

PRACTICAL

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

ELECTRONICS

DECEMBER 1982

85p

PE
Micrograsp



Stylochord

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



50p Coupon Inside

POWER PACKED — by POWERTRAN

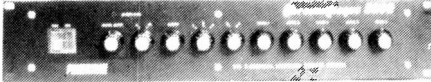
THE FIRST WORDS AND THE LAST WORD IN ELECTRONIC KITS

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.



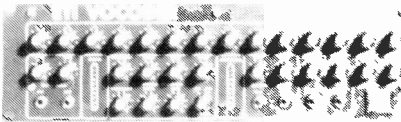
Complete Kit — £49.90 + VAT

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.



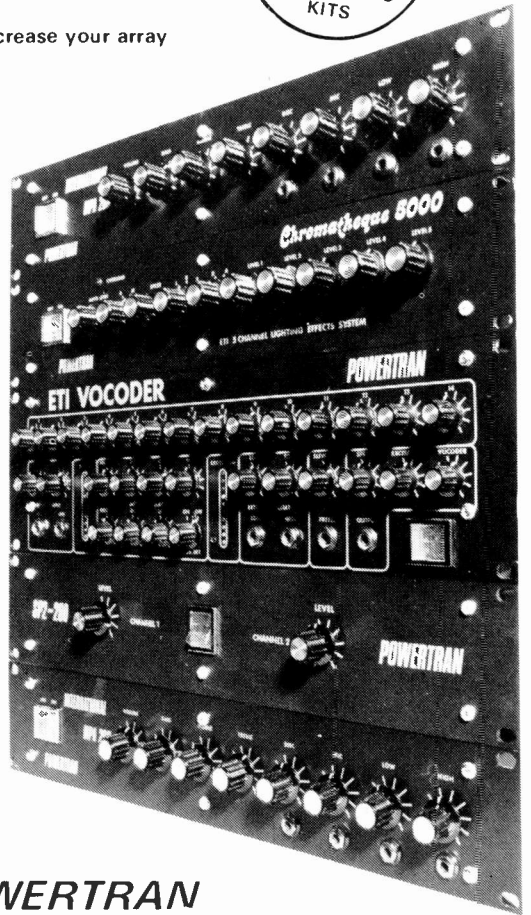
Complete Kit — £175.00 + VAT

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.

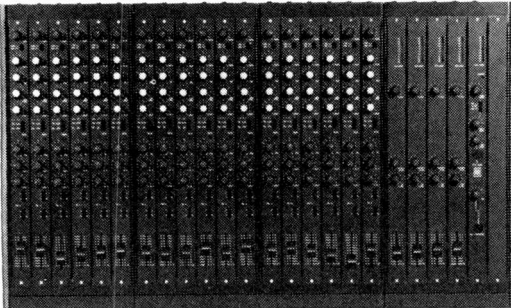


Complete Kit — £64.90 + VAT

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 price 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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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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SPEAKERS	8Ω 0.3W, 2", 2.25", 2.5", 3", 80p
	0.3W, 2.5" 40Ω; 64Ω or 80Ω
DIODES	AA119 15
	AA129 20
	AA130 15
	BA100 18
	BA133 20
	BY100 24
	BY126 12
	BY127 12
	CR033 250
	CR039 40
	OA47 12
	OA70 12
	OA79 15
	OAB1 20
	OAB5 15
	OA90 15
	OA91 8
	OA95 8
	OA200 8
	OA202 8
	1N914 4
	1N916 5
	1N4001/2 5
	1N4003 6
	1N4005 6
	1N4006/7 6
	1N4148 8
	1N5401 15
	1N5404 16
	1N5406 17
	1N5408 19
	1S44 9
	1S521 1
	6A100V 40
	6A400V 50
	6A800V 65
Noise Diode	Z5J 195
SCR's	Thyristors
	0.8A-100V 32
	5A/300V 38
	5A/400V 40
	5A/600V 48
	8A/300V 48
	8A/600V 95
	8A/800V 95
	12A/100V 78
	12A/100V 78
	12A/400V 82
	12A/400V 82
	12A/800V 188
	12A/800V 188
	BT108 150
	BT116 180
	CI06D 38
	TIC44 24
	TIC45 29
	TIC47 35
	2N2052 32
	2N5064 38
	2N4444 130
DIAC	ST2 25

OPTO ELECTRONICS	LEDs including Clips	TIL209 Red 3mm 10	TIL211 Green 3mm 14	TIL212 Yellow 12	TIL220 2" Red 14	0.2" Yel. Grn. Amber 10	Rectangular LEDs with two part clip. R, G & Y 12	Rectangl. Stackable LEDs 18	1A 100V 20	1A 400V 25	1A 600V 34	2A 50V 30	2A 200V 46	2A 400V 65	2A 600V 83	2A 100V 95	6A 100V 95	10A 200V 215	10A 600V 298	25A 200V 240	25A 600V 395	BY164 56	VM18 50		
BRIDGE RECTIFIERS	(plastic case)																								
ZENERS	Range 2V7 to 39V 400mW	81 Orange C.A. 250	FND357 or 500 120	3" Green C.A. 140	±1.3" Red or Green 150	Bargraph 10 seg. Red 225	Bargraph NSM3914 500	6.4x3.3" 150	7.5x3.3" 180	8.6x3.3" 210	10x4.1" 240	10x7.3" 275	12x5.3" 260	12x8.3" 295	6.4x3.3" 150	7.5x3.3" 180	8.6x3.3" 210	10x4.1" 240	10x7.3" 275	12x5.3" 260	12x8.3" 295	1.5lbag Anhydrous 15p	50p/p	90p	150p
VERO BOARDS	0.1" Clad Plain	VQ Board 370	DIP Board 144	Vero Strip 144	S100 Board 114	2x3x3" 80p	2x5" 91p	3x3x3" 91p	3x5" 105p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p
VERO WIRING PEN	and Spool Spare Wire (Spool) 75p; Wire Wrapping Stakes 100																								

SPECIAL OFFER

2114L-2	90p	25+	80p
2532	350p	300p	330p
2716	215p	199p	
2732	350p	330p	
4116	85p	80p	
4816-100ns	225p	205p	
6116-150ns	90p	360p	
6520/21	115p	105p	
6522	300p	280p	
6820/6821	100p	90p	

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**

ALUM. BOXES

3x2x1"	65
4x2x2"	85
4x2x2.5"	103
4x4x2.5"	120
5x4x2.5"	105
5x2x1.5"	90
5x2x2.5"	130
5x4x1.5"	99
5x4x2.5"	120
6x4x2.5"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4.1"	240
10x7.3"	275
12x5.3"	260
12x8.3"	295

COPPER CLAD BOARDS

Fibre Single	Double	SRBP
Glass sided	110p	9.5" x 8.5"
6" x 6"	90p	110p
6" x 12"	150p	195p

VERO BOARDS

0.1" Clad Plain	VQ Board 370	DIP Board 144	Vero Strip 144	S100 Board 114
2x3x3" 80p	2x5" 91p	3x3x3" 91p	3x5" 105p	3x7" 130p
3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p	3x7" 130p

PROTO-DECS

VeroBlock	405
S-Dec	350
Eurobreadboard	520
Spot Face Cutter	135p
Bin Insertion Tool	178p
Superstrip SS2	£13

ANTEX Soldering

Buy with Access

Just phone your order through, we do the rest.

Irons	C15W 450	CX17W 475	CCN15W 490	X25W 500
Spare bits	65			
Elements	210			
Iron stands	165			
Heat Shunt	30			

ASTEC UHF MODULATORS

6MHz	280p
8MHz Wide Bandwidth	425p

ULTRASONIC TRANSDUCERS

40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS	Low profile	Wire wrap
8 pin	8p	25p
16 pin	10p	35p
18 pin	10p	42p
20 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

24 way	475p
28 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	Grey	Color
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

D' CONNECTORS: Miniature

Pins	9	15	25	37
way	way	way	way	way
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
MALE	Solder	105p	160p	200p
FEMALE	Solder	165p	215p	290p
COVERS Top & Side Entry	95p	90p	100p	110p
IDC 25 way Plug	385p	Skt.	450p	

EDGE CONNECTORS

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

JUMPER LEADS

DIL Plug (Headers)	Single Ended Lead, 24" long	14 pin	16 pin	24 pin	40 pin
Length	14 pin	16 pin	24 pin	40 pin	380p
Double Ended Leads	6"	185p	205p	300p	465p
12"	198p	215p	315p	490p	
24"	210p	235p	345p	540p	
36"	230p	250p	375p	595p	

ID HEADER SOCKET Jumper Leads

24"	1 end	160p	200p	260p	300p
20 pin	2 ends	290p	370p	480p	525p

ULTIMUM

WATFORD'S most versatile MICRO EXPANSION SYSTEM. Interfaces with APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. As published in P.E. starting from Nov., 1982.

Send SAE for details.

IDC CONNECTORS (Speed block type)

PCB PLUG with latch	Female Header	PCB Plugs Unshrouded
2 rows	Strt. Angle	Male Male
	Pins	Strat. Angle
10 way	90p	99p
16 way	130p	150p
26 way	145p	168p
34 way	205p	236p
40 way	220p	250p
50 way	235p	270p
	85p	65p
	70p	78p
	80p	92p
	95p	110p
	110p	135p
	125p	150p
	150p	175p

EURO CONNECTORS

DIN 41617 31 way	170p	170p	175p
DIN 41612 2x32 way	285p	325p	220p
DIN 41612 2-3x32 way	300p	340p	300p
DIN 41612 3x32 way	360p	385p	240p

TRANSFORMERS (mains Prim. 220-240V)

3-0 3V, 6-0 6V, 10-0 100mA, 9-0 9V 75mA, 12-0 12V 75mA, 15-0 15V 75mA	98p
6VA: 2x6V-5A; 2x9V-4A; 2x12V-0.3A; 2x15V-25A	220p
12VA: 2x4V5-1.3A; 2x6V-1.2A; 2x12V-0.5A; 2x15V-0.4A	295p (35p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A	330p (60p p&p)
100VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-0.9A; 2x30V-0.7A; 2x36V-0.5A; 2x40V-0.4A; 2x50V-0.3A	920p (60p p&p)

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 4K 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**
- **MULTIVAR PSU KIT.** Output: +5V/5A; +12V; +24V; -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.

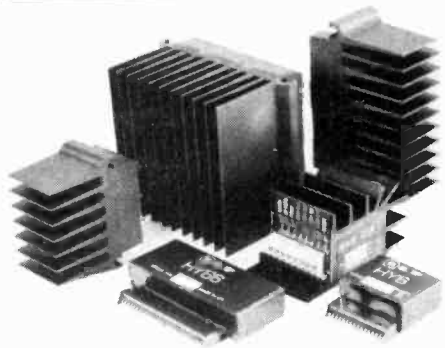
VOLTAGE REGULATORS

1A	T03 +ve -ve	7905	220p
5V	7805 145p	7912	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
8V	78L62 30p		
12V	78L12 30p	79L12	60p
15V	78L15 30p	79L15	60p
LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	320
78H12 12V/5A	580	LM317P	99
78HG-5 to +24V 5A	599	LM323K	500
79HG -2.25V to -24V 5A	685	LM723	35
		TBA625B	75

SWITCHES

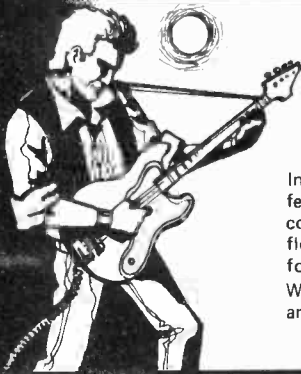
SLIDE 250V	TOGGLE 2A 250V
1A DPDT 14	SPST 33
1A DPDT C/OFF 15	DPDT 33
1A DP on/on/off 40	4 pole on/off 54
4 pole d/c over 240	
PUSH BUTTON	SUB-MIN
Spring loaded	TOGGLE
Latching or Momentary 6A	SP changeover 60
SPDT c/over 99	SPST on/off 54
OPDT c/over 145	SPDT c/off 105
	SPDT Biased 85
	DPDT 6 wags 75
	DPDT C/OFF 88
MINIATURE	DPDT on/on/off 185
Non Locking	DPDT Biased 145
Push to make 15p	3 pole c/over 205
Push break 25p	
ROCKER: 5A 250V SPST	28p
ROCKER: 10A 250V SPDT	38p
ROCKER: With neon lights red when on	85p
ROCKER: (W/LED) 10A 250V DPDT	72p
ROTARY: Make your own Multiway Switch Shafting 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,	

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 30	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY 40	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
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	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	Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93	PSU 52X	2 x HY124	£17.07
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83	PSU 53X	2 x MOS128	£17.86
PSU 42X	1 x HY128	£15.90	PSU 54X	1 x HY248	£17.86
PSU 43X	1 x MOS128	£16.70	PSU 55X	1 x MOS248	£19.52
PSU 51X	2 x HY128, 1 x HY244	£17.07	PSU 71X	2 x HY244	£21.75

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.

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	£30.21
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	£45.54

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 Entertainments

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.

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

WITH A LOT OF HELP FROM



ELECTRONICS LTD

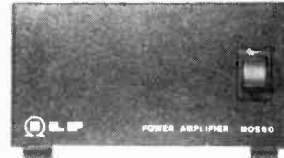
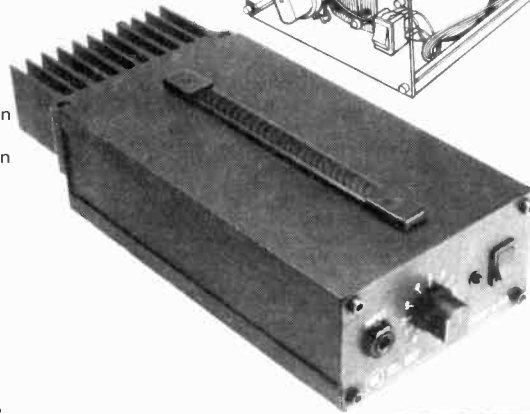
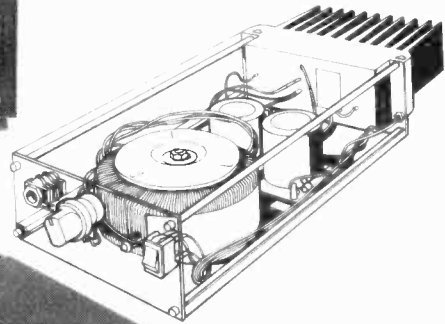
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Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

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.

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PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4-8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4-8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4-8Ω	MOS	Mono	HiFi	£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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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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SX28A 50 Assorted Silver Mica Caps 5.6pF-150pF £1.00
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SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50 1000ml	£1
SX24	20	Tantalum Beads, mixed	£1

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BARGAINS

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SX42	20 small 125 Red LEDs	£1
SX43	10 Rectangular Green LEDs 2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded New	£1
SX47	4 Black Instrument Knobs—winged with pointer, 1/2" Standard screw. Fit size 29 x 20mm	50p
SX49	20 Assorted Slider Knobs Black/Chrome, etc	£1
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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

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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 0-10A Acc 1.2%
Resistance 0-2-20-200k ohms
0-2 Megohms Acc 1%
BI-PAK VERY LOWEST POSSIBLE PRICE **£35.00** each

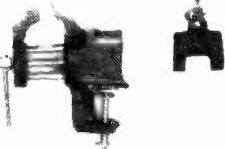


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Bi-Pak's Mini Vice at a Mini Price only

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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 hand unit available with or without magnifier.
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TO3 Size 45mm square 20mm high 40p
TO3 Size 45mm square 20mm high 40p
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FB2	3	11 x 3"	100	£1.50
FB3	4	13 x 3"	156	£2.00

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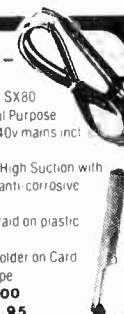
FB4	2	14 x 4"	110	£2.00
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NPN like 2N3055 — but not full spec
100 watts 50V min.
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PUT case TO106 plastic MEU22 Similar to 2N6027/6028 PNP Silicon
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5 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
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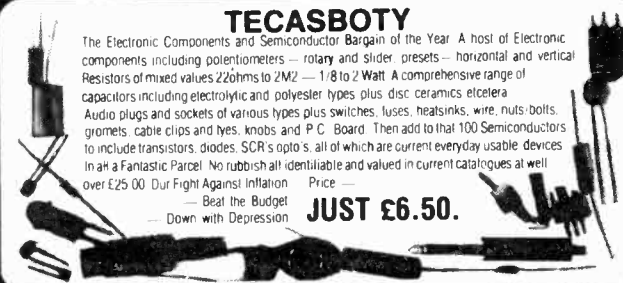
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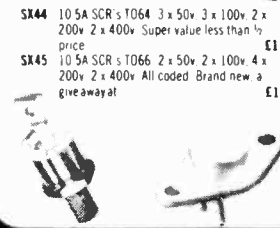
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Charges	Power
PP3 (9V)	220-240V AC
U12 (1.5V penlite)	Dims —
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Glass Type similar IN4000 SERIES IN4001-IN4004 50v — 500v — uncoded — you select for VLTS. ALL perfect devices — NO dud's Min 50v 50 for **£1.00** — worth double. ORDER NO. SX76

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1,000 opv including test leads by Battery AC volts - 0-15-150-500-1,000 DC volts - 0-15-150-500-1,000 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

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- TD300K Touchdimmer £ 7.00
- TDE/K Extension kit for 2-way switching for TD300K £ 2.00
- LD300K Rotary Controlled Dimmer £ 3.50



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.

£42.00

Order as XK112.

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

£13.50

CHRISTMAS PRESENTS GALORE



3-NOTE DOOR CHIME
Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. £5.00

LIGHT DIMMER KIT
Contains all components, including front panel and knob, to make a dimmer for lights up to 300W. £3.50

MW RADIO KIT
Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5 x 2.7 x 2 cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.00

LCD 3 1/2 DIGIT MULTIMETER
16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0.2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x88x31 mm. Requires PP3 9V battery. Test leads included. ONLY £29.00

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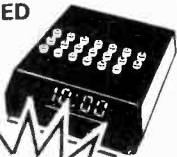
THE MULTI-PURPOSE TIMER HAS ARRIVED

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).
- Display blanking during power failure to conserve battery power.
- 18 programme time sets.
- Powerful "Everyday" function enabling output to switch every day but use only one time set.
- 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.
- Programme verification at the touch of a button.

(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000



NOW ONLY £39 WITH SO MANY EXTRA FEATURES. OPTIONAL BLACK PLASTIC CASE READY DRILLED £2.50



FREE SHORT FORM CATALOGUE - send SAE (6" x 9"). We also stock Vero, Books, Resistors, Capacitors, Semi-Conductors etc.

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 SL400, 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
- MK16 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 1/2V 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

24 HOUR CLOCK/APPLIANCE TIMER KIT

- 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) (Ready Built) £17.40
- £22.50

Add 55p postage & packing + 15% VAT to total. Overseas Customers; Add £2.50 (Europe), £6.00 (elsewhere) for p&p. Send S.A.E. for further STOCK DETAILS. Goods by return subject to availability.

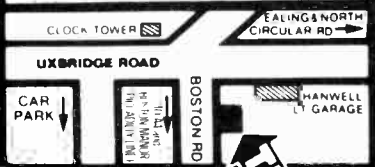
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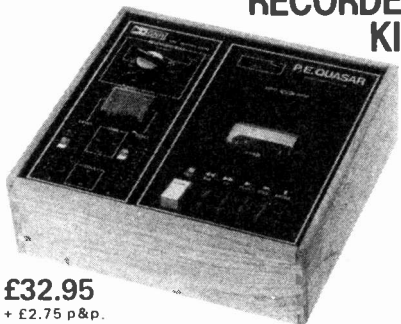
NEW T.V. SOUND TUNER BUILT AND TESTED



£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".

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT



£32.95
+ £2.75 p&p.

