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PRACTICAL ELECTRONICS

SEPTEMBER 1982

85p

Waveform Digitiser

MAKE SURE YOU STAY LEGAL!!

SEAT BELT REMINDER

Also...

CB Scanner

PRACTICAL
ELECTRONICS

VOLUME 18 No. 9 SEPTEMBER 1982

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, SEPTEMBER 9th, 1982
(for details of contents see page 35)

SPEAKERS
8Ω. 0 3W. 2": 2 25". 2 5". 3" 80p
0 3W. 2 5". 40Ω: 64Ω or 80Ω 80p

DIODES	
AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CR033	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

Noise Diode Z5J 195

BRIDGE RECTIFIERS (plastic case)	
1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

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

VARICAPS	
MVAM2	165
BA102	30
BB105B	40
BB106	40

SCR's Thyristors	
0 8A-100V	32
1A/100V	60
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC ST2 25

TRIACS	
3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

SOLDERCON PINS
100 70p
500 325p

OPTO ELECTRONICS	
LEDS including Clips	
TIL209 Red 3mm	11
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 2" Red	12
0 2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0 2" Flashing LED Red	55
0 2" Bicolour LEDs Red/Green	65
Green/Yellow	80
0 2" Tricolour LEDs Red/Green/Yellow	85
0 2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90
7 Segment Displays	
TIL321 ·5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
DL747 ·6" C.Cathod.	180
·8" 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

0·5" LIQUID CRYSTAL DISPLAYS	
3½ digit	525
4 digit	650
6 digit	750

BPX25	195
IL74	45
ILD74	99
ILQ74	185
TIL111	75
TIL117	90
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

FERRIC CHLORIDE
1 lb bag Anhydrous 210
195p + 50p p&p

DALO ETCH RESIST
Pen + Spare tip 90p

ALUM. BOXES	
3x2x1"	65
4x2½x2"	85
4x2¾x2½"	103
4x4x2½"	120
5x4x2"	105
5x2½x1½"	90
5x2½x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4½x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

COPPER CLAD BOARDS

	Single-sided	Double-sided
Fibre Glass 6"x6"	90p	110p
6"x12"	150p	195p

SRBP 9 5"x8 5" 95p

VEROBOARDS 0 1"

	Clad	Plain
2½x3¾"	73p	52p
2½x5"	83p	—
3¾x3¾"	83p	—
3¾x5"	95p	79p
3¾x17"	325p	211p
4¾x18"	425p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	118p	
Pin Insertion Tool	162p	

'VQ' Board	150
'DIP' Board	330
Vero Strip	144
S100 Board	£14

PROTO-DECs	
Veroblock	375
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 310p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

SPECIAL OFFER

	1+	25+
2114L-3	80p	75p
2114L-2	80p	75p
2532	365p	335p
2716	215p	205p
2732	380p	355p
4116	70p	65p
4816-120ns	225p	205p
6116-150ns	390p	370p
6520/21	115p	105p
6522	320p	295p
6820/6821	115p	105p

EPSON MX100FT Printer £489

EPSON 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. **£335**
- **MX100** 15½" Fr.&Tr. **£489**

ANTEX Soldering Irons

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

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GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS (TEXAS)

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

ZIF DIL SOCKET

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

DIL PLUGS (Headers)

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

RIBBON CABLE (price per foot)

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 way	15 way	25 way	37 way
PLUGS				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	395p
Strait	170p	160p	220p	310p
SOCKETS				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	95p	90p	100p	110p

Amphenol Plugs
24 way IEEE 575p
36 way Centronics Parallel 550p

EDGE CONNECTORS Two rows

	·1	·156
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	210p	—
2x25 way	225p	220p
2x28 way	235p	—
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

WATFORD'S Ultimate Monitor IC.

A 4K Monitor Chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £12.00 + 50p P&P

IDC CONNECTORS (Speed block type)

	PCB PLUG with latch Strt. Pins	PCB PLUG Angle Pins	Female Header Socket	PCB Pins Male Strt	PCB Pins Male Angle
2 x 5 way	90p	99p	85p	60p	65p
2 x 8 way	130p	150p	110p	70p	78p
2 x 10 way	145p	166p	125p	80p	92p
2 x 13 way	175p	200p	150p	95p	110p
2 x 17 way	205p	236p	169p	110p	135p
2 x 20 way	220p	250p	190p	125p	150p
2 x 25 way	235p	270p	200p	150p	175p

EURO CONNECTORS

		SOCKETS Strt.	SOCKETS Angle	PLUGS Strt.	PLUGS Angle
DIN41617	31 way	180p	—	—	185p
DIN41612	2 x 32 way	300p	345p	235p	295p
DIN41612	2(3) x 32 way	350p	355p	250p	350p
DIN41612	3 x 32 way	375p	380p	260p	370p

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-·5A; 2x9V-·4A; 2x12V-0·3A; 2x15V-·25A 220p
12VA: 2x4V5-1·3A; 2x6V-1·2A; 2x12V-·5A; 2x15V-·4A 295p
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 (44p p&p)
50VA: 2x6V-4A; 2x9V-2·5A; 2x12V-2A; 2x15V-1·5A. 2x20V-1·2A; 2x25V-2A; 2x30V-0·8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2·5A; 2x30V-1·5A; 2x40V-1·25A; 2x50V-1A 920p (60p p&p)

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

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

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

COMPUTER CORNER

- **EPSON MX** Series Printers. Full range available. See box above for details.
- **SEIKOSHA GP100A** – Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 10" Tractor feed. Parallel Interface standard. **£185**
- **SOFTY-2.** The complete microprocessor development system for Engineers & Beginners. New powerful instruction. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested & enclosed in a black ABS case. Price including plug-in PSU & Watford's extended warranty. **£169**
- **MENTA New Z80 Development System.** Plugs directly into TV & Cassette recorder. 40 Key direct ASSEMBLER/EDITOR. 24 Bit of I/O. Ideal for Study, Microcontrol Robotics. TV lead & PSU included. **£115**
- **ZENITH 12" Green Screen MONITOR** **£85**
- **VIDEO MONITOR** 9" fully cased. B&W. Fully guaranteed. 15MHz bandwidth value for money. **£75**
- **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**
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- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£29**
- **Space Invaders** for Superboard **£6**
- **Full ASC11** coded keyboard type '756' **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Cassettes** in Library Cases **40p**
- **STACK-PACK** Drawers rack including 10 x C12 Computer grade Cassettes. **550p**
- **8½" Fan fold paper** (500 sheets) (no VAT) **£5**
- **9½" Fan fold paper** (500 sheets) (no VAT) **£5**
- **Teleprinter Roll** (no VAT) **£3.50**

(P&P on most 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	
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p		7915	220p
18V	7818	150p			—
1A	T0220 Plastic Casing				
5V	7805	40p		7905	45p
12V	7812	40p		7912	45p
15V	7815	40p		7915	45p
18V	7818	40p		7918	45p
24V	7824	40p			
100mA	T092 Plastic Casing				
5V	78L05	30p		79L05	60p
6V	78L62	30p			—
8V	78L82	30p			—
12V	78L12	30p		79L12	60p
15V	78L15	30p		79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	350
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
79HG –2.25V to –24V 5A	785	LM337T	175
		LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40
4 pole c/over	240

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

PUSH BUTTON Spring loaded
Latching or Momentary 6A

SPDT c/over	99
DPDT c/over	145

SUB-MIN TOGGLE

SP changeover	60
SPST on off	54
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	75
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
3 pole c/over	205

MINIATURE Non Locking

Push to make	15p
Push break	25p

ROCKER: 5A, 250V, SPST 28p
ROCKER: (white) 10A 250V SPDT 38p
ROCKER: With neon lights red when on 10A 250V. DPST 85p
ROCKER: (White) 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: 6 pole/2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 8p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way 2p/2 to 6 way, 3 pole/2 to 4 way. 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 58p
DIL SWITCHES: (SPST) 4 way 85p; 6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p.

CRYSTALS	
32·768KHz	100
100KHz	350
200KHz	295
455KHz	370
1MHz	295
1·008M	275
1·28MHz	392
1·6MHz	395
1·8MHz	395
1·8432M	200
2·0MHz	225
2·4576M	220
3·2768M	150
3·57954M	98
3·6864M	300
4·0MHz	150
4·032MHz	290
4·80MHz	200
4·194304M	200
4·433619M	120
5·0MHz	160
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	225
6·5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
9·00MHz	200
9·375MHz	350
10·0MHz	175
10·7MHz	150
10·24MHz	200
12·0MHz	290
12·528MHz	300
14·31818M	170
16·0MHz	250
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	325
24·0MHz	170
24·930MHz	325
26·69M	150
26·670MHz	325
27·125MHz	295
27·648M	330
27·145M	190
38·66667M	175
48·0MHz	175
100·0MHz	375
116·0MHz	300

ASTEC UHF Modulators
6MHz 280
8MHz Wide bandwidth 425

ZX81 16K RAM PACK

Watford's 16K RAM pack for ZX81. Fully built and tested. Plugs straight on to your ZX81.
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- Complete range of connectors now available

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- TEAC Single FD-50E 80 track cased with PSU **£238**
- SIEMENS FDD 100-5 Cased, Head, Motors, track zero micro switch & motor control PCB with read, write & control electronics plus cable **£215**
- Apple II Interface Card for above. **£29**

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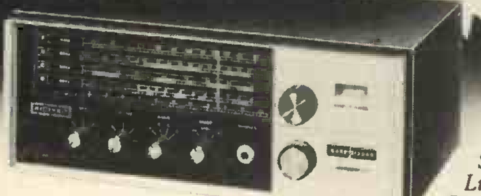
Beginners' luck

30% OFF
10 selected kits for first-time builders



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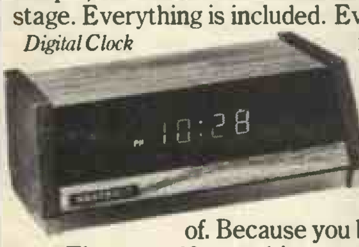

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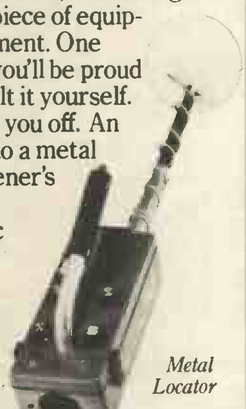
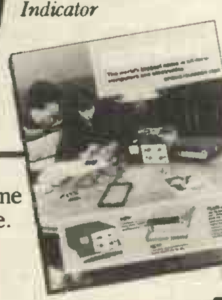


Metal Locator

Windspeed and Direction Indicator

To Heath Electronics (UK) Limited, Dept (PE10), Bristol Road, Gloucester GL2 6EE.



PE10

To start me off, please send me a copy of the Heathkit catalogue.
I enclose 28p in stamps.

