just send S.A.E. Below are a few of the Bargains still available.

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.

FIVE UNUSUAL SWITCHES

For inventors, experimenters, service engineers, students or in fact anyone interested in making electrical gadgets. The parcel contains: – delay switch – motor driven switch – two-way and off switch – polarity changing switch – and humidity switch. Our regular price for these switches bought separately is over £10, but this month you can have the 5 for **£2.50.**

MAINS OPERATED CLOCKS

Where can you buy a precision mains operated electric clock for only £1.25? The answer is from us, but you must be prepared to buy 8 at a time. Made for famous cookers, these are for normal 250 volt 50Hz mains and they still have the 25 amp timed on and off switches. They are all brand new and still in original manufacturer's packing. Don't miss this offer. Send **£10** for 8 today, or **£2.00** for sample one.

275 WATT TRANSFORMER

With normal mains primary and two secondary windings. The major one being 26 volts at 10 amps, the other being 12 volts at 1 amp. Extremely well made transformer impregnated and varnished with a substantial terminal plate on the top. Made for surface mounting with perforated clamps for fixing along any edge. **£8.50** + £2.00 post.

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.

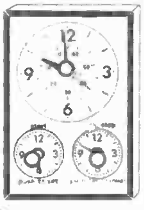
CLOCKWORK MOTOR

Precision movement with a balance wheel and main spring, goes for 1 hour at one winding – can be used to operate models, delay switches, etc. etc. **75p.**

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.

MUGGER DETERRENT

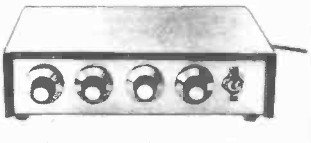
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. **£2.50** complete kit.



TIME SWITCH BARGAIN

Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. **£2.50.**

3 CHANNEL SOUND TO LIGHT KIT

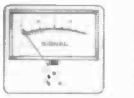


Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio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

REMOTE CONTROL for Sound to Light Systems (ours or any other circuit) saves connecting to speaker or amp – kit consists of 1 watt amplifier, crystal mike, case, sundries and diagram. Price **£3.95.**

LIGHT EXPANDER AND LATCH for Sound to Light, enables 3,000 watts of lighting to be controlled by single channel or each channel and enables lights to be latched on. Kit consists of latching relay, control switch, case, sundries and diagram. Price **£4.25.**

PANEL METERS "AMSTRAD"



We have two types, both approx 40mm (1 7/8" square) with modern clear perspex type front. Both have sensitivity 0 – 100 uA, one has a pointer in the centre and the scale calibrated 3 - 2 - 1 - 0 - 1 - 2 - 3. The other has the pointer in the normal position and the scale reads 0 - 5. The interesting feature of these meters is that if illuminated from behind, the scale and pointer seem to fluoresce, giving a very pleasing effect. Special price of **£1.75** each.

THIS MONTH'S SNIP

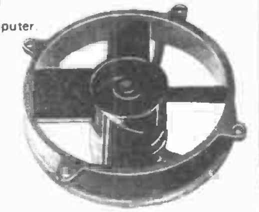
PUSH BUTTON G.P.O. TELEPHONES

For £25 (quickly recoverable in saved time) you will improve your image and efficiency with this push button desk telephone, ex. G.P.O. thoroughly reconditioned, can be yours in a few days, if you send today.

EXTRACTOR FAN

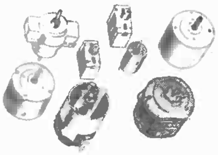
Mains operated – ex. Computer.

5" Woods extractor
£5.75 Post £1.00.
6" Woods extractor
£6.90 Post £1.25
6" Plannair extractor
£7.50 Post £1.00
4" x 4" Muffin 115v.
£4.50 Post 50p.
4" x 4" Muffin 230v.
£5.75 Post 50p.

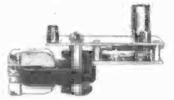


8 POWERFUL BATTERY MOTORS

For models, Meccanos, drills, remote control planes, boats, etc. **£2.50.**



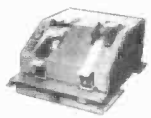
SPIT MOTORS



These are powerful mains operated induction motors with gear box attached. The final shaft is a ½" rod with square hole, so you have alternative couplingmethods – final speed is approx. 5 revs/min, price **£5.50.** – Similar motors with final speeds of 80, 100, 160 & 200r.p.m. same price.

TAPE PUNCH & READER

For controlling machine tools, etc, motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. **£17.50** pair. Post £3.00.



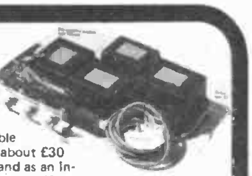
MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale. 11 instant range measures:

DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 – 100 mA.

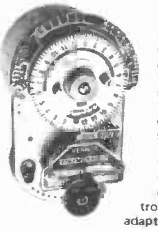
Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only **£6.75 + 50p** post and insurance.

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 eliptical 8"x5" speakers to match this amplifier.

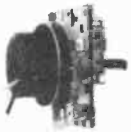


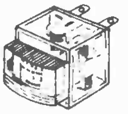
VENNER TIME SWITCH

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.**





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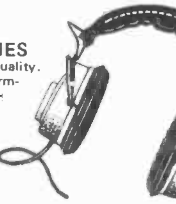

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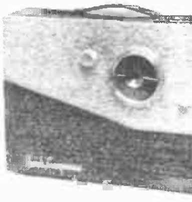

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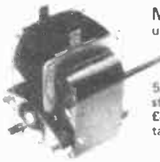