* NOISE REDUCTION SYSTEM. * AUTO STOP. * TAPE COUNTER. * SWITCHABLE E.Q. * INDEPENDENT LEVEL CONTROLS. * TWIN V.U. METER. * WOW & FLUTTER 0.1%. * RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. * FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TAPES

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.

£18.95

+£1.40p&p.

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.

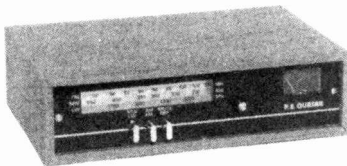
£12.95

Plus £2.00 p&p.

Suitable stainless steel fully retractable aerial (locking) and speaker (6" x 4" app.). available as a kit complete. **£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 diagram and instructions.

£17.95

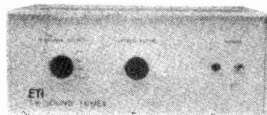
Plus £2.50 p&p.

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.



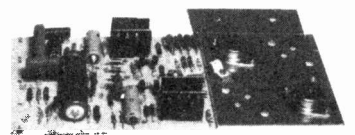
125W HIGH POWER AMP MODULES

£10.50 KIT
£14.25 BUILT
+ £1.15 p&p + £1.15 p&p

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.



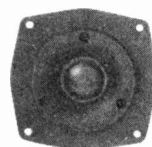
SPECIFICATIONS:

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.

HI-FI SPEAKERS AT BARGAIN PRICES

GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3 3/4" sq.) for use in up to 40W systems: with 2 element crossover.

£3.95 each (p&p £1) or
£6.95 each (p&p £1.50)

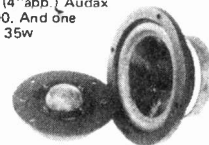


35 WATT MICRO 2-WAY SPEAKER SYSTEM

Unit comprises one 50w (4" app.) Audax soft dome tweeter HD100, And one 5" Audax bass/midrange 35w driver HIF1JSM. Complete with 2 element crossover. Total impedance of system 4 ohms.

£8.95

PER SET + £2.70 p&p.

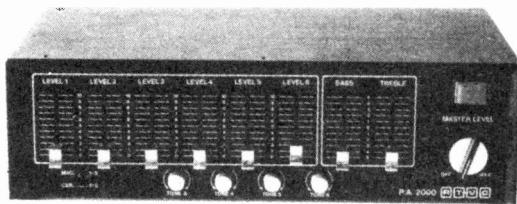


MONO MIXER AMP

Ideal for Church halls & Club houses.

£45.00
+ £2.00 p&p.

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" x 6 1/2" x 3 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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Very high thermal & electrical stability. Extremely low noise

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33/35V	17p
47/35V	17p
68/35V	17p
10/35V	17p
22/16V	17p
22/35V	22p
33/35V	22p
47/16V	22p
47/35V	24p
68/35V	25p
10/16V	25p
10/35V	34p
15/10V	22p
15/16V	30p
15/25V	32p
22/16V	26p
22/10V	36p
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14 9p	25p
14 9p	35p
16 10p	40p
18 16p	50p
20 20p	—
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Beautiful Mini Radial Low Voltage Matsushita only

ufd V	10	16	6p
22	10	6p	
22	16	7p	
47	10	7p	
47	16	8p	
100	10	9p	
100	16	10p	
220	10	11p	
220	16	12p	
470	10	17p	
470	16	18p	
1000	10	20p	
1000	16	24p	
2200	10	34p	
2200	16	44p	

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- Thin lines
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- Thick bends
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- Transistor pads
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- 0.1" edge comp.
- Mature Any sheet of above

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4 Core 4 Screens	18p
4 Core 1 Screen	44p
B Core	54p
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BiSS X25	1.50

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1N41	30p
1N42	82p
1N43	82p
1N44	4p
1N45	4p
1N46	4p
1N47	4p
1N48	4p
1N49	4p
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1N98	4p
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W01 (100)	20p
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Small Signal	30p
2N5600	30p
2N5601	32p
2N5602	36p
2N5603	37p
2N5604	40p
BR101	75p
BR102	80p
BR103	80p
BR104	80p
BR105	80p
BR106	80p
BR107	80p
BR108	80p
BR109	80p
BR110	80p
BR111	80p
BR112	80p
BR113	80p
BR114	80p
BR115	80p
BR116	80p
BR117	80p
BR118	80p
BR119	80p
BR120	80p

4.8 & 12 Amps Texas TO220

4.8 Amps	18p
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THYRISTORS

2N5600	30p
2N5601	32p
2N5602	36p
2N5603	37p
2N5604	40p
BR101	75p
BR102	80p
BR103	80p
BR104	80p
BR105	80p
BR106	80p
BR107	80p
BR108	80p
BR109	80p
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BR119	80p
BR120	80p

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BR106	80p
BR107	80p
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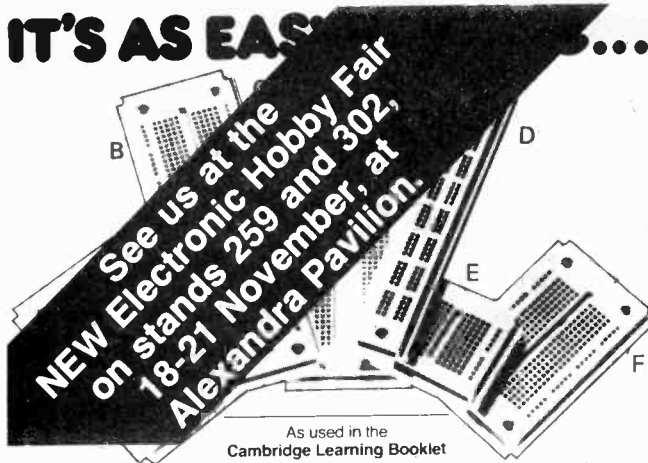
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3M157	3.00	IC1680	13p	IC462	33p	BD479	83p	BF138	1.20	MPS415	45p	ATI-5951	95p	TA6617	2.00	7422	20p	74LS41	12p	40MOS	40p	40MOS	41p
3M158	2.57	IC1681	13p	IC463	33p	BD480	83p	BF139	1.20	MPS416	45p	ATI-5952	95p	TA6618	2.00	7423	20p	74LS42	12p	40MOS	40p	40MOS	41p
3M164	2.56	IC1682	13p	IC464	33p	BD481	83p	BF140	1.20	MPS417	45p	ATI-5953	95p	TA6619	2.00	7424	20p	74LS43	12p	40MOS	40p	40MOS	41p
3M200	2.93	IC1690	13p	IC465	33p	BD482	83p	BF141	1.20	MPS418	45p	ATI-5954	95p	TA6620	2.00	7425	20p	74LS44	12p	40MOS	40p	40MOS	41p
3M209	6.98	IC1691	13p	IC466	33p	BD483	83p	BF142	1.20	MPS419	45p	ATI-5955	95p	TA6621	2.00	7426	20p	74LS45	12p	40MOS	40p	40MOS	41p
3M210	2.50	IC1692	13p	IC467	33p	BD484	83p	BF143	1.20	MPS420	45p	ATI-5956	95p	TA6622	2.00	7427	20p	74LS46	12p	40MOS	40p	40MOS	41p
40251	2.77	IC1693	13p	IC468	33p	BD485	83p	BF144	1.20	MPS421	45p	ATI-5957	95p	TA6623	2.00	7428	20p	74LS47	12p	40MOS	40p	40MOS	41p
40252	2.75	IC1694	13p	IC469	33p	BD486	83p	BF145	1.20	MPS422	45p	ATI-5958	95p	TA6624	2.00	7429	20p	74LS48	12p	40MOS	40p	40MOS	41p
40264	2.63	IC1700	17p	IC470	33p	BD487	83p	BF146	1.20	MPS423	45p	ATI-5959	95p	TA6625	2.00	7430	20p	74LS49	12p	40MOS	40p	40MOS	41p
40290	2.00	IC1701	17p	IC471	33p	BD488	83p	BF147	1.20	MPS424	45p	ATI-5960	95p	TA6626	2.00	7431	20p	74LS50	12p	40MOS	40p	40MOS	41p
40299	1.80	IC1702	17p	IC472	33p	BD489	83p	BF148	1.20	MPS425	45p	ATI-5961	95p	TA6627	2.00	7432	20p	74LS51	12p	40MOS	40p	40MOS	41p
40311	1.80	IC1703	17p	IC473	33p	BD490	83p	BF149	1.20	MPS426	45p	ATI-5962	95p	TA6628	2.00	7433	20p	74LS52	12p	40MOS	40p	40MOS	41p
40312	1.63	IC1722	15p	IC474	33p	BD491	83p	BF150	1.20	MPS427	45p	ATI-5963	95p	TA6629	2.00	7434	20p	74LS53	12p	40MOS	40p	40MOS	41p
40313	1.83	IC1723	15p	IC475	33p	BD492	83p	BF151	1.20	MPS428	45p	ATI-5964	95p	TA6630	2.00	7435	20p	74LS54	12p	40MOS	40p	40MOS	41p
40315	1.94	IC1728	15p	IC476	33p	BD493	83p	BF152	1.20	MPS429	45p	ATI-5965	95p	TA6631	2.00	7436	20p	74LS55	12p	40MOS	40p	40MOS	41p
40316	1.95	IC1729	15p	IC477	33p	BD494	83p	BF153	1.20	MPS430	45p	ATI-5966	95p	TA6632	2.00	7437	20p	74LS56	12p	40MOS	40p	40MOS	41p
40340	1.90	IC1730	15p	IC478	33p	BD495	83p	BF154	1.20	MPS431	45p	ATI-5967	95p	TA6633	2.00	7438	20p	74LS57	12p	40MOS	40p	40MOS	41p
40341	1.84	IC1731	15p	IC479	33p	BD496	83p	BF155	1.20	MPS432	45p	ATI-5968	95p	TA6634	2.00	7439	20p	74LS58	12p	40MOS	40p	40MOS	41p
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40373	2.60	IC1749	24p	IC484	33p	BD501	83p	BF160	1.20	MPS437	45p	ATI-5973	95p	TA6639	2.00	7444	20p	74LS63	12p	40MOS	40p	40MOS	41p
40374	1.84	IC1750	24p	IC485	33p	BD502	83p	BF161	1.20	MPS438	45p	ATI-5974	95p	TA6640	2.00	7445	20p	74LS64	12p	40MOS	40p	40MOS	41p
40404	1.39	IC1772	26p	IC486	33p	BD503	83p	BF162	1.20	MPS439	45p	ATI-5975	95p	TA6641	2.00	7446	20p	74LS65	12p	40MOS	40p	40MOS	41p
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40411	1.80	IC1784	24p	IC489	33p	BD506	83p	BF165	1.20	MPS442	45p	ATI-5978	95p	TA6644	2.00	7449	20p	74LS68	12p	40MOS	40p	40MOS	41p
40414	2.85	IC1788	25p	IC490	33p	BD507	83p	BF166	1.20	MPS443	45p	ATI-5979	95p	TA6645	2.00	7450	20p	74LS69	12p	40MOS	40p	40MOS	41p
40417	9.00	IC1789	25p	IC491	33p	BD508	83p	BF167	1.20	MPS444	45p	ATI-5980	95p	TA6646	2.00	7451	20p	74LS70	12p	40MOS	40p	40MOS	41p
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40472	8.99	IC1832	11p	IC503	33p	BD520	83p	BF179	1.20	MPS456	45p	ATI-5992	95p	TA6658	2.00	7463	20p	74LS82	12p	40MOS	40p	40MOS	41p
40473	8.99	IC1833	11p	IC504	33p	BD521	83p	BF180	1.20	MPS457	45p	ATI-5993	95p	TA6659	2.00	7464	20p	74LS83	12p	40MOS	40p	40MOS	41p
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40481	8.99	IC1840	11p	IC511	33p	BD528	83p	BF187	1.20	MPS464	45p	ATI-6000	95p	TA6666	2.00	7471	20p	74LS90	12p	40MOS	40p	40MOS	41p
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40484	8.99	IC1843	11p	IC514	33p	BD531	83p	BF190	1.20	MPS467	45p	ATI-6003	95p	TA6669	2.00	7474	20p	74LS93	12p	40MOS	40p	40MOS	41p
40485	8.99	IC1844	11p	IC515	33p	BD532	83p	BF191	1.20	MPS468	45p	ATI-6004	95p	TA6670	2.00	7475	20p	74LS94					

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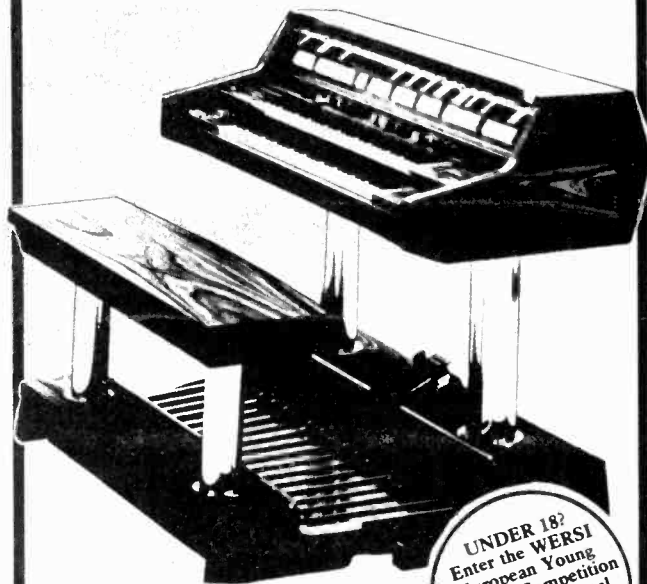
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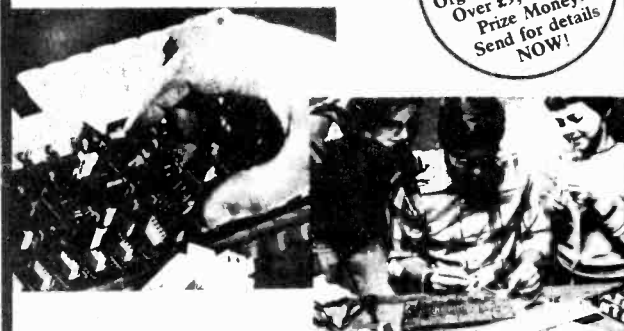
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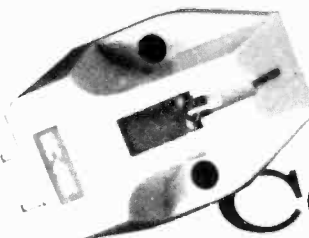
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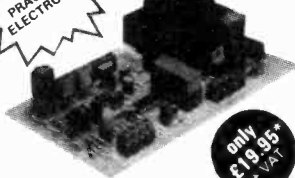
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MODULES FOR SECURITY & MEASUREMENT

INTRUDER ALARM CONTROL UNIT CA 1250



This exciting new module offers all the possible
features likely to be required when building an
intruder alarm system. Whether used with only 1 or
2 magnetic switches or in conjunction with several
ultrasonic alarm modules or infra-red units, a really
effective system can be constructed at a fraction of
the cost of comparable ready-made units. Supplied
with a fully explanatory Data Sheet that makes
installation straight forward, the module is fully
tested and guaranteed.

*available in kit form £16.95 plus VAT.

- Built-in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back-up with trickle charging facility
- Operates with magnetic switches, u/sonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for switching external loads
- Test loop facility

DIGITAL VOLTMETER MODULE DVM 314

Fully built & tested



- Positive & negative voltage with an FSD of 999mV which is easily extended
- Requires only single supply 7-12V
- High overall accuracy - 0.1% + 1 digit
- Large bright 0.43" LED displays
- Supplied with full applications data

With this fully built and calibrated module a wide range of accurate equipment such as multimeters, thermometers, battery indicators etc. can be constructed at a fraction of the cost of ready-made units. Full details are supplied for extending the voltage range, measuring current, resistance and temperature. Fully guaranteed, the unit has been supplied to electricity authorities, Government departments, etc.

Temperature Measurement Kit DT.10

£2.25 + VAT

Using the I.C. probe supplied, this kit provides a linear output of 10mV°C over the temperature range from 10°C to +100°C. The unit is ideal for use in conjunction with the DVM module providing an accurate digital thermometer.

Power Supply PS.209

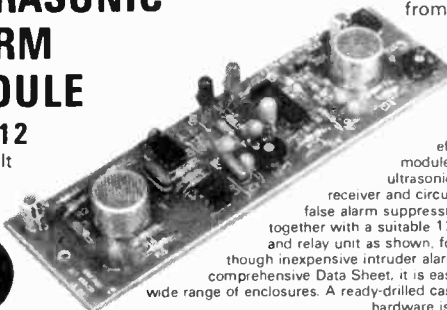
£4.95 + VAT

This fully built, mains power supply provides two stabilised isolated outputs of 9V, 250mA each. The unit is ideally suited for operating the DVM and Temperature Measurement module.

ULTRASONIC ALARM MODULE

US 4012

Fully built
& tested



Adjustable range
from 5ft. to 25ft.

A really effective fully built module containing both ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. This module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available below.

only
£10.95
+ VAT

Power Supply & Relay Units PS 4012

£4.25 + VAT

Provides a stabilised 12V output and relay with 3A contacts. The unit is designed to operate one or two of the above ultrasonic units. Fully built and tested.

Hardware Kit HW 4012

£4.25 + VAT

A suitable ready-drilled case with the various mounting pillars, mains switch socket and nuts and bolts. Designed to house the ultrasonic alarm module together with its power supply.
Size: 153mm x 120mm x 45mm

Siren Module SL 157

£2.95 + VAT

Produces a loud and penetrating sliding tone operating from 9-15V. Capable of driving 2 off 8 ohm speakers to SPL of 110db at 2M.
Contains an inhibit facility for use with shop lifting loops or other break to activate circuits.

★ ACCESSORIES ★

- 3-position Key Switch for use with CA 1250, supplied with 2 keys £3.43
- Magnetic switch (with magnet) £1.17
- 5" Horn speaker for use with CA 1250 and SL 157 £4.95

Add VAT & 50p post and packing
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Shop hours 9.00 - 5.30 p.m.

(Wed. 9.00 - 1.00 p.m.)

