Australia $1.60 New Zealand $1.75 Malaysia $4.95

PRACTICAL

AUGUST 1984 · 90p

ELECTRONICS

ROBOTICS · MICROS · ELECTRONICS · INTERFACING

RADIO ASTRONOMY

Spacewatch with Dr. Patrick Moore

Commodore 64 RS232C Interface

Field Measurements using a Cassette Recorder

PORTABLE CHESS GAME OFFER!

PRACTICAL

ELECTRONICS

VOLUME 20 **No. 8** **AUGUST 1984**

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, AUGUST 3rd, 1984
(for details of contents see page 34)

SPEAKERS

8Ω, 0.3W, 2", 2.25", 2.5", 3" 80p
0.3W, 2.5", 40Ω; 64Ω or 80Ω 80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	14
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

BRIDGE RECTIFIERS
(plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS
Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V 1.3W **15p each**

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

SCR's Thyristors

0.8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5064	38
2N4444	130

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/600V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	125

DIAC
ST2 25

SOLDERCON PINS
100 75p
500 370p

OPTO
LEDS price includes Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 .2" Red	12
0.2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	45
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	56
0.2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0.2" Tri colour LEDs Red/Green/Yellow	85
0.2" Red High Bright	59
High Bright Green or Yellow	65
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	55
TIL38	50
TIL81 82; TIL100	90

7 Segment Displays

TIL321 .5" C.An	140
TIL322 .5" C.th	140
DL704 .3" C.Cth	125
DL707 .3" C.Anod	125
FND357 or 500	130
.3" Green C.A	140
±1 .3" Red or Green	150
Bargraph 10 seg. Red	275
Bargraph NSM3914	500

FERRIC CHLORIDE
Crystals 1lb
195p + 50p p&p

DALO ETCH RESIST
Pen plus spare tip 100p

COPPER CLAD BOARDS

	Single-sided	Double-sided	SRBP 9.5"×8.5"
Fibre Glass			110p
6"×6"	100p	125p	
6"×12"	175p	225p	

VEROBOARDS 0.1"

	Clad	Plain		
2½×3⅜"	95	—	'VQ' Board	180
2½×5"	110	—	'DIP' Board	395
3¾×3⅜"	110	—	Vero Strip	144
3¾×5"	125	95p	**PROTO-DECs**	
3¾×17"	420	275p	Veroblock	480
4¾×18"	590	—	S-Dec	395
Pkt. of 100 pins	55p		Eurobreadboard	590
Spot Face Cutter	150p		Bimboard 1	695
Pin Insertion Tool	185p		Superstrip SS2	£13

VERO WIRING PEN and Spool 380p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

0.5" LCD DISPLAYS

3½ digit	495
4 digit	530
6 digit	625
BPX25	250
BPW21	320
BPX65	320
ILD74	145
ILQ74	275
ILCT6 Darlington Isolator	135
TIL111	70
OCP71	120
ORP12	78
2N5777	50
4N33	135
Pin diode	720
Schmitt Receiver	715

OPTO SWITCH
Reflective TIL139 225
Slotted similar to RS 186

ALUM. BOXES

4×2½×2"	100
4×2¼×2½"	103
4×4×2½"	120
5×4×2"	105
5×2½×1½"	90
5×2½×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS
1A T0220 Plastic Casing

	+ve		-ve	
5V	7805	50p	7905	50p
12V	7812	45p	7912	50p
15V	7815	45p	7915	50p
18V	7818	45p	7918	50p
24V	7824	45p		

100mA T092 Plastic Casing

5V	78L05	30p	79L05	50p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	50p

ICL7660	248	LM317K	250
78H05 5V/5A	550	LM317P	99
78H12 12V/5A	640	LM323K	500
78HG+5 to +24V 5A	599	LM337T	175
		LM723	30
79HG -2.25V to -24V 5A	685	TBA625B	75
		RC4194	375
LM309K	120	RC4195	180

SWITCHES

SLIDE 250V
1A DPDT 14
1A DPDT C/OFF 15
½A DP on/on/on 40

TOGGLE 2A 250V
SPST 35
DPDT 48
4 pole on off 54

PUSH BUTTON Spring loaded
Latching or Momentary 6A
SPDT c/over 150
DPDT c/over 200

SUB-MIN TOGGLE 2 amp
SP changeover 64
SPST on off 58
SPDT c/off 85
SPDT Biased 105
DPDT 6 tags 80
DPDT C/OFF 88
DPDT on/on/on 185
DPDT Biased 145
4-pole 2 way 220

MINIATURE Non Locking
Push to make 15p
Push break 25p

ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 48p

ROTARY: Mains 250V AC, 4 Amp 64p

DIP SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 100p; (SPDT) 4 way 190p.

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	475p	470p
36 way Centronix	450p	475p
24 way Female	525p	490p

ASTEC UHF MODULATORS
6MHz Standard 375p
8MHz Wideband 550p

ANTEX Soldering Irons

C15W	525p	Spare bits	85p
G517W	525p	Elements	230p
G18W	545p	Iron stand	175p
XS25W	550p	Heat Shunt	30p

DIL SOCKETS

	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

ZIF DIL SOCKET
24 way 565p
28 way 750p
40 way 845p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
28	185p	290p
40	195p	218p

RIBBON CABLE
(price per foot)

Ways	Grey	Colour
10	15p	28p
16	25p	40p
20	30p	50p
26	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	80p	75p	75p	90p

IDC 25 way Plg. 385p, Skt. 450p

SIL Sockets 0.1"
20 way 65p
32 way 95p

EDGE CONNECTORS
1"

2×18 way	210p
2×22 way	215p
2×23 way	175p
2×25 way	285p
2×28 way	190p
2×30 way	310p
2×36 way	360p
2×40 way	380p
2×43 way	450p
2×75 way	650p

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied. **ONLY £18**

IDC CONNECTORS (Speed block type)

2 rows	PCB Male with latch Strt. Pins	Angle Pins	Female Header Socket	Female Card-Edge Connector
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS
Gold flashed contacts

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2×32 way	275p	320p	220p	285p
DIN 41612 2-3×32 way	295p	340p	240p	300p
DIN 41612 3×32 way	360p	385p	260p	395p

TRANSFORMERS (mains Prim 220-240V)
3-0-3V, 6-0-6V 100mA, 9-0-9V 75mA, 12-0-12V 75mA, 15-0-15V 75mA 98p
6VA: 2×6V 5A, 2×9V .4A, 2×12V 0.3A; 2×15V .25A 250p
12VA: 2×4V5 1.3A, 2×6V 1.2A, 2×12V .5A, 2×15V .4A 345p (35p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A 20V-.6A 385p (60p p&p)
50VA: 2×6V-4A, 2×9V-2.5A, 2×12V-2A, 2×15V-1.5A, 2×20V-1.2A, 2×25V-2A, 2×30V-0.8A 520p (60p p&p)
100VA: 2×12V-4A, 2×15V-3A, 2×20V-2.5A, 2×30V-1.5A, 2×40V-1.25A, 2×50V-1A 965p (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	325p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC FEMALE RECEPTACLE Jumper Leads 36"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

COMPUTER CORNER

- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. **£138**
- **SEIKOSHA GP 250X** Printer **£199**
- **EPSON FX80 PRINTER** 160 CPS, 11×9 matrix, proportional spacing, superscript, subscript, dot addressable graphics, Normal, Italic & Elite characters. Up to 256 user definable characters. Down loadable character set. Condensed and double width printing. 4 user define margin positions. Tractor and Friction feed. 10" maximum width, Bi-directional, logic seeking. Centronix Interface standard. **£325**
- **EPSON RX80 PRINTER** **£235**
- **EPSON RX80 FT PRINTER** **£259**
- **KAGA – RGB** 12 inch medium resolution colour monitors **£195**
- **ZENITH 12" Hi-RES,** Green Monitor 40/80 column select switch, value for money. **£75**
- **MICROVITEC 14"** colour monitor. RGB input. Lead incl. **£195**
- **MICROVITEC 1451** Hi-res 14" Monitor incl. Lead **£319**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **Spare** UV lamp bulbs **£9**
- **C12 COMPUTER Grade BASF Cassettes** in Library Cases **36p**
- **8½" or 9½" Fan fold paper** (1000 sheets) (150p) **£7**
- **Teleprinter Roll** (no VAT) **£3.50**

MANY MORE PRINTERS, MONITORS, INTERFACES, AVAILABLE. CALL IN AT OUR SHOP FOR DEMONSTRATION OR WRITE IN FOR OUR DESCRIPTIVE LEAFLET.

(P&P on some of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

BROTHER HR-15 DAISEY-WHEEL PRINTER/

An exceptionally high quality Daisy Wheel printer at the price of a Dot matrix printer. 18CPS; Bi-directional, has 3K of Buffer; has clear buffer facility, Carriage skip movement, Proportional spacing; underlining; Bold print and Shadow print. Prints in two colours; Super and subscript facility. Impact control facility to vary pressure on paper for making carbon copies. Has Centronics parallel or RS-232 interface. Connects directly to BBC Micro. A ribbon cassette plus a separate red ribbon. Optional extras: Single Sheet Feeder takes up to 150 A4 sheets; & Keyboard that transforms HR15 into a sophisticated electronics typewriter. Attractively finished in Beige. Special Introductory Offer:
Only £349 (Carr. £7)

★ **It was the first! It is still the best!**

- ★ Centronics and **BI-DIRECTIONAL RS-232** with full hand-shaking.
- ★ Obeys **SPECTRUM LLIST** and **LPRINT.**
- ★ Split-Speed Operation for RS-232. (Use it to communicate with the **BBC MICRO** or **OTHER PERIPHERALS**).
- ★ Interface 1, Interface 2 & Microdrive compatible.
- ★ Configuration program creates customised M/C driver to suit your printer.
- ★ **HI-RES** screen dumps in 2 sizes on **EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA,** etc. This is a **STANDARD FEATURE!** Not an extra.
- ★ Compatible with **TASWORD TWO** and most professional programs.

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1.008M	275
1.28MHz	392
1.5MHz	420
1.6MHz	395
1.8MHz	515
1.8432M	250
2.0MHz	225
2.4576M	200
2.5MHz	225
2.56250M	220
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.867237M	220
9.00MHz	200
9.375MHz	350
10.0MHz	175
10.5MHz	250
10.7MHz	150
10.24MHz	200
12.0MHz	175
12.528MHz	300
14.31818M	170
14.7456M	175
14.765MHz	250
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
29.695MHz	150
26.670MHz	325
27.125MHz	295
27.145M	190
27.648MHz	300
38.66667M	240
48.0MHz	240
55.5MHz	400
100MHz	295
116.0MHz	300
145.8MHz	225

BBC MICROCOMPUTER

Model A **£299**; Model B **£399** (incl. VAT). We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, Printer Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM, The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEBCALC, Software (Educational Application & Games), BOOKS, etc. etc. Please send SAE for our descriptive leaflet.

DISC DRIVES FOR BBC MICRO

- **CS100 – TEAC** Cased with own Power Supply, S/S, 40 track, 5¼", 100K **£145**
- **CD200 – TEAC** Twin Cased with own PSU, S/S, 40 track, 5¼", 200K **£275**
- **CS200 – TEAC** Single Cased with own PSU, S/S, 80 track, 5¼", 200K **£210**
- **CD400 – TEAC** Twin Cased with own PSU, S/S, 80 track, 5¼", 400K **£365**
- **MITSUBISHI** 5¼" Slim line Disc Drives double sided, double density, track density 96 TPI, track to track access time 3msec.
- **SINGLE MITSUBISHI** Slim line – Cased with own PSU, DS/DD, 1 Megabytes (400K with BBC) **£259**
- **TWIN MITSUBISHI** Slim line – Cased with own PSU, DS/DD, 2 Megabytes (800K with BBC) **£425**
- Single Drive Cable for BBC Micro **£7**
- Twin Drive Cable for BBC Micro **£10**

Many more types available.

Please send SAE for our detailed leaflet.
N.B. Carriage is extra on drives.

WATFORD ELECTRONICS
Tel. (0923) 40588 Telex. 8956095

PE

VOLUME 20 No. 8 AUGUST 1984

TRIBUTE

REGULAR readers will have seen our obituary to Frank Hyde in the June issue and may be surprised by the appearance of an article by Frank in this issue. *Radio Astronomy* was Frank's love and the article was written for us some time ago. We are pleased to publish it as a tribute to him. Frank was an excellent contributor and friend to PE and we hope he would have approved of Dr. Patrick Moore as our new Spacewatch contributor.

Patrick Moore knew Frank, as you will see from his first Spacewatch, and expressed his sadness at the reason for his being asked to take over. We are also sad about this, but pleased to welcome Patrick to our pages. Hopefully, this month will see the start of another long and rewarding relationship.

AREAS

Alert readers will also have noticed the introduction of some extra wording to our front cover title. The words Robotics, Micros, Electronics, Interfacing spell out, in no uncertain terms, what PE is all about and it is our intention—as always—to be the best "practical" magazine for the hobbyist in these areas.

Next month sees the start of our second major series on robotics with publication of three new robot designs. PE has shown the way with serious practical robots and we plan to extend our lead. No other magazine has yet come near to providing its readers with similar high quality designs: designs which are now used extensively in education, light industry, research and by hobbyists: designs which cover the whole range from a turtle through small motor driven arm up to a semi-industrial hydraulic unit—five designs in all, with three more coming now and others planned for the future.

We will not leave out the beginner and it is our intention to publish a series aimed at the novice to robotics in our sister publication *Everyday Electronics*—watch out for that in the near future.

LEADING

Of course we realise that robotics and computing are not close to everyone's heart so we will continue to provide plenty of useful and sensible designs of a general nature—designs that are well thought out, well expressed and illustrated and that provide readers with value for money. Just to prove that we keep ahead, from this month our regular *Patents Review* has been changed in approach so that it now looks at where the patents are taking us and how they may influence future products. This page, written by Barry Fox—a recognised leading journalist in the field—has been renamed *The Leading Edge* so that its title reflects the new approach. We hope you like it.

Mike Kenward

Technical *and* editorial *queries and letters (see note below) to:*
Practical Electronics Editorial,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG

Phone: *Editorial* Poole 671191
We regret that lengthy technical enquiries cannot be answered over the telephone

Queries and letters concerning advertisements *to:*
Practical Electronics Advertisements,
King's Reach Tower,
Stamford Street, London SE1 9LS
Telex: 915748 MAGDIV-G

Letters and Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only**.

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers and Binders
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

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Items mentioned are available through normal retail outlets, unless otherwise specified. Prices correct at time of going to press.

...NEWS &

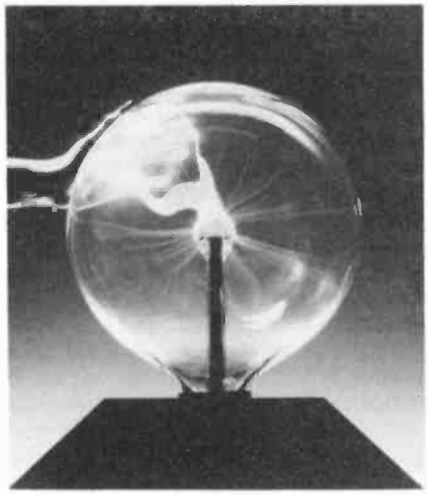
LIGHTNING PERFORMANCE

Over ten years ago, as a spin-off from a nuclear fusion modelling experiment, this ball of 'harnessed lightning' was just a brainchild of a theoretical physicist who predicted that a plasma could be limited to a tight beam even when shot across a relatively short gap so long as the control parameters were just right.

To prove the theory a model was made and ten years of refinement later the 'Starsculpture' emerged as a 'living lightning' art form. The effect you see is created by the emission of high frequency radio waves, pulsing at around 21kHz; these signals are broadcast from the small hemisphere in the centre of the 12inch diameter glass sphere. The generation circuitry is of course microprocessor controlled, the program searches for the one in a million condition where a high temperature plasma (chain of super-heated ion molecules) is triggered in the special rarified gas atmosphere. The plasma lasts for only a fraction of a second and is continuously restimulated by the microprocessor circuitry as it senses the exact triggering characteristics; in this way the continuous lightning effect is achieved.

The radio waves pulsing through these rare gases 'knock' electrons loose from their atoms, the result being an ionised gas which emits light when an electron is dislodged, and again when an electron is recaptured by another gas atom.

The Starsculpture is designed to be touched by one or more people, when the human body touches the sphere the free electrons floating inside are drawn to the natural 'ground'. This flow of electrons creates 'tunnels' in the rare gases through which the plasma then flows, and so it appears that the plasma is attracted to your hand when in fact the plasma flows through the tunnels created by your touch.



As if this visual extravaganza wasn't enough, the manufacturers have incorporated three slide control switches that enable the 'operator' to vary the shape, colour and pulse rate of the plasma, creating a truly infinite number of effects.

The Starsculpture took more than £½m to develop and each one is hand tuned by a plasma physicist which perhaps goes some of the way to justifying the £2,500 price tag. Harrods of Knightsbridge (who else) recently featured this item in their Technology at Play exhibition.

However interested parties should contact Markplan Ltd., Old Colony House, South King St., Manchester, M2 6DQ. (061-832 2765).

Look out for this *Leisuretronics* logo in forthcoming issues of *PE*, we will bring you up to date information of this exciting new exhibition to be held at the Royal Horticultural Hall in London from November 8th–11th 1984. The interests of all home hobbyists will be catered for from radio-controlled models to electronic music making, ham radio to Hi-Fi; robotics to photography; synthesisers to satellites; games and kits to disco and light show equipment. Hand tools and components will also be available along with many special and unusual exhibits demonstrating the most up-to-date developments in all areas of leisure electronics.

The organisers, Trident International Exhibitions, have many years experience in the exhibition industry and their efforts are expected to draw a large audience of enthusiasts with wide ranging interests. The venue is within walking distance of Victoria coach/train termini, and of course within tube and bus reach of all other London rail termini. Trident will be promoting the event through coach companies as well as British Rail. *Practical Electronics* along with our fellow publications—*Everyday Electronics*, *Practical Wireless*, *Software Index* and others will be sponsoring this new and multi-interest electronics event.

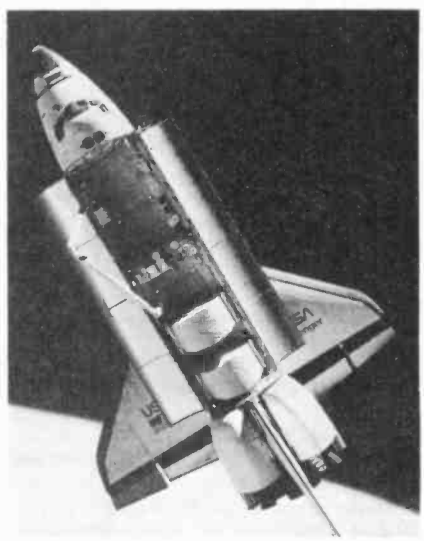
SHUTTLE SPACE COMPETITION

An exciting and quite unique competition is now open to all secondary school students and apprentices in the UK.

The challenge is to recognise the potential that space offers their future, and to create an experiment that takes into consideration the special environmental conditions in space, in particular vacuum and weightlessness.

The winning entry will have a reserved spot in the payload bay of the space shuttle due to be launched in early 1986. The simpler the project the better its chances as it must be small and simple enough to be housed in a self-contained cylinder no larger than 502mm diameter, 359mm long with an all up weight restriction of 27·2kg (60lb). The competition is being run by ITN (Independent Television News), one of Europe's leading space consultants SSI (Space Services International) and NASA (National Aeronautics and Space Administration).

NASA's technological expertise is undoubted and it would be easy for the entrant, in this prestigious company, to get 'too technical'. Don't forget that (as far as we know) the most basic of Earthbound natural phenomena have never been asked to perform in space. For instance, what happens to tomato pips or to bees or spiders? These were some of the experiments devised by students in the USA; simplicity is the key.



The ITN-SSI competition will be judged by a panel of experts in the space sciences. Finalists will be asked to construct the winning package from their own resources. Full details and conditions can be obtained by sending a large stamped addressed envelope to: Experiment in Space, ITN, PO Box 4BY, London W1A 4BY.

MARKET PLACE

RECON. DMM

If you did not manage to find yourself a suitable instrument from the Multimeter Buyer's Guide in the May issue of PE, then this Beckman model just might fit the bill.

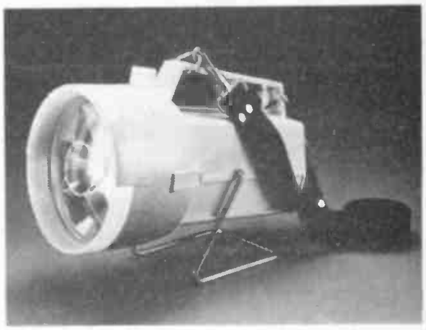
The 3020R is a hand-held DMM (a Beckman 3020 reconditioned by Beckman) with a d.c. accuracy of 0·1 per cent. D.c. voltage range 200mV to 1500V, a.c. voltage range 200mV to 1000V, current a.c./d.c. 200µA to 2A, resistance 0 to 20MΩ. The 3020R has a battery life of 2000 hours and would normally cost in excess of £143 (if new), the cost of the reconditioned model is £86.25 inc VAT and p&p. From, Intertec, PO Box 33, Dunstable, Beds, LU6 2QP. (0582 873377).

Rechargeable torch

The X-CELL rechargeable torch from Nitech is gaining a substantial foothold in the market place according to its manufacturers. The torch incorporates the X-CELL rechargeable power unit which is a patented British invention, it is capable of casting a half-mile beam.

Controlled tests have shown the X-CELL to have a beam strength of 50,000 candlepower at twenty feet using a standard PR 13 bulb. A revolutionary bulb will be available shortly that will double the power to 100,000 candlepower, with the three hours of full light duration time unchanged. The torch is injection moulded from high-impact materials making it suitable for the toughest working conditions; it is resistant to chemicals, oils and water and floats beam up.

A full charge takes 12hrs and it is possible to recharge the torch some 3,000 times at an estimated cost of 0·1 pence a time. Several charging voltages can be used from the mains to a low voltage source such as that of a car or boat. These are 110V to 280V a.c. and 8V to 28V a.c./d.c. The X-CELL weighs in at less than 1,000 grams and is supplied with a plug-in charging lead. A motorist's model is also available with a hazard warning light, this model the 'Carmate' costs around two pounds more than the standard unit which retails at around £28. For further details or local stockist information contact, Nitech Ltd, Maze House, Maze Hill, St. Leonards on Sea, Sussex (0424 435116).



PANASONIC'S TINY RADIO

It is anticipated that Panasonic will launch in the UK sometime in 1985 the World's smallest a.m./f.m. stereo personal radio—the RF-07.

The super-slim receiver measures 91mm high, 55mm wide and 3·9mm deep (approximately the size of a credit card). A rechargeable NiCad battery is the inclusive power source and will give up to five hours playing time under normal use, it can be recharged in about the same time. According to Panasonic they have optimised radio circuit miniaturisation into Radio High-density Circuits (RHC's); there are four RHC's in the design.

Many new components have been developed for use in the RF-07 including a variable capacitor, volume control, tantalum capacitor chips and an ultra-thin a.m. antenna. All these components were designed to be less than 2·8mm thick.

Accessories include a recharger unit, stereo headphones and a carrying case. It may be a while before we actually see this slim set in the High St. but when we do it is likely to cost in the region of £110.

Money Back

From now until the end of October Superswitch is making purchasers a money-back offer on all its products as part of a summer promotion. This will be £1 if one item is bought, £3 on two.

The offer will be generally available wherever Superswitch products are sold, including electrical, DIY, hardware and lighting shops, and leading department stores. The products include dimmers, programmable lightswitches, low voltage outdoor lighting sets, immersion heater timers, smoke alarms and plug-in timeswitches.

All the purchaser has to do is send off a product carton top together with a special sticker which will be on each carton. Superswitch will refund £1 (or £3 if two purchases are submitted at once) direct to the purchaser.

Further information from Superswitch Electric Appliances Limited, 7 Station Trading Estate, Camberley, Surrey, GU17 9AH. Telephone: Camberley (0276) 34556.

OPERATOR PROTECTION

Increasingly we hear of industrial working practices that damage the health of the operator, 'asbestosis' being a prime example. Goodness only knows what untold damage has been done to our bodies and those of our labouring forefathers over the past couple of hundred years?

As the acid rain continues to pour down, and the beaches around Sellafield remain contaminated, it seems that operator protection from 'hazardous environments' is still in its infancy, indeed as is so often the case, changes are only made after the damaging event.

Encouraging to see then the development of a mobile work platform for use in hostile or hazardous environments. The vehicle has been developed by researchers at the Battelle Memorial Institute's Ohio laboratories. Nicknamed 'Rocomp' (Radio or Computer Operated Mobile Platform) the tracked vehicle can, under computer control, follow a prescribed program developed for a particular application or be radio-controlled by an operator in a safe remote area. According to its inventors it is the result of combining mechanical engineering skills with 'smart' controls and sensors. A TV camera can be added for working in blind areas.

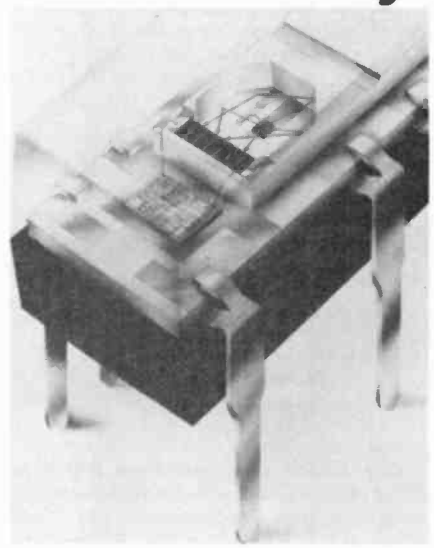
Rocomp is a tracked vehicle that can pass over obstacles, ascend and descend 45 degree slopes, and easily manoeuvre up and down stairs. It can carry weights of up to 250 pounds over almost any firm surface. In a nuclear environment the platform would be equipped to detect radiation levels, collect air and smear samples, perform simple mechanical tasks and function as a mobile tool caddy. In these inhospitable conditions fewer personnel would be required to enter the area and those that had to enter would face a lesser exposure time, similarly the unit could be used in areas from which personnel are completely restricted.

Photo-voltaic relay

A new concept in solid-state switching devices, the photo-voltaic relay (PVR), was previewed by International Rectifier at the 1984 All-Electronics/ECIF Show.

The new type of relay, which incorporates a photo-voltaic isolator array in conjunction with a new power integrated circuit known as a BOSFET (for 'bidirectional output switch field-effect transistor'), could offer an ideal solid-state replacement for electro-mechanical reed relays. Like reed devices, it can handle both a.c. and d.c. signals and other waveforms, but its reliability is several orders of magnitude better than electro-mechanical devices.

Relays using the PVR technique are expected to be commercially available in early 1985.



ATARI-400 KEYBOARD

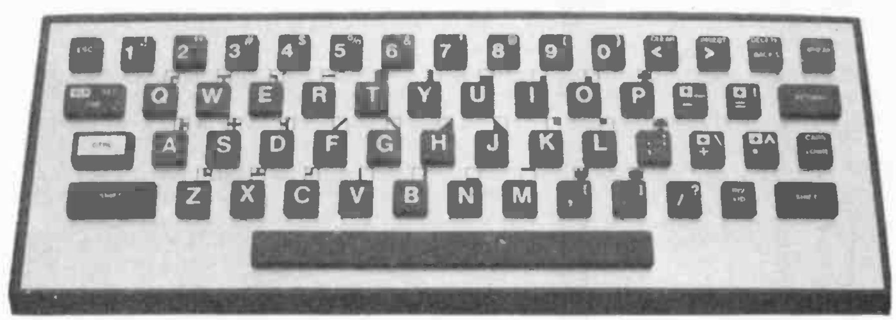
A new silicon rubber, stick-down keyboard for the Atari 400 computer has been developed by Filesixty, the London-based computer hardware company that has successfully marketed a similar product for the Sinclair ZX-81.

The keyboard, which is virtually indestructible, can be applied to the machine in seconds. It gives the operator a calculator-type feel, thereby overcoming the Atari 400's major drawback—its flat key pad.

The keyboard will make any operator functions more enjoyable, quicker and more satisfying.

The keyboard which has been designed to coordinate with the look of the machine, is moisture and dust proof and will not discolour. It has been tested to up to 3½ million impressions. It costs £19.95 and is available initially direct from Filesixty and later from selected retailers. The product will be marketed through the home computer and computer games specialist press.

Further information is available direct from Filesixty, 25 Chippenham Mews, London W9. Telephone: 01-289 3059 (office hours).



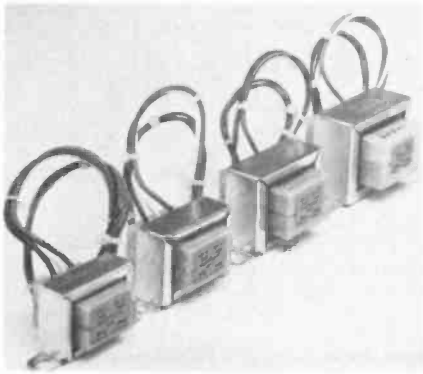
MARKET PLACE

ALL WOUND UP

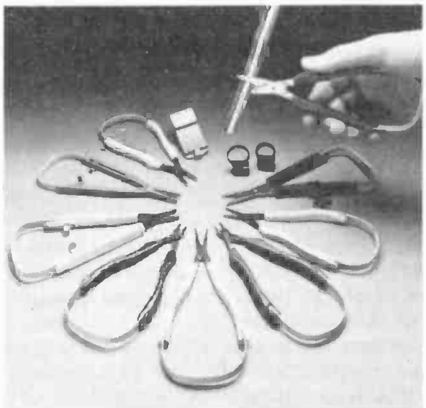
Clairtronic has introduced a new economy range of low voltage isolating transformers with wound-in flying leads. These cable connections provide additional safety by eliminating mains voltage terminals on the transformer and ensure that international safety standards for creepage and clearance distances are easily maintained. The integral cables also provide lower circuit installation costs.

This range of chassis mounting transformers comprise four sizes 2, 4, 10 and 18VA each with a choice of four centre tapped voltage outputs 6-0-6, 9-0-9, 12-0-12 and 15-0-15V. Primary voltages are 220 and 240V. All sizes are constructed on double section bobbins to provide 4kV insulation between primary and secondary.

Prices range from £1·59 to £3·42 including VAT and p&p. Further information from, Clairtronic Ltd., Churchfield Road, Chalfont St Peter, Bucks (0753 887227).



New Tools



A new range of pliers and cutters from OK Industries is available with sets of finger rings enabling the tools to be kept to hand for operations requiring both finger and tool work—twisting wires with the fingers and then cutting the wire ends, for instance. Finger rings with 19 and 23mm diameters are supplied to clip onto the tools' handles so that users can tailor a suitable grip. Another timesaver for gripping difficult-to-hold small components in place during assembly is the K-40 lockable tweezer-plier, it can grip objects up to 7mm thick leaving hands free for other tasks. Made of a tough glass-filled propylene, these tweezers are non-magnetic and resistant to most acids and can also be machine washed or even boiled for perfect cleansing. Details from, OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants. SO5 4AA (0703) 619841).

Briefly...

The *UK Patents Information Network* points out that oil rig workers in the Shetland Isles are among those now beginning to feel the benefits of research done nearly a decade ago. The workers' homes are kept warm by 'paint-on' electrical heating. The houses have heated panels which incorporate graphite and are coated with electrically conductive paint. This paint can act as a heating element when applied to non-conductive materials such as brick and plasterboard etc and connected by electrodes to a low voltage power supply. Methods are described in patents such as UK 1 296 855.

• • • •

According to the Alfred Marks research unit, a recent study of secretarial, clerical and word processing staff, showed that among the factors that influence people to leave their jobs, inept management ranks top. Of the 387 respondents, 288 were critical of their bosses' management abilities. The most frequent complaint was the lack of interest they showed in their subordinates' careers.

• • • •

Amstrad the consumer electronics PLC has moved its administration offices from Garman Road, Tottenham.

The move has been brought about by continued company growth and a need for larger premises in anticipation of the company's CPC 464 home computer sales. The new address will be, Brentwood House, 169 Kings Road, Brentwood, Essex CM14 4EF. (0277 228888).

Countdown ...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Light Fantastic Open 7 days a week at the Gallery of Holography, 48 South Row, The Market, Covent Gdn., London. **A8**
Cable July 10–12. Wembley Conf. Cntr., London. **O**
Education, Training & Development July 10–12. NEC. **B2**
BAEC Amateur Electronics July 14–28 (not Mon's, Tues' or Thurs'). The Shelter, The Esplanade, Penarth, S. Glam. **B9**
Electron & BBC User July 19–21. Alexandra Palace, London. **L**
Concerned Technology (for disabled) Aug. 2–4. Eldon Square Rec. Cntr. Newcastle. **Y3**
IBM System User Show Sept. 3–5. Olympia 2. **Q2**
Concerned Technology (for disabled) Sept. 3–7, Meadowbank Sports Cntr. Edinburgh. **Y3**
Laboratory Sept. 4–6, Barbican, London, **E**
Amplifiers & Speakers (meeting) Sept. 8. Electronic Organ Constructors Society. **Y4**
Testmex Sept. 11–13, Grosvenor Ho., Pk. Lane, London. **E**
Personal Computer World Show Sept. 19–23, Olympia 2, London. **M**
Building & Home Improvement Sept. 25–30. Earls Court, London. **M**
Computer Graphics Oct. 9–11. Wembley Conf. Cntr., London. **O**
Software Expo Oct. 16–18. Wembley Conf. Cntr., London. **O**
Drives, Motors & Controls Oct. 24–26, Harrogate Exhibition Cntr. **E**
Leisuretronics Nov. 8–11, Royal Horticultural Hall, London. **T**
P.c.b. Manufacture & UV Box Construction (meeting) Nov. 17. Electronic Organ Constructors Society. **Y4**

A8	Holographic Exhibitions Ltd. ✆ 01-836 6424
B2	Brintex ✆ 01-637 2400
B9	Cyril Bogod ✆ 0222 707813
E	Evan Steadman ✆ 0799 26699
L	Database ✆ 061-456 8383
M	Montbuild ✆ 01-486 1951
O	Online ✆ 01-868 4466
Q2	EMAP ✆ 01-837 3699
T	Trident ✆ 0822 4671
Y3	Expoman ✆ 01-788 7755
Y4	Percy Vickery ✆ 0202 423863

commodore 64
RS232C INTERFACE

R.A.PENFOLD

THE Commodore 64 home computer has a number of quite advanced features for a machine in its price bracket, and one of these is the user port. Apart from acting as an 8 bit input/output port for user add-ons, it can, with the aid of some built-in software, operate as an RS232C serial interface. This is obviously an extremely useful feature as it enables the unit to operate with equipment such as high quality printers, modems, etc., but there is a drawback in that the inputs and outputs are all normal 5 volt logic types, whereas the RS232C system uses nominal −12 volt and +12 volt signal levels. Also, an inverter is needed at some inputs and outputs to provide correct operation of the port. Presumably the necessary interfacing for RS232C operation has been omitted to enable the port to be used for other purposes as well.

Fortunately it is quite simple to add a level shifting circuit to the port so that proper RS232C operation can be obtained, and basically all that is needed is a power supply circuit and two inexpensive integrated circuits to provide the level shifting. As there is a 9 volt a.c. output on the user port which can be used to generate the required plus and minus 12 volt supplies the interface simply plugs between the port and the RS232C equipment, with no other connections being needed.

The driving software of the port can provide operation at any of the popular baud rates and with any normal word format.

LINE DRIVERS/RECEIVERS

The level shifting in this design is provided by line driver and receiver integrated circuits which have been designed specifically for use in this application. The devices in question are the MC1488 (or SN75188) quad line driver and the MC1489 (or SN75189) quad line receiver. Pinout details of both devices are shown in Fig. 1.

Fig. 2 shows the general arrangement used in each section of the MC1488 line driver. Transistor TRa is used as a sort of common base input stage, and it is normally switched on by the bias current that flows through Ra, Dc, Dd, and Rb, and the consequent voltage developed across Rb. A high input is therefore provided to the buffer stage at the output, but as the latter provides an inverting action its output goes low. If a low input signal is supplied to either input (or both inputs) of the device, the current flowing through Ra is diverted away from Dc and Dd, and instead flows to ground through Da/Db. TRa is then cut off, its collector goes low, and the output from the buffer goes high.

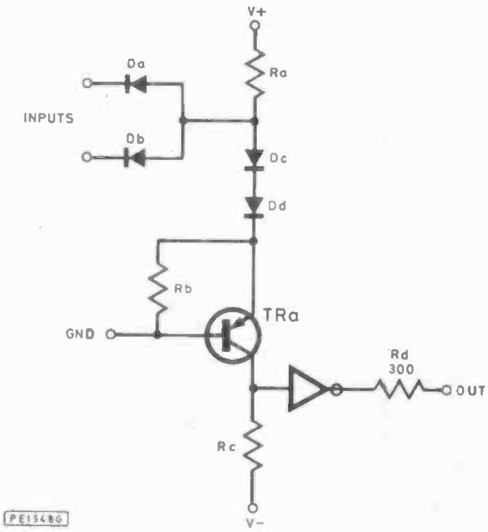


Fig. 2. The arrangement used in the MC1488 line drivers

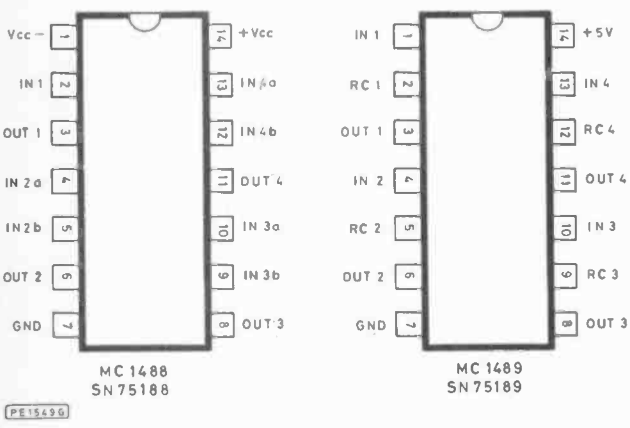


Fig. 1. Pinout details for the MC1488 and MC1489 devices

Some of the output signals from the user port of the Commodore 64 are of the wrong polarity, but the line drivers provide the required signal inversion in addition to the level shifting. Where no signal inversion is required an inverter added ahead of the line driver is used to counteract the inversion through the driver.

In most applications, including the present one, only one of the inputs to each driver is needed. Either the inputs can be wired in parallel or one of them can simply be ignored. Note that one of the drivers has only a single input. The 300 ohm resistor at the output is used to provide current limiting, which is a requirement of the RS232C standard.

The circuit diagram of Fig. 3 is for each of the line receivers in the MC1489 device. This is little more than three straightforward transistor inverters connected in series. This gives an overall inversion through the device, and an inverter must be used at the output of the device where a non-inverting interface is required. Ra and Da are used to clip the input signal at about −0·65 volts when it is negative in polarity, and this is done to protect TRa against an excessive reverse bias voltage and possible damage. Ra also provides current limiting when the input signal is positive in polarity and TRa is forward biased.

Resistor Rf is used to introduce a substantial amount of hysteresis which helps to avoid spurious operation due to stray pick-up of noise. A capacitor from the "Response Control" input to ground can be used to limit the high frequency response of the circuit, and again, this can help to prevent corrupted data due to noise pick-up, but in most cases this facility is not used.

THE CIRCUIT

Refer to Fig. 4 for the full circuit diagram of the interface.

The 9 volt a.c. output from the user port is capacitively coupled by C1 and C3 to two rectifier and smoothing circuits which produce the positive and negative supply rails. The unloaded supply voltages are approximately plus and minus 12 volts, but both reduce by about 2 volts or so when loaded. This gives an ample voltage swing from the line drivers (IC2) since RS232C standard requires minimum signal levels of only plus and minus 3 volts. There is a significant amount of ripple on both supplies, but this is perfectly acceptable in this application.

IC1 is the MC1489 line receiver, and this needs only a single +5 volt supply. A suitable supply is available from the user port, and this is used to power IC1.