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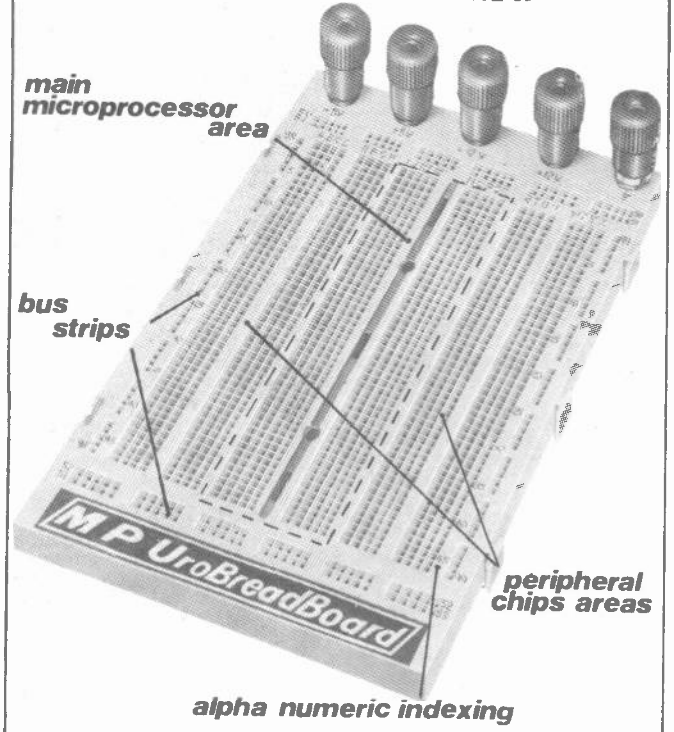

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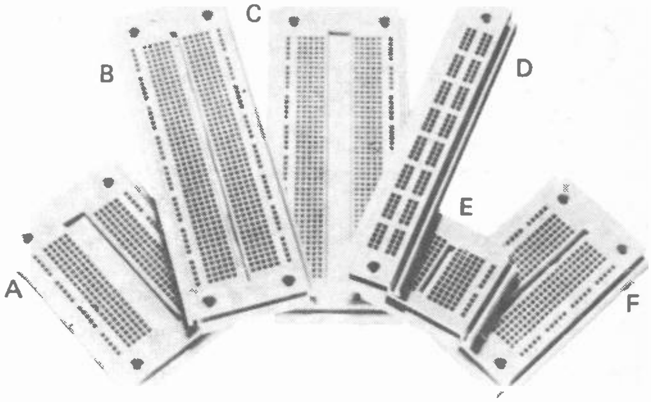

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Semiconductor News

NEW MICROCOMPUTER FAMILY

Microcomputer technology never stands still and one of the latest contenders in this field is the **NSC800** family from **National Semiconductor.** At present this comprises just three chips—a central processor, RAM-input/output-timer, and ROM-input/output. Additional memory and other peripheral chips are likely to be announced in the near future.

Design of the NSC800 has been greatly influenced by the popular 8085 and Z80 families and it has the added advantage of being manufactured by a CMOS process exclusive to the company. On average the NSC800 will require only half the power of comparable NMOS devices and will operate from a wide range of supply voltages.

Looking more closely we can see that the central processor, designated NSC800, is an 8-bit device with a multiplexed address/data bus and provides on-chip clock generation, interrupt capability and dynamic memory refresh control.

The instruction set runs to 158 commands and two different operating speeds are available, 2·5MHz and 4MHz.

The RAM device, designated NSC810, combines 128 bytes of memory with 22 individually programmable input/output lines partitioned into two 8-bit ports and one 6-bit port. Not content with this, the company have even managed to cram two 16-bit programmable timers onto the chip which can be operated in one of six modes.

The ROM i.c. designated NSC830, is a slightly less exotic affair although it still contains 2K bytes of mask programmable read only memory as well as 20 individually programmable input/output lines.

Putting the system together provides a powerful processing system which at the same time will only consume 100mW when operated at 5V. The makers claim that this reduction in power consumption "makes the NSC800 a natural choice for many applications especially those requiring a battery power supply."

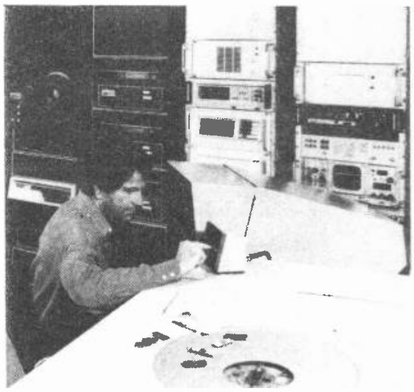
One of the major factors influencing that choice will be that of cost. Even with volume production the central processor alone will cost at least four times as much as a more conventional device.

SEMICONDUCTOR TEST SYSTEM

Before any new i.c. is released onto the market and indeed when it is in production, testing is all important. However, with the growing complexity of LSI and VLSI chips this requires rather more than a few voltage checks with a multimeter.

To meet this challenge **Tektronix** have just released their **S-3275** test system, aimed primarily at the manufacturer and design engineer.

The list of facilities is impressive and offers a wide range of test options but the one feature that makes the whole system work at all is the system software. It is known as Tektest III, version IV and is an English-like self-documenting language. All graphics generated can be easily converted to hard copy form and the networking option allows the system to be interfaced with any large computer.



DISPLAY DRIVERS

A new range of display drivers has been announced by **OKI Electronic Industries.** These are designed to interface directly between the output port of a microcomputer and seven-segment displays and turn the BCD code into a hexidecimal display.

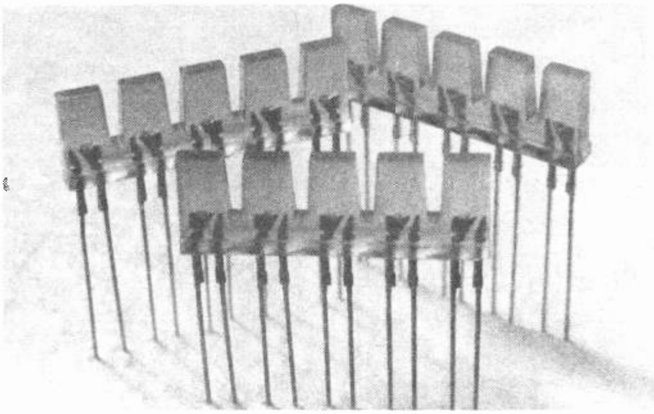
LOW NOISE AMPLIFIER

In low power amplifiers, noise and reliability of construction are always important, especially with r.f. circuits. A new integrated circuit from **Plessey**, known as the **SL560C**, provides 35dB gain at 75MHz bandwidth or 14dB at 300MHz bandwidth yet still manages a noise figure of less than 2dB.

