Australia $1.75 New Zealand $1.95 Malaysia $4.95

PRACTICAL SEPTEMBER 1985 · £1·00

ELECTRONICS

ROBOTICS · MICROS · ELECTRONICS · INTERFACING

New Series...

Experimenting with Robots

Alarm Systems D.I.Y. Buyer's Guide

Car Boot Alarm

PE ROBOTICS MICROS ELECTRONICS INTERFACING

ISSN 0032-6372

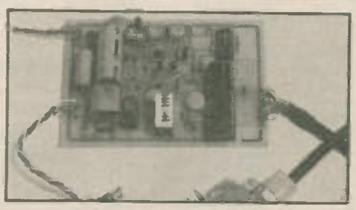
VOLUME 21 Nº9 SEPTEMBER 1985

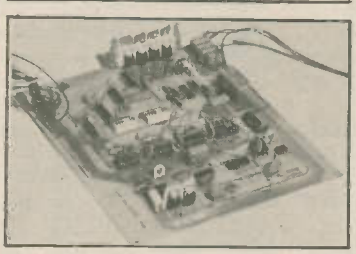
CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS & COMMENT

This month's front cover picture shows a 21st Century working class robot checking the racing results. His gears and hydraulics were supplied courtesy of Fischer Technik.





OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, SEPTEMBER 6th, 1985 *(see page 4)*

SPEAKERS
8Ω, 0·3W, 2"; 2·25", 2·5", 3" — 80p
0·3W, 2·5" 40Ω; 64Ω or 80Ω — 80p

DIODES	
AA119	8
AA129	10
AAY30	8
BA100	10
BY100	15
BY126	12
BY127	10
CRO33	198
OA9	10
OA47	10
OA70	9
OA79	10
OA81	10
OA85	10
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	12
1N5404	14
1N5406	15
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

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

DIAC
ST2 — 25

BRIDGE RECTIFIERS (plastic case)	
1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	30
2A/50V	26
2A/200V	40
2A/400V	42
2A/600V	50
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56

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

VARICAPS	
BA102	30
BB105B	40
BB106	40

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/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	125

SOLDERCON PINS
100 — 45p
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	100
Green/Yellow	80
0·2" Tri colour LEDs Red/Green/Yellow	85
0·2" Red High Bright	59
High Bright Green or Yellow	100
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

Fibre Glass	single sided	double sided
6"×6"	100p	125p
6"×12"	175p	225p

VEROBOARD

	Clad	Plain
2½×3¾"	95p	—
2½×5"	110p	—
3¾×3¾"	110p	—
3¾×5"	125p	95p
3¾×17"	420p	275p
4¾×18"	590p	—
Pkt. of 100 pins		55p
Spot Face Cutter		150p
Pin Insertion Tool		185p

VQ Board	180p
DIP Board	395p
Vero strip	95p
PROTO-DECs	
Veroblock	480
S-Dec	395
Eurobreadboard	590
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool — 380p
Spare Wire (Spool) 75p; Combs 8p ea.
Wire Wrapping Stakes 100 — 250p

0·5" LCD DISPLAYS

3½ digit	495
4 digit	530
6 digit	625

OPTO

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
4×2¾×4×2½"	103
4×4×2½"	120
5×4×2"	105
5×2¾×1½"	90
5×2¾×4×2½"	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
10×4¼×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS

1A	T0220 Plastic Casing +ve		-ve	
5V	7805	45p	7905	55p
12V	7812	45p	7908	55p
15V	7815	45p	7912	55p
18V	7818	45p	7915	55p
24V	7824	45p	7918	55p
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	LM317	99
78H12 12V/5A	640	LM323K	500
78HG+5 to		LM337T	175
+24V 5A	695	LM723	30
79HG −2.25V to		TBA625B	75
−24V 5A	785	RC4194	375
LM309K	120	RC4195	160
TL497	185	78S40	225

SWITCHES

SLIDE 250V
1A DPDT — 14
1A DPDT C/OFF — 15
½A DP on/off/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 — 68p

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

AMPHENOL CONNECTORS

	IDC	Solder
24 way IEEE plugs	465p	460p
24 way IEEE skt	485p	480p
36 way Centronics plug	395p	390p
36 way Centronics skt	480p	450p

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

ANTEX Soldering Irons
C15W 525p; C517W 545p
G18W 550p; XS25W 570p

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 SOCKET (TEXTOOL)
24 way — 575p
28 way — 695p
40 way — 845p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	40p	95p
16	45p	100p
24	85p	135p
28	150p	200p
40	200p	225p

RIBBON CABLE (price per foot)

Ways	Grey	Colour
10	15p	25p
16	20p	30p
20	25p	40p
26	40p	65p
34	50p	80p
40	60p	90p
64	90p	125p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	55p	80p	120p	150p
Angle	110p	175p	225p	300p
Strait	100p	100p	160p	250p
FEMALE				
Solder	90p	125p	180p	275p
Angle	150p	200p	260p	390p
Strait	100p	125p	195p	355p
COVERS	75p	70p	70p	85p

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

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

EDGE CONNECTORS

	·1"	·156"
2× 6 way	—	75p
2×12 way	—	160p
2×15 way	—	165p
2×18 way	175p	160p
2×22 way	200p	170p
2×23 way	150p	—
2×25 way	250p	245p
2×28 way	180p	—
2×30 way	280p	—
2×36 way	300p	—
2×40 way	320p	—
2×43 way	400p	—
2×75 way	600p	—

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied. **ONLY £22**

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	200p	236p	169p	340p
40 way	220p	250p	190p	350p
50 way	235p	270p	200p	470p

SPECIAL OFFER

	1+	10+
2764 – 250ns	299	275
27128 – 250ns	695	675
6116LP – 150ns	250	235
6264LP – 150ns	725	699

TRANSFORMERS
3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100MA 130p
PCB mounting; miniature, Split bobbin
3VA. 2×6V /0·25A; 2×9V /0·15A; 2×12V /0·12A; 2×15V /0·2A 235p
6VA: 2×6V /0·5A; 2×9V /0·3A; 2×12V 0·25A; 2×15V /0·2A 280p
Sranderd split Bobbin type.
6VA: 2×6V /0·5A; 2×9V /0·4A; 2×12V /0·3A; 2×15V /0·25A 250p
12VA: 2×4V5 /1A3, 2×9V /0A6; 2×12V /0A5; 2×15V /0A4; 2×20V /0A3 .... 345p (35p p&p)
24VA 2×6V /1A5; 2×9V /1A2; 2×12V /1A; 2×20V /0A5 .... 385p (60p p&p)
50VA. 2×6V /4A; 2×9V /2A5; 2×12V /2A; 2×15V /1A5; 2×20V /1A2; 2×25V /1A; 2×30V /0A8 .... 520p (65p p&p)
50VA multirail: +5V/5A, +12V, +25V, −5V, −12V @ 1A .... 620p (65p p&p)
100VA: 2×12V /4A; 2×15V /3A; 2×20V /2A5; 2×25V /2A; 2×30V /1A5; 2×50V 1A .... 955p (75p p&p)
(PS p&p charge to be added over & above our normal postal charge)

TURNED PIN Low Profile Professional
DIL SOCKET

8 pin	25p	22 pin	70p
14 pin	40p	24 pin	72p
16 pin	42p	28 pin	90p
18 pin	47p	40 pin	120p
20 pin	60p		

JUMPER LEADS
IDC FEMALE RECEPTACLE Jumper Leads 36"

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

COMPUTER CORNER

- **EPSON RX80** Printer £209
- **EPSON RX80** F/T Printer £219
- **EPSON FX80** Printer £315
- **EPSON FX100** Printer £429
- **KAGA/TAXAN KP810** Printer £239
- **KAGA/TAXAN KP910** Printer £339
- **BROTHER HR15** Daisywheel Printer £325
- **Centronics PRINTER CABLE** for all the above printers to interface with the BBC Micro £7
- **KAGA KX1201G Hi-RES,** Green Monitor. £90
- **ZENITH 12" Hi-RES,** Green Monitor 40/80 column select switch, value for money. £66
- **MICROVITEC 14"** colour monitor. RGB input. Lead incl. £175
- **MICROVITEC 1451** Hi-res 14" Monitor incl. Lead £237
- **KAGA VII 12" Hi-RES,** RGB Colour Monitor £255
- **KAGA VIII 12" ULTRA Hi-RES,** RGB Colour Monitor £310
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. £30
- **Spare** 'UV lamp bulbs £8
- **8½"** or 9½" Fan fold paper (1000 sheets) £7 (150p)

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.

BT CONNECTOR

LJU 1/4A Mini Line Master	435p
LJU 1/6A Mini Line Slave	295p
LJU 2/4A Line Master	370p
LJU 2/6A Line Salve	250p
LJU 3/4A Flush Master	370p
LJU 3/6A Flush Slave	240p
LJU 10/3A Dual Splitter	550p
4 WAY BT plug	65p

DISC ALBUMS

Attractively finished in beige leather-vinyl, these conveniently store up to 20 discs. Each disc can easily be seen through the clear view pockets.

ONLY £4.25

5¼" Disc Drive
HEAD CLEANING KIT
£9

BBC MICRO WORD PROCESSING PACKAGE

A complete word processing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor Please call in for a demonstration.

Example Package:
BBC Micro, with DFS Interface, Wordwise, Twin 400K TEC Disc Drives, 12" High-res green monitor, Brother HR15 Daisywheel printer, Beebcalc & Database software on Disc, 10 3M Discs, 500 sheets of paper, 4 way mains trailing socket, manuals and all cables.
Only: £999

CRYSTALS

32·768KHz	100
100KHz	400
200KHz	370
455KHz	370
1MHz	275
1·008M	275
1·28MHz	450
1·5MHz	420
1·6MHz	595
1·8MHz	545
1·8432M	220
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	150
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7·0MHz	150
7·168MHz	175
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
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	155
14·7456M	175
14·765MHz	250
15·0MHz	240
16·0MHz	220
18·0MHz	150
18·432M	150
19·968MHz	150
20·0MHz	150
24·0MHz	150
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

SPECIAL OFFER THIS MONTH .... ONLY £289
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.

DRIVES CASED WITH PSU & CABLES

- **CS100 – TEC** Single sided 40 track 100K 5¼" Single Disc Drive **£115**
- **CS200 – Epson** Double sided 40 track 200K 5¼" Single Disc Drive **£120**
- **CS400S – MITSUBISHI** Double sided 80 track 400K 5¼" Single Disc Drive **£140**
- **CD400 – EPSON** Double sided 40 track 400K 5¼" TWIN Disc Drives **£189**
- **CD800S – MITSUBISHI** Double sided 80 track 800K 5¼" TWIN Disc Drives **£265**
- **DFS** Manual (comprehensive) ..... **£7** (NO VAT)
- **TWIN** Disc Drive CASE with Power Supply to house your own Drives **£38**

N.B. All single drives with power supply with be supplied in a twin Case for later inclusion of a second Drive.

(Carriage on disc drives £7 Securicor)

WATFORD ELECTRONICS

Tel. (0923) 40588 — Telex. 8956095

all in your

OCTOBER

issue!

New Series

INTRODUCTION TO MICROPROCESSOR SYSTEMS

This major new series not only answers the question, "What is a microprocessor and how does it work?", it shows how a complete *practical* microcomputer system is put together, often making use of relatively cheap and readily-available components

BBC BYTEBOX

There is a massive amount of utility software available for the BBC which is only available as firmware (ROM or PROM). This well designed project is able to support up to 16 'side-ways' ROMS for the BBC micro as well as providing a host of other useful features.

MODULATED SYNDRUM

A complete electronic drum in a box. Just connect up to an amplifier—or even a headset, if the neighbours object—and get the full range of disco drum effects

PRACTICAL

ELECTRONICS

ROBOTICS · MICROS · ELECTRONICS · INTERFACING

OCTOBER ISSUE ON SALE FRIDAY, SEPTEMBER 6

MARCO TRADING

BARCLAYCARD VISA — Access

RESISTOR KITS

¼W Pack 10 each value E12 10R-1M
Total: 610 resistors ONLY 4.80
¼W Pack 5 each value E12 10R-1M
Total: 305 resistors ONLY 2.75
½W Pack 10 each value E12 2R2-2M2
Total: 730 resistors ONLY 5.25
½W Pack 5 each value E12 2R2-2M2
Total: 365 resistors ONLY 3.50
50v Ceramic Kit 5 each value
125 Per Kit £3.50

PRE-SETS

Vert + Horiz 100R to 1M 10p, 100 for £6.50

CERAMIC CAPACITORS

All 50V. 1p to 10 nf 4p each, 100 for £2.75

COPPER WIRE

Tinned + Enamelled Copper Wire. 2oz reels: 14 to 30 swg £1.00 per reel.

ZENER DIODE

400 m/w 3v to 75v: 8p each, 100 for £6.00. 1 watt 3v3 to 200v: 15p each, 100 for £12.50

SWITCHES

Sub-Miniature Toggle
SPST 60p SPDT 63p DPDT 66p
Miniature Toggle
SPDT 68p SPST 65p DPDT 72p
DPDT Centre off 85p
Standard Toggle
SPST On/Off Plate 48p
DPDT On/Off Plate 58p
Miniature DPDT Slide 15p
Push-To-Make 20p
Push-To-8reak 25p
Rotary Switch
1 pole 12 way, 2 pole 6 way, 3 pole 4 way, 4 pole 3 way 50p

SOLDERING AIDS

Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex Elements	2.00
Antex 8its	0.95
Antex stands	1.90
Desolder Tooi	4.50
Spare nozzle	0.65
25W Kit-iron with 13A plug & stand	ONLY 7.20

NI-CAD CHARGER

Universal charger to charge PP3, AA, C, D PRICE 6.00

SPEAKERS

4" Round 1.6W 4 Ohm £1.50 pair
4" Round 1.6W 4 Ohm Plus Mounting 8racket £1.00 each
2¼" Round 0.4W 8 Ohm 85p each

NI-CADS

PP3	£4.45,	4/16.00
AA	£0.95,	10/8.00
HPII	£2.30,	4/8.50
C	£1.95,	4/8.75

SERVICE AIDS

ALL SERVISOL PRODUCTS

Switch Cleaner	0.98
Circuit Freezer	1.14
Foam Cleanser	0.96
Aero Klene	0.90
Silicone Grease (Tube)	1.64

VOLTAGE REGULATORS

78L05/12/15	0.30
7505/12/15	0.55
7905/12/15	0.65
LM317K	3.50

DC MOTOR

6-12V 75p
5 for £3.00

PLUGS SOCKETS

Metal Co-ax Plug	0.18
Plastic Co-ax Plug	0.14
Metal Line Socket	0.50
Single Junc Socket	0.30
Plastic Phono	0.15
F.M. Plugs	0.20
PL259 Plugs	0.30
Reducer	0.15
Low loss splitter 1 in. 2 out	1.00

IC SOCKETS

Dil to Dil

8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
22 pin	0.21	1.95/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

HEADPHONES

Super lightweight miniature silver bands, sponge earcups (stereo) and mono £2.50

PERSONAL STEREO CASSETTE

Fantastic price £9.99 plus 50p extra postage. Murphy + Omega make. Complete with headphones and carrying strap.

WALKMAN TYPE SPEAKERS

Powered Stereo Speakers complete with carrying strap. Built-in Pre-amp. Needs to be heard to be believed. Uses 2 × D size batteries - not supplied. £8.50 each (plus additional postage £1 set).

CLOCK RADIO – VHF/LW/MW

Mains, digital display alarm clock/radio. Alarm control/Wake to music. Sleep control – 10 min. Snooze. Hour/Minute Time Setting. Brightness Control. £8.50 each (plus additional postage 75p per set).

PLASTIC BOXES

3 × 2 × 1"	0.35
3 × 2½ × 2"	0.65
4 × 3 × 1½"	0.83
6 × 4 × 2½"	1.15
8½ × 5 × 3¼"	2.15

Colour Black, all boxes with lids and screws.

L.E.D.s

RED: 3mm + 5mm 10p each, 100 for £6.00. YELLOW: 3mm + 55mm 13p each, 100 for £10.00. GREEN: 3mm + 5mm 13p each, 100 for £10.00. Prices include counting clips.

SPECIAL OFFER

The complete set of three strip-fix plastic signs, containing over two thousand words. Transmitters, frequencies, dials, letters and symbols etc. Three for £3.75.

Fuseholders

20mm Panel Mounting	0.28
20mm Chassis Mounting	0.06
1¼in Panel Mounting	0.35
1¼in Chassis Mounting	0.342
Carline 1¼in Mounting	0.10

FUSES

QB 20mm 100mA to 6.3A: 6p each, 100 for £3.50. Slow Blow 20mm 100mA to 200mA: 20p, 100 for £15.00. 20mA to 800mA: 12p, 100 for £7.50. 1A to 6.3A: 10p, 100 for £5.00.

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AC176	0.28	BFX26	0.28
AF239	0.68	BFX84	0.24
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BC108	0.10	BFX87	0.26
BC109	0.10	BFY50	0.21
A.B.C.	0.12	BFY52	0.21
BC147	0.09	BFY90	0.90
BC182	0.09	BSX20	0.34
BC182L	0.09	BU208	1.55
BC184	0.09	BU407	1.65
BC184L	0.09	MJ2955	0.90
BC212	0.09	OC45	0.58
BC212L	0.09	OC71	0.50
BCY70	0.15	OC72	0.52
BDI31/2	0.34	TIP31A	0.44
BDI33	0.56	TIP32A	0.42
BDI35	0.32	TIP33C	0.88
BDI36	0.36	TIP34A	0.72
BF115	0.32	TIP2955	0.60
BF184	0.32	TIP3055	0.60
BF185	0.32	TIS43	0.88
BF194	0.08	TIS88	0.40
BF195	0.10	2N3055	0.45
BF196	0.10	2SC1096	0.68
BF197	0.10	2SC1173Y	0.82
BF200	0.20	2SC1306	0.92
BF224	0.20	2SC1307	0.40
BF244	0.26	2SC1957	0.76
BF244A	0.28	2SC2028	0.73
BF244B	0.30	2SC2029	2.10
BF259	0.32	2SC2078	1.05
BF262	0.30	2SC2166	1.20
BF263	0.30	3SK88	0.65
BF337	0.38	40673	0.80

DIODES

IN916	0.04	AA119	0.12
IN4001	0.05	AA129	0.18
IN4004	0.06	AAY30	0.16
IN4005	0.06	BA100	0.24
IN4007	0.07	BY126	0.12
IN4148	0.05	BY127	0.10
IN4149	0.06	BY133	0.16
IN5400	0.12	BY184	0.40

74LS

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LS01	28p
LS02	28p
LS03	28p
LS03	32p
LS08	28p
LS09	28p
LS10	28p
LS11	28p
LS12	25p
LS13	33p
LS14	58p
LS15	25p
LS20	28p
LS21	28p
LS22	28p
LS30	30p
LS32	28p
LS37	23p
LS74	38p
LS122	70p
LS138	45p
LS139	68p
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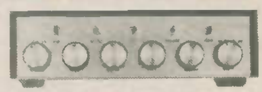

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PE VOLUME 21 Nº9 SEPTEMBER 1985

MOVEMENT?

IN THE July leader we commented on *Twenty Years of Stagnation* in UK schools and invited anyone interested or involved in this area to let us know their views. Some enlightening letters concerning this subject appear elsewhere in the issue and we hope they will generate further thought and response.

A number of highly enthusiastic people and organisations in the UK are actively trying to push back the boundaries and help to introduce students to technology. However, two things worry us most:

1. There appears to be little lead from government and educational authorities.
2. Not one student (or ex-student) has written to us with any views or comments.

Maybe these two points are linked? It is possible that many students are never introduced to modern electronics in schools, that they never do more than a conventional (conservative—outdated—call it what you will!) general science course and are therefore not fired with enough interest to worry about the quality and variety of their education. Are we beginning to train children to accept the mundane or the dole queue? Come on you students (past and present), let us hear what you think of the system. Let us know what instruction is/was available to you, what you would like to see going on in schools and how you feel it would be of benefit to you.

LET DOWN

Going back to the first point—it is very sad that facilities are so lacking in schools. Mr. Henderson's letter from Priestly College, Warrington, illustrates how the staff feel society is letting them down.

The points about the "low esteem" of the teaching profession held by society and lack of specialist staff show that perhaps we all need to change our attitude towards education. While in no way wishing to get involved in politics, it is all too easy to blame the teachers when a continuing lack of investment in training, staffing and facilities, at Government level, is not allowing education in the UK to keep up with progress and the new demands of industry. Education which has, for many years, had a worldwide reputation for excellence. Perhaps the state schools should follow the lead given by the Independent Schools Microelectronics Centre? Copies of the leaders and of the letters we have received have been forwarded to the Department of Education in the hope of a reply.

We wish to be constructive and with this in mind would particularly like to hear of your ideas and the clubs, courses, specialist schools etc. that are working in this area.

Mike Kenward

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Old Projects

We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee the indefinite availability of components used. **We are unable to answer letters relating to articles more than five years old.**

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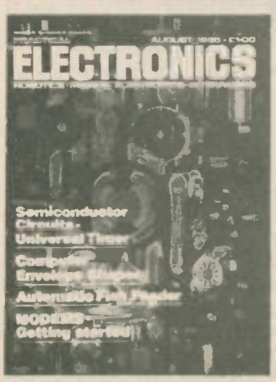

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We regret that lengthy technical enquiries cannot be answered over the telephone.

UK ABANDONS DBS

Only two years ago, great excitement abounded when plans to bring Direct Broadcasting by Satellite (DBS) to Britain were being finalised. Our hopes (or fears) of being treated to world-wide televisual entertainment have now been dashed. A Government selected body has decided that the potential demand is too small and the financial risk too great.

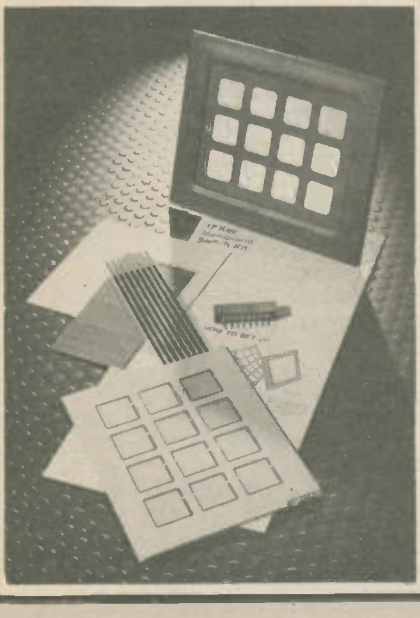
The unanimous pronouncement from 21 communications and broadcasting organisations, will have far-reaching effects on the proposed plans of many companies. Government franchised British Telecom, United Satellites, GEC-Marconi and British Aerospace will not now be building DBS satellites for Britain.

The High Street retailers and the manufacturers that supply them will also feel the pinch. Logically, the market for DBS dishes and associated conversion equipment would have been as vast as that of the television watching public; TV sales will also suffer. It is rumoured that a new 'novelty' will have to fill the gap if predicted sales figures are to be realised.

The future of Multiplexed Analogue Component signals (C-MAC) development must also be in jeopardy. The system is based on a single f.m. transmission channel with no sound carriers, colour carriers or subcarriers. It was designed to provide improved sound and picture quality from satellite broadcasts. (See, Getting to grips with MAC) *Practical Electronics, Sept 83.*

The Government, having spent time and money attempting to initiate DBS, will not be amused. However, looking for an alternative use for the £500 million scheduled for the project may help to ease the pain. So might the news that a last-hour reprieve is in the offing.

KEYBOARD KITS



Swissinco has introduced a prototype keyboard kit which contains all the parts necessary to build a customised membrane switch/keyboard panel.

Available in 4, 12, 16, 40, 80 and 102-key versions, the new kit includes the basic switch unit, overlay, colour pad, edge panel and connector. Optional transfer lettering is available to add numbers, letters or functions words depending on the user's application.

A choice of key colour and lettering styles is available, and a complete keyboard assembly can be made up in a matter of minutes. The switch technology used in the membrane keyboard combines low cost with high reliability, and the switches have been reliability-tested to over three million operations.

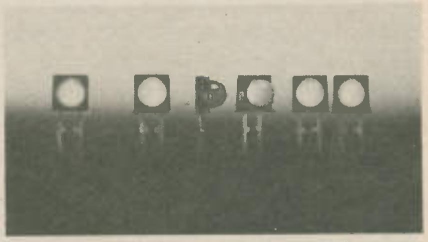
Prices respectively (inc. VAT and p. & p.) are £7.57, £10.07, £11.45, £19.55, £40.99 and £34.68. From Swissinco U.K. Ltd., Unit 2, 225 Hook Rise South, Surbiton, Surrey KT6 7LD (01-397 7041).

Side-on semicon

A new range of 'side view' l.e.d.s from Telefunken Electronic, the TLP Series, has been designed to simplify the way in which p.c.b.-mounted l.e.d.s are positioned to provide visual indication. They will be particularly useful in confined spaces where 'top view' l.e.d.s are difficult to view without bending the leads.

The TLP 56 Series utilises a dense translucent lens material to ensure that the light is even and consistent without loss of intensity. Red, orange, yellow and green types are available, with luminous intensity ranging from typically 0·5 m.c.d. (red types) to 1·5 m.c.d. (green, orange and yellow types).

Viewing angle (half intensity) is 50 degrees for red types and 80 degrees for others. Power dissipation is 100mW maximum for all types with reverse voltages down to 6V d.c. (max 20V d.c.). The lens on each type is a dome of 3·5mm diameter, and base 4·8mm square. Overall length of the component (including leads) is 18mm. Further details from AEG-Telefunken (UK) (0753 872120).



NEW MICROS FOR OLD

Until 31st August Mitsubishi Electric (UK) Ltd. will be offering a £50 trade-in on any computer or video games machine against the sale of a new Mitsubishi MSX home computer.

This offer will run additionally to the free starter software pack—consisting of six top tape games "worth over £45"—and a comprehensive 300 page operating instruction manual and basic language handbook.

The Mitsubishi 32k memory ML-F48 and 64k ML-F80 MSX home computers retail in the High Street at around £219 and £275 respectively and are available from most Mitsubishi Electric dealers.

MARKET PLACE

WIDE ANGLE REVERSE LCD

Epson has introduced a new wide angle, high contrast, easily readable liquid crystal display known as "Black Shutter".

The display, based on guest-host design principles, is unusual in that it consists of a normally black opaque l.c.d. panel which, when activated, turns transparent to light. By placing a light source behind, the l.c.d. gives a clear, positive display that can be easily read from a wide angle.

The secret of the display is a black dye with very high light absorption qualities that eliminates the need for two polarisers. Normal twisted nematic l.c.d.s often cannot be read from an oblique angle, from a distance.

Black Shutter, which has up to 25 to 1 contrast, is available in two versions. The first is a high specification l.c.d. designed to meet with the requirements of the automotive industry and is suitable for application in temperatures between −30°C and +80°C. The second system is suitable for use in consumer goods such as cookers, washing machines, clocks and office automation equipment, and has an application range between −10°C and +60°C.

The system is easy to read under all conditions when backlit, and has low power requirements, common with l.c.d.s.

Patent it!

Patents, designs and trade marks are not just for the likes of ICI or their fellow multinationals, they are designed to protect us all.

Admittedly though, for those of us who have ventured into this world of forms and counter forms, it can seem a rather daunting place, and it is all too easy to just leave it to the professionals. It is the intention of the Patent Office to show us that this should not be the case.

To prove the point the Patent Office has made a video which explains how to register a design, patent or trade mark, and to demonstrate the benefits that can be derived thereafter. The video also illustrates how the Science Reference Library can act as an invaluable source of material with its databank of some two million British patents and 23 million foreign patents.

As part of a programme to inform inventors and companies about who they can protect their intellectual property the office can also provide speakers for seminars or lectures to expand on the information given in the film.

The video costs between £35 and £40 depending upon the format, or it can be hired for five days at a cost of £9.78 (inc. p&p). From, CFL Vision, Chalfont Grove, Gerrards Cross, Bucks. SL9 8TN (02407 4433).

A wide range of booklets is always available from, The Patent Office, State House, High Holborn, London, WC1R 4TT.

POINTS ARISING...

DISK DRIVE PSU

April '85

The p.c.b. layout of Fig. 2 on page 20 shows R1 and R3 transposed.

SELF STUDY INTRO PACK

An 'Introducing Microelectronics' package produced for the educational market by Educational Electronics Limited is now available to a broader market. It is offered complete with all the components, circuit board and 136 page course booklet, needed to conduct a wide variety of investigations.

The course booklet, written by a leading authority on microelectronics assumes no previous knowledge of the subject. It provides a self-study guide to basic digital electronics and computer building blocks.

The basic circuit board is cleverly designed to incorporate a range of features that enables the user to make rapid progress. It contains four i.c. sockets, l.e.d.s., a pulser button and a pulse 'clock'. Bit patterns can be set up using the integral bit set switches and the edge connector port can be utilised for further experiments using a microcomputer.

The INTRO package is available at £59.50 inc. VAT and p&p from Educational Electronics Limited, 28 Lake Street, Leighton Buzzard, Beds, LU7 8RX (0525 373666).

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 Brian Butler.

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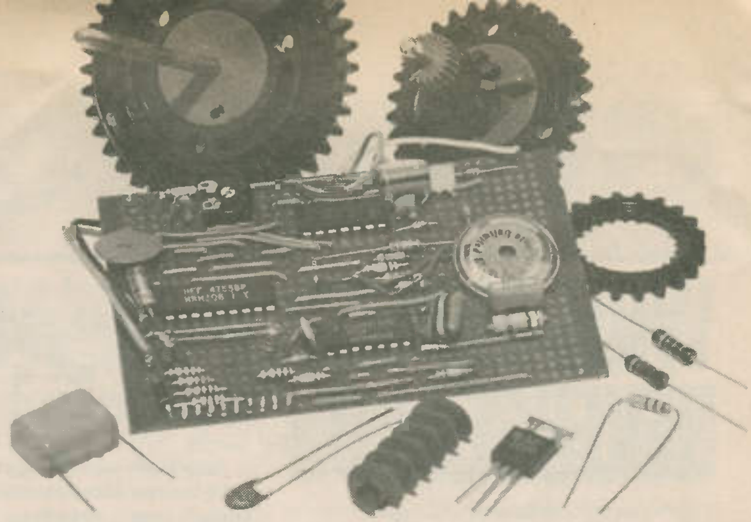
Experimenting with ROBOTS

Mike Abbott



SO FAR, to the hobbyist and student, getting into robotics is a matter of purchasing a kit of parts, assembling those parts, and thereafter learning to "drive" the robot through the host microcomputer. The experience is much the same, whether the machine be a straightforward arm or a mobile unit with one or two sensors.