There are a number of inputs and outputs available at the user port when it is used in its RS232C role, although some of these are unlikely to be needed in practice. The two principal ones are signal input and output, which are, of course, the ones that are used to carry data into and out of the machine. The others are mostly handshake lines which are used, where necessary, to regulate the flow of data into or out of the computer. For example, if the Commodore 64 is used to drive a printer, it is unlikely that the printer will be able to keep up with the flow of data from the computer. The printer's RS232C port should have a DTR (data terminal ready) or RTS (request to send) handshake line which would

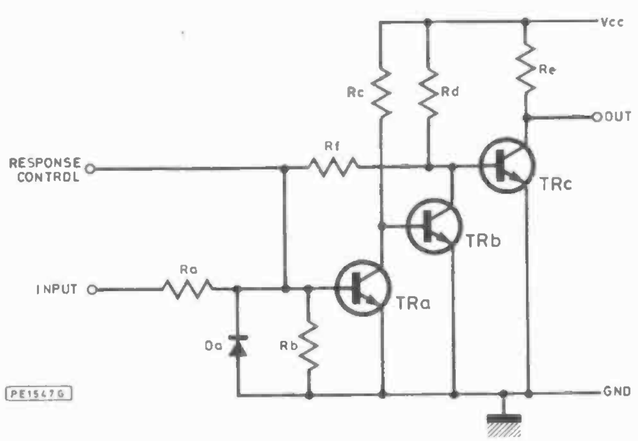


Fig. 3. The MC1489 line receiver

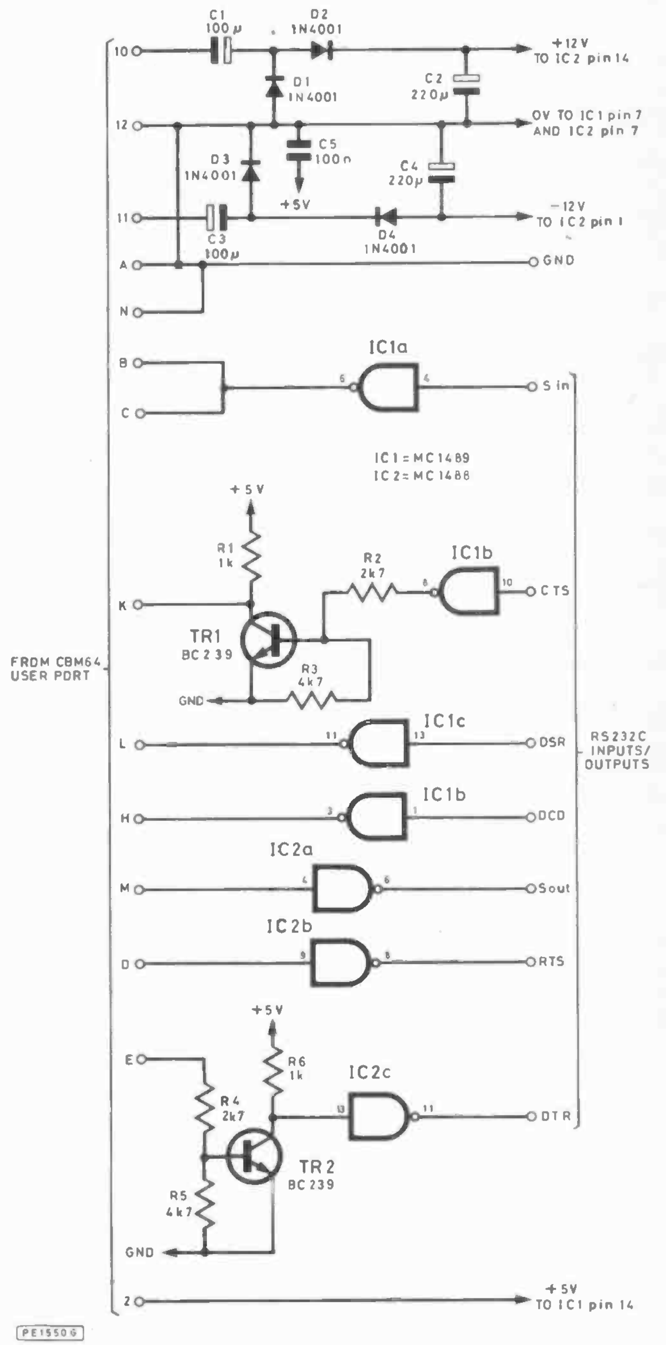


Fig. 4. The circuit of the RS232C interface

be connected to the CTS (clear to send) or DSR (data set ready) handshake input of the Commodore 64's RS232C interface. The handshake line is then used by the printer to indicate when it is not able to process data, and a software loop in the computer halts the outflow of data during these periods.

The Commodore 64 provides RTS and DTR outputs so that it can operate with handshaking when it is receiving data, although in most cases it will be able to keep up with the sending rate and handshaking will then be unnecessary.

The DCD (data carrier detect) is an input which enables the sending device to indicate to the Commodore 64 that the communication link has been established, but this is only utilised in automatic systems, and is unlikely to be needed.

When using the Commodore with a number of pieces of RS232C equipment it was always necessary to have the input and output data signals inverted. With the handshake lines things seem to be less universal, and it is usually necessary to experiment a little to find the method of connection that gives correct operation. TR1 and TR2 are used in simple inverter circuits which give non-inverted CTS and DTR lines, and this is likely to be the most useful arrangement in practice. However, if necessary it would not be difficult to reconfigure the circuit slightly.

CONSTRUCTION

Details of the printed circuit board and component layout for the interface are shown in Figs. 5 and 6.

While the board is quite straightforward and simple to construct, it is important to take great care not to make any mistakes. In particular, ensure that the electrolytics and rectifiers are connected with the correct polarity, and do not accidentally swop over the two integrated circuits!

The connection to the user port of the Commodore 64 is made via a piece of 14 way ribbon cable, one end of which connects to the printed circuit board. It is easier to make these connections by way of Veropins, but this increases the risk of accidental short circuits unless sleeving is used over the connections, and it is probably better just to make the connections direct to the board. A 2 × 12 way edge connector is fitted to the other end of the cable, and this must be a

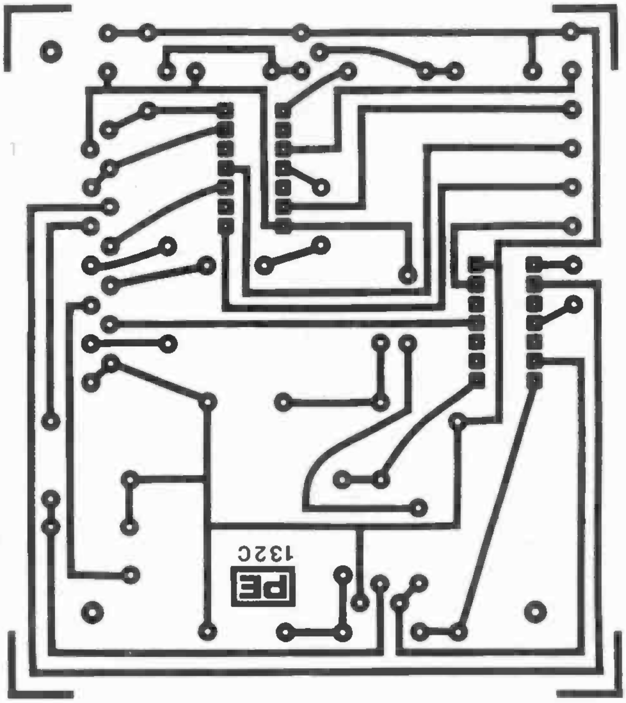


Fig. 5. Printed circuit board layout

COMPONENTS . . .

Resistors

R1,R6	1k (2 off)
R2,R4	2k7 (2 off)
R3,R5	4k7 (2 off)

All resistors 0·25W 5% carbon

Capacitors

C1,C3	100µ 25V axial electrolytic (2 off)
C2,C4	220µ 16V axial electrolytic (2 off)
C5	100n disc ceramic

Semiconductors

IC1	MC1489 or SN75189
IC2	MC1488 or SN75188
TR1,TR2	BC239 (2 off)
D1,D2,D3,D4	1N4001 (4 off)

Miscellaneous

Case about 119 x 99 x 44mm
Printed circuit board
5 way DIN socket (see text)
2 x 12 way 0·156 inch edge connector
14 way ribbon cable
6BA fixings, Veropins, wire, etc.

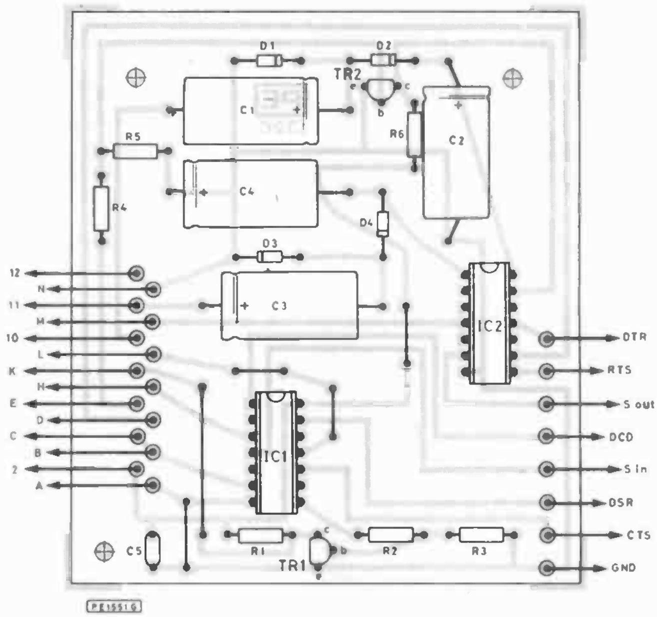


Fig. 6. Component layout

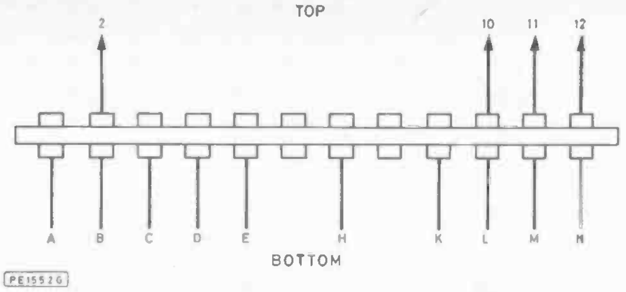
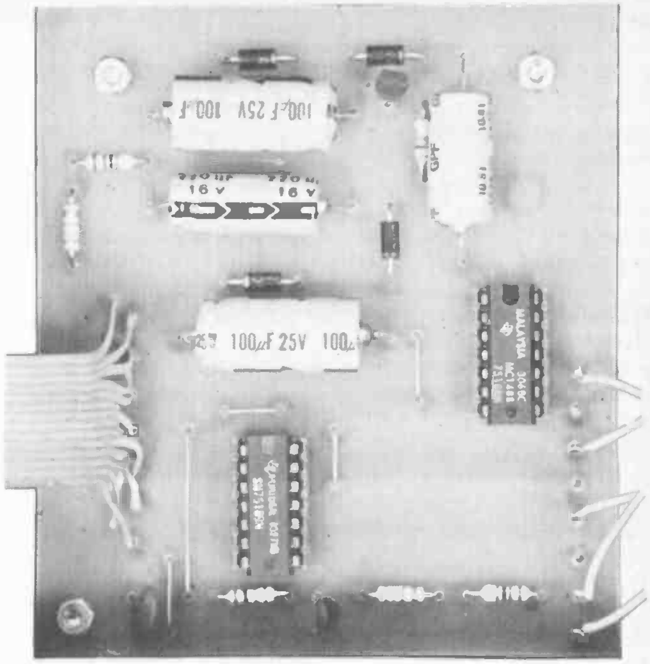


Fig. 7. The connections to the 2 × 12-way edge connector



The RS232C Interface mounted in its case, showing connections to the DIN socket (right), and the ribbon cable (left)

0·156 inch type (not the more common 0·1 inch variety). Fig. 7 shows the connections to the edge connector (which is viewed looking onto the pins at the rear of the connector). There are two slots in the Commodore 64's printed circuit board which can take polarising keys in the edge connector, but a suitable connector might be difficult to obtain. It would probably be possible to add these keys to an ordinary edge connector, or, alternatively, the top and bottom of the connector could be clearly marked as such.

The prototype is housed in a plastic box having approximate inside dimensions of 115 by 95 by 37mm. The RS232C lines are taken to a 5 way DIN socket, with the DCD, RTS, and DSR lines being left unused, but obviously any desired connector having a sufficient number of ways for the lines in use could be utilised. The lid and main part of the case are filed away to produce an exit slot for the ribbon cable. The board is mounted inside the box using M3 or 6BA fixings.

IN USE

In some applications it will merely be necessary to connect the ground and signal in/out terminals of the interface to the other item of RS232C equipment. If (say) a printer is driven from the interface it will be necessary to use handshaking, with the DTR output of the printer being connected to the CTS input of the interface perhaps. However, it may be necessary to experiment a little to find which handshake input/output combination gives the desired effect. Taking the CTS line high enables the output from the port. If the DSR line is used this is taken low to enable the output, but this can only function if the CTS line is taken high, or if TR1 and R1 to R3 are omitted from the board.

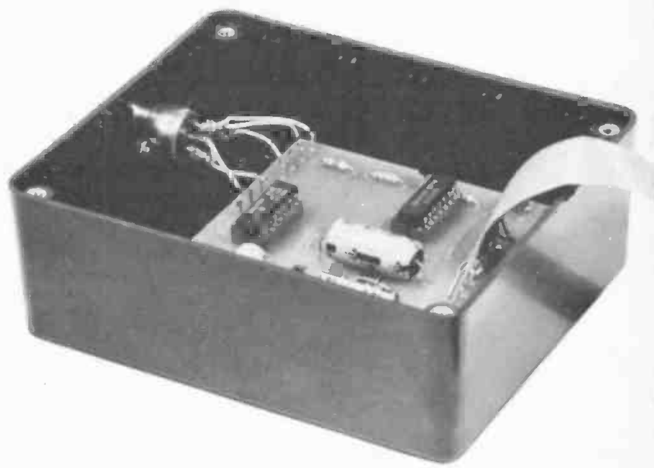
If data is fed into the port from (say) another computer it may be necessary to connect either the DTR or RTS line to the CTS or DSR line of the other computer, even though handshaking will normally be unnecessary in this type of application. This is simply because many serial interfaces cannot output data unless the appropriate handshake line is activated. For example, the CTS line on the BBC model B computer must be taken high to enable the outflow of data. The RTS output of this interface is normally low and the DTR output is normally high.

In order to use the interface a file must be opened, and the baud rate/word format must be specified. The baud rate is simply the rate at which data is sent, and 300 baud for instance, transmits data at 300 bits per second. The data is transmitted together with additional bits, and one of these is the start bit. There is always just one start bit at the beginning of each byte. One or two stop bits are added at the end of each byte. Some systems use parity checking, and this is where either an odd or an even number of bits are transmitted, with the parity bit being added where necessary to ensure that a suitable number of bits are sent. In order to send ASCII codes only 7 bits are required, and this is all that some systems send, but others use 8 data bits. This gives a large number of possible baud rate and word format combinations, but the Commodore 64 can handle all of the common ones.

A file is opened using the command:

```
OPEN X,2,0,CHR$(Y) + CHR$(Z)
```

Here X is the file number (which is used in subsequent commands relating to the RS232C channel), and can be any number in the range 1 to 255. A number greater than 127 is used if a linefeed must follow every carriage return. The figure 2 following the file number is the device number of the RS232C port incidentally.



The number used for Y sets the number of data bits, the number of stop bits, and the baud rate. The table given below shows the numbers that are used to select the desired word format and baud rate:

8 data bits	0
7 data bits	32
50 baud	1
75 baud	2
150 baud	5
300 baud	6
600 baud	7
1200 baud	8
2400 baud	10
1 stop bit	0
2 stop bits	128

For example, 7 data bits, 1200 baud, and 2 stop bits would require Y to have a value of 168 (32 + 8 + 128).

Odd, even, or no parity is selected by setting Z at the appropriate value, as follows:

No parity	0
Odd parity	32
Even parity	96

If handshaking is to be used 1 should be added to the value of Z.

To list a program through the RS232C interface the command:

CMDX : LIST

is used. Here X is the file number, and is the same as the file number used in the OPEN command which opened the RS232C channel. Data can also be sent using PRINT#X, "data".

When a program is listed and handshaking is utilised it may be found that the final part of the listing is not flushed from the Commodore 64's RS232C buffer. One or two PRINT# commands should flush the buffer and complete the listing.

Data can be fetched from the RS232C port using GET#X,A$

In both these examples X is again the file number used in the OPEN command which set-up the RS232C channel.

A final point to bear in mind is that the 255 bytes below RAMTOP are used as the RS232C buffer when the RS232C channel is opened, and any data stored there will obviously be lost.

Further information on using the Commodore 64's RS232C interface can be found in the "Commodore 64 Programmer's Reference Guide" which is published by Commodore. ★

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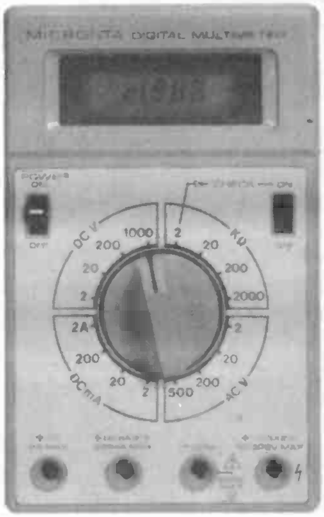

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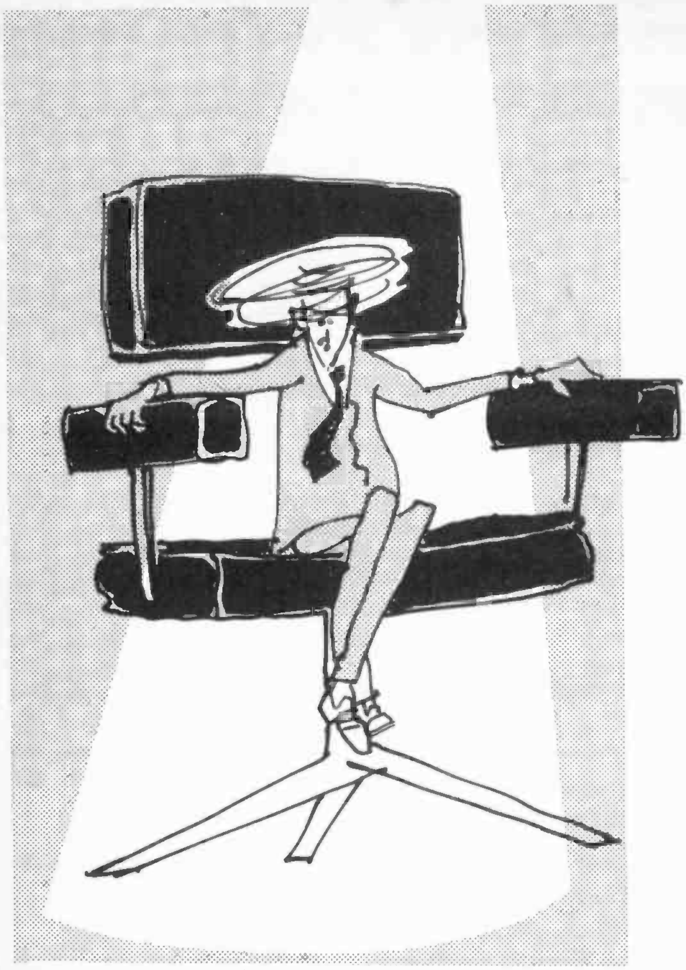
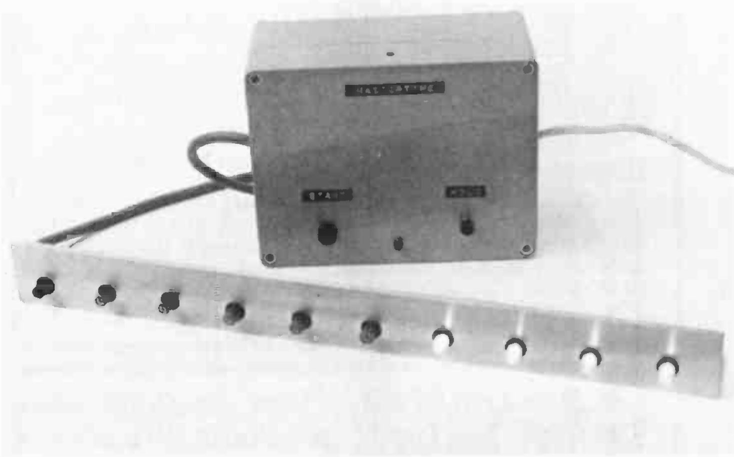


MASTERMIND TIMER...

J.D.Parkinson B.Sc.

A LOCAL cub scout pack had been asked to host a competition which was to be based on the BBC programme Mastermind. The cub scouts were to be asked a series of questions and had to answer as many as possible in two minutes. To keep the young audience interested, it was decided that time keeping should be more spectacular than that which can be achieved by a clock or stopwatch. It was then that I was approached and asked to design an alternative timekeeping system. On pressing the start button, nine lamps are illuminated in sequence after every twelve seconds. During the final twelve second period, an additional lamp is flashed on and off to warn the contestant that his time is nearly finished. At the end of the 120 seconds a buzzer sounds for 6 seconds and then all the lamps extinguish ready for the next contestant.



Mastermind your quiz games with the useful two minute timer

CIRCUIT DESCRIPTION

The circuit diagram of the timer is shown in Fig. 1. An oscillator is formed by a CMOS 4093 Schmitt NAND gate (IC1a) and is followed by a CMOS 4040 12 bit binary counter (IC2) wired as a divider. This gives a square wave with a 12 second period at the output on pin 1. This combination was chosen as oscillators running at higher frequencies are usually easier to keep stable than those running at lower frequencies. Even so, this type of Schmitt oscillator must have a well regulated supply, such as that provided by the 78L05 used in this design. The output of IC2 is passed through another NAND gate wired as an inverter to correct the phase of the clock for the shift register IC3 and IC4. It is these two integrated circuits and their interlinking that forms the heart of the Mastermind Timer. To understand their operation it may help to refer to the timing diagram (Fig. 2) and the i.c. pinout diagram (Fig. 3).

When the timer is switched on, the register will take up a random state and start clocking. After a time (maximum of 2 minutes), pin 12 of IC4 will go high and force the reset line high. This clears both stages of IC3 and the first stage of IC4 and consequently extinguishes all the lamps. It also holds the divider (IC2) in the non-operating mode.

On pressing the start button (S1) the second stage of IC4 clears and the RESET line goes low. IC2 starts counting. After 12 seconds, the clock causes the first shift in the registers IC3 and IC4. The first output (pin 5) of IC3 goes high, having clocked the input (pin 7) which is tied to +5V.

After a further 12 seconds another shift occurs and the second output (pin 4) also goes high.

After 96 seconds, all the outputs of IC3 are high. The final output of IC3 acts as the input of IC4 (pin 7) and so after another 12 seconds (108 seconds total) the first output of IC4 goes high (pin 5). During the 12 seconds a lamp is flashed at 3 second intervals by using the 3 second period output of IC2 (pin 14) gated with period "9" (IC1b and IC1c).

At 120 seconds the second output of IC4 (pin 4) goes high, causing the buzzer to operate. This output also acts as the input to the second stage of IC4 (pin 15) which is being

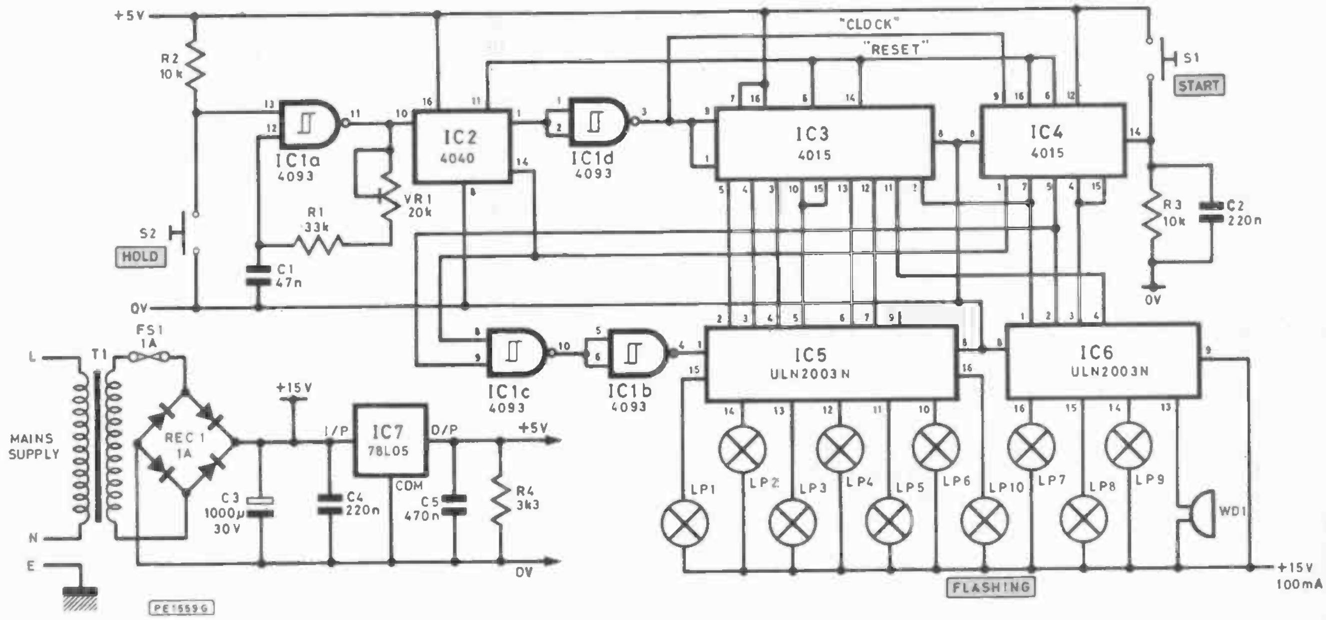


Fig. 1. Circuit diagram of the Mastermind Timer

clocked at 3 second intervals (pin 1). Six seconds was thought to be sufficient time for the buzzer operation so the second output of the second stage of IC4 (pin 12) is used to stop the buzzer by causing a reset. The timer is now automatically back in the "Ready" state. A "Hold" push-button (S2) can be used to introduce pauses in the timing if required. This may, however, affect the timing slightly as C1 will continue to charge.

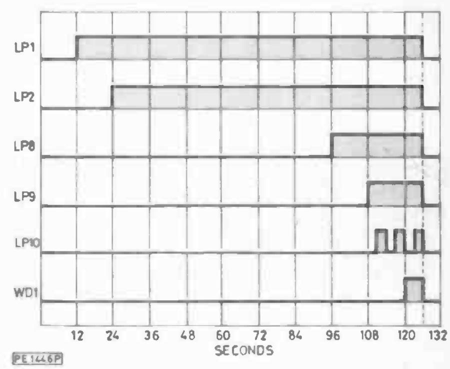


Fig. 2. Timing diagram of lamp sequence

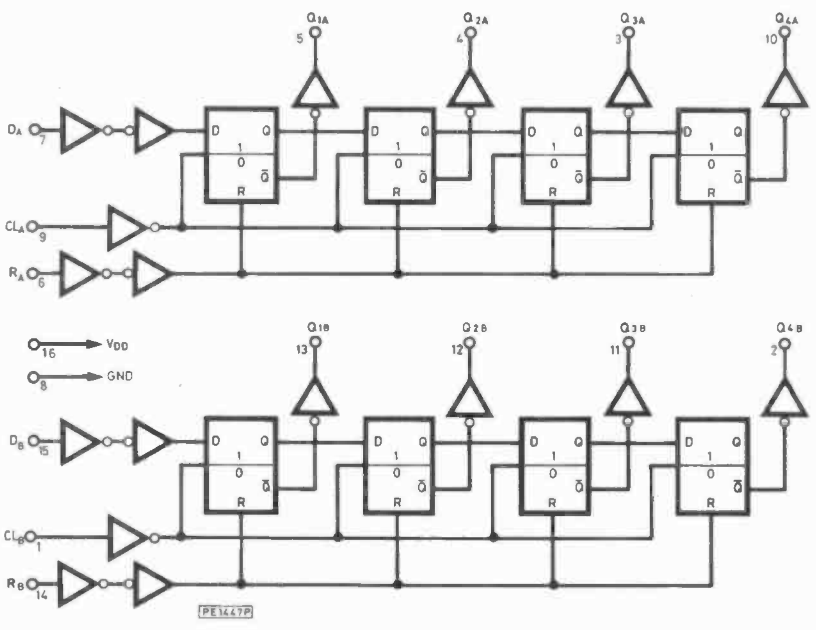


Fig. 3. Pin connections and logic schematic of the 4015

LAMPS AND LAMP DRIVERS

To economise on the transformer and rectifier, and to keep the cost of the power as low as possible, the bulbs were of the T1½ LES type as these have a current demand of less than 10mA. They were still bright enough however to be seen in a reasonably large room. Similarly, the buzzer was chosen carefully for current demand versus audibility but a bell could easily be substituted. If this were done, it would be essential to use the ULN2003 to drive a relay to switch a separate power supply to drive the bell. Failure to do this could cause excessive interference in the CMOS circuits.

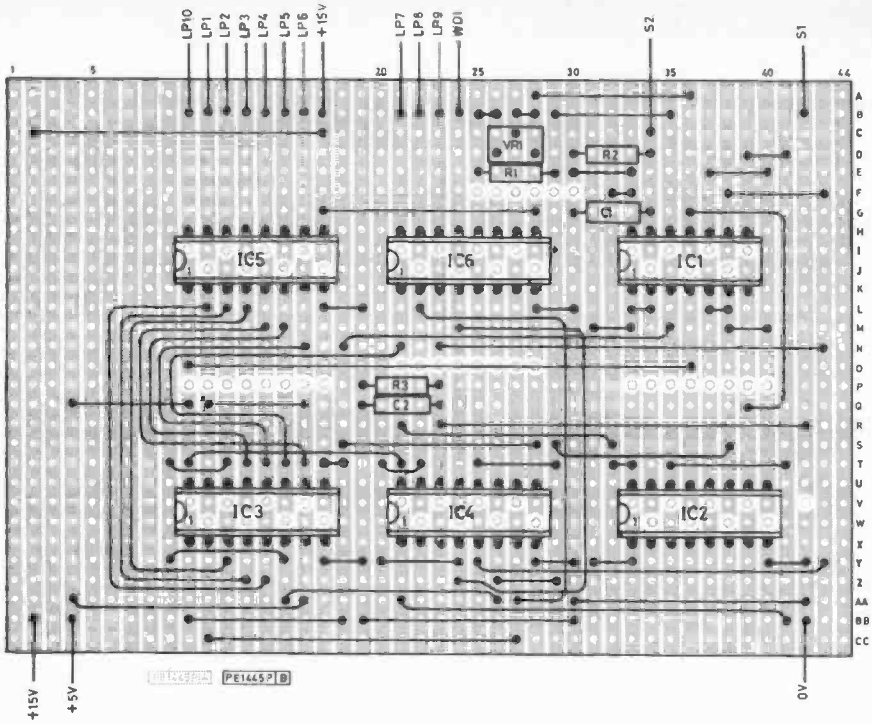
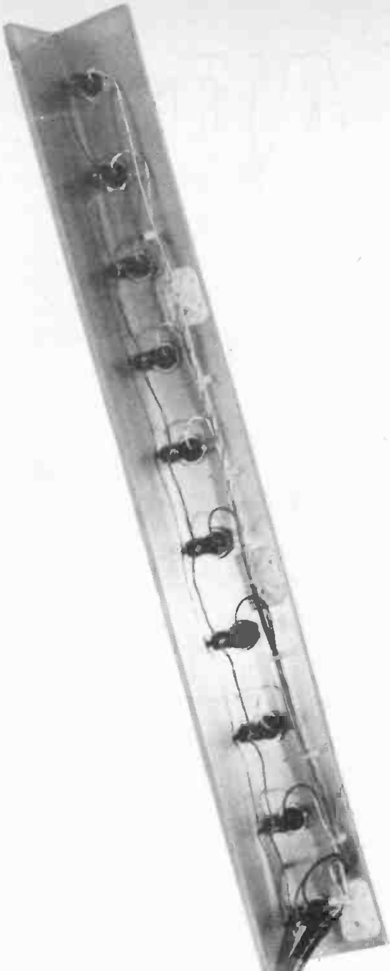
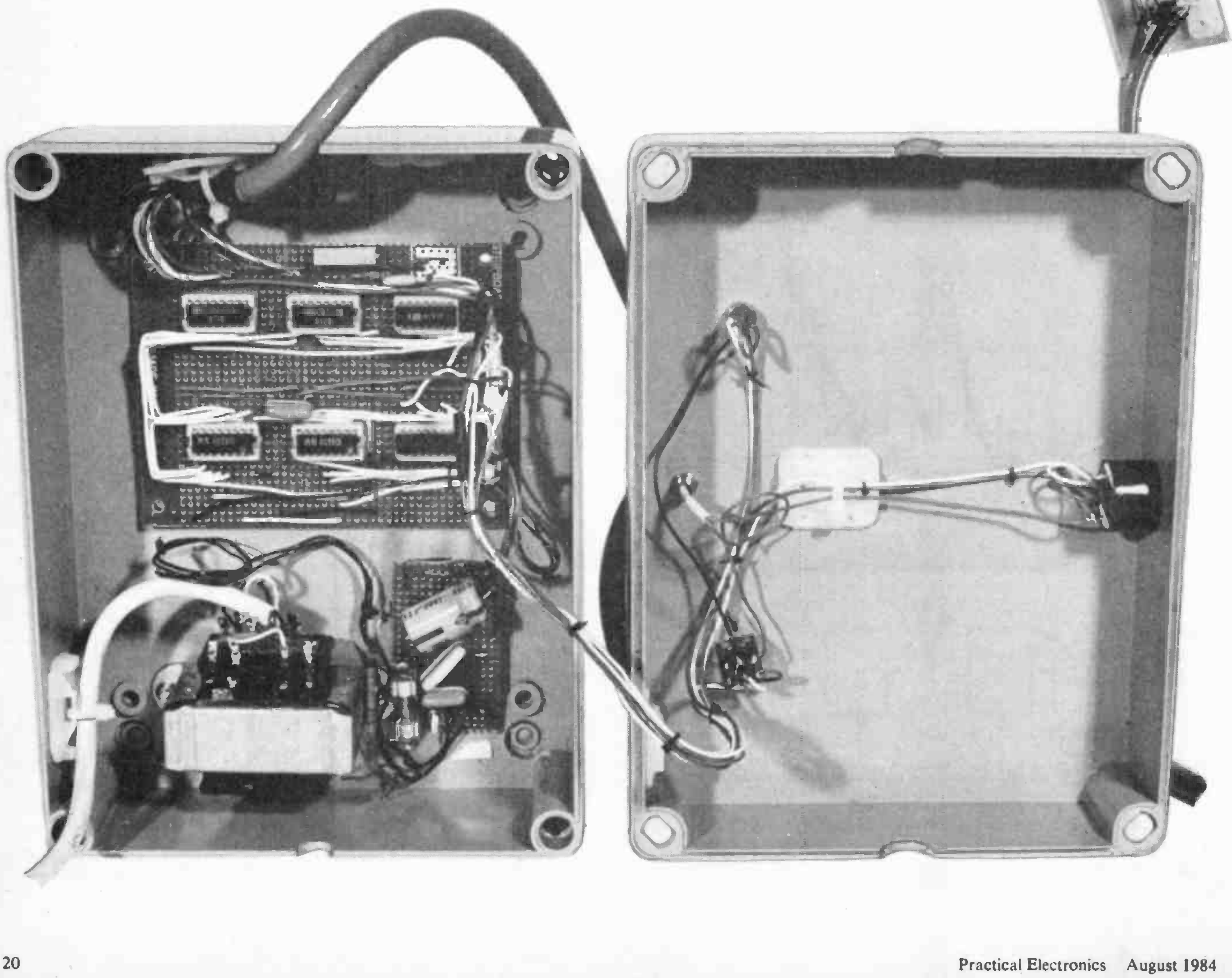


Fig. 4. Layout of timer board. Both boards are shown below, mounted in the case





COMPONENTS . . .

Resistors

R1	33k
R2,R3	10k (2 off)
R4	3k3
VR1	20k pre-set
All $\frac{1}{4}$W 5% Carbon	

Capacitors

C1	47n polyester
C2,C4	220n polyester (2 off)
C3	1000µ axial elect.
C5	470n polyester

Semiconductors

IC1	CMOS 4093
IC2	CMOS 4040
IC3,IC4	CMOS 4015 (2 off)
IC5,IC6	ULN2003N (2 off)
IC7	78L05

Miscellaneous

T1	240V (prim) 12V (sec) 12VA
REC1	1A 200V p.i.v.
FS1	1A
LP 1 to 10	14V LES T1$\frac{1}{2}$ (10 off)
Veroboard	60 x 40mm and 120 x 90mm
Fuse holder	P.c.b. mounting
Lampholders	as required
Case	ABS plastic (as required)
Lamp mounting	aluminium angle
S1,S2	N/o momentary
wire and cable	as required
WD1	Buzzer (as required)

CONSTRUCTION

In the prototype shown in the photographs, the power supply (excluding transformer) was assembled on a 60 x 40mm Veroboard and the timer circuit on a 120 x 90mm Veroboard. These two boards plus the transformer were mounted in a large ABS plastic box with the switches and the buzzer fitted in the lid.

Fig. 4 shows the layout used for the timer board and the link wires between tracks. The other interconnecting wires are loomed together down the sides of the board to produce as neat an appearance as possible given the relatively large number of connections.

The power supply board is shown in Fig. 5 with its board-mounting fuse holder. This board is quite simple and few problems should be encountered with its assembly. However, it is important to ensure the cabling is sound and adequate, especially if it is to be used by young and inexperienced people. Earthing and fusing arrangements should also be strictly adhered to.

The lamps should be mounted in a display panel with enough cable to ensure it can be seen. If possible multicore cable should be used to connect the box to the lamps but failing that instrument wire will suffice if fastened down securely. In the prototype, I had a desk mounted display consisting of an angle of aluminium (50 x 50mm) which was 600mm long drilled at 50mm intervals to take the lamps as shown in the photograph. Aluminium will oxidise very quickly after being handled producing the dull white colour normally associated with this metal. However, to prevent this the metal can be cleaned with a brillo pad (to take out the scratches and finger marks) and then, after rinsing and drying, by spraying with p.c.b. lacquer. The lamp which flashes should ideally be a different colour from the other nine to make it stand out clearly.

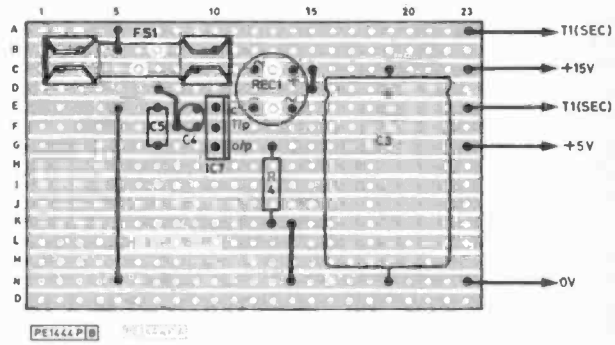


Fig. 5. Layout of power supply board

TESTING

The only test equipment required is a high impedance voltmeter.

1) Turn on the supply and check that the +15V and the +5V are on the correct pins. Also check the 0V pins are wired correctly.
2) Turn off and insert the integrated circuits.
3) Turn on; some lamps will be on and some off, but eventually all should extinguish. If this does not occur then the system is not clocking. Check that the output of IC2 (pin 1) is giving an output of approximately 6 seconds on and 6 seconds off. If it is, then follow the clock across through IC1d, IC3 and IC4. Check that pin 7 of IC3 is wired to +5V. If there is no output from IC2, check the input (pin 10): If IC1a is oscillating then a voltmeter will average the square wave and read approximately 2·5V. If the reading is either +5V or 0V then check the components around IC1a.
4) If all is working, adjust VR1 to give the right frequency by timing the two minutes between pressing "START" and the buzzer sounding. ★

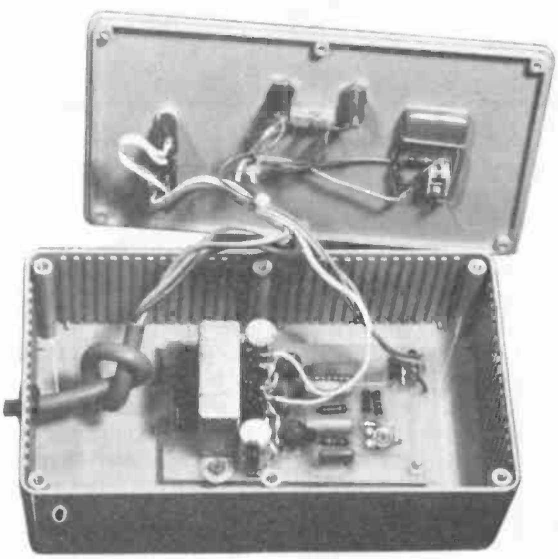
Field Measurements using a Cassette Recorder

T.P. Manning

DESPITE the ease with which data may be digitised and stored the real requirement of a lot of environmental experiments is a graph of change against time. Chart recorders are expensive items and schools and research establishments tend not to have an abundance of them, particularly d.c. powered models for use in the field. What is required is to provide as many students as possible with the means of collecting and examining their own data as cheaply as possible. I therefore adopted the policy some three years ago of advocating the collection of data on cassette tapes and obtaining the curves from the chart recorder in laboratory conditions. The advantages are many fold. The student only has to be provided with an ordinary, standard cassette recorder, the batteries and cassettes for which are obtainable almost anywhere; plus a simple converter. An expensive chart recorder is not used in "messy" environments and problems of lack of paper pens clogged etc. can no longer hamper the collection of field data and hence the ruination of a field trip. The system has been successfully used to record wave height, water and air temperatures and wind speed. The application decided upon for description, since it was slightly more specialised, is for attachment to a kite to measure air temperatures up to 300 metres, over a scale of $-5°C$ to $30°C$.

TECHNIQUE

The basis of the device is the 9400 CT, a 14 pin d.i.l. chip which as a voltage-to-frequency circuit provides 0-10kHz. for a d.c. input of 0-10 volts and can be used in the reverse manner, as a frequency-to-voltage circuit. Thus the transducer's range must be converted for an output of 0-10 volts, and the chip accomplishes the rest. Obviously in the described application weight is a prime consideration. A kite payload of 1lb was specified. The cassette recorder used is one of the miniature dictaphone types using MC60 cassettes. The machine and batteries weighs 8ozs. leaving ample allowance for the p.c.b. and PP3 batteries. The internal microphone is disconnected and the output from the V-to-F fed via the level divider and capacitor as shown. (The amplitude of the pulses coming from the V-to-F chip is 5 volts, and this level is reduced to approximately 200mV.) Although the tape recorder used has switched speeds of either 1·2 or 2·4 cm/sec (1 or 2 hours recording time) the faster speed setting was far superior. To read back the data the signal is taken from the earpiece output and fed through a pulse shaping circuit. (The chip requires a bipolar signal input of greater than $\pm 200mV$, but less than $\pm 2{\cdot}5$ volts). The output will be 0-4V for 0-10kHz input. Thus scaling is arranged to individual requirements.