The device is made up of three high performance transistors and associated components encapsulated in an 8-pin package. This circuit configuration together with many connection points, allows maximum flexibility with a minimum number of external components.

It can be used in common base or common emitter mode or as a 50 ohm line driver and will work with a supply voltage anywhere between 2-15V depending on the circuit configuration.

Several devices can be cascaded together and three SL560's will provide a gain greater than 40dB over a 300MHz bandwidth when used with a 9V supply.



L.E.D. ARRAY

L.E.D. displays are ten-a-penny these days but providing an array for such things as signal level indicators or vehicle instrumentation is rather more of a challenge.

A new range of l.e.d.s from **Impectron** has been designed to overcome this problem. The **GL series** is available in single form or straight-line arrays containing five or six elements each with a rectangular light emitting face.

The series offers a choice of three colours—red, yellow and green—and one array in the range features four elements in green and two in red. This is very useful for such items as VU meters or level indication in process control circuitry.

LITHIUM SUPER-BATTERY

One of the first attractions of semiconductor equipment was its portability and low current consumption. Unfortunately providing even this small amount of energy from an acceptable package has often posed something of a problem. Various solutions have been tried, but the most promising appears to be a new lithium/sulphur dioxide cell manufactured and marketed by **Vidor Industrial Batteries.**

Compared with other cells, this new device, developed from an American design, has a higher operating voltage (2·8V), higher energy density (up to 30 times greater than for an equivalent carbon/zinc cell), operating temperature range from −55 to 70 degrees Celsius, and ten-year shelf life.

In short this new cell, or "Eternacell" as it is called, is a very high energy, non-rechargeable primary cell designed to replace conventional dry battery systems. Cell designs are available in a variety of sizes from 0·5Ah up to 30Ah and versions are available to harmonise with standard IEC and BS specifications for zinc/carbon cells. Custom built designs can also be undertaken.

Unfortunately, these batteries are only available to industrial and military users but already their advantages are being felt.

Typical of the many applications is a new laser binocular for the army. Conventional battery packs are a back-breaking 5½kg in weight. The use of Eternacells brings this down to a more manageable 2kg.

Of course this power/weight advantage doesn't come free and the new cells cost roughly six times more than their conventional counterparts in terms of their price per watt-hour.

CIRCUIT EXCHANGE

THREE GAMES FOR A SUMMER FETE

In June last year we used the 555 timer and CD4017BE in a game at a summer fete. The circuit was similar to that given in your *Live Wire Game* (December 1980) except:

(a) We did not have the buzzer circuit.
(b) Instead of nine lives we used four lives with the l.e.d.s in series as shown in Fig. 1.

When the circuit was turned on four l.e.d.s were on. Each time the eye touched the wire, number of l.e.d.s on was reduced by one and the game finished when all four l.e.d.s were off.

The advantage of this circuit is that number of l.e.d.s on indicates lives available.

We used the 555 and CD4017BE for two more games and in both of these the 555 was used as an astable vibrator.

Fig. 2 shows the circuit for *Who Won the Pomagne*. When the switch S1 was pushed on, all the ten l.e.d.s were on because of the low time constant of the astable vibrator.

When switch 1 was released only one l.e.d. remained on. Because of the very high frequency, it is extremely difficult to predict which l.e.d. will remain on when the switch 1 is released.

Fig. 3 shows the circuit used for *Heads or Tails*. We used red and green l.e.d.s. The operation is by push-to-make switch S1 as explained for Fig. 2 above.

Mr Balkar,
Welling, Kent

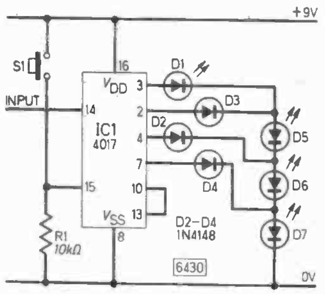


Fig. 1

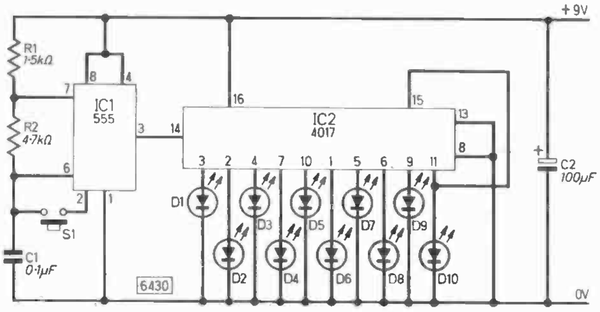


Fig . 2

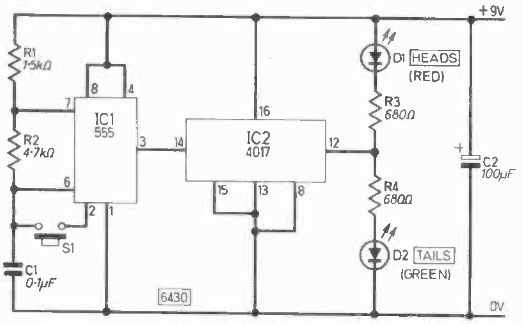
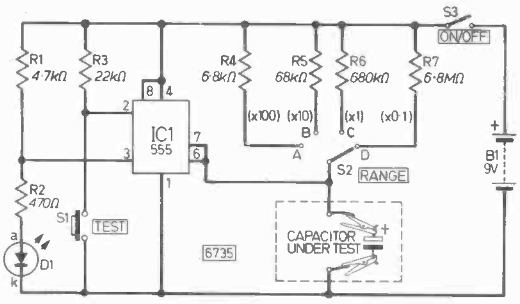


Fig. 3

SIMPLE CAPACITANCE INDICATOR

This circuit will provide a useful measurement of the value of capacitors ranging from about 0·2µF to 4,700µF or even greater. The capacitor under test is connected into the circuit with crocodile clips carefully observing its polarity.



RANGE SELECTOR SWITCH TABLE	
POSITION A	VALUE = TIME x 100
POSITION B	VALUE = TIME x 10
POSITION C	VALUE = TIME x 1
POSITION D	VALUE = TIME x 0·1

Press the TEST button, S1, momentarily and D1 will light. Note the time that it stays alight with a stopwatch or sweep second hand and multiply this by the value given in the table below for the appropriate range setting. This will determine the value of the capacitor.