Name ____________________

Address ____________________

____

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TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
30 VA 70 × 30mm 0 45Kg Regulation 18%	1x010	6+6	2 50	**£5.12** + p/p £1 04 + VAT £0 92 TOTAL £7 08
	1x011	9+9	1 66	
	1x012	12+12	1 25	
	1x013	15+15	1 00	
	1x014	18+18	0 83	
	1x015	22+22	0 68	
	1x016	25+25	0 60	
	1x017	30+30	0 50	
50 VA 80 × 35mm 0 9 Kg Regulation 13%	2x010	6+6	4 16	**£5.70** + p/p £1 30 + VAT £1 05 TOTAL £8 05
	2x011	9+9	2 77	
	2x012	12+12	2 08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1 13	
	2x016	25+25	1.00	
	2x017	30+30	0 83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA 90 × 30mm 1 Kg Regulation 12%	3x010	6+6	6.64	**£6.08** + p/p £1 87 + VAT £1 16 TOTAL £8 91
	3x011	9+9	4 44	
	3x012	12+12	3 33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1 81	
	3x016	25+25	1 60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0.33	
120 VA 90 × 40mm 1 2 Kg Regulation 11%	4x010	6+6	10.00	**£6.90** + p/p £1 67 + VAT £1 29 TOTAL £9 86
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 110 × 40mm 1 8 Kg Regulation 8%	5x011	9+9	8.89	**£7.91** + p/p £1 67 + VAT £1 44 TOTAL £11 02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3 63	
	5x016	25+25	3 20	
	5x017	30+30	2.66	
	5x018	35+35	2 28	
	5x026	40+40	2 00	
	5x028	110	1.45	
	5x029	220	0 72	
	5x030	240	0 66	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
225 VA 110 × 45mm 2.2 Kg Regulation 7%	6x012	12+12	9.38	**£9.20** + p/p £2 00 + VAT £1 68 TOTAL £12 88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110 × 50mm 2.6 Kg Regulation 6%	7x013	15+15	10.00	**£10.17** + p/p £2 00 + VAT £1 83 TOTAL £14 00
	7x014	18+18	8 33	
	7x015	22+22	6 82	
	7x016	25+25	6 00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140 × 60mm 4 Kg Regulation 4%	8x016	25+25	10 00	**£13.53** + p/p £2 35 + VAT £2 38 TOTAL £18 26
	8x017	30+30	8 33	
	8x018	35+35	7 14	
	8x026	40+40	6 25	
	8x025	45+45	5 55	
	8x033	50+50	5 00	
	8x042	55+55	4 54	
	8x028	110	4 54	
	8x029	220	2 27	
	8x030	240	2 08	
625 VA 140 × 75mm 5 Kg Regulation 4%	9x017	30+30	10 41	**£16.13** + p/p £2 50 + VAT £2 79 TOTAL £21 42
	9x018	35+35	8 92	
	9x026	40+40	7 81	
	9x025	45+45	6 94	
	9x033	50+50	6 25	
	9x042	55+55	5 68	
	9x028	110	5 68	
	9x029	220	2 84	
	9x030	240	2 60	

IMPORTANT: Regulation – All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows:

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For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.

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

FEATURES INCLUDE:-

- 0.5" LED 12 hour display.
- Day of week, am/pm and output status indicators.
- 4 zero voltage switched mains outputs.
- 50/60Hz mains operation.
- Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
- 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.

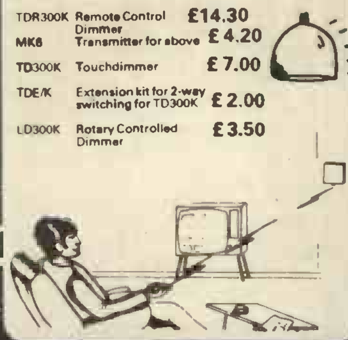
(Kit includes all components, PCB, assembly and programming instructions).

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

HOME LIGHTING KITS

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

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50



MINI KITS

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. 1KW £4.00

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac £2.60

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4.50

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the SL441 zero voltage switch, this kit may be wired to form a "burst fire" power controller, enabling the temperature of an enclosure to be maintained to within 0.5°C. Max. load 3KW £5.56

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max load 1KW. £4.50

♪ 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.
Order as XK102. **£5.00**

For a detailed booklet on remote control – send us 30p & SAE today.

THE 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 pre-drilled box for the transmitter.

Order as XK112

£42.00

DISCO LIGHTING KITS

DL 1000K
This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **Only £14.60**

DLZ1000K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1 Allowing audio ("beat") —light response. **60p**

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.
The kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

Only £23.75

Extra Solid State Switch Kits (XK104) and transmitters (XK105) can be supplied.

XK104 £2.40 **XK105 £10.50**

ALL PRICES EXCLUDE VAT

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (–50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week. **£15.50**

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 (RC500K –Special Price for MK6 and MK7 together £12.50)

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery. 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 was 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 DP3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. £9.50

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

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

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

We have the SOFTY 2 EPROM programmer in stock at £169

THE KEY TO YOUR SECURITY IS IN OUR LOCK

If the thought of car thieves, house breakers or people tampering with your electrical and electronic equipment upsets you, we have just tne kit for you.
Our ELECTRONIC LOCK KIT includesa 10-way keyboard and a special IC which provides a 750mA output to drive a solenoid or relay (not supplied) when four keys are depressed in the correct sequence. This gives over 5,000 possible combinations! The sequence is prewired and may be easily changed by means of a small plug and socket. A "SAVE" function is also available enabling the open code to be stored (especially useful in a car when it is left in a garage for servicing as the open code need not be disclosed). Size: 7x6x3 cms. Power Consumption is 40uA at 5V to 15V d.c.

At only **£10.50 + VAT.** It will make a smaller hole in your pocket than a bunch of keys!

Electric Lock Mechanism
Suitable for use with existing door locks and above electronic lock kit. **£13.50**

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)	£17.40
(Ready Built)	£22.50

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

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A.C. Amp., 0-1A, 0-5A, 10A.
A.C. Volt. 0-300V.
D.C. Amp., Type 65C5. 5A, 0-10A, 0-50A, 0-100A.
D.C. Volt. 15V, 30V.
All types £3.60 ea. + P. & P. 75p (£5.00 inc. VAT), except 0-50A, 0-100A. D.C. price £5.00 + 75p. P. & P. (£6.61 incl. VAT).

HEAVY DUTY SOLENOID, mf. by Magnetic Devices. 240V. A.C. Intermittent operation. Approx. 20 lb. pull at 1.25 in. Ex-equip. Tested. Price: £5.95 P. & P. £1.50. (£8.57 incl. VAT). R.&T.

240V AC SOLENOID. Approx: 10lb pull. 10% rating. Size 80x33x26mm. Price £1.75 + P. & P. 54p (£2.63 incl. VAT & P.)

12V D.C. SOLENOID. Price: £1.50 + P. & P. 40p. (£2.18 Incl. VAT). N.M.S.

WESTOOL SERIES D6 Model A3 24V. D.C. Price £1.50 + 50p p. & p. (Total incl. VAT £2.30).

WESTOOL SERIES D4 Model A. 24V. D.C. Price £1.00 + 30p p. & p. (Total incl. VAT £1.50). N.M.S.

AG/GT 24V. D.C. 70 ohm Coil Solenoid. Push or Pull. Adjustable travel to 3/16 in. Fitted with mounting brackets and spark suppressor. Size: 100 x 65 x 25 mm. Price: 3 for £2.85 P. & P. 50p. (min 3 off.) (£3.85 incl. VAT). N.M.S.

MINIATURE SOLENOID FLUID VALVE

12V D.C. 15 ohm coil normally closed. Stainless steel body with variable flow adjuster 1/8" B.S.T. inlet and outlet.
Size: 58x27x25mm. Weight: 130 gr.
Price: £2.60 + 35p. P. & P. (Total incl. VAT £3.39).

230V A.C. SOLENOID OPERATED FLUID VALVE.

Media: Air, Gas, 7 psi. Water 5 psi. 3/8" inlet/outlet. Forged brass body. Normally closed. Manuf. by Durance Asco. Price: £5.50 + £1.00 p. & p. (Total incl. VAT – £7.48).

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Input 230V ac. Fully isolated output 10mm spark. Approx. 15Kv. Built in 10 sec. Timer. Easily modified for 20 sec, 30 sec, to a continuous operation.
Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg. supplying neon or argon tubes etc.
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Type LS6/L11. Coil 240V 50 Rs. Contacts – 3 make: 600V: 20amp. 1 break: 600V: 20amp. Price: £5.75 P. & P. 75p. (£7.47 incl. VAT). N.M.S.

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230V AC coil 2 c/o 25amp contacts £5.50 P. & P. 75p total £7.19.

ARROW-HART MAINS CONTACTOR

Cat. No. 130A30. Coil 250V or 500V. AC Contacts 3 make 50 amp up to 600V. AC 20 hp at 440V. 3 phase. 50 Hz. Price: £7.75 + p&p £1.00 (total incl. VAT £10.06).

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Type FF8. 1706. Small, quiet, smooth running. 240V. A.C. operation. Output aperture 45×40mm. Overall size 135×165mm. Flange mounting. Price: £4.75. P. & P. £1.00 (£6.61 incl. VAT). Other types available. S.A.E. for details. N.M.S.

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Sub. Min. Honeywell Lever m/s type 3115m 906ft. 10 for £3.50 post paid (£4.03 incl. VAT). These V3 types.
Button type 10 for £3.00 (£3.45 Incl. VAT).
Short Lever type 16amp. rating (Crouzet) 10 for £4.00 (£4.60 incl VAT).
Long Lever 10 amp C.O. 10 for £4.50 (£5.18 incl. VAT).
Cherry E51 Rotary action low torque microswitch 5 amp contact £3.50. (£4.03 incl. VAT). N.M.S.
D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for £3.00 P. & P. 50p. (£4.02 Incl. VAT). (min. order 10). N.M.S.

A.C. Wkg. TUBULAR CAPACITORS.

Fraction of makers price. Motor start etc.

1.5 mfd.	440V.A.C.	60p	5 mfd.	400V.A.C.	£1.25
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2.2 mfd.	440V.A.C.	75p	7.5 mfd.	200V.A.C.	£1.00
3 mfd.	440V.A.C.	£1.00	15 mfd.	440V.A.C.	£2.50
4.1 mfd.	440V.A.C.	£1.00			

P. & P. up to 2.5 mfd. 25p. 3 mfd. to 20 mfd. 50p. All plus VAT.
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24 volt. D.C. BLOWER UNIT

Precision 24 volt. D.C. 0-8 amp Blower that works well on 12V 0.4 amp D.C. Producing 30 cu. ft. min at normal air pressure. £4.50 P. & P. 75p. (Incl. VAT £6.04). N.M.S.

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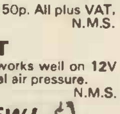

Test to I.E.E. Spec. Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb. 500V. 500mohm, £49.00 + £2.00 p&p (total incl. VAT £58.65). 1000V 1000MΩ. £55 P. & P. £2.00. (£65.55 incl. VAT). S.A.E. for leaflet.

Yet another outstanding offer.

IMFD 600V Dubilier wire ended capacitors, 10 for £1.50 P. & P. 50p. (£2.30 incl. VAT). (Min. 10) N.M.S.

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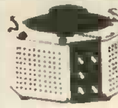
INPUT 230/240V a.c. 50/60 OUTPUT 0-260V



200 watt (1 amp inc. a.c. voltmenter	£15.00
0.5 KVA (2½ amp MAX)	£19.00
.1 KVA (5 amp MAX)	£25.00
.2 KVA (10 amp MAX)	£41.00
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.5 KVA (25 amp MAX)	£79.00
10 KVA (50 amp MAX)	£174.00
15 KVA (75 amp MAX)	£270.00

3-PHASE VARIABLE VOLTAGE TRANSFORMERS

Dual Input 200-240V, or 380-415V. Star connected.

3KVA 5 amp per phase max.	£108.00	Carriage, packing & VAT extra.
6KVA 10 amp per phase max.	£162.00	
10KVA 16 amp per phase max.	£329.00	

LT TRANSFORMERS

Phone for enquiries or send sae for leaflet.

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220/240V. Primary; secondary 24V @ 4A. LT. Transformer, fully shrouded. Price: £4.50 + £1 p. & p. (£6.38 incl. VAT).

INDUSTRIAL STROBE KIT

Suitable for both Industrial and Educational purposes. Kit when assembled produces a variable speed 1 to approx. 70 flash per second. Light output approx. 0.5 joules. Price, less cae, £27.00 + £2.00 P. & P. (total incl. VAT £33.36). **Super Hy-Light Strobe** (approx. 16 joules), Price £40
P. & P. £2.00 (£48.31 incl. VAT).
Suitable cases for either type £11.00 P. & P. £2.00 (£14.95 Incl. VAT). Super Hy Light Strobe Kit, details on receipt of foolscap sae.