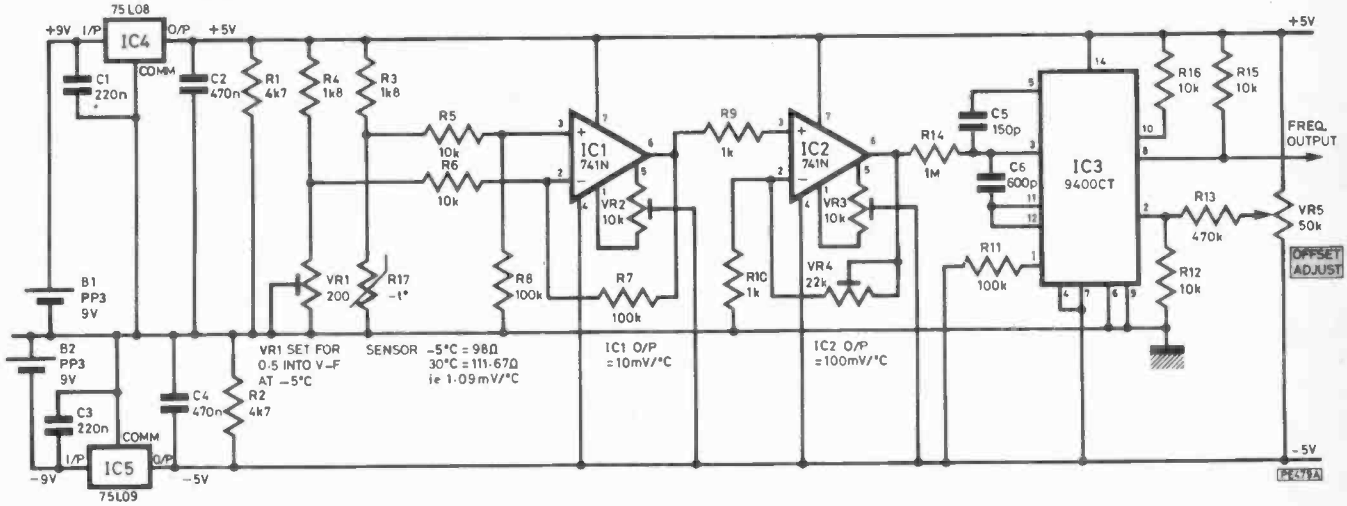


Fig. 1. Voltage-to-Frequency converter in the guise of temperature sensor. This circuit produces temperature related frequencies in a range suitable for domestic cassette recorders

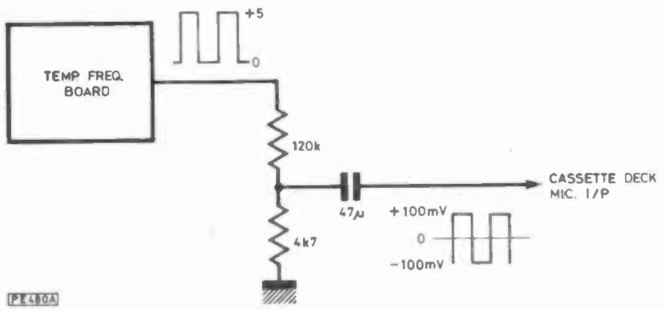


Fig. 2. Attenuator network for input to MIC socket

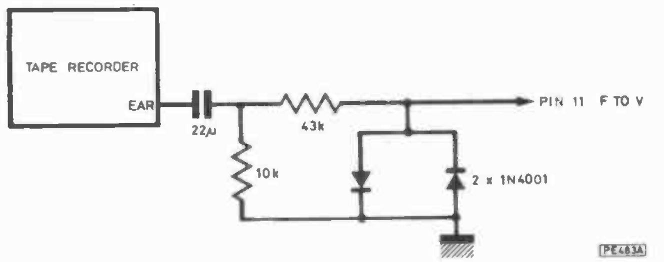


Fig. 3. Level correcting circuit to adapt the cassette recorder output to the F-to-V circuit input

Fig. 4. The 9400CT configured as a Frequency-to-Voltage converter

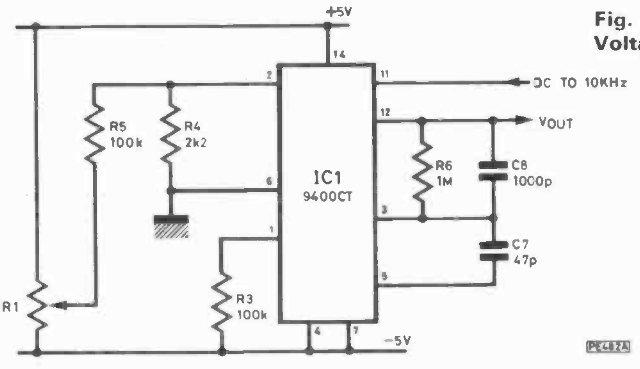
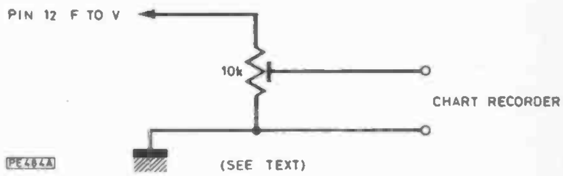


Fig. 5. Potentiometer is used to match F-to-V converter's output to a chart recorder



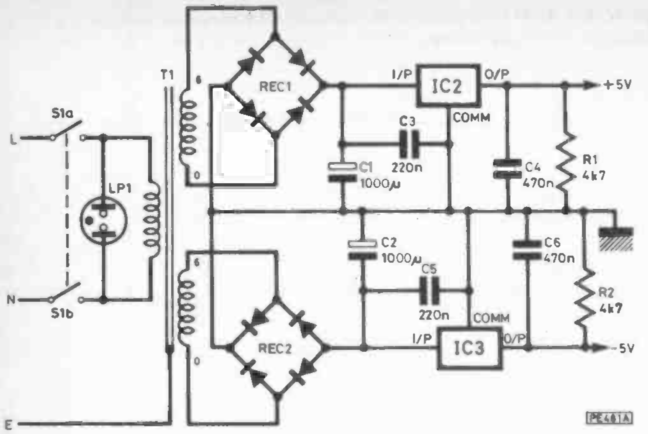


Fig. 6. Suitable PSU

REALTIME DATA LOGGING

COMPONENTS . . .

RECORD UNIT

Resistors

R1,2	4k7
R3,4	1k8
R5,6,12,15,16	10k
R7,8,11	100k
R9,10	1k
R13	470k
R14	1M
R17	Platinum detector ·385 ohm/°C, 1000 ohm/0°C (RS158-244)

All resistors ¼W 5%

Potentiometers

VR1	200 preset
VR2,VR3	10k preset (2 off)
VR4	22k preset
VR5	50k preset

Capacitors

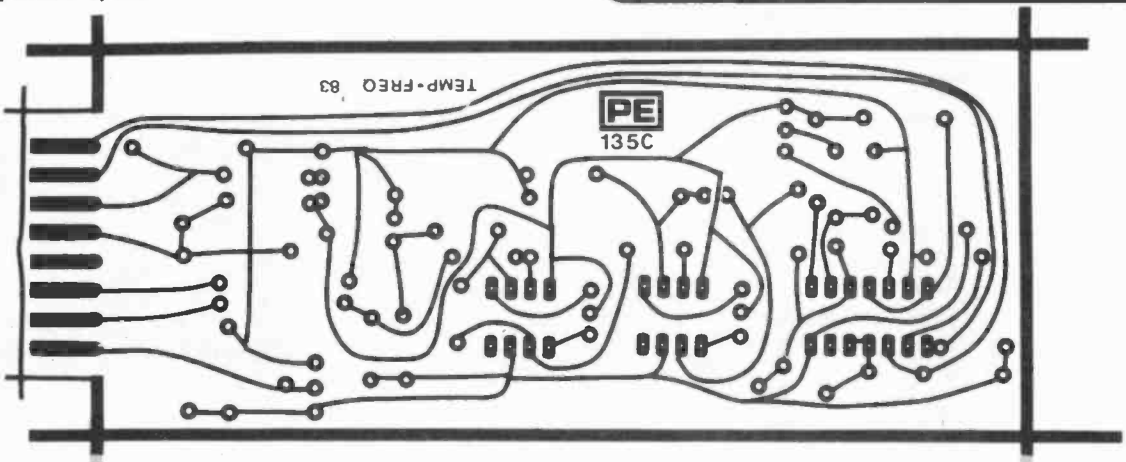
C1,3	220n
C2,4	470n (2 off)
C5	150p
C6	600p

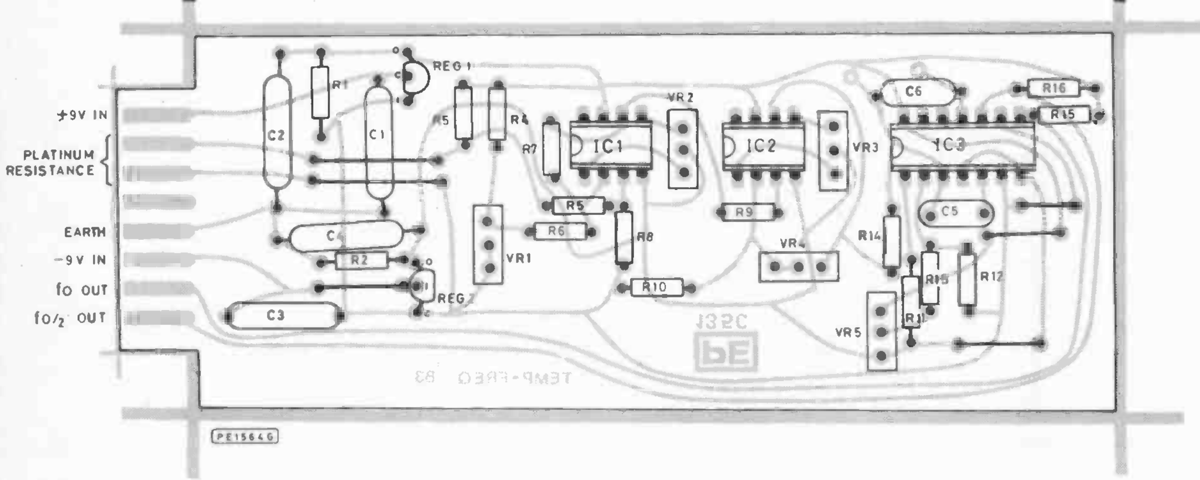
Integrated circuits

IC1,2	741N
IC3	9400CT
IC4	78L05
IC5	79L05

Fig. 7 (below). Temperature-to-Frequency circuit p.c.b. layout (actual size)

Fig. 8 (foot of page). Temperature-to-Frequency board component layout





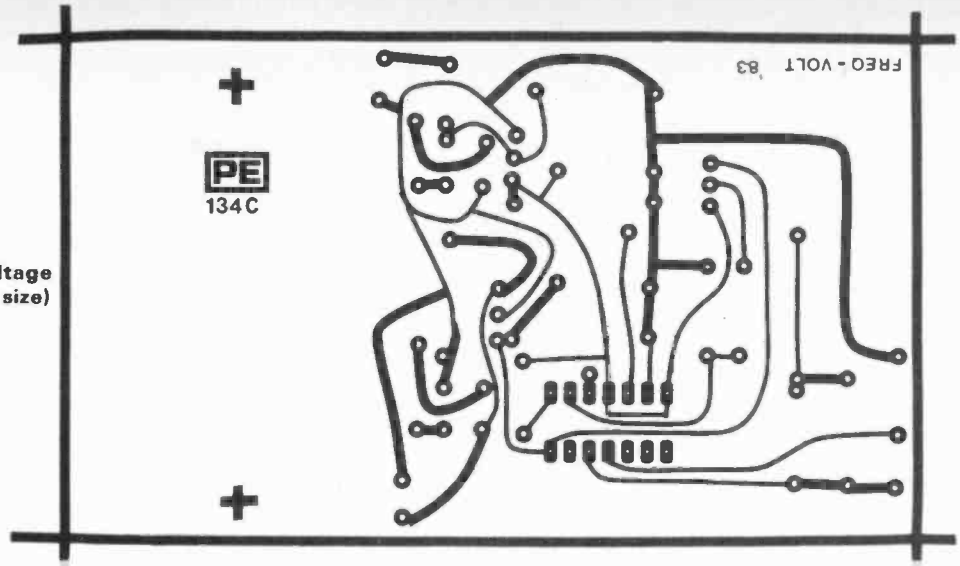


Fig. 9. Frequency-to-Voltage printed circuit layout (actual size)

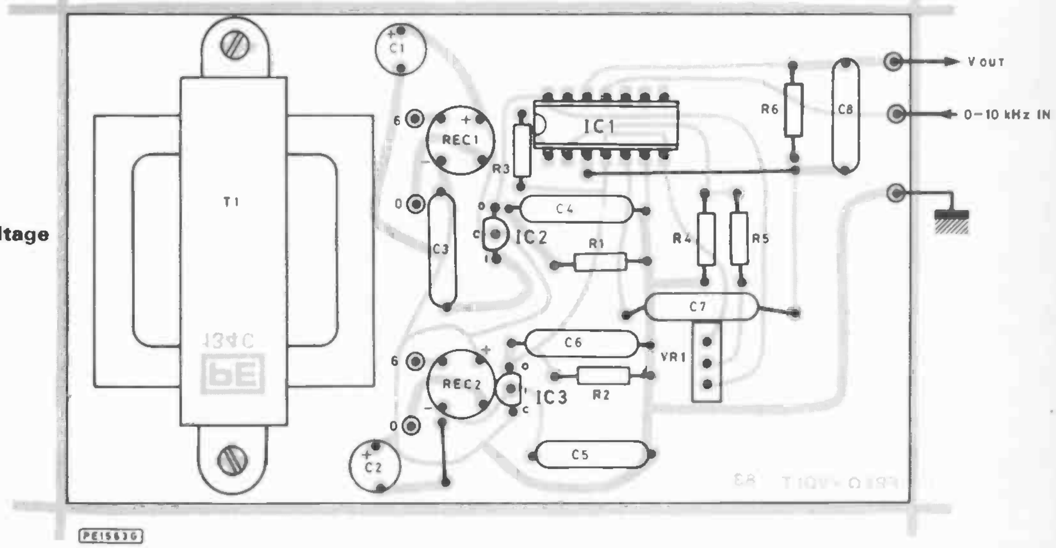


Fig. 10. Frequency-to-Voltage board component layout

In the instrument described the requirement was a range of −5°C to 30°C. The tape recorder has a response of 315 to 4000Hz. Therefore the system was bridged to give 500Hz for −5°C and 4000 for 30°C. This frequency fed to the playback unit produces a range of 0 to 1·6V so a series resistor is used to adjust the scale to 0 to 1V to be fed to the chart recorder.

CONCLUSION

This method is flexible, economic and simple. The transducer must be bridged and amplified to appear in the scale 0 to 10V ensuring that its range is within the frequency range of the recorder and its output range set as previously described. Cheap domestic recorders have proved adequate. ★

COMPONENTS . . .

PLAYBACK UNIT & PSU

Resistors

R1,2	4k7
R3,5	100k (2 off)
R4	2k2
R6	1M

All resistors ¼W 5%

Potentiometers

VR1	50k

Capacitors

C1,2	1000µ (2 off)
C3,5	220n (2 off)
C4,6	47n (2 off)
C7	47p
C8	1000p

Semiconductors

IC1	9400CT
IC2	78L05
IC3	79L05
REC1,2	W005 (2 off)

Miscellaneous

As required neons, switches, plastic boxes, diodes, tape recorders, battery connectors.

T1	0-6, 0-6 mains transformer

MICRO-BUS
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Appearing every month, Micro-Bus now presents ideas, applications and programs for the most popular microcomputers and all micro-related projects so far published in PE. Ideas must be original, and payment will be made for any contribution featured.

ZX80

Sir—The aim of this program is to convert a number in any base to its equivalent in any other base. Any number (or letter, A=11, B=12, C=13 etc), subject to the one proviso that the decimal number produced in line 22Ø does not exceed the machine's limit of 32,767, otherwise error code 6 will be displayed.

Unfortunately the final number produced cannot be used in further calculation due to the method used for displaying it, although in the unexpanded ZX80, there would probably not be enough memory remaining for any further calculation.

This program has been particularly useful for converting binary, decimal and hex into each other's bases.

Lines 16Ø to 26Ø convert the number in base (N) to its equivalent in decimal and lines 27Ø to 4ØØ convert and display the number into its base (M) equivalent.

This program could be run on the ZX81, provided that the following points are taken into account:

Lines 16Ø to 19Ø could be replaced by LEN A$.

Line 34Ø should read LET D=INT (Z/Y).

The character set should be checked that Ø=28 and that 9 is followed directly by A, if these are not the same, suitable modifications should be made to lines 2ØØ and 36Ø.

Graham Lattin,
South Norwood,
London.

Note: ** denotes "to the power of" (shifted 'H')

```
 1Ø  PRINT "BASE(N) TO BASE(M)
     CONVERTER"
 2Ø  PRINT
 3Ø  PRINT "INPUT BASE OF NUMBER
     YOU HAVE"
 4Ø  INPUT N
 5Ø  PRINT
 6Ø  PRINT "INPUT BASE TO WHICH
     YOU WISH TO CONVERT"
 7Ø  INPUT M
 8Ø  PRINT
 9Ø  PRINT "INPUT NUMBER TO BE
     CONVERTED, IF BASE >1Ø, A=11,
     B=12 ETC."
1ØØ  INPUT B$
11Ø  PRINT
12Ø  LET A$=B$
13Ø  LET C$=B$
14Ø  LET X=Ø
15Ø  LET Z=Ø
16Ø  LET A$=TL$(A$)
17Ø  LET X=X+1
18Ø  IF A$=" " THEN GOTO 2ØØ
19Ø  GOTO 16Ø
2ØØ  LET A=CODE (B$)-28
21Ø  LET Y=A *(N**(X-1))
22Ø  LET Z=Z+Y
23Ø  LET X=X-1
24Ø  LET B$=TL$(B$)
25Ø  IF X=Ø THEN GOTO 27Ø
26Ø  GOTO 2ØØ
27Ø  LET X=Ø
28Ø  LET Y=M** X
29Ø  IF Z<Y THEN GOTO 32Ø
3ØØ  LET X=X+1
31Ø  GOTO 28Ø
32Ø  LET X=X-1
33Ø  LET Y=M * * X
34Ø  LET D=Z/Y
35Ø  LET Z=Z-(Y * D)
36Ø  LET D$=CHR$ (D+28)
37Ø  PRINT D$;
38Ø  IF X=Ø THEN GOTO 4ØØ
39Ø  GOTO 32Ø
4ØØ  PRINT " IS THE BASE (";M;")
     EQUIVALENT OF ";C$;" IN BASE
     (";N;")"
41Ø  INPUT X$
42Ø  CLS
43Ø  GOTO 1Ø
```

MICROCONTROLLER

Sir—In response to your request for program material for PE computer projects, other than the UK101, I present below a program for the Microcontroller. This is part of a much longer program used for timed control of central heating and other processes.

In the original program "ky" was a subroutine located above Ø1ØØ and the table only left on page 1. The program reproduced here will run as it stands, but may be modified to be used as a subroutine simply by replacing out: with $39 and ØØ5E,ØØ5F with $39,$Ø1. It can be seen that "setApia" is only accessed once and the rest of the program is continuously polled, facility being provided to get out and make modifications through the "cancel" key.

Thus you can override timed outputs with the keyboard one at a time without clearing or upsetting existing output states.

To test the program a l.e.d. display as described in PE Oct '82 was used. Each l.e.d. being lit by one numeric key press and extinguished by first pressing "#" and while it is held down pressing the appropriate numeric key.

C. Gardiner,
Brighton.

```
                          ;
                          ;
                          ;
                          ;        KEYBOARD
                          ;
                          ;
                                             titl Keyboard subroutine for 68ØØ microcontroller
                          ;                       Adds old pia output status to a new status selected
                          ;                       from the hex numeric keys, Ø–F. (Only Ø–7 here)

             F82C                  keyboard   =   $F82C
```

```
                F877                keycode    =  $F877
                1ØØ1                pia        =  $1ØØ1
                ØØD2                kyfunct    =  $ØØD2
                ØØDØ                stat       =  $ØØDØ
                F8ØA                command    =  $F8ØA
                ØØF4                sto        =  $F4
                ØØ71                table      =  $71

                         ; TABLE located on page 1 (ØØØØ–ØØff) at $7Ø

                ØØFE                keyØ       =  $fe   @  $ØØ71
                ØØFD                key1       =  $fd   @  $ØØ72
                ØØFB                key2       =  $fb   @  $ØØ73
                ØØF7                key3       =  $f7   @  $ØØ74
                ØØEF                key4       =  $ef   @  $ØØ75
                ØØDF                key5       =  $df   @  $ØØ76
                ØØBF                key6       =  $bf   @  $ØØ77
                ØØ7F                key7       =  $7f   @  $ØØ78
                         ;
                         ;
                         ;          PIA Preparation Subroutine
                         ;
ØØØØ  7F        1ØØ3     setApia:             clr        $1ØØ3     ; set all user pia . . .
ØØØ3  86        FF                            ldaa       #$ff      ; I/O lines to be . . .
ØØØ5  B7        1ØØ1                          staa       $1ØØ1     ; outputs.
ØØØ8  86        Ø4                            ldaa       #$/U004   ; Select the pia . . .
ØØØA  B7        1ØØ3                          staa       $1ØØ3     ; output register.
ØØØD  86        ØØ                            ldaa       #$ØØ      ; load all Ø's
ØØØF  B7        1ØØ1                          staa       $1ØØ1     Set all outputs to Ø

                         ;
                         ;
                         ;          Keyboard polling and PIA output modification routine
                         ;
                         ;
ØØ12  BD        F82C     ky:        jsr       keyboard     ; Get monitor keyboard subroutine.
ØØ15  C1        ØØ                  cmpb      #$ØØ         ; Has a key been pressed?
ØØ17  27        47                  beq       clr          ; No—so clear # ky memory.
ØØ19  C1        FF                  cmpb      #$ff         ; Is keypress doubtful?
ØØ1B  27        F5                  beq       ky           ; Yes—so go back and have another try.
ØØ1D  BD        F877                jsr       keycode      ; No—produce code for key pressed.
ØØ2Ø  81        1E                  cmpa      #$1e         ; Is key the # key?
ØØ22  27        Ø9                  beq       hash         ; Yes—so enter in # key memory ($f3).
ØØ24  81        1Ø                  cmpa      #$1Ø         ; Is key any hex number key?
ØØ26  2D        Ø9                  blt       value        ; Yes—so service the selection.
ØØ28  BD        F8ØA                jsr       command      ; No—therefore key is command key . . .
ØØ2B  2Ø        E5                  bra       ky           ;
ØØ2D  97        F3       hash:      staa      $f3          ; Send # key code to # key memory.
ØØ2F  2Ø        32                  bra       out          ; Go back to main program.
ØØ31  97        F4       value:     staa      sto          ; Retain hex number value.
ØØ33  7F        ØØ7Ø                clr       table–1      ; Set Table–1 to zero
ØØ36  81        Ø7                  cmpa      #$Ø7         ; Only 8 functions are required (Change if necess)
ØØ38  2E        29                  bgt       out          ; Reject any other keys.
ØØ3A  4C                            inca                   ; Raise key value so Ø key can be used
ØØ3B  CE        ØØ7Ø                ldx       #table–1     ; Point I.R. to Table–1
ØØ3E  Ø8                 loop:      inx                    ; Point I.R. to next Table value
ØØ3F  4A                            deca                   ; Reduce key value by 1
ØØ4Ø  26        FC                  bne       loop         ; Test if key value now zero
ØØ42  A6        ØØ                  ldaa      0            ; Get the binary mask from the table and . . .
ØØ44  97        D2                  staa      kyfunct      ; store it then . . .
ØØ46  43                            coma                   ; invert it.
ØØ47  97        DØ                  staa      stat         ; Retain the complement of the mask
ØØ49  86        1E                  idaa      #$1e         ; Enter the # key code and . . .
ØØ4B  91        F3                  cmpa      $f3          ; check # store to find if # key down.
ØØ4D  27        Ø2                  beq       zero         ; Yes—so set selected output to off.
ØØ4F  2Ø        Ø3                  bra       fn           ; No—so set selected output to on.
ØØ51  7F        ØØDØ     zero:      clr       stat         ; Make complement of the mask zero instead.
ØØ54  B6        1ØØ1     fn:        ldaa      pia          ; Get current pia output status.
ØØ57  94        D2                  anda      kyfunct      ; Modify pia output by . . .
ØØ59  9A        DØ                  oraa      stat         ; one bit selected by the key pressed.
ØØ5B  B7        1ØØ1                staa      pia          ; Send modified status to pia.
ØØ5E  2Ø        B2                  bra       ky           ; Back to beginning
ØØ6Ø  7F        ØØF3     clr:       clr       $f3          ; Clear # key memory.
ØØ63  2Ø        AD       out:       bra       ky           ; Back to beginning.
```

```
0250  A57B     LDA  $7B
0252  8558     STA  $58        initialisation starts here
0254  A57C     LDA  $7C        copy 7B,C into 58,9 to be variable pointer
0256  8559     STA  $59
0258  A966     LDA  £$66
025A  8D1802   STA  $0218      make input vector point to variable list
025D  A902     LDA  £$02       routine, A
025F  8D1902   STA  $0219
0262  A960     LDA  £$60
0264  8503     STA  $03        disable OK
0266  A559     LDA  $59        actual program starts here
0268  C57E     CMP  $7E
026A  9019     BCC  $0285
026C  D006     BNE  $0274      are there any variables left to print?
026E  A558     LDA  $58
0270  C57D     CMP  $7D
0272  9011     BCC  $0285
0274  A94C     LDA  £$4C
0276  8503     STA  $03        NO—restore OK
0278  A9BA     LDA  £$BA
027A  8D1802   STA  $0218
027D  A9FF     LDA  £$FF           restore input vector
027F  8D1902   STA  $0219
0282  4C0000   JMP  $0000          warm start to get back to BASIC
0285  A202     LDX  £$02       YES—
0287  A93F     LDA  £$3F
0289  8513     STA  $13        put ?(PRINT) into BASIC buffer
028B  A000     LDY  £$00
028D  B158     LDA  ($58),Y    find first character of variable
028F  20EEFF   JSR  $FFEE      print it
0292  8514     STA  $14        put in BASIC input buffer
0294  C8       INY
0295  B158     LDA  ($58),Y    find second character of variable
0297  48       PHA
0298  297F     AND  £$7F       mask off Most Significant Bit on left
029A  F006     BEQ  $02A2      is it a two character variable?
029C  20EEFF   JSR  $FFEE      YES—print second character
029F  9513     STA  $13,X
02A1  E8       INX                 put in BASIC input buffer
02A2  68       PLA
02A3  1018     BPL  $02BD      is it a string variable?
02A5  A000     LDY  £$00
02A7  B9DB02   LDA  $02DB,Y
02AA  F00E     BEQ  $02BA
02AC  C8       INY             YES—put $CHR$(34) into input buffer
02AD  9513     STA  $13,X
02AF  E8       INX
02B0  D0F5     BNE  $02A7
02B2  B9DB02   LDA  $02DB,Y
02B5  F00B     BEQ  $02C2
02B7  20EEFF   JSR  $FFEE          print $="
02BA  C8       INY
02BB  D0F5     BNE  $02B2
02BD  A93D     LDA  £$3D
02BF  20EEFF   JSR  $FFEE      NO—print =
02C2  A558     LDA  $58
02C4  18       CLC
02C5  6906     ADC  £$06       make variable pointer point to next
02C7  8558     STA  $58        variable
02C9  9002     BCC  $02CD
02CB  E659     INC  $59
02CD  A000     LDY  £$00
02CF  9413     STY  $13,X      put marker at end of BASIC input buffer
02D1  840E     STY  $0E
02D3  A212     LDX  £$12
02D5  68       PLA
02D6  68       PLA             back to BASIC
02D7  68       PLA
02D8  68       PLA
02D9  8A       TXA
02DA  60       RTS
02DB/24        $
02DC/43        C
02DD/48        H
```

codes

```
02DE/52   R
02DF/24   $
02E0/28   (
02E1/33   3
02E2/34   4
02E3/29   )
02E4/00
02E5/24   $
02E6/3D   =
02E7/22   "
02E8/00
```

UK101

Sir—While working on a 380Z at school I found that I used the LVAR command a lot when writing or testing programs, and that I missed this when working at home on a UK101. To put this right I wrote this machine code routine (left) which lists all the variables which have been created by BASIC. It works with the UK02 and WEMON monitors and should work with any monitor if the input vector is at 0218,9(Hex) and points to FFBA(Hex). The table of variables used by BASIC are stored directly after the last line of BASIC and the address of the start of the table is held in page zero locations 7B,C. Location 7D,E holds the first free address after the table. Locations 13(H) to 58(H) form the BASIC input buffer.

When the program is first called, by setting the input vector to point to 0250, the initialisation routine: disables the OK which would be output after printing each variable; copies the contents of 7B,C to 58,9 which acts as the pointer to each variable; and makes the input vector point to the start of the actual program which first compares 58,9 with 7D,E to see if there are any variables left to list. If there is none left it resets the input vector back to FFBA, restores OK and executes a WARM START to get back to BASIC. If there is a variable left to list, say AB, it will print AB=, put ?AB into the BASIC input buffer and return to BASIC to print the value of AB. On the screen you will see AB=1 (or whatever). If it is a string variable, say AB$, it prints AB$=" and puts ?ABCHR(34) into the buffer (character 34 is a quotation mark) giving the output AB$="WHATEVER". The quotation marks were put in to show up string variables made up of spaces and also to allow variables to be saved on tape by setting the save flag and running the list variables program: if there were no quotation marks on string variables it would give a type mismatch error when loading in immediate mode. To run the list variables program type POKE 536,80:POKE 537,2 in immediate mode. Incidentally, RESET WARM START does not destroy variables. The following program lists all variables except arrays.

David Rogerson,
Morpeth,
Northumberland.

INDUSTRY NOTEBOOK

By Nexus

War and Peace

After last year's Labour Party and Trade Union conferences it became clear that at grass root level there had been a change in attitudes. This year we are beginning to see how the change is working out in practice.

The row over the banning of unions in the security-sensitive corridors of GCHQ had a unifying effect. Here was a cause in which everybody could join. A great principle seemed to be at stake. The protest was prolonged and noisy. In the event it was a lost cause with GCHQ employees surrendering their membership for immediate financial advantage.

When it came to the strike in the coalfields we had an entirely different situation. The cause was just but from the start there was a split on the wisdom of striking. By ingenious re-interpretation of the union rule book what was initially a walk-out in one pit was projected into a declaration of a total strike without recourse to the traditional ballot.

Mass picketing of working pits failed to intimidate the non-strikers. Verbal and digital obscenities and physical violence were not enough to force submission. Despite the provocation coal was still being mined. It was now civil war in the historically fraternal National Union of Mineworkers.

Worse was to come. Steelworkers were sympathetic but unwilling to co-operate too closely when it became obvious that their own jobs were in jeopardy. Lorry drivers, ordered by their own union not to cross picket lines, openly defied their union bosses.

Working class solidarity seemed to have dissolved. The cause is not difficult to see. Union members are no longer working class in the sense of fifty years ago. Today they have graduated to progressive property ownership, to driving a decent car, to annual holidays abroad, all not lightly to be cast aside.

I mention these disputes only to highlight the enlightened attitude towards *sweetheart* agreements which I mentioned a couple of months ago. The engineering unions are now moving towards the position adopted by the electricians wherein no-strike clauses are seen, in the long run, to be beneficial all round. Peaceful negotiation and the creation of wealth is more sensible than a destructive war and is now seen as a preferred option. The very idea seemed so outrageous to the old guard in the trade union movement that it has never been debated. But it could be the hottest topic at the autumn conferences.

The Economy

Optimism has been bursting out all over following first quarter results and forecasts for the future. Both CBI and Institute of Directors surveys of business opinion revealed high levels of confidence. In our own industry a major indication is the level of component sales. The Association of Franchised Distributors of Electronic Components (AFDEC) sees 1984 as a bumper year, so much so that there will be a shortfall in some component categories and principally i.c.s.

The manufacturers are responding with gusto. Texas Instruments is only one of many stepping up output. TI is spending £10 million to more than double output of linear i.c.s at their Plymouth plant with the prospect of another 400 people employed by next April. A group of companies from California is setting up a new company, Integrated Power Semiconductors, at Livingston, Scotland. Funding of £15 million guarantees an immediate start on plant construction and IPS will eventually employ about 500 people.

On the R & D front the Alvey programme is at last getting off the ground with a £3·6 million award for a prototype project. Defence electronics is moving smartly ahead with major contracts. Plessey's Ptarmigan secure tactical communications system has won a second phase contract worth £200 million of which £34 million goes to STC as a principal subcontractor.

Marconi Space and Defence Systems (MSDS) has scooped a £100 million contract as prime contractor for a new airborne electronics counter-measure system. Called Zeus it is initally to be carried by RAF Harrier close support aircraft. Partner in the deal is Northtrop Corporation of Chicago who will supply the jamming transmitters but MSDS has total responsibility for design and engineering.

Zeus is a good example of Anglo-American co-operation and justified if only because the American-built version of the Harrier, the AV8B, has commonality with the British-built GR5 Harrier of the RAF. Northrop is undertaking joint marketing of Zeus in the USA and other countries so the £100 million order could just be the beginning. Meantime that alone will keep 500 people busy at MSDS plus those employed at over a hundred outside suppliers.

Critics of defence spending often overlook two important factors. First is the ultra-high technology content which keeps our designers on the frontier of developments and second is the high value added. Very roughly if a military aircraft and its electronics cost, say, £10 million, the cost of raw materials would be under £1 million with the difference made up entirely in design and manufacturing skills. Very few countries have this measure of engineering capability whereas any country can press out kitchen utensils and similar everyday products which have low added value.

Salaries

Studying the situations vacant columns it is clear that the demand for qualified electronic engineers remains insatiable. According to a recent membership survey by the IEE 98.9 percent were in employment. Salaries in the 35–39 age group (i.e. at typical career midpoint) have risen from an average of £3,280 in 1973 to £14,470 in 1984. A young Associate should command over £6,000 on his/her first appointment while senior Members and Fellows can achieve £28,000 late in their careers and £30,000 and over in senior management.

It is a tragedy that so few young people are motivated towards getting the admittedly high qualifications needed for professional entry. For this the schoolteachers must bear some blame. When we learn that half of all employers who recruit school leavers are dissatisfied with educational attainment there must surely be cause for concern.

The brighter students of course will have moved on to further education but even here we could do with more in science and engineering and fewer in arts. It is to be hoped that the increase in computer studies in schools will fire the imagination in favour of electronics. It is also true that many successful engineers have had no formal training but have succeeded through enthusiasm and love of the subject. Nevertheless, other things being equal, the certificated engineer will always influence a potential employer to the disadvantage of a competitor less qualified.

Footlights and Whisky

Two unlikely topics for *Industry Notebook* but not unconnected. Footlights first. I was not surprised to hear that Evan Steadman, owner and organiser of the "All Electronics Show" and other trade and technical exhibitions, has branched out into popular entertainment as a backer of the musical 'Peg' in London's theatreland. Evan has always been a showman and it was always on the cards that he would succumb to the heady scent of greasepaint and the dazzle of footlights. We wish him success with his investment.

Less predictable was GEC's purchase of 10 million shares in Distillers. It seemed hardly likely that Lord Weinstock was planning a takeover and, in fact, his £45 million investment made over a lengthy period amounted to only some 3 percent of Distillers capital. GEC is still sticking to what it knows best. But with a cash mountain in the region of £1·5 billion Lord Weinstock has decided to invest in other companies and as a bonus is willing to give management advice.

Digital Dice

P. Leah

THE digital dice described in this article has several novel design features not usually available with electronic dice:

a) Single push-button operation for each 'throw' of the dice which provides two independent readouts for games such as backgammon and monopoly.

b) Seven segment displays for an easily readable display format.

c) No power on/off switch. The dice display remains active for over five minutes after the push-button has been depressed.

d) A l.c.d. for clear readout in all lighting conditions.

e) Minimal power requirements. Hence the dice is totally portable using a PP3 battery as a power source.

PRINCIPLE

Most designs of electronic dice use six independent l.e.d.s to display the numbers one to six rather than using a more readable seven segment display. Looking at the extensive range of i.c.s currently available, particularly counters and display decoder drivers, it seems surprising that dice using seven segment displays are not more common. However, consideration of the counting modes of i.c. counters shows only a binary range of 0 to 15 or a binary coded decimal range of 0 to 9 is available. A range of 1 to 6 can only be achieved by a complex gating arrangement using standard counters and a variety of NAND and NOR gates.

This particular design of digital dice overcomes these problems by using only a four bit down counter which interfaces directly to a binary coded decimal to seven segment display driver. The basic 'secret' of the design is simply to use a presettable binary down counter which presets to six and then counts down to 0. On reaching 0 the borrow output pulse is used immediately to preset the counter to 6 again. Fig. 1 shows the block diagram of the digital dice.

The oscillator operates at a frequency of approximately 3kHz which is divided by two, series connected, divide-by-six counters. Hence a final frequency of around 65kHz is available to drive the l.c.d. directly and hence ensure correct operation of the display. As this low frequency drive must be continuous for the time the display is active, the oscillators and counters must be permanently enabled when the display is active.

When the push-button is depressed, which is equivalent to a 'throw' of the dice, the display drivers are disabled, which blanks off the display for the period the push-button is depressed. At the same time the clock input to the two divide-by-six counters is disabled and the binary output from the counters at that instant is stored in the display decoder drivers. When the button is released the new 'throw' of the dice is displayed.

As the oscillator and counters are free running most of the time there is no possibility of cheating by pushing the button for a known period of time, or by pushing the button at defined intervals. That is, unless you can depress the switch to an accuracy of less than one thousandth of a second.

The push-button is also used to charge a large capacitor directly from the PP3 battery. This capacitor drives a transistor which connects power to the digital dice circuit. The capacitor takes approximately five minutes to discharge and switch off the transistor which consequently removes power from the digital dice circuit. As only CMOS i.c.s are used and the l.c.d. power requirement is negligible, the total power consumption is only around 2mA. Hence a PP3 battery is quite adequate to power the dice, making it totally portable.

CIRCUIT DESCRIPTION

The circuit diagram of the digital dice is shown in Fig. 2. The two NOR gates IC1a and IC1b form a 3kHz oscillator using negative feedback with the capacitor C6 and resistor R4 controlling the frequency of oscillation. Although the

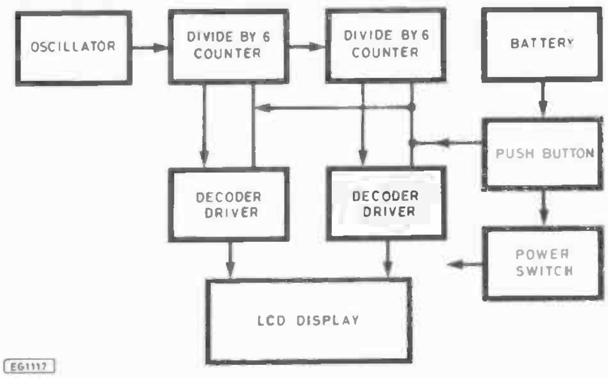

Fig. 1. Block diagram of the Digital Dice

exact frequency is not critical resistor R3 is included to give stability to the output of the oscillator which is buffered by IC1c before being connected to the clock input of the first divide-by-six counter (IC2).

The borrow output from this counter, as mentioned earlier, is connected to its preset load input (pins 13 and 11) to ensure the counter presets to six immediately it reaches 0. Capacitor C5 is included to ensure that the borrow output is of sufficient duration to load the counter correctly. The binary coded decimal output from IC2 is connected directly to BCD seven-segment decoder driver IC4.

The divide-by-six output from IC2 pin 6 is connected to the second divide-by-six counter (IC3) via the NOR gate IC1d. This counter and its BCD seven-segment decoder IC5 are connected in an identical manner to IC2 and IC4. The output from pin 6 of IC3 is approximately 65Hz which is used to drive the l.c.d. and the decoder drivers IC4 and IC5.

The 0V from the battery is connected directly to the 0V of

COMPONENTS . . .

Resistors

R1, R2	100k (2 off)
R3	220k
R4	56k
R5	1M
All resistors $\frac{1}{4}$W 5% carbon	

Capacitors

C1	250μ 16V elect
C2	2μ2 16V tant
C3	10n ceramic
C4, C5	680p polystyrene (2 off)
C6	2n2 polyester
C7	100n ceramic

Semiconductors

IC1	4001 quad 2 input NOR gate
IC2, IC3	74C193 binary up down counter (2 off)
IC4, IC5	4543 BCD seven-segment decoder driver (2 off)
X1	3$\frac{1}{2}$-digit l.c.d. $\frac{1}{2}$in high digits

Miscellaneous

S1	Single pole double throw min push-button switch
Case	Plastic 118 x 100 x 40mm
PP3 battery	
p.c.b.	