It is best to start at the highest range (position A) and work down until the l.e.d. stays alight for two seconds or more.

Eddie Ball (age 12),
Liverpool

CIRCUIT EXCHANGE

THESE SPACE INVADERS WILL ALARM YOU—the price won't!

The space invaders are back.
This time right on your wrist!

CA-90 game

The keyboard is effectively divided in half. Any or all of the left hand buttons (1, 2, 4, 5, 7, 8) become AIM and any or all of the right hand buttons become FIRE.

The random digital invaders attack from the bottom right and move across the display. Every time you tap AIM your missile number, displayed top right, progresses by 1. When your missile number coincides with an invader, tap FIRE and that spaceship will disappear, adding to your score. Since this is a speed game, the earlier you destroy an invader, the higher it will score. The game is over if 3 of the 16 spaceships in an encounter penetrate your defences.

There are 2 stages, each stage having 9 encounters. In stage 1 the game speeds up with each encounter and in stage 2 the invaders attack from a closer position. After stage 2 the game reverts back to the beginning of stage 1, but the score, which is added and displayed after each encounter, is carried forward.

Depending very much on your skill, one game can last for as much as an hour or more. The highest score so far will be retained in a non-volatile memory. (This will be erased if the stopwatch function is utilised).

- ● Calculator
- ● Stopwatch
- ● Alarm
- ● Dual time
- ● Digital *Space invader game*

Game display

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CASIO VL-TONE (VL-1)

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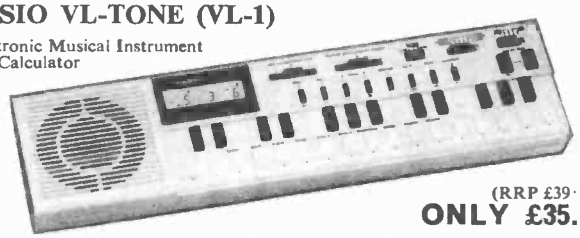
and Calculator



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Power source: Four AA size batteries or AC adapter type AD-4160 (price £5).

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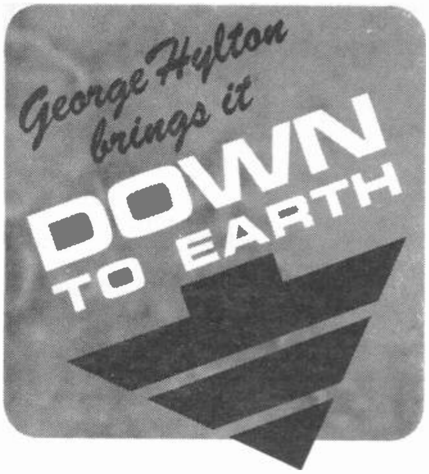

Visualising Amplifier Operation

FACED with the complexity of modern audio power amplifier circuitry the newcomer to electronics may find it hard to get a clear picture of how power is produced and supplied to the loudspeaker. This article shows that for the purpose of visualising how amplifier output circuits work simple "models" using resistances and capacitances and a bit of imagination can be a great help.

Transistor Tap

What is a transistor? A complex device made from specially treated semiconductor materials, of course . . . but for some purposes it can be regarded as the electronic equivalent of a water tap. Turn it on and a current flows. Turn it off and the current stops. It is turned on by driving the base with a small current and like a tap it can be set to any position between fully on and completely off.

Although we don't usually think of the flow of water from a tap as a means of doing useful work it could certainly be used to turn a small waterwheel or a little hydro-electric generator. In the same way, the flow of collector current through a resistance causes work to be done in overcoming that resistance.

Such a resistance (R_L in Fig. 1a) is generally referred to as a load resistance. In flowing through it the collector current generates heat. The rate at which this happens is called the power: the higher the power, the greater the heat production.

In audio amplifiers we are not interested in producing heat but in producing acoustic energy, which is what the loudspeaker does when audio-power from the amplifier is supplied to its "voice coil". A loudspeaker is not just a resistance but in one respect at least it has the same effect on the amplifier as a resistance: it absorbs energy.

So for the purpose of visualising how an amplifier works it is reasonable to replace the speaker by a load resistance, even though in a single-transistor stage like Fig. 1a, the real circuit would probably be quite complicated, with the speaker not connected directly but via an output transformer. To the amplifier it still looks very like a simple resistance R_L.

If the transistor is turned fully on then it offers virtually no resistance itself and behaves more or less like a short circuit from collector to emitter. The current drawn from the battery or power supply V_{CC} then depends only on the sizes of V_{CC} and R_L.

That is, $I_C = V_{CC}/R_L$. But when the transistor is only partly on it does offer resistance. This "collector resistance" is shown in Fig. 1b as r_c.

At this point we are going to forget about what actually turns on the transistor (I_B) and concentrate on the results of turning it on. If the transistor is turned on only to a small extent r_c is large and little current can flow. As the degree of turn-on is increased r_c becomes smaller and more current flows. So r_c is variable between infinity (no current) and zero (transistor fully on).

Using the Model

If a circuit like Fig. 1b is constructed and r_c varied by hand the meter reading varies accordingly. If r_c were varied up and down very quickly, at an audio frequency, and R_L were a loudspeaker it would emit a sound.

In a steady state with r_c set half way on and left alone R_L passes a certain steady current. If r_c is now varied a little this way and that around the half way mark the effect is to superimpose an "a.c. wobble" on the steady d.c. This means that some of the current from the d.c. supply V_{CC} is being converted to a.c. by the variation of r_c.

An audio power amplifier is a circuit which converts d.c. power into a.c. power in this way, that is by varying a resistance at an audio-frequency rate. Of course, the resistance is the r_c of a transistor or transistors and it is varied by driving the base with audio-frequency current which is controlled by the input signal from the gramophone pickup or whatever.

Stacked Transistor Output Stages

An alternative arrangement is shown in Fig. 2a. As the wiper contact of r_c is moved up towards the positive terminal of V_{CC}, the capacitance C charges. The charging current flows through R_L, or, if you want to be pedantic, electrons flow from the negative terminal of V_{CC} through R_L to form a negative charge on the right hand plate of C. This is the same thing as a conventional current flowing the other way, apparently starting at the wiper of r_c and flowing into the left hand plate of C and through C and R_L to "earth" ($-V_{CC}$).