XENON FLASHGUN TUBES

Range available from stock. S.A.E. for details.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft. 40 Watt £8.70 incl. VAT £10.00 (callers only).
2ft. 20 Watt £6.20 P & P £1.25 (£8.57 incl. VAT).
(For use in stan bi-pin fittings).
12in. 8 Watt £3.00 P. & P. 45p (£3.97 incl. VAT).
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Complete ballast unit for either 6", 9" or 12" tube 230V AC op £5.50 P. & P. 55p (£6.96 incl. VAT). Also available for 12V DC op £5.50 P. & P. 55p (£6.96 incl. VAT).

BLACK LIGHT BULBS

Self-ballasted Mercury U.V. 175W Bulbs, available for either B.C. or E.S. fitting. Price incl. p&p & VAT £11.50.
400W U.V. lamp and ballast complete. Price £38.00 + £3.50 p&p (total incl. VAT £47.73). 400 Watt U.V. lamp only, price £14.00 + £2.00 p&p (total incl. VAT £18.40).
Black Light U.V. Tubes from 6in to 4ft from stock. Foolscap s.a.e. for details.

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Why waste money? Build your own EPROM ERASURE for the fraction of the price of a made-up Unit. Complete Kit of parts less case to include 12" 8 watt 2537 Angst Tube, Ballast Unit, pair of bi-pin leads, Neon Indicator, Safety Microswitch, on/off Switch, and Circuit. LESS CASE. Price: £13.60 + 75p P&P (Total inc. VAT £16.50).
WARNING: Tube used in this circuit is highly dangerous to the eyes. Unit MUST be fitted in suitable case.

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, embedded winding heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/250/500/1kΩ/1.5kΩ. £3.10 P. & P. 30p, (£3.91 incl. VAT).
50 WATT 250Ω £5.50 P. P. 50p (£6.90 incl. VAT).
100 WATT 1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ/£7.20 P. & P. 75p (£9.20 incl. VAT).
Black, Silver, Skirted knob calibrated in Nos. 1-9 1½in. dia. brass bush. Ideal for above Rheostats 24p each + VAT.

RELAYS

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

230/240V A.C. 3 c/o. 11 pin base. Sealed 5 amp contacts £1.35 plus P. & P. 30p (£1.90 incl. VAT).
KMKI Relay. 230V. A.C. 1 c/o open type 10 amp contact, mf. by "Keyswitch" 80p P. & P. 25p (£1.21 incl. VAT). 5 for £3.75 postpaid (£4.32 incl. VAT).
24V A.C. Sealed 3 c/o. 10a. 11-pin. £1.50 + 25p P. & P. (£2.01 incl. VAT).
24V D.C. Sealed 3 c/o. 7a. 11-pin. £1.35 + 30p P. & P. (£1.90 incl. VAT).
24V D.C. 2 c/o. 7 amp contacts. Sealed, octal base. £1.30 P. & P. 30p (£1.84 incl. VAT).

VERY SPECIAL OFFER 0-12V DC. 2 make contacts. NEW. 3 for £1.75 + 25p P. & P. (£2.30 incl. VAT).

D.C. Relays: Sealed 12V 1 c/o 7 amp octal base £1.00 P. & P. 30p (£1.50 incl. VAT). Sealed 12V 3 c/o 7 amp 11-pin £1.35 P. & P. 30p (£1.90 incl. VAT). 24V. Sealed 3 c/o 7 amp 11-pin £1.35 P. & P. 30p (£1.90 incl. VAT).

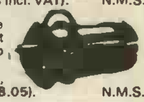
GEARED MOTORS

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

71rpm WYNSCALE motor approx. 10lb inch.
A.C. supplied with auto transformer 240V.
A.C. operation. £9.75 P. & P. £1.50 (£12.94 incl. VAT). N.M.S.

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

42 R.P.M. 110 A.C. 50hz. 100lb incl. reversible will operate on 230 A.C. Speed remains at 42 R.P.M. but torque reduces by 50%. Price £16.50 P. & P. £2.50 (£21.28 incl. VAT). N.M.S.



38.3 rpm GEARED MOTOR, torque 35 lb. in reversible. 115V A.C., inc. start capacitor. Price: £10.50 + £2.00 p&p (total incl. VAT, £14.38).
Suitable Transformer 230V A.C. operation, Price: £6.50 + 50p p&p (total incl. VAT £8.05). N.M.S.

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

200 rpm. 35lbs. In. 115V. 50kH.
Price: £16.50 P. & P. £2.00 (£21.28 incl. VAT). N.M.S.
Suitable Transformer for 230/240V. a.c.
Price: £6.00 P. & P. £1.50 (£8.62 incl. VAT). N.M.S.

230/240V A.C. SYNCHRONOUS GEARED MOTORS

1rpm, 2rpm, 6rpm, 12rpm. 6 revs. per day. 12 revs. per day. Any type. Price: £3.90 + 40p p. & p. (£4.94 incl. VAT).
Geared Motor. **120 rpm** 1/10 hp approx. 15 lb.in. 230V. A.C. Cont. Rating. Non-reversible. Size 150mm+90mm+85mm spindle 8mm dia + 30mm long. Complete with capacitor and relay for max. load starting. Offered at mere fraction of mfrs. price – £11.50 incl. of p. & p. & VAT.

Brand new CASSETTE TYPE MOTORS

3 types – 6V, 7½V, 12V. Price: 3 for £2.00 + 50p p. & p. (Total incl. VAT – £2.88).

230V a.c. FAN ASSEMBLY

Powerful continuously rated a.c. motor complete with 5 blade 6½in. or 4 blade 3in. aluminium fan. Price £4.50 P. & P. 75p (£6.04 incl. VAT).

24V. D.C. GEARED MOTOR

24V. D.C. 200 rpm 10lbs/ins. continuously rated geared Motor mfg. by either Parvalux or Carter. Easily removed from chassis containing 9x24V. D.C. Solenoids, microswitches, friction clutch, precision gearing etc. etc. Ex-equipment London Transport Ticket Printer. Price: £8.00 P. & P. £2.00 (£11.50 incl. VAT).

SUB-MINIATURE PRECISION BUILT GEARED MOTOR

3-9v. D.C. operation, speed 2-6 R.P.M. Current consumption incredibly only 2-5 M.A. Ratio 1670-1. Torque approx 2lbs inch plus. Motor – German, Gearbox Swiss.
Size: L. 48 mm. Dia. 16 mm.
Shaft L. 5 mm. Shaft Dia. 2 mm.
Price £8.50 Inc. P. & P.
(Total inc VAT £9.78).

24V D.C. REVERSIBLE MOTOR

Parvalux type SD 12L, 24 D.C. shunt wound Motor, either 133 rpm 65lbs in Gearbox ratio 30:1. Current 6.8 amp. Rating continuous. Will operate on reduced power and speed at 9V D.C. or less. Size Dia. 16mm, Width 150mm, Shaft dia. 16mm. Price £16.50 P. & P. £2.00 (£21.28 incl. VAT). N.M.S.
100W Rheostat 1 ohm speed control available £7.25 + P. & P. 75p (£9.20 incl. VAT).

ROTARY CARBON VANE VACUUM & COMPRESSOR.

Direct coupled to 1/3 h.p. 110/115V. A.C. Motor 4.2 amp. 1380 rpm. Motor manuf. by A.E.I. or G.E.C. Pump by Williams. Max. Vac. 25" H.G. Max. pressure cont. 10 p.s.i. Int. 15 p.s.i. Max. air-flow 3 c.f.m. at "0" H.G. Price: £30.00 P. & P. £4.00 (£39.10 incl. VAT). N.M.S.
Suitable transformer for 240V. op. £10.00 P. & P. £2.00 (£13.80 incl. VAT). N.M.S.

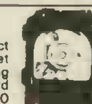
VEEDER-ROOT PRE-SET COUNTER

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

SANGAMO WESTON TIME SWITCH

Type S251 200/250V. a.c. 2 on/2 off every 24 hours. 20 amps contacts with override switch dia. 4 x 3 price £9.50 P. & P. £1.50 (£12.08 incl. VAT). Also available with Solar dial. R. & T.
Type S288 1 on, or 1 timed c/o every 24 hours, day omitting device. Price: £11.00 + £1.00 p. & p. (£13.80 incl. VAT).
Type S388. As above, plus 36-hours spring reserve. Less perspex cover. Price: £13.00 + £1.00 p. & p. (£16.10 incl. VAT).

VENNER TIME SWITCH



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

A.E.G. TIME SWITCH

80amp. 2-on/off Spring Reserve Timeswitch, Price £15.50 P. & P. £1.50 (£19.55 inc. VAT)

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HARDWARE

PP3 battery clips	6p
Red or Black crocodile clips	6p
Black pointer control knob	15p
Pr Ultrasonic transducers	350p
★6V Electronic buzzer	60p
★12V Electronic buzzer	65p
★PB2720 Piezo transducer	75p
★64mm 64 ohm speaker	70p
★64mm 8 ohm speaker	70p
20mm panel fuseholder	25p

PANEL METERS

Size 60 × 46 × 35mm

0-50 μA	0-500mA
0-100μA	0-1A
0-500μA	0-50V AC
0-1mA	VU
0-10mA	0-300V AC
0-50mA	0-25V
0-100mA	0-30V DC

495p each

CABLES

20 metre pack single core connecting cable ten different colours	65p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2·5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

NEW CATALOGUE

Our new catalogue details over 2000 stock lines all at very competitive prices backed by Rapids return of post service. Send 45p for your copy (free with orders over £10).

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K-2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K-500K, 63p each. Preset. Submin. hor. 100 ohms-1M. 7p each. Cermet precision multiturn, 0·75W ¾in 100 ohms to 100K. 88p each.

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Antex CS 17W Soldering iron	450p
2·3 and 4·7 mm bits to suit	65p
CS 17W Element	210p
Antex XS 25W Soldering iron	480p
3·3 and 4·7mm bits to suit	65p
Solder pump Desoldering tool	480p
Spare nozzle for above	70p
10 metres 22 swg solder	100p
Soldering iron stand for above	190p

★ FREE TRANSISTORS ★

Yes thats right! Its transistor month at Rapid! On all orders over £15 received we give you 10 BC184L general purpose transistors (value 70p absolutely free of charge. Offer expires 31st August 1982. Please mention this magazine.

SWITCHES

Submin toggle
SPST 55p. SPDT 60p. ★ DPDT 55p.
Miniature toggle
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle SPST 35p. DPDT 48p
★Miniature DPDT slide 12p.
★Push to make 12p. Push to break 22p
Rotary type adjustable stop
1P12W 2P6W 3P4W 4P3W all 55p ea.
DIL switches
4 SPST 80p. 6 SPST 80p. 8 SPST 100p

CAPACITORS

Polyester. Radial leads. 250V, C280 type. 0·01, 0·015, 0·022, 0·033, 6p; 0·047, 0·068, 0·1, 7p; 0·15, 0·22, 9p; 0·33, 0·47, 13p; 0·68 20p; ·1μ 23p.
Electrolytic. Radial or axial leads. 0·47/63V, 1/63V, 2·2/63V, 4·7/63V, 10/25V, 7p; 22/25V, 47/25V, 8p; 100/25V 9p; 220/25V, 14p; 470/25V, 22p; 1000/25V, 30p; 2200/25V, 50p.
Tag end Power Supply Electrolytics. 2200/40V 110p; 4700/40V 160p; 2200/63V 140p; 4700/63V 230p.
Polyester. Miniature Siemens PCB. 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n, 26p; 680n, 29p; 1μ, 33p; 2μ2, 50p.
Tantalum bead. 0·1, 0·22, 0·33, 0·47, 1·0 @ 35V, 12p; 2·2, 4·7, 10 @ 25V, 20p; 15/16V, 30p; 22/16V, 27p; 33/16V, 45p; 47/6V, 27p; 47/16V, 70p; 68/6V, 40p; 100/10V, 90p.
Ceramic disc. 22p-0·01μ 50V, 3p each.
Mullard miniature ceramic plate. 1·8pF to 100pF 6p each.
Polystyrene. 5% tolerance. 10p-1000p 6p, 1500-4700p 8p, 6800-0·012μ 10p.
Trimmers. Mullard 808 Series. 2-10pF 22p. 2-22pF 30p. 5·5-65pF 35p.