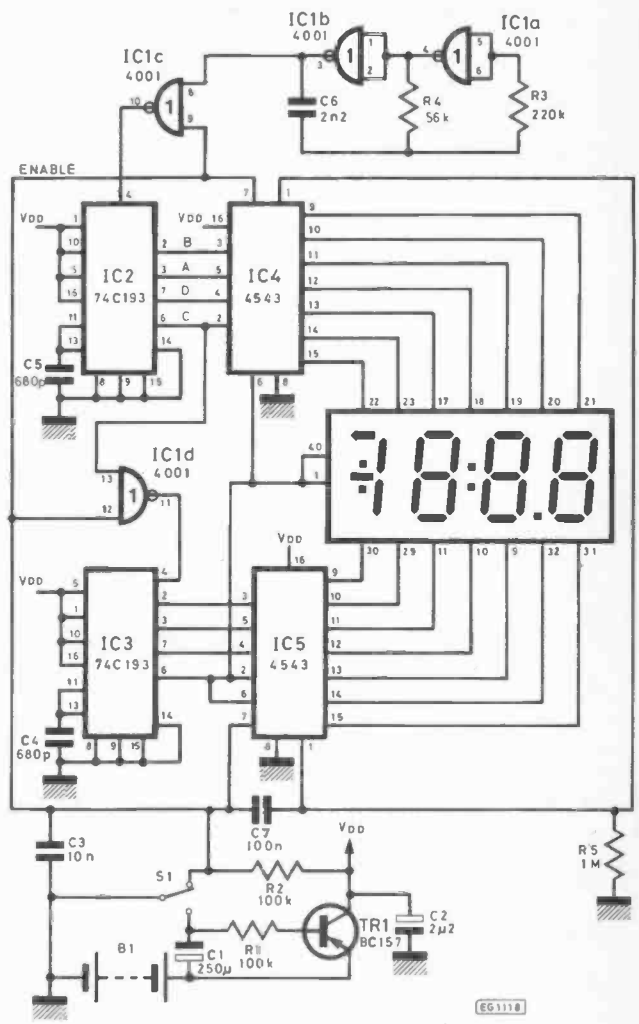

Fig. 2. Circuit diagram of the Digital Dice

the logic. The positive terminal is connected to the emitter of TR1. This transistor is switched on only when capacitor C1 is charged to a value greater than the base/emitter junction voltage of 0·7V. The collector of TR1 is connected directly to the Vcc of the logic. When the change-over, push-button switch is depressed the battery is connected directly across capacitor C1 which fully charges it, turning TR1 hard on. The battery voltage is then connected to the logic. The change-over switch also disconnects the enable earth to the clock buffer gates IC1c and IC1d which disables the clock to the counters and hence inhibits counting. At the same time the display drivers are disabled and hence the l.c.d. goes blank. Also the BCD output from the counters is stored in the latches of IC4 and IC5. When the push-button is released the new BCD numbers will be displayed on the l.c.d. The capacitor C3 ensures contact bounce from the push-button switch S1 does not cause corruption of the stored numbers whilst capacitor C2 is merely a decoupling capacitor.

The display will remain active for the time it takes capacitor C1 to discharge through R1. With the particular values of R1 and C1 chosen, the display will remain for approximately 7 minutes before switching off.

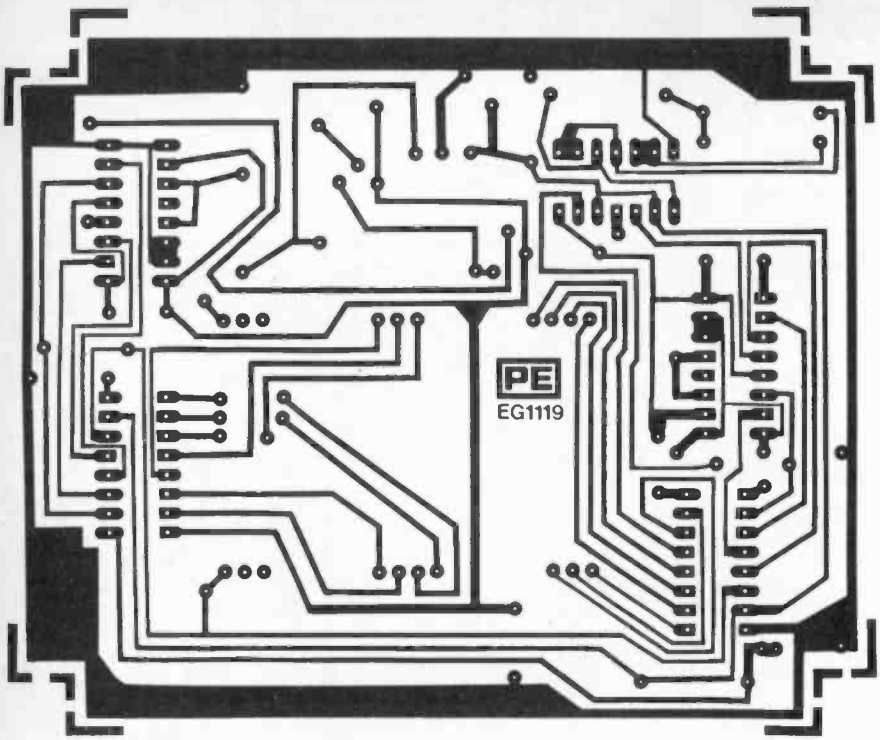

Fig. 3. P.c.b. design

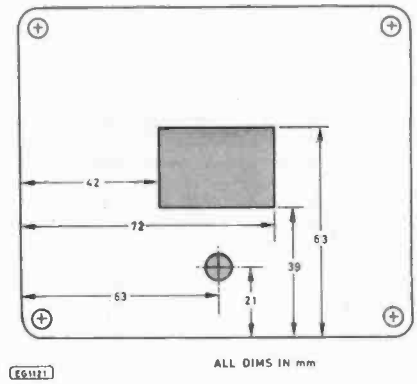

Fig. 5. Case cutting details

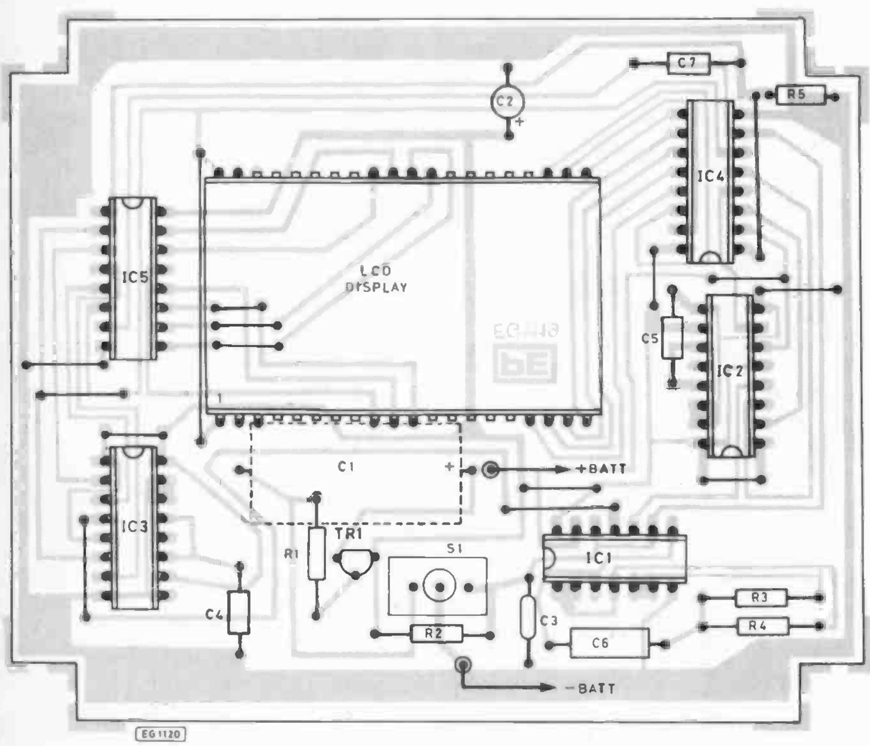

Fig. 4. Component layout

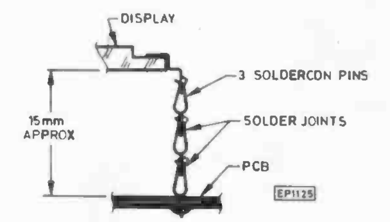

Fig. 6. Mounting arrangement for the display

CONSTRUCTION

The p.c.b. design for the dice is shown in Fig. 3 with the component overlay shown in Fig. 4. Sockets or soldercon pins should be used for mounting all the i.c.s and special care should be taken with the orientation of the i.c.s as their positions alternate. The push-button switch S1, which is mounted directly onto the p.c.b., secures the board to the lid of the case.

Although a $3\frac{1}{2}$-digit l.c.d. was used in the prototype a 4-digit display would also be suitable as it is pin-for-pin compatible. The l.c.d. is mounted onto the board by using three soldercon pins, one soldered inside the other, on each l.c.d. pin. This gives additional height to the display above the p.c.b. The electrolytic capacitor C1 is mounted on the copper side of the board and care should be taken that the body of the capacitor is clear of the tracks. ★

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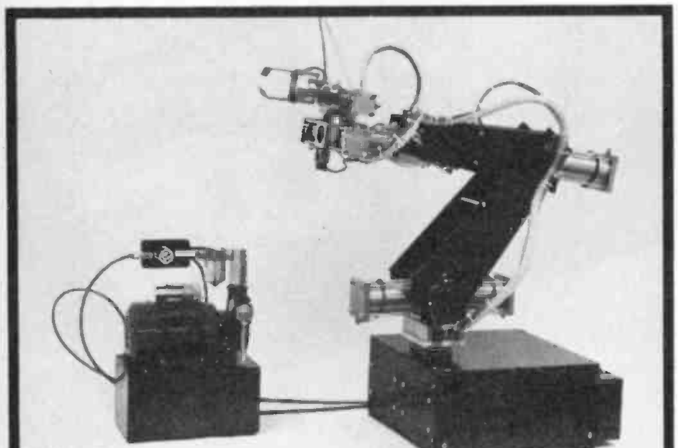

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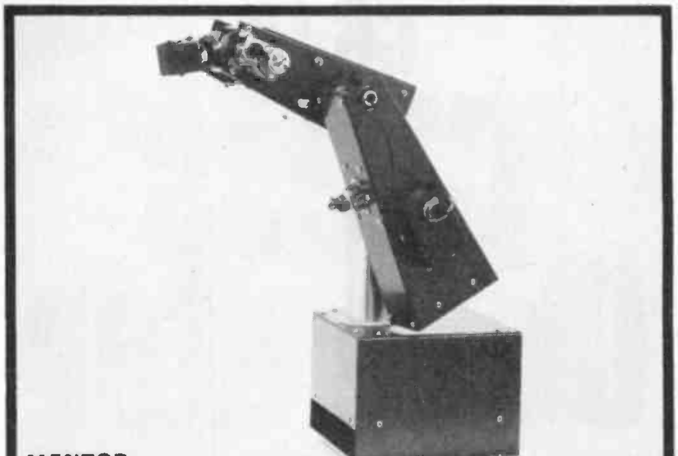

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SEPTEMBER ISSUE ON SALE FRIDAY, AUGUST 3

RADIO ASTRONOMY

THE BEGINNING

Fifty three years ago Karle Guthe Jansky became the first radio-astronomer. He had graduated from the University of Wisconsin and taken up a post with the Bell Telephone Laboratories. The company posted him to a field station in New Jersey. There he was assigned to the investigation into the causes of interference on trans-oceanic links. During the course of these observations he noticed certain peculiarities on a band of frequencies between 20MHz and 21MHz. He then built an aerial on an old Ford chassis which enabled him to point the system in azimuth.

At the time of these experiments there were many unknowns both in regard to receiver sensitivity and the origins of the signals. After many trials and modifications to his apparatus he noticed that there was a change in the position of a band of noise which he had at first thought to be coming from the Sun. As time went by it was clear that the source was not the Sun as Jansky was eventually receiving signals in the middle of the night. From this he concluded that the source was outside the solar system and situated in the direction of the Milky Way. He offered two thoughts on the subject. Firstly, that the radiations must be coming from a body in space that was emitting radio waves in a greater amount than light and heat. Secondly, the sounds that he heard from the output of his receiver were very similar to those produced by thermal agitation in a resistor carrying a current.

He considered that a mechanism of this kind, where charged particles were in constant agitation such as in stars, would explain the origin of this radiation. The temperature required to produce this kind of radio emission would be in the region of 15,000 to 20,000 degrees Kelvin. Later observations by those who came after Jansky fully confirmed this view

Jansky gave his famous paper in 1932 and caused a considerable stir with broadcasts of the noises from his receiver. However, except for a few amateurs his efforts did not succeed in inspiring the professional astronomers. It is impossible to over-estimate the importance of Jansky's work for here is another example of a turning point in history where research directed to one goal, opens up an entirely new avenue of discovery. His ability to recognise the unusual brought light to a new area of scientific thought and revolutionised an industrial horizon. It is perhaps fitting that the last paragraph of Jansky's paper published in 1932 reads, '*In conclusion, data has been presented which shows the existence of electromagnetic waves in the Earth's atmosphere which apparently come from a direction that is fixed in space. The data obtained gives the coordinates of this direction as a right ascension of 18 hours and a declination of −10 degrees*'. This was the part of the Milky Way toward the galactic centre.

Soon after the publication of his paper Jansky was transferred to other duties and did not pursue the subject further. He was not in fact a very robust man and he died before the full impact of his early work was recognised. However, one of the amateurs who was inspired was a radio engineer, Grote Reber, who decided to work at frequencies higher than those which Jansky used He reasoned that he could expect better results. He chose a frequency of 163MHz. In fact his reasoning was incorrect. There were in those days severe limitations in the techniques available and a lack of sensitivity with receivers. Reber built himself a 30 foot diameter dish of wood and aluminium for 160 to 170MHz. He caused some considerable disturbance to his neighbours for as the dish cooled down at night the contraction of the metal sounded to them like gunshots, and when it rained the water poured down through the centre hole provided for the aerial, they thought he was making rain.

Reber succeeded in making a map of the sky and this map is still valid to this day. He continued his own work and was concerned with the development of the new high frequency valve techniques. After the second world war he devoted much of his time to very low frequencies, working in Tasmania. Reber's dish was in fact the first of the parabolic aerials used for radio astronomy. It is now at the Bureau of Standards site in Virginia.

It would be an unjustified omission if an even earlier link with the past was not mentioned. The first indication of the existence of electromagnetic waves came from the publication of Maxwell's theory in 1865 though it was not till some 23 years

This article is published as a tribute to Frank W. Hyde who died recently — an obituary was published in *Spacewatch*, June issue.

FRANK W. HYDE

later that Hertz produced and demonstrated radio waves. It seems clear that some six years later Sir Oliver Lodge described, to a meeting at the Royal Institution, an experiment to detect radio waves. He failed, concluding that more sensitive apparatus would be needed. This is not surprising since his detector was the coherer and his indicating instrument the mirror galvanometer.

Later that year Charles Nordmann, a French graduate, attempted a similar experiment. His aerial was 175 metres long and his apparatus was set on a glacier at an altitude of 3,100 metres 'to eliminate the absorbing action of the atmosphere'. In his doctoral dissertation he referred to an earlier attempt made by Wilsing and Schiener at Potsdam in 1896. This must have been the earliest attempt to detect radiation from the Sun. Nordmann actually predicted that outbursts of solar radio activity would accompany sun-spot activity.

WARTIME ADVANCEMENT

The advent of the second world war changed many things, more sensitive receivers, more efficient aerials and many more people were engaged in searching in the atmosphere for enemy activity. Quite a mass of data was available but of course could not be published. Not surprising then was the fact that people gravitated toward this new window to the universe. One significant name here is that of J. S. Hey who in 1942 proved the existence of the radiations from the Sun. In this instance a sun-spot was visible to the naked eye so both visual and radio recording was available. This was confirmed by G. C. Southworth of Bell Telephone Laboratories some six months later. These observations were taking place while both Hey and Southworth were operating at government establishments and consequently no information was available to the public.

Hey was troubled by an incident in the English Channel. Considerable apprehension existed during February 1942 as to an imminent German invasion. It was the sudden interference with radar performance which made it necessary for Hey to be sent to investigate. Since the radar aerials were highly directional and could be pointed to any part of the sky it was easy to discover the source of the interference. At this time it became clear to Hey, as Nordmann had stated, that radio waves were associated with sun-spots. The radio frequency involved in Hey's work was between 55MHz and 80MHz. Southworth was using frequencies between 3,000MHz and 10,000MHz.

It is accepted now that Solar emissions are extremely complex and there is still much work to be done. This applies to many of the areas of the sky where so much has been accomplished but only serves to show that man has still only just touched the fringe of understanding. With the building and expansion of radio-telescopes the name of Radio Astronomy replaced the old definition of Radio Physics and things moved apace even before the war was over.

It was inevitable that the professional astronomers should come to accept their new sister and such was the enthusiasm from those who entered the field that now 40 years on it has become large enough to have sub-divisions such as Infra-Red astronomy, X-Ray astronomy and Gamma-Ray astronomy using the techniques of radio to expand horizons even further. Reading textbooks of the 1920's helps a little to put matters of Astronomy in perspective for much that is given there as positive fact is now of course abandoned.

THE TECHNIQUES

The principle of the radio-telescope is a simple electronic arrangement which can be shown as analogous with respect to its optical counterpart. It consists of a Collector, the aerial, a Receiver, the electronics and a Recording system. In fact it is possible to receive solar radiations by connecting a sensitive receiver to a directional aerial pointed at the Sun, many people began that way. With the amateur now at an advanced state of electronics, here is another fascinating hobby that is available to individuals as well as schools and colleges or youth centres.

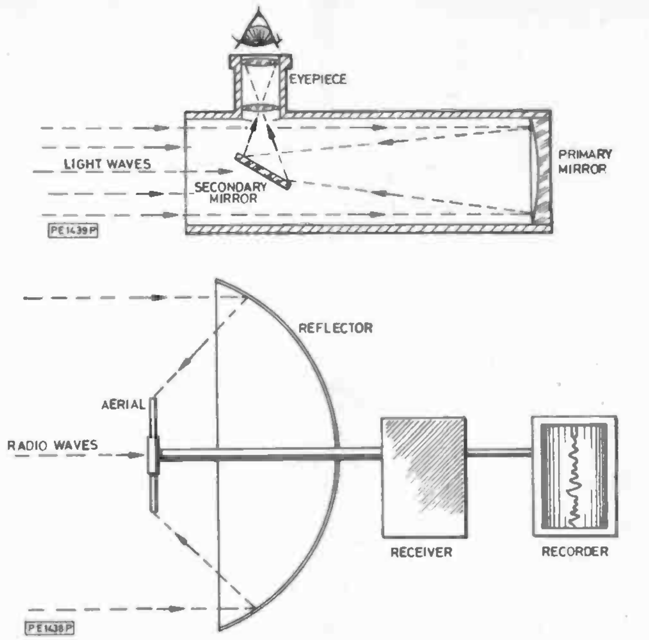


Fig. 1. Comparison of a reflecting optical telescope to a simple radio-telescope with parabolic reflector

Fig. 1 compares a reflecting optical telescope with a simple radio-telescope using a parabolic reflector and receiver with recorder. A typical recording from a radio-telescope is shown in Fig. 2. This recording is of the Sun as it passed through the aperture of the aerial main lobes. The frequency of the system was 81MHz. It is a good example of the change of level that occurs when the Sun comes 'into view' against the background. The straight lines of the pen on the paper indicates overloading of the receiver at meridian passage of the Sun. There are several basic designs which can operate separately or in combination. These are shown in Figs. 3, 4 and 5 (overleaf).

The simple radio-telescope shown in Fig. 1 would of course be used depending on the frequency of the radiation. However, since the resolution of the energy depends upon the resolving power of the system radio-telescopes are in the main large when compared with the optical system, other methods are necessary in order to obtain satisfactory data. Fortunately there is a solution based on the Michelson optical interferometer.

Michelson used two mirrors twenty feet apart mounted on the

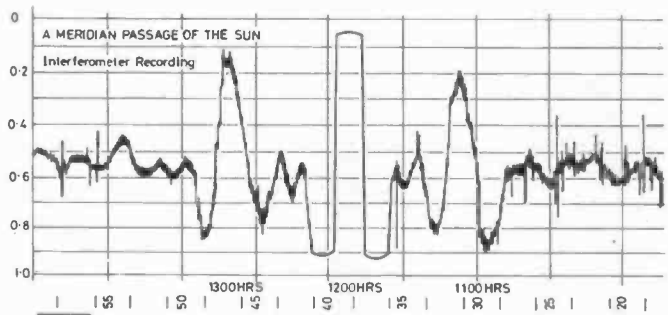


Fig. 2. A typical recording from a radio-telescope showing the Sun's passage of the aerial main lobes

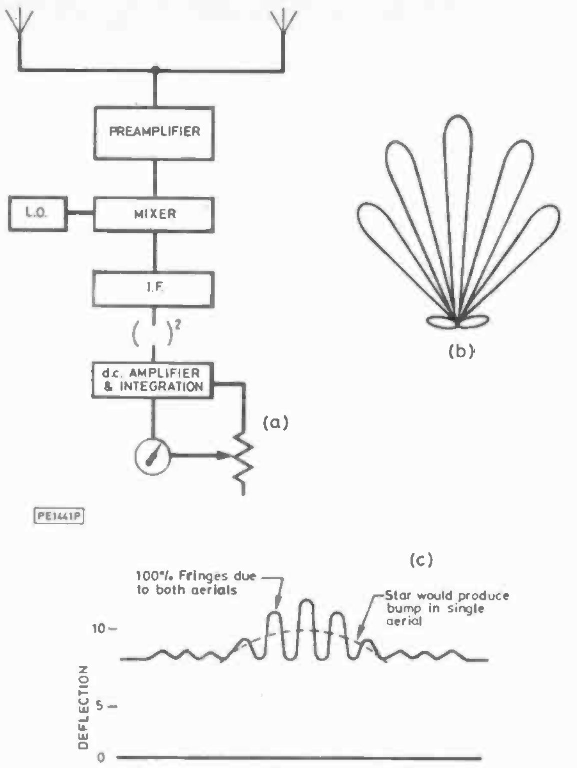


Fig. 3. (a) Simple interferometer
(b) Polar diagram
(c) Output from recorder chart in presence of source

drawback. Local interference could obscure weaker input signals. Ryle and Vonberg took their version of the Michelson interferometer a stage further so that it could overcome the principal difficulties of positional identification of radio sources. If an extended source of radiation is near to a smaller source it may become difficult to resolve the two, the larger source causing ambiguity. The new system was a method of phase switching which in effect moved the lobes of one of the aerials against those of the other. The method of doing this was to insert a half wavelength section of cable between one aerial and the input to the receiver (Fig. 4.—The phase-switched interferometer). It is usual to use a particular circuit design which switches the half-wavelength alternately in and out of circuit. This produces a lobe pattern which is only present when a source is intercepted. When no source is above the sensitivity of threshold the recording is a straight line and when a source is encountered the result is shown in Fig. 4.

So far the system receivers that have been described are used for the location of sources. In order to give an exact value to energy being received it is necessary to have a standard source as a comparator. This type of telescope can, in its basic form, search for and locate sources with an additional facility to evaluate their power. This is accomplished by switching a comparison signal, from a calibrated source, rapidly from the radio source to the standard. Such a system was devised by Dicke in America and modified by Ryle and Vonberg at Cambridge. The block diagram of the layout is shown in Fig. 5. Each system used is selected or designed for the job such is the sophistication of present day instruments. From the simple pen recorders of the earlier days it is now possible with the latest plotters to make maps of areas showing size and power of the sources which look like 3-dimensional views.

100 inch Mount Wilson telescope. The purpose of this arrangement was an attempt to measure the diameter of stars. The mirrors were so arranged that the light from the stars would be reflected into the telescope so that it travelled by differing paths. This would produce fringes at the eyepiece. Optical theory indicates that the diameter of a star is a function of the wavelength of the width at which it is examined and the distance between the two mirrors. Increased resolution was obtained, the effective aperture of the telescope being extended to the width of the two mirrors.

Utilising this principle Ryle and Vonberg used two separate aerials on a long base line. The energy collected by the two aerials was fed into a receiver simultaneously. With such an arrangement, the aerial system as a whole has a polar diagram beam in the shape of a fan (Fig. 3), in which occur a number of interference patterns or lobes. The width of each lobe will be dependent upon the angular separation between the points of minimum signal. The angular separation decreases as the distance between the aerials is increased, so if the aerials are separated by 20 wavelengths the minimum points of the lobes will be separated by approximately 3 degrees at the half-power points. A further separation will reduce the width between these minimum points. If now a radio source is of smaller diameter than the width of the separation of the minimum points, the output of the receiver will vary in a periodic manner. For a source that is greater in extent than the width of the lobes, the output from the receiver will maintain a fairly constant level. From this it will be appreciated that the resolution of the telescope is increased enormously.

The aerials are usually set up on an East to West baseline and the rotation of the Earth serves to sweep the beam across the heavens. Each individual aerial system can be moved in altitude thus enabling successive strips of the sky to be studied. Though valuable work can be done with this arrangement there is one

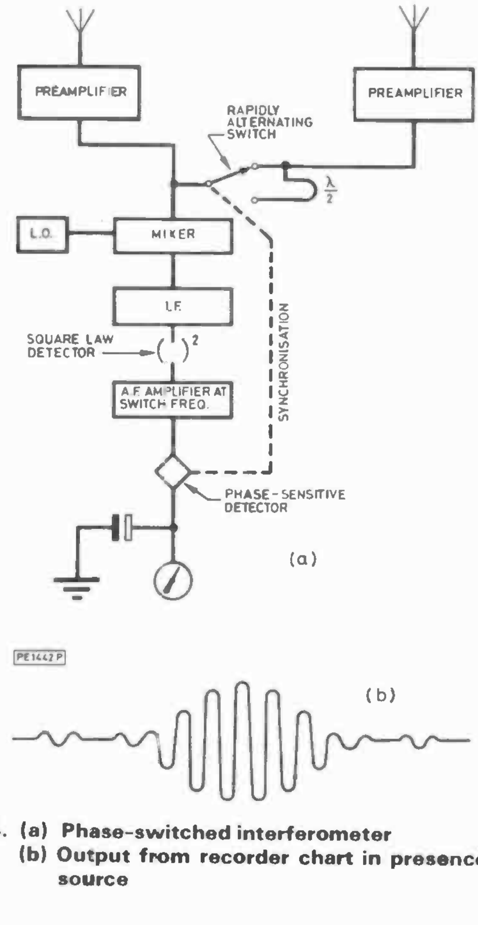


Fig. 4. (a) Phase-switched interferometer
(b) Output from recorder chart in presence of source

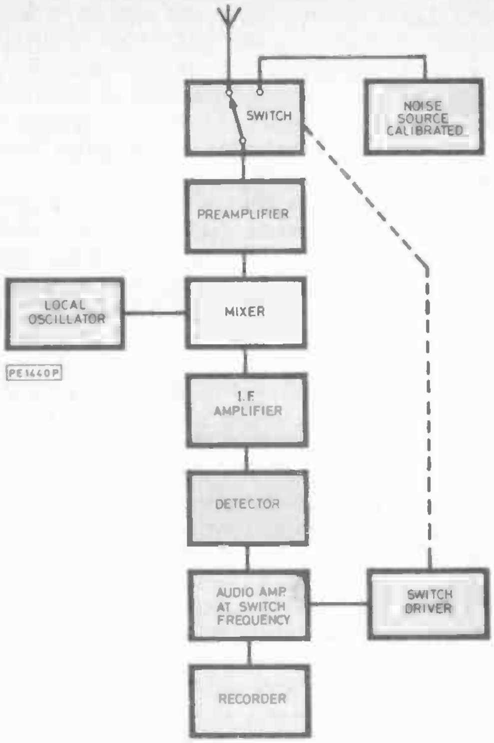


Fig. 5. (Dicke) receiver modified by Ryle and Vonberg, input signal is compared to a calibrated noise source

LOOKING OUT FROM THE EARTH

The Earth is but a small speck in the Solar System. It is also very young and for many people it is difficult to accept the fact that looking outwards into the sky means looking always into the past. Though new stars are coming into being every second (areas like the Nebula in Orion) it takes time. Glance at the Sun (with suitable eye protection of course) and it is seen as it was 8 minutes previously. A look at the Spiral Galaxy in Andromeda reveals its condition as it was 2·2 million years ago. Even to look at the Moon is to see it as it was 1·25 seconds before. Radio-astronomy opened up so much to the astronomer that comparing before and after is nearly impossible. The meticulous work in observation by those who were eminent in their fields has not been wasted, for at many points the conjectures offered by them have been confirmed. The vastness was recognised but the contents of that vastness are still to be catalogued. Sufficient classification has now been made to title broad divisions.

RADIO EMISSION FROM THE SUN

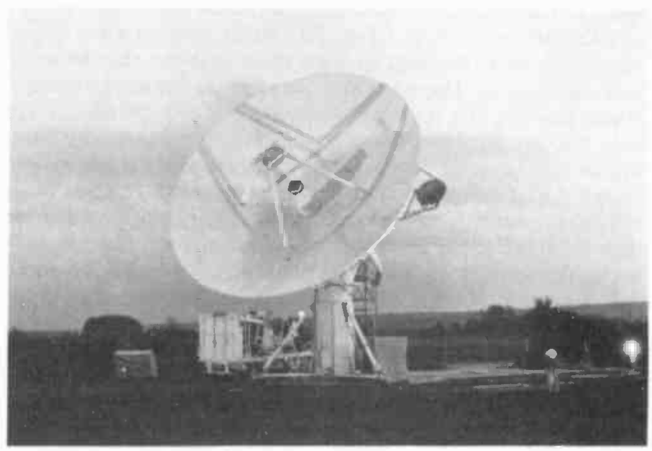
With a minor star for our Sun (and close by) there naturally has been a concentration of radio-observation. It is interesting to compare the types of emission for the greater part of the Sun's energy is given out in the visual part of the spectrum. Over the band there is little change in level. Variations of the luminous flux alters by no more than a few per cent. In contrast to this the radio-emission changes all the time. There is a constant quiet component which is relatively unchanged and superimposed on this are slow enhancements and sharp bursts whose intensity can reach several million times that of the quiet component. The bursts and slow variations are manifestations of the activity of the G-type star which commands all the life of planet Earth. The whole of the electromagnetic spectrum is involved.

The apparent visible size of the disc, the photosphere, is in constant turmoil and what appears to be brightly shining smooth surface is in fact made up of small areas of constantly varying temperature. These areas are in the order of 600 to 700 miles in extent. Occasionally the surface has areas which are dark against the bright surface. These are the sun-spots which sometimes have a disastrous effect on radio communications and the atmosphere of the Earth. These sun-spots appear in cycles and were observed in ancient times, and so a complete mythology now surrounds them.

Scientific observations have been carried out since the year 1610 by J. Fabricus of Holland. These were direct observations. Galileo was the first to observe them by the projection method. Newton also used the method in his study of the colour spectrum. These spots have a variable rhythmic cycle between 10·2 and 11·2 years and is also overlaid with longer overall variation between 170 and 200 years which is not yet entirely accepted. The effect on communications is such that superimposed on radio and television in the 1948 peak the taxi drivers in New York were heard in the British Isles and the enhanced Aurora Borealis brought disturbance of the television picture and spectacular visual display as far as 35 degrees latitude. If the very large spots, sometimes a single group could cover hundreds of Earths, are observed on a large projection screen the changes which are taking place all the time can be directly observed. This was done at the author's observatory where for the first time in history sun-spots were shown on the BBC programme 'Sky at Night' with Patrick Moore.

So far as the Earth is concerned the Sun is the most powerful source available for observation and is ideal for the amateur since only a minimum of apparatus is needed. From the radio point of view it matters not whether the Sun is actually visible optically for the atmosphere, no matter how clouded, is transparent to radio emission except at certain special very high frequencies. Simple aerial systems can even be operated from a block of flats or a bungalow in the suburban areas. If the system is set up properly then multiple observations by interested amateur astronomers whether as individuals or in groups would be a valuable contribution to the data banks, or merely pursued for the hobby interest. Some of the systems can be arranged to double up for the observation of satellites and space stations.

There are two other powerful sources that are available for study with simple units, these are in the constellation Cassiopeia and the Crab Nebula. There is also the planet Jupiter but this needs greater physical space and would be suitable for those living in the urban and country districts, though of course schools and colleges are better able to cope in built-up areas. It is important to accept that radio-astronomy does not require that the observer be present at the telescope. It is a hobby therefore which



This steerable 12-metre antenna communicates with the IRAS satellite as it tracks across the sky. Ground-station, Chilton, Oxfordshire

does not upset normal routine. This means that having decided on the plan of a project all systems can be put on time-control and allowed to operate automatically. However, if the observation is being carried out on the Sun then it will come to meridian passage every day at midday. With other sources the time of meridian passage will change each day. This of course also means that the conditions are reversed if the observatory is south of the equator. This would naturally mean that there could be a world 'net' of observers. However, whatever the horizon seen by a single enthusiast the motivation in the pursuit of this hobby is not necessarily a direct interest in radio-astronomy, much of the progress in optical-astronomy for instance was made by enthusiasts who sought to improve the techniques themselves. That is to say the improvement in the making and polishing of mirrors, the manner of mounting the assembly, the control system, the improvement in photographic techniques and processing. This is still an on-going activity in the whole of the astronomical world.

Naturally it follows that readers of *Practical Electronics* are concerned largely with electronics but the mechanical precision of robotics has also become a part of the design considerations for new astronomical endeavour. The problems that need to be solved should always be directed to the main requirement and constant up-dating of the design specification. It has taken many years to reduce the weight of the large reflector telescope. Indeed one highly respected optical-astronomer was always somewhat vociferously critical of such items as the Questar table top reflector, condemning it as a toy for the dilettante and that there was only one rule to be followed and that was that the weight of the assembly shall not be less than *'Half a ton per inch of diameter of the main mirror'*. An average size of mirror for an amateur would be some 8 inches diameter to do any effective observation. Thus these 'standard?' rules of thumb need looking at more closely. The modern electronics field offers great scope for innovation. Much of the technology already available is highly sophisticated but the challenge is still there to improve, whether it is to reduce cost, number of components, size and so on. Radio-astronomy, though it has become in a sense an opener of wide horizons, must of necessity become wider, and clearly the lesson of the twentieth century is a support of Einstein's words that the universe is 'finite but boundless'. It follows that the technology must therefore be the same.

Orbiting Observatories: The various types of orbiting telescopes were originally directed at special objects alternatively special arrangments were made for the attitude control of the vehicle. The latest of these was the IRAS satellite which was featured in the May issue of *Practical Electronics*. This was a purpose built telescope for short term observations in a special area of the infra-red spectrum. There will be later in this decade a very large optical telescope launched into orbit and this will no doubt open up further vistas and bring surprises. The electronics associated with such a project are very varied and complicated for not only has the guidance system to operate to extremely close limits but accurate re-setting will be of prime importance. Where very distant sources are concerned such re-setting will involve only microscopic changes in positional orientation, and all this in free space. This again emphasises the accuracy of the electronics. On Earth the control of the large telescope at Mauna Ki Hawaii is now capable of being controlled from a chair in an office of the Edinburgh Observatory. This is largely over standard links of communication networks and again emphasises not only the versatility of the electronics but also indicates again the need for faster operating switch networks. This is a major area of research at the moment. Now it is of course true that this is a matter which has been tackled already and at least three major companies are looking for a solution. So in a very short time the limit of silicon chip technology is holding up the innovations which are already waiting. Forward movement in all technology

An artist's impression of the Infra-Red Astronomical Satellite (IRAS).

seems to be logarithmic, the periods between each new level of advancement get shorter and shorter.

X-Ray and Gamma-Ray Astronomy: Here again the special needs of the detectors require sophisticated electronics to provide a means of translating the observations. This area of operations is not really accessible to the amateur and perhaps should not strictly speaking be referred to as radio-astronomy, the electronics still apply.

CATALOGUES OF THE RADIO SKY

The Cambridge catalogue was the first comprehensive attempt and is the accepted standard. Over the years a series have appeared. At Cambridge under Prof. Martin Ryle (Sir Martin Ryle, Nobel Laureate, a Fellow of the Royal Society and Astronomer Royal) together with a team who have themselves become household names, Professor Anthony Hewish FRS also Joint Nobel Laureate with Sir Martin Ryle and Professor Graham-Smith FRS who became Head of the Royal Greenwich Observatory who has now taken over Jodrell Bank from Sir Bernard Lovell FRS to mention only three of many who have passed through Cambridge and contributed to these records. In the early 1950's a catalogue was compiled in which the sources that are accessible with the simplest radio-telescope are marked. Since that time the improvements in electronics have enabled the amateur to deal with many more sources. Indeed there is a challenge here for a design of a *sidereal* clock which should be able to show the incremental change of ten seconds per hour in sequential display which has a read out in Hours/Minutes/Seconds. *(A design by J. S. B. Dick was published in our October '81 issue—photostats available for 75p from the editorial offices—Ed.)*

In concluding this short review of the potential for the amateur it is possible that there are readers who are looking at the future for an entrepreneur package radio-telescope. Could it be that another Sinclair could arise? ★

FRANK HYDE

The death of Frank Hyde, so long a contributor to *Practical Electronics*, has come as a sad blow to his many friends. I had known him for at least thirty years, and I appreciate the value of the contributions which he made to the science of radio astronomy. In some respects he was unorthodox, which is no bad thing, and he also had a strong sense of humour. I well remember my first visit to the radio astronomy observatory which he set up in a Martello tower near Clacton. It was crammed with technical equipment, and was most impressive. I asked him whether he had installed a toilet. He replied that he hadn't—but the tower did have a moat!

Frank, with his genial personality and his gift for imparting knowledge, will be much missed, but he will certainly not be forgotten. I am glad to have known him.

QUASARS: COULD WE BE WRONG?

Now to something much farther from home—a subject which has caused endless discussion since 1963, and which has again become headline news because of important work carried out in the United States. Let us turn to those enigmatical objects, the quasars.

Quasars were identified originally because of their radio emissions. Superficially they look like bluish stars, but they are much more dramatic than stars, because according to most astronomers they are super-luminous and very remote. The most distant quasar so far identified, PKS 2000-330, is thought to be about 13,000 million light-years away, in which case it is not so very far from the boundary of the observable universe.

For some years the quasars remained a total mystery, but it now seems that they are the nuclei of very active galaxies, and there may be an evolutionary link between quasars, Seyfert galaxies (systems with condensed centres and weak spiral arms) and more normal radio galaxies. But how do we measure quasar distances? There is only one way: by using the Doppler effect. A receding object has its light slightly reddened, because the effective wavelength is increased, and the spectra show this well, because the lines are moved over toward the red or long-wave end of the spectrum. The greater the red shift of the spectral lines, the greater the velocity of recession; and since recessional velocity is linked with distance, the distance of the object can be worked out. On the conventional picture, PKS 2000-330 is racing away at well over 90 per cent of the velocity of light.

But . . . could there be a serious mistake? If the red shifts are not pure Doppler effects, we could be grossly over-estimating the distances. And this is what is believed by some very eminent scientists, including Sir Fred Hoyle and, in America, Halton C. Arp.

RADICAL ALIGNMENT

Arp has drawn attention to significant lining-up arrangements of quasars and galaxies. Such alignments indicate genuine association—and yet the red shifts are different; those of the quasars are much greater than those of the galaxies. From this, Arp has concluded that the red shifts are giving spurious results, and that the quasars may be fairly close—not on our doorstep of course, but perhaps only a few million light-years away instead of hundreds or even thousands of millions of light-years distant.

Everything hinges upon whether these alignments are fortuitous or not. If they are genuine, we must do some radical re-thinking. Up to now few astronomers have believed this, and have dismissed Arp's alignments as sheer chance, but new evidence has now come to hand which could very possibly change the whole picture.

Working at Mount Wilson in California and the Las Campanas Observatory in Chile, Arp has been busy noting the numbers of quasars in different parts of the sky. He has found a marked concentration in the direction of the centre of our Local Group of galaxies—a system which is made up of our own Galaxy, the Magellanic Clouds, the Andromeda and Triangulum Spirals, and more than two dozen much smaller galaxies (plus, probably, the large elliptical Maffei 1, about which little is known because it is so heavily obscured by dust lying in the main galactic plane). Using the standard red shift–distance relationship, this indicates that the area in which quasars are concentrated measures 1300 million light-years by 4875 light-years. On the other hand, there is a paucity of observed quasars in the direction of the Virgo super-cluster of galaxies, some 65 million light-years away.

COSMOLOGICAL DOUBTS

If quasars are really as remote as is usually believed, there certainly should not be any marked concentrations or quasar-poor regions (it is hardly necessary to add that Arp has taken into account complications such as the absorption of light in space). And if there really are more quasars than expected in the direction of the centre of the Local Group, it seems only logical to assume that the Local Group itself is responsible in some way, and that the red shifts are not purely "cosmological", i.e. produced solely by the overall expansion of the universe.

There seem to be only a few alternatives, all of which have marked disadvantages and all of which will add to the already heated controversy:

1. Arp's red-shift measurements are wrong. This seems unlikely to the highest degree, because Arp is an extremely skilled and experienced observer.

THE SKY THIS MONTH

Unlike most modern professional astronomers, I like to keep a close eye on the sky, and I think it may be helpful if I begin these articles by giving some brief notes about the objects on view. During July and August the brilliant Venus starts to move outward from the Sun, and by the end of July it should be visible for a short while after sunset.