But what of the robots themselves? What of the engineering that goes into them, and of their peculiar and challenging marriage between electronics and mechanics? Potentially, there is a whole universe of intrigue to be explored in this world of gearwheels, motors, potentiometers and power transistors. At a glance, there would appear to be sufficient mechanical media available, in the shapes of *Fischer Technik, Meccano,* and even *Leggo (Technical)* to a limited degree, to open up that universe, along with the aid of improvised and home made bits and pieces. Interest is not confined to robot arms, nor even to the accepted formula mobiles. In fact, any servomechanism designed to do any job, controlled by "intelligent" electronics tends to be fascinating yet as far as this hobby is concerned it seems to be an underexploited area of creativity.

Experimenting With Robots is based on the aforementioned premise, but if the column is premature it will not continue for long, because although we have provided the "kick off" material it is hoped that the column will eventually become a kind of "*Ingenuity Unlimited* for robotics". Ideas, serious or silly, electronic or mechanical, tested or theoretical, large or small will be considered for publication. And, of course, payment at current rates will apply. If you think you have invented something which will interest other readers, then let us know.

GENERAL PURPOSE INTERFACE

With the exception of one feature, the interface described is both simple and conventional, allowing up to four servo-positional channels and one gripper control channel. Position-related voltages are generated by potentiometers mounted on the robot's axes, and these are compared to voltages generated by DACs to generate the error signals which drive the motors towards their null points. The DACs have onboard latches which are memory mapped into the host computer by a memory addressing circuit that can be set to any location by way of d.i.l. switches. The host computer requires no user I/O port. Numbers relating to angular positions (1–255) can be POKEd to the selected addresses in quick succession and the linear circuitry left to drive all the axes simultaneously. Although the interface does not provide a feedback path from the robot to the computer, the robot is nevertheless operating under closed loop conditions, and therefore likely to go where you expect it to, *every time*.

The value of the potentiometers mounted on the robot is not critical, the optimum being around 5K. The *Powertran Cybernetics "Micrograsp"*, which has 1k potentiometers, worked well with the interface (with a few wiring alterations).

All, or part of the interface may be built on stripboard (as was the prototype), or on the p.c.b. illustrated. The interface should work with most microprocessors because it is driven from the data bus, and the address bus of its host, as opposed to requiring an I/O port. A second prototype was constructed on the p.c.b. and hitched up to a ZX81. It worked perfectly with this simple and inexpensive micro.

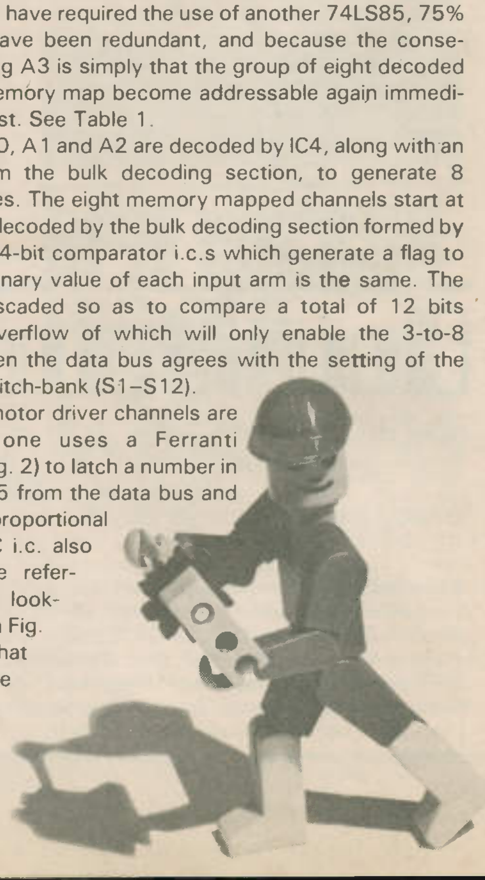
Since there is no point in cramming components together when there is no need, the p.c.b. is somewhat "rural" in appearance, which makes messing about with it all the easier. Particularly so with the fifth channel, which is not only unconventional, but which has a p.c.b. area that may be populated in different ways for different purposes. The technical possibilities of this channel are analysed further on.

CIRCUIT DESCRIPTION

The circuit diagram of the address decoding section is shown in Fig. 1, along with the servomotor driver circuits (4 channels). Address line A3 is not included in the base address decoding carried out by IC1–3. This is the case because that extra single bit of decoding would have required the use of another 74LS85, 75% of which would have been redundant, and because the consequences of ignoring A3 is simply that the group of eight decoded channels in the memory map become addressable again immediately above the first. See Table 1.

Address lines A0, A1 and A2 are decoded by IC4, along with an overflow line from the bulk decoding section, to generate 8 channel enable lines. The eight memory mapped channels start at the base address decoded by the bulk decoding section formed by IC1–3. These are 4-bit comparator i.c.s which generate a flag to show when the binary value of each input arm is the same. The 74LS85's are cascaded so as to compare a total of 12 bits (A4–A15), the overflow of which will only enable the 3-to-8 converter IC4 when the data bus agrees with the setting of the address select switch-bank (S1–S12).

The four servomotor driver channels are identical. Each one uses a Ferranti ZN428E8 DAC (Fig. 2) to latch a number in the range 0 to 255 from the data bus and convert it into proportional voltage. The DAC i.c. also provides a stable reference voltage, and looking at Channel A in Fig. 1 it can be seen that this is taken to the top end of the feedback poten-



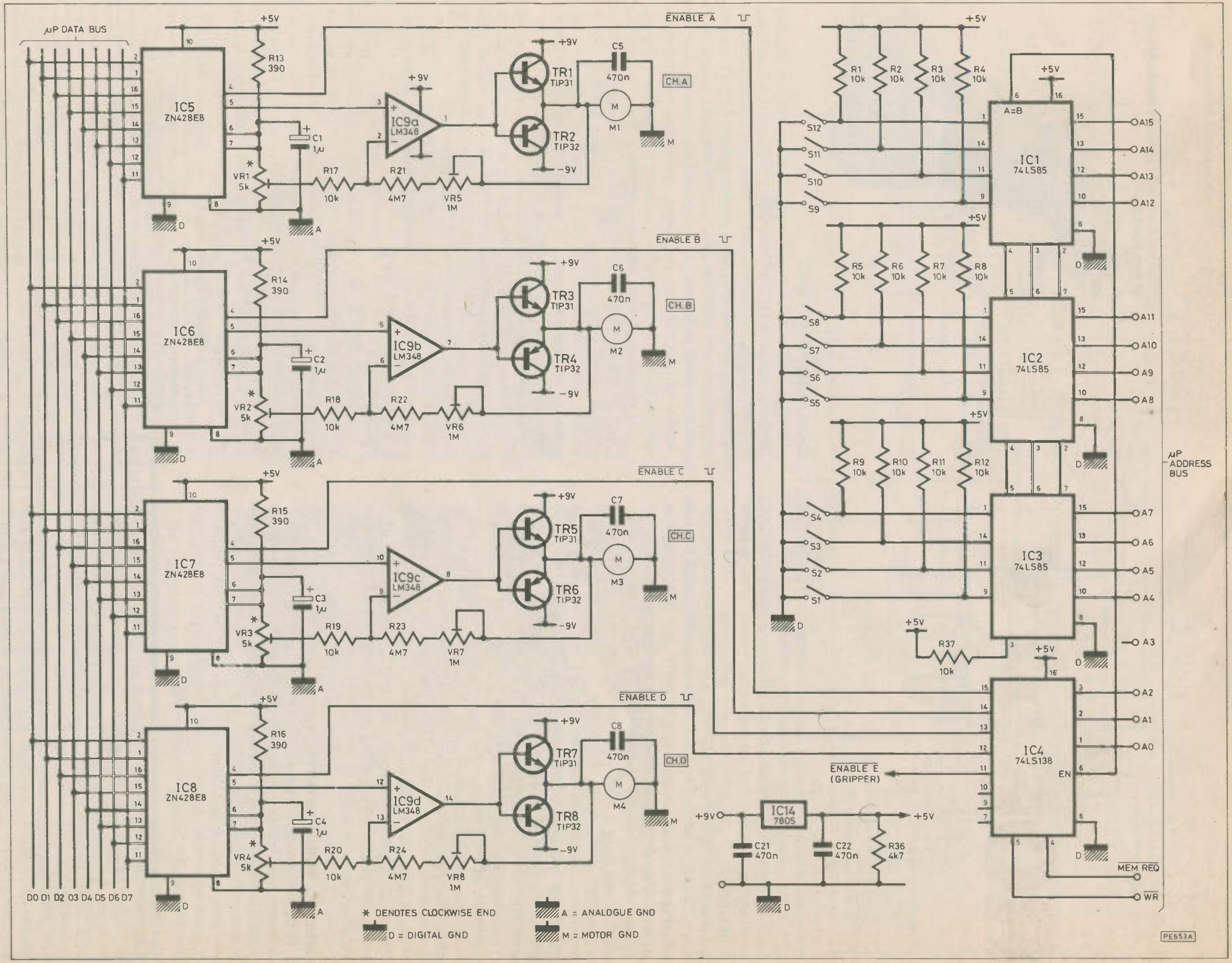


Fig. 1. Circuit diagram of address decoding and the four servo channels

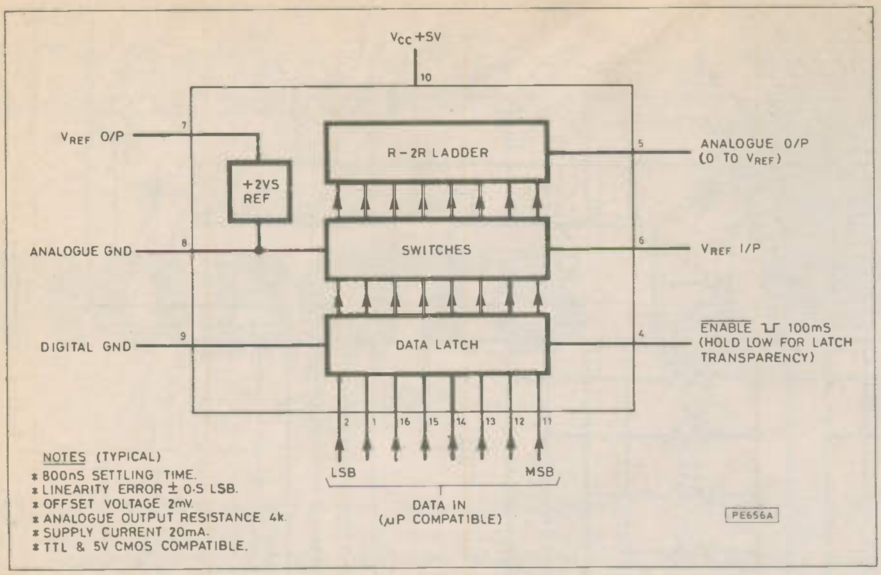


Fig. 2. The Ferranti ZN428E8 DAC incorporates μP compatible data latch

The Powertran Cybernetics Micrograsp robot arm

tiometer mounted on the robot. This connection (from IC5 pin 7 to VR1) ensures that the maximum position-related voltage from VR1 is exactly the same as the maximum voltage generated by the DAC itself, thereby ensuring that the entire loop is working to the same scaling factor.

The principle of operation is simple. A position instruction in the range 0–255 is latched into IC5 from the micro's data bus. A proportional voltage is produced at pin 5 and, assuming it is different from the voltage generated by position sensor VR1, the difference (error signal) is amplified by IC9a. This op. amp. operates in a very high gain mode, working almost as a comparator, since most of the time its output is driven into saturation. Current amplification by TR1 and TR2 allows this amplified error signal to drive the motor belonging to the same axis, which is wired in opposition to VR1, so that it will run in a direction which eventually cancels out the error signal. A closed loop control system is thus achieved in which the mechanism of the robot itself is a part.

Motors of anything up to 12V d.c. will run well with the interface, and their maximum permitted power rating is governed by the driver transistors (TR1–TR8). The transistors specified are rated at 3A, with a power dissipation of 3W at 25°C. Larger motors, or a heavy duty cycle, may well dictate the need for a larger heatsink. A curious effect results from taking the negative feedback loop around the op. amp from the emitters of the power transistors instead of directly from the amplifier output. The circuit was designed this way in order to avoid a *dead band* between the threshold voltages of the power transistors in which the op. amp's output would "wallow" around *outside* the control of the feedback loop. Taking the negative feedback path directly from the motor improves positional repeatability, but it has the side effect of never allowing the op. amp's output to settle at exactly 0V, which is without consequence, and means that sensitivity automatically increases as the null point is approached.

GAIN CONSIDERATIONS

Looking at Channel A again, it can be seen that the negative feedback path around IC9a incorporates two resistors, one fixed, and one variable. The series value of these two resistors will best be found by trial and error because the amount of gain required depends upon the reduction gearing in the axis under control. High reduction gearing between the motor and the potentiometer will require high gain in the op. amp. circuit, and hence a high feedback resistance. Low gain will result in inaccurate positioning of the axis.

Low reduction gearing between the motor and the potentiometer will require lower gain in the op. amp. circuit. High gain in this situation would cause hunting. That is to say, the motor overshoots back and forth, and never comes to rest. Generally speaking, the higher the reduction gearing in the servomechanism, the easier it will be to get positional accuracy.

Although the preset VR5, in Channel A, allows trimming to the optimum performance, it can be linked out. In this case it would be advisable to place solder pins in R21's position so that resistors may be "tacked" on to get the best effect. The professionals' euphemism for this method is SOT (Select On Test).

Some of the most basic laws of robotics design will begin to manifest themselves even at this early stage of experimentation, and in a most entertaining way.

TACACOOGA

The *TACACOOGA* is not a Latin-American dance step, but the acronym I found myself with when I added together all the features of this gripper circuit: *Torque Adjustable Closure, Automatic Cut-off On Opening Gripper Actuator* circuit. Don't run away! The p.c.b. will accommodate a number of conventional circuits as an alternative, and these are outlined further on. The *TACACOOGA* incorporates some of the ideas that tend to be speculated about but seldom tried, so I thought it best to begin at this, the mirky end.

Address Line	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	
Binary Weighting	32,768	16,384	8192	4096	2048	1024	512	256	128	64	32	16	
Switch (0=closed)	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	Memory location (Base address in decimal)
Example 1	0	0	0	0	0	0	0	0	0	0	0	0	00000
Example 2	1	1	1	1	1	1	1	1	1	1	1	1	65520
Example 3	1	1	1	1	0	0	0	1	1	0	0	0	61824

Table 1. Setting up the address decoding switches will be easier using the above table. Switches S1 to S12 allow the interface to be memory mapped to any location in the host computer's memory, setting up the base address (channel A). The base address (in decimal) is found by adding up the binary weightings at which a logic 1 (switch open) occurs. Channel B will then be at the base address +1, channel C at base address +2, etc. The robot is controlled by the POKE instruction using these decimal addresses. Note that for reasons of economy of hardware address line A3 is not decoded, but this does not generally matter. Hence, in example 2, POKE 65520,5 would have the same effect as POKE 65528,5 since the decoder cannot sense the difference. The lower address bits decode the individual channels, and in example 2 the gripper channel appears at 65524.

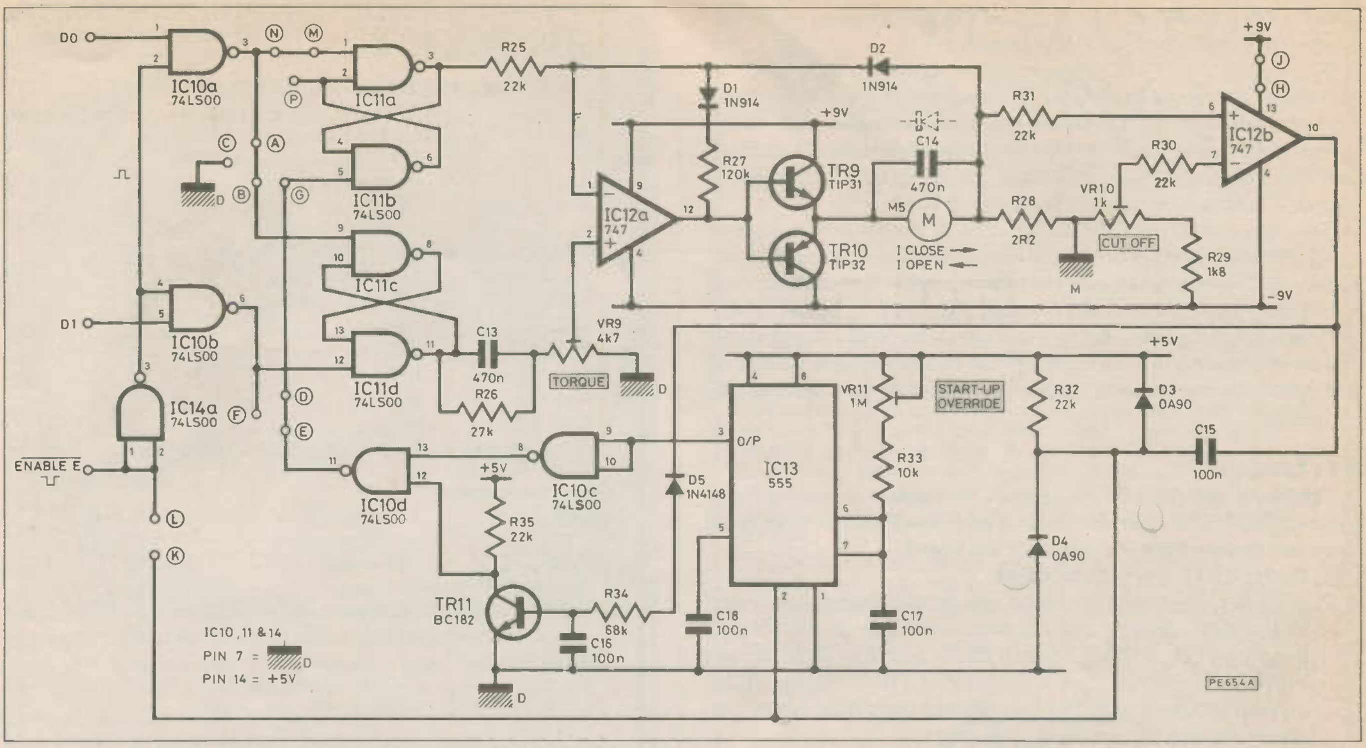


Fig. 3. Circuit diagram of the TACACOOGA

TAC . . .

The circuit diagram is shown in Fig. 3, and it can be seen that data from lines D_0 and D_1 are latched into two bistables formed of IC11, at the command of the $\overline{\text{Enable E}}$ line from the address decoding section illustrated in Fig. 1.

To close the gripper a logic 1 must be present on D_1 and a logic 0 on D_0 (denary 2 on the data bus), when Select is pulsed high. IC10 pin 6 will then pulse low, thus setting bistable IC11c and d. The steady logic 1 so created on IC11d's output (pin 11) generates a positive voltage at the non-inverting input of op. amp. IC12. However, VR9, in conjunction with R26, reduces this +5V logic signal to the op. amp., making it adjustable between 0V and 0·75V. The op. amp's inverting input remains low.

When the output of IC12a rises towards positive it reverse biasses D1 and cuts off the negative feedback path through R27. The output voltage rises rapidly because of open loop gain until TR9 begins conducting, at which point current is produced in the motor, and a positive voltage generated across R28. This voltage forward biasses D2, thus activating the unity gain negative feedback path. Because an op. amp. configured with negative feedback always tries to bring its input voltages to the same potential, it is clear that its output will stop rising when the voltage across R28 is the same as the voltage on the wiper of VR9. Therefore, by adjusting VR9 we can adjust the voltage across R28. This resistor is a mere 2·2Ω and is in the same current path as the motor, so that the motor current can be controlled by the voltage set across R28. The net effect is that VR9 controls the motor torque whilst the gripper is closed, or holding an object. With the component values specified the motor current may be varied from zero to just under 350mA.

. . . ACOOGA

The gripper opens when a logic 1 is present on D_0 and a logic 0 on D_1 and $\overline{\text{Enable E}}$ is pulsed. IC11a output is set high, bistable IC11c and d is reset, and a positive voltage appears at the op. amp's inverting input. Because the output of op. amp. IC12a is driven negative, forward biassing D1, we have negative feedback through R27, and an input resistor in the shape of R25. This is a conventional inverting amplifier with a gain of around 8, and its output swings negative to bias TR10 into conduction. The motor is therefore driven the opposite way, and its current produces a negative voltage across R28.

The comparator formed of IC12b is designed to ignore the "running" current of the motor, but to detect its "stall" current. The idea is that the motor runs in the "gripper open" direction until it strikes the end-stop, at which point the detected stall current is used to generate a signal to switch off the motor. This eliminates the need for limit switches mounted on the gripper. I have heard this possibility discussed many times, but the principle comes easier than the practise, I discovered.

The inverting input of IC12's second op. amp. is set to a negative voltage by way of VR10, and the amplifier compares this negative voltage with the negative voltage across R28. When the gripper motor is stalled its armature generates no back e.m.f. and so the motor conducts current heavily, and this in turn causes a greater negative voltage across R28. So, as soon as the voltage across R28 becomes more negative than the setting of VR10 the output of the op. amp. switches sharply negative to around −8V. The switch is rapid because the op. amp. is configured as a comparator, i.e. is in open loop gain configuration.

After two inversions (TR11 and IC10d) this signal resets bistable IC11a and b, thereby deactivating the motor.

As was stated earlier, the principle of operation runs aground on the fact that the motor is stationary at the outset, of course, and therefore the system immediately sends out a self-cancelling signal, for however briefly it may be, at start-up the motor conducts stall current.

The answer is a short time delay to override the start-up period of the motor, hence the 555 monostable circuit. By triggering the monostable from the same stall current signal, and gating the monostable's output back in at IC10d the stall current response is delayed long enough to overlook the motor start-up period. It might have been simpler to delay the stall current detect line with a C-R integrator, but the variability (VR11) of the monostable circuit gives a more universal capability, and this is necessary when the system is intended for no specific robot.

The inversion at TR11 is nevertheless delayed a little by C16, and this is intentional to ensure that the stall detect signal on start-up does not reach IC10d before the override signal from IC13, which goes through more switching functions. Diodes D3 and D4, and R32 simply clip the trigger signal generated by IC12b to levels acceptable to a 555 timer working on a 5V rail.

The capacitor across the motor, C14 is essential to suppress electrical noise which would otherwise cause havoc with the logic. Finally, C13 provides a small start-up voltage boost to the motor when the gripper is instructed to close, and may only be necessary with some motors when set to a low torque by VR9. I found some model engineering motors quite difficult to use with this feature of the circuit, an old cassette deck motor being by far the most co-operative.

SETTING UP

Confusion will reign if you are not methodical in setting up a *TACACOOGA*. The best approach is as follows (all pot directions are seen looking from the centre of the board):

1) Rotate VR11 fully anticlockwise.
2) With the power off, set VR10 fully anticlockwise, and break LK1. Power up, and use the host computer to instruct the gripper to open. Using either a DVM, scope or logic probe, monitor the voltage on the collector of TR11. Rotate VR10 slowly clockwise until TR11's collector goes high. Leave the preset adjusted to 'just past' this point.
3) Starting with VR11 fully clockwise, rotate it anticlockwise, opening the gripper after each increment (operated from micro), until the gripper *consistently* swings fully open.
4) VR9 should be adjusted clockwise until the gripper closure torque suits your requirement. From the point of view of power dissipation, torque should be kept to the allowable minimum if long periods of closure are anticipated.

THE TRADE-OFF

The system concept is a trade-off in which the electronics is necessarily more complex in order to keep the mechanics simple. In the case of the torque control, or grip strength, the gripper jaw mechanism *must be kept* simple. If the motor has any kind of mechanical advantage, such as through a worm gear, the tactile nature of the system will probably be lost.

	BINARY				
INSTRUCTION	D_2	D_1	D_0	DENARY	NOTES
OPEN	×	0	1	1	WILL AUTO-STOP
CLOSE	×	1	0	2	CONTROLLED TORQUE
NO CHANGE	×	0	0	0	
ILLEGAL	×	1	1	3	

SLACK JAW

Using the TACACOOGA driven gripper, at some angles it might drop shut again after obeying an instruction to open, due to gravity acting on the driven jaw. This is because the motor, and therefore the jaw, goes slack after striking the end-stop. In some applications this could be a nuisance, but one cure is to mount a small permanent magnet on the end-stop to capture the jaw once opened. If the driven jaw is not made of a ferrous material, then a small steel nut and bolt through it will give the magnet something to act on. The magnet needs to be strong enough to carry the weight of the jaw in the vertical position, but weak enough to allow the motor to pull the jaw away from it when energised in the "close" direction. An alternative is to use a *very* small pair of facing Velcro pads.

NEXT MONTH: Other gripper circuit configurations, the simplest gripper in the world (for the TACACOOGA), p.c.b. construction and software.

COMPONENTS...

STANDARD (FULLY POPULATED) INTERFACE

Resistors

R1–12	8 × 10k s.i.l. package (2 off)
R13–16	390 (4 off)
R17–20,R33,R37	10k (6 off)
R21–24	4M7* (4 off)
R25,R30,R31, R32,R35	22k (5 off)
R26	27k
R27	120k
R28	2·2/4W
R29	1k8
R34	68k
R36	4k7

*See text. All resistors ¼W 5% unless otherwise stated

Potentiometers

VR1–4	5k linear nominal. Mounted on robot (4 off)
VR5–8	1M preset (4 off)
VR9	4k7 preset
VR10	1k preset
VR11	1M preset

Capacitors

C1–4	1µ elect. or tant. (4 off)
C5–8,C13,C14, C21,C22	470n (8 off)
C9–12,C15–22	100n disc cer. (12 off)

Transistors & Diodes

TR1,TR3,TR5, TR7,TR9	TIP31 (5 off)
TR2,TR4,TR6, TR8,TR10	TIP32 (5 off)
TR11	BC182 or equiv.
D1,D2,D5	1N914 or 1N4148 (3 off)
D3,D4	OA90 (2 off)

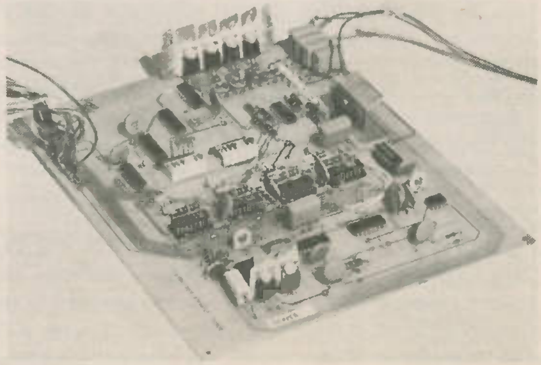
Integrated Circuits

IC1–3	74LS85 (3 off)
IC4	74LS138
IC5–8	ZN428E8 (4 off)
IC9	LM348
IC10,IC11	74LS00 (2 off)
IC12	747
IC13	555 timer
IC14	7805 regulator

Miscellaneous

S1–12 8 × dual-in-line switch (2 off)

P.c.b. (copies available from *PE* Poole office on request) or Veroboard, eyelets or solder pins (through-board connection), 22 s.w.g. tinned copper wire, instrument wire, aluminium sheet, mica washers and heatsink paste, motors and robot parts (*who knows what?*)



THE LEADING EDGE

SATELLITE BROADCASTING

Much has been happening, and equally important *not* happening, in cable and satellite television. First, the background, which now seems to have been conveniently forgotten in Government quarters.

In May 1981 the Home Office published a report on DBS, Direct Broadcasting by Satellite into homes. That report was prompted by the often-quoted WARC plan drawn up at the World Administrative Radio Conference held in Geneva in 1977.

This plan gave Britain, like most other countries, five channels, in the 12GHz band, for DBS. It also gave Britain an orbital slot, at 31°West, for a satellite. So far so good. But the report also gave some warnings, now apparently long forgotten, about the practical difficulties of running a DBS service.

The 31°West slot means that the UK satellite will be hanging in geostationary orbit over the Equator off the coast of Brazil. Dish aerials on roofs or in gardens will have to sight on that invisible spot in the sky. The Home Office warned that aerial alignment would have to be kept to within about 0·5 degrees and offered the reminder that in comparison the alignment of u.h.f. television aerials is far, far less critical.

The Home Office engineers went on to explain that GHz signals will not travel through ordinary roof tiles. This means that loft-type mounting is impractical, unless the roof is re-tiled with special electromagnetically transparent material.

The Home Office engineers also offered a guide to how easy it would be for a householder to find a suitable site for a dish aerial, with a view of the satellite unobscured by buildings, hills or even leafy trees. All will block the microwave signals.

At about 3pm on or about 13 October, the sun in the sky appears to an observer in the UK to be in the same position in the sky as that which a satellite in the orbital position assigned to the UK will occupy. The same test holds good at around 2pm on 2 March. You will be surprised, if you look for the sun at those times, to find how low in the sky it is hanging.

Assuming the sky is clear and the sun shining, only those parts of your house or garden in direct sunlight will be suitable spots for an aerial. If only part of the roof is in sunlight, it's tough luck if an aerial will look ugly, or be hard to secure, in that sunlit area. That's the only place you can put it.

SERVICE COSTS

In March 1982 the Home Secretary, then William Whitelaw, gave the BBC two channels for DBS. One was to be subscription service and the other financed basically by licence fee revenue.

At first the BBC was overjoyed. But soon the cold hard reality sank in. The Home Office told the BBC that it had to rent a satellite from a consortium, called United Satellites Ltd., of British Aerospace, British Telecom and GEC Marconi.

The BBC winced when it heard the cost; a rental of £12·2 million per channel per year over seven years. That meant nearly £25 million a year on transponder rental for two channels before even a single penny was paid for programming. The BBC got cold feet and eventually opted out.

The Home Office then threw the offer open to the commercial TV companies, but insisted that private industry be involved as well. They knew the BBC and ITV management would fight like cat and dog and achieve nothing unless held in check by a third party influence. The two-channel service was expanded to three-channels so that the three parties would have fair shares of the programming.

Since July last year the future of DBS has been in the hands of the so-called Group of 21. The BBC has a 50 per cent share, the 15 ITV companies 30 per cent and the remaining 20 per cent is split between Consolidated Satellite Broadcasting Ltd., Granada TV Rental, Pearson the publishers, Thorn-EMI and Virgin.

The first thing the Group of 21 did was check the price of satellites. They found it had risen from £24·4 million for 2 channels, to £80 million a year for 3 channels.

Members of the Unisat Consortium made it clear, informally, to the press, that they were worried about the high prices being quoted, but had their hands tied by the Home Office. United Satellites, the holding company representing British Aerospace, British Telecom and GEC Marconi, has to be the official mouthpiece. All press enquiries have to be referred to Unisat.