VERO

★ Verobloc 350p ★	
Size 0·1 matrix	
2·5 × 1	22p
2·5 × 3·75	75p
2·5 × 5	85p
3·75 × 5	95p
VQ board	160p
Veropins per 100	
Single sided	50p
Double sided	60p
Spot face cutter	105p
Pin Insert. Tool	162p

SOCKETS

	Low profile	Wire-wrap
★8 pin	7p	25p
★14pin	9p	35p
★16 pin	10p	42p
18 pin	15p	52p
20 pin	18p	60p
22 pin	20p	70p
24 pin	22p	70p
28 pin	26p	80p
40 pin	32p	98p

Soldercon pins 60p/100.

BRIDGE RECTIFIERS

1A 50V	22	6A 100V	80
1A 400V	35	6A 400V	95
2A 200V	40	VM18 DIL	
2A 400V	45	0·9A200V	50

RESISTORS

¼W 5% Carbon film E12 series 4·7Ω-10M 1p each.
½W 5% Carbon film E12 series 4·7Ω to 4M7, 2p each.
¼W 1% Metal film. E24 series 10Ω-1M, 6p each.

TRANSFORMERS

Please add carriage charges to our normal post charges.
Miniature mains.
606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature.
3VA 0-6, 0-6 @ 0·25A; 0-9, 0-9 @ 0·15A; 0-12, 0-12 @ 0·12A, 200p each.
6VA 0-6, 0-6 @ 0·5A; 0-9, 0-9 @ 0·3A; 0-12, 0-12 @ 0·25A, 270p each.

High quality. Split bobbin construction.
6VA 0-6, 0-6 @ 0·5A, 0-9, 0-9 @ 0·4A, 0-12, 0-12V @ 0·3A, 220p each.
12VA 0-6, 0-6 @ 1A, 0-9, 0-9 @ 0·8A, 0-12, 0-12 @ 0·5A, 0-15, 0-15 @ 0·4A 295p each (plus 40p carriage)
25VA 0-6, 0-6 @ 1·5A, 0-9, 0-9 @ 1·2A, 0-12, 0-12 @ 1A, 0-15, 0-15 @ 0·8A, 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1·5A, 440p each (plus 75p carriage)

Simply phone 0206 36412 with your order

Access BARCLAYCARD VISA

ORDERING INFO

All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/PO or Access/Visa number with your order. Please note new address. Callers most welcome—we are just 10 minutes from the centre of Colchester. Telephone orders welcome with Access and Visa. Official orders welcome from colleges and schools etc. Export orders no VAT but please add carriage. All components brand new + full spec.

CONNECTORS

	Plug	Skt		Plug	Skt
DIN			Jack		
2 pin	9p	9p	2·5mm	10p	10p
3 pin	12p	10p	3·5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors
PL259 Plug 40p Reducer 14p
SO239 square chassis skt 38p
SO 239S round chassis socket 40p

IEC 3 pin 250V/6A

Plug chassis mounting	38p
Socket free hanging	60p
Socket with 2m lead	120p

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	40	7905	45
7812	40	7912	45
7815	40	7915	45
LM309K	130	LM723	40
LM317K	350	LM338K	475
LM317T	120	78H05	
LM323K	350	5A 5V	550

DIODES

BY127	12	★1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
★1N4148	2	400mW zen	6

BZX61 Series zeners 1·3W 4V7-39V 15p each.

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.
¼W 5% Resistor kit. Contains 10 of each value from 4·7Ω to 1M (650 resistors) 480p.
Ceramic Capacitor Kit. Contains 5 of each value from 22p to 0·01μ (135 caps.) 370p.
Polyester Capacitor Kit. Contains 5 of each value from 0·01 to 1μF (65 caps.) 575p each.
Preset Kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets) 425p each.

Nut and Bolt Kit. Total 300 items 180p.

25 6BA ½" bolts	25 4BA ¼" bolts
25 6BA ½" bolts	25 6BA ½" bolts
50 6BA nuts	50 6BA nuts
50 6BA washers	50 6BA washers

VERO WIRING PEN

Pen + spool	310p
Spare spool	75p
Combs	6p

OPTO

★3mm red	8	★5mm red	8
★3mm green	12	★5mm green	12
★3mm yellow	12	★5mm yellow	12

Clips to suit 3p each.

Rectangular		TIL32	40
★red	12	TIL78	40
green	17	TIL111	60
yellow	17	ORP12	85
TIL38	40	TIL100	90
2N5777	45	Dual color	60

Seven segment displays

Com athode		Com anode	
DL704 0·3"	95	DL707 0·3"	95
★FND500 0·5"	100	FND507 0·5"	100
TIL313 0·3"	105	TIL312 0·3"	105
TIL322 0·5"	115	TIL321 0·5"	115

LCD: 3½ digit 580p. 4 digit 620p.

TRANSISTORS

AC125	35	BC157	10	BC548	10	BFR40	23	TIP29A	40	★ZTX107	8	2N3053	23
AC126	25	BC158	10	BC549	10	BFR80	25	TIP29B	55	★ZTX108	8	2N3054	55
AC127	25	BC159	8	BC558	10	BFX29	25	TIP29C	60	ZTX109	12	2N3055	50
★AC128	20	BC160	45	BCY70	18	BFX84	25	TIP30A	45	ZTX300	14	2N3442	120
AC176	25	BC168C	10	BCY71	18	BFX85	25	TIP30B	50	ZTX301	16	★2N3702	8
AC187	22	BC169C	10	BCY72	18	BFX86	28	TIP30C	60	ZTX302	15	2N3703	8
AC188	22	BC170	8	BD115	80	BFX87	25	TIP31A	45	ZTX304	17	★2N3704	8
AD142	120	BC171	10	BD131	35	BFX88	25	TIP31C	55	ZTX341	30	2N3705	9
AD149	80	BC172	8	BD132	35	BFY50	23	TIP32A	45	ZTX500	15	2N3706	9
AD161	40	BC177	18	BD133	50	BFY51	23	TIP32C	50	ZTX501	15	2N3707	10
AD162	40	BC178	18	BD135	30	BFY52	23	TIP33A	50	ZTX502	15	2N3708	10
AF124	60	BC179	18	BD136	30	BFY53	32	TIP33C	75	ZTX503	18	2N3709	10
AF126	50	BC182	10	BD137	30	BFY55	32	TIP34A	60	ZTX504	25	2N3772	190
AF139	40	★BC182L	8	BD138	30	BFY56	32	TIP34C	85	2N697	20	2N3773	210
AF186	70	BC183	10	BD139	35	BRY39	40	TIP35A	160	2N698	40	★2N3819	18
AF239	75	BC183L	10	BD140	35	BSX20	20	TIP35C	180	2N706A	20	2N3820	40
BC107	10	BC184	10	BD204	110	BSX29	35	TIP36A	170	2N708	20	2N3823	65
BC107B	12	★BC184L	7	BD206	110	BSY95A	25	TIP36C	195	2N918	35	2N3866	90
★BC108	9	BC212	10	BD222	85	BU205	160	TIP41A	60	2N1132	22	2N3903	18
BC108B	12	BC212L	10	BF180	35	BU206	200	TIP42A	60	2N1613	30	2N3904	10
BC108C	12	BC213	10	BF182	35	BU208	170	TIP120	90	2N2218A	45	2N3905	8
★BC109	9	BC213L	10	BF184	25	MJ2955	99	TIP121	90	2N2219A	25	2N3906	10
BC109C	12	BC214	10	BF185	25	MJE340	50	TIP122	90	2N2221A	25	2N4037	45
BC114	22	★BC214L	8	BF194	12	MJE520	65	TIP141	120	2N2222A	20	2N4058	10
BC115	22	BC237	8	BF195	12	MJE521	95	TIP142	120	2N2368	25	2N4060	10
BC117	22	BC238	14	BF196	12	MJE3055	70	TIP147	120	2N2369	16	2N4061	10
BC119	35	BC308	15	BF197	12	MPF102	40	TIP2955	60	2N2484	25	2N4062	10
BC137	40	BC327	14	BF198	10	MPF104	40	TIP3055	55	★2N2646	45	2N5457	36
BC139	40	BC328	14	BF199	18	MPSA05	22	TIS43	40	2N2904	20	2N5458	36
BC140	30	BC337	14	BF200	30	MPSA06	25	TIS44	45	2N2904A	20	2N5459	30
BC141	30	BC338	14	★BF244B	22	MPSA12	30	TIS45	30	2N2905	22	2N5485	36
BC142	25	BC477	30	BF245	30	MPSA55	30	TIS90	30	2N2905A	22	2N5777	45
BC143	25	BC478	30	BF256B	45	MPSA56	30	TIS91	30	2N2906	25	2N6027	30
BC147	8	BC479	30	BF257	32	MPSU05	55	★VN10KM	45	2N2906A	25	40360	40
BC148	8	BC517	40	BF258	25	MPSU06	55	VN46AF	75	2N2907	25	40361	50
BC149	9	BC547	7	BF259	35	MPSU55	60	VN66AF	85	2N2907A	25	40362	50
				BF337	30	MPSU56	60	VN88AF	95	2N2926	9	40408	70

LINEAR

★555 CMOS	80	★CA3240E	110	LM358	50	LM3915	220	NE570	400	TL071	30
556 CMOs	150	ICL7106	790	LM377	150	LM13600	120	NE571	400	TL072	50
709	25	ICL7611	95	★LM380	65	MC1310	150	★RC4136	68	TL074	95
★741	14	ICL7621	180	LM381	120	MC1496	68	★RC4558	60	★TL081	25
748	35	ICL7622	180	LM382	120	MC3340	135	SL480	170	★TL082	45
9400CJ	350	ICL8038	320	LM384	130	ML922	400	SL490	250	★TL084	95
AY-3-1270	840	ICL8211A	200	LM386	65	ML924	195	SN76018	150	TL170	50
AY-3-8910	600	ICM7224	785	LM387	120	ML925	210	SN76477	250	★UA2240	120
AY-3-8912	625	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2003	85
CA3046	60	LF351	45	LM709	25	ML927	140	TBA120S	70	ULN2004	90
CA3080	65	LF353	85	LM711	60	ML928	140	TBA800	80	★XR2206	300
CA3089	215	LF356	90	LM725	350	ML929	140	TBA810	96	ZN414	100
CA3090AQ	375	LM10	360	LM733	75	MM5387A	465	★TBA820	80	ZN423	135
CA3130E	90	LM301A	25	LM741	14	NE529	225	TBA950	290	ZN424	135
★CA3140E	45	LM311	70	LM747	75	NE531	150	TDA1008	320	ZN425E	350
CA3161E	100	LM318	120	LM1458	40	NE544	205	★TDA1022	525	ZN426E	330
CA3189	290	LM324	40	LM2917	200	★NE555	16	TDA1024	125	ZN427E	650
		LM334Z	100	LM3900	50	★NE556	45	TL061	40	ZN428E	480
		LM335Z	125	★LM3909	70	NE565	120	TL062	60	ZN459	285
		LM339	50	LM3911	120	NE566	150	TL064	96	ZN1034E	200
		LM348	60	LM3914	200	NE567	100				