If the wiper is now moved towards the negative end of r_c, C discharges (to an extent which depends on how far the wiper is moved) and the discharge current flows in R_L. This movement of the wiper at audio frequency generates audio-frequency currents and in flowing through R_L these produce audio power.

As the wiper is moved upwards the part of r_c marked "a" is reduced and the part marked "b" increased. Much the same effect can be obtained (Fig. 2b) by using two separate variable resistances (r_a and r_b) "ganged" in such a way that r_a decreases as r_b increases.

This two-resistance version of the circuit happens to be one which corresponds to a commonly used amplifier output circuit (Fig. 2c) in which two transistors are "stacked" one above the other. Here TRa corresponds to r_a and TRb to r_b. The driving circuits (not shown) are arranged to turn one transistor off and the other on, and vice versa.

When TRa conducts C charges. It discharges when TRa is turned off and TRb on. The discharge path is via TRb (and R_L). If TRa is fully off the collector supply voltage for TRb must come from the charge stored in C.

In practical amplifiers the circuit is arranged so that C acquires an average or d.c. charge of half V_{CC}. Operation can then be symmetrical, that is the a.c. wobbles can increase or decrease the steady charge on C by equal amounts. This maximises the power output obtainable without severe distortion.

Operating Class

Several modes of operation are possible. One mode is to arrange that no collector current is taken by either transistor when there is no input signal. Any positive-going input signal then turns TRa on while TRb stays off and C charges. Any negative signal does the reverse, allowing C to discharge via TRb.

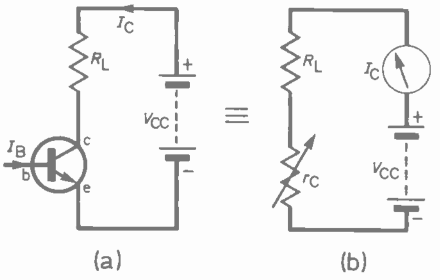

Fig. 1 Transistor amplifier and its 'model'.

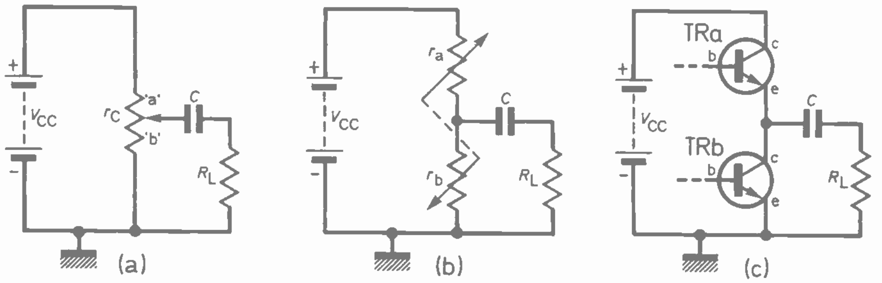

Fig. 2 Models for push-pull amplifier

This mode is called class-B operation. It has the great advantage that when there is no signal no current is drawn from the battery and no power is dissipated in the transistors.

The main snag is that in practice it is very difficult to get one transistor to turn off at exactly the same moment as the other turns on. If this changeover is not precise some of the audio signal can be missed out and the result can be bad distortion of a kind known as "crossover distortion" for obvious reasons.

To avoid crossover distortion it is possible to arrange for both transistors to conduct all the time even when there is no signal. Power is now wasted and the transistors tend to "run" hot all the time and need extra cooling, but since both transistors are in operation when the signals change from positive to negative crossover distortion is avoided. This mode of operation is known as class-A.

In practice both pure class-A and pure class-B operation is rare. Most practical amplifiers operate in a mode which is somewhere in between, even though they may be described as class-B in specifications.

The output transistors are biased to pass a small collector current all the time, with no input signal. For small signals the amplifier then operates as class-A and small-signal crossover distortion is avoided.

Large signals are big enough to cut off the collector current of one or other transistor and some crossover distortion then appears, but it is not nearly so bad (to the ear) as the distortion of a pure class-B amplifier.

Push-Pull Drive

We have been talking airily about positive and negative input signals, meaning the positive and negative half-cycles of the audio derived from a signal source such as a gramophone pickup. In fact, however, an output stage like Fig. 2c needs to be driven by a pair of signals one of which is a mirror image of the other; one going positive as the other goes negative but in other respects (waveform and so on), they are the same.

These "push-pull" signals are manufactured from the "single-ended" input signal by a "phase-splitting circuit" inside the amplifier. In old transistor amplifiers this was a special "driver transformer" but nowadays the job is done by a transistor circuit.

The most common transistor phase splitters make use of the fact that a positive signal at the base turns an *npn* transistor on but a *pnp* transistor off. By using *npn*/*pnp* "complementary pairs" (transistors with similar gain but opposite polarity) driven by the single-ended signal a push-pull output is obtained.

Low power amplifiers use this trick in the output stage itself, so that it does its own phase-splitting. High-power amplifiers however often use output transistors of the same polarity, as in Fig. 2c, in combination with opposite-polarity driver transistors which do the necessary phase splitting.

COUNTER INTELLIGENCE

By PAUL YOUNG

Electronics for All

I sometimes think that those of us whose hobby is electronics should stop now and then and count our blessings! I know of no other hobby that has so much scope. It can be indulged in whatever the weather. Give the enthusiast a few bits and pieces, one or two simple tools and two square feet of the kitchen table, and, not only is he in his heaven, but feels he is almost the equal of geniuses such as Sir Robert Watson Watt, or Dr. Schottky.

All this came to mind because I was discussing quite recently with our Editor the future of Electronics, particularly for the hobbyist, and I think our conclusions are worth noting. We agreed that there was no danger of the hobby diminishing while publications continue to set their present high standards and there are enough retailers to supply the enthusiasts' needs.

It is comforting to note that in spite of one of the worst recessions in the last 60 years, the majority of electronic component retailers have managed to survive. All this led to further speculation as to what a cross-section of electronic constructors consists of.