Mars, which is still above magnitude 0 even though it is well past opposition, is visible before midnight in the constellation of Libra, but by the end of July its apparent diameter has decreased to less than 12 seconds of arc, so that small telescopes will not show much on its surface. Up to the present time there have been no major Martian dust-storms this opposition, but one may start at any time; with Mars, one never knows.

Saturn is also in Libra, with a magnitude of 0·7, and since the rings are wide open the planet is a glorious sight through even a modest telescope. Jupiter, lower down in Sagittarius, is also imposing, with its yellowish, flattened disk, its cloud belts and its four bright satellites which have turned out to be such remarkable worlds. The Great Red Spot has not been at all prominent recently. I have seen it, using the 15-inch reflector in my Selsey observatory, and have measured its longitude (029 degrees), but it is only slightly pink.

Among the stars, look for the brilliant blue Vega, almost directly overhead during July evenings; this was one of two stars which was observed from last year's infra-red satellite IRAS, and found to be associated with material which may be a planetary system in the process of formation, though it would be premature to jump to any conclusions; Fomalhaut was the second star. Vega, Deneb in Cygnus, and Altair in Aquila make up a prominent triangle. Very low in the south look for Antares in the Scorpion, which is distinguished by its strong red colour; its very name means 'the Rival of Mars'.

Scorpio is a superb constellation, though unfortunately it is always so low from Britain that we never see it to advantage. Following it round is Sagittarius, the Archer, now graced by the presence of Jupiter, and of course, the lovely star-clouds which lie in the direction of the centre of the Galaxy.

I must mention Halley's Comet, which will be so very much in the news from now until late 1986. It is 'on course' but still so faint that it is beyond the range of any but the world's most powerful telescopes. It will brighten steadily, coming within the range of amateur-sized telescopes some time after mid-1985, and I will keep you fully informed.

2. The alleged concentration in the direction of the centre of the Local Group is spurious because of some factor which has not been taken into account. The same would have to apply to the quasar-poor region in the direction of the Virgo cluster.

3. Arp is right, and the quasar red shifts are not purely cosmological.

4. There are two kinds of quasars: those which are the nuclei of active galaxies, with high red shifts and which lie at immense distances, and those which are much closer and less luminous, with red shifts which are due to some other cause.

At the moment it seems safe to say that most authorities will opt for the second alternative, otherwise the consequences upon all theories of the universe would be dramatic indeed. But there are also a few more rather disquieting facts. Before the discovery of PKS 2000-330 in 1982, by Alan Wright and D. Jauncey at the Parkes Radio Astronomy Observatory in New South Wales, the holder of the 'distance record' was OQ 172, detected as long ago as 1973. The Parkes observers had made a careful and systematic hunt for more remote quasars, bearing in mind that OQ 172 itself is not particularly dim by quasar standards—and for nine years they were unsuccessful. It began to seem almost as though quasars simply did not exist farther out in the universe. This again seemed peculiar. Not long ago, while on a visit to Parkes, I asked Dr. Wright whether he believed that the quasar red shifts were purely cosmological. He replied that he tended to do so on Monday, Tuesday and Wednesday, but not on Thursday, Friday or Saturday.

So the whole question remains open; and although it is still officially believed that quasars represent the most distant objects known to science, definite doubts remain. And if Arp, Hoyle and their supporters prove to be justified—well, we may not be back to Square One so far as theory is concerned, but we will certainly be back to Square Two.

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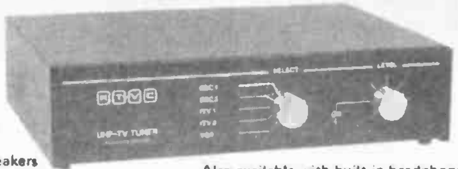
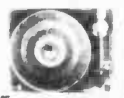
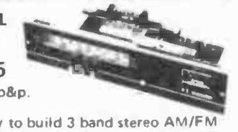






THE LEADING EDGE

BARRY FOX

TIME FOR A CHANGE

For what seems like several hundred years now I have been scanning new British patents and reporting them in these columns *(Patents Review)*. I will be continuing the scan, but with a different approach. Instead of taking patents one at a time and analysing them in depth, we'll look more briefly at more patents. We will also jigsaw them into the overall picture of modern consumer electronic information technology. In other words we will be casting the net wider in *The Leading Edge*.

Perhaps it is opportune that the Science Reference Library, which is housed in the building of the London Patent Office, has just announced its full-scale commitment to electronic technology. SRL has linked up with Telecom Gold, the electronic mail service (more of which in a future column). SRL also has telex and facsimile facilities. So anyone with a credit account with SRL (which is easy to arrange) can now order copies of technical documents, including patents, by electronic mail and have them either posted off or immediately sent down the line by facsimile.

The get-up-and-go attitude of the Science Reference Library makes a fascinating contrast with the sleepy goings-on at the Patent Office, in the same building. Searching through Patent Office lists these days would be funny if it weren't so annoying. To take just one example, the Patent Office killed off its system of written card indexing and replaced it with a modern computer system. How sensible and exciting? Not a bit of it. They started computer indexing before ironing the bugs out in their software. The top brass civil servant who organised the system switch admitted to me that he had never actually tried to use it. As a result some patents are listed under the name of the company that filed them, while others from the same company are listed under T for "The"!

The value of patents as a source for information is still not widely recognised. But just before Christmas Dr. Robin Nicholson, Chief Scientific Adviser to the Prime Minister, published a Green Paper on the subject. "Overall the impression given is of an arcane world rather than that of modern technological Britain" he wrote. "The lack of awareness of their (patents) importance to innovation and wealth creation is at its peak within Whitehall".

Nicholson was particularly critical of the Patent Office and its love of jargon. Taking up the gauntlet the Prime Minister asked for written comments to be sent to the Secretary of State for Trade and Industry, the Minister ultimately responsible for patents. I did just this, for instance mentioning the nonsense of filing company inventions under T for The. But I doubt that anything will change. What I received back was an acknowledgement letter signed by the man in charge at the Patent Office.

VOICE OF PROGRESS

Nicholson is right when he says that patents are an important source of information. Take for instance the recent state of innovation in the area of speech recognition. The patent record shows all too clearly that the Japanese are investing heavily in this new technology. Expect, for instance, the next range of cars from Nissan to use speech-control switching for some functions, like headlights, ventilation and door latching. European patent 100773 from Nissan is just one of a string of similar patents from the same company.

The basic technique of speech control is well known. The operator, in this case owner or driver of the car, speaks several key phrases while the recognition circuit is in "record" mode. The circuit analyses and stores the spoken phrase, which thereafter triggers a switch whenever it is recognised as input. Analysis is of duration, between peaks and of voice power sliced across the frequency band. Storage is in digital code on a simple memory chip. The practical snag is that when the command phrase is uttered, there is a good chance that background noise in the car will drown it out. To confuse the issue further, the background noise could well be changing, as for example when another car is overtaking or blowing its horn.

The trick, says Nissan, is to use band pass filtering and separate speech components from the major components of engine noise. These cluster around the frequencies of 200, 400 and 800Hz depending on engine speed. These bands are tightly notched out and speech passed in the bands 500—600Hz, 900—1200Hz and 1200—2200Hz. There is also high frequency boost to compensate for natural attenuation of speech at high frequencies.

The Nissan research work makes an interesting parallel with research work which I know the airlines are carrying out. Their aim is to make cabin announcements more intelligible without making them louder.

When the captain or crew make an announcement, the speech is split into separate frequency bands. At the same time the background noise in the cabin is split into separate frequency bands and each band analysed. Where there is high noise energy in a background band, the speech signal in the equivalent band is cranked up in level. Where there is limited energy in a background noise band, speech energy is dropped. So in each band speech energy is only just enough to stand out above background noise. The net result is low level speech which is able to cut through the background noise, rather than drown it out.

Without knowing it, factory workers use exactly the same technique to talk through noise on the shop floor. Instead of shouting, they subconsciously tailor their speech to find a way through cracks in the frequency noise spectrum.

One of the main differences between Japanese and Western industry is that the Japanese spend very little on military research. This follows from tight restrictions clamped on the country after the last war. But the West spends heavily on defence technology. This is why in the West speech recognition research is heavily subsidised by the military. Marconi, for instance, already has a speech control system for aircraft, which allows a fighter pilot to arm weapons under verbal control.

Casio has recently patented a computer controlled by voice input (UK patent application 2121217). It's an office computer that you quite literally shout at from across the room, to change programme function. Toshiba has filed a European patent application (99476) on a verification system that is based on speech pattern recognition. The idea could let credit card owners identify themselves by speech. The idea sounds attractive, but the snag is that human voices change quite considerably from day to day, especially when the owner has a cold or sore throat.

Not all consumer electronics work on speech recognition starts in the Far East. Thorn Ericsson has just shown off a telephone, which connects a caller to the right extension, by listening out for the spoken name and comparing it with control "library".

Perhaps most exotic of all, Swiss company Asulab (in British patent 2125990) offers up the answer to every traveller's dream; a watch that can be altered by talking to it.

The patent describes a speech sensitive watch in detail. The extent of detail suggests a prototype has been built. The watch can be set to give an alarm call or jump hours when travelling through time zones, all under direct speech control. If Asulab can make the system work reliably, and sell it at reasonable price, this could be a long overdue shot in the arm for the Swiss watch industry. But one of the inventors named on the patent does have a decidedly Oriental name, Ngoc Chau Bui.

Copies of British Patents can be obtained from: The Patent Office, Sales, St. Mary Cray, Orpington, Kent (£1.75); copies of Foreign Patents can be obtained from the Science Reference Library, 25 Southampton Buildings, London WC2A 1AJ. (Prices on application)

Ingenuity Unlimited

INGENUITY UNLIMITED has been a regular feature in Practical Electronics for many years, and has been a good reflection of the changing face of electronics, giving an up to date guide to new devices and circuit ideas. More recently we have introduced "I U of the month" for which we pay an additional £10 for especially good ideas.

We are looking for interesting circuit ideas, with useful or unusual applications. Test gear, micro-interfacing and peripheral devices, domestic and automobile circuits are all areas of considerable interest. This month's "I U special" should give a good guide to the type of circuits we are looking for.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned and that it has not been offered for or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not in the text.

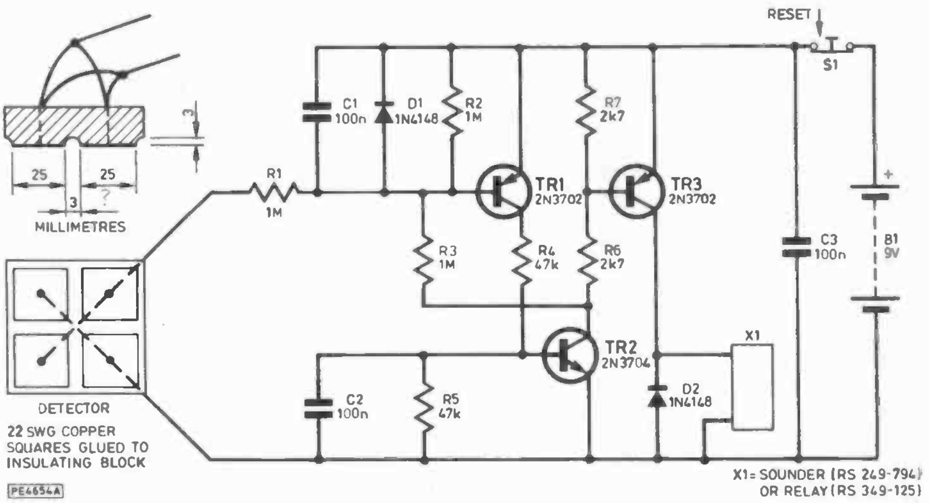
FLOOD ALARM

THE detector and circuit shown in the diagram have been used as an alarm for floods caused by faulty washing machines, leaky water-cooled systems etc.

The transistor TR1 requires a base current of a few microamps to turn on, and is then latched on by the regenerative action of TR2. Current to drive a sounder or relay is provided by TR3. If desired, the relay can cut off the power to a heavy duty relay feeding the machine, or to a water valve fixed direct to the tap.

The circuit is reset by interrupting the battery supply momentarily, assuming the conductive path at the detector has been cleared. The battery should have at least 2A/hr capacity, e.g. a PP9 type.

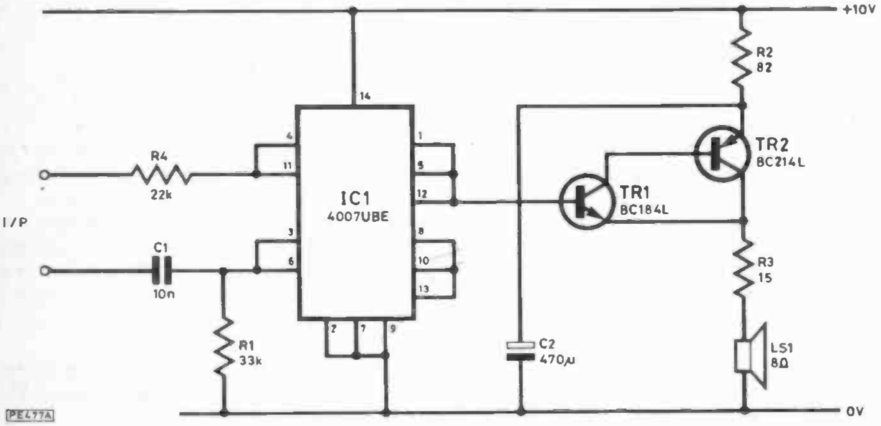
Dr. C.J.D. Catto,
Elsworth,
Cambs.



VOLTAGE CONTROLLED AMPLITUDE

IT is sometimes useful to be able to represent a varying DC voltage in the form of an audio tone whose volume varies with the value of the voltage. This circuit provides a simple and economical means of achieving this.

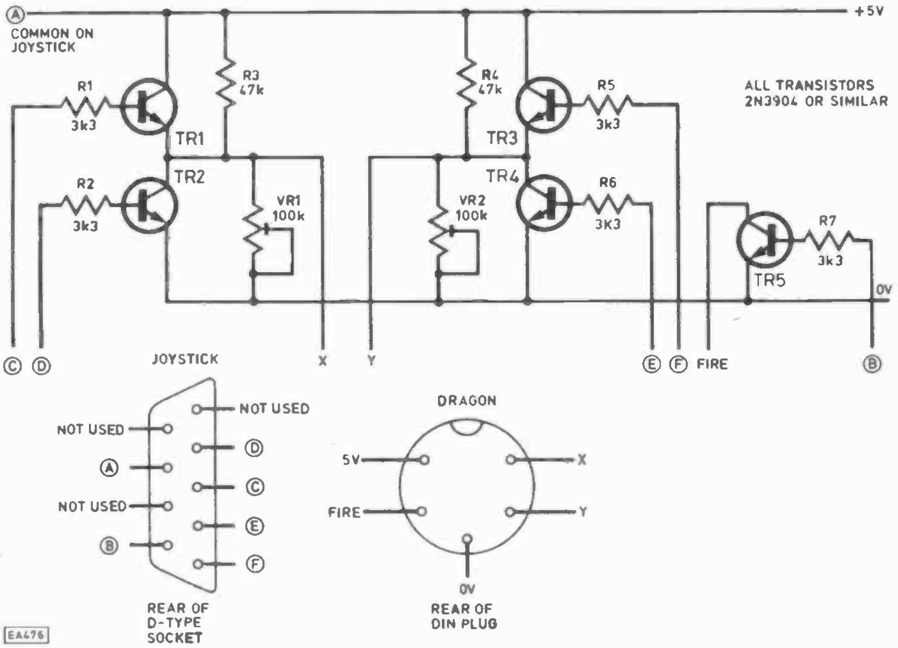
Essentially it consists of a C-MOS 4007UBE wired as a two-way switch, driven at audio frequency and switching between the input voltage and the negative supply. The drive tone should be a squarewave, and it is differentiated by C1 and R1 before application to the switch input. This causes the output to appear in the form of short pulses, which are ideal for creating lots of noise from small loudspeakers with fairly economical power consumption. It also prevents any chance of transistors Tr1 and Tr2 being held "on" for sustained periods, which would cause heavy current consumption and possible damage. These transistors buffer the output pulses, whose voltage is equal to that of the input signal, to a current capability sufficient to drive the speaker. The overall volume is set by the value of R3. R2 and C2 serve to keep the effect of the heavy spikes of output current from affecting the positive supply rail.



This circuit is not only simple; in use it has a much smoother response than many others tried, and virtually no problems of any kind have been experienced with it.

A Flind,
Taunton,
Somerset.

JOYSTICKS FOR DRAGON 32/64



I AM not a violent man but I have managed to break a couple of joysticks whilst playing Meteoroids on my Dragon 32. This sent me on a search for a robust digital joystick. The best one I could find is the "Altai RJ8353B". The only problem with this joystick is that it is not compatible with the Dragon. The following circuit is an interface between the Dragon 32/64 and a digital joystick normally used on Commodore Vic-20, Atari 400 and 800 home computers, Sears arcade game and Atari home video game. The settings for VR1 and VR2 are easily set by using the program, in the Dragon manual, designed for checking the joysticks.

Tony M. Gooding (G6TMG),
Dorset.

LOW POWER VOLTAGE REGULATOR

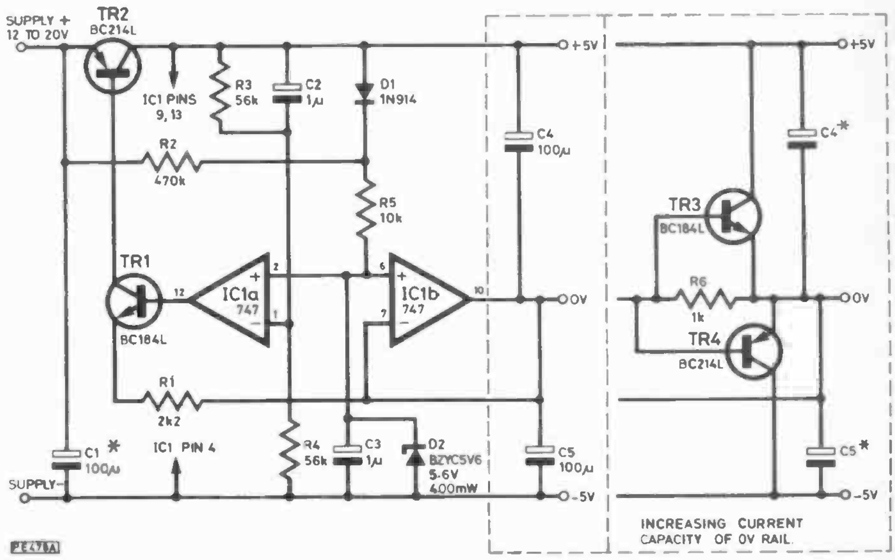
DESPITE the scores of integrated regulators now available, it can still sometimes be worth designing your own, particularly where batteries are to be the main power supply. The circuit shown has the following advantages; it draws only 1·25mA quiescent current, it operates down to just 0·1V difference between supply and output voltages, and it provides both positive and negative rails, useful for circuits containing op-amps.

The zener reference voltage is applied to both amplifier inputs. The op-amp IC1b is connected as a source follower, the output being termed "0V", so that supply negative can become −5V. The feedback to op-amp IC1a causes it to drive transistors Tr1 and Tr2 so that the collector voltage of Tr2 is maintained at twice V ref., this being termed +5V. The zener is somewhat underrun at 0·5mA; this reduces its voltage slightly but doesn't affect stability so long as it is supplied with a reasonably constant current, so this is taken from the regulated rail. Under some conditions this could prevent the circuit starting up when switched on, so D1 and R2 eliminate this possibility.

As shown the circuit can supply around 20mA, the limit being set mainly by the dissipation rating of Tr2, which could be replaced by something more substantial. No more than 10mA should be sourced or sunk by the 0V rail, but this can easily be uprated by adding a pair of transistors as shown, and possibly increasing the values of the three smoothing capacitors to 470µF.

A Flind,
Taunton,
Somerset.

IU OF THE MONTH



IU SPECIAL

POWER SUPPLY FAST SHUT OFF

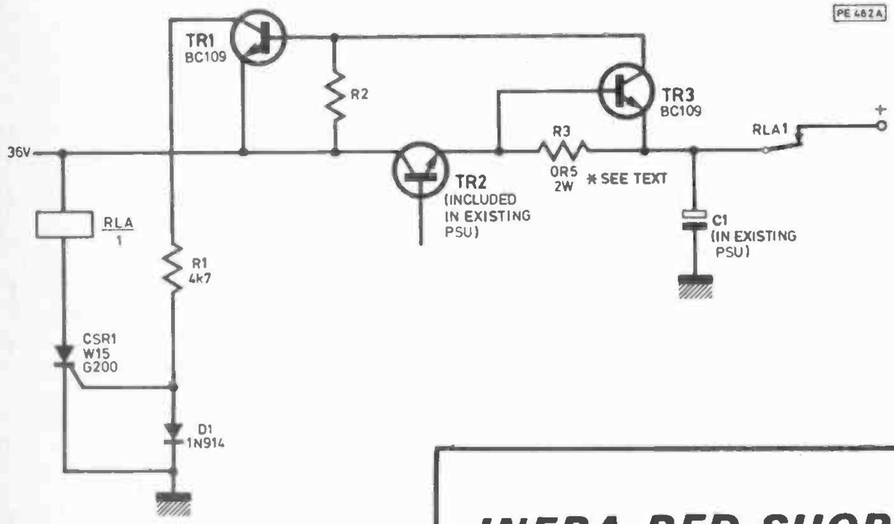
DURING the testing of prototype audio equipment it was found necessary to provide a power source which was capable of totally disconnecting itself from the load in the event of a short-circuit or excessive current drain.

The set up of TR3 and R3 form a current sensing circuit, which when switched due to excessive current will operate TR1 and thus fire the thermistor CSR1. The thermistor will operate the relay RLA1 causing the supply to be disconnected. Once the relay has been operated it can only be reset by switching off the power supply.

Although T3 could fire the thermistor directly it was found to be too slow when operating a "heavy relay". In practice the use of a 24V relay ensures fast operation with a 36 volt supply.

This circuit can be added to most power supplies and can be set up to "trip" at a specific current by selecting the correct value of R3. Assuming a forward bias base emitter voltage of 0·6V, then the trip current would be 0·6V/R3; thus for 1·2A, R3 would be 0·5Ω.

G.V. Whitney,
Sale,
Cheshire.



INFRA-RED SHOP DOORBELL

THIS circuit was designed for a shop door where a mechanical switch on the door has proved to be unreliable. To avoid using any moving parts, the triggering device is an infra-red emitter and detector, and the "bell" is the SAB0600 i.c. featured in PE May 1983.

D3 is an infra-red detector which allows a current to flow when infra-red falls upon it. It is very sensitive, however, so it is made to switch on SCR1 via TR1 only when infra-red light falls directly upon it. This occurs when D2, which is mounted on the door, passes over it. D2 can be any infra-red emitting LED, the one used having a lensed top to focus the light.

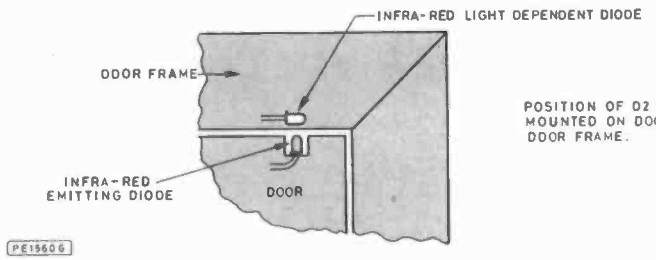
The SAB0600 was chosen as it only requires a momentary pulse from SCR1, and once switched on, goes through its chime sequence of three descending notes.

R5 and C4 were selected to give a high frequency sequence of notes to be heard easily at the back of the shop. Increasing the value of C4 reduces the frequency and lengthens the notes. With the chosen values, the sequence is finished before the door is closed, so the i.c. is triggered again when the door closes.

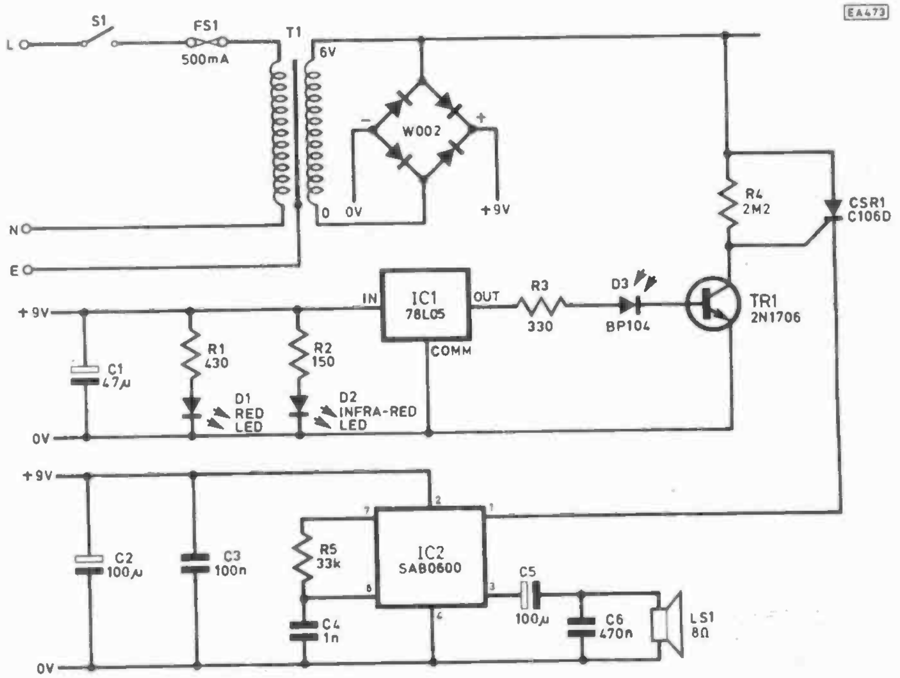
The capacitors C2 and C3 should be mounted as close as possible to the i.c. to ensure stability of the bell circuit. D1 can be any ordinary LED and is simply an on/off indicator.

This circuit was built for my father's pharmacy and has been working satisfactorily since installation in May 1983.

A. R. W. Hall,
Huntingdon,
Cambs.



POSITION OF D2 AND D3 MOUNTED ON DOOR AND DOOR FRAME.



IU SPECIAL

INTERNAL RESISTANCE METER

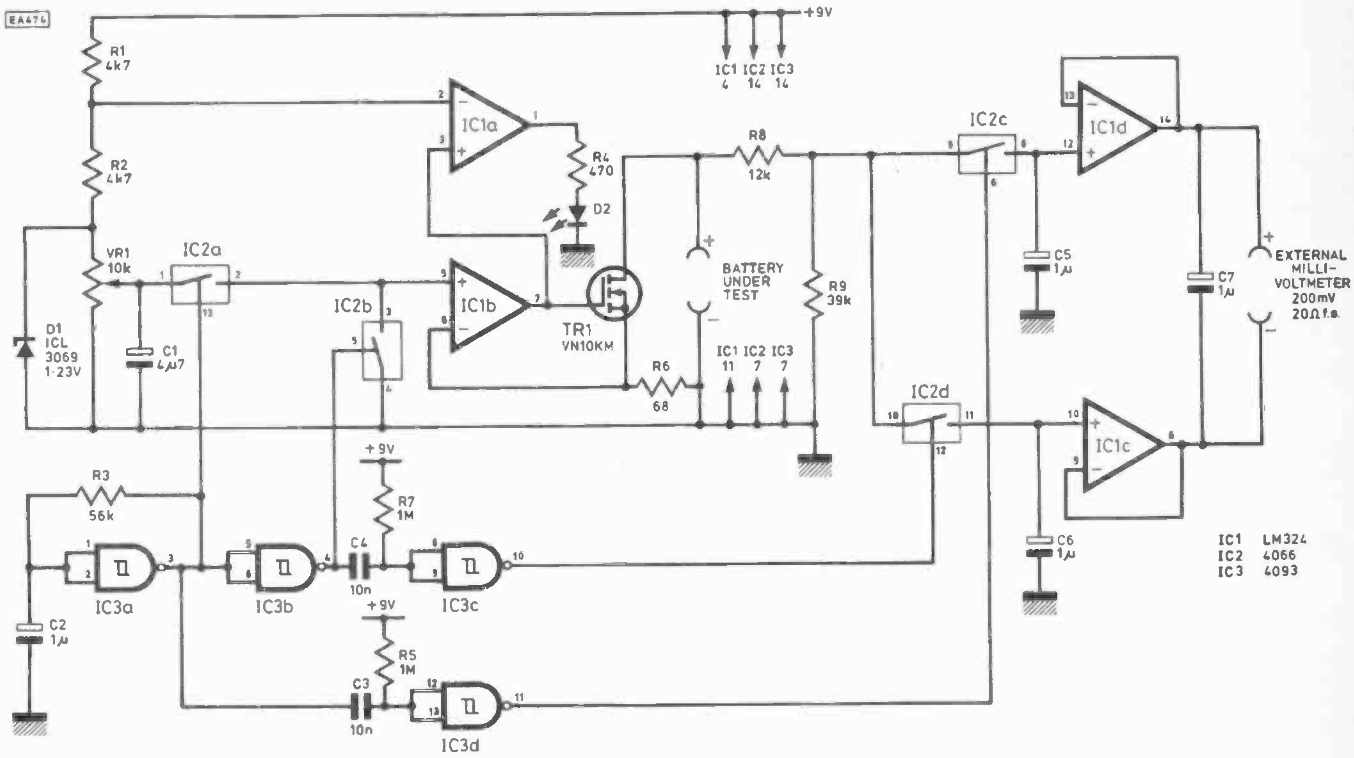
THIS circuit represents a different approach to checking the state of single cells, or batteries up to 9 volts, giving a reading which is complementary to the time-honoured measurement of open-circuit voltage. In determining the utility of a battery, some indication of its performance under load is needed, and hence many battery checkers incorporate a dummy load, normally a resistor. However, on designs for checking various batteries, an active current sink is often used which draws a constant current irrespective of battery voltage. Ideally though, a cell requires a load current in proportion to its capacity and so with a fixed load current, a meaningful result may not always be obtained. In this instance, the load applied is a current sink, but rather than simply reading the on-load voltage, it is the drop in terminal voltage that is measured. With the choice of a suitable load current, a direct readout of internal resistance can be made on an external voltmeter.

Three sections make up the circuit shown: a switchable precision current sink, a sample and hold subtractor and timing generation logic. A standard circuit is used for the current sink (IC1b and TR1) though with a VMOS FET as the current controlling element. This is used in preference to a bipolar transistor as it gives better linearity over a greater range of battery voltages, since the drain-source channel acts as a pure resistance. IC1a allows us to detect when the current sink is no longer in its active region—as the voltage across TR1 drops, the transistor is turned on harder and harder until the OP-AMP saturates at the positive supply. IC1a lights D2 under these circumstances, giving an indication of an invalid reading. IC2a and b are alternately energised, switching the voltage at pin 5 IC1b between ground and a preset reference, hence switching the current sink off and on. D1 is a 1·23V bandgap reference which gives superior performance over a zener at around one-tenth the bias current. A low voltage zener could be used instead with a suitable reduction in R1 and R2. IC3 forms an astable RC oscillator and two monostables arranged to have their pulse-widths slightly less than one half-cycle of the oscillator. The pulses from IC3c and d direct the on-load and open-circuit voltages respectively, through the analogue gates IC2c and d, to separate capacitors. Buffers IC1c and d prevent loading the stored voltages, which have been attenuated by R8 and R9, permitting batteries up to 9 volts to be tested without saturating the buffers. If higher voltages are likely to be tested, the values can be altered with a suitable adjustment of the test current.

In its present form, the circuit gives a full scale reading of 20Ω for 200mV output: thus a resolution of 1/100Ω is achieved with a 3½ digit voltmeter. For this range, VR1 is set up to give a sink current of 13·1mA though TR1, and this must be checked with C2 shorted with a temporary link. Calibration accuracy then rests on the tolerance of R8 and R9. In order to minimise offsets when measuring low resistance cells, a four-wire probe arrangement is used so that negligible current flows through the voltage sensing wires.

In use, it was found that even the very low internal resistance of nickel-cadmium cells could be resolved—these typically exhibit values of a few hundredths of an ohm. At the other extreme, lithium button cells were found to have values greater than 20Ω. To extend the measurement range of the circuit it is necessary to reduce the test current through TR1 since increasing the range on the external voltmeter will increase the likelihood of the 'invalid reading' LED illuminating for the lower voltage, higher resistance cells.

R. P. Dudley,
Newtown,
Southampton.



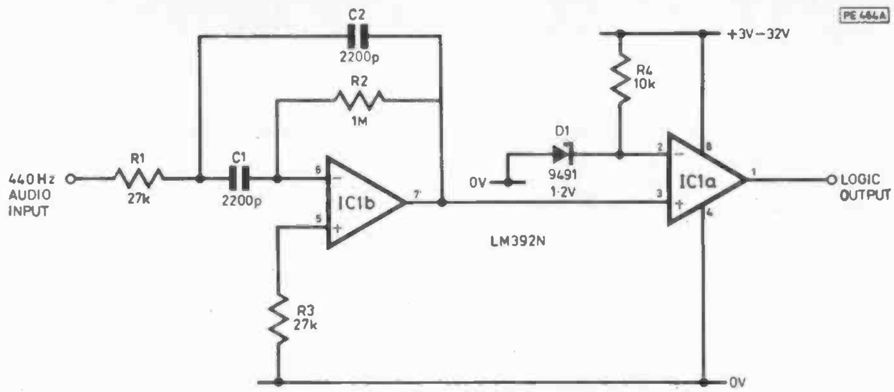
AUDIO TO LOGIC INTERFACE

THE circuit shown is for an interface, which allows logic circuitry to be driven by audio tones, recorded on cassette tape. The design is based upon a single LM 392 op-amp/comparator chip, and will operate with input levels as low as 60mV peak, over a supply range of +3V to +32V.

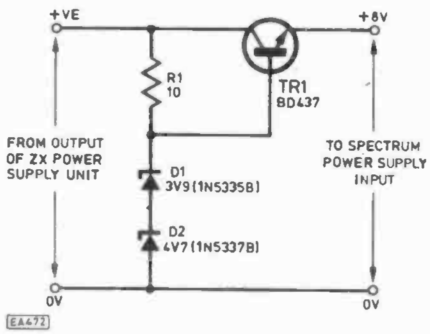
The op-amp is configured as a multiple-feedback bandpass filter, with f_0 centred on 440Hz. Its gain, at this frequency, is twenty, and rolls off at a rate of 6dB per octave. This gives effective discrimination of both switching transients and mains hum. The output from this stage feeds the comparator, whose threshold is set at 1·2V by a bandgap reference diode.

The comparator output switches virtually from supply rail to supply rail, making it suitable for use with either CMOS, T.T.L. or the 555 timer.

P. Thompson,
Glasgow,
Scotland.



COOLER SPECTRUM



A PROBLEM with the Sinclair Spectrum is its tendency to get hot, after periods of prolonged use. This is due mainly to the power being dissipated by the internal +5V regulator I.C.

The input voltage to this comes from the ZX power supply unit, which provides a raw d.c. that varies according to the current drawn. This gives a nominal +9V on full load, but rises to +10·5V when used with a 48K spectrum, taking its average of 0·6A. Under these conditions, the power dissipated is:

(10·5 − 5) × 0·6 = 3·3W (continuous)

The circuit shown was designed to reduce this power dissipation, by stabilising the output from the ZX supply at the minimum voltage required for the computer.

Two zener diodes, one with a positive temperature coefficient, the other with a negative temperature coefficient, are used to provide a stable +8·6V at the base of the series pass transistor. This is a power switching type that features a low collector-emitter volt drop. The output from this is the reference voltage less the 0·6V base-emitter volt drop, which equals +8V. This is more than sufficient for the on board regulator, a 7805, and also provides adequate drive for the circuits that produce the +12V and −5V supplies.

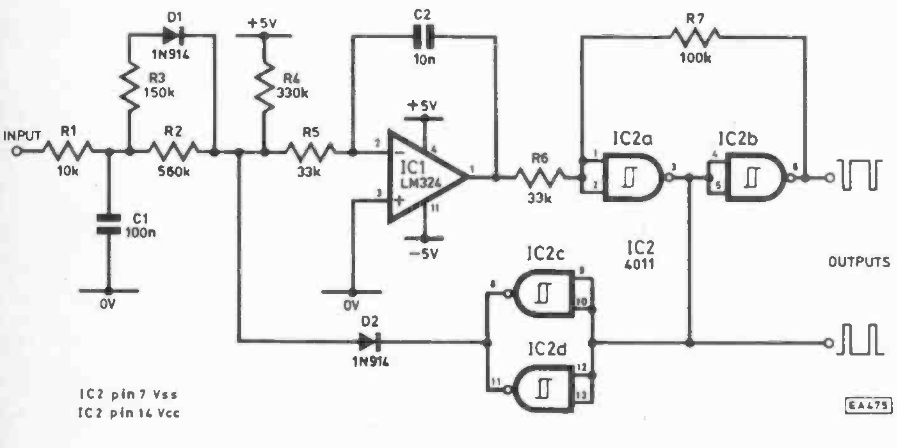
P. Thompson,
Lennoxtown,
Glasgow.

A SIMPLE VCO

THIS cheap, simple circuit was designed to indicate the value of a changing DC voltage by varying the pitch of an audio tone. It consists in essence of an integrator followed by a schmitt trigger. A positive input to the integrator causes its output to ramp downwards until the schmitt changes state; the output of this then pulls the input to the integrator almost to negative supply, and its output then ramps back upwards until the schmitt returns to the original state.

The four inverting gates are formed from a C–MOS 4011BE with its four pairs of inputs linked. Two of them make up the schmitt trigger, the remaining pair are paralleled to form a buffer for the feedback circuit. Almost any op-amp could be used, the original was tried with both ½ × LM358N and ¼ × LM324N.

Resistor R4 sets the centre frequency. Since the ear detects changes in pitch as an "octave" shift for each doubling or halving of frequency, the network R2, R3 and D1 was added to make the output sound (fairly!) linear over the input voltage range. R1 and C1 provide input noise smoothing, if required.



With the component and supply voltage values shown, and driven by the output of an LM358N (minus 5 to plus 3·5V) the circuit gave an output of about plus and minus one octave with a centre frequency of approximately 350Hz. The output consists of pulses, about 300 microseconds wide, both polarities being available.

A. Flind,
Taunton,
Somerset.

LOW COST KEYLESS LOCK

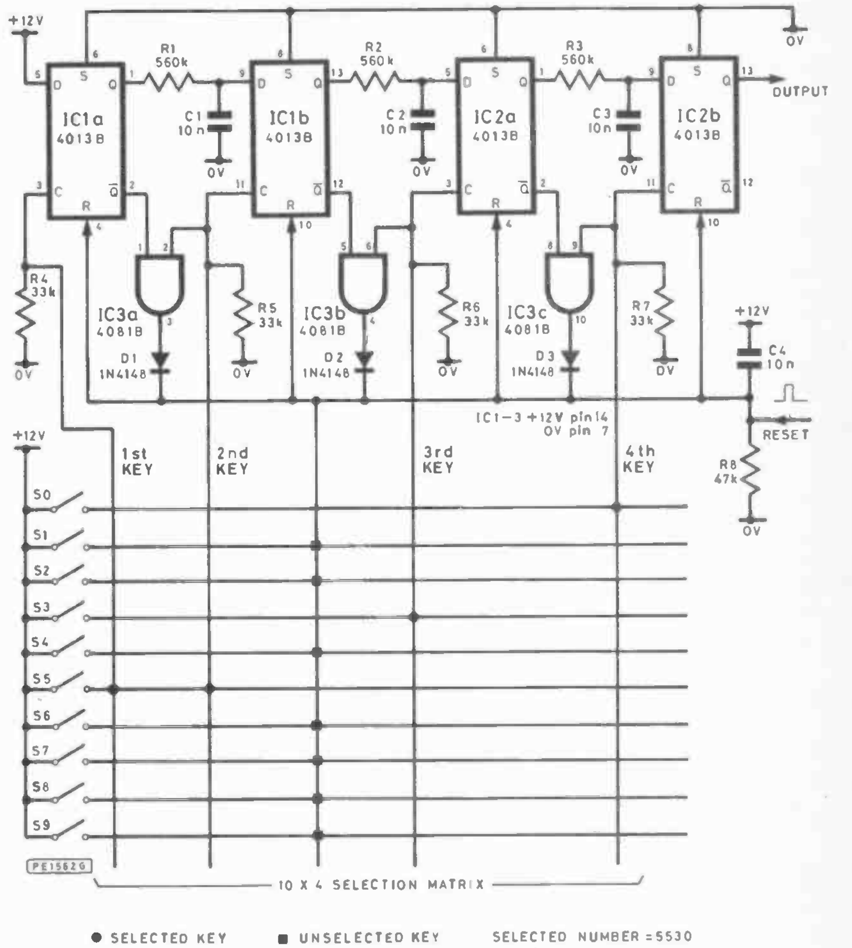
UNABLE to track down the LS7225 Keyless Lock i.c., I built my own Keyless lock using spare components. The resulting circuit was cheaper and boasts a better specification than the LS7225 I.C.

Keyless locks have numerous security applications in, for example, burglar alarms and door entry systems where the correct entry of a 4-figure number on a keypad will arm or disarm an alarm or activate a door-opening solenoid.

The diagram shows 10 keypad switches connected to a 10 × 4 selection matrix. This was easy to implement using strip-board and low-profile i.c. sockets. The selected keys are "patched in" to each flip-flop using single strand cable. All unselected keys are commoned and connected as shown.