CMOS

4000	10	★4017	38	4036	275	4055	95	4082	18	4502	60	4529	150
★4001	10	4018	45	4039	290	4059	480	4085	65	4503	40	4532	80
4002	12	4019	25	4040	50	4060	65	4086	60	4507	38	4534	485
4006	50	4020	50	4041	60	4063	85	4089	125	4508	150	4538	110
4007	15	4021	50	4042	45	★4066	30	★4093	30	4510	50	4543	100
4008	48	4022	50	4043	50	4067	295	4094	120	★4511	50	4549	360
		4023	15	4044	50	4068	16	4095	75	4512	50	4553	275
		4024	33	★4046	60	4069	16	4097	290	4514	120	4555	35
4009	24	4025	16	4047	60	4070	15	4098	75	4515	120	4556	35
4010	24	★4026	80	4048	40	4071	15	4099	90	4516	65	4559	390
★4011	11	4027	24	★4049	25	4072	15	40106	50	★4518	40	4560	175
4012	15	4028	50	★4050	25	4073	15	40109	110	4520	70	4584	45
★4013	25	4029	60	4051	45	4075	15	40163	100	4521	130	4585	60
4014	50	4030	30	4052	60	4076	50	40173	100	4526	70	4724	140
4015	50	4031	125	4053	50	4077	18	40175	100	4527	80		
4016	20	4034	140	4054	95	4081	14	40193	95	4528	70		

LS TTL

		LS21	12	LS76	18	LS125	26	LS161	37	LS221	54	LS365	30
		LS22	12	LS78	18	LS126	25	LS162	37	LS240	69	LS366	30
★LS00	11	LS26	14	LS83	40	LS132	42	LS163	37	LS241	69	LS367	30
LS01	11	LS27	12	LS85	52	LS136	26	LS164	43	LS242	75	LS368	35
LS02	11	LS30	12	LS86	19	★LS138	32	LS165	75	LS243	75	★LS373	65
LS03	12	LS32	13	★LS90	28	★LS139	32	LS166	75	★LS244	60	LS374	65
LS04	12	LS37	15	LS92	32	LS145	70	LS170	85	★LS245	70	LS375	45
LS05	13	LS38	15	★LS93	28	LS147	150	LS173	65	LS247	50	LS377	70
LS08	12	LS40	13	LS95	40	LS148	85	LS174	45	LS251	35	LS378	60
LS09	12	★LS42	32	LS96	95	LS151	38	LS175	45	LS257	35	LS390	55
LS10	12	★LS47	38	LS107	40	LS153	40	LS190	45	LS258	35	LS393	55
LS11	12	LS48	45	LS109	21	LS154	90	LS191	45	LS259	75	LS399	175
LS12	12	LS51	14	LS112	21	LS155	35	LS192	45	LS266	22	LS541	120
★LS13	22	LS55	14	LS113	23	LS156	36	LS193	45	LS273	68	LS670	150
LS14	38	LS73	18	LS114	22	★LS157	30	LS195	36	LS279	35		
LS15	12	★LS74	18	LS122	38	LS158	30	LS196	50	LS283	40		
LS20	12	LS75	22	LS123	38	LS160	37	LS197	60	LS353	88		

TTL

		★7413	18	7442	32	7480	48	74107	25	74155	40	74177	45
		7414	28	7444	90	7482	65	74109	25	74156	40	74179	80
★7400	11	7416	24	7446	65	7483	40	★74121	25	74157	30	74180	40
7401	11	7417	24	7447	40	7485	60	74122	40	74160	60	74181	115
7402	11	7420	15	7448	45	7486	20	74123	40	74161	50	74182	60
7403	12	7421	20	7450	16	7489	180	74125	35	74162	50	74190	50
7404	13	7422	20	7451	16	★7490	21	74126	36	74163	50	74191	50
7405	15	7427	22	7453	16	7491	45	74132	30	74164	50	74192	50
7406	24	7428	26	7454	16	7492	25	74141	60	74165	50	74193	45
7407	25	7430	14	7460	16	★7493	25	74145	50	74167	150	74194	50
7408	14	7432	20	7472	26	7494	38	74147	90	74170	125	74195	50
7409	14	7433	25	7473	26	7495	35	74148	70	74173	60	74196	50
7410	14	7438	25	★7474	20	7496	40	74150	55	74174	66	74197	50
7411	16	7437	25	7475	26	7497	95	74153	40	74175	55	74198	90
7412	18	7440	15	7476	30	74100	80	74154	55	74176	40	74199	90

TRIACS

400V 4A	50
400V 8A	65
400V 16A	95
BR100	25

SCRS

TIC45	28
C106D	30
400V 8A	70
400V 12A	99

BOXES

Aluminium		Plastic With lid + screws	
3 × 2 × 1in	70p	3 × 2 × 1in	55p
4 × 3 × 1½in	85p	4½ × 3 × 1½in	88p
4 × 3 × 2in	100p	7 × 4 × 2in	160p
6 × 4 × 2in	120p		
6 × 4 × 3in	150p		

PCB MATERIALS

Alfac transfer sheets—please state type (e.g. DIL pads etc.)	45p
Dalo etch resist pen	100p
Fibre glass board 3·75" × 8"	75p
Ferric Chloride 250ml bottle	100p

CRYSTALS

100KHz	290	6·0M	200
200KHz	370	6·144M	180
1MHz	300	7·0M	250
1·003M	370	8·0M	170
1·8432	300	10·0M	180
2·0M	270	12·0M	290
2·4576M	220	16·0M	240
3·276M	240	18·0M	240
3·579M	120	18·432	220
4·0M	150	38·667	320
4·194M	150	48·0M	220
4·43M	125		

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sinclair
ZX Spectrum
sinclair
ZX PRINTER

PE VOLUME 18 No. 9 SEPTEMBER 1982

TECHNICALITIES

Our technical post bag is usually varied, very often letters pose us many problems and sometimes they can be impossible. We will always try to answer technical queries on PE projects. What we cannot do is undertake a design or general advice service. It appears that we are now often asked to design circuits to meet readers individual needs, this we simply cannot undertake, nor can we undertake the provision of modifications to PE designs or information on incorporating a PE circuit into other equipment. As we are sure many readers will be aware such data is time consuming to provide; time that PE staff simply do not have.

We sometimes get questions like "I want to start designing circuits, which computer do you suggest I buy?" or even, "I am setting up a lab what equipment do you recommend?" These are rather akin to "I'm going to start driving, which car should I buy?" The assessment must be an individual one based on various factors, e.g. price, size, accuracy required, expandibility, essential functions etc. All we can do in such a case is suggest the enquirer decides exactly what he wants to do—now and in the future—then collects as much data as possible on likely equipment, including magazine reviews etc. and makes a decision for himself, based on that data, individual preference and requirements.

S.A.E.

We must also point out that our stamped addressed envelope, or addressed envelope and international reply coupons policy is now strictly enforced. A note about letters has been carried at the foot of this page for a number of years but it seems to be increasingly overlooked by readers. Sorry, but this means no s.a.e., no reply.

Please read all the information below so that you write to the correct department in the correct manner. This will help us to help you. Please also make sure that you write about only one project in your letter—if you have queries regarding two or more projects please write them out separately and send them with a s.a.e. each, even if they come in one envelope. Letters are often answered by designers who are not necessarily on the PE staff, so queries on different projects may be answered by different people, possibly in different parts of the world!

BAZAAR

It seems that *Bazaar* has been universally welcomed and it is interesting to see the wide range of items on offer or wanted; something for everyone! However, after five months we are still getting a few ads. without the date corner, with out-of-date corners, or ads. which do not comply with our rules. We also get the odd complaint about having to cut out the whole coupon. If you want to save the issue, photostat the coupon or copy it out and send it in **with a cut off corner**. Sorry, but if you send a stat or a copy, you must **cut off the corner,** it must be posted within the specified date period and your ad. must comply with the rules. If you don't do these things we will simply not publish it. Since the service is free and the rules are explicit we will not be writing to let you know the situation.

We are pleased to help with the free ads. We are pleased *Bazaar* is so popular. It would also please us if everyone makes sure they get it right, so we don't have to disappoint anyone.

Mike Kenward

Technical and Editorial queries and letters (see note below to):
Practical Electronics,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 671191

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

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

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

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

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

Binders
Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £13·00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

...NEWS &

Edited by Jasper Scott

Distel Data Base

Once again, the hobby electronics world has come up with another first—this time in the area of customer service.

Display Electronics, well known to most readers as suppliers of components and surplus electronic equipment, now offer a new service for customers known as Distel.

Distel is a data base with a multi-port dialling system: anyone whose computer system is equipped with a 300 baud modem or acoustic coupler can dial in 24 hours a day, seven days a week to check what is currently in stock and place orders. A credit card facility is available, and schools or colleges can even use their official ordering systems.

Managing Director Dave Fisher believes that Distel is the UK's first free-of-charge public access data base—all it costs the user is his initial phone call. Distel uses European Standard CCITT modem tones, and software is fully interactive, allowing the user to search through the data base.

For anyone who would like to make use of this facility, the telephone number of Distel is 01-683 1133. Alternatively, if you would like further details of the service, call Display Electronics on 01-689 7702.

Fair News

It won't be fair it should be marvellous. That's the Electronic Hobbies Fair that PE, PW and EE are organising later this year for all those interested in the various aspects of electronics. As last month's Countdown stated "taking exhibitions for the amateur a bold step forward". The details are given below and our photo shows the exciting new venue at night in it's lakeside setting.

Electronic Hobbies Fair, Alexandra Pavilion, Wood Green, London. November 18th — 21st 1982.

There will be free car parking and a special bus service to the station. The Fair will include special exhibits and demonstrations.

For further information about the show read this column next month.

MICRO-STRIP

Micro-strip is a self adjusting wire stripper which will deal with all p.v.c. and some thermo-resisting insulations.

A self adjusting floating cam adjusts the stripper's mechanism to the correct stripping depth and at the same time automatically sets the gripping pressure exerted on the insulation by the jaws, thereby preventing damage to the insulation.

The Micro-strip will deal with all sizes of wire up to a maximum of 1·5mm diameter without any adjustment; for very thin or very thick insulations, an adjustment mechanism is provided.

The Micro-stripper is priced at £17·85. from AB Engineering, Timber Lane, Woburn, Milton Keynes MK17 9PL.

Briefly...

Components and p.c.b., for the PE Quasar Stereo Cassette Deck described in the April and May issues are now available as a separate package from RTVC Ltd. This kit will allow the updating of almost any tape or cassette recorder mechanism at a cost of only £18·95 including VAT plus £1·40 post and packing. Mail order only to RTVC, 21b High Street, Acton W3 6NG. Callers to 323 Edgware Road, London W2.

• • • •

Not quite a new catalogue but one with a new addition is available from Semiconductor Supplies International Ltd. Their 81/82 catalogue is now accompanied by a free 82/83 Eagle International catalogue which carries a very wide range of consumer products from amplifiers and intercoms to test gear and security equipment.

Semiconductor Supplies own catalogue covers a particularly good range of i.c. devices — as their name would suggest — is 88 pages whilst the Eagle catalogue is 84 pages and virtually all in full colour.

Just send £1 to Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS (01-643 1266). Incidentally p&p on the two catalogues must amount to nearly £1 anyway.

POINTS ARISING ...

AUTOMATIC SIGNAL SWITCHING (July '82)

IC1 and IC2 should both be 7805 regulators. The components list contains a misprint.

INFRA-RED TAPE CONTROL (July '82)

Transistor TR1 is a BC461, *not* BCY 461!

CAR BATTERY CONDITION INDICATOR (March '82)

In Fig. 2 the cut-out shown at G16 should be moved up to F16.

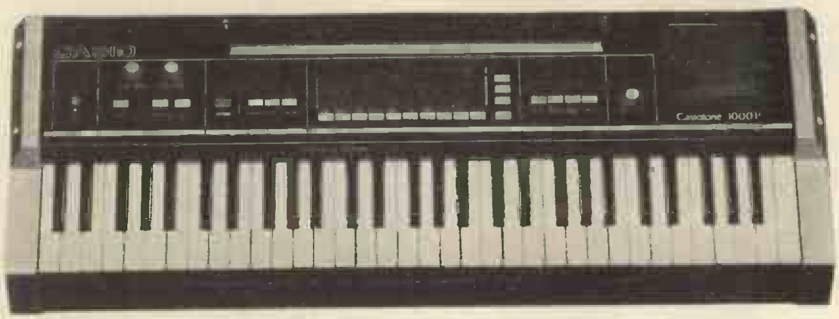
MARKET PLACE

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

CASIOTONE CT-100P

Casio, who must already have made other companies in the electronic musical instrument business feel positively uncomfortable have now come up with an offering that will surely have those companies' directors quaking in their boots!