Units on demonstration - callers
welcome. S.A.E. with all
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CMOS	*4017	30	*4036	248	4055	80	4082	12	4502	60	4529	150	
4000	10	4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
*4001	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4002	12	4020	42	4041	40	4063	80	4089	125	4508	125	4538	110
4006	50	4022	45	4042	38	*4066	22	*4093	18	4510	45	4543	70
4007	14	4023	45	4043	40	4067	225	4094	58	*4511	45	4549	360
4008	36	4024	33	*4046	50	4069	13	4097	290	4512	50	4553	245
4009	24	4025	16	4047	45	4070	13	4098	70	4515	120	4556	35
4010	24	*4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
*4011	11	4027	20	*4049	21	4072	13	40106	40	*4518	40	4580	175
*4012	15	4028	40	*4050	21	4073	13	40109	110	4520	50	4584	40
*4013	20	4029	45	4051	42	4075	15	40164	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		
4016	20	4034	140	4054	78	4081	12	40193	65	4528	50		

LS TTL	LS21	12	LS26	17	LS125	24	LS161	35	LS221	50	LS365	28	
	LS22	12	LS27	17	LS126	25	LS162	35	LS240	60	LS366	28	
*LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	60	LS367	28
LS01	11	LS27	12	LS84	48	LS133	35	LS164	35	LS242	60	LS368	28
LS02	11	LS30	12	LS86	16	*LS138	30	LS165	55	LS243	55	*LS373	60
LS03	12	LS32	13	*LS90	24	*LS139	30	LS166	60	*LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	*LS245	70	LS375	43
LS05	12	LS38	15	*LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
*LS08	12	LS42	10	LS96	48	LS149	38	LS175	45	LS252	38	LS379	57
LS10	12	*LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	45
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS417	78
*LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	*573	19	LS114	22	*LS157	26	LS195	32	LS279	30		
LS15	15	*574	19	LS115	22	LS158	29	LS196	45	LS283	38		
LS20	12	LS75	20	LS123	35	LS160	35	LS197	45	LS353	60		

TTL	*7413	17	7422	30	7480	45	74107	22	74155	36	74177	42	
	7414	23	7444	85	7482	65	74109	24	74156	36	74179	75	
*7400	11	7416	19	7446	58	7483	30	*74121	24	74157	28	74180	38
7401	11	7417	19	7447	36	7485	60	74122	38	74160	55	74181	100
7402	11	7420	19	7448	43	7486	19	74123	38	74161	46	74182	55
7403	11	7421	19	7449	19	7487	19	74124	38	74162	46	74183	55
7404	12	7422	19	7451	14	*7490	19	74126	33	74163	46	74191	40
7405	14	7427	18	7453	14	7491	34	74132	30	74164	46	74192	40
7406	19	7428	25	7454	14	7492	24	74141	54	74165	46	74193	40
7407	19	7430	13	7460	14	*7493	24	74145	48	74167	150	74194	40
7408	13	7432	20	7472	22	7494	33	74147	60	74170	115	74195	40
7409	20	7433	20	7473	24	7495	38	74148	60	74171	60	74196	40
7410	13	7438	24	*7474	19	7496	38	74150	48	74174	53	74197	40
7411	15	7437	23	7475	26	7497	86	74153	38	74175	45	74198	80
7412	17	7440	14	7476	25	74100	78	74154	47	74176	35	74199	80

LINEAR	*CA3240E	110	LM358	50	LM3915	200	NE570	375	TLO71	30	
*555 CMOS	ICL7106	790	LM377	150	LM3900	105	NE571	375	TLO72	30	
556 CMOS 150	ICL761	95	*LM380	65	MC150	150	RC4136	55	TLO74	95	
709	ICL762	180	LM381	120	MC1496	68	*RC4558	60	*TLO81	25	
*741	ICL8038	320	LM382	130	MC3340	135	SL480	170	*TLO82	45	
748	ICL821A	200	LM386	65	ML924	400	SL490	250	*TLO84	95	
9400C1	ICM722	785	LM387	120	ML925	210	SN7647	380	*UA2203	85	
AY-3-1270 840	ICM755	80	LM389	100	ML926	140	SP8629	250	ULN2002	120	
AY-3-8910 430	LF353	85	LM711	60	ML928	140	TBA800	80	ULN2004	90	
AY-3-8912 625	LF156	90	LM725	350	ML929	140	TBA810	96	*XR2026	300	
CA3046	LM0	360	LM733	75	MS587A	465	*TBA820	80	ZN414	40	
CA3080	65	LM301A	25	NE529	225	TBA950	290	ZN424	135		
CA3089	215	LM317	120	NE531	150	TD A1008	320	ZN425	350		
CA3094	375	LM318	70	NE544	180	*TDA1022	220	ZN426E	330		
CA3130F	LM324	40	LM2917	200	*NE555	16	525	ZN427	650		
CA3130E	LM334Z	100	LM3900	50	*NE556	45	TDA1024	125	ZN428E	480	
*CA3140F	LM335Z	125	*LM3909	70	NE565	120	TLO61	40	ZN428E	480	
CA3161E	LM339	50	LM3911	120	NE566	150	TLO62	60	ZN459	285	
CA3189	290	LM348	65	LM3914	120	NE567	100	TLO64	95	ZN103AE	20

TRANSISTORS	AC125	35	BC157	10	BC348	10	BF400	23	TIP29A	30	*ZX107	8	2N3053	23
AC126	25	BC158	10	BC558	10	BF429	25	TIP29C	36	TZ109	12	2N3054	55	
AC127	25	BC159	8	BCV70	18	BF484	25	TIP30A	35	TZ100	14	2N3442	120	
*AC128	20	BC160	45	BCV72	18	BF486	28	TIP30B	40	TZ101	16	*2N3702	6	
AC176	25	BC161	10	BD115	80	BF487	25	TIP31A	35	TZ102	17	*2N3704	6	
AC187	22	BC162	10	BD131	35	BF488	25	TIP31C	35	TZ103	17	*2N3705	9	
AC188	22	BC170	8	BD132	35	BF520	23	TIP32A	38	TZ104	15	*2N3706	9	
AD142	120	BC171	10	BD133	50	BFY51	23	TIP32C	42	TZ105	15	2N3707	10	
AD149	80	BC172	8	BD135	50	BFY52	23	TIP33A	50	TZ106	15	2N3708	10	
AD161	40	BC177	18	BD136	30	BFY53	32	TIP33C	75	TZ103	18	2N3709	10	
AD162	40	BC178	18	BD137	30	BFY55	32	TIP34C	85	TZ104	25	2N3772	190	
AF124	60	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N697	20	2N3773	20	
AF126	50	BC182	10	BD139	30	BFY59	40	TIP35A	105	2N698	40	*2N3819	18	
AF139	40	*BC182L	8	BD140	35	BSX20	20	TIP35C	128	706A	20	2N3820	40	
AF186	70	BC183	10	BD204	110	BSX29	35	TIP36A	129	2N708	20	2N3823	65	
AF239	10	BC183L	10	BD206	110	BSY95	25	TIP41A	45	2N918	35	2N3866	90	
BC107	12	BC184L	7	BD222	85	BU205	160	TIP42A	50	2N1132	22	2N3903	10	
*BC108	9	BC212	10	BF182	35	BU208	170	TIP121	70	2N1613	30	2N3904	10	
BC108L	12	BC213	10	BF184	25	BU209	170	TIP122	70	2N219A	25	2N3906	10	
*BC109	9	BC214	10	BF185	25	MJE340	50	TIP123	70	2N221A	25	2N4037	45	
BC109C	12	BC215	10	BF194	12	MJE320	65	TIP142	98	2N222A	20	2N4058	10	
BC114	22	*BC214L	8	BF195	12	MJE321	95	TIP147	108	2N368	25	2N4061	10	
BC115	22	BC237	8	BF196	12	MPF102	10	TIP295	60	2N369	16	2N4062	10	
BC117	22	BC238	14	BF197	12	MPF104	40	TIP305	55	2N484	25	2N4062	10	
BC119	35	BC308	15	BF198	18	MPSA05	22	TIS44	45	2N2646	45	2N4577	36	
BC137	10	BC327	14	BF199	18	MPSA05	22	TIS44	45	2N2904	20	2N4585	36	
BC139	40	BC328	14	BF200	30	MPSA06	25	TIS45	45	2N2904A	20	2N4589	36	
BC140	30	BC337	14	*BF244B22	10	MPSA12	30	TIS90	30	2N2905	22	2N4585	36	
BC141	30	BC338	14	BF245	30	MPSA30	30	TIS91	30	2N2905A	22	2N5777	45	
BC142	25	BC378	30	BF256B	45	MPSA30	30	*VN10KM	2N2906	25	2N6207	30		
BC143	25	BC478	30	BF257	32	MPSU05	55	VN46AF	75	2N2907	25	40361	50	
BC147	40	BC479	30	BF258	25	MPSU05	55	VN66AF	85	2N2907A	25	40362	50	
BC148	8	BC517	40	BF259	35	MPSU06	60	VNB8AF	95	2N2926	9	40408	70	
BC149	8	BC547	7	BF337	40	MPSU06	60							

SOCKETS	Low Profile	wrap	8 pin	6p	25p	14 pin	8p	25p	16 pin	12p	52p	20 pin	13p	60p	22 pin	16p	79p	24 pin	19p	79p	40 pin	25p	98p	Solder can pins	60p/100	
VERO	* Verobloc 350p	Size 0.1 matrix	2.5	1	75	2.5	1	75	2.5	1	75	2.5	1	75	2.5	1	75	2.5	1	75	2.5	1	75	2.5	1	75
SWITCHES	Submin toggle	SPST 55p	SPDT 60p	* DPDT 65p	Miniature toggle	SPDT 80p	SPDT centre off 90p	DPDT 90p	DPDT centre off 100p	Standard toggle	SPST 35p	DPDT 48p	* Miniature DPDT slide switch	12p	* Push to make 12p	Push to break 22p	22p									



ELECTRONIC HOBBIES FAIR

Alexandra Pavilion London November 18 – 21 1982
**The biggest and best event ever to be
staged for the
electronic hobbies enthusiast!**

Walk into a whole world of electronic equipment. – Everything from resistors, IC's to home computers, transmitting and receiving units, citizens band radio and peripheral equipment, video games, musical instruments, radio control models. . . . In fact whatever your particular electronic hobby you'll find this show will be the most interesting and informative way to discover all the latest developments in your particular field.

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.

OPENING TIMES

Thursday 18 Nov. – 10.00-18.00

Friday 19 Nov. – 10.00-18.00

Saturday 20 Nov. – 10.00-18.00

Sunday 21 Nov. – 10.00-17.00



50p OFF

admission if you produce this coupon
at the door of Electronic Hobbies Fair.
Valid one per person only any day.

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.

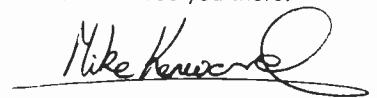
Special fares are available from all

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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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, Perrymount 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.

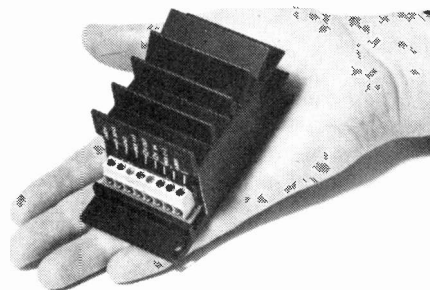
"The proposals of the Hunt Committee will be crucial to the expansion of broadcasting. Mistakes made now would take years to correct. It is for this reason that the Authority calls for a winter of public debate before the final decisions are taken. The Authority has no wish to delay the changes which 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 3½ 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-

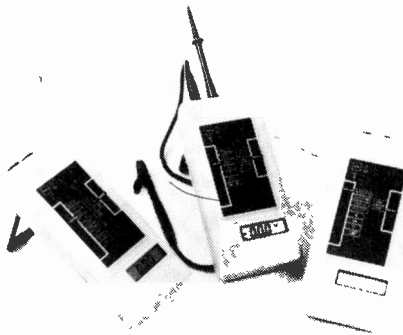
ple continuity testing without reference to the display.

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.

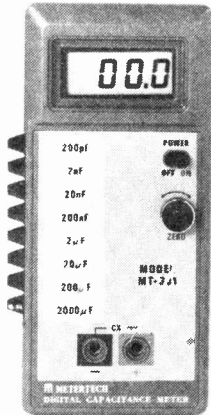
Thorn EMI Instruments Ltd., Archcliffe Road, Dover, Kent (0304 202620).



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-riden 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).

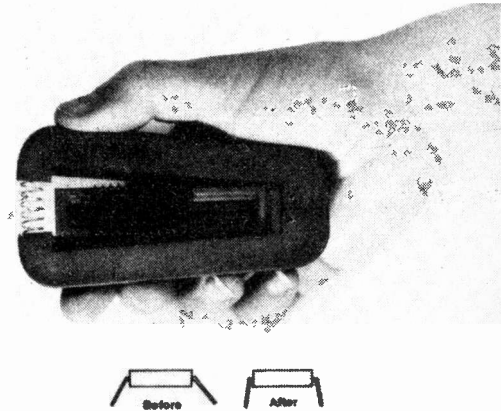


CHIP LEG HAND TOOL

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.

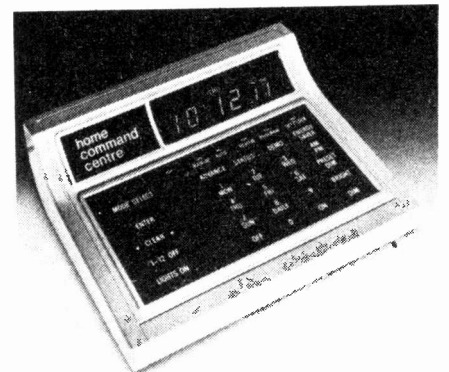
Other features of the unit include the manual dimming and brightening of lamps, battery back-up and the ability to turn on all lamps simultaneously. The Command Centre is priced at £73.70 with the appliance and lamp modules priced at £24.00 each.

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.

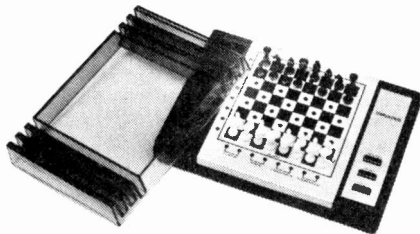
Up to 5 units can be used in conjunction with each other or a private conversation can be carried out between two units without the others on the system being able to hear. The intercom is priced at £37.45 per unit.

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



CHESS 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/Measurement) 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

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 machine, and includes, initially, programs for education and entertainment.

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

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.

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.

ORDER NOW!

Please send me:—

JUPITER ACE MICROCOMPUTER(S) @ £89.95.

Name. Mr./Mrs./Miss _____

Address _____

_____ PE

STYLO CHORD

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.

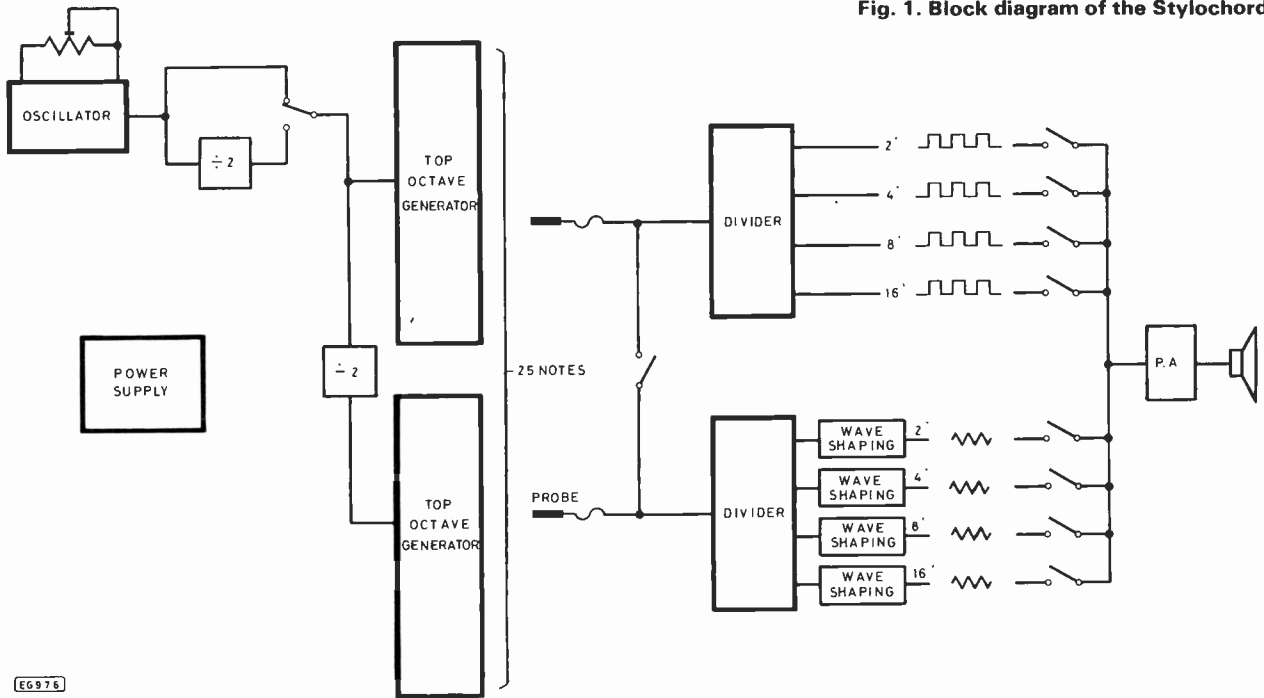
If pin 12 of IC6 is taken as an example, a square wave comes out, but R8 controls the charging rate of C2, giving a slope to the leading edge of the square wave; and R12 controls the discharge rate, giving a slope to the trailing edge resulting in an approximate triangular waveform. None of these values 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

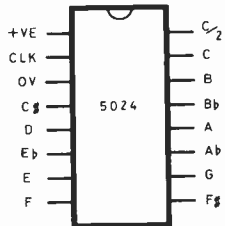
THE instrument popularised by Rolf Harris some years ago generated a plethora of similar designs, and many people clearly derived a great deal of enjoyment from these ingenious devices. With the inexorable march of progress, many i.c.s have developed, and become cheap enough for new improved designs 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

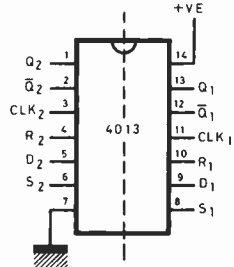


EG976



EG972

Fig. 2. 4013 in $\div 2$ mode (right)



EG975

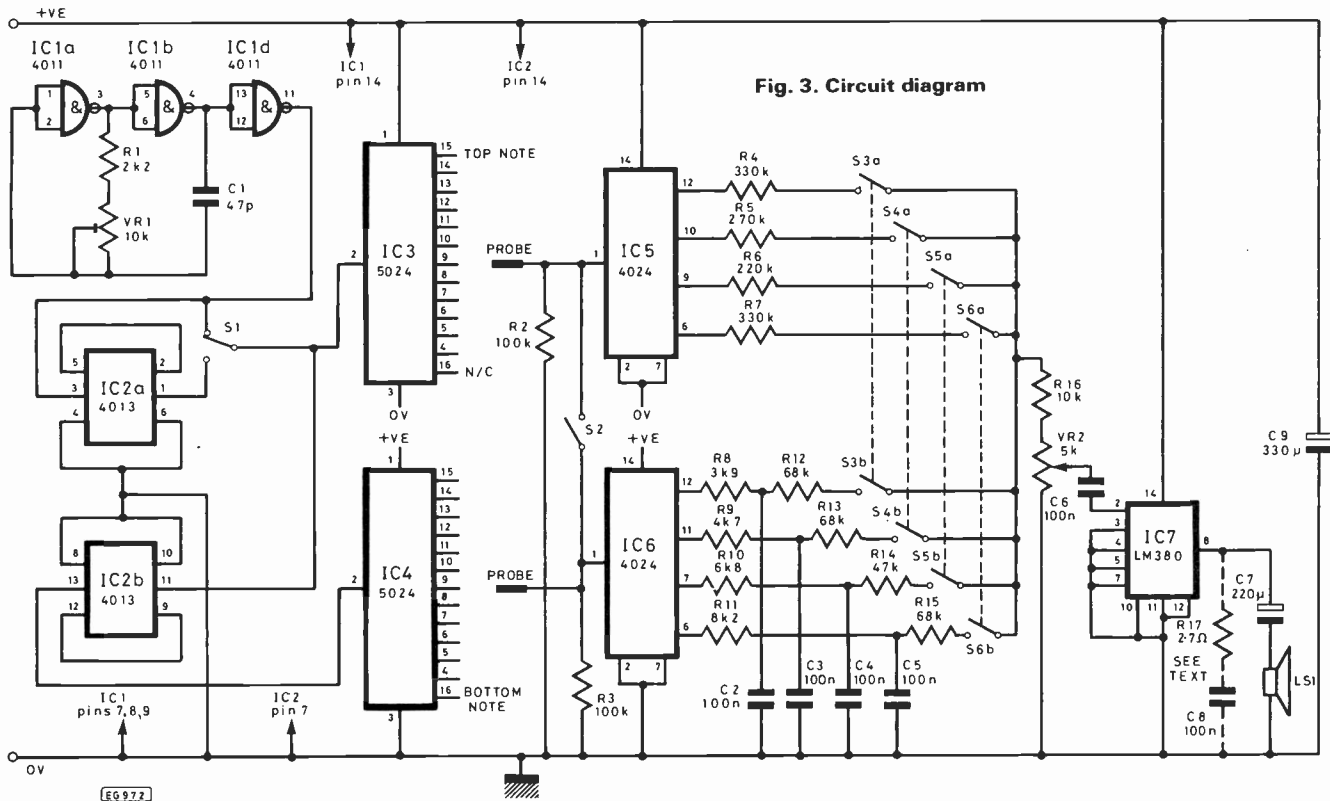
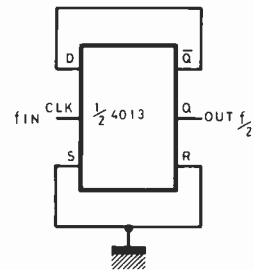


Fig. 3. Circuit diagram

EG977

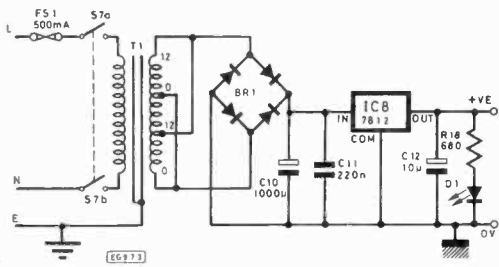


Fig. 4. PSU circuit diagram

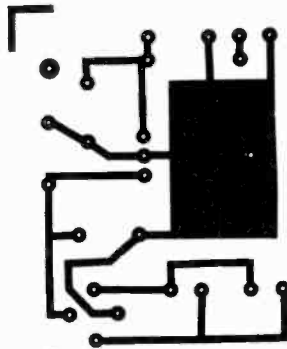
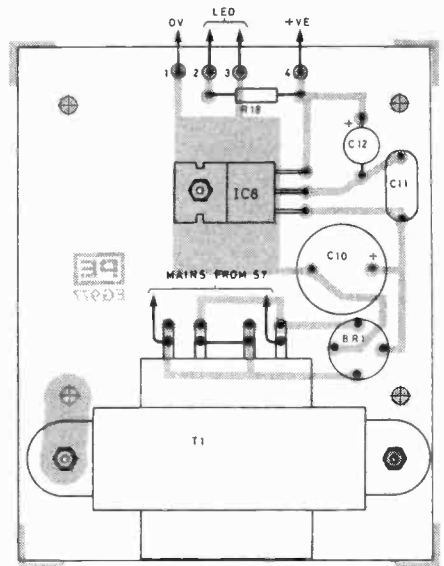


Fig. 5. PSU printed circuit (actual size)

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.