To some extent I can answer this. While the sex is predominantly male, we haven't got it exclusively to ourselves, and indeed there is no reason why we should have. The fair sex can, and do, shine just as brightly in this hobby as their male colleagues.

On the question of age I can truthfully say that all ages from nine to ninety participate, and the youngsters take to it like ducks to water. The number of elderly and not so elderly, retired people who are turning to electronics as a hobby, is heart-warming.

I must add, in passing, that it makes more work for retailers like myself and my colleagues, usually in the shape of answering the phone to an octogenarian or baby in nappies who want to know what the fourth wire on an AF125 transistor does when only three are shown on the diagram! We accept this cheerfully and hope perhaps there may be a little something more tangible on the end of it.

Another group of people who are taking up electronics are the sick and incapacitated, as this is something they can take on and have a chance to equal or even excel their more active counterparts. As one elderly gentleman said to me the other day "I find it very therapeutic".

Well, I think all in all, this represents a bright picture in a world that at present is rather depressed.

Flying Solar

A few years ago I became very interested in solar cells. I found that on a sunny day they would produce enough current to drive a tiny electric motor and turn a toy windmill, so in my next project I linked together several cells and managed to work a radio with loudspeaker.

At this stage I felt I was only about one step behind Marconi! Shortly afterwards I read about a chap in America who had designed an electric car to run on solar cells, and he said he intended to drive it right across America finishing at the White House in Washington in order to demonstrate to President Carter the need for energy conservation. I smiled to myself as I thought that the journey would take so long that Jimmy Carter wouldn't be in Office when the chap arrived.

However, about a month later I read in an American magazine of a lady, Mrs. Janice Brown, piloting an aircraft driven by solar cells! ! ! The joke was on me. although I was firmly of the opinion that it was a hoax—but no—recently the *Observer* published photographs and full details of the aircraft.

If you saw this, you may have been struck, as I was, at the likeness of another aircraft in the news in the last 18 months, and you would have been right, because it was designed by the gentleman who also designed the aircraft that was propelled across the channel by manpower. The designer was interviewed about his solar cell aircraft, and he was decidedly frank in saying that as a commercial proposition it is quite useless, but great fun! He hopes to fly it from London to Paris next year. May the sun shine on him all the way.

Microwave Detector

I mentioned recently in one of my articles, that I was suspicious of Microwave Ovens, and I still am for that matter. This prompted one of my readers to tell me that his family has one, and he doesn't like eating food cooked in it.

He concludes his letter as follows, "I am sure I may be tricked into eating food out of it, by being cooked in this dreaded creation, and then in a gas one. Is there by any chance, anything which could detect, if or not it has been cooked in one?" I don't know if there is an answer to this one, but I would like to hear from anyone who can help.

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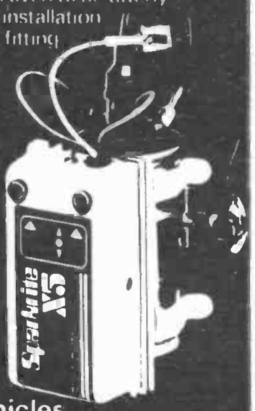

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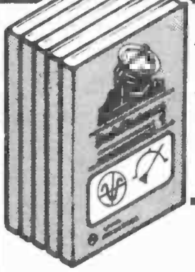

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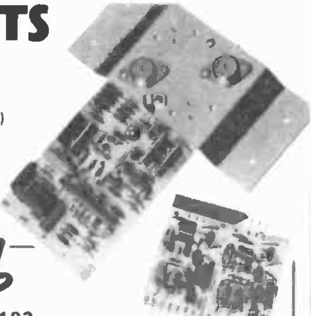

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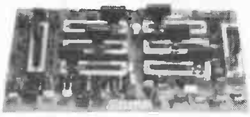

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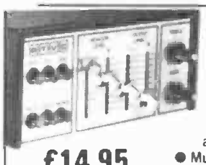

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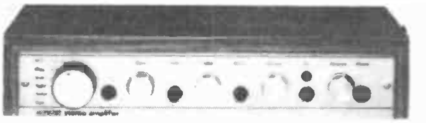

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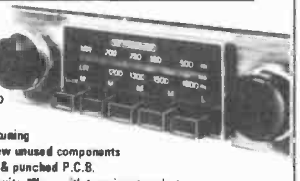

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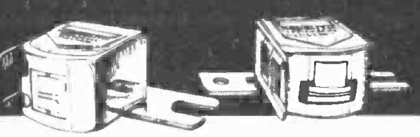

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The Monolith Electronics Co. Ltd., 5/7 Church Street, Crewkerne, Somerset TA18 7HR. Tel: 0460 74321. Telex: 46306 MONLTH G.

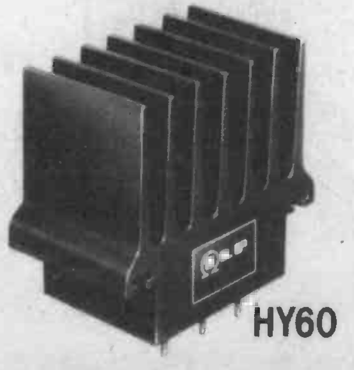
I.L.P

SIMPLY AHEAD and staying there

The range grows bigger...better...

