

PRACTICAL

ELECTRONICS

DECEMBER 1982

Australia \$1.35 Malaysia \$4.95 IR £1.26 (inc. VAT)

85p

PE

Micrograsp



Stylochord

Also... **MICRO-FILE Pull-out**
MICROPROCESSOR DATA

**ELECTRONIC
HOBBIES FAIR**

50p Coupon Inside

POWER PACKED — by POWERTRAN

Powertran's black boxes are packed with punch. Not only are they superb kits to buy and build they really do the job! Imaginative and ingenious design goes hand in hand with top quality materials and outstanding performance capability. With their smart black styling the kits harmonise visually as well as musically. You can build each unit independently for its set task and then gradually increase your array until you have a complete bank of formidable controllable power.

THE FIRST
WORDS AND
THE LAST
WORD IN
ELECTRONIC
KITS



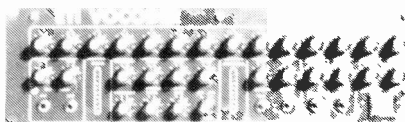
Complete Kit — £49.90 + VAT

MPA 200 — is a low price, high power 100W amplifier. Its smart styling, professional appearance and performance, make it one of our most popular designs. Adaptable inputs mixer accepts a variety of sources yet straightforward construction makes it ideal for the first-time builder.



Complete Kit — £49.50 + VAT

Chromatque 5000 — a 5-channel lighting system powerful enough for professional discos yet controllable for home-effects. Sound to light, strobe to music level, random or sequential effects — each channel can handle up to 500W yet minimal wiring is needed with our unique single board design.



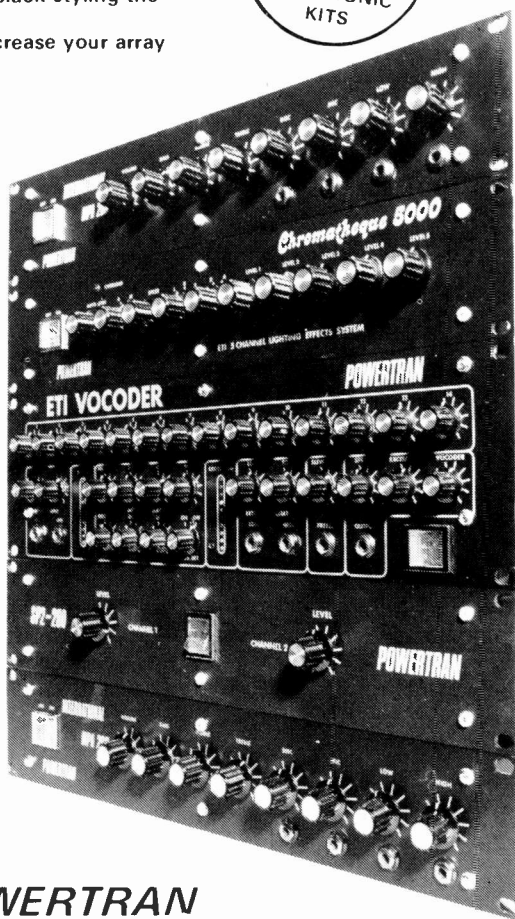
Complete Kit — £175.00 + VAT

ETI Vocoder — 14 channels, each with independent level control, for maximum versatility and intelligibility, two input amplifiers — speech/external — each with level and tone control. The Vocoder is a powerful yet flexible machine that is interesting to build and, thanks to our easy to follow construction manual, is within the capability of most enthusiasts.

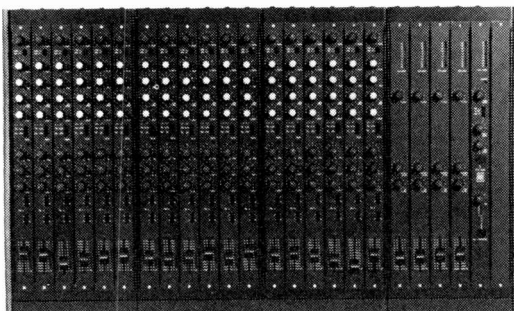


Complete Kit — £64.90 + VAT

SP2 2000 — twice the power with two of the reliable, durable and economic amps from the MPA 200, fed by separate power supplies from a common toroidal transformer. Superb finish and quality components throughout — up to (even over!) the standard of high priced factory-built units.



STOP PRESS: NEW FROM POWERTRAN DESTINY Modular Mixer AS BEING FEATURED IN THIS MAGAZINE!



This versatile modular mixer, featured as a constructional article in this magazine can be built up to a maximum of 24 inputs, 4 outputs and an auxiliary channel. Each input channel has Mic and Line inputs, variable gain, bass and treble controls and a parametric middle frequency equalizer. There are send and return jacks, auxiliary, pan and fader controls and output group switching. The output channels have PPM displays and record and studio outputs. The auxiliary channel also has a PPM display and there is a headphone monitor jack and a built-in talk-back microphone. The mixer modules plug into base units each of which takes up to 6 channels. To eliminate hum, the power supply is in a separate cabinet.

Kit Prices:			
Input channel	£19.90	Base unit and wooden front	£27.50
Output channel	£18.50	Pair of mahogany end cheeks	£12.50
Auxiliary channel	£22.50	Power Supply and cabinet	£19.50
Blank Panel	£3.00	All prices are VAT exclusive	

.... Quite simply the best way to make music



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

PRICE STABILITY: Order with confidence. Irrespective of any prices changes we will honour all prices in this advertisement until Jan. 31st 1983. If this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.

U.K. ORDERS: Subject to 15% surcharge for VAT. No charge is made for carriage, or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit. FREE ON ORDERS OVER £100.

SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m.-12 noon, 1-4.30 p.m. Monday-Friday.



MORE SUPERB KITS IN OUR
CATALOGUE



PRACTICAL ELECTRONICS

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P.S.U., Disbug and 6800 programming	

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SPECIAL SUPPLEMENT

MICRO-FILE by <i>R. W. Coles</i>	between pages 42 & 43
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OUR JANUARY ISSUE WILL BE ON SALE FRIDAY, DECEMBER 10th, 1982
(for details of contents see page 66)

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Practical Electronics December 1982

SPEAKERS

BQ. 0.3W. 2". 2.25". 2.5". 3". 80p

0.3W. 2.5" 40Q. 64Q or 80Q 80p

DIODES

AA119	15	1A 100V	18
AA129	20	1A 100V	25
AA130	15	1A 100V	25
BA100	15	1A 100V	25
BA130	24	1A 100V	25
BY100	24	1A 100V	25
BY126	12	1A 100V	34
BY127	12	2A 50V	30
CR033	250	2A 200V	46
CR033	40	2A 400V	46
OA47	12	2A 600V	65
OA70	12	6A 100V	83
OA79	15	6A 100V	95
OA81	20	6A 100V	95
OA85	15	10A 200V	215
OA90	15	10A 600V	298
OA91	8	25A 200V	240
OA95	8	25A 600V	395
OA200	8	BY164	56
OA202	8	VM18	50
IN914	4		
IN916	4		
1N4001/2	5		
1N4003	6		
1N4004/5	6		
1N4006/7	6		
1N4148	4		
1N5401	15		
1N5404	16		
1N5406	17		
1N5408	19		
1S44	9		
1S921	4		
6A100V	40		
6A400V	50		
6A800V	65		
Noise Diode	25J		195

SCR's

Thyristors

0.8A-100V	32	3A 100V	48
5A/300V	38	3A 800V	55
5A/400V	40	3A 100V	60
5A/600V	48	8A 400V	69
8A/300V	68	8A 800V	115
8A/600V	95	12A 100V	78
12A/100V	78	12A 400V	82
12A/400V	95	12A 800V	135
12A/800V	188	16A 100V	103
BT108	150	16A 400V	105
BT116	180	16A 800V	180
CI068	38	25A 400V	185
TIC44	24	25A 800V	295
TIC45	29	25A 100V	295
TIC47	35	30A 400V	480
2N5062	32	30A 400V	480
2N5064	38	12A 800V	120
2N4444	130		

DIAC

ST2 25 100 70p 500 325p

OPTO ELECTRONICS

LEDs including Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	12
TIL220 2" Red	14
2" Yel. Grn. Amber	14
Rectangular LEDs with two part clip. R. G & Y	18
Rectangl. Stackable LEDs	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	55
0.2" Bi colour LEDs	59
Red/Green	65
Green/Yellow	80
0.2" Tri colour LEDs	85
Red/Green/Yellow	85
0.2" Infra Red Bright	25
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	82
TIL8	82
TIL100	82

0.5" LIQUID CRYSTAL DISPLAYS

3 1/2 digit	495
4 digit	530
6 digit	625

8PX21

8PX21	195
8PW21	295
8PX65	270
IL74	45
IL74	99
ILQ74	185
TIL111	75
OC7P1	120
ORP12	78
ORP81	85
2N577	85
4N33	135

OPTO SWITCH

52 Reflective	118
TIL139	170
54 Slotted similar	170
10 RS	186

ALUM. BOXES

3x2x1	65
4x2x1	85
4x2x2	103
4x4x2	120
5x4x2	105
5x2x1	90
5x2x2	130
5x4x1	99
5x4x2	120
6x4x2	120
6x4x3	150
7x5x3	180
8x6x3	210
10x4x1	240
10x7x3	275
12x5x3	260
12x8x3	295

7 Segment Displays

TIL322 5" C.A.	115
TIL322 5" C.Ch	115
DL704 3" C.Ch	99
DL707 3" C.A.	99
FND357 or 500	120
3" Green C.A.	140
±1 3" Red or Green	150
Bargraph 10 seg.	225
Bargraph NSM3914	500

FERRICHLORIDE

1lb bag Anodup 15p

1lb bag 50pp&p

DALOETCH RESIST

Pen - Spare tip 90p

COPPER CLAD BOARDS

Fibre Single	Double	SRBP
6"x6"	90p	110p
6"x12"	150p	195p

VERO BOARDS

1" VQ Board	180
2"x3 1/2" Clad	374
2"x3 1/2" Plain	144
2"x5" C.C.H	91p
3"x3 1/2" C.C.H	91p
3"x5" 105p	87p
3"x7 1/2" 360p	232p
4"x18" 470p	
Pkt. of 100 pins	50p
Spot Face Cutter	135p
Pin Insertion Tool	178p

VERO WIRING PEN and Spool

Spare Wire (Spool) 75p

Wire Wrapping Stakes 100

SPECIAL OFFER

2114L-2 90p 2532 350p 2716 215p 2732 350p 4116 85p 4816-100ns 225p 6116-150ns 290p 6520/21 115p 6522 300p 6820/6821 100p

PRINTERS

● **MX80T** 10" Tractor Feed, 9x9 matrix, 80 column, 80 CPS, Bi-directional, Centronic Interface. Baud Rate 110-9600. £275

● **MX80FT/3** Tractor & Friction feed. Has hi-resolution, bit image graphics, Subscript & Superscript, italics & underlining facility plus all the MX80FT features. £325

● **NEC PC-8023BE-C**, 100CPS bi-directional, logic seeking, 80 column, 7x9 Dot matrix, super/subscript, underlining, true decoders Tractor/Friction, Hi-Res, 2K Buffer, Proportional Spacing, at a Special Price £295

ANTEX Soldering Irons

C15W	450
CC17W	475
CXN15W	490
X25W	500

Spare bits 85

Elements 210

Iron stands 165

Heat Shunt 30

ASTECUHF MODULATORS

6MHz 280p

8MHz Wide 280p

Bandwidth 425p

ULTRASONIC TRANSDUCERS

40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS

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

ZIF DIL SOCKET

16 way	475p
24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

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

RIBBON CABLE

Ways	Price per foot
10	12p
20	25p
20	25p
26	35p
34	48p
40	55p
60	75p

'D' CONNECTORS:

Miniature

Pins	9	15	25	37
Male	80p	110p	160p	240p
Female	150p	210p	250p	350p
Strait	170p	160p	220p	310p
Strait	105p	160p	200p	338p
Strait	165p	215p	290p	440p
Strait	175p	200p	300p	420p

COVERS Top & Side Entry

95p 90p 100p 110p

IDC 25 way Pin 385p, Skt. 450p

Amphenol Plugs

24 way	156p
2x10 way	135p
2x15 way	140p
2x18 way	180p
2x22 way	199p
2x23 way	210p
2x25 way	225p
2x28 way	210p
2x30 way	235p
2x36 way	315p
2x40 way	315p
2x43 way	395p
2x75 way	550p

EDGE CONNECTORS

Two rows

24 way	156p
2x10 way	135p
2x15 way	140p
2x18 way	180p
2x22 way	199p
2x23 way	210p
2x25 way	225p
2x28 way	210p
2x30 way	235p
2x36 way	315p
2x40 way	315p
2x43 way	395p
2x75 way	550p

JUMPER LEADS

Ribbon Cable Assembly

DIL Plug (Headers)

Single Ended Lead, 24" long

Length	14pin	16pin	24pin	40pin
24"	145p	165p	240p	380p

Double Ended Leads:

Length	14pin	16pin	24pin	40pin
12"	185p	205p	300p	485p
18"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

ID HEADER SOCKET Jumper Leads 24"

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

COMPUTER CORNER

● **EPSON MX Series Printers.** Full range available. See box above for details.

● **SEIKOSHA GP100A** - Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. FREE 500 Sheets £175

● **EPSON HX20** Microcomputer. Portable, Full size Keyboard, LCD Virtual Screen, 5x7 Dot Matrix Printer incorporated £1299

● **SOFTY-2.** The complete Microprocessor development system. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built & tested. Price includes plug-in PSU, Watford's extended warranty & a FREE 2732. £169

● **WEMON.** Watford's 3K Ultimate Monitor IC for Superboard & UK101. £10

● **VIDEO MONITOR 9"** fully cased. B&W. Fully guaranteed. 15MHz bandwidth value for money. £69

● **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. £33

● **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. £43

● **Spare UV lamp bulbs** £9

● **5V/5A PSU** Ready built and tested £25

● **MULTIRAIL PSU KIT.** Output: +5V/5A; +12V; +25V; -5V; -12V @ 1A. £40

● **Attractive Beige/Brown ABS CASE** for Superboard/UK101 or Home Brew £29

● **Full ASC11** coded keyboard type '756' £39

● **4 x 4 matrix keypad** (reed switch assembly) £4

● **C12 COMPUTER Grade Cassettes** in Library Cases 40p

● **STACK-PACK.** Unique 10 section stackable Drawers rack including 10 x C12 Computer grade Cassettes. 550p

● **8" Fan fold paper** (1000 sheets) (no VAT) £7

● **9 1/2" Fan fold paper** (1000 sheets) (no VAT) £7

● **Teleprinter Roll** (no VAT) £3.50

(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.

VOLTAGE REGULATORS

1A	T03	+ve	-ve	220p
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		

1A T0220 Plastic Casing

5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		

100mA T092 Plastic Casing

5V	78L05	30p	79L05	60p
6V	78L6	30p		
8V	78L8	30p		
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H 170 LM305H 140 LM304H 160 LM309H 135 LM305 5V/5A 550 LM317K 320 LM3712 12V/5A 580 LM317P 99 LM378-5 10 LM323K 500 LM378-5 10 LM337T 175 LM378-5 10 LM723 35 LM378-5 10 LM723 35 LM378-5 10 LM723 35

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
1A DP on/on/off	40
4 pole d/c over	240

PUSH BUTTON

Spring loaded

Latching or Momentary 6A

SPDT c/c over 99

OPDT c/c over 145

SUB-MIN TOGGLE

SP changeover 60

SPST on/off 54

SPST c/c over 85

SPDT Biased 105

DPDT 6 wags 75

OPDT c/c over 88

DPDT on/on/off 185

DPDT Biased 145

3 pole c/c over 205

ROCKER: 5A 250V SPST 28p

ROCKER: 10A 250V SPST 28p

ROCKER: With neon lights red when on 85p

ROCKER: (White) 10A 250V DPDT 72p

ROTARY: Make your own Multiway Switch Shifting Assembly accommodates up to 6 wafers 90p

Break before make Wafers. Silver contacts

1 pole 12 way, 2 pole 6 way, 3 pole 4 way, 4 pole 3 way, 6 pole 2 way 45p

Mains DPST Switch to fit Screen & Spacers 6p

ROTARY: (Adjustable Stop Type)

1 pole 2 to 12 way, 2 pole 2 to 6 way, 3 pole 2 to 4 way, 4 pole 2 to 3 way 45p

ROTARY: Mains 250V AC 4 Amp 56p

DIL SWITCHES: (SPST)

4 way 65p

6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p

THUMBWHEEL

Mini front mounting

Decade Switch Module 250p

B.C.D. Switch Module 275p

Mounting Cheeks (pair) 75p

PROXIMITY Switch with magnet 125p

CRYSTALS

3.576KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1.068MHz	392
1.8MHz	275
1.5MHz	420
1.6MHz	395
1.8MHz	395
1.8432M	200
2.4576M	225
2.5MHz	225
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032M	290
4.194304M	200
4.433619M	100
4.608MHz	200
4.8MHz	200
5.0MHz	175
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
8.8333M	395
8.86727M	175
9.00MHz	200
9.375MHz	375
10.0MHz	150
10.5MHz	250
10.7MHz	150
10.24MHz	200
12.0MHz	175
12.58MHz	300
14.31818M	170
14.765MHz	250
15.0MHz	200
16.0MHz	180
18.432M	150
19.68MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
26.670MHz	325
27.125MHz	295
27.45M	190
27.648MHz	330
38.66667M	175
48.0MHz	175
55.5MHz	400
100.0MHz	375
116.0MHz	300
145.8MHz	225

SPECIAL OFFER

TEX EPROM ERASER with SAFETY Switch £35

Electroni Solid-State TIMER for above £12

BBC MICRO UPGRADE KITS

Upgrade your BBC Micro with our upgrade kit and save yourself £ s s s . . .

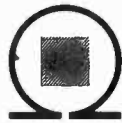
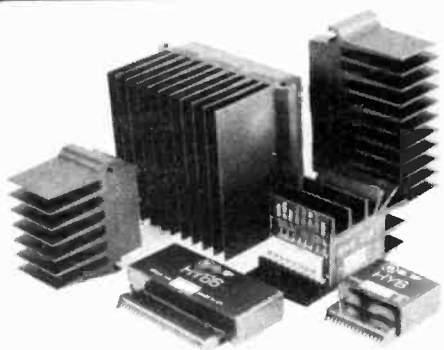
- 16K MEMORY (8x4816-100ns) BBC1 £18.00
- Printer User I/O Port BBC2 £8.20
- SK10 with 36" Cable £2.00
- Complete Printer Cable 36" £12.00
- SK9 with 36" Cable £3.00
- Disc Interface Kit BBC3 £41.00
- Analogue I/O Kit BBC4 £6.75
- Serial I/O Kit BBC5 £7.50
- Expansion Bus Kit BBC6 £6.50
- SK11 with Cable 36" £3.00
- SK12 with Cable 36" £3.75
- Complete Upgrade Kit from Model A to B £45
- Complete range of Cables & Connectors for BBC Micro available. Send SAE for list.

FLOPPY DISC DRIVES

- TEAC Single FD-50A uncased £125
- TEAC Single FD-50A cased with PSU £180
- TEAC Twin FD-50A cased with PSU £335
- TEAC Single FD-50E 80 track cased with PSU £238
- SIEMENS FDD 100-5 Cased, Head, Motors, track zero micro switch & motor control PCB with read, write & control electronics plus cable (Ideal for Apple) £215
- Apple II Interface Card for above. £39
- 10 Floppy Diskettes 5 1/4" S.D. Verbatim £22
- 10 Floppy Diskettes 5 1/4" D.D. Verbatim £30

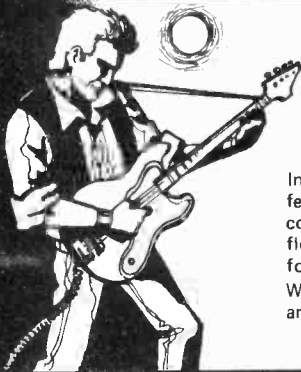
WATFORD ELECTRONICS
Tel. (0923) 40588 Telex. 8956095

GET BIG POWER



Modular Amplifiers the third generation

Due to continuous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.



BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY 30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY 60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY 120	60	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY 124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY 128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY 244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY 248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY 464	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY 468	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15V/ μ s. Rise time: 5 μ s. S/N ratio: 100db. Frequency response (-3dB): 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K Ω . Damping factor: 100Hz > 400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY 6	Mono pre-amp	Mic/Mag. Cartridge/Tuner/Tape/Aux. + Vol/Bass/Treble	10mA	£7.60
HY 66	Stereo pre-amp	Mic/Mag. Cartridge/Tuner/Tape/Aux. + Vol/Bass/Treble/Balance	20mA	£14.32
HY 73	Guitar pre-amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY 78	Stereo pre-amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre-amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6-HY13 £1.05 (inc. VAT) and the B66 for modules HY66-HY78 £1.29 (inc. VAT).

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.94

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).

Slew rate: 20V/ μ s. Rise time: 3 μ s. S/N ratio: 100db. Frequency response (-3dB): 15Hz - 100KHz. Input sensitivity: 500mV rms. Input impedance: 100K Ω . Damping factor: 100Hz > 400.

'NEW to ILP' In Car Entertainment

C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

£9.14 (inc. VAT)

Robust construction.

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4 Ω .

Frequency response (-3dB): 15Hz to 30KHz. T.H.D. 0.1% at 10w 1KHz.

S/N ratio (DIN AUDIO) 80dB. Load Impedance 3 Ω .

Input Sensitivity and impedance (selectable) 700mV rms into 15K Ω 3V rms into 8 Ω .

Size 95 x 48 x 50mm. Weight 256 gms.

C1515

Stereo version of C15.

£17.19 (inc. VAT)

Size 95 x 40 x 80. Weight 410 gms.

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

WITH A LOT OF HELP FROM **ILP** ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

Unicase

Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, ($<0.01\%$), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

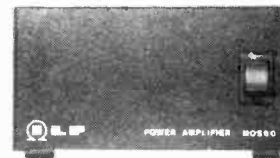
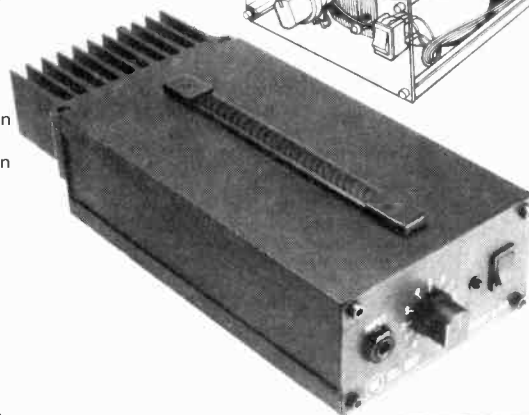
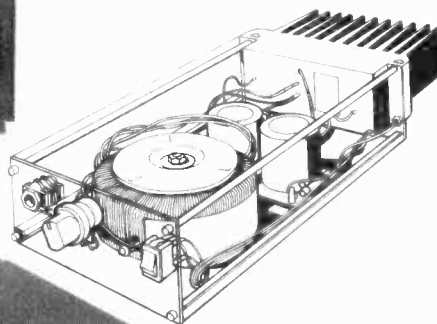
Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HiFi Separates						Price inc. VAT
UC1	Preamp					£29.95
UP1X	30 + 30W/4-8Ω	Bipolar	Stereo	Hi-Fi		£54.95
UP2X	60W/4Ω	Bipolar	Mono	Hi-Fi		£54.95
UP3X	60W/8Ω	Bipolar	Mono	Hi-Fi		£54.95
UP4X	120W/4Ω	Bipolar	Mono	Hi-Fi		£74.95
UP5X	120W/8Ω	Bipolar	Mono	Hi-Fi		£74.95
UP6X	60W/4-8Ω	MOS	Mono	Hi-Fi		£64.95
UP7X	120W/4-8Ω	MOS	Mono	Hi-Fi		£84.95
Power Slaves						
US1X	60W/4Ω	Bipolar	Power	Slave		£59.95
US2X	120W/4Ω	Bipolar	Power	Slave		£79.95
US3X	60W/4-8Ω	MOS	Power	Slave		£69.95
US4X	120W/4-8Ω	MOS	Power	Slave		£89.95

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.). All units except UC1 incorporate our own toroidal transformers.



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BI-PAK BARGAINS



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6 precision screwdrivers in hinged plastic case. Sizes — 0.8, 1.4, 2.2, 2.9 and 3.8mm. **£1.75**

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5 precision nut drivers in hinged plastic case. With turning rod. Sizes — 3, 3.5, 4, 4.5 and 5mm. **£1.75**

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5 precision instruments in hinged plastic case. Crosspoint (Phillips) screwdrivers — H 0 and H 1 Hex key wrenches — 1.5, 2 and 2.5mm. **£1.75**

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5 precision wrenches in hinged plastic case. Sizes — 4, 4.5, 5, 5.5 and 6mm. **£1.75**

BUY ALL FOUR SETS 5121-5151 and get HEX KEY SET FREE

HEX KEY SET ON RING

Sizes 1.5, 2, 2.5, 3

4, 5, 5.5 and 6mm

Made of hardened steel

HX/1 **£1.25**



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Pak No.	Qty.	Description	Price
SX10	400	Mixed All Type Resistors	£1
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SX12	200	1/4 watt Carbon Resistors	£1
SX13	200	1/4 watt Carbon Resistors	£1
SX14	150	1/4 watt Resistors 22 ohm-2M Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2M Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.

*Quantities approximate, count by weight

25 pieces of Audio Plugs, Sockets and Connectors to include DIN 180, 240, 240 Pin, Speakers, Phono, Jack Stereo and Mono etc Valued at well over £3 normal! Order No. SX25. Our Price **1.50** per pak.

Guaranteed to save you money

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SX27A 60 Assorted Polystyrene Bead Capacitors Type 9500 Series PPD £1.00

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SX29A 50 Assorted Silver Mica Caps 180pF-470pF £1.00

SX30A 50 High Voltage Disc Ceramics 750v min up to 8KV Assorted useful values £1.00

SX31A 50 Wirewound 9 watt (avg) Resistors Assorted values 10hm-12K £1.00

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Pak No.	Qty.	Description	Price
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SX19	100	Mixed Ceramics 68pf-0.5mF	£1
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SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50 1000mF	£1
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SX91	20 x Large, 2" RED LED	£1
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BRAND NEW LCD DISPLAY MULTITESTER.

RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
*3 1/2 digit * 16 ranges plus HFE test facility for PNP and NPN transistors * Auto zero, auto polarity * Single handed pushbutton operation * Over range indication * 12 5mm (1/2-inch) large LCD readout * Diode check * Fast circuit protection * Test leads, battery and instructions included

Max indication 1999 or — 9999

Polarity indication Negative only

Positive readings appear without + sign

Input impedance 10 Megohms

Zero adjust Automatic

Sampling time 250 milliseconds

Temperature range —5°C to 50°C

Power Supply 1 x PP3 or equivalent 9v battery

Consumption 20mW

Size 155 x 88 x 31mm

RANGES

DC Voltage 0-200mv

0-2-20-200-1000V Acc. 0.8%

AC Voltage 0-200-1000V

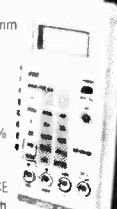
Acc. 1.2% OC Current 0-200uA

0-2-20-200mA 0-10 A Acc. 1.2%

Resistance 0-2-20-200k ohms

0-2 Megohms Acc. 1%

BI-PAK VERY LOWEST POSSIBLE PRICE **£35.00** each



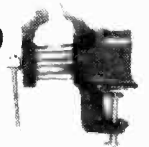
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This small cast iron quality made vice will clamp on to any bench or table having a max thickness of 1 1/2". The 2 1/2" jaws open to max of 1 1/2". Approx size 80 x 120 x 66mm

Bi-Pak's Mini Vice at a Mini Price only

£2.50

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The Third and Fourth Hand...

... you always need

but have never got until now

This helpful unit with Rod mounted

horizontally on Heavy Base. Crocodile clips

attached to rod ends. Six ball & socket joints

give infinite variation and positions through

360° also available attached to Rod a 2 1/2" diam

magnifier giving 2.5 x magnification. Helping

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Our Price with magnifier as illustrated ORDER

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Kit comprises ORDER NO. SX80

1 High Quality 40 watt General Purpose

Lightweight Soldering Iron 240v mains incl

3/16" (4.7mm) bit

1 Quality Desoldering pump. High Suction with

automatic ejection. Knurled, anti-corrosive

casing and teflon nozzle

1.5 metres of De-soldering braid on plastic

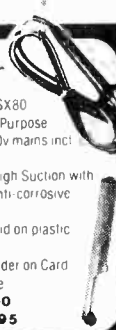
dispenser

2 yds (1.83m) Resin Cored Solder on Card

1 Heat Shunt tool tweezers Type

Total Retail Value over **£12.00**

OUR SPECIAL KIT PRICE **£8.95**



BI-PAK PCB ETCHANT AND DRILL KIT

Complete PCB Kit comprises

1 Expo Mini Drill 10 000RPM 12v DC incl 3

collets & 1 x 1mm Twist bit

1 Sheet PCB Transfers 210mm x 150mm

1 Etch Resist Pen

1 1/2 lb pack FERRIC CHLORIDE crystals

3 sheets copper clad board

2 sheets Fibreglass copper clad board

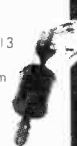
Full instructions for making your own PCB

boards

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OUR BI-PAK SPECIAL KIT PRICE **£9.75**

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PROGRAMMABLE UNIJUNCTION TRANSISTOR
PUT case T0106 plastic MEU22 Similar to 2N6027/6028 PNP Silicon
Price 1-9 10-49 50-99 100- Normal Retail
Each 20p 18p 15p 13p Price £0.35 each

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Equivalent M12955 — BD312 — 103
SPECIAL PRICE **£0.70** each 10 off **£8.50**



5 watt (RMS) Audio Amp

High Quality audio amplifier Module. Ideal for use in record players, tape recorders, stereo amps and cassette players, etc. Full data and back up diagrams with each module

Specification

• Max Power Supply 30v • Power Output 5 watts

RMS • Load Impedance 8-16 ohms • Frequency

response 50Hz to 25KHz — 3db • Sensitivity 70mv

for full output • Input Impedance 50k ohms • Size

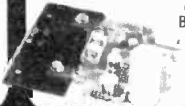
85 x 64 x 30mm • Total Harmonic

distortion less than 5%

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4 AMP — 400v — T0202 — TAG 136G	10 OFF	50 OFF	100 OFF
60p	£3.75	£17.50	£30.00
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			£50.00

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SX64 5 x 1k Lin	SX68 5 x 47k Log
SX65 5 x 22k Lin	SX69 5 x 100 Lin
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ALL AT
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Miniature round nose side cutters — insulated handles 4 1/2 inch length. Order No Y043.

Miniature long nose pliers — insulated handles 5 1/2 inch length. Order No Y044.

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ALL AT
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each

All with insulated handles

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A flexible shaft screwdriver for those awkward to get at screws. Overall length 8 1/2 inch. Order No FS-1 Flat blade 4mm FS-2 Cross point no 1 **£1.75** each.

GRIP DRIVER
6 inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places. Order No SD-1 Flat blade 4mm SD-2 Cross point no 0. **95p** each.

INEXPENSIVE TOOLS OF IMMENSE VALUE

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Set of 5 BA spanner shafts plus universal handle in roll-up wallet. Sizes 0BA 2-4-6-8BA Order no T192

£2.75 set

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Guarantee

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is. All these Sale items are in stock in quantity and we will despatch the same day as your order is received.

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The lowest price ever.

Pin	10 off	50 off	100 off
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16 pin	95p	£4.00	£7.00

VOLTAGE REGULATORS

T0220	Positive +	Negative -
	7805 — 50p	7905 — 55p
	7812 — 50p	7912 — 55p
	7815 — 50p	7915 — 55p
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A selection of Large & Small size LED's in Red, Green, Yellow and Clear, plus shaped devices of different types. 7 Segment displays, photo transistors, emitters and detectors. Types like MEL11, FPT100 etc. Plus Cadmium Cell ORP12 and germ photo transistor OCP71.

D/N0 SX57A
Valued Normal Retail £12.00
Our Price
£5.00

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100
A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's, Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices.

Guaranteed Value over £10 at Normal Retail Price

£4.00
Data etc in every pak
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MW398 NI-CAD CHARGER

Universal Ni-Cad battery charger. All plastic case with lift up lid. Charge/Test switch. LED indicators at each of the five charging points.

Charges	Power
PP3 (9V)	220-240V AC
U12 (1.5V penlite)	Dims
U11 (1.5V C)	210 x 100 x 50mm
U2 (1.5V D)	£6.95

POWER SUPPLY OUR PRICE £3.25

Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug. Input — 240V AC 50HZ Output — 3 3.5 6 7.5 9 12V DC Rating — 300 ma MW88

1 Amp SILICON RECTIFIERS

Glass Type similar IN4000 SERIES IN4001-IN4004 50 — 500v — uncoded — you select for VLTS. ALL perfect devices — NO duds Min 50v 50 for **£1.00** — worth double ORDER NO SX76

Silicon General Purpose NPN Transistors T0-18 Case. Lock fit leads — coded CV7644 Similar to BC147 — BC107 — 2789 ALL NEW! VCE 70v IC500mA Hfe 75-250 50 off 100 off 500 off 1000 off
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T0-92 Plastic centre collector. Like BC182L — 183L — 184L. VCEO 45 VCE 30 IC 200mA Hfe 100-400. ALL perfect devices — uncoded ORDER AS SX183L 50 off 100 off 500 off 1000 off
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PNP SILICON TRANSISTORS:

Similar ZTX500 — ZTX214 — E-Line. VCEO 40 VCE 35 IC 300mA Hfe 50-400. Brand New — Uncoded — Select Devices. 50 off 100 off 500 off 1000 off
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Red plastic case with adjustable living bracket. Emits high pitched wailing note of varying pitch. 100 cycles per minute. Dims 90mm (dia) 60mm (depth). Power 12 v DC. Our Price: **£5.50**

8 Bit MICROPROCESSOR

National INS8080AN 40 Pin DIL N Channel Silicon GATE MOS TECHNOLOGY As used in Nationals N8080 Micro Computer Family. Instruction Cycle Time 2 µs. Supplied with functional Block Diagram. BRAND NEW — NOT seconds or reclaims. 100% perfect ORDER NO SX8080 Normal Sell price £4.50 each. Our BI-PAK Special Price **£2.00** SO HURRY — LIMITED STOCKS

40 Pin IC Socket to fit SX8080. Offer price ORDER NO 1609 **30p**

MULTITESTERS

30,000 opv Including test leads and case. AC volts — 0.25-10-25-100-250-500-1,000. DC volts — 0.025-1-2.5-10-25-100-250-1,000. DC current — 0-50ua 0-5ma-50ma 0-12amps. Resistance — 0-6K ohms-70K ohms-6meg ohms-60meg ohms. Decibels — -20db to plus 56db. Short test — Internal buzzer. Dims — 160 x 110 x 50mm.

O/N0. 1315. OUR PRICE **ONLY £24.75**

1,000 opv Including test leads & Battery. AC volts — 0-15-150-500-1,000. DC volts — 0-15-150-500-1,000. DC currents — 0-1ma-150ma. Resistance — 0-2.5 K ohms 100 K ohms. Dims — 90 x 61 x 30mm.

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There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts: i.e. price, description and individual features of what we have available. But remember, BI-PAK's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

BI-PAK'S COMPLETELY NEW CATALOGUE is now available to you. You will be amazed how much you can save when you shop for Electronic Components with a BI-PAK Catalogue. Have one by you all the time—it pays to buy BI-PAK.

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These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w of lighting.

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- TD300K Touchdimmer £7.00
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HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

Order as XK112. £42.00

Additional Receivers XK111 £10.00

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a pre-wired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Output: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

ONLY £10.50

Electric lock mechanism for use with latch locks and above kit

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Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:

- 0.5" LED 12 hour display
- Day of week, am/pm and output status indicators
- 4 zero voltage switched mains outputs
- 50/60Hz mains operation
- Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied)
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- Useful "sleep" function—turns on output for one hour
- Direct switch control enabling output to be turned on immediately or after a specified time interval
- 20 function keypad for programme entry
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(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000



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This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3 1/2 digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL1000K This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. £14.60

DL2100K A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. Optional opto input DLA1. Only £8.00

DL3000K This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply & lamps. Only £11.95 (1Kw/Channel)

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery £4.20

MK7 INFRA RED RECEIVER Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. £9.00

MK8 CODED INFRA RED TRANSMITTER Based on the SL480, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms £5.90

MK10 16-WAY KEYBOARD For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. £5.40

MK11 10-Channel + 3 Analogue o/p IR Receiver Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. £12.00

MK12 16-CHANNEL IR RECEIVER For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs — please specify when ordering. Includes its own mains supply. £11.95

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. £4.35

MK18 Mains Powered IR Transmitter Mains powered for continuous operation — single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. £2.50

MK17 12V d.c. IR RECEIVER For use with MK6 or MK16. Relay output with DP 3 Amp change over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6.13V d.c. £9.50

MK18 HIGH POWER IR TRANSMITTER Similar to MK8 but with range of approx. 60ft. £6.20

Ancillary Kits: MK2 Solid State Relay Opto-isolated with zero voltage switching. No triac supplied. £2.60

MK15 DUAL LATCHED SOLID STATE RELAY Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output. triacs required (not supplied). £4.50

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit £14.90

CT1000K with white box (56/131 x 71mm) £17.40

(Ready Built) £22.50

Add 55p postage & packing + 15% VAT to total.

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NEW T.V. SOUND TUNER BUILT AND TESTED



£22.95 + £2.00 p&p.

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11 1/4" x 8 1/2" x 3 3/4".

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Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.

Featured in April issue P.E.
Reprint 50p. Free with kit

Self assembly simulated wood cabinet - ONLY £4.50 plus £1.50 p&p.

ELECTRONICS ONLY!

Ideal for updating your existing cassette. Includes pcb diagram, all semiconductors, IC's, Capacitors, resistors.

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PRACTICAL ELECTRONICS CAR RADIO KIT SERIES II

2 WAVE BAND
MW -- LW

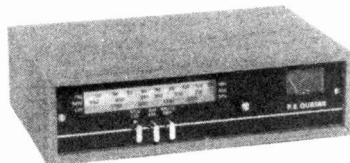
• Easy to build
• 5 push button tuning
• Modern design
• 6 watt output • Ready etched and punched PCB • Incorporates suppression circuits.

All the electronic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics March issue. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type pre-aligned and assembled, and a Bird pre-aligned push button tuning unit.

Suitable stainless steel fully retractable aerial (locking) and speaker (6"x4"app.). available as a kit complete. **£12.95** Plus £2.00 p&p. **£2.50/pack.** + £1.50 p&p.