When S5 is depressed, IC1a's clock input (C) momentarily changes from logic '0' to logic '1'. This transition transfers logic '1' on the data input (D) to its Q output. This procedure repeats for the other 3 flip-flops until the output of IC2b changes to logic '1' for the correct 4-key entry. The RC circuit between flip-flops is quite novel in that it allows each keypad switch to bounce for up to 10ms without clocking the output of two consecutive flip-flops for one key depression, as shown for IC1a and b.

Two features make this lock virtually fool-proof: pressing an unselected or out-of-sequence key will take each flip-flop reset input (R) high resetting the opening sequence. The combination of C4 and R8 will suppress any momentary AND gate (IC3) output transitions that may occur while allowing the opening sequence to be externally reset. D1-D3 are essential to prevent the logic '0' output of any AND gate from sinking current when a legitimate reset pulse occurs.



Unlike the LS7225 keyless lock, this circuit allows two sets of two identical consecutive numbers to be entered without resetting the opening sequence. This allows 10 × 10 × 9 × 9=8,100 possible four-figure number combinations as compared to 10 × 9 × 8× 7=5,040 with the LS7225.

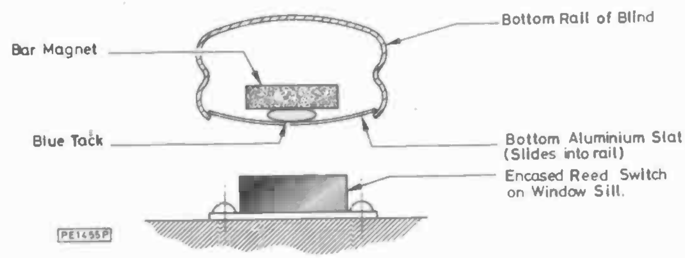
Steve A. Brown,
Wembley,
Middlesex.

VENETIAN BLIND INTRUDER SENSOR

IF YOUR house is fitted with modern Venetian Blinds, you have a source of protection available to you which would take a lot of ingenuity to overcome.

A system was set up nearly three years ago in my house and it has proved very satisfactory. The reed switch type of intruder detector is screwed to the window cill in the appropriate place and the magnet part of the combination is removed from its case (if it is encased) and positioned as shown in the sketch using a bit of Blu-Tack.

The bottom rail of some blinds is steel but the slat used to fill the gap at the underside of the steel rail is generally of aluminium and matches the remaining slats which form the blind. A plastic end cap is usually fitted over the steel rail end and this is first removed before fitting the magnet in the rail. It can be replaced when the correct position has been found for the magnet, whereupon it would appear that



one has a magic Venetian Blind which, when disturbed, triggers the burglar alarm.

In order to enable the blind to be raised or a window opened without risking the wind disturbing the blind with consequent triggering of the alarm, a small slide switch can be fitted in the reed switch casing and wired across the reed switch or a spare bar magnet may be placed over the switch casing when the blind is raised.

When a large window needs protection, I used a sensor at each end of the blind, so that it would not be possible to intrude without one or other switch being tripped. The two reed switch arrangement must be wired such that the two reeds are in series.

Gordon E. Lumley,
Richmond,
N. Yorks.

Simple Logic Analyser

CHRIS ATKINS

PART TWO

OBVIOUSLY, construction of the analyser is a matter of choice, however, if the diecast box approach of the prototype is made, the photographs in Parts One and Two indicate a suitable layout.

CONSTRUCTION

A wiring diagram is provided: see Fig. 2.1. The circuit diagram given last month shows a filament lamp across the mains transformer secondary winding to act as a pilot light. An alternative is to wire an l.e.d. (in series with a 270Ω resistor) across 0V and +5V. This method is employed in the wiring of the prototype unit illustrated in the wiring diagram, except that a self-current regulating l.e.d. has been used so that no series resistor is necessary.

KEYPAD

The keypad used was an RS Components unit (see components list) and the diagram shows how this is wired. Almost any matrix Hex keypad will suffice, but reference to the 74C922 (IC1) data sheet will be necessary to arrive at the correct wiring arrangement.

DISPLAY BOARD

The display board is shown in Fig. 2.3. Some links are necessary, but assembly is straightforward. Be sure to insert the displays in the correct orientation. The displays TIL311 incorporate internal decode and drive logic, and as such are referred to as i.c.s.

8-BIT/16-BIT SWITCH

The Eight/Sixteen Bit change-over switch, S2, requires a small alteration to its connections as portrayed in Fig. 1.2. If the wiring diagram of Fig. 2.2 is followed this will be automatically taken care of, but to correct the circuit diagram, make the following corrections to S2c: IC14 pin 8 and IC15 pin 8 line goes to the *upper* contact (the switch position illustrated as "closed") leaving the *lower* contact open circuit instead. In addition to moving this line it should also incorporate a 4k7 pull-up resistor to +5V (shown in Fig. 2.1 as R8).

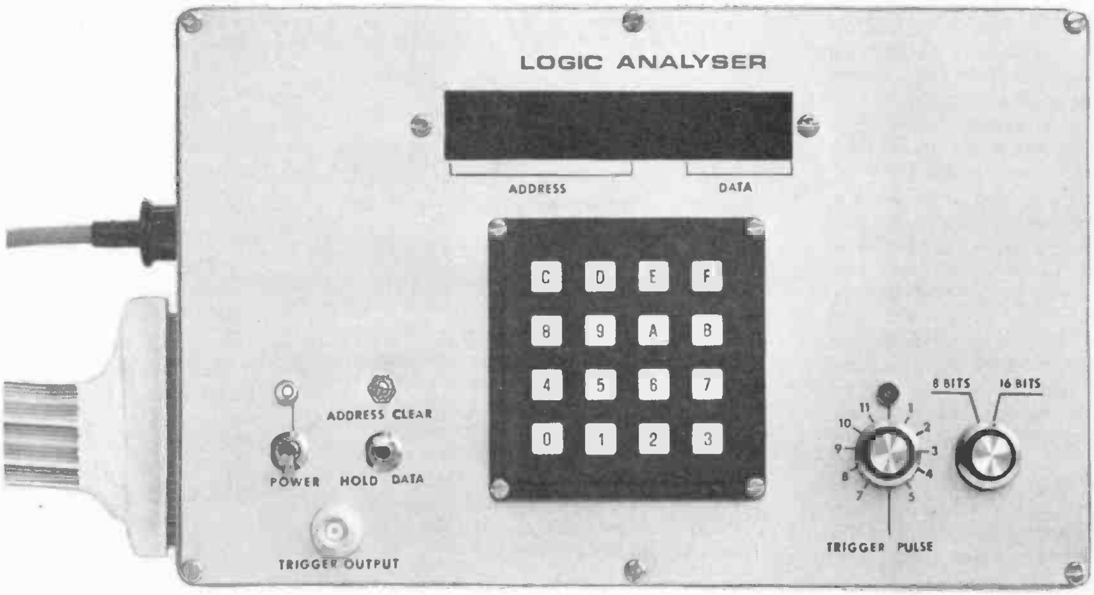
WHOOPS!

The circuit diagram in Part One shows a 2k2 resistor connected to S2b which should be called R7, not R1. In fact, R1 is a 2k2 pull-up resistor wired between IC6 pin 1 and +5V. Note also that the line linking IC18 pin 5 and IC19 pin 5 to IC5 pin 2 (STROBE) can be interrupted with a biased on/off toggle switched marked HOLD DATA. The switch should be wired so that ICs 18 and 19 (pins 5) can be isolated from the remainder of the circuit. Referring to the main board component layout, note that the capacitor linking the STROBE output to 0V is C10, not C9. Also the annotations C7 and C8 should be transposed.

One final addendum which should clear up confusion appears below, and it pertains to the *correct* Data input pins to IC18 and IC19.

IC19	*IC18*
D0—12	D4—13
D1—13	D5—12
D2— 2	D6— 2
D3— 3	D7— 3

No setting up procedure is required prior to use. ★



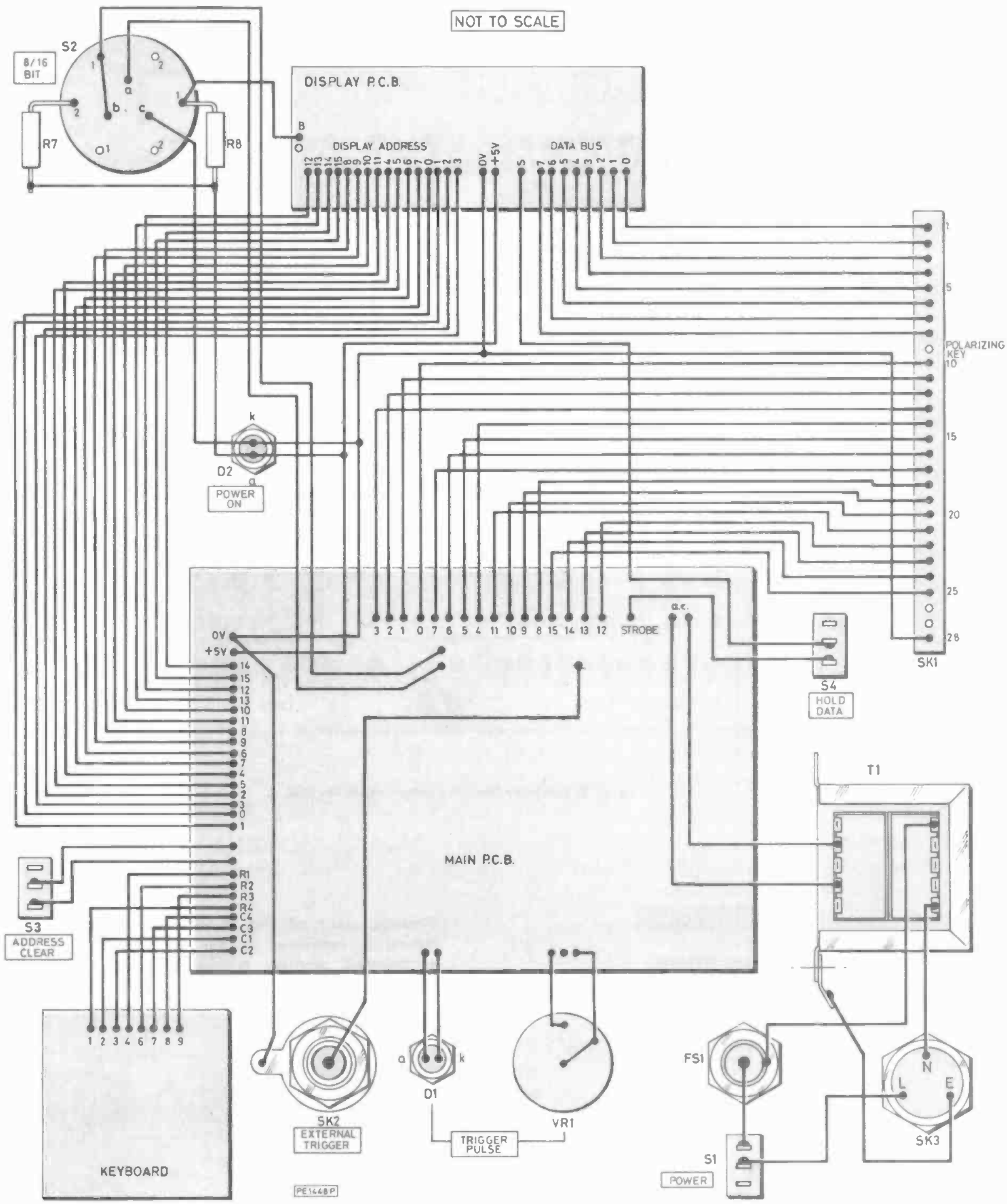


Fig. 2.1. Wiring diagram. Some corrections to Part One are referred to in the text, and these are already taken into account here

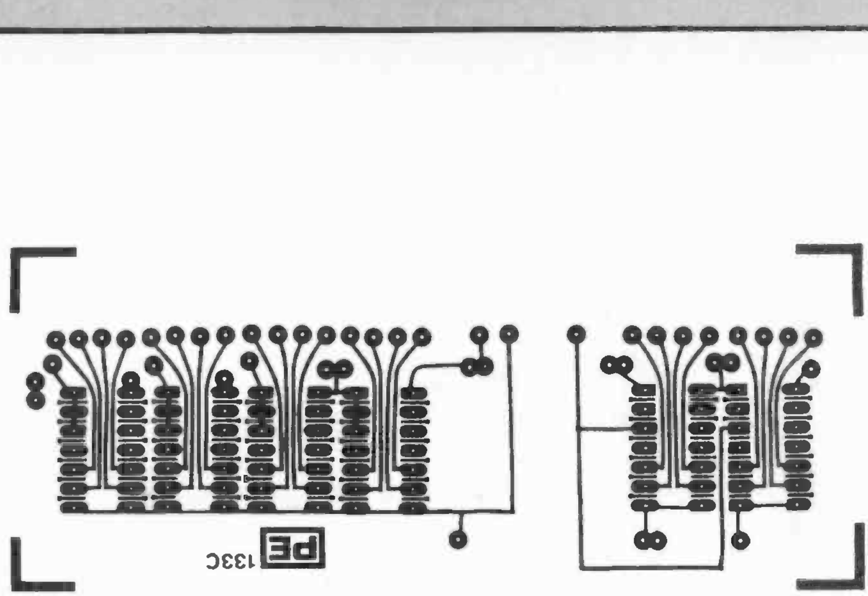


Fig. 2.2. Display board printed circuit layout (actual size)

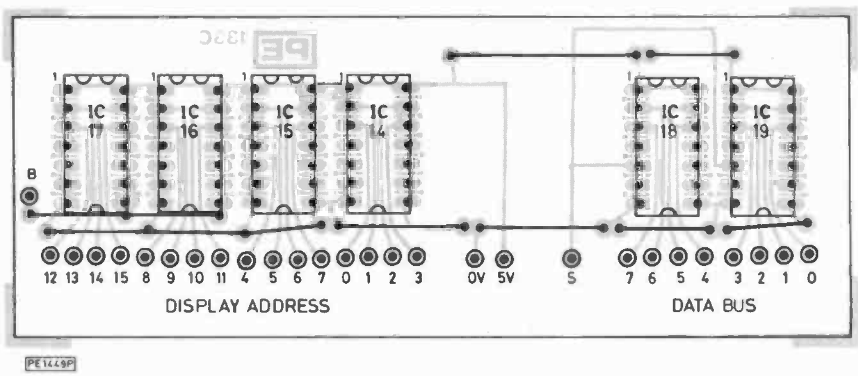
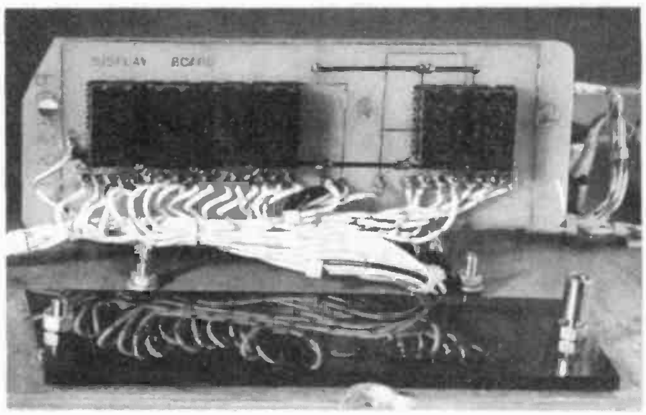


Fig. 2.3. Display board component layout

Frontal view of the display board. A double-sided board is featured in the photograph, although, as presented above, a single-sided board only is necessary



LOGIC ANALYSER

AUGUST FEATURES...

MICROWAVE ALARM SYSTEM...

Built into a hi fi speaker cabinet, this microwave doppler intruder alarm has a range of 8m, yet is completely self-contained, requiring no external wires. The unit measures only 245 x 155 x 155mm.

KITCHEN APPLIANCE TIMER...

Ever needed a third hand in the kitchen? This is it—a useful project with lots of practical applications. A timer which can switch mains appliances up to 5A, with a fully adjustable time setting.

TEMPERATURE INTERFACE for BBC...

Using the machine's own four channel A to D converter this article shows how a simple temperature interface can be made with good linearity and accuracy over a temperature range of −50° to +150° Centigrade.

FEATURE ARTICLE: WHAT IS RADIATION?

EVERYDAY ELECTRONICS and computer PROJECTS

AUGUST 1984 ISSUE ON SALE FRIDAY, JULY 20

VERNON TRENT *at Large!*

V.T.'s views and opinions are entirely his own and not necessarily those of PE

SOME time back, over a soothing thimble of lung syrup, my old mate Tony Kenward (no relation to PE's Mike), the genial secretary of the Society of Electronic & Radio Technicians (SERT), surprised me more than somewhat. And that doesn't happen very often.

He told me that according to an official survey, carried out, I believe, by the Engineering Industries Training Board, less than five per cent of engineers and technicians now elect to join a professional association upon qualifying in their chosen disciplines.

How times have changed. It's not so long ago, as I recall, fresh-faced young fledglings, bearing their diplomas like Olympic torches, used to fall over each other to stick magic letters after their names. In terms of a headlong dash it ranked with the stampede of hopeful panhandlers to the Yukon in '98.

So this current reluctance to is something of an oddity. After all, we're known as a nation of joiners of societies, clubs, associations, fraternities and federations. Not to mention trade unions where, regrettably, one is sometimes faced with Murray's choice.

Every calling and profession has its corporate body. From the Scout movement which, no doubt to the chagrin of Baden Powell up there, now covers its knees, to the Freemasons where breasts are still, I am assured, bared on appropriate occasions. From the Freshwater Biological Association, which sounds like fun and games on lakes, to the British Horological Institute, which, one would conjecture, time has not passed by.

"Blinkered and ostrich-like"

If there is an explanation why times have changed, it could be that outlooks have changed with them. The newly-qualified man—whatever his field—may no longer feel the need for the support of a consolidating body. He sees little logic in forking out what could be a hefty subscription for the honour of adding to his handle a suffix which in many cases no longer carries the weight or exerts the influence it did in former days.

It could also be that in the view of the lately-qualified man, particularly in the current industrial climate, his ability to do a job is of far greater importance than membership—even fellowship when his beard begins to grey—of organisations which by tradition offer what they still happily believe to be the only true hallmark of proficiency.

How far the employee is supported by the employer in this respect I do not know. But I think it is safe to assume that the latter, similarly influenced by the prevailing need for realism, recognises that practicality is the prime consideration. Unless, that is, he happens to be one of the leading lights of a professional society himself.

"I do not write without experience"

Another contributory factor of this switch of attitudes may be the reluctance of many august bodies to acknowledge that they no longer hold the sway they did. Many still cling, blinkered and ostrich-like, to their assumed standing, blandly confident that without membership of their fold, an operator in their particular area might just as well give up and get a job stacking shelves in Tesco's.

* * *

Speaking from the touchline and basing my views entirely on superficial impressions—which means that I have resigned myself to a hail of indignant fire—I would cite the Institution of Electrical Engineers as a case in point.

I do not write without experience. I have had contacts with the IEE for more than 20 years and have the deepest respect for the talents and inventiveness it enshrines and the work it has accomplished. None the less, isn't its image a bit out of date?

Even its headquarters in Savoy Place, London, grand and imposing as they are, epitomise an age which ought to be decently buried. All that marble—enough to equip a dozen Victorian super-loos. Those lofty wood-panelled chambers—highly conducive to nodding off on a warm afternoon. And, most off-putting of all, that larger-than-life statue of Faraday, looking thoroughly cheesed-off after a rotten day with his electro-magnets, extending anything but a warm welcome in the entrance hall.

This, I submit, is hardly the way to attract the young engineer whose only aim in life in the 1980s is to get himself a good job which will pay the mortgage and keep his kids decently fed, clothed and shod. Insularity and the academic concept have no place outside universities. Maybe not even there either.

I don't want to rub it in, but here's another example of how outfits like the IEE tend to wrap around themselves the shawls of yesteryear. They don't hold meetings, debates and conferences. No. They have seminars, or what is even more unacceptable, conversaziones.

I cannot believe that the latter affection is meant as a compliment to the Italians. After all, the IEE and others have been at this form of nonsense since long before Italy joined the Common Market. Let's remember the words of Winston Churchill: "Foreign words were made for Englishmen, not Englishmen for foreign words."

Attitudes have altered just as dramatically in yet another zone. Twenty years ago your aspiring subject expert would have drooled like an infant presented with the teat at the offer of writing—for free, mind you—a 10,000-word article for a professional journal. The sordid matter of money never crossed his mind. The kudos was in itself worth a king's ransom. Brothers, we now exist in another age and your prospective author needs to be coaxed and cajoled and everything depends on the answer to the question: "How much?" It must be very hard for those who have opted to dwell in the past.

* * *

In spite of all this sniping at the professional institutions, I am still convinced that they have a place, even if a modified one, in the scheme of things. Their demise would be the loss of yet another of those traditions which are part of our heritage.

I would like to see them becoming more of an advisory force rather than a rigid dictatorial one. There is no room in modern society for the Star Chamber attitude, with membership restricted to those who graduated from Oxbridge or who turned in an examination paper without error or blemish.

It is as well to bear in mind that your average engineer or technician is today a responsible and dedicated person who has studied hard and worked just as hard to gain his laurels. He is professionally motivated by instinct and he has a natural respect for the requirements and ethics of his calling. The only control function a professional society needs to exercise is against the cowboys of electronics who, like the poor, will probably be with us for a long time.

Given this new approach, one could expect budding engineers and technicians to present themselves for membership in ever-increasing numbers. And, as their ranks swell, one could also hope for less prohibitive annual fees.

Tell me, Tony. Is this any help?

* * *

If you thought from the foregoing that the professional association movement was a bit rocky, here's news of one of the latest. The Association of Diagnostic Engineers (ADE) is to hold its first annual convention in September. Formed in April 1981, it now has a membership of 3,000 worldwide. They come from the UK, Brazil, Canada, Australia, Egypt, Greece, Poland, Sri Lanka and Nigeria.

The ADE publishes a monthly newsletter with technical articles relating to defect recognition and diagnostic techniques. It even has a "trouble shooters" dining club, which is aimed at exchanging experiences between fellow-members under, as they put it, "conditions of friendship and progress".

If you will forgive me, isn't that just what I've been talking about?

SEMICONDUCTOR CIRCUITS

TOM GASKELL BA(Hons) CEng MIEE

FLUID DETECTOR (LM 1830N)

THE use of electronic sensors to replace old electromechanical devices is widespread, bringing benefits in reliability, smaller size, and lower cost. Some types of sensor are easier to implement as a purely electronic system than others, and one of the most straightforward of these involves the detection of liquid levels. During the past year in *Semiconductor Circuits* we've looked at two applications circuits designed to measure moisture levels in soil. This month we feature the LM 1830N, a bipolar i.c. specifically designed for detecting the presence of water or any other conductive fluid in containers or enclosures.

BLOCK OPERATION

The pinout and specification of the i.c. is shown in Fig. 1 with the basic block diagram shown in Fig. 2. An internal oscillator passes an audio frequency signal via an internal resistor, R_{ref}, to one half of a probe, the other half of which is connected to ground. A detector determines whether the liquid is present or not by measuring the level of signal on the probe; a low level infers that the liquid's own resistance is shunting the probe signal to ground, i.e. 0 volts, whereas a high level suggests that no such shunting is taking place, i.e. the liquid is not present. Hence, the detector effectively compares the resistance of the fluid to R_{ref}. When the detector is triggered it passes the signal directly to the base of an npn transistor, which then provides an open collector current sinking capability for loads of up to 20mA. This transistor turns on when the liquid is NOT present, i.e. it is a 'low level' warning arrangement.

Because the transistor is turned on by an audio frequency a.c. signal, it will sink current from the load as a series of pulses. This is ideal for driving a loudspeaker via a suitable load resistor, as shown in Fig. 3, or for driving an l.e.d., but could be unsatisfactory for feeding into a relay, or as part of a logic system. To avoid any problems, the collector of the detector transistor is brought out to the 'filter pin', pin 9. Connecting an electrolytic capacitor from pin 9 to 0 volts will smooth the a.c. signal, causing the output transistor to turn on continuously in the absence of any liquid. The use of this capacitor is also recommended for incandescent lamp driving applications, or when using any form of inductive load.

Because the detector works on a level sensing principle, it is important that the oscillator signal amplitude and the detector threshold are unaffected by supply voltage variations. For this reason, an internal voltage regulator is provided to stabilise the internal supply.

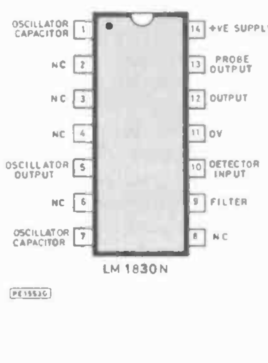
OTHER EXTERNAL COMPONENTS

An external capacitor must be provided for the oscillator (C2 in Figs. 2, 3, and 4), and should normally be 1nF, giving a typical frequency of 7kHz. The output at pin 13 is usually a.c. coupled to the probe via a 47nF capacitor, preventing any problems of electrolysis or plating that would occur with d.c. polarisation. The surface area and spacing of the probes can affect the effective resistance seen to ground, and it may be necessary to adjust the sensitivity of the detector to compensate for different probes or liquid resistivities. This can easily be achieved by using an external reference resistor as shown in Fig. 3. Although the i.c. is primarily used to detect liquid levels, it can also be used to sense changes in resistance of other devices. Fig. 4 shows the arrangement used to detect heat or light levels with a suitable thermistor or optodetector. No 47nF coupling capacitor is shown since these sensors are usually d.c. coupled. Again, an external reference resistor can be used to change the range of sensor resistances which the i.c. will respond to.

Also shown in Fig. 4 is a filter capacitor connected to pin 9, since the output drives a relay via an external npn transistor. The transistor is arranged to invert the output signal, such that the relay turns on when the sensor resistance is low, corresponding to a high liquid level warning system. Other arrangements of output transistor could give the opposite effect, of course. If the output of the i.c. is to feed into logic circuitry a pull-up resistor to the logic system's own supply must be provided. This should be typically 1k to +5V for TTL. and 10k to 1M up to V_{dd} (the +ve supply rail) for CMOS. The LM 1830N need not share the same positive supply rail as the logic.

PRACTICAL USES OF THE I.C.

The i.c. depends on the resistance of the liquid in question; unfortunately, some liquids are non-conducting, which prohibits the use of this technique. Table 1 shows a list of conducting and non-conducting liquids. If a conducting container, e.g. a stainless steel sink or tank, is used to hold the fluid, then this can be



Characteristic	Notes	Min. value	Typically	Max. value	Units
Supply voltage	All specs measured at +16V	5	16	28	V
Quiescent current			5·5	10	mA
Temperature range		−40		+85	°C
Oscillator output voltage — **Low level**	Measured at pin 5		1·1		V
Oscillator output voltage — **High level**			4·2		V
Oscillator frequency	Oscillator capacitor = 1nF	4	7	12	kHz
Internal reference resistor	R_{ref} – see Fig. 2	8	13	25	kΩ
Detector threshold voltage			680		mV
Detector threshold resistance		5	10	15	kΩ
Output sink current	at pin 12			20	mA
Output saturation voltage	10mA sink current, pin 12		0·5	2·0	V
Output leakage	For pin 12 at +16V			10	µA
Power dissipation				300	mW

Fig. 1. Pinout and specifications

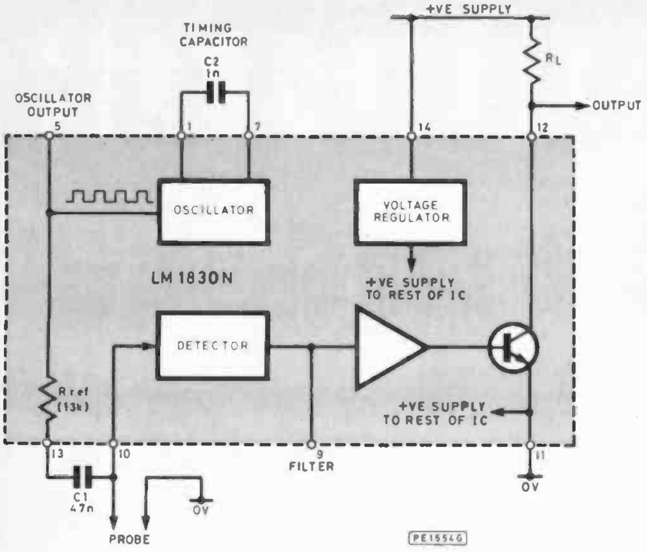


Fig. 2. Block diagram

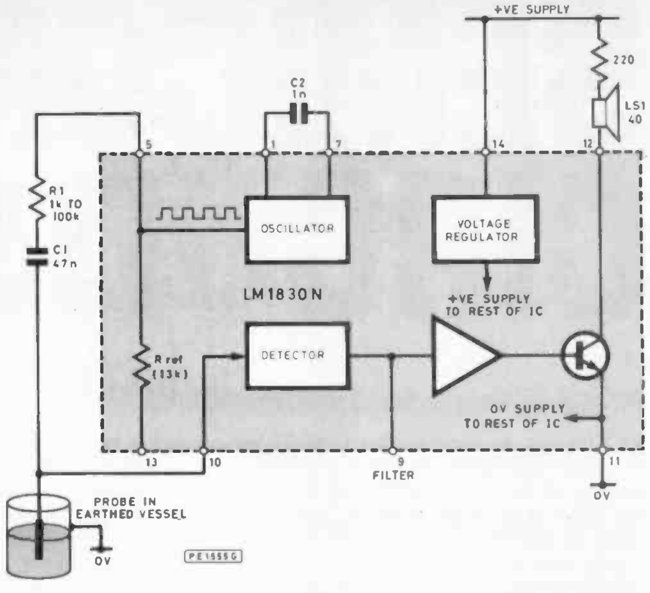


Fig. 3. External R_{ref} and direct driving of a loudspeaker

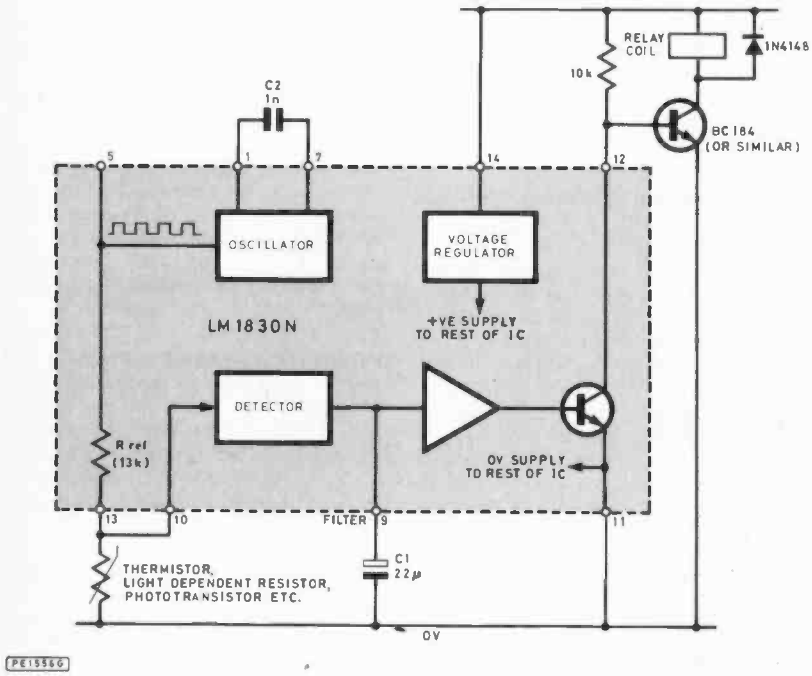


Fig. 4. Other sensors and driving a relay with inversion

Conducting Liquids	Non-Conducting Liquids
Ordinary water (the majority of water)	Pure water
Sea water	Whisky
Weak acid	Petrol
Weak alkali	Oil
Coffee	Alcohol
Wet soil	Dry soil
Copper sulphate solution	Paraffin
Water and Glycol mixture	Brake fluid
Household ammonia	Ethylene glycol

Table 1. Conducting and Non-Conducting Liquids

connected to 0 volts directly, and the probe need only consist of a single conductor held in the vessel. In other cases the probe should be a two conductor arrangement; a piece of glass fibre p.c.b. material, suitably etched, could suffice, as could many configurations of metal and insulator.

APPLICATIONS CIRCUIT

The circuit diagram of a low water level alarm is shown in Fig. 5, with Fig. 6 giving the Veroboard layout. This circuit can be used in many water level detection applications, and is ideal for use in vehicles; a good example is to give early warning of a low windscreen wash water level. The LM 1830N is used as already described, with a filter capacitor to ensure that the output transistor is turned on with a d.c. signal. A 'low level' warning l.e.d., D1, illuminates as soon as the water level drops to an appropriate point. As soon as this occurs D2 becomes reverse biased and C4 starts to slowly discharge via R3. After several seconds the voltage across C4 becomes sufficiently low to cause the output of IC3a to go to logic 1 (a high level), assuming that pin 1 of IC3a is at logic 0 (a low level), too. This turns on an audio frequency oscillator formed by IC2c and IC2d with R9, R10, and C7. The oscillator, in turn, causes WD1 to sound, driven by spare gates IC3b, IC3c, and IC3d in parallel to ensure a more than adequate current capability. IC2a and IC2b form a latch or flip-flop, which is set when power is first applied to the circuit by R6 and C8, and is reset by S1. When set it allows IC3a to operate normally and the tone to sound, but when reset it feeds a logic 1 to IC3a, preventing any tone being heard until the power is turned off, then on again.

In use, the warning l.e.d. illuminates as soon as the liquid level goes low. The tone is only heard after a few seconds, to allow time for the l.e.d. to be noticed and remedial action taken, or to prevent false alarms caused by momentary drops in level; for example, due to liquid

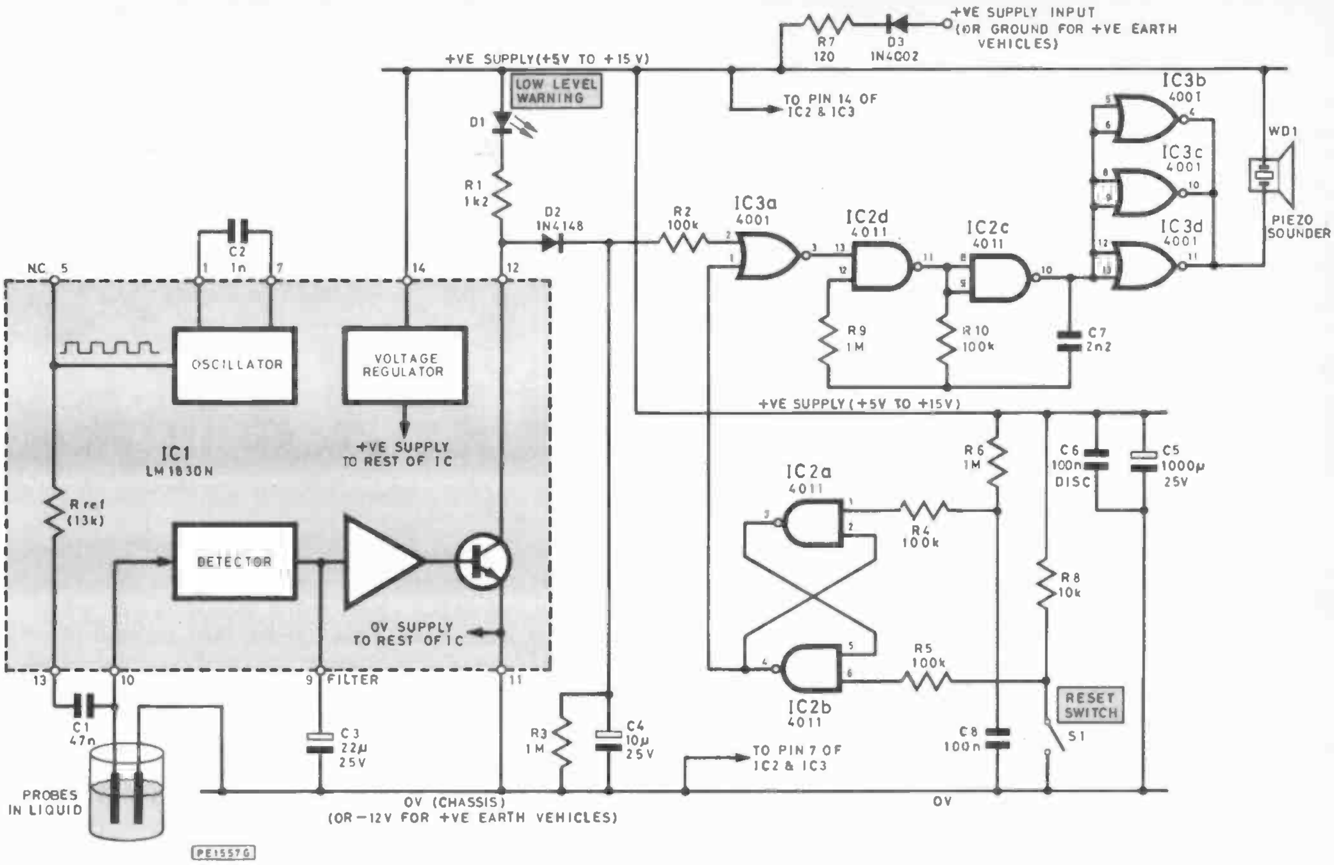


Fig. 5. Circuit diagram of low water level alarm

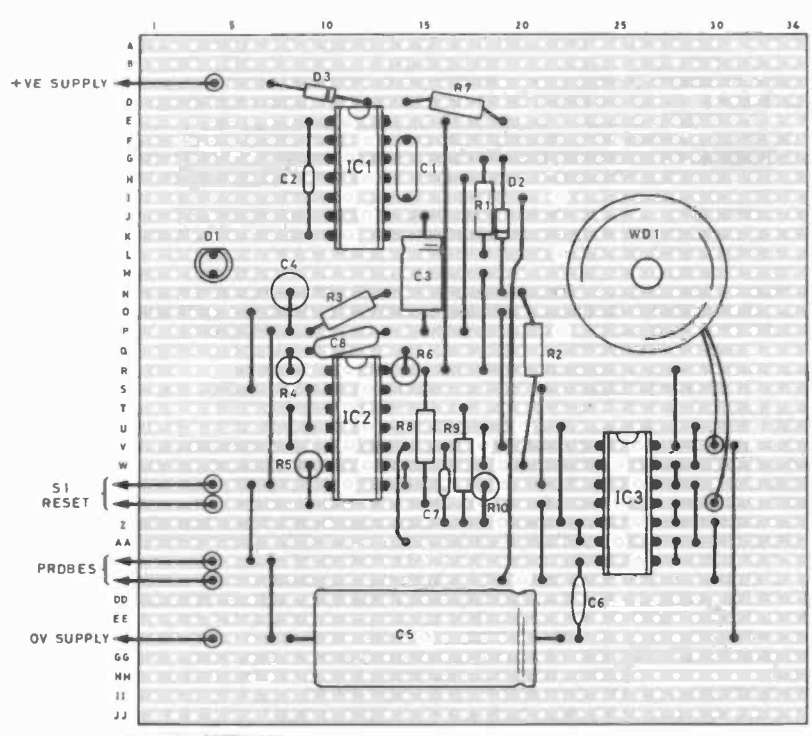


Fig. 6. Veroboard layout

movement during vehicle cornering. When the tone is heard it can be stopped either by adding more liquid to the container, or by pressing S1 (the momentary action reset button). The tone signalling is re-armed when power is re-applied to the circuit as described above. Note that the power should be turned off for several seconds to allow C5 time to discharge. The tone will sound immediately, with no delay, if the liquid level is low when power is first applied, since C4 and R3 will not have had any chance to charge up to a logic 1 level.

Finally, D3, R7, C5 and C6 smooth the supply to the circuitry, helping to avoid problems caused by the large spikes and transients found in most vehicle electrical systems. The internal oscillator of IC1 wasn't used for the tone signalling in this design (via the output pin 12) because of the requirement for a simple time delay provided by D2, R3, and C4. Also, the small oscillator amplitude at IC1 pin 5 (4 volts peak at maximum) made it easier to provide a separate audio oscillator (IC2c and IC2d) than to try to exploit the LM 1830N's own oscillator. Other circuit configurations, of course, could make good use of this internal oscillator facility.

The LM 1830N is not a new i.c. by any means, but it offers a simple, economical, and interesting solution to many problems in liquid level sensing, and is very straightforward to design with and use. It is available from **Maplin Electronic Supplies Ltd.**

Alarm SYSTEM

PART TWO

G.E.LUMLEY

BOTH internal and external alarms have been left to the preference of the constructor.

The relays in both the Comparator and the Two Timer have 24 volts d.c. at 1 ampere local contact capacity. The internal warning might well be a bell or buzzer or indeed the door gong. If a more exotic sound is sought, the Warbler described later in this article will probably suffice. A variety of alternatives present themselves including the lighting of lights. In such a case use will be made of a power triac or second relay since the relays given are limited to 100 V a.c..

Of all the external alarms the electric bell is very economic in both price and power terms but years of discredit due to bells ringing for long periods due to badly designed alarm systems false triggering rather rules them out as effective. A very good and economic alternative has been located by the writer. This is a little 'Micro-Siren', which is quoted by the manufacturer as producing over 90dB at 3 metres, audible at 400 metres at least and requiring 850mA with an input supply of 12 volts. This little howler is small enough to either hide away or build into a box along with a power supply and other devices such as flashing beacons. Setting the Two Timer is a case of personal feeling but is surely a question of common sense; if the the internal alarm has fired, followed by the external alarm which is allowed to run for a full three or four minutes, it is very unlikely that there is any intruder hanging around after that. Perhaps a flashing beacon might be desired after the cessation of the siren; this could be achieved by picking up the l.e.d. output from the Two Timer and by suitable amplification and relay, flash a lamp or Zenon Tube.