The Casiotone CT-1000P, which Casio describe as a digitalised synthesiser can produce up to 1000 different sounds, all with eight-note polyphony, by varying combinations of three elements—FOOTAGE, ENVELOPE, and MODULATION. Each element has ten different settings, thus giving 1000 possible combinations. A memory facility allows you to store up to ten settings for instant recall—a particularly useful feature if you are playing on stage.



As if this were not enough in itself, the CT-1000P also features a programmable arpeggio function which combines arpeggio patterns and can also be used as a sequencer; and a range of ten preset sounds. In addition, the CT-1000P boasts sustain and various vibrato effects, a pitch control which incorporates a transposing function, and a built in speaker for home use.

Recommended retail price for the CT-1000P is an incredible £375, and we know already of one company offering a substantial discount—£325 is the all inclusive price being quoted by Tempus, 38 Burleigh Street, Cambridge, CB1 1DG (0223 312866).

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.

ICCC 82 (Computer Communication Conf.) Sept. 7–10. Barbican **O**
BEX Reading (Business Equipment) Sept. 8–9. Hexagon Cntr. **K**
BEX Manchester Sept. **K**
Personal Computer World Show Sept. 9–12. Barbican Cntr. London **M**
Laboratory London Sept. 14–16. Grosvenor Ho. Park Lane, London **E**
ElectroWEST Sept. 14–16. Bristol Exhibition Cntr. **Q**
Two Counties Fair Sept. 15–18. Plymouth Exhibition Cntr. Millbay, Devon **T**
IBC (Int. Broadcasting Convention) Sept. 18–21. Metropole, Brighton **N**
Microprocessors In Audiology Sept. 24 **A7**
Holographic Techniques Sept. 30–Nov. 28. Light Fantastic Gallery, Covent Gdn. London **A8**
BEX Basingstoke Oct. 6–7. Ladbroke Mercury Hotel **K**
BEX Cardiff Oct. **K**
Viewdata Oct. 12–14. Wembley Conf. Cntr. London **O**
Video Show Oct. 16–18. West Cntr. Hotel, London **Z1**
Computer Graphics Oct. 19–21. Royal Gdn. & Bloomsbury Cntr. London **O**
Testmex Oct. 26-28. Wembley Conf. Cntr. **T**
BEX Southampton Oct. 27–28. Polygon Hotel **K**
BEX Plymouth Nov. 10–11. Holiday Inn **K**
Compec Nov. 16–19. Olympia **Z1**
Hobby Electronics Fair (is this a new concept?) Nov. 18–21. Alexandra Palace, London **Z1**
BEX Bristol Nov. 24–25. Holiday Inn **K**
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**
BEX Bournemouth Feb. 9–10 1983. The Pavilion **K**
Brighton Electronics March 1983 **T**
BEX Leeds Mar. 16–17. Dragonara Hotel **K**
INSPEX Mar. 21–25 1983. National Exhibition Cntr. Birmingham International **Z1**
HEVAC (Heating, Ventilation & Air Cond.) Apr. 26–28 1983. Barbican **I**
Semlab June 1983. Olympia, London **I**

A7	Institute Of Acoustics ✆031 225 2143
A8	Holographic Exhibitions ✆01-836 6423
E	Evan Steadman ✆0799 22612
I	Industrial Trade Fairs ✆021 705 6707
K	Douglas Temple Studios ✆0202 20533
L1	World Trade Cntr., Europe Ho., London E1
M	Montbuild ✆01-486 1951
N	Institute Electrical & Electronics Engineers
O	Online ✆09274 28211
Q	Exhibitions For Industry ✆08833 4371
T	Trident ✆0822 4671
Z1	IPC Exhibitions ✆01-643 8040

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SOFTY puts out a TV picture of memory contents, with many code-manipulating and editing facilities. There is also a fast cassette data storage system. **SOFTY** is also a **ROMULATOR** (a lead is supplied which may be inserted into a board under development to emulate the ROM using **SOFTY**'s internal RAM. This procedure can also be used on the single-chipper piggy-back type MPU.) **SOFTY** is complete in itself as a **PRODUCT DEVELOPMENT SYSTEM**.
Code may be entered in **HEXADECIMAL** via the keyboard also **SERIAL** and **PARALLEL** inputs and outputs allow downloading of object code from your computer or printing **EPROM** contents on your printer.

SOFTY 2 — £169.00 **TEX UV EPROM ERASER — £39**

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MENTA puts out a **TV PICTURE** of memory in hexadecimal.
The 40 key keyboard will accept inputs,
both in hexadecimal and Z80 mnemonics;
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Dataman Designs

INDUSTRY NOTEBOOK

By Nexus

Atlas Saga

Twenty years ago the conventional wisdom in computers was 'big is beautiful'. True, second generation computers were appearing with transistors instead of thermionic valves which helped shrink physical size but the accent was on big in performance. The yardstick was not on capital cost but cost per calculation per second.

Using this formula the mammoth mainframe computer seemed justified. IBM, the world leader, set the pace with the 7030 Stretch capable of performing more than a million logical operations per second. Ferranti, one of the British pioneers in association with Manchester University, went bigger and better with Atlas with a prototype installed at Manchester in 1961 described triumphantly in the Daily Telegraph as the most powerful computer in the world. It cost the then enormous sum of £2 million.

Computer industry historians record that both Stretch and Atlas were expensive flops. Performance in both cases fell short of expectations. Four years after the prototype Atlas had been installed at Manchester another Atlas at London University was still disappointing its users despite the injection of additional expertise from ICT (later to become today's ICL) who by this time had taken over Ferranti's large mainframe interests. To be fair the difficulty was not so much in the giant hardware but in software where the problem had been grossly underestimated. The thousands of tasks planned to be undertaken by the mighty number-crunching Atlas had to be clipped back to hundreds and the balance transferred to other machines.

The costly experiment didn't automatically lead to a reversal of policy to 'small is beautiful' but from then on there was a trend to smaller modular units, more manageable, which could be grouped into larger units. Later, we progressed through the mini to the micro and to distributed data processing. Over the years the hardware/software cost ratio has also changed dramatically. The home computer hobbyist can check this for himself by charging a notional commercial rate of, say, £10 per hour for programming time compared with his once-for-all capital outlay in the low hundreds.

There are still jobs which need some mammoths although today they are described as ultra-high-powered. And, as in the battle for size two decades ago, the competitors are again IBM and ICL. And ICL, in challenging IBM, have chosen to resurrect the old name Atlas for two new systems, the Atlas 10, Models 15 and 25.

Naturally enough after 20 years today's Atlas is very different in architecture, type of components, speed and overall capability. It is an entirely different beast owing little of its ancestry to Ferranti or Manchester University or even ICL. It is in fact made in Japan by Fujitsu, a name unheard of in computer science in the days of the original Atlas.

Challenge

The Atlas story dramatically illustrates the changing balance of technological power. Japan has not yet achieved superiority in every field but has been successful in all that have been systematically attacked. In cameras, motorcycles, shipbuilding, cars, consumer electroncs and now, we have to assume, the drive is on to achieve market dominance in professional and capital goods electronics, perhaps to be soon followed by defence electronics, challenging the leading companies in the United States and Western Europe.

History is repeating itself. Only the geography has changed. As Japanese success in consumer electronics decimated the domestic industries of Western Europe and the United States, so Japan's own industry is under increasing threat and pressure from the torrent of consumer electronics from Hong Kong, Singapore, Korea and Taiwan. Japan today is in the same position as the UK a decade or so ago, forced to go up-market to keep factories emplyed because their original products can now be made more cheaply elsewhere.

Looking round the globe we find other nations learning fast. Space vehicle launchers are no longer exclusive to the Soviet Union, the United States and Western Europe. Japan has her own as has India and China. Indonesia put up a satellite some six years ago. The Arabs and some South American countries are also beginning to get involved in space technology. Most still depend on technical assistance from the Eastern or Western blocs but Third World countries must eventually achieve a degree of technological independence.

Happily electronics remains an expanding world industry and newcomers can still be accommodated, albeit at the risk of increasingly growing competition. With a labour-cost handicap the West's relative position can be maintained only by keeping a jump ahead in technology and, as the Atlas story shows, this is no easy challenge when a vigorous young pupil can so easily surpass an ageing tutor.

Push-button War

All the world's military experts have been and still are evaluating electronic sensors and weapons systems deployed in the battle of the South Atlantic. It might have been imagined that sophisticated weapons with built-in 'intelligence' operating at great range by remote control would have been the decisive factor. In the event this was no push-button war. Foot-slogging, blood-and-guts discipline, courage and traditional rifle, machine-gun, mortar and artillery fire were the main components of the land battle rather than the electronic battlefield predicted and promoted by defence equipment salesmen.

The French-built Exocet anti-ship missile was the nearest thing to push-button war. Its stand-off fire-and-forget concept was effective but its hit rate was nowhere near 100 per cent although it is not yet clear whether the misses were missile malfunction or efficient defensive electronic countermeasures (ECM) by British warships. At some 200,000 US dollars each the Exocet is a cheap weapon if it sinks a ship but an expensive failure if it doesn't. Exocet is big business with over 1,000 missiles delivered to 20 countries including the UK.

Exocet first appeared in 1972. The new generation British Sea Eagle, barely yet in service, is said to have a stand-off range of 100km compared with Exocet's 50km. Another new British system was not available for the crisis. This was Nimrod Mk III airborne early warning and control system (AWACS) of which eleven are on order. But even had they been available it is hard to imagine how they could be maintained flying over the battle area so far from Ascension Island, their only possible base. Lack of AWACS allowed low-flying aircraft to close-in on warships with only limited warning time from shipborne radar. Thus, British casualties have to be judged taking into account the self-imposed handicaps as well as those of distance and climate.

From 3,500 BC to the present day there have been 14,500 recorded wars and only 292 years of peace according to Francis A. Beer in his book "Peace Against War".

Outlook

All the leaders in UK electronics turned in good half year results with defence contractors Plessey, GEC, Racal and Ferranti all showing gains in profits and turnover. This due, of course, to delivery on past orders all pre-Falkland. Post-Falkland business is expected to be brisk following re-appraisal of future defence needs and replacement of lost equipment. But in the non-defence sector there is plenty of optimism with Cable & Wireless, for example, nearing the £100 million pre-tax profit milestone.

Thorn-EMI have survived the worst of the recession but streamlining savaged the workforce by some 30,000. Chairman Sir Richard Cave will be pleased to have seen a leading stockbroker forecasting substantial profit improvement for 1983 and 1984. Apart from being the biggest TV and VCR rental company in Europe the company has a number of important defence contracts.

MENTA Review...

DAVID WHITFIELD M.A. M.Sc.

MENTA—Micro Electronic mNemonic Teaching Aid

LEARNING about microprocessors is best done in a practical fashion, at machine code level on a CPU which is an accepted industry standard in its field. This was recognised in the original specification for "Auntie's Micro" (subsequently better known as the BBC Microcomputer), which called for a Z80-based design with good support for machine code programming, as well as BASIC. Although other pressures eventually led the BBC to adopt a non-Z80 design, the exercise does give an indication of the wide degree of acceptance gained by the Z80 since its introduction by Zilog in the late 1970's.

The Z80 was developed by Zilog as a "super-8080", an 8-bit third-generation that would do everything that the then standard Intel 8080 would do, and then much more. The result was a product which has found wide acceptance in many fields of control and stand-alone applications. The 158 instructions offered by the Z80 include the full 78 instructions of the 8080, thereby providing software compatibility with the 8080, and increasing its already considerable appeal.