I tried enquiring. Daniel Gruneberg, the man in charge at Unisat, made his position clear. The cost figures quoted in the press he said were "nonsense"; not just the currently quoted £80 million per year for three channels, but the original £24·4 million per year for 2 channels. That's odd, because it was the BBC who originally quoted the £24·4 million!

As the BBC were being asked to pay it, they should surely have been in a position to know. Gruneberg told me that in the past he had given briefings to journalists, but they had just "gone away and printed rubbish". So now he does not give briefings.

I then put the point to British Aerospace, British Telecom and GEC Marconi separately. If the Unisat mouthpiece thinks that briefing journalists verbally produces "printed rubbish", then the consortium should produce a written briefing sheet on the crucial matter of satellite costs. That was a month ago, and so far I've heard nothing.

Meanwhile, behind the scenes, the Group of 21 is lobbying the Home Office to throw the contract for a DBS satellite open to tender. If that happens, one of two things will happen. Either a foreign satellite maker will win the contract, at around half the price being quoted by Unisat; or Unisat will drop its price to around half.

SIGHT AND SOUND

In what looks like a desperate attempt to stimulate some fresh confidence in the idea of a British satellite broadcasting direct into British homes, the members of the Unisat consortium have recently been trying to plant the idea in receptive minds that it is much easier to receive signals than the original Home Office report suggested. The deliberately leaked word now is that 12GHz signals *could* be received on a set top aerial, through a window, or by a loft aerial, through roof tiles.

It's true that receiver front end technology (mainly f.e.t.s) has improved greatly since the 1977 WARC conference. The 240W transmitters planned for Unisat will now be able to serve smaller dishes on the ground. But the laws of physics haven't changed. Either 12GHz signals will go through conventional roof tiles or they will not. A test, with a land-based transmitter, a receiver and a few roof tiles in between is all that is necessary.

The talk of a set top aerial is just plain daft. Of course, an aerial on top of a set will pick up signals through glass (provided it is unleaded), but only if there is direct line of sight between the aerial and the satellite and if no-one has dusted the aerial and moved its position by more than a degree or so. How many people have their TV sets in a room next to a window that is in direct line of sight with the sun at 3pm on October 13?

One further spanner has now been thrown in the works. The British Government decided, in November 1982, that any British satellite service must use the MAC transmission system developed by the IBA, instead of the Extended Pal system proposed by the BBC.

To cut a long, and well-worn story short, MAC (Multiplexed Analogue Components) separates the colour and black and white picture signals in *time*, rather than *frequency* as in existing colour TV systems. The sound is in digital code, slotted into the gaps in the video waveform.

British and other European broadcasters plan to use PCM digital sound. But the snag with PCM sound is that it falls apart on a go/no-go basis when the signal strength drops, for instance in poor weather/or if the aerial is misaligned (or behind roof tiles?). The picture, being analogue, gets progressively more snowy but the sound just switches off.

British Aerospace recently mounted an impressive demonstration which showed how modern receiver technology can squeeze acceptable pictures from a DBS signal, even in poor conditions, and as far away from Britain as the South of France. But, significantly, the demonstrations did not involve sound.

DELTA LINK

In America, Dolby Labs, best known for their analogue tape noise reduction system, have propoosed an alternative approach to PCM. This is an update on the old idea of Delta Modulation, where only the signal changes are coded. The snag with Delta Modulation is that sampling has been much faster than for PCM, up to several hundred thousand times a second. Dolby used the old idea of Adaptive Modulation, where the coding steps are made of variable size and the transmitter sends a control signal which tells the receiver what size each step should be.

Normally, this would introduce unwanted background noise into the sound, and any error signal interfering with the control channel will knock out the system. Dolby solved the problem by using three bit steams instead of one. One runs slowly and controls the step size by second; another runs slowly and controls the amount of pre-emphasis to keep the wanted signal above background noise; the third signal runs fast and carries the audio signals.

A memory circuit in the transmitter introduces a delay in the audio signal which gives the slow-moving control signals a chance to cope with the rapid changes of sound. The obvious advantage is that the extra expense, in the memory delay, is in the single transmitter, not the millions of receivers.

The remarkable thing about Dolby Delta Mod (and I have heard it demonstrated) is that when the signal is contaminated with errors, the sound degrades like an analogue sound signal. In fact it is very much like listening to a gramophone with a fluffy stylus.

The advantqage of Delta Mod obviously appealed to Australian broadcasters. They chose MAC, but B-MAC with Dolby Delta Mod instead of C-MAC with PCM. When I reported this in print, the IBA jumped like a scalded cat, to defend C-MAC and downplay the Australian decision. Significantly, the Australians responded.

According to the Department of Communications in Australia, and I quote: "There is a definite advantage with the Delta Link system when operating at low receiver power, due to the very graceful degradation of subjective performance, compared to the rapid onset of irritating click noise with the C-MAC PCM sound". In other words the Australian broadcasters heard what I heard when Dolby Labs in San Francisco demonstrated Delta Modulation to me with deliberately degraded signal strength.

Perhaps instead of writing angry letters defending C-MAC PCM, the IBA could join with United Satellites to mount a demonstration of satellite transmission with PCM sound. They could then deliberately degrade the signal with aerial misalignment, and simulate bad weather and leafy trees in the signal path. We could then hear and see for ourselves how the system holds up in practice. It may well be significant that when GEC Marconi recently ran a test of its proposed satellite transponder, the press were not invited.

UPDATE

The Group of 21 have decided not to proceed with its planned British Satellite Service (see News & Market Place page 8). This follows pronouncements from a Government select body that "the potential demand is likely to be too small and the financial risk too great". Also, in their view, the Government constraints being imposed on them are too restrictive.

However, most European countries are still planning a satellite service using low power equipment. Now the big question is will the British DBS group be allowed to use cheap, low powered technology from abroad?

More on this subject in a later issue.

Next month we'll look at what is happening, and also equally to the point, *not* happening, in Cable TV in Britain.

BARRY FOX

INDUSTRY NOTEBOOK

By Nexus

Bust . . .

First the bad news. The great *personal* computer boom has gone bust. Perhaps I played a small part in this by suggesting last Christmas that intending buyers would profit by delaying purchase.

There was nothing clever in this advice. The price war had already gained momentum during 1984 and fears had already been expressed that the peak trading month was unlikely to peak this time round. So prices tumbled to the benefit of the bargain hunter.

Huge unsold stocks during the first quarter of this year inevitably created ripples back down the line to manufacturing subcontractors and component suppliers, short-fall in cash flow, plummeting share values, prospects of re-grouping, lay-offs, imminent bankruptcy.

One recalls earlier consumer crazes. The yo-yo, the hula-hoop and, more recently, the skateboard, that puzzle cube the name of which is already forgotten, and the BMX bike which still appeals and may enjoy permanency. I hesitate to include the PC as a passing novelty but the craze, if that is the name for a particular human phenomenon, is over.

Computer literacy is now much greater than that of the early 1980s and buyers will be much more discriminating. The big problem for those serving the low-price end of the market is how long they can survive once the Asian manufacturers start flooding the world in the manner we have already seen in pocket calculators. Again, incidentally, benefiting the buyer.

It is a pity that Sir Clive Sinclair, highly profiled as a superman in electronics, is now a victim of a fickle public. Hardly ruined but now dented in reputation. But he is still to be praised for creating a completely new business sector in electronics and for stimulating public interest in computers.

His present set-back is nothing new to him. His progression of ups and downs is closely linked with his obsession for tiny products. His first was the "smaller than a matchbox" Micromatic radio, which was profitable; his pocket calculators, successful at first before intense competition set in. Then there was his early micro-TV, a comparative failure; his Black Watch, a disaster; his present flat screen pocket TV, which may yet prosper; and finally, his revolution in personal transport, the C5, gravely disappointing following an overheated publicity build-up.

But Sir Clive remains full of ideas for the future and, on the surface at least, is not discouraged by past failures and present doldrums. And those of us who were home-constructing in the 1960s and 1970s still remember with affection (sometimes exasperation!) his hi-fi modules and kits which were very often our first experience of solid state technology and particularly of early integrated circuits.

The personal computer business is now in a chaotic state. I often think there must be better ways of organising our affairs. Central planning, Soviet style? They would still be talking about it. Chaotic as free enterprise may appear, it does in practice deliver the goods faster and cheaper than planned economies and provides great opportunities for innovators to exercise their skills and investors to take calculated risks on profit and loss.

. . . and Boom

While consumer electronics has its periodic horrors the capital goods sector is doing quite nicely. 1984 was a record year with output up 19 percent at £3·2 billion, exports up 9 percent at just over a £1 billion. But imports were up 18 percent at £777 million carrying the warning that competition is still the name of the game.

The Paris Air Show, as much to do with electronics as aircraft, once again demonstrated that avionics is still the forcing ground for innovation in the electronics industry as a whole. The first miniature computers, shoe-box size, were being fitted in aircraft all of 20 years before Sir Clive brought his first model into the home.

GEC Avionics is the largest firm in Europe in this specialised market. With 12,000 people on the payroll its products sell at the rate of over £1 million per day with nearly £500,000 a day coming from overseas customers. The company also claims to have the widest range in avionics of any company in the world.

Even so, GEC Avionics still needs partners in many projects. One such is the link-up with Lockheed on world sales of a budget-priced Airborne Early Warning system based on Lockheed's C-130 Hercules aircraft, of which hundreds are in use throughout the world, fitted with GEC Avionics APY 920 Mission Avionics derived from the system developed for the British AEW Nimrod. Potential export sales, say GEC, could well exceed the whole cost of the British AEW programme.

Another GEC company, Marconi Radar Systems, has teamed up with Raytheon in tendering for the US Federal Aviation Agency Radar Replacement (FARR) programme. This involves the supply of up to 50 3-D solid-state unattended L-band radar systems for installation in the USA on a budget of some 500 million US dollars.

Early this year Racal Radar Defence Systems and Selenia in Italy teamed up on avionics equipment for fitting in a variety of aircraft. And, again at Paris, Smiths Industries Aerospace and Defence Systems announced a cooperative agreement with VDO of Germany and Thomson CSF of France on avionics for the new European combat aircraft. This agreement allows for later participation of Italian and Spanish avionics companies.

Smith Industries is one of the world's leading avionics companies with 60 percent of output exported. Pointer-on-dial cockpit instruments are no longer the mainstay of the business and may disappear entirely by the end of the century, displaced by the all-electronic display on the face of a cathode ray tube.

An example is the flight deck of the British Aerospace Advanced Turbo Prop (ATP), the first orders for which were announced at the Paris Show. Instead of the usual multiplicity of dedicated instruments most have been replaced by Smiths with four CRTs which can be switched to various roles as required by push-button. The push-buttons or keyboard may themselves be relegated to standby emergency use if and when Direct Voice Input is perfected. With DVI the flight crew will just tell the system what instrumentation is to be displayed and hey-presto it appears.

The advantages of the CRT displays don't end at the flight deck. Unseen and largely unthought of by the passenger is the costly business of ground maintenance. With dozens of different pointer instruments in each aircraft, spares holdings are expensive as, indeed, are the skilled mechanics to repair them.

With the new system a single CRT module as spare is all that is required and the airport electronics trouble-shooter can cope with that as easily as with the other systems he normally looks after. To him, it is just another black box. In fact expensive instrument mechanics at airports are all set to go the same way as those whose sensitive fingers once tweaked the relays in electro-mechanical telephone exchanges—retraining or early retirement.

In Brief

Electronics has done well in this year's defence estimates. Although the total equipment budget for the armed forces has been increased by only 3·8 percent the electroncis spend is up by nearly 10 percent. Five years ago electronics accounted for 28 percent of the total spend. Now it is 36·5 percent.

The USA is still Britain's top export market helped along by vigorous marketing. A recent breakthrough is BICC's 10 million dollar contract for the supply of optical fibre cable for the US trunk network. The fibre will come from the BICC/Corning factory at Deeside and the completed cable from BICC's plant at Blackley, Manchester.

Another breakthrough is the Cable & Wireless partnership with Tel-Optik of the USA for the first private fibre-optic link between the UK and USA.

Robotics Review

Nigel Clark

ONCE again we start with SCARAs as they are quickly becoming an option for people wishing to buy a small robot. Only a few months ago there were none on the market and now there are five.

Two months ago we had details of the Serpent, last month it was IVAX and the more powerful RTX. It is now the turn of **Reekie Technology** and **Feedback Instruments**.

John Reekie, who last year left **Colne Robotics**, the company he had created, to set up **Reekie Technology**, has chosen a SCARA to be one of the three products which are to be the first launched by the new company.

Cepek 1 has five axes plus an optional gripper, with the height being manually adjusted and other axes operating under computer control. It can lift 2kg and has repeatability of ±0·25mm. The drive is either all electric, steppers, or electric/pneumatic.

Vertical movement is limited to 250mm, with the shoulder and elbow being able to move through 200 degrees and 180 degrees. The gripper can rotate through a full 360 degrees and has 50mm of vertical movement. That gives it a working envelope with an arc of 200 degrees at a radius of between 100mm and 350mm.

The software for Cepek was developed by **TA Education**, of Sheffield. Reekie says that the arm will work with any micro but software has as yet only been developed for the BBC B, IBM PC, Apple IIe and Olivetti M24. Two programs are available, SCARA basic which comes with the Cepek package and SCARA Advanced which will cost an extra £130.

BASIC allows all the usual controls, such as keyboard instructions, edit, save and load plus three point variable ramping to allow various rates of acceleration and deceleration, continuous status display and a split screen display for all facilities and options. Additional features of the Advanced include point-to-point teaching, variation of speed of each axis and the creation of sub-routines. Costing about £3,000 the Cepek is aimed at the usual light industrial and education markets.

. . vision, speech and voice recognition . .

Reekie's other products include the Reekie Universal Robot featured in *Practical Electronics* in recent months and selling in kit form at £249. Education and hobbyists are seen as potential customers.

The company has plans for extending RUR's capabilities with a number of add-ons, which will include vision, speech and voice recognition.

A conventional arm has also been developed. Looking remarkably like the Armdroid of Reekie's previous company it has five axes and a gripper and uses stepper motors. However at £250 it is about half the cost of the Armdroid and is toothed belt driven, rather than cord.

Meanwhile back to the SCARAs, Feedback, the company which took over **Powertran**, has announced its own version with the snappy title of PW801. At a price of about £4,500 for the robot plus £1,500 for the workcell, it is again aimed at the education market.

It has four axes, the shoulder and elbow being powered by d.c. motors, controlled by shaft encoders, and the gripper rotation and vertical movement powered by stepper motors. The working envelope has an arc of 240 degrees with a radius of between 190mm and 380mm.

Software is available for the BBC B, Apple IIe and Apricot.

The machine has been designed to work in an educational workcell known as Pedro, which is said to stand for *peda*gogic *ro*botic workcell. The software however has been designed to cover specific curricula and the package includes a tutorial text and a manual of hardware and software exercises. The whole package will cost in the region of £6,000 putting it in the colleges of further education area.

. . possible to change grippers . .

Colne Robotics is developing a larger, more sophisticated version of its Armdroid 1. Already christened Armdroid II, it should cost about £3,000. Like its smaller brother, it is a jointed arm powered by stepper motors with additional control from optical encoders.

Unlike the earlier version however it has six axes plus a gripper, the extra axis being on the wrist giving it pitch, yaw and rotation and is chain and toothed belt-driven. Its lifting capability is 500 gms and has an accuracy of 2mm. It will be possible to change grippers.

With an onboard processor it is intended to provide a comprehensive control language allowing it to operate in joint-offset or cartesian programming modes and a networking facility. Launch is expected towards the end of this year.

Responding to the need for more software Colne has launched its version of Forth for the Armdroid 1. Known, unexpectedly, as Colneforth, it is said to be highly interactive, emphasising the communication needed between user and robot.

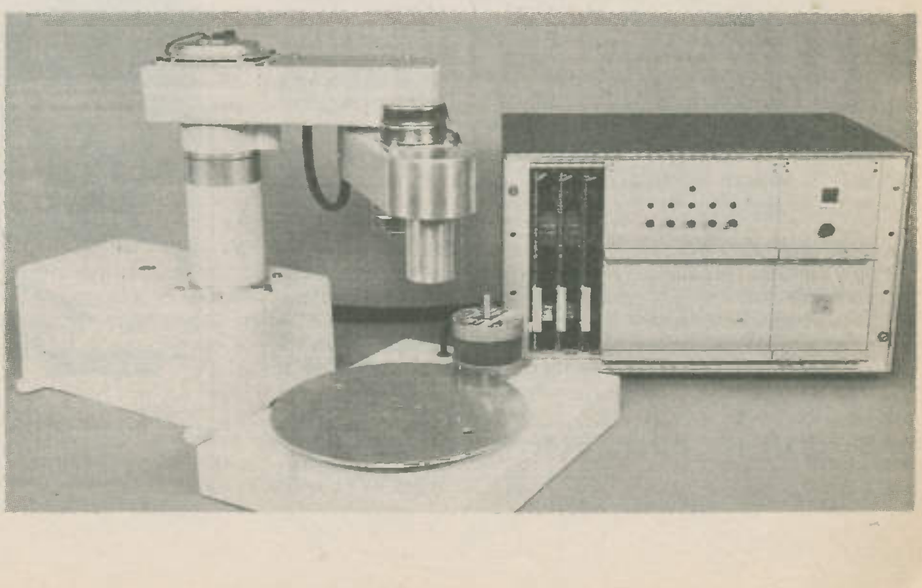
Using the language each joint can be given commands allowing each axis to achieve specific positions and with FORTH's structured approach, complex sequences can be built up in a form which is simple to edit, extend and save. At a cost of £75, Colneforth is available for the BBC B and Commodore 64.

. . a mobile base . .

At the less-expensive level, Alfred (published in *Everyday Electronics*—Nov. 84 to Jan. 85) from **Robot City Technology** of Milton Keynes is getting some extra facilities later this year. When introduced the makers said that Alfred had been designed in modular form so that it could be added to.

The first of these additions is expected in the autumn when a mobile base becomes available. Following that will be an onboard processor. At present it can be controlled from the BBC B or any micro with an 8 bit I/O port.

Feedback Instruments' PW801 SCARA robot and Pedro workcell



PLOTTER REVIEW...

D. WHITFIELD MA MSc CEng MIEE

DRAWING PICTURES should be a 'natural' application for the high resolution graphics facilities found on many of today's small computers. However, a standard computer keyboard is not exactly the most natural drawing instrument yet developed. Indeed, if the picture has to be built using a series of BASIC PRINT statements, the 'artist' either needs to be some form of software enthusiast, or (more likely) he loses interest very rapidly.

What is needed, therefore, is a more natural way of interacting with the computer to produce an image on the screen. After all, the computer is meant to be a tool that we use, rather than the other way round. It should adapt itself to the ways of the artist, rather than vice versa. This review looks at the Image Plotter, a product from Reekie Technology which allows you to produce pictures on the screen, but without having to use the keyboard as a 'pen'. First, however, a little background.

LIGHTPEN OR TABLET?

There are actually quite a number of different ways in which the natural hand-and-eye coordination inherent in freehand drawing can be supported by the computer. The best known of these is probably the lightpen, where the artist literally draws on the screen using a special pen linked to the computer. Using the CRT controller within the computer, linked to a light sensor in the pen, the artist's drawing movements are followed on the screen. This sounds easy, but it relies on being able to access the CRT controller in the computer, which is not always possible. Also, performance can vary significantly between different monitors, and even between different colours on the same monitor.

An alternative to the lightpen is the graphics tablet. With this the computer senses the position of the artist's pen on a drawing surface (the tablet), and then produces a corresponding display on the screen. In some situations this can be particularly convenient because it allows parts of existing drawings to be traced. Also, there are many different ways of sensing the position of the pen, depending on the accuracy required and the interface facilities on the computer. The Image Plotter is an example of this graphics tablet approach to computer drawing for the BBC Micro model B.

IMAGE PLOTTER

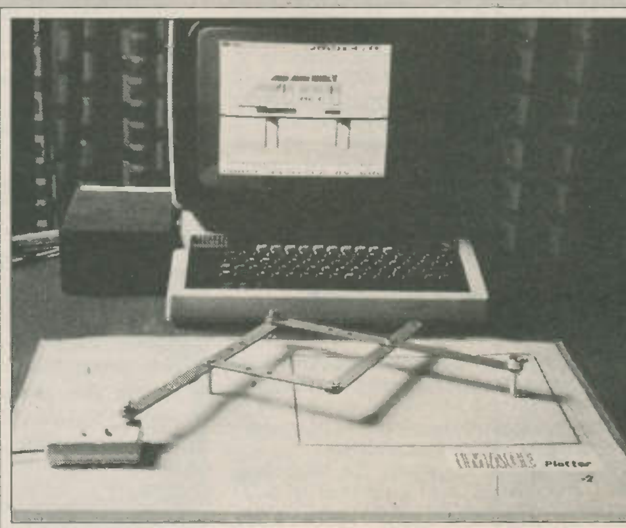
The Image Plotter system arrives complete with software (on tape or disc), a drawing arm, a calibrated overlay sheet, and a set of instructions. The overlay sheet forms the basis for the actual 'tablet', and measures approximately 420 × 630 mm. It is provided with self-adhesive strips to attach it to a smooth work surface or to a convenient backing board. On the overlay there is a squared grid approximately 320 × 250 mm, a number of calibration marks, and an area for attaching the drawing arm control unit.

The drawing arm is a pantograph arrangement which is attached to a small control unit at one end, and to the drawing stylus at the other end. On the control unit there are switches for mode control (toggle) and point plotting (pushbutton). The lead to the computer's analogue port also emerges from the control unit. After the overlay sheet has been fixed to a working surface or board, the control unit is attached to the sheet using a number of self-adhesive pads. One end of the pantograph arm is therefore fixed, and the computer uses potentiometers mounted on two of the pivots of the pantograph to follow the stylus position. The reach of the arm is approximately 600 mm and this allows it to cover the squared drawing area with ease. Overall this is a simple but very effective arrangement, and is best set up permanently on a piece of chipboard or similar material.

SOFTWARE

The hardware is only half the story when it comes to actually drawing pictures. The Image Plotter software provided with the system is really what makes it all so useful. The software is provided in three parts and a form which can be listed, and thus can be modified or extended for particular applications. The first part gives a load screen, and sets up various character definitions and machine code routines, before CHAINing in the second part to calibrate the plotter.

Calibration is a question of relating the potentiometer settings on the pantograph to the position of the drawing



"A more natural way of interacting with the computer to produce an image on the screen"

stylus. The problem is that the components used in individual plotters and BBC Micro's all vary, even if only slightly. In addition, the ADC performance varies as the computer warms up. However, this can all be corrected in software by measuring the voltages from the arm's potentiometers when the stylus is in a known position. The eight calibration marks on the overlay sheet are used for this purpose. The software offers the choice of using the preset calibration values, a previously saved set of values, or of re-calibrating the plotter. The latter involves moving the stylus to each calibration mark in turn, as indicated on the screen, and pressing the plot button at each point. This process is quick and easy, and when complete you have the opportunity of saving the new values for next time. When satisfied with the calibration, the final part of the software is CHAINed.

From now on all interaction with the system (except when entering text for labels on drawings) is via the drawing arm. The initial screen is essentially blank, with a row of sixteen boxes across the top, and a cross-hair cursor to indicate the current stylus position. The blank section is the drawing area, and the boxes at the top represent a menu. Selecting an option from the menu is a simple matter of moving the cursor into a box and pressing the plot button. It is a shame that the box positions are not marked on the overlay, but nevertheless the procedure is still very convenient. There are actually more options available than can be shown on one menu, and consequently switching between the menus is an option offered on each menu. Rather confusingly, the four menus are called 'modes' in the manual, but they are not related in any way to the micro's screen modes, and I rather prefer to think of them as simple 'menus'.

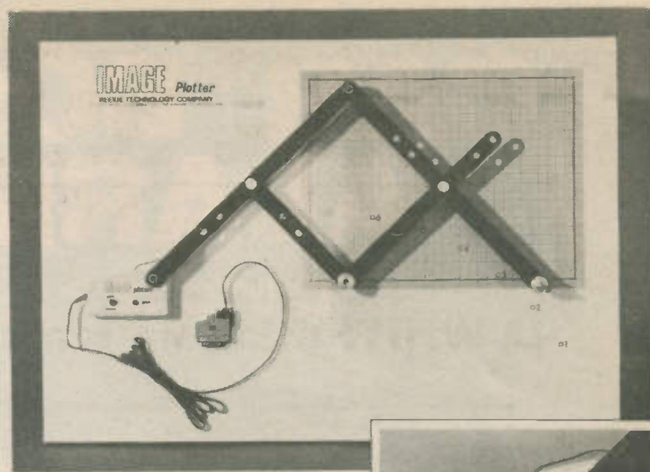
DRAWINGS

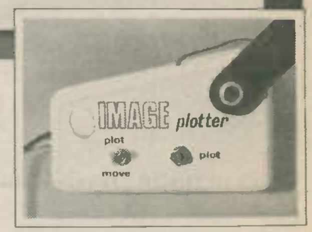
It is worth saying at the outset that it takes less than half an hour to become proficient with the Image Plotter, which gives some idea of its ease of use. At the start you are presented with a blank drawing sheet, which has a cursor and menu boxes as its only features, so how do you go about drawing on it?

The first thing to try is the way in which the cursor follows the drawing arm. With the mode switch in the 'move' position, the cursor moves with the arm. When you are happy with the way that the cursor behaves, the next thing to try is selecting an option from the menus. There are two main types of menu options: palette functions (which determine colour), and brush functions (which set the style or shape of the graphics). Selecting a menu option is simply a matter of moving the cursor to the appropriate box and pressing the plot button. The boxes are identified by numbers 1 to 16 (left to right) in the manual.

On menu 1, as on all four menus, box 14 moves the user on to the next menu, and box 15 displays the current menu number. Box 16 always shows the currently selected brush and the colour that the graphics will be drawn (initially black). Changing the drawing colour is easy, and uses boxes 1 to 8 on menu 1; move the cursor into the box of the chosen colour, and press the plot button. The single dot brush set up at the start allows you to draw like a pen on paper. To draw dots, simply move the cursor to the desired position and press the plot button. For drawing lines, change the mode switch from 'move' to 'plot', and now the line will follow the cursor. Switching back to 'move' is the equivalent to taking the pen off the paper.

Box 9 of menu 1 allows flashing colours to be selected instead of steady colours. The start-up freehand brush is box 10, and box 11 gives a straight line brush. This uses a 'rubber banding' technique which is really very effective, and is nice





A piece of chipboard makes an ideal backing board (Top). Control unit close-up (Right)

to use. The plot button is pressed when the cursor is at one end of the line. From now on, a line is drawn from this point to wherever the cursor is currently positioned. When you are happy with the line position, simply press the plot button to fix the line in place. The cursor is now free for drawing another line, or for selecting another menu option. Box 12 allows text to be typed in and then moved around the screen at will; the same text may be printed as often as required, and in any colour. The final option in menu 1 is to clear the whole drawing sheet; very wisely this has a double check facility!

The second menu provides a number of other shapes, which make great use of the rubber banding technique just described. The dotted line option works as for solid lines. Solid triangles, outline triangles, and dotted triangles are drawn by plotting three points. Rectangles are produced by plotting the two opposite corners, while circles are defined by their diameters. Two 'air brushes' are provided to add shading and subtlety, while box 13 allows an enclosed area to be filled with a colour.

The third menu allows you to change the palette make up, and change the plotting logic. This is designed to mirror the options of the PLOT command in BBC BASIC. The fourth menu allows the flash rates of the flashing colours to be varied, and pictures to be loaded or saved on the filing system. Once saved, a suitable screen dump can be used to output the image to a printer.

CONCLUSION

The Image Plotter is certainly easy to use, and can be recommended for all types of user. After about half an hour, you can safely put the manual away and concentrate on drawing. The performance is good, with no obvious feeling of having to wait for the computer while drawing. To see the results at their best really requires a colour monitor, such are the capabilities of the system. If you want a system which is simple but effective, and allows you to get the very best out of the BBC Micro's graphics facilities, then you should give careful consideration to the Image Plotter.

The Image Plotter is available in two forms, either as a kit at £37.95 or ready built from £44.45 (prices include VAT and p&p). From: Reekie Technology Company, Beaufort Road, Twickenham, TW1 2PQ (01-892 2877). (State tape or disc for software).

CAR BOOT ALARM

D. STONE

WHEN ASKED to design an alarm to operate in case of attempted theft from a car-boot, the first idea that occurred was to make use of the inbuilt courtesy light wiring. However, since the model of car—like many others—did not have a boot-light fitted as standard, some more thought was needed.

After a little experimentation with different triggering methods, it was decided to use a light-activated device. This operates on the elementary principle that when the boot is opened light is allowed in, and that when the boot is shut, it is dark. The circuit also had to be sensitive enough to trigger at night by street-light illumination.

CIRCUIT DESCRIPTION

The inverting input of IC1—a standard 741 operational amplifier—is held at half the supply voltage by the potential divider formed by R2 and R3; see Fig. 1. IC1 is wired as a comparator with its non-inverting input connected to the photo-Darlington pair TR1 and TR2, and resistor R1.

When light falls on TR1, the transistor passes a small current. This is amplified by TR2 and converted to a voltage drop by R1. As the voltage rises above the threshold voltage, governed by the potential divider, the output of the comparator changes state, and goes high. This output is scaled suitably by R4 and R5. This voltage level is now in turn converted to a base current by R6 to drive output transistor TR3. This transistor then drives either the horn, via relay RLA, or the indication l.e.d. D2.

In the "On" position, the relay will latch, as RLA1 shorts TR3; and even if the boot is immediately closed again, cutting off light from TR1, the horn will continue to sound until either S1 or S2 is switched. In the "Standby" position, the l.e.d. will simply indicate whether the boot is open or closed.

CONSTRUCTION

The circuit can be built using the p.c.b. layout, as shown in Fig. 2, or alternatively, by making use of matrix stripboard. As usual, the circuit should be built following the convention of resistors and capacitors first, followed by the semiconductors.

The majority of the prototype circuit was mounted in the car boot, with the relay being situated near the horn under the bonnet. The l.e.d. indicator, D2, was mounted on the dashboard—see the layout suggested in Fig. 3.

This layout, as it stands, is suitable for use with all vehicles which have a *negative earth* supply. If this is so, the boxed part of the circuit may be grounded by taking a flying lead from the "0V" point on the p.c.b., and bolting this lead to bare metal on the vehicle bodywork.