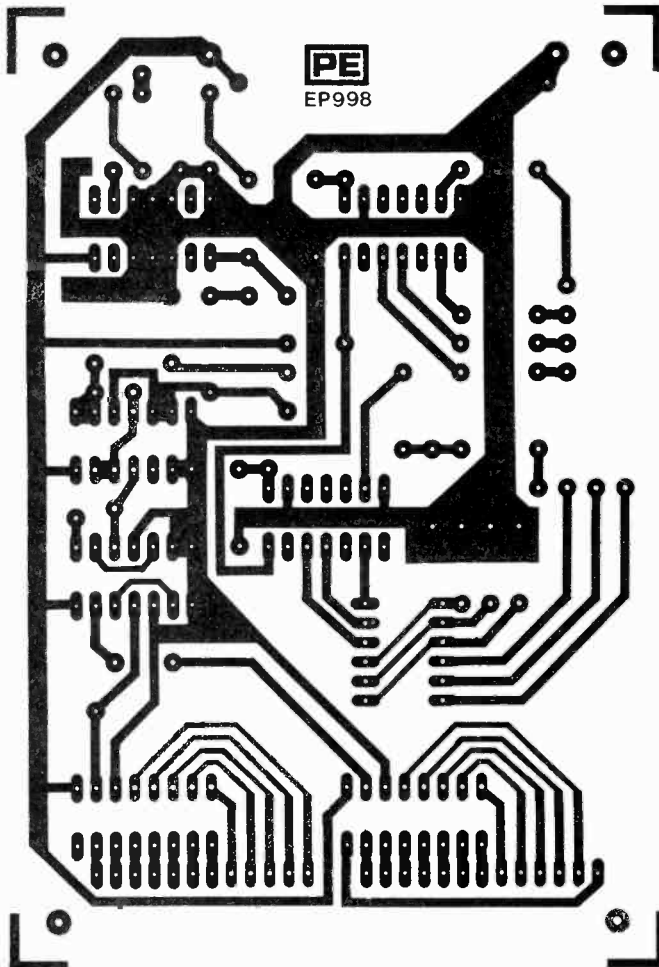


Fig. 7. Stylochord p.c.b. (actual size)

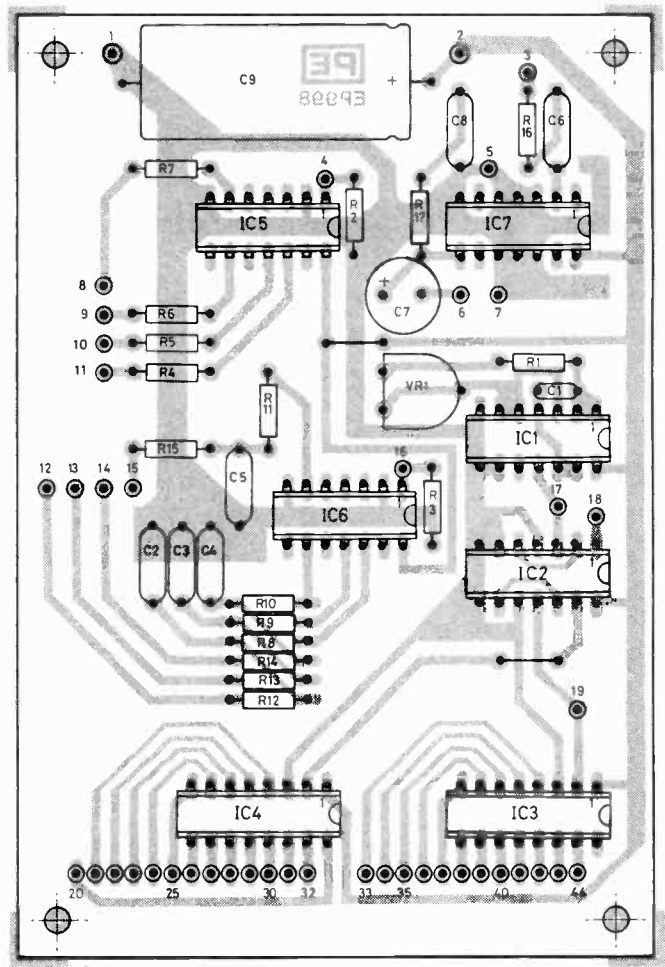


Fig. 8. Stylochord component layout

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.

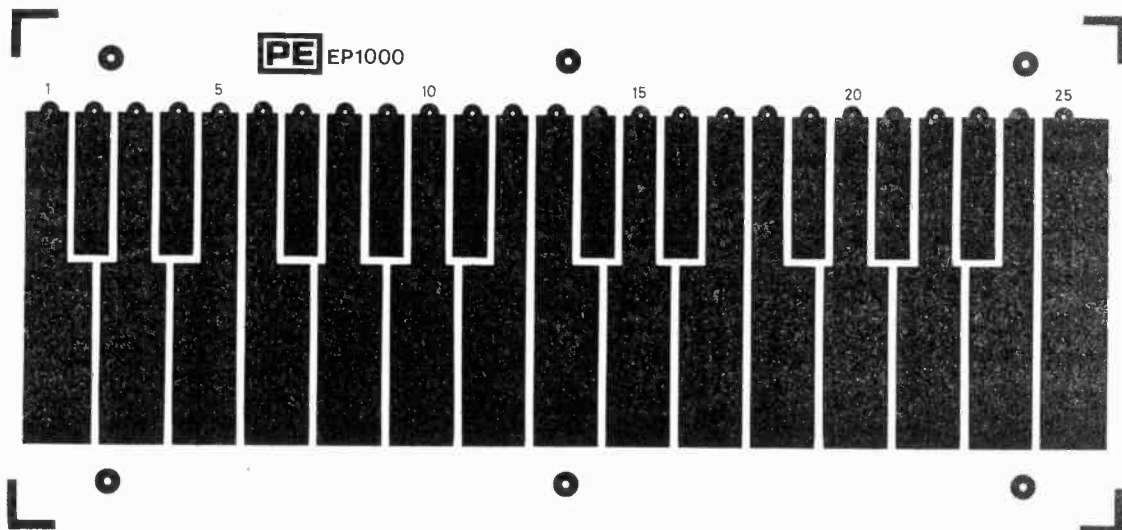


Fig. 9. Keyboard printed circuit

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

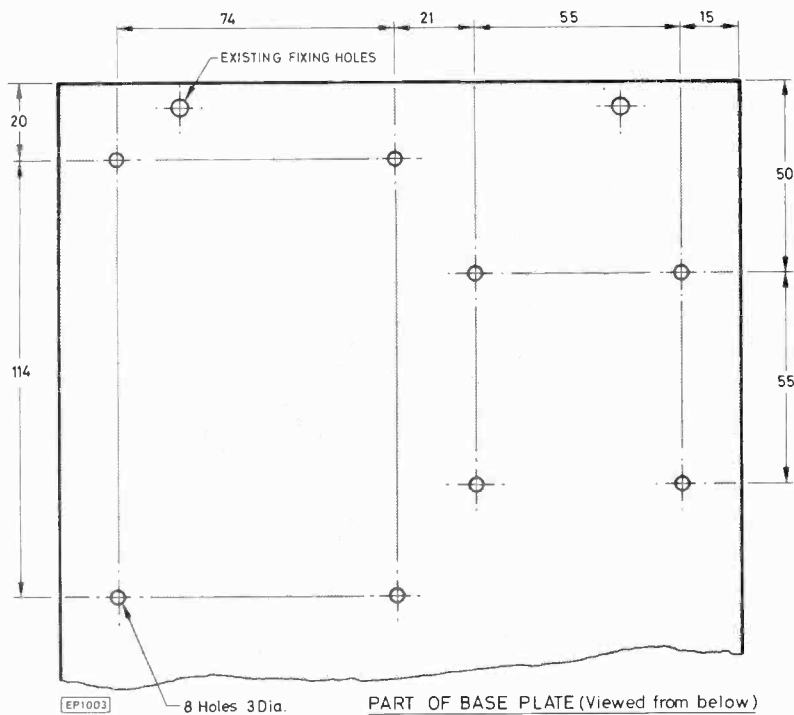


Fig. 10(a). Base plate drilling details

Fig. 10(b). Switch fascia drilling details

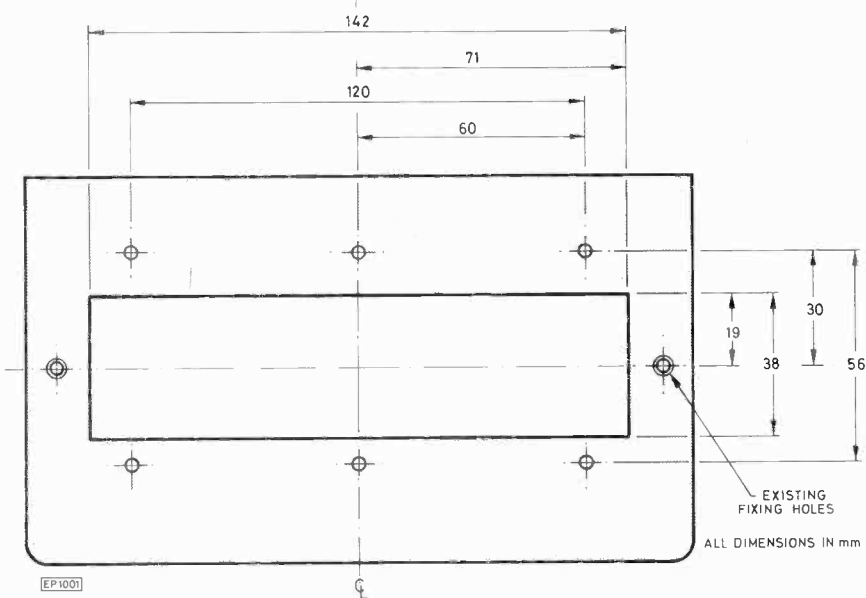
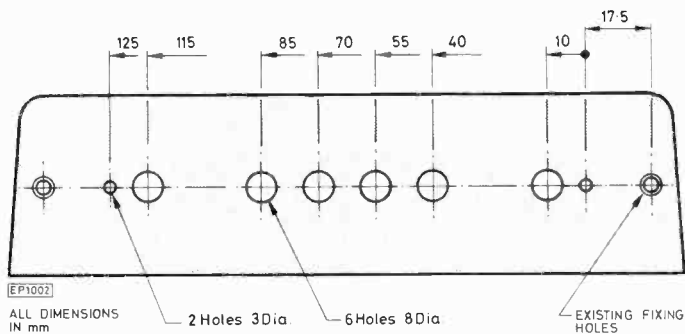


Fig. 10(c). Keyboard bezel details

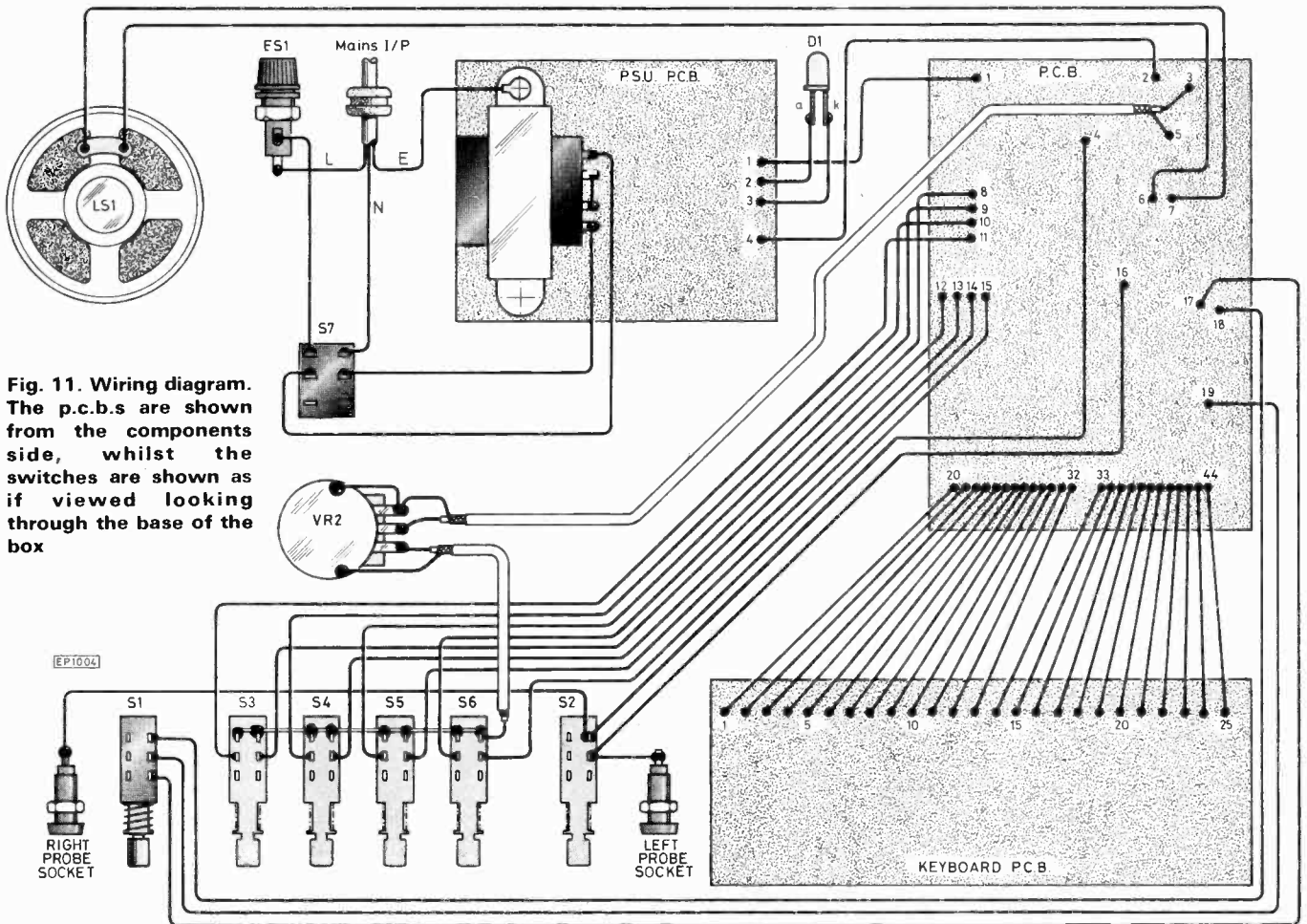
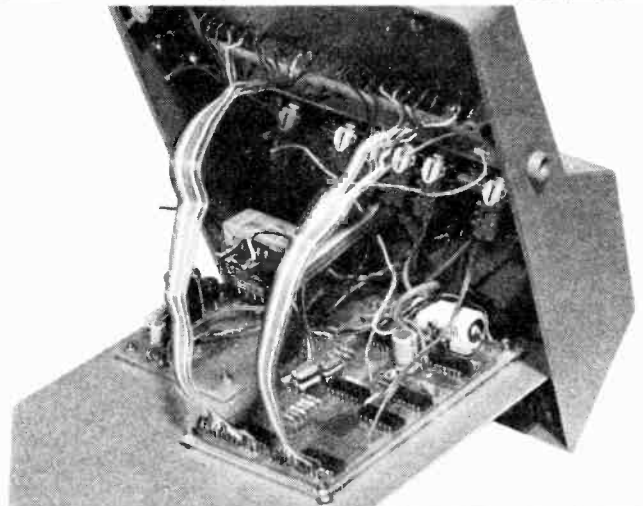


Fig. 11. Wiring diagram. The p.c.b.s are shown from the components side, whilst the switches are shown as if viewed looking through the base of the box

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 stylies 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! ★



This coupon entitles the bearer to

£2 OFF

the price of a Hi-Style Desk Top Case as featured in Practical Electronics **STYLOCHORD** project. This coupon is valid until 31st December 1982

To the Retailer:—

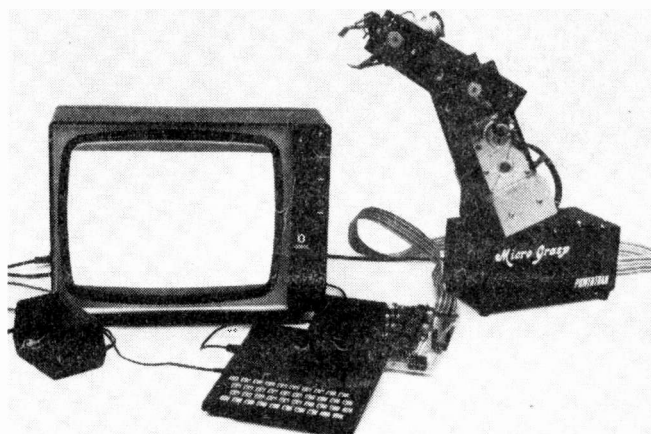
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New developments in UK Robotics

ADVANCED DESIGNS FOR EDUCATION, INDUSTRY AND THE HOME CONSTRUCTOR

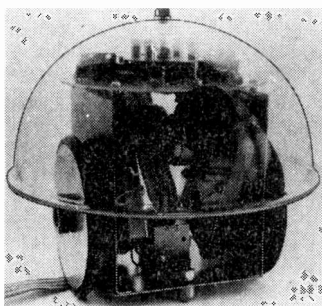
Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. 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



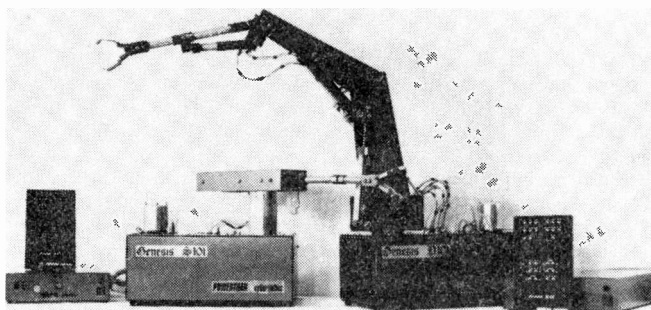
MICROGRASP, INTERFACE BOARD AND ZX81

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.