P.E. STEREO TUNER KIT



This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System. FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size: 10 1/2" x 2 1/4" approx. Complete with d diagram and instructions.

£17.95

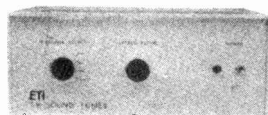
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Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11 1/4" x 8 1/2" x 3 3/4" **£3.50** Plus £1.50 p&p.

TV SOUND TUNER KIT

£11.45

+ £2.00 p&p.



As featured in E.T.I. December '81 issue. Kit of parts including PCB, UHF tuner and selector switch with all components excluding case. + Transformer £1.50 + £1.50 p&p (p&p free on transformer if ordered with kit).

BIRD AUDIO STEREO CAR RADIO BOOSTER

To boost your car radio or radio cassette to 15W r.m.s. per channel.

£9.95 + £1.50 p&p.



125W HIGH POWER AMP MODULES

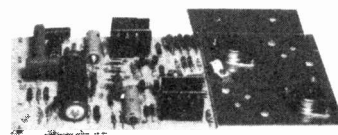
KIT **£10.50**
+ £1.15 p&p

BUILT **£14.25**
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The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use.

Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES: Suitable mains power supply kit with transformer: £8.00 plus £2.00 p&p. Suitable LS coupling electrolytic: £1.00 plus 25p p&p.



SPECIFICATIONS:

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

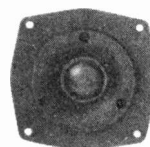
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£3.95 each (p&p £1) or

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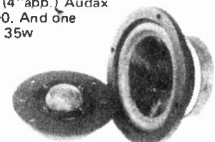


35 WATT MICRO 2-WAY SPEAKER SYSTEM

Unit comprises one 50w (4"app.) Audax soft dome tweeter HD100. And one 5" Audax bass/midrange 35w driver HIF11JSM. Complete with 2 element crossover. Total impedance of system 4 ohms.

£8.95

PER SET + £2.70 p&p.



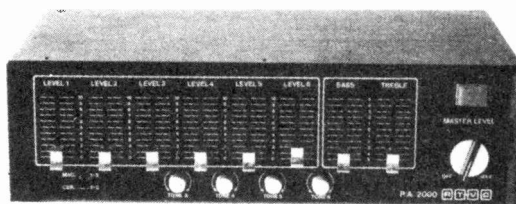
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Ideal for Church halls & Club houses.

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50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic. and aux. inputs. Size 13 1/4"x6 1/2"x3 3/4"app. Power output 50 watts R.M.S. (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.



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IN92 30p
IN93 30p
IN94 30p
IN95 30p
IN96 30p
IN97 30p
IN98 30p
IN99 30p
IN100 30p

SCREENED CABLE

Single 14p
Stereo 27p
Mini Single 15p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p

AERIAL CABLE

50S1 RG58A 36p
75S1 LH 36p
75S1 VHF 14p
100S1 Flat 14p

RAINBOW RIBBON CABLE

10 Way 65p
24 Way 1.50
40 Way 2.10

ANTEX SOLDERING IRONS

C240 (15W) 4.59
X25 (25W) 4.99
Iron Stand 1.65
C240 Element 1.99
X25 Element 2.05
No 2 (Small) 65p
No 3 (Med) 65p
No 6 (Micro) 65p
Bays 18 30p
Bays 19 15p
Bays 20 15p

CRICKLEWOOD ELECTRONICS LTD

No 51 (Med) 65p

No 52 (Lge) 65p

DIL SOCKETS

Lo W.Wp 10p
Pins prof 10p
8 9p 25p
14 9p 35p
16 10p 40p
18 16p 50p
20 20p —
22 22p —
24 24p 70p
28 28p 79p
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ufd V 6p
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1000 16 24p
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2. Thick lines
3. Thin bends
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Ferric Chloride 60% Solution 250ml bottle

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Prices per metre
Solid Hook up Wire
Any colour 5p

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Twin 2 1/2 amp 16p
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Solid Multicore

4 Core 33p
8 Core 39p
12 Core 46p
50 Core 1.37

Screened Cable

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IN41 30p
IN42 30p
IN43 30p
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AERIAL CABLE

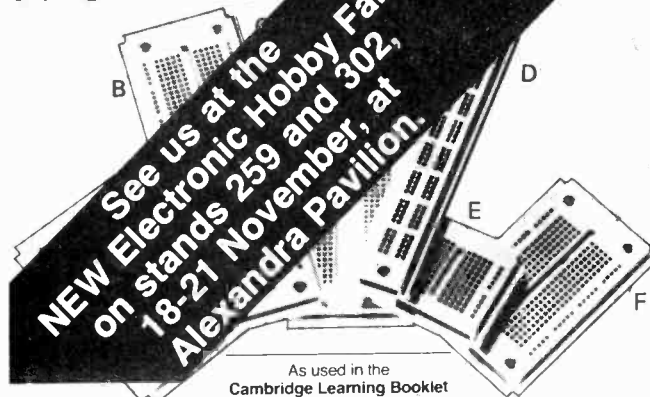
50S1 RG58A 36p

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3M143	2.85	3M147	13p	3M148	13p	3M149	13p	3M150	13p	3M151	13p	3M152	13p	3M153	13p	3M154	13p	3M155	13p	3M156	13p	3M157	13p	3M158	13p	3M159	13p	3M160	13p	3M161	13p	3M162	13p	3M163	13p	3M164	13p	3M165	13p	3M166	13p	3M167	13p	3M168	13p	3M169	13p	3M170	13p	3M171	13p	3M172	13p	3M173	13p	3M174	13p	3M175	13p	3M176	13p	3M177	13p	3M178	13p	3M179	13p	3M180	13p	3M181	13p	3M182	13p	3M183	13p	3M184	13p	3M185	13p	3M186	13p	3M187	13p	3M188	13p	3M189	13p	3M190	13p	3M191	13p	3M192	13p	3M193	13p	3M194	13p	3M195	13p	3M196	13p	3M197	13p	3M198	13p	3M199	13p	3M200	13p	3M201	13p	3M202	13p	3M203	13p	3M204	13p	3M205	13p	3M206	13p	3M207	13p	3M208	13p	3M209	13p	3M210	13p	3M211	13p	3M212	13p	3M213	13p	3M214	13p	3M215	13p	3M216	13p	3M217	13p	3M218	13p	3M219	13p	3M220	13p	3M221	13p	3M222	13p	3M223	13p	3M224	13p	3M225	13p	3M226	13p	3M227	13p	3M228	13p	3M229	13p	3M230	13p	3M231	13p	3M232	13p	3M233	13p	3M234	13p	3M235	13p	3M236	13p	3M237	13p	3M238	13p	3M239	13p	3M240	13p	3M241	13p	3M242	13p	3M243	13p	3M244	13p	3M245	13p	3M246	13p	3M247	13p	3M248	13p	3M249	13p	3M250	13p	3M251	13p	3M252	13p	3M253	13p	3M254	13p	3M255	13p	3M256	13p	3M257	13p	3M258	13p	3M259	13p	3M260	13p	3M261	13p	3M262	13p	3M263	13p	3M264	13p	3M265	13p	3M266	13p	3M267	13p	3M268	13p	3M269	13p	3M270	13p	3M271	13p	3M272	13p	3M273	13p	3M274	13p	3M275	13p	3M276	13p	3M277	13p	3M278	13p	3M279	13p	3M280	13p	3M281	13p	3M282	13p	3M283	13p	3M284	13p	3M285	13p	3M286	13p	3M287	13p	3M288	13p	3M289	13p	3M290	13p	3M291	13p	3M292	13p	3M293	13p	3M294	13p	3M295	13p	3M296	13p	3M297	13p	3M298	13p	3M299	13p	3M300	13p	3M301	13p	3M302	13p	3M303	13p	3M304	13p	3M305	13p	3M306	13p	3M307	13p	3M308	13p	3M309	13p	3M310	13p	3M311	13p	3M312	13p	3M313	13p	3M314	13p	3M315	13p	3M316	13p	3M317	13p	3M318	13p	3M319	13p	3M320	13p	3M321	13p	3M322	13p	3M323	13p	3M324	13p	3M325	13p	3M326	13p	3M327	13p	3M328	13p	3M329	13p	3M330	13p	3M331	13p	3M332	13p	3M333	13p	3M334	13p	3M335	13p	3M336	13p	3M337	13p	3M338	13p	3M339	13p	3M340	13p	3M341	13p	3M342	13p	3M343	13p	3M344	13p	3M345	13p	3M346	13p	3M347	13p	3M348	13p	3M349	13p	3M350	13p	3M351	13p	3M352	13p	3M353	13p	3M354	13p	3M355	13p	3M356	13p	3M357	13p	3M358	13p	3M359	13p	3M360	13p	3M361	13p	3M362	13p	3M363	13p	3M364	13p	3M365	13p	3M366	13p	3M367	13p	3M368	13p	3M369	13p	3M370	13p	3M371	13p	3M372	13p	3M373	13p	3M374	13p	3M375	13p	3M376	13p	3M377	13p	3M378	13p	3M379	13p	3M380	13p	3M381	13p	3M382	13p	3M383	13p	3M384	13p	3M385	13p	3M386	13p	3M387	13p	3M388	13p	3M389	13p	3M390	13p	3M391	13p	3M392	13p	3M393	13p	3M394	13p	3M395	13p	3M396	13p	3M397	13p	3M398	13p	3M399	13p	3M400	13p	3M401	13p	3M402	13p	3M403	13p	3M404	13p	3M405	13p	3M406	13p	3M407	13p	3M408	13p	3M409	13p	3M410	13p	3M411	13p	3M412	13p	3M413	13p	3M414	13p	3M415	13p	3M416	13p	3M417	13p	3M418	13p	3M419	13p	3M420	13p	3M421	13p	3M422	13p	3M423	13p	3M424	13p	3M425	13p	3M426	13p	3M427	13p	3M428	13p	3M429	13p	3M430	13p	3M431	13p	3M432	13p	3M433	13p	3M434	13p	3M435	13p	3M436	13p	3M437	13p	3M438	13p	3M439	13p	3M440	13p	3M441	13p	3M442	13p	3M443	13p	3M444	13p	3M445	13p	3M446	13p	3M447	13p	3M448	13p	3M449	13p	3M450	13p	3M451	13p	3M452	13p	3M453	13p	3M454	13p	3M455	13p	3M456	13p	3M457	13p	3M458	13p	3M459	13p	3M460	13p	3M461	13p	3M462	13p	3M463	13p	3M464	13p	3M465	13p	3M466	13p	3M467	13p	3M468	13p	3M469	13p	3M470	13p	3M471	13p	3M472	13p	3M473	13p	3M474	13p	3M475	13p	3M476	13p	3M477	13p	3M478	13p	3M479	13p	3M480	13p	3M481	13p	3M482	13p	3M483	13p	3M484	13p	3M485	13p	3M486	13p	3M487	13p	3M488	13p	3M489	13p	3M490	13p	3M491	13p	3M492	13p	3M493	13p	3M494	13p	3M495	13p	3M496	13p	3M497	13p	3M498	13p	3M499	13p	3M500	13p	3M501	13p	3M502	13p	3M503	13p	3M504	13p	3M505	13p	3M506	13p	3M507	13p	3M508	13p	3M509	13p	3M510	13p	3M511	13p	3M512	13p	3M513	13p	3M514	13p	3M515	13p	3M516	13p	3M517	13p	3M518	13p	3M519	13p	3M520	13p	3M521	13p	3M522	13p	3M523	13p	3M524	13p	3M525	13p	3M526	13p	3M527	13p	3M528	13p	3M529	13p	3M530	13p	3M531	13p	3M532	13p	3M533	13p	3M534	13p	3M535	13p	3M536	13p	3M537	13p	3M538	13p	3M539	13p	3M540	13p	3M541	13p	3M542	13p	3M543	13p	3M544	13p	3M545	13p	3M546	13p	3M547	13p	3M548	13p	3M549	13p	3M550	13p	3M551	13p	3M552	13p	3M553	13p	3M554	13p	3M555	13p	3M556	13p	3M557	13p	3M558	13p	3M559	13p	3M560	13p	3M561	13p	3M562	13p	3M563	13p	3M564	13p	3M565	13p	3M566	13p	3M567	13p	3M568	13p	3M569	13p	3M570	13p	3M571	13p	3M572	13p	3M573	13p	3M574	13p	3M575	13p	3M576	13p	3M577	13p	3M578	13p	3M579	13p	3M580	13p	3M581	13p	3M582	13p	3M583	13p	3M584	13p	3M585	13p	3M586	13p	3M587	13p	3M588	13p	3M589	13p	3M590	13p	3M591	13p	3M592	13p	3M593	13p	3M594	13p	3M595	13p	3M596	13p	3M597	13p	3M598	13p	3M599	13p	3M600	13p	3M601	13p	3M602	13p	3M603	13p	3M604	13p	3M605	13p	3M606	13p	3M607	13p	3M608	13p	3M609	13p	3M610	13p	3M611	13p	3M612	13p	3M613	13p	3M614	13p	3M615	13p	3M616	13p	3M617	13p	3M618	13p	3M619	13p	3M620	13p	3M621	13p	3M622	13p	3M623	13p	3M624	13p	3M625	13p	3M626	13p	3M627	13p	3M628	13p	3M629	13p	3M630	13p	3M631	13p	3M632	13p	3M633	13p	3M634	13p	3M635	13p	3M636	13p	3M637	13p	3M638	13p	3M639	13p	3M640	13p	3M641	13p	3M642	13p	3M643	13p	3M644	13p	3M645	13p	3M646	13p	3M647	13p	3M648	13p	3M649	13p	3M650	13p	3M651	13p	3M652	13p	3M653	13p	3M654	13p	3M655	13p	3M656	13p	3M657	13p	3M658	13p	3M659	13p	3M660	13p	3M661	13p	3M662	13p	3M663	13p	3M664	13p	3M665	13p	3M666	13p	3M667	13p	3M668	13p	3M669	13p	3M670	13p	3M671	13p	3M672	13p	3M673	13p	3M674	13p	3M675	13p	3M676	13p	3M677	13p	3M678	13p	3M679	13p	3M680	13p	3M681	13p	3M682	13p	3M683	13p	3M684	13p	3M685	13p	3M686	13p	3M687	13p	3M688	13p	3M689	13p	3M690	13p	3M691	13p	3M692	13p	3M693	13p	3M694	13p	3M695	13p	3M696	13p	3M697	13p	3M698	13p	3M699	13p	3M700	13p	3M701	13p	3M702	13p	3M703	13p	3M704	13p	3M705	13p	3M706	13p	3M707	13p	3M708	13p	3M709	13p	3M710	13p	3M711	13p	3M712	13p	3M713	13p	3M714	13p	3M715	13p	3M716	13p	3M717	13p	3M718	13p	3M719	13p	3M720	13p	3M721	13p	3M722	13p	3M723	13p	3M724	13p	3M725	13p	3M726	13p	3M727	13p	3M728	13p	3M729	13p	3M730	13p	3M731	13p	3M732	13p	3M733	13p	3M734	13p	3M735	13p	3M736	13p	3M737	13p	3M738	13p	3M739	13p	3M740	13p	3M741	13p	3M742	13p	3M743	13p	3M744	13p	3M745	13p	3M746	13p	3M747	13p	3M748	13p	3M749	13p	3M750	13p	3M751	13p	3M752	13p	3M753	13p	3M754	13p	3M755	13p	3M756	13p	3M757	13p	3M758	13p	3M759	13p	3M760	13p	3M761	13p	3M762	13p	3M763	13p	3M764	13p	3M765	13p	3M766	13p	3M767	13p	3M768	13p	3M769	13p	3M770	13p	3M771	13p	3M772	13p	3M773	13p	3M774	13p	3M775	13p	3M776	13p	3M777	13p	3M778	13p	3M779	13p	3M780	13p	3M781	13p	3M782	13p	3M783	13p	3M784	13p	3M785	13p	3M786	13p	3M787	13p	3M788	13p	3M789	13p	3M790	13p	3M791	13p	3M792	13p	3M793	13p	3M794	13p	3M795	13p	3M796	13p	3M797	13p	3M798	13p	3M799	13p	3M800	13p	3M801	13p	3M802	13p	3M803	13p	3M804	13p	3M805	13p	3M806	13p	3M807	13p	3M808	13p	3M809	13p	3M810	13p	3M811	13p	3M812	13p	3M813	13p	3M814	13p	3M815	13p	3M816	13p	3M817	13p	3M818	13p
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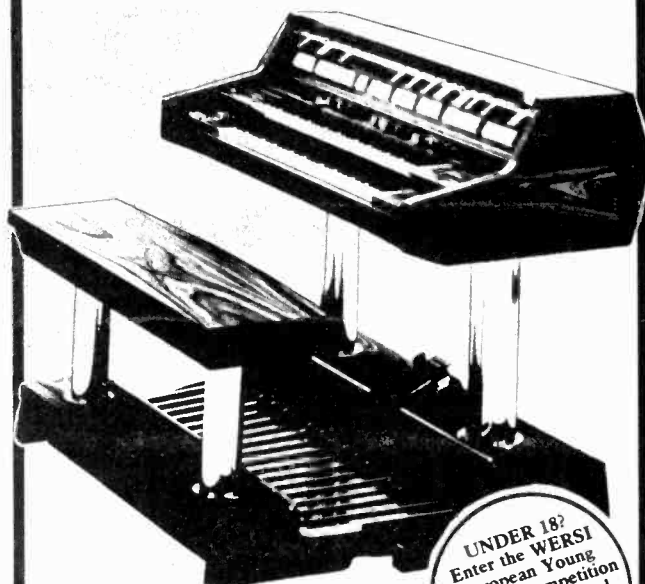
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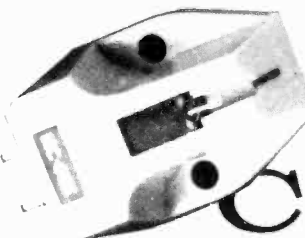
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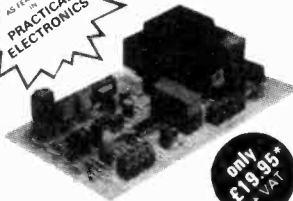
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Other attractions will include radio and TV transmission, electric vehicles, radio controlled models, and demonstrations by local and national organisations.

This is the age of the train – British Rail are offering a cheap rate rail fare from all major

stations in the country direct to Alexandra Palace – a bus will be waiting on your arrival to take you to the show. Ticket price also includes admission to the exhibition – so let the train take the strain to the Electronic Hobbies Fair.

Ticket prices at the door are £2 for adults, £1 for children but party rates are available for 20 people or more. To find out more, contact the Exhibition Manager, Electronic Hobbies Fair, IPC Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. Tel: 01-643 8040.

Electronic Hobbies Fair is sponsored by Practical Electronics, Everday Electronics and Practical Wireless and is organised by IPC Exhibitions Ltd.

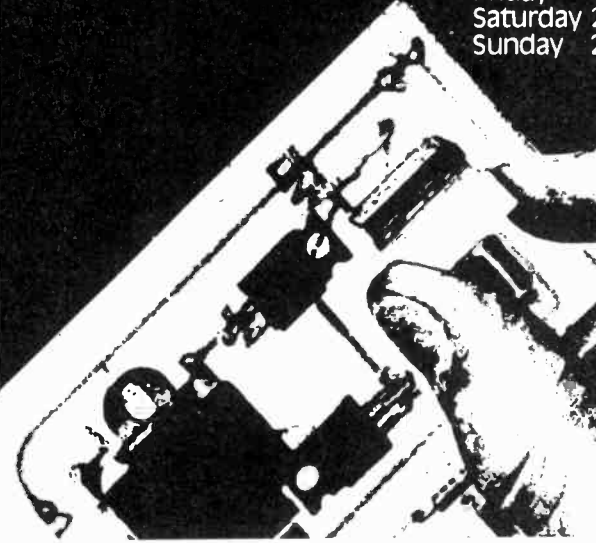
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E.H.F.

JUST one last reminder re. **Electronic Hobbies Fair** (November 18th to 21st Alexandra Pavilion), this will be the best event ever for the hobbyist in this country. Just about all the top names in the retail supply business will be there—some are arranging special offers for the Fair, our own 50p off coupon is on the opposite page. In addition to the trade stands there will be a number of special attractions; like the Luxor satellite TV receiver mentioned last month; a display of electric vehicles built by members of the Battery Vehicle Society (more about them later); a demonstration of holography by Holographic Developments (you will be able to purchase some examples); some working radio controlled models; an exhibit by the Royal Signals and an amateur radio talk-in station operating on the 2m band, channel S22 (145.55MHz).

You will be able to try out computers have a go at the latest video games and much, much more. There will be stands representing clubs and organisations—like the RSGB—and plenty to buy.

On the PE stand Editorial staff will be waiting to meet you and discuss the

various projects on display. Among other things we will be showing *Micro-grasp*, *Microsynth*, *Microcontroller* our *Semi-Professional Mixing Desk*, *Ultimum* and one or two future projects. The other sponsoring magazines PW and EE will have similar stands and the following IPC magazines will also have a presence at the Fair; Practical Hi-Fi, Television, Wireless World, Practical Computing, Your Computer, and CB World.

ACCESS

Access to the show is easy—there's plenty of car parking and a park-and-ride bus. The Victoria and Piccadilly lines provide fast access to and from the West End and British Rail main line stations—King's Cross, St. Pancras, Euston and Victoria. Finsbury Park and Wood Green underground stations are linked to Alexandra Pavilion by the London Transport W3 bus service which runs every 7 to 10 minutes on all the Fair days. Also Alexandra Palace British Rail station will be linked to the show by a free bus shuttle service; this station is close to Wood Green underground station and is on the BR main and suburban lines from King's Cross and Moorgate.

Special fares are available from all

major British Rail stations direct to Alexandra Palace station and ticket price will include admission to the show—over 300 stations in the U.K. can provide access to Alexandra Palace with only one change of train. Through tickets to BR Alexandra Palace are available at underground ticket offices.

B.V.S.

Finally, a word about the Battery Vehicle Society. The B.V.S. was founded in 1973 to promote battery electric vehicles in all their forms and to provide a forum for everyone interested in this form of transport. The Society publishes a monthly magazine, *Battery Vehicle Review*, containing articles on the history, development and use of battery vehicles.

Following the 1979 Lucas 'How far can you get' competition for design and construction of lightweight electric vehicles, the B.V.S. competition section has monthly runs where the creations of members challenge each other to make the best of 56lbs of lead/acid battery. Some of these vehicles will form the special B.V.S. display at Electronic Hobbies Fair—see you there.

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

Queries and letters concerning advertisements to:

Practical Electronics Advertisements,
King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
Telex: 915748 MAGDIV-G

Letters and Queries

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

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

Back Numbers

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

Binders for PE are available from the same address as back numbers at £4.60 each

to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £13.00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perry Mount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

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

...NEWS &

'Now is the Winter for Public Debate'

Both the IBA and the BBC are concerned about the affects unregulated cable TV could have on the standard of British Broadcasting. The Independent Broadcasting Authority has called for a winter of public debate on the expansion of cable and satellite broadcasting. After its first Autumn meeting the IBA made the following statement.

"The Independent Broadcasting Authority recognises the Government's commitment to the establishment of a national information grid through the expansion of broadcasting in the United Kingdom; and it is eager to use its many years of experience to contribute to the opportunities presented by this expansion of communications in the 80s while maintaining the high standards of British broadcasting. The unique quality of output which has earned a world-wide reputation for British programme-makers must not be eroded.

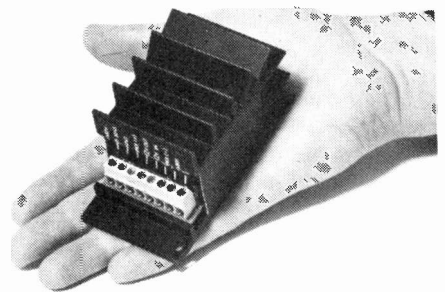
"The proposals of the Hunt Committee will be crucial to the expansion of broadcasting. Mistakes made now would take years to correct. It is for this reason that the Authority calls for a winter of public debate before the final decisions are taken. The Authority has no wish to delay the changes which clearly are on the way—on the contrary, the Authority believes that the creation of Channel Four was far too long delayed—but it believes that it is crucial to lay down the best possible framework for new developments and to ensure that meeting the challenge of wider choice need

not mean lower standards."

Meanwhile the BBC in its evidence to the Hunt Committee said that unregulated cable TV would be "socially divisive, sacrifice hard won programme standards and coarsen popular taste". It also warns that it might lead to the disappearance of big sporting events such as the FA Cup Final and the Olympic Games from BBC and ITV screens because the BBC says cable operators concentrating their resources on 'blockbuster' attractions might well be in a position to outbid the BBC and ITV in the areas of sport and entertainment, thus posing the public service broadcasters with a cruel dilemma. "They must either commit a disproportionate amount of their resources to matching the bids of the cable operators—thus impoverishing other areas of programming—or see the majority deprived of such star attractions in favour of a paying minority". The BBC also pointed out that perhaps no more than 50% of British viewers will have access to the proposed cable systems and that individuals will have no power to affect the issue because access will be determined by economic or geographical status.

POWER MODULE

The C15 mono power booster amplifier from ILP is designed to increase the output of any in-car entertainment system to a nominal 15W r.m.s. The amplifier is encapsulated into an integral heatsink making it a very compact, robust unit.



The system features automatic supply switch-on which is activated when the radio or cassette is turned on. It also has a selectable input level facility so it can be driven from either the low signal levels of a pre-amp or straight from the existing units speaker leads. If stereo operation is required then two units can be used.

Priced at £9.14 inclusive of VAT and p&p the C15 is available from ILP Electronics Ltd., Graham Bell House, Roper Close, Canterbury, CT2 7EP (0227 54778).

AVO 2000

A new British design concept in hand-held digital multimeters—for a wide range of electrical maintenance, field servicing and vehicle testing applications—has been launched by THORN EMI Instruments Limited.

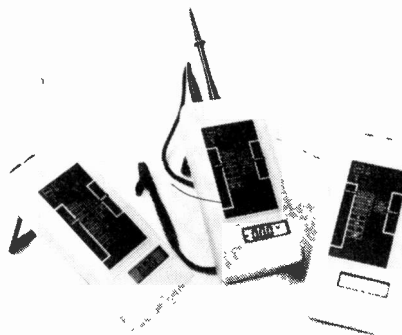
With the AVO 2000 Series the company has concentrated on providing a design offering a host of 'ease-of-use' features.

Initially, the AVO 2000 Series comprises three instruments for specific applications: the AVO Digiminor 2000; the AVOMeter 2001 and the AVO Vehicle Test 2002.

Each is housed in a tough ABS case and fitted with non-slip safety pads, the important new features of all three instruments include: Direct entry prods—giving true one-hand operation; A $3\frac{1}{2}$ digit l.c.d. readout at the

base of the housing; Positive action slide switching with dustproof, positive range selection; Improved safety, with fully shrouded plugs for the lead set; and a three-position stand—the instrument can be used in the hand, on a bench or while hung from a hook.

Ideally suited to maintenance applications, the Digiminor 2000 incorporates a special buzzer socket for sim-



ple continuity testing without reference to the display.

The AVOMeter 2001 is designed primarily for field servicing applications. Featuring more comprehensive ranges than the Digiminor 2000, it ensures correct mode and range selection by the inclusion of an audible alarm which signals any discrepancy. Both the unit and mode of measurement are displayed on the l.c.d.

The AVO Vehicle Test 2002 is unique: it is the first digital multimeter of its kind designed specifically to simplify the testing of electrical circuits of any road vehicle from a small saloon car to HGV.

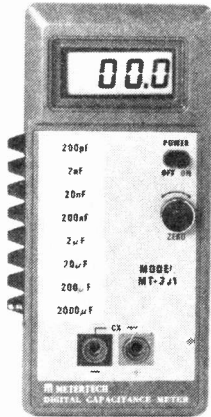
The AVO Digiminor 2000 is priced at £69.40, the 2001 at £85.40 and the 2002 at £97.00. Each multimeter is supplied with the appropriate lead sets, battery and operating instructions.

Thorn EMI Instruments Ltd., Archcliffe Road, Dover, Kent (0304 202620).

MARKET PLACE

CAPACITANCE METER

The Metertech model MT301 is a low cost hand held digital capacitance meter which is battery operated with a 3½ digit liquid crystal display capable of measuring



capacitance values from 0.1pF to 2000µF over 8 push button ranges.

The unit is priced at £69 and is available from Centemp Instrument Co., 62 Curtis Road, Hounslow, Middlesex (01-894 2723).

ENERGY SAVER

The Velleman Heating Controller is designed to control the temperature inside offices, factories, houses etc., enabling central heating systems to work more economically.

It provides a 4 program daily cycle controlling the temperature at any given period. The programs are totally independent and therefore it is possible to select day and night temperatures separately.

The display functions as a clock as well as a thermometer with the device replacing conventional mechanical thermostats without additional wiring. The unit can be manually over-ridden at any time without disturbing any of the preselected programs.

The system is available in kit form (£75.00 ex VAT) and also as a built and tested unit.

Velleman (UK) Limited, P.O. Box 30, St. Leonards on Sea, East Sussex, TN37 7NL. (0424 753246).



CHIP LEG HAND TOOL

A simple hand tool that restores splayed-out legs on integrated circuits to the correct spacings has just been introduced by Aries Electronics. Called the DIP-R-SIZER, the new tool can handle integrated circuits with either 0.300in or 0.600in leg spacing.

When manufactured, the legs on integrated circuits are often outside the tolerances specified for centre spacings. The nominal 0.300in and 0.600in centres have a maximum tolerance of +0.020in. In practice a considerable proportion of integrated circuits leave the factory with spacings up to 0.095in above the nominal centre spacing. Particularly with high pin-count devices, attempts to insert out-of-tolerance legs into integrated circuit sockets or printed circuit boards often results in damage to the legs, the contacts in the socket or the holes in the printed circuit board.

The tool which has a pair of jaws hinged at one end is held open with a spring at the other. An anvil between the jaws is contoured to the correct angle and spacing for the integrated circuit legs. One side of the anvil takes 0.300in centre devices while the other takes the 0.600in size. To rectify splayed legs, the device is placed on the appropriate side of the anvil and the jaws squeezed lightly together. This presses the legs against the anvil, and brings them automatically into tolerance. While inten-



ded primarily for correcting leg spacings as received from the manufacturer, the tool can also be used to rectify legs put out of tolerance through mishandling. However, it cannot restore damaged devices where the legs have been displaced longitudinally—that is where the pitch between individual pins have been disturbed.

The tool which is priced at £10.50 including VAT and p&p. is available from Aries Electronics (Europe) Ltd., Metrostore House, Eastways, Witham, Essex CM8 3YQ. (0376 519318).

SUPERSWITCH HOME COMMAND CENTRE

The Superswitch Command Centre has been developed for the remote control of lamps and electrical appliances.

The unit which transmits high frequency coded signals along existing mains wiring is capable of controlling up to 16 appliances either manually or automatically. The centre can be pre-programmed up to 7 days in advance with a maximum of 24 programs.

The coded signals are received by modules which plug into the 13A socket outlets. Appliance modules operate electrical loads up to 13A whereas lamp modules can control Tungsten lighting loads up to 400W.

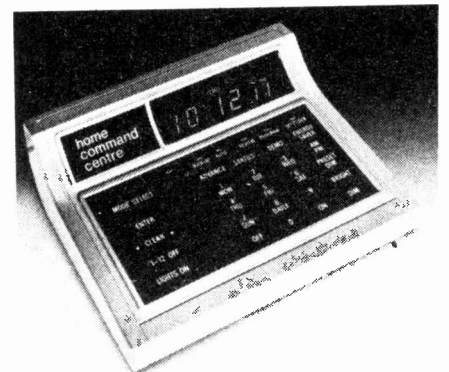
Other features of the unit include the manual dimming and brightening of lamps, battery back-up and the ability to turn on all lamps simultaneously. The Command Centre is priced at £73.70 with the appliance and lamp modules priced at £24.00 each.

Another Superswitch system which uses mains wiring is the Plug-In Intercom. This FM unit can plug into any 13A socket anywhere on a ring main, and send messages

using the mains wiring.

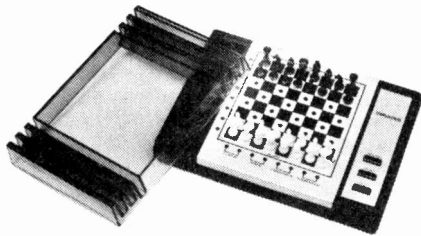
Up to 5 units can be used in conjunction with each other or a private conversation can be carried out between two units without the others on the system being able to hear. The intercom is priced at £37.45 per unit.

Superswitch, 7 Station Trading Estate, Blackwater, Camberley, Surrey.



CHESSE SENSOR

The CG1 Sensor Computer chess game from Systema has 8 levels and is priced under £30. The unit measures only 175x120x47mm and can be either battery powered for up to 50 hours from a standard PP3 or mains operated.



The unit has a built-in sensory board which is operated by pressing down on the piece you are moving, a light shows your 'from' position and pressing down the piece on your 'to' position. The computer then records your move and indicates its reply.

Other features include changeable levels during play, side changes during play, en-passant captures, castling and pawn promotion.

Systema (UK) Limited, 25 King's Road, Reading, Berkshire.

Sensalite

An automatic light switch called Sensalite enables a room light to be automatically switched on when someone enters a room where lights are needed and then automatically switches the lights off when the room is vacated.

The unit operates by looking for movement and then at the prevailing lighting condition.



When the unit detects movement it checks the natural light level and, if required, switches on the light. The level at which the lights are energised can be set by the user.

Sensalite, a 100mm cube which is linked into the existing lights has provision for an additional burglar alarm module.

The unit is priced at £85 including VAT. Leading Edge Technologies Ltd., 1-4 Kings Parade, Croydon, Surrey (01-686 0255).



A new 16K RAM pack for the ZX81 which overcomes the "wobble" or disconnection problems associated with many add-on units is also available with a keyboard sounder as an optional extra. The sounder enables a faster entry of programs from the keyboard by giving an audible feedback when a key is pressed.

The RAM pack is priced at £19.95 and with a keyboard sounder is priced at £24.95.

Ground Control, Alfreda Ave, Hullbridge, Essex, (0702 2303 24).

POINTS ARISING . . .

COMBO AMPLIFIER (Sept. '82)

The following winding details should accompany L1 in Fig. 2.8: Three layers of ten turns each (30 turns total) should be wound using 18 s.w.g. enamelled copper wire. Resistor R13 should be 15k. The drain and source annotations of TR8 and TR9 in Fig. 2.1 should each be transposed.

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.

Compec Nov. 16-19. Olympia. Z1

Electronic Hobbies Fair Nov. 18-21. Alexandra Pavilion, London. Z1

INTRON Nov. 23-25. RDS Dublin, Ireland. V

BEX Bristol Nov. 24-25. Holiday Inn. K

Northern Computer Fair Nov. 25-27. Belle View, Manchester. Z1

Christmas Holography (+items for sale) Dec. 2-Mar. (1983) Light Fantastic Gallery, London. A8

ElectroNORTH Dec. 7-9. Harrogate Supercenter. Q

IT82 (Information Technology Year Conf.) Dec. 8-9. Barbican. O

Continuous exhibitions at the National Microprocessor & Electronics Cntr. (nr. tower of London). L1

Peripherals Feb 2-4 1983. Cunard Int. Hotel, Hammersmith, London. Z1

BEX Bournemouth Feb. 9-10 1983. The Pavilion. K

Microsystems Feb. 23-25 1983. West Cntr. Hotel, Fulham, London. Z1

CAD North Mar. 1-3 1983. Belle Vue Ex. Cntr., Manchester. Z1

Mailing Efficiency Mar. 1-3 1983. Bloomsbury Cntr. Hotel, London. Z

Local Networks Mar. 8-10 1983. Royal Lancaster Hotel, London. O

Laboratory Edinburgh Mar. 16-17 1983. Assembly Rooms, George St. E

Brighton Electronics March 1983. T

BEX Leeds Mar. 16-17 1983. Dragonara Hotel. K

INSPEX Mar. 21-25 1983. National Exhibition Cntr. Birmingham International. Z1

Sensors & Systems Mar. 22-24 1983. The Forum, Wythenshawe. T

Compec Wales Mar. 22-24 1983. Cardiff University. Z1

ETM (Electronic Test/Masurement) Mar. 22-24 1983. The Forum, Wythenshawe, Manchester. T

Laboratory Manchester Mar. 23-24 1983. New Century Hall, Corporation St. E

American Holography Mar.-June inc. Light Fantastic Gallery, Covent Garden, London. A8

All Electronics Show April 19-21 1983. Barbican Cntr. London. E

Fibre Optics April 19-21 1983. Porter Tun Rooms, The Brewery (!), Chiswell St., London EC1. E

International Materials Handling April 19-26 1983. Earls Court. I

International Packaging Exhibition April 25-29 1983. NEC B/ham. I

A8 Holographic Exhibitions ☎01-836 6423

E Evan Steadman ☎0799 22612

K Douglas Temple Studios ☎0202 20533

L1 World Trade Cntr., Europe Ho., London E1

O Online ☎09274 28211

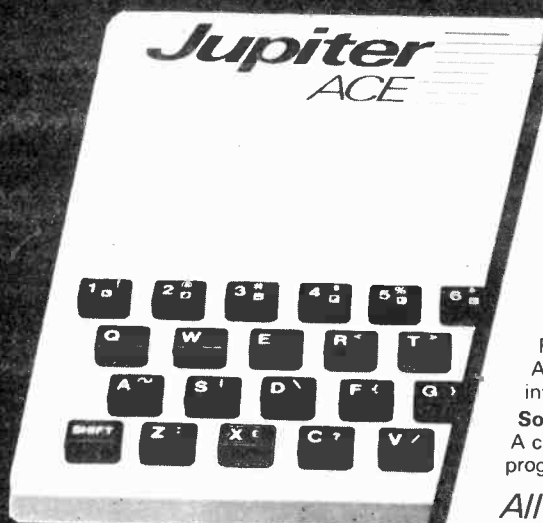
Q Exhibitions For Industry ☎08833 4371

T Trident ☎0822 4671

Z BETA Exhibitions ☎01-405 6233

Z1 IPC Exhibitions ☎01-643 8040

Jupiter ACE



only
£89.95

All inclusive price

For £89.95 you receive your Jupiter Ace, a mains adaptor, all the leads needed to connect to most cassette recorders and T.V.s (colour or black and white), a software catalogue and a manual.

The manual is a complete introduction to the world of personal computing and a course in FORTH programming on the Ace.

Even if you are a complete newcomer to computers, the manual will guide you step by step from first principles to confident programming.

The price includes postage, packing and V.A.T.