If the car has positive earth wiring, the circuit can still be used, but obviously great care is necessary to ensure that the whole of the circuitry is electrically isolated from the chassis. The simplest approach would be to mount the p.c.b. in a plastic box, and to run separate leads from the battery to provide the +12V and 0V supplies. If this is done, *it is essential* that some other warning

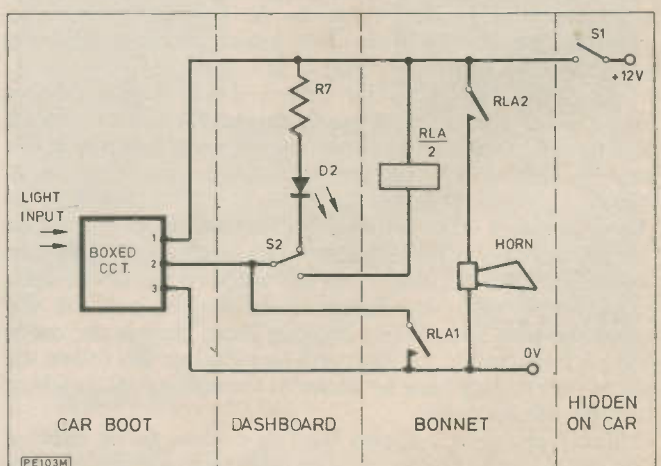


Fig. 3. Suggested layout for the system, showing the physical location for the elements of the circuit

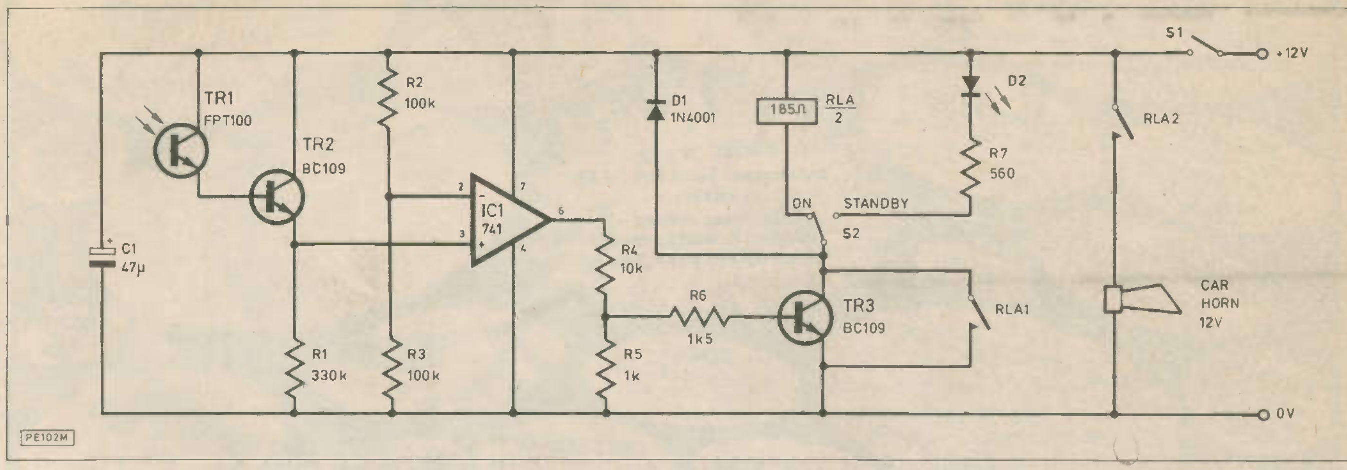


Fig. 1. Complete circuit diagram for the Car Boot Alarm

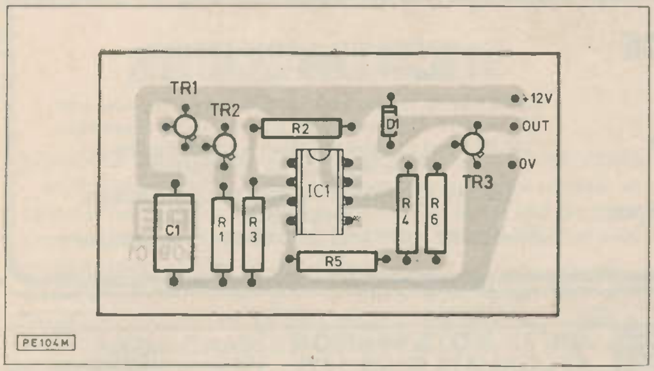


Fig. 2. Component layout on the printed circuit board, for the boxed part of the unit. The p.c.b. is available from the *PE PCB Service,* as shown in the components list

COMPONENTS . . .

Resistors

R1	330k
R2, R3	100k (2 off)
R4	10k
R5	1k
R6	1k5
R7	560
All ¼ Watt ±5%	

Capacitor

C1	47µ electrolytic

Semiconductors

D1	1N4001
D2	green l.e.d.
TR1	FPT100 phototransistor
TR2, TR3	BC109 (2 off)
IC1	741 op-amp

Miscellaneous

RLA	Double-pole relay, coil resistance 185 ohms
S1	Single-pole switch
S2	Single-pole changeover switch

Suitable case for boxed part of the circuit; l.e.d. clip; interconnecting wiring; printed circuit board, available from the *PE PCB Service,* order code 509-01.

device than the car horn be used—car accessory shops sell suitable units—and that all wiring and component mounting is electrically isolated from the car chassis.

To activate the alarm, S2 is switched to "Standby", and S1 is switched on. The l.e.d. should not be lit: if it is, then there is some light falling on the sensor. When the l.e.d. is out, S2 can be switched to "On", and the alarm is armed.

It is possible to wire the circuit without S1, and have the alarm switched between "Standby" and "On". The sensitivity of the detector is governed by R1: increasing the value of R1 will make the alarm more sensitive.

Initial setting-up will require "tweaking" the value of R1, and the constructor may find it useful at first to wire a 470k potentiometer into the position that R1 will ultimately go.

TESTING

Ensuring that the circuit works properly is obviously best done under real conditions. However, the repeated sounding of the car horn, as the project is tested, is likely to annoy the neighbours, and possibly invite a visit from the police.

The most sensible approach is to substitute a suitable buzzer, or a 12V lamp for the car horn (refer again to Fig. 1), and make adjustments in the workshop. Daylight falling on the phototransistor TR1 should activate the buzzer, and the value of R1 (assuming a potentiometer is used) should be altered until the buzzer always sounds in "normal" conditions of daylight. This (minimum) value of R1 should be measured, using an ohmmeter across the potentiometer removed from the circuit.

This process should now be repeated under subdued artificial lighting, and the new (maximum) value for R1 noted.

From these two readings, it ought to be possible to choose a standard-value resistor which will effectively be a compromise: 330k is suggested, as this worked well in the prototype. The chosen value resistor should be soldered in position, and the finished circuit will then be ready for installation.

IN USE

Once the system is in position, final testing can take place. With S1 closed and S2 in the "Standby" position, the alarm circuit should be checked for proper operation under day- and night-time conditions.

If the alarm is inconsistent, then either R1 or TR1 are likely to be the culprits—assuming that there are no wiring or component errors. However, when the system is in place and working correctly, the alarm should give satisfactory results over a long period. ★

BRIAN BUTLER

PERHAPS this is the time of year when we are most concerned with home security. As the holiday season gets into top gear so does the nation's expanding band of house-breakers, and lazing in the seaside sun is a total waste of time if you are preoccupied with the vulnerability of your distant home.

As we are so often being reminded these days, burglary is on the increase and the chances of your home being illegally entered is therefore greater, it is estimated that a home is burgled in the UK every 60 seconds.

Of the £180 million worth of burglariously seized goods in 1983, only £7 million worth was ever recovered; on the other hand in 75 per cent of break-ins the value of the haul does not exceed £500.

How then can we best protect our property from unauthorised entry? Perhaps the installation of an intruder alarm would put the mind at rest.

PROTECTION REQUIREMENTS

The degree of protection required is probably the first and most fundamental consideration. For instance CCTV (Closed Circuit Television) is hardly necessary if all you want to protect is your prize petunias—a make/break contact in the conservatory door-frame is more suitable here. In the sections that follow, the main points to be considered when fitting an alarm system will be explained. It should then be a simple matter of fitting the most suitable system for your own requirements. At this point it may prove prudent to contact your local CPO (Crime Prevention Officer) who will point out to you where security improvements can be made in your home. The advice is free and the survey is free. The recommendations may well amount to nothing more than window locks, better door locks and security bolts etc. For the purpose of this guide however we will assume that an alarm system is required. Incidentally, each Police force has its own 'Intruder Alarms Policy' giving their guide lines and requirements for the installation and maintenance of systems.

Essentially a complete alarm system will consist of three main elements—a detection device or devices, a control unit and some method by which the alarm is raised; this will usually take the form of an exterior bell box/flashing light or both. Automatic telephone dialling systems can also be incorporated, which will auto-dial the police using a tape-loop technique.

DETECTION APPARATUS

In this section the majority of currently available detection devices are listed. The basic function of the item will be explained with its main characteristics. If it is intended, after due consideration, that the system is to be assembled with parts from different sources, then it must be borne in mind that the characteristics of the detection devices must match the capability of the control unit. The main thing to look out for here is that normally open and normally closed hardware are properly matched.

Make-break contacts

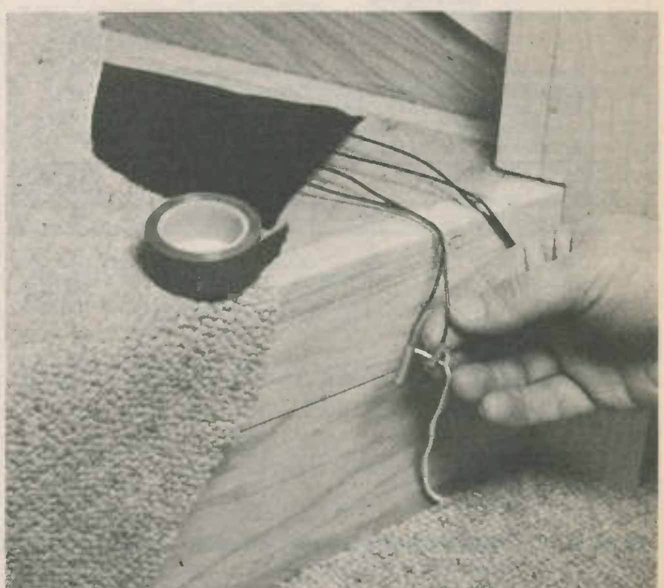
These are used to protect windows and doors and are in the main magnetic devices more commonly referred to as reed switches. They consist of two parts—a pair of contacts and a magnet. They are fitted on opposite sides of the door or window frame to be protected, so that the magnet will hold the contacts in a normally closed state. If the window or door is then opened the circuit is broken and the alarm raised. A hidden reed switch is more effective than a surface mounting type—if a thief can see it he can feasibly beat it. The suitability of such methods should be considered if metal frames are to be protected. Microswitches could be employed as an option in these areas.

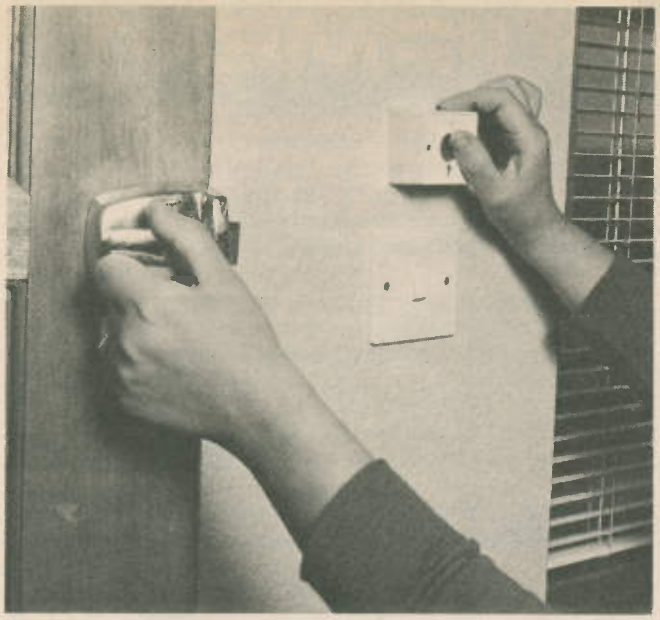
Anti-tamper switches

As the name suggests these are simply microswitches strategically placed within the housings of the separate elements of the system; for instance in the exterior bell box or main control box etc. Any attempt to open by force such a protected enclosure will operate the spring-loaded switch. Further anti-tamper protection is often simply incorporated in connector blocks where the fixing screw in the housing holds two contacts in a normally closed condition, if the screw is removed the alarm is raised.

Pressure pads

These may be used in areas where it is expected that an intruder is most likely to tread. This is often in a busy area at the foot of the stairs for instance (see photo) or in a hallway or landing. Unfortunately, when placed in such areas these mats are also subjected to great wear by the householder and may therefore wear out rather quickly and be prone to false alarms, they also tend to 'creep'. Strategic placement of this 'sensor' is a thoughtful business. Its construction however is much simpler, a wafer technique is employed where an insulating layer separates the two normally open contact layers which make contact when pressure is applied to the surface.





Panic buttons

A simple normally open or normally closed switch on a 24hr circuit. This circuit should be armed even when the rest of the system is off.

The fixture is usually fitted near the main entrance door (see photo) and/or, in many cases, in the master bedroom. It is quite simply depressed if the protectee is under imminent threat; the alarm will sound and the switch can only be reset with the use of a key.

Seismic detection

This device consists of a pair of contacts in a small enclosure, the contacts are kept in a normally closed state by a ball bearing which permanently rests across them. It would normally be fixed to a window pane so that when the glass is broken the ball bearing will move and the contact will be broken, sounding the alarm. Only a momentary break in the circuit need be detected as the control circuitry will latch into the alarm mode. These devices can be the cause of false alarms, if for instance a large shop window receives a 'Saturday night bump' this may be enough to trigger the device.

Window foil

A self-adhesive conductive, metallic strip which is simply stuck across the glass to be 'monitored', it forms as such, a closed circuit which is broken when the glass is broken.

Infra-red beam

There are several methods by which an intruder may be detected as he moves across a room. Perhaps the most straightforward of these is the infra-red beam which is transmitted across say a doorway or window to a photosensitive receiver unit. Because the beam is invisible to the human eye it is easy for an intruder to unwittingly step through it. When this happens the receiver senses the break in transmission and the alarm is raised. Careful consideration should be given to the placement of the transmitter and receiver. An experienced thief may spot them and just by-pass the beam.

VOLUMETRIC PROTECTION

Several methods have been devised to detect the presence of an intruder in a given area either indoors or outdoors. They can be used as part of a system or as 'stand alone' sentinels with on-board high-output sirens. These can be mains operated with or without battery back-up. Their effective ranges may vary considerably. Most of these units have a walk-test facility which uses an l.e.d. to display the sensitivity of the unit before the system is armed.

Passive infra-red

This method employs a heat sensor which peaks when human body heat is detected. A multi-faceted mirror directs the radiated heat information toward a focal point detector, each facet receiving information from a segment of the protected area. It is the movement of an intruder between these segments that gives the necessary modulation of radiated body heat required to trigger the alarm. These detectors are most sensitive to bodies which move across their field of 'vision'. According to my local CPO passive infra-red detectors are the least likely (of the volumetric detectors) to produce false alarms.

Ultrasonic

High frequency sound waves (in the 20–50kHz region) are transmitted and received by this device which will produce a balloon shaped area of protection emanating from the unit. If an object moves within this field a frequency shift occurs (due to the Doppler effect) to the waves which are reflected from the moving object. When this occurs the unit effectively receives two different frequencies which are combined to produce a beat note which is then amplified and used to operate the alarm. Most effective with objects moving in front of or towards the unit.

Radar/microwave

The radar system has essentially the same operating principles as ultrasonic but uses radio transmissions in the 10GHz region rather than sound waves. This enables the system to 'see' more as the radio waves penetrate more deeply into the environment, enabling for instance the detection of a moving object behind a piece of furniture or non-metallic structure.

Closed Circuit Television (CCTV)

CCTV equipment has now come down in price sufficiently to be of interest to the DIY home market. Several basic set-ups are available which include a camera with mounting bracket, a connecting lead and a monitor. Obvious applications would be hidden doorways and entrances etc.

CONTROL

The detection devices are connected to the control system by hidden wiring in most cases. The control box should be situated in a part of the property that is well protected once the system has been armed.

So that the user will not trigger the system an entry/exit delay is usually incorporated in the control box which allows a reasonable time for entry to and exit from the property before the system 'arms' itself; this is usually adjustable and between 30 seconds and three minutes.

The flexibility of the control mainly depends on the price of the system and many options are available. In some cases for instance the control will allow for the protected area to be split into more than one zone so that at night, for example, when the house is occupied and everyone is upstairs—then just the ground floor can be armed. This allows householders to move about upstairs at will during the night. Alternatively the whole house can then be armed when the house is empty. If personal attack buttons are incorporated in the system, it is generally arranged for these to be on a separate circuit which is armed 24 hours a day. If the house is occupied during the day then all but the panic buttons can be disarmed.

Most control panels allow for a test procedure to be carried out ensuring that the system is in good order. Controls are generally mains supplied with or without battery back-up.

RAISING THE ALARM

Once the system has been triggered various options are available as to how to raise the alarm. The most obvious and by far the most common is of course a simple audible warning device, usually the

exterior wall mounted siren or bell box. A bright flashing light is another option and sometimes the two are used together.

If tamper switches and back-up batteries are fitted to these bell boxes then they can be self actuating—if the wire to them is cut or the housing forced then the bell will sound. Internal warning bells are another option, they are usually fitted as well as an external bell. Basically an audible and/or visual alarm is intended to alert the neighbours and also to 'frighten off' the intruder.

Empty or 'dummy' boxes are sometimes fitted instead of or as well as the real thing, these can arguably deter as many prospective thieves as a real system.

If, for instance, an audible or visual alarm is not suitable—in a remote or quiet area, then a remote signalling system may be employed. In this case an automatic outgoing call device is used with a recorded message. Any number can be automatically dialled (usually 999) when an intruder is detected. Often an audible warning will be incorporated here which is set to sound after a specified delay. So that an intruder will not know he has been 'rumbled' until PC Plod is waiting outside. In some cases 'dedicated' outgoing telephone lines are used. Alternatively the existing line can be employed. Modules exist that will sound the alarm if the line is cut or blocked, the siren will sound instantly overriding the delay timer.

USEFUL ALTERNATIVES

Less elaborate techniques may be employed to deter the potential intruder and one or more of the following suggestions may be incorporated instead of, or as well as, those previously mentioned.

The use of plug-in time switches is gaining popularity for simply switching on and off (at pre-set times) such things as radios, TV's and bedside lamps etc. These timers have varying capabilities and full switching cycles range from 24 hours to 7 days. Your local electrical wholesaler should give you further information.

Another popular item is the photo-sensitive wall switch which can directly replace an existing wall switch. A photo-sensitive detector within the unit will switch on the room light when a low light threshold is detected—at dusk. Some units will switch off the lights after a preset period, whereas others will do so at dawn. Several types are available with varying capabilities—once again your local electrical wholesaler will help here. Plug-in timers and photo-sensitive replacement switches generally retail for under £20.

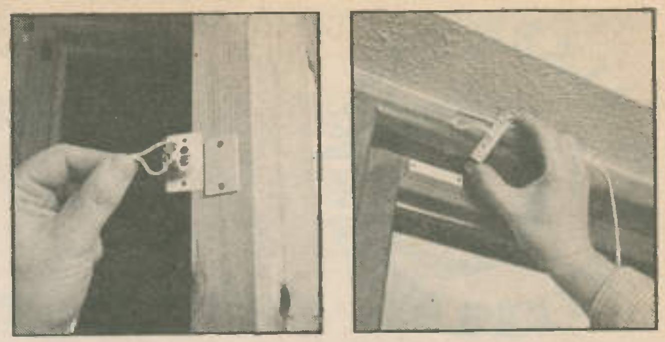
It is now well established that high on a burglar's list of 'don't likes' is a well lit property. The use of outside lights with proximity switches should therefore be considered; these can easily be incorporated into a system.

YOUR OWN HOME GUARD

The 'Neighbourhood Watch' scheme is gaining popularity and seems to give positive benefits. The principle is very simple—a group of householders get together to look after each others interests, peeling the proverbial eye. They basically adopt a more old-fashioned inter-protective community spirit and to a certain extent police their own environment. Your Crime Prevention Officer will help in establishing such groups with advice and film shows etc. In areas where the Neighbourhood Watch scheme has already been adopted a marked decrease in the incidence of vandalism, burglary and theft has been noted.

FALSE ALARMS

It is almost certain that anyone who has an alarm system will have had a false alarm and some systems are more vulnerable to this annoyance than others. More often than not it is operator error that causes the problems. A door or window which is not properly closed. Entering a protected area having forgotten to switch off the system. Pets, draughts blowing curtains etc. can trigger volumetric detectors, oversensitivity is a further problem; all these factors contribute to false alarms. Perhaps, as with all things, simplicity is the key.



Typical applications of door and window contacts

In the vast majority of cases when the police are (automatically or otherwise) called to attend a potential intrusion it is attributed to a false alarm. Besides the obvious disadvantages of a system that persistently makes 'mistakes' we must consider the social effects.

The neighbours and/or keyholders, for instance, may decide that enough is enough, and so for that matter might the police. The local Environment Health officer may also employ the Control of Pollution Act 1974 in order to minimise a persistently noisy disturbance to the public. It is usual for systems, however, to switch off and reset automatically after a set time.

The names and addresses of keyholders should be given to the local Crime Prevention Officer. Regular maintenance of your system should also reduce the risk of problems. If secondary or back-up batteries are part of your system they should be checked regularly as is the case with professionally maintained systems.

GOVERNING BODIES

As with all installations, a degree of consumer protection with regard to standards of workmanship etc. is all important. Two main bodies look after our interests here. The National Supervisory Council for Intruder Alarms (NSCIA) who were founded in 1977 are an organisation who list installers that have been 'vetted' according to a demanding list of requirements.

On the other hand the British Security Industry Association (BSIA) cover the security industry more widely and include manufacturers in their listings as well as installers. Both the NSCIA and the BSIA are concerned with maintaining good standards throughout the professional security market. They liaise with the police, the Home Office and insurance companies etc., and both use the British Standards 4737 as their standard technical reference.

The BS 4737 is playing an increasingly important role in the industry, it covers just about every aspect of an alarm system, from maintenance and records to in-depth specifications on detection devices, warning devices and control circuit requirements. The BS 4737 can be consulted at most central libraries.

Although the DIY market is not strictly catered for by the above-mentioned organisations, the fact that they exist has influenced the manufacturing standards of much of the security market and therefore the incidence of goods manufactured to BS 4737 has been greatly increased.

ACKNOWLEDGEMENTS

Thanks to Jeff Brown, Crime Prevention Officer, Dorset Police H.Q., Winfrith.

Thanks to Alan Matley, Security Consultant, Secure Alarms, (Poole).

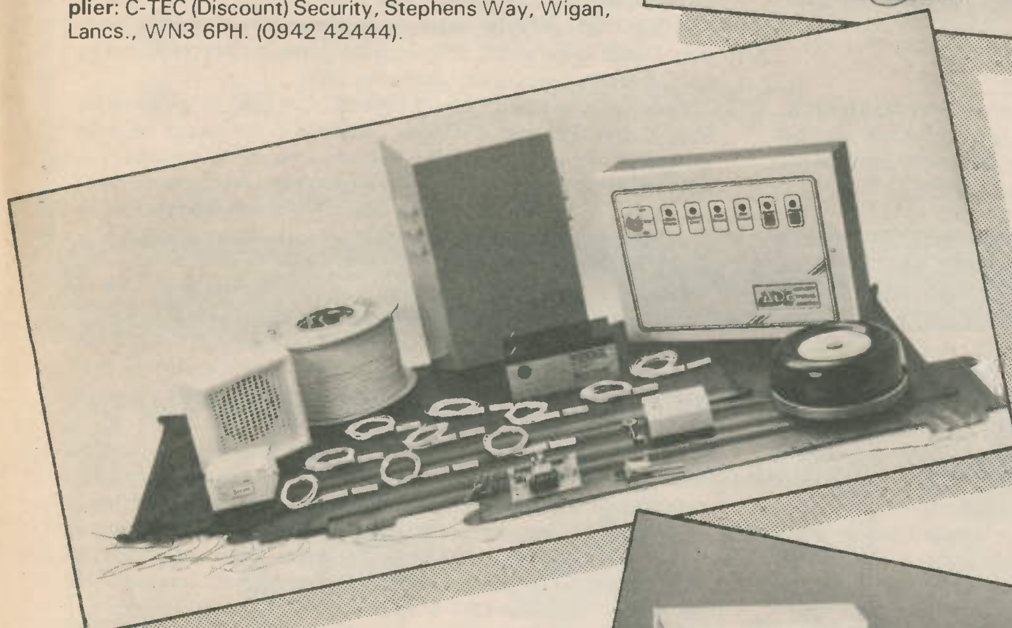
ADDRESSES

NSCIA, St. Ives House, St. Ives Road, Maidenhead, Berks., SL6 1RD; (0628 37512).

BSIA, 68 James' Street, London, SW1A 1PH; (01-493 6634).

British Standards Institute, Linford Wood, Milton Keynes, MK14 6LE; (0908 320066).

C-TEC K641/Kit comprises: 3 Pressure pads (one small); 6 pairs flush fitting magnetic contacts; 1 Panic button; 1 Bell; 1 Bell box (steel) (red, white or yellow); 1 Anti-tamper Microswitch; 1 Auto cut-off/reset control panel; 1 Rechargeable battery; 50 Metres 4-core cable; 100 Clips; Instructions. **Price:**: £87·70. **Features:** Single zone; conforms to BS4737 and is expandable; Mains operation. **NB:** This company supplies a wide range of security equipment and kits (catalogue available). **Supplier:** C-TEC (Discount) Security, Stephens Way, Wigan, Lancs., WN3 6PH. (0942 42444).

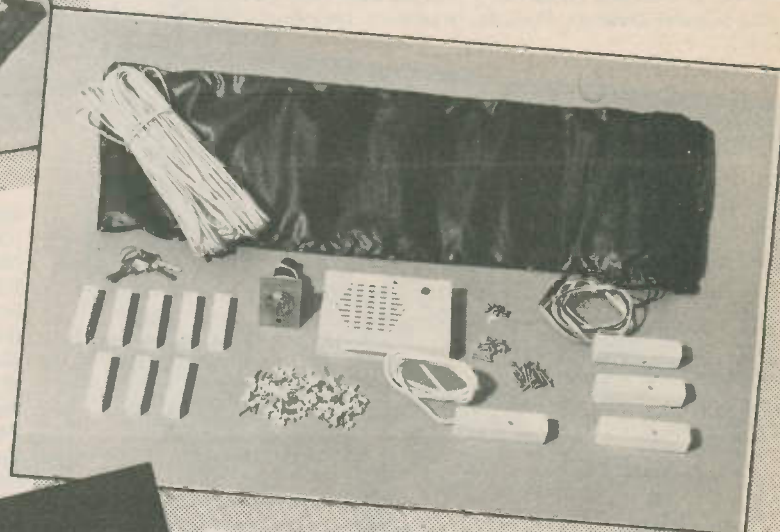


ASP-515/Kit comprises: 5 Pressure pads (one small); 10 Pairs flush fitting magnetic contacts; 1 Panic button; 1 Bell; 1 Bell box (steel); 1 Bell reset module; 1 Siren; 1 Anti-tamper microswitch; 1 Auto-cut-off/reset control panel; 1 Rechargeable battery; 100 Metres 4-core cable; 100 Clips; Fixings; Instructions. **Price:** £136·86. **Features:** 3 Zones (1 main, 2 switchable), conforms to BS4737; mains operation. **NB:** This company supplies a wide range of security equipment and kits (catalogue available). **Supplier:** Advanced Security Products, Ealing Road, Aintree, Liverpool, L9 OHV. (051-523 8440).

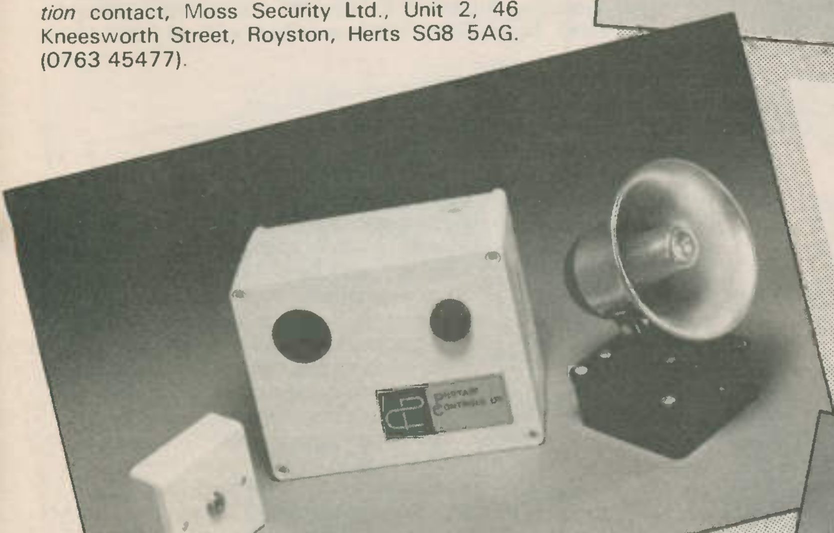
SECURE ALARMS DIY-1/Kit comprises: 6 Pairs magnetic contacts (5 flush fitting, 1 surface mounting); 1 Panic button; 1 Siren; 1 Bell box (polycarbonate); 1 Self-actuating module (bell box); 1 Anti-tamper microswitch; 1 Passive infra-red motion detector; 1 Auto cut-off/reset control panel; 1 Rechargeable battery; 100 Metres 4-core cable; 200 Clips; 1 Mains unswitched spur; Instructions. **Price:** £235·00. **Features:** 2 Zones (switchable), conforms to BS4737 and is expandable; mains operation. **NB:** This system can be tailored to customer specification upon request. **Supplier:** Secure Alarms, 96 Bournemouth Road, Parkstone, Poole, Dorset, BH14 9HY. (0202 737025).

The information in this guide gives a simple insight into, and a price/content comparison of, currently available DIY security equipment and kits. Further information can be gleaned from the addresses given.