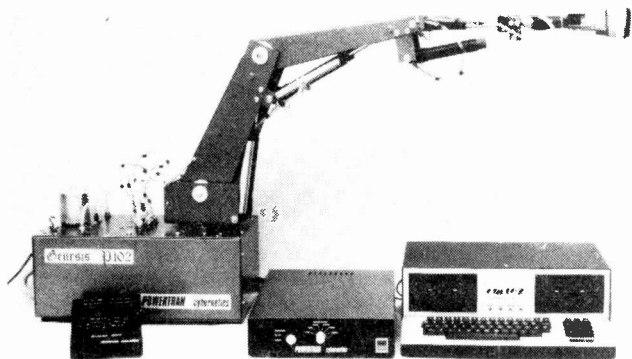
Hebot II kit £75.00
 Universal computer interface board £10.00
 23 way edge connector £2.50
 ZX81 peripheral/RAM Pack splitter board £3.00

'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.

ALL PRICES EXCLUSIVE OF VAT

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Telephone: ANDOVER (0264) 64455

POWERTRAN cybernetics



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 infrared 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 kilograms. Twenty five satellites later the Intelsat series 5 was launched in December 1980 and weighs 1,870 kilograms. 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.

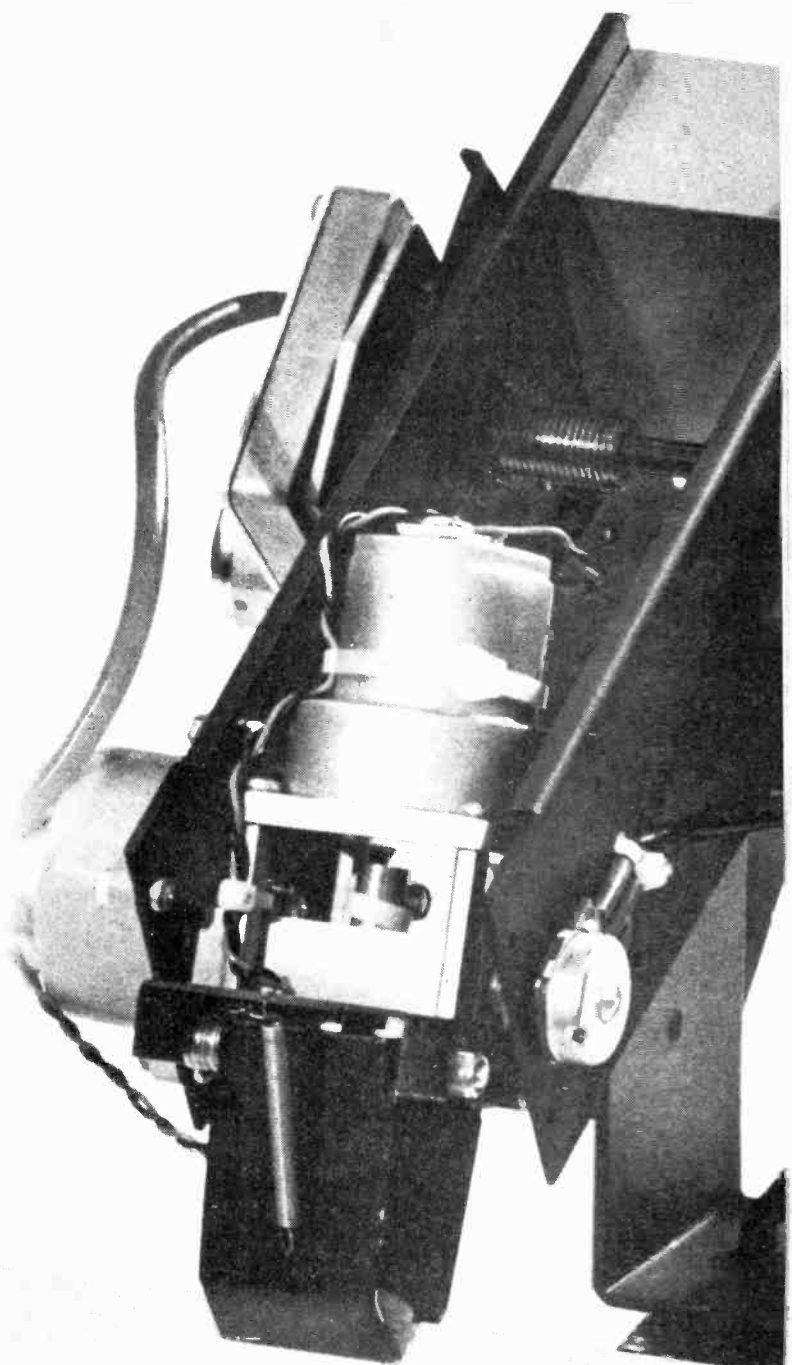
Also on the lower arm are the position sensing potentiometers. On the bushes of these are plastic bushes on which the arm rotates. The shaft of each potentiometer is held in the steel bush fitted to the upper arm or support bracket.

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.

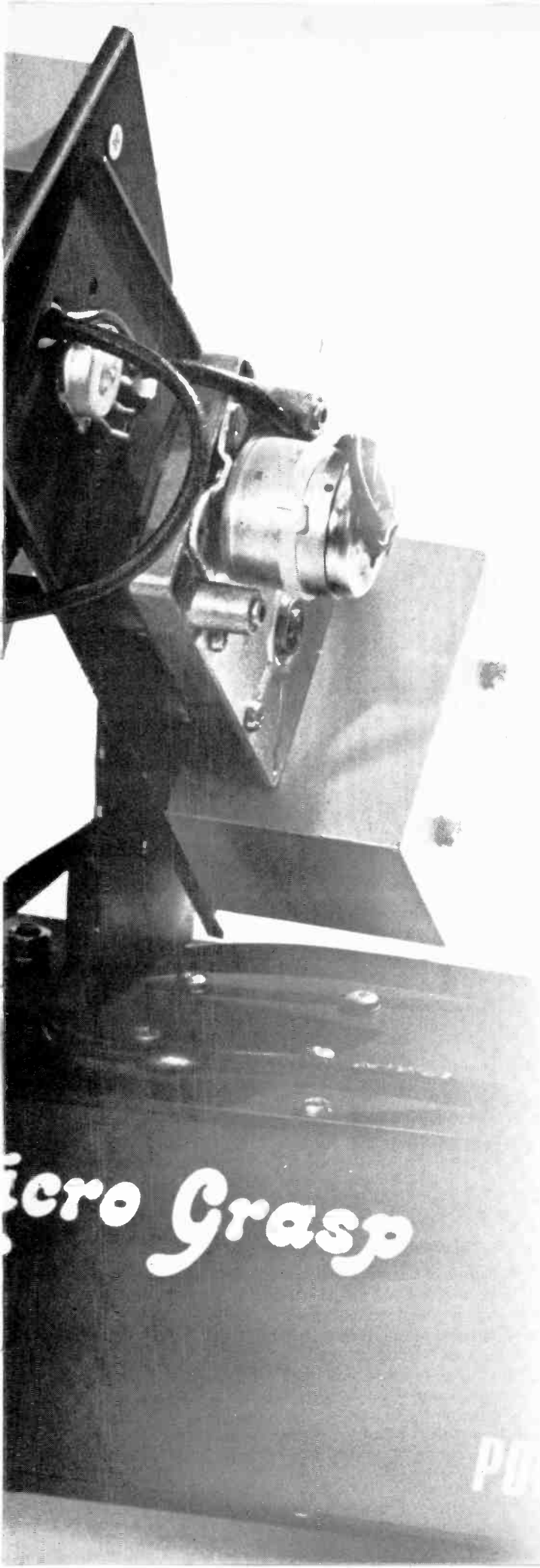
For raising and lowering the wrist (axis 3) the gearbox shaft rotates a bar to which the potentiometer shaft and gripper mounting plate are fitted (Fig. 3). Through this bar the drive shaft for the gripper lead screw passes. When the

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

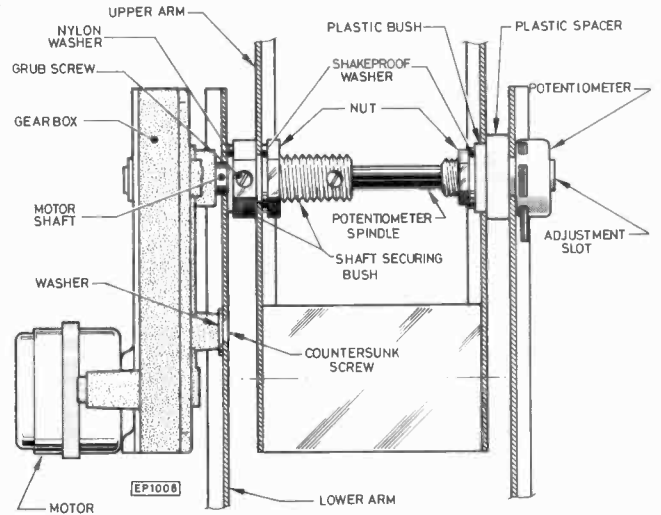


Fig. 1 Linkage between the motor, arms and potentiometer for axis 2 movement. Axis 1 operation is similar

(Left) Showing central position of the above linkage assembly

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

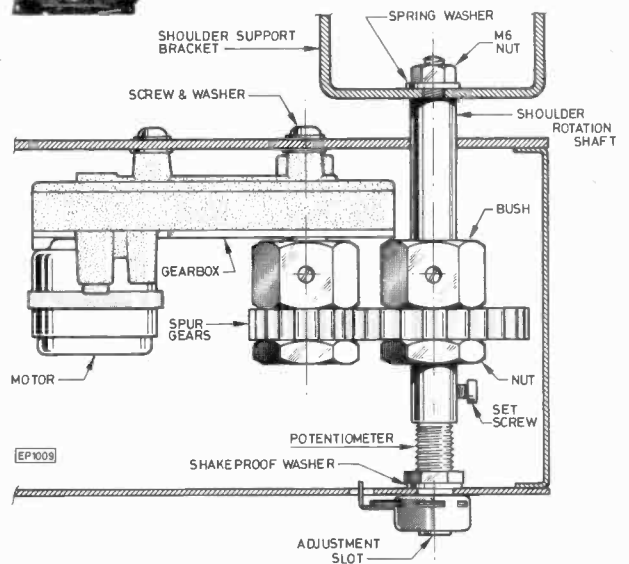
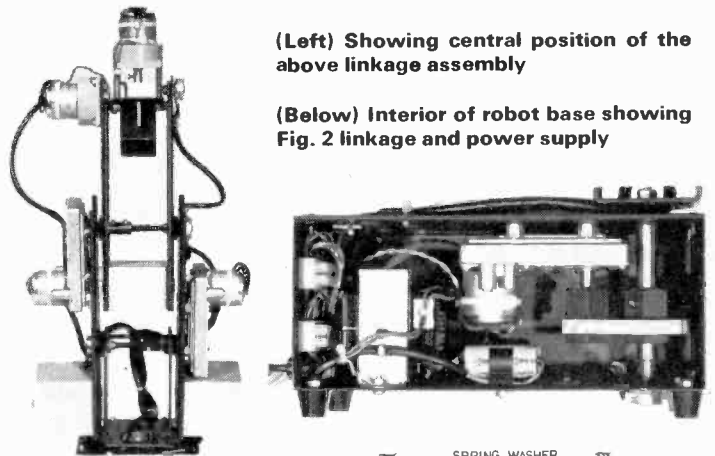


Fig. 2 Linkage between motor, spur gears, shoulder support bracket and potentiometer for axis 0 movement

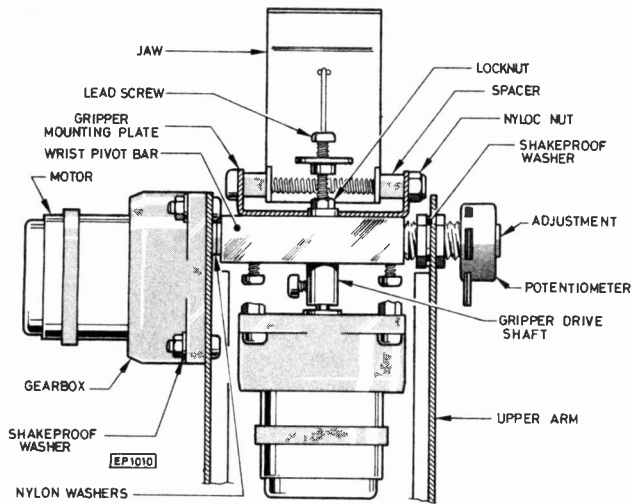


Fig. 3 Linkage between motor, gripper mounting bar and potentiometer for axis 3 movement

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

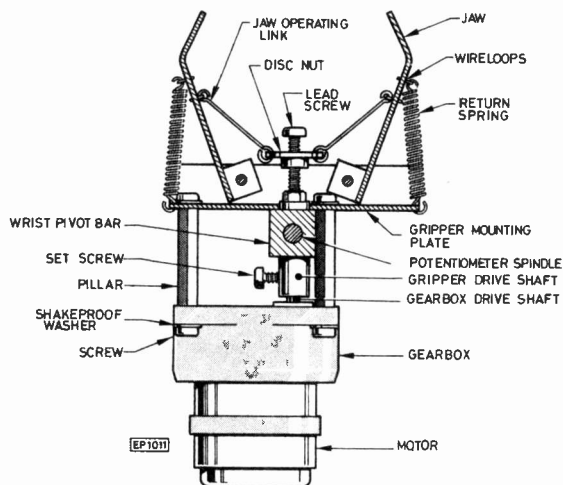


Fig. 4 Operating mechanism for the gripper

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.

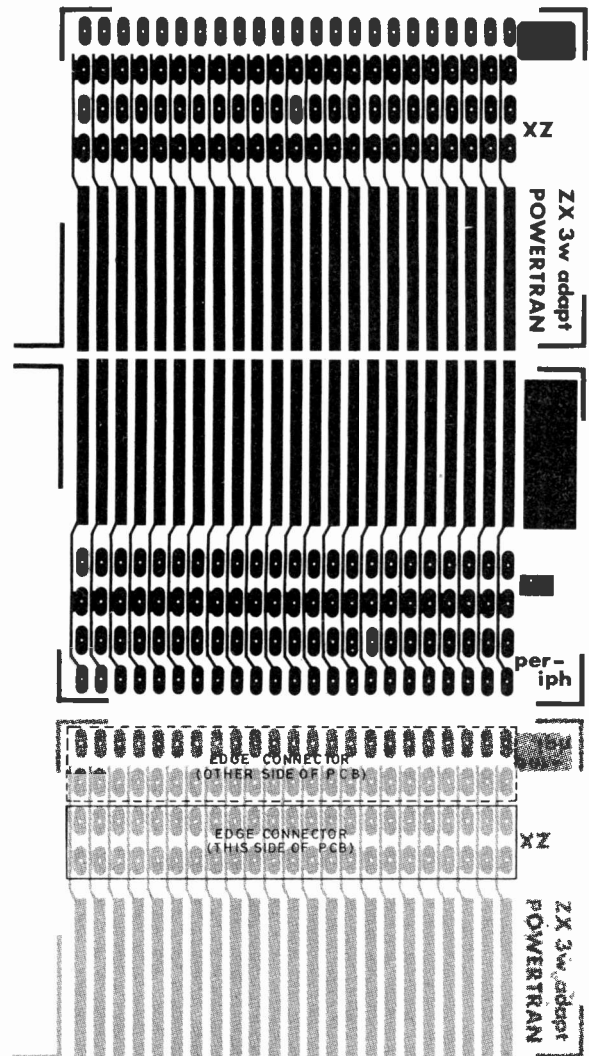


Fig. 5 Printed circuit of three way adaptor

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

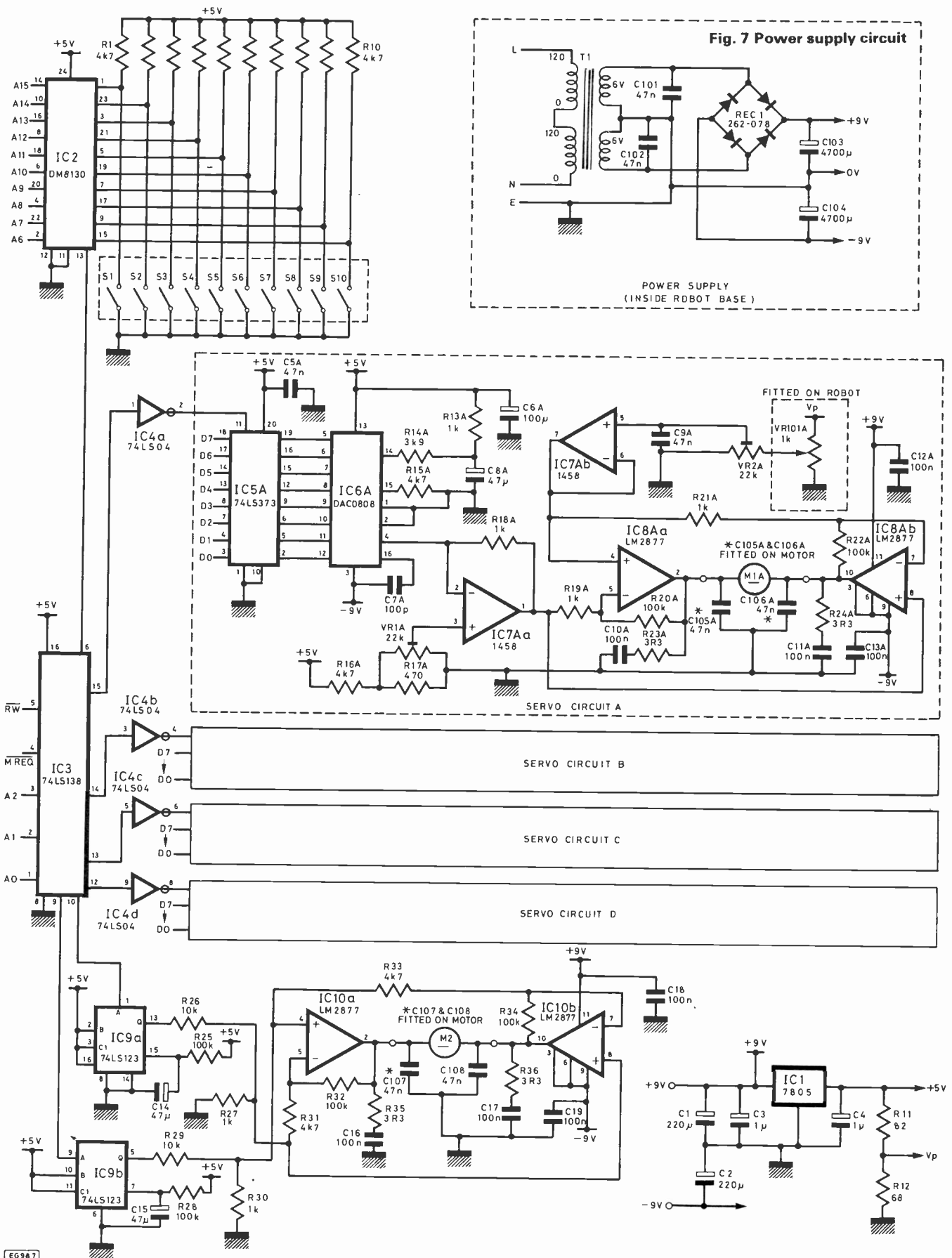
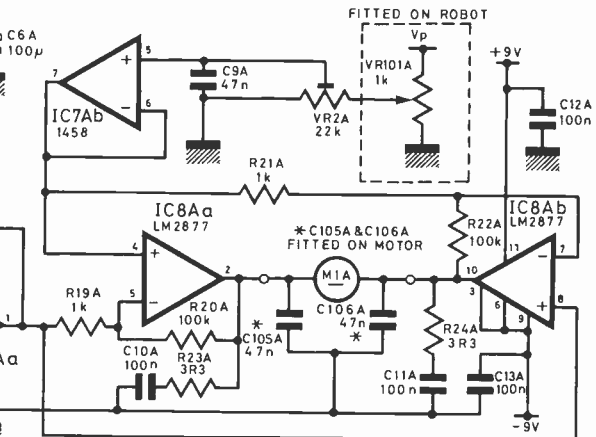


Fig. 6 Circuit of computer interface

Fig. 7 Power supply circuit

POWER SUPPLY
(INSIDE RDBOT BASE)



SERVO CIRCUIT A

SERVO CIRCUIT B

SERVO CIRCUIT C

SERVO CIRCUIT D

EG987

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)
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Capacitors

C1, 2	220 μ /16V vertical electrolytic (2 off)
C3, 4	1 μ /16V tantalum (2 off)
C5A-D	47n ceramic (4 off)
C6A-D	100 μ /10V vertical electrolytic (4 off)
C7A-D	100p ceramic (4 off)
C8A-D	47 μ /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	47 μ /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	4700 μ /16V horizontal electrolytic (2 off)

Diodes

REC1	6A rectifier block
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Transformer

T1	0-120V, 0-120V primary 6-0-6V at 4A secondary
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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 valved 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, Cheadle 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 Clarkes 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 $\frac{1}{2}$ A, 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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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.

