Australia $1.60 New Zealand $1.75 Malaysia $4.95

PRACTICAL JANUARY 1985 · £1·00

ELECTRONICS

ROBOTICS · MICROS · ELECTRONICS · INTERFACING

8 EXTRA PAGES

Mono/Stereo Chorus & Flanger

Lasers & Holograms

RADAR SECURITY ALARM

CONSTRUCTION DETAILS

Featured in Electronics & Music Maker

TAKE COMPLETE CONTROL OF YOUR MUSIC with the

MCS-1

professional quality MIDI-controlled sampling unit

Once again, Powertran and E&MM combine to bring you versatility and top quality from a product out of the realms of fantasy and within the reach of the active musician.

The MCS-1 will take *any* sound, store it and play it back from a keyboard (either MIDI or lv/octave). Pitch bend or vibrato can be added and infinite sustain is possible thanks to a sophisticated, looping system.

All the usual delay line features (Vibrato, Phasing, Flanging, ADT, Echo) are available with delays of up to 32 secs. A special interface enables sampled sounds to be stored digitally on a floppy disc via a BBC microcomputer.

The MCS-1 gives you many of the effects created by top professional units such as the Fairlight or Emulator. But the MCS-1 doesn't come with a 5-figure price tag. And, if you're prepared to invest your time, it's almost cheap!

Specification

Memory Size: Variable from 8 bytes to 64K bytes.

Storage time at 32 KHz sampling rate: 2 seconds.

Storage time at 8 KHz sampling rate: 8 seconds.

Longest replay time (for special effects): 32 seconds.

Converters, ADC & DAC: 8 bit companding. Dynamic range: 72 dB.

Audio Bandwidth: Variable from 12 KHz to 300 Hz.

Internal 4 pole tracking filters for anti-aliasing and recovery.

Programmable wide range sinewave sweep generator.

MIDI control range: 5 octaves.

+1/V/octave control range: 2 octaves with optional transpose of a further 5 octaves.

Digital Delay Line

Introduced in 1982, Powertran's DDL has brought digital quality effects to thousands of musicians. Still available in kit form at only £179.00 + VAT.

KIT £499 + VAT

BUILT £699 + VAT

Write or phone now to place an order.
Powertran Cybernetics Limited,
Portway Industrial Estate,
Andover, Hants, SP10 3PE.
Telephone: 0264 64455

VISA

Access

POWERTRAN cybernetics ltd

PE ROBOTICS MICROS ELECTRONICS INTERFACING

ISSN 0032-6372

VOLUME 21 Nº 1 JANUARY 1985

CONSTRUCTIONAL PROJECTS

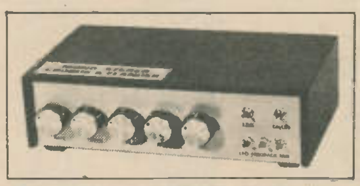
GENERAL FEATURES

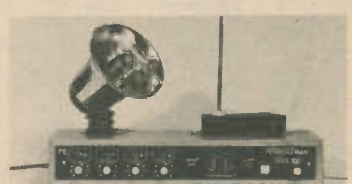
NEWS & COMMENT

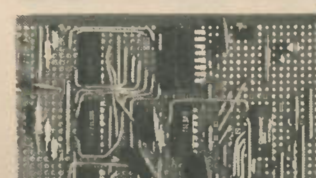
THIS MONTHS COVER...

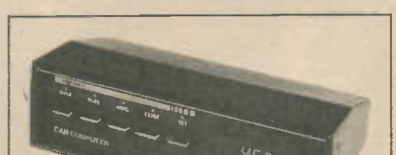
Internal "anatomy" of the Stereo/Mono Chorus & Flanger project.

Our inset photograph shows a British Telecom technician checking for Laser radiation emission. This month's article, LASERS & HOLOGRAMS explains how they are created and what they are used for.









OUR FEBRUARY ISSUE WILL BE ON SALE FRIDAY, JANUARY 4th, 1985 ***(see page 28)***

SPEAKERS

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

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	14
CRD33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

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

ZENERS

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

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

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 indudes 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

VEROBOARDS 0·1"

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

VERO WIRING PEN and Spool — 380p

Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 — 250p

0·5" LCD DISPLAYS

3½ digit	495
4 digit	530
6 digit	625

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
4×2¾×2½"	103
4×4×2½"	120
5×4×2"	105
5×2¾×1½"	90
5×2¾×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS

1A T0220 Plastic Casing

	+ve		−ve	
5V	7805	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	LM317P	99
78H12 12V/5A	640	LM323K	500
78HG+5 to		LM337T	175
+24V 5A	599	LM723	30
79HG −2.25V to		TBA625B	75
−24V 5A	685	RC4194	375
LM309K	120	RC4195	160
		78S40	225

SWITCHES

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

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

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

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

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

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

ROTARY: Mains 250V AC, 4 Amp — 64p

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

AMPHENOL CONNECTORS

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

ASTEC UHF MODULATORS

6MHz Standard — 375p
8MHz Wideband — 550p

ANTEX Soldering Irons

C15W	535p	Spare bits	90p
G517W	545p	Elements	280p
G18W	550p	Iron stand	180p
XS25W	560p	Heat Shunt	35p

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 TEXTOOL DIL SOCKET

24 way — 575p
28 way — 695p
40 way — 845p

DIL PLUGS (Headers)

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

RIBBON CABLE

(price per foot)

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

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	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

Gold flashed contacts	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41612 2×32 way	275p	—	220p	285p
DIN 41612 2-3×32 way	295p	—	240p	300p
DIN 41612 3×32 way	360p	385p	260p	395p

'D' CONNECTORS:

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

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

SIL Sockets

0.1"
20 way **65p**
32 way **95p**

EDGE CONNECTORS

·1"

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

TRANSFORMERS (mains Prim. 220-240V)

3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA — **98p**
6VA: 2x6V- 5A; 2x9V- 4A; 2x12V-0 3A; 2x15V–25A — **250p**
12VA: 2x4V5-1 3A; 2x6V-1 2A; 2x12V- 5A; 2x15V- 4A — **345p** (35p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1 2A 9V-1 2A; 12V-1A 12V-1A; 15- 8A 15- 8A; 20V- 6A 20V- 6A — **385p** (60p p&p)
50VA: 2×6V-4A; 2×9V-2·5A; 2×12V-2A; 2×15V-1 5A; 2×20V-1 2A; 2×25V-2A; 2×30V-0 8A — **520p** (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2·5A; 2×30V-1 5A; 2×40V-1 25A; 2×50V-1A — **965p** (60p p&p)

TUNED 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 **£229**
- **EPSON RX80** F/T Printer **£245**
- **EPSON FX80** Printer **£316**
- **EPSON FX100** Printer **£435**
- **SEIKOSHA GP100A** **£125**
- **KAGA/TAXAN KP810** Printer **£246**
- **KAGA/TAXAN KP910** Printer **£346**
- **BROTHER HR15** Daisywheel Printer **£339**
- **Centronics PRINTER CABLE** for all the above printers to interface with the BBC Micro **£7**
- **KAGA – RGB** 12 inch medium resolution colour monitors **£195**
- **ZENITH 12" Hi-RES**, Green Monitor 40/80 column select switch, value for money. **£68**
- **MICROVITEC 14"** colour monitor. RGB input. Lead incl. **£165**
- **MICROVITEC 1451** Hi-res 14" Monitor incl. Lead **£255**
- **QL RGB MONITOR**, medium resolution **£239**
- **TEX EPROM ERASER**. Erases up to 32 ICs in 15-30 min. **£30**
- **Spare 'UV lamp bulbs** **£8**
- **C12 COMPUTER Grade BASF Cassettes** in Library Cases **36p**
- **8½" or 9½" Fan fold paper** (1000 sheets) **£7** **(150p)**
- **Teleprinter Roll** (no VAT) **£4**

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.

Plastic Library DISC STORAGE CASES

Holds ten 5¼" Diskettes **£2**

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
£14

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE

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

Price: £29.95 (Carr. £1)
Centronics Cable **£8**

CRYSTALS

32·768KHz	100
100KHz	545
200KHz	370
455KHz	370
1MHz	275
1·008M	275
1·28MHz	450
1·5MHz	420
1 6MHz	595
1·8MHz	545
1·8432M	250
2 0MHz	225
2·4576M	200
2·5MHz	225
2·56250M	220
3·2768M	150
3·57954M	98
3 6864M	300
4 0MHz	150
4·032MHz	290
4·194304M	200
4·433619M	100
4 608MHz	200
4·80MHz	200
5 0MHz	160
5·185MHz	300
5·24288M	390
6 0MHz	140
6·144MHz	150
6 5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8 867237M	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	170
14·7456M	175
14·765MHz	250
15·0MHz	240
16·0MHz	220
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	265
24·0MHz	170
24·930MHz	325
29·695MHz	150
26·670MHz	325
27·125MHz	295
27·145M	190
27·648MHz	300
38·66667M	240
48·0MHz	240
55·5MHz	400
100MHz	295
116·0MHz	300
145·8MHz	225

BBC MICROCOMPUTER

SPECIAL OFFER THIS MONTH ...... ONLY £315

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

DISC DRIVES FOR BBC MICRO

- **CS100 – TEC** Cased with own Power Supply, S/S, 40 track, 5¼", 100K **£125**
- **CD200 – TEC** Twin Cased with own PSU, S/S, 40 track, 5¼", 200K **£236**
- **CS200 – TEC** Single Cased with own PSU, S/S, 80 track, 5¼", 200K **£149**
- **CD400 – TEC** Twin Cased with own PSU, S/S, 80 track, 5¼", 400K **£299**
- **MITSUBISHI** 5¼" Slim line Disc Drives double sided, double density, track density 96 TPI, track to track access time 3msec.
- **SINGLE MITSUBISHI** Slim line – Cased with own PSU, DS/DD, 1 Megabytes (400K with BBC) **£169**
- **TWIN MITSUBISHI** Slim line – Cased with own PSU, DS/DD, 2 Megabytes (800K with BBC) **£349**

51¾" Disketies (Life Time Warranty)

- 10 3M Diskettes S/S D/D **£13**
- 10 3M Diskettes D/S D/D **£23**

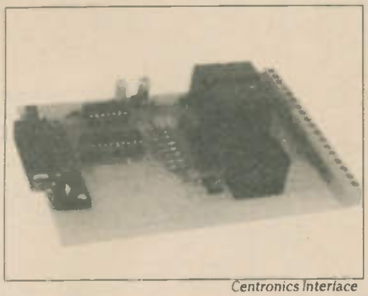
Many more types available.
Please send SAE for our detailed leaflet.
N.B. Carriage is extra on drives.

WATFORD ELECTRONICS

Tel. (0923) 40588 **Telex. 8956095**

Cirkit. Making it bigger and better.

Cirkit stock all the components, accessories and tools and the kits you're looking for. Designed and selected to offer the best possible standards at the best possible price.



Centronics Interface

Cirkit Kits

CIRKIT ELECTRONICS TOOL KIT
Contains: 15W Soldering Iron 2 spare bits, heat shunt, solder, pliers, cutter, screwdriver 40-00007 15.56

AUDIO FUNCTION GENERATOR
Versatile waveform generator with sine, triangular and square wave outputs. On board mains PSU 41-01302 27.00

STEREO 40W AMPLIFIER
Single board 40W per channel stereo amplifier 41-01301 38.00

STEREO VU METER
5 LED per channel stereo VU meter for use with stereo amplifiers 41-01401 11.50

5W AUDIO AMP
A very compact audio output stage for use in a wide range of equipment 41-01406 4.60

UNIVERSAL AMP
A universal audio pre-amp with a gain of 10 41-01604 6.45

MONO REVERBERATION UNIT
Single channel, spring line reverb unit to add echo effects to tape recording etc. 41-01602 10.00

TONE GENERATOR AND DETECTOR
Very low distortion tone generator and signal detector for circuit fault finding 41-01603 10.46

10MHz DFM
8 Digit LED digital frequency meter and period measurement 41-01500 54.10

50MHz PRESCALER
Extend the range of the 10MHz DFM to 50MHz 41-01501 8.55

1-5MHz PRE AMP
Low frequency pre-amp and waveform shaper for the 10MHz DFM 41-01502 5.13

70cm PRE AMP
Low noise, miniature pre-amp for the 70cm amateur band 41-01506 4.78

70cm CONVERTER
70cm to 144MHz low noise converter featuring pre-aligned helical filter, schottky diode mixer and low noise transistors 41-01405 21.50

1-30V 1mA-2A PSU
Adjustable 1-30V Power supply with pre-setable current limit from 1mA-2A 41-01600 37.46

5-12V 1A PSU
Adjustable PSU from 5-12V with current protection, 1 amp max output 41-01504 6.45

1-30V 1.5A PSU
1-30 volt adjustable PSU with protected output up to 1.5 Amps 41-01402 10.45

3 DIGIT LED DVM
DVM to read up to 99.9 volts or configured as an ammeter to read up to 9.99 amps 41-01403 17.00

INFRA RED LINK
Single channel IR Link with relay output 41-01300 9.60

TEMPERATURE SENSOR
Thermistor based temperature sensor with relay output 41-01303 6.20

LOCOMOTIVE SOUND GENERATOR
Realistic steam sound and whistle for model railways 41-01304 9.20

LAMP DIMMER
Control lamps and drill speed 41-01305 5.70

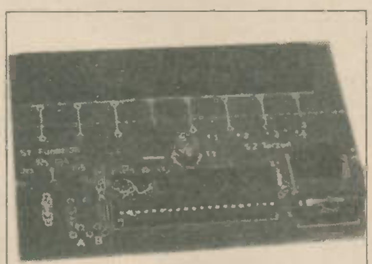
WATER LEVEL ALARM
Alarm to indicate high water level or flooding 41-01601 2.70

3 NOTE CHIME
Doorbell chime with adjustable tones 41-01503 7.00

2M PRE AMP
Miniature low-noise MOSFET pre-amp for the 2m amateur band 41-01307 3.91

2M CONVERTER
Low noise 144MHz-28MHz amateur band converter 41-01306 17.35

2M POWER AMP
20W - 10dB gain - power amplifier for the 2m band. Automatic TX switch over, RX pre-amp, robust construction 41-01404 32.87



10MHz DFM

CRYSTAL CALIBRATOR
Crystal reference calibrator for alignment of receivers, outputs at 4, 2, 1MHZ, 100, 50 AND 10KHz 41-00801 4.32

CB NOISE SQUELCH
Improves the mute performance of the majority of CB rigs 41-01605 5.40

CENTRONICS INTERFACE
Connect your personal computer to the outside world via the Centronics printer output 41-01406 22.50

70cm PA
10W Power amp to boost the output of handheld and portable 70cm transceivers 41-01505 33.82

Selected Lines

BBC to Centronics Connect Cable		03-10019	7.25
Dragon to Centronics Connect Cable		03-10017	7.25
C12 Computer Cassette		21-00012	0.55
Interface 84 multiplexed Ram Card		40-84000	59.95
Z80A Industrial controller		40-82000	54.95
EPROM Eraser 84T		40-82001	59.95
6502 Micro Controller		40-65020	54.95
6802 Micro Controller		40-68020	54.95
PB2720	80dB Piezo Buzzer	43-27201	0.55
10M15A	10.7 Center Freq.	20-10152	2.10
10M08AA	10.695 Center Freq.	20-11152	3.49
FC177	LCD (Freq.)	39-17700	20.00
CM161	LCD Clock	40-80161	8.25
8 x 0.3"	IC socket	28-00800	0.12
14 x 0.3"	IC socket	28-14000	0.13
16 x 0.3"	IC socket	28-16000	0.13
6V	KUIT-A Relay	46-80000	0.48
9V	KUIT-A Relay	46-80001	0.48
12V	KUIT-A Relay	46-80002	0.48
CX120P	COAX Relay	46-90120	11.96
CX520D	COAX Relay (N-type)	46-90520	26.98
CX540D	COAX Relay (BNC)	46-90540	26.98

HT-320
Multimeter (20kΩ-V) 56-83201 14.00

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £5 please. We reserve the right to vary prices in accordance with market fluctuation.
Just send for our catalogue or visit one of our three outlets at:

200 North Service Road, Brentwood, Essex. CM14 4SG;
53 Burrfields Road, Portsmouth, Hampshire. PO3 5EB;
Park Lane, Broxbourne, Hertfordshire. EN10 7NQ.
Items in stock despatched within 48 hours

To: Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire. EN10 7NQ.
I enclose 85p. Please send me your latest catalogue and 3 x £1 discount vouchers!
If you have any enquiries please telephone us on Hoddesdon (0992) 444111.

Name ______________________

Address ______________________

____

Telephone ______________________

Area of Special Interest ______________________

PE1

Cirkit
Bigger Stock. Better Service

New Winter Catalogue Out Now!

ELECTRONIC SIREN KIT

Produces an extremely loud piercing swept frequency tone from a 9-15V supply. Enable input for easy connection to alarm circuits. Includes 5in. Horn Speaker. £7.90

Mini Siren
As above, but with a small speaker (instead of horn speaker) for internal use. £4.30

SECURITY PRODUCTS

Protect your home and property and save by building your own burglar alarm system.

Stair Mat 23 × 7 in (950 120) £1.70
Floor Mat 29 × 16 in (950 125) £2.60
Tamper-proof connecting block (950 110) £0.30
Door/Window Contacts. Flush mounting, 4 wire, Magnet/switch Per Pair. (950 140) £1.05
Window Tape 0.5'' wide. 50m. (950 145) £2.50
Window Tape Terminations Per pair. (950 150) £0.36
Key-operated Switch. 1.5A/250V SPST Heavy chrome metal. (350 128) £4.50
Passive Infra-Red Detector
Detects intruder's body heat. Range 10 metres. 12V DC, n/o & n/c contact. Size: 4 × 2 × 2 ins. (950 135) £45.00
Alarm Control Unit. 4 input circuits, 2 instant and 2 delayed. Adjustable entry, exit and alarm times. Built and tested. Full instructions supplied. Size: 180 × 130 × 30mm. Supply: 12V DC. (950 160) £26.00
Ultrasonic Burglar Alarm. Self-contained mains or battery powered unit complete with horn and AC adaptor. £45.00 + p&p £2.20
8W Horn Speaker. 5.5 ins. 8 ohm. Ideal for sirens, etc. 2.5m lead and 3.5mm jack plug. (403 148) £6.15

IR GARAGE DOOR CONTROLLER KIT

For controlling motorised garage doors and switching garage and drive lights on/off up to a range of 40 ft.

Lots of applications like controlling lights and TVs, etc. in the home. Ideal for aged or disabled persons, this coded kit comprises of a mains-powered infra-red receiver with a normally open relay output plus two latched transistor outputs, battery-powered transmitter and opto-isolated solid state mains switch.

XK103 £25.00
XK105 Extra transmitters £10.50

PANTEC KITS

PN2	FM Micro Transmitter	£7.50
PN3	Stabilised Power Supply	£13.70
PN5	2 × 10w Stereo Amplifier	£14.50
PN6	2 × 40w Stereo Amplifier	£24.95
PN7	Pushbutton Stereo Preamp	£12.80
PN8	Tone & Volume Control	£13.60
PN11	3w FM Transmitter	£11.95
PN13	Single Channel FM Transmitter	£9.80
PN14	Receiver for above	£15.50

TOP QUALITY . . . TOP SERVICE *BOTTOM PRICES!*

For FREE CATALOGUE send 9" × 6" SAE — contains full list of stock range all at very competitive prices. Cash with order (except account customers). Access or Barclaycard telephone orders welcome. Add 65p p&p + 15% VAT to all UK orders. Overseas customers add £2.50 p&p Europe, £6.00 elsewhere. Giro No. 529314002. Goods by return subject to availability. Shop open 9am – 5pm (Mon-Fri). 10am – 4pm Sat). ALL PRICES EXCLUDE VAT

CHRISTMAS PRESENTS GALORE

BEGINNERS' PROJECTS PACK
Contains solderless breadboard, components and booklet with instructions to build TEN fascinating electronic projects, e.g. thermostat, burglar alarm, light operated switch, electronic lock, touchswitch, siren. Requires 9V PP3 battery. £12.50

MW RADIO KIT
Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2 cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.50

3-NOTE DOOR CHIME
Based on SAB0600 IC the kit includes all components, loudspeaker, PCB, pre-drilled box (95 × 71 × 35mm) and full instructions. Requires a 9V battery and pushswitch. IDEAL PROJECT FOR BEGINNERS. Order as XK102. £5.50

20kV MULTIMETER
19 ranges including 10A dc. Resistance to 10M, ac & dc volts to 1kV. Battery checker and continuity buzzer. Size: 135 × 89 × 40mm. (405 104) £11.75

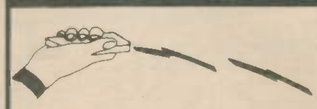
DIGITAL MULTIMETER
19 ranges including dc current to 10A, resistance to 20M, ac & dc volts and npn/pnp transistor gain. Full overload protection. Comes with test leads, battery and case. Size: 175 × 93 × 42mm (405 204) £32.00

20kV MULTIMETER
23 range quality multimeter with 12A dc current, ac and dc volts to 1200V, resistance to 1M and dB scale. Transistor gain and leakage scales, battery tester. Size: 155 × 102 × 56mm. (405 106) £16.95

STOCKING FILLERS All full spec. branded devices.

PACK (1) 650 Resistors 47 ohm to 10Mohm — 10 per value £4.00
PACK (2) 40 × 16V Electrolytic Capacitors 10µF to 1000µF £3.25
PACK (3) 60 Polyester Capacitors 0.01 to 1µF/250V — 5 per value £5.55
PACK (4) 45 Sub-miniature Presets 100 ohm to 1 Mohm — 5 per value £2.90
PACK (5) 30 Low Profile IC Sockets 8, 14, and 16 pin — 10 of each £2.40
PACK (6) 25 Red LEDs (5mm dia.) £1.50

INFRA-RED REMOTE CONTROL KITS



These kits are designed to enable infra-red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi-Fi or TV. The application will determine the interface circuitry between the receiver and the controlled device. General instructions and applications are supplied. The kits are coded and provide a high degree of security and noise immunity.

MK 18 Transmitter Kit — for use with MK11/MK12 receivers. Requires PP3 battery. Size: 8 × 2 × 13cms. Range approx. 60 ft. £6.80

Keyboards for MK18
MK9 4-way for use with MK12 £1.90
MK10 16-way for use with MK12 £5.40
MK13 11-way for use with MK11 £4.35

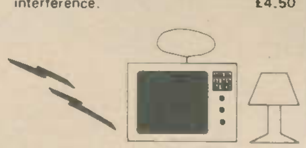
MK11 Receiver Kit — mains powered. Provides 10 latched plus 3 analogue outputs ideal for controlling audio amplifiers, TV or lighting where control of light brightness is required. £13.50

MK14 AC Power Controller Kit — for (phase) controlling AC loads from MK11 analogue outputs, eg lamp dimming. £5.20

MK19 Stereo Amplifier Controller Kit — for remote control of bass, treble and volume (or balance) by MKII. Includes a one of 10 decoder remote channel or input selection. May be connected between the pre-amp and power amp of almost any audio system. £10.70

MK12 Receiver Kit — mains powered with 16 latched or momentary outputs. Latched version is for applications requiring one output on at a time, eg TV channel selection. Momentary type gives an output only during transmission. Lines may be latched as required.
Size: 9 × 4 × 2cms. £13.50

MK15 Dual Latched Solid State Relay — for switching mains loads such as lamps, TVs, etc. from the outputs of the MK12 (momentary). 15 items may be switched independently using 8 MK15s. Triacs (not supplied) switch at mains zero to reduce interference. £4.50



MICROPROCESSOR TIMER KIT

Designed to control 4 outputs independently switching on and off at preset times over a 7-day cycle. LED display of time and day, easily programmed via 20-way keyboard. Ideal for central heating control (including different switching times for weekends). Battery back-up circuit. Includes box. 18 time settings.

CT6000K £39.00
XK114. Relay Kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts £3.90
701 115 Additional Relays £1.65

ELECTRONIC LOCK KIT

With hundreds of uses indoors, garages, car anti-theft devices, electronic equipment, etc. Only the correct easily changed four-digit code will open it! Requires a 5-15V DC supply. Output 750mA. Fits into standard electrical wall box.
Complete kit (except front panel)
XK101 £11.50
Electric Lock Mechanism for use with existing door locks and the above kit. (Requires relay.) 12V AC/DC coil. (701 150) £14.95

HOME LIGHTING KITS

These kits are designed to replace a standard wall switch to control up to 300w of lighting.

TDR300K	Remote Controlled Light Dimmer	£14.95
MK6	Transmitter for above	£4.50
TD300K	Touch Dimmer	£7.75
TS300K	Touch Switch	£7.75
TDE/K	2-way extension for above kits	£2.50
LD300K	Rotary controlled Light Dimmer	£3.95

DISCO LIGHTING KITS

DL1000K — This value-for-money 4-way chaser features bi-directional sequence and dimming. 1kW per channel. £15.95
DLZ1000K — A lower cost uni-directional version of the above. Zero switching to reduce interference. £8.95
Optional opto Input allowing audio 'beat'/light response (DLA/1) 70p
DL3000K — 3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. £12.95

OTHER KITS

CT1000K	Clock/Timer	£14.90
CT1000KB	Clock/Timer + Box	£17.40
XK126	DVM/Thermometer	£15.50
MK1	Thermostat	£4.60
MK2	Solid State Relay	£2.60
MK4	Temperature Control	£6.50
MK5	Mains Timer	£6.50
MK6	Infra Red Transmitter	£4.50
MK7	Infra Red Receiver	£10.50

All kits include PCBs, components and assembly instructions.
For further details send S.A.E.

TK ELECTRONICS

11-13 Boston Road
London W7 3SJ

ORDERS 01-567 8910
ENQUIRIES 01-579 9794
01-579 2842 TECHNICAL AFTER 3pm

PE VOLUME 21 Nº1 JANUARY 1985

BEWARE

It is sad to reflect that with all the technology available to us we are still unable to control the general level of theft. With sophisticated detection and alarm systems protecting so many areas one would assume the likelihood of theft would be reduced. However, we simply seem to be breeding an ever-more sophisticated criminal.

Of course, electronics is often the reason for the theft. With tasty loot like video recorders, colour TVs and home computers in most homes, the ease with which thousands of pounds worth of equipment can be removed is frightening. With this in mind we are constantly publishing new alarm systems and looking at ways in which the householder can help himself. We bring you the means to do it in this issue with the radar alarm system.

This article was started in our October issue but we had to delay publication of the second part due to problems with the transmitter design. These problems have been overcome with a new, more simple and compact transmitter and we show all the constructional details of this sophisticated unit in this issue. For any readers who missed part one (see what you miss by not buying every issue!) we can supply a photostat for 75p.

The system can work through walls and floors/ceilings so you can detect that intruder without any tell-tale wires and switches; because of this it is also much more difficult to avoid. Such a system is of course easier to install than a "wires and switches" type of unit.

COMPUTER CHRISTMAS

At the time of writing all the signs are pointing to another boom in sales of microcomputers this Christmas. Once you have the new machine and are becoming tired of continual games, what do you do with it? While a magazine like *Software Index* can inform you of software availability (it now lists over 5000 programs!), we on *PE* and our sister publication *Everyday Electronics and Computer Projects* can give some extra abilities to the micro with our add-on projects.

Robots are a specialised area of add-ons but we also carry many other ideas. Next month *PE* will publish a Spectrum DAC/ADC board and the following month a low cost speech synthesiser for the BBC. In March we will also start a monthly page on the BBC micro, looking at hardware, interfacing and giving general information on the machine. The page will be written by our regular contributor David Whitfield, a self confessed BBC fanatic and professional software man to boot.

GREETINGS

The staff of *PE* extend seasonal greetings to all our readers.

Mike Kenward

Editor Mike Kenward

Secretary Pauline Mitchell

Editorial Tel: Poole (0202) 671191

Advertisement Manager
David Tilleard 01-261 6676

Secretary
Christine Pocknell 01-261 6676

Classified Supervisor
Barbara Blake 01-261 5897

Ad. Make-up/Copy
Brian Lamb 01-261 6601

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

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

Components are usually available from advertisers; where we anticipate difficulties a source will be suggested.

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.

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

BACK NUMBERS and BINDERS...

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

Binders for PE are available from the same address as back numbers at £5.50 each to UK or overseas addresses, including postage, packing and VAT.

SUBSCRIPTIONS

Copies of Practical Electronics are available by post, inland for £13, overseas for £14 per 12 issues, from: Practical Electronics, Subscription Department, IPC Magazines Ltd., Room 2816, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment for subscriptions can also be made using a credit card.

Phone:
***Editorial* Poole (0202) 671191**

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

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

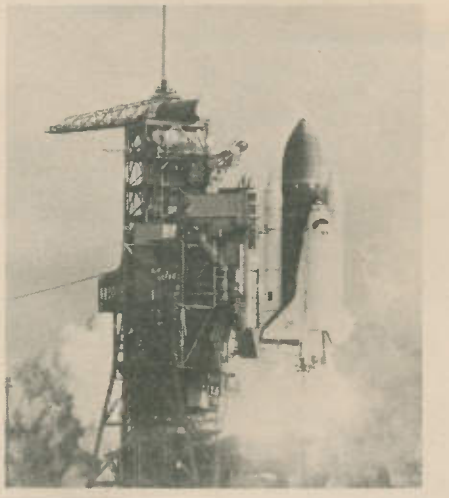
WINNERS TO WITNESS LAUNCH

Industry sponsored schools' competitions are an interesting, if not new marketing method. Some of you may remember the annual 'Cocoa Project' from Cadbury/Bournville, when the prizewinners won a decorative tin-box filled with a chocolate assortment. Some of the prizes these days are certainly less edible but are nevertheless a great deal more exciting. A trip to see the Space Shuttle launch, including a trip to see Walt Disney's EPCOT centre is presently on offer from the Bradford based display-monitor manufacturers, Microvitec PLC.

Children in around ten and a half thousand secondary schools throughout the UK are presently busying themselves with the problems posed in the preliminary rounds of the *CUB British Schools Computer Challenge.* These initial rounds require the entrant to provide hard-copy proof when a set of programming problems has been solved. Each of the rounds is being dealt with on a mail-out basis. The quarter finals will deal with more complex programming and robot interfacing problems, negotiations are at present being held for the televising of the final stages of the competition in April or May. The competition involves teams of three contestants with a maximum upper age limit of 16, so as to encourage young people in as many schools as possible to take part. The rounds have been organised with the natural cycle of the academic year in mind, so that it can be run during term time with the major prize being taken in August. It has been structured so as to accommodate a challenge between British and American schools, possibly in 1986.

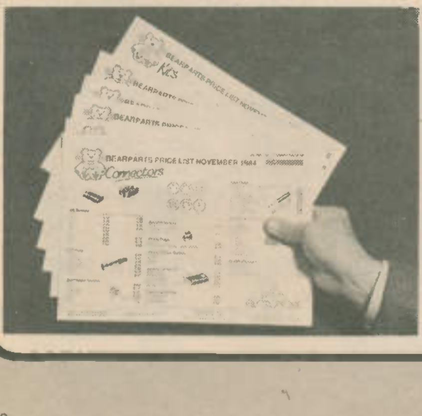
Microvitec is a new company, only four years old. During that time, according to their Managing Director Tony Martinez, they have managed to supply over 92 per cent of all UK schools with their CUB colour monitors.

The Shuttle launch trip will be awarded to the winning team of three and their competition support teacher.



FREE COMPONENTS PACK

A new components supplier is operating a service from Deeside, North Wales. Systems Electronique have a new slant on giving their customers information about the components they supply. A4 size price cards are supplied free of charge along with cards containing kits' information and special offers, they are automatically updated by post.



Six basic component-cards are used which cover the general ranges required by hobbyists, schools and colleges etc; they are Connectors, Passive components, Opto-electronics, Hardware and Semiconductors (2). A return-of-post service is promised and a telephone-order service via Barclaycard and Access will soon be introduced. The company HQ also operate a counter service, and will be retaining their 10 per cent off kits and components offer until the end of January.

A free sample pack of components is available along with a set of cards and easy to use order forms from, Systems Electronique (UK) Ltd., Unit 26, Engineer Park, Sandycroft, Deeside, Clwyd. (0244 536700).

Down Under

A shroud of mystery surrounds an artifical intelligence system, developed in secret by a Western Australian company. The system 'Hi-Q' is being marketed by the Government of Western Australia as an entirely new approach to artificial intelligence. Few details have yet been released, what follows therefore is a brief summary of information so far received by this office.

Three years ago, a team of researchers from Formulab Technology (Australia) Pty Ltd. stubbed its toe on a particular 'effect' which was studied for four months before it was fully understood. It is this as yet unqualified effect that forms the basis of the new technology, or autonomic intelligence.

Further work was carried out in well-guarded research premises in close liaison with the Government until, over a year ago, a graphics recorder using the system "astonished" visitors to an international electronics exhibition in Sydney. The veil was partially lifted recently when Mr. Bryce, Deputy Premier and Minister for Technology, announced that one of the keys to the security of the system was an LSI custom chip commissioned by a US manufacturer. The recorder has many skills. The most basic is the clever and simple production of graphics for promotional and teaching purposes. Another capability is the recording of complete books in its silicon circuits.

Formulab say, "Our secret is that we are able to produce the system and its ancillary devices in an extremely compact form and at only a fraction of the cost—perhaps only five per cent—of equipment with similar functions. We further believe that, as a generic technology, it has more potential than anything else known to us in the world. Its potential is enormous." Moreover, the recorder is "a computer-like structure incorporating non-volatile solid state cartridges—and advanced enough to be analogous to the human brain. It makes possible the high-speed storage of more data than ever before in an extremely compact area; one solid state memory brick alone has the capacity of eight standard micros and the recorder's memory can be easily trebled."

The versatile recorder can also be used for the electro-mechanical control of machine tools. At the touch of a switch it becomes a security system. The intelligence system is also the heart of a non-volatile portable memory pack that makes possible low voltage recording of data in almost any area.

The language used is called Confluent, because it has many streams whose values merge to expand the language. It is believed to be the first exponential language. A Formulab spokesman said: "We hope to bring the recorder to the UK in the near future."

MARKET PLACE

NEW SPECTRUM

The new ZX Spectrum + has been in the shops now since last October. It is the latest offering from Sinclair, expecting to grab yet another slice of the micro market's Christmas pie.

This new machine is essentially the standard Spectrum with seventeen function keys and a space bar added. It is housed in a similar case to the QL and costs £179.95, the price includes six applications programs, Scrabble, Make a Chip, Chequered Flag, Chess, VU-3D—a design and graphics program and Tasword 2—a 'Spectrum range' word processing program. Also supplied is an 80 page user guide complemented by an introductory cassette.

The machine's most obvious advantage is the more professional typewriter action keyboad. It is fully compatible with all existing Spectrum software and peripherals. Features such as, eight colours, high resolution graphics, and sound over ten octaves, have been retained.

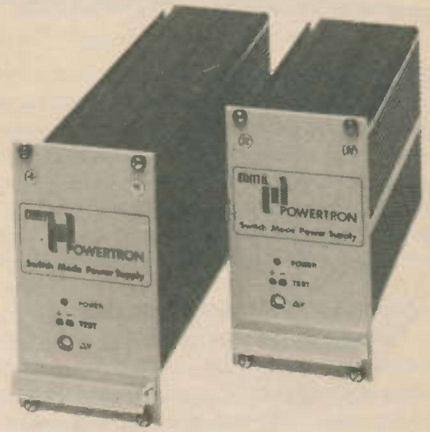
The Spectum + was actually available in the shops on the day it was announced, which went some way to retrieving the good-will lost by Sinclair during the QL saga. They believe that their main competitor in this venture will be the Commodore 64, followed by the Amstrad CPC 464 and the MSX machines from Japan.

State of the Art PSU's

West Hyde Developments Ltd., has come of age and as part of its twenty first birthday celebrations has launched a new range of switched mode power supplies—designed by Powertron.

Traditionally West Hyde has been known as suppliers of cases and enclosures for electronic and electrical equipment, and has always worked in close liason with the hobbyist market.

The power supplies represent a big step forward in power supply technology in that they have eliminated the need for bulky 50Hz transformers and huge capacitors. The state of the art high frequency switching techniques and high output power to volume ratios have also contributed to reducing weight and heat generation. There are eight models in the range giving a choice of either 5, 12, 15 or 24 volts at 60 or 100 watts. Further details from, West Hyde Developments Ltd., 9–10 Park Street Ind. Est., Aylesbury, Bucks. HP20 1ET (0296 20441).



** The general principles of switched mode power supplies will be the subject of a feature article in PE later this year.*

POINTS ARISING...

INGENUITY UNLIMITED

October '84

We have received a letter concerning the 'Automatic Bilge Pump' control circuit, which points out some potential hazards in deploying this kind of circuitry.

Designers of bilge sensor probes have to compromise between *high sensitivity* to work through probes fouled by oil and dirt, and *low sensitivity* to avoid false triggering caused by condensation. Electrolytic corrosion by salt water is yet another problem.

Most important of all is that the relay contacts which energise the pump be *sealed from the potentially explosive engine fumes*. The pump is a highly inductive load and therefore, apart from the current surge across the contacts on closure, there is also a spark generated by back e.m.f. each time the contacts open. In the confined atmosphere of an engine compartment any spark can cause a disaster.

Countdown...

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

Amusement Trades International Dec. 18–Jan. 14. Olympia. **E5**
Your Computer Xmas Fair Dec. 30–Jan. 2. Olympia. **K2**
International Light Show Jan. 14–28. Olympia. **E6**
British Toy & Hobby Fair Jan. 18–Feb. 2. Olympia. **D6**
Windmills (IEEIE meeting) Jan 24. Seeboard H.Q. Hove, Sussex **B3**
Component Fair March 10. Carleton Community Cntr., Pontefract (on A1 to Darrington). **F2**
Circuit Technology March 26–28. **E**
IFSSEC (fire/security) April 4–22. Earls Court, London. **S**
Cast (Cable & Satellite) April 16–18. NEC, Birmingham **F5**
Photoworld April 23–May 6. Earls Court. **I**
Fibre Optics & Lasers April 30–May 2. Olympia. **E**
Custom Electronics & Design Techniques April 30–May 2. **E**
All Electronics Show/ECIF April 30–May 2. Olympia 2. **E**
Field Service & Repairs April 30–May 2. Olympia 2. **E**
Automan (manufacturing) May. NEC. **T1**
IBM Computer User May 14–16. NEC, Birmingham. **O**
Business Telecom May 21–23. Barbican, London. **O**
Networks June 25–27. Wembley Conf. Cntr. **O**
Cable July 9–11. Metropole, Brighton **O**
Personal Computer World Show Sept. 18–22. Olympia 2. **M**

D6	✆ 01-701 7127
B3	IEEIE ✆ 01-836 3357 (non-members welcome. Tickets not required)
E	Evan Steadman ✆ 0799 26699
E5	✆ 01-228 4107
E6	✆ 058 84 658
F2	Pontefract Am. Rad. Soc. N. Whittingham ✆ 0977 792784
F5	✆ 01-487 4397
I	ITF ✆ 021-705 6707
K2	Reed Exhibitions, Surrey Ho., 1 Throwley Way, Sutton, Surrey
M	Montbuild ✆ 01-486 1951
O	Online ✆ 01-868 4466
S	✆ 01-387 5050
T1	Cahners ✆ 0483 38085

Mono/Stereo Chorus & Flanger

JOHN M.H.BECKER **PART ONE**

THE majority of circuits published for musical effects units are usually only designed for mono use, and as such are ideal for the performing musician. However, there are many instances where the effects can be beneficially used with stereo prerecorded sources such as cassettes or record players. Home studio recordings can also benefit from special effects enhancement of a composite stereo mix, when facilities do not run to separate multitrack processing.

AÇOUSTIC ENHANCEMENT

Solo tracks sometimes lack depth to their acoustic quality, and can sound flat and dull, particularly when close microphone recording techniques have been used. Frequently the microphone has to be kept close to the performer in order to provide sufficient signal strength, and to minimise the intrusion of background sounds. With most recording requirements it is vital to allocate separate microphones to individual performers, or groups of performers, so that with multitrack recording each track can subsequently be treated to its own mix down characteristics. Restoration of acoustic depth can then be given by several methods including echo and reverb units, of which a stereo version was published in *PE September 1984*. Greater depth can also be simulated by introducing a chorus effect.

CHORUS

Basically chorus is the sound produced by two or more performers singing or playing identical music. Naturally none of the performers, however professional, will be precisely in identical pitch, amplitude or synchronisation with the others, and consequently the sound will be characteristically fuller. It is not always possible or desirable to use several performers to produce a full sound, and other techniques are sometimes preferable. One method is to use several identical recordings played back simultaneously, though with a short time displacement between them. This though is not practical for live performances and anyway the sound is subject to the same amount of time and amplitude displacement on each track, and without pitch modification. For a better simulated chorus effect the relationships between the various time and pitch displacements should be perpetually varying. It is feasible, though not very convenient, to constantly vary the playing speeds of the same recorders to give this changing synchronisation, but modern electronics allow a simpler method to be employed, and one that can be used with both live and recorded sources.

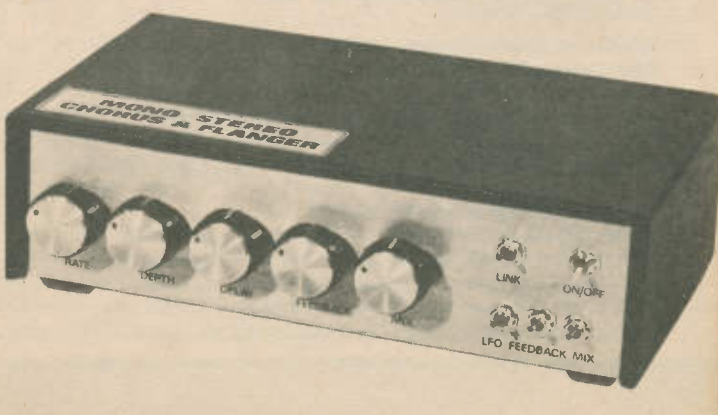
ELECTRONIC DELAY

Several chips have become available which can be fed with a signal, and then emit it at the other end after a suitable delay. By varying the amount of delay on a regular or irregular basis, the relationship of the delayed signal to the original can be kept constantly shifting and by mixing the two together the chorus effect can be simulated. The use of such a unit will not replace the need for multi-musician groups, but an enhanced and fuller sound can be created by this simple technique.

Very usable chorus effects can be produced by using only one modulated delay circuit, though if several are used with differently varying delays a closer approximation to the true natural chorus effect can be obtained. Unfortunately in simple electronic chorus units it is not straightforward to satisfactorily provide differently varying delay rates to several delay chips. Certainly each can be driven by a separate delay controlling signal, but there is the danger of reaction between the control signals as these are produced by high frequency oscillators having their clock frequency varied by a modulating voltage. Although the clock signals are normally outside the audio range, if two or more interact then an additional composite signal can be produced that contains low frequency sub-harmonics. As the high frequency signals vary in relation to each other, the sub-harmonics can intrude into the audio spectrum, and cannot be filtered out without also losing essential information from the required audio signal. There are techniques for eliminating the harmonic interaction, but these add to the complexity and the cost. None the less, excellent results can be achieved just by using one or more delays in series all controlled by the same modulated clock frequency. If each delay is fed separately to a mixer stage and combined with the original unprocessed signal, multitracked chorusing results.

DELAY OSCILLOGRAMS

Using a pulse as the signal source, the varying delay relationships of a double tracked chorus unit can be easily seen on an oscilloscope. In the oscillograms shown in Fig. 1a to 1c the first peak is that of the original pulse and the other two are the signals emerging from two cascaded delay chips. The amplitude of the peaks is shown to be different, but it can be readily varied. The clocking frequency is being modulated so that the time delay is constantly increasing and decreasing. The photographs show the progression of the delay from its shortest to its longest. It will be seen that not only are the delayed peaks changing their time delay in relation to the original, but that they are also changing with regard to each other. In addition to the delay changes, pitch



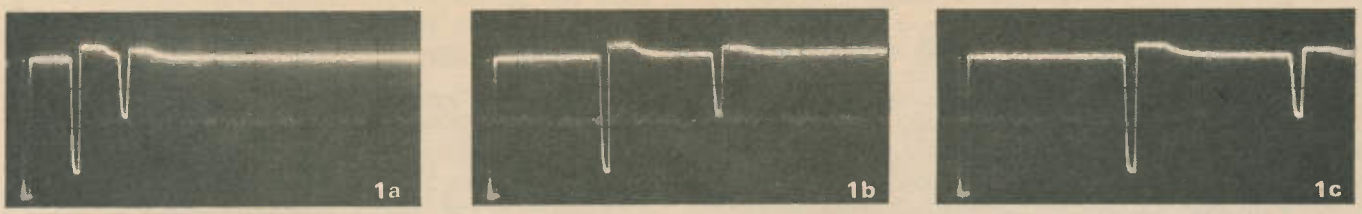


Fig. 1. Progression of pulse echo as delay is lengthened by the modulation control. Peak 1 is the original click, peak 2 is the first echo and peak 3 is the second echo

changes also occur. Consider a note of 440Hz, concert 'A'. Normally the time of each cycle remains constant at 1/440 of a second. If the time between the cycles is varied by introducing a changing delay then by definition the note is no longer the same. In effect the doppler shift principle often associated with approaching or receding fire engine sirens is being introduced. As the distance between the cycles shortens so the pitch increases, and vice versa. Thus in a modulated chorus unit not only is the synchronisation between the original and processed sounds changing, but also the frequency relationship, just as occurs with natural chorus. It will also be apparent that if pitch is being constantly varied, then vibrato is also occurring.

MODULATION

There is an optimum modulation rate that produces the most interesting and satisfying results and is associated with the consequent vibrato depth and rate. If too slow a modulation rate is given, the effect tends to sound similar to a 'wowing' record deck due to the pitch change. Too fast a modulation rate either will produce delay changes too fast to be noticed, or at its worst, will have a frequency that is within the audio spectrum, and will be heard as a low hum. Certainly this could be filtered out, but again only at the expense of the frequency response of the original. The generally accepted ideal modulation rate is about 6·5Hz and analysis of most vibrato and tremolo rates shows a rate within this region. However, slightly faster rates can also produce interesting results. The maximum depth of modulation and thus the maximum degree of pitch change can also be quantified from analysis of the recordings of professional musicians. The results show a strong tendency towards the maximum pitch change of about a quarter to half a tone of the original frequency. With a delay chip the degree of pitch change will only be the same for identical frequencies. Other frequencies present at the same time will be subject to greater or lesser degrees of pitch change. Thus for a composite signal passing through a chorus unit, true vibrato can only be approximated.