CONSTRUCTION OF THE COMPARATOR BOARD

The p.c.b. design for the Comparator is shown in Figs. 2.1 and 2.2 with the component layout in Fig. 2.3. The board is double sided and Veropins are used as lead throughs. Be careful to tin both sides of any lead through circuits. Usually these are foil pads soldered to through pins but there are some which consist of the pins of d.i.l. sockets or potentiometers. Lead through Veropins not used as terminals can be cut off short after soldering. The 10n disc ceramic capacitors soldered close to the supply pins of those i.c.s listed are very important in the suppression of 'glitches' which would cause false triggering.

A sub-panel is made to carry the switches and l.e.d.s along with the Compensator sub-assembly. The details are in Figs. 2.7 and 2.8. The drawing can be used for both the sub-panel cutouts and the lid of the box. The slide switches are not screwed but glued to the sub-panel and when the sub-panel is screwed to the box lid, they are held fast. The details of the Compensation panel should be followed closely using a scrap of Vero board to carry the resistors. Use a d.i.l. socket for the d.i.l. switch for ease of assembly and to avoid damage to the switch. The top pins of the d.i.l. switch are commoned and the outside ends of the resistors are commoned on the Vero strip left on the board. The other ends of the resistors go each to a free pin on the switch (socket if used). Make sure the assembly is well fixed as it will see considerable use.

POWER UNIT

The p.s.u. described fits the 2006 box and is intended to supply the Comparator board and the Two Timer board. The circuit diagram is in Fig. 2.4 and a p.c.b. layout in Fig. 2.5 with a component layout shown in Fig. 2.6.

It is not intended that the p.s.u. shall supply extra circuitry, although the specified transformer and rectifier combination is capable of doing so. The main restriction is in the regulation provided by the Zener diodes. Replace these with appropriate voltage regulators and another 50mA would be available; however, since the project philosophy is to leave the audible warning devices to the choice of the constructor, it is necessary to note the design limits of the p.s.u. as it stands.

The two Ni-Cad PP3's are charged at just 1 to 3mA by adjusting the two associated variable resistors. The batteries must have been on charge for some two days before the final adjustment is made, or alternatively they could be charged on a normal charger at a normal rate first.

The position of the p.s.u. in the box is at about 7 or 8 slots from the top. This allows ample ventilation for the transformer by virtue of the vents cut in the box. The two PP3's are held by double sided adhesive pads in a convenient position. Take care not to allow fouling of the sub-panel components when the box lid is positioned.

When the system is triggered, a state of discharge will be seen if the batteries are monitored. This is intentional and cycles the batteries at least whilst testing the installation. The charge/discharge currents are monitored by lifting one side of the battery connector and placing a milliammeter in series. (About 30mA from one PP3 and 20 from the other.)

The 240 volt mains input must be wired with care, covering terminal pins with systoflex or shrink sleeving. Use a fused plug at 2A and fit a 500mA fuse in the internal holder.

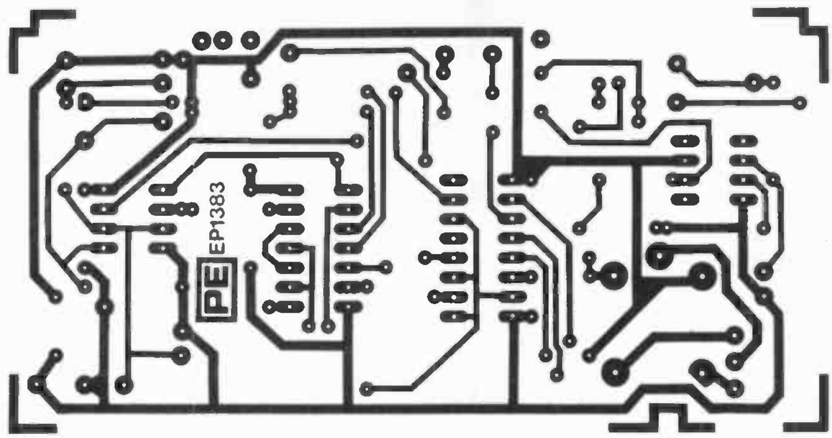


Fig. 2.1. P.c.b. design (track side)

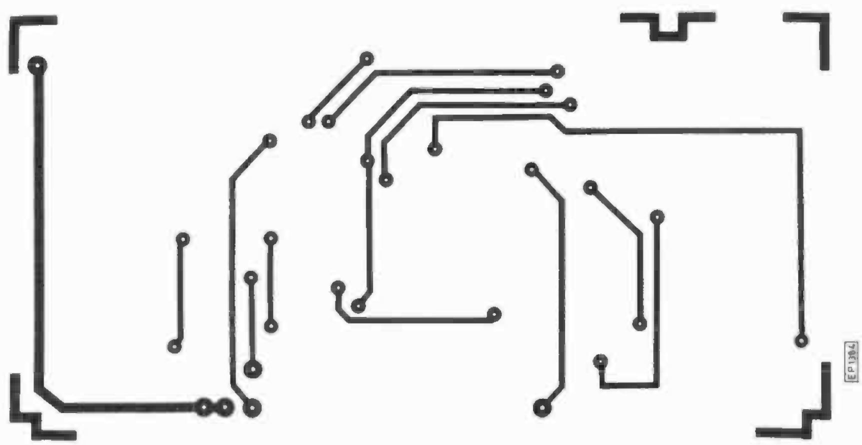


Fig. 2.2. P.c.b. design (component side)

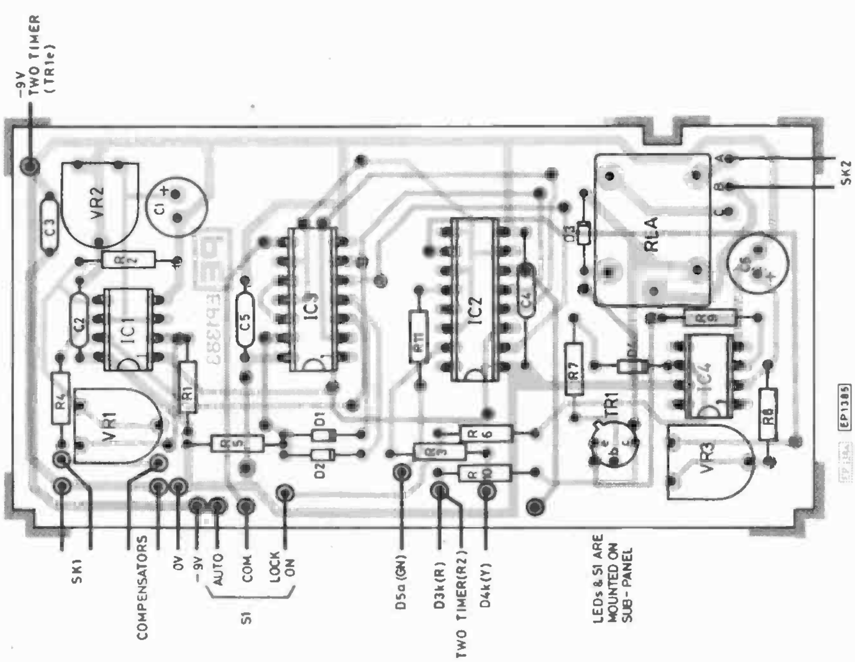


Fig. 2.3. Component layout

COMPONENTS . . .

COMPARATOR BOARD

Resistors

R1,R2	1M (2 off)
R3,R10,R11	1k (3 off)
R4	100
R5,R6	150k (2 off)
R7	470
R8	100k
R9	470k
VR1,VR2	100k hor. preset (2 off)
VR3	1M5 hor. preset

All resistors $\frac{1}{4}$W 5% carbon

Capacitors

C1,C3	47μ 16V elect (2 off)
C2,C4,C5	10n (3 off)
C6	470μ 16V elect

Semiconductors

D1,D2,D3	1N4001 (3 off)
D4	BZY88 5V6 Zener
TR1	BC109
IC1	LF353
IC2	4049
IC3	CD4011
IC4	741

Miscellaneous

8-pin d.i.l. low profile i.c. socket; 14-pin d.i.l. low profile i.c. socket; 16-pin d.i.l. low profile i.c. socket; Relay 9 volts 225 ohms Kuit A (Ambit 46-80001); P.c.b. double sided board; Veropins.

SUB-PANEL

Resistors

R1 to R8	470k $\frac{1}{4}$W 5% carbon

Semiconductors

D1,D2,D3	5mm red l.e.d. (3 off)
D4	5mm yellow l.e.d.
D5	5mm green l.e d.

Miscellaneous

S1,S2 d.p.d.t. slide switch (2 off)
S3 push switch single pole push to make
S4 to S11 Octal d.i.l. switch (Maplin XX27E), Veroboard, Veropins, 16-pin d.i.l. i.c. socket, *Reed switches (10 off), SK1,SK2,SK3 2-way LS type DIN sockets (3 off)

*If reed switches complete with magnets are used then it will be necessary to insert a 470k resistor in series with the reed.

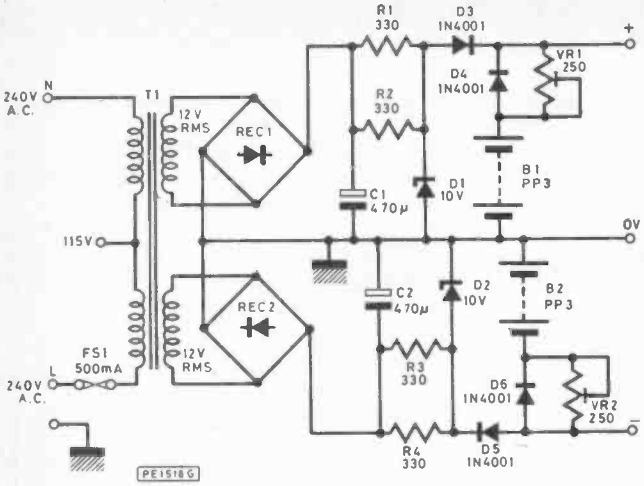


Fig. 2.4. P.s.u. circuit diagram

INTERWIRING

The various p.c.b.s are connected together using the interconnection diagram in Fig. 2.9. Ribbon cable was used but constructors may wish to use singles. Use stranded interconnecting wire, not solid core, and enough length should be used to enable all p.c.b.s to be withdrawn from the box.

The adjustment is simple enough. If all the external circuits have been installed, these may be used, otherwise connect a resistor of value equivalent to the parallel value of the proposed external network, to the input DIN socket. (Compensators switched in are the equivalent of sensors.)

If the external network or its equivalent resistor is used, switch out all compensators. Adjust VR1 on the comparator to about mid position and adjust VR2 so that half Vcc appears at pin 3 or 6 of IC1. S1 must be switched to Auto-Reset.

The green l.e.d. should now be lit.

Switch in a compensator at the d.i.l. switch. The green l.e.d. should extinguish and the yellow l.e.d. should light.

The next step is to set up the delays. Only the Comparator delay is described at this stage, the Two Timer will be covered later.

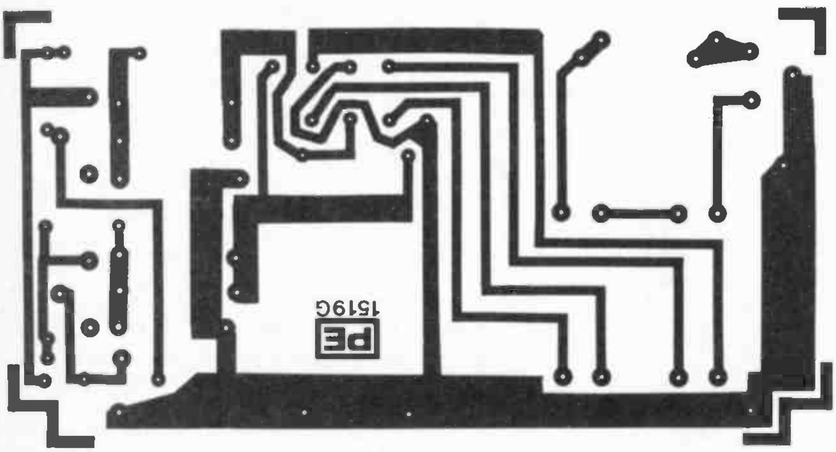


Fig. 2.5. P.c.b. design for p.s.u.

COMPONENTS . . .

POWER SUPPLY UNIT

Resistors

R1,R2,R3,R4	330 ¼W 5% carbon (4 off)
VR1,VR2	250 verrtical presets (2 off)

Semiconductors

D1,D2	10V Zener BZY88 (2 off)
D3,D4,D5,D6	1N4001 (4 off)
REC1,REC2	Bridge rectifier 50V p.i.v. (2 off)

Miscellaneous

Ni-Cad rechargeable battery (2 off); Mains transformer 12V–0–12V @ 140mA (Ambit 57-10052); Fuse clips p.c.b. mounting (2 off); Fuse 500mA; P.c.b.

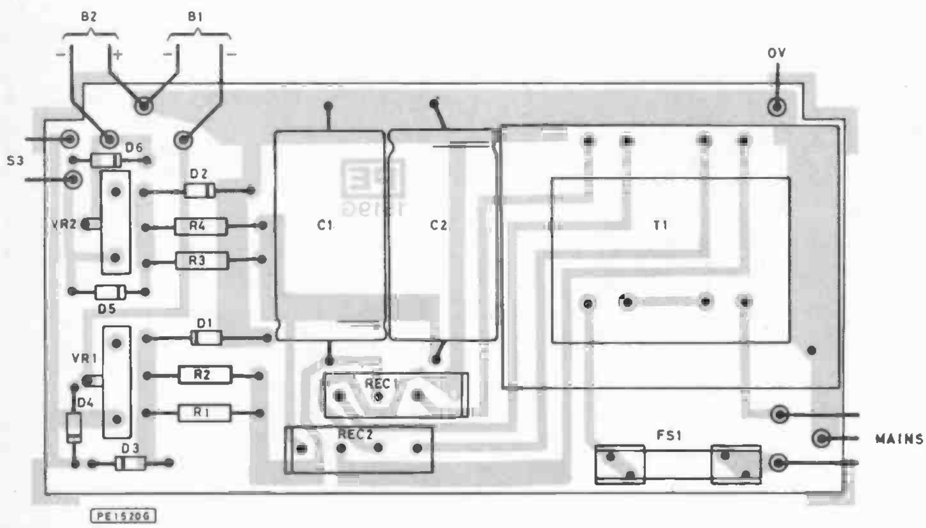
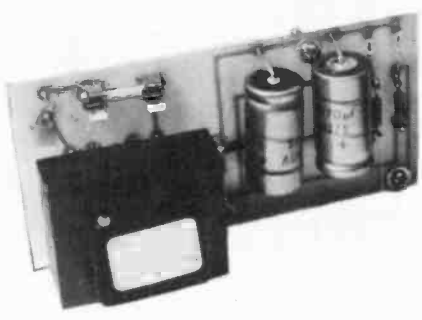


Fig. 2.6. Component layout



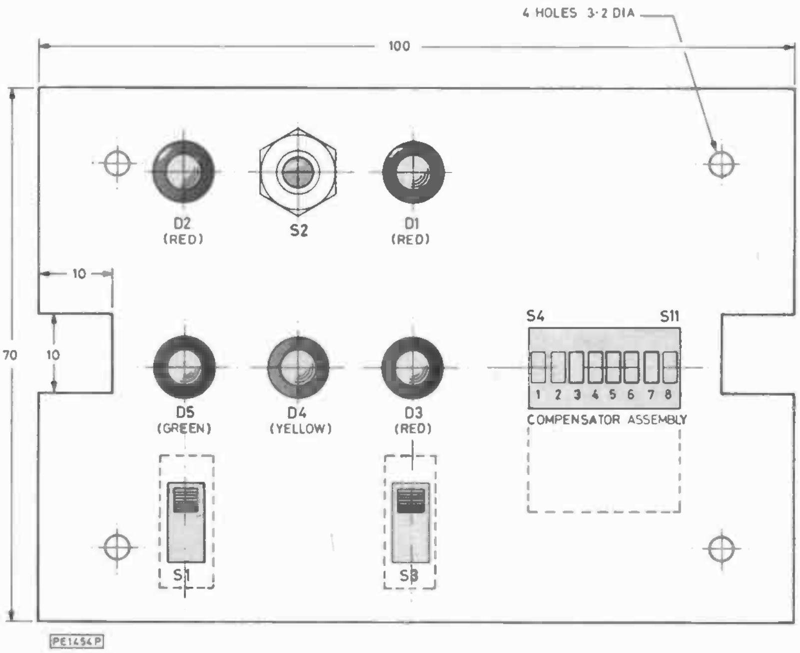
Prototype p.s.u. board

Set the delay control VR3 to minimum. Set the input network to 'Alert' and all Compensators off. The green l.e.d. should be on.

With a stopwatch or similar timer, measure the delay from the point of switching in a Compensator to the point where the red l.e.d. lights and the relay closes. Switching in a Compensator is the equivalent of a tamper condition when the external network is 'All Intact'.

The adjustment of the delay can now be made, based on the minimum period just obtained. It will be very roughly about 8 seconds. See if the delay arrived at is adequate to leave the house and close the door. It will need to be if 'Lock-On' is to be used when the premises are vacated.

Switch to Lock-On and retrigger the Comparator using the Compensator. The green should extinguish and the yellow light up. Wait until the red comes on then remove the input



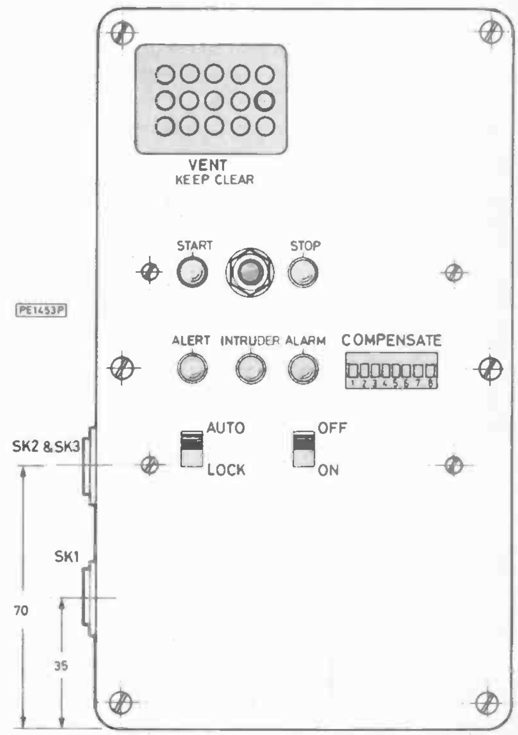


Fig. 2.7 (above). Sub-panel assembly and layout diagram (full-size). Fig. 2.8 (right). Front panel assembly diagram (half-size)

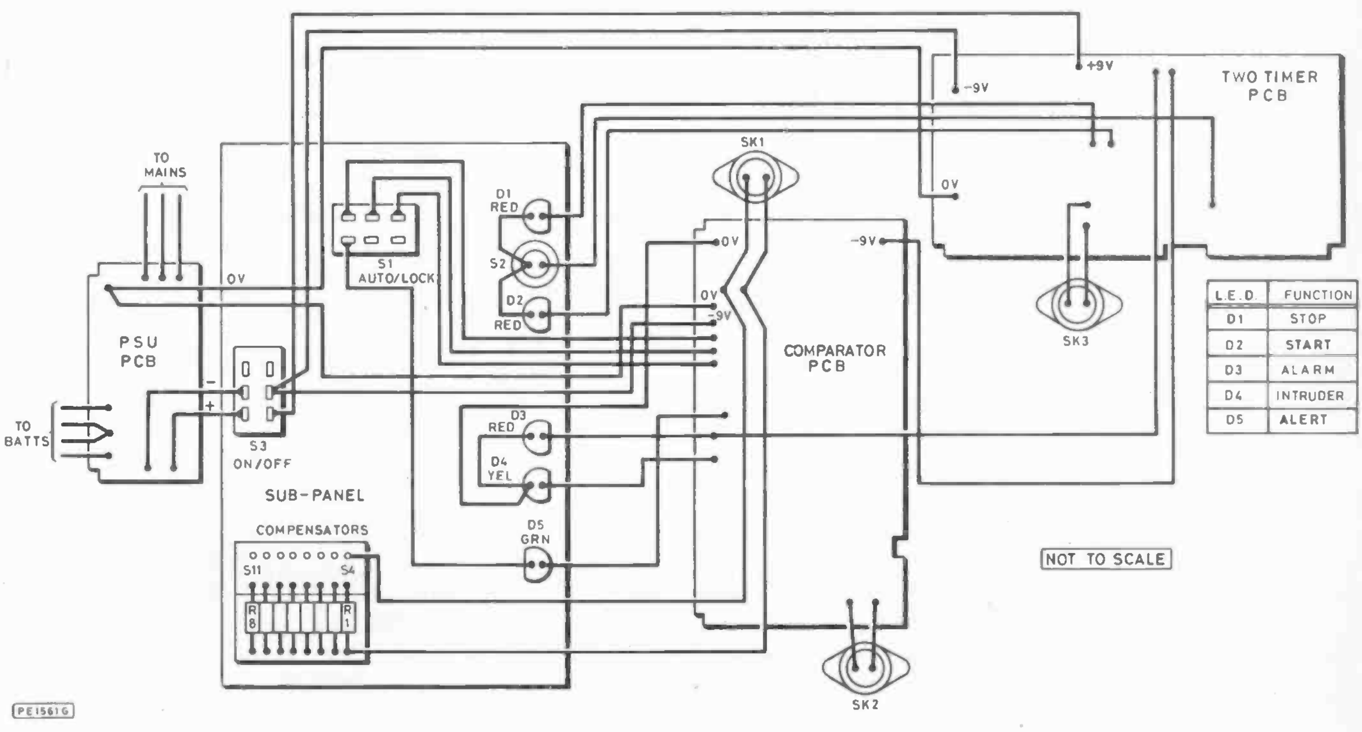


Fig. 2.9. Wiring diagram for the Alarm System

by switching out the Compensator. The yellow and the red l.e.d.s should persist until the 'Auto-Reset' mode is applied and the Compensator removed.

The Width Control is all that remains to be set. It is necessary to either use the external network or simulate it.

Use 'Auto-Reset' mode, then with all sensors (or simulated sensors) in circuit and all compensators out, green l.e.d. lit and previous settings (VR2) correct, switch in one compensator and the yellow l.e.d. should light. Switch out the compensator and the green should replace the yellow. Now open circuit one sensor (remove one 470k from the network) or reduce the number of simulated sensors by one, whereupon the yellow should light again and the green should extinguish.

Turning the Width Control anti-clockwise narrows the Width and therefore the system will appear more sensitive; try a pair of wet fingers across the external network when all compensators are out and all sensors in. If it proves impossible to trip the system either by decreasing the number of sensors in circuit or putting in one extra 470k by using the compensator, the system is too insensitive and the Width Control should be turned anti-clockwise. A point can generally be found where the system is so sensitive that the green and yellow l.e.d.s tend to flutter on and off. This state must be avoided. By and large set the system to that Width where either an open circuit sensor or an additional compensator will trigger the l.e.d.s.

Alternatively, a more accurate method may be used. By plotting the necessary change in input voltage for each of several settings of the Width Control, it can be ascertained which value of VR1 is stable and yet sensitive enough. A 100k potentiometer across the input socket but set to equal the setting of VR2 (say 47k) and a high impedance voltmeter to measure the change in input voltage, can be used to check the increment and decrement necessary to trigger the system for each of say five settings of VR1.

EXTERNAL NETWORK (INSTALLATION)

Little can be said about the external network as much depends on the building and its occupier. The wiring need not be concealed because of the anti-tamper facility. One very important point however, great care must be taken to ensure that moisture cannot make ingress at any point, since the Comparator would see this as a tamper state. Any junction blocks are best filled with wax or resin (paraffin wax or Araldite).

TESTING THE TWO TIMER

When the whole system is complete and the Comparator has been set up, it will be necessary to adjust the delays in the Two Timer. The procedure is simple, there are two potentiometers in the Two Timer, one for the Delay before

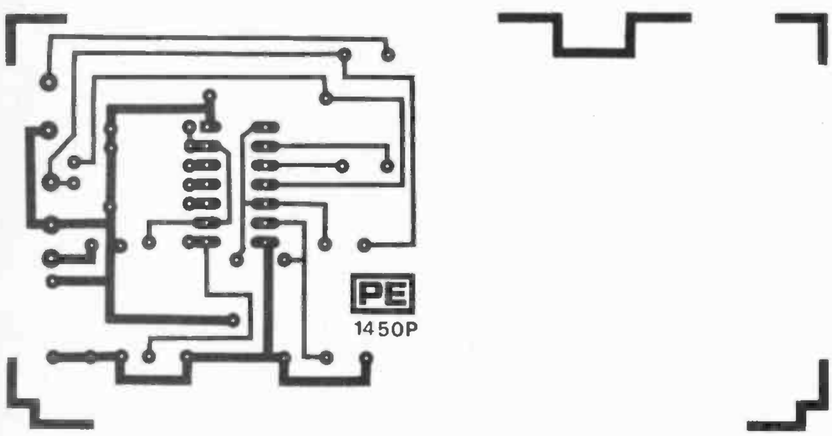


Fig. 2.11. P.c.b. design for the Warbler Unit

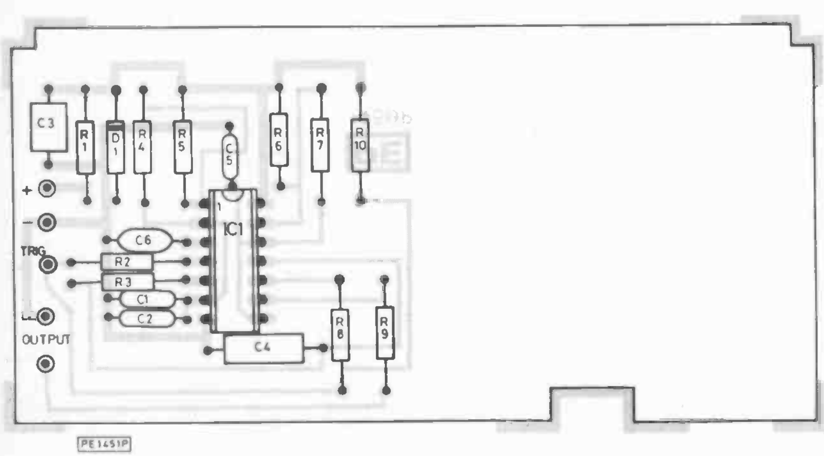


Fig. 2.12. Component layout

COMPONENTS . . .

WARBLER UNIT

Resistors

R1,R9	100 (2 off)
R2,R8,R10	47k (3 off)
R3	27k
R4	1M2
R5	1k5
R6,R7	33k (2 off)

All resistors $\frac{1}{4}$W 5% carbon

Capacitors

C1,C2,C3	100n (3 off)
C4	22µ 16V elect.
*C5	2n7 disc
C6	10n ceramic disc 25V

*Can be shunted with a 4n7 in order to peak tone to horn resonance

Semiconductors

D1	15V Zener BZY88
IC1	NE556 or 7556 for reduced power consumption

Miscellaneous

P.c.b.
14-pin d.i.l. I.c. socket (if required)
Piezo horn

the external siren starts and the other for the period of operation of the siren. Remembering that both are initiated simultaneously by the Comparator and each independent of the other, set first the delay time to somewhere around 45 seconds after the yellow l.e.d. in the Comparator lights; this will mean that the external siren relay will close after that period. Next set the other potentiometer to establish the duration of the external warning. A length of time up to about four or five minutes is adequate, since if no action has been taken by then, there would seem to be little chance of the intruder being around or indeed catching him.

In addition to an external siren, some users might like to include a flashing beacon with the siren. There are possibilities with Zenon Tube beacons or more simply, just a red lamp powered from the 12 volt siren supply.

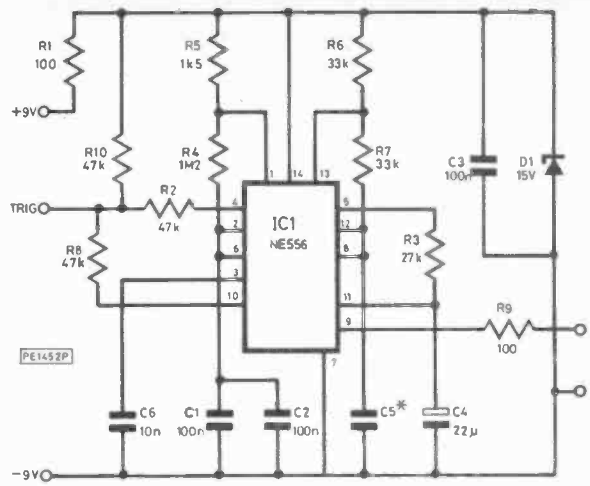


Fig. 2.10. Circuit diagram of the Warbler Unit

WARBLER UNIT

It is possible to construct a unit which produces a warbling note for use as the internal warning. When a piezo horn is connected to the Warbler, adequate noise is generated to put off most intruders before the external siren is activated.

The circuit diagram of the Warbler Unit is shown in Fig. 2.10 with the p.c.b. and component layout shown in Figs. 2.11 and 2.12.

The output relay of the Comparator which is available at the socket SK2 is used to switch external power (batteries perhaps up to 18 volts) to the Warbler which should be located out of reach. The normal house offers a good position high up in the stair well, with leads running down from the loft. The object is to avoid leading the intruder to the electronics.

The components specified will suit most horns but as they are frequency conscious, experiment a little with the timing components C1/C2 and C4. C1 should be chosen to generate a tone which coincides with the peak resonance of the horn, usually around 2 to 2·5kHz. This is easily sensed by ear. Do not be too persistent, the noise can become quite painful. A fine tune on the warble can be made by replacing the 1M2 (R4) by a variable. C4 is important in that it forms part of an integrator which shapes the modulation waveform.

The housing of the Warbler is left to the constructor. Any box which could also house the dry batteries and even the horn could be used. ★

BAZAAR

CRIMSON Electrik 100 Watt Stereo Slave in 19" Rack Mounting Cases. Two only for sale £70·00 each. Mr. Kerry Williams, 10 Wilmot Street, Melyncryddan, Neath, West Glamorgan SA11 1AH. Tel: (0639) 51948.

TELEQUIPMENT Scope D67 Manual wanted to buy or borrow. Mr. J. Rayner, 30 Westbourne Park, Scarborough, N. Yorks. Tel: (0723) 372588.

WANTED Diagrams with explanations of an EPROM 2716 Programmer with CPU 8085 Intel or Z80 Zilog. Mr. D. Vandewalle, 6 Chee G Richet, 7860 Lessines, Belgium.

SYNTHESISER 4600, Mostly working. (Not completely finished) Large wooden case. Internal Amps/Speakers. Huge Patchboard £220. Mr. T. A. Gaskell, Cambridge. Tel: Cambridge (0223) 893593.

MAPLIN organ complete working including Reverb Rhythm units two Keyboards Pedals etc. Best offer accepted. Mr. D. Dockree, 6 Pine Road, New Southgate, London N11 1EP.

PRACTICAL Electronics 1969–1984 less 2. Buyer collects. M. E. L. Yates, 5 Whinney Moor Lane, Retford, Notts. Tel: Retford 704995.

6 ROLLS Sinclair Printer. Paper unopened £5. Broken Printer £1 Plus postage. Mr. Ralph Lovelock, 14 Knightley Road, Exeter EX2 4SR. Tel: (0392) 75826.

INTEREST p.c.b.'s i.c.'s Amplifier Chase and Moving Lights Circuitry Exchange. Write. Mr. A. Larry, 56 Becher Street, Derby DE3 8NN.

TWO 2½ft 34 Way Ribbon Cable with Edge Connector on each end. £2·50 each including postage and packing. Mr. G. Blount, 39 Rectory Lane, Roack, Kidderminster, Worcs, DY14 9RU.

TELEQUIPMENT Serviscope with probe and manual £60. Suggest collection. Tel: (0865) 779855 Mr. C. Dean.

SALA safety block £25. Coax cable 140ft. $\frac{7}{8}$in £50. Mr. J. Denby, 107 Station Road, Lepton, Huddersfield HD8 0DE. Tel: (0484) 603898.

CHEAP Armstrong FM tuner. Truvox tape deck, pre-amp/record unit, power supply. Belling-Lee 'Eliminoise' aerial kit. Mr. Smith. Tel: 01-366 7115.

WANTED circuit to build Electrostatic Gen up to 70kVA as used for paint or flocking spraying. Will buy. Mr. W. Beetwell, 23 Buckingham Avenue, Thornton Heath, Surrey. Tel: 01-679 3983.

LOOKING for plan Schema operator manual 'Graph' 303C oscilloscope by Waveforms Bournemouth or New York. D. E. Piere, 222 Lge Leemstraat, 20/8 Antwerp, Belgium.

WANTED oscilloscope must be modern and good condition. Will pay up to £100. Dual if possible. Mr. P. Hale, 31 South Road, Stourbridge, West Midlands DY8 3YA. Tel: (0384) 379120.

PYE Vanguard TX RX crystalled 4 metres 70-26 Megs VG condition. 1 TX 1 RX crystals. £12. Mr. R. Pearson. Tel: (0792) 582941.

HAMEG scope HM203-4 £250. Realistic scanner £190. Revco discone £30. PE 1972–81 + 83, offers, plus carriage. W. Edwards, 2 Beach Road, Burton Bradstock, Bridport, Dorset. Tel: (0308) 897625.

UK 101 cased 16K RAM + Exmon/assembler in Eprom via. 300/600 baud full documentation. £115 o.n.o. Mr. B. H. Hancock. Tel: Ringwood 6950.

XC68000L prototype 4MHz 68000 processor: 3 surplus to requirements. Ideal for experimenter at £15 each. B. Benson, Plumtree Cottage, Mill Lane, Legbourne, Louth, Lincs.

ACORN Atom 12K RAM with p.s.u. and software £50 o.n.o. Consider breaking for spares. Mr. D. Butler, 28 Twining Road, Lexden, Colchester, Essex CO3 5XG. Tel: Colchester 48603.

OSCILLOSCOPE Telequipment type 43 with manual. Works sometimes! For repair or spares £12. Mr. B. Marriott, 79 The Myrke, Datchet, Slough, Berks. SL3 9AG. Tel: Slough 35195.

SEIKOSHA GP 100A printer, needs repair! Best offers. Want—swap monitor, keyboard, 74LS's recorder, w.h.y. Mr. M. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

SEEKING a friend having interest in electronics or collecting something In exchange of electronics components. D. Amroudi, PO Box 13595–114, Tehran, Iran.

KEMPSTON S interface Spectrum to Seikosha with software. Working but replaced with Kempston E. £20. Mr. R. T. Lovelock, 14 Knightley Road, Exeter EX2 4SR. Tel: Exeter 75896.

WANTED Akai model GXR 82D 8-track stereo recorder. Buy or borrow service manual or circuit diagram please. P. Harding, 4 York Road, Brentwood, Essex. Tel: Brentwood (0277) 222693.

SCOPEX 4D10B (dual trace) £125. Nascom 2 32KB green screen VDU, languages etc., £290. Sensible offers considered. Mr. G. J. Wicks, 89 Headroomgate Road, St. Annes-on-Sea, Lancs. Tel: (0253) 721099.

ZX81 16K Spectrum-type keyboard still under guarantee plus good games, £59. Mr. M. Huq, 31 Darfield Road, London SE4. Tel: 01-692 4751.

MEMORY 1C^5 HM6116LP3 unused fully guaranteed £1·75 each. Over 100, £1·50 each. P&P 25p. Mr. R. G. Potts, 371 Heathcote St., Chesterton, Newcastle, Staffs. Tel: (0782) 564037.

Strictly Instrumental

by K. Lenton-Smith

THE process of invention is perpetual but it is fascinating to note how it has galloped over the past 30 years. There are no prizes for guessing the reason. Who would have thought that widespread ownership of powerful, miniature computers and digital watches would arrive so soon—and at prices we can all afford.

Transistor action was discovered in 1949 but a good few years were to elapse before the delicate 'point contact' device evolved into a really dependable component which was both inexpensive and available in quantity.

Twenty years ago the transistor had gained wide acceptance. There was another important event taking place at that time: the Publisher and his Editor were planning the launch of a new magazine. Practical Electronics made its debut in November 1964.

Then, as always, P.E. was forward-looking, with the semiconductor its main preoccupation. In those early issues there were occasional references to valve circuitry, which may seem strange in retrospect, but the long-term reliability of transistors was still being proved. A number of organ manufacturers were very conservative in this respect, understandably so as their good names were at risk if they made a wrong decision.

Gulbransen was the first manufacturer to produce a fully-transistorised instrument but competitors were often slow to make the change from proven valve circuitry. Organs were just about the most expensive piece of electronic equipment you could own, were extremely well-made and built to endure many years of use. A close look at the cabinet work of vintage instruments will show that this aspect was better than it is today.

AGEING

Being built to last, many valve organs are still in existence today and work quite happily. There were no 'frills' such as rhythm units or synthesizers though possibly a simple form of percussion might have been embodied. A straightforward instrument of this type is suited to secular music and is often found in a chapel or small church today. A good number of church organists take an interest in electronic music and nurse their instruments over the years.

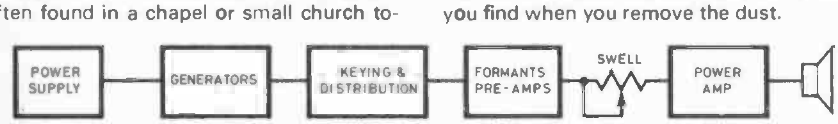
If an old valve organ works reasonably well and up-to-date facilities are not essential, why bother to replace it? Provided the owner takes care to keep a set of spare valves, it might as well be used until it gives its last gasp. At the same time, valve circuitry does suffer from *anno domini* and needs occasional attention. Taking the back off will reveal some 'CEGB' engineering as steel chassis had to be used to support large transformers. The valve filament current alone may well have been in the region of 25A if tone generation was electronic rather than mechanical. The h.t. supply was perhaps some 400V for the output stages and all the discrete components had to be suitably rated and were consequently bulky.

Being interested in electronics, you will naturally be considered very expert by anyone knowing less than you—so you can get saddled with curious tasks from time to time! Being asked to look at an ageing electronic instrument is a possibility so it may be useful to consider what you could encounter.

UNFAMILIAR

The impressive armour-plated innards may look forbidding but the circuitry was far less complex than it is today. The circuit diagram may have been lost years ago, to add to the problems, so you may have to (as at the keyboard!) play it by ear.

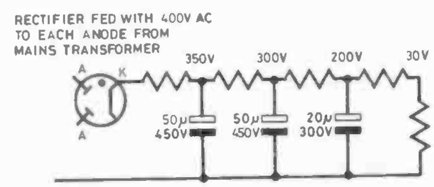
Basically, a block diagram of an average instrument was as shown in Fig. 1. If the instrument works tolerably well but appears to lack punch and volume, the chances are that the h.t. voltage is well below par. This is fairly typical and will be due to the rectifier valve losing its emission and the state of the electrolytic capacitors in the power supply section. We tend to forget the enormous difference between working voltages today and in yesterday's circuitry. Large electrolytics suffer particularly from being bombarded by high voltages year after year: it used to be the practice to put the date of manufacture on these large capacitors so you may be surprised by what you find when you remove the dust.



EG1352

Fig. 1. Block diagram showing basic layout of an average instrument of yesteryear

Fig. 2 shows a typical power supply where the rectifier feeds its output through a chain of resistors to provide voltages for the various parts of the organ. I would suggest replacing the rectifier and the first two capacitors without question. Although the life of semiconductors appears to be limitless if they are operated within the correct parameters, valves age due to loss of cathode emission. The smoothing and reservoir capacitors suffer extra surge every time the instrument is switched on: filaments take time to warm up and until they do the power supply is virtually off-load. Replacement capacitors should therefore be rated *at least* as high as the originals.



EG1350

Fig. 2. Typical power supply

Resistors in this part of the organ are probably wire-wound and will not have altered in value, but lift the chassis and examine the tags of the capacitors and you may well find that electrolyte is oozing out.

GENERATORS

These were often mechanical and will need to be lubricated carefully. Compton generators can seize through lack of oil but take care not to spill oil on the drive belt. Hammond tone wheel instruments have fine capillary threads which feed oil to the bearings and can be accidentally broken quite easily. This type of generator should not be over-oiled as drips will fall directly onto the valves below.

The circuitry used for electronic tone generation was varied and even neon tube dividers were not uncommon. If a frequency is missing at all points on the keyboard whatever the chosen pitch, look first at the valve itself. High voltages collect dust and dirt which, together with traces of oil, can get into the valveholder. Clean everything—valve pins and socket—with carbon tetrachloride and see if that helps before changing the valve.

Another source of trouble in valve equipment are resistors that go high. Long use with high voltages will 'in effect' give a change in the colour of the multiplier band! For example, a 220k resistor can increase its value to 2M or more and if it happens to be the anode load it will stop the valve working.

Fig. 3 shows a typical amplifier stage. Unsolder and check the resistor connected to the anode of any valve that appears to be working at a very low voltage: anode volts for generators and amplifier stages are in the region of 150V. If the resistor has gone high, replace it with a hi-stab of the correct rating: ordinary carbon resistors were often used through the generator and later stages, but hi-stabs are preferable in being less noisy.