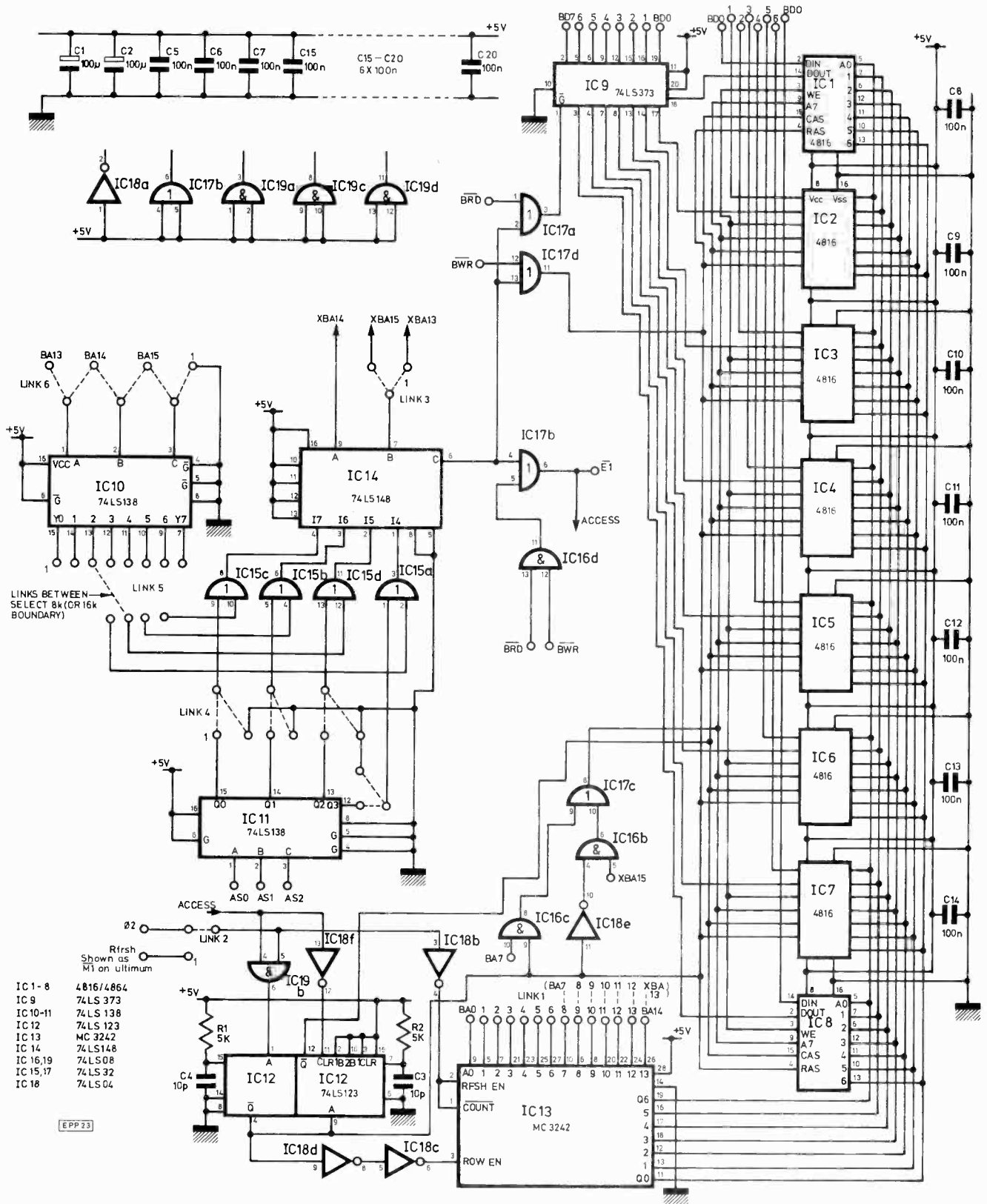


Fig. 2.1. Circuit diagram of the 16/64K Dynamic RAM board

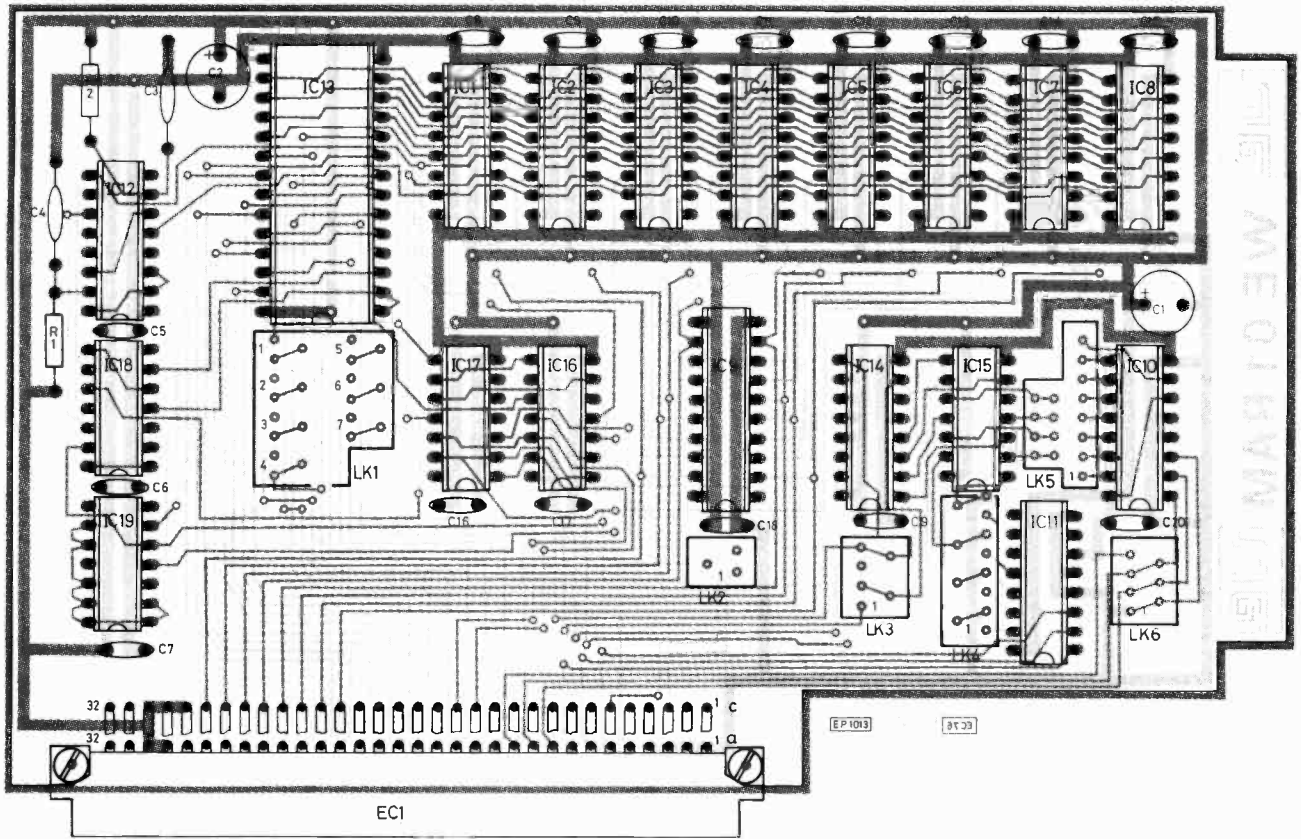


Fig. 2.2. Component layout of the RAM board

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 resistors and finally insert the i.c.s. taking special care with the static-sensitive memories.

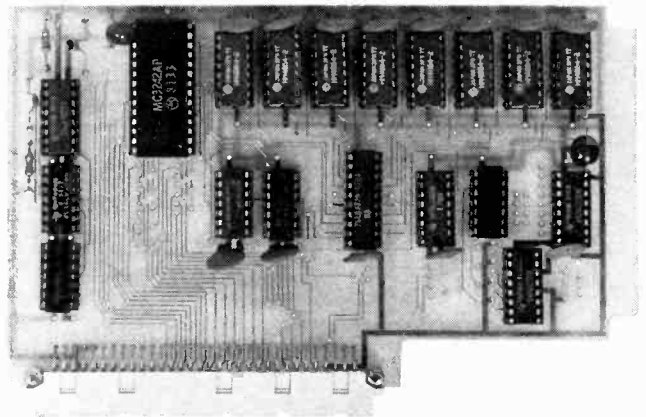
THE LINKS

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 IC15)

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

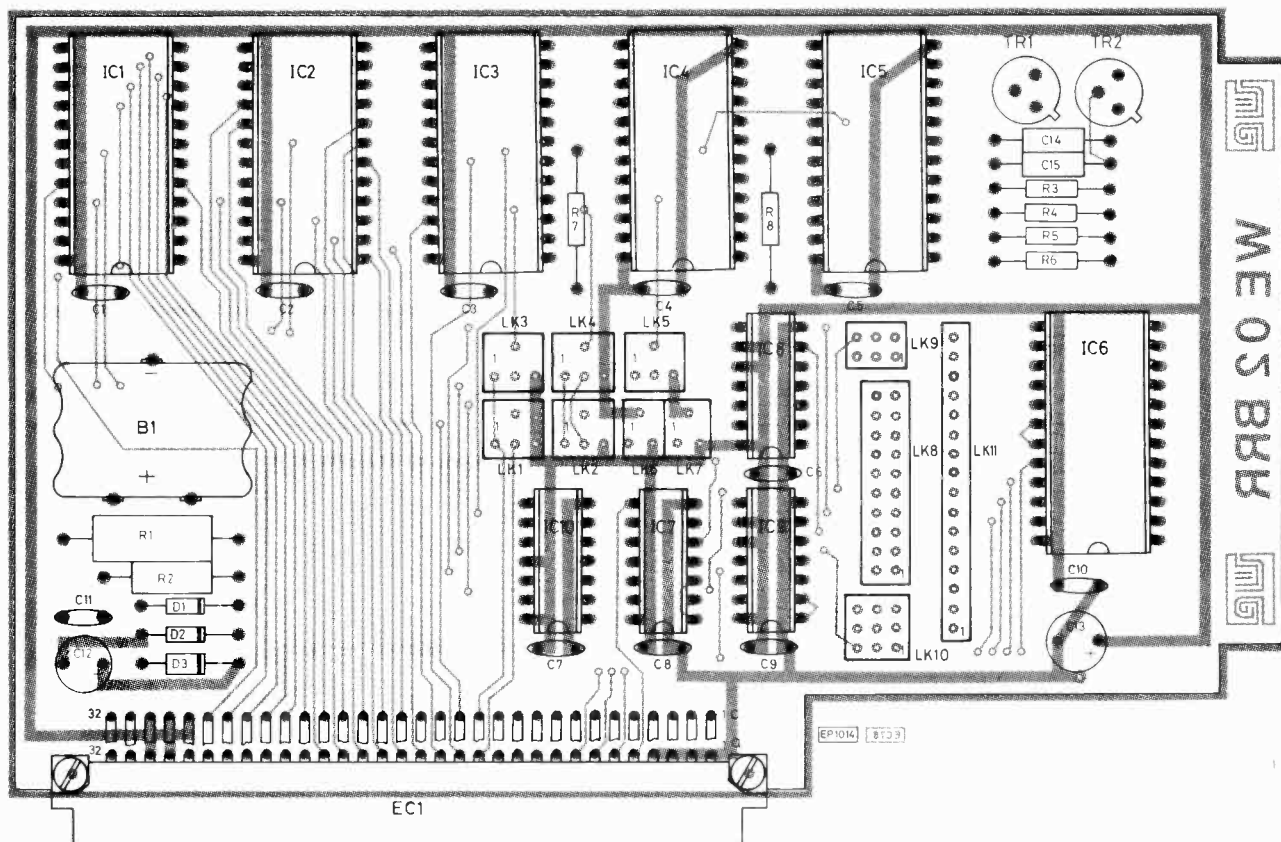


Fig. 2.5. Battery back-up board component layout

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 ½W
R3, R4	330 (2 off)
R5-R8	1k (4 off)

All resistors ¼W 5% unless otherwise stated

Capacitors

C1-C11	100n disc. cer. (11 off)
C12	47µ/6V3 tant.
C13	100µ/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

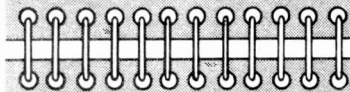
IC1/IC5	EPROM/RAM see text (5 off)
IC6	74LS154
IC7	74LS04
IC8, IC9	74LS32 (2 off)
IC10	74LS30

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 for 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 world-wide 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.

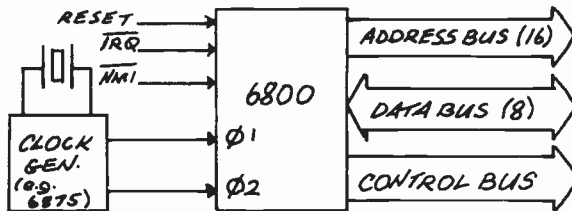
ACCUM A	8	ACC A
ACCUM B	8	ACC B
INDEX REG	16	IX
STACK POINTER	16	SP
PROGRAM CNTR.	16	PC

FLAGS:-

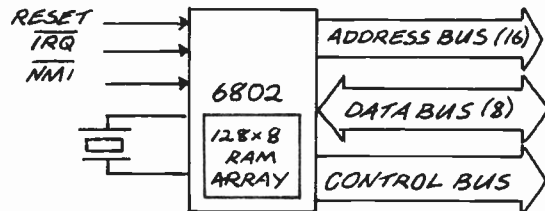
D7	D6	D5	D4	D3	D2	D1	D0
		AUX CARRY	INT	SIGN	ZERO	OVER FLOW	CARRY

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 locations FFFE & 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:-	TRQ	TRQ
	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

Pin	6800	Pin	6802
VSS	1	VSS	1
HALT	2	RESET	2
phi 1	3	TSC	39
TRQ	4	N.C.	MR
VMA	5	phi 2	37
NMI	6	DBE	36
BA	7	N.C.	NMI
VCC	8	R/W	35
A0	9	DO	34
A1	10	D1	33
A2	11	D2	32
A3	12	D3	31
A4	13	D4	30
A5	14	D5	29
A6	15	D6	28
A7	16	D7	27
A8	17	A15	26
A9	18	A14	25
A10	19	A13	24
A11	20	A12	23
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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 2 phi 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	IMPLD	OP	OP	OP	OP		
Compare Index Reg	CPX	BC 3	3 9C 4	2 AC 6	2 EC 5	1	0	1	0	1	0	
Decrement Index Reg	DEX					0	4	1				
Increment Index Reg	INX					0	4	1				
Load Index Reg	LDD	CE 3	3 DE 4	2 EE 6	2 FE 5	3						
Store Index Reg	STD	8E 3	3 9E 4	2 AE 6	2 BE 5	3						
Stack Pointer - Index Reg	TXS					3	5	2	AF 7	2	BF 6	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	IMPLD	OP	OP	OP	OP	
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	BEE	27 4	2								
Branch If Greater Than Zero	BGT	2C 4	2								
Branch If Higher	BHI	2E 4	2								
Branch If Lower Or Same	BLS	2F 4	2								
Branch If Lower Than Zero	BLT	2D 4	2								
Branch If Minus	BMI	28 4	2								
Branch If Not Equal Zero	BNE	26 4	2								
Branch If Overflow Clear	BVC	28 4	2								
Branch If Overflow Set	BVS	29 4	2								
Branch If Plus	BPL	2A 4	2								
Branch To Subroutine	BSR	8D 8	2								
Jump	JMP					6E 4	2	7E 3	3		
Jump To Subroutine	JSR					AD 8	2	BD 9	3		
No Operation	NOP									01 2	1
Return From Interrupt	RTI									38 10	1
Return From Subroutine	RTS									39 5	1
Software Interrupt	SWI									3F 12	1
Wait For Interrupt*	WAI									3E 9	1

*WAI puts Address Bus, RW, and Data Bus in the three state mode while VMA is held low.

- ① (Bit 1) 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.

6800-6802 INSTRUCTION SET

CONDITION CODE REGISTER INSTRUCTIONS

OPERATIONS	MNEMONIC	ADDRESSING MODES				COND. CODE REG.					
		IMMED	DIRECT	INDEX	EXTND	IMPLD	OP	OP	OP	OP	
Clear Carry	CLC					0C 2	1				
Clear Interrupt Mask	CLI					0E 2	1				
Clear Overflow	CLV					DA 2	1				
Set Carry	SEC					DD 2	1				
Set Interrupt Mask	SEI					DF 2	1				
Set Overflow	SEV					0F 2	1				
Accumulator A - CCR	ACMtr A					0B 2	1				
CCR → Accumulator A	CCR → ACMtr A					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	IMPLD	OP	OP	OP	OP	
Add	ADD	98 2	2 98 3	2 AB 5	2 BB 4	3					
Add Accumulators	ABA					18 2	1				
Add with Carry	ADCA	89 2	2 99 3	2 A9 5	2 B9 4	3					
And	AND	84 2	2 94 3	2 A4 5	2 B4 4	3					
Bit Test	BIT	85 2	2 95 3	2 A5 5	2 B5 4	3					
Clear	CLR					4F 2	1				
Compare	CP	81 2	2 91 3	2 A1 5	2 B1 4	3					
Compare Accumulators	CPA					5F 2	1				
Complement 1's	COM					11 2	1				
Complement 2's (Negate)	COMB					43 2	1				
Decimal Adjust, A	DAA					19 2	1				
Decrement	DEC					5A 2	1				
Exclusive OR	EOR	88 2	2 98 3	2 AB 5	2 BB 4	3					
Increment	INC					5A 2	1				
Load Accumulator	LDA	86 2	2 96 3	2 A6 5	2 B6 4	3					
Or, Inclusive	ORA	8A 2	2 9A 3	2 AA 5	2 BA 4	3					
Push Data	PSHD					35 4	1				
Pop Data	PULD					37 4	1				
Rotate Left	ROL					69 7	2	79 6	3		
Rotate Right	ROR					66 7	2	76 6	3		
Shift Left, Arithmetic	ASL					68 7	2	78 6	3		
Shift Right, Arithmetic	ASR					67 7	2	77 6	3		
Shift Right, Logic	LSR					64 7	2	74 6	3		
Store Accumulator	STA	93 4	2 93 5	2 AB 7	2 BB 6	3					
Subtract	SUB	80 2	2 90 3	2 A0 5	2 B0 4	3					
Subtract Accumulators	SBA					10 2	1				
Subtract with Carry	SBCA	82 2	2 92 3	2 A2 5	2 B2 4	3					
Transfer Accumulators	TAB					16 2	1				
Test, Zero or Minus	TST					60 7	2	70 6	3		
	TSTA					4D 2	1				
	TSTB					50 2	1				

CONDITION CODE REGISTER NOTES:

- ① (Bit 1) Test: true if set and cleared otherwise
- ② (Bit C) Test: Result = 10000000?
- ③ (Bit C) Test: Result = 00000000?
- ④ (Bit V) Test: Result = 10000000 prior to execution?
- ⑤ (Bit V) Test: Result = 01111111 prior to execution?
- ⑥ (Bit V) Test: Set equal to result of NOC after shift has occurred

CONDITION CODE SYMBOLS:

- H Half Carry from bit 3.
- I Interrupt mask
- N Negative (sign bit)
- Z Zero (byte)
- V Overflow, 2's complement
- R Carry from bit 7
- S Stack Always
- Not Affected

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

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 $\emptyset 1$ and $\emptyset 2$ clock inputs for obvious reasons. Since the $\emptyset 2$ 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.