FLANGING

Flanging is an effect somewhat related to reverberation and phasing, and can be readily produced with only slight modification to a chorus unit circuit. It has similar feedback qualities to reverb, though with greater resonance, and at the same time consists of a modulated phase change relationship both to itself and to the original signal. It produces a strong tunnel-like effect with an accentuated upper frequency pitch change and under some conditions of speech or singing, this can sound like an eerie additional

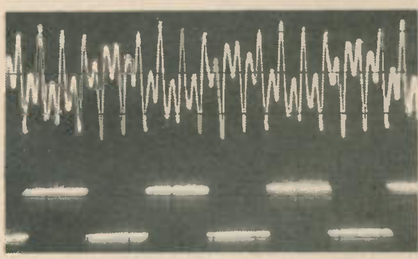


Fig. 2a. Square-wave input

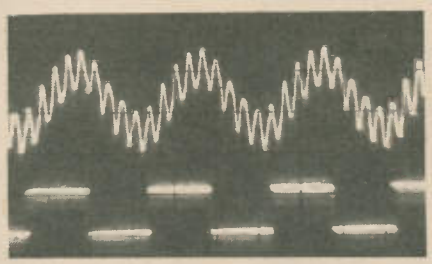


Fig. 2b. Square-wave input with a different delay setting

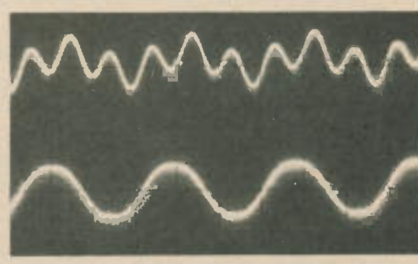


Fig. 2c. Sine-wave input

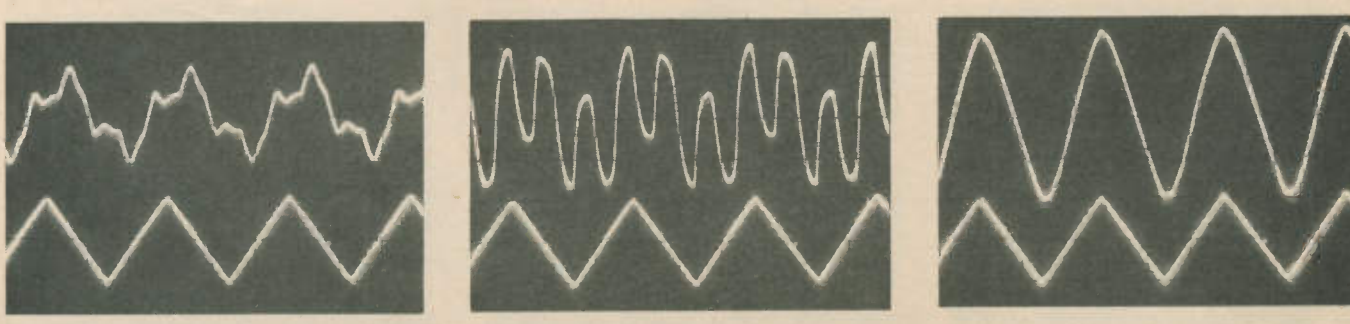


Fig. 2d to 2f. Flanging resonance as modulating sweep progresses.

Fig. 2. The bottom trace is the original and the top trace is the mixed output

background voice accompanying the performer. The effect is produced by passing the signal through the delay stage, the delay rate of which is constantly changing, though at a slower rate than for chorusing. After passing through the delay stage, the signal is fed back upon itself to the start of the delay loop. The amount of feedback is critical. If too much is given, the signal level will increase each time round the loop, resulting in perpetual howl. Whilst howl can be used if well controlled in some effects units, in this instance it is definitely undesirable. If too little feedback is given, the flanging effect does not develop. The correct amount lies within a narrow band, so that the maximum enhancement results without howl. At the correct settings and with the optimum delay times and modulation rate changes, the phase and pitch changes of the feedback loop result in repeated emphasis and de-emphasis of particular frequencies and their harmonics. The oscillograms of Fig. 2a to 2f show some of the effects visible on an oscilloscope.

The filtering occurs of course because the time delay produces a full 180° phase shift at particular frequencies, and when the shifted signal is mixed with the unshifted one, they cancel each other out. The counterpart of the cancellation is when both are in phase, and so enhance each other. (Oscillograms Fig. 3a to 3c.) The enhancement occurs at the peaks of the waveforms, in other words at their edges. By definition a flange is a raised edge, so presumably this is where the name of the effect comes from. The most noticeable flange effect is created with higher frequencies having a high harmonic content, with short delay times modulated at a slow rate. Although the effect is still produced with purer or lower frequency tones, it is less noticeable to the ear. Paradoxically a very pronounced different effect is produced by fast modulation with deep sweeping delay changes. Music then loses its tonal qualities and takes on a very deep whooshing effect, but although it is unmusical, it none the less can be used for dramatic sound changes.

CIRCUIT DESCRIPTION

The dual chorus and flanging unit to be described here has been designed to produce strong chorus and flanging effects with both mono and stereo signals. For normal stereo use each channel retains its independence with the effects being produced by separate processing circuits. With mono signals there is a choice of single or double chorusing, and single or double flanging. Stereo signals can also be combined for treating as a mixed mono signal and given the same doubly enhanced processing, though with the loss of channel separation for the processed part of the signal. A block diagram is given in Fig. 4. In essence the unit consists of two identical signal routes each providing a delay, controlled feedback, and controlled mixing producing separate composite processed signals suitable for presenting to a normal amplifier system. However, the two delay and feedback paths can be cascaded to produce enhanced chorus and flanging with identical composites appearing at both outputs.

BASIC SIGNAL ROUTING

The complete circuit diagram of the Chorus and Flanger unit is shown in Fig. 5. A mono signal, or one half of a stereo pair, is brought into the initial buffer stage IC1a. Two inputs are provided to this stage, one via R1, the other bypassing R1. The route via R1 is more suited to higher level signals from a preamplified source up to about 1·5V r.m.s. The stage gain here is nominally at unity, that is, the same level comes out from IC1a as goes in. The low input bypasses R1, and the gain is then about 10. This input is more suited to sources producing an output up to about 150mV r.m.s., but for retention of the best signal to noise characteristics any input signal should be capable of producing an output from IC1a in the region of 1 to 1·5V r.m.s. and so ideally should be pre-amplified. From IC1a the signal is split, one path going direct to the output mixer stage IC1d, and the other to the filter and mixer stage IC1b. To achieve greater clarity of the processed signal, slight pre-emphasis of the treble regions is given by the parallel path of R5 and C2. The gain of stage IC1b is set by the relationships of R5 to R8, but higher frequencies bypass R5 via C2 and so are given greater gain. Lower frequency signals are forced to pass through R5 as they cannot get through C2, and so only achieve normal gain. The low pass characteristics of IC1b are set by C3 and C33, and limit the very high frequencies which could otherwise produce distortion within the delay stage IC2. Normal waveform balancing through IC2 is trimmed by applying an optimum d.c. bias to its input via VR3. At the correct setting of VR3, equal emphasis is given to both phases of the a.c. signal passing through. IC2 is a superb delay line chip that consists of 1536 separate delay stages within its small 8-pin d.i.l. format. It is a bucket brigade type analogue delay unit that passes a sampled amplitude charge from stage to stage at a rate determined by a controlling clock frequency. The time taken for a sample charge to pass through can be calculated from the formula: time = (delay stages/clock frequency)/2000 where the frequency is in hertz and the answer in milliseconds. The stream of sampled charges emerge from two outputs at the end of the delay, are summed at VR1 and are typically at the same level as they went in. Because the signal has been sampled, a residual trace of the clocking frequency is also contained in the output. This is partially cancelled out by adjustment of VR1. The remainder is filtered out in the stage

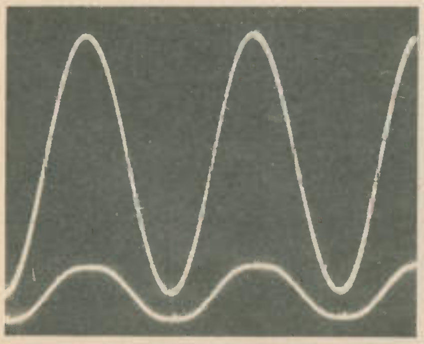


Fig. 3a. In-phase (accentuated)

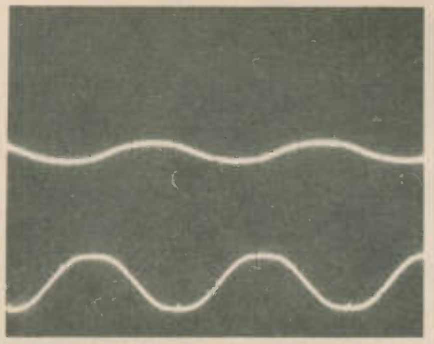


Fig. 3b. Nearly out of phase

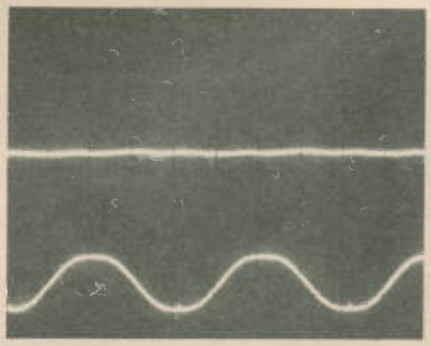


Fig. 3c. Out of phase

Fig. 3. Phase enhancement and cancellation. Top trace combined output, bottom trace original signal

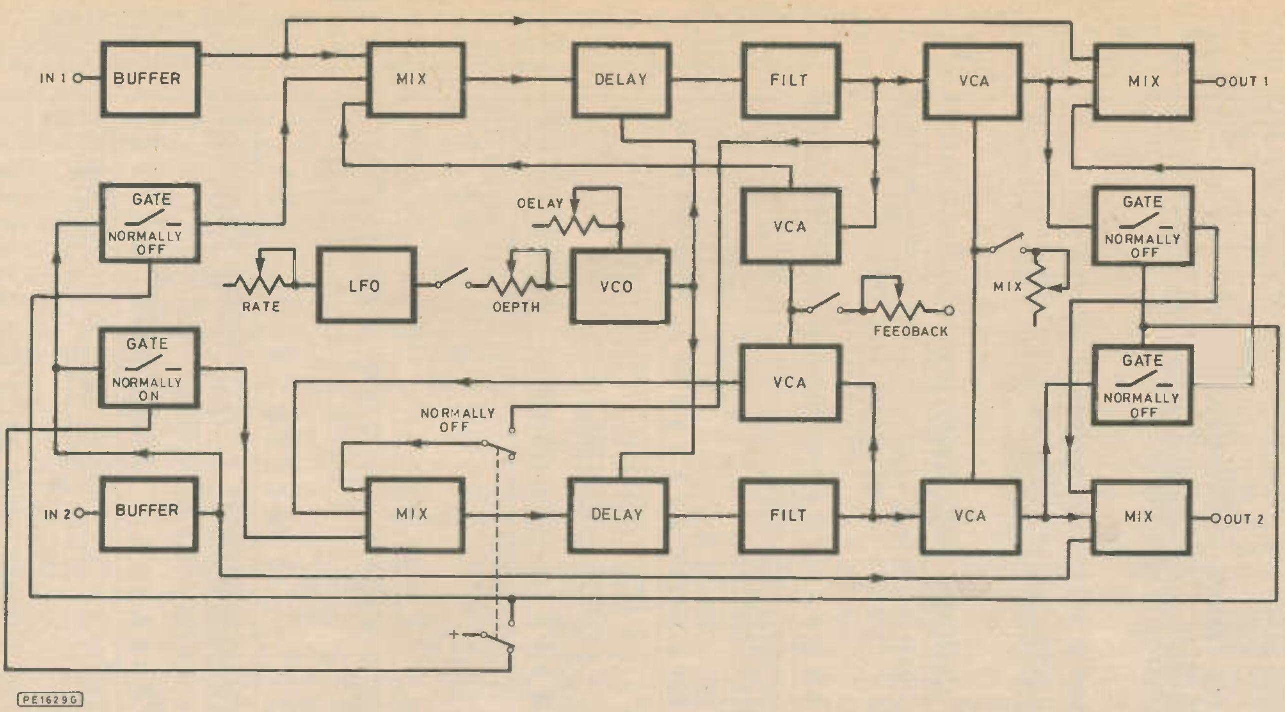


Fig. 4. Block diagram of the Chorus and Flanger unit

COMPONENTS . . .

Resistors

R1, R28	91k (2 off)
R2, R29, R73, R75, R82, R83	10k (6 off)
R3, R4, R6, R7, R8, R9, R10, R14, R15, R16, R17, R21, R22, R23, R24, R25, R26, R30, R31, R33, R34, R35, R36, R37, R41, R42, R43, R44, R45, R49, R50, R51, R52, R56, R57, R66, R71, R72, R74, R80	100k (40 off)
R5, R32, R63	390k (3 off)
R11, R12, R13, R38, R39, R40, R54, R55	47k (8 off)
R18, R19, R46, R47, R59, R60, R61, R65, R67, R69, R70	1k (11 off)
R20, R48	200k (2 off)
R27, R53, R62	470 (3 off)
R58, R64	180k (2 off)
R68	4k7
R76, R78	2k (2 off)
R77	82k
R79	300k
R81	1M2

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

Capacitors

C1, C4, C8, C9, C13, C18, C20, C21, C23	1µ 63V elect. (9 off)
C2, C10	4700p polystyrene (2 off)
C3, C12, C25	56p polystyrene (3 off)
C5, C6, C15, C16	330p polystyrene (4 off)
C7, C17	180p polystyrene (2 off)
C11, C33, C34, C35, C36	100p polystyrene (5 off)
C14	4µ7 63V elect.
C19	470µ 6V elect.
C22, C26	22µ 10V elect. (2 off)
C24	470p polystyrene
C27, C28	470µ 10V elect. (2 off)
C29, C30, C31, C32	100n polyester (4 off)

Potentiometers

VR1, VR2	4k7 skeleton pre-set (2 off)
VR3	10k skeleton pre-set
VR4	1M skeleton pre-set
VR5, VR6, VR8, VR9	100k lin (4 off)
VR7	1M lin

Semiconductors

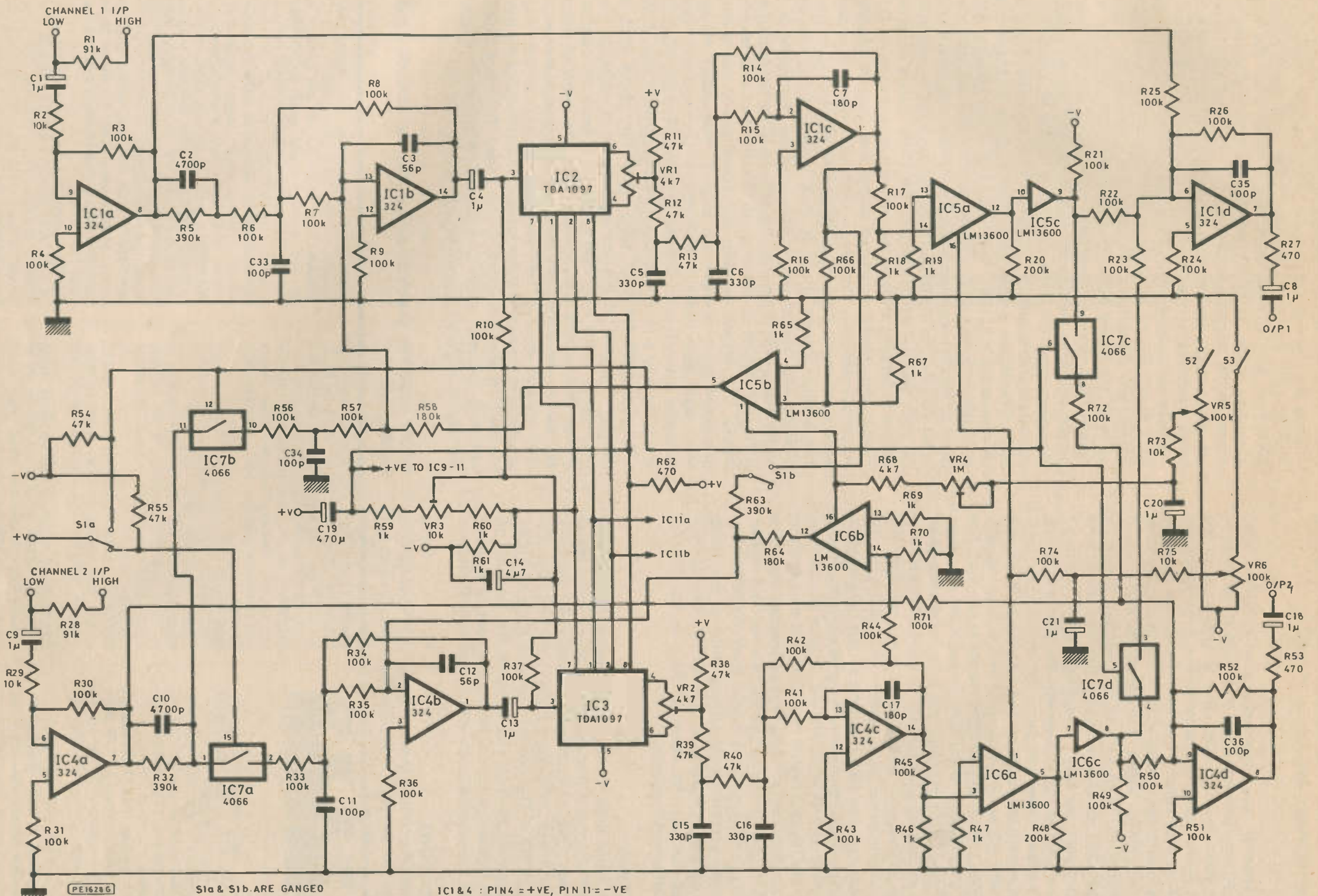
IC1, IC4	324 (2 off)
IC2, IC3	TDA 1097 (2 off)
IC5, IC6	LM13600 (2 off)
IC7	4066
IC8	TL082
IC9	4046
IC10	4013
IC11	4011B

Miscellaneous

PP3 battery clips (2 off)
P.c.b. clips (8 off)
Knobs (5 off)
Stereo jack socket (3 off)
8-pin d.i.l. socket (3 off)
14-pin d.i.l. socket (5 off)
16-pin d.i.l. socket (3 off)
S2, S3, S4 s.p.d.t. (3 off)
S1, S5 d.p.d.t. (2 off)
Case BK 3
P.c.b.s 235A, 235B
4 rubber stick-on feet
Wire, solder

Constructor's Note

A complete kit of parts for the Chorus and Flanger unit is available from Phonosonics, 8 Finucane Drive, Orpington, Kent BR5 4ED. Price £55.66 excluding VAT and p&p. Plus £1.00 p&p £8.34 VAT.



IC1&4 : PIN4 = +VE, PIN 11 = −VE
IC5&6 : PIN6 = −VE, PIN 11 = +VE
IC7 : PIN7 = −VE, PIN 14 = +VE

Fig. 5. Circuit diagram of the Chorus and Flanger unit

around IC1c. C5, C6 and C7 perform the cleanup job, leaving only the required delayed audio signal to pass.

VCAs

IC1c is followed by two transconductance amplifiers, IC5a and IC5b. They both conduct a signal through in response to a current on their control nodes. This is derived from the voltage seen at the wiper of the controlling potentiometers VR5 and VR6, and is in proportion to the resistance between the wiper and the control node. IC5b is the VCA controlling the amount of signal fed back to the start of the delay loop at the mixer-filter IC1b. With VR5 at its negative end, IC5b cannot conduct but as VR5 is rotated towards the ground end, so conductance increases. The maximum conductance available is deliberately higher than actually required, so that the precise feedback level can be tightly adjusted by VR4. Switch S2 allows for the feedback to be switched in and out as required. With S2 open the wiper of VR5 is automatically held at a negative level, so that IC5b ceases to conduct. The presence of C20 gives a slight fade in and fade out effect when S2 is used. IC5a governs the amount of processed signal that is allowed to pass through to the final mixer IC1d via the high impedance buffer IC5c. VR6 controls the amount of conductance, S3 permits the effect to be switched in and out, and C21 creates a similar fade slope to that produced by C20. The maximum signal strength arriving from IC5c is set at a little above the original signal level arriving on the bypass route via R25. The combined processed and unprocessed signals pass through the unity gain mixer IC1d, and thence can be fed to a normal amplifier system. Although IC1d contains output short circuit limiting, R27 is included as an additional current limiter so that using a mono jack plug in the stereo socket will not over-tax the endurance of the i.c. The value of R27 is too low to significantly affect the output level.

CHANNEL TWO

Up to this point both channels are essentially identical. The equivalent channel 2 stages consist of the input buffer IC4a, filter mixer IC4b, delay stage IC3, filter IC4c, feedback VCA IC6b, effect level VCA IC6a, buffer IC6c and final output mixer stage IC4d. The control nodes of IC5b and IC6b are directly coupled so that VR5 controls the feedback of both channels simultaneously. Likewise the control nodes of IC5a and IC6a are coupled to the effect level control VR6.

ENHANCED MODE

In the normal mono and stereo modes, each channel can give weight to the amount of effect passed through and fed back. The circuit has been arranged though so that the effect created by channel one can be added to the effect from channel two. Switch S1 in conjunction with the quadruple electronic gate IC7 performs the switchover to the dual emphasis route. With S1 off IC7b–d are held closed to signals by the negative voltage from R54, whilst IC7a allows signals through due to the positive voltage from S1a thus allowing signals to pass from IC4a to IC4b. Switching on S1 reverses the polarity seen at the control nodes of the gates. IC7a then prevents the output of IC4a from reaching IC4b. Instead any signal from IC4a is routed now via IC7b to join up with the signal from IC1a of channel one at IC1b, so presenting a mono composite to the input of IC2. The delay occurs as before, passing through IC4b and IC5a as desired. However, from IC1c the first delay signal is additionally routed via S1b across to the start of the second delay loop at IC4b. The signal is then given further delay and feedback treatment via IC3, IC4c, and IC6b. The signal coming from IC6c then contains double the delay and feedback enhancement to that coming from IC5c. Each of these signals is now cross switched to the opposite output mixers IC1d and IC4d via IC7c and IC7d respectively. The mono doubly enriched chorus or flanging effect is thus present at both outputs. Obviously the stereo processed signal has lost its channel separation identity, though in both channels the bypass signals arriving at the outputs retain their separate identities. The original stereo image is thus preserved but can be overlaid with the mono doubly enhanced composite. If a mono only signal is input to the unit via IC1a, the output at IC1d will consist of the original plus the first and second delays. The output at IC4d will contain only the doubly processed signal without the original. Remember though that with this variety of feedback and enhancement available, signal levels are going to be modified and that IC2 and IC3 prefer a maximum input level of no more than 1·5V r.m.s. On each feedback path when the phase shift is positive the level of the feedback signal is added to the original signal, the total thus being about twice the original. If both delay paths are cascaded, then the levels of these signals are also added, resulting in a further increase in the final output level. When switching across to the dual emphasis route with a signal present on both inputs, the amplitude of these two signals is also added. Therefore before switching between single and double enhancement modes with stereo signals it is preferable to reduce VR6 first.

NEXT MONTH: Clock circuit, p.s.u., construction and setting up.

BAZAAR

AVO Model 8 MKS multimeter £80. Edgcumbe insulation test meter £40. Sinclair digital DM2 multimeter £30. Tel: 0482 848951.

KEMPSTON interface S Spectrum Seikosha printer with software good working order £20 or near offer. Ralph Lovelock, 14 Knightley Road, Exeter. Tel: 75896.

TERMINET 300 printers RS232 300 Baud letter quality print. Fully working 2 off £70 each. Buyer collects. A. G. Seagrave, 175 Sorrel Bank, Linton Glade, Forestdale, Croydon CR0 9LZ. Tel: 01-651 4885.

HELP circuit to work 24V triac (type 8223-TIC 2530) controlling bulb in slide projector. R. Henly, Mount Temple School, Malahide Road, Dublin 3.

CHIPS Z80A S 10/0, 2 for £10. 8202A—£10. 8086—£5. 2516 5 for £8. 4116 16 for £7. J. Walker, 7 Warwick Place, Peterlee, Co. Durham SR8 2EZ. Tel: Peterlee 868255 after 7.00 p.m.

CRT DG7 132 still boxed and unused. £25 plus postage. W. Mawson, 8 Elsdon Drive, Forest Hall, Newcastle upon Tyne NE12 9RH. Tel: 0632 662082.

FOR SALE 215 magazines PW, ETI Elektor 1967 onward. Also counter/timer A.C. bridge 2 scopes. Alan Auden. Tel: 01-568 5458.

NEWNES Radio & TV Servicing, 15 volumes up to 1970 £20 good condition. T. D. Jennings 0734 780514 after 6.30 p.m. or 0734 586429 during day.

WANTED service manual for Tektronix 53C plug-in buy, borrow or swap other Tektronix manuals, parts etc. T. J. L. Haley. Tel: 01-868 4221.

DESYNN transmitter pot wanted please. About 3" diameter or less, for wind vane project. Mr. S. Gibbons, 77 Windlehurst Road, High Lane, Stockport SK6 8AE. Tel: 061 427 4317.

WANTED Ferguson model 3T11 3-band radio cassette recorder. Tel: 01-451 3093.

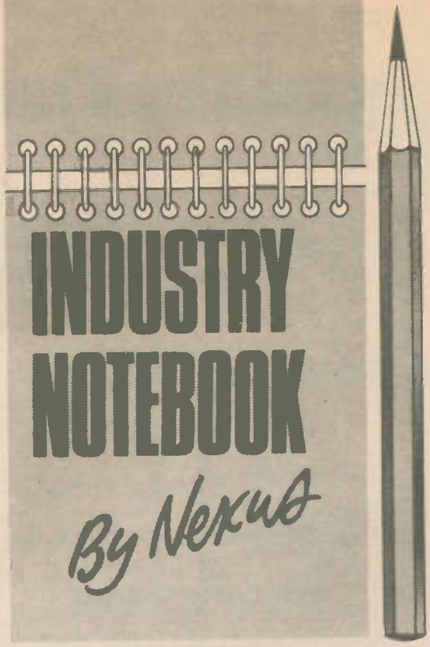
SOLARTRON scope plug-in unit CX1441 or CX1449 wanted. Could swap for CX1442. Patrick O'Donohoe, 29 Devon Close, Perivale, Middx. Tel: 01-997 0181.

INFORMATION wanted on LA30 Decwriter. G8004 board or circuit diagram required. C. Adams, 10 St. Annes Place, Neyland, Dyfed.

WANTED superboard OH10 expansion system by Watford Electronics either complete or p.c.b.s only as in PE June 79. G. S. Houghton, Well Farm, Great Ouse Burn, York YO5 9RQ. Tel: Green Hammerton 30620.

WANTED modern dot matrix printer. Serial or parallel. Must be working. Mr. P. Hale, 31 South Road, Stourbridge, West Midlands DY8 3YA. Tel: 0384 379120.

RAMS ex comp. All good. 16 x 4116 50p each. 16 x 2114 £1 each. 4 x 4118 £1.50 each. 1 x 6116 £2. Wavemeter type 'D' no lid, £12. Mr. A. Glover, 13 South Close, Braunston, Nr. Daventry, Northants NN11 7JE.



End of Term

As the year draws near its end it is clear that 1984 will be recorded in history as a year of industrial turmoil, dominated by disputes in the coalfields and their social, legal, political and economic consequences. If striking miners gained little for themselves they at least focused our attention on the problems of employment and, in their minds, the fear of unemployment although none has been threatened for those on the books of the NCB.

Few of us enjoy such gilt-edged security. We have to rely for our defence on remaining useful and thus in demand in the labour market. Knowledge of electronics and ability to exploit it is the safest bet at present of all the engineering disciplines.

Take the case of a young lad just 11 years of age in, shall we say, Wigan. He has a natural curiousity and like many of us built balsa wood aeroplanes and Meccano models. He made his own crystal set, then a two-valver. He got interested in remote control, first with strings and pulleys on his Meccano, then on a model yacht.

The lad could be today's typical younger hobbyist. But the love of construction, the joy of making things work, the satisfaction of finding out how things work and why they work all happened in this lad's life 50 years ago.

Yes, he was born in Wigan, or at least near it, and we know him today as Professor John West, the 1984–85 President of the IEE and Vice Chancellor of the University of Bradford.

Of course he needed professional help and so read electrical engineering, graduating from Manchester in 1943. After national service in the Royal Navy in which his interest in control engineering was stimulated by the problems of anti-submarine warfare he became an academic.

This didn't stifle enthusiasm for the practical and he has always been in demand as a consultant to industry on control problems ranging from the manufacture of Nylon yarn to automatic stabilisation of the early 'flying bedsteads', forerunners of the Harrier vertical take-off aircraft. Since his professional life is largely devoted to electronics and control problems his new hobby is now philately in which he enjoys a considerable reputation.

Obviously we can't all be Professor Wests but as keen hobbyists with no less enthusiasm than he had there are still openings for those determined to make electronics their profession. And there is a crying shortage, increasing yearly, mainly for qualified engineers but also for maintenance engineers, testers and installers. And the spread of automation has meant that electronics posts are available throughout the whole of industry, not just a few sectors.

A final note of encouragement. I know a builder's labourer, scarcely even a 'brickie', who became interested in electronics. He was entirely self-taught and has just retired. His last post over several years was as laboratory technician in a university.

Let me indulge in a final final note! Sir Robert Telford has been made Life President of The Marconi Company on his retirement as Chairman. His only predecessor with the title was Guglielmo Marconi himself, the original founder. Sir Robert has been with Marconi (and parent GEC) all his working life having served initially a two-year apprenticeship as a management trainee.

Yes, there is life north of Watford. Sir Robert was born in Liverpool.

Pioneers

Last month I mentioned Jack Kilby and Bob Noyce who are credited with being first with the integrated circuit in the late 1950s, actually in 1958 and 1959. They, of course, produced practical i.c.s but the concept of the i.c. had a much earlier mention and by none other than the Englishman G.W.A. Dummer when giving an address before the US Electronic Components Symposium in May 1952.

He put forward the idea that it would now seem possible to envisage electronic equipment in a solid block with no connecting wires. In 1957 Dummer, then employed at the presently named RSRE at Malvern, actually showed a model not unlike that later patented by Kilby. The model was made by Plessey and unveiled at Malvern for the first time.

Although Dummer's ideas, through no fault of his own, never came to full fruition at that time he deserves every credit for his vision of the future. Another Englishman whose idea was in fact adopted is Charles J. Hughes who was awarded the Martlesham Medal, 1984, by British Telecom.

It was Hughes who developed the idea of using a MPU as the vital component in a telephone exchange. He called his device a 'mini-processor' as it came in 1968–1969, long before the MPU as we know it today. But Hughes' invention was essentially the same animal which in a more compact, more efficient and cheaper package has but changed its name.

Tempest

A friend of mine has recently, and at some personal expense, invested in a push-button telephone. His enthusiasm for electronics in all its variety has led to him being a licensed radio amateur.

Alas, he finds the telephone and his transmitter entirely incompatible. His wife can't use the telephone during radio transmission. There were no such problems with his old dial telephone. Readers will also recall CB operators (mainly those with illegal 'afterburners') who disabled the electronics in petrol pumps. Better screening of apparatus and filtering against outside interference is the solution.

The other problem is just the reverse. How to keep signals inside the box, particularly with computers involved in processing confidential data. Modern surveillance technology is such that transfer of data within the machine is detectable from the outside unless precautions are taken.

The name of the precautionary game is Tempest for which there are stringent specifications. Tempest evaluation is expensive. Large electrically screened rooms are necessary to exclude all external interference and the test equipment is exceptionally sensitive and also expensive.

Racal-SES at Tewkesbury, Gloucestershire, has three screened rooms for Tempest evaluation operated under contract from the UK Government for securtiy sensitive equipment. The company has just installed an additional facility for industrial equipment and offers a consultancy service on modifications to meet Tempest requirements.

Outlook

As we move into 1985 the outlook for electronics remains good. Particularly welcome is a move towards a semblance of balance in the two-way street on military procurement between the UK and the USA. This has been almost one-way for so many years that it became a joke. The order for 300 Hawk aircraft for the US Navy was a triumph and on the purely electronics front a recent order for British positioning and data processing equipment for mine countermeasure activities is a straw in the wind, as is further US orders for British naval communications equipment.

China is still good news with their navy buying Marconi communications equipment. A huge market is opening up which is likely to develop into joint ventures as the Chinese develop their own skills and manufacturing capability.

Scotland will benefit from further growth with Hewlett-Packard investing yet another £12 million on factory expansion and Honeywell at Newhouse geared up to a 30 percent increase in output.

On the labour front the electricians union, EEPTU, continues a campaign for more orderly and sensible relations with employers. Despite violent opposition from other unions there is every indication that the new approach, including no-strike agreements, will prove popular.

Sequential Logic Techniques Part 4

M.TOOLEY BA and D.WHITFIELD MA MSc C Eng MIEE

We shall begin Part Four with an interesting and unusual shift register application in the form of a pseudo random sequence generator. Whilst such a device may at first appear to be nothing more than a mere curiosity, a number of electronic circuits and devices do require a signal which has an apparently random value. Typical of these are data scrambling devices as well as the more obvious 'pink' noise sources used in audio work.

A shift register can be used to generate a signal that is repetitive but also random. All that is required is some simple external gating and, where an analogue output is required (as would be the case with an audio system) a digital to analogue converter. Such an arrangement is shown in Fig. 4.1. The pseudo noise generated by this arrangement consists of a sequence of random voltage levels which repeats each time the shift register is clocked through 2^n-1 clock cycles, where n is the number of bistable stages contained in the register. Thus, for example, the six stage shift register shown in Fig. 4.1 produces 63 random states before repeating the sequence.

A practical 4-bit pseudo random sequence generator using a 74195 shift register and a 7486 exclusive-OR gate is shown in Fig. 4.2. To ensure that this circuit starts, a capacitor is used to place a logic 1 at the data input of the shift register whenever power is applied.

The 7486 and 74195 devices should be inserted into sockets A and B respectively of the Logic Tutor, taking care to ensure that the usual orientation is observed. The following connections are required:—

A1 to D4
A2 to D3
A3 to B2 via a 220 ohm resistor
A7 to 0V (common)
A16 to +5V (supply)
B1 to logic 1
B2 to B3
B3 to +5V via a 10µF capacitor
B4 to B5
B5 to B6
B6 to B7
B7 to logic 0
B8 to 0V
B9 to logic 1
B10 to clock
B12 to D4 (D4 shows the state of Q3)
B13 to D3 (D3 shows the state of Q2)
B14 to D2 (D2 shows the state of Q1)
B15 to D1 (D1 shows the state of Q0)
B16 to +5V (supply)
(A total of 18 links and 2 components)

The above arrangement conforms to the circuit of Fig. 4.2. Readers should note down the output states produced by the pseudo random sequence generator and compare these with those shown in Table 4.1.

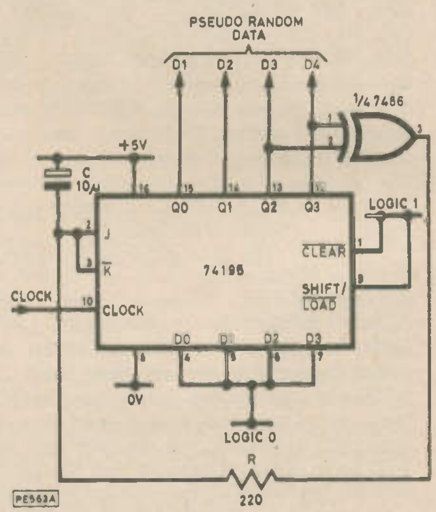


Fig. 4.2. Practical 4-bit pseudo random sequence generator

Q_0 (MSB)	Q_1	Q_2	Q_3 (LSB)	DENARY VALUE
1	0	0	0	8
0	1	0	0	4
0	0	1	0	2
1	0	0	1	9
1	1	0	0	12
0	1	1	0	6
1	0	1	1	11
0	1	0	1	5
1	0	1	0	10
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15
0	1	1	1	7
0	0	1	1	3
0	0	0	1	1

Table 4.1. Pseudo random sequence produced by the circuit of Fig. 4.2.

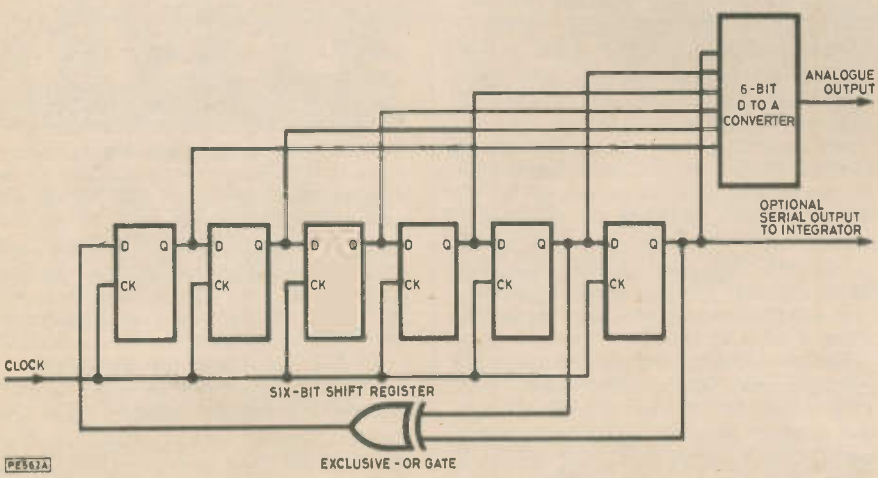


Fig. 4.1. Pseudo random sequence generator

An alternative sequence can be generated by removing the two start-up components (C and R) and replacing them by an inverter, as shown in Fig. 4.3. Unlike the previous arrangement, this circuit always starts when power is applied. The resulting sequence is, however, complementary to that produced by the previous circuit.

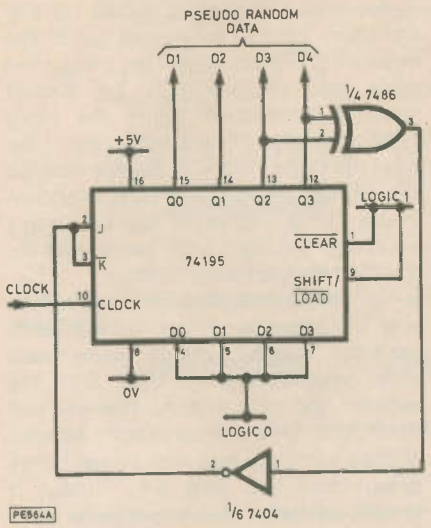


Fig. 4.3. Alternative arrangement to that shown in Fig. 4.2.

To investigate the performance of the alternative pseudo random sequence generator it is first necessary to remove the 10µF capacitor from B3 to +5V and the 220 ohm resistor from A3 to B2. Then insert the 7404 into socket E (checking that pin-1 aligns with D1) and make the following connections:—

D1 to A3
D2 to B2
D7 to 0V (common)
D16 to +5V (supply)

The random sequence produced by this arrangement should follow the pattern shown in Table 4.2.

UNIVERSAL SHIFT REGISTERS

We have previously examined several simple shift register arrangements using both the 74175 quad data latch and the 74195 4-bit parallel access shift register. Unfortunately, whereas this latter device can be configured for both right and left shifting, the left shifting arrangement was not only inelegant but also precluded the parallel loading of data.

Such problems can be easily solved with the aid of the so-called "universal" shift register. Such devices earn their somewhat grandiose title by virtue of their ability to shift data in either direction whilst retaining the ability to input and output data in parallel form. It thus becomes possible to realise all of the basic shift register types (SISO, SIPO, PISO and PIPO) using just one device!

Q_0 (MSB)	Q_1	Q_2	Q_3 (LSB)	DENARY VALUE
1	0	0	0	8
1	1	0	0	12
1	1	1	0	14
0	1	1	1	7
1	0	1	1	11
1	1	0	1	13
0	1	1	0	6
0	0	1	1	3
1	0	0	1	9
0	1	0	0	4
1	0	1	0	10
0	1	0	1	5
0	0	1	0	2
0	0	0	1	1
0	0	0	0	0

Table 4.2. Pseudo random sequence produced by the circuit of Fig. 4.3.

We shall continue our series on Sequential Logic with a detailed examination of the operation of a typical 4-bit universal shift register. We will show how this device can be configured to perform both right and left shifting without sacrificing the ability to load data in parallel form.

THE 74LS194 UNIVERSAL SHIFT REGISTER

The 74LS194 is a true bi-directional 4-bit shift register capable of all four (SISO, SIPO, PISO, and PIPO) modes of operation. The device is housed in a 16-pin d.i.l. package having the pin connections shown in Fig. 4.4. The internal logic of the 74LS194 is shown in Fig. 4.5. From this it should be noted that mode select inputs, S1 and S0, are gated, together with serial and parallel data inputs, into the SET and RESET inputs of each of the four internal bistable stages. The truth table for the mode select inputs is shown in Table 4.3.

The 74LS194 has separate serial data inputs for right and left shifting whereas, like other shift registers, the CLOCK and CLEAR inputs remain common to each stage. The 74LS194 is thus very easily cascaded, in multiples of four bits, to make shift registers of any desired length. All data transfers are synchronous with positive going transitions of the clock.

To investigate the 74LS194 we shall make use of the circuit shown in Fig. 4.6. Since the Logic Tutor has only four logic level generating switches, we shall hard-wire the four parallel data inputs (to produce an input of 1010) and the active low clear input (to logic 1). The serial data inputs for right and left shifting are respectively driven from the momentary switches, S1 and S2. The two mode select lines are connected to the two latching switch outputs, S3 and S4.

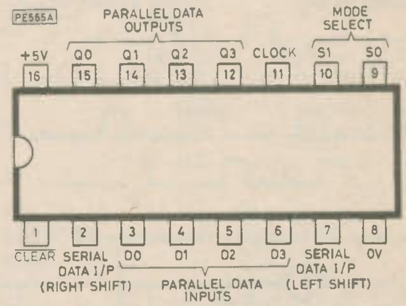


Fig. 4.4. Pin connections for the 74LS194

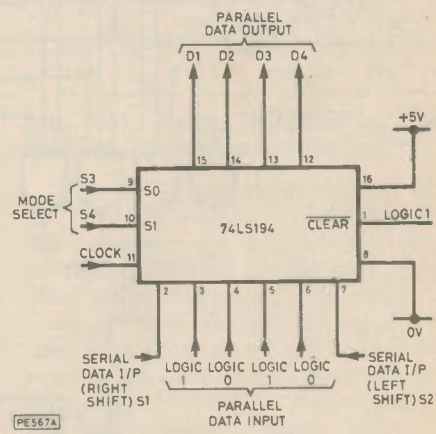


Fig. 4.6. Basic universal shift register arrangement using the 74LS194

MODE SELECT INPUT		MODE OF OPERATION
S1	S0	
0	0	Inhibit shift (hold)
0	1	Shift right
1	0	Shift left
1	1	Load parallel data

Table 4.3. Truth table for the 74LS194 mode select inputs

The 74LS194 should be inserted into socket B of the Logic Tutor, taking care to observe the usual orientation in which pin-1 aligns with B1. The following connections should then be made:—

B1 to logic 1	(active low clear input)
B2 to S1	(serial data input—right shift)
B3 to logic 1	(parallel data input—D0)
B4 to logic 0	(parallel data input—D1)
B5 to logic 1	(parallel data input—D2)
B6 to logic 0	(parallel data input—D3
B7 to S2	(serial data input—left shift)
B8 to 0V	(common)
B9 to S3	(mode select input—S0)
B10 to S4	(mode select input—S1)
B11 to clock	(clock)
B12 to D4	(D4 shows state of Q3)
B13 to D3	(D3 shows state of Q2)
B14 to D2	(D2 shows state of Q1)
B15 to D1	(D1 shows state of Q0)
B16 to +5V	(supply)

(A total of 16 links)

Adjust S3 and S4 to produce logic 0 inputs on the mode select inputs. In the absence of a depression, the logical state of the two momentary switches, S1 and S2, will of course be zero. In this condition, the four Q outputs (indicated by D1 to D4) should all remain at logic 0 as, in this state, shift operation is inhibited.

Now wait until the clock next goes low and then adjust S3 and S4 to produce logic 1 on both of the select inputs. When the clock next goes high, D1 and D3 should become illuminated (while D2 and D4 remain extinguished) showing that the data on the parallel data inputs (1010) has been loaded into the register and transferred to the Q outputs.

Now adjust S3 for logic 1 and S4 for logic 0. Wait a few clock cycles for the pre-loaded data to shift out and then, when the clock next goes low, depress S1 and note that D1 becomes illuminated when the clock next goes high. Release S1 and note how the logic 1 data shifts right through the register (from Q0 to Q3), as shown in the timing diagram of Fig. 4.7. In this condition the left shift serial data input (S2) should have no effect.

S3 should then be adjusted for logic 0 whilst S4 is set to produce logic 1. Again wait a few clock cycles for any transitory data to be shifted out of the register and then, when the clock next goes low, depress S2. D4 should become illuminated when the clock next goes high. Release S2 and note how the logic 1 data shifts left through the register (from Q3 to Q0), as shown in the timing diagram of Fig. 4.8. In this condition the right shift serial data input (S1) should have no effect.

To further familiarise themselves with the operation of the universal shift register, readers should experiment with parallel loading data into the register and then shifting first left and then right. This can be readily accomplished using the two mode select lines driven from S3 and S4. Finally, it should be noted that the register con-

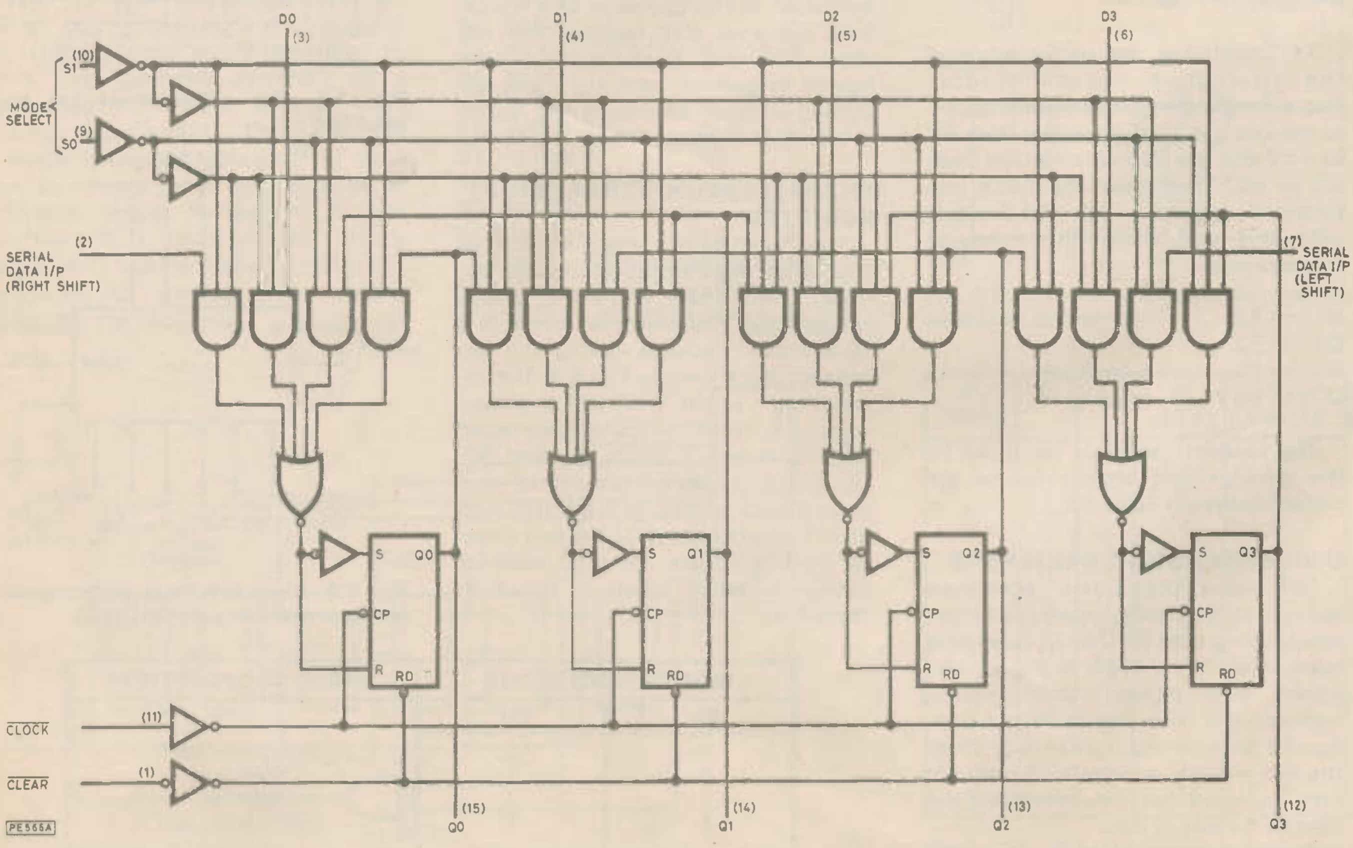


Fig. 4.5. Internal logic of the 74LS194

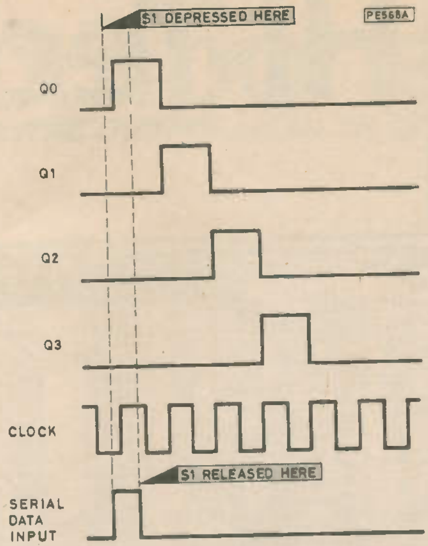


Fig. 4.7. Timing diagram for shift right operation

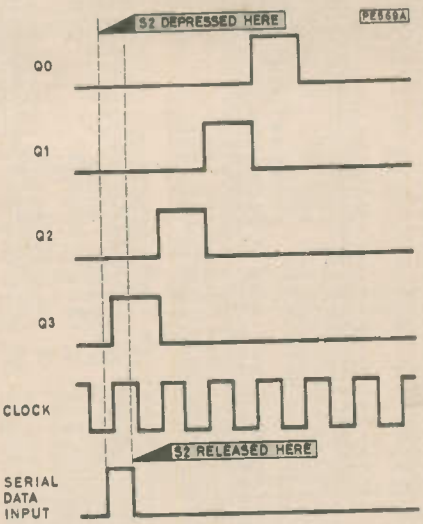


Fig. 4.8. Timing diagram for shift left operation

tents can be 'frozen' simply by taking both of the mode select lines to logic 0.