In the field of popular microcomputers, the Z80 is used as the CPU in the Sinclair ZX81, Tandy TRS-80 and Video Genie, to name but a few. These alone represent a user base of over a million systems. The majority of these machines, however, concentrate in the main on the support of BASIC, The *B*eginner's *A*ll-purpose *S*ymbolic *I*nstruction *C*ode. These systems are mainly concerned with applications programming; the user is usually not even aware of the variety of CPU which lurks behind the keyboard.

The MENTA is not part of the common trend in home computing, and it does not support BASIC in any shape or form. The MENTA is dedicated to teaching how to program and use the Z80 for control applications; it provides a unique opportunity to use a microprocessor to actually DO something. An unusually powerful in-built keyboard assembler and television display facility support a novel approach to learning and using assembly language. The facilities of the MENTA take much of the pain, in terms of both effort and cash, out of the process of learning how to use a real microprocessor in its native environment. Direct comparisons with other systems are difficult; many of the facilities are only offered on microprocessor development systems or mini-computer systems costing upwards of 10 to 20 times the cost of the MENTA. The MENTA lays down a challenge to the user, provides the necessary facilities, and encourages the development of microprocessor based controllers for real applications.

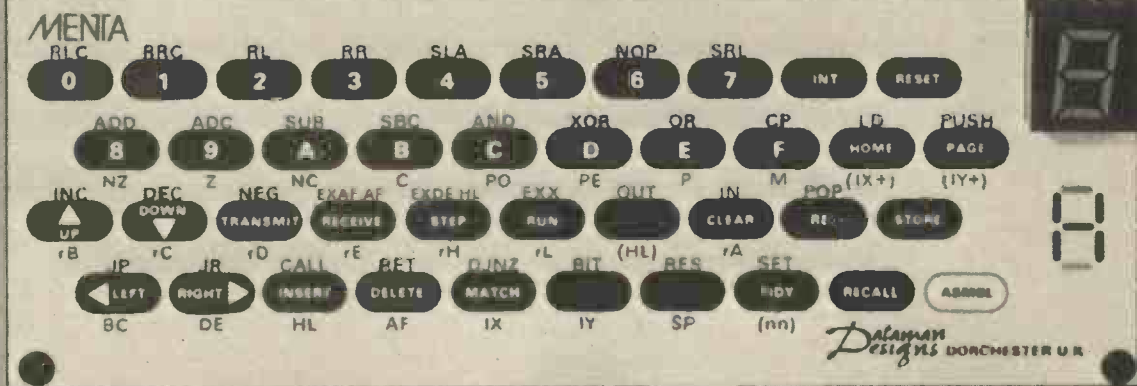
FIRST IMPRESSIONS

The MENTA comes securely packed in a cardboard box measuring approximately 250 mm × 180 mm × 100 mm. Inside the box is a complete MENTA system, and only a mains outlet and a domestic u.h.f. television (set to the ubiquitous channel 36) are required to start programming in assembler. The package includes the MENTA itself, an a.c. mains adaptor with integral 13A plug, a television lead to suit a standard TV coaxial socket, and two manuals. The two unlabelled A5 sized booklets turn out, on inspection of the contents (in the absence of titles), to be the instruction manual and a listing of the monitor ROM.

The first impressions of anything new are always to be treated with care, but initial reaction to the MENTA is rather mixed. The main unit comes housed in a rather strangely contoured vacuum-formed black ABS case a little larger than a Sinclair ZX81. The case is in two distinct halves, the top half of which covers approximately two-thirds of the bottom half, and the two halves are held together by four plastic fasteners (which are not easily separated). The case design seems to owe its origins to the Softy 2, also from Dataman Designs, but does nothing to enhance the appearance of the MENTA.

The keyboard is fabricated directly on the main circuit board on the part which extends beyond the limit of the top half of the case. The flat plastic keyboard is made using silver printing technology and contains 40 clearly marked keys. The keys represent the hexadecimal digits 0 to F, and the rest are used for control and editing functions. When the keyboard assembler is in use, most keys have further functions for entering assembler mnmonics; no key has more than three functions, and no shift keys are necessary. The keyboard layout is shown reproduced in Fig. 1. The plastic surface is relatively immune to dirt and dust, and can easily be cleaned with a soft cloth.

Fig. 1. MENTA keyboard layout



The great improvement of the MENTA keyboard over that of, say, the ZX81 is the audible feedback provided for the user. Each keystroke is accompanied by a short bleep, or by a squawk if that stroke represents an invalid operation. This saves much of the tiresome and continual looking up at the television screen in order to check whether the keystroke has registered or not.

At the top right of the keyboard are a seven-segment l.e.d. display, which stands proud of the board, and a 26-pin input/output connector. This connector has long exposed pins which must be susceptible to accidental damage, and which are certainly painful if encountered while trying to pick up the unit! At the rear of the unit there are sockets for connecting the power supply, television and cassette recorder. The sockets are not labelled in any way on the case, and it is necessary to refer to the manual to be sure of making a correct connection; the same comment applies to the I/O connector. From the outside therefore, the first impression is of a unit with a full range of facilities, but rather bizarre styling and inadquate labelling of connectors.

Removing the top cover from the MENTA immediately moves one to wonder why such a high quality board is hidden by such an uninspiring cover. The main circuit board is a neatly designed, well laid out, double-sided fibreglass printed circuit board. The major i.c.s are all fitted in sockets, and the top surface of the board is coated and then screen printed to simplify identification of components from the circuit diagram in the manual. The CPU, PPI and monitor ROM occupy the space immediately above the keyboard. The piezo-electric audio unit, Astec u.h.f. modulator and tape/power sockets are at the back of the unit. In the middle of the board is the quartz oscillator, counters, RAMs, and assorted logic i.c.s. One very neat feature of the board is the way in which the metal case of the television modulator is used as a heatsink for the voltage regulator i.c. All in all, a very nicely constructed board, well laid out and neatly labelled.

SYSTEM DESCRIPTION

The overall MENTA system incorporates a Z80 CPU, 2048 bytes of read-only memory (ROM), 1024 bytes of random access memory (RAM), a programmable peripheral interface (PPI), a 40-key keyboard, and all of the circuitry necessary to drive a standard u.h.f. television receiver as a display unit. Additional features include a 7-segment l.e.d. display to give prompts and information to the user, a cassette tape recorder interface for storing and retrieving programs, and a miniature loudspeaker. Power for the unit is provided by a separate a.c. mains adaptor which has an integral 13A plug, and which works in conjunction with the internal voltage regulator to provide power for the MENTA circuitry. The PPI also provides three 8-bit input/output (I/O) ports for hardware control applications.

As with any system, the hardware provided should be considered in the light of how it is configured, and the manner in which it performs its functions. A block diagram for the MENTA is shown in Fig. 2, showing a conventional two-bus structure. At switch on, the Z80 CPU is started up under the control of the monitor program stored in ROM. The monitor is the program to which the user "talks" in order to make the MENTA perform the functions which are required. The monitor is responsible for detecting and identifying, via the PPI, keyboard depressions, and for deciding what action is to be taken, if any. As previously mentioned any valid keyboard entry echoes a short "*beep*", whereas an invalid entry evokes a rather appropriate "*squawk*". In addition, the monitor drives the television display (doing most of its processing during the line blanking interval), and via the PPI, handles the loudspeaker, cassette tape interface, and the I/O ports.

The monitor is a program which is permanently stored in

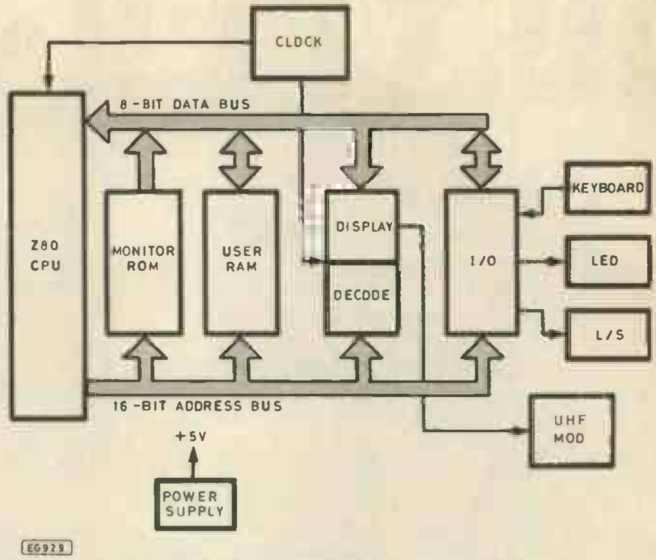


Fig. 2. Block diagram for the MENTA system

ROM, and as such it cannot be modified by the user. In order to write applications programs, the user is provided with an area of RAM, and enlists the services of the MENTA's powerful monitor facilities to enter the necessary instruction codes into the RAM area of the memory. Once satisfied that the stored program is correct, the user instructs the monitor to pass CPU control from the monitor to the program in RAM and RUN the program. At the end of the program, or when the program is halted, control is returned to the monitor for possible further user action or modification.

USING MENTA

Switching on the MENTA produces a display on the television screen of 256 pairs of numbers. Closer inspection shows that the numbers are in hexadecimal notation. For display purposes, the user RAM area of 1024 8-bit locations starting at address F8ØØ is separated into four discrete pages each of 256 locations, identified as pages 0 to 3. These pages, therefore, will display the contents of the 256 (1ØØ HEX) locations starting from F8ØØ, F9ØØ, FAØØ and FBØØ, respectively, with the addresses for each row of the display incrementing by 1Ø HEX. The manual advises the user that the last $3\frac{1}{2}$ rows of page 3 (locations FBC7 to FBFF inclusive) are reserved for use by the monitor; the details provided allow the user to gain an interesting insight into the operation of the MENTA's monitor. At any time, the display shows the contents of the page which is identified by the seven-segment display; at switch-on the display comes up at page 0. Different pages are selected by the PAGE key, followed by the required page number (illegal page numbers are ignored).

The initial contents of the memory are random and the whole of the user RAM may be cleared at switch-on by operating the CLEAR key twice. This double operation is a deliberate safety feature included to prevent accidental loss of a program from memory. Similarly, the press-twice feature is provided on the RUN key. The CLEAR key actually zeroes the RAM locations from the current cursor position up to the start of the monitor RAM (FBC7). Movement of the flashing cursor is by four direction keys (UP, DOWN, LEFT, and RIGHT).

Auto-repeat is a facility provided to assist in rapid positioning of the cursor; holding the required key down will cause the cursor to move at a rate of approximately three positions per second. Full row and column wrap-around is implemented, with the next position RIGHT from the end of a row being the start

of the next row, and similarly for pages; page 0 follows page 3 in the normal wrap-around scheme. The HOME key causes the cursor to return to the start of the current page. The cursor is automatically reset to this home position whenever the PAGE key is used to move between pages.

There are two distinct methods of entering machine code instructions into the MENTA's RAM storage area. The first method will be familiar to users of many microprocessor evaluation systems and involves entering the hexadecimal instruction codes into memory directly. The second method is a significant advance over the first and it uses an in-built ROM-based keyboard assembler to allow keys representing the standard Z80 instruction mnemonics to be used to enter instructions into memory. Both entry methods are well supported by the monitor and the features of each will be considered in turn.

PROGRAMMING IN HEX

Entering programs in hex is simply a matter of positioning the cursor at the selected memory start address, and then typing in the hex instruction codes. The cursor automatically moves on to the next location whenever two hex digits have been entered; this does, however, mean that leading zeroes must be used in entering codes. Correction of errors is simply achieved by using the LEFT cursor shift key, followed by retyping the 2-digit code. At the end of the program, the user includes an 'FF' to cause the program to return control to the monitor. The program is started by positioning the cursor at the start address, and then typing the RUN key twice. Should the program run out of control, it may be stopped using the INT or RESET key, which causes the monitor to resume control. The program may be stepped through one instruction at a time using the STEP key to monitor its operation in detail (the contents of the registers are displayed at the bottom of page 3, and readily accessed using the REG key).