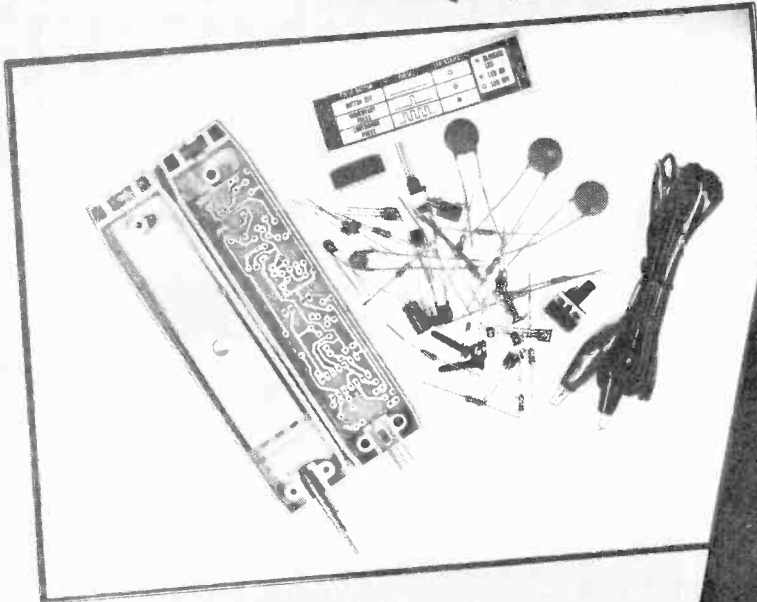
APPLICATIONS

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.

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.

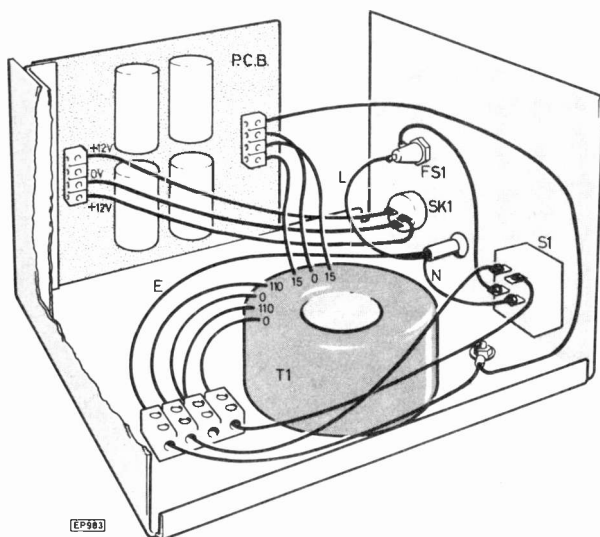


Fig. 3. Wiring diagram for the p.s.u.

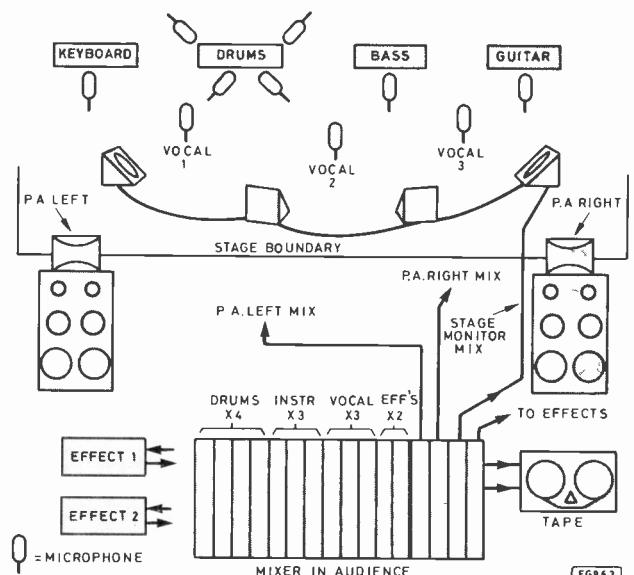


Fig. 4. Live concert mixing

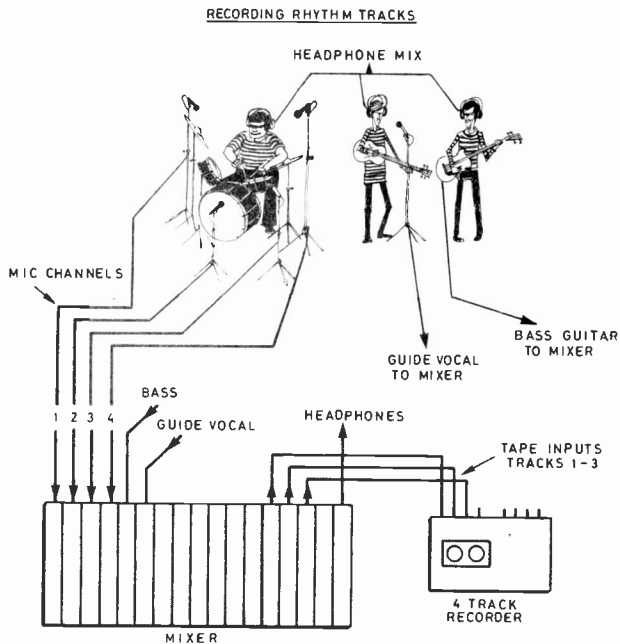


Fig. 5. Recording rhythm tracks

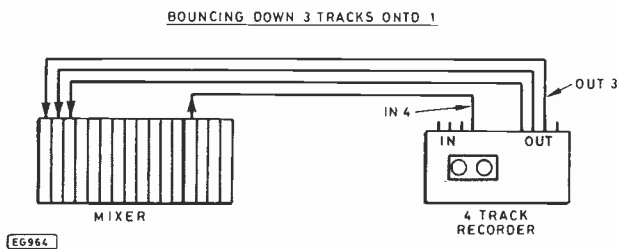


Fig. 6. Bouncing down 3 tracks onto 1

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

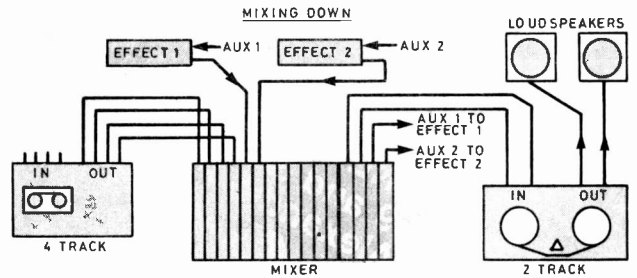


Fig. 7. Mixing down

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. ★

BAZAAR

100 T1L220, 5 ULN2003A, 50 BC108, 50 BC 308, 20 BC170, 50 1N4004. Plus more. £25. Send cheque made payable to A. Hodgson to: G. Hodgson, 2 Marlborough Avenue, High Harrington, Wokington, Cumbria CA14 4NW.

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OLIVETTI TE300 10 CPS terminal with stand. £35 o.n.o. Tel: Wokingham 782461.

WANTED Rockwell/Aim 65 £50, KIM 1 or SYM 1. Also interested in MK14 or Acorn SYS 1. R. Billingham, 35 Morland Road, Croydon, Surrey CR0 6HA. Tel: 01-654 6822.

PE MINISONIC MK2 perfect £125. Transcendant 2000 immaculate £150. Venner professional DFM £15 wanted small television. Hugh Bridge, 175 Crofton Road, Orpington, Kent BR6 8JB. Tel: Farnborough, Kent (0689) 57055.

SEM Sentinel fet 160m converter, 9V, 1F 14MHz £15 inc. i/p. Mr. A. E. Dowdeswell, Silver First, 7a Leatherhead Road, Ashted, Surrey KT21 2TW. Tel: Ashted 72515.

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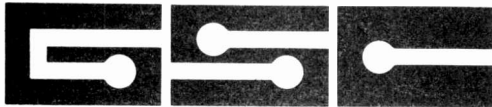
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SEMICONDUCTOR UPDATE

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 childs 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.

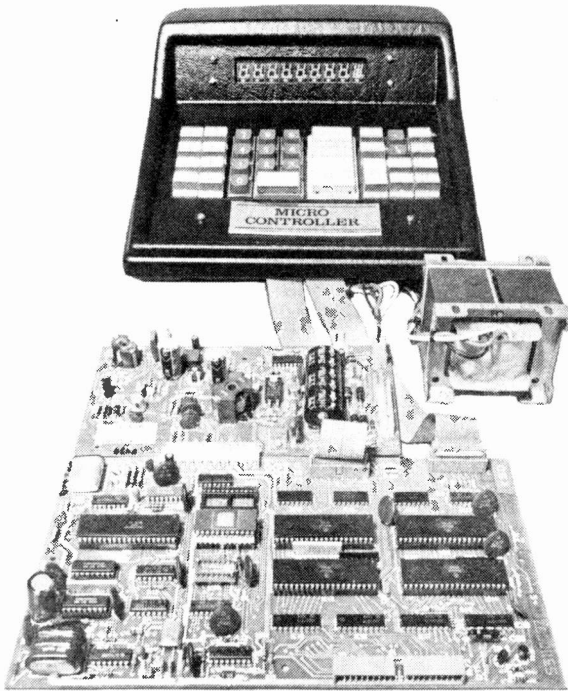
"Micropower" generally means supply currents of a few tens of micro-amps for battery supply applications, and the new PMI device brings precision operation to these areas for the first time. The supply current of the OP-22 can be set externally with a single resistor anywhere between 1 and 400 microamps, 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

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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 Micro-controller 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

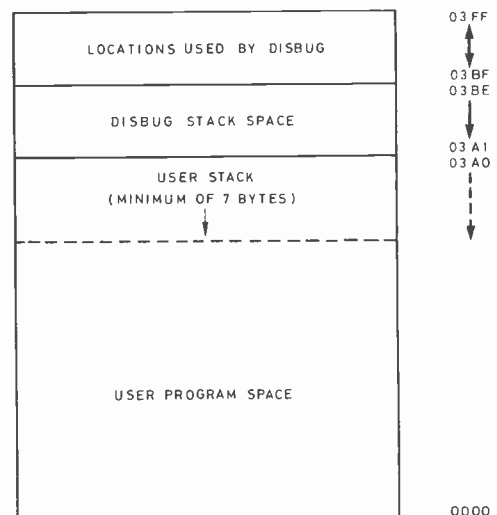
The displays output by DISBUG follow a standard format. The normal prompt used when DISBUG is awaiting a command from the keyboard is "... dIS ...". When an editor key (MEMORY, REGISTER, PRESET or BREAKPOINT) is pressed, the display will change to the form "p-aaaa-dd". The "p" field will contain a prompt 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



EG979

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.

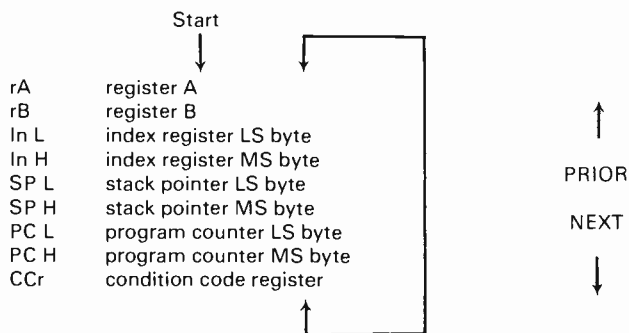
The CANCEL key may be used at any time to abandon an uncompleted memory change and return to the "... DIS ..." prompt. To exit from the memory editor when the "A- -" prompt appears, either the ENTER or CANCEL keys may be used.

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.

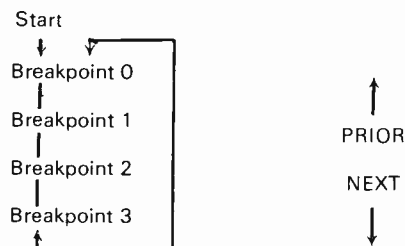
The CANCEL key may be used at any time to exit from the register editor, and this will abandon any change which has not yet been completed.

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, "rStArt". 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:

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

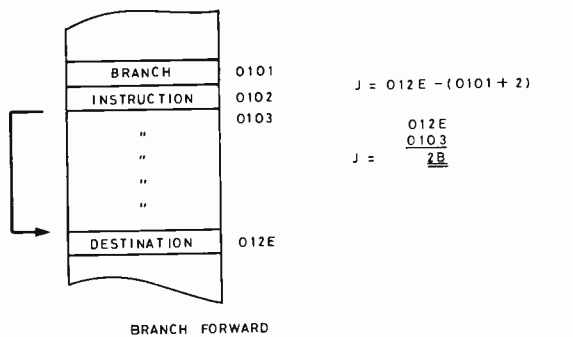
The stack works on a last-in first-out (LIFO) principle and a stack pointer (16 bits) is provided in the CPU to indicate the address of the next free stack location. When data (e.g. a return address) is "pushed" onto the stack, the stack pointer is *decremented* by the number of bytes pushed (e.g. two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

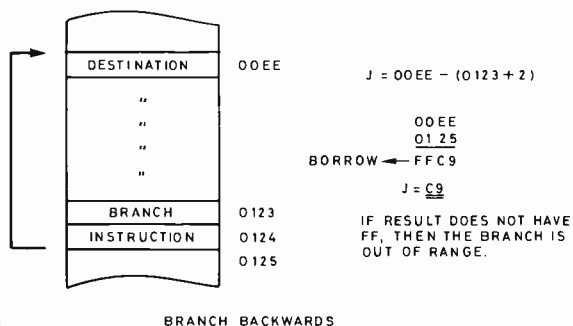
GETTING STARTED

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



EG980



EG981

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	

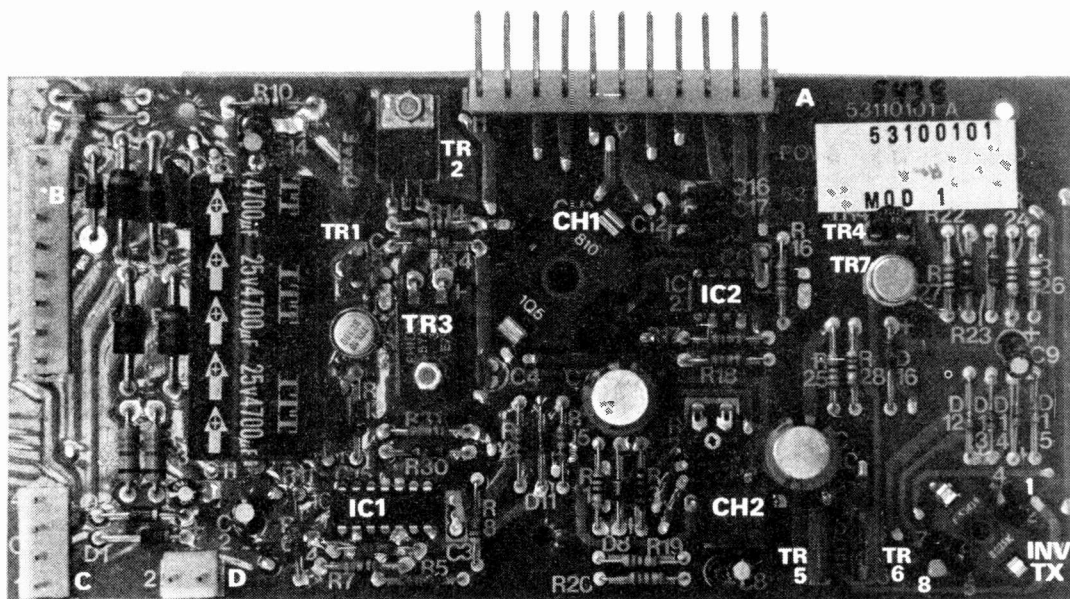
EG983

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:

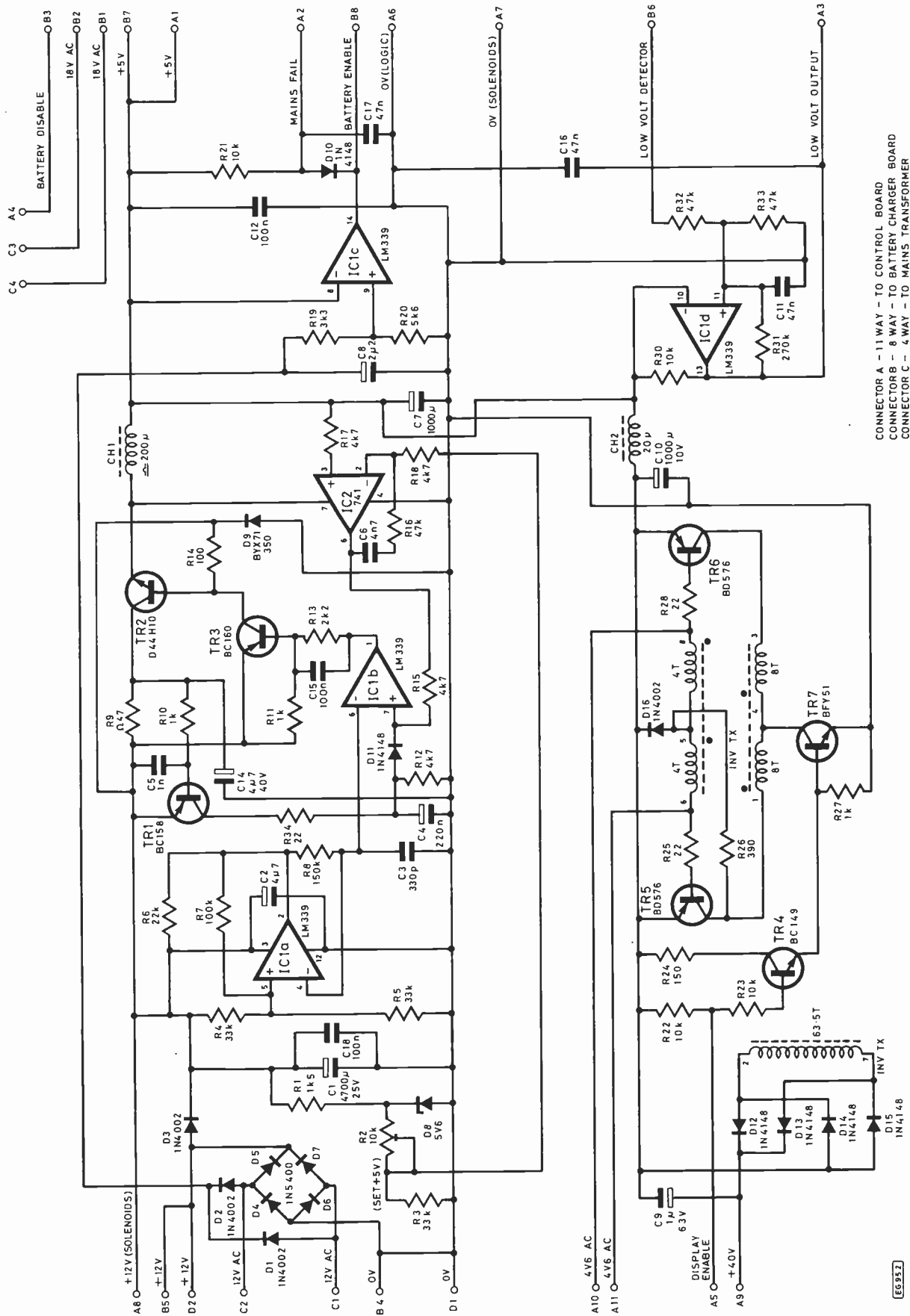
	...DIS...
PROCEED	E-001A-Pr
ENTER	

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

EG952

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.