BI-DIRECTIONAL SEQUENCER USING THE 74LS194

A sequencer is an arrangement based on a shift register which can be used to produce a recurrent binary pattern in much the same manner as that produced by a binary counter. Typical applications for sequencers involve scanning a number of data lines placing a logic 1 (or logic 0) on each line in turn. A 4-bit sequencer might, for example, produce the output states shown in Table 4.4. Such a pattern can be produced quite simply by circulating a logic 1 through a shift register which has its output fed back to its input. All transfers through the register will, of course, occur synchronously with the clock.

Parallel data output				Clock transition
Q0	Q1	Q2	Q3	(0 –> 1)
1	0	0	0	1
0	1	0	0	2
0	0	1	0	3
0	0	0	1	4
1	0	0	0	5
0	1	0	0	6
0	0	1	0	7
0	0	0	1	8
1	0	0	0	9
etc.				etc.

Table 4.4. Typical output sequence of a 4-bit sequencer

A practical bi-directional 4-bit sequencer is shown in Fig. 4.9. The serial data inputs for right and left shifting are respectively connected to the Q3 and Q0 parallel data outputs. The parallel data input lines are used to initialise the shift register so that it always starts with the Q0 output going to logic 1. Thereafter, shifting can be to the right or left depending upon the mode selection inputs. These latter inputs also allow us to freeze the output state or to re-initialise the register.

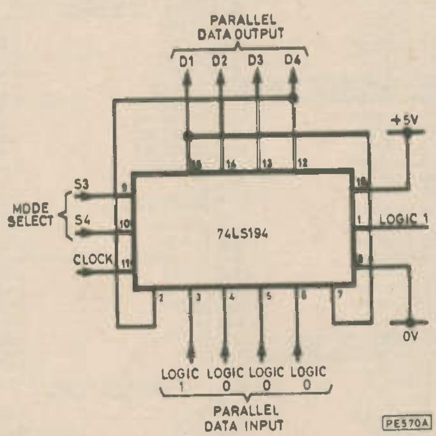


Fig. 4.9. 4-bit sequencer using the 74LS194

The previous arrangement can be modified as follows:—

B1 to logic 1 (active low clear)
B1 to B12
B3 to logic 1
B4 to logic 0 (initial data to
B5 to logic 0 be shifted)
B6 to logic 0
B7 to D15
B8 to 0V (common)
B9 to S3
B10 to S4
B11 to clock
B12 to D4
B13 to D3
B14 to D2
B15 to D1
B16 to +5V (supply)

(A total of 16 links)

S3 and S4 should initially be set to logic 1 in order to load the parallel data into the register. As soon as the clock next goes high D1 will become illuminated whilst all of the other l.e.d. indicators should remain extinguished. The register remains in this state as long as S3 and S4 are held at logic 1.

Now set S3 to produce a logic 1 leaving S4 generating a logic 0. On the next rising clock edge the data in the shift register should shift to the right, circulating through the register with the logic 1 re-appearing at the first stage (Q0) of the register as soon as D4 becomes extinguished. This action is shown Fig. 4.10.

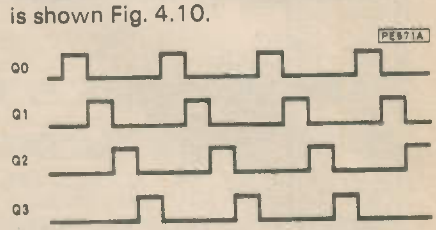


Fig. 4.10. Timing diagram for the 74LS194 sequencer (right shift operation)

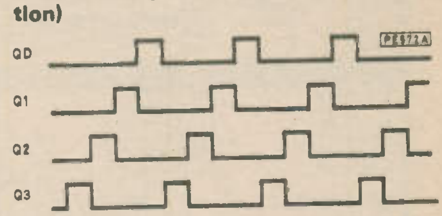


Fig. 4.11. Timing diagram for the 74LS194 (left shift operation)

Now set S3 to produce a logic 0 and S4 to produce a logic 1. In this state the data within the register should start to shift to the left on the next rising clock edge. Data will then circulate through the register with the logic 1 re-appearing at the last stage (Q3) of the register as soon as D1 becomes extinguished. This action is illustrated in the timing diagram of Fig. 4.11.

S3 and S4 should now both be set to logic 0. On the next rising clock edge the data within the register should remain frozen for as long as both of the mode select inputs are held low. Finally, readers may wish to experiment with hard-wiring some alternative data patterns using the four links connected to B3, B4, B5 and B6.

NEXT MONTH: we shall be taking a look at data multiplexers.

TERMS OF BUSINESS

- ★ All prices exclude V.A.T. and carriage. Please add carriage to order total before adding V.A.T.
- ★ Carriage charges extra on all orders as follows:

Components	£0.75
Books/Data/Software	£2.00
Printers, Monitors, Disc drives, etc.	£4.50

- ★ Strictly cash with order or credit card (Access or VISA) only.
- ★ Delivery is normally from stock but please allow up to 28 days.
- ★ Any query or complaint regarding an order should be made in writing within 7 days of receipt of the order. No telephone queries will be entertained.
- ★ Goods incorrectly ordered cannot be accepted for replacement without our prior agreement. Due to high processing costs, a minimum of 15% handling charge may be levied on any returns or cancelled orders.
- ★ We will issue a full immediate refund, if requested, for out of stock items.
- ★ All items carry full manufacturers warranty.
- ★ A V.A.T. receipt will be supplied with all orders.
- ★ Prices quoted are correct at the time of going to press but we reserve the right to effect changes without prior notice.

Hi-Tech

HI-TECH COMPONENTS

6502 FAMILY

6502	3.50
6502A	4.95
6520	2.25
6520A	2.45
6522	3.40
6522A	4.45
6532	5.45
6532A	5.95
6551	5.95

6800 FAMILY

6800	2.15
6802	2.70
6803C	8.40
6809E	6.25
6809P	6.25
6810	1.70
6821	1.70
6840	3.70
6845	6.45
6850	1.70
6862	3.75
6875	4.95
68B00	4.30
68B09	9.95
68B10	1.88
68B21	3.70
68B40	6.60
68B50	1.58
68B54	7.95

8086 FAMILY

8086	29.50
8088-2	22.50
8216	0.75
8237A-5	23.50
8251A	7.50
8253-5	7.50
8255A-5	7.00
8259A	6.60
8272	35.00
8284A	9.50
80C86	46.65
80C88	46.65
82C52	15.68
82C54	19.04
82C55A	212.98
82C59A	15.22
82C82	6.26
82C84A	8.94
82C88	16.80

Z80 FAMILY

Z80ACPU	2.99
Z80ACTC	2.99
Z80ADMA	7.95
Z80APIO	2.99
Z80ASIO-0	7.95
Z80ASIO-1	7.95
Z80ASIO-2	7.95
Z80BCPU	5.95
Z80BCTC	5.95
Z80BPIO	5.95
Z80BSIO-0	19.95
Z80BSIO-1	19.95
Z80BSIO-2	19.95
Z80SIO-0	6.00
Z80SIO-1	6.00
Z80SIO-2	6.00

6805 FAMILY

MC1468052P	12.60
MC146818P	7.20
MC146823P	8.80
MC68705KT3	75.00
MC68705R3L	40.00
MC68705U3L	36.00

68000 FAMILY

MC68000G10	50.00
MC68000L8	50.00
MC68008L8	45.00
MC68230L8	19.50
MC68451L8	67.00
MC68901P	75.00

TI 9900 FAMILY

TMS9901-95	4.50
TMS9902	4.50
TMS9918	35.00
TMS9927	11.60
TMS9928	13.00
TMS9929	13.00
TMS9937	6.70
TMS9980	17.20
TMS9995	13.70

Hi-Tech components

0379 4131

MEMORIES — EPROM

2532-300ns	4.95
2532-450ns	3.95
2564-300ns	6.95
2708-450ns	3.95
2716-450ns	3.50
2716-3 RAIL	7.95
2732-350ns	4.95
2732-450ns	4.45
2764-200ns	7.95
2764-250ns	5.15
2764-300ns	4.75
27C64-250ns	10.95
27C64-300ns	10.45
27128-250ns	19.00
27128-300ns	16.00

MEMORIES RAM

4116-150ns	1.28
4116-200ns	1.20
4164-150ns	4.45
4416-200ns	4.70
4532-200ns	2.45
4564-150ns	4.45
8118-100ns	1.95
81256-150ns	25.00
8416-200ns	6.00
8416-LP-200ns	6.40
8417-200ns	6.00
8417-LP-200ns	6.40

MEMORIES — RAM *ZERO POWER ZKXB CMOS*

MK48Z02B-150ns	32.00
MK48Z02B-200ns	24.00
MK48Z02B-250ns	23.00

BIPOLAR PROMS

TBP18S030N	1.54
TBP18SA030	1.38
TBP24S10N	2.06
TBP24S41N	6.68
TBP24S81N	5.50
TBP24SA10N	1.40
TBP24SA41N	4.40
TBP28L22N	3.10
TBP28LA22N	4.14
TBP28S166N	19.00
TBP28S42N	4.50
TBP28S46N	4.50
TBP28S86N	5.00
TBP28SA42N	4.50
TBP28SA46N	4.50
TBP28SA86N	8.62
AM27S13PVC	3.74
AM27S19PC	1.92
AM27S191DC	15.00
AM27S25DC	15.00
AM27S29DC	6.46
AM27S35DC	22.00

MEMORIES E2 PROM

X2804AP-300ns	14.95
X2804AP-350ns	13.45
X2804AP-450ns	12.75
X2816AP-300ns	29.95
X2816AP-350ns	25.00
X2816AP-450ns	22.50

LINEAR/INT. DEV.

4702	8.90
HCI-55564-5 (Speech Synthesis)	10.66
AM7910DC	34.88
AM7911DC	34.88
25LS2518PC	3.60
25LS2521PC	3.28
25LS2538PC	2.72
25LS2539PC	2.72
26LS31PC	2.62
26LS32PC	2.62
6402	6.40
75107BN	0.69
75110AN	0.86
75150P	0.86
75154N	1.05
75159	2.30
75160AN	2.60
75161AN	2.82
75162AN	4.08
75172NG	1.96
75173N	1.44
75174	2.82
75175	1.96
75182	0.50
75183	0.50
75188	0.86
75189	0.86
75451BP	0.22
75452BP	0.29
75453BP	0.22
75454BP	0.22
75468N	0.88
75491N	0.31
75492N	0.41
AY-3-1015	3.50
AY-3—1270	9.40
AY-3-8910	6.40
AY-5-3600	8.84
DP8304	4.50
L203	0.99
LF398	3.80
LM301AN	0.30
LM308AN	0.94
LM308N	0.56
LM311N	0.60
LM317MT	0.80
LM317T	1.06
LM319N	3.30
LM324N	0.50
LM337T	1.20
LM339	0.48
LM339N	0.48
LM348N	0.64
LM350T	3.12
LM358N	0.60
LM3900	0.68
LM393N	0.48
LM725CN	3.00
741CP	0.16
LM747CN	0.60
LM748CN	0.30
MC1413P	0.80
MC1416	0.80
MC14411	10.10
MC14412	14.20
MC1458CPI	0.35
MC1495L	6.30
MC1496P	0.70
MC1723P	0.40
MC3242A	6.30
MC3302P	0.48
MC3340P	2.36
MC3357P	1.90
MC3423PL	0.81
MC3441AP	2.90
MC3446AP	2.90
MC3447P	4.30
MC3448A	3.99
MC3470P	6.44
MC3480	7.76
MC3487	1.80
NE555P	0.25
NE556CP	0.65
RO32513-L	9.40
RO32513-U	9.40
TL010-CP	0.44
TL061-CLP	0.28
TL062-CP	0.47
TL064-CN	0.95
TL066-CP	0.28
TL071-CP	0.28
TL072-CP	0.56
TL074-CN	1.10
TL081-CP	0.29
TL082-CP	0.49
TL084-CN	1.02
TL091-CP	0.39
TL092-CP	0.72
TL094-CN	1.30
TL487-CP	0.59
TL489-CP	0.59
TL494-CN	1.99
TL496-CP	0.59
TL507-CP	1.22
ZN450-E	6.08
ZN451-E	7.40
ZN451-KIT	29.95

F.D. CONTROLLERS

8272	35.00
FD1771P	30.00
FD1791	15.50
FD1791-02	11.00
FD1793	18.40
FD1793-02	11.00
FD1795	25.00
FD1797	21.00
WD1691	14.00
WD2143	12.00

DATA CONVERTERS

ZN425E-8	3.76
ZN425J-8	8.00
ZN426E-8	1.90
ZN427E-8	6.68
ZN427J-8	12.50
ZN428E-8	5.10
ZN428J-8	9.70
ZN429E-8	1.60
ZN432CJ-10	20.79
ZN432E-10	13.00
ZN433CJ-10	25.00
ZN434	0.98
ZN435	4.38
ZN436E	1.26
ZN440	55.00
ZN441	46.80
ZN447	7.80
ZN448E	6.66
ZN448J	12.48
ZN449	2.72
ZNA134J	22.50
ZNA234E	9.40

VOLTAGE REF.

ZN404	0.50
ZN423	0.98
ZN458	0.92
ZN458A	0.92
ZN458B	1.12
ZNREF 025	1.90
ZNREF 040	1.90
ZNREF 050	1.90
ZNREF 062	1.90
ZNREF 100	3.05

BUFFERS

81LS96	1.10
81LS97	1.10
81LS98	1.10
8T26A	1.10
8T28	1.10
8T28A	1.10
8T95	1.10
8T97A	1.10
8T98	1.10

OPTOISOLATORS

4N25	0.75
4N26	0.75
4N33	0.90

UHF MODULATORS

UM1111	2.95
UM-1233	3.45

VOLTAGE REG.

7805	0.75
7812	0.75
7815	0.75
78H05SC	7.50
78H12ASC	8.95
78HGASC	9.95
78L05	0.30
78L12	0.30
78L15	0.30
78S40DM	7.50
78S40PC	3.00
7905	0.95
7912	0.95
7915	0.95
LM309K	0.95
LM317K	2.45
LN323K	4.95
LM338K	4.50

FAIRCHILD FAST

74F00PC	0.60
74F04PC	0.60
74F08PC	0.65
74F109PC	0.65
74F11PC	0.52
74F138PC	0.52
74F138PC	1.26
74F139PC	1.26
74F151	1.26
74F153	1.26
74F157	1.30
74F158	1.17
74F161	2.34
74F164	1.68
74F175	1.82
74F181	3.90
74F189	5.10
74F190	3.20
74F191	3.20
74F194	1.68
74F20PC	0.52
74F240	3.16
74F241	2.42
74F243	2.80
74F244	2.96
74F245	6.08
74F251	1.26
74F253	1.26
74F257	1.26
74F258	1.34
74F280	1.74
74F283	1.74
74F32PC	0.52
74F352	1.26
74F353	1.26
74F373	3.16
74F374	3.16
74F379	1.83
74F381	6.62
74F382	4.22
74F398	3.16
74F399	2.70
74F521	2.76
74F533	3.16
74F534	3.16
74F537	6.02
74F538	4.38
74F539	4.38
74F64PC	0.52
74F74PC	0.58
74F86PC	0.77

HIGH SPEED CMOS

74HC00N	0.42
74HC02N	0.42
74HC03N	0.64
74HC04N	0.44
74HC08N	0.42
74HC107N	0.78
74HC109N	0.50
74HC10N	0.64
74HC112N	0.86
74HC113N	0.86
74HC132N	1.28
74HC137N	1.81
74HC138N	1.20
74HC139N	0.78
74HC151N	1.16
74HC153N	0.90
74HC157N	1.02
74HC158N	1.02
74HC160N	0.90
74HC161N	0.90
74HC162N	1.51
74HC163N	1.51
74HC164N	0.95
74HC165N	2.24
74HC173N	1.35
74HC174N	0.80
74HC175N	0.78
74HC194N	1.28
74HC195N	1.28
74HC20N	0.40
74HC237N	1.80
74HC240N	1.38
74HC241N	1.34
74HC242N	2.24
74HC243N	2.24
74HC244N	1.32
74HC251N	1.03
74HC253N	1.03
74HC257N	1.03
74HC266N	0.92
74HC273N	2.24
74HC27N	0.80
74HC280N	3.26
74HC32	0.40
74HC373N	2.40
74HC374N	2.40
74HC393N	1.78
74HC4002	0.64
74HC4017	1.16
74HC4020	1.46
74HC4024	1.20
74HC4040	1.46
74HC4060	1.46
74HC4075	0.64
74HC42N	0.90
74HC4511	2.51
74HC4514	3.76
74HC4538	2.36
74HC4543	3.04
74HC51N	0.64
74HC533N	2.40
74HC534N	2.40
74HC589N	1.72
74HC58N	0.64
74HC595N	1.84
74HC597N	1.72
74HC73N	0.84
74HC74N	0.84
74HC75N	0.92
74HC76N	0.64
74HC85N	2.02
74HC86N	0.80
74HCU04N	0.80

TTL

74LS00	0.25
74LS01	0.25
74LS02	0.25
74LS03	0.25
74LS04	0.25
74LS05	0.25
74LS08	0.25
74LS09	0.25
74LS10	0.25
74LS109	0.54
74LS11	0.25
74LS112	0.54
74LS113	0.42
74LS114	0.44
74LS12	0.25
74LS122	0.75
74LS123	0.95
74LS124	2.30
74LS125	0.49
74LS126	0.49
74LS13	0.46
74LS132	0.73
74LS136	0.46
74LS138	0.77
74LS139	0.77
74LS14	0.80
74LS145	1.23
74LS148	1.50
74LS15	0.25
74LS151	1.10
74LS153	1.10
74LS155	0.77
74LS156	0.77
74LS157	0.62
74LS158	0.62
74LS160	0.80
74LS161	0.80
74LS162	0.80
74LS163	0.80
74LS164	1.10
74LS165	1.30
74LS166	1.95
74LS173	1.13
74LS174	1.30
74LS175	0.96
74LS181	2.09
74LS190	0.98
74LS191	0.75
74LS192	1.10
74LS193	1.10
74LS194	0.78
74LS195	0.78
74LS196	1.10
74LS197	1.10
74LS20	0.25
74LS21	0.25
74LS22	0.25
74LS221	1.08
74LS240	1.40
74LS241	1.40
74LS242	1.36
74LS243	1.36
74LS244	1.40
74LS245	1.95
74LS248	1.16
74LS249	1.16
74LS251	0.78
74LS253	0.78
74LS257	0.78
74LS258	0.78
74LS259	1.77
74LS26	0.30
74LS261	2.60
74LS266	0.35
74LS27	0.25
74LS273	1.35
74LS279	0.77
74LS28	0.25
74LS283	1.00
74LS290	0.86
74LS293	0.86
74LS30	0.25
74LS32	0.25
74LS33	0.30
74LS365	0.55
74LS366	0.55
74LS367	0.55
74LS368	0.55
74LS37	0.25
74LS373	1.50
74LS374	1.50
74LS375	0.75
74LS377	1.50
74LS378	1.22
74LS379	1.50
74LS38	0.25
74LS386	0.50
74LS390	1.10
74LS393	1.10
74LS40	0.25
74LS42	0.85
74LS47	1.00
74LS48	1.00
74LS49	1.00
74LS51	0.25
74LS54	0.25
74LS55	0.25
74LS670	2.30
74LS73	0.30
74LS74	0.35
74LS75	0.50
74LS76	0.35
74LS78	0.35
74LS83	0.90
74LS85	1.16
74LS86	0.42
74LS90	0.66
74LS91	1.30
74LS92	0.66
74LS93	0.66
74LS95	0.77

CMOS 4000 Series

4000	0.25
4001	0.52
4002	0.25
4006	0.90
4007	0.25
4008	0.92
4009	0.25
4010	0.25
4011	0.30
4012	0.25
4013	0.45
4014	0.50
4015	0.65
4016	0.46
4017	0.63
4018	0.46
4019	0.39
4020	0.45
4021	0.56
4022	0.42
4023	0.34
4024	0.66
4025	0.25
4026	0.74
4027	0.52
4028	0.34
4031	0.93
4033	2.40
4034	1.00
4035	0.54
4040	0.65
4041	0.36
4042	0.76
4043	0.64
4044	0.62
4045	2.00
4046	0.77
4047	0.50
4048	0.40
4049	0.50
4050	0.49
4051	0.52
4052	0.48
4053	0.66
4054	1.30
4055	0.72
4060	0.68
4063	0.60
4066	0.50
4068	0.25
4069	0.40
4070	0.40
4071	0.40
4072	0.40
4073	0.40
4075	0.46
4076	0.48
4077	0.40
4078	0.2
4081	0.4
4082	0.2
4085	0.6
4086	0.4
4093	0.3
4099	0.5
4502	0.8
4507	0.4
4508	0.9
4510	0.6
4511	0.6
4512	0.4
4514	1.7
4515	1.6
4516	0.6
4518	0.4
4519	0.2
4520	0.9
4521	1.3
4522	0.8
4526	0.5
4527	0.5
4528	0.4
4532	0.6
4541	0.8
4543	0.6
4553	2.4
4555	0.4
4556	0.4
4585	0.4

CRYSTALS

A111B	1MHz	4.50
A112A	1.008MHz	4.00
A113A	1.8432MHz	3.50
A116A	2.4576MHz	2.00
A120B	4MHz	1.25
A132A	6MHz	1.70
A140A	8MHz	1.25
A169A	3.6864MHz	2.00
A173A	9.8304MHz	2.75
A182A	19.6608MHz	2.50

DIL SKTS TIN

		1+	100+
07070802	8 PIN	0.07	0.05
07071402	14 PIN	0.09	0.07
07071602	16 PIN	0.09	0.07
07071802	18 PIN	0.15	0.10
07072002	20 PIN	0.19	0.14
07072202	22 PIN	0.21	0.15
07072402	24 PIN	0.24	0.16
07072802	28 PIN	0.26	0.17
07074002	40 PIN	0.29	0.18

DIL SKTS GOLD

06060802	8 PIN	0.16
06061402	14 PIN	0.20
06061602	16 PIN	0.21
06061802	18 PIN	0.22
06062002	20 PIN	0.28
06062202	22 PIN	0.32
06062402	24 PIN	0.42
06062802	28 PIN	0.46
06064002	40 PIN	0.66

DIL SKTS W/WRAP TURNED PIN

9090802	8 PIN	0.36
9091402	14 PIN	0.75
9091602	16 PIN	0.85
9091802	18 PIN	0.96
9092002	20 PIN	1.08
9092202	22 PIN	1.18
9092402	24 PIN	1.28
9092802	28 PIN	1.50
9094002	40 PIN	1.70

ZIF SOCKETS

08082402	24 PIN	5.70
08082802	28 PIN	6.90
08084002	40 PIN	8.25

components

GILRAY ROAD, DISS, NORFOLK. TEL: 0379 4131

INSULATION DISPLACEMENT CONNECTOR SYSTEM

HEADERS

	SHROUDED 90°	OPEN 90°	OPEN — STRAIGHT PINS
0 way	0.86	0.65	0.47
4 way	1.22	0.83	0.59
6 way	1.34	0.92	0.65
0 way	1.36	1.13	0.77
6 way	1.70	1.40	0.95
4 way	2.04	1.78	1.19
0 way	2.28	2.07	1.37
0 way	2.70	2.54	1.67
0 way	3.20	3.02	1.96

SOCKETS

0 way	0.88
4 way	1.06
6 way	1.16
0 way	1.38
6 way	1.66
4 way	1.94
0 way	2.08
0 way	2.78
0 way	3.34

CARD EDGE

0 way	1.84
0 way	3.14
6 way	3.80
4 way	4.90
0 way	5.52
0 way	6.68
0 way	8.06

DIP PLUGS

14 way	0.92
16 way	1.06
24 way	1.60
40 way	2.40

TRANS. CONNS.

10 way	0.86
16 way	1.17
20 way	1.37
26 way	1.67
34 way	1.87
40 way	2.23

D-TYPE SOCKETS

9 way	1.47
15 way	2.02
25 way	2.90
37 way	3.97

D-TYPE PLUGS

9 way	1.38
15 way	1.85
25 way	2.52
37 way	3.34

CABLE ASSEMBLIES

IDC JUMPERS SINGLE ENDED

36" cable	IDC socket
10 way	1.72
14 way	2.07
16 way	2.22
20 way	3.14
26 way	3.75
34 way	3.98
40 way	4.23
50 way	5.36
60 way	6.36

DIP JUMPERS

Single Ended

	— 24" cable
14 pin	1.73
16 pin	1.90
24 pin	2.73
40 pin	3.96

Double Ended

	6" cable	12" cable	18" cable
14	2.74	2.84	2.94
16	3.03	3.14	3.25
24	4.18	4.36	4.55
40	5.89	6.18	6.47

DISC DRIVE CONNECTING CABLES

34 way card edge to 34 way card edge 1M	11.30
34 way card edge to 2 × 34 way card edge 1.5M	18.00
34 way card edge to 34 way IDC SKT (BBC) 1M	8.50
34 way card edge to 2 × 34 way IDC KT (BBC) 1.5M	14.50
BBC Power Cable — Single Drive	3.50
BBC Power Cable — Dual Drive	4.75

RIBBON CABLE (PRICED PER FOOT)

	GREY	RAINBOW
9	0.16	0.25
10	0.16	0.25
14	0.21	0.35
15	0.22	0.37
16	0.23	0.39
20	0.28	0.48
25	0.34	0.60
26	0.35	0.62
34	0.45	0.80
40	0.52	0.92
50	0.64	1.14
60	0.76	1.35

BBC MICRO CONNECTORS

DIN PLUG 7 PIN	0.40
DIN PLUG 6 PIN	0.40
DIN PLUG 5 PIN 180°	0.40
DIN PLUG 5 PIN DOMINOE	0.40
POWER PLUG (36" CABLE)	3.00
ANALOGUE INPUT PLUG	2.25
5 WAY DIN SKT 180°	0.90
5 WAY DIN SKT DOMINOE	0.90
6 WAY DIN SKT	0.90
7 WAY DIN SKT	0.90
15 WAY DIN SKT	2.15

Connecting cables for personal computers

A comprehensive range of high quality interconnecting cables for popular micro computers. All cables utilise high quality connectors and are individually tested to ensure trouble free use.

Part number	Description	Computer	
Video cables			
CON100	Phono plug to phono plug (2M)		1.20
CON101	Phono plug to BNC plug (2M)		2.95
CON102	BNC plug to BNC plug (2M)		3.95
CON107	6 pin DIN to open end (1M)	BBC	1.05
CON108	6 pin DIN to 6 pin DIN (1M)	BBC	1.50
CON119	Phono plug to coax plug		1.35
CON160	DIN plug to 2 phono plugs	Dragon	1.20
Cassette recorder cables			
CON109	7 pin DIN to open end	BBC	1.25
CON110	7 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	BBC	2.50
CON111	7 pin DIN to 5 pin DIN + 2.5mm J/plug	BBC	2.50
CON118	5 pin DIN to 2 × 3.5mm J/plugs	Spectrum/ZX	2.50
CON117	5 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	Dragon	2.50
Parallel printer cables			
CON130	36 way plug to 36 way plug (2M)	Sirius/Apricot	18.00
CON131	36 way plug to 36 way plug (5M)	Sirius/Apricot	26.50
CON132	36 way plug to 36 way socket (2M)		18.00
CON133	36 way plug to 36 way socket (5M)		26.50
CON144	36 way plug to 25 way male D type (2M)	IBM/TI PC	19.00
CON145	36 way plug to 25 way male D type (5M)	IBM/TI PC	27.50
CON134	36 way plug to 25 way male D type (2M)	RML/Apple	19.00
CON135	36 way plug to 25 way Male D type (5M)	RML/Apple	27.50
CON142	36 way plug to 20 way IDC socket (2M)	Dragon	13.95
CON139	36 way plug to 26 way IDC socket (2M)	BBC	9.95
CON140	36 way plug to 26 way IDC socket (5M)	BBC	22.95
CON141	36 way plug to 34 way card edge (2M)	TRS80 Lev.1	18.50
CON143	36 way plug to 34 way IDC socket (2M)	TRS80 Lev.2/ Memotech	10.95
RS232 Cables			
CON106	25 way male D type to 5 pin DIN	BBC	5.85
CON128	'Universal' RS232 cable (pins 1-8, 20 connected and 20 jumpered as required) 2M		15.95
CON164	'Universal' RS232 cable as above but 5M		20.95
CON120	25 way male to male 1-25 connected (2M)		16.95
CON121	25 way male to male 1-25 connected (5M)		22.50
CON122	25 way male to male 1-25 connected (10M)		32.50
CON123	25 way male to male 1-25 connected (30M)		68.00
CON124	25 way male to female 1-25 connected (2M)		15.45
CON125	25 way male to female 1-25 connected (5M)		21.00
CON126	25 way male to female 1-25 connected (10M)		31.00
CON127	25 way male to female 1-25 connected (30M)		66.50
CON129	25 way male to 9 way male	Spectrum	15.95
CON162	25 way male to 9 way male	Mackintosh	15.95
CON163	25 way male to 5 pin DIN	RML 480Z	14.95

PART NO.	DESCRIPTION	MAIL ORDER PRICE
BBC MICROS AND ACCESSORIES		
ANB01	BBC Model B Micro	£325.00
ANB02	BBC Model B Micro with Econet I/F	£385.00
ANB03	BBC Model B Micro with Disc I/F	£406.00
ANB04	BBC Model B Micro with Disc & Econet	£445.00
ALA01	Acorn Electron	£139.00
ANB21	DNFS ROM	£17.91
ANB23	Disc Interface Kit	£71.65
ANB14	Speech Interface	£40.00
ANK01	IEEE488 Interface Adaptor	£277.75
ANB22	Econet I/F Kits	£35.00
BBC 45	Joysticks	£8.00
STAND	Monitor Stand	£7.50
SRE1	Sideways ROM Expansion Board	£25.95
DISC DRIVES WITHOUT POWER SUPPLY		
BBC30	Single 100k TEC 40 track single sided	£99.95
BBC31S	Single 100k TEC (expandable to dual) 40 track	£115.00
BBC31D	Dual (2 × 100k) TEC 40 track single sided	£225.00
BBC34	Single 400k TEC 80 track double sided	£174.00
BBC34S	Single 400k TEC (expandable to dual) 40/80 track switchable double sided	£194.00
BBC34SW	Single 400k TEC 40/80 track switchable double sided	£184.00
BBC 34D	Dual (2 × 400k) TEC 40/80 track switchable double sided	£310.00
BBC34S/80	Single 400k TEC (expandable to dual) 80 track double sided	£184.00
BBC34D/80	Dual (2 × 400k) TEC 80 track double sided	£300.00
DISC DRIVES WITH POWER SUPPLY		
BBC30P	Single 100k TEC 40 track single sided with P.S.U.	£130.00
BBC31SP	Single 100k TEC (expandable to dual) 40 track with P.S.U.	£150.00
BBC31DP	Dual (2 × 100k) TEC 40 track single side with P.S.U.	£250.00
BBC34P	Single 400k TEC 80 track double sided with P.S.U.	£209.00
BBC34SP	Single 400k TEC (expandable to dual) 80 track with P.S.U.	£229.00
BBC34DP	Dual (2 × 400k) TEC 40/80 track switchable with P.S.U.	£345.00
MECHANISMS		
FB501	TEC 100k single sided	£91.00
FB504	TEC 400k double sided	£150.00
FLOPPY DISCS		
MD-1C/B	Nashua single sided, single density 40 track (10 discs)	£12.00
MD-1DC/B	Nashua single sided, double density 40 track (10 discs)	£13.00
MD-2DC/B	Nashua double sided, double density 40 track (10 discs)	£15.50
MD-2FC/B	Nashua double sided, quad density 80 track (10 discs)	£17.85
SPECIAL OFFER		
BBC40TD	BASF double sided, double density 40 track (10 discs)	£14.00
DISC STORAGE BOXES		
MDT25/3	3½" Flip 'N' file Micro disc box (cap. 25)	£7.75
DT25/5	5¼" Flip 'N' file lockable disc box (cap. 25)	£18.77
DT60/5	5¼" Standard lockable disc box (cap. 60)	£10.65
MONITORS		
9MON	9 inch green screen high resolution NEC high quality monitor	£125.00
12MON	12 inch green screen high resolution NEC high quality monitor	£135.00
1431	Microvitec 14" RGB colour monitor	£175.00
1441	Microvitec 14" RGB colour monitor high resolution	£410.00
1451	Microvitec 14" RGB colour monitor medium resolution	£295.00
1431/AP/MS	Microvitec 1431 PAL & RGB inputs and sound facility	£225.00
BBC COMPATIBLE SOFTWARE		
SBB03	View Rom	£45.00
SBB04	View Printer Driver	£7.50
AES20	Fileserver Level 1-40 track	£80.50
AES21	Fileserver Level 2-80 track	£202.00
SNB08	Acornsoft Invoicing program	£16.00
SNB09	Acornsoft Mailing System program	£16.00
SNB10	Acornsoft Accounts Receivable program	£16.00
SNB11	Acornsoft Stock Control program	£16.00
SNB12	Acornsoft Order Processing program	£16.00
SNB13	Acornsoft Acounts Payable program	£16.00
SNB14	Acornsoft Purchasing program	£16.00
SNL01	Forth — 40 track	£15.00
SNL02	Lisp — 40 track	£15.00
SNL04	Microtext — 40 track	£47.50
MATRIX PRINTERS		
RX80	Epson RX80 100cps matrix printer	£204.00
RX80F/T	Epson RX80F/T 100 cps matrix printer friction or tractor feed	£231.00
FX80	Epson FX80 150cps matrix printer	£328.50
MT80SP	Mannesmann Tally MT80 matrix printer friction or tractor feed with film ribbon and tear off facility	£209.00
LETTER QUALITY PRINTERS		
HR5	Brother HR5 Thermal printer A/C mains or battery	£115.00
HR15	Brother HR15 Daisy wheel printer (13cps)	£326.00
HR25	Brother HR25 Daisy wheel printer (23cps)	£550.00
UCHIDA	Uchida DWX305 Daisy wheel printer (20cps)	£227.00
PRINTER SUPPLIES		
11241P160	11×9½ 1 part plain listing paper (2,000)	£11.25
11241P2CI	11×9½ 2 part (otc) plain listing paper (1,000)	£14.00
11241P3CI	11×9½ 3 part (otc) plain listing paper (700)	£16.25
11370R160	11×14½ 1 part ruled listing paper (2,000)	£13.50
11370R2NC	11×14½ 2 part (ncr) ruled listing paper (1,000)	£22.50
11370R2CI	11×14½ 2 part (otc) ruled listing paper (1,000)	£15.00
12235P160S	12×9½ 1 part plain listing paper with side perfs. (2,000)	£12.00
HR1R	Brother HR1 ribbon	£2.20
RIB119	Diablo Hytype II Multistrike film ribbon	£1.75
GP205	Diablo Hytype II fabric ribbon	£2.50
MX80	Epson MX80, RX80, FX80, fabric ribbon	£3.00
MT80	Mannesmann Tally MT80 film ribbon	£6.50
RIB117	Uchida DWX305 multistrike film ribbon	£2.75
HR5R	Brother HR5 ribbon	£2.20
HR15R	Brother HR15 multistrike ribbon	£4.00
HR25R	Brother HR25 multistrike ribbon	£4.00
	Brother daisy wheels	£14.00
	Uchida/Qume daisywheels	£4.00
LAB089361C	3½×1.7/16 Labels — 1 wide (12,000)	£20.00
LAB089361S	3½ 1.7/16 Labels — 1 wide (2,000)	£13.00
LAB070363F	2¾ 1.7/16 Labels — 3 wide (1/10") (2,000)	£8.00

CAR COMPUTER

S.H.COUSINS BSc PhD P.D.WILSON BEng PART TWO

IF YOU are building up your own boards then all holes are to be drilled to 0·8mm except for specific instances. On the main board the 1N4003 diodes and the voltage regulator require 1mm and the variable resistor 1·5mm. The 0V, +12V and ignition connections also require 1mm. On the front panel the two locating lugs on each of the five switches require 1mm holes; the upper lug goes into the 5mm pad at the top of the switch position on the p.c.b. and the lower lug into the vacant small pad directly below this on the 5V rail. The case-front has a locating lug which requires a 3·5mm hole in the p.c.b. and a pad is provided between the switches and the 7-segment l.e.d.s for this purpose.

When trimming the boards to size check the fit to the case as you proceed; trim to sit well in the case and allow room for connector wires to pass between them.

CONSTRUCTION

Put in the 10 wire links first. The five indicator l.e.d.s come next and a 5mm gap should be left between the board and the base of each l.e.d. This will allow the l.e.d.s to protrude into the holes provided in the case-front.

The 7-segment l.e.d.s can be placed in sockets which are soldered to the board, or soldered direct into the board themselves. The appearance of the computer when finished

COMPONENTS . . .

Resistors	
R1,R5	270 (2 off)
R2,R11	3k3 (2 off)
R3	22/2W
R4,R9,R15	10k (3 off)
R6	470
R7,R14,R20–24	1k (7 off)
R8	12k
R12	620k
R13	2k2
R16,R10	220k (2 off)
R17	22k
R18	6k8
R19	100k
R25	4k7
Potentiometers	
VR1	10k/2·5W skeleton vert. preset
Capacitors	
C1	1000µ/40V elect.
C2,C8,C9,C10	47n (4 off)
C3,C5	47µ/16V elect. (2 off)
C4	470n/16V elect.
C6,C7	22p (2 off)
C11	10n
Semiconductors	
IC1	7805 reg. (TO220)
IC2	6803 uP
IC3,IC4	3140 op amp (2 off)
IC5	74LS10
IC6	74LS373
IC7	2716 EPROM
IC8	74LS374
X1–4	D201PA 7-seg. disp. (4 off)
TR1,TR2,TR4–8	2N3706 (7 off)
TR3	2N3703
D1,D3,D4	1N4003 (3 off)
D2,D5,D6	1N4148 (3 off)
D7–11	3mm yellow l.e.d. (5 off)
Miscellaneous	
S1–5	REKN1A switch (5 off)
XTAL	3·5795545MHz

Sockets for i.c.s, sensor coil and clip, wire, flexible connectors, p.c.b.s, fuse and holder.

CONSTRUCTORS' NOTE

The Outrider fits nearly all makes of car including diesel and fuel injected vehicles. A kit of basic parts containing the complete case with labels, the high brightness 7-segment l.e.d.s, the five switches (REKN1A), the p.c.b.s and the programmed PROM are available at £29·95; the full kit is available at £59·95; both prices include VAT and P&P, from Mark Space Enterprises, 11 Church Green Road, Bletchley, Milton Keynes MK3 6BJ. With your order please specify the make and model of the car to which it is to be fitted if this is known.

Please note the following corrections to the circuit diagram in Part One. There are two R18s; the left-hand one should read R14 (1k). There are two R10s; the right-hand one should read R11 (3k3).

R26 should be omitted. C9, R10, R13 and IC8 were given the wrong identification but this month's components list is correct. Note that pin 18 of the 2716 is not connected 0V. The unreferenced pin on IC2 (6803) is R/W and is pin 38, not pin 28. Pin 4 is NMI. The top end of C10 should be connected to Vcc. The inset drawings of 373 and 374 at the top of the circuit diagram show an alternative wiring pattern as used on the p.c.b. layout. The Car Computer design is protected by British Patent GB2086577 and application 8221832.

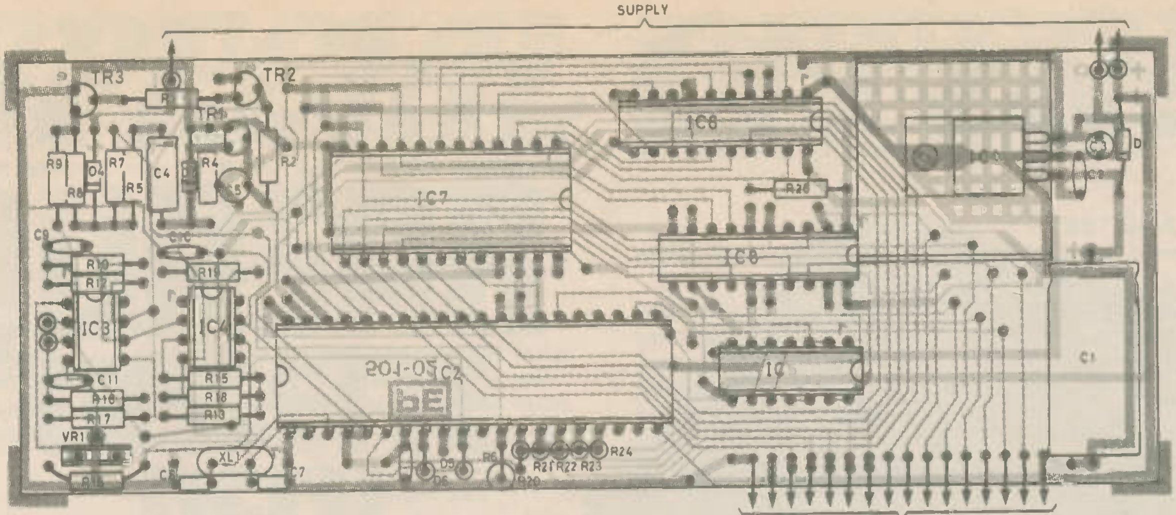


Fig. 2.1. Main p.c.b. component layout

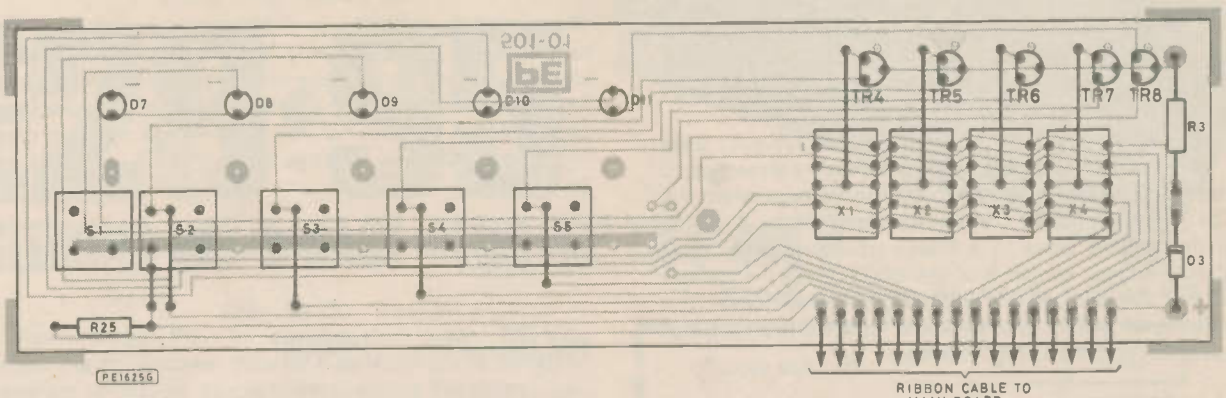
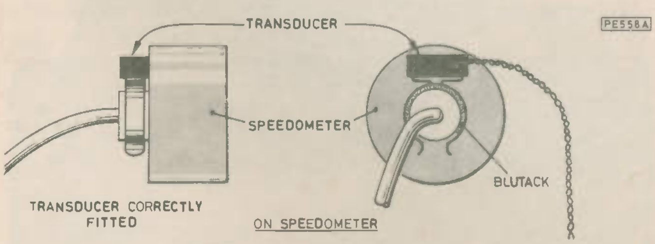


Fig. 2.2. Display p.c.b. component layout (actual size)

is enhanced if these l.e.d.s are soldered direct to the board. The other components can now be fitted but check that the five switches are correctly mounted with the location lugs in the board. The connecting wires from the front panel to the main board should remain on the rear of the front for soldering, i.e. the connector wires should not wrap round onto the component side of the front panel, see Fig. 2.2. But do not at this stage connect the front panel p.c.b. to the main board.



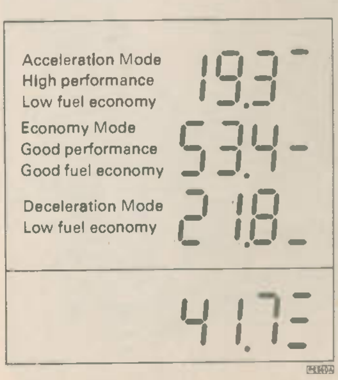


Fig. 2.3 (above). Speed sensor arrangement. (Left). Instanteneous MPG readouts, and (bottom reading) Trip Average MPG readout, displayed below 20 m.p.h. Note bar positions.