The Jupiter Ace is backed by a full 12 month warranty.

The Jupiter Ace is available only by mail order. Please allow up to 28 days for delivery. Send cheque or postal order with the form to:—
JUPITER CANTAB, 22 FOXHOLLOW
BAR HILL, CAMBRIDGE CB3 8EP

The Jupiter Ace uses FORTH

The Jupiter Ace personal computer runs in FORTH, an easily understood language, typically four times as compact and ten times as fast as BASIC. Before the Ace all personal computers used BASIC and FORTH was only available to a privileged few. The Jupiter Ace also features a full-size moving-key keyboard, high-resolution graphics, sound, floating point arithmetic, a fast and reliable cassette interface and 3K of RAM.

Available soon

Plug-on parallel printer interface.

For around £20.00 this will connect your Jupiter Ace to anything from high-speed dot matrix to letter-quality daisy wheel printers.

Plug-on 16K Memory Expansion

For around £30.00 you will increase the memory of your Jupiter Ace to 19K giving you instant access to enormous amounts of information.

Software

A catalogue will be sent with every machines, and includes, initially, programs for education and entertainment.

Technical Information

Hardware

Z80A running at 3.25 MHz.
8K bytes ROM
3K bytes RAM

Keyboard 40 Moving-key keyboard with auto repeat on every key and Caps Lock.

Screen Memory mapped 32 column x 24 line flicker-free display with upper and lower case ascii character set.

Graphics Chunky graphics (64 x 46 pixels) may be plotted, unprinted or over-plotted (XOR operation). Also, the entire character set (128 characters and their video inverses) may be redefined allowing intricate shapes to be drawn with a resolution equivalent to 256 x 192 pixels.

Sound Internal loudspeaker may be programmed to operate over the entire audio spectrum.

Cassette Programs and data in the compact dictionary format may be saved, verified, loaded and merged. Blocks of memory can be saved, verified, loaded and relocated. All tape files are named. Running at 1500 baud, the Ace will connect to most portable tape recorders.

Expansion Port Contains D.C. power rails and full Z80 Address, data and control signals. May be used to connect extra memory and other peripherals. IN and OUT words allow port-based peripherals to be addressed.

Data Structures Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types. There are no restrictions on names.

Control Structures IF-ELSE-THEN, DO-LOOP DO-+LOOP, BEGIN-WHILE-REPEAT, BEGIN-UNTIL, all may be mixed and nested to any depth.

The Jupiter Ace closely follows the FORTH 79 standard with extensions for floating point, sound and cassette. It has a unique and remarkable editor that allows you to list and alter words that have been previously compiled into the dictionary. This avoids the need to store screens of source, allowing the dictionary itself to be saved on cassette. Comprehensive error checking removes the worry of accidentally crashing your programs.

ORDER NOW!

Please send me:—

☐ JUPITER ACE MICROCOMPUTER(S) @ £89.95.

Name. Mr/Mrs/Miss _____

Address _____

_____ PE

Designed by Jupiter Cantab

Computer Designers Steven Vickers and Richard Altwasser played a major role in creating the ZX Spectrum and then formed Jupiter Cantab to develop advanced ideas in personal computing. The Ace is the result, another all-British computer to lead the world.

STYLOCHORD

Stephen Ibbs



HOW IT WORKS

The main i.c. being used is the 5024 top-octave-generator, (also coded S50240 by Tandy). From a single frequency input of 2.0024 MHz it will produce thirteen semitones, equally tuned. This frequency is generated by the astable multivibrator IC1a and b, adjustment being made by VR1. If the input frequency is halved, the 13 outputs will also be halved, sounding an octave lower. Consequently IC2b (part of a 4013), is connected as a $\div 2$ divider which feeds 1.0012 MHz into another 5024 to give another lower octave of notes. The 4013 is a dual D type flip-flop, and contains two identical circuits. If the data pin is connected to the $\bar{Q}$ pin, and the set and reset pins are connected to earth it will divide the incoming frequency by two. See Fig. 2 for details. Thus half of the 4013 was still unused, and this can be utilised to divide the output of the multivibrator prior to entry into IC2b and IC3, giving the unit an octave-down shift. Originally IC1a and b fed IC2b and IC3 direct, but it was found during development that switching in the octave shift caused a slight shift in frequency, affecting the tuning, so IC1d was included to act as a buffer, and this cured the problem.

The outputs from the top-octave-generators are connected to the appropriate keys, (see Fig. 3) and selected by either of the stylii, with S2 selecting whether one or both of IC5 and 6 are connected to each stylus. R2 and R3 are included to make sure that the inputs of IC5 and 6 are grounded when not in use. These i.c.s further divide the frequencies to bring them into the required audio octave range. Four outputs of each can be selected by the switch bank S3-S6, being square waves from IC5 and triangular waves from IC6, the change in waveform shape being accomplished by the resistors R8-R15, and capacitors C2-C5.

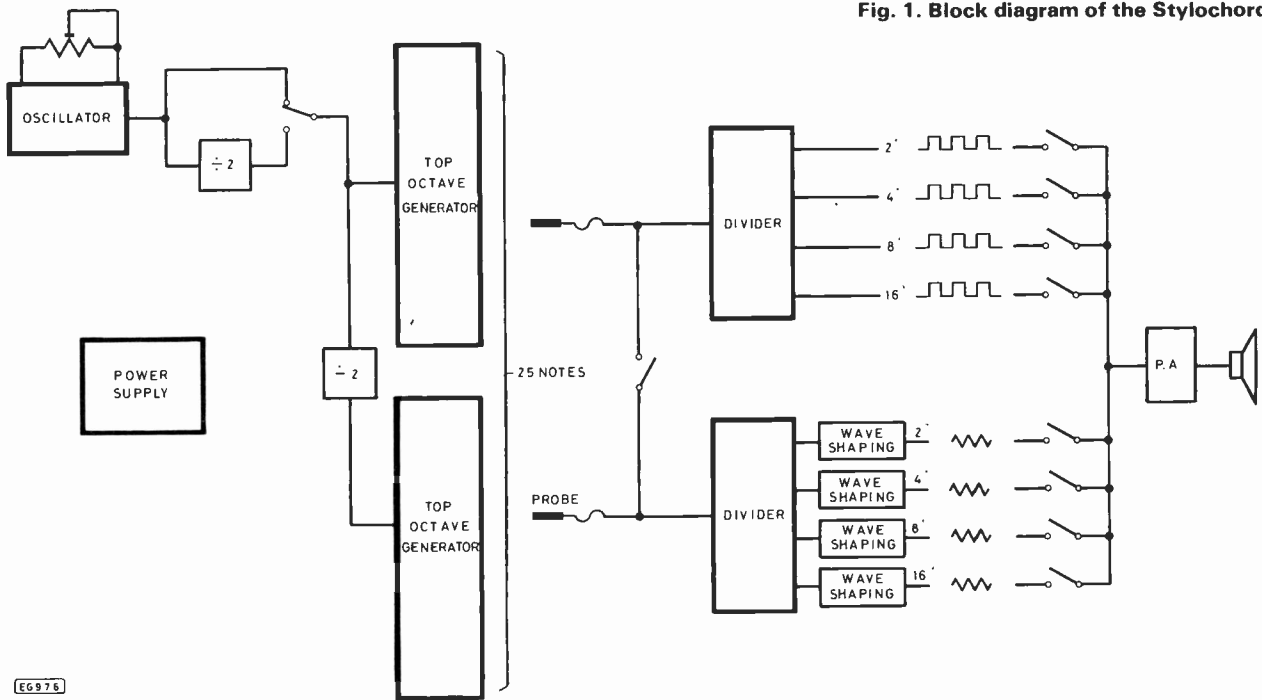
If pin 12 of IC6 is taken as an example, a square wave comes out, but R8 controls the charging rate of C2, giving a slope to the leading edge of the square wave; and R12 controls the discharge rate, giving a slope to the trailing edge resulting in an approximate triangular waveform. None of these values are critical and constructors should experiment to find the most satisfactory result. Different values will affect the waveform shape and the amplitude (loudness) of each voice.

TWIN PROBE STYLUS ORGAN

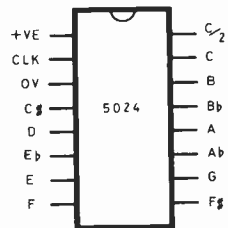
THE instrument popularised by Rolf Harris some years ago generated a plethora of similar designs, and many people clearly derived a great deal of enjoyment from these ingenious devices. With the inexorable march of progress, many i.c.s have developed, and become cheap enough for new improved designs to be produced. However, all the designs seen by the author demanded accurate resistor chains, or several presets, making the tuning of the instrument difficult. They were also limited in the sound they could produce.

The project described here is a two octave keyboard, with only one tuning preset, no resistor chains, and eight different voices: 16', 8', 4', 2' Square-wave, and 16', 8', 4', 2' triangular wave. The footages refer to the approximate physical length of organ pipes, but are used to indicate octave pitch, 8' being the standard, 16' being an octave lower, and 4' and 2' being one and two octaves higher respectively. The whole instrument can be transposed by an octave by means of a switch, and so the unit has a total range of six octaves. It contains two stylii, each controlling four voices, to enable the playing of two notes at a time, and a further switch decides whether one stylus plays one or both waveforms. See Fig. 1 for a simplified block diagram. Regular readers will note that the project is a development from the 'Instrument Tuner' (July 82).

Fig. 1. Block diagram of the Stylochord

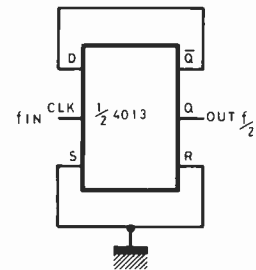
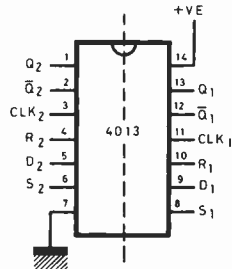


EG976



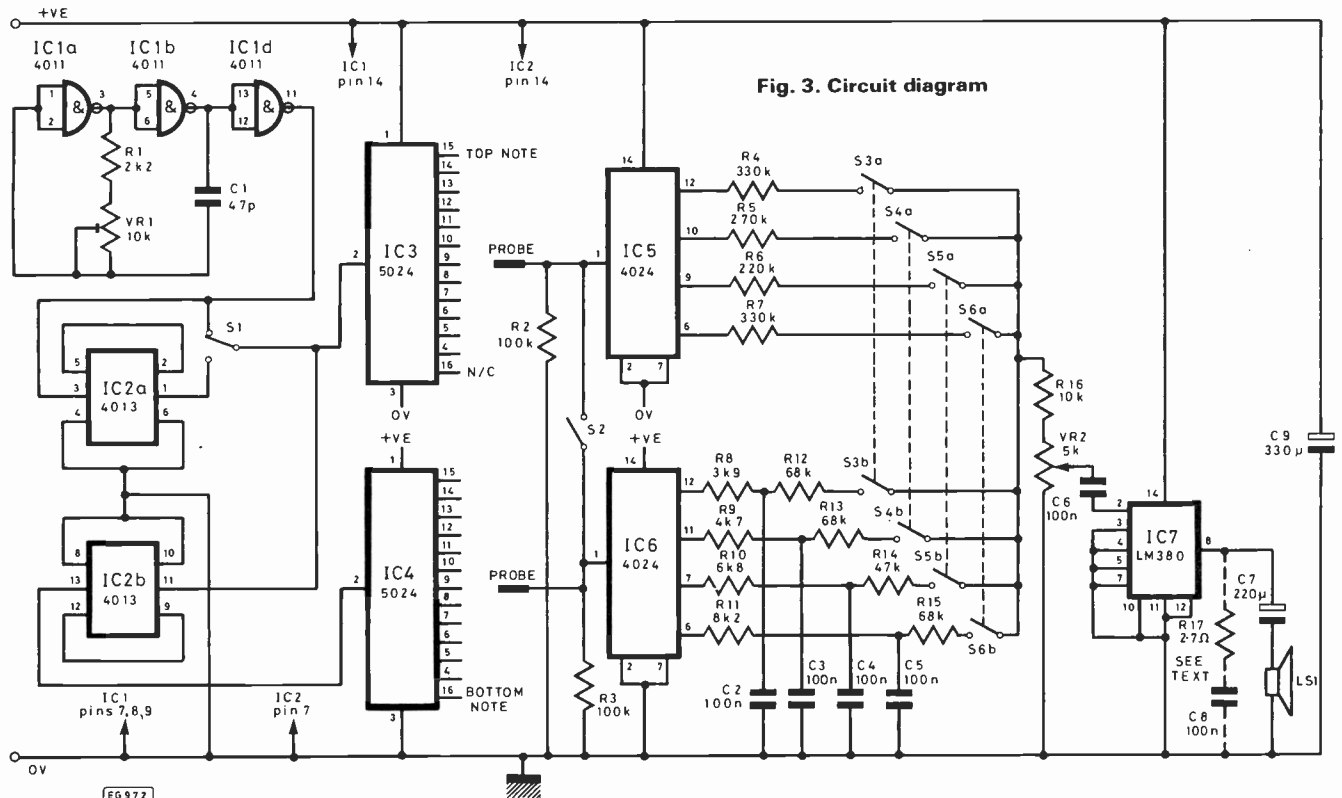
EG 972

Fig. 2. 4013 in ÷2 mode (right)



EG975

Fig. 3. Circuit diagram



EG977

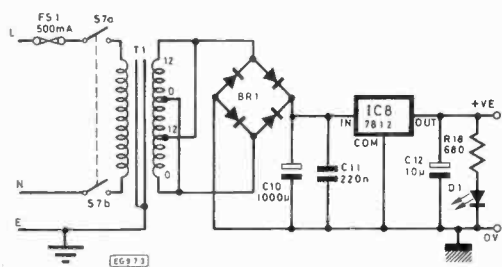


Fig. 4. PSU circuit diagram

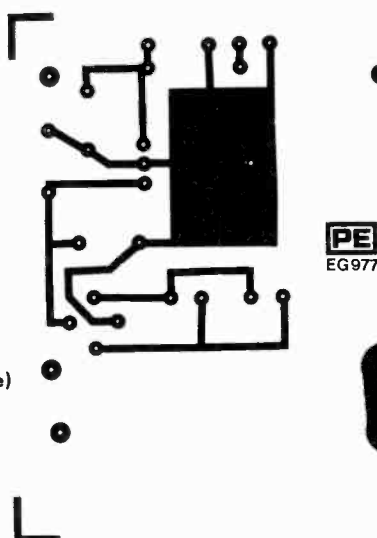


Fig. 5. PSU printed circuit (actual size)

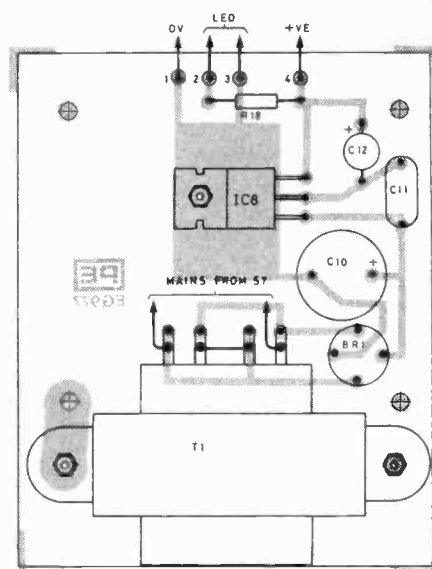


Fig. 6. PSU component layout (right)

The outputs can be switched in via S3-S6 and the result goes via the potential divider VR2 acting as a volume control to the audio amp. IC7, an LM380 2 watt i.c. If high frequency oscillation occurs, a Zobel network consisting of a 2.7 ohm resistor and a 1μ polyester capacitor in series from pin 8 to earth can be inserted, but this was not found to be necessary in the prototypes. However, space is made for these two components on the p.c.b.

The inclusion of a mains power supply may seem strange

to readers, but there are several reasons for it. IC3 and 4 require 11-16 volts, so the convenient PP range of batteries couldn't be used, and with the volume control turned up, the battery drain would be quite high. Also a mains powered regulated supply ensures a reliable voltage source, preventing frequency stability problems. Readers can, of course, omit the power supply and replace it with batteries, and it is for this reason that the power supply p.c.b. is separate.

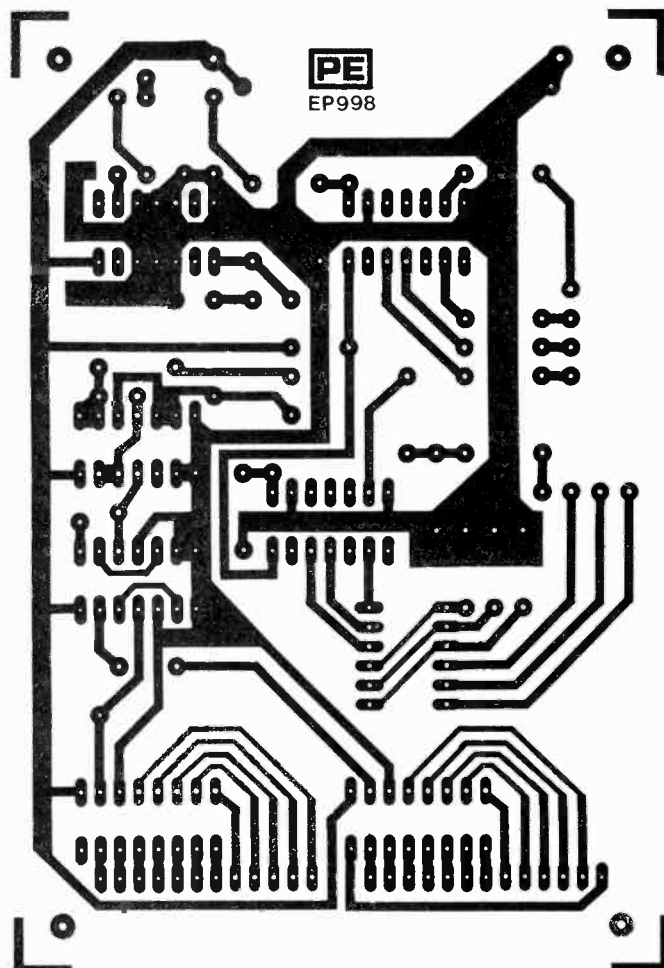


Fig. 7. Stylochord p.c.b. (actual size)

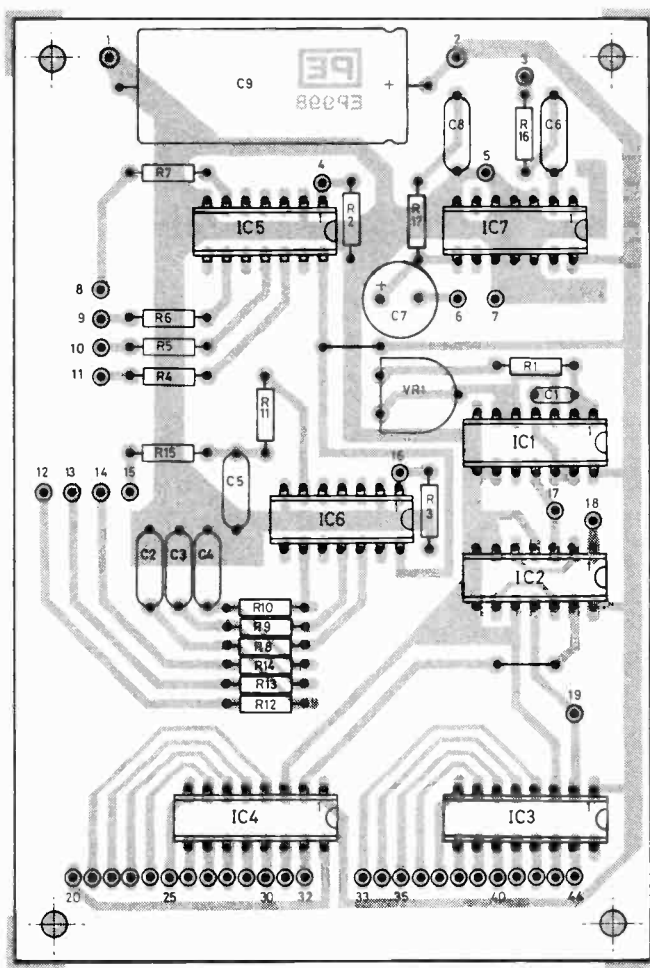


Fig. 8. Stylochord component layout

COMPONENTS . . .

Resistors

R1	2k2
R2, R3	100k (2 off)
R4, R7	330k (2 off)
R5	270k
R6	220k
R8	3k9
R9	4k7
R10	6k8
R11	8k2
R12,13,15	68k (3 off)
R14	47k
R18	680Ω
R16	10k
R17	2.7 Ohm (see text)

Capacitors

C1	47p ceramic
C2-C6	100n polyester (5 off)
C7	220μ elect.
C8	100n poly (see text)
C9	330μ elect 16V
C10	1000μ elect. 25V
C11	220n polyester
C12	10μ elect. 16V

Potentiometers

VR1	10k min horiz
VR2	5k log

Integrated Circuits

IC1	4011
IC2	4013
IC3,4	5024 (S50240 Tandy) (2 off)
IC5, 6	4024 (2 off)
IC7	LM380
IC8	7812

Miscellaneous

8 Ohm loudspeaker
 0-12, 0-12V transformer (RS 196-303 for example)
 Bridge rectifier (e.g. RS 262-141)
 2 probes
 6 off 2 pole *latching push-button* switches } SUE series
 8 way bracket, 15mm spacing } (AMBIT)
 6 knots 'A' (4 red, 2 black)
 L.e.d. + Holder
 Vero case (Order Code 75-1715G)
 D.p.d.t. toggle switch
 Knob
 20mm fuseholder and 500mA fuse
 P.c.b.s
 Ribbon cable
 Veropins, grommet, nuts and bolts etc.

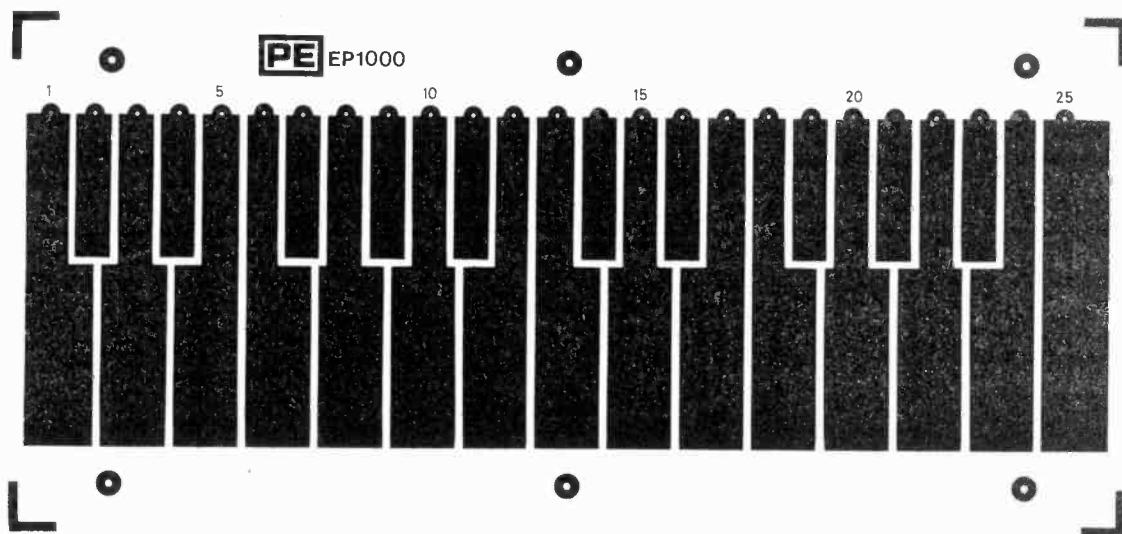


Fig. 9. Keyboard printed circuit

CONSTRUCTION

Readers are advised to use p.c.b.s, designs for which are given in Figs. 6 and 7, as this makes construction easier. There are quite a lot of interconnections to be made, and the prototype used ribbon cable, so that each wire is individually colour-coded and therefore easily traceable. Assemble the components, making sure that the i.c.s, diode, capacitors, and voltage regulator etc. are the correct way round. It is recommended that single-sided Veropins be used as solder terminals for all the wires.

The main p.c.b. and the power-supply p.c.b. are bolted to the base panel of the case, and the plastic housing is drilled to accept the cable retention grommet, fuseholder, speaker holes, switches, l.e.d., pot and probe sockets, see drilling details in Fig. 10.

The aluminium panel for the keyboard is cut and the keyboard mounted behind this with small spacers, nuts and bolts. The smaller aluminium panel is drilled to accept the switch bank. These switch modules are much cheaper than miniatures toggle switches, and the finished result looks extremely professional. Slot them into the 8-way bracket (positions 2 and 7 are left blank), bend the small tabs over to retain them, and then mount the unit behind the panel.

Make all wire interconnections (except those connecting the power supply to the main p.c.b.), taking care, as there are a number of them. See Fig. 11. Shielded audio lead was used where necessary, to avoid hum pick-up, and the case of the pot was earthed. When a final check has been made, turn on the mains and check that 12V is delivered by the regulator, and if so, turn off, connect up the two p.c.b.s

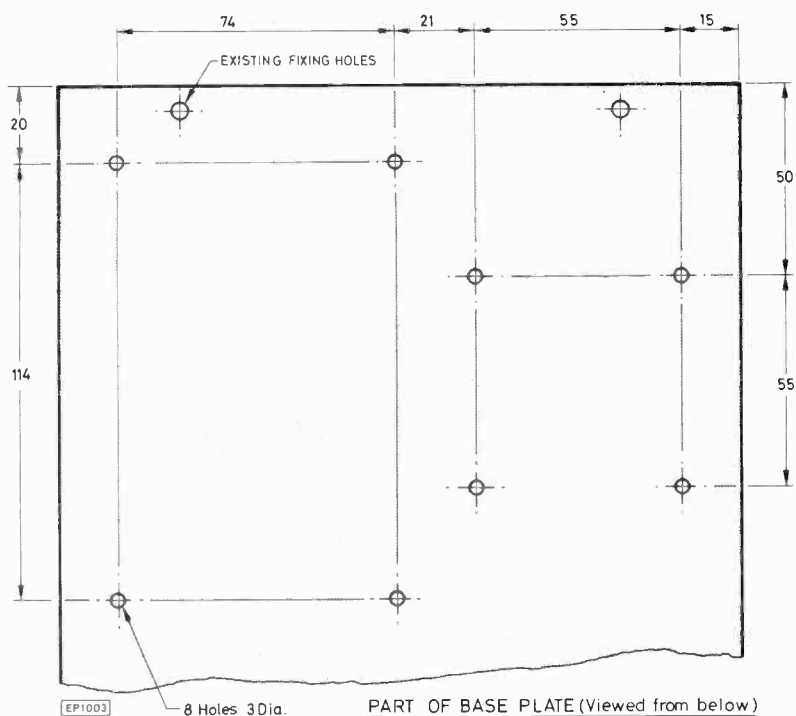


Fig. 10(a). Base plate drilling details

Fig. 10(b). Switch fascia drilling details

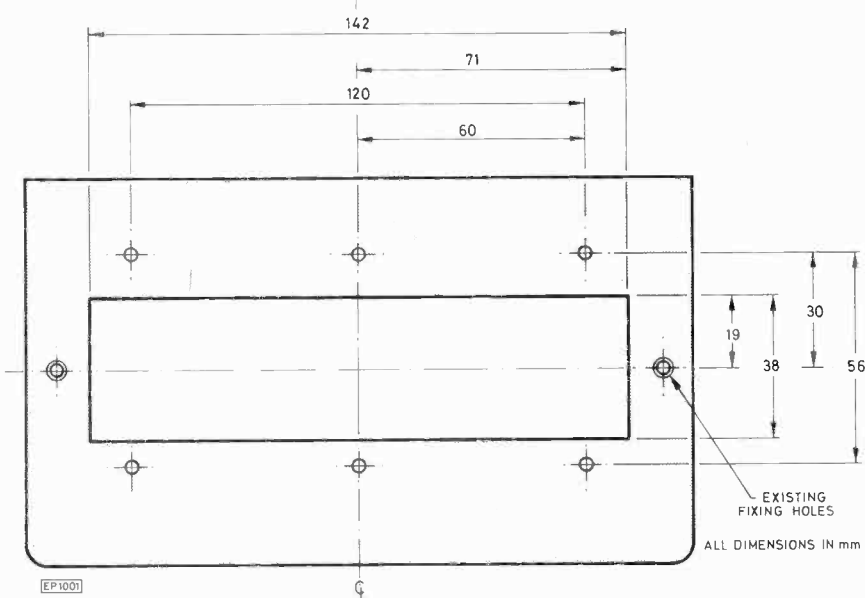
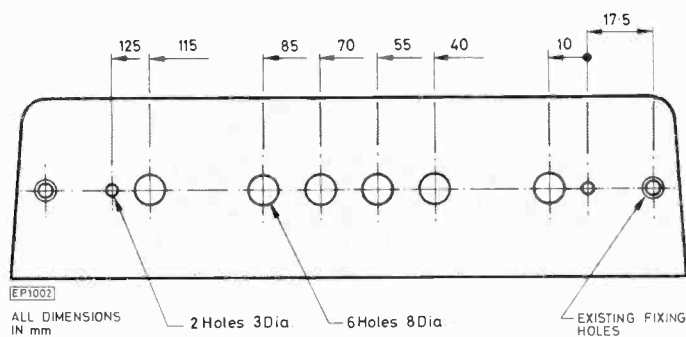


Fig. 10(c). Keyboard bezel details

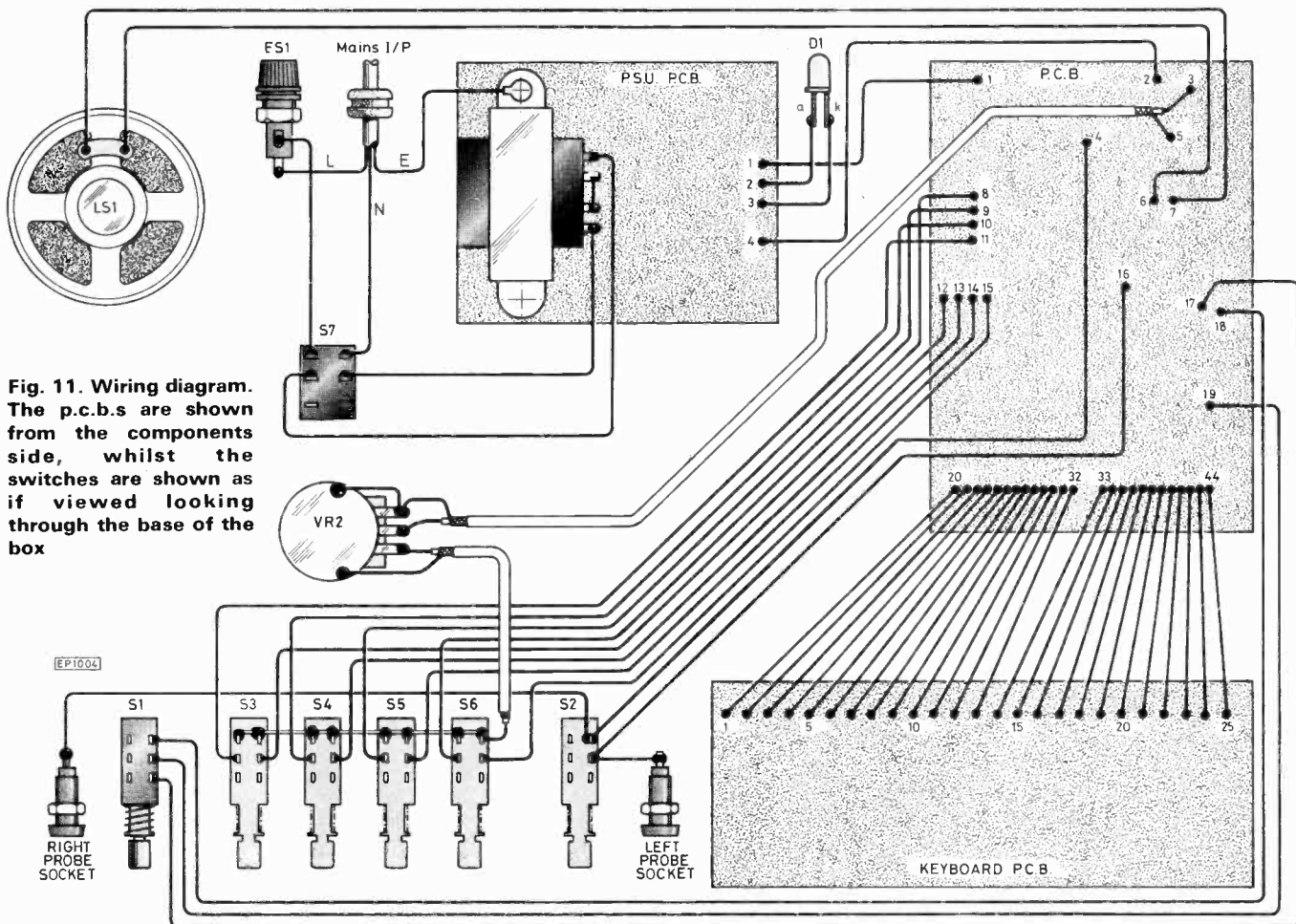
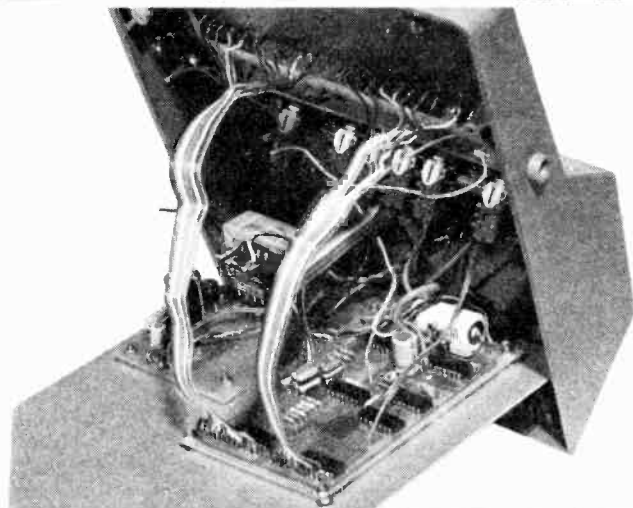


Fig. 11. Wiring diagram. The p.c.b.s are shown from the components side, whilst the switches are shown as if viewed looking through the base of the box

and turn on once more. Adjust the preset VR1 to tune the whole instrument up or down as necessary, and if all is well, bolt the unit together. You are now ready to start playing. If the probe switch is closed you cannot use both probes as you will try to put two different frequencies into ICs 5 and 6. A nasty sound will result!

CONCLUSION

The author has a prejudice against the vibrato effect, and so did not include one, but readers who are adventurous enough will find scope for development in this instrument, such as adding a phaser or a delay unit. However, the unit as described should give many hours of enjoyment, with various combinations of voices and stylis being possible. For greater variety, switches S3-S6 can be separated 'a' and 'b' to give e.g. 16' square with 2' triangular ... a *pig-and-whistle* effect! ★



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New developments in UK Robotics

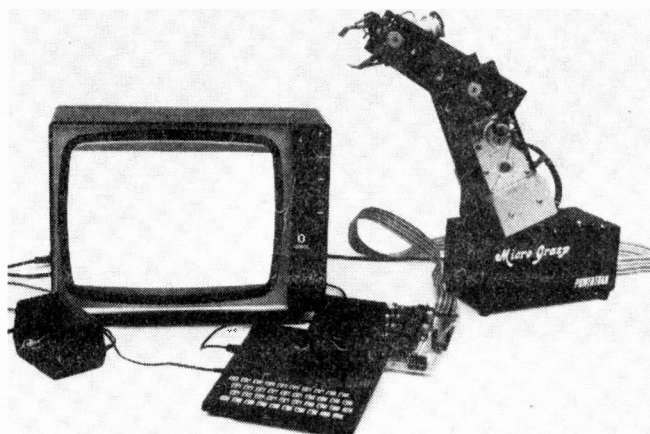
ADVANCED DESIGNS FOR EDUCATION, INDUSTRY AND THE HOME CONSTRUCTOR

Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus – the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer-specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply	£125.00
Universal computer interface board kit	£48.50
23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00

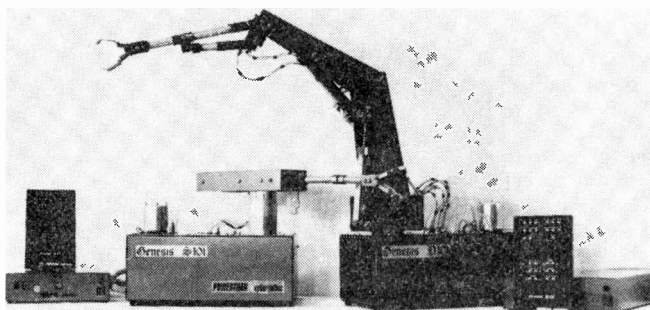
HEBOT II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control – forwards, backwards, left and right – with each wheel independently controlled. It has blinking eyes, beeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled to its shell return data, about its environment, to the computer for it to calculate evasive or exploratory action. Hebot II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a ZX81 or other computer.

Hebot II kit	£75.00
Universal computer interface board	£10.00
23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00



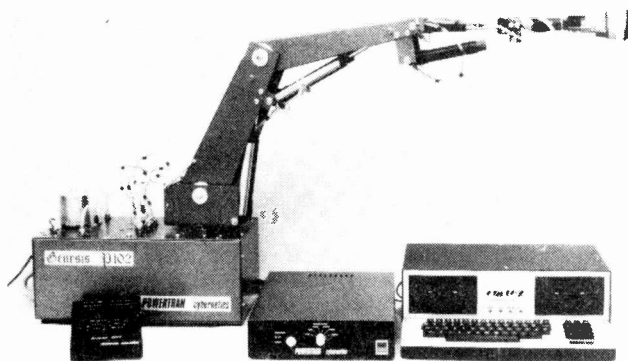
MICROGRASP, INTERFACE BOARD AND ZX81

'HIGH-TECH' FROM HANTS . . .



GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operates from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.



GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER

Top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory, position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

6 axis system READY BUILT	£1950.00
Powertran CORTEX 16 bit 64K computer Kit	£295.00;
READY BUILT £395.00	
(Electronics Today International December issue on CORTEX)	

Example prices and specifications

Genesis S101

Base: 19.5" x 11" x 7.5"
Lifting capacity: 1500gm
Arm lift: 6.6"
Weight: 29Kg

4 axis model in kit form £390
5 axis model in kit form £445
5 axis model READY BUILT £790

Genesis P101

Base: 19.5" x 11" x 7.5"
Lifting capacity: 2000gm
Arm lengths between axes: 14.0"
Weight: 34Kg

4 axis model in kit form £495
6 axis model in kit form £595
6 axis model READY BUILT £950

COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE

Genesis S101

4 axis system in kit form £635.50
5 axis system in kit form £695.00
5 axis system READY BUILT £1355.00

Genesis P101

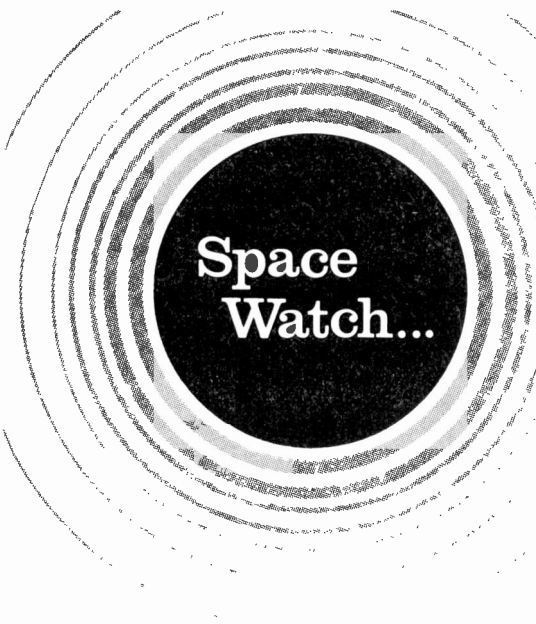
4 axis system in kit form £742.00
6 axis system in kit form £852.00
6 axis system READY BUILT £1525.00

As featured in this journal November '81–April '82 issues.

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Space Watch...

ASTRONOMICAL OBSERVATIONS BY REMOTE CONTROL

Astronomers of the Royal Observatory of Edinburgh have achieved a technological superiority by remotely controlling the UKIRT (United Kingdom Infra Red Telescope) on the 14,000ft. high peak of Mauna Kea, Hawaii, from a computer terminal in Edinburgh. This experiment will lead to improved flexibility in the use of major astronomical facilities.

When this project was in its early stages there was great concern about the high cost of the movement of personnel to attain the best advantage from the site. Not only is it the best site from the reason of *seeing* but it has special advantages because of its height above sea level. The disadvantages lay in the cost of personnel movement, the difficulty of working at the height, even after long acclimatisation for any length of time and the limited hours that could be devoted to observations. Now this problem is solved and not only will personnel benefit but far more time will be available for the operation of UKIRT. For example all operations can be carried out from sea level and it will be possible to operate the telescope from Edinburgh during normal office hours for night time activities in Hawaii. The reason for this is, that the observers will be able to operate from any terminal connected to the SERC computer network, including all users of the STARLINK network.

Other advantages are that when unusual weather is prevailing the special observations, which can only be made at these times, may be undertaken. All this is now possible at a cost of normal leased lines and networks. Once again necessity provides not only the solution but also the expertise. It is perhaps worth noting that no longer can the cry of no money for essentials be raised. The remote control facility provides two levels of operation at the 1.8 metre UKIRT site. Almost all the operations that can be carried out at the Hilo laboratory in Hawaii including television reception are already available to the remote user via a 2-channel 9600bit/sec lines to the

telescope. This facility is expected to be in use for extensive observations at the longer infra-red wavelengths and also sub-millimetre wavelengths during daytime hours. The second level of operation, pioneered by the first breakthrough of this system, is a 1200 bit/sec intercontinental link to any United Kingdom astronomer with a terminal of the SERC computer network SERCNET.

For the purpose of the first experimental observations the terminal was linked via the GEC 4090 computer at the Royal Observatory in Edinburgh to the Regional centre then via SERCNET to the Rutherford Appleton Laboratory in Oxfordshire. Thence by the British Telecom PSS (Packet Switching Service) to the IPSS (international Packet Switching Service) through a transatlantic common carrier by TELENET. The nearest node centre of TELENET is at Honolulu. From there to the Hilo Laboratory of UKIRT by leased telephone lines. Though this sounds a little complicated the delay is only between 3 and 6 secs. This did not prove to be a difficulty in the first experiment. The entire communications during the preparation times were quite good according to the staff astronomers at Hilo, David Beattie and Dr. Ian Gatley. A significant point to be made here is that the total cost was some £80. The establishment of the remote facility had been achieved through the work of Peter Thanisch and Dr. Peredur Williams under the direction of Dr. Terry Lee in Hawaii, B. McNally at the Royal Observatory Edinburgh and Dr. P. Bryant at the Rutherford and Appleton Laboratory.

The Historic experiment took place on the 6th September this year when Malcolm Stewart secured an infrared photometric measurement and a spectrophotometric scan of the star HR 8824.

ARIANE

Following the great hopes, the Ariane launcher has again failed. There has now arisen a situation that the Insurance companies must face with current claims against losses having already reached very high figures. This is another of those hiccups which are usually very firmly pushed into the background. Such a long record of failure has dogged this enterprise that it is not easy to continue to hope for success. Is there perhaps a lesson to be learned from the history of the whole project? Are such questions as "is it wise to adopt the composite philosophy for the motors of a launcher" justified?

From an observer's point of view this seems pertinent enough, yet is it perhaps unfair to speculate without a great deal more first hand information. This is not just "one of those things", too many things seem to happen to this project. It suggests that there are areas of incompatibility. Is it concerned with the materials or components. Are there different standards under the same specification. Is the real cause satisfactorily diagnosed. This raises many other questions also. Is the launching site viable. It would seem timely to begin some horizontal thinking. If as was stated, the vehicle was fully qualified at what stage did the onset of failure occur?

Other failures are also continuing in other places and if Insurer's raise the premiums or the operators under-insure then developing industries may fail. What of the computer

modelling. How much of such technology has been applied. Many fantastic claims for such steps have been made especially *after* the events. Why not fund one of the claimants that continually pour out pamphlets, set up seminars at high cost and show little in practice. Is there too little hard practical engineering skill being applied. It is easy to cry wolf. This is true but perhaps such an emotional approach may inspire a defence.

TWENTY FIVE YEARS OF SPACE ACTIVITIES

For twenty-three years of this period the United States has made successful launchings of 44 vehicles for communications, weather and navigational activities. In addition there have been some 62 launches of a similar nature under International agreements. These particular satellites by the use of microwave techniques are able to function by line of sight since neither the atmosphere nor the curvature of the Earth are obstacles. Moving in straight lines, the signals can be acquired by earth based stations and passed on, or linked with other satellites. The now famous early suggestions by Arthur C. Clarke, made in the early forties and which earned him the universal credit for the invention of satellite communication systems, have become an active reality.

The most economic distance for profitable use, both technically and financially, is between 800 and 1,000 kilometres. The famous *Early Bird* was launched in 1965 and was the first of the communications satellites. *Early Bird* now renamed Intelsat 1, had a capacity for 240 channels of data or telephone and also had one television channel. The satellite had a life of three years and weighed 60 kilogrammes. Twenty five satellites later the Intelsat series 5 was launched in December 1980 and weighs 1,870 kilogrammes. Its life will be seven years and has 12,000 voice circuits and two television channels. Intelsat has 106 member countries and provides communications services to more than 150 countries.

The regulations of the United States Government prohibit the use of domestic satellites for overseas communications. All overseas communications in the Comsat network have to use the Intelsat network for the overseas link. It is getting crowded now and serious attention is being given to the difficulty which is a matter of rearranging the separation distances. This will be one of the subjects of the next issue of SPACEWATCH.

INDIA & SPACE

Russia has been assisting India to design and launch satellites for scientific studies including remote sensing and communications. During the late Yuri Gagarin's visit to India, soon after his epic mission, India determined she would have a cosmonaut. Nothing was done about it though it was discussed at a meeting in Moscow in 1978 with Moraji Desai, the Prime Minister of India at the time. Now some 8 Indian pilots are queuing for a cosmonaut assignment.

Frank W. Hyde

MICROGRASP was designed to be priced at under £200 inclusive of power supply, computer interface board and even VAT! However, despite that restriction, it has some very powerful features. Driven by a simple computer, the ZX81 being eminently suitable, Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about the base and there is a motor-driven gripper. Each of the arm movements is servo controlled i.e. there are position sensors feeding back information to the interface board, where it is compared with the programmed-in intended position, and automatically taking corrective action. This servo action is independent of the computer, greatly simplifying the software to drive the robot and all programming is carried out with a small number of Basic commands.

MECHANICAL OPERATION

For each of the five axes there is a motor with integral gearbox. For the wrist and gripper motors small in-line gearboxes are used. The other axes use more powerful gearboxes in heavy duty zinc alloy castings. The shoulder and elbow joints are driven directly from the motors gearboxes with both motors mounted on the lower arm (Fig. 1). On the upper arm and the shoulder support bracket are steel bushes clamping the gearbox shaft so that when the motors are driven there is relative movement between the lower arm and the upper arm and the support bracket.

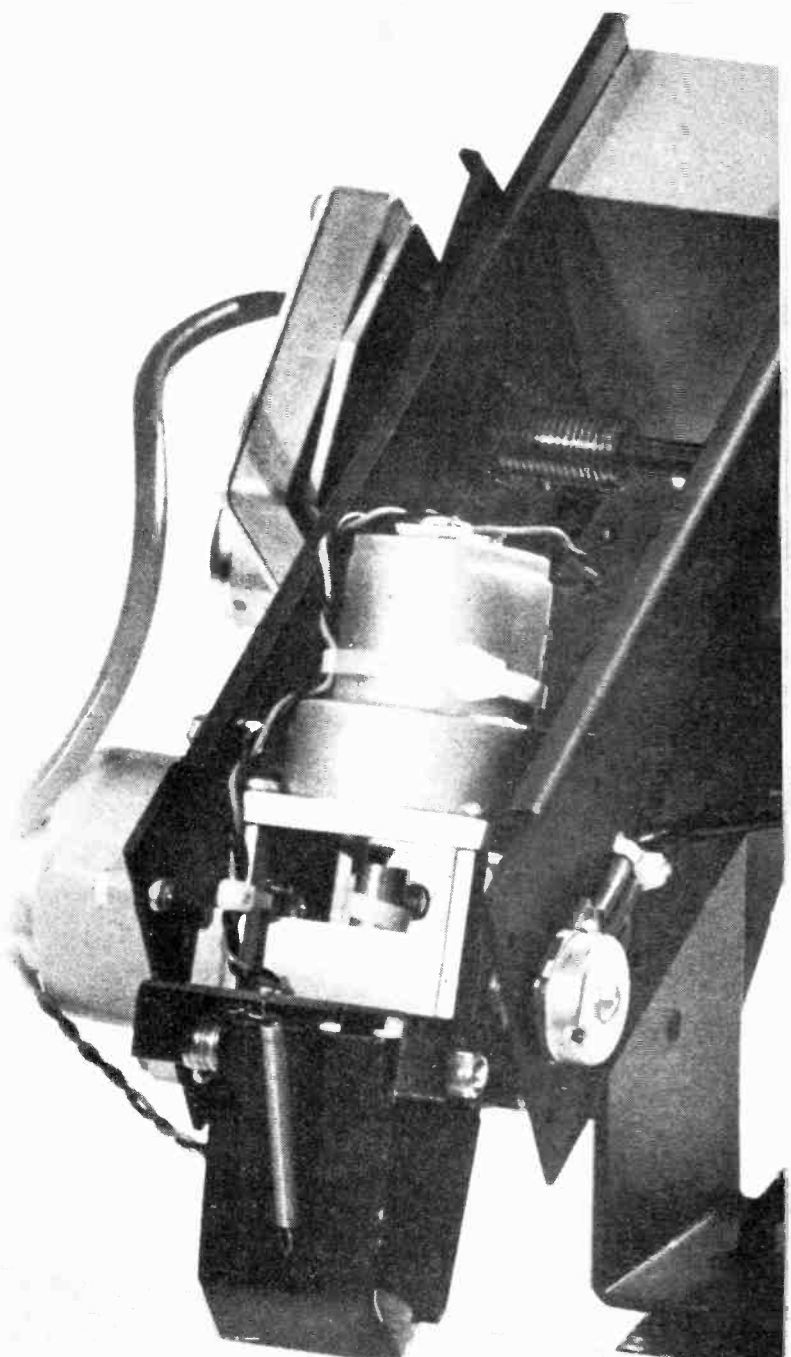
Also on the lower arm are the position sensing potentiometers. On the bushes of these are plastic bushes on which the arm rotates. The shaft of each potentiometer is held in the steel bush fitted to the upper arm or support bracket.

For rotating the arm (axis 0) it is not possible to have the gear box shaft, the potentiometer and the shoulder support bracket all in line so the power is taken from the gearbox (Fig. 2) by a pair of spur gears which being of 2:1 ratio result in a doubling of torque. For this axis the gearbox shaft is taken out from the motor side of the gearbox.

For raising and lowering the wrist (axis 3) the gearbox shaft rotates a bar to which the potentiometer shaft and gripper mounting plate are fitted (Fig. 3). Through this bar the drive shaft for the gripper lead screw passes. When the

The Genesis range of robots published in these pages last winter have most effectively filled their role of providing a low cost introduction to robotics. Although their price is well within the budgets of further education establishments, industrial production and research and development departments; state run schools and home constructors have found it more of a struggle to raise the funds. In order to provide them with hands-on-experience of robotics we have created the ultra low cost Micrograsp.

At the same time further development of the Genesis P101 has resulted in P102, a higher performance version.



PE
MICROGRASP
PART 1
RICHARD BECKER

screw turns clockwise the disc nut is moved in pulling the jaws together (Fig. 4). On turning anticlockwise the disc nut moves out and the springs pull the jaws apart.

The arms for the robot each have counterbalance weights so that no voltage needs to be applied to the motors to hold the arm in the desired position. This improves the accuracy of the servoing. Without balancing an error signal would

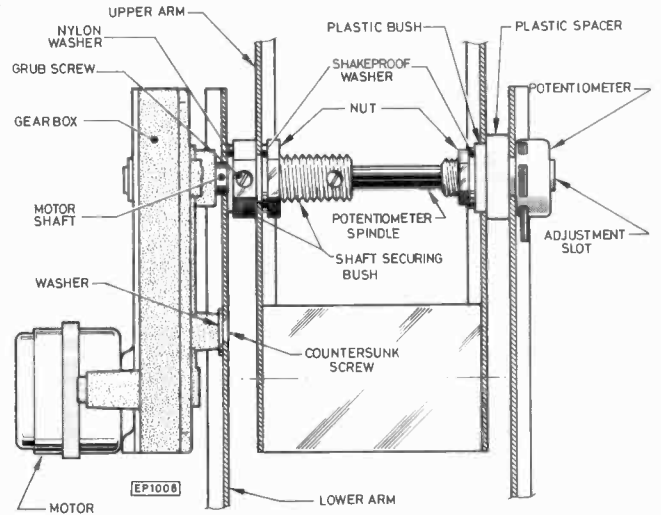


Fig. 1 Linkage between the motor, arms and potentiometer for axis 2 movement. Axis 1 operation is similar

(Left) Showing central position of the above linkage assembly

(Below) Interior of robot base showing Fig. 2 linkage and power supply

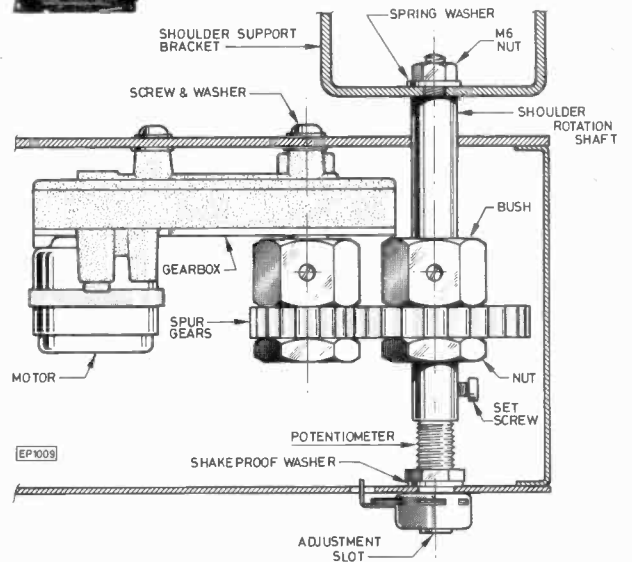
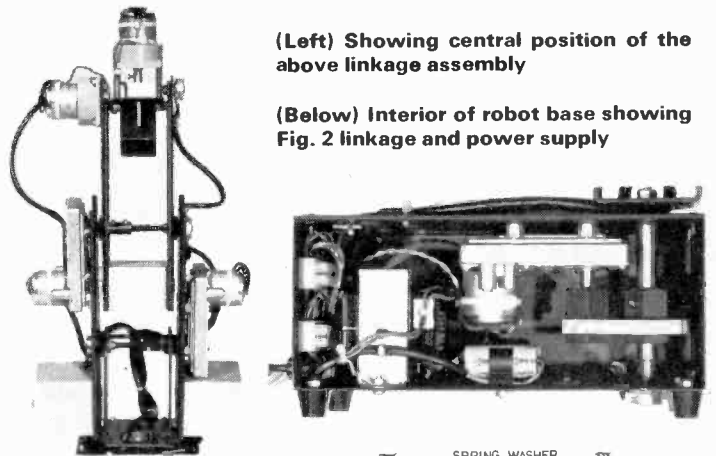


Fig. 2 Linkage between motor, spur gears, shoulder support bracket and potentiometer for axis 0 movement

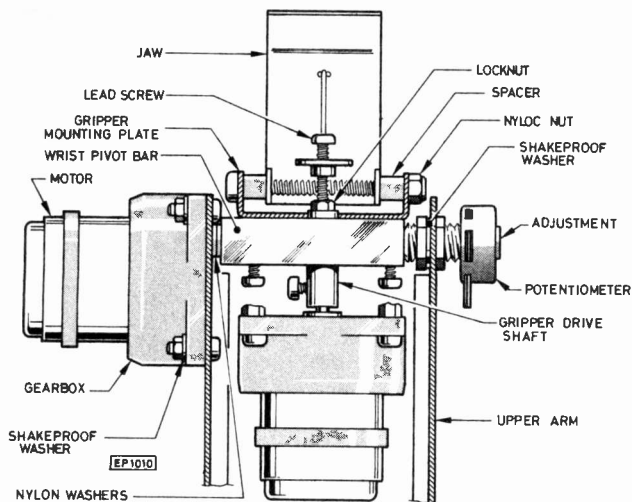


Fig. 3 Linkage between motor, gripper mounting bar and potentiometer for axis 3 movement

always be required for the arm to be motionless and a considerable torque would also have to be provided by the gearboxes causing an undue strain upon them.

CIRCUIT OPERATION

The interface board is designed to operate as a memory mapped peripheral of the controlling computer which generates the positional and manipulative commands whilst servoing is taken care of by linear circuitry on the interface board greatly simplifying the work of the computer and avoiding the requirement for extensive software specific to each type of machine. Some computers have I/O ports by which data could be sent to the robot, however the commonest and cheapest computer on the market, the ZX81 does not have this facility. It does however have an expansion bus giving access to all the address, data and control lines. Virtually all other micro computers also have this facility making practical a universal interface. The signals required are the address bus, data bus, Write and Mem REQuest. The connector format choice could have been arbitrary but in view of the particular cost effective suitability of the ZX81 the layout of that machine was selected and by using two back-to-back 23 way double sided connectors, a very neat connection with no wires can be made.

For any other computer a 23 way connector would be wired to one of the type recommended by that computers

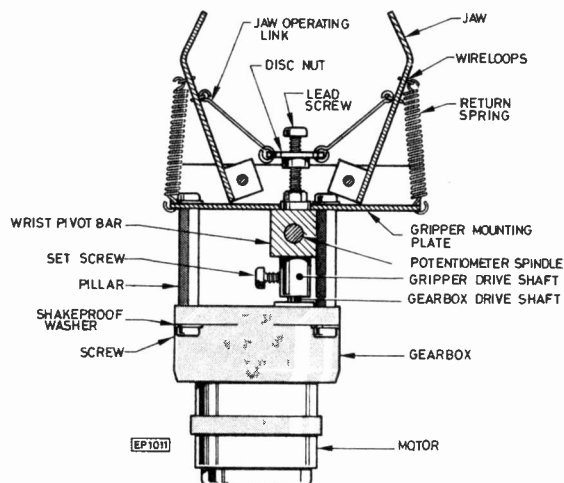


Fig. 4 Operating mechanism for the gripper

manufacturer. Using back-to-back connectors does however prevent the use of the 16K RAM pack limiting program length to about 30-60 lines. This restriction is avoided by use of the three way adaptor p.c.b. (Fig. 5) whereby the RAM pack lies neatly on top of the computer.

By setting the ten bank DIL switch (Fig. 6) any one of 1024 blocks of 64 bytes of the memory area can be selected. Actually only six bytes are required but to narrow down the memory area used would call for extra circuitry and with memory costs per byte of around 0.15p or less such extra complexity is pointless. IC2 is a ten bit comparator. The ten most significant address lines are compared with the +5V or 0V levels set up by the switch and when there is a match, i.e. when the computer selects an address within the 64 byte block, pin 13 goes high. The three least significant address lines are connected to IC3, a three into eight decoder, to select which axis is to be given a fresh command.

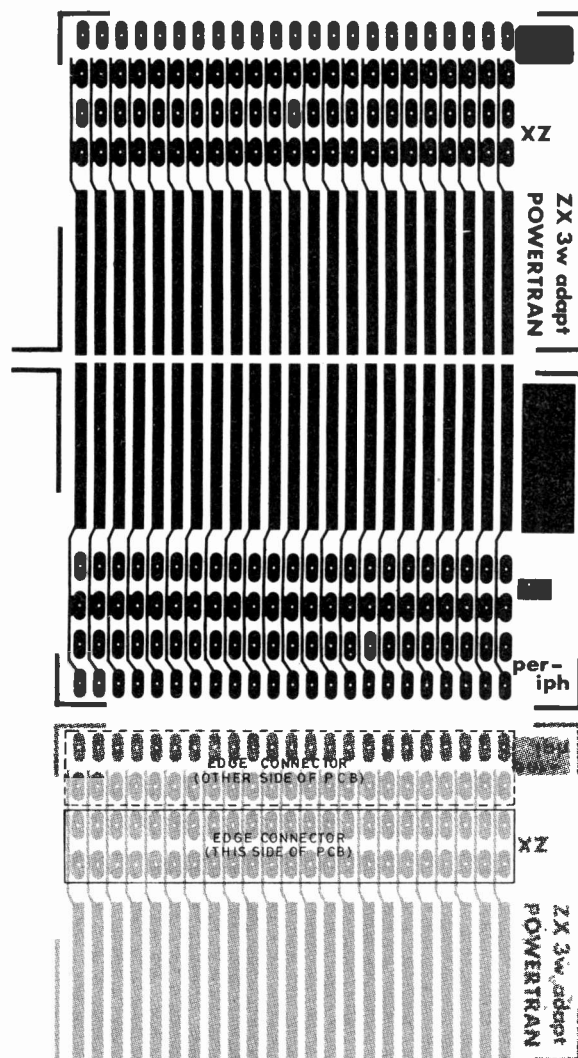


Fig. 5 Printed circuit of three way adaptor

The output of the decoder is enabled only when WR and MREQ are low and IC2 pin 13 is high i.e. when the computer is addressing the chosen axis as if it were a memory location into which data is to be written. For example if the top of the address space is to be used all the switches would be set to be open therefore addresses 65472-65535 are allocated to the robot. To move the rotation axis (servo circuit A) to the centre position the command would be POKE 65472, 128. 128 being the centre of the range of positions defined as 0

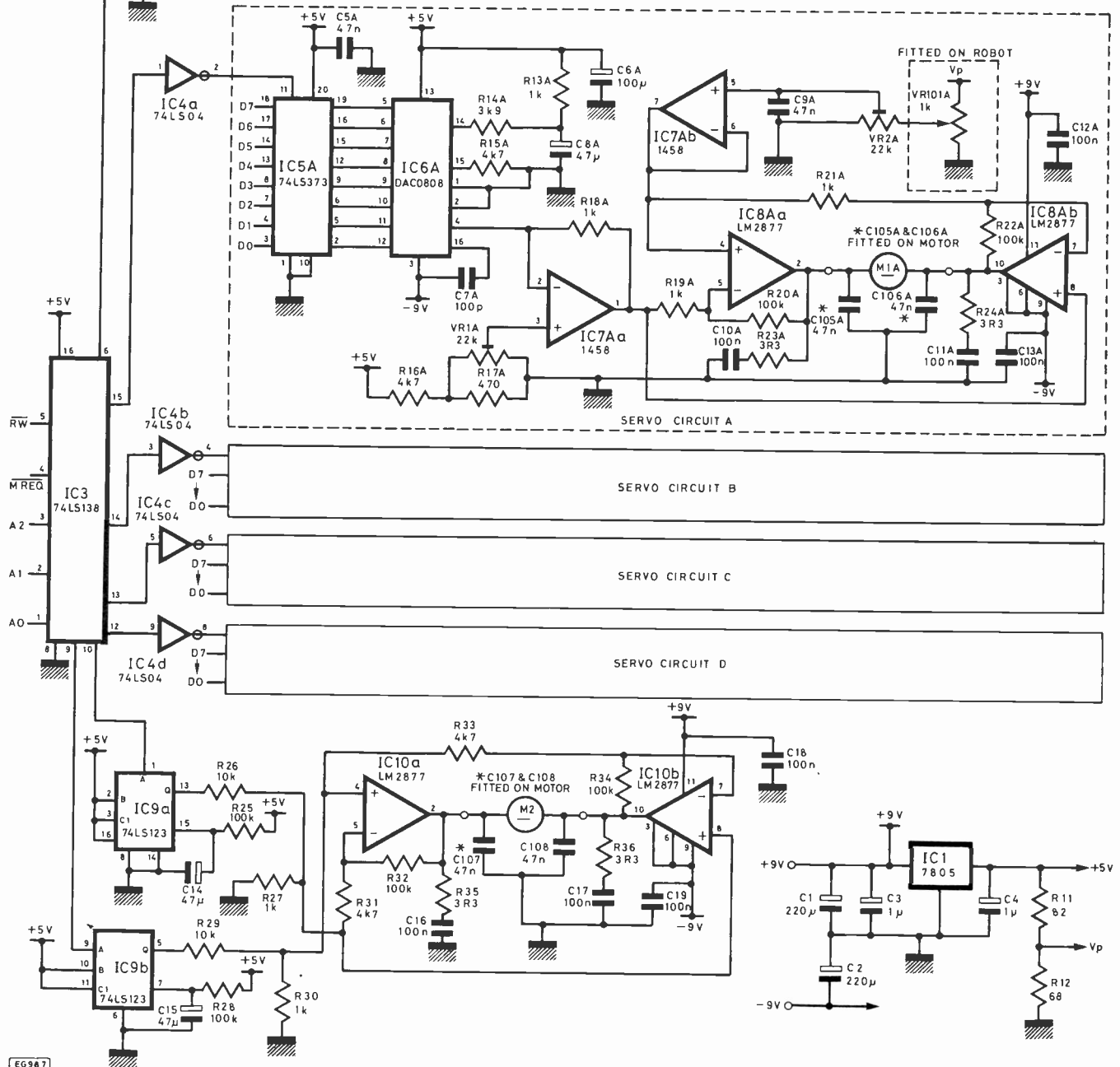
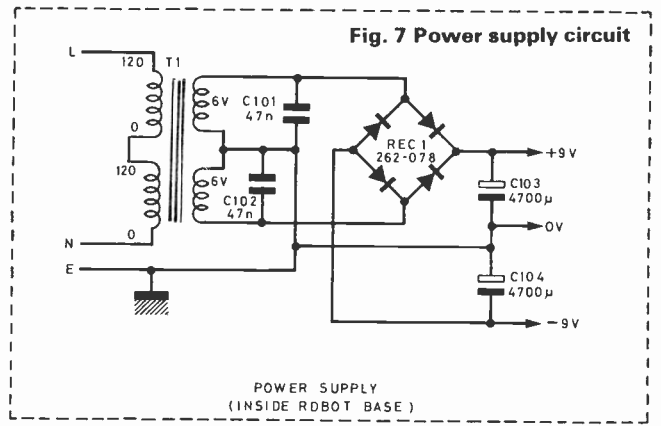
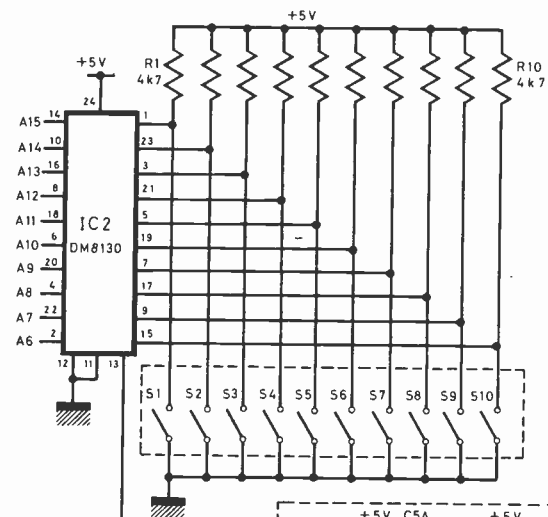


Fig. 6 Circuit of computer interface

COMPONENTS

INTERFACE BOARD

Resistors

R1, R2, R15A-D, R16A-D, } R31, R33	4k7 (12 off)
R3-10	4k7 SIL network
R11	82R
R12	68R
R13A-D, R18A-D, R19A-D, } R21A-D, R27, R30	1k (18 off)
R14A-D	3k9 (4 off)
R17A-D	470R (4 off)
R20A-D, R22A-D, R25, R28, } R32, R34	100k (12 off)
R23A-D, R24A-D, R35, R36	3R3 (10 off)
R26, R29	10k (2 off)

Potentiometers

VR1A-D, VR2A-D	22k preset (8 off)
----------------	--------------------

Capacitors

C1, 2	220µ/16V vertical electrolytic (2 off)
C3, 4	1µ/16V tantalum (2 off)
C5A-D	47n ceramic (4 off)
C6A-D	100µ/10V vertical electrolytic (4 off)
C7A-D	100p ceramic (4 off)
C8A-D	47µ/10V vertical electrolytic (4 off)
C9A-D	47n polyester (4 off)
C10A-D, C11A-D, } C12A-D, C13A-D, }	100n polyester (20 off)
C16-19	
C14, C15	47µ/6V3 tantalum (2 off)

Integrated Circuits

IC1	7805
IC2	DM8130
IC3	74LS138
IC4	74LS04
IC5A-D	74LS373 (4 off)
IC6A-D	DAC0808 (4 off)
IC7A-D	1458 (4 off)
IC8A-D, IC10	LM2877 (5 off)
IC9	74LS123

Miscellaneous

Printed circuit board	
S1-S10-SPST 10 bank DIL switch	
TV5 heatsink	
8 pin i.c. socket (4 off)	
14 pin i.c. socket	
16 pin i.c. socket (6 off)	
20 pin i.c. socket (4 off)	
24 pin i.c. socket	

ROBOT

Capacitors

C101, C102, C105A-D, } C106A-D, C107, C108 }	47n ceramic (12 off)
C103, C104	4700µ/16V horizontal electrolytic (2 off)

Diodes

REC1	6A rectifier block
------	--------------------

Transformer

T1	0-120V, 0-120V primary 6-0-6V at 4A secondary
----	--

Potentiometers

VR101A-D	1k linear
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Miscellaneous

Motors, mechanical parts, fixings etc.
A kit of parts is available from—

**Powertran Cybernetics,
Portway Industrial Estate,
Andover,**

Hants, SP10 3NN £125—Robot plus 15% VAT
£48.50—Interface plus 15% VAT.

to 255. Because of the redundancy in address selection 65480, 65488, 65496, 65504, 65512, 65520 and 65528 would be equally effective addresses.

The decoder enables IC4 which is an eight bit wide data latch which holds the data indefinitely after the writing-in process is completed. The data is converted into a d.c. level in the range 0V to 1V by IC6 which is a digital-to-analog converter and IC7a converts the current output of the DAC into a voltage, the feedback resistor R18 giving it a gain of 1 volt/ma. IC7a is also used to add in an offset voltage to balance out the residual voltage from VR101 when the axis is at its zero code position i.e. lowest or furthest left position. The position of the axis is sensed by VR101 to which is applied about 2V derived from the 5V rail via R11, R12. 1V corresponds to the position in the centre of the travel of that axis. VR2 is used in setting the range of movement and IC7b is a unity gain buffer enabling the low (1k) input impedance of the power amplifier stage to be driven without loading VR101 significantly.

IC8 performs two functions simultaneously. It compares the measured position of the axis with the programmed-in desired position and serves as a bridge output power amplifier to drive the motor either backwards or forwards with a voltage dependent on how far away from the desired position the axis has reached. To see how the circuit operates,



Micrograsp with computer interface board, RAM pack and adaptor

first we consider the half with pins 7, 8, 10. The desired position voltage (DPV) is applied to pin 8, feedback via R22 makes pin 7 a virtual earth point elevated above ground by the voltage on pin 8. The measured position voltage (MPV) forces a current into this point via R21 resulting a voltage at pin 10 which is $R22(DPV-MPV)/R21$ i.e. pin 10 will go positive when MPV is less than DPV.

The other half of the i.c. behaves similarly except that pin 2 will go negative when MPV is less than DPV. As the circuit is symmetrical the voltage applied to the motor is therefore twice $R22(DPV-MPV)/R21$. The components selected resulting in a servo action which is close to critically damped.

R23 + C10 and R24 + C11 are the Zobel networks used almost universally to stop power amplifiers becoming power oscillators in the MHz region.

Capacitors C12, C13 are for local decoupling to also assist in ensuring stability and C105, C106 are suppression capacitors fitted as close as possible to the motor. Without these the interference from the motor brushes is sufficient to make the computer abort its program. Only four of the five axes are servo controlled as the gripper needs only to be either holding or releasing.

The gripper is activated by a motor turning a lead screw which then pulls together the jaws. To hold an object IC9a is triggered in a manner similar to the enabling of the data

latches. This monostable then provides a signal for about 2 seconds, as determined by R25, C14, which causes IC10 to apply a voltage to the motor to pull in the jaws. When an object is seized the motor will stall but the amplifier is fully protected and as the stall period is less than 2 seconds no overheating occurs. On triggering IC9b the motor is driven the opposite way until it stalls at the jaws fully open position. Gripper operating commands could be POKE 65477,0 to hold and POKE 65478,0 to release, though this data as indicated by 0 is quite irrelevant and anything between 0 and 255 could be written. If the address allocated to axis 0 (servo circuit A) is A then axis 1 is A + 1, axis 2 is A + 2, axis 3 is A + 3, hold is A + 5 and release is A + 6.

The rotation shoulder and elbow motors take up to about 1A each and the other two motors up to about 0.5A each. The reference voltage for the DAC and the position sensing potentiometers comes from IC1 which provides excellent stability. The amplifiers requirements however are non-critical and an unbalanced supply is entirely adequate. The circuit shown (Fig. 7) provides $\pm$ approximately 9V. The supply is sited in the robot base where, as well as providing useful ballast at the rear of the base the mains connections are fully enclosed. The interface board is therefore free of mains and is safely operated whilst unenclosed and closely connected to the computer.

Next Month: Assembly, testing and calibration

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VALVES, unused assortment. Details Oxford (0865) 779855. Mr. G. Dean, 66 Fern Hill Road, Oxford.

ZX81 16K, Micro Gen. Joysticks, two books and software. Best offer taken. Tel: 01-556 5994. Michel Nair, 114 Richmond Road, Leytonstone, London E11.

2 x 61 NOTE keyboards or the whole PV valued organ as is. W.H.Y. acceptable. A. Johnson, 1 Babbacombe Road, St. Yvechale, Coventry CV3 5PE.

WANTED: BF900, BF494, Chokes: 4.7mH (TOKO), 47mH. M. Ekbatani, 95 Nursery Road, Cheshire Hulme, Cheshire. Tel: 061 485 4493.

RADIO telephone Cambridge Boot Cambridge Dash Mount £25 each Vanguard No control unit £10. Edwards, 2 Beach Road, Burton Bradstock, Bridport, Dorset DT6 4RF. Tel: 0308 89625.

POCKET computer—Sharp PC1211 with cassette interface and printer only £50. Phone: 01-876 6661.

COMMUNICATIONS Receiver, 2–20MHz, Ex R.A.P., calibrator, variable selectivity, 3kHz readout, mains p.s.u., R1475, working well, £48.

Tel: Cambridge 860150.

MULTIMETER with metal case £15 incl. postage. Tel: 01-554 2913 Evenings.

UK101 Mon 2. 8K, Marrick sound generator, software. Swap for PE string ensemble or similar. Tel: Newcastle 582449.

ZX80 Computer with leads transformer manual etc. £60 ono. Tel: Glyndwr 310 after 6p.m. Terry J. Bluck, 2 Maes Owain, Glyndyfrdwy, Nr. Corwen, Clwyd.

CB TRANSCEIVER, Commtron Nato CXX. £40 plus small straight forty rig or £85. Tel: 061 998 9109.

TANDBERG 3541X, Mint, unused, £90, SME FD200 Damper £12. Pair monitor audio 7.5m cable £12. Unopened. Tel: (07605) 402.

110V 1kW mains transformer with voltmeters/fully enclosed with sockets and carrying handle. Buyer collects. Offers. C. H. Kaufman, "Spring Grove", Sledgate Drive, Wickersley, S. Yorks S66 0AW. Tel: (0709) 548564.

CLEF Bandbox, fully complete working £265 o.n.o. Phone: 0233 812406. C. Maxwell, "Red Tiles", Brook, Ashford, Kent, TN25 5PG.

WANTED back issues Practical Electronics from June 1979—till July 81 any price paid. I. V. Olver, 11 Clarks Close, Deal, Kent CT14 9JE. Tel: 03045-64445.

VOLTAGE tester probe £5. Transistor checker £12. Signal injector £6. Tel: 01554 2913 Evenings.

2708 EPROM's, little used, erased, still some left at £1.50 each. First come first served! Newnham, 21 Welbeck Avenue, Ilkeston, Derbyshire, DE7 4NL. Tel: Ilkeston (0602) 304339.

32K DYNAMIC RAM board, suitable for PET, UK101 etc. £40. Also PE/Technomatic interface boards £40. S. Riddle, St. Marshalswick Lane, St. Albans, Herts AL1 4UT.

SELENIUM bridges, One 25A, One 12A, fifty ½A, sell or swap for any working oscilloscope tube. Mark Daniels. Tel: Leicester 823249 (After 5p.m.)

CRT-lin GEC E4103/B/4 + Data £5; Morse-key £2; two Army hand-telephones No. 2 £6; Variac non-working £2. D. L. Buckley, 142A Lynton Road, West Acton, London W3. Tel: 01-993 3123.