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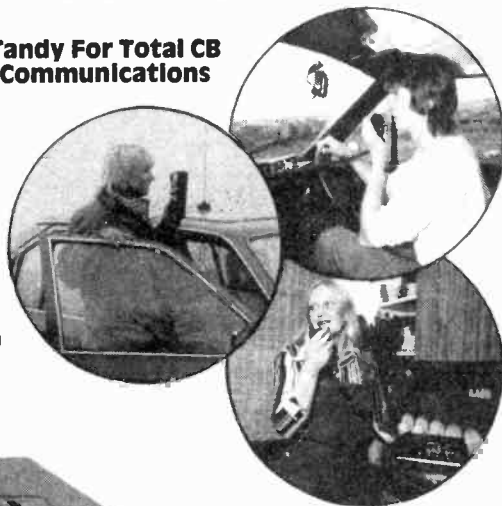
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PIN BULLETINS

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 Electronica, 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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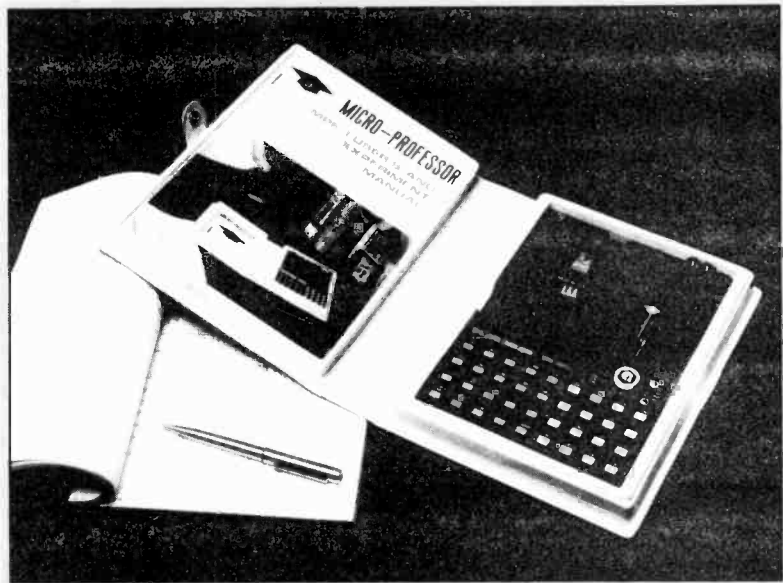
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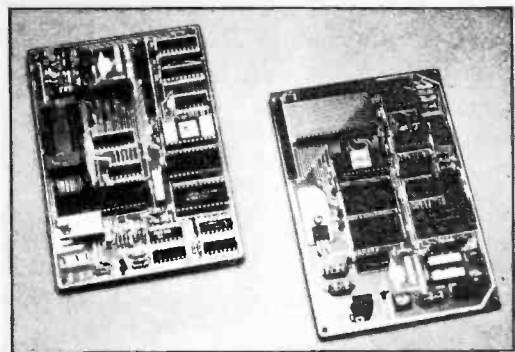
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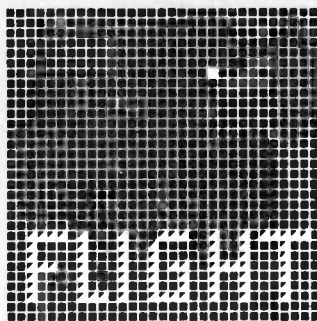
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UNIVERSAL PROBE

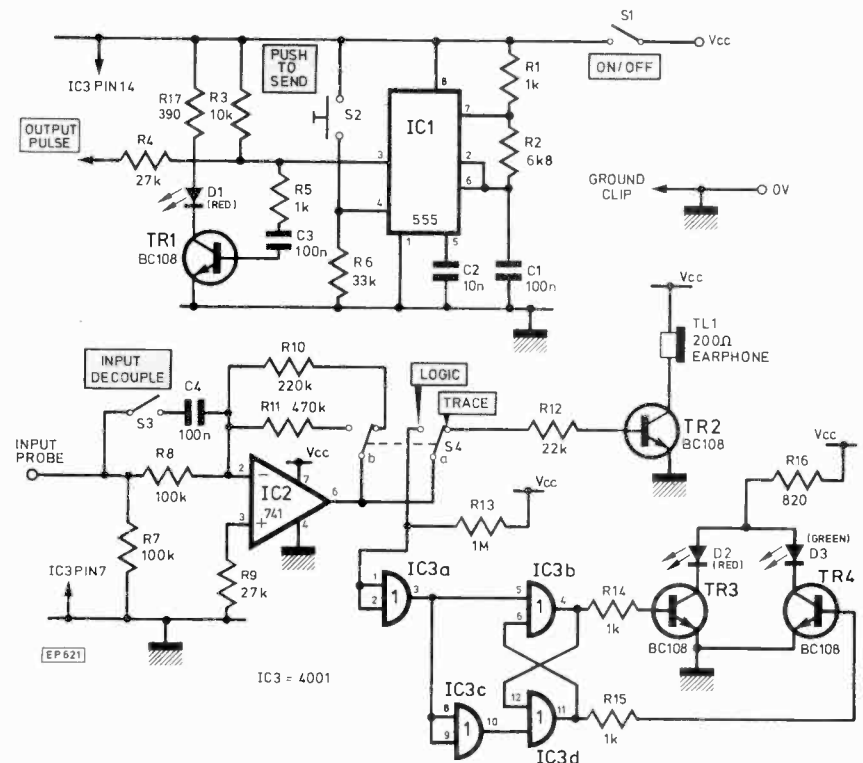
THIS unit consists of a square wave generator with a 27 kilohm output resistance. The frequency of oscillation is about 1 kHz.

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.

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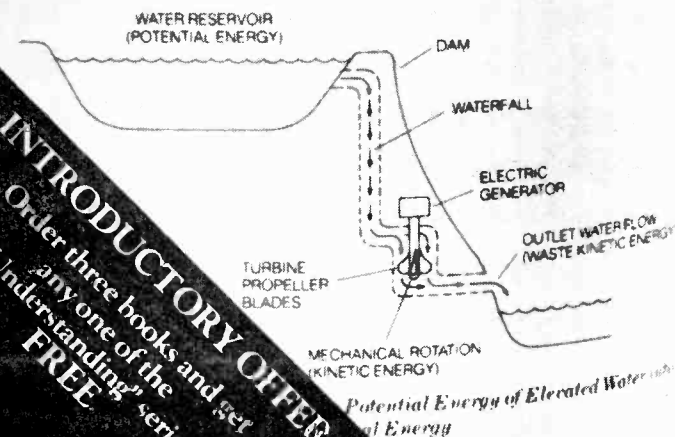
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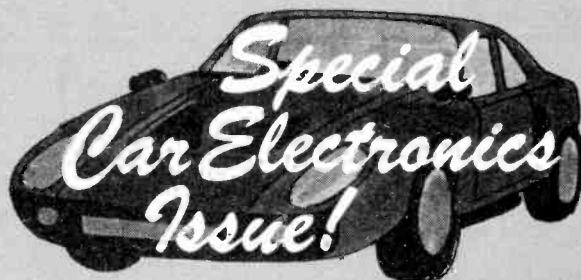
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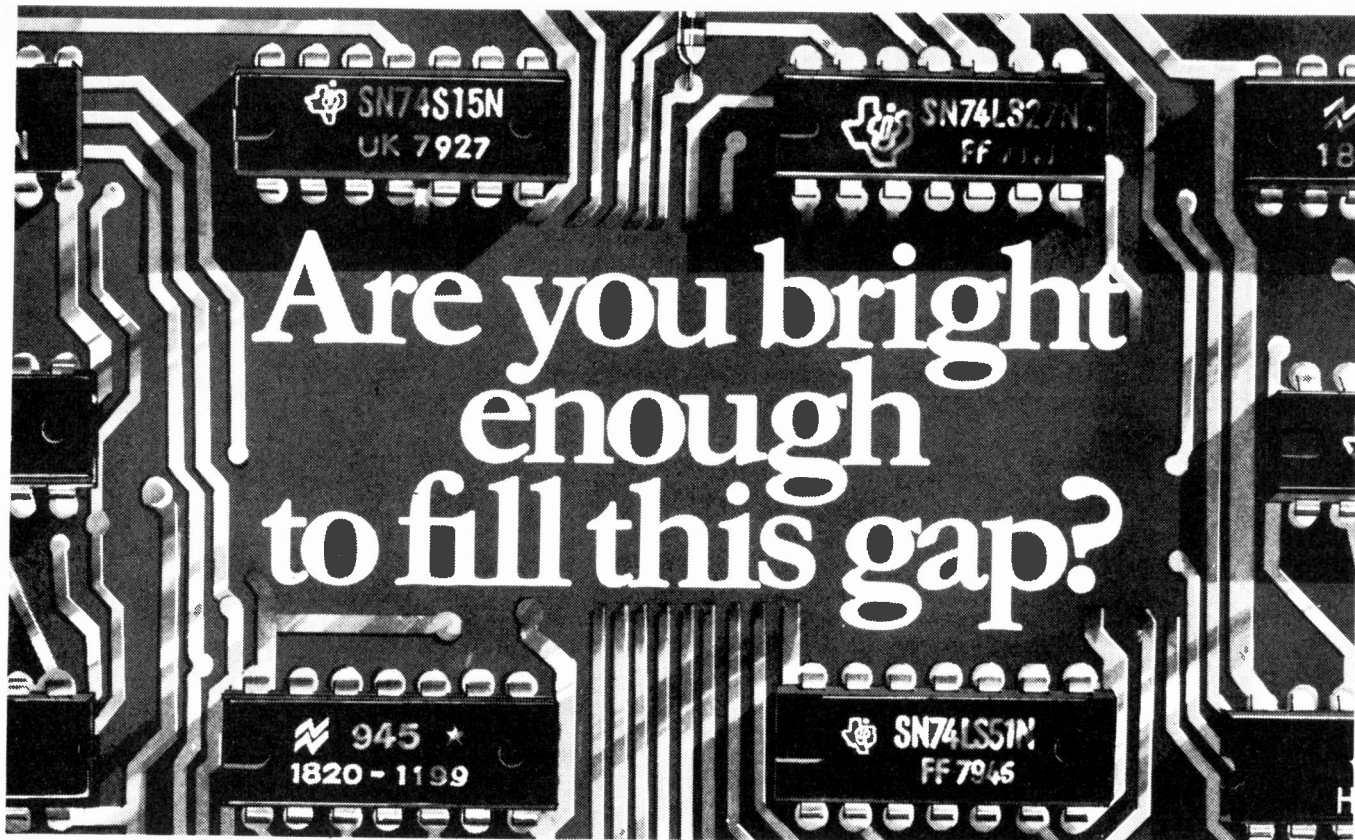
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Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

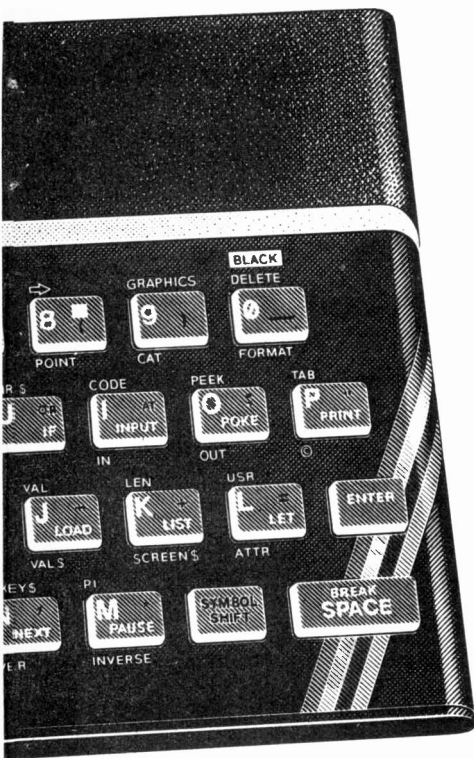
There's no need to stop there. The ZX Printer—available now—is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.



Key features of the Sinclair ZX Spectrum

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- Full-size moving-key keyboard— all keys at normal typewriter pitch, with repeat facility on each key.
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- Sinclair 16K extended BASIC— incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

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The ZX Printer – available now

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A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

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The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.



RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

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How to order your ZX Spectrum

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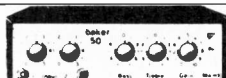
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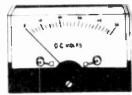


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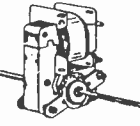
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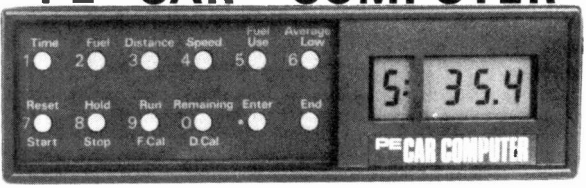
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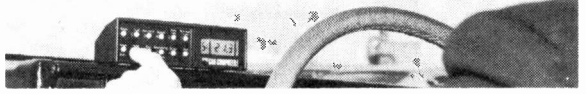
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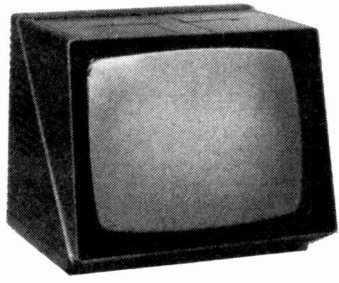
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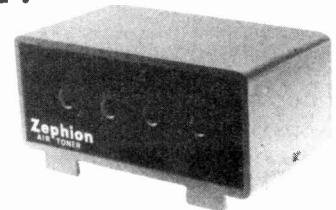
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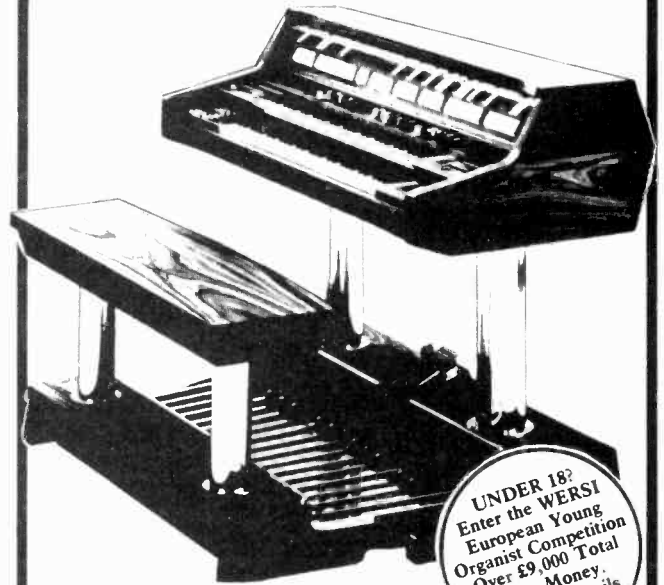
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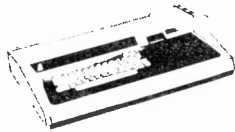


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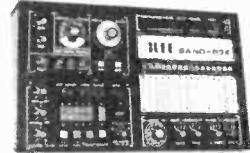
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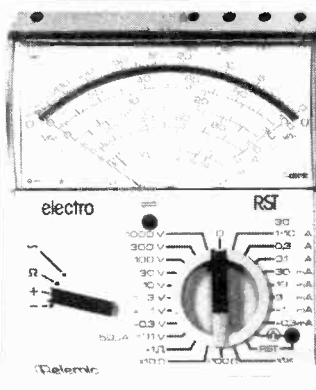
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7438	14p	74LS30	13p	74LS409	100p	4051	60p	ICL7100	TA7222	150p
7439	14p	74LS31	13p	74LS410	100p	4052	60p	ICL7100	TA7222	150p
7440	15p	74LS32	13p	74LS411	100p	4053	50p	ICL7100	TA7222	150p
7441	55p	74LS33	14p	74LS412	100p	4054	50p	ICL7100	TA7222	150p
7442A	30p	74LS34	14p	74LS413	100p	4055	90p	ICL7100	TA7222	150p
7443	50p	74LS35	14p	74LS414	100p	4056	90p	ICL7100	TA7222	150p
7444A	30p	74LS36	14p	74LS415	100p	4057	90p	ICL7100	TA7222	150p
7445	50p	74LS37	14p	74LS416	100p	4058	90p	ICL7100	TA7222	150p
7446A	30p	74LS38	14p	74LS417	100p	4059	90p	ICL7100	TA7222	150p
7447A	30p	74LS39	14p	74LS418	100p	4060	90p	ICL7100	TA7222	150p
7448	45p	74LS40	14p	74LS419	100p	4061	90p	ICL7100	TA7222	150p
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7467	15p	74LS59	14p	74LS438	100p	4080	90p	ICL7100	TA7222	150p
7468	15p	74LS60	14p	74LS439	100p	4081	90p	ICL7100	TA7222	150p
7469	15p	74LS61	14p	74LS440	100p	4082	90p	ICL7100	TA7222	150p
7470	15p	74LS62	14p	74LS441	100p	4083	90p	ICL7100	TA7222	150p
7471	15p	74LS63	14p	74LS442	100p	4084	90p	ICL7100	TA7222	150p
7472	15p	74LS64	14p	74LS443	100p	4085	90p	ICL7100	TA7222	150p
7473	15p	74LS65	14p	74LS444	100p	4086	90p	ICL7100	TA7222	150p
7474	15p	74LS66	14p	74LS445	100p	4087	90p	ICL7100	TA7222	150p
7475	15p	74LS67	14p	74LS446	100p	4088	90p	ICL7100	TA7222	150p
7476	15p	74LS68	14p	74LS447	100p	4089	90p	ICL7100	TA7222	150p
7477	15p	74LS69	14p	74LS448	100p	4090	90p	ICL7100	TA7222	150p
7478	15p	74LS70	14p	74LS449	100p	4091	90p	ICL7100	TA7222	150p
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7482	15p	74LS74	14p	74LS453	100p	4095	90p	ICL7100	TA7222	150p
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7486	15p	74LS78	14p	74LS457	100p	4099	90p	ICL7100	TA7222	150p
7487	15p	74LS79	14p	74LS458	100p	4100	90p	ICL7100	TA7222	150p
7488	15p	74LS80	14p	74LS459	100p	4101	90p	ICL7100	TA7222	150p
7489	170p	74LS107	20p	74LS460	100p	4102	90p	ICL7100	TA7222	150p
7490A	20p	74LS109	27p	74LS461	100p	4103	90p	ICL7100	TA7222	150p
7491	20p	74LS110	27p	74LS462	100p	4104	90p	ICL7100	TA7222	150p
7492A	25p	74LS111	27p	74LS463	100p	4105	90p	ICL7100	TA7222	150p
7493A	25p	74LS112	27p	74LS464	100p	4106	90p	ICL7100	TA7222	150p
7494	25p	74LS113	27p	74LS465	100p	4107	90p	ICL7100	TA7222	150p
7495A	25p	74LS114	27p	74LS466	100p	4108	90p	ICL7100	TA7222	150p
7496	35p	74LS123	34p	74LS467	100p	4109	90p	ICL7100	TA7222	150p
7497	35p	74LS124	34p	74LS468	100p	4110	90p	ICL7100	TA7222	150p
7498	35p	74LS125	34p	74LS469	100p	4111	90p	ICL7100	TA7222	150p
7499	35p	74LS126	34p	74LS470	100p	4112	90p	ICL7100	TA7222	150p
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