MAIN BOARD

The main board is double sided and begin by soldering the connections required between the two sides. There are 67 of these illustrated as single "black dots" in Fig. 2.1 (the p.c.b. diag. with the component layout). Next fit those components which require soldering on the top of the board. They are as follows:

3k3 pull-up resistor on pin 1 374
3k3 pull-up resistor on the reset line
6k8 resistor into pin 8 of the 6803
2k2 into the +5V rail, potential divider in sensor circuit
1k resistors on pins 13 to 17 on the 6803
470 pull-down resistor on pin 12 of the 6803
diode anode on pins 10,8 of 6803

Then go on to fit the remaining components which are soldered to the rear of the board. Note that the five 1k resistors on pins 13 to 17 of the 6803 have the +5V connection taken along their tops. The variable resistor is mounted vertically. Do not connect to the front panel yet.

CASE ASSEMBLY

Bend forward the heat sink vanes so that the main board fits snugly into the bottom runners of the case. Place the assembled front panel in position too. In the main case there are two slots on each side which retain the case-front in position. These should be visible when both boards are in position and any obstructions trimmed off if this is required.

We do not advise frequent opening and closing of the case so therefore do the bench tests (next section) before completing the assembly. Now solder the connections between the two boards and again check that the slots in the case are visible before closing the case. The connection wires should not be pinched when the case is closed, i.e. it should close easily.

SET-UP AND TEST

You should check the operation of the Outrider before connecting it to your car. Here are some guidelines:

With the 12V connected but with the ignition line open circuit check that there is 5V on the output of the regulator and Vcc standby (pin 21 6803), and that Vcc and reset are low (pins 6 and 7). Take the ignition to 12V and Vcc and the reset will go to 5V. The Outrider should draw a current of about 400mA with the display on and 300mA with the display immediately off which is reduced to 10mA after 15 minutes.

The crystal frequency should be clearly seen on pins 2 and 3 of the 6803.

The keyboard/display strobes (pins 13 and 17) have a cycle period of 1·8ms. The cycle starts with all lines going high for the first 0·3ms. The remaining 1·5ms are divided into five time slots in each of which one strobe line goes high.

The variable resistor (10k pot.) should be adjusted until 1·5V is given on pin 6 of the op amp directly connected to the sensor. Care should be taken to set this voltage when the system has warmed up. To test the operation of the distance sensor hold the coil close to a mains transformer. A 50Hz signal should appear on pin 8 of the 6803. With the default calibration of the computer a 50Hz signal corresponds to a speed of around 180 m.p.h. which is outside the range of normal operation of the m.p.g. function.

INSTALLATION

Begin by choosing where you are going to mount the computer. It is very important to place it where you can read the display *without taking your eyes from the road.* Therefore the computer should be placed on top of the dashboard or high in the dashboard area. To mount the computer low in the dashboard can be *dangerous.*

ELECTRICAL CONNECTIONS

There are just three electrical connections to be made between the computer and your car, these are the 0V, +12V permanent and +12V when ignition on. The computer is designed for fitting to negative earthed vehicles only. Use a test light to identify the required connection points on the car. Each of these connections should be firm clean connections. The existing terminals and connectors on the car battery should also be in good condition. For positive earth cars write to M.S.E. for circuit modifications.

Fitting the distance sensor is shown in Fig. 2.3 and discussed in the transducer section (last month).

CALIBRATION

The computer does require calibration in the car when it is first fitted. The calibration mode CAL is obtained by pressing the SET key for four seconds. Begin calibration by entering,

CAL DIST 0001 SET

Now go for a drive. Drive for one mile and note the number which is displayed on the computer. Suppose this number were 1530, then enter this number (which is the number of pulses per mile detected by your distance transducer on the back of the speedometer) thus,

CAL DIST 1530 SET

That completes the distance calibration.

The next function to calibrate is FUEL. You should enter the volume of the fuel tank in gallons here. It is ESSENTIAL that you enter a value for tank volume for your computer to function. Suppose it is 10 gallons

CAL FUEL 10.00 SET

That completes the fuel tank calibration.

The next function is MPG. You should enter an estimate of what the average fuel consumption of your vehicle is, in miles per gallon. Accuracy is not important here as the computer will compute this figure for itself once it is fitted and a tank of petrol has been used. Suppose your estimated MPG is 35mpg, then,

CAL MPG 35.00 SET

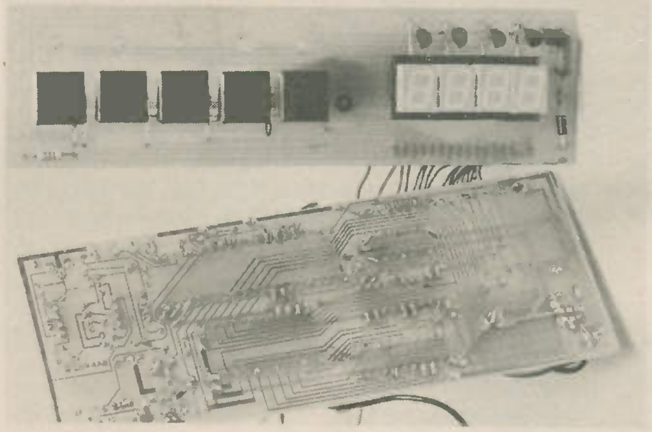
That completes MPG calibration.

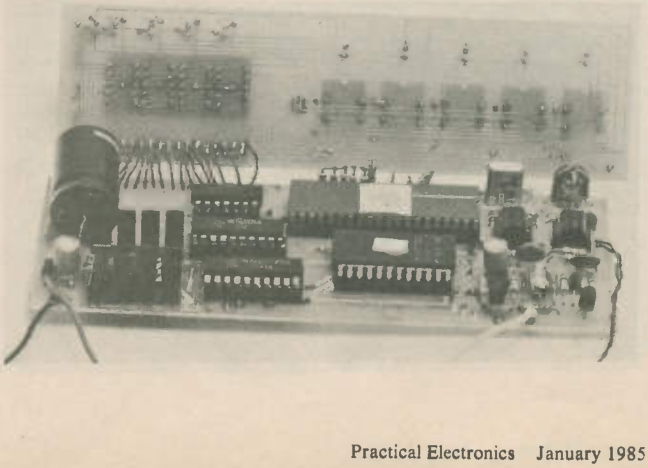
The remaining function is COST. You should enter an estimate of the costs per mile other than petrol. These costs should certainly include the cost of oil, tyres and an amount for wear and tear on the engine, exhaust etc. Depreciation is also affected by how far you drive—high mileage cars are worth less than low mileage ones when it comes to selling your vehicle.

Suppose you set these additional costs at 10 pence a mile, then enter,

CAL COST 00.10 SET

That concludes all calibration. ★





SPECIAL OFFER!

QUASAR CASSETTE DECK

£29·95

INCLUDING VAT & CASE PLUS £2·75 P and P

In April 1982 PE, in conjunction with RT-VC, published the *PE Quasar Stereo Cassette Deck* design. The design provides some outstanding features, including variable recording bias and a gate noise reduction system. As a result of this successful design we are now pleased to be able to offer kits to PE readers at this exclusive price. The kits, including a wrap round simulated wood finish case, will be accompanied with a reprint of the PE articles which fully describe the unit and its construction.

The offer is for a limited period only and a coupon should be sent to the address shown. The specification of the made-up unit is given below:

SPECIFICATION

Case size 285 × 260 × 90mm approx.
Mechanism with automatic stop and tape counter with reset button.
Tape Speed: 4·76cm/sec. ($1\frac{7}{8}$in/sec.).
Wow & Flutter: Typically 0·1%.
Drive Motor: 12V d.c. with electrical governor.
Play Torque: 40–75g/cm (DYNAMIC).
Rewind & Fast Forward Torque: 60–140g/cm (STATIC).
Rewind & Forward Time: Less than 100 sec. for C60 tapes.
Bias/Erase Oscillator: Externally variable, frequency 90–100kHz.
Output: (Adjustable) Up to 1 volt r.m.s.
Mic. Sensitivity: 1mV @ 47k.
DIN Sensitivity: 30mV @ 47k.
Frequency Response; 30Hz–12·5kHz (–3dB).
Signal to Noise Ratio.
Noise reduction OFF –50dB
Noise reduction H.F. –56dB
Noise reduction FLAT –70dB
Cross Talk: Typically –50dB.

To: RT-VC, 21B High St., Acton, London W3 6NG

Please complete both parts of the coupon in BLOCK CAPITALS

Please send me .... Kit/s

One deck kit costs £29·95 plus £2·75 p&p (£32·70)

I enclose PO/Cheque No .... Value ....

Name ....

Address ....

....

....

Please allow 28 days for delivery

OFFER CLOSES FRIDAY DECEMBER 14 1984

Name ....

Address ....

....

....

Access 'phone orders 01-992 8430

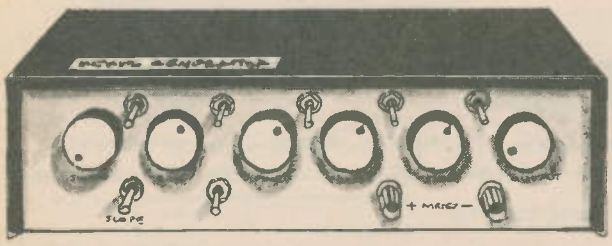
To: RT-VC, 21B High Street, Acton, London W3 6NG

all in your FEBRUARY issue!

8 EXTRA PAGES

MODULAR AUDIO POWER SYSTEM

This new series deals with the construction of a flexible audio system giving up to 150W output. The basis of this system is a 50W power amplifier module which can be used with pre-amps, line drivers, tone controls and mixers to construct a wide range of high powered sound reinforcing systems.



SIGNAL GENERATOR & F-V CONVERTER

One of the most useful pieces of test equipment after the multimeter is the signal generator. A must for the home constructor, this multifunction Signal Generator with built-in Frequency-to-Voltage converter.

Microwriting

The Principle and the Product...

The Microwriter is a hand-held box with only six keys and a liquid crystal display, but it represents a real alternative to the QWERTY keyboard.

SPECTRUM DAC/ADC BOARD

This DAC/ADC board for the ZX Spectrum plugs into the expansion port and enables both analogue-to-digital and digital-to-analogue conversions, with an 8-bit resolution, to be achieved.

PRACTICAL
ELECTRONICS
ROBOTICS · MICROS · ELECTRONICS · INTERFACING

FEBRUARY 1985 ISSUE ON SALE FRIDAY, JANUARY 4

LASERS & HOLOGRAMS

RICHARD BARRON

IT would be futile to try to describe the fantastic experience of LASER light, as it can only be fully appreciated by seeing first hand its absolute uniqueness. Similarly a hologram is the equivalent of a thousand pictures, and since it takes a thousand words to describe a picture, then it must require a million words to adequately describe a hologram. Because paper, ink and my patience are in short supply, I shall not attempt to do this, instead I shall try to explain the nature of, and the methods by which LASERS and holograms are produced.

MICROWAVE AMPLIFICATION BY THE STIMULATED EMISSION OF RADIATION (MASER)

A MASER is a device which produces intensified electromagnetic radiation by a method first predicted by Einstein in 1917. It is the process of stimulated emission that renders the unique characteristics of the radiation produced. The electromagnetic spectrum includes Gamma-waves, radio waves and visible light, which differ only in their frequency and wavelengths. Infra-red radiation and visible light have wavelengths between 1mm and 0·001mm and it is this part of the MASER spectrum which constitutes a LASER . . . Light Amplification by the Stimulated Emission of Radiation. Before considering the meaning of stimulated emission we must first understand a little about the nature of atoms and the energy states within them.

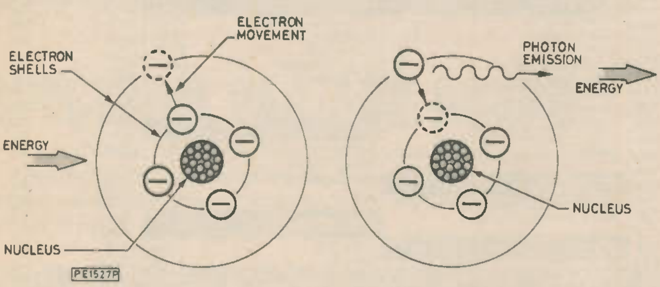


Fig. 1. The energy states within atoms causing spontaneous emission

All elements are made from atoms which consist of a number of electrons surrounding a central nucleus containing tightly packed particles known as protons and neutrons. In the early days it was thought that electrons orbited the nucleus in a similar manner to that of the planets round the sun, but the theory relating to the energy and motions of these particles has developed to such an extent that we no longer believe this to be true. Electrons are arranged in 'shells' around the nucleus; the number of shells and electrons depending on the particular type of atom. At normal temperatures the radii of the various electron shells are fixed and the electrons in them possess a fixed amount of energy. Under these conditions the atom is said to be in its lowest energy state, or ground state. However if the atom is given extra energy by being heated or struck by a fast moving ion then one or more electrons may jump from one shell to another. It is then excited, i.e. in a high energy state. This state is not maintained for long and the electrons will soon jump back to its 'natural' shell thus giving out energy in the form of electromagnetic wave pulses called photons.

According to Plancks quantum theory the amounts of energy involved in the high to low transitions are considered to be finite bundles of energy called quanta; the quantity of energy being termed a photon. The frequency and wavelength of the emitted photon depends upon its energy and the type of energy transition involved. For example if an ordinary filament lamp is heated then the light produced contains a wide range of wavelengths, since the number of energy states and possible transitions are high. The time between gaining thermal energy and emission of energy will also differ, thus giving out random photons which are out of phase with each other. This process, random emission is said to be incoherent. Another process which may also occur is absorption, where a quantum of radiation strikes an atom which will absorb the energy causing excitement. Once excited, the atom may emit a photon and return to ground state at a later stage, causing spontaneous emission.

LET'S GET STIMULATED

If an atom is bombarded by a photon with an energy content or wavelength such that it causes it to emit a photon, then the emitted photon will be exactly the same wavelength and in phase with the striking photon. The atom will then be reduced to a lower energy state which is the reverse of the absorption process. This gives rise to a situation where the striking photon carrying on its journey is added to by the emitted photon. If this is repeated with each collision, then an intensified beam of photons is produced all of which have the same wave motion and phase. This is called coherent light and the process is termed stimulated emission. Under these conditions we have Light Amplification by the Stimulated Emission of Radiation, yes a LASER.

So far so good but in practice most electrons will have low energy states which will reduce the intensity of the beam by absorbing energy. What is required is an external energy source to keep the beam 'topped up.'

THE RUBY LASER

The first real development in the successful production of light amplification by this process was the construction of the ruby laser. Ruby is a crystal of aluminium oxide with some of the aluminium atoms replaced with chromium which gives it its deep red colour. This also accounts for the amplification effects of the ruby LASER.

A practical ruby LASER consists of a crystal ruby rod with its ends ground flat, polished and coated with a highly reflective material (one end partially coated). Surrounding the crystal is an external flashlight source which is used to 'pump' light energy into the crystal causing the chromium atoms to be raised to a high energy state. This causes spontaneous emission of light, most of which escapes through the sides of the crystal rod. However some of the spontaneous energy is emitted in the direction of the mirrored ends and is reflected back into the crystal. When this radiation strikes a chromium atom, stimulated emission occurs thus amplifying the radiation. As the light travels back and forth between the ends of the rod it becomes more and more intense giving rise to an effective LASER. For continuous operation the ruby has to be cooled, as a great amount of heat can be produced as energy is transferred.

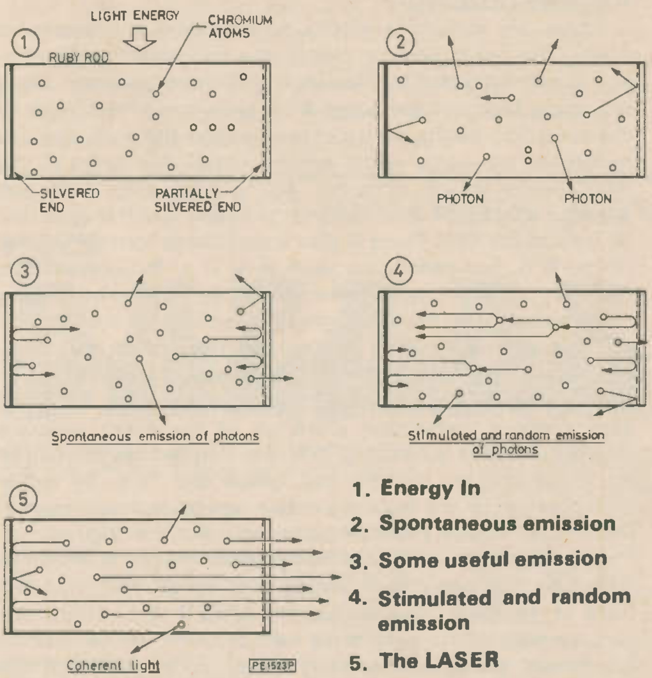


Fig. 2. The principles of LASER operation

GAS LASERS

Since the development of the ruby LASER there have been many types of LASER devices, most of which have employed the use of gas as their amplifying medium. The first device of this kind contained a mixture of Helium and Neon which was excited by passing an electric current through the gas; a similar technique to that used in Neon signs and Sodium street lighting. With Helium and Neon it was found that it was possible to excite the gas causing stimulated emission which produces radiation of 1·15 micrometers wavelength, which is of course in the infra-red spectrum. The radiation is once again reflected back and forth within the gas chamber increasing in intensity as more and more electrons become stimulated.

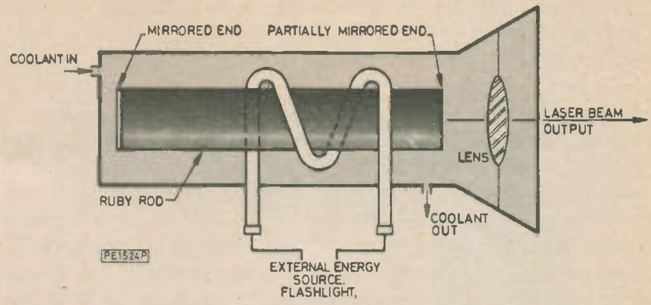


Fig. 3. Basic construction of a Ruby LASER

There are many other combinations of gas used, particularly Argon and Krypton which produces amplification in more than one region of the visible spectrum. This results in an emitted beam giving the appearance of intense white light.

Modern LASERS make use of the principles already described, but many advances in technology have been made, enabling complex and very powerful LASERS to be produced. The energy source for these 'machines' is now often high frequency radio energy operating at very high powers.

The thyratron shown in the photograph below is capable of providing energy pulses of 30kV with peak currents in the range of 15,000 Amps. These are used in modern gas discharge LASERS.

APPLICATION OF LASERS

Today there are many applications of LASERS in the fields of industry, medicine and communication. This is largely due to the great versatility in aiming and focusing of LASER energy, using optical lenses and mirrors. In industry LASERS have been focused onto very tiny areas and used for cutting, welding and drilling and in medicine have been successfully used in the treatment of eye disorders such as detached retinas, and more recently shown promise in the treatment of cancer and similar illnesses. Because the nature of light is similar to that of 'conventional radio' LASERS have found many applications in electronics and communication, employing speech and data transmission.

LASERS are now widely used in the printing industry to produce mass copies, and are now even employed on small printers associated with personal computers. Fig. 4 shows a LASER being used in the printing industry.

Another use of LASERS is in the production of holograms.

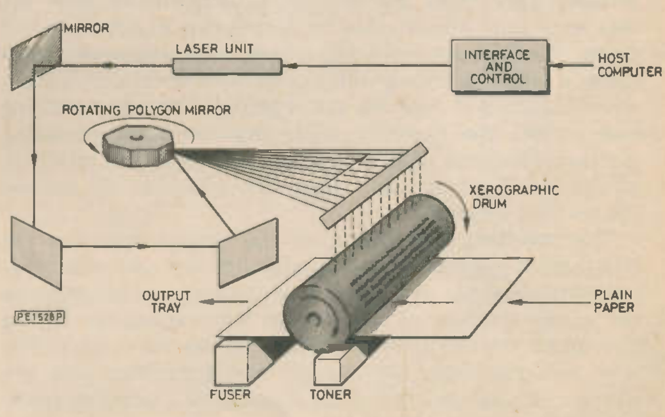


Fig. 4. LASERS used in the printing industry

HOLOGRAPHY

Like photography, holography is a technique used for storing images on film, however, the two processes are fundamentally different. In conventional photography the light source essential to the production of an image is white light, that is to say a jumbled mixture of frequencies ranging from infra-red to ultra-violet. Because of this wide spectrum of frequencies it is impossible to record information regarding the depth of a scene or object. In 1947 the British scientist Dennis Gabor conceived and predicted the hologram which was capable of recording 3-dimensional (3D) detail on film, but the practical demonstration had to wait for the invention of a particular type of light source, that being the LASER. The essential properties being monochromatic, i.e. single frequency and also coherence (each wave being in phase with each other). As was suggested the details of the depth of the scene illuminated by LASER light can be contained in the phase relationship of the light reflected off the subject. A wave coming from a closer point in a scene will lead a wave arriving from a further point, this being true because the speed of light is constant.

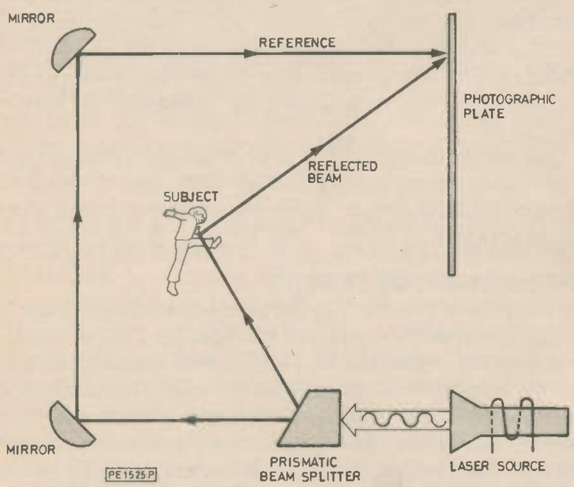


Fig. 5. Schematic representation of a LASER being used in the production of a holographic image, and stored on a photographic plate

To record this information a LASER source is set up and split into two beams, one being aimed at the subject, the other being used as a reference beam. If the reflected beam arriving back from the subject is recombined with the reference then constructive or destructive interference will occur. That is to say if the two waves are in phase with each other, a crest coinciding with a crest, then constructive interference occurs, If they are out of phase, a trough coinciding with a crest, then destructive interference occurs, producing a phase difference of half a wavelength. With this principle, all the variations between these two extremes will contain the detail of depth.

The resulting amplitudes of the waves reaching the holographic plate at particular points do not vary with time, but standing wave patterns are established and recorded on the sensitive plate or film. When the holographic film is developed, the recording looks nothing like the original. The light reflected from the subject and combined with the reference causes the film to be made up of a complex series of concentric circles and bands of varying intensity.

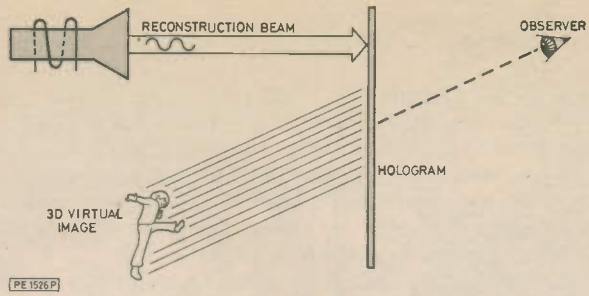


Fig. 6. Schematic representation of the reconstructed image

RECONSTRUCTION

There are several methods of recording a holographic scene, the most common being as a transparency. The image is reconstructed by illuminating the transparency with a reference beam of the same frequency and wavelength as the recording beam. As it passes through the recording, interference will occur which will be exactly the same as the interference which occurred during recording. This will produce a three-dimensional virtual image which is apparently behind the film. There is also a real image formed in front of the film, but cannot be seen as it is a 'focused image'. However, different parts of the image can be seen by moving a screen back and forth, bringing it into the focal area.

The methods outlined so far have one major drawback. Because of the nature of the light source, the resulting image is monochromatic; one frequency, one colour. Nowadays modern techniques allow us to use three separate reference beams employing different frequencies relating to the three primary colours; red, green and blue. By clever manipulation of the beams a scene can be reconstructed in 3-D colour, to give a faithful reproduction of the original.

In practice the quality of holographic images is often impaired by dust particles on lenses or in the air, and imperfections in the glass. This causes the LASER to be diffracted, and because of its coherence odd patterns are created on the image, giving it a 'spotted' effect. To some extent this can be overcome by careful cleaning and use of top quality polished glass. Another method widely used, nowadays, is to deliberately spread diffraction patterns over the whole image giving an overall speckled effect.

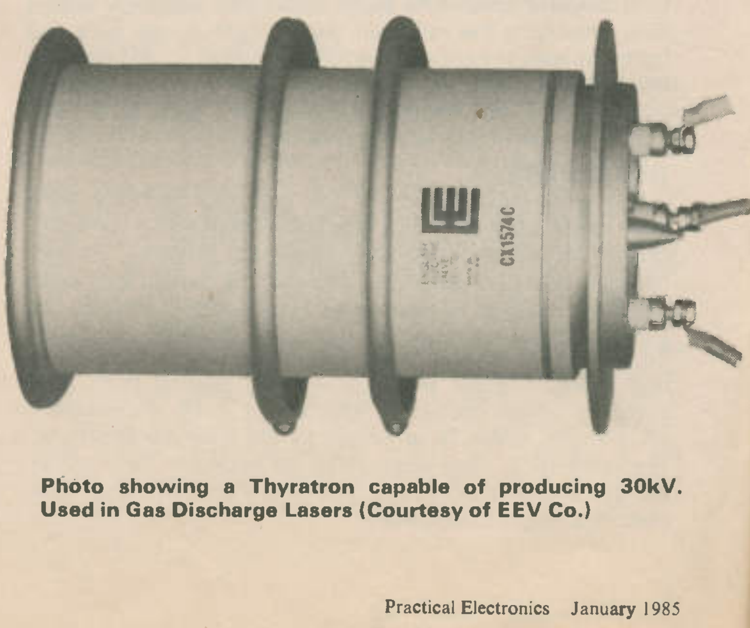


Photo showing a Thyratron capable of producing 30kV. Used in Gas Discharge Lasers (Courtesy of EEV Co.)

APPLICATIONS OF HOLOGRAMS

Like LASERS, holograms are being used in all areas of industry and new ideas are being developed all the time. By changing the direction (angle) of a reference beam between exposures it is possible to create a vast amount of entirely different images on one film. Each image can be reconstructed using the same technique, giving rise to many applications in the field of information and data storage and 3-D motion films.

Scientists and technologists are using holograms to measure minute size differences in similar objects. A hologram is made of an object and a reference beam is reflected off a copy to produce interference patterns on the plate. When the image is viewed, interference fringes will be apparent representing a size difference of half a wave length for each fringe. Using this technique it is possible to measure sizes as small as three hundred millionths of a millimeter.

One application of holograms is becoming very common, that being their use in security systems. Many banks are now issuing credit and bankers cards with a holographic monogram or signature. Because of the complexity of holograms it is almost impossible to forge.

As more and more scientists become interested in light energy and its applications, holograms and LASERS are certain to play a major role in all areas of our future industries and everyday lives. By the turn of the century 3-D films will be commonplace and the first 'optical computers' will be brought into service.

Holographic images used to avoid credit card fraud. (By courtesy of Barclays Bank PLC)

FREE! READERS' ADVERTISEMENT SERVICE

PE BAZAAR

RULES Maximum of 16 words plus address and/or phone no. Private advertisers only (trade or business ads. can be placed in our classified columns). Items related to electronics only. No computer software. PE cannot accept responsibility for the accuracy of ads. or for any transaction arising between readers as a result of a free ad. We reserve the right to refuse advertisements. Each ad. must be accompanied by a **cut-out valid** "date corner". Ads. will not appear (or be returned) if these rules are broken.

OSCILLOSCOPE Tele S31R in working order. £30 o.n.o. Mr. G. Graham. Tel: Burton Latimer 6413.

RADIO Shack TRS–80 acoustic coupler mint condition £75. Mr. A. Ding. Tel: Wickford 62943.

WANTED service manual & circuit diagram for UK 101/broken board. Write, stating value: Mr. Y. J. Qalanzi, PO Box 182739, Amman, Jordan.

VIC 20 with cassette recorder, printer, 16k expansion, joystick, lots of software £200 o.n.o. Vernon Carter, Fitznells, 2 Chessington Road, Ewell, Surrey. Tel: 01-393 1577.

TWELVE 7" reels of Tandberg TGB professional recording tape 1800 ft. New. Made by 3M company. Offers. L. T. Hill, 14 Rothesay Terrace, Bedlington, Northumberland. Tel: Bedlington 825967.

CENTRONICS 306 120 CPS dot matrix printer full working order with manual £60. Tel: 0473 328013.

WANTED headshell for Goldring Lenco GL78 turntable. Good price offered. Mr. V. J. Owen, 14 Lower Oxford Road, Newcastle, Staffs. ST5 0PB. Tel: 0782 619698.

TEKTRONIX oscilloscope dual trace delay sweep 24MHz £145. Manuals H.P. DVM £20. Texas printer £45. Mr. T. J. L. Haley. Tel: 01-868 4221.

TEXAS calculators: T1 57, new battery £14. T130 rechargeable battery £7. New Sharp EL345, solar powered, £4. N. G. Savill, 31 Jubilee Avenue, Ascot, Berks. Tel: 0344 884832.

POWERTRAN density mixer modules wanted, kit or assembled. Contact D. Hanley. Tel: 0875 20692.

MAPLIN 5600 p.c.b.s, front panel and some components — over £100 worth. Only £50. Peter Makin, Tel: Atherton (0942) 892193.

ALUMINIUM boxes $\frac{1}{4}$ x $1\frac{1}{4}$ x 2 inches hinged lid. Suit small item storage £5 per 100. SAE + 20p for sample (unused). R. H. Pearce. 8 Holly Oak Road, Coxford, Southampton SO1 6GD. Tel: Southampton 788278.

WANTED circuit diagram of wireless remote control range up to two kilometres. Ajaz Jalal, A-237 Sector 11.A, Gulshan-E-Usman, North Karachi, Pakistan.

DISC DRIVE, controller, PSU fits any machine VIA PIA. Flex O/S for 6800. £250. Mike Davies 01-543 4977.

TOSHIBA 25W Hi-Fi speakers £30. Fisher Hi-Fi remote control/timer unit. 25 channel IR £30. Tel: 0206 48603.

I AM interested in communicating with someone who has information on electronic science. Please write to: Abbas Rezaei, PO Box 62, Nagafabad, Isfahan, Iran.

SUPERBOARD MKII 8K with case and p.s.u. 2MHz CIS monitorum centronics. Parallel interface £45 o.n.o. Tel: 051 924 2611.

WANTED manual or circuit diagram for Solartron type CD523S oscilloscope. Tel: 01-274 7566.

I NEED to buy LSIs AY–3–8710 and T.M.S. 1000 with price of £30. Please write to: Abbas Rezaei, PO Box 62, Nagafabad, Isfahan, Iran.

WANTED any unusable, broken, computer—cheap, with real keyboard; keyboard must be in working order. Mr. M. West, 28 Rectory Lane, Houghton Conquest, Beds. MK45 3LD. Tel: Bedford 740332.

Please publish the following small ad. FREE in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules. I enclose a **cut-out valid** date corner.

Signature .... Date ....

Please read the RULES then write your advertisement here—one word to each box. Add your name, address and/or phone no.

COUPON VALID FOR POSTING BEFORE 4 JANUARY 1985 (One month later for overseas readers.)

SEND TO: PE BAZAAR, PRACTICAL ELECTRONICS, WESTOVER HOUSE, WEST QUAY ROAD, POOLE, DORSET BH15 1JG.

BLOCK CAPITALS PLEASE

Name & Address:

For readers who don't want to damage the issue send a photostat or a copy of the coupon (filled in of course) with a **cut-out valid** "date corner"

PE BAZAAR JANUARY '85

RICHARD B. H. BECKER — SYSTEM DESIGN AND MECHANICAL ENGINEERING.

TIM ORR — COMPUTER INTERFACE AND CONTROL ELECTRONICS.

ROBOTS neptune and mentor

PART FIVE

THE BASIC construction and the electro-mechanics of the MENTOR robot were explained last month, and circuit diagrams for computer interfacing were given, as well as the circuits for writing to, and reading from, the robot. This month the servo-control and the power supply circuits are published.

SERVOING

The robot has dedicated hardware which performs the servoing tasks as shown in Fig. 5.2. This can be illustrated by examining the "axis Ø" electronics. IC200 buffers the feedback signal from the position feedback potentiometer, provides gain and a variable d.c. offset (VR200). It is almost impossible to fit the potentiometers to give exactly 0V at exactly the axis minimum positions so they are fitted with about 5% of travel still to go and the residual voltage is then nulled out with the pre-set potentiometer. The next operational amplifier (IC201) produces two signals, the feedback VFB voltage which is sent to the ADC and the MP (Measured Position) voltage.

The MP voltage and the DP (Desired Position) are subtracted from each other by the voltage comparator IC202 pins 1,2,3. The output of this operational amplifier is an error voltage which is a measurement of the difference between the axis current position and where the computer has instructed it to go to. The error voltage is further amplified by the second half of IC202. This stage has a non-linear gain-to-output voltage relationship. The gain is greater when the output is near to 0V, but falls by a factor of 10 for large signals. The additional gain at low signal levels ensures that there is sufficient voltage on the motor to keep it moving when close to the desired position and the error voltage is low.

The final stage, IC203, is a power operational amplifier which can deliver up to 350mA but otherwise behaves like a 741 or similar. The i.c. amplifies the error voltage and sends its output directly to the servo motor. These are d.c. motors which can operate with as little as 20mA drive but have peak demands of about 100mA. If the servo loop has not been wired up backwards the axis will always move towards a position dictated to it by the data from the computer. A pair of l.e.d.s (D204,205) are also connected to the output of IC203 and these give a visual display of the drive to the motors.

POWER SUPPLY

The transformer T500 which has tappings for use on 110, 130, 220 or 240V mains has 3 secondaries which supply separate circuits for the logic, analog and motor drive circuitry. This prevents the voltage spikes on the power rails of the motor drive circuits and logic from interfering with the operation of the other parts of the system. CN502 leads to a double-pole switch to allow for the de-powering of the motors during initial setting up of the computer.

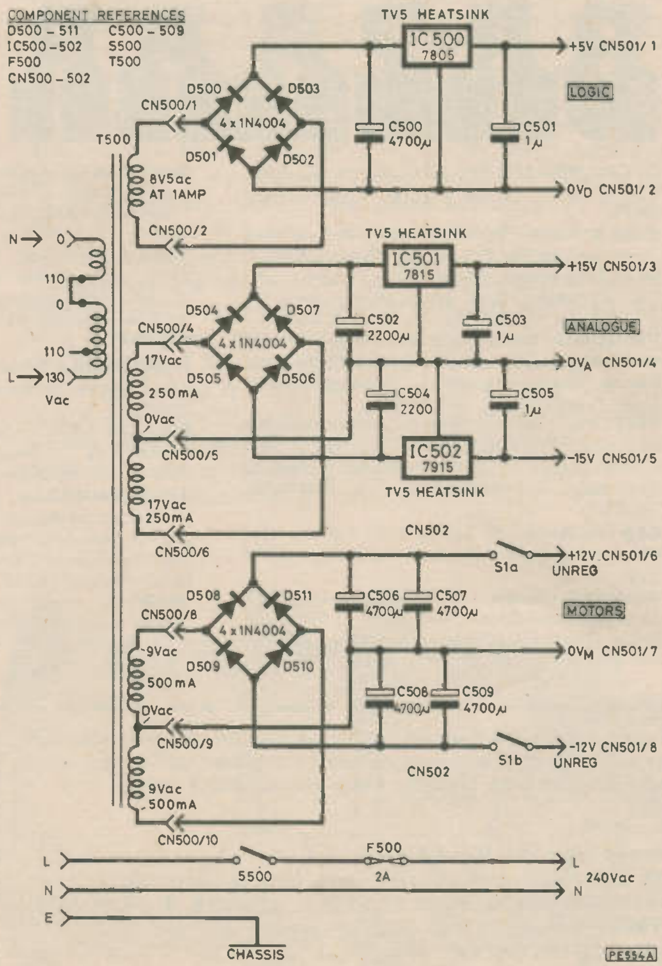


Fig. 5.1. Power Supply for MENTOR

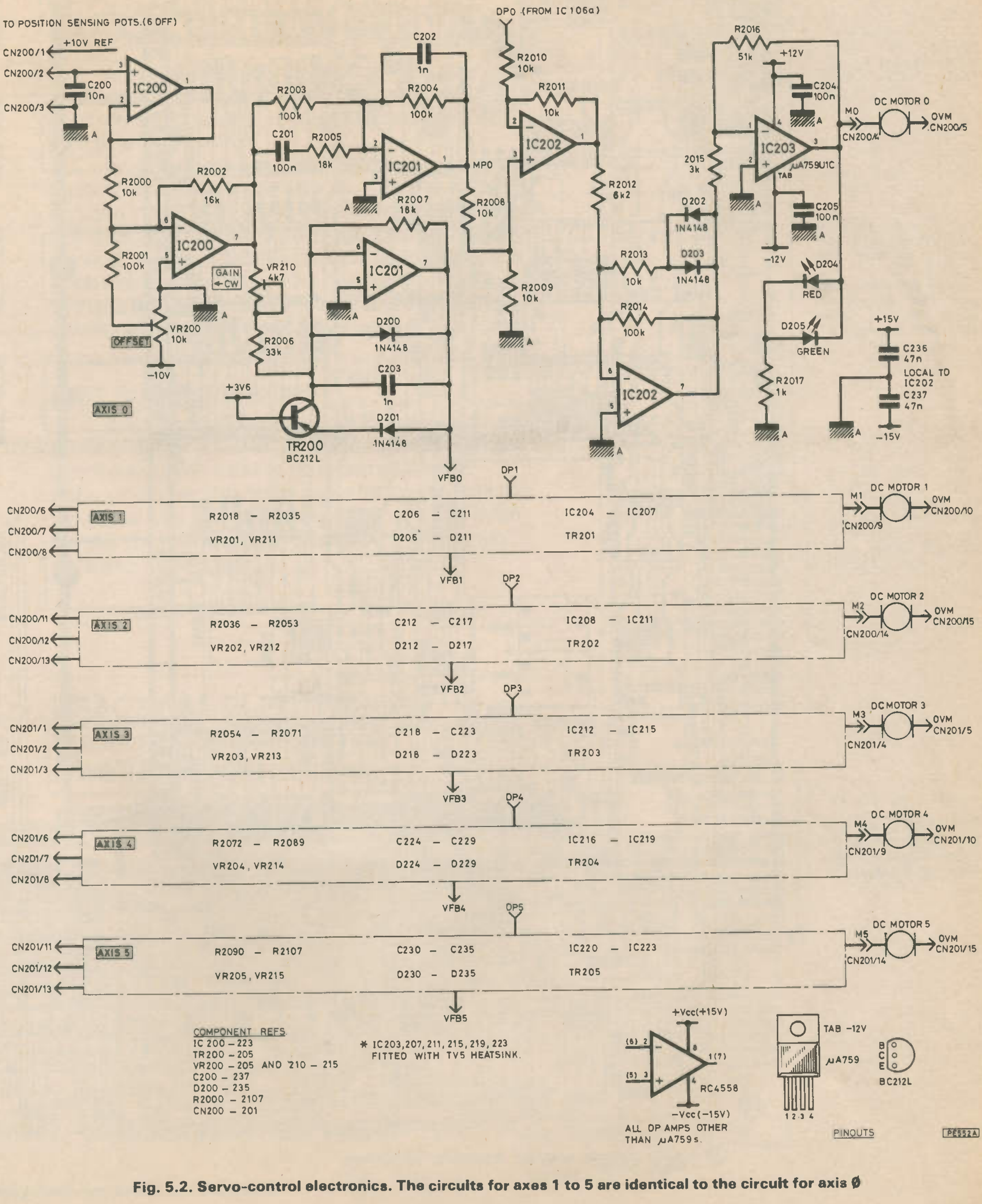


Fig. 5.2. Servo-control electronics. The circuits for axes 1 to 5 are identical to the circuit for axis Ø

To position-sensing potentiometers on each of six axes. See Fig. 5.2.
Also difference voltages for motors on each of six axes (MO–M5). See Fig. 5.2.

To CN501, Power Supply. Logic, analog, and motor supply voltages. See Figs. 4.7 and 5.1.

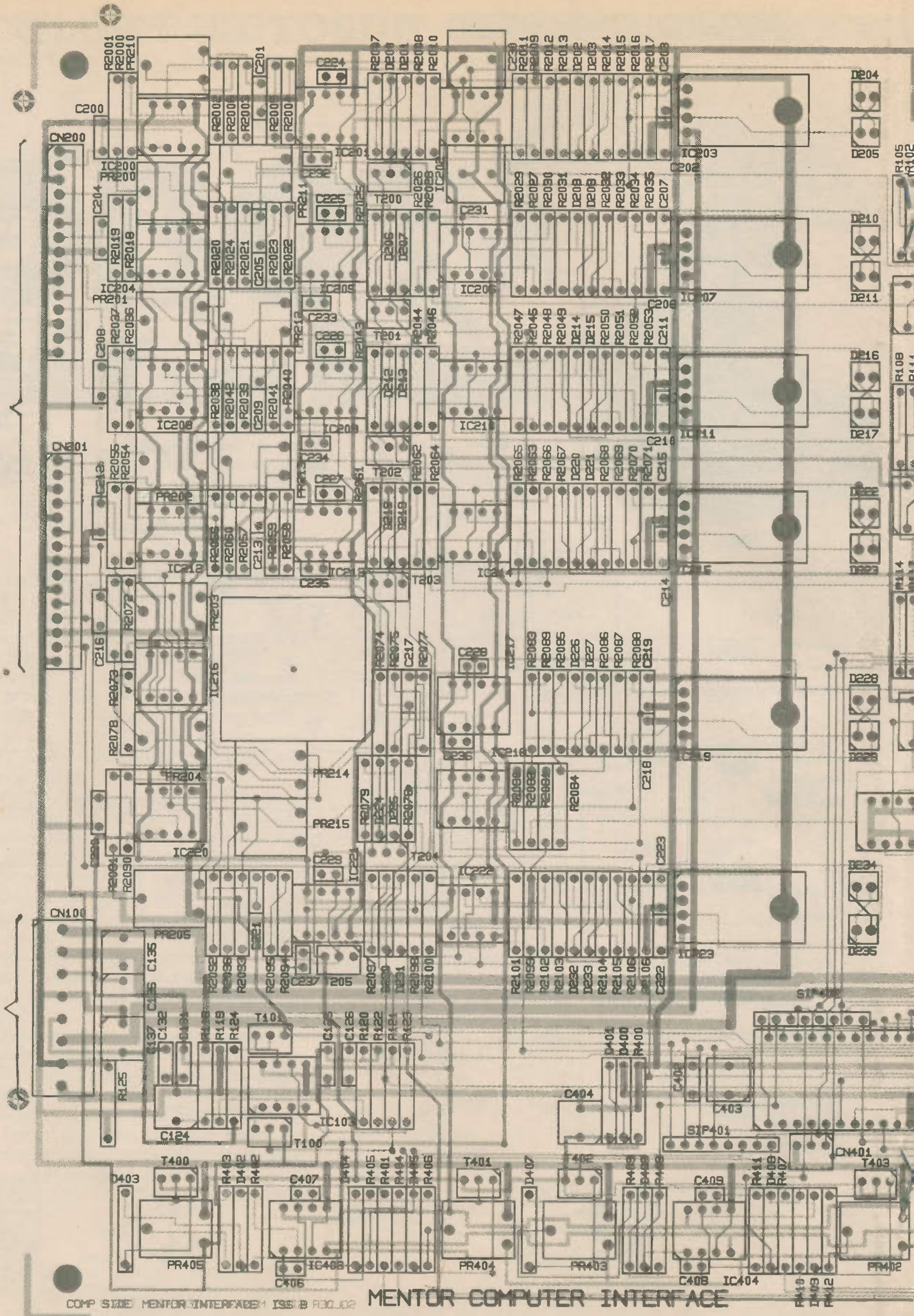
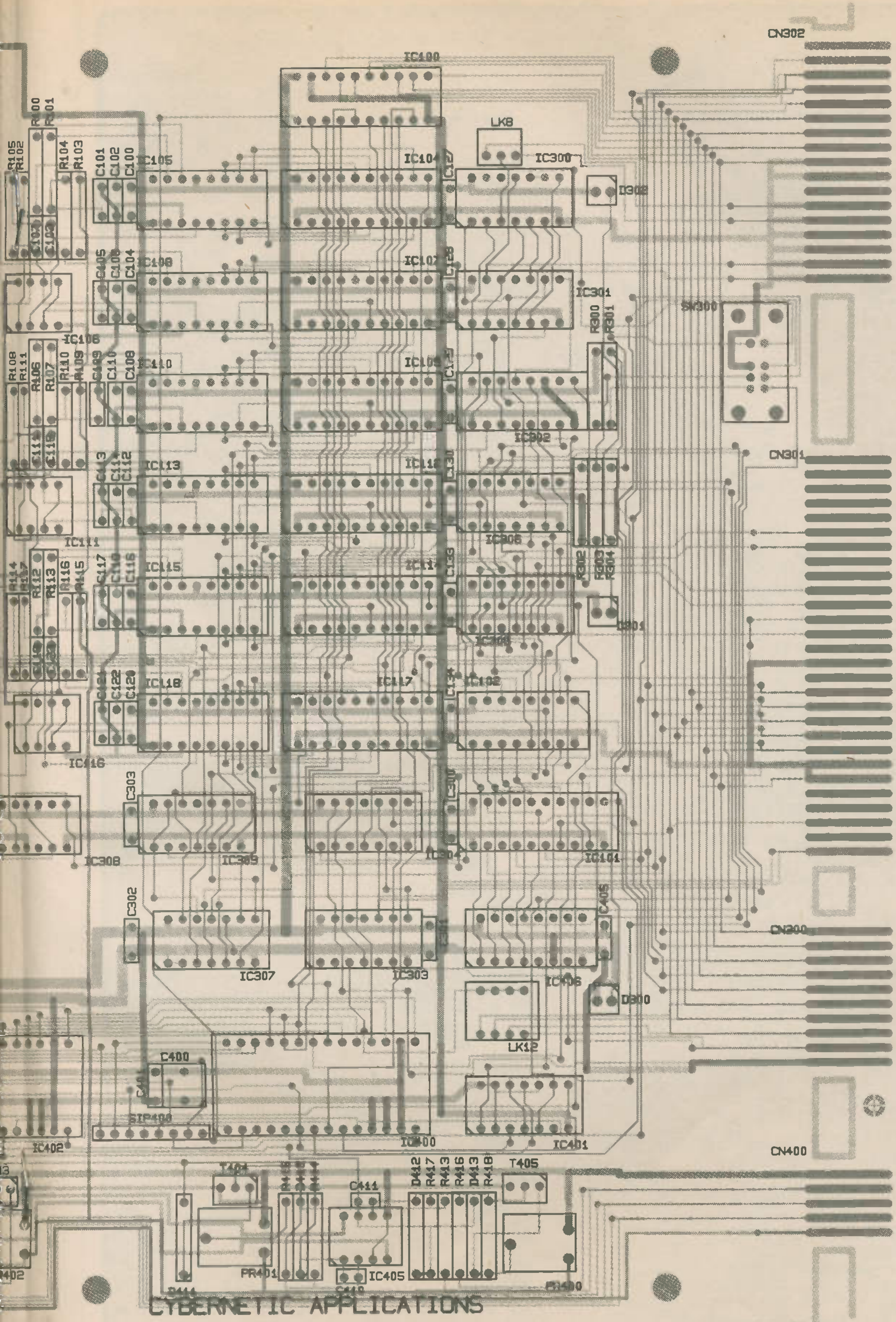


Fig. 5.3. P.c.b. and component layout for ME



To BBC 1MHz BUS. Data lines D0–D7, Address lines $\overline{A0–A4}$. Control lines R/$\overline{W}$, $\overline{JIM}$, $\overline{FRED}$, 1MHz clock. See Fig. 4.6.