New Profile Amplifiers - Two New Series

HY120



HY60

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

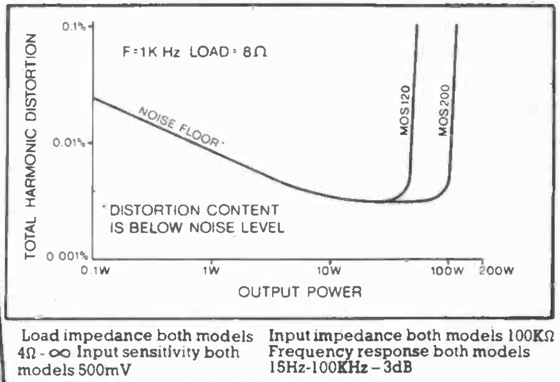
BIPOLAR

(Standard o/p transistors)

CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

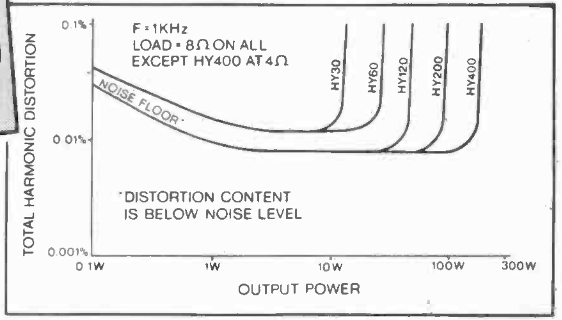
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



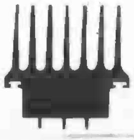
Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



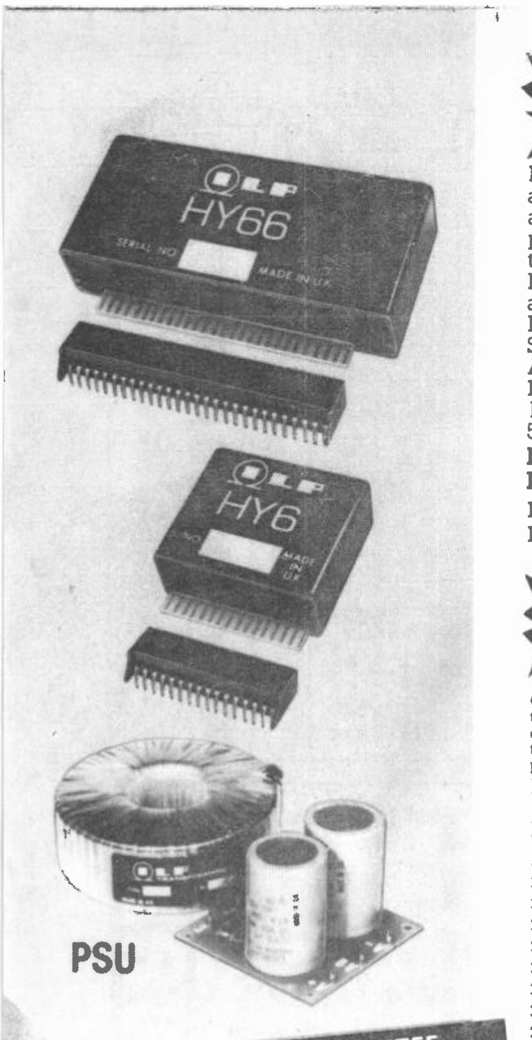
Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS

The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.



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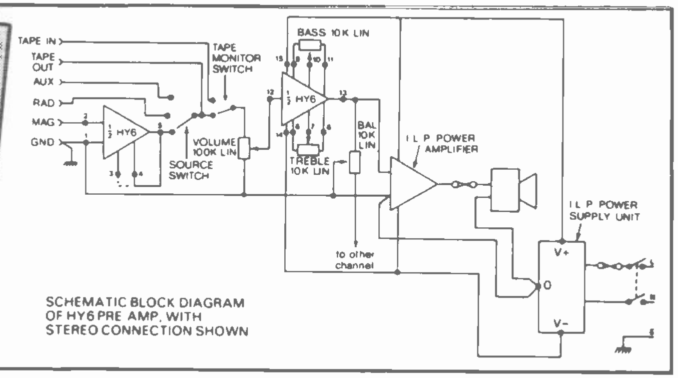
I.L.P. PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost. **Inputs Sensitivity** – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £6.44 + 97p VAT Connectors included
HY66 stereo £12.19 + £1.83 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM
OF HY6 PRE AMP, WITH
STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

I.L.P. POWER SUPPLY UNITS

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	**£4.50** + 0.68p VAT
● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*	
PSU36 for use with 1 or 2 HY30's	**£8.10** + £1.22 VAT
● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*	
PSU50 for use with 1 or 2 HY60's	**£10.94** + £1.64 VAT
PSU60 for use with 1 HY120	**£13.04** + £1.96 VAT
PSU65 for use with 1 MOS120	**£13.32** + £2.00 VAT
PSU70 for use with 1 or 2 HY120's	**£15.92** + £2.39 VAT
PSU75 for use with 1 or 2 **MOS120**	**£16.20** + £2.43 VAT
PSU90 for use with 1 HY200	**£16.20** + £2.43 VAT
PSU95 for use with 1 **MOS200**	**£16.32** + £2.48 VAT
PSU180 for use with 1 HY400 or 2 HY200	**£21.34** + £3.20 VAT
PSU185 for use with 1 or 2 **MOS200**	**£21.46** + £3.22 VAT

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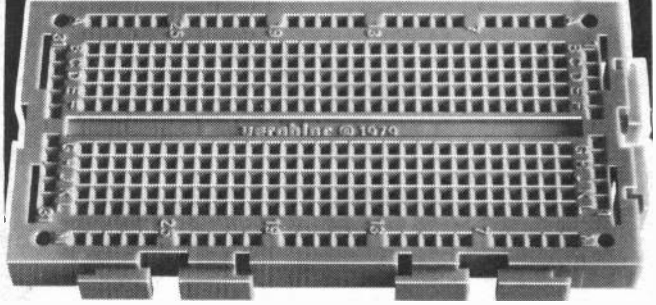

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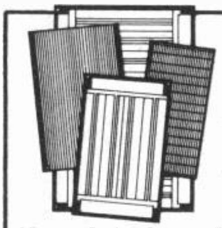

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Rotary Controls Tuning, volume, balance, treble and bass.
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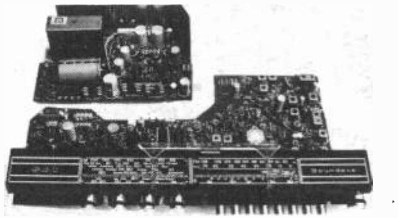
Tape Sensitivity output typically 150mv. Input 300mv for rated output.
Disc Sensitivity 100mv (ceramic cartridge).
Stereo Beacon Indicator LED or bulb.
Size Tuner—2⅜" × 15" × 7½" approx. Power amp.—2" × 7½" × 4½" approx.
Price £23·50 + £2·50 Postage and Packing.