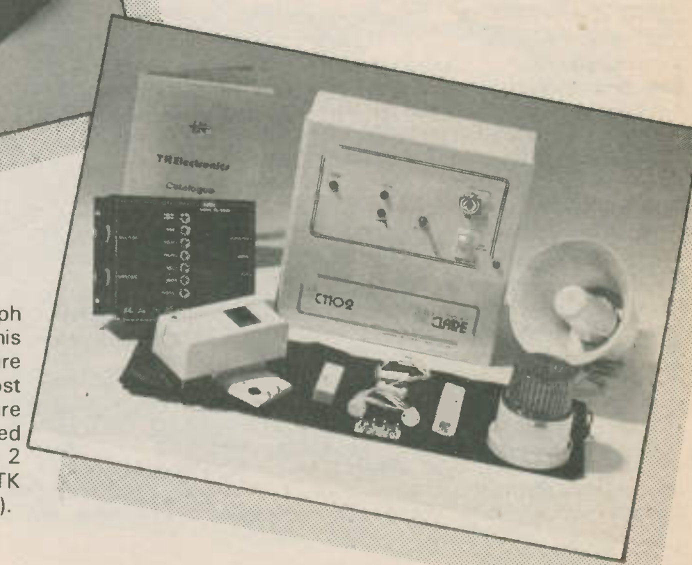
COLOROLL HOUSEWATCH 2000/Kit comprises: 1 Pressure pad, 6 Pairs magnetic contacts (5 flush fitting, 1 surface mounting); 1 Panic button; 1 External box plus siren; 1 Auto cut-off/reset control panel; 50 Metres 2-core cable; 15 Metres 4-core cable; Plug-in mains adaptor; **Fixings;** Instructions. **Price:** £150.00 **Features:** 2 Zones (switchable), expandable (infra-red module £55 extra); mains operation. **Supplier:** Munford & White Ltd., Hither Green, Clevedon, Avon, BS21 6XU. (0272 870078).



MS-200/Kit comprises: 1 Pressure pad; 4 Pairs magnetic contacts (surface mounting); 3 Tamper-proof junction boxes; 1 Control unit with sounder; 1 Key switch; 25 Metres 2-core cable; Clips; Fixings; Instructions. **Price:** Around £64.00. **NB:** This kit is designed to give simple protection for up to five door/window points. Add-on kits available; battery operation. **Supplier:** *Information* contact, Moss Security Ltd., Unit 2, 46 Kneesworth Street, Royston, Herts SG8 5AG. (0763 45477).

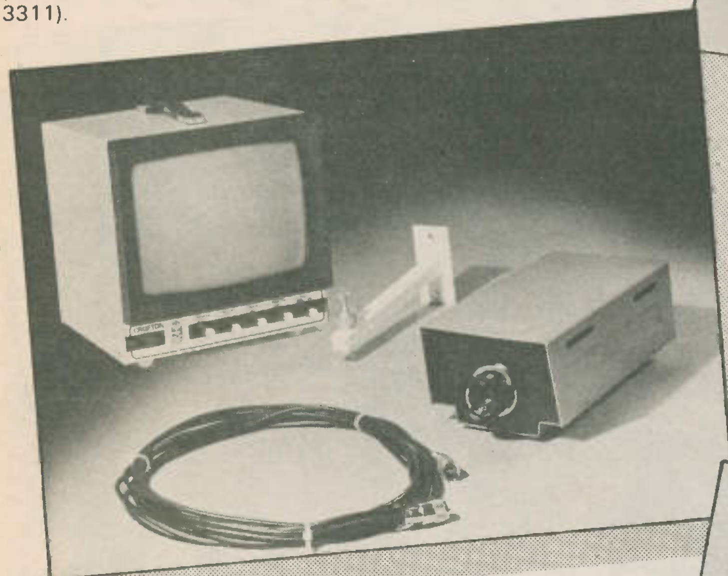


PIRSC/Kit comprises: 1 Key switch unit; 1 Infra-red/control unit; 1 Rechargeable battery; 1 Remote siren. **Price:** £148·35. **Features:** Both the key switch and the remote siren can be situated up to 500 metres distant from the main unit. The system is expandable. **NB:** A range of optional extras is available; mains operation. **Supplier:** Photain Controls Ltd., Unit 18, Ford Aerodrome, Arundel, West Sussex, BN18 0BE. (0903 721531).



TK ELECTRONICS: The items featured in this photograph represent a typical selection from the TK catalogue. Although this company do not stock complete kits, a wide range of elements are available enabling the assembly of systems suitable for most requirements. **Prices:** Typical prices for pictured item—Pressure mat £2.99; 6 Magnetic contacts (flush fitting) £7.24; Infra-red sensor £51.75; Siren £7.76; Xenon beacon £12.07; BS4737 2 zone control panel £57.21. **NB:** Catalogue available. **Supplier:** TK Electronics, 11 Boston Road, London, W7 35J. (01-579 9794).

THIEFCHECK (HOOVER)/Kit comprises: 2 Pressure pads; 6 Pairs magnetic contacts (flush fitting); 1 Panic button; 1 External siren (in steel box); 1 Auto cut-off/reset control panel; 4-Core cable; Clips; Fixings; Instructions. **Price:** £166.89. **Features:** Passive infra-red accessories available; battery operation. **NB:** Batteries and 2-core cable not included. **Supplier:** Hoover PLC (Home Security Division), Perivale, Greenford, Middlesex. (01-997 3311).



CCTV KIT-1/Kit comprises: PM 101 nine-inch monitor; 1 (reconditioned) Ikegami one-inch vidicon camera; 1 20 Metre connecting lead; 1 Mounting bracket. **Price:** £193·20. **NB:** A multi-function door entry module is available as an accessory for this system. Basically as a timer/power supply it will allow interaction between camera and bell push or porch light etc., and facilitate a wide range of other functions such as two-way speech control etc. Can be tailored to customer requirements (mains operation). **Price:** £103·45. **NB:** Other CCTV equipment and catalogue available. **Supplier:** Crofton Electronics, 35 Grosvenor Road, Twickenham, Middlesex, TW1 4AD. (01-891 1923).

C-TEC K665/Kit comprises: 6 Pressure mats (4 large, 2 small); 10 Pairs magnetic contacts (flush fitting); 2 Panic buttons; 1 Bell; 1 Steel bell box (white, red or yellow); 1 Self-activation module; 1 Auto cut-off/reset control panel; 1 Rechargeable battery; 100 Metres 4-core cable; 100 Clips; Instructions. **Price:** £133·70. **Features:** 2 Zone system. **NB:** This company supplies a wide range of security equipment and kits (catalogue available); mains operation. **Supplier:** C-TEC (Discount) Security, Stephens Way, Wigan, Lancs, WN3 6PH. (0942 42444).

DRA-100/Kit comprises: 4 Transmitter units; 1 Siren; 1 Control unit; Complete instructions. **Price:** £159.85. **Features:** This is a Doppler shift radar alarm that will detect an intruder moving within the radius of operation of a transmitter, (from zero to around six metres). **NB:** This system requires complete assembly from component level. Its construction should only be considered by those with a fair knowledge of p.c.b. and electro-mechanical assembly. Mains operation. **Supplier:** Powertran Cybernetics Ltd., Portway Industrial Estate, Andover, Hants., SP10 3NN. (0264 64455).

PI-FLY: (left) This item is a small portable battery alarm, it is controlled with a key switch and detects movement. Once in position (in a filing cabinet drawer, or a briefcase for instance) it will trigger when moved, emitting a 98dB signal. Can be used on doors and windows.

Pi-SPIDER (right) A similar battery operated device to the 'Fly' that will protect up to five items of value with its four tamper-proof 'tentacles' (the mains unit being the fifth sensor). Each 'tentacle' is 1·5 metres in length and is simply attached to a group of valuables such as TV's, videos, computers etc. **Prices:** Fly £24·95. Spider £34.95 **Supplier:** Product Innovation Ltd., 7 Berners Mews, London W1P 3DG. (01-580 7636).

PROPERTY PROTECTOR/Kit comprises: 2 Large Pressure pads; 6 Pairs magnetic contacts (surface mounting, with cable); 2 Tamper-proof junction boxes; 1 Passive infra-red motion detector; 1 Bell box (steel) with bell, auto cut-off/reset unit and rechargeable battery; 1 Control panel with rechargeable battery; Clips; Instructions. **Price:** £287·50. **Features:** 2 Zone (switchable) control. Expandable system, conforms to BS4737; mains operation. **Supplier:** Webalarm Products Ltd., 3 Bonsey's Lane, Chobham, Surrey. (099 057781).

CK-5063/Kit comprises: 1 Siren; 2 Ready-assembled p.c.b.s; 1 Key switch; Fixings; Casing. **Price:** **£37.95.** **Features:** Stand-alone unit generates a 110dB alarm signal when triggered; Entry/Exit delay incorporated, also three levels of discrimination. **NB:** Some soldering/assembly reqd., mains operation (catalogue available). **Supplier:** Riscomp Ltd., 51 Poppy Road, Princes Risborough, Bucks. (08444 6326).

ALARM GUARD/Kit comprises: 1 Pressure pad; 5 Pairs magnetic contacts (surface mounting); 1 Panic button; 1 Bell; 1 Bell box (steel); 1 Auto cut-off/reset control panel; 4-Core cable; 2-Core cable; Clips; Fixings; Instructions. **Price:** £119·25 (Battery £7·48). **Features:** Expandable. **NB:** Battery operation. **Supplier:** Banham Patent Locks Ltd., 233-235 Kensington High Street, London, W8 6SF. (01-937 4311).

OBSERVATIONS

As reported last month, the Observatory of Los Muchachos, on the Canary Islands, has been officially opened by the King of Spain. It is now in full operation, though the great William Herschel reflector is not yet ready. A major telescope is being planned by the four Nordic countries, Denmark, Sweden, Norway and Finland, and other nations are also involved in the observatory, which is truly international.

Meanwhile, a new radio telescope has been sent to the high-altitude Mauna Kea Observatory, in Hawaii, at an altitude of almost 14,000 feet. It was commissioned by the Rutherford-Appleton Laboratory, and has a 15-metre "dish" designed to operate at millimetre and sub-millimetre wavelengths. It will probably be the most accurate instrument of its kind ever built, and is a joint Anglo-Dutch project. Most radio telescopes stand in the open, but the high winds on top of Mauna Kea make it necessary to house the new instrument in an observatory which will automatically rotate with the movements of the telescope.

There are interesting new results concerning that somewhat mysterious region, the centre of the Galaxy. Astronomers in California have announced the detection of gas-streamers moving at a rate of at least 700,000 km/hour around the central region, and this may well indicate the presence of a Black Hole with at least 4,000,000 times the mass of the Sun. As yet it is impossible to be sure, but the evidence is growing that a central Black Hole really does exist there.

RECURRENT NOVAE

Considerable interest has been aroused this year by a new outburst of the recurrent nova RS Ophiuchi. During January it brightened so much that it was on the fringe of naked-eye visibility, though it soon faded back to its usual obscurity.

Normal novae are believed to be binary systems, made up of a red dwarf star together with a very dense White Dwarf. The White Dwarf pulls material away from the red star, and an accretion disk is built up around it. When sufficient material has accumulated, thermonuclear reactions are triggered off, and the resulting flare-up can be very spectacular.

The last really bright nova was a V.1500 Cygni, of 1975, which reached magnitude 1.8 at its maximum, though it faded very rapidly. (I was an independent discoverer of this nova. It could hardly be missed, and was seen by many observers within a few hours of its outburst; I think I was 87th in order of priority!).

Recurrent novae differ inasmuch as they flare up more than once. This is not to say that a "classical" nova is limited to one outburst, but the interval between one maximum and the next must be very long indeed.

Of the recurrent novae, the best known is the so-called Blaze Star, T-Coronae in the Northern Crown, which is normally of about the tenth magnitude, but which burst forth in 1866 and again in 1946, reaching naked-eye visibility on each occasion; in 1866, indeed, it brightened up to the second magnitude. Other examples are WZ Sagittae (outbursts in 1913, 1946 and 1979) and the southern T Pyxidis (1890, 1902, 1920, 1945 and 1965).

RS Ophiuchi, in the Serpent-bearer, has a normal magnitude of below 12. Previous outbursts occurred in 1901, 1933, 1958 and 1967, so that this year's event was the fifth to be observed. The maximum magnitude was 5.8, and the star would have been an easy binocular object; had it flared up at a more convenient time of the year.

It is now generally believed that the red component of a recurrent nova is not a dwarf, as with a classical nova, but a giant. Obviously this provides a greater supply of material, and the accretion disc round the White Dwarf companion is denser and more massive.

In January this year RS Ophihchi ejected so much gas that its mass was as great as that of the Earth, and the ejection velocity

THE SKY THIS MONTH

With the longer nights, we are approaching the start of the new "observing season". The Moon is new on 16 August, so that it will not seriously interfere with the maximum of the Perseid meteor shower on the 12th; the Moon is next full on 30 August, by which time the shower will be over. The Perseids can always be relied upon to give a good display, and this year should be no exception.

Halley's Comet is still too faint to be seen except with large telescopes, but there is another comet on view: Giacobini-Zinner, which is being widely used as a "Halley rehearsal". Its position on 1 August is R.A. 1h 12m, declination N.59°57', which puts it in the constellation of Cassiopeia; and as the magnitude is above 9 it should be an easy telescopic object.

It was first seen in 1900, and has been observed at most returns since then. Its period is 6.5 years, and at times it has been associated with spectacular meteor showers—notably in 1933, when for a while the Z.H.R. or zenithal hourly rate of the "Giacobinids" exceeded 1000. No such display is expected this year, owing to the fact that the orbit has been perturbed by Jupiter, but the comet itself is well worth finding, particularly as an American spaceprobe is expected to by-pass it.

Jupiter reaches opposition on 4 August. Unfortunately it is rather low, in Capricornus, but it is visible for much of the night, and mutual phenomena of the four Galilean satellites have begun, to the great interest of planetary observers. Saturn, with its ring system wide open, is visible in the South-west during the evenings, and Venus is brilliant in the eastern sky before sunrise; it passes only 7 degrees south of Pollux, one of the Twins, on 23 August—a good opportunity for a photograph!

Mars is too near the Sun to be seen, but Mercury becomes well placed in the morning sky late in the month, reaching its maximum western elongation (18 degrees) on 28 August. At its brightest Mercury attains a magnitude of −0.5, which is brighter than any fixed star apart from Sirius and Canopus, but it is never particularly easy to find, because it can never be seen against a really dark background.

SUMMER TRIANGLE

The evening stellar sky is still dominated by the so-called "Summer Triangle" of Vega, Deneb and Altair, with the Great Bear low in the north and the 'W' of Cassiopeia not far from the zenith. The Square of Pegasus has come into view, and it is interesting to survey its four stars with binoculars; three of them are white, while the fourth (Scheat, or Beta Pegasi, in the upper right-hand corner of the Square) is obviously orange. Beta Pegasi is a variable star, with a small range of from about magnitude 2.4 to 2.8 and a rough period of approximately 35 days.

Below the Square, skirting the southern horizon, is Fomalhaut in Piscis Australis, the Southern Fish—one of the stars found by IRAS in 1983 to have an infra-red excess, indicating the presence of cool material which may possibly be planet-forming or even a fully-fledged planetary system. Fomalhaut is only 22 light-years away, and is 13 times as luminous as the Sun.

was at least 3000 kilometres per second, with a temperature rising to millions of degrees. The outburst was also recorded at radio, ultra-violet and X-ray wavelengths; observations in infra-red were made with UKIRT, the United Kingdom Infra-Red Telescope on Mauna Kea.

UNPREDICTABLE

Recurrent novae are unusual stars, and may possibly provide a link between classical novae and the "dwarf novae" or SS Cygni stars, which show mild outbursts frequently (in the case of SS Cygni itself, about every 50 days). Clearly it is important to study their outbursts as closely as possible, and in this field amateur astronomers can play a vuluable rôle. There are many regular observers, and it is always likely that an amateur will be the first to detect an outburst, in which case professional observatories can be alerted at once.

One can never tell just when a recurrent nova will decide to "perform". With T-Coronae, the two observed outbursts were separated by eighty years; logically we cannot except another before the end of the century—but one never knows.

It is also worth while keeping a watch upon old classical novae, some of which are of tremendous interest. For instance, there is HR Delphini, which flared up in 1967 and reached magnitude 3.6. It remained visible with the naked eye for months, and when I last observed it, a few nights ago, it was still above the 12th magnitude—whereas the more spectacular Cygnus nova of 1975 has now become so faint that it is hard to detect with any telescope.

Supernovae, of course, come into an entirely different category. Many have been observed in external galaxies, but the last supernova to be seen in our own system dates back to 1604, before the invention of the telescope. By the law of averages we are long overdue for another, but when it will happen is something which nobody can foresee!

CAROLINE HERSCHEL

On a personal note, I greatly regret to have to report the death of Caroline Herschel, great-great-granddaughter of Sir William Herschel, who discovered the planet Uranus in 1781. Caroline—the namesake of William Herschel's famous sister, who acted as his assistant—was not herself an astronomer, but she took a great interest in science, and was actively involved in the setting-up of the Herschel Museum at 19 New King Street, Bath, from the garden of which William Herschel discovered Uranus.

Her delightful personality made her popular everywhere, and she will be sadly missed. It is tragic that she should not have lived long enough to watch the *Voyager 2* pass of her ancestor's planet, due in January next year.

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CLEARANCE! Memories, 2102's, £1.00; 2114's, £1.60; UAA170, £1.00; dil sockets, 16 pin, 5p, all brand-new. C. B. Shaw, 1 Guilford Cottages, East Langdon, Dover, Kent CT15 5JD. Tel: 0304 852097.

T199/4A expansion box, C/W interface, also 32k ram. Both new. Never used. £80 for both. Mr. C. Shaw, 123 Ironside Road, Hemsworth, Sheffield. Tel: 657898 after 6 p.m.

COMPONENTS Moving, must sell. Lots of junk, £2.00 a box plus 50p. postage and packing. J. H. Winpenny, Penpont Villa, Redruth Highway, Redruth, Cornwall.

VOX 1120 amp solid state pre-amp valve output (KT88's) 120W, inbuilt reverb. Rare vintage model. £180. R. Metcalf, 39 Bates Street, Crookes, Sheffield. Tel: 0742 683608.

MAGAZINES. PE 1979/85, one missing. PW 1968/85 and Radio Constructor 1967/79, both complete. Offers invited. A. L. Terry, 41 Abbey Road, Narborough, Leicester LE9 5DB. Tel: 0533 862428.

PRACTICAL WIRELESS and Practical Television 1947/50. Wireless World from 1930. Offers. Mr. Limburn, 74 Ellesfield Drive, Ferndown, Dorset.

MAGAZINES—PE 1969–78; PW 1960–65; most in Easi-binders. Offers for all or part. C. T. Watts, 27 Fairview Court, Manor Road, Ashford, Middx. TW15 2SH. Tel: 07842 51485.

PENSIONER wants tuner and i.f. panel for Decca TV model MS2400 or MS20000. All letters/calls answered. Mr. G. Martin, 39 Green Lane, Middleton, Manchester M24 2NF. Tel: 061-653 8275.

TAYLOR type 33a Oscilloscope, 5 MHz, £30; also AE1 CT52 Oscilloscope, 1 MHz, in metal transit case. £20. J. C. Priest, 53 Gaskell Crescent, Thornton-Cleveleys, Blackpool FY5 2TB. Tel: 0253 854486.

SHUGART SA801 8in. floppy disc drives. As new. Pair £190, including manuals + 20 blank new discs. Mr. P. Lacey, 32 Mill Close, Denmead, Portsmouth, Hants. Tel: 0705 266856.

WANTED: Word Wizard on tape. Eprom or disc from 'Premier'. J. Ockier, Mgr. Christiaensstraat 16, 8880 Tielt, Belgium.

PANASONIC TECHNICS set of service manuals, £1.50; small items (radios), £3.00. Colour televisions, videos, organs. SAE. E. S. Zych, 9 Edinburgh Drive, St. Ives, Cambs. PE17 6DA.

WANTED: Hardware manual or technical information in any form for TI-99/4A. Larry Lumsden, 46 Parnell Road, Harolds Cross, Dublin 12, Ireland.

TELEQUIPMENT D52 Oscilloscope, dual trace. Manual/leads. £50 ono. AVO multimeter model 40, £25 ono. Carlisle. Tel: 0228 20867.

TEKTRONIX 7603 four-trace Oscilloscope, recently calibrated. Cost £4,000 new. No reasonable offer refused. Barry Francis. Tel: 01-804 5081.

WANTED: IMFO scope Safgan DT420. Any reasonable price paid. Mike Smith, 1 Dan-Y-Lan, Aberkenfig, Bridgend, Mid. Glamorgan CF32 9AB.

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PE BAZAAR SEPTEMBER '85

BBC Micro Forum...

David Whitfield MA MSc CEng MIEE

THIS month I start with some software for the digital thermometer circuit described last month. As we shall see when investigating this, there is a little more to producing a usable project than the theory put forward might at first suggest. However, we have seen that putting micros to work in the real world frequently presents a few "wrinkles" to overcome. This is arguably one of the challenges which makes these problems all the more interesting!

THERMOMETER SOFTWARE

A simple program to provide a continuous display of temperature is given in listing 1. This assumes that the circuit is as shown last month (particularly that the value of series resistance is 1kΩ), and it provides a continuous display in Celsius and Fahrenheit. The preset resistor should be adjusted to give a correct reading when the sensor is used to measure a known temperature (see last month). The program includes a delay between readings to ensure a readable display. Even so, one of the first things which you may notice about the display is the sometimes quite significant fluctuation between readings. This is not quite so surprising, however, when you consider that each °C is separated by less than three ADC levels (each corresponding to approximately 0·44mV). This means that any noise or other fluctuation on *either* the voltage from the sensor, *or* on the Vref used by the ADC, will show up as a significant temperature variation. What then can we do to improve this situation?

The voltage across the 1kΩ series resistance is 1mV/°C, and this means that at room temperature the voltage being measured is around 300mV. At the maximum temperature specified for the sensor (150°C), the voltage will still only be around 450mV. This compares with a maximum ADC input (i.e. the value of Vref) of approximately 1·8V.

One possible way of improving the performance of the display, therefore, is to improve the noise immunity; that is to say, by increasing the voltage which the sensor produces for a given temperature. This is a simple process, and only involves increasing the series resistance, with a corresponding software change. The maximum value of series resistance is approximately 3·9kΩ, wired in series with the existing preset. Using this maximum means that each degree is now separated by approximately 9 ADC levels, with a corresponding improvement in immunity to sensor signal noise.

```
 10 REM DIGITAL THERMOMETER
 20 REM -------------------
 30 :
 40 X=@%: R=1000: Delay=30
 50 ON ERROR GOTO 190
 60 MODE 7: @%=&20105
 70 VDU 23.1.0;0;0;0;
 80 :
 90 REPEAT: TIME=0
100  REPEAT UNTIL TIME>=Delay
110  T=ADVAL(1)*1800/(65.52*R)
120  T=T-273.2: PRINTTAB(8.12);
130  PRINT CHR$141;T;" 8C";
140  PRINTSPC(10);T*1.8+32;" 8F"
150  PRINTTAB(8)CHR$141;T;"  C":
160  PRINTSPC(10);T*1.8+32;"  F"
170  UNTIL FALSE ,
180 :
190 VDU 23.1.1;0;0;0:
200 @%=X: PRINTTAB(0.23)
```

Listing 1. Simple thermometer display

The software change involves simply changing the value of "R" in line 40 of listing 1. It is worth noting in passing, that changing the value of R in the software is an alternative to adjusting the preset when calibrating the thermometer. We will come back to this later.

FURTHER IMPROVEMENTS

Even with the improvements above, the performance of the thermometer still leaves a little to be desired. It is soon apparent that, even when just calibrated, the temperature readings still seem to drift as time passes. One of the main reasons for this behaviour is the fact that the Vref used by the ADC drifts as the micro warms up. On my own machine, the value fell from 1·82V at switch on, to 1·77V after 30 minutes, finally settling down to 1·69V after 8 hours. This is equivalent to an error varying from +1·1% to −6·1% when compared with the nominal 1·8V. This may not seem to represent much of an error for a temperature of 25°C, and indeed it is comparable with the accuracy of a typical room thermostat. However, the temperature sensor actually measures the *absolute* temperature, and this means that at 25°C (approximately 298°K), the error in Vref is equivalent to a range of −3·3°C and +18·2°C. This is quite a sizeable error!

One way of compensating for this reference drift is to adjust the value which the software assumes for Vref; the default value is set to 1800mV in line 110. However, this is not very practical in many situations, particularly since the thermometer may be used at different times after switch-on, hence when the value of Vref will be different. An alternative, and more practical solution, is to use the improved thermometer circuit shown in Fig. 1. This includes a bandgap voltage reference source (Vcal) which is measured on the second ADC channel. If the bandgap reference is measured by the ADC, the value read will correspond to a known voltage, and hence this reading can be used to calibrate the ADC levels. By including a measurement of the bandgap source every time the temperature sensor is measured, the Vref drift can be compensated. The bandgap source shown in Fig. 1 has a nominal voltage of 1·22V, has a typical temperature coefficient of only 30ppm/°C, and is available for around £1 from sources such as RS (282–283).

```
 10 REM Digital Thermometer v2.0
 20 REM -------------------------
 30 REM
 40 REM This parameterised digital
 50 REM thermometer display program
 60 REM allows various circuit and
 70 REM s/w configurations to be used
 80 :
 90 F%=4      : REM ADC bits ignored
100 T%=75     : REM Display interval
110 R%=2200   : REM Series resistor
120 Vcal=1220: REM Bandgap voltage
130 Vref=1800: REM ADC nominal ref
140 Temp%=1   : REM Sensor channel
150 Cal%=2    : REM Ref volts channel
160 :
170 MODE 7: ON ERROR GOTO 400
180 F%=2^F%: VDU 23.1.0;0;0;0;
190 PRINTTAB(2.22)"(Z/X to dec/inc)"
200 PRINTTAB(22.22)"(N/M to dec/inc)"
201 PRINTTAB(15.6)"Bandgap Ref:"
202 PRINTTAB(17.12)"ADC Ref:"
210 :
220 REPEAT: @%=&020105
230  C$=INKEY$(T%)
240  IF C$="T" R%=R%+5
250  IF C$="R" R%=R%-5
260  IF C$="X" Vref=Vref+5
270  IF C$="Z" Vref=Vref-5
280  IF C$="M" Vcal=Vcal+5
290  IF C$="N" Vcal=Vcal-5
300  X=1000*(ADVAL(Temp%)DIV F%)*F%/R%
310  Xref=X*Vref/65520-273.2
320  Xcal=X*Vcal/((ADVAL(Cal%)
     DIV F%)*F%)-273.2
330  PRINTTAB(8.8)CHR$141;Xcal;" 8C";
     SPC(10);Xcal*1.8+32;" 8F  "'TAB(8)
     CHR$141;Xcal;"  C";SPC(10);
     Xcal*1.8+32;"  F  "
340  PRINTTAB(8.14)CHR$141;Xref;" 8C";
     SPC(10);Xref*1.8+32;" 8F  "'TAB(8)
     CHR$141;Xref;"  C";SPC(10);
     Xref*1.8+32;"  F  "
350  @%=&000006
360  PRINTTAB(3.20)"Vref = ";Vref;"mV";
     SPC(7);"Vcal = ";Vcal;"mV";
370  PRINTTAB(5.2)"R = ";R%;
     " ohms  (R/T to dec/inc)"
380  UNTIL FALSE
390 :
400 VDU 23.1.1;0;0;0;
```

Listing 2. Calibrated thermometer display

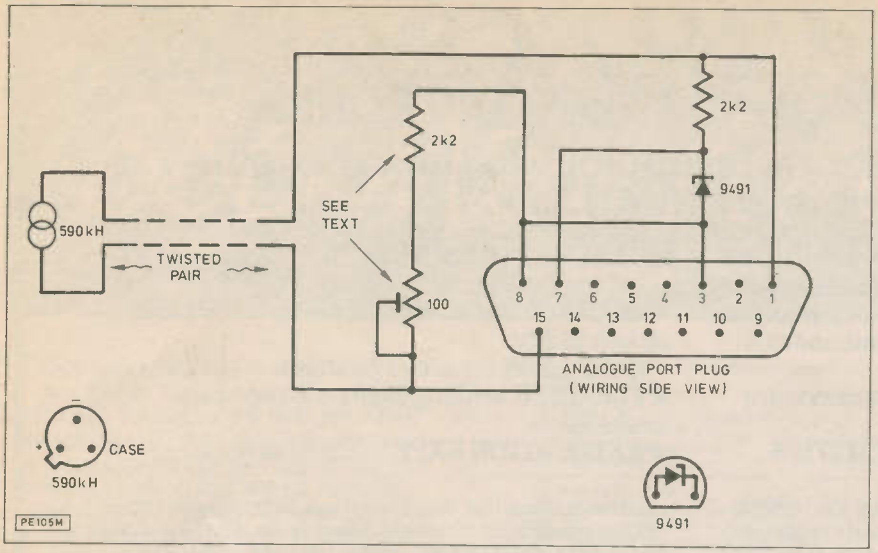


Fig. 1. Improved thermometer circuit using a bandgap source of nominal voltage 1·22V and temperature coefficient of only 30 p.p.m./°C

The program in listing 2 is a more sophisticated version of listing 1, and allows the thermometer to be calibrated in software rather than in hardware. It starts by assuming that the circuit shown in Fig. 1 has been set up, and initial values are assumed as follows:

Vref	1800mV
Vcal	1220mV
R	2200Ω

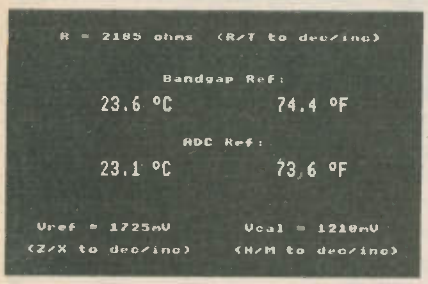


Fig. 2. Thermometer display

The display (example shown in Fig. 2) gives a comparative display of the temperature with and without the bandgap reference. The currently assumed values of Vref, Vcal and R are also shown on the display, but these may be altered from the keyboard while the program is running by using the keys indicated. When satisfactory values have been determined, the actual program may be altered to make these the default values (changes to lines 110–130).

Listing 2 is ideally suited to experimentation with the thermometer. Once you have determined the required settings, it is simply a matter of removing those parts of the program which are no longer required. The rest is up to you . . .

Book Corner

This month's book fills a gap in the wide range of literature available for the BBC Micro. **The Advanced BASIC ROM User Guide** by Colin Pharo is published by the Cambridge Microcomputer Centre at £7·95, and is another book (albeit a somewhat slimmer one) in the style of the original User Guide. However, this book is quite different from the general run of books on BBC Basic. While it concentrates on the Basic ROM (versions 1 and 2) provided with the machine, it is *not* intended primarily for people wishing to write Basic programs. Instead, it recognises that the subroutines used inside the ROM have been very carefully designed and coded (in assembler), and hence they could be useful in their own right. Essentially, this book sets out to answer the question: "What are these routines, and how can they be accessed?"