To ZX SPECTRUM BUS. Data lines D0–D7, Address lines A0–A3, A5, A6, A13–A15. Control lines $\overline{MREQ}$, $\overline{RD}$, $\overline{WR}$, $\overline{IORQ}$, CK. See Fig. 4.6.

To VIC-20 I/O USER PORT. Data lines D0–D7, Address lines A0–A4. Control lines CR/$\overline{W}$, S/Ø2, $\overline{BLK1}$–$\overline{BLK4}$. See Fig. 4.6.

To learning arm (simulator). Inputs VL0–VL5, from simulator. See Fig. 4.8.

or MENTOR interfacing and control electronics

COMPONENTS . . .

MENTOR COMPUTER INTERFACE BOARD

Refer to Figs. 4.6, 4.7, 4.8, 5.1 and 5.2.

Resistors

R100–117,2105	5k1 (19 off)
R118	27k
R119,120,122,123,2000, 2008–2011,2013,2018, 2026–2029,2031,2036, 2044–2047,2049,2062–2065,2067,2080–2083, 2085,2090,2098–2103	10k (39 off)
R121,124	100 (2 off)
R125	1
R2001,2003,2004,2014, 2019,2021,2022,2032,2037, 2039,2040,2050,2055,2057, 2058,2068,2073,2075,2076, 2086,2091,2093,2094,2104, 401,404,407,410,413,416	100k (30 off)
R2002	16k
R2005,2007,2020,2023, 2025,2038,2041,2043, 2056,2059,2061,2074, 2077,2079,2092,2095, 2097	18k (17 off)
R2006,2024,2042,2060, 2078,2096	33k (6 off)
R2012	6k2
R2015	3k
R2016,2034,2052,2070, 2088,2106	51k (6 off)
R2017,2035,2053,2071, 2089,2107	1k (6 off)
R2030,2048	8k2 (2 off)
R2033,2051	4k3 (2 off)
R2054,2072	15k (2 off)
R2066,2084	3k9 (2 off)
R2069,2087	2k (2 off)
R300,302	4k7 (2 off)
R301,303,304	330 (3 off)
R400	1k5
R402,405,408,411,414,417	91k (6 off)
R403,406,409,412,415,418	1M (6 off)
SIP400–402	2k2 × 4 sil (3 off)

Pre-set resistors

VR200–205,400–405	10k (12 off)
VR210–215	4k7 (6 off)

Capacitors

C100,101,103–105, 107–109,111–113,115–117,119–121,123,131, 132,201,204,205,207, 210,211,213,216,217, 219,222,223,225,228, 229,231,234,235	100n polyester (38 off)
C102,106,110,114,118, 122,125,126,200,206, 212,218,224,230	10n polyester (14 off)
C124,400,403,404	10µ 25V tantalum (4 off)
C127–130,133,134,236, 237,300–303,401,402, 405	47n ceramic (15 off)
C203,209,215,221,227, 233,202,208,214,220, 226,232,406–411	1n ceramic (18 off)

Semiconductors

D200–203,206–209,212–215, 218–221,224–227,230–233, 400,402–413	1N4148 (37 off)
D204,210,216,222,228,234, 300–302	red l.e.d. (9 off)
D205,211,217,223,229,235	green l.e.d. (6 off)
IC100	74LS245
IC101	74LS244
IC102,406	74LS138 (2 off)
IC103,106,111,116,200–202, 204–206,208–210,212–214, 216–218,220–222,403–405	RC4558 (25 off)
IC104,107,109,112,114,117	74LS374 (6 off)
IC105,108,110,113,115,118	DAC0800 (6 off)
IC203,207,211,215,219,223	µA759 (6 off)
IC300,303,305	74LS04 (3 off)
IC301,304	74LS21 (2 off)
IC302	74LS153
IC306	74LS11
IC307	74LS27
IC308	74LS74
IC309	74LS20
IC400,402	ADC0809 (2 off)
IC401	74LS00
TR100	BC182L
TR101,200–205,400–405	BC212L (13 off)

Miscellaneous

CN100	8-way 0·156" Molex
CN200,201	15-way 0·1" Molex (2 off)
S300	RS334–117

8-pin d.i.l. socket (25 off)
14-pin d.i.l. socket (10 off)
16-pin d.i.l. socket (9 off)
20-pin d.i.l. socket (20 off)
28-pin d.i.l. socket (2 off)
TV5 heatsink (6 off)

MENTOR POWER SUPPLY

Capacitors

C500,506–509	4,700µ 16V electrolytic (5 off)
C501,503,505	1µF 35V tantalum (3 off)
C502,504	2,200µ 35V electrolytic (2 off)

Semiconductors

D500–511	1N4004 (12 off)
IC500	7805
IC501	7815
IC502	7915

Miscellaneous

CN500	10-way terminal block
CN501	8-way 0·156" MOLEX
T500	Laminated transformer primaries: 0–110, 0–110–130V secondaries: 0–7·5V at 1A 15–0–15V at 250mA 10–0–10V at 500mA

TV5 heatsink (3 off)

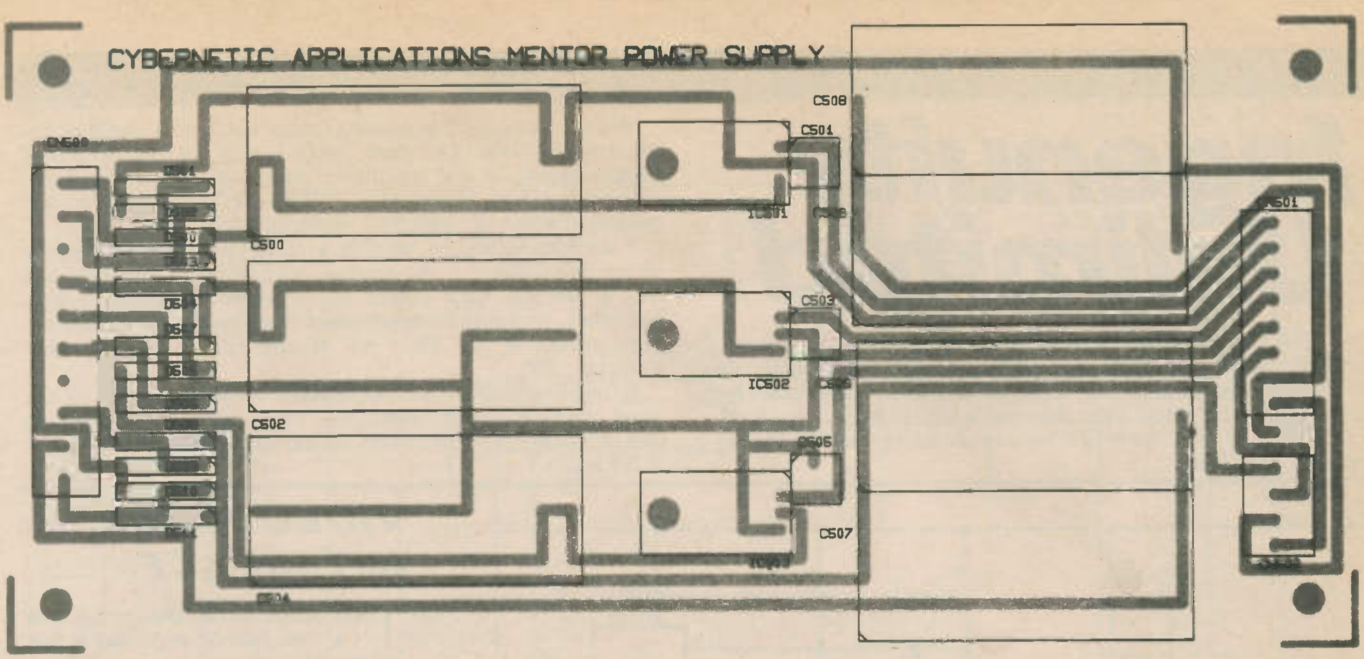


Fig. 5.4. Power Supply p.c.b. and component layout

All components (except those for the power supply) are mounted on one double-sided p.c.b., as shown in Fig. 5.3. This main board performs the functions of computer interfacing, digital-to-analog and analog-to-digital conversion, and the control of the servo-motors for the six axes. The p.c.b. should be looked at in conjunction with Figs 4.6, 4.7 and 4.8, and also Fig. 5.2, which together detail the circuitry involved in performing the operations of conversion, control and interfacing.

The p.c.b. for the power supply shown above (Fig. 5.4), can be related to the circuit diagram of Fig. 5.1. The ten-way terminal block CN500 connects directly to transformer T500 secondary, and all rectification, smoothing, and voltage-regulation components are then mounted on this p.c.b.

NEXT MONTH: The assembly and use of the robots.

Ingenuity Unlimited

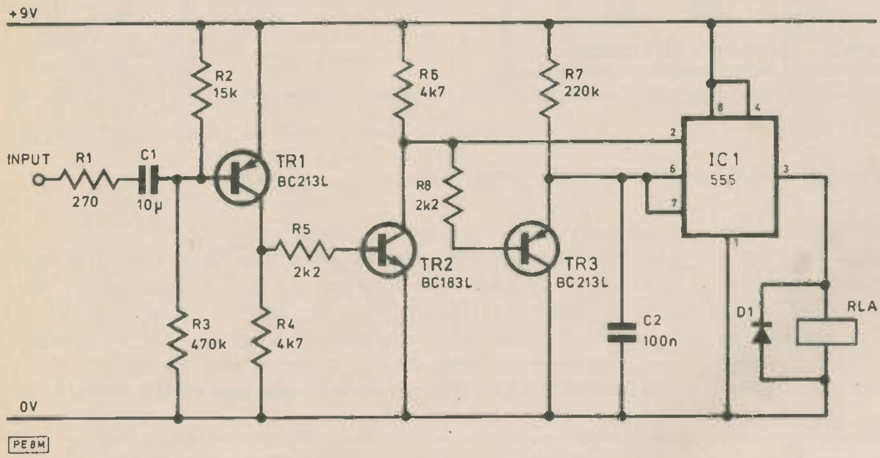
INGENUITY UNLIMITED has been a regular feature in Practical Electronics for many years, and has been a good reflection of the changing face of electronics, giving an up to date guide to new devices and circuit ideas. More recently we have introduced "I U of the month" for which we pay an additional £10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

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

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

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

VIDEO TIMER INTERFACE



THIS design enables the internal timer of a video recorder to be used to control external equipment.

The circuit is connected to the video output of the recorder and detects the presence of sync pulses, whenever the machine is recording. These are then used to fire a 555 monostable, which operates a relay.

The composite video signal, at the input, is fed to the base of TR1. This acts as a sync separator, producing positive going pulses at its collector. These are inverted by TR2, and used to trigger the 555. The pulses also drive TR3 which periodically discharges the timing capacitor, preventing the mono from timing out.

When the video timer switches off, the 555 is allowed to complete its cycle, and the relay drops out, de-energising the load.

P. Thompson,
Lennoxtown,
Glasgow.

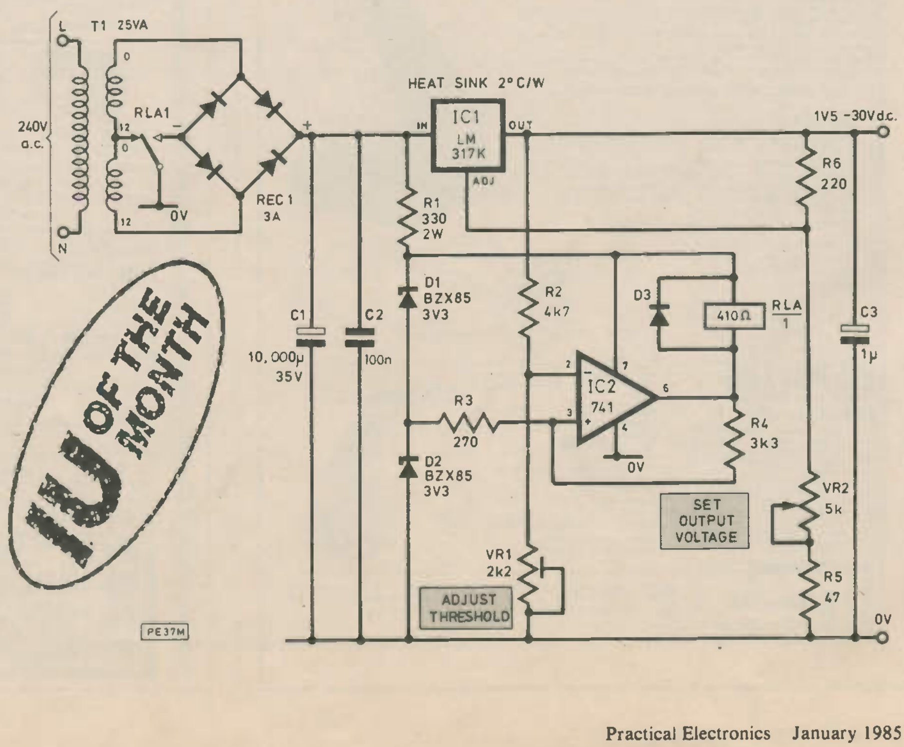
WIDE RANGE HIGH CURRENT SUPPLY

INTEGRATED circuit, variable voltage regulators offer a simple means of constructing high spec. power supplies. Unfortunately, when used over a wide voltage range, the power limitations of the i.c. impose a restriction on the current available. In the case of an LM317K, providing up to 30V, the 20W maximum dissipation means that at 5V only about 0·7A may be taken. This is due to the voltage difference across the regulator.

The circuit shown below overcomes this by switching the rectifier configuration, to reduce the raw d.c. applied to the regulator. IC1 is an LM317K with a continuously variable output from 1·5V to 30V. This is sensed by a 741 (IC2) used as a Schmitt trigger. The threshold is set so that when the supply output goes below 13V, the Schmitt pulls in a relay, switching the rectifier from full wave bridge to full wave centre tap. This reduces the input to the regulator from 33V to 16·5V.

The circuit will supply 1·5A over the range 3V to 12V, and up to 1A for all other voltages.

P. Thompson,
Lennoxtown,
Glasgow.



PRACTICAL

ELECTRONICS

SUBSCRIPTION SERVICE

A faulty connection is the last thing you want in an electronic gadget. And the last thing you want in your regular reading is to miss just one copy of Practical Electronics.

From now on, why not arrange to have no more missed issues, no more worries, no more half-finished jobs. Avoid these breakdowns by taking advantage of the Practical Electronics subscription service: the most reliable method of ensuring you get each issue delivered to your door *every* month. Just fill in the order form overleaf and use the addressed envelope attached. Then leave us to do the rest.

GIFT SUBSCRIPTIONS

A subscription to Practical Electronics makes an ideal gift for a friend or relative with the same interests. All you have to do is complete the appropriate section of the order form and post it in the same way. We take over from there. We even send a card announcing your gift with your own personal message on it.

PRACTICAL ELECTRONICS
Subscription Service
...we'll keep you posted.

IPC Magazines Ltd
Room 2816
King's Reach Tower
Stamford Street
London SE1 9LS

PRACTICAL

ELECTRONICS

SUBSCRIPTION RATES

	Full Rate	Student Rate
UK, CI, IOM, IR	£13	£12
Overseas	£14	£13

Six-month subscription costs half the above rates.

AIR MAIL rates available on request.

Please register the Practical Electronics subscription(s) below:

- I enclose payment (cheques payable to Practical Electronics) ☐
- Charge my credit card account: ☐

name of card____________________

valid from____________ to____________

Card no. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

AMERICAN EXPRESS VISA

Name____________________ 52 weeks________ ☐

Address__________________ 26 weeks________ ☐

____

____

I would like to arrange the gift subscription to the person named below. (Enter your own name and address above as donor).

Name____________________ 52 weeks________ ☐

Address__________________ 26 weeks________ ☐

____

__________________________ Total amount £S________

GIFT SUBSCRIPTION MESSAGE TO RECIPIENT

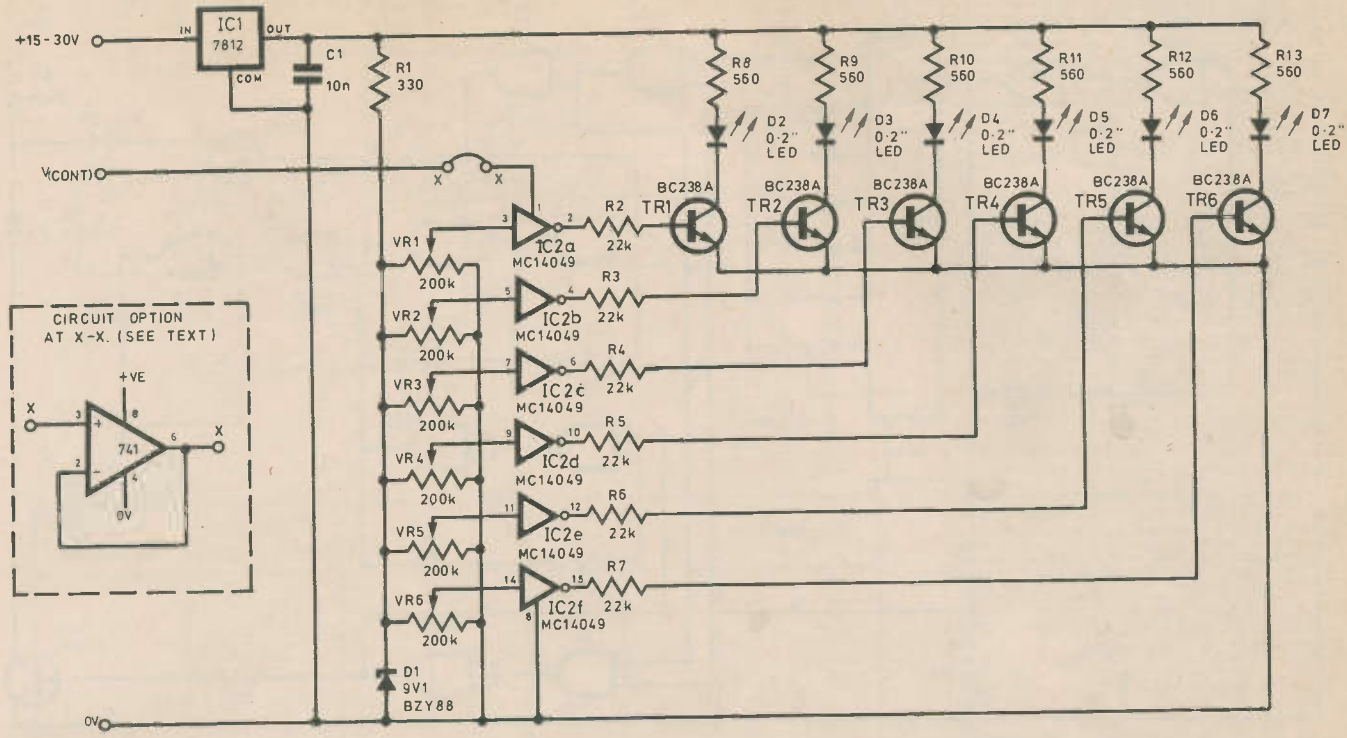
____

____

DETACH HERE

MOISTEN HERE AND FOLD DOWN

PRACTICAL ELECTRONICS



PE9M

BAR-GRAPH DISPLAY

HERE is a little circuit that is very flexible, which depends upon a characteristic of CMOS devices often forgotten when designing logic circuits. It can, however, be used to advantage in the circuit shown to produce an inexpensive, programmable, bar-graph display. The only limitation being the Vcc of 18V quoted in most specifications for the device used. With luck though, this could be stretched to about 24V as very often the low-current avalanche comes out between 25 and 35 volts. Nevertheless 18V will do quite nicely to give a bar-graph display of 18 × 1V steps (or 36 × ½V steps) or whatever you choose, so long as the control voltage does not exceed the device maximum.

The effect used here (the one that is not too often considered) is the variation in switching threshold resulting from changes in Vcc. The threshold normally occurs at about 45% of power supply voltage and is constant throughout the supply voltage range. Thus if we were to hold the inputs of a device at a constant voltage reference level and vary Vcc, then when Vcc exceeds Vin by 55% a transition of the output would occur. This effect is not of much use at the lower end of the range but above a couple of volts can produce useful results by causing l.e.d.s to turn on.

The 4049 chip used here is capable of sinking adequate current to drive the transistors. So, taking into account the earlier statement about varying Vcc and holding input levels constant, the hex-inverter package, with suitable input biasing, forms the basis of a l.e.d. bar-graph driver which can be preset for a given rànge using the potential dividers at the input pins. The Vcc pin then becomes the "Control" (V_{cont}) input.

A couple of disadvantages lie in store of course, these are:

(a) The drive to the new "input" (Vcc pin) must be capable of supplying adequate current (20–25mA) for the device without self-limiting. A 741 op.amp. would suffice if inserted at x–x shown. This does, however, introduce a limitation insofar (V_{cont}) into pin 1 of the 4049 can only swing to half the 741's supply line voltage. Nevertheless, it is then possible to obtain gain from the circuit so that only a few millivolts will drive the display.

(b) The l.e.d.s can only be illuminated thermometer style and not on a rising dot pattern.

The above are only minor considerations when one considers the cost-saving against bar-graph drivers. Stackable? Yes, of course, the only limitation being, as stated earlier, the Vcc factor.

Three 4049's could be used (stacked) with all their pin 1's commoned to give an 18 step range to a maximum of 18V (V_{cont}) input.

The design application here was for a variable power supply unit which did not use the 741 op.amp. as plenty of current was available but applications are numerous as readers will no doubt realise. Especially when used with an op.amp. front end.

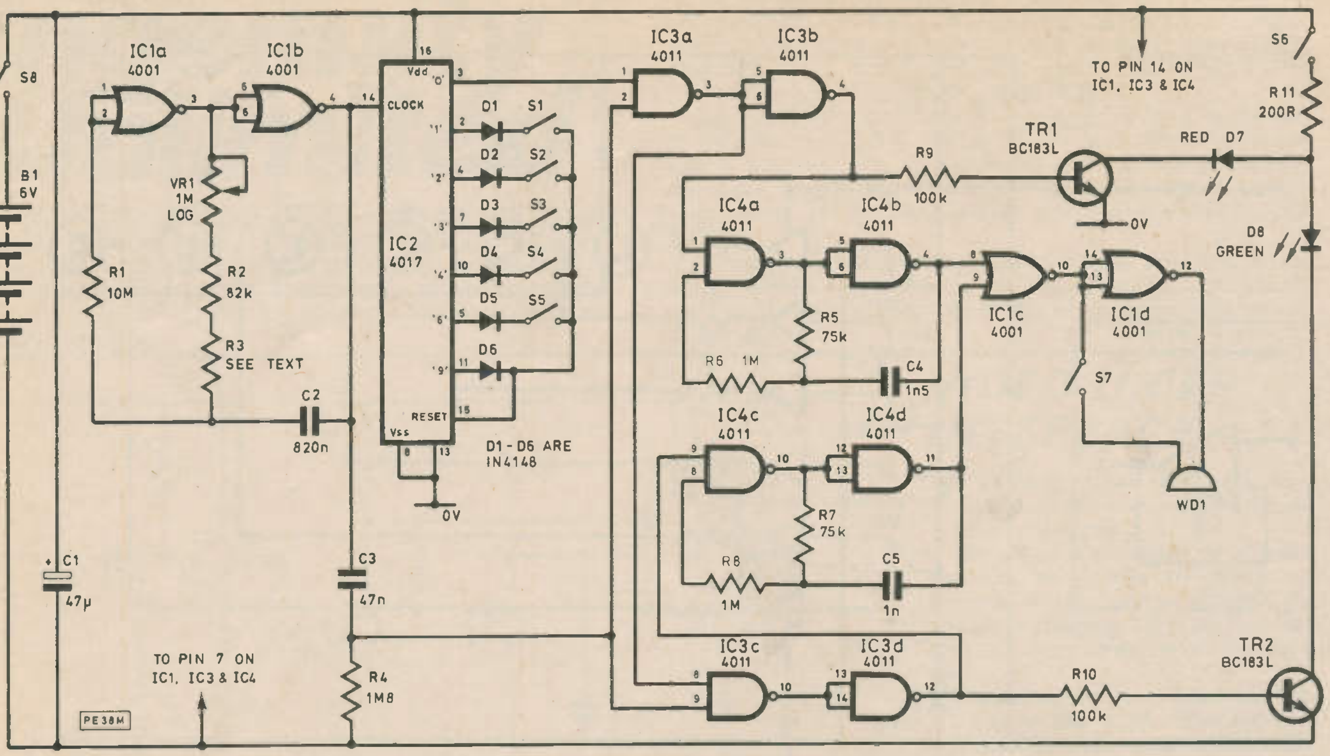
OPERATION/CALIBRATION

The operation is already explained in principle and results from the switching threshold shift of the hex inverter package(s) used. The preset input bias being obtained from a simple zener reference of 9·1V and the 6 (or more) potential dividers. The relationship of the input bias voltage to the control voltage (V_{cont}) is shown in the table and it will be seen that 9·1V is adequate for the full range.

On the outputs of the hex inverter are 22k resistors to limit the base current of the transistors and the output source current of the inverters. Transistors also give the inversion required to drive the l.e.d.'s and thus sink current from the main supply line (12V) rather than from pin 1 of the inverter package (V_{cont}) as this would be a less desirable condition. It would also preclude the use of the 741 op.amp add-on.

To calibrate the display, simply supply V_{cont} with a variable source (metered) and adjust the input bias potentiometers to the required steps. Re-check again after initial setting to account for minor variations in adjustment.

A. M. Owen,
Reading,
Berks.



ACCENTED BEAT METRONOME

THE circuit shown is an Accented Beat Metronome, which can accent each second, third, fourth, sixth or ninth beat, making it an ideal tool for producing musical time signatures.

The start of an accented beat is indicated by a flash of D7 (red l.e.d.) and a low frequency bleep from WD1, whilst the start of an unaccented beat is indicated by a flash of D8 (green l.e.d.) and a high frequency bleep. The audible output may be turned off by opening S7, and the l.e.d.s turned off via S6. S8 is the on/off switch.

The audible output for the accented beat is produced by IC4a, IC4b, R5, R6 and C4 and the audible output for the unaccented beat by IC4c, IC4d, R7, R8 and C5. IC1a, IC1b, R1, R2, R3 and C2 form the oscillator which produces the beat, controlled by VR1. With the values shown and R3 equal to 15k, a range of 30 to 300 beats per minute is possible. The output of the oscillator is converted to sharp positive spikes by C3 and R4.

IC2 is a decade counter with ten decoded outputs, which can cause a reset via S1 to S5, the lowest taking priority. An accented beat starts when both inputs to IC3a are high and an unaccented beat when the output of IC3a (pin 3) is high and the junction of C3–R4 is high.

The prototype was assembled on a small piece of stripboard and the switches S1 to S8 were all contained in a d.i.l. package mounted on the board.

H. J. Karmazyn,
Handsworth,
Birmingham.

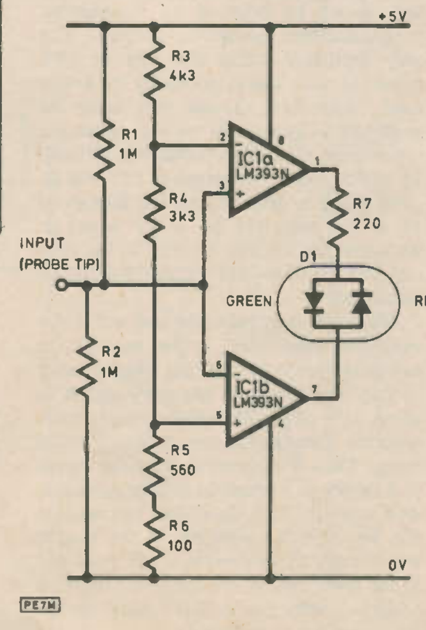
DUAL LED LOGIC PROBE

THE circuit diagram shown is for a TTL logic probe using a bi-colour l.e.d. to indicate five possible logic states.

The input is fed to a dual comparator, with switching thresholds set by the potential divider, at 0·4V and 2·4V, i.e. worst case TTL output levels. With the probe connected to a logic '0' the output from IC1a is low and IC1b is high, turning on the red l.e.d. If the signal lies between '0' and '1' indicating an open circuit or a floating gate input, both the comparator outputs are low and the l.e.d. is unlit. For a logic '1' IC1a switches high and IC1b stays low, switching the green l.e.d. A slow pulse train flashes alternately red and green, while higher frequencies cause the l.e.d. to glow yellow.

The probe may be also used with CMOS, in which case the potential divider should be made up with three 10k resistors, setting the logic thresholds at 1/3Vcc and 2/3Vcc respectively.

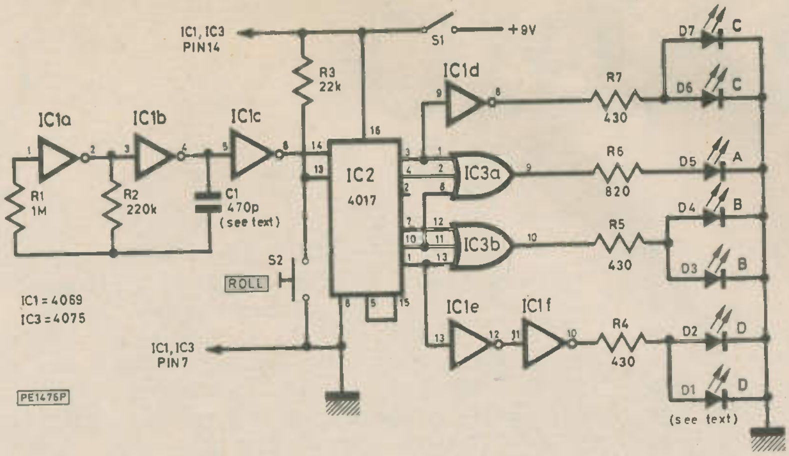
P. Thompson,
Lennoxtown,
Glasgow.



The circuit diagram of the Logic Probe

IU SPECIAL

ELECTRONIC DICE



Number Displayed	IC2 (4017) Output (high)	A	B	C	D	Pattern
1	3	on	off	off	off	○ ○ ○ ⊗ ○ ○ ○
2	2	off	off	on	off	○ ⊗ ○ ○ ○ ⊗ ○
3	4	on	off	on	off	○ ⊗ ○ ⊗ ○ ⊗ ○
4	7	off	on	on	off	⊗ ⊗ ○ ○ ○ ⊗ ⊗
5	10	on	on	on	off	⊗ ⊗ ○ ⊗ ○ ⊗ ⊗
6	1	off	on	on	on	⊗ ⊗ ⊗ ○ ⊗ ⊗ ⊗

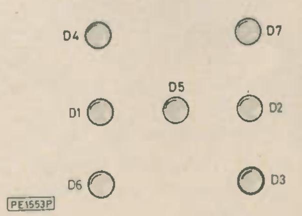
Truth table showing display outputs

THE circuit shown gives a 'spot pattern' readout, similar to conventional dice. To all intents and purposes the output is random as it operates at 5kHz, being much too fast to see during the 'roll'.

The oscillator is constructed using three CMOS inverters contained in IC1 and is used to drive a 10 stage divider (IC2) whose outputs are decoded to drive the display. The oscillator is inhibited by pin 13 being held high via R3. When the 'roll' switch S2 is depressed the oscillator is enabled and counting begins.

On release of S2, IC2 is once again inhibited and the output remains stable. The display decoding and driving is arranged via the simple logic circuit and is best understood by referring to the truth table shown.

The prototype was built using two identical circuits and together with the battery, fitted into a box measuring 115 × 77 × 36mm. To give a slightly more interesting effect the second die is set up to stop after the first by changing C1 to 680pF. The l.e.d.s can also be different colours.



MOUNTING OF L.E.D.s IN A DICE FORMAT.

P. Clarke,
Thame,
Oxon.

CELLULAR RADIO

BARRY FOX

THIS month Britain gets cellular radio. Think of it simply as a telephone dial tone facility in a car, or hand-held unit. British Telecom, then the Post Office, first offered a car phone service in 1959. It used manual connection on 55 v.h.f. channels. The mobile subscriber had to call in by radio to a telephone operator who then patched the call into the public network. Direct dialling, without operator assistance, came in 1981. At the same time BT halved the bandwidth of each channel from 25kHz to 12·5kHz, to create more channels at some loss of audio quality. The old manual service will be shut down at the end of next year. Only then will BT's v.h.f. service have its full 110 channels.

CELLULAR DEVELOPMENT

Under the old Telecom's monopoly, the Home Office would allow private firms to provide only a clumsy message relay service by radio. But in the late 70s some of these firms, like Securicor, were given permission to plug radio subscribers direct into the telephone network. There is now a great muddle of competitive systems, but the service providers are in the happy position of not needing to advertise in London because demand has always outstripped supply.

Bell Labs in America, the research wing of the American telephone company, came up with the idea of cellular radio soon after the war, but did not have the computer power or radio technology to make it work. To recap briefly, cellular radio works a bit like the four colour map theorem. This age old puzzle says that you never need more than four colours to distinguish all the different areas of a map. To anyone with four coloured crayons, the theorem may seem obvious, but mathematicians have felt for a hundred years that until proof to the contrary is produced, we must assume that somewhere there could be a map which needs five colours. So far no-one has been able to draw it, despite computer programmes written to draw every imaginable map shape.

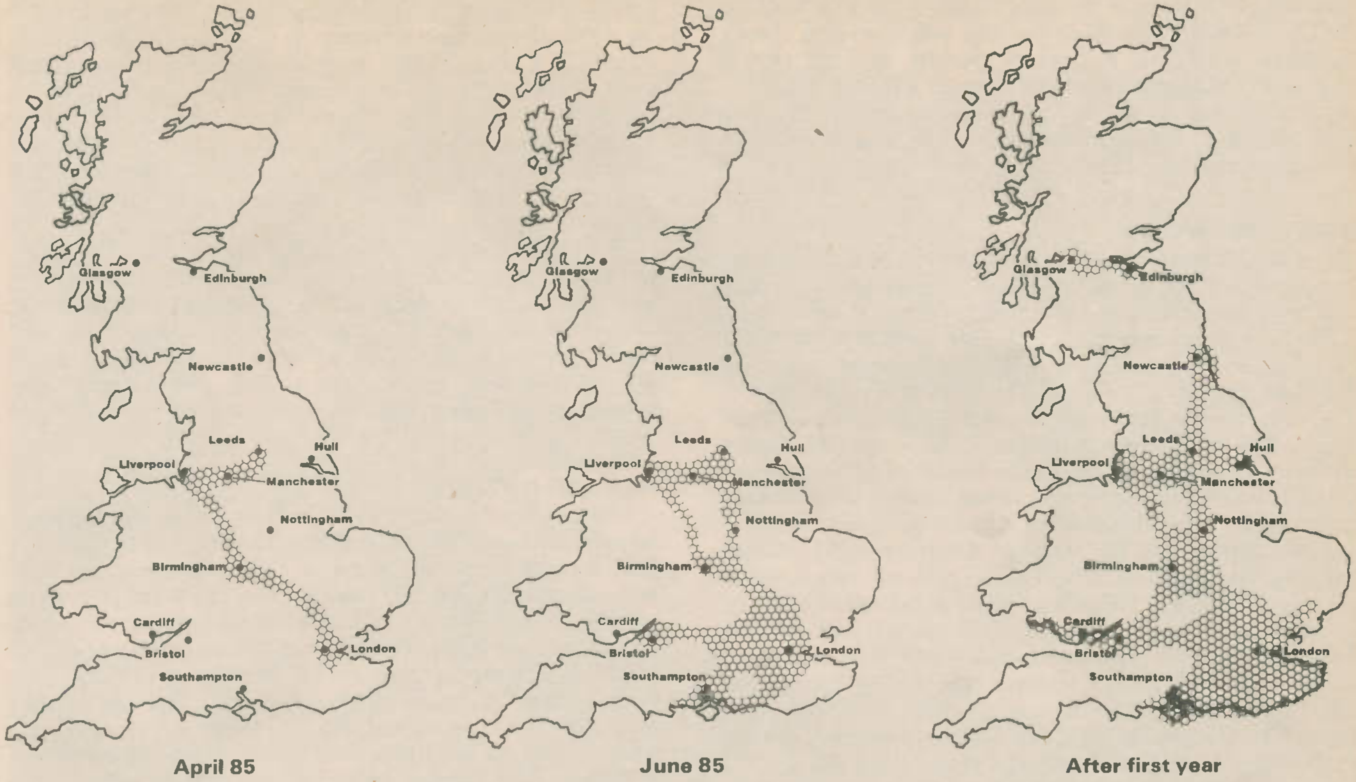
For cellular radio the area to be covered is divided into a honeycomb of hexagonal cells, with a transmitter in each. The hexagonal cells naturally fall into clusters of seven, which means that the same frequencies can be used over and over again outside each cluster, provided that the power is kept low and the wavelengths high to limit propagation. The key to cell radio is frequency re-use.

Cell size varies depending on the number of users. The more users, the smaller the cells must be. Country cells can be 20 or 30 miles across with city cells down to a mile or less. Transmitter power for the large cells is around 100 watts and for small cells 25 watts or less. The frequencies used are in the u.h.f. band, at around 900MHz, where radio waves travel in more or less straight lines. Provided the low power transmitters are running from low height aerials, the clusters of cells can be thought of as isolated islands. As a car drives in one cell it receives and transmits on frequencies assigned to that cell. When it drives into the next cell, the transmitter base station senses loss of signal and switches, or "hands off", the mobile to another frequency used by the transmitter in the next cell. In this way a relatively small number of radio channels can be used to serve a large number of subscribers across the country.

STATUS SYMBOL

In late 1978 Bell Labs developed its idea into a working system, known as AMPS (Advanced Mobile Phone System) and began large scale testing with 2,000 customers in Chicago. The experiment was a roaring success because there was a long waiting list of subscribers for the hopelessly congested v.h.f. car phone service IMTS (Improved Mobile Telephone Service).

It soon became a status symbol in Chicago to become a trial user. Lawyers, doctors and city councillors jumped at the chance. When the five year trial finished, and the system went commercial in 1983, virtually everyone signed on. Ameritech, the Bell subsidiary which served Chicago, sold 5,000 systems in the first two and a half months after it went commercial in October 1983. But then the sales levelled off. There are now around 8,000 subscribers. Although Ameritech forecast 100,000 subscribers by 1990, the company quietly admits that nobody really knows what will happen. The initial 5,000 pre-Christmas boom was created by the pent up demand from frustrated



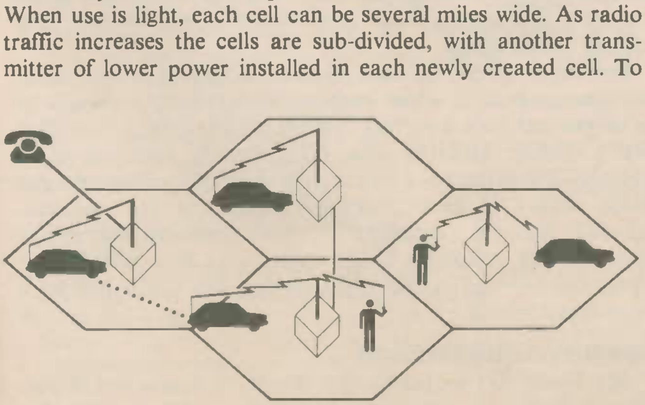
Proposed coverage of the British Telecom/Securicor service (Cellnet)

businessmen already using or queueing for a congested service. Now the system has to be sold, to people who do not yet know they cannot live without it.

Inevitably the fast-buck merchants are already climbing on the bandwagon in the US, offering cellular radio at cut price. It is bound to happen in Britain, too. The most important lesson learned by Ameritech, is that businessmen want to buy at a "one-stop" sales outfit. You take the car in to a garage in the morning and collect it that night, with the telephone unit, on-board transmitter and aerial installed. The engine interference has been suppressed, the number is allocated and all the forms for service ready to sign. What the busy businessman wants is a dial tone in the car in exchange for a single signature.

UNKNOWN POTENTIAL

Privately, engineers admit that they do not know how far a cellular system can be expanded if it becomes too successful. When use is light, each cell can be several miles wide. As radio traffic increases the cells are sub-divided, with another transmitter of lower power installed in each newly created cell. To economise on transmitter construction they can be located at the cell corners and designed to beam sectored signals of different frequency into free adjacent cells. But there has to be a bottom limit on practical cell size and transmitter power. Nobody will know what this limit is until it has been reached. This is why engineers are already looking for ways of using existing channel space more efficiently.



Basic cellular structure showing honeycomb format

The Science and Engineering Research Council in Britain is working behind the scenes to stimulate research into cellular radio. The SERC believes there will be room for a completely new generation of cellular radio telephone technology in the 1990s, probably using satellites, which will give everyone the chance to communicate on the move. The hope is that the technology will be British. Bath and Liverpool Universities already have SERC grants to work on the key problem, which is cramming more speech into less radio bandwidth. University College Swansea and Southampton are also working on it.

All current mobile radio systems transmit the speech as analogue waves, by frequency modulation (f.m.). Reducing the bandwidth of each channel makes more channels available but lowers audio quality. There are two ways of maintaining audio quality, while reducing bandwidth: the use of single sideband modulation (s.s.b.) or digital encoding of the analogue speech before transmission. It should even be possible to combine both and transmit digital speech by s.s.b. Until recently s.s.b. was unusable at the high frequencies, of around 900MHz, allocated for cellular radio. This is because there is no carrier wave for s.s.b. to hold the receiver on tune, and tuning becomes inherently less stable as the frequencies get higher. Bath University believes it has licked the problem by transmitting a pilot tone to lock the receiver onto the right frequency. With s.s.b., bandwidth can be reduced to 5kHz per channel, but Bath complains of trade apathy. "Everyone says it looks interesting, but no-one is interested," says a researcher.

Digital transmission on a narrow channel relies on breaking down the speech into crude code which is then used to trigger a speech generator at the receiver. So far the coding circuits consume too much power for a portable set which must rely on small batteries. Fortunately the existing cellular system chosen for Britain should not run out of capacity until the 1990's. Because no new system of reduced bandwidth could be compatible with existing cellular technology, engineers can afford to consider using satellite transmissions to give nationwide coverage with s.s.b. and/or digital coding.

BRITAIN'S CHOICE

The cellular technology adopted for Britain and due to start this month, is the Total Access Communications System (TACS) which is a modified version of the US technology AMPS. The choice was made only after much high level soul searching, and it caused a rift with other European countries which had hoped for a 'standard' Pan-European system.

Norway, Sweden and Denmark developed their own systems. So did Japan and Siemens in Germany. Philips and CIT-Alcatel developed the MATS-E system. This boasts an advantage over AMPS in that it does not tie up a speech channel while a call is being dialled, rung and connected. Another dedicated channel is used for this instead. But when, in December 1983, Britain opted for TACS, the MATS-E system was still only a paper proposal. Europe will decide what to do at the end of 1986. In 1979 the World Administrative Radio Conference released enough air space for 1,000 channels of mobile radio throughout Europe at around 900MHz. Four hundred of these channels are being kept in reserve for the European system. If Europe adopts British TACS (which is unlikely) the UK gets a bonus of another 400 channels. If (more likely) Europe goes it alone with MATS-E, anyone driving across Europe will need two different reception systems; one to cover Britain and one the Continent. But whatever happens there will be a delay because the 400 channels reserved for Europe are still being used by NATO. Any premature attempt at transmitting the digital control signals needed for cellular radio on these frequencies might well launch a missile!

RIVAL SYSTEMS

The British Government has licensed two rival consortia to operate cellular radio in the UK. British Telecom and Securicor Cellular Radio (TSCR) is a joint venture between British Telecom and Securicor which will offer the Cellnet service. Racal will offer Vodafone as a private sector rival. Both consortia are promising a service from the beginning of 1985. But I, for one, wonder how comprehensive these services will be. Racal will not even start trials until December. The Racal news sheet of "technical information", which has been re-published by the mobile radio trade press, contains at best a misleading description of how the system works. It talks of clusters of five cells and explains how this means that 200 channels can be split into 5 groups of 40. Perhaps Racal has discovered its own version of the 4 colour map theorem which can group hexagonal cells into clusters of 5. After a TSCR press conference, where spokesmen seemed thoroughly confused on technical points, I tried to telephone the BT/Securior consortium to check some points. There was no reply from the numbers they had given me. TSCR, although part owned by BT, had changed its office telephone number without making reliable arrangements for calls to be re-routed.

If would-be users of Cellnet cannot get through, they might just as well subscribe to Vodafone. But the cost of both services will be similar, under £20 a week for moderate use. "There will be no price war," says Racal. But there may be a publicity war. Racal recently embarked on an astonishing series of image building television adverts even though the company sells nothing to consumers. The cost is estimated at £0·3 million a month.

REAGAN RUCKUS

Cellnet upset the American White House by running full page advertisements in the press, including The Times, showing President Reagan apparently using a Cellnet phone during the economic summit held in London in June. The White House has since confirmed that it was not asked permission, and would have refused it if asked. TCSR admits that the photo was a fake, with Reagan's head grafted onto a British model's body. One thing Cellnet did not advertise was the fact that the Summit politicians had to be warned that they should not say anything sensitive over the air. Although it is more difficult to eavesdrop on cellular radio, because the frequency is liable to switch, there is no real security unless speech is additionally scrambled.

The Chicago system started with 17 cells; it is now up to 23 and should be 30 by the end of the year. Almost every original Chicago cell has now been split to cope with extra demand. Ameritech saves money by buying small unusable corners of land for its transmitters; the back of a golf course, the corner of a police car pound or the side of a public parking lot. Unforseen technical problems are still turning up. Because the cells are small, the transmitters are of low power with relatively low aerials. Mysteriously, reception was found to be better in the winter. It turned out that this was because in the summer, leaves on the trees can materially attenuate the high frequency, low power signals.

BLACK SPOTS

Normally, "hand-off" is inaudible. But, as the Chicago operators have found in practice, there will always be reception black spots where the mobile receiver hunts vainly for a strong enough signal, switching between every transmitter and spare frequency in the area. Under these circumstances the switching process can be heard.

In Britain, TCSR has demonstrated a prototype data communications system, which enables electronic mail messages to be sent to and from a moving vehicle, using a portable computer like a Tandy TRS100. The snag, already encountered in Chicago, is that there is a loss of data in the 300 millisecond gap which occurs at each "hand-off". This can be important, especially for data transmitted in a bank statement with strings of zeros! The prototype TCSR system uses data buffering, to bridge the gap and correct digital errors. But this is not yet a commercial service. ★

ACKNOWLEDGEMENTS

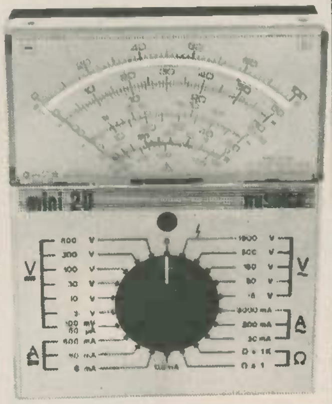
We would like to thank The Board of Trade and British Telecom/Securicor who furnished the illustrations used in this article.