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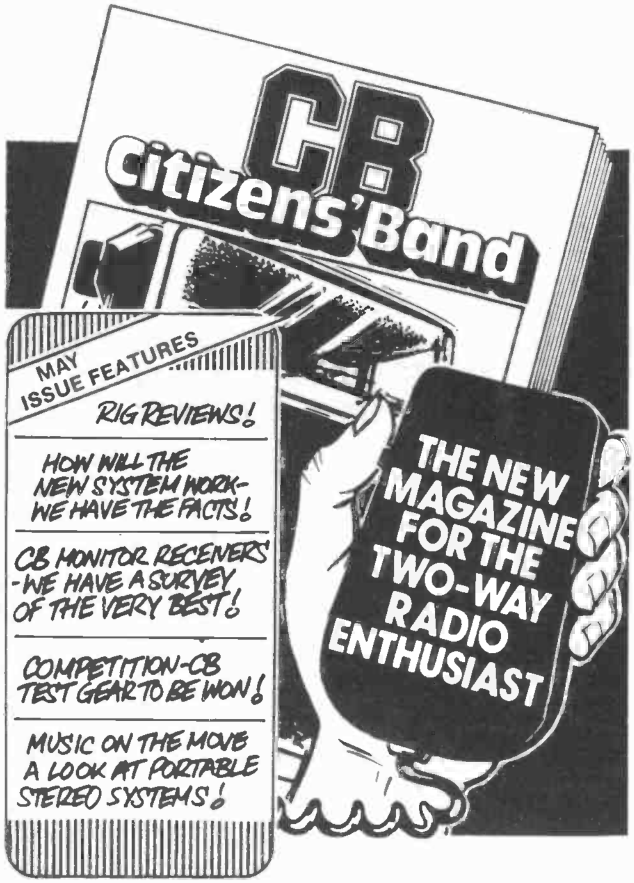
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4008	77p	4040	86p	4081	22p
4011	22p	4044	82p	4082	21p
4013	39p	4046	95p	4085	72p
4015	73p	4048	42p	4093	55p
4016	36p	4049	43p	4501	24p
4017	76p	4050	42p	4510	77p
4018	76p	4051	74p	4511	85p
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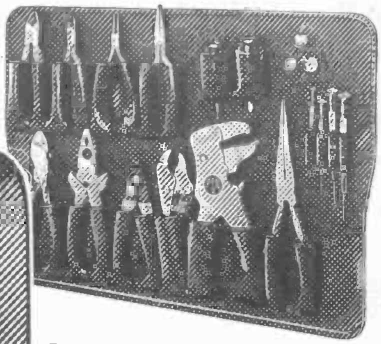

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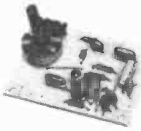
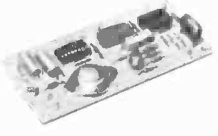


KS100 MINIATURE V.H.F/A.M/F.M RECEIVER. Varicap tuned, 88-108 MHz earphone output 240mV, sensitivity 1uV, operates from 9V D.C. (PP3) 2·5mA semiconductors EET/E300 & BC205-G. **£5·31 inc VAT**



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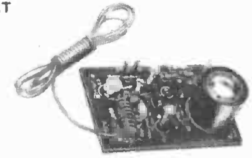
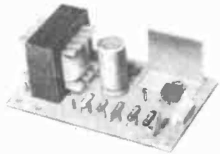
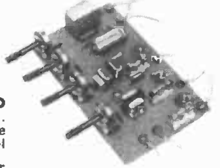
KS238 "MICROPHONE OPERATED THREE CHANNEL SOUND TO LIGHT". Complete with microphone, 300 Watts per channel, automatic treble-middle-bass filters. Operates from 240V A.C. **£14·34 inc VAT**



KS200 MINIATURE F.M. TRANSMITTER. 88-108MHz complete with dynamic microphone, operates from 9V D.C. (PP3), semiconductors 2N708 & BC208-8. Not Licenceable in U.K. **£7·37 inc VAT**



KS490 "NICAD BATTERY CHARGER". Constant current in five ranges, 10–20–45–100–150mA. Max. charge voltage 15V. Operates from 240V A.C. **£9·02 inc VAT**



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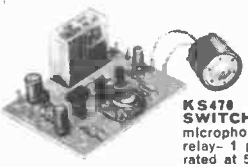

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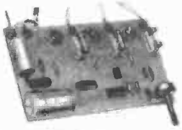

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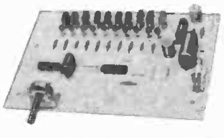

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BC158	0·09
BC159	0·09
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BC170B	0·10
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BC173B	0·10
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BC212L	0·09
BC213	0·09
BC213L	0·09

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BC238	0·08
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BF195	0·11
BF196	0·11
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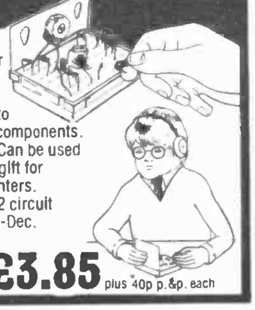

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71	2	1	2·51	0·90
18	4	2	3·24	1·43
68	3	1·5	3·15	1·43
85	5	2·5	5·52	1·43
70	6	3	6·26	1·43
108	8	4	7·36	1·73
72	10	5	8·05	1·65
116	12	6	8·57	1·90
17	16	8	10·53	2·05
115	20	10	13·69	2·05

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SEC 0V 12V 15V 0V 5V 9V 15V
VOLTS AVAILABLE 3 ⟹ 15—0—15

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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
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SEC: 0V 20V 25V 0V 8V 15V 25V
VOLTS OUT 5 ⟹ 25—0—25

TYPE	AMPS		PRICE	P/P
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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		PRICE	P)P
	30v	60v	£	£
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		PRICE	P/P
	48v	96v	£	£
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

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65VA — 10 KVA
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TYPE	VA	PRICE	P/P
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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

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TYPE	VA	PRICE	P/P
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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

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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

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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

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244F	100	8·61	1·73
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249F	750	32·08	7·00
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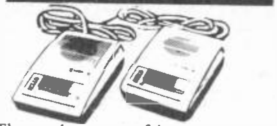

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