The book starts with a brief refresher covering binary and hexadecimal arithmetic. The major part of the book (120 out of the 182 pages) is then devoted to describing 69 routines contained in the ROM which can be called from assembly language programs. These routines cover:

- 32-bit integer arithmetic
- floating point arithmetic
- maths functions (e.g. sine, log)
- data conversions
- random numbers

Each group of routines is described in a separate chapter which starts with a general discussion of their applicability, and any additional information regarding the numbering system or data representation used, e.g. the floating point system. This provides a useful basis for understanding the theory behind the techniques supported by the routines. The routines themselves are then discussed one at a time, giving their start addresses (Basic 1 and 2), entry conditions, exit conditions, error reports, execution times, and any comments. For the integer group, an example listing is given for each routine. For the subsequent chapters, the demonstrations cover the whole group. This gives all the information that you are ever likely to need, short of the source listings of the ROM!

Following on from the description of the routines, Chapter 7 looks at the ROM's use of memory. This chapter also lists the Basic token values. Chapter 8 then looks at the execution times of the 69 routines, and includes the code used to make the measurements. The next chapter looks at speeding up trigonometrical functions; the example used is drawing a circle, which takes 6 seconds in Basic, and 5·5 seconds in machine code. Using the various techniques described allows a circle to be drawn in as little as 0·28 seconds. The final chapter describes various techniques which can be used to allow the creation of large machine code programs. This is a useful chapter, particularly since it addresses a topic which is not often even mentioned, never mind illustrated as here with sample listings.

Verdict: *This is a book which will be of great interest to anyone with an application involving any form of intensive "number crunching". In such problems, the use of these tested routines will provide a real increase in speed over Basic, but without using up extra memory or requiring an intimate knowledge of the assembly language programming techniques involved.*

NEXT MONTH

Next month *BBC Micro Forum* will be moving on to look at the pushbuttons and lightpen inputs on the analogue port.

Serpent Robot Review

DICK BECKER
ROGER GAY

SCARAS are a relatively new class of small industrial robot filling the gap between simple pneumatic pick-and-place robots and servo controlled robots modelled upon the human arm like the *Unimation Puma*. SCARAs originated in Japan and having rapidly become established in manufacturing in that country are now spreading throughout Europe and North America; being used for handling and assembling small components.

Prices of SCARAs are generally in the range £15K–£25K. Load capacities rarely exceed 10kg and the actual load may be just a screw or integrated circuit weighing a few grams. Some manufacturers offer alternatives to a gripper such as devices for hole tapping, spot welding and soldering, presumably for soldering to top side of p.c.b.s where flow soldering is not to be recommended.

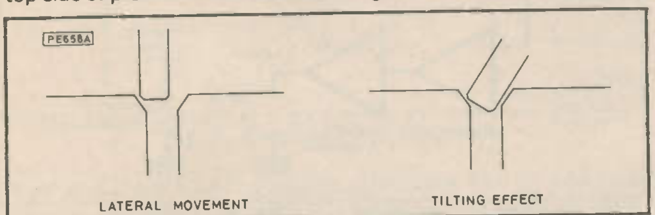


Fig. 1. Illustration of selective compliance

COMPLIANCE

SCARA is an acronym for Selectively Compliant Articulated Robot Arm. This feature comes from the fact that any servo controlled arm will automatically have springiness or compliance in the plane of the operation of that arm. A small displacement of the arm will cause a small correcting force to be applied by the servo system whilst a larger displacement will cause a larger correcting force, hence the springiness. A SCARA has joints moving in only the XY (horizontal) plane. Assuming good engineering the arm will be stiff (non-compliant) in the vertical direction. The arm is thus selectively compliant!

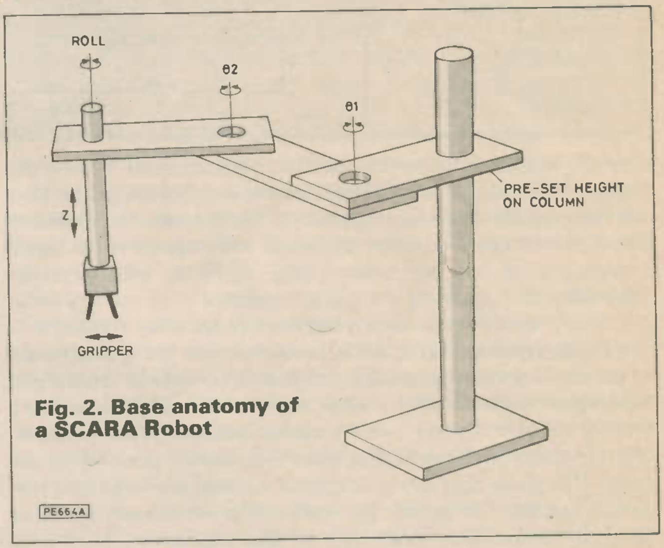
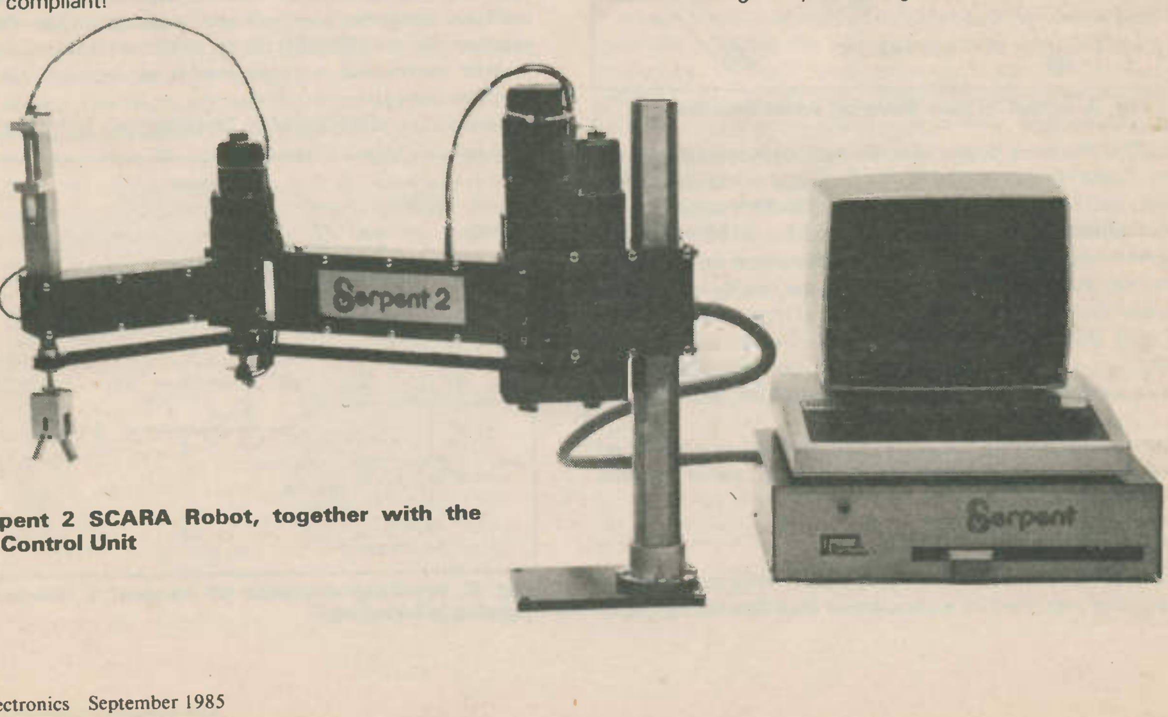


Fig. 2. Base anatomy of a SCARA Robot

The significance of selective compliance becomes apparent during assembly operations (Fig. 1). If there is a small error of position then the compliance in the XY plane will allow the part to be inserted into a hole, with a chamfered edge, when vertical pressure is applied. Had there been lack of stiffness (i.e. compliance) vertically then the part could tilt and jam.

SCARA ANATOMY

The anatomy of the SCARA is shown in Fig. 2. SCARAs operate predominantly on the XY plane, there being 2 servo controlled horizontal joints. THETA 1 is the shoulder and THETA 2 the elbow. A third rotary axis is ROLL which is the wrist. Typically this is belt driven from a motor at the fixed end of the arm. This at first sight seems a strange way of driving it as there would usually be little



The Serpent 2 SCARA Robot, together with the Serpent Control Unit

SPECIFICATIONS

SERPENT I

Main arm length	250mm
Fore arm length	150mm
Theta 1 axis (shoulder movement)	200°
Theta 2 axis (elbow movement)	250°
Roll axis (wrist rotation)	450°
Z axis (up-down)	75mm
Control system	12 bit
Resolution	1:4096 (3·7 minutes of arc)
Repeatability	1·0mm
Maximum tip velocity	550mm/sec
Capacity	2·0kg

SERPENT II

Main arm length	400mm
Fore arm length	250mm
Theta 1 axis (shoulder movement)	200°
Theta 2 axis (elbow movement)	250°
Roll axis (wrist rotation)	450°
Z axis (up-down)	75mm
Control system	12 bit
Resolution	1:4096 (3·7 minutes of arc)
Repeatability	1·5mm
Maximum tip velocity	850mm/sec
Capacity	2·0kg

difficulty in placing the motor close to the joint itself. Having the motor on a fixed point keeps down the mass at the gripper end but the main reason for the arrangement is that it keeps the wrist and hence the workpiece at a constant angle with respect to the bench irrespective of arm movements (Fig. 3). It is, therefore, not necessary to constantly compute a suitable drive for the wrist motor in order to avoid turning the work piece when moving it.

Vertical movement of SCARAs is very simple. The overall height of the arm is pre-set by adjusting its position on a fixed column and the gripper is moved only a small amount in the Z direction by a vertical actuator. Sometimes the vertical actuator is servo driven, e.g. by motor and ball screw, but more usually pneumatics are used. This gives high speed operation working between two pre-set end stops. The gripper generally has pneumatically powered jaws but vacuum pick-up devices are also popular.

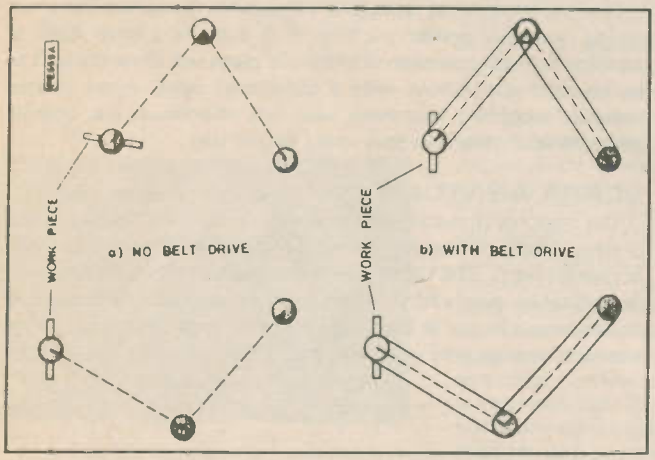


Fig. 3. Effect of belt drive on wrist rotation

The SERPENTs were designed to be fully representative of the SCARAs found most frequently in industry. There are two articulating joints of the arm using d.c. servo motors under closed-loop servo control. There is wrist rotation by d.c. servo motor also under closed loop servo control. A very fast vertical axis operates pneumatically and there is a pneumatic gripper readily replaceable by a vacuum pick-up pad. Compressed air, at a pressure of 5 to 8 bars, enters the control box via a plug-in connector from a compressor or regulated CO_2 cylinder. A combined electrical/pneumatic connector takes the signals and air to and from the robot.

The servo control system is extremely flexible being based on hardware but with software control of the servo system characteristics.

SERVO CONTROL

The simplest form of servo control of a d.c. motor consists of a power amplifier preceded by a comparator (Fig. 4) which gives an output voltage dependent on the difference between a voltage representing the desired position and a voltage representing the actual position. If a potentiometer is fitted to the axis being moved then this provides the position indicating voltage. Assuming the amplifier is linear then the drive voltage to the motor will depend linearly upon the error voltage, i.e. the difference between desired

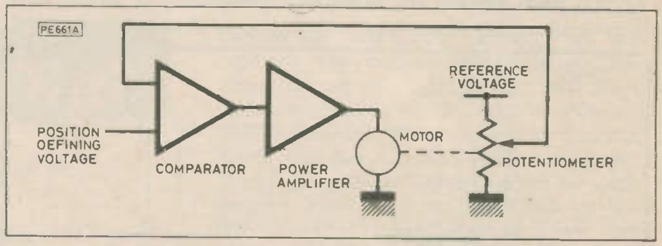


Fig. 4. Basic servo control system

position and actual position. As the desired position is reached the drive to the motor reduces thereby slowing it down and finally stopping it when the error is zero which occurs when the desired position is finally reached.

Such a simple control system, however, ignores the effects of inertia and the drive capability of motors at low voltage. Inertia would result in overshooting the target unless the gain of the amplifier is very low resulting in low operating speed of the arm. Furthermore, as the gain is reduced, the motor drive voltage for a given error voltage is also reduced.

Because of friction, a motor requires a certain amount of voltage on it before any rotation occurs, consequently when there is sufficient gain the arm will stop moving before the target is reached. On the MENTOR robot, described earlier this year, there is little inertia and a simple non-linear network on the servo amplifier giving it extra gain near the target was adequate for the 8-bit resolution of that system. However, the SERPENTs are much

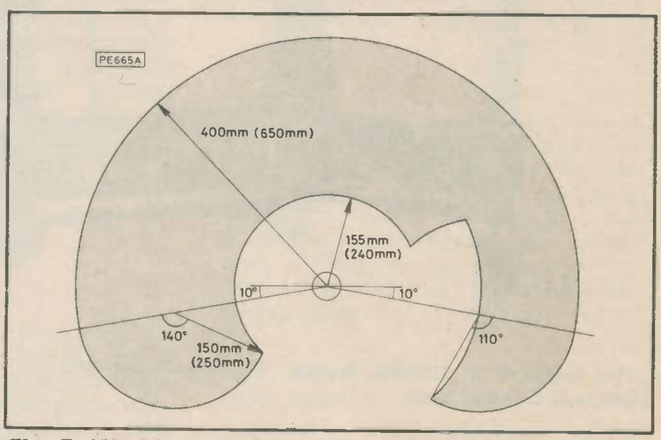


Fig. 5. Working envelope of Serpent 1 (Serpent 2 figures in brackets)

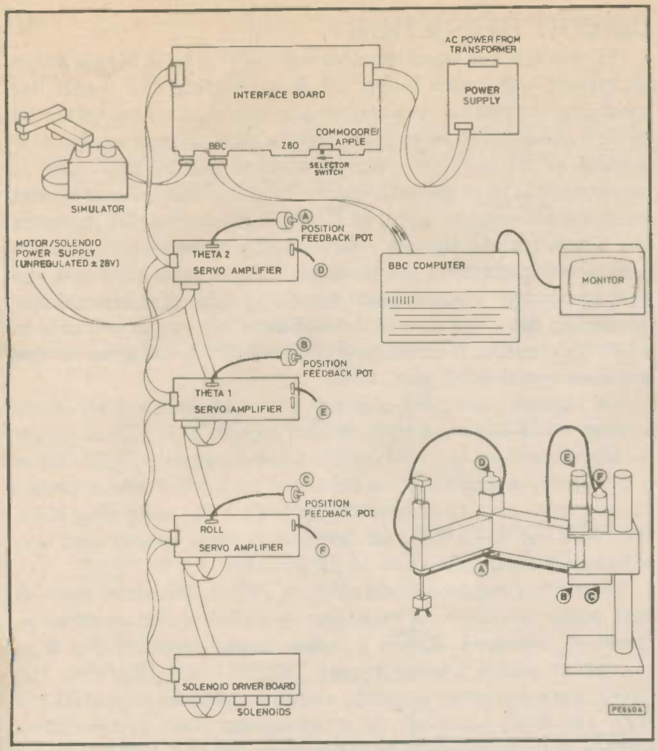


Fig. 6. Serpent control system

larger and faster covering a large workspace (Fig. 5) with high accuracy making 12-bit resolution necessary. A more complex control system was therefore required.

One approach to the problem of control would be to send the position data to a micro-based system, compute a suitable drive voltage and send it to the motor via an ADC (analogue to digital converter) or PWM (pulse width modulation) pulse generator. The drawback of this is that if a computer is used then it must be constantly working on the servoing and if halted the arm would go out of control. A second microprocessor, devoted to servo control could, however, be used under supervision of the computer but then intelligibility and accessibility of the software would be lost. This would seriously detract from the system's value for education and training purposes.

An alternative approach is to use hardware which provides analogue servoing which will continue without computer intervention and have programmability of the hardware characteristics which are hence modifiable under computer control.

THE SERPENT CONTROL SYSTEM

The SERPENTs are controlled by three servo amplifiers (Fig. 6), a solenoid driver (for the pneumatics) and an interface board connected to a small computer, e.g. BBC, Commodore 64, Apple, etc. Most of the software is written in BASIC. Machine code subroutines are called from BASIC only where high speed of execution is essential.

The interface board is a well proven design being the same as used for the NEPTUNE hydraulic robots and was described in the *PE October 1984* issue. Data from the computer is passed to the interface board which is essentially a multiplexed DAC (digital to analogue converter) and multiplexed ADC and provides six outputs and 16 inputs of 12-bit resolution analogue voltages.

The position of each rotary axis of the arm is sensed by a high quality (conductive polymer) potentiometer and after adjusting offset and gain in the buffer (Fig. 7) there is a 0 to +10V signal which passes via an ADC to the computer for it to know the current position of the arm. Desired position comes from the computer via a DAC as a voltage also in the range 0 to +10V. The comparator gives an error voltage in the range −10V to +10V. As ADCs do not like bipolar signals the buffer converts the error voltage to a range of 0 to +10V. The error voltage next passes through a VCA (voltage controlled amplifier) controlled by another DAC output which enables the gain of the system to be software selectable. Finally a power amplifier drives the motor with a voltage in the range of −24V to +24V.

With this software adjustable system there are different levels of control which can be exercised. At the simplest level the computer sends out 4 bytes to the interface board (memory mapped). Two bytes define the desired position of the axis whilst the other 2 bytes define the gain that the amplifier is to have whilst reaching its target. In software, progressively greater control can be achieved by increasing the complexity of the algorithms used for modifying the gain.

The gain required depends upon the error signal (directly accessible) and the velocity and acceleration (derived from successive reading of the current position). Velocity, acceleration and deceleration are all controllable from the computer though full commitment of the computer is not required in that if it is interrupted then the hardware will continue taking the arm to the desired position.

In the main control program "CHARMER" a multi-tasking technique is used to keep a machine code servo routine operating in the background whilst the main program continues in BASIC. This has been achieved through the use of interrupts. Most 6502 machines are fitted with or can be fitted with a 6522 VIA (Versatile Interface Adaptor). The BBC computer includes a VIA as standard. This chip has two 16-bit timers, one of which can be used to generate an interrupt request (IRQ) whenever it counts down to zero.

Where there is no VIA an external counter, e.g. a 555, can be used. On receiving the interrupt and after completing its current instruction, the 6502 loads its program pointer with the interrupt service routine vector giving control to this routine. By altering the vector to the start of one's own routine, multi-tasking is easily implemented. The interrupt service vector is at location &FFFE and &FFFF, which is normally ROM, but on some computers, e.g. the BBC, the resident interrupt service routine indirects through a location in RAM. On the BBC the locations are &206 and &207.

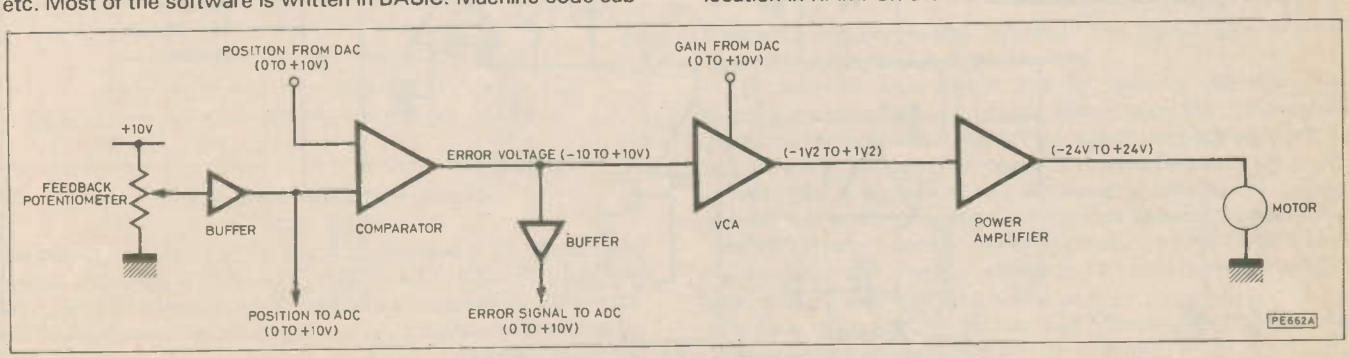


Fig. 7. Basic servo amplifier of the Serpent

CIRCUIT OPERATION

The circuit of the servo amplifier is shown in Fig. 8. IC1a is a high impedance unity gain buffer to avoid loading and hence de-linearising the position sensing potentiometer. As it is impractical to fit a potentiometer to give exactly zero voltage at the zero position of the axis the voltage is nulled out by VR1. Gain is provided by IC1b to give a range of 10V. IC2b is an inverter so that the feedback voltage going to the ADC is positive. D1 prevents any possibility of a reverse voltage during setting-up. IC2a is the comparator comparing the feedback voltage from IC2b with the desired-position voltage from the DAC. IC5a is a level shifter converting the −10V to +10V range error voltage to one of 0 to +10V for the ADC. It works by adding in +10V to the error voltage and then applying 0·5 gain.

The voltage controlled amplifier which alters the gain of the system is IC3. IC3b is a transconductance amplifer whose gain is linearly dependent upon the current flowing into pin 16. IC3a takes a 0 to +10V signal from the DAC and converts it into a current ranging from zero to approximately 500μA for controlling IC3b. VR2 nulls out any offsets so that zero in gives exactly zero out. VR3 sets the maximum gain of the system.

The motors require several amps at 24V to fully drive them. A high power amplifier not dissimilar to a 60W audio amplifier is, therefore, necesary. IC4 is a power driver providing the drive current for power transistor pairs TR1/TR3 and TR2/TR4. The gain of the stage when driven by a large signal is the ratio of R22 to R17, i.e. X40, however, for small signals there is insufficient voltage to cause conduction in the diode network and the gain is increased, in that region, by the ratio of R41 to R40, i.e. there is over 20 times extra gain for very small error signals. The effect of this is to provide the motor with sufficient voltage to move even when the error is less than 1 bit. After that the voltage only increases gradually with increasing error.

VR4 is used to null out the input offset voltage so that zero error gives zero output to the motor. IC4 includes transistors to protect

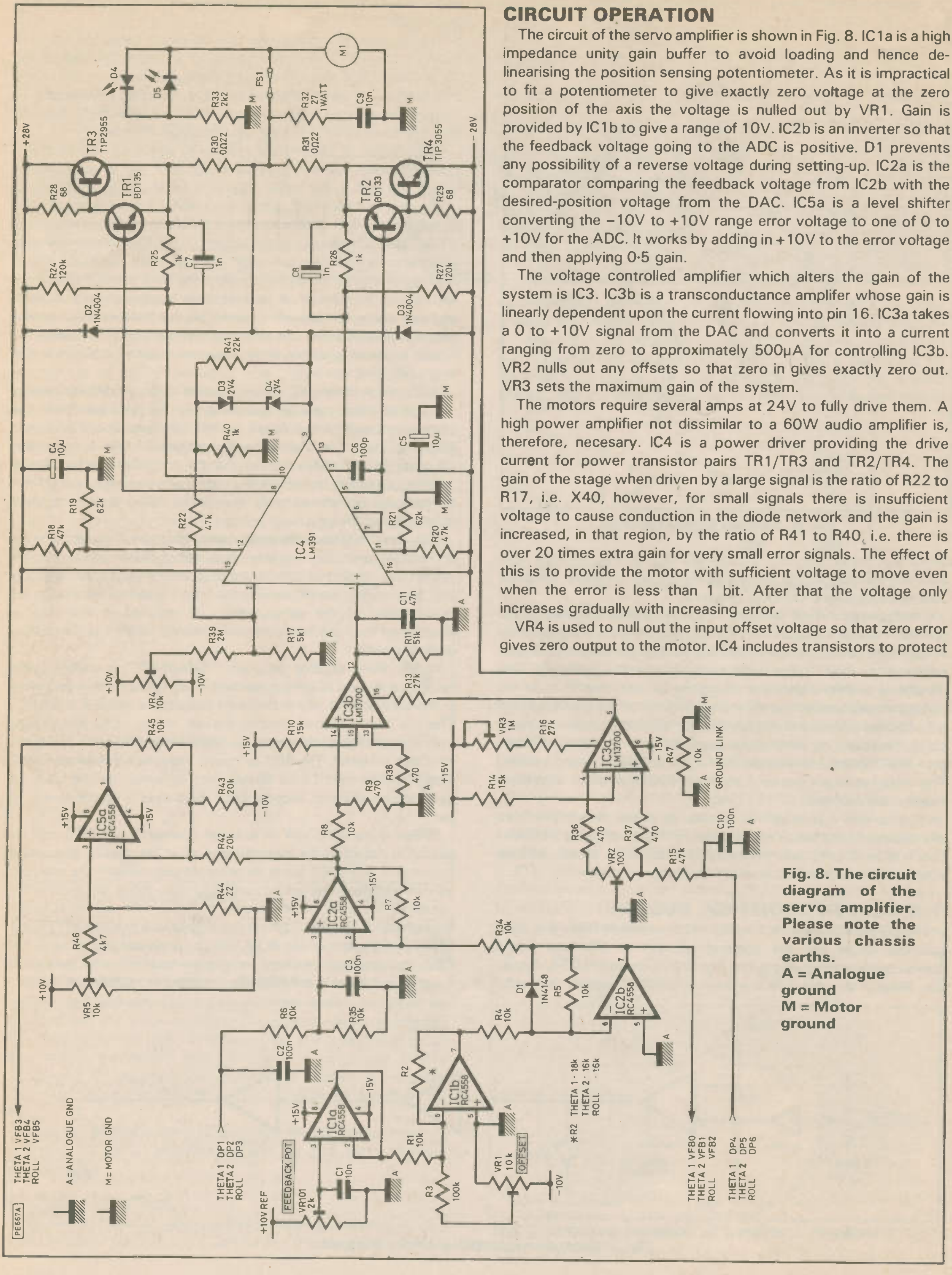


Fig. 8. The circuit diagram of the servo amplifier. Please note the various chassis earths.
A = Analogue ground
M = Motor ground

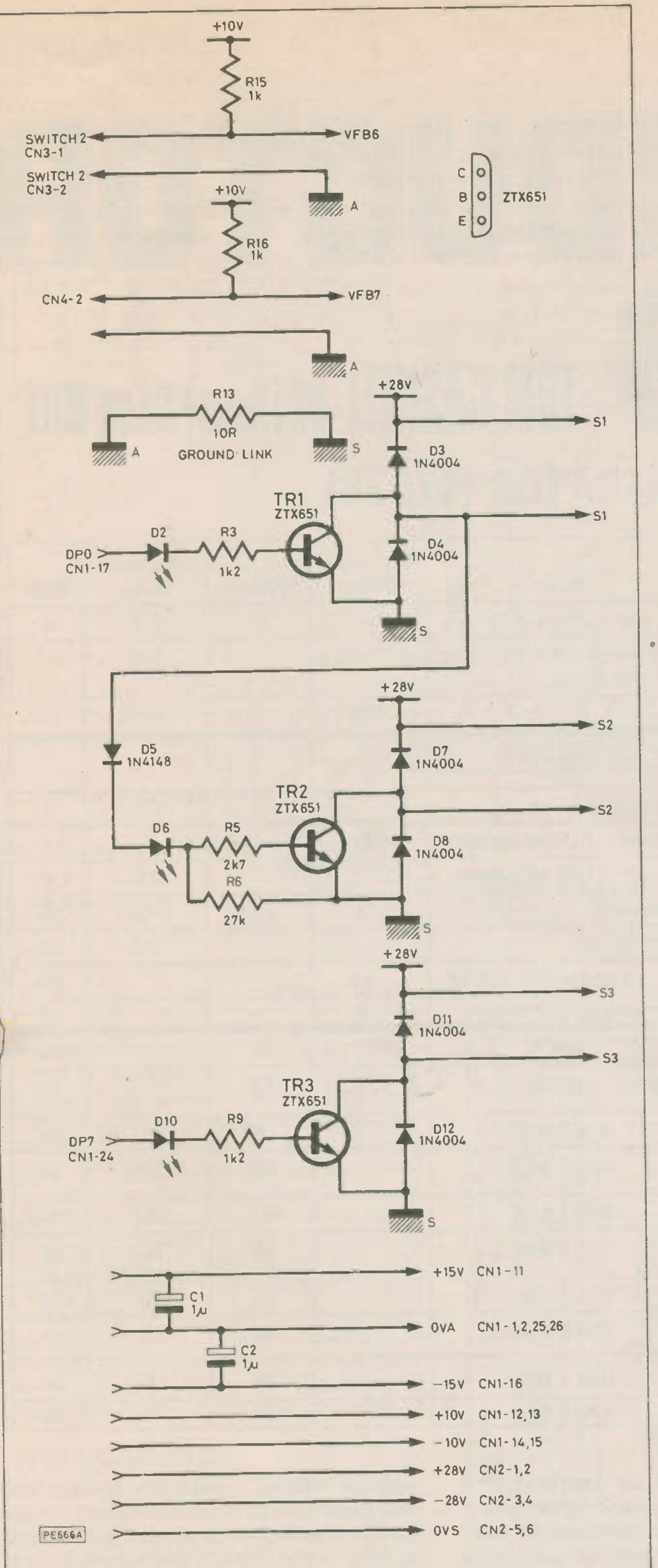


Fig. 9. Solenoid driver circuit

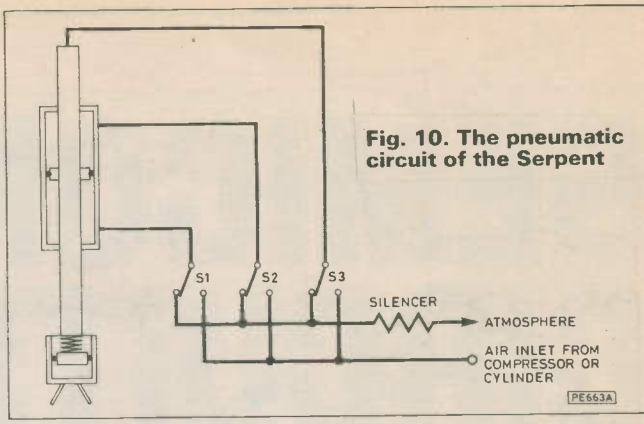


Fig. 10. The pneumatic circuit of the Serpent

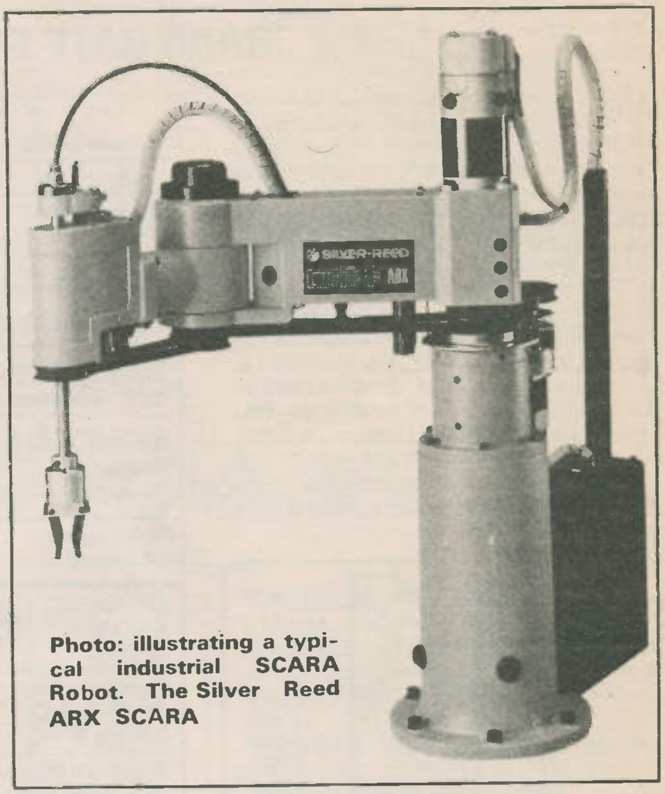


Photo: illustrating a typical industrial SCARA Robot. The Silver Reed ARX SCARA

Constructor's note

The SERPENTs are available as self-assembly kits or ready built from: **Cybernetic Applications**, West Portway Industrial Estate, Andover, Hants SP10 3PE. A range of FMS (Flexible Manufacturing System) workcell components will also be available.

the power transistors in the event of overload if the motors are stalled. Resistors R18 to R21, R24 to R27, R30, R31 set the voltages and currents at which the protection operates. D2 and D3 are flywheel diodes protecting the power transistors from reverse voltages which can occur when an amplifier drives an inductive load. C6 to C8 and network R32/C9 are for providing high frequency stability to the amplifier. The l.e.d.s give a visual indication of the output of the amplifier.