TWO FABULOUS OFFERS FROM

ALCON

The incredible 'MINI 20'

28 ranges
20kΩ/V d.c. & 4kΩ/V a.c.
(With protective fuse)



Accuracy: 2% d.c. and resistance, 3% a.c.
28 ranges: d.c. V 100mV, 3V, 10V, 30V, 100V, 300V, 600V. d.c. I 50μA, 600μA, 6mA, 600mA. a.c. V 15V, 50V, 150V, 500V, 1500V. a.c. I 30mA, 300mA, 3.0A. Ohms 0–2kΩ, 0–2MΩ dB from −10 to +62 in 6 ranges.
Dimensions: 105 × 130 × 40mm.

The 28 ranges cover all likely requirements. Operation is straightforward, just turn the selection switch to the required range.

This special offer is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £10.00.

THE IDEAL INSTRUMENT FOR THE CONSTRUCTOR **ONLY £21.60**
(complete with carrying case, leads and instructions)

'SUPER 20'

A SUPER PROTECTED UNIVERSAL MULTIMETER

★ **20K Ω/V** AC AND DC
★ **39 RANGES**
★ **INDESTRUCTIBLE** (automatically protected on all ranges but 10A)

Accuracy: d.c. ranges and Ω 2% a.c. 3% (of f.s.d.)
39 ranges: d.c. V 100mV, 1·0V, 3·0V, 10V, 30V, 100V, 300V, 1000V.
d.c. I 50μA, 100μA, 300μA, 1.0μmA, 3mA, 10mA, 30mA, 100mA, 1A, 10A
a.c. V 10, 30V, 100V, 300V, 1000V;
a.c. I 3mA, 10mA, 30mA, 100mA, 1.0A, 10A.
Ω 0–5.0kΩ, 0–50kΩ, 0–500kΩ, 5MΩ, 50MΩ.
dB from −10 to +61 in 5 ranges.
Dimensions: 105 × 130 × 40mm.
These special offers is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £20.00.

(complete with carrying case, leads and instructions) **ONLY £33·50**

PRICES Our prices include VAT and postage and goods are normally despatched by return.

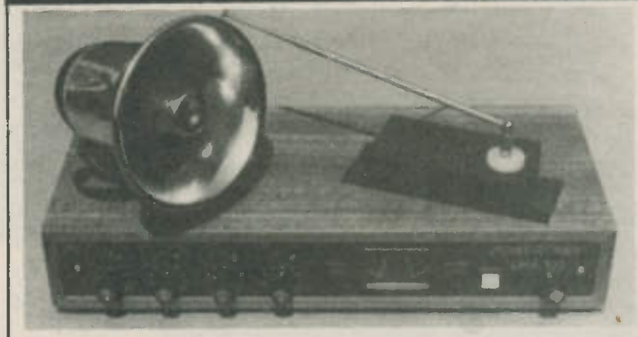
For details of these and the many other instruments in the Alcon range, including multimeters, components measuring, automotive and electronic instruments, please write or telephone:

ALCON Instruments Ltd.

19 MULBERRY WALK · LONDON SW3 6DZ · TEL: 01-352 1897 · TELEX: 918867

DRA 100

(SEE "RADAR SECURITY" PROJECT IN THIS ISSUE)



SIMPLY THE BEST

★ **The best** because its blanket coverage means that all doors and windows can be covered without the need for individual switches and wiring.

★ **The best** because its low power RF radiation pattern is unaffected by air disturbance – unlike ultrasonic or passive IR systems.

★ **The best** because movement can be detected through brick walls. Intruders can be deterred before they intrude!

★ **The best** because the system can be enlarged by the addition of passive detectors such as reed switches, heat detectors, personal attack buttons etc.

★ **The best** because the size of the protected area is variable. Careful adjustment of the transmitters allows "safe areas" to be created, enabling legitimate callers to avoid triggering the alarm.

★ **The best** because it represents top value, the DRA 100 kit form costs less than most perimeter wiring systems – and offers so much more protection for your money.

Standard Kit (including 2 transmitters) **£119.00 + VAT**
Pair of extra transmitters **£29.00 + VAT**

Special Offer
Extended Kit (including 4 transmitters) **£139.50 + VAT**

The DRA 100 is available from

POWERTRAN cybernetics ltd.

PORTWAY INDUSTRIAL ESTATE,
ANDOVER, HANTS. SP10 3PE.
TEL (0264) 64455

Access
BARCLAYCARD VISA

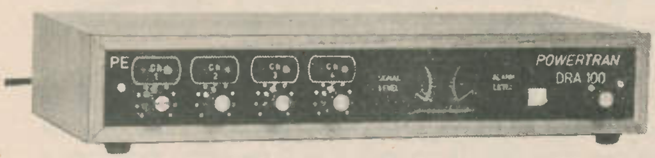
Radar Security Alarm PART TWO

A DESIGN BY POWERTRAN CYBERNETICS

AS some readers may have noticed, Part Two of this project has been delayed for some time. This was due to modifications which have been made to the Oscillator/Detector units to alter the operating frequency. The improved version has several advantages over the original: fewer components, single p.c.b., increased sensitivity.

The new circuit diagram is shown in Fig. 11 and the p.c.b. design and component layout is shown in Fig. 12. The rest of the circuitry and construction remains unchanged.

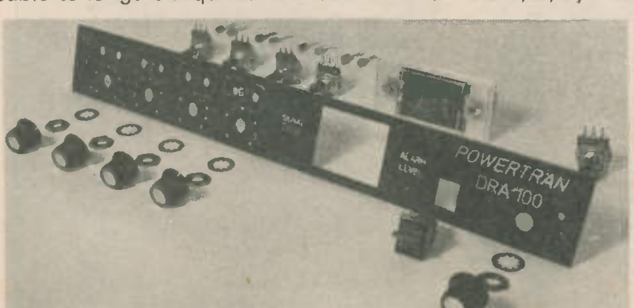
In Part One of this article, the operation of the complete unit was described in detail and the construction of the Oscillator/Detector modules was fully covered. Part Two, the final part, deals with the construction, assembly and setting up of the main unit. Fig. 9 shows the p.c.b. and component layout of the main unit. Fig. 10 shows the wiring diagram and the photographs below illustrate the various stages of assembly of the Radar Alarm.



MAIN ASSEMBLY

The chassis assembly is shown in the following photographs, and should be completed as follows:

1) Assemble 4 tapped spacers to the alloy base in the 2 corner holes. Use 6mm CSK screws.
2) Fix end brackets to base plate using 6mm CSK screws. Ensure that the holes for fixing the front and rear panels are towards the centre.
3) Insert alarm ON-OFF switch through the front of the panel and bend the retaining tags outwards.
4) Insert l.e.d. grommets from front panel.
5) Bend solder tags on VR101, 201, 301 and 401 at right angles and mount the sensitivity controls with the tags under the l.e.d.s.
6) Cut the 1·2 metre length of 2 core miniature screened cable to lengths required to wire from channels 1, 2, 3, 4 to the relevant inputs. As only the screen and one wire is required the red and blue can be bound together at each end.



Front panel components

7) Insert l.e.d.s (red left, green right) for channels 1 to 4, with long lead uppermost. Take the 200mm length of tinned copper wire and connect all the anodes (long leads) about 5mm from the l.e.d.s. Cut off the excess length.
8) Using white wire connect the cathodes (short leads) of the red l.e.d.s to the p.c.b. Use the 1mm sleeving over the cathodes of the l.e.d.s.
9) Using orange wire connect the cathodes of the green l.e.d.s. to the l.e.d. 108, 208, 308, 408 positions on the p.c.b.
10) Wire the alarm ON/OFF switch with three colours.
11) Connect the top terminal of ME1a to VU+ on p.c.b. adjacent to VR2 using red wire, and the VU− to the bottom meter terminal using the black wire. At the same time connect a red wire to the common l.e.d. rail to provide a common HT line (+12V).
12) Connect the bottom terminal of ME1b to VU+ adjacent to the piezo sounder, with red wire and the top terminal to VU− with black wire.
13) In order to record the wiring from front panel to p.c.b., take the grey screened wire, white and orange from each channel, tape the ends and label 1, 2, 3, 4. The cables can then be routed to the board and held together with cable ties.

Chassis assembly

14) Wire the relay coil solder tags to the relay coil p.c.b. holes below the piezo sounder and wire a pair of the normally open contacts of the relay to the relevant holes. Wire the piezo flying leads to the p.c.b.
15) Using 2 core miniature screened cable, wire the p.c.b. to the 3-pole jack sockets, CH1 to CH4. The connections on the jack socket starting nearest the panel are screen (earth) blue (detector) red (transmit). On the p.c.b. the connections are as follows:
   (1) Under the 100Ω resistor—blue
   (2) Bottom of 100Ω resistor—red
   (3) Earth—screen
16) Wire up all the pots on the front panel, and the p.c.b. as shown on the wiring diagram.
17) Now connect the labelled groups from each channel

Complete rear panel view

control to the appropriate holes in each channel on the p.c.b.
i.e. screened cable—screen to earth
blue and red—VR101, 201, 301, 401
orange—D108, 208, 308, 408
white—D109, 209, 309, 409

18) Connect the VU meters to the appropriate p.c.b. holes.
19) Connect VR3 to blue and grey.
20) Connect the switch wires, white, orange and blue as shown in the wiring diagram.
21) Route the wires under the board to exit through the grommet and into the terminal block 1 and 2 (viewed from rear).

Using red and black wire, wound together, connect BATT+ and BATT− on p.c.b. 3 and 4 on term block.

22) Twist together 20cm blue and wire the contacts of the relay to 5 and 6 on term block. Strap up wires with tie tags.
23) Connect 2 × 25cm lengths of white to the ~12V holes in the p.c.b. and one 25cm length of orange into GND. Wind the three wires together and connect to the transformer terminal block.
24) All the wiring must be checked for bad connections and dry joints. The inside of the case must be cleaned to remove any stray bits of wire and solder. Before switching on give the unit a final check for any obvious errors in the construction or wiring.

TESTING

The oscillator detector boards can be tested using a 9V supply. Connect the positive to the red wire and the negative to the screen, with the antenna extended to about 330mm. A d.c. voltmeter should be connected across the screen and the blue wire and if the oscillator is working, it should read between 1 and 2 volts. Any movement close to the antenna should produce a small variation in the d.c. voltage which can be just seen on a moving coil meter, or fairly easily on a digital meter.

SETTING UP

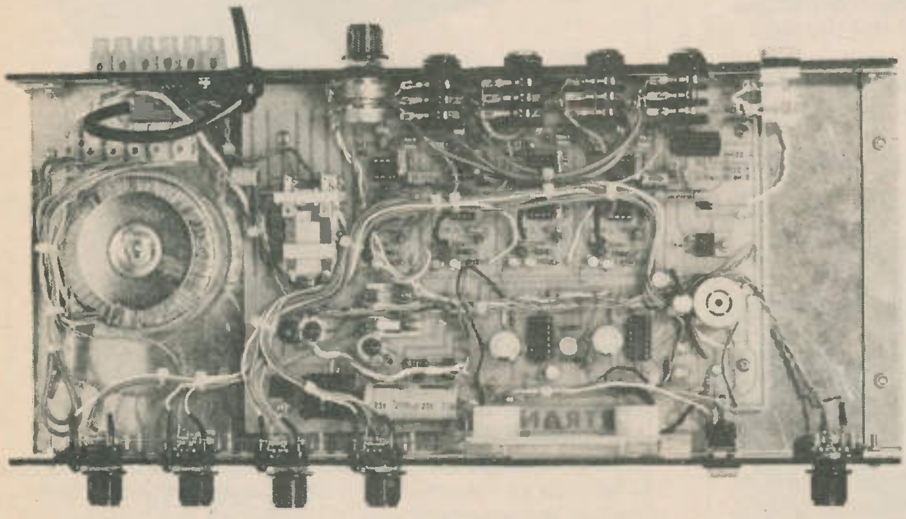
With the detectors plugged into their relative jack sockets, turn the individual gain controls to zero (counter clockwise). Adjust VR1 so that the green l.e.d.s (line break detectors) just extinguish. Verify correct operation by pulling out the jack plugs one at a time and see that the green l.e.d.s light.

The detectors can be placed in positions best suited to cover entry and access points in the premises being protected. It should be borne in mind that if a detector is placed on the inside of an outside wall of a building, although some attenuation of the signal occurs, a moving target on the outside wall will trigger the alarm. This can be a positive advantage in covering the approaches to the building provided there is no right of way over the protected area.

A plan of the premises being protected can be overlaid with circles representing up to 20 feet radius and if protection should stop inside the front door then the approximate site can be found for the detector. The patterns from individual detectors can overlap with no adverse effect on each other. For man-size targets, the antenna of the detector should be about 5ft from ground level. It is possible to screen off areas from pattern radiation by using aluminium foil a few inches from the antenna, thus casting a 'shadow'. This small variation is the Doppler frequency appearing at the output and is visible as a voltage variation because the Doppler frequency is only about 1Hz. Extend or retract the antenna 1cm at a time until the highest reading is obtained on the meter. This is optimum tuning, so measure the length and write on the base, the length for future reference.

If spurious triggering at high sensitivity settings is experienced, then it can be reduced as follows:-
Connect the anode of a diode to the junctions of R115 & R116. Add 10kΩ in series and hard wire to the collector of TR3. When incoming signals trigger the timers and TR3, the collector goes low. This allows C111, the pump capacitor, a quick discharge and holds it low for the alarm period. Wire the 3 remaining channels in the same way.

An additional decoupling capacitor may be required to prevent a pulse on the 12 volt line when the relay contacts supply power to the Noise Generator Circuit. This is a 100µF 25V electrolytic which can be wired from the ground end of R13 to the +12V which is located on Link 5.



The internal details of the Main Unit

Constructor's Note

Because of the modifications to the Oscillator/Detector units, the price of the Doppler Radar Alarm kits have been reduced to the prices shown below.

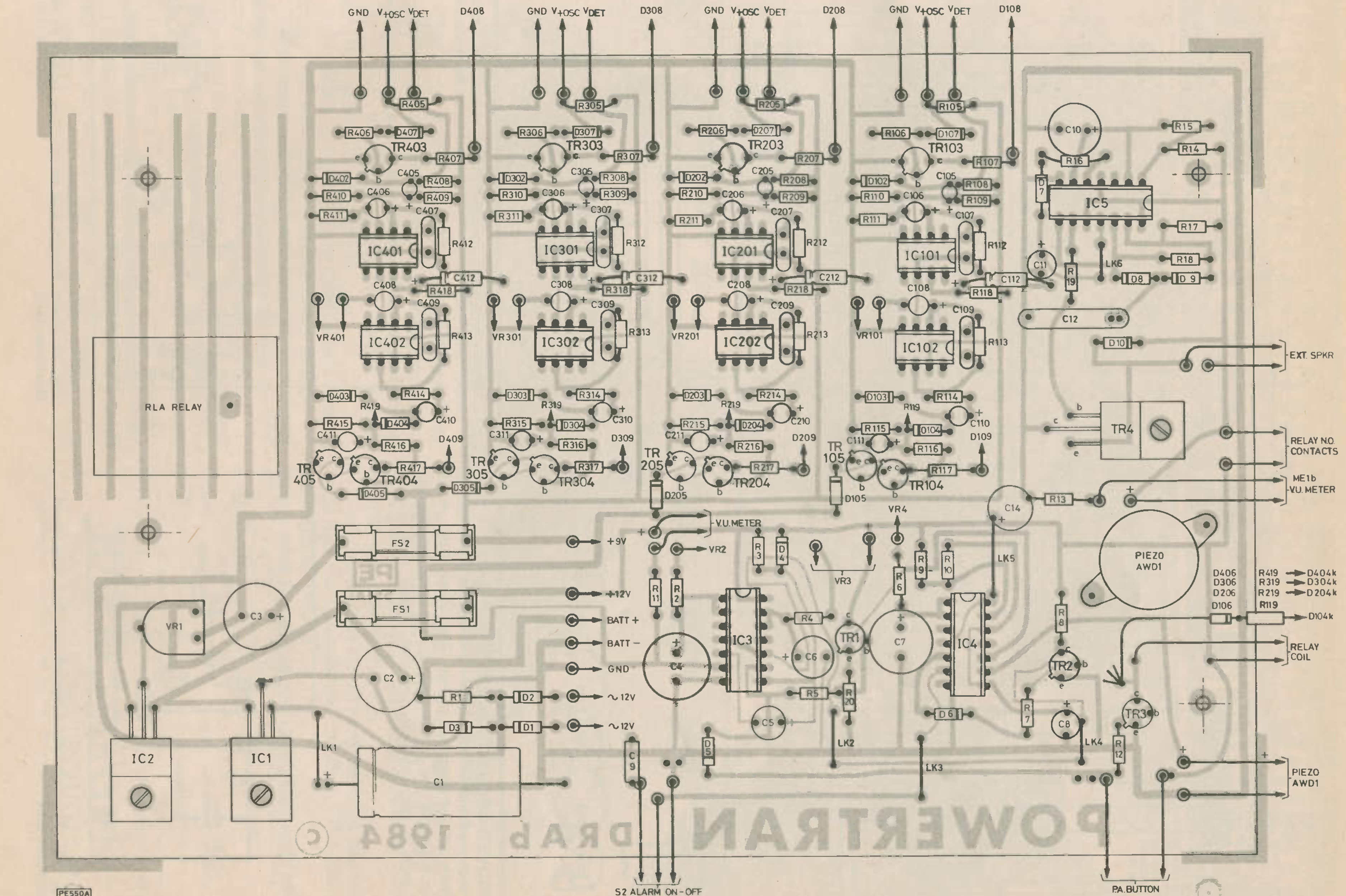


Fig. 9. The component layout of the Main Unit

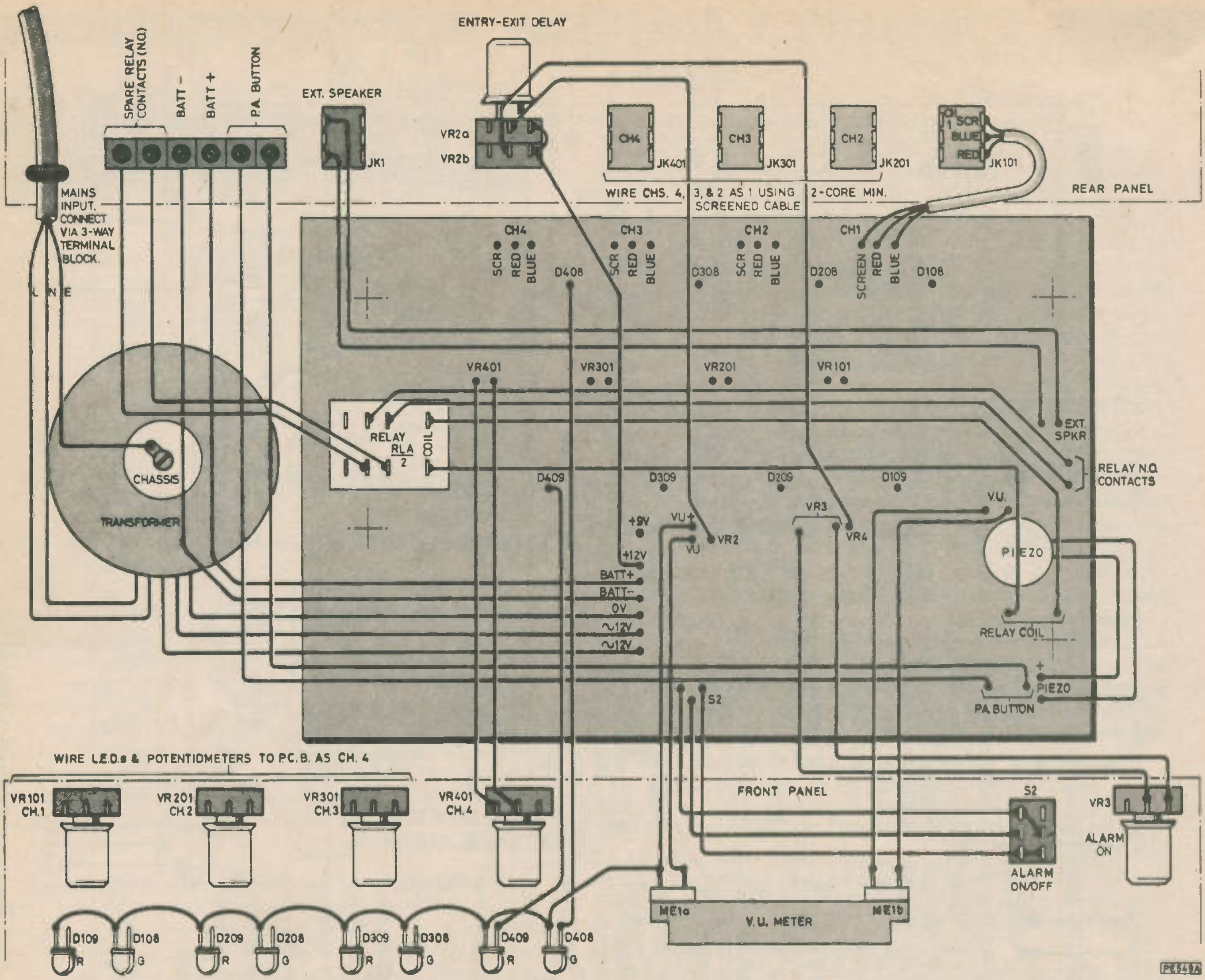


Fig. 10. The wiring diagram of the Main Unit

IMPROVED OSCILLATOR/DETECTOR UNIT

The improved Oscillator/Detector Unit can be connected to the main unit as described in Part One. Most of the circuit acts in the same way to that described in Part One, the only difference is the oscillator operation, which now is at a higher frequency. The oscillator in Fig. 11 is a 'one transistor' Hartley oscillator which relies on feedback from the inductance of the circuit. ★

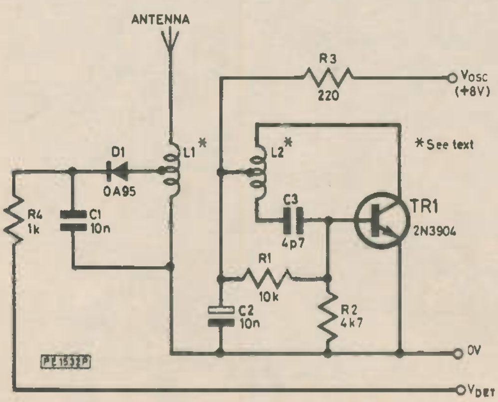


Fig. 11. The circuit diagram of the improved Oscillator Unit

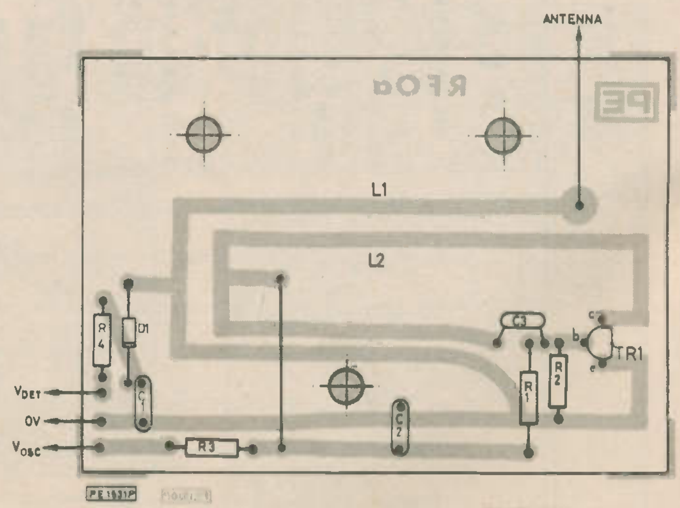


Fig. 12. P.c.b. design and component layout at the Oscillator Unit

VERNON TRENT *at Large!*

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

THE festive season, as your family probably keeps reminding you, is at hand. Or, if you prefer it, the time of the great rip-off is almost upon us. So let's make ourselves even more miserable by looking into the likely future.

The time is early evening on Christmas Eve. The place: Santa Claus's workshop. I was always brought up to believe that this was somewhere in Greenland. Not any more. Like the rest of us, Santa has been sucked into the vortex of modern electronic technology and so as to keep in the swim is now doing his stuff in Silicon Valley. At least it's warmer there.

By the way, he doesn't have a workshop anymore. It's now called his Manufacturing & Distribution Headquarters Operations Unit. If you could find two more words to add to that title you'd have an acronym of MADHOUSE.

". . . the time of the great rip-off is almost upon us"

The old man himself has changed a bit, too. Remember that snowy beard into which he used to mutter, in his grotty department store grotto, warnings to be good and get to kip early or you'd get nothing?

That's gone. It has fallen a sad victim to the Philips and the Brauns and others on the lucrative hair-removal circuit. And the passing of the fuzz has meant also, for some of us, the passing of a lot of dignity and romance.

How long, I wonder, before the rot really sets in and that familiar red robe is replaced by Farah cords and a T-shirt bearing the declaration: 'I Hate Kids'?

Relaxing quietly in preparation for his night of global travel, Santa reclines on a vibrating water bed. He's wearing headphones through which quadrophonic white noise replenishes his mental and physical tissues and stimulates his phagocytes. His what? Well, we've all got them. Take my word for it.

A carton of electronically-energised, high-protein junk food, fresh from its microwave oven, stands at his elbow. Vitamin-reinforced, decaffeinated and rich in polyunsaturates (I got that word from Terry Wogan) it is likely to be his only sustenance until the morn. The days when he could find a slab of indigestible home-made Christmas cake—prepared by loving if inexpert hands—on the doorstep are over.

"What a pity that this childish fun has gone by the printed circuit board"

An adjacent VDU keeps him briefed on the progress of the gift-stacking operation. On to his sleigh (sorry, his all-purpose, containerised freight transportation module) go the wrist-worn personal computers, the top-pocket TVs and multi-dimensional advanced video games—complete with their own totes.

You'll have to look hard to find a bus conductor's outfit or a nappy-wetting doll of former and, dare I say it, happier years. Organised squads of lively elves—all paid-up members of the TGWU on a treble-time bonus agreement—labour at their computerised loading programme like demented ants.

★ ★ ★ ★

What of the reindeer, whose red noses were once immortalised in song, who used to leap gleefully across the chimney pots of the world? They are no more the bearers of Santa's blessed load. In their place have come long-life, self-rechargeable power packs, sufficient to take the old man from California to Colchester, from Siberia to Surbiton and back via Wogga Wogga to Weston-super-Mare.

In the days of my blameless youth (I don't know about yours) we used to write letters to Santa at the beginning of November telling what we'd like to find on the end of the bed on Christmas Day. Sometimes we'd get a reply, written in not very well disguised parental handwriting, promising us that the old chap would do his best.

What a pity that this childish fun has gone by the printed circuit board. Now, if you don't get your order in, by punching it up on Prestel before the end of Lent, you've had it. Provided the system hasn't gone down under the weight of traffic, you can access a formal acknowledgement around Guy Fawkes Night. This will allocate your requisition number and give your gift applications a degree-of-priority rating.

You may well be told that your request is 'temporarily out of stock'. In such instances you will be instructed to re-submit after Candlemass the following February. This tends to make December 25th a rather bleak day.

In other cases you may be advised that your choice is a 'discontinued line' and be offered a wildly inappropriate substitute. And, most chilling of all, is to be told that your desires are so outrageously extravagant they have been referred back to Mum and Dad for a 'merit status report'. When things have sunk that low you might as well resign yourself to settling for a couple of specky oranges and a polished five pence piece.

★ ★ ★ ★

The day wears on and things are hotting up. Toffee-nosed, superior robots, seasonably wearing holly in their antennae, check on weather, wind direction, deep and shallow depressions and other Michael Fish type data. These robot gentry are, of course, pulling down a much higher rake-off than the TGWU elves. The latter are but glorified labourers. The former all have Ph.Ds in Yule physics—a rare but essential qualification.

Santa downs a final dollop of balanced diet and climbs into his customised, multi-continental, air-conditioned delivery suit. This is designed to meet every kind of environmental and atmospheric condition, from the stiffening zero temperatures of wintertime Lapland to the torrid heat of a honeymoon hotel bedroom at Eastbourne.

We're getting near lift-off time now. The Christmas Operations Controller (known to his intimates as COC) makes a final check on every graph, meter and monitor in sight. Then, giving a shrill blast on his ultrasonic whistle (this is a purely symbolic exercise, for only the depot dog can hear it) he sets the annual journey of goodwill and financial embarrassment in motion.

Although Santa still remains the star of the whole operation, he really hasn't much to do from that point onwards. Chimney climbing is virtually out. The central heating industry has done a fine takeover job.

He may even find it hard to get a foot inside the house at all. Electronic sensors may betray his presence. Every move he makes may be followed on an image-intensifier night surveillance unit. The actuating of a central station alarm could bring carloads of police on the scene. Fancy Santa, of all people, having to spend Christmas Eve in the local nick.

But suppose he manages to gain entry. What will he find? Not slumbering kiddiwinks dreaming happily of the morrow. No. In all probability they'll still be wide awake, drooling, with their boy and girl friends maybe, over their video nasties. Innocent deception belongs to yesterday.

★ ★ ★ ★

Now, I ask you. Is this really the kind of world we want? Isn't there still room for some of the un-chipped things of life, like the Christmas joys of olden times?

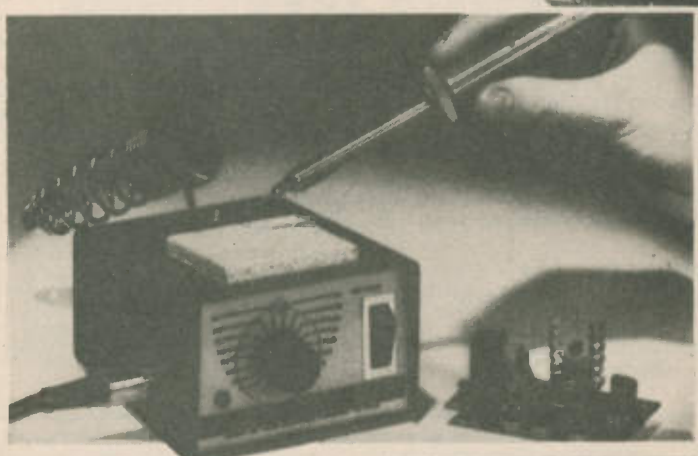
We move too fast for our own good. This obsessive race to be bigger, better and more complex than the next man is perhaps summed up in the story of the two bulls. One is young and raring to go. The other is old and a bit of a seasoned philosopher.

Young bull: "I say, why don't we belt up that hill and make love to some of those smashing cows?" Old bull: "I've got a better idea. Why don't we *stroll* up that hill and make love to *all* of them?"

Maybe we still have something to learn from the animals.

Industrial Soldering Equipment–for the discerning amateur

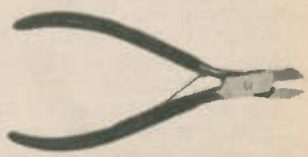
SEND FOR NEW CONCISE LEAFLETS



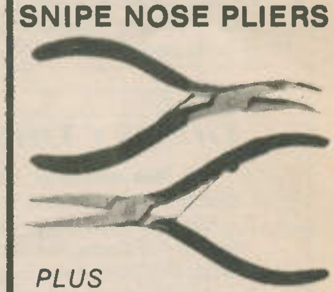
101 ELECTRONIC CONTROLLED SOLDERING STATION

for precision soldering with accuracy suitable for use on MOS, FET etc 240V input - 24V on tool. Temperature range 120-420°C
Many extra features

ADCOLA ACCESSORIES
include:
SIDE CUTTERS



SNIPE NOSE PLIERS

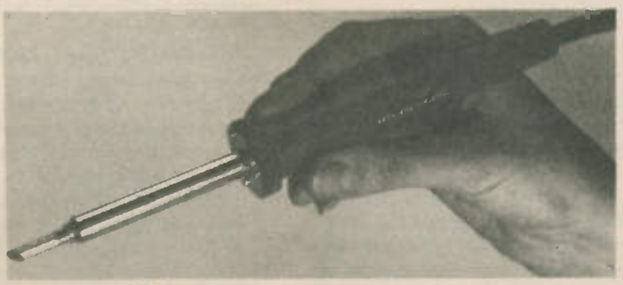


PLUS
- Desoldering Braid
- Desoldering Guns
- Tip cleaners
- Soldering aids
- Lamps, Lenses etc

'K' SERIES SOLDERING TOOLS FOR ALL APPLICATIONS

K1000 micro soldering
K2000 general electronic soldering
K3000 heavy duty soldering

- Small selection of **AD-IRON® LONG LIFE SOLDERING TIPS** suitable for all Adcola soldering irons.



ADCOLA
(Regd Trade Mark)
ELECTRONIC PRODUCTION EQUIPMENT

For a no obligation demonstration, please contact:
ADCOLA PRODUCTS LIMITED Gauden Road London SW4 6LH
Telephone Sales (01) 622 0291 Telex 21851 Adcola G

MIRROR IMAGES

Plans have now been announced for the construction in America of the N.N.N.T., or National New Technology Telescope, which will be by far the most powerful in the world, equal to a 15-metre reflector. Making a single mirror of this size would be virtually impossible, so the N.N.N.T. will make use of four 7½-metre mirrors working together—a principle which has already been satisfactorily tested with the M.M.T. or Multiple-Mirror Telescope on Mount Hopkins in Arizona.

It is hoped to have the N.N.N.T. ready by 1992. A site has not been selected as yet; the top of Mauna Kea, in Hawaii (14,000 feet high) is one possibility.

Meanwhile, design work has already started on the 10-metre telescope for the University of California. This time the mirror will be segmented—that is to say, made up of many smaller mirrors fitted together to produce a perfect optical curve.

It may well be that the Russian 6-metre reflector in the Caucasus will remain the largest single-mirror telescope. It does not in fact work well, mainly because the thick glass mirror never cools down quickly enough or uniformly enough to produce really good images. Meanwhile, the Isaac Newton Telescope in La Palma is functioning excellently, and the construction of the even larger William Herschel Telescope is proceeding satisfactorily.

Observations of the occultation of a star by the planet Neptune, made by three Indian astronomers, indicate that Neptune may have one or two small satellites in addition to the two already known, Triton (larger than our Moon) and Nereid (much smaller).

It is also suggested that there may be a ring system similar to that of Uranus—though the fact that Triton has retrograde motion may well make for unstable conditions, preventing the formation of rings. We may find out in 1989 if *Voyager 2* survives operationally to send back data from close range.

VOLCANOES OF VENUS

This month Venus is so brilliant that it cannot be overlooked. Inevitably it will be asked "Can Venus have been the Star of Bethlehem?" The answer seems to be a decisive "No", because Venus is a familiar object, and if the Wise Men were deceived by it they can hardly have been very wise!

The same objection disposes of all other normal planets and stars. No planetary conjunction was visible from the Holy Land around the time of Christ's birth (which was probably in B.C.4, not A.D.1); Halley's Comet came back a dozen years too early, and again would have been on view for some time; no novae or supernovae were recorded by contemporary astronomers.

All in all, it seems that the Star has no scientific explanation, and it is hardly likely that the mystery will ever be solved now.

GODDESS OF BEAUTY

Venus is named after the Goddess of Beauty, and with the naked eye it is superb; at its best it can even cast shadows. Telescopically it is a disappointment, since its surface is permanently hidden by its dense, cloudy atmosphere. This month it is at gibbous phase: about 70 per cent illuminated at the start of December, 60 per cent at the end.

Before the Space Age, very little was known about Venus. It was even suggested that there might be broad oceans, containing primitive life-forms which might eventually develop just as they have done on Earth.

The early space missions ruled this attractive idea out of court. The temperature at the surface is not far short of 1000 degrees Fahrenheit; the surface pressure of the atmosphere is 90 times that of the Earth's air at sea-level; the atmosphere itself is made up principally of carbon dioxide, and those lovely clouds prove to contain large amounts of sulphuric acid. As I have said on various occasions, anyone who lands on Venus and steps outside his spacecraft will be immediately fried, poisoned, squashed and corroded.

LIFELESS

No life can be expected there now; but there is a chance that life may have gained a foothold in the early days of the Solar System, over 4000 million years ago. The Sun was then about 30 per cent less luminous than it is now, and it is possible that Venus and the Earth, which are of very similar size and mass, may have started to evolve along similar lines. But when the Sun became more powerful, the oceans of Venus evaporated, the carbonates were driven out of the rocks, and there was what has been called a "runaway greenhouse" effect, transforming Venus into the furnace-like environment of today.

Russian automatic vehicles have soft-landed there, and sent back pictures of a gloomy, rock-strewn landscape under a bright orange sky. Both Soviet and American vehicles have been put into closed orbits, and by now the surface has been reliably mapped by radar; the US *Pioneer* has been particularly successful in this respect.

THE SKY THIS MONTH

The last weeks of 1984 show that the night skies are still short of planets! The exception is, of course, Venus, which is a magnificent object in the west after sunset; at the end of December it will be visible for over three hours after the Sun has disappeared, so that it will be seen against a dark background.

Mercury is technically an evening object in the first part of the month and a morning object after the 14th, but it is so far south in the sky that British observers will probably not be able to see it with the naked eye. Mars moves into Aquarius, and is visible in the early evening, but it is now no brighter than Aldebaran, and no telescope will show much upon its disc.

Jupiter is to all intents and purposes out of view; Saturn, in Libra, rises shortly before the Sun at the end of the month, but is not well placed. There are no eclipses of the Sun or Moon, and no bright comets are expected; Halley's Comet is still beyond the range of any but very large telescopes.

The starlit sky is dominated by Orion, now high in the south-east by late evening; it is interesting to compare its two leaders—Rigel and Betelgeux—which are very different. Rigel is a true "cosmic searchlight", white and hot, shining some 60,000 times as powerfully as the Sun. Betelgeux, "only" 15,000 Sun-power, is a lovely orange-red. It is decidedly variable in light, and at times it may rival Rigel, though probably never quite equals it.

Look also for the Orion Nebula, below the three stars of the Belt; this is the most famous of the gaseous nebulae, and is a stellar birthplace, where fresh stars are condensing out of the thinly-spread gas and dust. Deep in the heart of the Nebula is the mysterious Becklin-Neugebauer Object, detectable only in infra-red, which may be a very luminous star permanently hidden from us by the intervening nebular material.

Of Orion's retinue, Capella in Auriga (the Charioteer) is almost overhead, while Aldebaran in Taurus (the Bull) is high up; also in Taurus is the lovely star-cluster of the Pleiades or Seven Sisters. Most people can see seven stars without optical aid, and binoculars will show many more.

The Square of Pegasus is sinking in the west. Below it lies Cetus, the Whale, distinguished mainly by its long-period variable star Mira. At maximum Mira becomes as bright as the Pole Star, but this month it is well below naked-eye visibility.

Venus is a world of craters and plains, together with two major upland areas, now called Ishtar and Aphrodite. There is also Beta Regio, a highland area which seems to consist of two giant shield volcanoes, Rhea and Theia.

Recent results indicate that these volcanoes—and at least one other, in the region called Atla Regio—are active. There has been a sudden, marked increase in the amount of sulphur dioxide in the planet's atmosphere, attributed to violent vulcanism.

The situation on Venus is however very different from that on the Earth. Our world has several major "plates" which drift very slowly around; vulcanism occurs at the boundaries of these plates (remember the "Ring of Fire" round the Pacific). Venus, on the other hand, is probably a one-plate planet, so that vulcanism is restricted to a few areas. Because of the lack of movement, a volcano on Venus will persist for much longer than a similar volcano on Earth.

Hawaii gives an example of this. Mauna Kea used to lie over a "hot spot", but has now shifted away and become extinct (at least, one hopes so in view of the major observatories now on its summit). Mauna Loa has taken its place over the hot spot, and is active.

PROBING SPACE

One of the most effective space-probes to date has been *Pioneer* Venus. It has also been used for other studies. In April 1984 it was tilted so as to examine Encke's periodical comet, and found that the comet is losing water at three times the expected rate.

In February 1986 it will be tilted again, this time to study Halley's Comet. Halley reaches perihelion (its closest point to the Sun) on 9 February 1986, but will then be out of view from Earth, because it is on the other side of the Sun.

However, it will be observable from Venus, and *Pioneer* is to be pressed into service. The information will be of immense value at that particular time, since the various comet probes are scheduled to rendezvous with Halley in the following month.

Less than thirty years ago it was widely believed that as a potential colony, Venus might be more promising than Mars. This has turned out to be quite wrong, and the chances of any manned expeditions to Venus in the foreseeable future seem to be nil.

Carl Sagan has suggested that it may eventually be possible to "seed" the planet's atmosphere, break up the carbon dioxide and sulphuric acid, and make conditions there tolerable, but at the moment any such procedure is quite beyond us. We must be content to study Venus from a respectable distance.

One other experiment is worth noting. On their way to Halley's Comet, two Russian *Vega* probes will by-pass Venus and, it is hoped, drop balloons into the atmosphere, so that information can be obtained from different levels as the balloons float around. Whether this experiment will be successful remains to be seen.

Another Venus orbiting probe is planned for the late 1980s, and will be of tremendous interest. We have learned a great deal about this strange, unfriendly world, but there is still much that we do not know.

PRACTICAL ELECTRONICS PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain PE constructional projects are now available from the PE PCB Service, see list. They are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: ***PE PCB Service, Practical Electronics Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG.*** Cheques should be crossed and made payable to IPC Magazines Ltd.

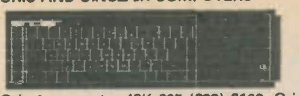
Please note that when ordering it is important to give project title, order code and the quantity. Please print name and address in Block Caps. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed here or in the November 1984 issue.

PROJECT TITLE	Order Code	Cost
APRIL '82		
Med. Resolution Equaliser (UK 101)	204–01	£1.73
Enlarger Timer	204–02	£4.02
AUG '82		
Automatic Photographer	208–01	£1.94
Home Alarm	208–02	£3.21
SEPT '82		
Waveform Digitiser	209–01	£8 24
FEB '83		
Radio Booster	302–02	£1.80
MAR '83		
Into the Real World	303–01	£3.99
Accessory PSU	303–02	£1.35
$4\frac{1}{2}$ Digit Frequency Meter	303–03	£3.69
APRIL '83		
Phaser	304–01	£3.41
JUNE '83		
Program Conditioner	306–01	£2.30
SEPT '83		
Guitar Active Tone Control	309–01	£2.27
Ground Communication System	309–02	£2.13
,,	309–03	£2.31
DEC '83		
Expanding the Vic 20	312–01	£5.18
MAR '84		
Spectrum Autosave	403–01	£1.83
APRIL '84		
Microstepper	404–01	£10.74
MAY '84		
Sustain Unit	405–02	£2.82
Audio Signal Generator	405–03	£4.28
,,	405–04	£2.51
JUNE '84		
Cross Hatch Generator	406–01	£3.52
JULY '84		
Simple Logic Generator	407–01	£7.73
EPROM Duplicator	407–02	£3.74
Alarm System	407–03	£3.19
Oscilloscope Calibrator	407–04	£4.23
AUG '84		
Comm. 64 RS232C Interface	408–01	£3.02
Field Measurement	408–02	£3.19
,,	408–03	£2.76
Digital Dice	408–04	£4.23
Simple Logic Analyser	408–05	£2.93
Alarm System	408–06	£4.24
,,	408–07	£3.14
,,	408–08	£3.23
SEPT '84		
Parallel to Serial Converter	409–01	£2.92
Through the Mains Controller	409–02	£2.88
,,	409–03	£2.71
OCT '84		
Logic Probe	410–01	£1.90
NOV '84		
Computer DFM Adaptor	411–01	£2.76
DEC '84		
Ni-Cad Charger	412–01	£2.40
JAN '85		
Outrider Car Computer (Set of 2 boards)	501–01/2	£9.10

ORIC AND SINCLAIR COMPUTERS



Oric 1 computer 48K £95 (£92) £102. Oric Atmos computer 48K £171 (£158) £168. Oric Colour Printer £134 (£123) £140. Oric disc drive £304 (£278) £298. New Sinclair Spectrum Plus Computer with 6 free programs while Sinclair make this offer £182 (£176) £187. New Sinclair QL Computer £406 (£385) £410. Sinclair Spectrum 48K (with 6 free programs while Sinclair's offer lasts) £131 (£131) £143. Microdrive £51 (£50) £60. RS232 interface 1 £51 (£50) £60. Limited period special offer:- Microdrive + Interface 1 + 4 Blank cartridges £102 (£100) £120. Blank microdrive cartridges £5.50 (£6) £7. Interface 2 £20.45 (£20) £24. 32K memory upgrade kit for 16K Spectrum (Issue 2 and 3 only) £31 (£28) £30. Spectrum printer interfaces with cables:– Centronics £51 (£47) £52, RS232 £35 (£33) £38. ZX printer has been replaced by the Alphacom 32 £71 (£69) £82. 5 printer rolls (State whether Sinclair or Alphacom) £13 (£16) £2T. ZX81 computer £45 (£44) £54. 16K ram packs for ZX81 £28 (£25) £30.

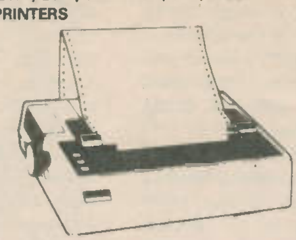
COMMODORE COMPUTERS

Commodore C16 Starter Pack £145 (£142) £162. Commodore Plus/4 £305 (£281) £301. Commodore 64 £222 (£215) £235. Vic 20 starter pack £75 (£85) £115. Convertor to allow most ordinary mono cassette recorders to be used with the Vic 20 and the Commodore 64: £9.78 (£9) £11. Bargain package:- cassette convertor + compatible cassette recorder £37 (£38) £44. Commodore cassette recorder £43 (£44) £50. Printer interfaces for Vic 20 and the Commodore 64:- Centronics £45 (£41) £46, RS232 £45 (£41) £46. Disc drive £233 (£209) £234. 1520 printer/plotter £165 (£149) £159. MPS801 Printer £235 (£220) £245. MPS802 Printer £350 (£330) £360. Light pen £29 (£29) £33. Vic 20 Accessories:– Super expander high res cartridge £33 (£29) £34; Programmers aid cartridge £33 (£29) £34, Extra memory ram packs 8K £19 (£17) £20, 3K £6 (£7) £9.

ACORN COMPUTERS

Electron £203 (£209) £229. Electron joystick and printer interface £61 (£62) £69. BBC Model B £404 (£357) £387. BBC Light Pen £29 (£29) £33. 14" Colour monitor £228 (£299) £319. Kenda double density disk interface system £149 (£131) £141. Disc drives 5.25" 40 track:- single £170 (£154) £184, dual £295 (£270) £308.

PRINTERS



Brother HR5 £162 (£146) £170. Shinwa CTI CP80 £225 (£218) £248. Cannon PW1080A £332 (£299) £329. Epson RX80 £277 (£251) £282. Epson RX80F/T £314 (£286) £316. Epson FX80 £399 (£358) £388. Combined matrix printers and electric typewriters:– Brother EP22 £173 (£166) £186. Brother EP44 £258 (£235) £260. Smith Corona TP1 Daisy wheel printer £252 (£225) £255. MCP40 Oric colour printer/plotter £134 (£123) £140. Interfaces to run the above printers from Vic and the Commodore 64 £45 (£41) £46. We can supply interfaces to run the above printers from Sharp computers £58 (£52) £55.