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.

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

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Ultimum Computer Interface

Part 2

THE ULTIMUM is a motherboard organised universal interface system, the bus of which is broad based enough to allow it to interface with almost any microcomputer. It can also evolve to become a computer in its own right.

THE 16/64K RAM CARD

The first card available for the ULTIMUM is a dynamic RAM card. It may be configured as a 16 or 64Kbyte card, dependent on the RAM i.c.s used.

Fig. 2.1 shows the circuit diagram. This is a rather unconventional design as it has to cater for both Z80 and 68/65xx busses which have very different timing requirements.

The dynamic RAMs have to be refreshed to preserve their contents, and this is done when the microprocessor is not reading or writing to the memory. This kind of refresh is called transparent as it does not affect the processor.

65/68 series microprocessors never address memory when their clock output is low (the Q1 cycle) so this time slot is used for refresh. The Z80 on the other hand, provides a refresh timing signal to indicate that the memory is not being accessed. The Z80 also provides other refresh signals but these are not used in this design.

The refresh involves sequencing through a series of consecutive addresses on the RAM address lines. IC13 has a built in counter which is incremented on each memory refresh cycle.

Because dynamic RAMs are in 16 pin packages, there are not enough lines to fully address them. Consequently some of the pins have to have addresses multiplexed into them. IC13 will do this for 16K memories, but additional circuitry is needed for the 64K RAMs and this is provided by IC16 and IC17.

ULTIMUM is the missing link between your computer and the outside world! Just take a look at the interface board line-up.

WE01 RAM

A 16/64K Byte dynamic RAM card (detailed in this article).

WE02 BRR

A ROM/Battery back-up RAM card for use with 2516/2716/2732 EPROMS and 6116 static memory chips. There are two sockets available for 6116 RAMS with battery back-up allowing up to 4K per card of RAM to be stored permanently when the system is switched off.

WE03 PRG

An EPROM programmer designed for use in conjunction with the EPROM card above. This has hardware timers and EEPROM facilities.

WE04 FDC

This is perhaps the most complex of the daughter cards. It is a very comprehensive floppy disc controller for up to 5 disc drives per card. It has *its own* processor which performs all the standard disc read/write routines and communicates to the ultimum bus via a pia chip. This makes software patching for different computers possible. The card includes an operating system ROM programmed for each host computer.

WE05 PRT

A part card with RS232c, parallel and Centronics interfaces, and a real time clock.

WE06 ADC

An analogue card with 12-bit precision A>D and D>A capability. A fast conversion 8-bit A>D is also included.

WE07 SBD

A sound board using a brand new chip to give up to nine oscillators with programmable frequency, waveform, ADSR envelope shaping and band filtering.

WE08 SPK

A phoneme speech card which is software programmable from RAM or ROM.

WE09 RES

A terminal card which provides 80 column video output and a keyboard interface to allow for connection of up to eight keyboards. It has optional character sets including teletext and block graphics.

WE10 CPU

A second processor card based on the very powerful 6809 c.p.u. This card can share the other system cards with the host computer and can be used to control the terminal card for multitasking operations.

WE11 PRO

The system breadboarding card—an invaluable card for anybody wishing to experiment with their own daughter cards.

WE12 EMU

This card has facilities to emulate up to 4K of ROM. RAM is memory mapped into host computer, then software switched into emulation.



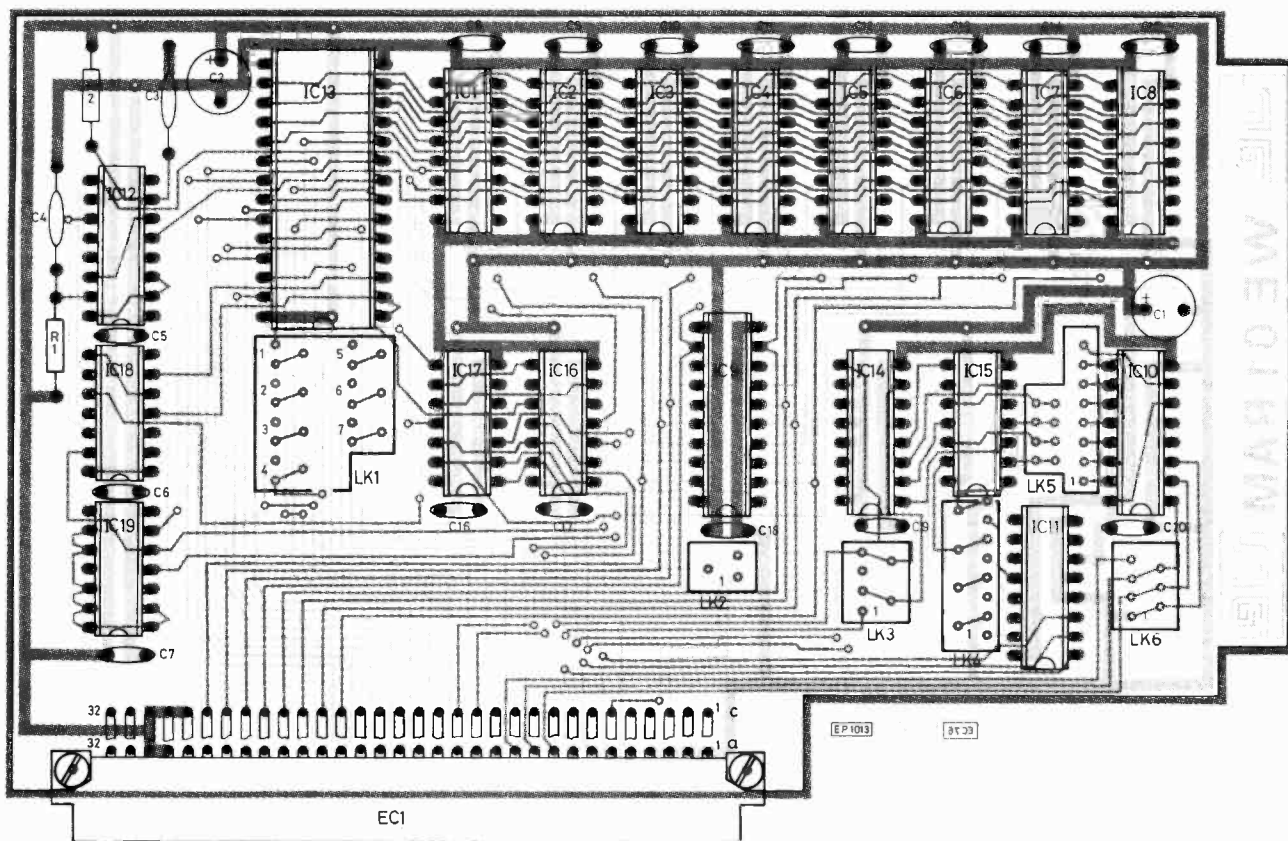


Fig. 2.2. Component layout of the RAM board

IC12 is used to provide the multiplex timing. The rest of the circuitry is decoding and buffering to allow paging and connection to the mother board.

ASSEMBLY

The component layout is shown in Fig. 2.2. As with the ULTIMUM, start with the sockets, then the capacitors and finally insert the i.c.s. taking special care with the static-sensitive memories.

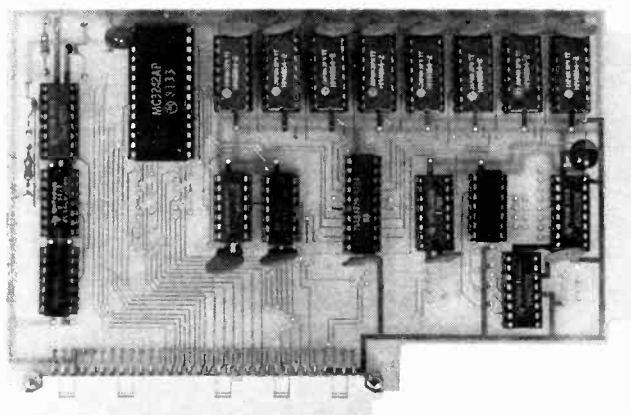
THE LINKS

There are several links to be set up. To make life a little easier, many are initially configured for 64K RAMs, as most people will opt for this capacity.

Link 2 is set to the Rfsh position for Z80 based systems and Q2 for 65/68xx computers.

To give the user a wide range of decoding options there are several links used for setting up the address space. The function of these links is given in Table 2.1. The paging facility can be used to allow the 64K RAM to be mapped in pages of 16K, and 4K blocks for the 16K. Many other configurations are possible. The paging may be omitted if not required.

If you are using 16K memories, link sets 1 and 3 require cutting and switching over. Cutting the set-up tracks is best done with a sharp blade. Applying a hot soldering iron will then remove the tracks between the cuts.



ULTIMUM is a motherboard configured universal interface system designed to work with most microcomputers

COMPONENTS . . .

16K/64K DYNAMIC RAM CARD

Resistors

R1, R2 5k1 $\frac{1}{4}$ W 5% (2 off)

Capacitors

C1, C2 100 μ /6V3 tant. (2 off)
C3, C4 10p disc ceramic (2 off)
C5-C20 100n disc ceramic (16 off)

Integrated Circuits

IC1-IC8 4816/4864* (8 off)
IC9 74LS373
IC10, IC11 74LS138 (2 off)
IC12 74LS123
IC13 MC3242
IC14 74LS148
C16, IC19 74LS08 (2 off)
IC15, IC17 74LS32 (2 off)
IC18 74LS04

Miscellaneous

14 pin d.i.l. socket (5 off)
16 " " " (12 off)
20 " " " "
28 " " " "
Printed circuit board WE01
PL1 2 x 32 'A+C' DIN Euro Plug (right-angled pins)

Option*

- a) For 16K RAM IC1-8=4816 (16384 x 1 bit i.c.)
- b) For 64K RAM IC1-8=4164/4864 (65536 x 1 bit i.c.)

TABLE 2.1. Links for the RAM board. Some links are in sets

Link set 1 (7 links near IC13)

These links set for 64K RAM. Cut and change over for 16K option. Their function is to set up IC13 address multiplexer for 64K or 16K operation.

Link set 2 (one link)

Set to RFSH position for Z80 systems, to Q2 position for 68/65x systems.

This all-important link tells the refresh circuitry when it may perform the refresh. It also gives the timing for read and write.

Link set 3 (2 links near IC14)

These links set for 64K RAM. Cut and change over for 16K operation.

These links determine whether the RAM is to be decoded in 8K or 16K blocks.

Link set 4 (4 links near IC11)

These links set for permanent (not paged) memory mapping. Cut one or more links and connect to Q0, Q1, Q2 or Q3 to allow AS lines (from 8255 port on mother board) to map in/out memory.

Link set 5 (four double links near IC10)

These are the main decoding links. Y0 to Y7 of IC10 allow you to map the RAM in blocks of 16K (in the case of 64K RAM) to any 16K boundary. If 16K RAM is fitted and link set 6 set up (see below), the memory may be mapped to any 8K boundary, in 2 blocks of 8K each.

Link set 6 (three links near IC10)

These are set up for 64K RAM. Cut and link the other way for 16K RAMs.

These links set the decoder up to decode in 8K or 16K blocks. If left in their default position, these only Y0, Y1, Y2, Y3 are available from IC10. Linked the other way, all outputs are enabled each representing an 8K boundary.

ROM AND BATTERY BACK-UP RAM CARD

This card provides five sockets each of which may be configured to accept a 4K EPROM, a 2K EPROM or a 2K x 8 RAM. Two of the sockets have back-up power from a rechargeable battery, giving up to 4K of non-volatile RAM. All the necessary address decoding and selection is provided on the card.

OPERATION

This is a nice simple card. IC6 provides address decoding to 4K boundaries which is sufficient for 2732 EPROMS. The provision of the inverter on the A11 line and ICs 8 and 9 allows decoding to 2K boundaries for 2716/2516 PROMS and 6116 RAMs. Fig. 2.4 shows the link layout for setting up the addressing. The As lines allow for the overlaying in sophisticated systems of up to three 4K slots per Battery RAM/ROM card, accessible under software control by writing the appropriate data to the Motherboard 8255 AO acts as an enable. A1 as a disable. Care should be taken not to enable more than one chip into the same part of memory space at a time.

Sockets 4 and 5 are provided with the option of a battery back-up power supply of 3V. This is sufficient for low power 6116 RAMs to hold information for about a year—even if the card is unplugged. The power for normal-mode use and for the battery trickle charge is derived from the twelve volt rail by a Zener shunt regulator (R1 D2). Switching between

main and back-up power is effected by diodes D3 and D1. The transistor circuitry on the CS lines ensures that they stay up with the back-up power line when the main power disappears, keeping the RAMs deselected and thus in low power mode. Links 6 and 7 provide for not using the battery back-up if this option is not required. Links 1 to 5 configure respectively sockets 1 to 5 for 2732s, 2716/2516s or 6116s. Fig. 2.4 shows the required layout of these links. Finally IC10 tells the motherboard when the data bus buffers must be activated.

CONSTRUCTION AND TESTING

Construction is straightforward. Links should be inserted and soldered in place first, discrete components next, and then the integrated circuits. The battery should be fitted last.

Testing the card requires an operational Motherboard and host computer. To test for EPROM you will require (a) an EPROM with known contents, and (b) a program to read it. If you have access to a PROM programmer and an eraser then life is made easy for you; simply copy your operating system or language system ROM into a spare EPROM drop this into the socket to be tested and write a little program to check the copy against the original. Mere mortals will have to make do with viewing their language ROMs first few bytes using operating system facilities, noting them down on a scrap of paper, moving the ROM in question to the socket under test and viewing them again in their new position in

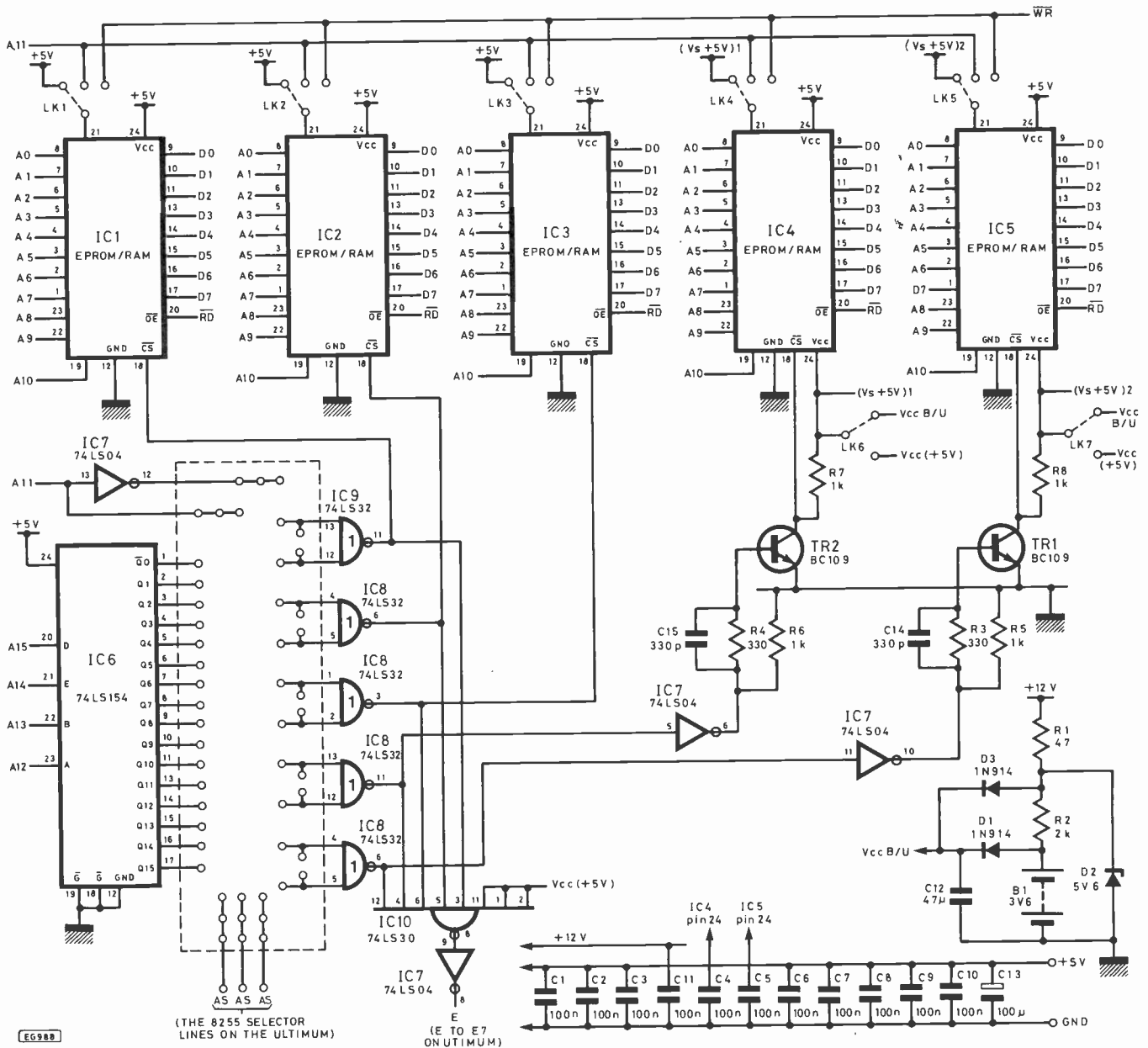


Fig. 2.3. Circuit diagram of ROM/Battery Back-up RAM board

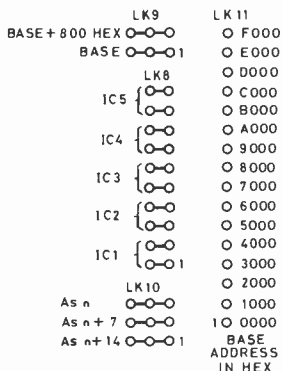


Fig. 2.4a. Addressing links on the Battery Back-up board. Link one of the pad pairs for each i.c. in L8 to the appropriate one in L11 to set the 4K base address. If the i.c. is only 2K, link the other pair to either of the L9 triplets to set the 2K boundary. Otherwise, link the two pad pairs together (unless you want to be clever and bring in an As line with L10! N is the number of the Euroconnector into which the card is plugged. The relationship between the As line numbers and the 8255 port bits was shown last month on the Mother-board circuit diagram)



Fig. 2.4b. Power links

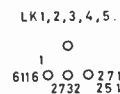


Fig. 2.4c. Configuration links

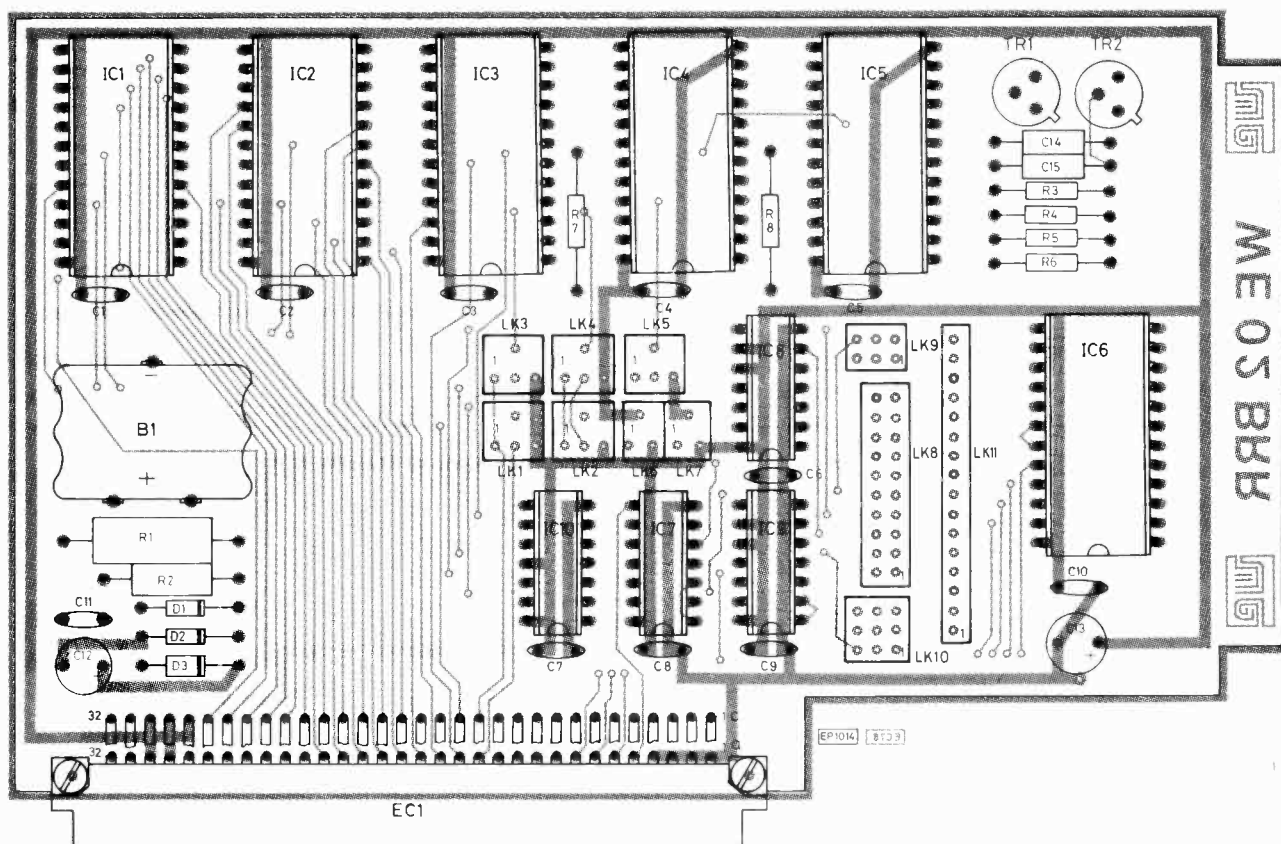


Fig. 2.5. Battery back-up board component layout

memory. If your system is such that you cannot move a ROM without losing your operating system then you have real problems!

Testing RAM is more simple; all that is required is to write

a known pattern into a location (e.g. all zeroes or all ones), read it back to check it, and go on to the next one. Keep a count of the errors; it should be zero over several cycles through the RAM.

COMPONENTS . . .

BATTERY BACK-UP BOARD

Resistors

R1	47 1W
R2	2k $\frac{1}{2}$ W
R3, R4	330 (2 off)
R5-R8	1k (4 off)

All resistors $\frac{1}{4}$ W 5% unless otherwise stated

Capacitors

C1-C11	100n disc. cer. (11 off)
C12	47 μ /6V3 tant.
C13	100 μ /6V3 tant.
C14, C15	330p polystyrene (2 off)

Semiconductors

TR1, TR2	BC109 (2 off)
D1, D3	1N914 (2 off)
D2	5V6/1W3 Zener

Integrated Circuits

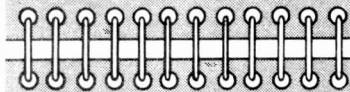
IC1/IC5	EPROM/RAM see text (5 off)
IC6	74LS154
IC7	74LS04
IC8, IC9	74LS32 (2 off)
IC10	74LS30

Miscellaneous

14 pin low profile d.i.l. socket	(4 off)
24 pin low profile d.i.l. socket	(6 off)
P.c.b. mounting battery	3V6
P.c.b. WE02 BRR	
2 x 32 A+C DIN Euro-Angle plug	

Constructors Note

All kits for the Ultimium system are to be available from **Watford Electronics** (See advertisers' Index). Send SAE for price list of boards now available.



INDUSTRY NOTEBOOK

By Nexus



Genesis

Overwhelmed by the profusion of electronics in daily life all the way from children's toys to giant computers, we tend to forget that in the beginning all we had was wireless telegraphy as distinct from telegraphy by wire. The 'wireless' in its then embryonic state had only one application where it could obviously score and that was in maritime communication where, quite clearly, it was impractical to link ships at sea by wires. Up to the advent of what we now call radio communications a ship's position could be reported only when visually sighted and identified by a watcher on shore. Similarly, ships at sea could only communicate when in visual or hailing range of each other.

When Marconi formed the Wireless Telegraph and Signal Company Ltd on 20th July 1897 it was the maritime world which quickly saw new possibilities. The Italian navy was first off the mark in adopting the Marconi system but within months Lloyds of London, the great shipping insurance syndicate, also became interested. The impetus thus originated with both naval and mercantile shipping interests becoming enthusiastic supporters of a remarkable invention which was to blossom years later into the huge and exciting industry which we now call electronics.

Marine radio and electronics nowadays doesn't get much of a press. We take it for granted as 'old hat'—a remote and hazy background to more exciting and immediate developments such as the laser or optical fibres or the popular crazes for personal computers and video.

Although in the background, marine electronics remains big business and highly competitive. I was reminded of this as further details of maritime operations in the Falklands conflict came to light. A total of 51 warships and 52 merchant ships were employed together with 171 aircraft of the

Fleet Air Arm. Eighteen thousand sailors and marines were at sea and at any one time during the operation the supply 'pipeline' of 8,000 miles length was carrying half a million tons of fuel and stores to sustain the armada.

One may imagine the organisation required and the level of efficiency of communications necessary to ensure smoothness, particularly as the sharp end was in perpetual flux of battle. And, as this was in every sense a war (albeit undeclared by either side as is today's custom) there would have been the additional complications of encryption to preserve secrecy and periods of radio silence to conceal ship movements.

The whole electromagnetic spectrum from VLF (for submerged submarines) to microwave (satellite communication to the operations centre near London) was employed. VHF and UHF to aircraft and between ships at short range. The bulk of naval ship-to-ship traffic, however, was on HF through the Marconi Integrated Communications System Mk 3 (ICS3), standard in the Royal Navy and adopted by other NATO and non-NATO navies. ICS3 is flexible both in frequency and power management and enables commanders to access the transmitter, receiver and antenna systems best suited to his communications requirement at any time with a number of different users working into the system simultaneously on different frequencies using voice, telegraphy or data.

ICS3 is also adaptable to new technology. It already has frequency agility from extensive use of broad-band techniques and auto-tuning enabling rapid change of frequency. Although unlikely to have been used in the South Atlantic it is also adaptable to frequency hopping.

In the merchant navy, too, we have come a long way from early spark transmission. Minimum radio requirements for vessels over 1,600 grt were established at the 1974 Safety of Life at Sea Convention (SOLAS 74). They include main and reserve MF telegraphy transmitters and receivers, automatic keyers, radiotelephone transmitter and receiver on the distress frequency with auto-alarm, VHF radiotelephone and portable lifeboat transceiver.

Most large vessels have far more than the minimum equipment with additional high-powered HF transmitter and telex and facsimile facilities, radio direction finders, and other radio navigation equipment which may include Loran C, Decca Navigator, Omega (a world-wide VLF positioning system), and Satellite Navigation. If we include radar (often a dual installation) and echo sounders, the total electronic package can approach £100,000.

Although world shipbuilding, including the UK, is in recession, ships are being built and the race is on to supply equipment. Marconi International Marine, who supply radio and electronic sea-going officers if required as well as hardware, have recently won orders for complete installations in ten new buildings under construction in India, Japan and Korea. Apart from proven quality

of equipment, Marconi export successes in merchant shipping are due to the worldwide servicing network with a Marconi presence in every major port.

The slack caused by decline in the number of ships at sea has been taken up by large installations on oil rigs which, in addition to SOLAS requirements, have continuous need for commercial transmission and extra housekeeping requirements such as UHF/VHF radio paging and aero-nautical beacons for helicopter guidance.

Balance

Overseas sales of marine electronics equipment is just one area of industry that contributed to a record £6 billion surplus on current account balance of payments last year and helped repay £1.6 billion on foreign currency borrowing. Compare this performance with the rising total of virtually bankrupt countries unable to service interest charges let alone repay capital borrowed.

Surprise

There were plenty of raised eyebrows when Racal announced entry into the Pay-TV business. This was a company which had always shunned the entertainment sector of electronics. When Racal acquired Decca they couldn't get rid of Decca's domestic TV interests fast enough, eventually selling it off to a Far Eastern entrepreneur. Had Sir Ernest Harrison gone off his rocker doing a U-turn? Closer examination showed that he hadn't lost his touch or his sense of direction.

In fact Racal stays in the capital goods sector of the industry as an extension of traditional communications business and expect to generate billions of pounds in the next decade in cable and subscription TV. To get in on the act Racal has teamed itself on a 50/50 basis with Oak Industries of San Diego, California, who are already established with not only the technology but also operating experience with five Oak-owned STV systems and 610,000 paying subscribers. Old-timers in the industry will remember Oak switches which were the first products.

Oak moved into Pay-TV in 1977 and is now in all modes, cable, STV and direct broadcast by satellite (DBS). All use encryption technology to ensure that programmes can be received only by subscribers who have appropriate decoding apparatus. Racal have great experience in signal encryption and will no doubt contribute to the technology in the years ahead.

Immediately, however, Oak need to expand into international markets and the new joint company, Racal-Oak Communications Ltd, although based in the UK will cover the whole of Europe. The two equal partners are clearly delighted with their marriage which was blessed at the inauguration ceremony by none other than Mr Kenneth Baker, Minister for Information Technology, who hinted ever so slightly that he, himself, might have been the marriage broker following a meeting with Oak's chairman last June.

PE micro-file

FILESHEET 2

R.W.Coles

6800 • 6802

APPEARING hot on the heels of the Intel 8080A in 1974, the 8 bit NMOS Motorola 6800 soon established a significant following of designers who liked it for its single 5 volt supply operation and its elegant instruction set which had been modelled after the PDP11 minicomputer. By the end of the decade Motorola was building on its success and introducing several new devices, all described as "6800 family members" and all bearing a close resemblance to their parent. The 6802 was one of these, and was intended to directly replace the 6800 in new applications where its on-chip clock and RAM array would make it easier to use than the basic 6800 which was itself becoming obsolete.

The powerful 6801 is intended as a 6800 system-on-a-chip, with RAM, ROM, Clock, Multiplier, Serial and Parallel I/O all available in a single package. The 6803 is a ROM-less version of the 6801 but the 6805 goes the other way with a "sawn-off" version of the 6800 architecture for smaller single chip applications and low cost. The shortened registers and reduced memory addressing range of the 6805 allow it to fit into a 28 pin package complete with ROM RAM and parallel I/O. A CMOS version, the MC 146805 and an EPROM version, the 68705, are also available. Perhaps the thing to note about the 6801 and the 6805 is that they share, to a large extent, the instruction set and features of their ancestor.

Also in the 6800 family is the 6809 which represents an attempt to capture a slice of the data processing market for the Motorola family which until the 6809, could not compete well in this field with the 8080A or more particularly with the Z80. The 6809 is a very nice chip with most of the problems of the 6800 put right and with lots of new features and facilities, but unfortunately for Motorola, it turned up too late, when most of the data processing sockets had already been gobbled up by the 6502 made by MOS Technology. The 6502 is to the 6800 what the Z80 is to the 8080A, a successful attempt by outsiders to improve on the basic chip and to steal a march on the originators.

The 6800 and 6802, then, can be considered to be at the centre of a large and expanding family of devices which have a big following, and a large part of this success must be attributed to the original designers of the 6800 who came up with a simple but capable architecture and an elegant instruction set. The popularity of these devices should ensure their availability for many years to come.

REGISTERS

With so much going for it, you may be wondering why the 6800 lost out to the 8080 and its "messy" instruction set in many applications. Although there are many secondary reasons, the primary reason must surely be the 6800's lack of CPU registers. In some respects the 6800 register set is good. There are two general purpose accumulators, compared with the one on the 8080A, and there is a 16 bit index register where the 8080 has none, but that is as far as it goes. Where the 8080A has six general purpose 8 bit registers the 6800 has none, with the result that temporary data storage and counters usually have to reside in main memory. To be sure, the use of main memory for this purpose is well supported with extra instructions to allow register like operations to be performed there, and it could be argued that access is made available to a virtually unlimited register set by this method, but the net result is a reduction in flexibility and in speed of access to the temporary data and the counters.

Even more of a problem, according to some, is the provision of only one index register, since most programs need two. Although

the 8080 has no true index registers, it is quite possible to use the DE and HL pairs as pseudo index registers at the cost of a few extra instructions. Achieving the same result with the 6800 would be a more difficult and time consuming job.

As can be seen from the file sheet, the 6800 and the 6802 share the same register set, which has two 8 bit registers ACCA and ACCB, and three special purpose 16 bit registers IX (Index register) SP (Stack Pointer) and PC (Program Counter). In addition there are 5 single bit flags which are for some operations grouped together as the 8 bit CCR (Condition Code Register).

The two accumulators are identical and are used as the focus of many of the instructions, particularly those which use the ALU (Arithmetic and Logic Unit). The accumulators may be added or compared with one another and either can be used to hold the result of arithmetic, logic, data test, and data handling instructions.

The Index Register is intended for use as a memory pointer and is used to implement register indirect addressing of data tables which are created in RAM by the programmer. Since only the Index Register is available as an indirect address pointer, this addressing mode is actually termed Indexed Addressing. The Index Register pointer can be moved through the full address range of 64K bytes by increment and decrement instructions, but the real advantage of this 6800 feature lies in the ability to add an offset value which is specified in the instruction. In effect, the Index Register may be used to hold the base address of a table with access to individual table entries being gained by specifying a 0-255 offset value to be added to the Index Register value. The contents of the Index Register itself are not modified when this addressing mode is invoked. For example, the two byte instruction: ADDA 00H,X adds the content of the memory location pointed to by the Index Register to the accumulator, while: ADDA 08H,X adds the content of the memory location pointed to by the Index Register value plus 8, to the accumulator, leaving the Index Register itself unmodified. It is this offset capability which makes Indexed addressing so efficient; the 8080A programmer would have to use extra register arithmetic instructions to achieve the same result and would end up with a modified pointer value into the bargain.

The Stack Pointer register in the 6800 and 6802 works in exactly the same manner as the 8080A version, and is used to control access to a Last-In-First-Out (LIFO) stack in RAM memory. In comparison with the 8080A however, the 6800 stack instructions are more limited, the 6800 is restricted to pushing or pulling a single byte from one of the two accumulators. The stack concept is also important for automatically storing subroutine return addresses and processor status following an interrupt, and the 6800 comes out well here since on interrupt it saves *all* the CPU registers on the stack automatically whereas the 8080A saves only the Program Counter, leaving the programmer to save the rest using PUSH instructions.

The Program Counter holds no surprises and is virtually identical to the 8080A in terms of its addressing range and its operation.

The 6800 and 6802 flags are somewhat different to those of the 8080A. There is no Parity flag, and this is sometimes a drawback, but there are two extras, namely Overflow, which is set if arithmetic overflow occurs as the result of an ALU operation, and Interrupt, which indicates whether interrupts have been enabled or disabled.

INSTRUCTIONS

The 6800/6802 instruction set is regular and elegant, and this makes these processors easy to program and ideal for use in tutorial systems.

6800/6802 REFERENCE FILE SHEET

GENERAL

Although appearing shortly after the 8080A the 6800 never really caught on quite as well. This is mainly due to the more powerful architecture of the former but it is a pity because the 6800 has a more elegant instruction set and hardware which makes it a good device for beginners and a better device than the 8080A when it is capable of doing the job. The 6802 is a simple upgrade of the 6800 which has an on-chip clock generator and 128 bytes of RAM. The 6802 is recommended for all new designs.

REGISTERS The 6800/6802 have two 8 bit general purpose data registers (ACC A & ACC B) and three specialised 16 bit memory pointers.

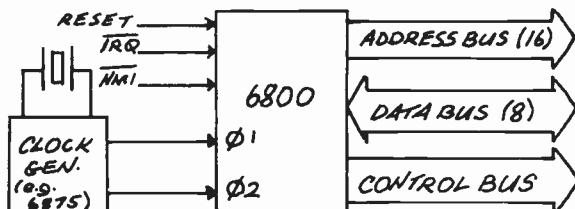
ACCUM A	8	ACC A
ACCUM B	8	ACC B
INDEX REG	16	IX
STACK POINTER	16	SP
PROGRAM CNTR.	16	PC

FLAGS:-

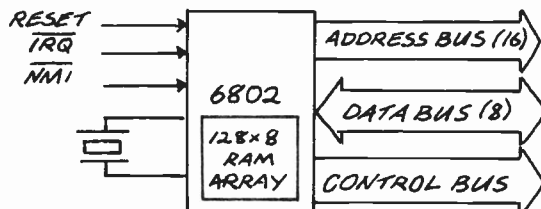
D7	D6	D5	D4	D3	D2	D1	D0
		AUX CARRY	INT	SIGN	ZERO	OVERFLOW	CARRY

INSTRUCTION SET AND SOFTWARE

The 6800 and 6802 share a common instruction set which has been modelled after the PDP11 minicomputer as far as possible. The instruction set is more elegant and less messy than the competing 8080A/8085A but is hindered by a scarcity of CPU registers which is overcome to some extent by the "Direct" addressing mode which allows fast access to page zero (256 bytes) of memory. Reset causes branch to address which must be stored in address/location's FFFF & FFFF. One, two and three byte instructions are used and "Direct, Extended, Immediate, Relative, Indexed and Implied" addressing modes are available. Chips are well supported in software including Tiny Basic.



BASIC TWO CHIP 6800 CPU COT



BASIC SINGLE CHIP 6802 EQUIVALENT

PERFORMANCE DATA

	6800	6802
MEMORY ADDRESS RANGE:-	64K	64K
I/O ADDRESS RANGE:-	(MEMORY MAPPED)	
CLOCK FREQUENCY*:-	1MHz	1MHz
POWER SUPPLIES:-	5V	5V
INTERRUPTS:-	IRQ	IRQ
	NMI	NMI

*NOTE: 1.5 MHz & 2.0 MHz SELECTIONS OF BOTH CHIPS ARE ALSO AVAILABLE.