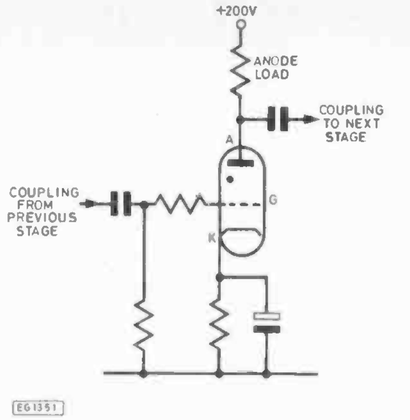


Fig. 3. Typical amplifier stage

Capacitors in generator and amplifier stages were of various types. Ceramics usually stand the test of time but coupling capacitors of the paper type become very leaky and will best be replaced with plastic-bodied types of the correct rating. The lower voltage, small electrolytics can be unsoldered at one end and checked on an RC bridge but will usually be found to have survived.

WIRING

Under chassis wiring should not be disturbed more than necessary as there is a real risk of inducing 'heater hum' in doing so. Flexible wiring and cables should be examined carefully, especially the mains lead. The colour-coding of the mains cable will indicate its age and, if it happens to be rubber-covered, the chances are that the insulation is turning to powder. Replace this lead to eliminate fire hazard.

Co-ax cable of the same age often had a bare screen and rubber insulation for the inner. I would replace this type of cable for two reasons. If the bare outer touches anything it can cause trouble—hum, for example, if it contacts the chassis. Old co-ax can also produce an elusive fault where the audio signal evaporates without an apparent reason. What happens is that flexing the cable powders the insulation, which earths out the signal.

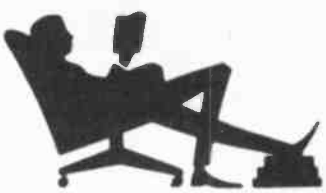
KEYING

If a generated frequency is missing somewhere, a test amplifier and speaker can be used to check whether the fault lies in the generator or with the keying. Traced to a keyswitch the problem will probably be dirt on the contacts and nothing more. A small brush will usually help to clear it, in stubborn cases, moistened with carbon tetrachloride.

Precious metal-to-metal contacts were usual and their wiping action kept them clean. Some organs used progressive resistance switches for earthing out a generator signal (extremely prone to ciphers!) but any problem with these systems can usually be traced to dirt. Rotating busbars were fitted to some models to allow a new switching surface to be presented in the event of the precious metal plating wearing through.

One very obvious precaution with valve instruments is to keep a set of spares as valves are becoming increasingly hard to find. When you buy them, the £ s d price is often still marked on the box—and bears no relationship to what you will pay today! If unfamiliar with valve circuitry, renovating one of these old instruments is an interesting challenge and there is great satisfaction in injecting new life into a worthy instrument.

As it is some time since valve circuitry appeared in this magazine, there is one final tip: if delving into the works with the organ switched on, keep one hand in your pocket!



BOOK REVIEWS

FROM COMPASS TO COMPUTER

Author	W. A. Atherton
Price	£20 Hard back, £9.95 limp
Size	230 × 155mm. 337 pages
Publisher	Macmillan
ISBN	0-333-35266-1

THE subtitle of this book, "A History of Electrical and Electronics Engineering", tells you more about its content than the title. The history spans roughly the last century, though in the early chapters due acknowledgement is made to William Gilbert, Coulomb, and Benjamin Franklin, among others.

The work of Oersted is well told: his crucial experiment demonstrated the magnetic force present when current flows through a wire, by the deflection of a compass-needle. This will be familiar to many readers today as school science, but Dr. Atherton gets across well the feeling that the discovery was one of major importance: a repeatable experiment which showed conclusively the existence of invisible forces.

This was the foundation for the work of men such as Ampere, Davy, Ohm, Wheatstone, and Faraday; and in the fifty years following Oersted's determined attempts to unify theories of electricity and magnetism there was what today would be called an "information explosion". The work of mathematicians, chemists and physicists gave rise, almost inevitably it seems now, to telegraphy and telephony (in 1865 a cable could be sent to India, via a landline), electric lighting and power, and, ultimately, radio.

The chapter on theories and discoveries contains references to the achievements of dozens of the important mathematicians and physicists of this century. But, just because the scope is so wide, there is very little depth, and some readers might find this irritating.

The story of the miniaturisation of electronics is better, well-paced and clear, and the penultimate chapter—computers—also covers the ground well in an interesting way, though without going into the details of computer architecture.

Finally, Dr. Atherton considers the effects of new technology on society, pointing out its benefits as well as the dangers, and the inter-relatedness of the technology with political, military, and economic factors. It is a comprehensive book, well-presented, and may well find a wider audience than Dr Atherton envisages. Certainly O- and A-level students will find it useful, as will many engineering undergraduates; but it is also a book for anyone who is interested in modern Western history.

D.A.B.

THE ART OF MICRO DESIGN

Author	A. A. Berk
Price	£13.95
Size	215 × 135mm. 176 pages
Publisher	Butterworth and Co.
ISBN	0-408-01403-2

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R.M.B.

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QUALITY COMPONENTS FROM CRICKLEWOOD! This list contains only a fraction of our stock, which is constantly being updated. Prices quoted are for "one-offs" – quantity discounts by negotiation. Official orders from Schools, colleges, Goods Dept etc welcomed. WE SPECIALISE IN CREDIT CARD PHONE ORDERS. A quick call will check stock position and current prices. Prices subject to change. Add 60p p&p + 15% VAT to all orders. Catalogue 40p + A4 SAE envelope All in-stock items despatched same day unless notified.

CRICKLEWOOD ELECTRONICS LTD

40 CRICKLEWOOD BROADWAY
LONDON NW2 3ET
01-452 0161/01-450 0995 Tlx:914977

RESISTORS

CARBON FILM 5% HI STAB LOW NOISE 10Ω TO 10MΩ
- 1/4W E24 2p
- 1/2W E24 3p
- 1W E12 6p
- 2W E12 12p

METAL FILM ULTRA STABLE 0.4W EXTRA LOW NOISE 10Ω TO 1MΩ 1% E24 6p

LOW OHMIC GLAZE 1/2W 0.22Ω to 8.2Ω E24 11p

WIRE WOUND ON CERAMIC E12 SERIES
- 2 to 3W 0.22Ω to 330Ω 28p
- 4 to 7W 0.47Ω to 6K8 33p
- 9 to 11W 1Ω to 33K 37p

POTS & PRESETS

ROTARY POTS LOW NOISE 1/4" SPINDLES E3 SERIES
- 4K7 to 2M LIN 44p
- 4K7 to 2M LOG 44p
- As above with DP Mains Switch 99p
- As above stereo 1.30p

PRE-SETS PIHER (DUSTPROOF) E3 100Ω to 10MΩ
- Mini Vert 16p
- Mini Horiz 16p
- Standard Vert 19p
- Standard Horiz 19p

CERMET 20 TURN PRECISION PRESETS 3/4" E3 SERIES 50Ω to 500K 95p

CAPS

CERAMIC 100V DISC (PLATE) E12 MICRO MINI TYPICALLY 5%
- 1pF to 10nF 7p

POLYCARB 5% SIEMENS 7.5mm MINI BLOC E12 250V
- 1nF to 6n8 7p
- 8n2 to 47nF 8p
- 56nF to 150nF 12p

100V
- 100nF to 150nF 13p
- 180nF to 270nF 16p
- 330nF to 390nF 25p
- 470nF to 560nF 32p
- 680nF 38p
- 1μF (10mm) 40p

POLYESTER 250V RADIAL (C280)
- 10nF, 15nF
- 22nF, 33nF
- 47nF, 68nF
- 100nF 7p
- 150nF, 200nF 10p
- 330nF, 470nF 13p
- 680nF 18p
- 1μF 22p
- 1.5μF 39p
- 2.2μF 39p

FEEDTHROUGH 1nF 500V 35p

HIGH VOLTAGE Capacitors please enquire many types in stock

TANT BEADS
- 1 35V 14p
- 22 35V 14p
- 33 35V 14p
- 47 35V 14p
- 68 35V 14p
- 10 35V 14p
- 2.2 35V 18p
- 3.3 35V 18p
- 4.7 16V 18p
- 4.7 35V 20p
- 6.8 25V 20p
- 6.8 35V 21p
- 10 16V 22p
- 10 35V 27p
- 15 10V 22p
- 15 16V 30p
- 15 25V 32p
- 22 6.3V 26p
- 22 16V 29p
- 33 10V 30p
- 47 3V 34p
- 47 6.3V 34p
- 47 16V 39p
- 100 3V 32p

ELECTROLYTICS

Mainly Matsushita (Panasonic) & Siemens

AXIALS (Wires each end)

uFd	V	
47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	1.34p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end) Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

- 7400 75p
- 7401 24p
- 7402 29p
- 7403 29p
- 7404 35p
- 7405 35p
- 7406 1.69p
- 7407 1.69p
- 7408 35p
- 7409 35p
- 7410 35p
- 7411 35p
- 7412 35p
- 7413 35p
- 7414 56p
- 7416 1.49p
- 7417 1.49p
- 7420 35p
- 7421 35p
- 7422 35p
- 7423 35p
- 7425 35p
- 7426 35p
- 7427 35p
- 7428 35p
- 7430 35p
- 7432 95p
- 7433 35p
- 7437 35p
- 7438 35p
- 7440 29p
- 7441 69p
- 7442 58p
- 7444 65p
- 7445 75p
- 7446 75p
- 7447 65p
- 7448 75p
- 7450 29p
- 7451 29p
- 7453 29p
- 7454 29p
- 7460 29p
- 7470 49p
- 7472 49p
- 7473 35p
- 7474 49p
- 7475 49p
- 7476 49p
- 7480 59p
- 7481 1.29p
- 7482 99p
- 7483 69p
- 7484 99p
- 7485 99p
- 7486 39p
- 7489 1.99p
- 7490 45p
- 7491 59p
- 7492 49p
- 7493 39p
- 7494 99p
- 7495 49p
- 7496 59p
- 7497 1.75p
- 74100 1.39p
- 74104 59p
- 74105 59p
- 74107 45p
- 74109 45p
- 74110 69p
- 74116 1.25p
- 74118 1.25p
- 74119 1.25p
- 74120 1.25p
- 74121 45p
- 74122 49p
- 74123 79p
- 74125 49p
- 74126 49p
- 74128 65p
- 74132 59p
- 74136 49p
- 74141 79p
- 74142 1.99p
- 74143 1.99p
- 74144 1.99p
- 74145 89p
- 74147 99p
- 74148 99p
- 74150 1.39p
- 74151 59p
- 74153 59p
- 74154 1.99p
- 74155 55p
- 74156 55p
- 74157 55p
- 74159 1.29p
- 74160 79p
- 74161 59p
- 74162 59p
- 74163 59p
- 74164 75p
- 74165 85p
- 74166 99p
- 74170 1.49p
- 74172 2.49p
- 74173 75p
- 74174 89p
- 74175 69p
- 74176 69p
- 74177 69p
- 74178 99p
- 74180 69p
- 74181 1.59p
- 74182 69p
- 74184 1.49p
- 74185 1.49p
- 74190 69p
- 74191 75p
- 74192 85p
- 74193 85p
- 74194 55p
- 74195 55p
- 74196 55p
- 74197 89p
- 74198 1.50p
- 74221 1.50p

74LS TTL

- 74LS00 75p
- 74LS01 29p
- 74LS02 29p
- 74LS03 29p
- 74LS04 pls ask
- 74LS05 29p
- 74LS08 29p
- 74LS09 29p
- 74LS10 29p
- 74LS11 35p
- 74LS12 35p
- 74LS13 35p
- 74LS14 45p
- 74LS20 29p
- 74LS21 29p
- 74LS22 35p
- 74LS27 35p
- 74LS28 35p
- 74LS30 29p
- 74LS37 pls ask
- 74LS33 29p
- 74LS37 29p
- 74LS38 35p
- 74LS40 39p
- 74LS42 45p
- 74LS47 75p
- 74LS51 29p
- 74LS54 29p
- 74LS55 35p
- 74LS73 45p
- 74LS74 59p
- 74LS75 45p
- 74LS76 39p
- 74LS78 45p
- 74LS83 55p
- 74LS85 75p
- 74LS86 39p
- 74LS90 35p
- 74LS92 45p
- 74LS93 35p
- 74LS95 55p
- 74LS96 75p
- 74LS107 45p
- 74LS109 45p
- 74LS112 45p
- 74LS113 39p
- 74LS114 39p
- 74LS122 59p
- 74LS123 1.19p
- 74LS124 1.55p
- 74LS125 55p
- 74LS126 55p
- 74LS132 49p
- 74LS133 39p
- 74LS136 45p
- 74LS138 89p
- 74LS139 59p
- 74LS145 95p
- 74LS147 1.35p
- 74LS148 1.25p
- 74LS151 59p
- 74LS153 59p
- 74LS154 2.35p
- 74LS157 69p
- 74LS158 69p
- 74LS160 75p
- 74LS161 75p
- 74LS162 75p
- 74LS163 85p
- 74LS164 5p
- 74LS165 99p
- 74LS168 1.39p
- 74LS169 1.29p
- 74LS170 99p
- 74LS173 99p
- 74LS174 65p
- 74LS175 85p
- 74LS181 1.05p
- 74LS183 1.45p
- 74LS190 65p
- 74LS191 65p
- 74LS192 65p
- 74LS193 65p
- 74LS194 65p
- 74LS195 65p
- 74LS196 65p
- 74LS197 65p
- 74LS221 1.15p
- 74LS240 1.99p
- 74LS241 1.99p
- 74LS242 1.99p
- 74LS243 1.99p
- 74LS244 2.95p
- 74LS245 3.25p
- 74LS247 1.99p
- 74LS248 1.99p
- 74LS249 1.99p
- 74LS251 75p
- 74LS253 75p
- 74LS257 75p
- 74LS258 75p
- 74LS259 1.19p
- 74LS261 99p
- 74LS266 55p
- 74LS273 pls ask
- 74LS275 1.75p
- 74LS279 65p
- 74LS280 1.75p
- 74LS283 75p
- 74LS290 75p
- 74LS293 65p
- 74LS295 75p
- 74LS298 75p
- 74LS299 1.75p
- 74LS323 2.25p
- 74LS324 1.75p
- 74LS325 1.75p
- 74LS326 2.99p
- 74LS327 2.99p
- 74LS347 75p
- 74LS348 1.75p
- 74LS352 85p
- 74LS353 85p
- 74LS362 99p
- 74LS365 49p
- 74LS366 49p
- 74LS367 49p
- 74LS368 49p
- 74LS373 2.80p
- 74LS374 2.80p
- 74LS378 99p
- 74LS386 45p
- 74LS390 75p
- 74LS393 99p
- 74LS395 99p
- 74LS396 2.95p
- 74LS398 1.29p
- 74LS399 1.29p
- 74LS445 99p
- 74LS490 1.15p
- 74LS540 1.19p
- 74LS541 1.45p
- 74LS640 2.50p
- 74LS641 2.50p

CMOS

- 4000 28p
- 4001 28p
- 4002 28p
- 4006 69p
- 4007 25p
- 4008 55p
- 4009 29p
- 4010 29p
- 4011 28p
- 4012 29p
- 4013 45p
- 4015 65p
- 4016 45p
- 4017 69p
- 4018 69p
- 4019 55p
- 4020 89p
- 4021 79p
- 4022 79p
- 4023 49p
- 4024 99p
- 4026 89p
- 4027 45p
- 4028 53p
- 4029 89p
- 4030 39p
- 4031 1.60p
- 4032 89p
- 4034 1.99p
- 4035 79p
- 4036 2.69p
- 4038 1.19p
- 4040 79p
- 4041 72p
- 4042 72p
- 4044 72p
- 4045 1.19p
- 4046 89p
- 4047 75p
- 4048 54p
- 4049 45p
- 4050 49p
- 4051 75p
- 4052 75p
- 4053 75p
- 4054 85p
- 4056 99p
- 4059 4.49p
- 4060 88p
- 4063 89p
- 4066 44p
- 4067 2.79p
- 4068 31p
- 4069 31p
- 4070 31p
- 4071 31p
- 4072 31p
- 4073 31p
- 4075 31p
- 4076 85p
- 4077 31p
- 4078 31p
- 4081 31p
- 4085 59p
- 4086 69p
- 4089 1.25p
- 4093 65p
- 4094 99p
- 4095 89p
- 4096 89p
- 4098 89p
- 4099 1.09p
- 40103 2.59p
- 4502 59p
- 4503 59p
- 4505 3.75p
- 4507 45p
- 4508 1.49p
- 4510 69p
- 4511 69p
- 4512 69p
- 4514 1.25p
- 4515 1.25p
- 4516 89p
- 4518 69p
- 4519 75p
- 4520 79p
- 4521 1.05p
- 4522 89p
- 4526 89p
- 4527 89p
- 4528 75p
- 4529 89p
- 4532 89p
- 4534 3.95p
- 4536 2.29p
- 4538 89p
- 4543 99p
- 4553 2.19p
- 4555 58p
- 4556 58p
- 4560 1.79p
- 4566 1.99p
- 4569 1.99p
- 4584 49p
- 4585 64p

LOGIC

CPUs
- 1802 6.49p
- 6502 3.99p
- 6502A 6.49p
- 6800 2.75p
- 6802 2.99p
- 6809 9.95p
- 8035 pls ask
- 8039 pls ask
- 8080A 3.55p
- 8085 pls ask
- Z80A CPU 3.59p
- Z80B CPU 9.45p

MEMORIES
- 2114 pls ask
- 2532 4.25p
- 2564 pls ask
- 2708 3.95p
- 2716 (5v) 3.45p
- 2764 8.99
- 4116 pls ask
- 4118 4.39p
- 4164 4.99p
- 6116 pls ask
- 6810 1.59p

MISC LOGIC IC's
- ADC0804 pls ask
- ADC0816 pls ask
- ADC0817 pls ask
- INS1771 pls ask
- RO2513LC 7.50p
- RO2513UC 7.50p
- SAA5000 4.05p
- SAA5010 7.81p
- SAA5012 7.81p
- SAA5020 5.95p
- SAA5030 6.99p
- SAA5040 15.95p
- SAA5041 15.95p
- SAA5050 8.95p
- SAA5070 18.95p
- 8T26 1.19p
- 8T28 1.19p
- 8T95 99p
- 8T97 99p
- 81LS95 2.27p
- 81LS96 2.27p
- 81LS97 2.27p
- 81LS98 2.27p
- 6522 3.69p
- 6522A 5.55p
- 6532 6.45p
- 6821 1.99p
- 6840 3.75p
- 6845 6.49p
- 6847 6.49p
- 8154 pls ask
- 8155 pls ask
- 8212 pls ask
- 8216 pls ask
- 8224 pls ask
- 8226 pls ask
- Z80ACTC 3.49p
- Z80ADART 8.39p
- Z80APIO 1.45p
- ZN425EB 1.49p
- ZN426EB 3.10p
- ZN427EB 6.99p
- ZN428EB 4.55p

V REGS

– Positive – 100mA
- 78L05A 29p
- 78L12A 29p
- 78L15A 29p
- 78L24A 29p

1 Amp TO202
- 7805T 45p
- 7812T 45p
- 7815T 45p
- 7824T 45p

– Negative – 100mA TO92
- 79L05 49p
- 79L12 49p
- 79L15 49p

1 Amp T0220
- 7905T 57p
- 7912T 57p
- 7915T 57p
- 7924T 57p

TRANSISTORS

- 2N2219 33p
- 2N2219A 36p
- 2N2220 33p
- 2N2221A 33p
- 2N2222 29p
- 2N2222A 33p
- 2N2223 5.85p
- 2N2223A 5.25p
- 2N2368 33p
- 2N2369 34p
- 2N2369A 35p
- 2N2904A 35p
- 2N2905 35p
- 2N2905A 38p
- 2N2906 35p
- 2N2907 35p
- 2N2907A 38p
- 2N2926 13p
- 2N3053 35p
- 2N3054 65p
- 2N3055 65p
- 2N3055H 1.89p
- 2N3439 1.15p
- 2N3440 99p
- 2N3441 1.49p
- 2N3442 1.59p
- 2N3638 62p
- 2N3702 16p
- 2N3703 16p
- 2N3704 16p
- 2N3705 16p
- 2N3706 16p
- 2N3707 16p
- 2N3708 16p
- 2N3709 34p
- 2N3710 34p
- 2N3711 37p
- 2N3773 2.09p
- 2N3819 55p
- 2N3902 5.88p
- 2N3903 19p
- 2N3904 19p
- 2N3905 19p
- 2N3906 19p
- 2N4030 88p
- 2N4031 82p
- 2N4032 67p
- 2N4036 72p
- 2N4037 66p
- 2N4400 19p
- 2N4401 33p
- 2N4402 37p
- 2N4902 2.25p
- 2N4903 2.38p
- 2N4904 2.46p
- 2N4905 2.99p
- 2N4906 3.09p
- 2N4907 3.42p
- 2N4908 3.58p
- 2N4909 3.15p
- 2N5089 43p
- 2N5190 79p
- 2N5191 79p
- 2N5192 89p
- 2N5194 83p
- 2N5195 89p
- 2N5245 48p
- 2N5246 59p
- 2N5247 63p
- 2N5248 65p
- 2N5249 62p
- 2N5266 3.75p
- 2N5401 57p
- 2N5415 1.36p
- 2N5416 1.73p
- 2N5447 29p
- 2N5448 31p
- 2N5449 27p
- 2N5450 63p
- 2N5451 66p
- 2N5457 39p
- 2N5458 39p
- 2N5459 39p
- 2N5460 83p
- 2N5551 41p
- 2N6121 91p
- 2N6122 93p
- 2N6123 99p
- 2N6125 1.01p
- 2N6126 1.03p
- 2N6127 1.09p
- 2N6129 99p
- 2N6130 1.05p
- 2N6131 1.23p
- 2N6132 1.09p
- 2N6133 1.15p
- 2N6134 1.33p
- 2N6253 1.63p
- 2N6254 1.77p
- 2SC1306 99p
- 3N201 1.99p
- 40361 75p
- 40362 75p
- 40363 3.99p
- 40406 1.75p
- 40408 1.75p
- 40410 1.99p
- 40411 3.99p
- 40673 1.49p
- 40822 1.99p
- AC125 99p
- AC126 35p
- AC127 35p
- AC128 39p
- AC141K 39p
- AC142K 39p
- AC151 77p
- AC152 77p
- AC153 77p
- AC153K 87p
- AC176 39p
- AC176K 49p
- AC187 39p
- AC188 39p
- AC187K 49p
- AC188K 49p
- BC107 16p
- BC107A 17p
- BC107B 19p
- BC108 16p
- BC108A 17p
- BC108B 18p
- BC108C 20p
- BC109 17p
- BC109B 18p
- BC109C 21p
- BC140 38p
- BC141 43p
- BC147 15p
- BC147A 16p
- BC147B 17p
- BC147C 27p
- BC148 15p
- BC148A 17p
- BC148B 19p
- BC148C 25p
- BC149 16p
- BC149B 19p
- BC149C 26p
- BC157 39p
- BC157A 41p
- BC157B 44p
- BC158A 37p
- BC158B 39p
- BC159 44p
- BC159A 45p
- BC159B 46p
- BC159C 48p
- BC160 55p
- BC161 59p
- BC167 19p
- BC169 19p
- BC169B 22p
- BC169C 23p
- BC177 29p
- BC177A 33p
- BC177B 36p
- BC178 29p
- BC178A 33p
- BC178B 36p
- BC179 31p
- BC179B 39p
- BC179C 41p
- BC182 15p
- BC182A 17p
- BC182B 19p
- BC182L 15p
- BC182LA 17p
- BC182LB 19p
- BC183 14p
- BC183A 16p
- BC183B 19p
- BC183C 25p
- BC183L 15p
- BC183LA 16p
- BC183LB 18p
- BC183LC 23p
- BC184 16p
- BC184B 19p
- BC184C 24p
- BC186 29p
- BC187 29p
- BC212 16p
- BC212A 18p
- BC212B 21p
- BC213 17p
- BC213A 18p
- BC213B 19p
- BC213C 24p
- BC213L 15p
- BC213LA 16p
- BC213LB 19p
- BC213LC 23p
- BC214 18p
- BC214B 22p
- BC214C 27p
- BC214L 19p
- BC214LB 21p
- BC214LC 26p
- BC300 59p
- BC301 59p
- BC302 59p
- BC303 59p
- BC327 16p
- BC327A 19p
- BC327B 23p
- BC327C 25p
- BC440 35p
- BC441 37p
- BC460 38p
- BC461 42p
- BC547 19p
- BC550C 29p
- BC560C 29p
- BCY70 31p
- BCY71 33p
- BCY72 25p
- BD124 2.99p
- BD131 63p
- BD132 63p
- BD135 38p
- BD136 38p
- BD137 39p
- BD138 39p
- BD139 42p
- BD140 42p
- BD239A 65p
- BD239C 69p
- BD240A 68p
- BD240C 79p
- BD241A 72p
- BD241C 79p
- BD242A 75p
- BD242C 79p
- BD743A 85p
- BD243C 89p
- BD244A 88p
- BD244C 1.15p
- BD245A 1.19p
- BD245C 1.49p
- BD246A 1.39p
- BD246C 1.67p
- BD249A 2.30p
- BD249C 2.57p
- BD250A 2.48p
- BD250C 2.75p
- BD529 1.75p
- BD530 1.95p
- BD535 89p
- BD536 89p
- BD537 97p
- BD538 97p
- BD539 1.08p
- BD539C 1.33p
- BD540 1.04p
- BD540C 1.39p
- BDX66B 6.35p
- BDX67B 6.35p
- BDY54 2.28p
- BDY55 2.39p
- BDY56 1.99p
- BDY57 5.91p
- BDY58 6.33p
- BF194 18p
- BF195 18p
- BF196 18p
- BF197 18p
- BF198 18p
- BF199 18p
- BF200 79p
- BF244A 61p
- BF244B 55p
- BF245A 63p
- BF245B 66p
- BF246 77p
- BF246A 79p
- BF246B 79p
- BF247A 79p
- BF247B 79p
- BF254 66p
- BF255 68p
- BF256A 59p
- BF256B 59p
- BF256C 69p
- BF257 39p
- BF258 41p
- BF259 45p
- BF457 48p
- BF458 59p
- BF459 65p
- BFR39 pls ask
- BFR40 pls ask
- BFR41 pls ask
- BFR79 pls ask
- BFR80 pls ask
- BFR81 pls ask
- BFR90 2.25p
- BFS61 99p
- BFS98 99p
- BFX29 44p
- BFX30 46p
- BFY53 53p
- BSX19 29p
- BSX20 33p
- BSX21 49p
- BU104 2.32p
- BU105 1.89p
- BU108 2.49p
- BU109 2.49p
- BU126 1.55p
- BU204 2.49p
- BU205 1.99p
- BU206 2.16p
- BU208 1.93p
- BU226 4.45p
- BU326S 2.63p
- BU406 1.45p
- BU407 1.58p
- BU408 1.49p
- BU409 1.65p
- BU500 3.56p
- BUY18S 4.33p
- E430 6.32p
- J300 88p
- J310 88p
- MJ802 4.25p
- MJ900 3.21p
- MJ901 3.39p
- MJ1000 2.76p
- MJ1001 3.26p
- MJ1800 3.79p
- MJ2500 2.39p
- MJ2501 2.63p
- MJ2955 99p
- MJ3000 2.39p
- MJ3001 2.63p
- MJ4502 4.25p
- MJE340 75p
- MJE350 1.49p
- MJE2955 1.99p
- MJE2955T 95p
- MJE3055 1.59p
- MJE3055T 69p
- MPSA05 29p
- MPSA06 33p
- MPSA10 59p
- MPSA12 49p
- MPSA13 49p
- MPSA14 49p
- MPSA20 49p
- MPSA42 49p
- MPSA43 48p
- MPSA55 29p
- MPSA56 33p
- MPSA65 62p
- MPSA66 65p
- MPSA70 49p
- MPSA92 49p
- MPSA93 48p
- MPSL01 69p
- MPSL51 75p
- MPS405 89p
- MPSU06 99p
- MPSU07 1.75p
- MPSU51 1.29p
- MPSU56 1.22p
- MPSU57 1.95p
- TIP29A 35p
- TIP29C 42p
- TIP30A 37p
- TIP30C 44p
- TIP31A 39p
- TIP31C 47p
- TIP32A 46p
- TIP32C 49p
- TIP33A 69p
- TIP33C 83p
- TIP34A 1.19p
- TIP34C 1.26p
- TIP35A 1.26p
- TIP35C 1.39p
- TIP36A 1.42p
- TIP36C 1.49p
- TIP41A 52p
- TIP41C 58p
- TIP42A 62p
- TIP42C 65p
- TIP49 1.29p
- TIP50 1.52p
- TIP53 1.58p
- TIP54 1.65p
- TIP110 79p
- TIP112 85p
- TIP115 89p
- TIP117 1.05p
- TIP120 79p
- TIP122 85p
- TIP127 99p
- TIP130 1.06p
- TIP132 1.09p
- TIP135 1.16p
- TIP137 1.19p
- TIP140 1.21p
- TIP142 1.22p
- TIP145 1.21p
- TIP147 1.22p
- TIP162 4.99p
- TIP2955 81p
- TIP3055 79p
- TIS43 61p
- VN10KM 69p
- VN46AF 1.15p
- VN66AF 1.09p
- ZTX107 12p
- ZTX108 13p
- ZTX109 14p
- ZTX300 12p
- ZTX301 16p
- ZTX302 17p
- ZTX303 25p
- ZTX304 18p
- ZTX310 39p
- ZTX311 36p
- ZTX312 39p
- ZTX313 41p
- ZTX314 27p
- ZTX320 37p
- ZTX330 39p
- ZTX341 31p
- ZTX450 41p
- ZTX500 15p
- ZTX501 15p
- ZTX502 15p
- ZTX503 18p
- ZTX504 19p
- ZTX510 28p
- ZTX531 29p
- ZTX650 47p
- ZTX651 48p
- ZTX652 49p
- ZTX653 50p
- ZTX750 47p
- ZTX751 48p
- ZTX752 49p
- ZTX753 50p

DIODES

- IN34A 52p
- IN821 70p
- IN823 92p
- IN914 4p
- IN916 6p
- IN4001 4p
- IN4002 4½p
- IN4003 5p
- IN4004 5½p
- IN4005 6p
- IN4006 6½p
- IN4007 7p
- IN4009 20p
- IN4148 3p
- IN4150 18p
- IN4448 22p
- IN5400 12p
- IN5401 13p
- IN5402 14p
- IN5404 16p
- IN5406 18p
- IN5407 19p
- IN5408 20p
- BA102 49p
- BA115 29p
- BA133 51p
- BA138 36p
- BA142 25p
- BA155 18p
- BA156 41p
- BA157 28p
- BA158 34p
- BA159 38p
- BA182 49p
- BA201 23p
- BA202 29p
- BA316 27p
- BA317 28p
- BA318 31p
- BAX13 21p
- BB105 65p
- BB109G 69p
- BY126 12p
- BY127 14p

SCR's TRIACS DIACS

THYRISTORS 4, 8 & 12 Amps Texas T0220
Suffix A = 100V, B = 200V, C = 300V, D = 400V, M = 600V

4A
- TIC106A 49p
- TIC106B 51p
- TIC106C 53p
- TIC106D 55p
- TIC106M 72p

8A
- TIC116A 69p
- TIC116B 72p
- TIC116C 75p
- TIC116D 78p
- TIC116M 84p

12A
- TIC126A 74p
- TIC126B 75p
- TIC126C 76p
- TIC126D 79p
- TIC126M 99p

TRIACS Texas 400V TO220 Case
- TIC206D(4A) 69p
- TIC225D(6A) 79p
- TIC226D(8A) 92p
- TIC236D(12A) 1.25p
- TIC246D(16A) 1.35p
- TIC253D(20A) 1.99p
- TIC263D(25A) 2.25p

DIACS
- BR100 29p
- ST2 29p

ZENER'S

many inc specials see our CAT

400 to 500mW E24 Series
- 2.4 to 47V 7p

1.3 Watt E24 Series
- 3.3 to 82V 14p

BRIDGE

(PIV shown in brackets)

1½ amp type
- W01(100) 28p
- WO2(200) 34p
- WO4(200) 38p
- WO8(800) 50p

2 amp type Square with hole
- S01(100) 46p
- S02(200) 50p
- S04(400) 55p
- S08(800) 66p

6 amp type Square with hole
- PW01(100) 95p
- PW02(200) 99p
- PW04(400) 1.30p
- PW06(600) 1.39p

25 amp type Metal clad with hole
- K01(100) 2.62p
- K02(200) 2.75p
- K04(400) 3.25p
- K06(600) 4.10p
- BYW64 35A 400V 4.50p

OPTO

many inc specials see our CAT

LED LAMPS
R = Red
G = Green
Y = Yellow

Large diffused 1"
- R5D 10p
- G5D 16p
- Y5D 15p

Small diffused
- R3D 8p
- G3D 13p
- Y3D 13p

Micro 0.1"
- RIM 27p
- GIM 29p
- YIM 29p

Large clear
- R5C 12p
- G5C 17p
- Y5C 17p

Super bright high efficiency Large (100 times brighter)
- R5U 42p
- G5U 47p
- Y5U 47p

Rectangular Stackable LEDs
- R5R 19p
- G5R 20p
- Y5R 22p

LIN ICs

- AY15050 99p
- AY38910 3.99p
- AY38912 4.95p
- CA3048 2.15p
- CA3059 3.29p
- CA3090AQ 3.70p
- CA3130E 87p
- CA3130T 2.35p
- CA3140E 54p
- CA3140T 1.40p
- HA1366W 2.40p
- HA1388 2.54p
- ICL7106 2.50p
- ICL7107 9.50p
- ICL7611 97p
- ICL8038 2.99p
- ICM7555 1.10p
- ICM7556 1.49p
- LC7120 3.20p
- LC7130 3.40p
- LC7137 3.95p
- LF347 1.50p
- LF351 59p
- LF353 1.05p
- LF355 83p
- LF356 99p
- LF357 1.30p
- LF398 4.62p
- LM335Z 1.60p
- LM348N 62p
- LM349N 1.09p
- LM350K 4.89p
- LM379S 5.50p
- LM380N14 pls ask
- LM380N8 pls ask
- LM381AN 2.26p
- LM381N 1.40p
- LM382N 1.22p
- LM383T 3.40p
- LM384N 1.40p
- LM386N 1.20p
- LM388N 2.43p
- LM391N60 2.25p
- LM391N80 1.65p
- LM723CH 99p
- LM723CN 49p
- LM725CH 3.40p
- LM725CN 3.19p
- LM741CH 96p
- LM741CN 19p
- LM741CN14 80p
- LM747CN 69p
- LM748CH 1.00p
- LM748CN 42p
- LM1871 3.25p
- LM1872 4.39p
- LM1877 5.95p
- LM1886 7.44p
- LM1889 3.77p
- LM2907N 2.75p
- LM2907N8 2.60p
- LM2917N 2.40p
- LM2917N8 2.40p
- LM3900 62p
- LM3911 1.45p
- LM3914 3.25p
- LM3915 3.25p
- LM13600 1.15p
- MF10 3.75p
- NE531N 1.36p
- NE543N 2.50p
- NE544N 1.95p
- NE555 22p
- NE556 65p
- NE558 1.89p
- NE560 3.25p
- NE565 1.18p
- NE566 1.49p
- NE567 1.37p
- NE570 4.07p
- NE571 3.99p
- NE5534A 1.95p
- RC4194 3.95p
- RC4195 2.95p
- RC4558 44p
- SN76477 7.95p
- SN76003 3.45p
- SN76013 3.45p
- SN76023 3.45p
- SN76033 3.45p
- TA7204 1.99p
- TA7205 1.20p
- TA7222 1.75p
- TA7227 5.82p
- TBA500 2.97p
- TBA500Q 3.11p
- TBA510 2.95p
- TBA510Q 3.05p
- TBA520 2.57p
- TBA520Q 2.75p
- TBA530 2.55p
- TBA530Q 2.76p
- TBA540 2.72p
- TBA540Q 2.74p
- TBA550 3.25p
- TBA550Q 3.27p
- TBA560C 2.87p
- TBA570 2.37p
- TBA570Q 2.48p
- TDA1002 3.39p
- TDA1003 4.35p
- TDA1004 P.O.A.
- TDA1004A 5.45p
- TDA1005 4.35p
- TDA1010A 2.25p
- TDA1022 4.95p
- TDA2002 3.25p
- TDA2003 3.25p
- TDA2020 3.15p
- TDA2030 2.85p
- TDA2611A 2.50p
- TDA7000 3.45p
- TL061 51p
- TL062 77p
- TL064 1.50p
- TL071 47p
- TL072 62p
- TL074 1.50p
- TL081 47p
- TL082 55p
- TL084 1.70p
- UAA170 2.49p
- UAA180 2.49p
- ULN2003 75p
- UPC575C2 2.00p
- UPC1156 2.75p
- UPC1156H 2.75p
- UPC1182 3.75p
- UPC1185 1.95p
- UPC2002 2.95p
- XR2206 3.95p
- ZN409 2.25p
- ZN414 1.00p
- ZN1034 1.99p

TRANS-FORMERS

Post Inclusive prices cheaper to callers. All 240V Primary Split Bobbin

100mA
- 6-0-6 1.50p
- 9-0-9 1.70p
- 12-0-12 1.85p
- 15-0-15 1.95p
- 1A as above 3.75p
- 20.0 20V 0.125A 3.75p
- 12.0 12V 50VA 7.95p
- 12.0 12V 100VA 11.99p
- 0 + 6 + 6 + 9 + 9 1.25A 5.65p

VERO

0.1" COPPER TRACKS
- 2.5 × 3.75 95p
- 2.5 × 5 1.08p
- 3.75 × 3.75 1.09p
- 3.75 × 5 1.23p
- 2.5 × 17 3.27p
- 3.75 × 17 4.29p
- 4.79 × 17 5.99p
- VQ Board 2.10p
- DIP Board 3.95p
- Track Cutter 1.63p
- Pin insertor 2.21p
- 100 Pins 61p
- Verobloc 4.66p
- Vero Wiring Pen & Spool 3.39p
- Spare Spool 75p
- Combs 6p

PCB

FERRIC CHLORIDE Quick dissolving Enough to make over 1 litre 1.69p

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots & holes
8 0.1" edge connectors
9 Mixture
Any sheet of above 39p

GRADE ONE GLASS PCB SINGLE-SIDED
- 178 × 240mm 1.50p
- 420 × 195mm 1.95p
- 420 × 245mm 2.95p

DALO ETCH RESIST PEN + spare nib 1.29p

PHOTO SENSITIVE PCB 1st Class Epoxy Glass for better results than spraying expose to UV

Single sided
- 100 × 160 2.10p
- 100 × 220 2.50p
- 203 × 114 2.40p
- 233 × 220 5.20p

Double sided
- 100 × 160 2.20p
- 100 × 200 2.80p
- 203 × 114 2.20p
- 233 × 220 5.90p

Developer for above (do not use Sodium Hydroxide) 500ml 2.95p

WIRE

PRICES PER METRE

Solid connecting wire

MAINS/SPEAKER
- Twin 1 Amp 14p
- Twin 2½ Amp 16p
- 3 Core 2½ Amp 18p
- 3 Core 13 Amp 66p

SCREENED
- Single 14p
- Stereo 27p
- Mini Single 12p
- Mini Stereo 15p
- 4 Core 4 screens 44p
- 4 Core single screen 54p
- 8 Core 61p
- 12 Core 60p
- Heavy Duty Mike/Guitar Lead 25p

AERIAL
- 50Ω RG58A 25p
- 75Ω UHF 29p
- 75Ω VHF 28p
- 300Ω Flat 14p

RAINBOW RIBBON Prices per foot
- 10 way 25p
- 16 way 39p
- 20 way 48p
- 24 way 62p
- 30 way 75p
- 34 way 82p
- 40 way 88p
- 64 way 1.49p

RECHARGE BATTERIES

Top quality Don't throw these batteries away – they charge up to 1000 times!
- HP2(1.2AH) 2.39p
- HP2(4AH) 4.75p
- HP7(½AH) 99p
- HP11(1.2AH) 2.29p
- PP3(110mAH) 4.95p

Chargers
- TYPE H: Adjusted to 6 of any HP type Above 15.59p
- TYPE M: As above but faster charge for 4AH 25.95p
- TYPE P: PP3 5.50p
- TYPE A: HP7(Up to 4 at a time) 5.85p

SOLDER

ANTEX SOLDERING IRONS
- C240(15W) 5.20p
- XS240(25W) 5.40p
- Iron Stand 1.75p
- Elements (State Iron) 2.05p

C240 Bits
- No2 (Small) 85p
- No3 (Med) 85p
- No6 (Micro) 85p

XS240 X25 Bits
- No50 (Small) 85p
- No51 (Med) 85p
- No52 (Lge) 85p

SOLDER 125gms
- 18swg 2.95p
- 22swg 3.10p

PLUGS & SOCKETS

'D' Connectors 25 Way Solder
- Male 1.60p
- Female 2.09p

PCB Wire-Wrap
- Male 1.60p
- Female 2.09p
- Covers 1.00p

Phono plugs Blk, Red, Grn, Wt or Yell 15p
- Line Skts 15p
- Chas Skt × 1 16p
- Dual Skt 30p
- Quad Skt 40p

ZIF SOCKET

- 24 pin 4.35p
- 28 pin 5.00p
- 40 pin 5.35p

SWITCHES

TOGGLE (MINI)
- SPST 59p
- SPDT 65p
- DPDT 74p
- DPDT C OFF 90p
- 4PDT 3.25p

909