16 DIL SUB-MINIATURE RELAYS

5V 56 ohm coil 1 SPDT contact 1 amp D.C. UK price 67p each plus 35p postage on total order.

UK101, SUPERBOARD AND VIDEOGENIE COMPUTERS

We still support these gorgeous machines. Please write for our free list.

SWANLEY ELECTRONICS

The Computer Export Specialists

Dept PE, 32 Goldsel Rd., Swanley, Kent BR8 8EZ, England.

Please allow 7 days for delivery.

Tel: Swanley (0322) 64851. *Official orders welcome. UK prices are shown first and include post and VAT. The second price in brackets is for export customers in Europe and includes insured air mail postage. The third price is for export customers outside Europe (including Australia etc) and includes insured airmail postage.*

1984/85 CATALOGUE

84 page A4 size – Bigger, Brighter, Better – more components than ever before! With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. All for just £1.00!! Winter Supplement due out November – Send large SAE for your free copy.

NEW PACKS:

K524 OPTO PACK – a variety of single point and seven segment LEDS (incl. dual types) of various colours and sizes, opto isolators, numicators, multi digit gas discharge displays, photo transistors, infra red emitters and receivers. 25 assorted £3.95; 100 £14.95; 250 £35.

K525 PRESET PACK – Big, Big variety of types and sizes – submin, min and std, MP, slider, multiturn and cermets are all included. Wide range of values from 20R to 5M. 100 assorted £6.75; 250 £12.95; 1000 £48.

K526 HEATSINK PACK – Lots of different sizes and shapes of heatsink for most diode and transistor case styles. A pack of 25 assorted including several large finned types – total weight over 1kg £5.50; 100 £19.50.

K527 HARDWARE PACK – This has a large variety of pk and self tapper screws from 2×¼" up to 8×1½" also washers, some BA, metric and Whit. screws plus other miscellaneous brackets, captive nuts and bits and pieces. 1kg (up to 1000 pieces) £4; 3kg £9; 10kg £25.

K528 ELECTROLYTIC PACK – All ready cropped for PCB mounting, this pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF, 6v to 100v. 100 £3.95; 250 £8.95; 1000 £32.

K531 PRECISION RESISTOR PACK – High quality, close tolerance R's with an extremely varied selection of values mostly ½ and ¼w tolerances from 0.1% to 2% – ideal for meters, test gear etc. 250 £3; 1000 £10.

K532 RELAYS – Wide selection of styles voltages and contacts. 4v-240v, AC/DC, SP to 4PCO. 20 for £6: 100 £25.

1W AMPLIFIER

Z914 – Audio amp panel 95×65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied. Only £1.50; 10 for £12; 25 for £25; 100 £75.

Z915 – Stereo version of above 115×65mm featuring 2 × TBA820M and dual vol. control. £3.50; 10 for £30; 25 for £65; 100 £200.

AM TUNER PANEL

Z916 – For use with mono amp above. Neat panel 60×45mm. Only £1.50; 10 for £12.00.

NI-CAD CHARGER SCOOP!

Ever-Ready model CH4, this charger will take up to 4 AA, c or D cells plus 2 PP3 if required. Smart two tone grey case 212×97×60mm. Only £7.95.

"TORUS"

Computer-controlled Robot built around the gearbox described below. Complete kit of parts inc PCB, program listings for BBC (other micros soon). £44.85. 20W ribbon cable (min 3m recommended – 5m better) £1.30/m. SAE for illustrated leaflet.

The unit has 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle, and a gearbox contained within the black ABS housing. Data is supplied with the unit showing various options on driving the motors etc. £5.95. Suitable wheels also available: 79mm dia plastic with blue tyre, drilled to push-fit on spindle. 2 for £1.30 (limited qty). 3" dia aluminium disc 3mm thick drilled to push-fit on spindle. 2 for 68p.

FIBRE OPTICS

Scoop purchase of single and twin cable. For use with visible light or infra-red. Core 1mm dia, overall 2.25mm dia. Single 50p/m; 20m coil £6.30. Twin 90p/m; 20m coil £11.00.

MINIATURE RELAYS

PCB mounting, DPCD size 20×15×15mm. Available in 3, 9 or 12V. £1 each.

PCB MOUNTING NI-CADS

Much sought after 4.8V 150mA batts with PCB mntg tags on 25mm pitch. Batt size 25×16 Ø. Ideal for paralleling. 99p ea; 10+ 85p; 25+ 70p; 100+ 60p.

Official orders welcome – minimum invoice charge £10. No min. on CWO.

Our shop has enormous stock of components and is open from 9-5.30 Mon-Sat. Come and see us!!

Minimum Access order £5.00

GREENWELD

443C Millbrook Road Southampton SO1 0HX Tel (0703) 772501/783740

ALL PRICES INCLUDE VAT: JUST ADD 60p P&P

FREE CAREER BOOKLET

Train for success, for a better job, better pay

Enjoy all the advantages of an ICS Diploma Course, training you ready for a new, higher paid, more exciting career. Learn in your own home, in your own time, at your own pace, through ICS home study, used by over 8 million already! Look at the wide range of opportunities awaiting you. Whatever your interest or skill, there's an ICS Diploma Course there for you to use. Send for your FREE CAREER BOOKLET today — at no cost or obligation at all.

GCE Over 40 'O' and 'A' Level subjects from which to choose. Your vital passport to career success. ☐

COMPUTER PROGRAMMING ☐	RADIO AMATEUR'S LICENCE ☐
ELECTRONICS ☐	INTERIOR DESIGN ☐
COMMERCIAL ART ☐	WRITING FOR PROFIT ☐
TV, RADIO & AUDIO SERVICING ☐	CAR MECHANICS ☐
BOOK-KEEPING & ACCOUNTANCY ☐	

Please send FREE DETAILS for the course ticked above.

Name ____________

Address ____________

P.Code ____________

ICS Dept. EDS 15
8 Elliot Place
Clydeway Centre
Glasgow G3 8EF

041 221 2926
or 01 622 9911
(all hours)

CACC

AA117	0.090
AA119	0.090
AAY32	0.090
AC107	0.280
AC126	0.170
AC127	0.150
AC128	0.150
AC128K	0.230
AC141K	0.230
AC142K	0.220
AC153K	0.230
AC176	0.180
AC176K	0.200
AC187	0.150
AC187K	0.200
AC180	0.170
AC188K	0.230
ACY18	0.480
ACY19	0.480
AD142	0.600
AD149	0.450
AD161	0.220
AD162	0.220
AF124	0.250
AF125	0.250
AF126	0.250
AF127	0.250
AF139	0.220
AF239	0.220
AL112	0.700
AL113	0.800
ASZ15	1.000
ASZ17	1.000
AU110	1.100
AY102	1.800
AY106	1.800
BA145	0.100
BA148	0.100
BA154	0.060
BA157	0.120
BB101	0.130
BB103	0.160
BB105B	0.180
BB205B	0.240
BC107	0.070
BC108	0.070
BC109	0.070
BC115	0.100
BC118	0.110
BC140	0.190
BC141	0.190
BC142	0.190
BC143	0.190
BC147	0.055
BC148	0.055
BC149	0.055
BC157	0.055
BC159	0.055
BC182	0.060
BC182L	0.060
BC183	0.060
BC183L	0.060
BC184	0.060
BC184L	0.060
BC212	0.060
BC212L	0.060
BC213	0.060
BC213L	0.060
BC214	0.060
BC214L	0.060
BC237	0.070
BC238	0.070
BC300	0.150
BC301	0.180
BC302	0.180
BC303	0.180
BC327	0.060
BC382	0.060
BC337	0.060
BC328	0.060
BC557	0.060
BCY32	1.500
BCY33	1.500
BCY34	1.800
BCY42	0.200
BCY56	0.160

BCY70	0.160
BCY71	0.160
BCY72	0.160
BD115	0.260
BD124P	0.500
BD124	1.100
BD128	0.350
BD131	0.250
BD132	0.250
BD135	0.200
BD136	0.200
BD137	0.200
BD138	0.200
BD139	0.200
BD140	0.200
BD144	0.900
BD150	0.300
BD157	0.380
BD158	0.380
BD166	0.300
BD175	0.300
BD177	0.300
BD179	0.320
BD181	0.450
BD201	0.330
BD202	0.380
BD203	0.420
BD204	0.420
BD222	0.310
BD225	0.310
BD232	0.310
BD237	0.210
BD238	0.240
BD433	0.280
BD437	0.280
BD535	0.380
BD536	0.380
BD537	0.400
BD538	0.400
BDX32	1.000
BDX65	0.800
BF180	0.160
BF181	0.180
BF183	0.200
BF184	0.200
BF185	0.200
BF194	0.050
BF195	0.050
BF196	0.060
BF199	0.060
BF200	0.160
BF257	0.180
BF258	0.180
BF259	0.180
BF336	0.200
BF337	0.200
BF338	0.200
BF362	0.300
BF422	0.210
BF458	0.190
BF459	0.190
BFX29	0.200
BFX84	0.200
BFX85	0.200
BFX87	0.150
BFX88	0.150
BFY50	0.140
BFY51	0.140
BFY52	0.140
BFY56	0.250
BYF57	0.250
BFY64	0.250
BR100	0.140
BSX19	0.150
BSX20	0.150
BSX21	0.150
BSX26	0.150
BSX29	0.190
BZX78	0.150
BT106	0.900
BT109	0.900
BT116	0.800
BT119	1.000
BT120	1.000
BU104	1.000
BU106	0.800
BU108	1.000
BU110	1.100

BU111	1.400
BU126	0.700
BU204	0.750
BU205	0.700
BU208	0.750
BU208A	0.800
BU208D	1.200
BU326	0.850
BU406	0.850
BU407	0.750
BU408	1.000
BU500	1.100
BU526	0.800
BY126	0.060
BY127	0.080
BY133	0.080
BY164	0.220
BY176	0.850
BY179	0.350
BY182	0.320
BY184	0.320
BY187	0.320
BY196	0.200
BY206	0.110
BY207	0.110
BY223	0.720
BYX10	0.150
CA270	0.400
CA3086	0.250
CA3089	1.500
CA3240	0.900
C106D	0.230
MC1327	0.700
MJ2500	1.000
MJ2501	1.100
MJ2955	0.550
MJ3000	1.150
MJ3001	1.150
MJE29A	0.300
MJE30A	0.300
MJE340	0.250
MJE350	0.800
MJE520	0.300
MJE2955K	0.900
OA47	0.080
OA90	0.040
OA91	0.040
OA200	0.070
OA202	0.070
OC28	1.000
OC29	0.800
OC35	1.000
OC45	0.500
OC71	0.300
OC72	0.500
OC200	1.800
OCP71	1.000
ORP12	1.000
ORP60	1.000
ORP61	1.000
R2008B	0.800
R2010B	0.800
SAS560	1.100
SAS570	1.100
SN76003N	1.400
SN76013N	1.400
SN76023N	1.400
SN76033N	1.500
SN76110N	0.700
SN76115	0.700
SN76226	0.900
SN76227	0.800
T2800D	0.520
TAG08-60	0.420
TAG521-200	0.720
TAG4443	0.760
TAG4444	0.760
TAA550	0.150
TBA120S	0.450
TBA395	0.600
TBA396	0.600
TBA520	0.750

TBA530	0.750
TBA540	0.750
TBA560	0.700
TBA800	0.350
TBA810S	0.600
TBA820	0.750
TBA920	0.800
TBA950	0.800
TBA990	0.800
TCA800	0.800
TCA940	0.850
TDA1170	0.900
TDA1412	0.600
TDA2002	0.800
TDA2003	1.500
TDA2020	1.400
TDA2030	1.400
TDA2522	0.800
TDA2530	0.800
TDA2532	0.750
TDA2540	0.700
TDA2560	0.700
TDA2593	0.800
TDA2690	0.700
TIP29	0.150
TIP29A	0.220
TIP29C	0.250
TIP30	0.160
TIP31A	0.240
TIP32	0.240
TIP32A	0.240
TIP33	0.500
TIP34	0.500
TIP41A	0.220
TIP41C	0.250
TIP42A	0.220
TIP42C	0.250
TIP47	0.400
TIP48	0.400
TIP49	0.400
TIP110	0.470
TIP112	0.540
TIP115	0.450
TIP117	0.560
TIP120	0.430
TIP121	0.460
TIP122	0.470
TIP125	0.470
TIP126	0.560
TIP127	0.560
TIP2955	0.340
TIP3054	0.380
TIP3055	0.340
TIS61	0.150
TIS90	0.150
TIS91	0.150
2N.2904	0.200
2N.2905	0.200
2N.2906	0.180
2N.2907	0.180
2N.2926	0.080
2N.3019	0.280
2N.3063	0.180
2N.3054	0.350
2N.3055	0.320
2N.3055H	0.380
2N.3440	0.580
2N.3442	0.850

2N 3771	0.850
2N.3772	0.900
2N.3773	1.000
2N.4031	0.250
2N.4036	0.250
2N.4037	0.250
2N.4443	0.760
2N.4444	0.760
2N 5061	0.200
2N.5294	0.300
2N.5296	0.300
2N.6106	0.400
2N.6107	0.400
2N.6109	0.400
3N.128	0.550
3N.143	0.650
IN.914	0.020
IN.4001	0.040
IN.4002	0.040
IN.4003	0.040
IN.4004	0.040
IN.4005	0.040
IN.4006	0.040
IN.4007	0.060
IN.4148	0.020
IN.5400	0.090
IN.5401	0.100
IN.5402	0.100
IN.5403	0.110
IN.5404	0.110
IN.5405	0.120
IN.5406	0.130
IN.5407	0.130
IN.5408	0.130

VOLTAGE REGULATORS	
7803	0.350
7812	0.350
7815	0.350
7818	0.350
7824	0.350
7905	0.350
7912	0.400
7915	0.400
7918	0.400
7924	0.400
78L05	0.280
78L12	0.280
78L15	0.280
74L18	0.280
74L24	0.350
LM309K	1.000
LM317K	2.200
LM317T	1.800
LM323K	4.200
LM723	0.320
78HGKC	5.700
78H05KC	5.200
78GU1C	1.900
79GU1C	2.150
79HGKC	6.700

JAPANESE TRANSISTORS	
2SA73	0.300
2SA104	0.320
2SA198	0.220
2SA203	0.300
2SA473	0.370
2SB54	0.250
2SB77	0.320
2SB337	1.200
2SB405	0.220
2SC460	0.210
2SC495	0.600
2SC733	0.400
2SC1161	1.100
2SC1172Y	1.500
2SC1279	0.240
2SC1306	1.000
2SC1307	1.000
2SC1520	0.250
2SC1969	1.300
2SC2029	1.200
2SC2078	1.200
2SC2122A	2.000
2SC2952	0.270
2SD234	0.370
2SK135	4.000
MB3712	1.500
TA7205	1.500
UPC575	1.000

ICS SOCKETS	
8 pin	0.060
14 pin	0.080
16 pin	0.090
18 pin	0.120
20 pin	0.140
22 pin	0.160
24 pin	0.180
28 pin	0.200
40 pin	0.250

VALVES	
DY87	0.530
DY802	0.450
ECC82	0.400
ECC83	0.430
ECC83	0.400
ECC85	0.400
ECH81	0.490
ECH84	0.520
ECL80	0.570
ECL82	0.250
ECL84	0.570
ECL85	0.570
ECL86	0.490
EF80	0.310
EF85	0.340
EF89	0.430
EF183	0.450
EF184	0.530
EL34	1.900
EY86	0.310
EY87	0.310
PC97	1.000

PCC85	0.420
PCF80	0.580
PCF200	1.350
PCF801	1.100
PCF802	0.570
PCF806	1.150
PCH200	1.000
PCL81	0.540
PL519	4.500
PCL82	0.630
PCL84	0.500
PCL85	0.550
PCL86	0.550
PCL805	0.550
PFL200	0.850
PL36	0.800
PL504	0.950
PL508	1.900
PY81	0.700
PY88	0.480
PY500A	1.600

ZENERS	
400MV	
BZY88 Range	
2V7 to 39V0	060
13W Zeners	
BZX61 Range	
2V7 to 39V0	120

MEMORIES	
2114	2.000
2716	3.000
2532	4.000
2732	4.000
2764	7.000
4116	0.750
6116	6.000
LM324	0.300
LM380	0.500
LM381	1.000
LM709 Dil	0.300
LM723	0.320
LM741 Dil	0.150
LM741 Met	0.450
LM3900	0.250
NE555	0.150
NE556	0.400
BYX55/350	0.300
BYX55/600	0.300
BYX65/600	0.300
BYX55/800	0.320
BYX70/500	0.290
BYX70/500	0.310
BYX70/800	0.360
BYX71/600	0.800

LED	
LED 3mm RED	0.050
LED 3mm YELLOW	0.100
LED 3mm GREEN	0.100
LED 5mm RED	0.050
LED 5mm YELLOW	0.100
LED 5mm GREEN	0.100

BRIDGE RECTIFIERS	
1A/50V	0.160
1A/100V	0.180
1A/200V	0.190
1A/400V	0.210
1A/600V	0.230
1A/800V	0.280
2A/100V	0.350
2A/200V	0.360
2A/400V	0.420
2A/600V	0.540
2A/800V	0.580
3A/200V	0.660
3A/400V	0.680
3A/600V	0.780
6A/200V	1.000
6A/400V	0.600
25A/100V	1.600

ELECTROLYTIC	
4700UF-16V CAN	0.200

TRIPLERS	
LP1195 (4000Ser)	2.250

Please add 50p P&P and VAT at 15%. Govt. Colleges, etc. orders accepted
Quotations given for Large Quantities
Please allow 7 days for delivery
All brand-new Components. All valves are new and boxed
Ring for items not listed. We stock 3,000 items

GRANDATA LTD.

9 & 12 THE BROADWAY, PRESTON ROAD WEMBLEY, MIDDLESEX, ENGLAND

Telephone: 01-904 2093 & 904 1115/6

Telex: 932885 Sunmit

SEMICONDUCTOR CIRCUITS

TOM GASKELL BA(Hons) CEng MIEE

PROGRAMMABLE DELAY TIMER (LS7210)

THE digital timer i.c. is a very common building block in all kinds of circuitry, and can vary in complexity from simple devices such as the '555' up to programmable microprocessor peripheral i.c.s. This month we look at the LS7210 from LSI Computer Systems, an interesting PMOS device with several novel features.

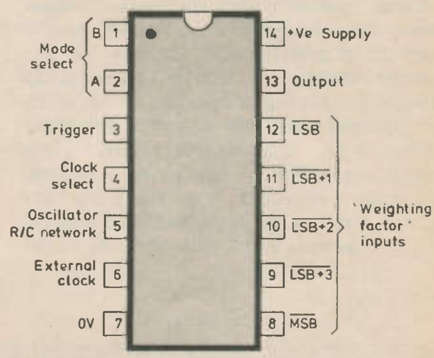
Essentially, the LS7210 consists of a digital timer with a period which can be programmed by a 5 bit binary code, giving a range of periods from 1 to 31 times the basic time interval. The basic time interval itself is determined by a clock which can either be generated internally or fed in from an external source. The feature that sets this timer i.c. apart from other similar devices is that it can be made to operate in four distinctly different modes; delayed operate, delayed release, dual delay, or monostable ('one-shot').

The block diagram is shown in Fig. 2. The internal oscillator requires only an external capacitor and resistor to be connected to pin 5 as shown. If preferred, an external clock can be fed in to pin 6. A logic 1 on pin 4 (high level, or open circuit because of the internal pull-up resistor) selects the external clock, and a logic 0 (low level) the internal clock oscillator. The selected clock is then divided by 1023 and fed into a programmable timer/counter. This block of circuitry divides the incoming signal by anything from 1 to 31, depending on the code set up on pins 8 to 12. The timer/counter output is then latched and used to drive a MOSFET output stage.

An unusual feature of this i.c. is that the trigger input and the two mode select inputs are latched by the clock. Hence, no action will be taken when pins 1, 2 or 3 change state until the next negative transition of the clock. Master control logic arranges for the correct sequence of events to occur, and power-on reset circuitry ensures that all parts of the i.c. are reset when power is first applied.

OPERATING MODES

The selection of operating modes of the LS7210 is made by applying the following codes to the mode select inputs A and B:



PE39M

LS7210

Characteristic		Notes		Minimum Value	Typically	Maximum Value	Units
Supply Voltage				+4·75		+15·0	V
Quiescent Current		+15V supply, output turned off				3·0	mA
Temperature Range				−25		+70	°C
Trigger Input Voltage, Pin 3.	For Logic 1	+ve supply = +5V		4·0		5·0	V
		+ve supply = +15V		12·0		15·0	V
	For Logic 0	+ve supply = +5V		0		1·0	V
		+ve supply = +15V		0		3·0	V
Input Voltage (All other Inputs)	For Logic 1	+ve supply = +5V		3·5		5·0	V
		+ve supply = +15V		10·5		15·0	V
	For Logic 0	+ve supply = +5V		0		1·5	V
		+ve supply = +15V		0		4·5	V
Output Source Current		+ve supply = +5V	Output = +4·5V	0·55			mA
			Output = +4·0V	1·0			mA
		+ve supply = +15V	Output = +14·0V	4·2			mA
			Output = +13·0V	8·1			mA
Internal Oscillator Frequency				0·01		100k	Hz
External Clock Frequency				D.C.		160k	Hz
External Clock Pulse Widths		t_H and t_L	For External Clock—See Fig. 4	3·0			µs
I/P Set-up time, pins 1, 2 and 3		t_S			200	300	ns
Ext. Clock to Output Delay		t_{nd}			700	1000	ns
Ext. Clock to Output Delay (At Time-out)		t_{od}			1·0	1·6	µs
Ext. Clock to Output Delay (Monostable Mode)		t_{sd}			400	600	ns
"Pull-up Resistor" Constant Current					3·0		µA

Fig. 1. Pinout and specification

A (pin 2)	B (pin 1)	MODE
0	0	Monstable ('one-shot').
0	1	Delayed Operate.
1	0	Delayed Release.
1	1	Dual Delay.

A logic 1 corresponds to either a high level, or open circuit due to the internal pull-up resistors. Fig. 3 shows the effect of these different modes on the output. Dual delay provides a time delay when both turning on and turning off the output. Once turned on, the output will remain on as long as the trigger input is at logic 0. Once turned off, the output will remain off as long as the trigger input is at logic 1. (Note that the output is inverted with respect to the input; a logic 1 on the trigger input results in a logic 0 being present, with or without a time delay, at the output.)

The delayed release mode causes a retriggerable delay to occur before the output is turned off whenever there is a positive going transition at the trigger input, while negative going trigger edges turn on the output immediately. The converse of this is true for the delayed operate mode. In the monostable mode the i.c. operates as a retriggerable monostable multivibrator. The output is turned on whenever there is a negative going transition at the trigger input. At the end of the programmed delay the output is turned off automatically. If there is a negative going trigger edge before the time period has ended, the delay is re-started. A positive going edge has no effect on the output or the time delay. Fig. 3 shows all the variations of output operating modes for the trigger input.

Although the operating mode of the LS7210 can be changed as often as required by altering the logic states of pins 1 and 2, this should NOT be done while a timing period is in progress, or erroneous effects will be caused. The internal pull-up resistors on the mode select inputs, in common with all other pull-up resistors in the i.c., are actually 3μA constant current sources. Their resistance is effectively 1·6M with a +5V supply, or 5M with a +15V supply.

THE WEIGHTING FACTOR

The 'weighting inputs', i.e. the binary inputs that determine the programmed division ratio, are active low; a logic 0 turns that bit on, and a logic 1 or open circuit turns it off. Hence, for a weighting factor of 31 (the highest possible number) pins 8 to 12 should all be at logic 0. The exact delay is given by the formula:

$$\text{Delay} = \left(\frac{1 + 1023N}{f}\right)$$

N is the binary weighting factor as defined on pins 8 to 12 (8 is the most significant bit, and 12 the least), and f is the clock frequency used. The internal clock frequency range is shown in Table 1. The tolerance on all these frequencies, i.e. the variation from i.c. to i.c., is ±5%.

RESISTOR R_t	CAPACITOR C_t	SUPPLY +5V	SUPPLY +15V
47k	200p	79kHz	85kHz
	500p	37kHz	36kHz
	1n	22kHz	20kHz
	50n	610Hz	475Hz
470k	100p	15kHz	16·5kHz
	200p	9kHz	9·5kHz
	500p	4kHz	4kHz
	1n	2·4kHz	2kHz
	50n	63Hz	47Hz
2M	100p	4·2kHz	5kHz
	200p	2·5kHz	2·8kHz
	500p	1·1kHz	1·1kHz
	1n	670Hz	610Hz
	50n	17Hz	14Hz
10M	10μF	0·02Hz	0·013Hz

Table 1. Oscillator Frequencies as Determined by External Components

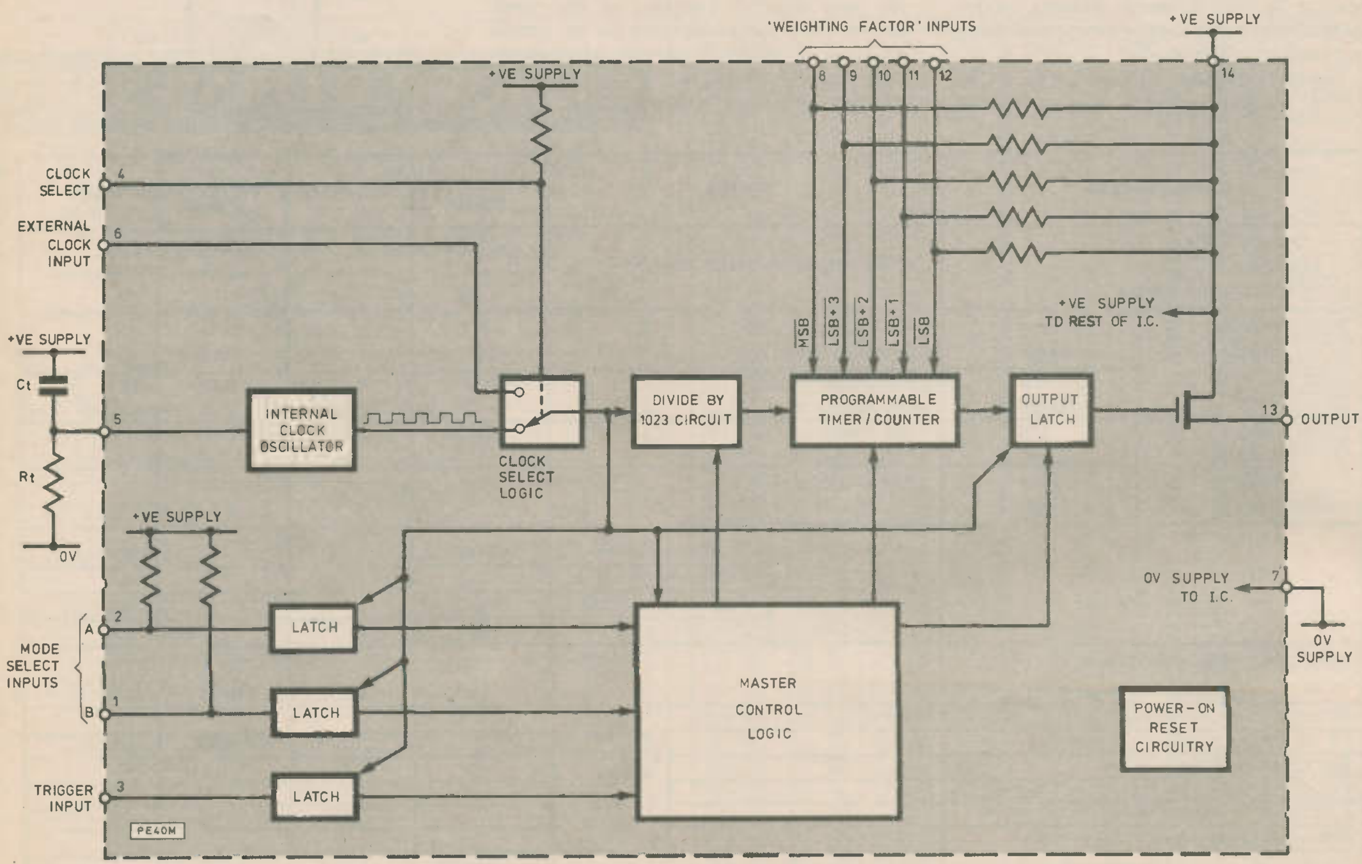
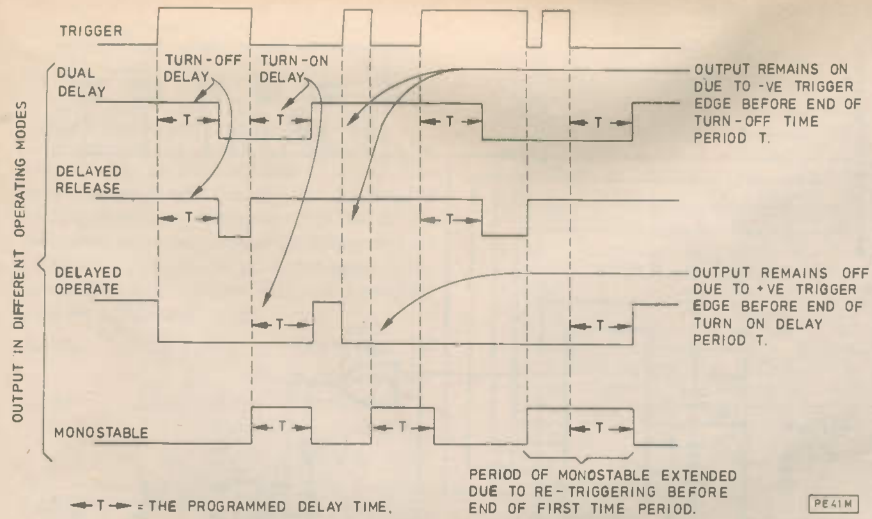
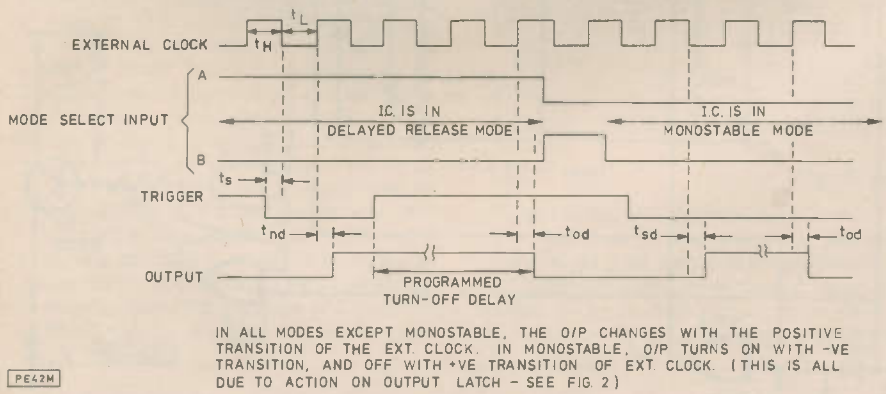


Fig. 2. Block diagram of the LS7210





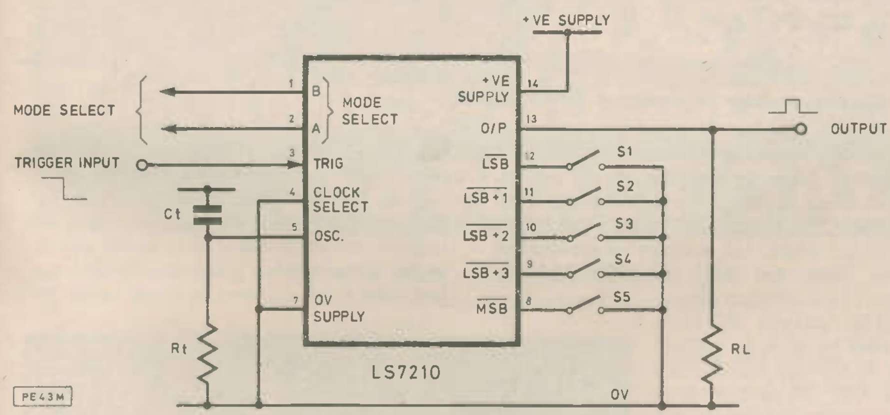


Fig. 3 (top). Timing diagram for the four modes of operation

Fig. 4 (middle). Timing diagram for the external clock

Fig. 5 (bottom). Typical simple application

USING THE I.C.

This is a fairly straightforward chip to use, although there certainly are some pitfalls for the unwary! The most obvious of these are the inverted logic levels on the weighting factor binary inputs, and the requirement that the clock should latch in both mode select inputs and the trigger input. Hence, when using the internal clock, the trigger pulse must always be wider than the clock period or it may never get latched in at all. The clock can operate down to very low frequencies, so this trigger pulse duration requirement could present problems if not catered for in the circuit design.

The output is an open drain f.e.t. which must be pulled down to 0V with an appropriate load resistor to obtain an output voltage swing. The available current drive is not very high, as shown in Fig. 1, so any loading should carefully take account of these current limits. Fig. 4 shows the exact timing relationships when the external clock is being used. The time periods t_H, t_{nd}, etc., are specified in Fig. 1.

APPLICATIONS

A typical application of the LS7210 is shown in Fig. 5. The internal clock is used, so no input is needed to pin 6. Pins 1 and 2 are connected to 0V, to the positive supply, or just left floating as required. The i.c. has a wide supply range of +4·75V to +15V, and features CMOS, PMOS and TTL compatible inputs. The value of R_t and C_t can be varied over a wide range, although it should be borne in mind that the internal oscillator (pin 5) can source a maximum of 0·6mA at +5V supply, and 2·7mA at +15V supply. These limits must not be exceeded.

The ability of this i.c. to produce delays varying from only a few microseconds up to several hours is a great attraction. Several units can even be cascaded to give extremely long delays or sequential switching effects. Altogether, it makes for an extraordinarily versatile programmable delay timer. The LS7210 is available from **Macro Marketing**, Burnham Lane, Slough, Berks.

A MICROCOMPUTER 'WATCHDOG' TIMER

GENERALLY speaking, microcomputers are very reliable devices. They rarely 'give up' part way through running a program as long as sensible precautions have been taken with regard to power supplies, transient protection, etc. However, when they do go wrong, it's usually very dramatic! When a microprocessor has jumped to an incorrect or non-existent memory location, it will almost never recover from that error. This can cause serious problems in dedicated control applications: robot arms thrashing wildly about, washing machines doing a cold rinse for ever more, etc.

One way of minimising any damage done is to provide a 'watchdog' or 'lock-up' timer. This requires that the microprocessor triggers a timer at regular intervals in such a way that the timer never quite reaches the end of its time period before being re-triggered. If this re-triggering fails to happen it is assumed that the computer has developed a fault, so the timer finishing its time period signals a warning. The ending of the time period can also be used to try to re-establish correct operation by resetting the microprocessor and running the program again.

Such a circuit is shown in Fig. 6, with the Veroboard layout (a rather complex one this month, as all-digital circuits tend to be) shown

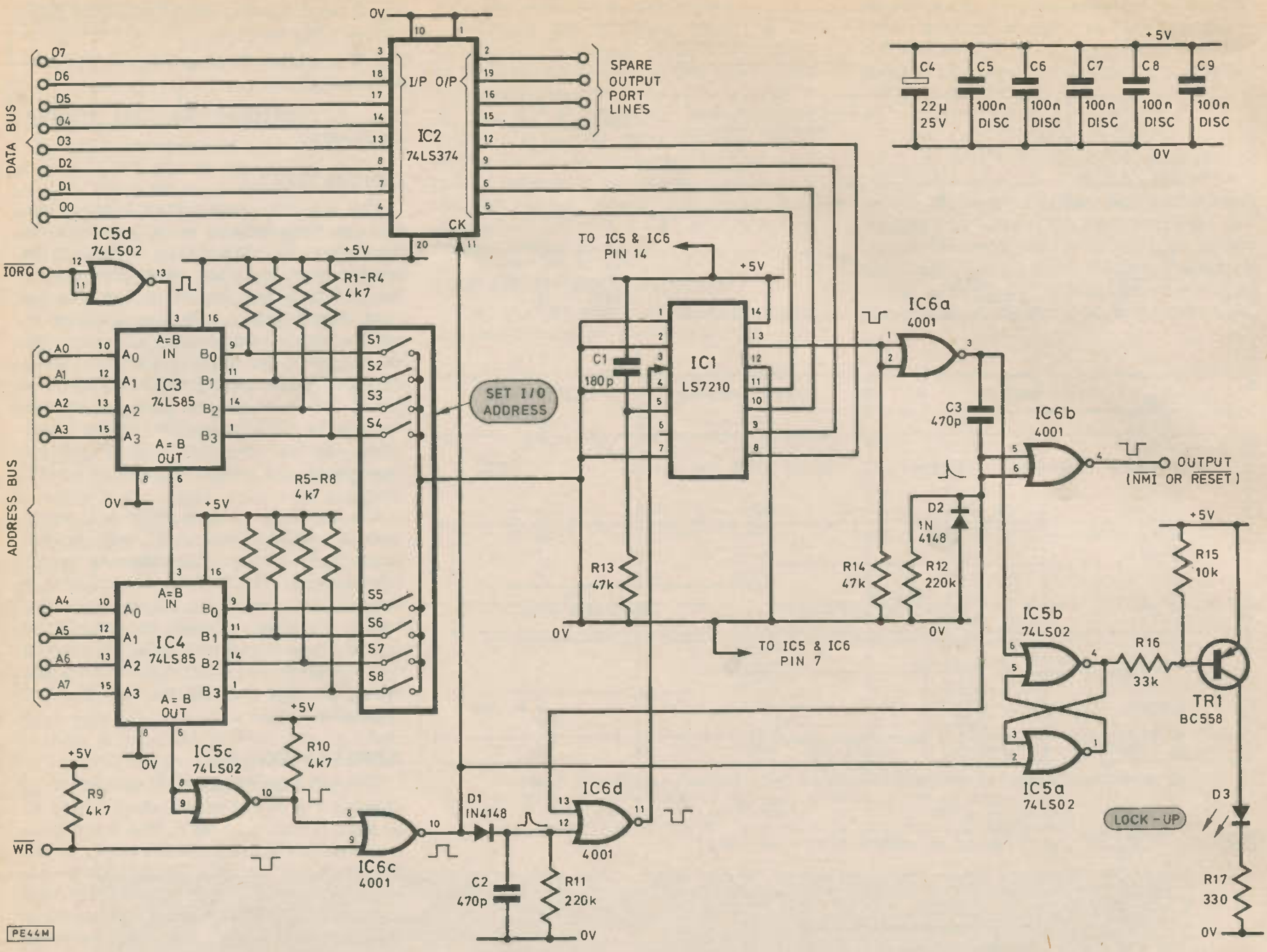


Fig. 6. Microcomputer 'Watchdog' Timer circuit

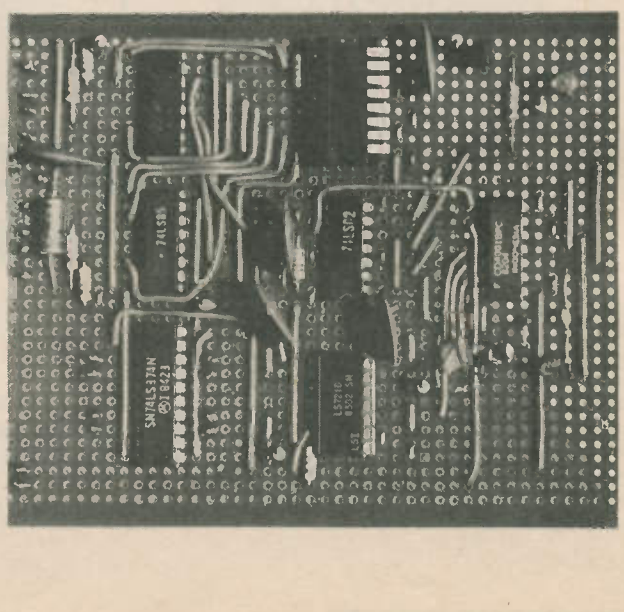
in Fig. 7. It was designed for a Z80 based system, but is easily adapted for other microprocessors or systems. In this circuit the microprocessor is able to control the actual time delay before resetting. This allows fast reactions to a failure during a period when the microprocessor is able to regularly re-trigger the timer, but also enables a longer time period to be allowed when a more complex and lengthy part of the program is being executed.

IC3 and IC4 are comparators used to decode a unique port address from the Z80 address bus. The port address required is programmed in binary on switches S1 to S8. These switches should be turned on for a logic 0, and turned off for a logic 1. IC5c, IC5d and IC6c arrange for the output of the comparators to be enabled only when the microprocessor is performing a WRITE operation to an I/O address. D1, C2 and R11 stretch the resultant pulse to typically 30 or 40µs, i.e. longer than the period of the oscillator of IC1, to allow the clock to latch in the trigger pulse from the output of IC6d. IC1 has the $\overline{\text{LSB}}$ of the weighting input always tied to logic 0 to ensure that the weighting input is always greater than zero. The other four weighting bits are fed from IC2, an 8 bit latch, which holds the data written to that port address. The top nibble (4 bits) is spare, so these lines can be used for other output functions if required. When writing data to the port to control IC1, it should be remembered that all the weighting inputs must be inverted. Hence ØFH (i.e. ØØØØ1111 in binary) is the shortest time delay, and ØØH (i.e. ØØØØØØØØ in binary) is the longest delay.

The output of IC1, loaded by R14, is buffered by IC6a, then fed to IC6b via C3, D2 and R12 to ensure that the output can never sit at a logic 0 level continuously. The output can be used as a non-maskable interrupt line, $\overline{\text{NMI}}$, or a reset line, $\overline{\text{RESET}}$, as appropriate.

It is unwise to use this output to feed into any form of maskable interrupt or polled input, because there is every chance that the computer would disable such facilities as part of its random 'crashing' effect, preventing any remedial action by the watchdog circuit.

Note that the output of IC6a is also fed back to IC6d. This arranges that IC1 retriggers itself at the end of every timing period, so that if the resetting action doesn't work the first time, it will try over and over again. In-



Circuit board component layout for the Microcomputer 'Watchdog' Timer circuit

dication of lock-up is given by D3, which is turned on by the flip-flop formed by IC5a and IC5b, via TR1. This flip-flop is turned on by the output of IC1 changing state (i.e. trying to re-start the processor) and turned off again by a WRITE operation to re-start the timer.

In practice, the circuit is connected to the address, data, and control lines as shown. The program should start (usually after loading the stack pointer) by writing a word out to the watchdog timer port; it's a good idea to start with the longest time delay. For example, if the output port is at address 44H, the assembled code for a Z80 could read:

```
3E ØØ      LD A,Ø          ; Put req'd
                             value in Accumulator
D3 44      OUT (44H),A     ; Output the
                             Accumulator to the port.
```

In BASIC, the simple instruction OUT 68,Ø would normally be used. The program should then continue, but must repeat this code regularly. The value Ø can be changed up to ØFH, or 15 in the case of BASIC, to vary the delay. Higher numbers, of course, will cause the 'spare' bits to be changed in IC2. The code must be repeated before IC1 finishes its time period, which is approximately 350ms for the maximum delay (ØØH, or Ø decimal) or 12ms for the minimum delay (ØFH, or 15 decimal). Programs written in assembler or directly in machine code usually run very much quicker than interpreted BASIC, so if used with the latter it might be necessary to extend the 350ms to even longer. This should be done by increasing the value of C1 or R13 (or both). C2, C3, R11 and R12 should all be changed by the same amount, too.

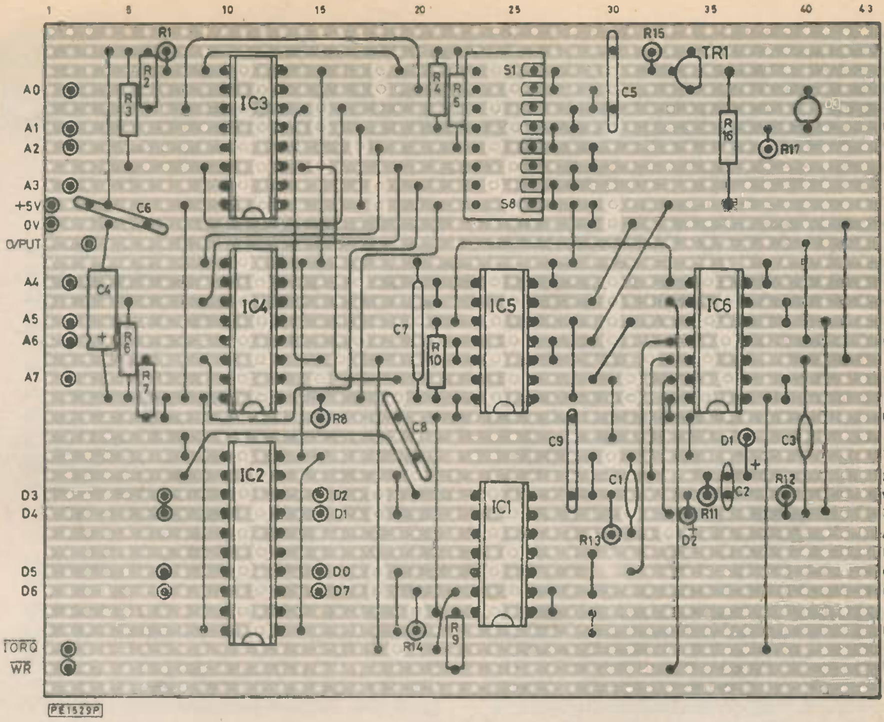


Fig. 7. Veroboard layout

At the reset address (normally ØØØØH) and/or at the NMI vector address (ØØ66H for the Z80) the above code should again be loaded in, or at least jumped to or passed through very shortly in the program path. After execution of this code, the program should then jump to a suitable place where the system can be re-initialised and re-started. Again, the port must be written to on a regular basis to prevent the timer ever reaching the end of its period.

THE LEADING EDGE

BARRY FOX

PROPHYLACTIC DISCLOSURE

There has been a spate of patents and research disclosures recently on still picture cameras that use electronic memory instead of film. A research disclosure, by the way, is the opposite of a patent.

If you invent something and don't patent it, you run the risk that someone else may also invent it, patent it, and perhaps stop you using your own invention. But once an idea has been published, it cannot be patented. So the safest way to ensure that no-one, including yourself, can patent an idea is to publish it.

Some firms play the sneaky trick of publishing in an obscure language, like Finnish or Danish, and choosing a little known publication in that country. Remember that once you have published an idea without patenting it, you have effectively made it a gift to anyone who reads what you have written.

By publishing in an obscure language there is a good chance that no-one will read it. But if the idea is later patented, the obscure language publication can still be used to invalidate the patent. This technique is quaintly known as "prophylactic disclosure".

A more normal approach is to publish openly, for instance in a learned journal. But this takes time. It is quicker to take advantage of the services offered by some firms which exist solely to publish ideas on which inventors want to block patents. *Research Disclosures* is one such British publication and a British journal recently devoted two pages to a not very interesting idea for electronic still picture cameras which an anonymous firm had published as a patent blocking procedure.

IN THE FRAME

The electronic picture bandwaggon started rolling with Sony's Mavica. Note incidentally that Mavica was the word originally used by Sony to describe a very wide video tape format which ran very slowly past a helical scan head. The wide tape format was dropped and the name Mavica was later switched to an SLR camera with CCD image sensor and magnetic disc instead of film.

They built and demonstrated some Mavica prototypes back in August 1981 and before long the popular press was talking about the end of film cameras. One American video magazine reported Mavica as if it were already on sale. Sony talked about a launch in Japan "sometime in 1983". But it never happened!