BENCHMARKS

	6800	6802
ADD REGISTER TO ACCUM	2μS	2μS
O/P ACCUM TO PORT ①	5μS	5μS
MOVE FROM MEMORY TO MEMORY	9μS	9μS
① EXTENDED ADDRESSING MODE		

VSS	1	40	RESET	VSS	1	40	RESET
HALT	2	39	TSC	HALT	2	39	XTAL
phi1	3	38	N.C.	MR	3	38	EXTAL
IRQ	4	37	phi2	IRQ	4	37	E
VMA	5	36	DBE	VMA	5	36	RE
NMI	6	35	N.C.	NMI	6	35	VCC(STBY)
BA	7	34	R/W	BA	7	34	R/W
VCC	8	33	D0	VCC	8	33	D0
A0	9	32	D1	A0	9	32	D1
A1	10	31	D2	A1	10	31	D2
A2	11	30	D3	A2	11	30	D3
A3	12	29	D4	A3	12	29	D4
A4	13	28	D5	A4	13	28	D5
A5	14	27	D6	A5	14	27	D6
A6	15	26	D7	A6	15	26	D7
A7	16	25	A15	A7	16	25	A15
A8	17	24	A14	A8	17	24	A14
A9	18	23	A13	A9	18	23	A13
A10	19	22	A12	A10	19	22	A12
A11	20	21	VSS	A11	20	21	VSS

PIN DIAGRAMS

MANUFACTURERS

ORIGINATOR :- MOTOROLA
 6800 2ND. SOURCES:- A.M.I, HITACHI, FAIRCHILD
 SESCOSEM
 6802 2ND. SOURCES :- A.M.I, HITACHI, FAIRCHILD
 SESCOSEM + MITEL
 PLESSEY, MEDL (IN CMOS)

SUPPORT CHIPS

6800 needs an external 2φ clock generator such as 6871 or 6875 and has a family of support devices including:- 6821 (parallel I/O) 6828 (interrupt controller) 6840 (timer-counter) 6844 (DMA) 6850 (UART) 6802 has ROM/timer/I/O combo chip (6846) In addition to above 6800 parts

INDEX REGISTER AND STACK POINTER INSTRUCTIONS

OPERATIONS	MNEMONIC	ADDRESSING MODES				COND. CODE REG.			
		IMMED	DIRECT	INDEX	EXTND	H	I	N	Z
Compare Index Reg	CPX	BC 3	3	9C 4	2	AC 6	2	BC 5	1
Decrement Index Reg	DES								
Increment Index Reg	INX								
Load Index Reg	LDS	CE 3	3	DE 4	2	EE 6	2	FE 5	3
Store Index Reg	STS	DF 3	3	9E 4	2	AE 6	2	BE 5	3
Stack Pointer - Index Reg	TSX	9F 3	3	AF 4	2	BF 6	2	CF 5	3

- ① (Bit N) Test Sign bit of most significant (MS) byte of result = 1?
 ② (Bit V) Test: 2's complement overflow from subtraction of ms bytes?
 ③ (Bit N) Test Result less than zero? (Bit 15 = 1)

JUMP AND BRANCH INSTRUCTIONS

OPERATIONS	MNEMONIC	ADDRESSING MODES				COND. CODE REG.			
		IMMED	DIRECT	INDEX	EXTND	H	I	N	Z
Branch Always	BRA	20 4	2						
Branch If Carry Clear	BCC	24 4	2						
Branch If Carry Set	BES	25 4	2						
Branch If Equal	BED	27 4	2						
Branch If Greater Than Zero	BGT	2E 4	2						
Branch If Higher	BHI	22 4	2						
Branch If Less Than Zero	BLE	2F 4	2						
Branch If Lower Or Same	BLS	23 4	2						
Branch If Minus	BNE	26 4	2						
Branch If Not Equal Zero	BVC	28 4	2						
Branch If Overflow Clear	BVS	29 4	2						
Branch If Overflow Set	BPL	2A 4	2						
Branch If Plus	BSR	8D 8	2						
Jump	JMP								
Jump To Subroutine	JSR								
No Operation	NOP								
Return From Interrupt	RTI								
Return From Subroutine	RTS								
Software Interrupt	SWI								
Wait for Interrupt*	WAI								

- ① (All) Load Condition Code Register from Stack. (See Special Operations)
 ② (Bit 1) Set when interrupt occurs. If previously set, a Non Maskable Interrupt is required to exit the wait state.

CONDITION CODE REGISTER INSTRUCTIONS

OPERATIONS	MNEMONIC	ADDRESSING MODES				COND. CODE REG.			
		IMMED	DIRECT	INDEX	EXTND	H	I	N	Z
Clear Carry	CLC	0C 2	1						
Clear Interrupt Mask	CLI	0E 2	1						
Clear Overflow	CLV	DA 2	1						
Set Carry	SEC	0D 2	1						
Set Interrupt Mask	SEI	0F 2	1						
Set Overflow	SEV	0B 2	1						
Accumulator A ← CCR	TAP	06 2	1						
CCR ← Accumulator A	TPA	07 2	1						

- R = Reset
 S = Set
 * = Not affected
 ① (ALL) Set according to the contents of Accumulator A

OPERATIONS	MNEMONIC	ADDRESSING MODES				COND. CODE REG.			
		IMMED	DIRECT	INDEX	EXTND	H	I	N	Z
Add	ADD	38 2	2	98 3	2	AB 5	2	BB 4	3
Add Accumulator	ADDB	C8 2	2	DB 3	2	EB 5	2	FB 4	3
Add with Carry	ABA	89 2	2	99 3	2	AB 5	2	BB 4	3
And	ADC	C3 2	2	DB 3	2	EB 5	2	FB 4	3
And	ANDB	84 2	2	94 3	2	AB 5	2	BB 4	3
Bit Test	BITA	85 2	2	95 3	2	AB 5	2	BB 4	3
Clear	CLR	C5 2	2	DB 3	2	EB 5	2	FB 4	3
Compare	CLRB	81 2	2	91 3	2	AB 5	2	BB 4	3
Compare Accumulator	CMPS	C1 2	2	DB 3	2	EB 5	2	FB 4	3
Complement 1's	COM	63 7	2	73 6	3				
Complement 2's (Negate)	NEG	60 7	2	70 6	3				
Decimal Adjust, A	DAA	19 2	1						
Decrement	DEC	6A 7	2	7A 6	3				
Exclusive OR	EXOR	88 2	2	98 3	2	AB 5	2	BB 4	3
Increment	INC	C8 2	2	DB 3	2	EB 5	2	FB 4	3
Load Accumulator	LDA	86 2	2	96 3	2	AB 5	2	BB 4	3
Or, Include	ORA	C8 2	2	DB 3	2	EB 5	2	FB 4	3
Push Data	PSHB	CA 2	2	DA 3	2	EA 5	2	FA 4	3
Pop Data	PULB	69 7	2	79 6	3				
Rotate Left	ROL	59 2	1						
Rotate Right	ROR	58 2	1						
Shift Left, Arithmetic	ASL	48 2	1						
Shift Right, Arithmetic	ASR	58 2	1						
Shift Right, Logic	LSR	54 2	1						
Store Accumulator	STAB	93 4	2	A7 5	2	AB 5	2	BB 4	3
Subtract	SUBB	80 2	2	90 3	2	AB 5	2	BB 4	3
Subtract Accumulator	SBCA	82 2	2	92 3	2	AB 5	2	BB 4	3
Subtract with Carry	SBCB	C2 2	2	DB 3	2	EB 5	2	FB 4	3
Transfer Accumulator	TAB	17 2	1						
Test, Zero or Minus	TST	60 7	2	70 6	3				
Test, Zero or Minus	TSTB	40 2	1						

- LEGEND:
 DP Operation Code (Hexadecimal)
 # Number of MPU Cycles
 + Number of Program Bytes
 - Arithmetic Plus
 * Arithmetic Minus
 MGP Contents of memory location pointed to by Stack Pointer
 R Register
 S Set
 * Not Affected
 ① Bit = Zero
 00 Byte = Zero

Note - Accumulator addressing mode instructions are included in the column for IMPLIED addressing

6800-6802
INSTRUCTION SET

There are 72 basic instructions in the set, but the availability of more than one addressing mode for many of them results in a total set of 197 different instructions. Instructions may be one, two or three bytes in length, where the first (or only) byte contains sufficient information to identify the instruction and its addressing mode, and the other byte or bytes contain ancillary information such as a memory address. Instructions are provided for binary and BCD 8 bit arithmetic, logic operations, shifts and rotates, data load, data store, conditional or unconditional branch, and interrupt and stack manipulation.

Two instructions of particular note are SWI and WAI. SWI stands for SoftWare Interrupt and is rather similar in operation to the 8080A Restart (RST) instruction with the exceptions that there is only one (as opposed to 8 RSTs) and SWI causes all registers to be stacked, not just the PC. The SWI vector is also in high memory (FFFAH and FFFBH) as opposed to low memory for the 8080A RSTs. WAI stands for Wait for Interrupt, and has no direct equivalent in the 8080A. It causes all CPU registers to be stacked and the processor to be halted while awaiting an interrupt. This provides a fast interrupt response but also nullifies some of the advantages to be had from asynchronous interrupts. A comprehensive set of addressing modes are available as follows:— Direct; in which a single byte page zero address is specified as part of the instruction; Extended; in which a two byte address is specified (like 8080A Direct!), Immediate; in which the instruction contains the data to be used, not an address reference, Inherent; (the same as 8080A Implied), Relative; which allows branching forwards or backwards in memory relative to the program counter value, and Indexed which uses the Index Register and an offset supplied by the instruction as already described. Both the Relative and the Indexed mode have no direct equivalent in the 8080A instruction set. The Relative addressing range is from -125 to +129 locations relative to the first byte of the two byte relative branch instruction, this mode reduces the size and the execution time of a program.

SOFTWARE

Like the 8080A family, the 6800 family has extensive software support because of its popularity and its long existence. It does, however, lack a universally accepted disc operating system such as the 8080A's CP/M. Perhaps the best known 6800 software is the Motorola MIKBUG monitor which was supplied with their evaluation board, the MEK68D2, but there are also a number of other software tools including Editors, Assemblers, Compilers (notably for FORTRAN) and Interpreters, including a TINY BASIC.

INTERFACING

The 6800/6802 have no need of the IO/M line of the 8080A family since there is no separate I/O address space. Also, instead of the separate $\overline{RD}$ and $\overline{WR}$ lines of that family the 6800/6802 have a single RD/ $\overline{WR}$ line and a separate VMA (Valid Memory Access) line. By use of appropriate gating it is possible to convert the 6800 scheme to the 8080A version and vice-versa, and this is important if you ever wish to use peripheral chips such as UARTs from a different family to that of the processor itself.

The 6800 requires an external two phase clock generator, and two approaches to this are possible. The first approach to appear was a rather unconventional hybrid device, the MC6871, which included not only the clock generator electronics but also an appropriate crystal *inside* the package. Later on, the more conventional MC6875 appeared in a 16 pin DIL. This device provides some extra facilities but needs an external crystal.

The 6802 does not need an external clock generator, only a crystal, and has the added bonus of a 128 byte RAM array on the chip. The first 32 bytes of this array may be retained in a low power standby mode by using the additional supply pin, VCC Standby. These differences mean that the 6802 is not completely pin compatible with the 6800. The DBE (Data Bus Enable) and TSC (Three State Control) pins of the 6800 are not available on the 6802, and neither are the $\phi 1$ and $\phi 2$ clock inputs for obvious reasons. Since the $\phi 2$ clock signal is used for systems control, an equivalent output is provided on the 6802 by E (Enable). Two other new 6802 pins (in addition to the crystal pins) are MR (Memory Ready) which when driven low causes the memory cycle to be extended to allow interface to slow memory or peripherals, and RE (RAM Enable) which is used to select the internal RAM array when required.

The interrupt schemes used by the 6800 and 6802 are identical and fairly simple. One advantage of the 6800/6802 over the 8080A is that the former have a Non-Maskable Interrupt (NMI) in addition to the standard maskable input available on all three. The NMI can never be disabled and is therefore useful in some systems to warn of power failure or other not-to-be-ignored happenings. Intel at first said that there was no need for an NMI, and then introduced one on their 8085A!

On the occurrence of an NMI, the processor stores the CPU registers on the stack and then loads the PC with the address stored in memory locations FFFCH and FFFDH. The maskable IRQ interrupt has the same general effect except that the vector is fetched from FFF8H and FFF9H. Note that only a single vector is normally available for each source and without an external interrupt controller chip, multiple interrupt sources have to be polled by software. The 8080A is difficult to compare directly, since it always needs at least some external gating to accept vectors, but thanks to the single byte RST instructions it is a comparatively simple matter to build a scheme to cater for up to 8 separate sources without polling. The 8085A has additional direct interrupt lines of course.

PERIPHERAL CHIPS

The 6800 series is blessed with an extensive family of peripheral devices capable of performing most of the commonly required functions and some of the rather more exotic ones.

Apart from the clock generators mentioned earlier, perhaps the most often specified peripheral device is the Peripheral Interface Adaptor or PIA for short. This function is performed by the 6821 device which has two 8 bit parallel ports useful for communicating with the full range of possible input and output devices such as switches, lamps, and line printers.

Communication with the CPU takes place over the bidirectional CPU data bus using standard 6800 or 6802 control signals, and two interrupt outputs (one for each port) are available for connection to an interrupt controller chip like the 6828 or to be Wire-OR'ed to the IRQ input of the processor. Each of the four possible sources of interrupt can be separately enabled or disabled by the processor if required. After the 6821 in popularity comes the 6850 Asynchronous Communications Interface Adaptor (ACIA) which most (Non-Motorola!) people call a UART. The 6850 is a simpler device than the Intel 8251 USART because while the 8251 provides asynchronous or synchronous serial communication, the 6850 is asynchronous only, with an additional part, the 6852, available if a synchronous link is required.

Other devices available include the 6840 triple 16 bit timer, the 6844 Direct Memory Access (DMA) controller, and the 6860 Modem. The 6802 also has its own special "Combo" peripheral device, the 6846, which provides 2K bytes of ROM, 10 parallel I/O lines and a timer. Since this device uses masked ROM it is not usually suitable for home projects.

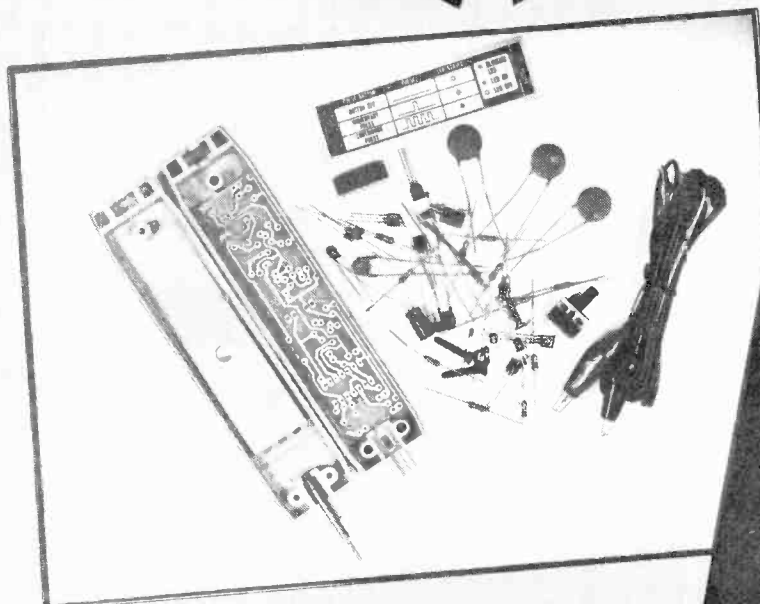
APPLICATIONS

As with the 8080A/8085 there would appear to be little point in using the 6800 in new applications now that the 6802 is available at a reasonable price. An added incentive to use the 6802 is the fact that CMOS versions are available from other manufacturers making it possible to build a low power consumption system when necessary for battery powered applications.

Both processors are ideal for learning about both the hardware and software aspects of microprocessors and the 6800 is widely used in tutorial systems for this reason. Neither chip can be recommended for data processing applications, however; if this is your requirement and you like the style of the 6800, then choose the 6502 or better still the 6809.

The 6800 and 6802 come into their own as controllers for small systems and are mostly used for this purpose. Their simple low-cost hardware approach and their elegant easy to use instruction set suit them ideally for jobs such as appliance control, vending machines, car computers, and PROM programmers. In the author's opinion, if a 6802 is powerful enough to perform a particular control task then it is probably wise to choose it in preference to the 8085A because the resulting system will probably be simpler, cheaper, and easier to program. All in all the 6800 or the 6802 are not a bad choice for the hobbyist because it will later be easy to move on to more powerful chips like the 6502 or the 6809.

SPECIAL OFFER



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SEMI-PROFESSIONAL MIXING DESK

Part Three



THE p.c.b. design for the power supply unit is shown in Fig. 1 with the component layout shown in Fig. 2. Before the components are soldered, the 'L' shaped heatsink should first be fitted to the p.c.b.

All the components should then be soldered into position with mica washers being used on the two i.c.s. Carefully check the orientation of the semiconductors and the electrolytic capacitors.

The case components should be mounted as shown in Fig. 3 and all the mains wiring covered with rubber sleeving. The two output rails should be tested before the power supply is connected to the mixing desk.

PA MIXING—LIVE CONCERTS

Mixing the sound for a live music show differs considerably from mixing in a recording studio. Firstly everyone plays at the same time which means that there are many more mixer channels to be balanced and equalised etc. Secondly the high sound level on stage makes it difficult for the players to hear each other with any degree of sound balance. Fig. 4 shows how all the instrument amplifiers, drums and singers are set-up and fed to the mixer which is normally positioned in the audience where the sound engineer can hear clearly the sound of the PA system. It also shows how a separate sound system is provided for the players on stage, so that they can all hear what each person is playing. This other mix is derived from an auxiliary mixer output which is independent from the main stereo PA mix.

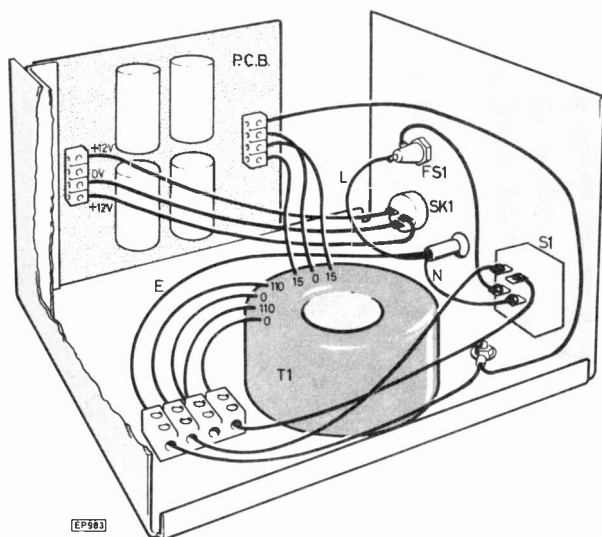


Fig. 3. Wiring diagram for the p.s.u.

The mixer also adds effects to the overall sound, such as reverb and echo, using the other auxiliary outputs as well as taping the stereo mix for the inevitable post-mortem of the concert. Live sound mixing is certainly more liable to problems than studio recording, the most common one being feedback or howl-round between the microphones and the on-stage monitoring systems which are placed close to the players. Highly directional microphones are favoured for this reason. Also, because there is never any second chance with live sound it is essential to set up the system and balance the sound before the audience arrives, so that everything is ready when the players walk on to give their performance.

USING THE MIXING CONSOLE

The mixing desk is a modular system built up from sets of 6 input channel modules, individual output channels and the Auxiliary PFL/Headphone output channel. Its main applications lie in the small four-track recording studio where cassette systems are now available for around £600, and live music mixing with PA systems. However, it is flexible enough to be considered for almost any sound mixing requirement. A simplified description follows to illustrate how the mixer is used in the multitrack studio for recording and mixing down as well as in the live concert situation.

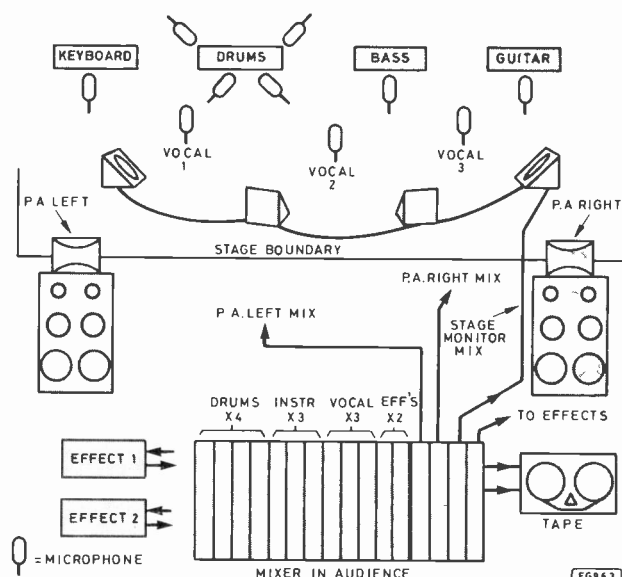


Fig. 4. Live concert mixing

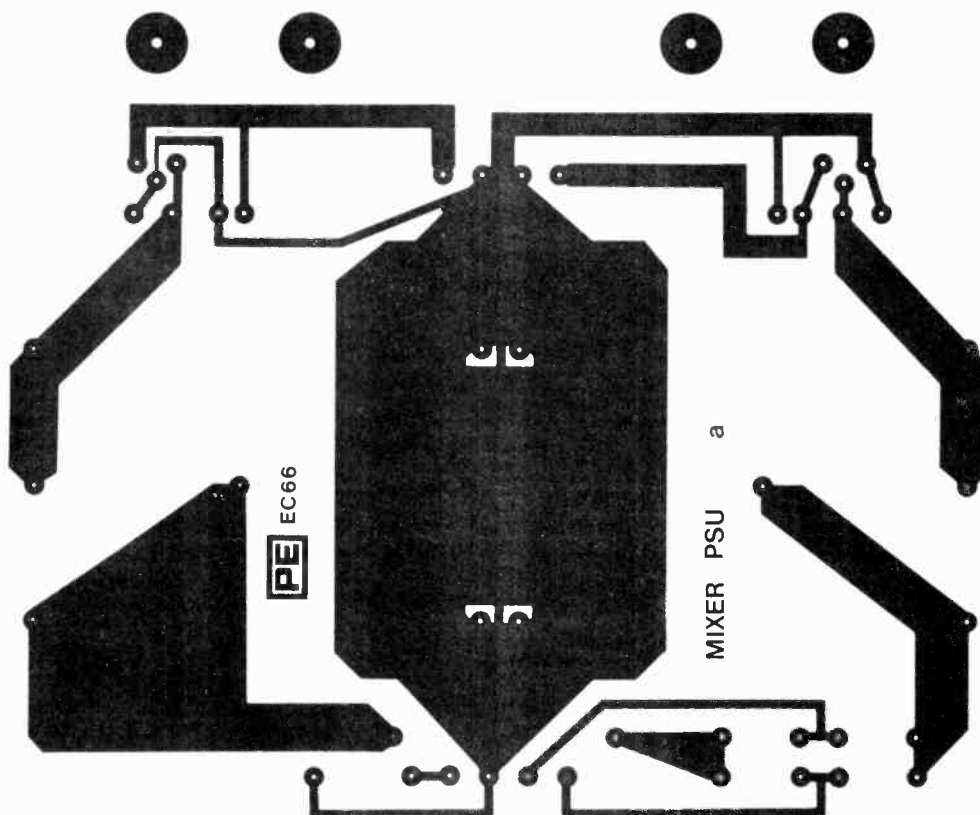


Fig. 1. P.c.b. design for the p.s.u.

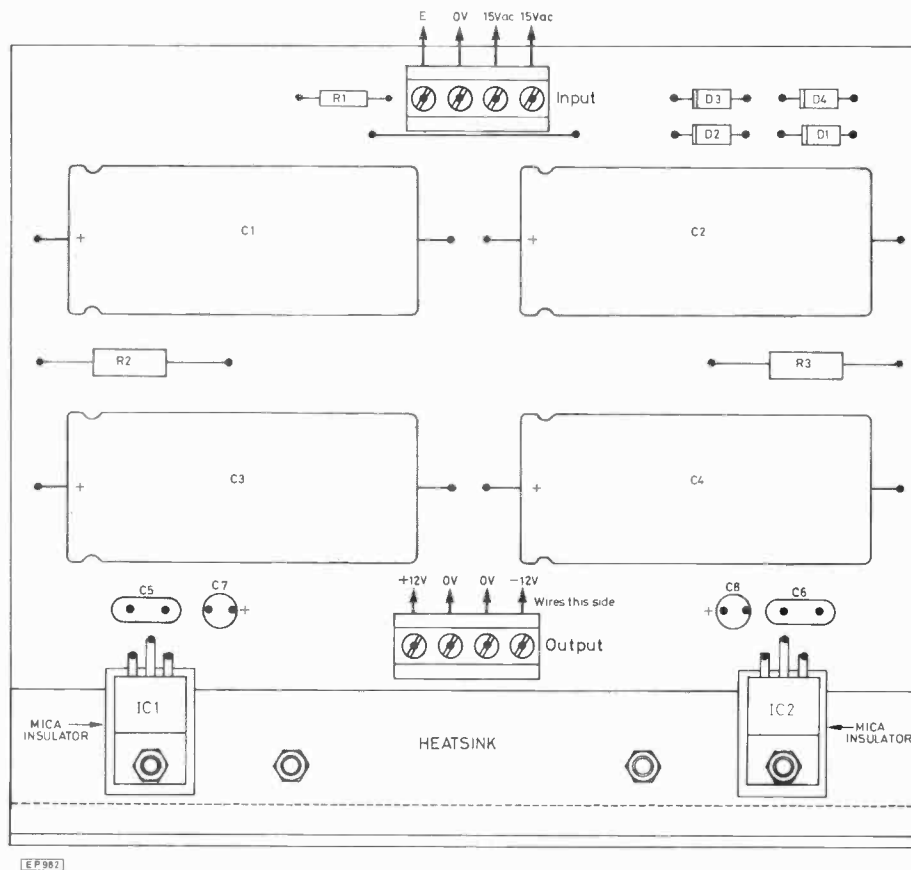


Fig. 2. Component layout

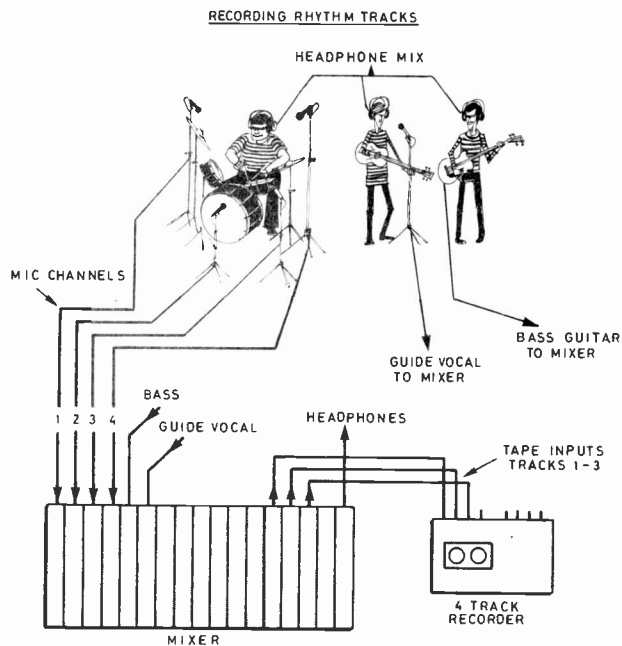


Fig. 5. Recording rhythm tracks

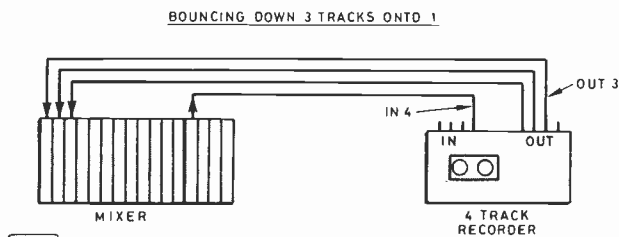


Fig. 6. Bouncing down 3 tracks onto 1

THE MULTITRACK STUDIO

Recording

The first stage of most music recording involves laying down on tape the basic rhythm structure. This usually means drums and bass guitar, along with a rough 'guide' track of vocals to help the rhythm players through the song's arrangement. Fig. 5 shows 4 microphones set up around the drum kit, the bass guitar and the vocal microphone which have all been connected to the mixer input channels. Listening on headphones the recording engineer uses the Pre Fade Listen (PFL) function to examine the sound coming in on

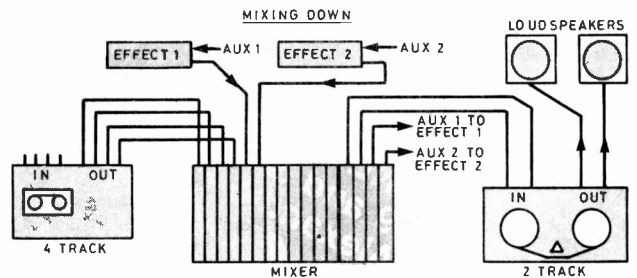


Fig. 7. Mixing down

each mixer channel, to check that all is well and to add equalisation to any sounds that need it. The drum microphones are all routed to one mixer output and recorded onto one tape track, while the bass and vocals are separately recorded on two other tracks. During this process the players listen to each other using headphones, driven from one of the auxiliary outputs of the mixer which allows them a balanced mix of what is being recorded onto tape. Next comes the addition of the other instrument sounds like guitars, keyboards and vocals, but because of the limited number of tracks available on tape a process known as 'bouncing-down' is used to conserve tape track space. Fig. 6 shows how the mixer may be used to mix three tracks together onto the one remaining track, which then makes room for three new tracks. In this way the recording is built up layer by layer until all the necessary ingredients of the sound are on tape and ready for the final 'mix-down'.

Mixing Down

In this final stage of the recording process the four tracks of sound are reduced to a two-channel stereo format which necessitates the use of a second tape recorder. Fig. 7 shows how the mixer is used to transfer the sound across from one recorder to the other, and in doing so it allows a number of useful enhancements to be made for the final result. Firstly there is the question of attaining the right balance between the four tracks and the positioning of each track within the stereo sound image. This is known as panning. Final alterations are also made to the equalisation of each track to highlight the overall tone quality, and there is a further opportunity to add special effects such as reverberation, echo, chorus and phasing etc. The auxiliary mixer outputs are used to send any mixture of the sounds to these effects, whose outputs are then brought back on the remaining mixer input channels. Finally the end result is reached with a stereo tape that may be played on any domestic sound system. Improvements in technique come with practice, and care is taken to ensure that maximum level goes onto tape wherever possible. ★

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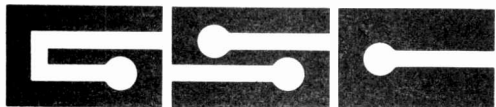
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4144	0.12
4145	0.12
4146	0.12
4147	0.12
4148	0.12
4149	0.12
4150	0.12

NEW JOYSTICKS AND CONTROLLER FOR ZX81 AND SPECTRUM

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SEMICONDUCTOR UPDATE

R.W.Coles

FEATURING MC1468705G2 D60T OP-22

ONE CHIP WONDER

I have always considered one chip microprocessors (that is to say those devices that cram CPU, RAM, ROM and I/O onto a single silicon chip), to be ideal for hobby projects. I say this because these devices are relatively simple to program and understand, and because they do not require any of the complex interconnections which would be necessary to support a multi-chip system based on, say, a Z80. All the budding designer has to worry about is interfacing to the outside world and program design, what could be easier?

Unfortunately there are some snags: The first one-chippers, such as the Intel 8048, had *masked* ROM which meant you had to buy them by the truck-load. These were soon followed by EPROM versions, such as the 8748, which improved things a lot, but even with these you still had to have a suitable PROM programmer. They also had the limitation of being made in NMOS only, so small battery powered systems were out because of the current drain. There has in fact always been at least *one* good excuse for not using them in the latest pet project!

Well the excuses have now run out, and as far as I can see there is absolutely no valid reason for not planning to build that pseudo-random, microprocessor controlled lawn sprinkler you have always promised yourself, thanks entirely to Motorola and their brand new MC1468705G2. (By the way, if you find that long part number off-putting, look at it this way: The MC14 bit just means its Motorola and CMOS, the 7 means that it has EPROM rather than masked ROM, and the G2 means that it is better than a G1(?) Take that lot away and you're left with a Motorola 6805, which my "Boys Wonder Book of Micros" tells me is just a sawn-off 6800 with added RAM, ROM and I/O).

The MC1468705G2 has 2106 bytes of U.V. erasable EPROM, 112 bytes of RAM, 4 eight bit I/O ports and a timer, all squeezed inside a 40 pin d.i.p. Enough to implement a pretty nifty sprinkler system! Even better, the chip has a 128 byte chunk of masked ROM pre-programmed with an EPROM programming algorithm so you don't even have to buy one of those. This means that you can make up a simple circuit board with a socket for the MC1468705G2 and a few external components which, given appropriate input data and a -13 volt programming supply, will act as your very own EPROM programmer.

Best of all though, the new chip is made in low power CMOS and has two additional instructions which also help to reduce supply current. The operating power consumption is typically 10 milliwatts, but execute a

WAIT instruction and this drops to 4 milliwatts even though data is retained and the clock and timer continues to run. Execute a STOP instruction and everything does just that, causing the power consumption to plummet to just 10 microwatts *without* destroying memory or register data. After issuing a STOP you can get the whole thing running again by generating an external interrupt or using the RESET input.

Anyone who knows the 6800 will get on fine with the MC1468705G2, although there are some differences. The new device only has a 13 bit address width to cover RAM, ROM and I/O, but this is more than enough for the on-chip resources and even allows for the addition of external EPROM if ports can be sacrificed as busses.

WHOPPER

In these days of glamorous microprocessors and ever more complex integrated circuits, it is easy to forget the humble transistors and diodes which were of course the start of it all. But these simple components are still essential at the "business-end" of most systems, and the development of newer and better devices continues despite the fact that the lions share of research funding has been diverted towards producing the ultimate microprocessor or memory chip.

The designers at Westinghouse have certainly not neglected semiconductor development it seems, because their latest device, the D60T, has pushed the frontiers of power transistor technology further out than ever before by providing the capability to switch 40 amps and 650 volts at 20kHz! There is nothing simple about the D60T either. Its semi-conductor chip is nearly 1 inch in diameter for example, bigger by far than most microprocessor chips, and the manufacture involves a triple diffusion process. Even the package is bigger and better, because that massive chip is mounted in a hex-nut housing which measures over 1.5 inches across the points and stands nearly 2 inches above the heat sink surface. (Yes, you *definitely* need a heat sink if you want to get anywhere near the D60T's maximum 885W dissipation at 25 degrees C!)

But mere physical details do not do justice to the mighty D60T, and the real story can only be revealed by examining the electrical specs. Would you believe a maximum collector current of 100 amps? or a maximum *base* current of 20 amps? Well then, how about a sustained collector-to-emitter voltage (V_{CE0}) of 800 volts, or even 1200 volts if you reverse bias the base? Yes folks, the D60T can do all this and more!

Probably the most important feature of the D60T though, is not all those noughts after the amps and volts numbers, but the speed at which it operates. Switching at 20kHz may not sound fast to all you logic fans who are used to Shottky TTL switching in a nanosecond or two, but at 40 amps and 600 volts its *very* fast

There are two problems with D60T, and the first is what on earth can you use it for. The manufacturers intend people to use it in place of Thyristors for motor speed controllers hooked up to 30 horsepower induction motors, but maybe you could use it in a 25 kilowatt class D disco amplifier, or to control your arc welder or... or... or something.

The second problem is that a single D60T could set you back around £50. Makes microprocessors look like child's play, doesn't it!

TIDDLER

Well if microprocessors make your head spin and the hairy-chested D60T makes you worry about your electricity bill, why not try an OP-22 from Precision Monolithics Inc?

PMI are famous, as their name suggests, for high grade analogue integrated circuits and especially op-amps. Their usual ploy is to take a standard design and to produce from it a higher performance version which they can sell to those who need that little bit extra and are prepared to pay a bit more for it. The OP-22 has been introduced as a high specification version of micropower op-amps like the National LM4250, with which it is pin compatible.

"Micropower" generally means supply currents of a few tens of micro-amps for battery supply applications, and the new PMI device brings precision operation to these areas for the first time. The supply current of the OP-22 can be set externally with a single resistor anywhere between 1 and 400 microamps, but as you may expect, bandwidth is also affected, so to get 10kHz you would need at least 300 microamps and even PMI cannot overcome that constraint.

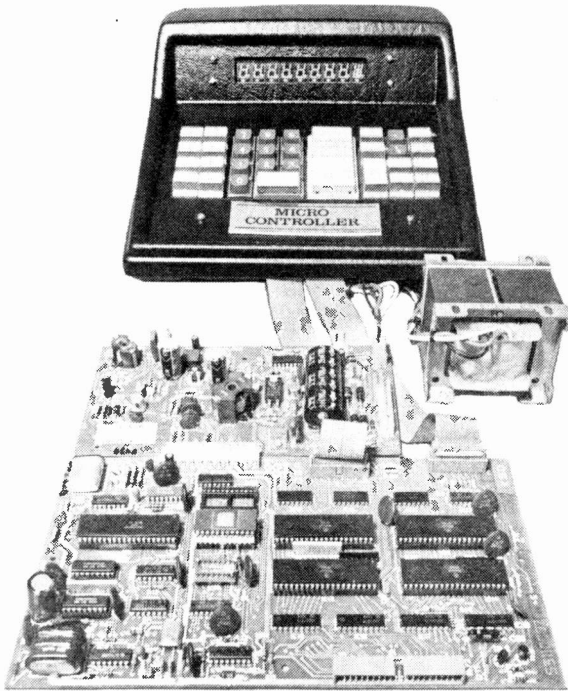
Where PMI can deliver the goods however, is in the areas of open loop gain, input offset voltage, and common-mode rejection. The OP-22 has a gain of more than a million, a guaranteed offset voltage of 300 microvolts or less, and it can realise a common-mode rejection ratio of over 100dB for voltages to within 1.5 volts of the supply rails. Supplies of from 3 to 30 volts, single or split, can be used, and the OP-22 is available in either an 8 pin mini-d.i.p. or a TO99 metal can.

MICRO CONTROLLER

MICHAEL TOOLEY B.A.

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PART TWO



THIS month we describe in detail how to use the DISBUG monitor facilities. The instruction set for the 6800 is listed in full in Micro-file and there is a description given here of the full range of addressing modes. A step-by-step example of how to enter and run a program on the Microcontroller is included. Finally, the circuit and operation of the power supply module is described.

DISBUG MONITOR FACILITIES

The DISBUG monitor provides the user with facilities to allow the entry of programs into the user RAM area, the examination and change of memory locations (including PIA registers), the debugging of prototype routines, and the control of execution of developed programs. The user communicates with DISBUG via the keyboard, and the monitor uses the display to respond with prompts and information.

The Microcontroller contains 1024 bytes of read/write memory (addresses 0000 to 03FF inclusive). Some of this memory is required to allow DISBUG to operate, but the remainder (0000 to 03A0) is available for user applications. Fig. 2.1 shows the allocation of address space in the RAM area.

The DISBUG monitor facilities are grouped into editor modes (memory, register, preset and breakpoint) and command functions (go, proceed and restart). Each mode or function is invoked separately, and they are each described in detail below.