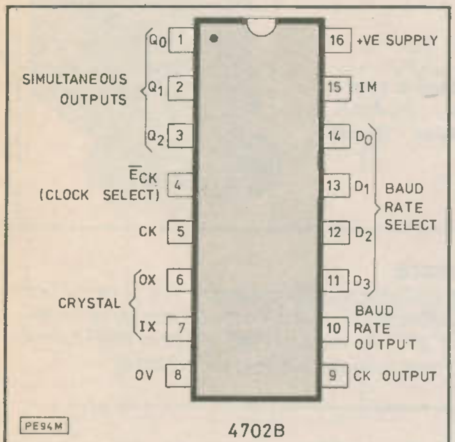
The solenoid driver circuit (Fig. 9) used for controlling the pneumatic circuit (Fig. 10) consists of little more than 3 transistors switching the solenoid current. The control voltages are the 0 to 5V outputs off one of the latches on the interface board. When DP_0 is high TR1 is turned on and saturates at only about 100mV thereby not getting hot despite 300mA of collector current. TR1 thus switches on valve S1 applying pressure to the lower end of the Z axis cylinder. The low voltage on TR1 collector holds off TR2 switching S2 into the state where air from the upper end of the cylinder is released to the atmosphere. Miniature needle valves on the cylinder adjust the ascent and descent rates of the axis to give it smooth travel.

SEMICONDUCTOR CIRCUITS

TOM GASKELL BA (Hons) C Eng MIEE

BAUD RATE GENERATOR (4702B)

WITH the dramatic increase in recent years of cheap, readily available LSI circuits, there has been a corresponding increase in smaller scale i.c.s to service them and provide various interconnection and buffering facilities. These smaller i.c.s are often known as 'glue' chips, and typically comprise of data latches, tri-state buffers, memory control functions, etc. One of the most commonly used LSI devices is the UART—a Universal Asynchronous Receiver/Transmitter. This is a versatile i.c. which is used to convert serial data into 8-bit parallel data words, or parallel data into serial data stream. UARTs are often found in modems, RS232 inputs and outputs, and microcomputer cassette recorder interfaces; in fact, wherever serial and parallel data is required to interact.



Characteristic	Notes	Minimum Value	Typically	Maximum Value	Units
Supply voltage	All spec's measured at 5·0V	4·5	5	5·5	V
Quiescent current	$\overline{Eck}$ = +5V, CK = 0V (Other I/P's at either)			1·0	mA
Temperature range		−40		+85	°C
Input high threshold	For logic 1 (all inputs)	3·5			V
Input low threshold	For logic 0 (all inputs)			1·5	V
Output high voltage	Current < 1μA (all outputs)	4·5			V
Output low voltage	Current < 1μA (all outputs)			0·5	V
Input current (all inputs)	Input at 0V	−15	−30	−100	μA
	Input at +5V			1·0	μA
Output current (all outputs)	Current source O/P = 4·5V	−0·3			mA
	Current sink, O/P = 0·4V	1·6			mA
Minimum clock pulse width (at pin 5)	Logic 1	120	60		ns
	Logic 0	120	60		ns
Propagation delay CK (pin 5) to CK O/P (Pin 9)	0 to 1 edge		130	260	ns
	1 to 0 edge		110	220	ns
Propagation delay CK O/P (pin 9) to Q_0, Q_1, or Q_2	0 to 1 edge		53	367	ns
	1 to 0 edge		45	367	ns
Propagation delay CK (pin 5) to baud O/P (pin 10)	0 to 1 edge		37	85	ns
	1 to 0 edge		32	75	ns
Output transition time (all outputs)	0 to 1 edge		80	160	ns
	1 to 0 edge		35	75	ns

Fig. 1. Pinout and specifications

The UART, however, is not a fully self-contained device. Amongst other things, it requires one or two clocks—square wave oscillator inputs which control and define the speed of transmission or reception of data. The usual arrangement is that the serial data will be received or transmitted at a rate of one-sixteenth of the clock rate. Hence, if the clock was a 16kHz waveform, the serial data rate would be 1000 baud, where a baud is defined as one bit per second. This month's featured i.c. is a baud rate generator—a specially designed 'glue' chip which provides an excellent and flexible way of feeding clock signals into a UART to produce industry standard baud rates, but which can also be used as a general purpose clock source and divider system.

BLOCK OPERATION

The 4702B is a 16 pin CMOS device, with pinout and specifications shown in Fig. 1. The block diagram is shown in Fig. 2. The clock source can be either external, via pin 5, or internally generated by a crystal oscillator. The crystal oscillator requires only an external crystal, one resistor, and two capacitors to operate. Selection of the clock source is done at pin 4; if pin 4 is held at logic 0, the clock is taken from the CK input (pin 5), whereas if pin 4 is held at logic 1, or left open circuit (due to the internal pull-up resistor), the clock will be taken from the crystal oscillator. The clock signal which is selected is suitably buffered, and is made available at pin 9. The clock signal divided by 2, 4, and 8 is made available at pins 1, 2, and 3 respectively.

There then follow a number of divider circuits which provide a variety of clock

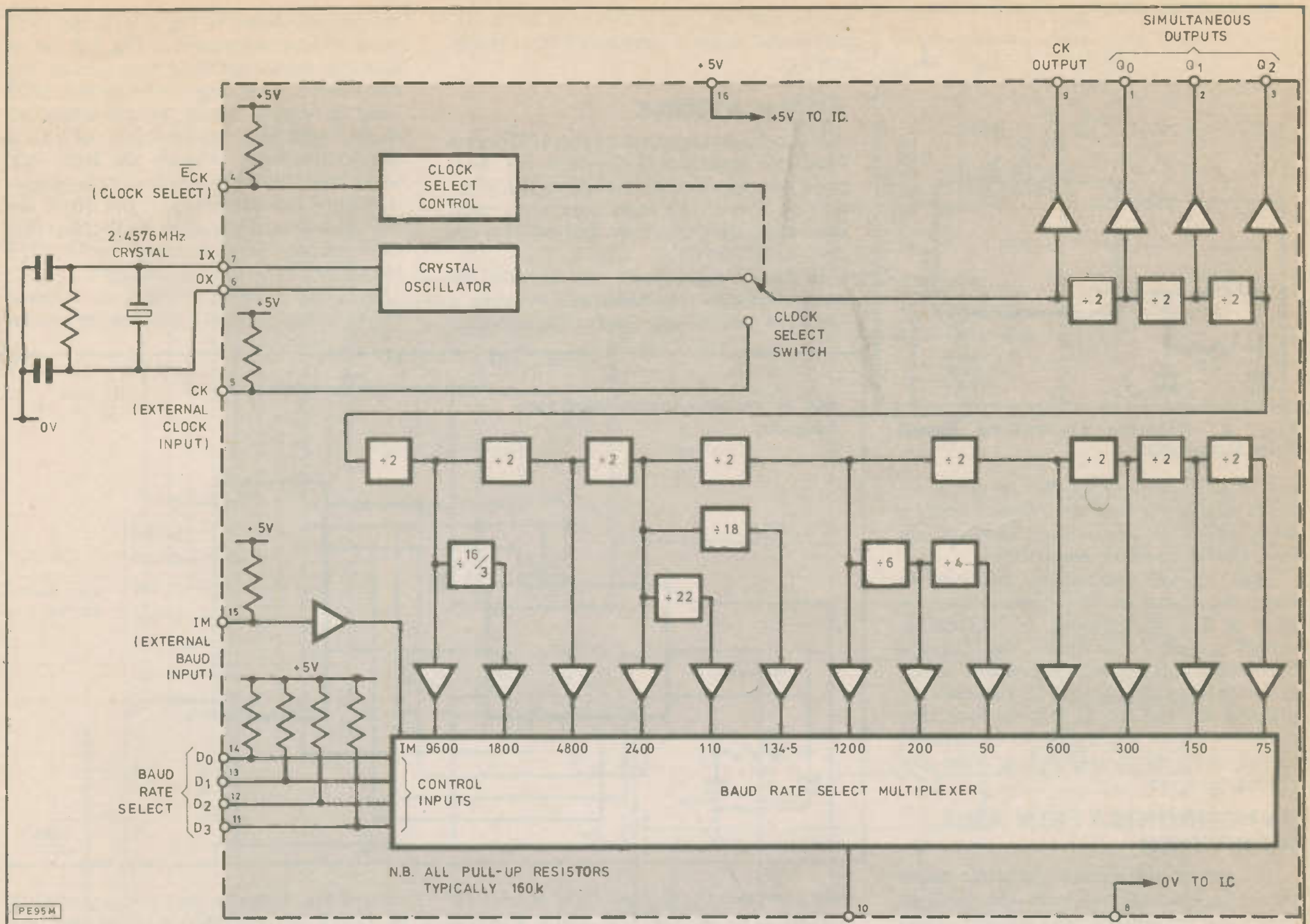


Fig. 2. Block diagram

frequencies to the baud rate select multiplexer or output switch. These clock frequencies, when used with a UART, will produce baud rates which are commonly used in electronic systems, from 50 baud which is used in old electromechanical devices, up to 9600 baud for modems and RS232 data links. The actual frequency which is fed to pin 10 can be selected by using the baud rate select inputs D_0 to D_3. Fig. 3 shows the baud rate select codes, with their corresponding baud rate output and the actual output frequencies, which are 16 times the baud rate itself. Note that there are two different codes corresponding to 2400 baud: either of these may be used.

THE DIVIDERS

There are slight complications involving the implementation of the divider chain which give rise to inaccuracies, or even potential difficulties in some circumstances, with some of the outputs. The 134·5 baud output has a frequency error of −0·87%, and the 110 baud output has an error of −0·83%. The division by 16/3 to produce the 1800 baud signal is done by dividing by 5 twice, then by 6 once, then by 5 twice, then by 6 once, etc. The average frequency of all this is exactly correct, but the output waveform is not a square wave (all other outputs are square waves, i.e. 50/50 mark/space ratio) and there is a small amount of frequency modulation present. When the divide-by-16 effect of the UART is taken into account, the resulting distortion in frequency is less than 1%, but care should be taken if the 1800 baud output is to be used for other purposes. Similarly, the 134·5 and 110 baud errors would be easily tolerated in most UART based systems, but if used in other types of circuitry these freqeuncy discrepancies should be borne in mind.

D_3	D_2	D_1	D_0	BAUD RATE OUTPUT	ACTUAL OUTPUT FREQUENCY
0	0	0	0	Im/16	Im
0	0	0	1	Im/16	Im
0	0	1	0	50	800
0	0	1	1	75	1200
0	1	0	0	134·5*	2152*
0	1	0	1	200	3200
0	1	1	0	600	9600
0	1	1	1	2400	38400
1	0	0	0	9600	153600
1	0	0	1	4800	76800
1	0	1	0	1800	28800
1	0	1	1	1200	19200
1	1	0	0	2400	38400
1	1	0	1	300	4800
1	1	1	0	150	2400
1	1	1	1	110*	1760*

* = These values are approximate: The actual outputs are 2133Hz & 1745Hz respectively

Fig. 3. Output baud rate selection

The baud select codes 0000 and 0001 both cause the I_m input (pin 15) to be routed directly to the baud rate output, with no division taking place. This can be used to select either external clocks to the output, or even to select the individual clock output, or half clock, quarter clock, or eighth clock, by connecting pin 15 to pin 9, pin 1, pin 2 or pin 3 respectively. Specifically, the standard rate of 19200 baud will be obtained if Q_2 (pin 3) is connected to I_m, then I_m is selected by the baud select codes.

USING THE I.C.

All the logic inputs to the 4072B have internal pull-up resistors to the +5V supply rail, which makes it very easy to use external switches to select various rates and facilities. The switches merely have to pull inputs down to 0V; when switched off, the internal resistors pull the inputs up to logic 1. The resistors can vary in value between 50k and 333k, but are typically around 160k. The use of actual logic signals at inputs rather than switches, is perfectly acceptable of course. The inputs are really

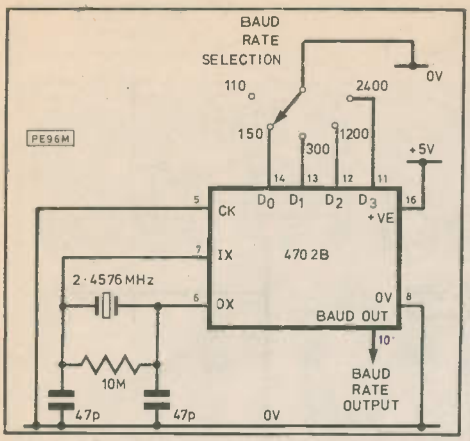


Fig. 4. Simple switched Baud Rate Generator

only CMOS compatible due to the minimum voltage required for a logic 1 being a fairly high 3·5V. The outputs, however, are both CMOS and TTL compatible.

The external components required to make the crystal oscillator operate can be seen in Fig. 4. Although a 2·4576MHz crystal is required to obtain the standard baud rates, it is perfectly acceptable to use different frequency devices if other uses are planned for the i.c. If this is done, the capacitor values might have to be changed to arrange for the correct loading of the new crystal, however.

SYNCHRONISATION AND RESETTING

The output of the baud rate select multiplexer is synchronised with the clock to cancel out the considerable internal delays that would otherwise occur due to time delays in the various stages of division. The baud rate output signal, however, can take several hundred nanoseconds to change after the baud rate select inputs have changed. The i.c. also has an internal reset facility. This senses the first high level at the CK input (pin 5) after $\overline{E_{ck}}$ is taken low, and resets all the internal dividers. If $\overline{E_{ck}}$ is taken high (logic 1) or left open circuit, thus selecting the crystal oscillator to be the clock, then CK must be kept low (held at 0V, or logic 0), since a high level at the CK pin would apply a continuous reset inside the i.c.

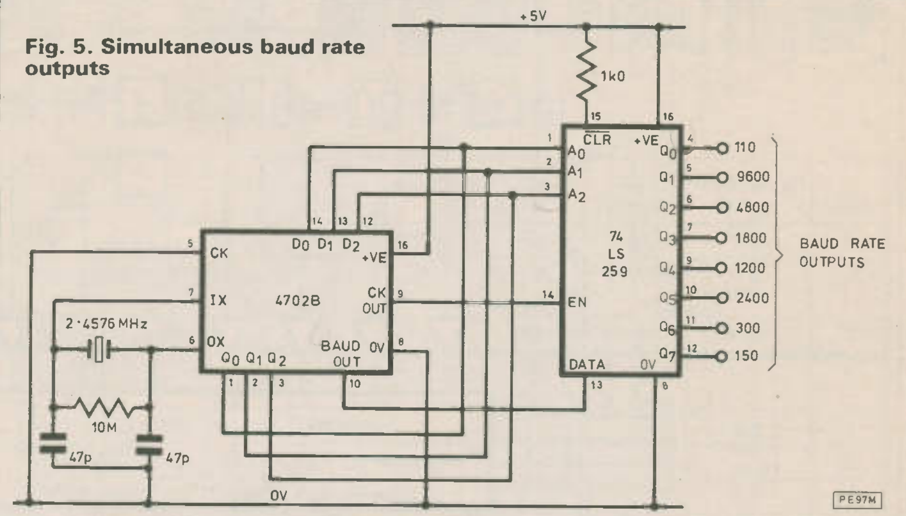
APPLICATIONS

A simple arrangement of the 4702B as a baud rate generator is shown in Fig. 4. A baud rate selection switch allows the selection of five of the most commonly used baud rates, all of which are derived from the 2·4576MHz crystal.

In Fig. 5, eight baud rate outputs are made available simultaneously by using a 74LS259 addressable latch. The simultaneous outputs Q_0, Q_1, and Q_2 of the 4702B are used to address the eight separate latches in the 74LS259. These outputs go through two complete sequences of eight states of every period of the highest output frequency (ie. the frequency corresponding to 9600 baud). Using the outputs to control the baud select inputs D_0, D_1, and D_2 causes the 4702B baud rate output to represent eight different baud rates in sequence, changing in rapid succession. This multiplexed output is converted back to eight separate baud rate outputs in a de-multiplexing action by the 74LS259. Comparing the outputs shown in Fig. 5 with the baud rate selection codes given in Fig. 3, it can be seen that the output baud rates seem to 'lag one behind' what might be expected; 9600 baud is coming out of the pin where we might expect 4800 baud to come out. This is due to the delay between the baud rate select inputs being changed, and the respective baud rate appearing at pin 10 of the 4702B, as described earlier. By the time that the baud rate output changes, the 74LS259 has moved on to the next channel.

By using different crystals, or external clocks, many different frequencies can be catered for. Although the i.c. is intended to be a baud rate generator, it can be used as a general purpose crystal oscillator/divider in many control and timing applications. In practice, the majority of applications are likely to use the i.c. as the clock for a UART in a data transmission type of circuit, so that is the basis of this month's applications project.

Fig. 5. Simultaneous baud rate outputs



AVAILABILITY

The 4702B is available from **Maplin Electronic Supplies Ltd.**

AN RS232 TO CENTRONICS CONVERTER

Most printers communicate with microcomputers using either the RS232 or the Centronics communications standards. The two are completely dissimilar; RS232 is a serial data arrangement, whereas Centronics uses parallel data transmission, each having their own advantages. Unfortunately, many printers only offer Centronics inputs, or cost considerably more if fitted with an optional RS232 interface. Similarly, some computers only have RS232 outputs available. This project enables printers with Centronics interfaces to be driven from RS232 serial data links, with a wide range of baud rates and data formats being catered for.

Fig. 6 shows the circuit diagram, with the control table shown in Fig. 7. IC1 is connected as a straightforward baud rate generator, with baud rate selection by S1 to S4. IC2 is a standard 6402 UART used as a receive device only, i.e. serial in, parallel out. Serial data comes in from pin 3 of the RS232 connector. Transistor TR3 along with its associated components form a buffer for the incoming data, converting it from its potential range of up to ±12V, to the 0 to +5V logic signal fed into the receive input of IC2, pin 20. TR2 drives the l.e.d. D18 to show when data is being received.

The serial data is converted to parallel within IC2 and fed out to the Centronics output via pins 5 to 12. When one parallel word's worth of data has been converted by IC2, the DR output (pin 19) goes to logic 1. Assuming that the busy line from the printer is low (i.e. the printer is ready for new data) then the monostable of IC3 is triggered, and produces 5µs wide negative going pulse at IC3 pin 12. This pulse is used to reset the DR output (via the $\overline{\text{DRR}}$ pin), and is also fed to the printer as a $\overline{\text{STROBE}}$ line, to latch the parallel data into the printer. If the printer happens to be busy (i.e. it's still printing the last piece of information sent) it sets pin 11 of the Centronics connector to a high level. This prevents any triggering of IC3 and turns

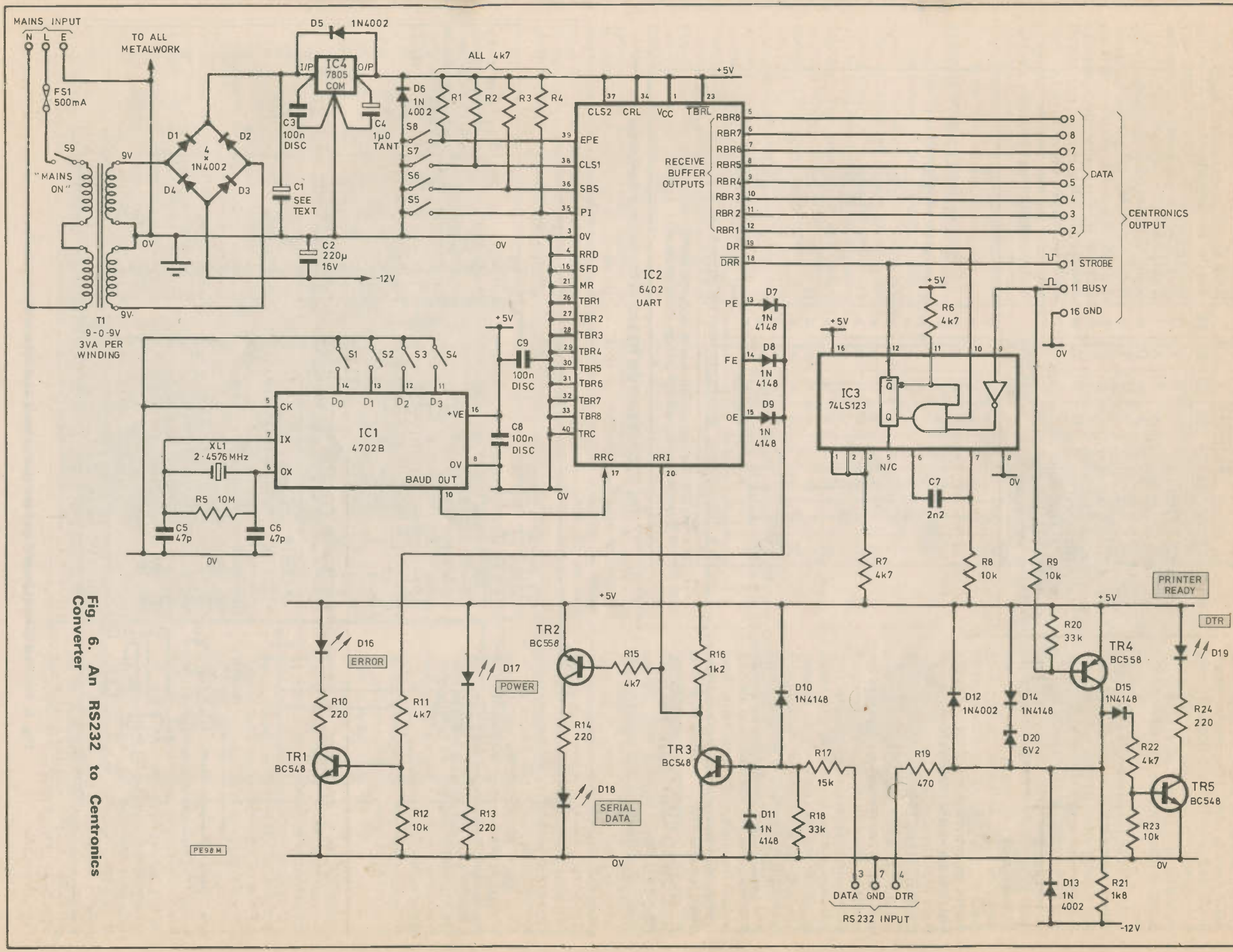


Fig. 6. An RS232 to Centronics Converter

TR4 off, causing the RS232 DTR line to be pulled down to −6·8V. (The negative excursion is limited by D14 and D20.) This tells the computer to wait before sending any more data. D19 is turned on as soon as the printer is ready for data, and off when it is busy.

D7, D8 and D9 form a simple 'OR' gate which causes D16 to be turned on if there was a parity error, framing error, or even over-run error in the received data. Hence, any illumination of D16 shows that the problems exist in the decoding of incoming serial data. S5, S6, S7 and S8 set up the various options for parity, stop bits, and character length as shown in Fig. 7. A regulated +5V, and an unregulated −12V supply, are provided by T1, D1 to D4, IC4 and their associated components.

CONSTRUCTION

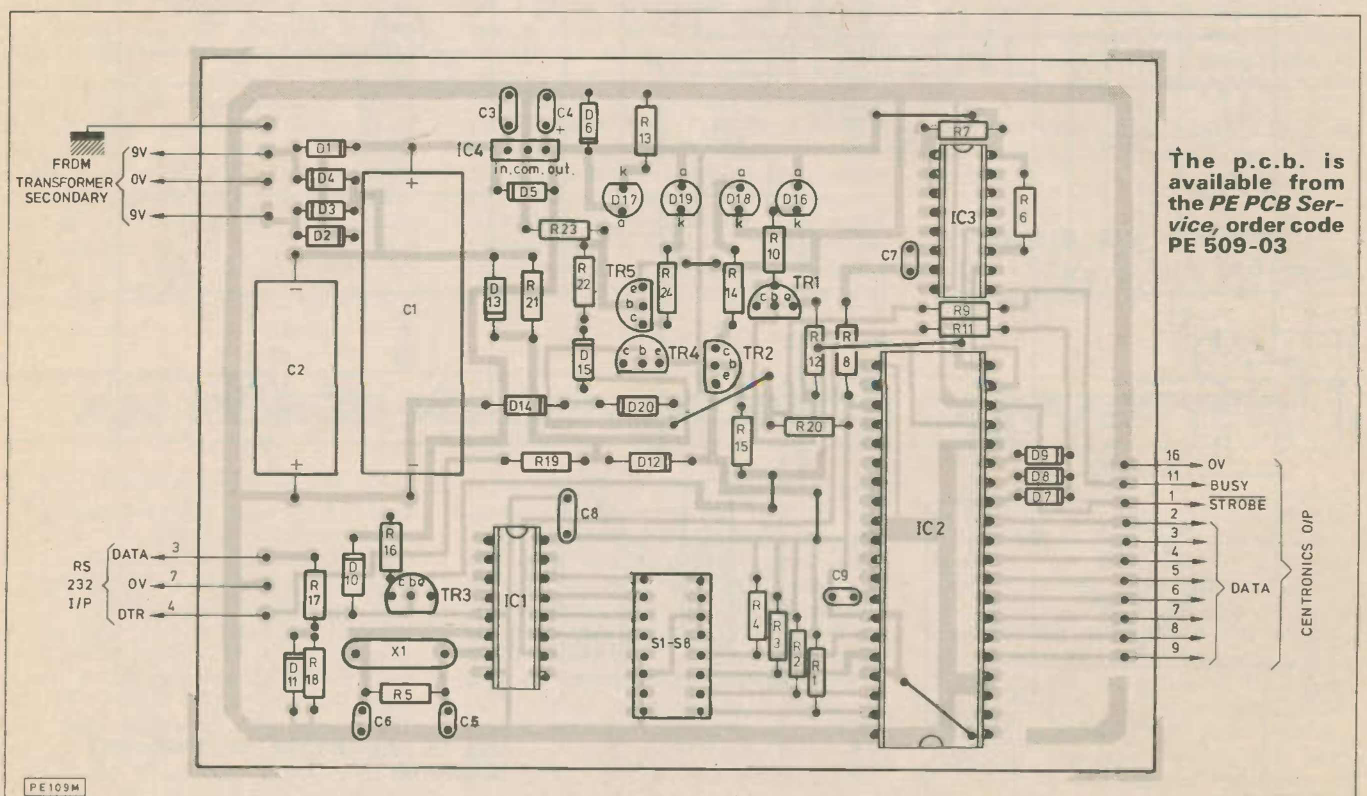
The p.c.b. layout for the circuit is shown in Fig. 8. All components are kept very low profile to allow the board to be mounted close to the upper surface of a suitable box, with holes cut out to allow the d.i.l. switch (S1 to S8) and the l.e.d.s to poke through. The l.e.d.s are held firmly off the board with cut lengths of 'Rawplug' or similar, and the d.i.l. switch is held off the board by placing it in a standard (not low profile) 16 pin d.i.l. socket. Naturally, the transformer, fuseholder, and mains switch (S9) are mounted inside the case itself. C1 should be at least 470μF 16V, and preferably higher in value—2200μF would be ideal. Due to the likely size, this capacitor may also be mounted off the board, and should be held

SWITCHES								
S1	S2	S3	S4	S5	S6	S7	S8	FUNCTION
×	×	×	×	×	×	×	0	ODD PARITY (IF SELECTED WITH SWITCH S5)
×	×	×	×	×	×	×	1	EVEN PARITY (IF SELECTED WITH SWITCH S5)
×	×	×	×	×	×	0	×	7-BIT CHARACTER LENGTH
×	×	×	×	×	×	1	×	8-BIT CHARACTER LENGTH
×	×	×	×	×	0	×	×	1 STOP BIT
×	×	×	×	×	1	×	×	2 STOP BITS
×	×	×	×	0	×	×	×	PARITY ENABLED
×	×	×	×	1	×	×	×	PARITY INHIBITED
BAUD RATE SELECTION				FUNCTION SELECTION				BAUD RATE
0	0	0	0	×	×	×	×	Im/16
1	0	0	0	×	×	×	×	Im/16
0	1	0	0	×	×	×	×	50
1	1	0	0	×	×	×	×	75
0	0	1	0	×	×	×	×	134·5
1	0	1	0	×	×	×	×	200
0	1	1	0	×	×	×	×	600
1	1	1	0	×	×	×	×	2400
0	0	0	1	×	×	×	×	9600
1	0	0	1	×	×	×	×	4800
0	1	0	1	×	×	×	×	1800
1	1	0	1	×	×	×	×	1200
0	0	1	1	×	×	×	×	2400
1	0	1	1	×	×	×	×	300
0	1	1	1	×	×	×	×	150
1	1	1	1	×	×	×	×	110

× = "Don't care" condition—can be either 0 or 1

0 = Switch turned on (or a low voltage level)
1 = Switch turned off (or a high voltage level)

Fig. 7. Control of the RS232 to Centronics Converter

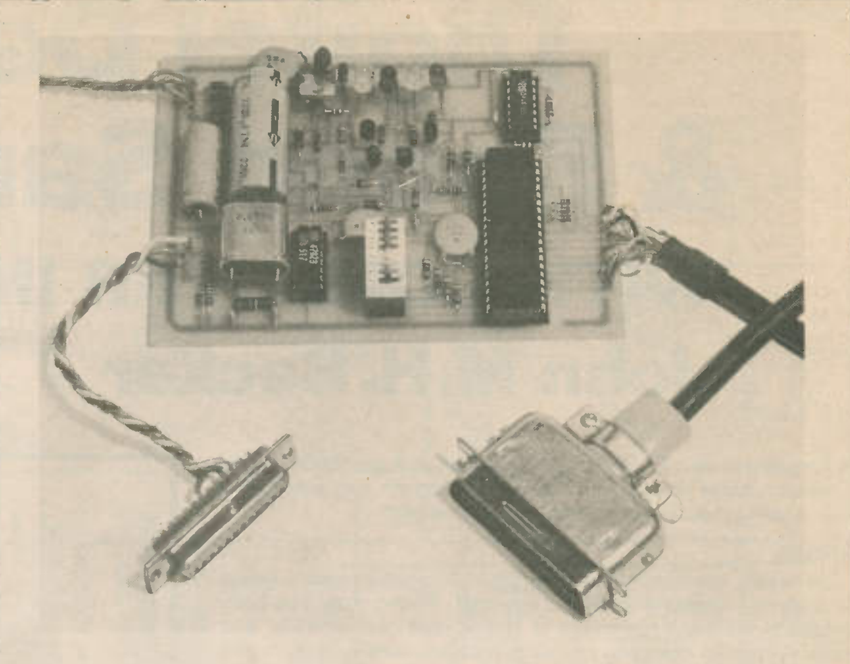


The p.c.b. is available from the *PE PCB Service*, order code PE 509-03

Fig. 8. Printed circuit board component layout and interwiring details

inside the case with suitable clips. Mains earth should be taken to the case (if metal) and all exposed metalwork, as well as to 0V. Take GREAT CARE with the mains wiring, and shroud all mains connections carefully.