Instead Sony did a quiet deal with one of the leading Japanese daily newspapers to field test Mavica electronic cameras. The idea was to let newspaper reporters on location send their pictures back to head office by telephone wire.

The original Mavica was a colour camera but the newspaper version was black-and-white only to offer improved resolution. The last I heard, the field trials were still going on and Sony was planning a big announcement for when the newspaper made a full scale switch to electronic camera work.

So far this has not happened. But I noticed a recent patent from Sony for a multi-coloured ink ribbon for printing Mavica colour pictures onto paper. This is a modification of a printer demonstrated in London in March 1982.

Normally the pictures from an electronic camera are displayed on a TV screen and the screen image can of course be photographed with an instant picture film camera. But there is inevitably loss of definition so they devised a hard copy printer which worked independently of the TV screen.

The electronic image is read out four times, with a thermal printer working over four dye sheets, one at a time. The dye sheets are yellow, magenta, cyan and black. The dye works by sublimation, that is to say it changes from solid to gaseous state when heated and then goes back to solid powder again, without an intermediary liquid stage. The snag with all electronic film photography so far (and virtually every major Japanese company has a system under development) is that definition is limited to well below photographic film level.

Kodak, with most to lose, has made much public noise about this. The company responded to the threat of Mavica by launching the Kodak film disc camera. This works like a dream, making it almost impossible for anyone to take a really dud picture. But unfortunately the picture quality available from the very small film frame is so poor that it undermines the Kodak argument about the benefits of using film rather than electronic storage.

Polaroid has also stuck with film, although, like Kodak, it has professional interests that extend to electronic imaging. As emphasised to me when I visited Polaroid in their Cambridge, Massachussets headquarters recently, the real hurdle is to produce an electronically stored image of photographic film quality on equipment which matches conventional film cameras in price and reliability.

No-one has come anywhere near achieving this aim. It will happen, eventually, but not yet. In the meantime the popular press will continue to proclaim the end of film is nigh. When next you read this, bear in mind some of the hard technical facts.

The Mavica camera records its pictures on a small magnetic disc, looking like a computer floppy. In April 1983 a group of 20 Japanese companies agreed on a standard format for the discs: 47mm in diameter, coated with metal powder and capable of recording either 50 pictures with single field definition or 25 pictures with interlaced full frame quality.

The camera uses a CCD light sensor with 280,000 individual light sensitive elements, under a striped three colour filter. This gives colour resolution of 350 lines, that is to say the camera can resolve 350 separate vertical lines. Resolution is trebled by removing the three colour filter to give a black-and-white image.

The Sony printer could resolve up to 700 lines. Picture quality on screen, and on the hard copy print outs, could best be described as reasonable. The limiting factor was the CCD with its 280,000 individual picture elements.

When I talked with Sony they told me they hoped to raise definition by developing a CCD with 350,000 elements. But even the 280,000 element CCD stretched the technology. When Hitachi launched a video camera (for use with a portable video recorder), which had a solid state sensor instead of a conventional miniature picture tube, it had only 220,000 elements; and it costs more than a similar camera with a conventional tube that offers better resolution.

PERSPECTIVE IMAGES

To put these figures into perspective let's think about what happens when a broadcast quality TV signal is converted into digital code, for instance to enable the use of special effects of the type you see every day on sports broadcasts and pop music promo' films. The technique used is to sample the black and white, or luminance, picture content at 13·5MHz while sampling the two colour component signals at 6·75MHz each.

There is no point in sampling any faster, because the picture is already broken up into individual lines, around 575 of which are active picture lines in the European 625 line system. Each sample is then described in 8-bit words, which means you need around one million 8-bit bytes of memory to freeze just one 625 line TV picture without quality loss.

Sampling at this rate breaks the picture up into around 0·4 million individual picture points or pixels (around 575 picture lines each divided into 720 picture points). So the sampling needed to store a broadcast quality TV picture is far in excess of the sampling available from a CCD sensor.

The unseen part of the equation is that CCD sensors are far more expensive to make than miniature TV tubes. So hard truth number one is that it costs more to get less quality if you use a solid state sensor. Hard truth number two is that the amount of memory needed to capture a TV picture is far in excess of anything currently available at reasonable price.

Although Sony talked only vaguely about the technology used to record Mavica pictures onto disc, the company's engineers did confirm to me that it was stored in analogue format by frequency modulation rather than digital code.

Now let's look at the kind of definition offered by film with silver halide emulsion. Kodak estimates that only a video system with around 2,000 active picture lines can convey all the information available in a frame of 35mm film.

Even this does not solve the problem of contrast, the ratio between lightest and darkest picture content. For film it is around 500:1 and for video it is around 50:1. A single film frame of 35mm film has around 3·5 million silver halide memory elements, each capable of recording blue, green and red light information separately with a range of contrast which is roughly equivalent to a 5-bit digital word. So each frame of 35mm film is a memory for over 50 million bits of information.

Now compare this with a 625 line TV picture, which at very best has around 0·7 million discrete pixels. Compare it also with solid state sensors which still have less than 0·3 million picture elements.

Polaroid makes the same point in a different way. The company says it believes that "silver halide photography will dominate for some years to come".

To prove the point Polaroid points to its new machine for giving magazine and newspaper printers a chance to produce a pre-proof copy of a colour picture stored in digital code on Winchester discs. The storage is achieved by scanning the original photograph in a matrix of 2,000 x 3,000 lines to give a total of 6 million individual picture points or pixels.

Each pixel is then coded into three eight-bit words, one for red, one for green and one for blue. This creates a total data stream for just one photograph of well over 100 million bits.

For printout this data stream is used to control an oscillating light beam. The 100 million bit stream takes around 5 minutes to print out and quality is almost as good as an original photographic picture. But around twice the number of bits would be necessary for no quality loss at all from an original 10 x 8 photo.

Even as it currently stands the Polaroid equipment costs over 100,000 dollars and takes up half a small office. All this to get from an electronic memory store the kind of quality you can get from a single sheet of photographic film!

COST OF QUALITY

As the price of electronic memory plummets and the storage density of magnetic disc rockets, the balance of convenience, cost and quality will change. Bit reduction techniques, as for instance used for teleconferencing to cram the 140 megabits a second needed for moving video into a 2 megabit stream, will also help the trend towards electronic imaging. But the high quality, low cost electronic camera that slips in your pocket is still a long way off.

The low quality, high cost pocket video recorder is however promised for America later this year and for Europe who-knows-when. Earlier this year Kodak announced its intention of selling a camcorder (combined video camera and recorder) that uses the new format of 8mm magnetic tape. The Kodak camcorder will be made by Japanese company Matsushita and a big question mark hangs over its commercial and technical viability.

When I visited Polaroid in Boston I was subjected to three days of the broadest hints imaginable that the company would NOT be following the same route. Less than a week later the company announced that it had signed a deal with Toshiba to do just that! I was left re-writing articles hastily pulled back from the printing presses of several magazines. I shall be *very* wary of anything Polaroid in America tells me in the future.

The 8mm video format is questionable because it comes late on the market, with VHS already the *de facto* world video standard and a very small VHS camcorder already on sale in the US and Japan and promised for the UK about now. The 8mm camcorder price will be high, around £1000, which is far out of the price range of most of Kodak and Polaroid's traditional customers.

Strictly Instrumental

by K. Lenton-Smith

MEMBERS of COS (The Cinema Organ Society) spend a great deal of their time in rescuing and reviving the diminishing number of cinema organs still in existence and will happily travel long distances to hear a well-known organist's recital. Those of us interested in electronic keyboard instruments owe a great debt of gratitude to the near-extinct cinema organ.

CINEMA ORGANS

It is probable that most readers of *PE* will not have experienced hearing a cinema organ played live. The BBC's programme "The Organist Entertains" may give an idea of the scope of the Wurlitzer, Compton and other cinema organs and of the immense skill of the masters of their keyboards but broadcasts and recordings are not to be compared with the "happening" itself.

The cinema organist was an entertainer in the full sense—a showman and not simply a skilled musician able to cope with three or four manuals, pedals and the myriad of controls round his horseshoe console. He even controlled the lighting beamed on him from above (by means of tabs on the console) to suit the particular mood of the music, and the hydraulic ram that brought him up from the pit.

There were no rhythm units in those days but he had a very comprehensive percussion department in the pipe chambers, including piano (at several pitches), chimes, xylophone etc., remotely controlled from his console. Drums and cymbals could be coupled to pedals and manuals—much as they were with electronic instruments 30 years ago.

The cinema organ's original function was to replace the piano accompaniment for silent movies, but eventually became part of the entertainment programme. Many of these instruments had four manuals and, at the height of the era, a seven manual instrument was built for general entertainment.

I suspect that the cinema itself was in its heyday 35 years ago and that the popularity of its organ has run in parallel. Patrons saw two full-length films, newsreel, cartoon, the resident organist gave his recital and there was possibly a stage show as well. All good family stuff—and the films mostly had a happy ending! The cinema catered for complete escapism and even the grand architecture of the picture palace (and indeed they *were* palaces) was geared towards that ideal.

The cinema has suffered in many ways. TV was in existence before the Second World War but viewers were few and it was the BBC's poor relation. Transmissions were halted during the war to avoid presenting the enemy with perfect direction finding facilities. Resumption of the BBC's service, the addition of ITV and eventually colour have tended to make the public seek entertainment in the home. Videotapes have made further inroads in this respect.

Many cinemas were demolished during the Blitz, or so badly damaged that their organs were lost. Those that survived often fell into disrepair and, while the pipework was relatively sound, the electrical circuitry rotted away. These instruments were electrically blown—at fairly high pressure—and wind allowed from wind-chest to pipe by means of pallets operated by pneumatics and solenoids wired to the console. Miles of wire was involved and the flexible cable connected to the rising console was very substantial. Disuse, exposure to the elements and the high cost of an overhaul for the cinema chain resulted in the expiry of many a fine instrument.

Consequently, most of the surviving instruments have become museum pieces and are still operating because of the hard work put in by COS members. To preserve them, whole instruments were dismantled and re-built elsewhere and relatively few cinema organs are still to be found in their original locations. Some are in private houses and public halls and the pipework has been known to find its way into churches—although only part of the tonal arsenal can be used in that situation!

POP MUSIC

The cinema organ's struggle for survival was not only due to old age but also to the public's changing musical taste. Among the junk in the attic, there may be a pile of sheet music inherited from an earlier age. Sixpence may well have bought the score for the latest popular *melody*. Those were the days when music was composed to be played and sung by everyone—big bands, small combos, popular vocalists and those round the family piano.

Apart from being played over the air, these melodies formed the basis for a cinema organ performance—and were exactly what the patrons wanted and expected. The position today is vastly different as pop music is quite often written by a member of a group that records that number for its own popularity. And so the disco is overtaking the dance band.

Melody hardly applies to modern pop music, which seems to emphasise intricate rhythm patterns and often has little melodic content. Vocals are often banal and not in the 'sing-along' category: much of this output will be here today and gone tomorrow. Oh yes, there *are* exceptions, such as the Beatles' compositions. Fortunately we still have a few composers of note—such as Mancini, le Grand and Joabim—who write songs that can be sung and will be remembered.

Musical tastes also changed with the arrival of rock and skiffle, when the guitar suddenly became the centre of interest for aspiring pop fans. Keyboard instruments began to lose favour, especially the family piano; a "sport" at that time was breaking up pianos against the clock.

No wonder the cinema organ fell out of favour. Good tunes were becoming scarce, keyboards were less popular and the lugubrious style of the cinema organ couldn't cope with the new wave of pop music. Many cinema organists gave in as, whilst they could please the mums in the audience, the kids made it plain that this sort of music was not to their liking.

ELECTRIC ORGANS

I hope that COS members will forgive me for concluding that the cinema organ is a musical dinosaur but we should be grateful to that Society because, like the animal species, this dinosaur has evolved.

The Hammond organ was around in the late 1930s, if you could afford one, but was rare in this country. It was offered to the public as an electric organ capable of completely new tones. It sounded unlike the cinema organ, largely due to the early methods of vibrato it used. Some time elapsed before the public took to the electric organ but, because of its portability, gained popularity during the war for outside broadcasts. Jazz performers found its rapid attack useful and even liked the key-click.

The generation that grew up with films with organ recitals were sufficiently hooked to be among the first home-organ owners. The average age of Organ Clubs will support this fact and, as they sit at their 'plug-ins' crunching through 'Spanish Eyes' in the instruction book, they are mentally back in that long-gone picture-palace of their youth, seated at the Mighty Wurlitzer and bathed in purple limelight!

Whereas the finest pipe organs have complete ranks for each stop, cinema organs were usually based on extension principles—and today's electronic instrument follows that principle in general. For a complete 5-octave manual, 61 pipes are required for each stop of a given pitch.

The alternative is extension, where, say, 97 Tibia pipes can be made to cover all pitches between 16' and 2', any 61 being brought into play by a stop tab. Notes were thus 'borrowed' or duplicated liberally: this is noticeable only by the most critical ear, but it did reduce the cost.

The electronic organ with Top Octave Synthesiser and bistable divider strings is also an extension organ. When reverberation and other effects have been added to the signal, it is difficult to hear the shortcomings.

The percussion department of a cinema organ was not limited to drums etc. There were bird whistles, hooters, thunder and other effects—not surprising, as the original task was to accompany films.

Today the percussion or rhythm section probably comprises some eight instrument voices, triggered by a ring counter, all of which were available on a cinema organ. The piano stop today also derives from that source, where a grand piano in the chamber could be played from the console.

The modern electronic counterpart is just as complex because it will probably embody synthesisers (mono- and polyphonic) as well as 'organ tone'. Organ tones of entertainment, as distinct from classical, organs owe their origins to the cinema and basically fall into three categories.

The backbone of the tonal array is the ***Tibia*** (for the classical organ, the Diapason) which comes under the generic group of **Flue** pipes. The pipe itself is of wide scale without much harmonic content and in electronic terms is close to a sine wave. Square waves contain odd harmonics but the output from a bistable divider may be low-pass filtered to remove most of the harmonics.

Selective filtering and mixing will allow some overtones to pass, so that other flues may be produced. Stopped pipes, where the pipe is literally capped so that the pulses of air are bounced back and emerge at the mouth, contain some odd harmonics. Stopped **Flutes** are therefore easily arranged from a square wave source.

The second group form the ***Strings***, the pipes being of smaller scale: the fundamental is weaker and plenty of harmonics exist. If square waves are the starting point, super-octave frequency has to be added to provide even harmonics. By staircasing several octaves together, an almost full harmonic series can be obtained; a high-pass filter will suitably reduce the fundamental. If there is a choice of waveform, sawtooth provides a ready-made full harmonic series.

The last group, ***Reeds,*** is not quite as simple if the correct result is to be obtained. The reed pipe itself actually contains a reed at its base, the pipe in this case simply acting as a resonator. To duplicate the sound, a full harmonic series is treated by band-pass filtering.

It should be emphasised that pipe organ tones were never intended to be replicas of their orchestral counterparts, the Trumpet being a good example. To copy a trumpet reasonably well you need synthesised tones as both portamento and the envelope are adjustable—and these are not really organ facilities.

SPINET

I have visited private houses where cinema organs were installed. For this purpose, you need a large house or a large outbuilding! So the organ has been scaled down over the years. If you are classically inclined, you still need a minimum of two manuals and a 32-note pedalboard. With anything less, you soon run out of notes.

For entertainment purposes, you can get by with far less and the so-called 'Spinet' organ thus came into being: it is lighter, smaller and less expensive. The two manuals are normally shortened to $3\frac{1}{2}$ or 4 octaves each and are offset.

The top manual is the solo and its bottom note around tenor *F* but the addition of a 16′ stop brings it one octave lower. The accompaniment (lower) manual is offset to be one octave below the solo but the lowest pitch available is usually 8′: thus, the lowest frequency is generally the same on both keyboards.

A full size pedalboard is probably too large for most living rooms and most of its compass probably unnecessary for light music. Hence an octave of stub pedals is usually fitted—even so, an expert can do wonders with those '12 sticks'.

NO ABDICATION

The King is Dead—but long live the King of Instruments. He may have changed somewhat, fitted with synthesisers, memories, automatic chords and rhythm units. Some home-organs still feature a horseshoe console and we should remember that the King has sired some related instruments—the electric piano, computer keyboard and polyphonic synthesiser.

So, although nearly extinct, the entertainment pipe organ has set a few precedents in the design of electronic instruments and given many people the opportunity to make music on what is still the most complete and complex of all instruments. We must hope that COS members will continue to preserve those mighty giants so that we can still enjoy hearing them—and venerating them for their contribution to the Art of Electronic Music.

MICRO-BUS

and MICROPROMPT

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

ZX80 TESTS

Sir—The first of my two programs for the ZX80 should be of interest to all ZX80 owners, while the second is mainly of use to students of mathematics and physics. They will run on any memory size.

Program One will test the user's mental arithmetic by firing twenty questions including the four major operations at him. The answer is always a whole number, by design, and after the test you are given your score. If you score eleven or more correctly then you can either finish or have another test; however, if you do not then the program forces another test.

Program Two solves simultaneous equations of three unknowns, and having recently completed my second sixth form year I can recommend the program to any user wishing to check his matrix multiplication solutions of these equations. One merely enters the information requested and the solution is displayed. Remember to enter Ø where no variable exists and don't forget negative coefficients.

Conversion to run on other machines should not cause many problems; however, major modification would have to be performed to RUN either program on a 1K ZX81 (limited memory).

M. J. Davies,
Dyfed.

SOFTWARE

Program 1

```
1Ø RANDOMISE
2Ø PRINT ,“MATHS TEST”
3Ø PRINT “I WILL ASK YOU 2Ø
MATHEMATICS”,“QUESTIONS.
INVOLVING +,–,* OR /.”
4Ø PRINT “ENTER NO. TO ANSWER”
5Ø GO SUB 55Ø
6Ø LET RI=Ø
7Ø FOR G=1 TO 2Ø
8Ø LET R=RND(4)
9Ø CLS
95 PRINT “QUESTION ”;G
1ØØ GO SUB 28Ø+R*4Ø
11Ø PRINT “=?”
12Ø INPUT A$
13Ø LET B$=STR$(B)
135 LET C=Ø
14Ø IF A$=B$ OR (CODE(A$)=22Ø AND
CODE(B$)=18 AND TL$(A$)=TL$(B$))
THEN LET C=–1
15Ø IF C THEN PRINT “CORRECT”
155 IF C THEN LET RI=RI+1
16Ø IF NOT C THEN PRINT
“WRONG . . . ANSWER= ”;B$
17Ø GO SUB 55Ø
18Ø NEXT G
19Ø CLS
2ØØ PRINT “YOU GOT ”;RI;“ RIGHT”
21Ø IF RI=2Ø THEN PRINT
“EXCELLENT”
22Ø IF RI<2Ø AND RI>1Ø THEN PRINT
“NOT BAD”
23Ø IF RI<11 THEN PRINT “YOU NEED
SOME MORE PRACTICE”
24Ø GO SUB 55Ø
25Ø CLS
26Ø IF RI<11 THEN RUN
27Ø PRINT “MORE? (Y/N)”
28Ø INPUT A$
29Ø IF A$=“Y” THEN RUN
3ØØ IF A$=“N” THEN STOP
31Ø GO TO 28Ø
32Ø GO SUB 49Ø
33Ø PRINT A;“+”;B;
34Ø LET B=A+B
35Ø RETURN
36Ø GO SUB 49Ø
37Ø PRINT A;“–”;B;
38Ø LET B=A–B
39Ø RETURN
4ØØ GO SUB 49Ø
41Ø GO SUB 52Ø
42Ø PRINT A;“*”;B;
43ØLET B=A*B
435 RETURN
44Ø GO SUB 49Ø
45Ø GO SUB 52Ø
46Ø LET C=A*B
47Ø PRINT C;“/”;A;
48Ø RETURN
49Ø LET A=RND(1ØØØ)
5ØØ LET B=RND(1ØØØ)
51Ø RETURN
52Ø LET A=A/1Ø
53Ø LET B=B/1Ø
54Ø RETURN
55Ø PRINT “PRESS NEWLINE”
56Ø INPUT A$
57Ø RETURN
READY.
```

Program 2

```
1 LET CH=38
2 GO SUB 57
3 INPUT A
4 GO SUB 57
5 INPUT B
6 GO SUB 57
7 INPUT C
8 GO SUB 57
9 INPUT D
10 GO SUB 57
11 INPUT E
12 GO SUB 57
13 INPUT F
14 GO SUB 57
15 INPUT G
16 GO SUB 57
17 INPUT H
18 GO SUB 57
19 INPUT I
2Ø GO SUB 57
21 INPUT J
22 GO SUB 57
23 INPUT K
24 GO SUB 57
25 INPUT L
26 CLS
27 LET DØ=A*F*K+E*J*C+I*B*G–
C*F*I–G*J*A–K*B*E
28 LET D1=D*G*J+H*K*B+L*C*F–
B*G*L–F*K*D–J*C*H
29 LET D2=D*G*I+H*K*A+L*C*E–
A*G*L–E*K*D–I*C*H
3Ø LET D3=D*F*I+H*J*A+L*B*E–
A*F*L–E*J*D–I*B*H
31 IF DØ=Ø OR D1=Ø OR D2=Ø OR
D3=Ø THEN GO TO 65
32 PRINT “SOLN.:”
33 LET Q=–D1
34 PRINT “X=”;
35 GO SUB 47
36 LET Q=D2
37 PRINT “Y=”;
38 GO SUB 47
39 LET Q=–D3
4Ø PRINT “Z=”;
41 GO SUB 47
42 PRINT “MORE?(Y/N)”
43 INPUT A$
44 IF NOT (A$=“Y” OR A$=“N”) THEN
GO TO 43
45 IF A$=“Y” THEN RUN
46 STOP
47 LET C=Q/DØ
48 LET A=Q–DØ*C
49 PRINT C;“.”;
5Ø FOR B=1 TO 3
51 LET C=1Ø*A/DØ
52 LET A=1Ø*A–C*DØ
53 PRINT C;
54 NEXT B
55 PRINT
56 RETURN
57 CLS
58 PRINT “EQUATIONS WITH 3
UNKNOWNS”
59 PRINT “AX+BY+CZ=D”
6Ø PRINT “EX+FY+GZ=H”
61 PRINT “IX+JY+KZ=L”
62 PRINT “GIVE ”;CHR$(CH)
63 LET CH=CH+1
64 RETURN
65 PRINT “EQUATIONS ARE
INCONSISTENT”
66 GO TO 42
READY.
```

SPECTRUM SECONDS AWAY

Sir—Here is a program for the Spectrum which is basically a seconds counter. However, its main importance to Spectrum owners is the use that can be made of line 35, in view of the fact that there is no SCROLL instruction in the machine's vocabulary.

J. W. H. King,
Cambridge.

```
5 REM “SECONDS COUNTER” and
  “SCROLL CONTROL” for Spectrum.
1Ø LET p=1: PAUSE 48
2Ø PRINT p
3Ø LET p=p+1
35 POKE 23692,2: PAUSE 48
4Ø GO TO 2Ø
5Ø REM This programme COUNTS
   SECONDS. It can be stopped by pressing
   CAPS SHIFT and BREAK. ENTER
   RUN to start.
6Ø REM Line 35 entered in any programme
   before a GOTO line will produce scrolling
   at one line per second.
7Ø REM If entered as POKE 23692,1, it will
   scroll one line at each depression of almost
   any key. POKE 23692,2 without the
   PAUSE will give continuous scrolling at a
   very fast rate.
```

SMALL ADS

The prepaid rate for classified advertisements is 36 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £12.00 per single column centimetre (minimum 2·5 cms). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Banks Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Practical Electronics, Room 2612, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser to check both prices and availability of goods before ordering from non-current issues of the magazine.

RECEIVERS AND COMPONENTS

FREE! Parcel of components worth £10. Send only 80p postage! D. HORSLEY, 113 Clare Road, Braintree, Essex.

BRAND NEW COMPONENTS BY RETURN
Electrolytic Capacitors 16V, 25V, 50V.
0·47, 1·0, 2·2, 4·7 & 10 Mfds. — **5p.** 22 & 47—**6p.** 100—**7p.** (50V—**8p**). 220—**8p.** (50V—**10p**), 470—**11p.** (40V—**16p**), 1000/15V—**15p.** 1000/25V—**25p.** 1000/40V—**35p.** 4700V/25V—**70p.**
Subminiature bead Tantalum electrolytics.
0·1, 0·22, 0·47, 1·0 @ 35V, 4·7 @ 6·3V — **14p.** 2·2/35V, 4·7/25V—**15p.** 10/25V, 15/16V—**20p.** 22/16V, 33/10V, 47/6V, 68/3V & 100/3V—**32p.** 15/25V, 22/25V, 47/10V—**35p.** 47/16V—**80p.**
Subminiature Ceramic Caps. E12 Series 100V. 2% 10 pf. to 47 pf.—**3p.** 56 pf. to 330 pf.—**4p.** 10% 390 pf. to 4700 pf.—**4p.**
Vertical Mounting Ceramic Plate Ceps. 50V. E12 22 pf. to 1000 pf. E6 1500 pf. to 47000 pf.—**2p.**
Polystyrene E12 Series 63V. Horizontal Mntg. 10 pf. to 820 pf.—**3p.** 1000 pf. to 10,000 pf.—**4p.**
Miniature Polyester 250V Vert. Mtg. E6 Series. ·01 to ·068—**4p.** ·1—**5p.** ·15, ·22—**8p.** ·33, ·47—**10p.** ·68 — **12p.** 1·0 — **15p.** 1·5 — **22p.** 2·2 — **24p.**
Mylar (Polyester) Film 100V. Vertical Mounting. ·001, ·0022, ·0047—**3p.** ·01, ·022—**4p.** ·04, ·05, 0·1—**5p.**
High Stability Miniature Film Resistors 5%.
¼W E24 Series 0.51R – 10M0. — **1p.**
¼W E12 Series 1R0 to 10M0. — **1½p.**
1W E12 Series 10R to 10M0. — **5p.**
¼W metal film E12 Series 10R-1M0. 5% – **2p.** 1%-E24 – **3p.**
1N4148—**2p.** 1N4002—**4p.** 1N4006—**6p.** 1N4007—**7p.** BC107/8/9—**12p.** BC147/8/9, BC157/8/9, BF195 & 7—**10p.** 8 Pin i.c's. 741 Op. amp.—**18p.** 555 Timer—**24p.** Dil Holders 8 pin—**9p.** 14 pin—**12p.** 16 pin—**14p.** LED's. 3 & 5mm. Red—**10p.** Green & Yellow—**14p.** Grommets for 3mm.—**1½p.** Grommets for 5mm—**2p.** 20mm. Q.B. Fuses ·15, ·25, ·5, 1, 2, 3 & 5A—**5p.** 20mm. Anti Surge 100mA to 5·0A—**8p.** 20mm. Fuseholders P.C. or Chassis Mtg.—**8p.** Battery Snaps (pairs) PP3—**8p.** PP9—**12p.** 400mW Zener diodes E24 series 2V7 to 33V—**8p.**
Prices VAT inclusive Post 20p. (Free over £5.00).
THE C.R. SUPPLY CO.
127, Chesterfield Rd., Sheffield S8 0RN.

FIFTY 74 SERIES I.Cs on panel £2.20. Assorted components £5.00/£6.50 7lbs or 10lbs post paid. J. W. BLANSHARD, 2 Barnfield Crescent, Sale, Cheshire M33 1NL.

RESISTOR PACKS FOR ALL PROJECTS
¼ watt carbon film resistors 5% 1 ohm to 10M E24 series. Packs of 10 each value (1690 resistors) **£10.00.** Your choice of quantities/values 125 for **£1.00.** VAT and Post Free.
GORDON HALLETT
20 Bull Lane, Maiden Newton, Dorchester, Dorset DT2 0BQ.

BOURNEMOUTH/BOSCOMBE. Electronic components specialists for 33 years. FORRESTERS (NATIONAL RADIO SUPPLIES), Late Holdenhurst Road. Now at 36, Ashley Road, Boscombe. Tel. 302204. Closed Weds.

TURN YOUR SURPLUS capacitors, transistors, etc into cash. Contact COLES HARDING & CO., 103 South Brink, Wisbech, Cambs. Tel. 0945 584188. Immediate settlement.

SERVICE SHEETS

BELLS TELEVISION SERVICES for service sheets of Radio, TV, etc £1.50 plus SAE. Colour TV Service Manuals on request. SAE with enquiries to B.T.S., 190 Kings Road, Harrogate, N. Yorkshire. Tel. (0423) 55885.

SOFTWARE

UK101 SOFTWARE ON TAPE
from the guy who wrote "Le Passe-Temps"
GALACTIC HITCHHIKER (8K). An adventure, all in machine code. A beauty! **(£7.00)**
SUPERTREK (8K). Sail boldly through the universe zap-ping moving Klingons in real time. Superb graphics. **(£7.00)**
STARTREK (8K). The old favourite, beautifully presented. **(£6.00)**
LUNAR LANDER. A real challenge. You won't get down in less than 3 hours. **(£3.00)**
HANGMAN. Excellent graphics. P.E. said so! **(£3.00)**
BASIC TUTOR (8×4K). The only way to learn – at the keyboard. **(£12.00)**
LE PASSE-TEMPS. You NEED this, if you haven't already got it. **(£3.00)**
MAD MONK (8K). It's ready at last! A machine code adventure with some truly remarkable graphics, this programme is in a class by itself. **(£9.50)**
These ORIGINAL PROGRAMS are compatible all 2K Monitors and are available for 16×48 and 32×48 displays (including enhanced Superboards).
HARDWARE
These kits are complete in every way:- Fuly socketed high quality PCB, all components, switches etc, plus preformed cable assembly for easy interconnection to J1, or our . . .
MOTHERBOARD SYSTEM. Now you can add on all those extras easily. Provides eight, yes EIGHT, fully buffered J1 type sockets. **(£19.50)**
8K STATIC RAM BOARD. (£39.50)
HI-SPEED CASSETTE INTERFACE. At last, a system that works. COMPLETELY RELIABLE 4000 baud (8000 with reasonable cassette) plus software for named file handling. A delight to use. **(£19.50).** For software in EPROM, add **£6.00.**
VIDEO ENHANCEMENT. Switch selectable 16×48 or 32×48 displays without butchering your computer. **(£19.50)**
Monitor EPROMS re-blown to suit for just **£2.50**
8K EPROM BOARD (£19.50). A 2K Extended Monitor is available in EPROM for £12.00 plus, coming soon, **TOOLKIT** in EPROM and BASIC V.
MONITOR BOARD. Plug into Monitor socket to provide switch selection of up to 4 EPROMS. **(£9.50)**
All inclusive prices – absolutely no hidden extras.
Please write or phone for further details:
KNIGHT SOFTWARE,
93a High Street, Eston, Cleveland TS6 9JD. Tel: (0642) 454883.

FOR SALE

PHILIPS DIGITAL MULTIMETER PM 2521. Cost £365, accept £250 with operating manual. Tel. 0704 31153.

BOOKS AND PUBLICATIONS

FULL SIZE, top quality service sheets £2.50 + l.s.a.e. CTV/Music Centres £3.50 + l.s.a.e. Repair data almost any named TV-Video £10.50 inc. circuits. L.s.a.e. brings any quote free magazine/price lists. TISPE, 76 Churches, Larkhall, Lanarkshire. 0698 883334.

COURSES

FULL-TIME TRAINING COURSES

15 MONTHS
B-TEC NATIONAL CERTIFICATE in TELEVISION & VIDEO SERVICING

15 MONTHS
B-TEC NATIONAL CERTIFICATE in COMPUTING TECHNOLOGY

9 MONTHS
B-TEC HIGHER CERT (HNC) in COMPUTING TECHNOLOGY & ROBOTICS

- PRINCIPLES OF ELECTRONICS
- TELEVISION (MONO/COLOUR)
- VIDEO CASSETTE RECORDERS & CCTV
- COMPUTERS & MICROPROCESSORS
- INDUSTRIAL ROBOTICS

Short courses (from 6 weeks) with previous electronics knowledge.

Courses commence Jan '85, April '85, September '85.

Prospectus from:

LONDON ELECTRONICS COLLEGE

Dept: AA, 20 Penywern Road, London SW5 9SU. Tel: 01-373 8721.

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of Practical Electronics for ....

insertions. I enclose Cheque/P.O. for £..........

(Cheques and Postal Orders should be crossed Lloyds Bank Ltd. and made payable to Practical Electronics)

NAME ....

ADDRESS ....

....

....

PRACTICAL ELECTRONICS
Classified Advertisement Dept., Room 2612, King's Reach Tower, Stamford Street, London SE1 9LS. Telephone 01-261 5846
Rate:
36p per word, minimum 12 words. Box No. **60p** extra.

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS. 1/85

TUITION

IMPROVE YOUR PROSPECTS

with skills that employers want – learn the easy way with modern home study courses from Ideal Schools.

MODERN ELECTRONICS
Train for success in the fastest ever growing industrial sector.

COMPUTER PROGRAMMING
The demand for Programmers is increasing constantly – don't miss out!

For free booklet write today to

IDEAL

IDEAL SCHOOLS
(Ref. PE2)
60 St. Enoch Sq
Glasgow G1 UK.
Tel: 041-248 5200

HOME SECURITY

SECURITY Alarm Systems

FREE COMPREHENSIVE CATALOGUE!

- *LOWEST DISCOUNT PRICES*
- *HIGHEST QUALITY EQUIPMENT*
- *FREE DIY DESIGN GUIDE*
- *FULLY ILLUSTRATED*
- *MICROCHIP CIRCUITRY*
- *QUICK DESPATCH SERVICE*
- *FULL INSTRUCTIONS*

SEND SAE OR PHONE

C-TEC SECURITY, Dept PW
60 Market St, Wigan WN1 1HX
Telephone (0942) 42444

Trade Enquires Welcome

CENTURION® ALARMS

Manufacturers of Professional Alarm Equipment, for **DIY** & the **TRADE**. Send now for our New 16-page Brochure, Full of **Information** & the **Lowest prices.**

Tel: (0484)
21000
or 35527 24 hr.

CENTURION Dept PE
93 Wakefield Road,
Huddersfield.
HD5 9AB
W. Yorks.

® "CENTURION" is a Registered Trademark of Centurion Alarms

WHO CAN PUT A PRICE ON PEACE OF MIND

PROFESSIONAL EQUIPMENT AT LOW! LOW! PRICES.

HOME SECURITY IS NOW AVAILABLE AT TRADE PRICES

ADVANCED SECURITY PRODUCTS LTD
2 Ealing Road, Aintree,
Liverpool L9 0HU, Merseyside.
Tel: 051-525 3440

FREE CATALOGUE PHONE OR S.A.E.

SERVICES

INVENTORS

Think of something new?
Write it down!–

American industry offers potential royalties for your innovations and new products. We offer free confidential disclosure registration and initial consultation in London regarding your idea's potential value. Write without delay for your free information package.

American Inventors Corporation
82, Broad Street, Dept PT
Westfield, Massachusetts 01086
United States of America.

A fee based marketing company.

MISCELLANEOUS

SUPERB INSTRUMENT CASES by Bazelli, manufactured from PVC. Faced steel. Vast range, competitive prices start at a low £1.50. Punching facilities at very competitive prices. BAZELLI, (Dept. 23), St. Wilfreds, Foundry Lane, Halton, Lancaster LA2 6LT.

ADAPTORS – Power supplies for calculators, TV games, computers etc. Send for details. RTE ELECTRONICS, Britania Mill, Rossendale, Lancs. BB4 8BA.

HEATHKIT. U.K. spares and service centre. CEDAR ELECTRONICS, Unit 12, Station Drive, Bredon, Tewkesbury, Glos. Tel. (0684) 73127.

TERMINET PRINTER RS232. Working £70.00. Everyday Electronics No. 1 to Vol. 9 £20.00. Buyer collects. Tel. 01-651 4885.

CLEARING LABORATORY, scopes, generators, P.S.U.'s, bridges, analysers, meters, recorders etc. Tel. 0403-76236.

BURGLAR ALARM EQUIPMENT. Ring Bradford (0274) 308920 for our catalogue or call at our large showroom, opposite Odsal Stadium.

THE SCIENTIFIC WIRE COMPANY
811 Forest Road, London E17. Telephone 01-531 1568

SWG	1 lb	8 oz	4 oz	2 oz
ENAMELLED COPPER WIRE				
8 to 34	3.63	2.09	1.10	0.88
35 to 39	3.82	2.31	1.27	0.93
40 to 43	6.00	3.20	2.25	1.61
44 to 47	8.67	5.80	3.49	2.75
48	15.96	9.58	6.38	3.69
SILVER PLATED COPPER WIRE				
14 to 30	9.09	5.20	2.93	1.97
TINNED COPPER WIRE				
14 to 30	3.97	2.41	1.39	0.94
Fluxcore Solder	5.90	3.25	1.82	0.94

Prices include P&P VAT. Orders under £2 add 20p.
SAE for list of copper and resistance wire.
Dealer enquiries welcome.

NEW AND SURPLUS components and equipment now in stock. Also amateur F.M. and T.V. aerials, and a complete range of burglar alarm equipment. Write or phone for price list: SPECTRUM RADIO & ELECTRONICS LTD, 36 Slater Street, Liverpool L1 4BX. 051 709 4628.

ELECTRONIC ORGAN KEYBOARDS and other parts being cleared out as special offer. ELVINS ELECTRONIC MUSICAL INSTRUMENTS, 40a Dalston Lane, London E8. Tel. 01-986 8455.

CABINET FITTINGS

Fretcloths, Coverings, Handles, Castors, Flight Case Locks & Parts, Jacks, XLRs, Bulgins, Reverb Trays, P & N mic Stands, ASS Glassfibre Horns. CELESTION POWER Speakers.

ADAM HALL SUPPLIES LTD.

Send 30p cheque/ P.O. for illustrated catalogue: Adam Hall (PE Supplies), Unit G, Carlton Court, Grainger Road, Southend-on-Sea.

leader of the Packs

AC/DC COMPONENT PACKS

Pack No.	Qty	Description	Price
TF 11	12	RED 5mm LED	£1.00
TF 12	30	500mz ZENERS 5%	£1.00
TF 15	50	1 amp Rect. Diodes in 4000 series	£1.00
TF 16	6	1 amp Bridge Rect.	£1.00
TF 17	100	Transistor pads	£1.00
TF 18	20	A/S Fuses 20mm	£1.00
TF 19	10	3A Rect. Diodes	£1.00
TF 110	2	ORP 12	£1.00
TF 111	5	BR 100 DIAC	£1.00
TF 112	10	BC109B	£1.00
TF 113	10	LC's all different	£1.00
TF 114	50	BFR 86	£1.00
TF 115	12	8 pin DIL sockets	£1.00
TF 116	20	10mm Horiz. Pre set (10 values)	£1.00
TF 117	10	Slide Pots – 3K all the same	£1.00
TF 118	10	Mixed Pots	£1.00
TF 119	10	Feed throughs	£1.00
TF 120	25	Electrolytic Caps	£1.00
TF 121	50	Polyester Caps	£1.00
TF 122	100	Mixed Resistors – Incl. Wire Wound	£1.00
TF 123	100	Mixed Transistor Hardware	£1.00
TF 124	25	5mm LED clips and rings	£1.00
TF 125	10	BC 107	£1.00
TF 126	10	BC 108	£1.00
TF 127	6	Green 5mm LED	£1.00
TF 128	6	Yellow 5mm LED	£1.00
TF 129	150 approx.	Mixed nuts/bolts/washers/ self tapper	£1.00
TF 130	25	Mixed Electrolytics Axial	£1.00
TF 131	25	Mixed Electrolytics Radial	£1.00
TF 132	50	Mixed Polyester Axial	£1.00
TF 133	50	Mixed Polyester Radial	£1.00
TF 134	15	BC 337	£1.00
TF 135	20	500MA A/S 20mm Fuse	£1.00
TF 136	50	Mixed Ceramic Discs	£1.00
TF 137	50	Mixed Ceramic Plates	£1.00
TF 21	200	47 pf 160V Polystone Cap	£2.00
TF 22	10	LM 3900 N	£2.00
TF 23	10	Mixed DTL	£2.00
TF 24	5	4700 mf 25V Tag Elect 2" × 1"	£2.00
TF 25	10	1000 mf 63V Ax Elect	£2.00
TF 26	50	.022 mf 400V RAD POLY	£2.00
TF 27	10	100 mf 250V Ax	£2.00
TF 28	10	2.2 mf 160V Polyester RAD	£2.00
TF 29	10	VDR's	£2.00
TF 210	10	Mixed TTL (74 series)	£2.00
TF 211	4	2N 3055 H(RCA)	£2.00
TF 213	200	IN 4151 Diodes	£2.00
TF 214	200	IN 4148 Diodes	£2.00
TF 51	100	White/Red 5mm LED	£5.00
TF 52	50	BC 108C	£5.00
TF 53	2	10,000 mf 63V Comp. grade	£5.00
TF 54	½KG	Reel 22g ersin multicore	£5.00
TF 55	10	2N3055 H(RCA)	£5.00
TF 56	5	OCP71	£5.00
TF 57	3	10,000 mf 40V Comp. grade elect	£5.00
TF 58	720	¼W Carbon film 1Ω–10MΩ ten values	£5.00

ALL PRICES INCLUDE VAT – ALL GOODS BRAND NEW & NORMALLY DESPATCHED BY RETURN POST.
TERMS: Cash with order. POST & PACKING: Please add 75p to total order.

AC/DC ELECTRONICS COMPONENTS

DEPT P.E., 45 CHURCH STREET, ENFIELD, MIDDLESEX.

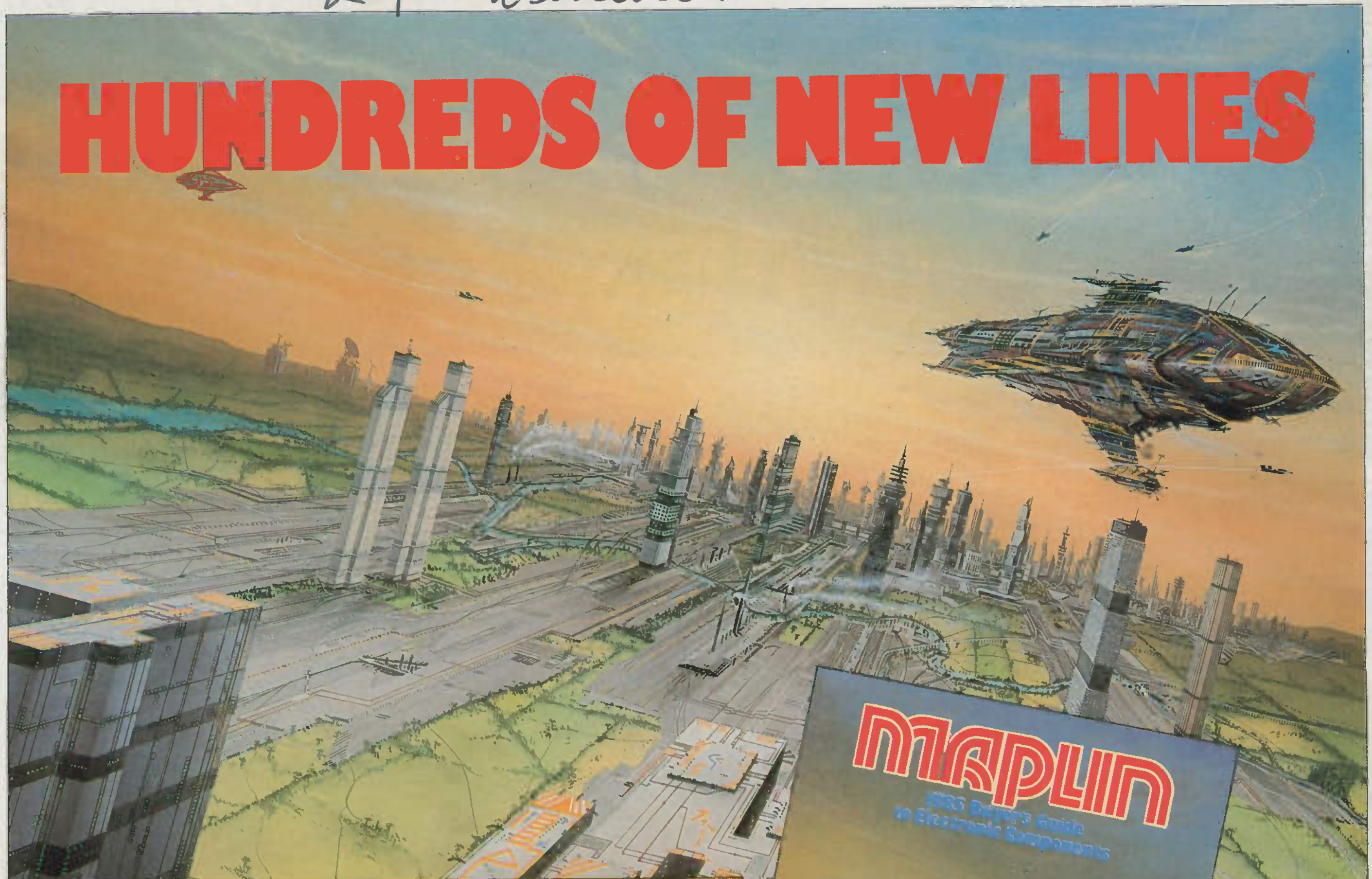
INDEX TO ADVERTISERS

Published approximately the third Friday of each month by IPC Magazines Ltd., King's Reach Tower, Stamford St., London SE1 9LS. Printed in England by McCorquodale Magazines Ltd., Andover, Hants. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/sia) Ltd.; South Africa—Central News Agency Ltd. Subscriptions: Inland £12.00, Overseas £13.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated conditon or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.


Have you one of these?
BBC * COMMODORE 64
DRAGON * VIC 20
ORIC 1/ATMOS
ATARI 400/800
SPECTRUM * ZX81
Then you need one of these
Best Guide to Microcomputer Software
SOFTWARE INDEX
1984 No. 5 £1.50
Now with 5,000 programs
more educational, games, business & personal management listings than ever before!
ON SALE NOW!

29 Windsor

HUNDREDS OF NEW LINES



The amazing Maplin Catalogue is here again! The new edition is packed with hundreds and hundreds of new electronic components to bring you right up to date with all the latest developments. As all home constructors agree (and a good many professionals too) the Maplin Catalogue is the one essential piece of equipment they really need. And now with all our **prices on the page** the Maplin Catalogue is better value than ever.

On Sale From 10th November 1984.

Pick up a copy as soon as it's published at any branch of W.H. Smith or in one of our shops. The price is still just £1.35, or £1.75 by post from our Rayleigh address (quote CA02C).

Post this coupon now for your copy of the 1985 catalogue.
Price £1.35 + 40p post and packing. If you live outside the U.K. send £2.40 or 11 International Reply Coupons.
I enclose £1.75.

Name ....

Address ....

....

.... PE1/85

MAPLIN
ELECTRONIC SUPPLIES LTD

Maplin Electronic Supplies Ltd. Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR.
Tel: Southend (0702) 552911. •Shops at: 159-161 King Street, Hammersmith, London W6. Tel: 01-748 0926. •8 Oxford Road, Manchester. Tel: 061-236 0281.
•Lynton Square, Perry Barr, Birmingham. Tel: 021-356 7292.
•282-284 London Road, Westcliff-on-Sea, Essex. Tel: 0702-554000.
•46-48 Bevois Valley Road, Southampton. Tel: 0703-25831. All shops closed all day Monday.