DISBUG DISPLAYS

The displays output by DISBUG follow a standard format. The normal prompt used when DISBUG is awaiting a command from the keyboard is "... dIS ...". When an editor key (MEMORY, REGISTER, PRESET or BREAKPOINT) is pressed, the display will change to the form "p-aaaa-dd". The "p" field will contain a prompt character to remind the user what input is expected next (e.g. "A" for address), the "aaaa" field will hold the address value, and the "d" field will hold the data value. Initially the second and third fields will often be empty. e.g. when the preset editor is invoked, the

display will show "L- -", indicating that the lower address value is expected. The data field will sometimes be used to display advisory information, rather than a strict data value. Such information (e.g. the breakpoint number) will not use standard numeric representation, to avoid confusion.

The numbers which are mentioned in the descriptions which follow, and those which appear in the DISBUG displays, are all in hexadecimal notation. All addresses must comprise of four hex digits (e.g. 008F), and all data values must comprise of two hex digits (e.g. 07); leading zeroes *must* be used where necessary to fill the fields to the appropriate lengths.

THE MEMORY EDITOR

The contents of any memory location may be examined and (optionally) changed using the memory editor. The memory editor is also used for entering programs into the user RAM area (0000 to 03A0). Remembering that the 6800 treats PIA registers as memory locations, the memory editor may even be used directly to control the operation of the Microcontroller's PIAs; modifications to the programming of the keyboard and display PIAs, however, may interfere with the normal operation of DISBUG. Writing new values to

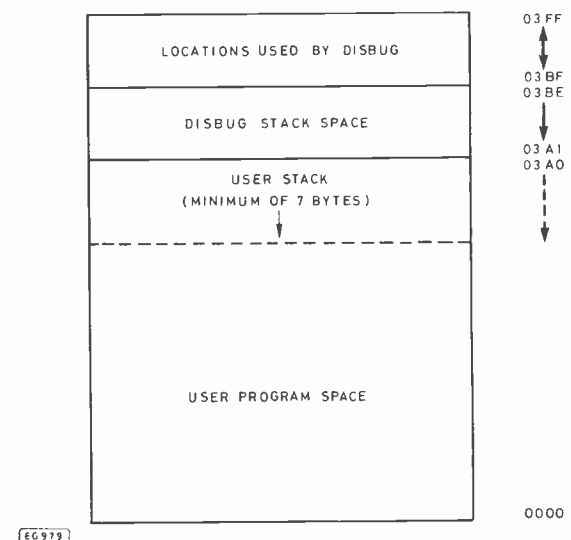


Fig. 2.1. Microcontroller RAM address allocations

EPROM addresses and unused addresses in the address map will have no effect, but beware of address images.

The memory editor may be invoked whenever the "... dIS ..." prompt is displayed by pressing the MEMORY key. The display will then change to "A- ", indicating that the memory editor is expecting the address of the memory location to be examined to be input. The numeric keys 0 to F are then used to specify the appropriate 4-digit address. After the fourth digit has been struck, the prompt character will change from "A" to "d", and the current contents of the specified location will be displayed in the data field of the display. The "d" prompt indicates that, if the user wishes to change the contents of this location, a new 2-digit value may now be input. When the first digit of the new value is entered, the data field will be cleared, and the new digit displayed, e.g. the display might show "d-01Fb- 7". No change is necessary, however, and by default the contents of the location will remain as currently displayed.

After any new value, if any, has been entered, the location may be closed with the ENTER key. This will cause the "A- " prompt to re-appear, ready to examine another location. If the NEXT key is used in place of the ENTER key, the next sequential location will automatically be opened and displayed. The PRIOR key will cause the previous location to be opened and displayed.

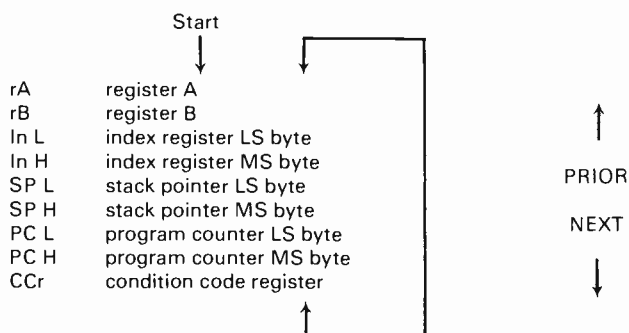
The CANCEL key may be used at any time to abandon an uncompleted memory change and return to the "... dIS ..." prompt. To exit from the memory editor when the "A- " prompt appears, either the ENTER or CANCEL keys may be used.

To gain familiarity with the operation of the memory editor, readers are encouraged to step through the DISBUG EPROM (addresses F800 to FFFF), safe in the knowledge that the contents of these locations are permanently programmed.

THE REGISTER EDITOR

After a breakpoint has been encountered in a program under development, the contents of the CPU registers may be examined/changed using the register editor. The REGISTER key may be pressed to invoke the register editor whenever the "... dIS ..." prompt is displayed. The register values with which the program will 'proceed' may then be examined, and optionally changed. Users should note that changing the address held in the program counter will affect the address from which the program will proceed.

The display of register contents used by DISBUG is cyclic in nature, and shows only one 8-bit (2 hex digit) value at a time. The sequence is as follows:



The initial display will show the current contents of the A register. Typically the display would be "d- rA -32", indicating that the current contents of register A is 32, and that this may be changed by entering a new 2-digit data

value (hence the "d" prompt character). The ENTER key will cause the currently displayed value to be saved and the register editor to be exited. The NEXT key will cause the current value to be saved, and the contents of the next register (B in this case) to be displayed. The PRIOR key will cause the displayed value to be saved and the contents of the previous register (the condition code register in this case) to be displayed. The previous value of any register will remain unchanged if no new value has been specified.

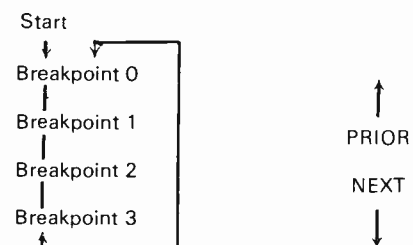
The CANCEL key may be used at any time to exit from the register editor, and this will abandon any change which has not yet been completed.

THE BREAKPOINT EDITOR

Temporary halts or breakpoints are often useful as an aid to debugging a program. They allow the programmer to split programs into convenient blocks so that each block may be tested separately. In practice, breakpoints are implemented by using the monitor program to replace instruction codes at the specified point(s) with software interrupt codes (3F's on the 6800). The replaced instruction codes, and their addresses, are remembered by the monitor so that the breakpoints may be removed when required. The software interrupt allows the contents of the CPU registers to be examined at the breakpoint because these are pushed onto the stack; users should remember to allow 7 bytes of stack to be used by the breakpoint editor.

Breakpoints are set and reset by pressing the BREAKPOINT key to enter the breakpoint editor. This may be done whenever the "... dIS ..." prompt is displayed. DISBUG allows the user to insert up to four breakpoints in a program; these breakpoints are numbered from 0 to 3, and are identified in the displays as b0 to b3, respectively. It is important to note that, for 2-byte and 3-byte instructions, the breakpoint must be set at the FIRST byte of the instruction, i.e. at the op code byte.

When the breakpoint editor is entered it displays the address at which the first breakpoint (b0) has been set. A typical display of "A-01E5-b0" would indicate that breakpoint 0 has been set at address 01E5. If no breakpoint has been set, the address shown will be FFFF; this address is within the DISBUG EPROM, and is therefore not a possible breakpoint address. The address of the breakpoint may be changed by entering a new 4-digit address (hence the A prompt character), followed by ENTER, NEXT or PRIOR. These keys will respectively: change the current breakpoint address to any new value specified and then exit from the breakpoint editor; change the current breakpoint address to any new value specified and then display the next breakpoint; or change the breakpoint address to any new value specified and then display the previous breakpoint. A breakpoint is reset by specifying an address of 'FFFF'. No change to a breakpoint is required, however, and unless a new 4-digit address is specified, the breakpoint address remains unchanged. The CANCEL key may be used at any time to exit from the breakpoint editor; any uncompleted breakpoint change will be abandoned.



The display of breakpoints is cyclic, i.e. the next breakpoint from 3 (the last one) is breakpoint 0, and the prior breakpoint from 0 (the first one) is breakpoint 3.

THE PRESET EDITOR

Areas of read/write memory may be preset to the user-defined values using the preset editor. This is particularly useful for initialising RAM to known values, e.g. all zeroes, filled with NOP instruction codes (01's), etc.

The area of memory to be preset is specified by entering the lower and upper addresses for the block. If the two addresses are equal, only the specified address will be preset with the data value; in effect the same as using the memory editor, but much slower. If the lower address is specified as greater than the upper address, all memory locations *except* those between the two limits, but including the limits, will be preset. This will also have the effect of causing DISBUG to crash if the memory over-written includes the DISBUG RAM!

The preset editor may be entered whenever the normal DISBUG prompt is displayed. Pressing the PRESET key will cause the display to change from ". . . dIS . . ." to "L- -". This indicates that the lower (start) address of the block of memory to be over-written should be entered. After the appropriate four digits have been entered, the ENTER key should be pressed to record the address. The display will then change to "U- -", indicating that the upper (end) memory address should be entered. After the appropriate four digits have been entered, the ENTER key should again be used to record this address. DISBUG will then output a display of "d- -" to indicate that the data value to be written to memory should be entered. When the appropriate two digits have been entered, the ENTER key should be pressed. This will cause the data value to be recorded, and the block of memory identified to be over-written with the specified data value. Over-writing DISBUG EPROM addresses and "unused" addresses in the address map will have no effect. After the preset operation has been completed, DISBUG will return to its usual ". . . dIS . . ." prompt.

A preset operation may be abandoned at any stage by using the CANCEL key; no change to any address specified occurs until the ENTER following the data value is pressed.

THE GO FUNCTION

A user program is started using the GO function key. After GO has been pressed, DISBUG will prompt for the program start address by displaying "A- -". The user should then enter the 4-digit address from which execution of the program should commence. After entering the four address digits, the program may be started by pressing the ENTER key. Alternatively, using the CANCEL key will abandon the start request.

When DISBUG starts a program the 6800's registers are set up to the following initial values:—

rA = 00
rB = 00
In = 0000
SP = 03A0 (Start of the user stack)
PC = The requested start address
CCr = 00 (Interrupts enabled and all status bits clear)

Before the user program is actually started, DISBUG inserts any breakpoints which may have been set. A breakpoint which has been set at the program start address will be ignored, but it will be remembered for a future occasion (e.g. for starting at a different address or proceeding from a breakpoint). DISBUG then starts the program from the address now held in the PC, with all of its other registers in the states specified above.

THE PROCEED FUNCTION

The proceed function allows the user to continue with the execution of a program after a breakpoint has been encountered. Alternatively, proceed can be used to start a program from a defined point, but with the CPU registers in user-defined states. This is achieved by first using the register editor to set up the required register values, with the start address in PC, and then using proceed to start the program. The proceed function may be called whenever the ". . . dIS . . ." prompt is displayed.

After the PROCEED key has been pressed, DISBUG will respond by producing a display of the form "E-aaaa-Pr". The "E" prompt indicates that the next input expected is the ENTER key. The "aaaa" value will show the address from which the program will resume execution. The "Pr" reminds the user that a proceed has been requested. Pressing the ENTER key will cause the program to proceed (after a brief delay). The display will go blank unless the user program writes to the display PIA. The CANCEL key in place of ENTER will abandon the proceed request and return to the ". . . dIS . . ." prompt.

If the user has changed any register contents since the last breakpoint, the program will resume with these new values; any change to the program counter will change the address from which execution restarts. Before DISBUG passes control back to the user program, any breakpoints which have been set (with the exception of any set at the restart address) will be re-installed.

When an executing program encounters a breakpoint (or other software interrupt instruction), it will cause control to return to DISBUG. The monitor will then remove all of the breakpoints which have been set, and replace the original op codes. Any SWI instructions inserted directly will remain. DISBUG will then output a display of the form "E-aaaa-Br", where "aaaa" specifies the address of the breakpoint, and "E" indicates that the ENTER key will cause the ". . . dIS . . ." prompt to re-appear. The address of the breakpoint (or other SWI) encountered may always be re-inspected by examining the PC contents with the register editor. A command key may be used in place of ENTER to enter an editor or function directly instead of via the prompt.

THE RESTART FUNCTION

The restart function is provided to allow the user to re-initialise the DISBUG monitor program. A restart will have the same effect as entering the monitor from switch-on, but without the need to interrupt the mains supply. The RAM area used by DISBUG (03A1 to 03FF) is reset to its start-up values, and the display and keyboard PIAs are correctly configured; the user RAM area is totally unaffected. Restarts are thus a convenient way of ensuring that user programs have not corrupted the DISBUG RAM or PIAs.

A restart may be requested whenever the normal ". . . dIS . . ." prompt is displayed. Pressing the RESTART key will result in the display of the restart prompt, "rEstArt". The restart may then be activated by pressing the ENTER key, or abandoned by pressing CANCEL. ENTER causes the welcome message "dISr1.0" to be displayed for approximately 2 seconds, followed by the normal DISBUG prompt of ". . . dIS . . .".

THE 6800 INSTRUCTION SET

The 6800 instruction set contains 197 different instructions which fall into four major categories:

- (a) accumulator and memory
- (b) index register and stack
- (c) jump and branch
- (d) condition code register

The full instruction set is shown in Micro-file. This table also summarises the op codes, number of bytes, number of machine cycles required for execution, and the effect of the instruction on the registers and memory. Each instruction is also represented by a mnemonic code (e.g. CLR for clear), which is of no significance to the 6800, but which provides a useful standard notation for writing programs.

In many cases, more than one instruction op code is associated with each mnemonic (e.g. LDA A can have op codes of 86, 96, A6 or B6). The actual op code selected will depend on the addressing mode required; in the case of LDA A the modes available are immediate, direct, indexed and extended, respectively. When an assembler is used to translate from mnemonic codes to hex op codes, and there is a choice of addressing modes, some means must be provided to indicate the mode required. This is usually specific to the assembler being used, but for example # is often used to indicate the immediate mode. In manual translation, the programmer selects the appropriate op code from the table, but such a notation is still useful when writing the program in mnemonics.

The following sections describe the features of the six addressing modes which are available. When translating from mnemonic codes to op codes, the programmer should select the most appropriate mode, bearing in mind the length and flexibility of the resulting instruction. No attempt is made to provide a full description of the operation of each instruction; users are referred to a 6800 programming manual for further details. It should be remembered that the 6800 treats the peripheral registers in the PIAs as memory locations and the same instructions are used for manipulating their contents, e.g. B7 18 02 writes the contents of register A to the A control register in the display PIA.

INHERENT ADDRESSING MODE

Some instructions do not require additional address information for them to be completely meaningful since the required data is already present in the microprocessor's own internal registers. The following are examples of the inherent addressing mode:

CLRA	sets register A to zero (i.e. it clears the register).
PSHA	pushes data onto the stack. The contents of register A is stored on the stack at the address specified by the stack pointer and the stack pointer is then decremented by one.
INX	increments the index register by one.
SEI	sets the interrupt mask in the condition code register. The processor is then inhibited from servicing an interrupt emanating from a peripheral device, and will continue to ignore interrupts and execute the program instructions until interrupts are re-enabled by means of a clear interrupt mask instruction (CLI).
NOP	causes the program counter to be incremented without affecting any of the other registers. It is useful during program development as a "stand-in" for some other instruction that is to be determined during debug, and also for equalising execution time through alternate paths in a control program.

IMMEDIATE ADDRESSING MODE

In this addressing mode the operand immediately follows the op code, and may consist of one or two bytes. Two byte operands are only used for instructions relating to the index

register and stack pointer (CPX, LDX, LDS). In all other cases a single byte follows the op code. Examples of immediate addressing are:

LDA A FF	this instruction loads register A with the value FF (the instruction would be coded as 86 FF).
LDX 0300	this instruction loads the index register with the value 0300 (the instruction would be coded as CE 03 00).

DIRECT ADDRESSING MODE

Using this mode of addressing the operand of the two-byte instruction is stored in a memory location with an address which has a most significant byte equal to 00, and the least significant byte equal to the second byte of the instruction. With direct addressing, the valid memory address range is 0000 to 00FF, and consequently only a restricted range of memory is accessible. This addressing range falls within the user RAM area of the Microcontroller.

Examples of the use of direct addressing are:

LDA A 43	this instruction loads the contents of location 0043 into register A (the instruction op code would be 96 43).
CMP B BC	this instruction compares the contents of register B with the contents of memory location 00BC, and sets the condition code register bits as appropriate (the instruction op code would be 91 BC).

EXTENDED ADDRESSING MODE

In this mode the memory address of the operand is specified by the second and third bytes of the instruction. The most significant byte of the memory address is specified by the second byte of the instruction, and the least significant byte of the memory address is specified by the third byte. Instructions using the extended addressing mode are able to access the full 64K bytes of the 6800's address range, i.e. 0000 to FFFF. Examples of instructions using the extended addressing mode are:

LDA B 00BC	this instruction loads register B with the contents of memory location 00BC (the instruction op code would be F6 00 BC). Note that this instruction would use only 2 bytes if it used direct addressing, but is a valid instruction, nevertheless.
INC 03B7	this instruction increments by one the contents of memory location 03B7 (the instruction op code be 7C 03 B7).
LDX 01A5	this instruction loads the most significant byte of the index register with the contents of location 01A5, and the least significant byte with the contents of location 01A6 (the instruction op code would be FE 01 A5). Note that the index register, like the stack pointer, is a 16-bit register and requires 2 bytes of memory to specify its contents.

RELATIVE ADDRESSING MODE

The relative addressing mode in the 6800 is used solely for branch instructions. These instructions allow the normal sequence of "one instruction following another" to be

changed, and enable the implementation of decision making in programs. The instructions used for branching are two-byte instructions. The first byte contains the opcode which specifies the branch condition (e.g. BCS is used to branch if the carry bit is set), and the second byte contains the offset.

The offset is a 2's complement 8-bit number which is used to specify where the program will branch to if the branch condition is satisfied; in the example the branch will only occur if the carry bit is set when the instruction is encountered. The range of destination addresses is restricted to $-7D$ to $+81$ relative to the branch instruction (hence the name). This range results from the fact that, when the branch instruction is executed, the program counter will be pointing to the next instruction, which will be two bytes on from the branch code. If A is the address of the branch instruction in memory, then the destination address, D, will be in the range:

$$[(A + 2) + 7F] \geq D \geq [(A + 2) - 80]$$

Two examples are given in Fig. 2.2 which illustrate how to calculate the two hex-digit offset value, J, which must be coded as the second byte of the branch instruction. With practice the values may rapidly be worked out by mental arithmetic!

INDEXED ADDRESSING MODE

Indexed addressing involves 2-byte instructions, and makes use of the contents of the 16-bit index register, in addition to op code, to specify the address of the source/destination of the instruction operand.

The address is calculated by taking the contents of the in-

dex register and adding the offset value contained in the second byte of the instruction. For example, if the current contents of the index register are 0300, an instruction of STA A 27,X (coded as A7 27) would result in the contents of register A being stored in memory location 0327. The offset in the second byte of the instruction may take any value in the range 00 to FF, and is assumed to be positive. The index register is unaffected by indexed instructions; thus STA A 27,X followed by STA B 28,X would result in registers A and B being stored in locations 0327 and 0328, respectively.

Special instructions are provided for loading, manipulating and storing the contents of the index register, as used by the indexed addressing modes of instructions. Typical instructions relating to the index register are LDX, INX, DEX, and STX. The use of indexed addressing is particularly useful for manipulating tables, and for jumping to addresses picked up from tables/memory locations (JMP nn,X and JSR nn,X); this is a technique much used internally by DISBUG.

THE STACK

The 6800 uses part of its read/write memory to implement a stack. This stack is used for:

- (a) storing subroutine return addresses
- (b) temporary program data storage
- (c) storage of CPU status (register contents) while responding to interrupts.

The stack works on a last-in first-out (LIFO) principle and a stack pointer (16 bits) is provided in the CPU to indicate the address of the next free stack location. When data (e.g. a return address) is "pushed" onto the stack, the stack pointer is *decremented* by the number of bytes pushed (e.g. two for a return address). When data is "pulled" from the stack, the stack pointer is correspondingly *incremented*.

The stack pointer must be initialised (via the LDS instruction) to the start (top) of the stack area. The amount of RAM allocated for stack operations must allow two bytes for each nested subroutine call, and seven bytes for each category of concurrent interrupt (NMI, IRQ, SWI). Additional allowance must be made if the stack is to be used for temporary variable storage (via PSHA and PSBH). Every stack push must have a corresponding stack pull if the stack is not to extend indefinitely! Once initialised, maintenance of the stack pointer is performed automatically by the CPU.

GETTING STARTED

A practical demonstration of programming the Micro-controller concludes the second part of this series. The program which is presented is used as a means of demonstrating the operation of DISBUG. However, it is not expected that readers will fully understand the detailed operation of the program since it uses a number of sub-routines which are contained within DISBUG itself. In the next issue further examples of programs will be presented to illustrate how control programs may be constructed. Once the user has become familiar with the way in which programs are entered and controlled, it is but a short step to write a PIA control program. The sample program is:—

Address	Instruction	Mnemonic	Op Code
0000	LDA A	# 15	86 15
0002	JSR	F9BD	BD F9 BD
0005	CLR	03FA	7F 03 FA
0008	LDX	# 03FB	CE 03 FB
000B	LDA A	03E3	B6 03 E3
000E	JSR	F8F7	BD F8 F7
0011	LDA A	03E2	B6 03 E2
0014	JSR	F8F7	BD F8 F7
0017	JSR	F814	BD F8 14
001A	BRA	E4	20 E4

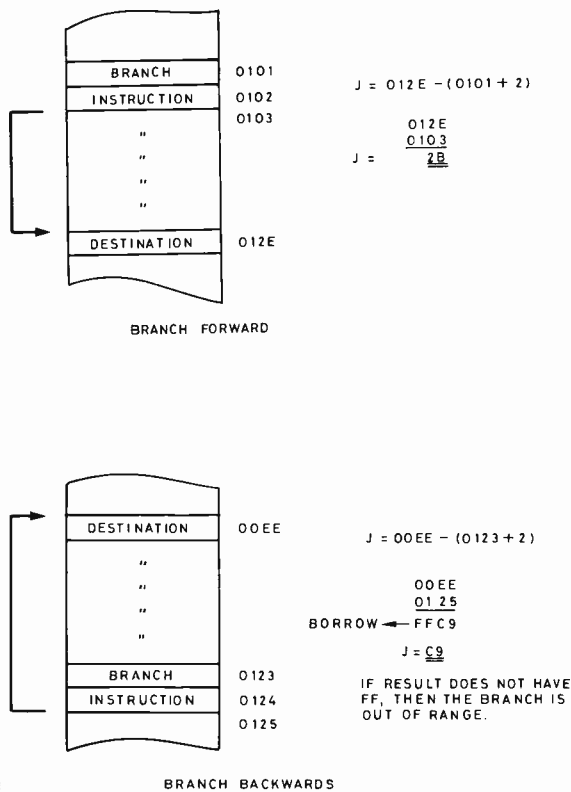


Fig. 2.2. Calculation of branch offset values

When the Microcontroller is switched on, DISBUG outputs a display of "dis r1.0" for approximately 2 seconds. After this time, the display changes to the normal prompt of "...dis..." to indicate that DISBUG is awaiting a user command from the keyboard. The memory editor is used to enter programs into the user RAM area of memory. The sequence of keystrokes required to enter the demonstration program is as follows:

KEYSTROKE(S)	DISPLAY
	...dis...
MEMORY	A- -
0 0 0	A- 000-
0 8	d-0000- 8
6	d-0000- 86
NEXT 1 5	d-0001- 15
NEXT B D	d-0002- bd
NEXT F 9	d-0003- F9
"	"
"	"
repeat for remaining codes	"
"	"
NEXT E 4	d-001b-E4
ENTER	A- -
ENTER	...dis...

EG985

The program is now stored in RAM. To demonstrate the use of the breakpoint editor, a breakpoint will now be placed at the end of the loop at location 001A. This is done as follows:

KEYSTROKE(S)	DISPLAY
	...dis...
BREAKPOINT	A-FFFF-b0
0 0	A- 00-b0
1 A	A-001A-b0
ENTER	...dis

EG982

The program is now run from the start address (0000) as follows:

	...dis...
GO	A- -
0 0 0 0	A-0000-
ENTER	

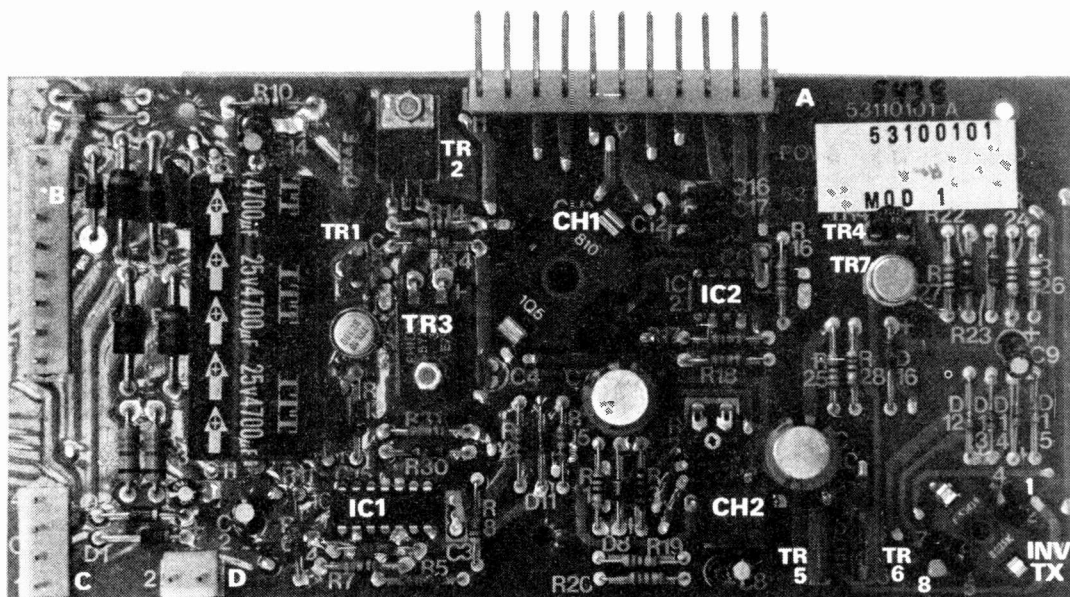
EG983

The display will now go blank, flash briefly, and then return with a display of "E-001A-bP" to indicate that it has found the breakpoint at location 001A. Pressing the ENTER key will cause "...dis..." to reappear. The PROCEED key is then struck to request that the program continue from the breakpoint:

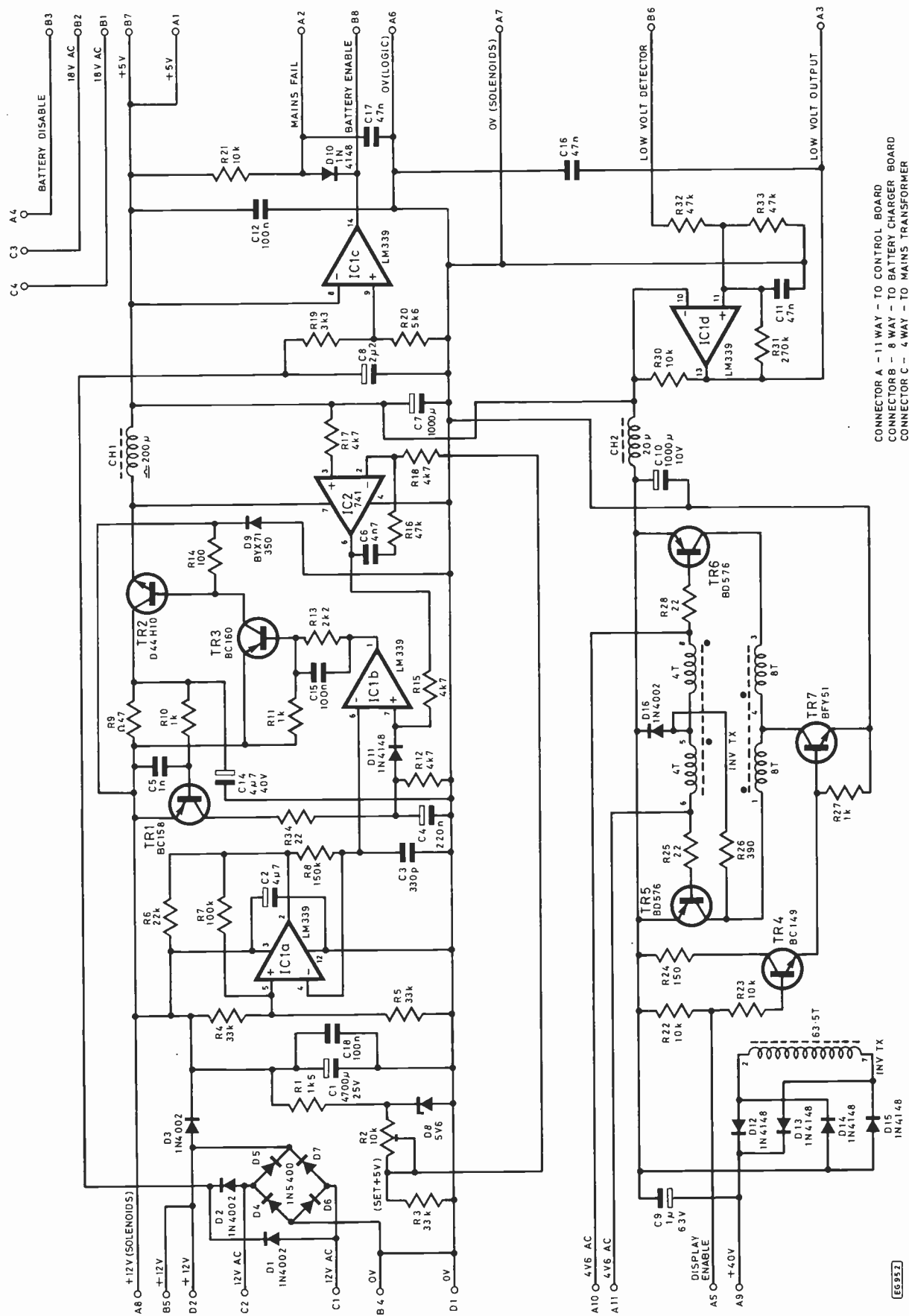
	...dis...
PROCEED	E-001A-Pr
ENTER	

EG984

The program will then restart from location 001A. The display will go blank for a short period, and then a four-digit running seconds count will appear in the centre of the display. The program, which uses the 1 second real time clock interrupt, must be stopped by interrupting the power.



P.s.u. board



CONNECTOR A - 11 WAY - TO CONTROL BOARD
 CONNECTOR B - 8 WAY - TO BATTERY CHARGER BOARD
 CONNECTOR C - 4 WAY - TO MAINS TRANSFORMER

Fig. 2.3. Circuit diagram for the p.s.u.

POWER SUPPLY

The power supply provides the following outputs which are required for the Microcontroller:

- (a) +12V high current supply (unregulated) for the four output interface buffers. Unloaded output is approximately 17V.
- (b) +5V regulated supply for the CPU, RAM, ROM system clock, and control logic
- (c) +40V supply for the gas discharge display
- (d) 4-6V a.c. for the display filament.

In addition to the above supply rails, logic control signals are provided for detecting the presence of low-voltage or mains failure conditions.

The mains transformer has two series-connected 110V primary windings and two separate secondary windings. One of these provides 12V at approximately 2A for the bridge rectifier arrangement formed by D4, D5, D6 and D7. The other secondary winding provides approximately 17V at 0.5A and is not used in the basic Microcontroller system. It may, however, be used in conjunction with ancillary equipment or for system expansion.

The complete circuit diagram of the Microcontroller power supply is shown in Fig. 2.3. The unregulated d.c. output from the bridge rectifier is developed across reservoir capacitor, C1, and additional high frequency decoupling is provided by C18. The regulator operates on the switched mode principle with series-pass transistor, TR2. IC1a is connected as an oscillator which produces a square wave output at approximately 33kHz. The output of this oscillator is inverted by means of the comparator formed by IC1b. Over-current protection is provided by means of TR1 which effec-

tively turns off the comparator stage. The output current is sampled by means of the voltage drop developed across R9 and trip operates at a load current of approximately 1.5A.

The voltage reference for the supply regulator is provided by D8 and associated components. Potentiometer, R2, provides accurate adjustment of the reference voltage to 5V. The reference voltage is compared with the output voltage of the supply using the comparator arrangement formed by IC2. Feedback components, C6 and R16, improve the stability of this stage.

Failure of the supply mains is detected by a further comparator arrangement formed by IC1a. Low voltage detection is similarly provided by IC1d. Both the mains failure and low-voltage control signals are used in the Microcontroller RAM control logic.

A simple inverter arrangement is used to provide the +40V rail. TR5 and TR6 are connected as an astable oscillator which operates at 12kHz and is gated by means of TR7. The secondary of the inverter transformer feeds the bridge rectifier, D12, D13, D14 and D15. Positive feedback to the bases of TR5 and TR6 is by means of two further secondary windings and these are also used to provide the 4-6V a.c. filament supply. The display is enabled by a logic 'high' which turns TR4 and TR7 'on'. Note that R22 acts as a pull-up which ensures that the inverter supply operates when the power supply is disconnected from the Microcontroller.

NEXT MONTH: *Programming the PIA's, writing control programs, controlling peripheral hardware and sample applications.*

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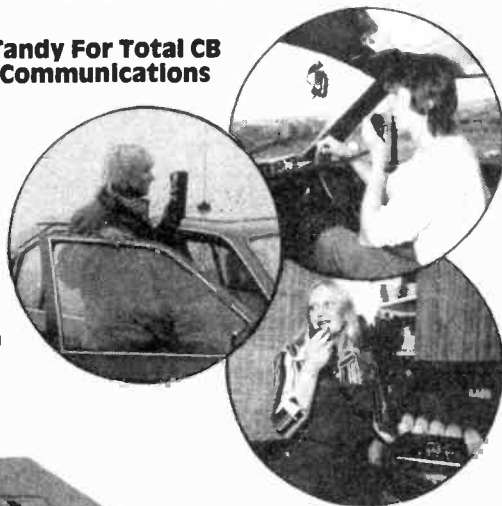
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PIN BULLETINS

At last something useful for nothing! Although surprisingly few people realise it, patents are often a wonderful source of first hand information on technology. A patent effectively freezes the inventor's original thoughts in print because, once filed and published, a patent can't be re-written, like the second edition of a book. Also patents remain perpetually in print. Even if all the printed copies have been sold you can still buy a photo-copy from the Patent Office. The problem of course is in finding the information you want from the literally millions of patents on file. A search by name (i.e. the name of the inventor, or the firm which filed the application for the inventor) is relatively easy, but still tedious because you have to search through annual alphabetical lists. And some firms file hundreds of patents a year. A subject matter search (i.e. all patents in a particular field of technology) is much more difficult and time-consuming. You first have to establish the classification mark for the technology that interests you, and then look up every patent that carries that mark. As often as not most of them are irrelevant, because it's only occasionally that your field of interest exactly coincides with a particular classification mark. Random searches, relying on pure serendipity, are like the football pools.

Now, the British Library is publishing a series of newsletters, called PIN Bulletins, which deal with interesting and important patents in popular and topical subject areas. These bulletins can be a very valuable short cut. Bulletin No. 2, for instance, discusses the patents on the Sinclair flat screen television research. Bulletin No. 3 looks at the patent coverage on Prestel-Viewdata, the war-time Enigma coding machines and satellite data communications. You can get copies of the PIN Bulletins free, from any of the libraries in the Patents Information Network. In practice this means any large library which keeps copies of published patents.

THE CRANFIELD PATENT

There's an interesting story behind British Patent 1 394 291. It was applied for in February 1972, by the Cranfield Institute of Technology, with Jack Dinsdale named as inventor. Dinsdale is a lecturer at Cranfield and hi-fi enthusiast, who had invented a clever bearing for a gramophone turntable. The patented bearing is like a fairly loose fitting piston and cylinder arrangement, but with helical grooves cut in the mating cylin-

drical surfaces. The bearing is filled with oil and when the central piston part (which carries the gramophone turntable) is rotated, the helical grooves create a hydrodynamic thrust which pumps the oil downwards. So the rotating parts float on oil. If the spindle is turned in the opposite direction the oil is pumped upwards and the bearing locks like a brake.

The patent application was accepted and published by the British Patent Office in May 1975 and in December that year Cranfield sold the patent rights to Plessey, then the parent company of hi-fi manufacturer Garrard. The sale price was said to be £5,000. At that time hi-fi sales were still reasonably strong and Garrard was a major name in British hi-fi. Garrard planned to incorporate the Cranfield bearings in a new, top range turntable. But hi-fi sales slumped and so did Garrard's fortunes. No turntable with the Cranfield bearing ever appeared. But even after Plessey shed loss-making Garrard, the Ilford company kept on paying the annual renewal fees necessary to keep the Cranfield patent in force. This has prevented other manufacturers from using the idea.

The Rock turntable made by Elite Townshend of Walton-on-Thames incorporates other Cranfield technology, such as artificial granite material for damping and a viscous fluid damped pickup arm. But Cranfield could not license Elite Townshend to use the patented bearing and had to design another, which relies on a cup of PTFE. It's unclear why Plessey kept the patent in force, because after the Garrard experience Plessey showed no further interest in hi-fi. Perhaps the patent was automatically renewed because no one thought to decide otherwise.

In April, 1982, however, Plessey sold the patent rights back to Garrard, for a nominal £1. So it is now up to Garrard to keep the patent in force and this will entail paying over £100 a year in renewal fees. After being sold off by Plessey, Garrard was bought by the Brazilian company Gradiente Electronics, but the future of Garrard is again in doubt. The company pulled out of the 1982 Harrogate International Festival of Sound and Video at the last minute, leaving the official exhibition catalogue with a glossy advert for Garrard on the front page, but no Garrard products on display. The next renewal fee for the Cranfield patent falls due for payment on February 2nd, 1983. Although there is a period of grace available for late payment it's likely that several hi-fi manufacturers will be checking with the Patent Office in February to establish

whether or not Garrard is still keeping the Cranfield patent alive.

LOUDSPEAKERS

The Hohyu Rubber Company Ltd of Osaka, Japan has filed a British patent application for a new type of loudspeaker diaphragm. (2 087 688). Although patents for new speakers and new diaphragm materials, all supposedly offering perfect sound reproduction, are two a penny, this Japanese proposal is worth noting because of its radical thinking. This is probably due to the fact that the applicants are primarily involved in rubber technology, rather than loudspeaker design.

Traditionally a loudspeaker diaphragm is built as light and rigid as possible, so that it moves as a piston without isolated vibrations which cause cone breakup. The Japanese here suggest that this approach should be abandoned. Instead the diaphragm should be made of cured rubber with a very low rigidity so that it can vibrate freely, and not as a piston. The inventors liken their new cured rubber diaphragm to "artificial vocal cords".