The Centronics output can be wired up on a flying lead to a 'Centronics type' 36-way plug. The lead should be as short as practical; preferably less than 1 metre, and certainly it must be less than 1·5 metres in length, and should ideally be screened multicore or a ribbon cable. The RS232 connector is normally taken to be a 25-way 'D-type' connector with socket contacts. This can either be on a flying lead, or more conveniently as a chassis mounted socket fixed to the case.

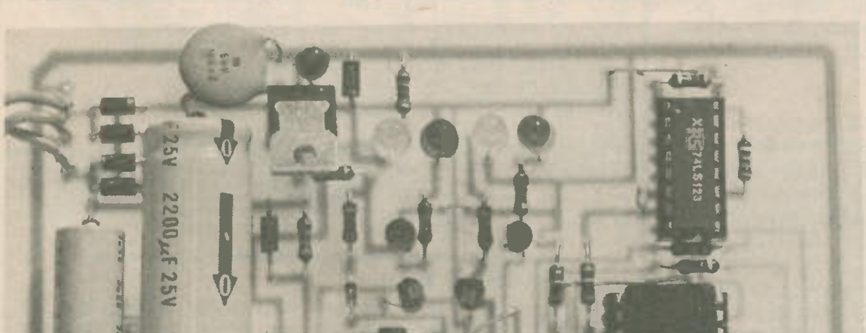


Photos: The photograph above shows the power supply, input and output leads together with the completed p.c.b. The photograph below is a close-up of the p.c.b. showing all component assembly details

USING THE CONVERTER

Switches S1 to S8 should be set according to the format of the computer's RS232 output. If this is not known, try 300, 600, 1200 or 2400 baud to start off with, and most probably 8-bit character length, one stop bit, and even parity, or possibly parity inhibited. The 'error' l.e.d. will flash if incorrect settings are being used, although sometimes the printer will apparently still function normally. Completely spurious characters being printed, or no printing action at all, is usually symptomatic of incorrect baud rate settings. Note that selecting parity to be inhibited can cause errors to be detached, since the UART will assume that the serial data contains no parity bits—if the incoming data *does* contain parity bits, errors will occur.

Finally, note that the RS232 standard is notorious for having a vast number of alternatives with regard to pin numbering, data format, and handshaking lines. Specifically, the DTR line is often applied to different pins, so try moving DTR to pin 20 of the connector for a start; if that doesn't help, then it will be necessary to look more carefully at the RS232 requirements of the computer, especially if it requires more handshake lines to be held at a fixed voltage level, as sometimes happens. Despite this cautionary note, the RS232 to Centronics converter will prove ideal for use with almost all normal RS232 and Centronics systems.



SEMICONDUCTOR CIRCUITS

This article brings to an end the current series of **Semiconductor Circuits.** In the past two years we have looked at a wide range of different integrated circuits, from electronic locks, doorbells, and power supplies through to VCAs, timers, and thermometers. Throughout the series I have tried to steer slightly away from the beaten track of very well known i.c.s, whose characteristics and performance are thoroughly documented. Hopefully, this has had two significant effects; the first being to stimulate new ideas, showing different ways of going about circuit design and different techniques, and the second being to introduce the reader to specific integrated circuits which can implement functions either previously unknown, or perhaps which were considered too complex to be practical.

Throughout the series I have tried to give plenty of practical hints and suggestions about using the i.c.s. I do hope that you have found the articles to be of interest, and that some of the applications projects have been of practical use, either in their own right as self-contained circuits, or as illlustrations of applications for the i.c.s featured each month.

We hope to be able to produce some *'Semiconductor Circuits Specials'* on an occasional basis in months to come, covering larger families of i.c. devices. For the moment, though, thanks to my friends and colleagues for their help and suggestions during the preparation of the series, and the best of luck to you if you decide to try some of the industry's more interesting or unusual i.c.s for yourself! ★

Digital Delay & Sound Sampler

WITH COMPUTER INTERFACE

John M.H. Becker **Part 4**

In this, the final part of this project, we will complete all the constructional details with the wiring diagram and also take a look at using the unit as a computer only version.

WIRING

The wiring diagram is shown in Fig. 17 together with a list of p.c.b. points which have to be connected. Wiring should be fairly straight forward but remember to check each joint carefully. It is probably best to tick each connection on the wiring diagram and chart as each connection is made.

COMPUTER PROGRAMS

If the computer program is written in Machine Code a data transfer rate of about 15kHz is possible with the 3032. This is more than adequate for the computer to act as the memory for musical echo effects without the use of the unit's own memory. Programs written in Basic are unfortunately far too slow to use for normal musical purposes, though some special effects programs might be written successfully in Basic. I am not an expert on Machine Code programming, but Listing 1 shows an example of one code that enables the 3032 to be used as an echo unit. The 3032 uses a 6502 microprocessor, as do many makes of computer, including, I believe, the various Commodores, Apples, Atari, Acorn and BBC, so this code can probably be readily converted for these machines amongst others. For series 2, 3 and 4 Commodore PETs it is likely that the code can be used unchanged. For other machines, some location addresses as indicated will need to be changed. Your manual should give the equivalents.

BASIC PROGRAM

In the program in Listing 2, lines 100 to 260 are the sub routine that accesses the machine code program. Lines 270 to 360 are the decimal equivalents of the code's Hex numbers. These allow it to be self-entered, by line 130, into memory from location 1808. Then the Basic sub routine calls up the machine code routine which runs until an interrupt from the unit causes the code to drop back to Basic for the next instruction about the delay factor to be used. I have allowed for factors of 1 to 119 to be programmed, using 30464 memory locations (119 × 256). Other memory sizes may need a different maximum delay factor. Lines 790 to 870 are the Basic equivalent of the machine code so that you know the principle, but is far too slow for musical use.

KEYBOARD SCAN

If you are writing your own code, you will probably need to disable the computer's keyboard scanning routine by the use of SEI at the start. On the 3032 the keyboard is scanned 60 times a second, and this rate is clearly heard on an audio processed signal, as the data transfer is interrupted during the scan. For this reason on my own program I call up SEI to disable the scan and rely on the S1 switch on the unit to signal an interrupt so that the code drops back to Basic whereupon another delay factor can be entered. With your machine or experience in machine code programming you may find a different way. Switching S8 back to internal memory will have the same effect upon the computer as pressing the interrupt switch S1.

Program Listing 1

```
$0710   78        SEI               ┐ DISABLE INTERUPT
$0711   A2 00     LDX   #$00        ┘ & RESET LSB COUNTER
$0713   A9 01     LDA   #$01        ┐ SET LATCH TO CA1
$0715   8D 4B E8  STA   $E84B       ┘
$0718   A9 CD     LDA   #$CD        ┐ TOGGLE CB2 DOWN
$071A   8D 4C E8  STA   $E84C       ┘
$071D   A9 ED     LDA   #$ED        ┐ TOGGLE CB2 UP & DOWN
$071F   8D 4C E8  STA   $E84C       │
$0722   A9 CD     LDA   #$CD        │
$0724   8D 4C E8  STA   $E84C       ┘
$0727   A0 00     LDY   #$00        ┐ SET PA0-7 AS INPUTS
$0729   8C 43 E8  STY   $E843       ┘
$072C   AD 4D E8  LDA   $E84D       ┐ LOOK FOR CA1 SET AND
$072F   29 02     AND   #$02        │ IF SUCCESSFUL THEN
$0731   D0 08     BNE   $073B       ┘ BRANCH AHEAD
$0733   C8        INY               ┐ OTHERWISE IF FAILED
$0734   C0 00     CPY   #$00        │ AFTER 256 ATTEMPTS
$0736   F0 02     BEQ   $073A       │ THEN JUMP BACK
$0738   D0 F2     BNE   $072C       │ TO BASIC
$073A   60        RTS               ┘
$073B   E8        INX               ┐ INCREMENT LSB COUNTER
$073C   E0 00     CPX   #$00        │ AND IF LESS THAN 256 STEPS
$073E   D0 1E     BNE   $075E       │ THEN JUMP AHEAD
$0740   EE 63 07  INC   $0763       │ OTHERWISE INCREMENT MSB
$0743   AC 63 07  LDY   $0763       │ OF MAIN ADDRESS AND CHECK
$0746   C0 81     CPY   #$81        │ THAT IS HAS NOT PASSED
$0748   90 05     BCC   $074F       │ MAXIMUM. IF IT HAS THEN
$074A   A0 08     LDY   #$08        │ THEN RESET TO MINIMUM
$074C   8C 63 07  STY   $0763       ┘ ADDRESS
$074F   EE 6B 07  INC   $076B       ┐ ALSO INCREMENT DISPLACEMENT
$0752   AC 6B 07  LDY   $076B       │ ADDRESS AND CHECK THAT IT
$0755   C0 81     CPY   #$81        │ NOT PASSED MAXIMUM.
$0757   90 05     BCC   $075E       │ IF IT HAS THEN RESET
$0759   A0 08     LDY   #$08        │ TO MINIMUM
$075B   8C 6B 07  STY   $076B       ┘
$075E   AD 41 E8  LDA   $E841       ┐ GET SIGNAL DATA AND
$0761   9D 00 08  STA   $0800'X     ┘ STORE IT AT CORRECT ADDRESS
$0764   A0 FF     LDY   #$FF        ┐ SET PA0-7 AS OUTPUTS
$0766   8C 43 E8  STY   $E843       ┘
$0769   BD 00 08  LDA   $0800'X     ┐ GET DATA FROM DISPLACEMENT
$076C   8D 4F E8  STA   $E84F       │ ADDRESS AND SEND TO OUTPUT
$076F   4C 1D 07  JMP   $071D       ┘ THEN LOOP BACK AGAIN
LOCATIONS -
$E841 (DECIMAL 59457) DATA REGISTER
$E843 (DECIMAL 59459) DATA DIRECTION REGISTER
$E84B (DECIMAL 59467) SHIFT REGISTER & LATCH
$E84C (DECIMAL 59468) CB2 PLUS CA1 POLARITY
$E84D (DECIMAL 59469) CA1 INTERUPT
$E84F (DECIMAL 59471) USER POST DATA LINES
$0800 (DECIMAL  2048) DATA STORE LOC (UPDATED BY PROGRAM)
AS WRITTEN PROG STARTS AT $0710 (DECIMAL 1808) FOR EACH 256 LOCATIONS
FURTHER ON INCREMENT THE $07 BY $01. THUS TO START AT DECIMAL 2320 (512
PLACES LATER/ ALL $07'S BECOME $09. THE #$08 MUST ALSO BE INCREMENTED BY
BY THE SAME AMOUNT/ IN THIS CASE TO #$0A. ADJUSTING THE #$81 RAISES OR
LOWERS THE MAXIMUM MEMORY LOCATION BEFORE RESET TO THE START ADDRESS/ SO TO
RESET AT 32768 INSTEAD OF 33024 AS HERE/ #$81 BECOMES #$80.
```

Constructors' Note

A full kit of parts or separate p.c.b.s and Commodore 64 and PET computer programs are available from: **Becker Phonosonics,** 8 Finucane Drive, Orpington, Kent BR5 4ED.

COMPUTER ONLY VERSION

The unit has been designed so that the timing, addressing and internal memory circuits can all be omitted and the remaining circuits used directly with a computer. For this short version all components on p.c.b. Figs. 12, 14 and 15 are omitted, and also IC33, IC34, C34, R60, S4 to S8, VR14, 15, 18, 19, 20. IC24a is not used and its pins 11 to 15 should be taken direct to the 0V line. In the place where IC33 would have been connect pin holes 1 and 2, 10 and 11. Link p.c.b. points 14 to 52, and 40 to 54. Take 63 also to 39 (as well as to 15) so that the computer toggling output is used to generate the negative voltage needed. Insert C31 on the p.c.b. in Fig. 13, which then activates a frequency generator within IC5. ★

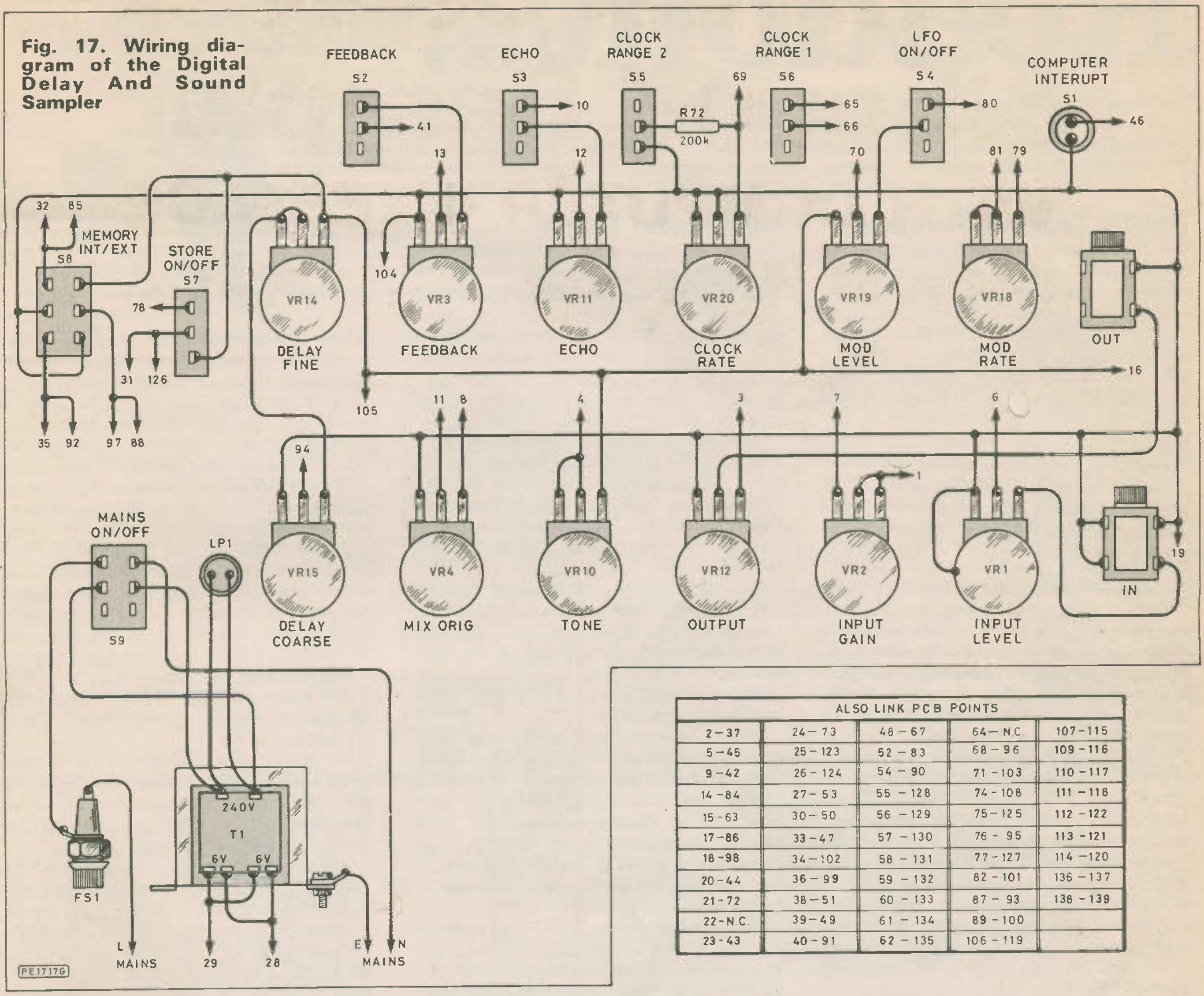


Fig. 17. Wiring diagram of the Digital Delay And Sound Sampler

ALSO LINK PCB POINTS				
2–37	24–73	48–67	64–N.C.	107–115
5–45	25–123	52–83	68–96	109–116
9–42	26–124	54–90	71–103	110–117
14–84	27–53	55–128	74–108	111–118
15–63	30–50	56–129	75–125	112–122
17–86	33–47	57–130	76–95	113–121
18–98	34–102	58–131	77–127	114–120
20–44	36–99	59–132	82–101	136–137
21–72	38–51	60–133	87–93	138–139
22–N.C.	39–49	61–134	89–100	
23–43	40–91	62–135	106–119	

Program Listing 2

```
100 PRINT"]DELAY CONTROL BASIC SUB ROUTINE PLUS    LOADER - COMMODORE 3032"
110 PRINT"QQQQQQQQQQ"
120 D=1808
130 FORA=0TO99:READC:POKEA+D,C:NEXTA
140 C=8:POKE52,1:POKE53,C
150 B=119
160 PRINT"QDELAY FACTOR 1-";B
170 INPUT A
180 IFA<0THENA=ABS(A)
190 IFA=0THENA=1
200 IFA>BTHENA=A-B:GOTO200
210 A=B+1+C-A
220 IFA>(B+C)THENA=A-(B+1):GOTO220
230 POKE(D+83),C
240 POKE(D+91),A
250 SYS(D)
260 GOTO160
270 DATA120,162,0,169,1,141,75,232,169,205
280 DATA141,76,232,169,237,141,76,232,169,205
290 DATA141,76,232,160,0,140,67,232,173,77
300 DATA232,41,02,208,8,200,192,0,240,2
310 DATA208,242,96,232,224,0,208,30,238,99
320 DATA7,172,99,7,192,129,144,5,160,8
330 DATA140,99,7,238,107,7,172,107,7,192
340 DATA129,144,5,160,8,140,107,7,173,65
350 DATA232,157,0,8,160,255,140,67,232,189
360 DATA0,8,141,79,232,76,29,7,0,0
370 :
380 :
390 EXPLANATION OF ABOVE
400 ALL LINES FROM LINE 370 ON MUST BE OMITTED WHEN TYPING IN PROGRAM
410 "]" IS THE COMMODORE WAY OF SAYING 'CLEAR THE SCREEN'
420 "QQQQQQQQQQ" IS THE COMMODORE WAY OF MOVING THE CURSOR DOWN 10 PLACES
430 D=1808:START ADDRESS FOR MACHINE CODE AS GIVEN
440 FORA=0TO99:READC:POKEA+D,C:NEXTA
450 PUTS MACHINE CODE PROG DIRECTLY INTO MEMORY FROM LOCATION 1808 ONWARDS
460 C=8:POKE52,1:POKE53,C
470 THIS LOWERS THE TOP OF MEMORY AND RESERVES IT FOR SIGNAL DATA USE
480 LOCATIONS 52 & 53 ARE COMMODORE 2000, 3000, AND 4000 SERIES LOCATIONS
490 INDICATING LSB AND MSB OF TOP OF MEMORY
500 CALCULATES AS (8 X 256) + 1 = 2049 THUS THE MEMORY ABOVE 2048 IS
510 RESERVED. FURTHER EXAMPLE - POKE 52,10: POKE 53,15
520 MEANS (15 X 256) + 10 = 3850. I.E. MEMORY RESERVED ABOVE 3849
530 B=119:SETS MAXIMUM DELAY FACTOR
540 PRINT"QDELAY FACTOR 1-",B
550 INPUT A
560 DELAY FACTOR OF ONE IS MINIMUM DELAY OF 1 X 256 MEMORY BYTES
570 DELAY FACTOR OF 119 IS MAXIMUM DELAY OF 119 X 256 MEMORY
580 BYTES = 30464 MEMORY BYTES. I.E. MEMORY LOCATIONS FROM 2048 TO 32512
590 (2048 + 30464) CAN BE USED FOR DATA STORAGE. FOR THE 3032 COMPUTER
600 THIS PUTS LAST 256 BITS OF DATA ONTO THE SCREEN (FOR INTEREST ONLY)
610 IFA<0THENA=ABS(A):IF -VE NUMBER IS USED, CONVERT TO A +VE ONE
620 IFA=0THENA=1:PROHIBITS THE USE OF A ZERO FACTOR
630 IFA>BTHENA=A-B:GOTO200:RESTRICTS RANGE
640 A=B+1+C-A:MAKES LOW NUMBERS HIGH AND HIGH NUMBERS LOW
650 IFA>(B+C)THENA=A-(B+1):GOTO220:RESTRICTS NUMBER TO WITHIN RANGE
660 POKE(D+83),C:RESETS MACHINE CODE COUNTER TO MINIMUM MEMORY LOCATION
670 POKE(D+91),A:RESETS DISPLACEMENT COUNTER TO MINIMUM
680 SYS(D):JUMPS INTO MACHINE CODE ROUTINE
690 GOTO160:AFTER DROPPING OUT OF MACHINE CODE GO FOR NEXT INSTRUCTION
700 IF YOU ARE LOCATING MACHINE PROG HIGHER IN MEMORY, SOME DATA NUMBERS
710 NEED CHANGING. FOR EXAMPLE IF YOU ARE LOCATING AT 2320 THEN IN
720 LINES 320 TO 360 NUMBERS '7' BECOME '9' AND '8' BECOMES '10'
730 TO LOWER MAXIMUM MEMORY LOCATION BY 256 PLACES TO 32768 THEN IN LINES 320
740 AND 340 '129' BECOMES '128'.
750 :
760 :
770 BASIC EQUIVALENT OF MACHINE CODE
780 :
790 F=10:REM DELAY FACTOR
800 M=2048:D=M+F:POKE59467,1:POKE59468,205
810 POKE59468,237:POKE59468,205:POKE59459,0:Y=0
820 IFPEEK(59469)AND2THEN850
830 Y=Y+1:IFY<256THEN820
840 END: (RETURN TO BASIC SUB ROUTINE FOR NEXT DELAY FACTOR)
850 K=PEEK(59457):POKEM,K:M=M+1:IFM>33024THENM=2048
860 POKE59459,255:POKE59471,PEEK(D):D=D+1:IFD>33024THEND=2048
870 GOTO810
```

Readout...

The letters published below have been received in response to an Editorial in the July issue, they show a gratifying movement in some areas but tend to underline the need for Government initiative in technical education. We will be following up this subject (see this month's Editorial)—more views are welcome.

Twenty Years of Stagnation

Sir—I write in response to your editorial July 1985 and your favourable comments regarding AEB 'O' level electronics.

You may be aware that AEB also offer *Electronic Systems* at 'A' level. This syllabus attracts about 1,000 candidates each year.

It would be easy to believe that Electronic Systems, taken as a *Third* 'A' level alongside Maths and Physics, would produce the motivation required to steer sixth form students towards degree courses in Electrical Engineering. However, the Institution of Electrical Engineers do not appear to encourage such a subject combination.

I quote from their booklet *Have you got what it takes to be an Electrical Engineer* —"Minimum qualifications for entry to an electrical engineering degree course are normally GCE 'A' levels in Mathematics and Physics, and to have a wide choice of course, it is advisable to take a third subject. This may be a second science or maths subject or an arts subject such as economics".

This view is also echoed in a pamphlet published recently by the Standing Conference on University Entrance—I quote—"You might think Electronics 'A' level has specific relevance as a preparation for university courses in the same field . . . *Most admissions tutors will be prepared to accept Electronics as a third 'A' level but it is a common view that a traditional arts subject such as English or a foreign language is preferable on general educational grounds".*

I think that the reasoning behind these statements goes something like this—

1) Vocational and Practical subjects such as Electronics, Technology etc. do undoubtedly provide career motivation towards engineering,

but

2) They do not select sixth form students with high standards of literacy and scholarly culture—only an Arts 'A' level is capable of providing these assets.

therefore

3) It is better to have a shortfall of engineers rather than accept students who have been tainted by subjects which required them to increase competence by the *practice* of skills and the *use* of knowledge.

Perhaps the education system in our country is a glorious example of the tail wagging the dog to the detriment of everyone.

David L. Thompson,
Welbeck College,
Notts.

Independent Course

Sir—We have been regular subscribers to Practical Electronics for many years at The King's School, and have tried a wide range of the ideas and projects given in your excellent magazine. I was very interested in your comment under *Twenty Years of Stagnation* in your Editorial recently and thought I would mention what is happening in a number of Independent Schools.

Recognizing the need for development in this field the Independent Schools pooled their resources in the formation of The Independent Schools' Microelectronics Centre or ISMEC. The Centre is based in Oxford at Westminster College, North Hinksey.

For the last three years, Charles Sweeten was its Director and he had a couple of staff to help. Among the variety of activities and papers produced by the Centre is the Electronics course, coming in three sections, called *Electronics 11–13*, *Electronics 13–16* and *Electronics 16–19*.

The thinking behind the course is a coordinated and integrated approach, based on the *real* situation in schools. By using a systems approach and by fitting the work into existing Physics courses, and since nearly everyone does Physics up to 'O' level, this means that the old problem of how to find the time within the curriculum can be solved relatively easily.

We have been using "11–13" for a couple of years, have trialled the "13–16" and will be one of the trial schools for the "16–19" as soon as the work has been completed. Clearly there have been teething problems, but we have found the courses to be interesting, educationally valuable and fun to do.

I hope this gives you some encouragement in the light of your worried remarks.

J. M. Roslington
(Physics Department),
The King's School,
Worcester.

Unanimous Support

Sir—May I congratulate you on your editorial on the state of electronics education in Britain in the July issue of *Practical Electronics*.

As a manager of a 60 place ITeC with a strong electronics bias, my staff and I are acutely concerned with the issue and unanimously support your protest at the general neglect of technology in our education system.

However, some glimmer of hope may be emerging—albeit at the moment on a somewhat localised scale.

Among a growing range of socially useful hardware and software coming out of this Centre our most successful product to date is an Electronics Pack, commissioned by our local Education Authority, which aims to start "hands-on" electronics training for 9 to 10 year olds in primary schools.

We have monitored initial use of the Pack in local primary schools and can attest to its success and its popularity with both teachers (non-technical) and pupils alike. The first 500 Packs are now out in force in classrooms in our 125 local primary schools and samples are being requested from isolated schools in Merseyside, Cheshire and Lancashire. We feel it deserves wider use.

We are now proceeding with a further 1,000 packs and would like to see them spread throughout more than 12,000 schools in the UK.

We have two local teachers on secondment working with us to develop Stage II of the pack, which will include devices to interface with a BBC computer in the conduct of more advanced experiments.

This is only one of several initiatives taken by Wirral Metropolitan Borough Education Authority to introduce a strong technological element into its education programme which I feel might well be worth an article. Charles Harrison, Wirral's Science Inspector of Schools has offered to host a fact finding tour of local schools and colleges.

Please keep up the pressure!

Vic Taylor,
Bromborough In-Tech Centre,
Wirral, Merseyside.

Doing Our Best

Sir—We are trying to do our best! (Ref. UK Losing Ground—*Editorial,* July '85).

When we opened in 1979 as a Sixth Form College in Warrington we introduced AEB 'A' level Electronics Systems. Having a "New Town" with Science Parks we were perhaps more conscious of the wind of change than other areas of the country.

Since we have taken on board AEB 'O' level Electronics (as soon as it was introduced) and 'O' and 'A' level Computer Science. From our viewpoint the constraints we feel are:

Accommodation. We have one physics laboratory and two classrooms converted to an "Electronics Lab" and "Com-

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Please note that when ordering it is important to give project title, order code and the quantity. Please print name and address in Block Caps. Do not send any other correspondence with your order.

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,,		409–03	£2.90
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,,	MAY '85	504–04	£9.06
,,		504–05	£5.12
,,		504–06	£9.54
,,		504–07	£5.40
,,		504–08	£10.24
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puter Lab" respectively. These labs are in use for teaching purposes every minute of every day, and even then we have to teach physics 11 hours each week out of the laboratory.

Staffing. Staffing policy is number, rather than curriculum based. For example, our school is allocated a certain number of staff and has to cover curriculum needs from this.

Thus numbers in physics and electronics and maths classes are large in order to suppport minority subjects. With the practical work involved in electronics we therefore have to limit numbers taking the subject (even if we had the accommodation to cope).

Perhaps the most worrying aspect of all is the fact that none of our electronics or physics students over the past years has ever considered the possibility of a career in teaching. They are all too aware of the low esteem in which the teaching profession is currently held by society.

We are fortunate in that we are due to have a New Technology Design Centre built at the college. However, in the current economic climate we are not counting on anything until we see the first brick laid.

How do we staff it? We have to find the staff from our normal allocation!

We do try but need support from society.

D. Henderson, B.Sc.
Priestly College, Warrington.

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GOODMANS	HB WOOFER	8in.	60	8	£13.50	£1
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CELESTION	DISCO/Group	10in.	50	8/16	£21	£2
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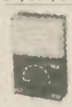

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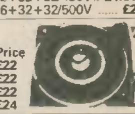

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