Various rubber materials are listed, all highly flexible and formed by moulding and heat-curing under pressure. According to the patent the conventional diaphragms were stripped out of a three-way hi-fi speaker system and replaced by samples of the new floppy rubber units. Signals were then fed in from a hi-fi system (Sansui amplifier, Denon turntable and Shure V-15 type III cartridge) while a panel of "four trained listeners" made notes. Whereas the original system sounded only "ordinary" the system modified according to the invention sounded consistently "excellent".

European Patent Application 0 054 945 from the Nissan Motor Company offers a high level of sound in a motor car from a small loudspeaker drive unit. Most in-car systems, especially budget units factory-fitted prior to sale, rely on small loudspeaker drive units mounted in the door panels. These easily overload when the system is played loud, for instance on a motorway. They are also prone to irritating cavity resonances at specific frequencies in the high bass range. Nissan suggests the answer is to join the resonance problem rather than fight it. Instead of using a conventional loudspeaker, with drive coil and diaphragm, the Nissan unit has a driver which is coupled directly to a panel of the vehicle. So the vehicle panel acts as a diaphragm. Obviously the system is usable only at fairly low frequencies.

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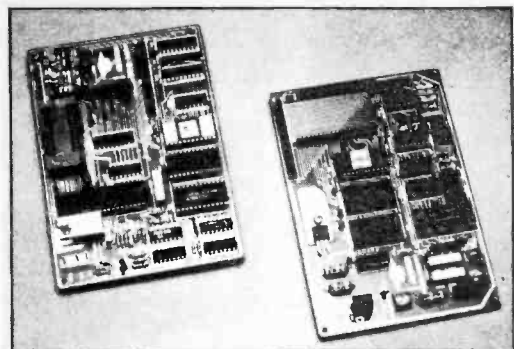
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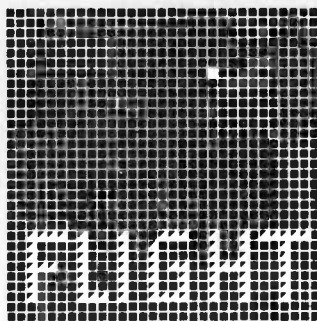
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UNIVERSAL PROBE

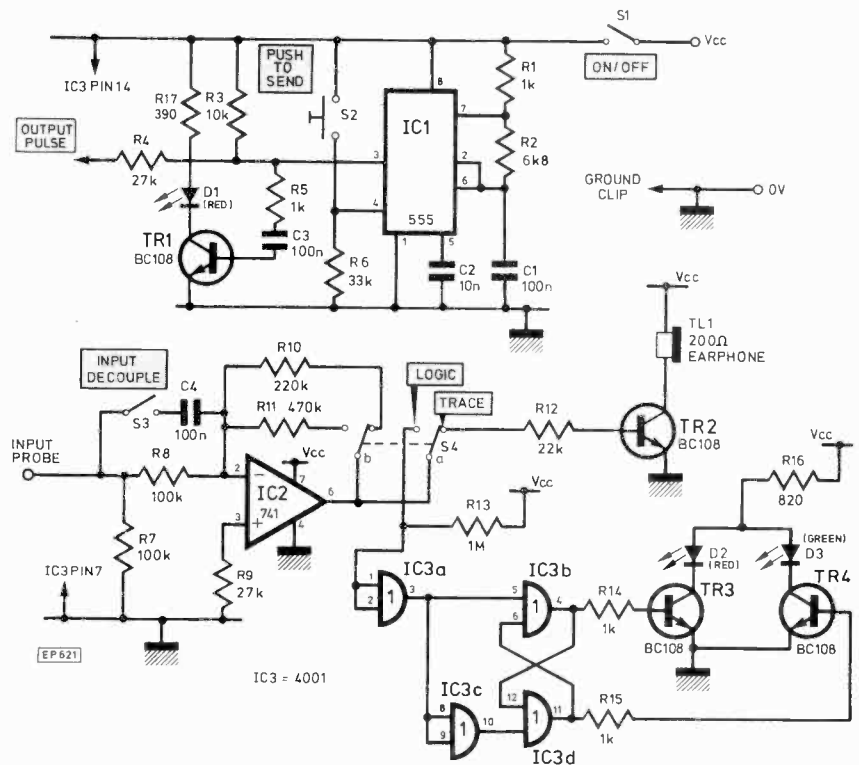
THIS unit consists of a square wave generator with a 27 kilohm output resistance. The frequency of oscillation is about 1 kHz.

Tracing is done through an operational amplifier with a gain of about 2.2. Further gain is obtained by use of TR2 which drives an earphone. This should be mounted on the circuit board, inside the unit, to avoid too many umbilical cords. The sound tube on the earphone should be removed. If low level signals, with a d.c. component, are to be traced, C4 and S3 provide decoupling of the input probe. This may load some high impedance circuits but is not likely to prevent testing for most applications.

S4 allows the unit to be switched from an analogue function to a digital function. It should be noted that for most digital uses, S3 should remain open.

The input voltage is fed to the inverting input of the 741, so that the output is normally high. As the input voltage of the amplifier rises, so the output voltage falls; as decided by the amplifier gain R_{11}/R_8 . The high to low transition of the gates in IC3, was found to be approx. 3.6V; but if this varies, R11 can be set accordingly. When the output of the 741 falls below 3.6V the flip flop of IC3 changes state, and a logical high is indicated. Variations exist at the construction stage—precise voltage level change may be obtained by using a Schmitt device in place of IC3. The input voltage that causes a logical '1' to be indicated can be altered by changing R11. If R11 is reduced, the gain of the amplifier is reduced, and so the input voltage level which is necessary to cause a low to high change will rise. The object of the universal instrument is to use a voltage level suited to both TTL and CMOS.

As mentioned previously in the article, the Universal Probe may be used for other—more diverse applications. When S2 is open, the output lead, through R3 and R4, is at a logical '1' and so if used in conjunction with the input probe (Set to 'Logic' mode), continuity tests on high resistance circuits can be made; e.g. the instrument indicates logical '1' if the circuit is continuous.



If the output lead were connected to one side of a good capacitor and the input probe to the other side, the logical '1' indicator may flash momentarily but logical '0' should prevail. If now the 'Push to Send' button is pressed, an alternating current will pass through the capacitor and the logic l.e.d.s will indicate pulses. This test could be done with the unit set to 'Trace' and an audible indication of capacitor operation will follow. The square wave contains some high frequency harmonics so most capacitors can be tested in this way. High value electrolytic capacitors may take some time to charge through R3 and R4 before a logical '0' is shown. This fact could be used to estimate the value of an electrolytic capacitor. The

unit should be calibrated with certain known values. Charging time to 1.5V can be counted since it will take 10s of seconds and differences will be noticed between capacitors of different sizes.

Semiconductor components may also be tested using the logical high at the output lead, and the input probe. Diodes will conduct and show a logical '1' when the output lead is connected to the anode and input probe to the cathode. Where reverse connection is made a logical '0' will result. Transistors may be tested in a similar way—testing base-emitter, base-collector junctions.

J. L. Gordon,
St. Helens,
Merseyside.

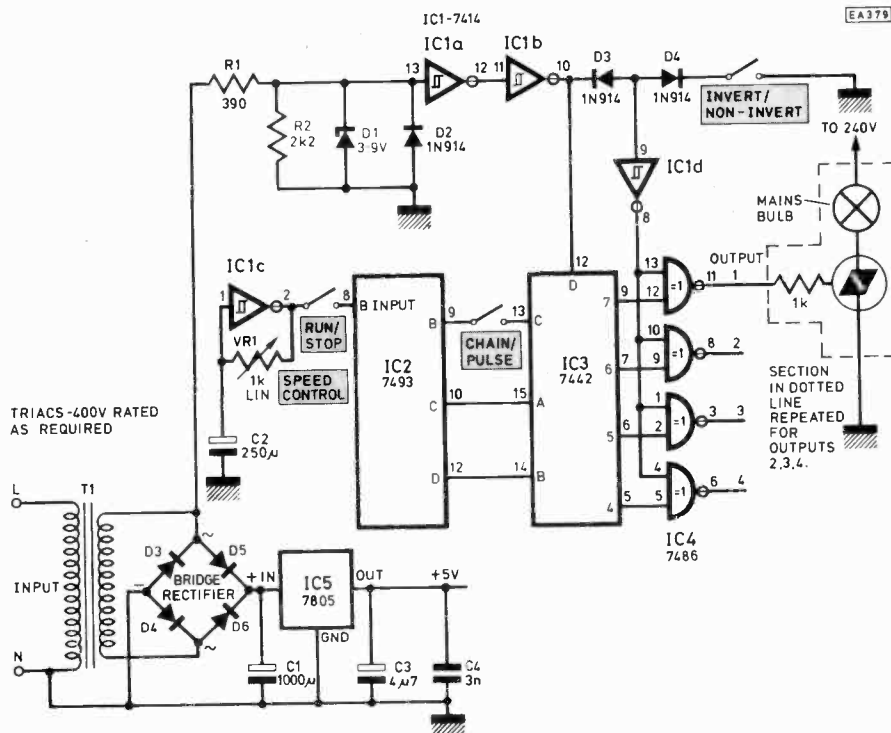
THE circuit shown is a Disco Lights Sequencer with four channels rated at whatever wattage the user chooses. The unit, as well as having the standard "1 bulb on, 3 bulbs off" operating mode has, in addition, two other operating modes, which makes it considerably more versatile and yet cheaper than the expensive units that are bought commercially.

The two new modes are:

- An invert mode where instead of "1 on, 3 off" there is the converse mode of "3 bulbs on, 1 bulb off" which gives a higher ambient light level.
- A pulse/chain mode which gives a pronounced effect of the bulbs being pulsed rather than the usual effect of switching instantaneously from one bulb to the next and results in a very convincing stroboscopic effect being obtained. This strobe effect is greatly enhanced if different coloured bulbs are used and an exciting strobe lighting display occurs when fast, lively disco music is being played.

From the technical viewpoint the circuit features some distinct advantages over some commercial units. It has zero voltage switching so essential if r.f.i. is to be avoided and has the unique feature of powering the bulbs on both the positive and negative swings of the mains supply which means that the bulbs have full power and give full illumination in contrast with many commercial units that supply only half-wave to the bulbs. In addition,

DISCO LIGHTS SEQUENCER



there is the all important safety aspect, because many commercial units require their circuitry to be live and so are inherently dangerous; however, the design given here has its circuitry tied to the neutral rail

and so the circuitry is harmless if accidentally touched.

P. McChesney,
Wirral,
Merseyside.

BAZAAR

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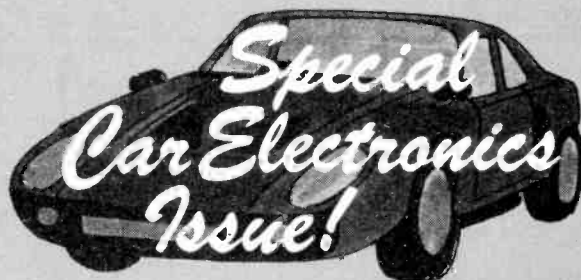
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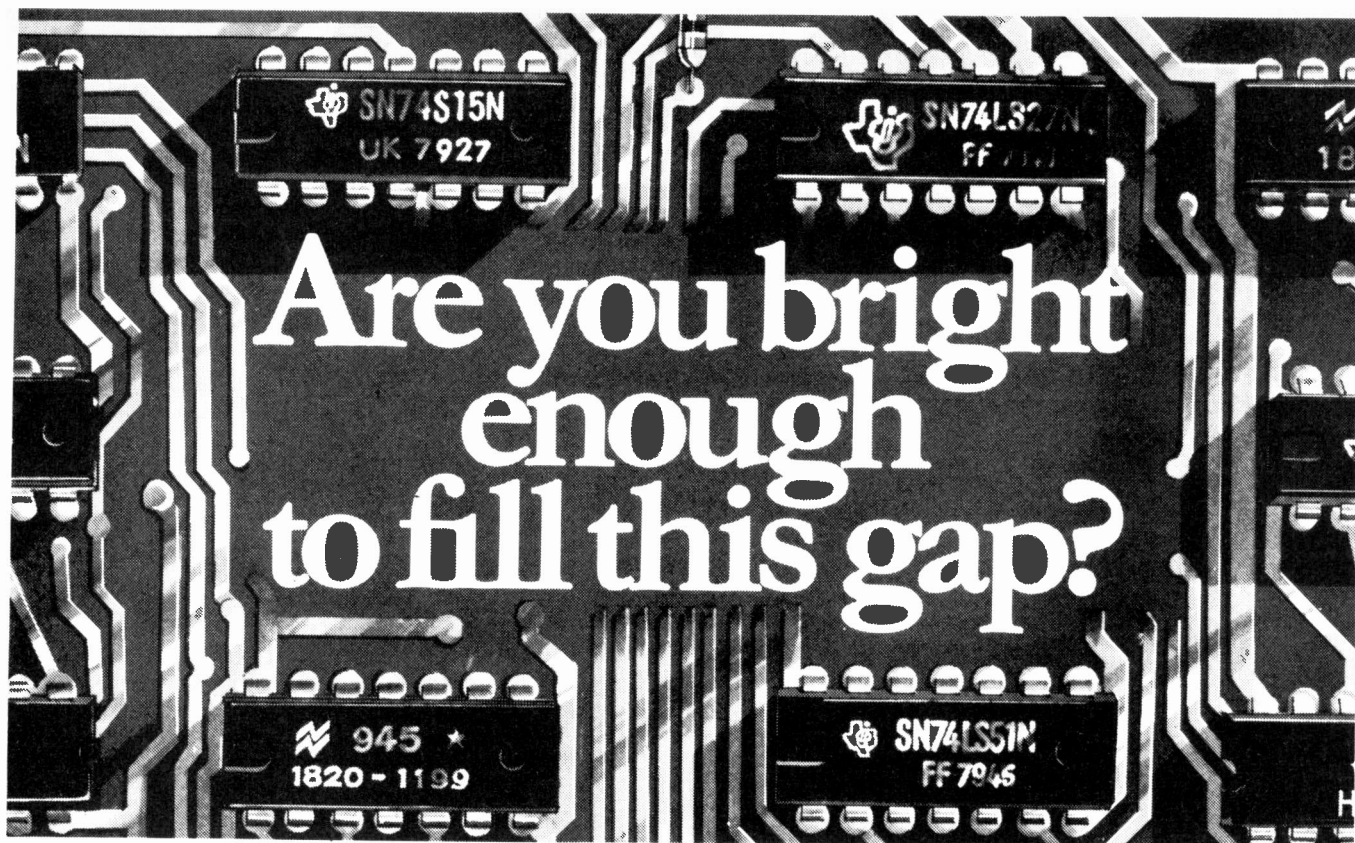
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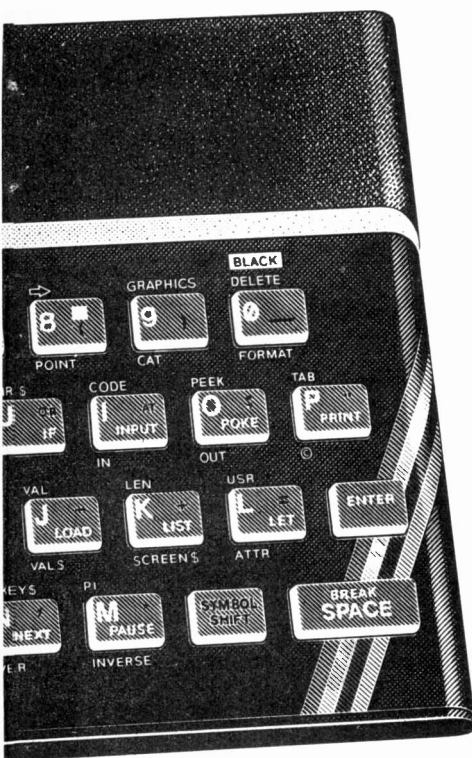
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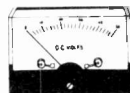
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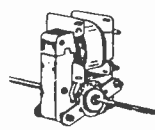
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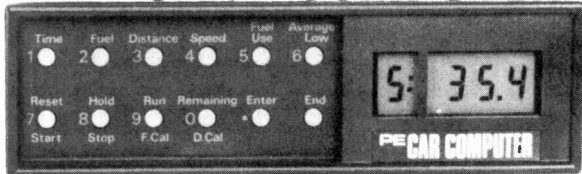
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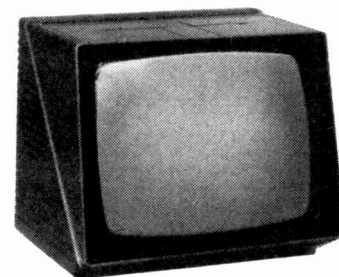
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Complete ballast unit for either 9" or 12" tube 230V AC or £5.50 P. & P. 55p (£6.96 incl. VAT). Also available for 12V DC or £5.50 P. & P. 55p (£6.96 incl. VAT).

BLACK LIGHT BULBS

Self-ballasted Mercury U.V. 175W Bulbs, available for either B-8 c/o. or E.S. fitting. Price incl. p&p & VAT £11.50.

400W U.V. lamp and ballast complete. Price £38.00 + £3.50 p&p (total incl. VAT £47.73).

400 Watt U.V. lamp only, price £14.00 - £2.00 p&p (total incl. VAT £18.40).

Black Light U.V. Tubes from 6in to 4ft from stock. Foolscap s.a.e. for details.

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Why waste money? Build your own EPROM ERASER for the fraction of the price of a made-up Unit.

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WARNING: Tube used in this circuit is highly dangerous to the eyes. Unit MUST be fitted in suitable case.

***** SUPERIOR Quality Precision Made *****

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New ceramic construction, embedded winding heavy duty brush assembly, continuously rated.

25 WATT 5/10/25/50/100/250/500/1kΩ 1.5kΩ £3.10 P. & P. 30p (£3.91 incl. VAT).

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100 WATT 1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ £7.25 P. & P. 75p (£9.14 incl. VAT).

Black, Silver, Skirted knob calibrated in Nos. 1-9 1/2 in. dia. brass bush. Ideal for above Rheostats 24p each + VAT.

RELAYS

Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

230/240V A.C. 3 c/o. 11 pin base. Sealed 5 amp contacts £1.35 plus P. & P. 30p (£1.90 incl. VAT).

KMKI Relay. 230V. A.C. 1 c/o open type 10 amp contact, m.f. by 'Keyswitch'. 80p P. & P. 25p (£1.21 incl. VAT). 5 for £3.75 postpaid (£4.32 incl. VAT).

24V A.C. Sealed 3 c/o. 10a. 11-pin. £1.50 + 25p P. & P. (£2.01 incl. VAT).

24V D.C. Sealed 3 c/o. 7a. 11-pin. £1.35 + 30p P. & P. (£1.90 incl. VAT).

24V D.C. 2 c/o. 7 amp contacts. Sealed, octal base. £1.30 P. & P. 30p (£1.84 incl. VAT).

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5rpm 240V A.C. Mf. by Carter. £5.50 + £1.00 P. & P. (£7.48 incl. VAT).

7 1/2 rpm Motor approx. 30 lb. in. 110V A.C. complete with Transformer for 240V A.C. £9.25 + £1.50 P. & P. (total incl. VAT £12.94).

71rpm WYNSCALE motor approx. 20lb inch. A.C. supplied with auto transformer 240V. A.C. operation. £9.75 P. & P. £1.50 (£12.94 incl. VAT). N.M.S.

30 rpm. 230/240V. a.c. 50lb in. mf. PARVALUX. Price £15.50 P. & P. £2.00 (£20.13 incl. VAT). N.M.S.

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Suitable Transformer 230V A.C. operation. Price: £6.50 + 50p p&p (total incl. VAT £8.05). N.M.S.

N.E.C. GEARED MOTOR. 152 rpm 200 lb. in. 230V A.C. 50 Hz. Ratio 9.2 to 1. Non reverse. Incl. capacitors. Fraction of maker's price: £37.50 + Carr. & VAT. N.M.S.

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Suitable Transformer for 230/240V. a.c. Price: £6.00 P. & P. £1.50 (£8.62 incl. VAT). N.M.S.

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Powerful continuously rated a.c. motor complete with 5 blade 6 1/2 in. Price £4.50 P. & P. 75p (£6.04 incl. VAT).

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BLOWER/VACUUM PUMP. 3 phase A.C. Motor. 220/250V or 380/440V. 1.425rpm. 1/4 h.p. cont. Direct coupled to William Allday Alcosa carbon vane blower/vacuum pump. 0.9 cfm B hg. Price: £22.00 + £4.00 p&p (total incl. VAT £29.90).

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Type MG1636. 3 fig. countdown any number from 999 to 001. 230V A.C. 2 Wheel setting. Changeover Microswitch to inform external circuitry on completion of countdown. Size: Width 85mm. Ht. 65mm. Dpth. 70mm. Price £4.00 - 75p P. & P. (Total incl. VAT £5.46).

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Type S251 200/250V. a.c. 2 on/2 off every 24 hours. 20 amps contacts with override switch dia 4 x 3 price £9.50 P. & P. £1.50 (£12.65 incl. VAT). Also available with Solarial R. & T.

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ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs. at any manually pre-set time. 36 hour Spring Reserve and day omitting device. Built to highest Electrician Board specification. Price £11.50 P. & P. £1.50 (£14.95 incl. VAT). R.&T.

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Boost those outside octaves! Each unit has depth & range controls.

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Is hiss a problem? This could clean it up nicely.

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Gen-purpose freq-generator with Sine, Sq, Tri, Ramp, Pulse & variations. Switchable 0.4Hz-470KHz plus fine tune.

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Spiky fuzz with fringing effect. 3 controls. Fringing Balance. Output.

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Also, auto-control for deeper fringing from above.

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Humming badly? This steep notch filter really cuts live or recorded hum. Tunable for 25-100Hz.

SET-141 £11.43

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Mic or guitar pre-amp with gain control & Bass & Treble cut sw's.

SET-144 £8.92
Ditto less tone sw's SET-147 £8.13

SUPER-MIX

2-chan mixer with variable input level & gain. No tone controls. Use Super-Tone if reqd. For more chans add several units.

SET-149 P.O.A.

SUPER-NOME

Variable metronome with audio-visual accented beat marker.

SET-143 £13.52

SUPER-PASS

Variable band-pass filter with gain & centre freq control.

SET-142 £9.69

SUPER-TONE

Tone control for Bass & Treble cut, gain, & range.

SET-139 £13.62

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A powerful tremolo with depth and rate controls.

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Vibrato with extra Phasing & Reverb controls, plus rate & depth. An amazing unit!

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Wah-wah with auto & manual controls.

SET-140 £17.31

P.O.A. Price on Application - details in list.

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FOUNDED 1972. A DECADE OF DESIGN AND DELIVERY!

C.B.

C.B.

These are suitable for CB or standard audio use depending on socket type chosen (2 reqd for most - see below). For kit contents & order details see top left cols.

C.B. COMPRESSOR

Really helps avoid blasting your mods and adjacent channels! Preset it for the maximum that your rig will like and your signal strength won't top it.

SET-133-LS £12.37

FUNKY-WOBULO!

Add a wobble to your warble! A voice tremulant with depth & filtering modulation. 1 skt reqd.

SET-149 £11.49

FUNNY TALKER MK2

Modified ring modulator for fascinating metallic and modulated quality to your voice. Includes new high-gain pre-amp, voltage stabiliser, and output level control. SET-99-MK2-LS £19.06
Add-on kit for MK1 users to convert to the MK2 (box not required): SET-99ADN £3.39

MAD-RO!

Space invaders, machine gun, police cars, sounds like these & more from this 4-control unit. 1 skt reqd.

SET-146 £9.99

MULTIPLEXER

Are you using several front-end add-ons? This unit splits the microphone signal in up to 6 directions for feeding various extras, and also contains a six-input mixer for recombining the add-on signals onto one line. An extra two skts reqd for each to-from direction.

SET-132-LS £11.60

MUSICAL CALL SIGN

Programme your own individual 8-note call sign. Push button operated for use when you want.

SET-121-LS £14.23

ROGER TWO-GONG

Two-tone gong-like sound automatically activated at the end of transmission.

SET-126-LS £14.72

SIGNAL COMPARATOR

Uses special three-colour LEDs to give a visual indication of speech level. Also compares microphone level with levels from other units such as Roger Bleeps, etc. Helps avoid overmodulation and cross channel break-through.

SET-129-LS £16.70

SIMPLE REVERB

Enhances the spacious quality of your transmission, and at full control can produce that 'Monster-from-the-Deep' effect. With control over balance, echo and duration. The response from listeners is astonishing!

SET-122-LS £20.39

SINGLE ROGER

Gives a single bleep of a preset duration and pitch when the microphone switch is released at the end of transmission. SET-127-LS £10.07

SPEECH PROCESSOR

Dramatically improves the intelligibility of speech signals. We are making many sales on this directly because people have heard it on the air!

SET-110-LS £11.77

VOICE FILTER

For limiting the frequency band-width that reaches the rig from the microphone, helping to reduce background noise. Six selectable ranges plus by-pass.

SET-131-LS £12.97

VOICE OPERATED SWITCH

Release your hands for other things, let your voice do the switching for you!

SET-123-LS £13.80

CB POWER SUPPLY

From the mid-range of 13.8 volts, can be set anywhere between about 10V and 16V at approx. 300mA. Ideal for driving all these various CB add-ons! (Mic skts not required).

SET-130-LS £13.85

CONNECTORS AVAILABLE

4-pin chassis-socket SKT-SC4 46p plus P&P

4-pin line-socket SKT-LS4 P.O.A.

4-pin chassis-plug PLG-SP4 46p plus P&P

4-pin line-plug PLG-LP4 62p plus P&P

5-pin 180° DIN chassis-socket SKT-KS 16p plus P&P

5-pin 180° DIN line-plug PLG-KP 34p plus P&P

Std mono plus chassis-socket SKT-US 20p plus P&P

Std mono plus line-plug PLG-UP 18p plus P&P

If connectors ordered with kits in this ad, no P&P charge, else add 60p to total cost.

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Powerful mains operated induction motors with gear box attached. The final shaft is a 1/2" rod with square hole, so you have alternative coupling methods - final speed is approx. 5 revs/min. PRICE £5.50. Similar motors with final speeds of 80, 100, 160 & 200 r.p.m. same price.

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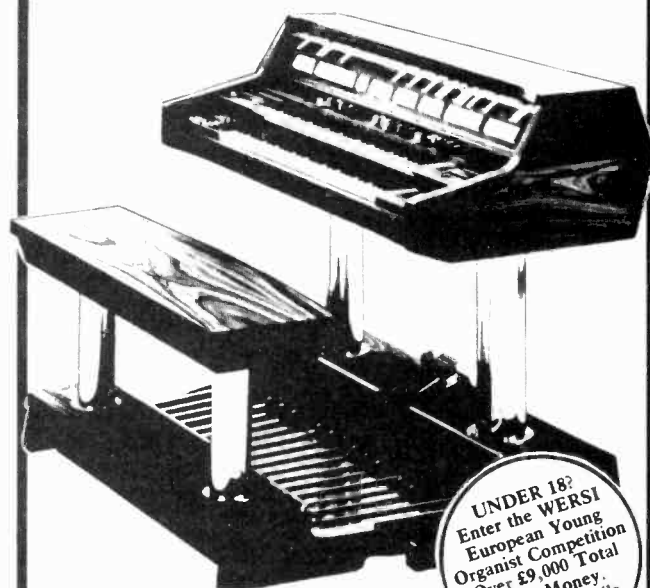
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30V or 12V-0-12V or 15V-0-15V.

Ref	30V	15V	Price	P&P
112	0.5	1	£3.19	£1.20
79	1	2	£4.32	£1.40
3	2	4	£6.99	£1.60
20	3	6	£8.10	£1.85
21	4	8	£9.67	£1.90
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117	6	12	£13.52	£2.26
88	8	16	£18.10	£2.24
89	10	20	£20.88	£2.24
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92	20	40	£35.64	£4.83

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Ref	50V	25V	Price	P&P
102	0.5	1	£4.13	£1.40
103	1	2	£5.03	£1.40
104	2	4	£8.69	£1.84
105	3	6	£10.36	£1.90
106	4	8	£14.10	£2.12
107	6	12	£18.01	£2.34
118	8	16	£24.52	£2.70
119	10	20	£30.23	O.A.
109	12	24	£36.18	O.A.

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Pri 0-120; 0-100-120V (120, 220, 240V) Sec 0-CT-120V twice.

Ref	VA	Price	P&P
*07	20	£5.30	£1.50
149	60	£8.63	£1.60
150	100	£10.06	£1.84
151	200	£13.69	£2.12
152	250	£16.31	£2.64
154	500	£25.02	£2.90
155	750	£35.91	O.A.
156	1000	£45.89	O.A.
157	1500	£60.02	O.A.
158	2000	£72.43	O.A.
159	3000	£101.12	O.A.
160	6000	£207.92	O.A.

*Pri 0-240V Sec 115 or 240V only. State sec volts required.

CASED AUTO TRANSFORMERS

240V cable in 115V USA flat pin outlets.

VA	Price	P&P	Ref
20	£7.21	£1.25	56W
75	£9.35	£1.50	64W
150	£12.10	£1.84	4W
250	£14.73	£1.60	69W
500	£22.14	£2.24	67W
1000	£33.74	£2.80	84W
2000	£60.47	O.A.	95W

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Volts out: 105, 115, 190, 200, 210, 220, 230, 240, for step up or step down.

Ref	VA	Price	P&P
113*	15	£2.39	£1.20
64	80	£4.85	£1.40
4	150	£6.48	£1.60
67	500	£13.30	£2.24
84	1000	£22.70	£2.80
493	1500	£28.17	O.A.
95	2000	£42.14	O.A.
73	3000	£71.64	O.A.
480	4000	£93.01	O.A.
57	5000	£108.30	O.A.

*0, 115, 220, 240.

96/48/36V RANGE

Pri 0-120/240V

Sec 2 windings 0-36-48V to give 36-0-36V or 48-0-48V or 96V.

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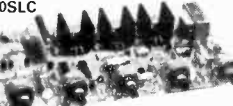
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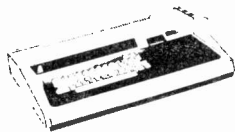


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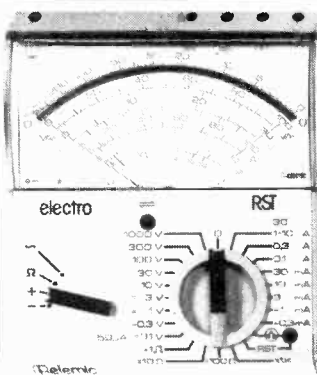
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	2x011	9+9	2.77	
	2x012	12+12	2.08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
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	3x011	9+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
120 VA 90 x 40mm 1.2 Kg Regulation 11%	3x020	110	0.72	£6.90 +p/p £1.87 +VAT £1.79 TOTAL £9.56
	3x029	220	0.36	
	3x030	240	0.33	
	4x010	6+6	10.00	
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
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	4x015	22+22	2.72	
	4x016	25+25	2.40	
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	6x017	30+30	3.75	
	6x018	35+35	3.21	
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	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
	7x013	15+15	10.00	
300 VA 110 x 50mm 2.6 Kg Regulation 6%	7x014	18+18	8.33	£10.17 +p/p £2.00 +VAT £1.83 TOTAL £14.00
	7x015	22+22	6.82	
	7x016	25+25	6.00	
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	7x018	35+35	4.28	
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	7x025	45+45	3.33	
500 VA 140 x 60mm 4 Kg Regulation 4%	8x033	50+50	5.00	£13.53 +p/p £2.35 +VAT £2.18 TOTAL £18.06
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
	9x017	30+30	10.41	
	9x018	35+35	8.92	
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	9x028	110	5.68	
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7427	20p	74LS21	13p	74LS401	100p	4040	40p	HA1368	195p	SA01024A	80p
7428	20p	74LS22	13p	74LS402	100p	4041	40p	ICL7100	700p	SF96364	80p
7429	20p	74LS23	13p	74LS403	100p	4042	105p	ICL7100	700p	SL490	350p
7430	20p	74LS24	13p	74LS404	100p	4043	50p	ICL7100	700p	SN76477	450p
7431	20p	74LS25	13p	74LS405	100p	4044	45p	ICL7100	700p	SN76488	450p
7432	20p	74LS26	13p	74LS406	100p	4045	45p	ICL7100	700p	SR815	750p
7433	20p	74LS27	13p	74LS407	100p	4046	45p	ICL7100	700p	TA7120	150p
7434	20p	74LS28	13p	74LS408	100p	4047	45p	ICL7100	700p	TA7204	150p
7435	20p	74LS29	13p	74LS409	100p	4048	45p	ICL7100	700p	TA7205	150p
7436	20p	74LS30	13p	74LS410	100p	4049	45p	ICL7100	700p	TA7222	150p
7437	20p	74LS31	13p	74LS411	100p	4050	45p	ICL7100	700p	TA7310	150p
7438	20p	74LS32	13p	74LS412	100p	4051	45p	ICL7100	700p	TA7311	150p
7439	20p	74LS33	13p	74LS413	100p	4052	45p	ICL7100	700p	TA7312	150p
7440	20p	74LS34	13p	74LS414	100p	4053	45p	ICL7100	700p	TA7313	150p
7441	20p	74LS35	13p	74LS415	100p	4054	45p	ICL7100	700p	TA7314	150p
7442	20p	74LS36	13p	74LS416	100p	4055	45p	ICL7100	700p	TA7315	150p
7443	20p	74LS37	13p	74LS417	100p	4056	45p	ICL7100	700p	TA7316	150p
7444	20p	74LS38	13p	74LS418	100p	4057	45p	ICL7100	700p	TA7317	150p
7445	20p	74LS39	13p	74LS419	100p	4058	45p	ICL7100	700p	TA7318	150p
7446	20p	74LS40	13p	74LS420	100p	4059	45p	ICL7100	700p	TA7319	150p
7447	20p	74LS41	13p	74LS421	100p	4060	45p	ICL7100	700p	TA7320	150p
7448	20p	74LS42	13p	74LS422	100p	4061	45p	ICL7100	700p	TA7321	150p
7449	20p	74LS43	13p	74LS423	100p	4062	45p	ICL7100	700p	TA7322	150p
7450	20p	74LS44	13p	74LS424	100p	4063	45p	ICL7100	700p	TA7323	150p
7451	20p	74LS45	13p	74LS425	100p	4064	45p	ICL7100	700p	TA7324	150p
7452	20p	74LS46	13p	74LS426	100p	4065	45p	ICL7100	700p	TA7325	150p
7453	20p	74LS47	13p	74LS427	100p	4066	45p	ICL7100	700p	TA7326	150p
7454	20p	74LS48	13p	74LS428	100p	4067	45p	ICL7100	700p	TA7327	150p
7455	20p	74LS49	13p	74LS429	100p	4068	45p	ICL7100	700p	TA7328	150p
7456	20p	74LS50	13p	74LS430	100p	4069	45p	ICL7100	700p	TA7329	150p
7457	20p	74LS51	13p	74LS431	100p	4070	45p	ICL7100	700p	TA7330	150p
7458	20p	74LS52	13p	74LS432	100p	4071	45p	ICL7100	700p	TA7331	150p
7459	20p	74LS53	13p	74LS433	100p	4072	45p	ICL7100	700p	TA7332	150p
7460	20p	74LS54	13p	74LS434	100p	4073	45p	ICL7100	700p	TA7333	150p
7461	20p	74LS55	13p	74LS435	100p	4074	45p	ICL7100	700p	TA7334	150p
7462	20p	74LS56	13p	74LS436	100p	4075	45p	ICL7100	700p	TA7335	150p
7463	20p	74LS57	13p	74LS437	100p	4076	45p	ICL7100	700p	TA7336	150p
7464	20p	74LS58	13p	74LS438	100p	4077	45p	ICL7100	700p	TA7337	150p
7465	20p	74LS59	13p	74LS439	100p	4078	45p	ICL7100	700p	TA7338	150p
7466	20p	74LS60	13p	74LS440	100p	4079	45p	ICL7100	700p	TA7339	150p
7467	20p	74LS61	13p	74LS441	100p	4080	45p	ICL7100	700p	TA7340	150p
7468	20p	74LS62	13p	74LS442	100p	4081	45p	ICL7100	700p	TA7341	150p
7469	20p	74LS63	13p	74LS443	100p	4082	45p	ICL7100	700p	TA7342	150p
7470	20p	74LS64	13p	74LS444	100p	4083	45p	ICL7100	700p	TA7343	150p
7471	20p	74LS65	13p	74LS445	100p	4084	45p	ICL7100	700p	TA7344	150p
7472	20p	74LS66	13p	74LS446	100p	4085	45p	ICL7100	700p	TA7345	150p
7473	20p	74LS67	13p	74LS447	100p	4086	45p	ICL7100	700p	TA7346	150p
7474	20p	74LS68	13p	74LS448	100p	4087	45p	ICL7100	700p	TA7347	150p
7475	20p	74LS69	13p	74LS449	100p	4088	45p	ICL7100	700p	TA7348	150p
7476	20p	74LS70	13p	74LS450	100p	4089	45p	ICL7100	700p	TA7349	150p
7477	20p	74LS71	13p	74LS451	100p	4090	45p	ICL7100	700p	TA7350	150p
7478	20p	74LS72	13p	74LS452	100p	4091	45p	ICL7100	700p	TA7351	150p
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7480	20p	74LS74	13p	74LS454	100p	4093	45p	ICL7100	700p	TA7353	150p
7481	20p	74LS75	13p	74LS455	100p	4094	45p	ICL7100	700p	TA7354	150p
7482	20p	74LS76	13p	74LS456	100p	4095	45p	ICL7100	700p	TA7355	150p
7483	20p	74LS77	13p	74LS457	100p	4096	45p	ICL7100	700p	TA7356	150p
7484	20p	74LS78	13p	74LS458	100p	4097	45p	ICL7100	700p	TA7357	150p
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7486	20p	74LS80	13p	74LS460	100p	4099	45p	ICL7100	700p	TA7359	150p
7487	20p	74LS81	13p	74LS461	100p	4100	45p	ICL7100	700p	TA7360	150p
7488	20p	74LS82	13p	74LS462	100p	4101	45p	ICL7100	700p	TA7361	150p
7489	20p	74LS83	13p	74LS463	100p	4102	45p	ICL7100	700p	TA7362	150p
7490	20p	74LS84	13p	74LS464	100p	4103	45p	ICL7100	700p	TA7363	150p
7491	20p	74LS85	13p	74LS465	100p	4104	45p	ICL7100	700p	TA7364	150p
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492 pin	645p	2480 pin	1290p	XTX712	15p
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