When entering a program, by whatever means, the facilities offered for making changes, rather than completely retyping, are important. To delete an instruction without affecting those which remain, the cursor is simply moved to the appropriate address and the code over-written with "ØØ". This is a NOP instruction for the Z80 and is ignored by the CPU. To add an instruction, the INSERT key is pressed as many times as there are bytes in the instruction, making room (filled initially with "FF" codes) for the addition by shifting the following instructions to the right. Any subsequent jump instructions will, of course, require suitable modifications. The DELETE key performs the opposite function from that of the INSERT, deleting bytes and moving to the left.

Code entry in hex is thus very quick and very easy to use. The key "click" takes much of the effort out of entering the code initially, and the whole program can easily be seen on the screen when complete, a vast improvement on systems which display only single locations at one time. The cassette tape interface may then be used to record the contents of the whole memory, in about four seconds, allowing several programs to be developed in different parts of the memory and then saved on tape at the same time.

USING THE KEYBOARD ASSEMBLER

The keyboard assembler is started by pressing the ASMBL KEY. This causes the top bar of the l.e.d. display to be illuminated, indicating that the next keystroke will be interpreted as the instruction mnemonic printed in blue above the next key. Once the first mnemonic has been entered, the bottom bar of the l.e.d. will be illuminated, showing that the mnemonic marked in red below the next key will be entered. Some instructions will prompt for more than one red-coded mnemonic to be entered. When all of the necessary mnemonics (up to 3) for the instruction have been correctly entered, the instruction will be assembled and entered into memory, starting at the current cursor position. The cursor will then move on to the next available memory location and the top bar of the l.e.d. will again be illuminated, indicating that the assembler is ready for the next instruction. The instruction codes do not appear on the display screen until a particular instruction has been completed and assembled. An error during the entry of an instruction will produce a "squawk", and the instruction must be re-started.

The assembler handles 94 per cent of the Z80's instruction codes; the remaining 6 per cent must be entered in hex directly. This may be easily done by using the ASMBL key to leave the assembler, keying in the appropriate box code(s), and then using the ASMBL key again to return to the assembler mode from the direct mode. When the keyboard assembler is used to enter code, the first byte of each instruction is automatically highlighted to assist the user in identifying steps in the program.

One of the significant advantages of the MENTA is the way in which jump offsets and addresses do not need to be worked out by hand. When an address is required for a jump instruction, the user leaves the assembler, moves the cursor to the first byte of the target instruction (which will have been highlighted by the assembler), and then types the STORE key. The cursor is then returned to its original position and the RECALL key is used to enter the jump absolute address or jump relative offset, as appropriate to the instruction selected.

The keyboard assembler puts the MENTA in a class of its own; the traditional hex entry method is retained, but programming the Z80 in the more familiar mnemonic codes is provided with the minimum of fuss. A significantly larger and more expensive system would be required before any greatly improved facilities would become apparent to the average user.

USER DOCUMENTATION

The manual describes the MENTA as "a product made to teach microprocessor application", and the typical user as "a trainee engineer or system designer". It is also mentioned in the introduction to the manual that the MENTA has been designed to meet the requirements of the School's Council's Project "Courses in Modular Technology".

The user documentation provided with the MENTA comprises two A5-sized manuals. The primary, and much the thicker, manual contains approximately 150 pages, of which the first half is the real user guide. This is followed by a 10-page alphabetically ordered listing of the Z80's instruction set. Further appendices contain hex conversion and ASCII code tables. The final 40 or so pages are taken up by two data book extracts; a 19-page data sheet on the 8255 PIA chip, and a 22-page data sheet on the Z80 CPU. The secondary manual contains a copy of the 80-page assembler listing of the MENTA's monitor program.

The primary manual, while easily readable, is somewhat sparsely illustrated and lacks either an index or contents list. The manual does, however, contain a great deal of useful and helpful information, and even includes a complete circuit diagram. The order of presentation of the material in the manual, even allowing for the fact that the manual is not intended to be a teach yourself text, leaves much to be desired. The first sample program, for example, is introduced one-third of the way through chapter one, but it requires the user to "first read quickly through chapter 2", before proceeding. This first program is presented before any discussion of the Z80's CPU has occurred.

The purpose of each example in the text is well explained; the way in which the program achieves its objective, however, is not well covered. This seems a rather strange omission for such a system. The examples are presented as hex codes, with assembler listings given towards the middle of the manual. The listings, however, also err towards providing information on what the programs do, rather than how they do it. The number of examples (three) is rather low, and none are included to cover the latter part of the user text.

The latter part of the user text covers the subjects of I/O and control applications in some detail. This is really what the MENTA is all about, and this section would be excellent if it were extended to include some practical experiments for the user to try, and some sample listings. Much interesting and useful information is included on how hardware should be driven from the I/O ports; further guidance on some aspects of writing software for control applications would have been extremely useful.

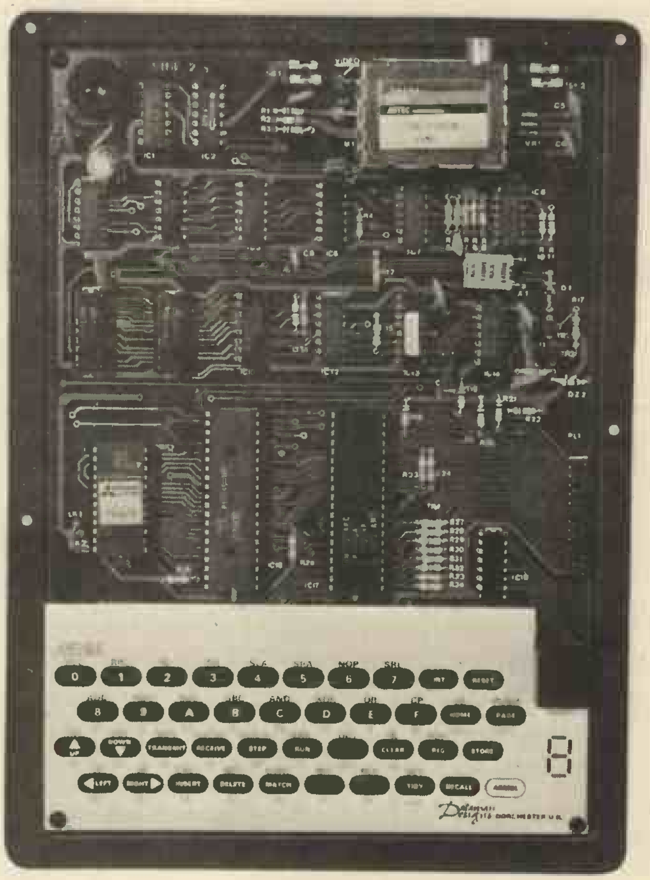
In general, the individual user will probably benefit greatly by reading one of the standard Z80 programming books in conjuction with the MENTA manual. The manual otherwise relies heavily on the user studying the Z80 data sheet (not an ideal primary learning text even for an experienced microprocessor design engineer) for details of the Z80 instruction sheet and architecture. Such an additional text should also provide some practical examples in order to complete the picture. It should be mentioned, however, that the School's Council's Course for the MENTA is intended to provide the complete support for the system. Course material is available which extends far beyond the scope of the standard user manual.

CONCLUSION

The MENTA provides a well supported and cost effective approach to learning assembly language programming, with particular reference to control applications. The choice of a Z80 as the CPU makes this a particularly relevant system to the real world of microprocessor-based applications. The system encourages the adoption of a microprocessor design for roles at which they excel; the replacement of large amounts of dedicated combinational logic by a programmable controller, allowing many changes to be accommodated simply by changes in the software.

The facilities offered by MENTA have been well thought out, and then implemented in a way which minimises many of the difficulties normally associated with low-level programming teaching. The user feels encouraged to start programming, and the keyboard mnemonic assembler removes the need for continual reference to lists of hex instruction codes. The flat keyboard is well complemented by good audible feedback facilities. Program debugging is also well supported, with single stepping and the facility to examine and change registers simply at any step. The cassette tape interface allows the final program to be built up over a number of sessions, and an option is available to allow the program to be sent over a serial link to, say, a PROM programmer, if required.

The MENTA is made in the UK by Dataman Designs, Lombard House, Cornwall Road, Dorchester, Dorset, DT1 1RX; telephone 0305-68066. The one-off price is £115·00, and the dis-assemble option to produce a serial output link is £19·50; prices exclude VAT. ★



Patents Review

SURROUND SOUND

British patent application 2 067 057, from the IBA, offers a useful, and clearly worded, run down on the current state of play over broadcast surround sound. The patent application, naming Jonathan Halliday as the inventor, was filed on 19th December 1979, just two days before a press release from the IBA announcing the development of the "MSC" (Mono-Stereo-Compatible) system of surround sound. This followed a June announcement by the IBA engineers that they had reduced the number of practical options of surround sound to two "irreconcilable" approaches. These are the NRDC-Ambisonics approach (to which the BBC is closely aligned) and the IBA MSC approach. As the IBA used the MSC system to transmit from Radio Victory on September 23rd, 1979 and from Capital Radio on November 25th and December 11th, an interesting legal question is raised: does the transmission of programmes using a new technology constitute public use of the idea? If it does, then the IBA's application for a patent, made on 19th December, could be legally invalid. But valid or not, the IBA patent application makes interesting reading.

It is acknowledged that the IBA system "takes as a basis the Ambisonics B format". This provides four basic signals:

W—an omni directional signal;

X—a signal which, together with W, is indicative of front-back positions;

Y—a signal which, together with W, is indicative of side-to-side positions; and

Z—a signal which, together with W, is indicative of height.

From these four signals linear mixing techniques provide three signals;

Σ—a sum signal equivalent to mono;

Δ—a difference signal which, when taken with the Σ signal gives stereo, and may also be decoded to give horizontal surround-sound of limited quality and;

T—a third signal which, with the other two signals, gives horizontal surround-sound of good quality.

IBA test transmissions made in 1978 left the Authority's engineers in no doubt that the phase differences between the Σ and Δ signals, and consequently between the received stereo left and right signals, degraded the sound. The IBA engineers then looked for a way to avoid this degradation. Starting with the same four B format signals they arrived at an encoding matrix with the following characteristic:

$$\begin{bmatrix}\Sigma\\ \Delta\\ T\end{bmatrix} = \begin{bmatrix}0{\cdot}9 & 0{\cdot}1092 & 0\\ 0 & 0 & 0{\cdot}6897\\ -0{\cdot}3954j & 0{\cdot}3954j & 0\end{bmatrix}\begin{bmatrix}W\\ X\\ Y\end{bmatrix}$$

Surround-sound decoding is not possible using the Σ and Δ signals alone. However, since there are no phase differences present between these signals, no compromise is made over normal mono and stereo reception. So the IBA signal produces perfect mono and stereo from existing mono and stereo receivers but requires a three channel receiver and decoder to produce horizontal surround-sound. Moreover the three channel receiver must have a full bandwidth capability on all three channels. This differs from the Ambisonics UHJ approach which is hierarchical. A reasonable surround-sound effect is obtainable by decoding from two signal channels and an improved effect is obtained when a third channel, of either limited or full bandwidth, is received and decoded. This is the "irreconcilable choice" to which the IBA referred in 1979.

With both approaches, the transmission of a fourth channel enables the reproduction of height information.

The decoding matrix is an inverse of the encoder, and delivers signals W' X' and Y', which are equivalent to the original B format signals. In both approaches (Ambisonics and IBA) the decoded W, X and Y signals require further processing to produce speaker feed signals for three, four, five, or even more loudspeakers around the room.

Figure 1 shows an encoding circuit for the IBA system. Linear mixer and amplifier 2 receives the W and X signals, eg from a microphone array, and generates two output signals. One is fed through all-pass filter 3 to produce the Σ signal and the other is passed through all-pass filter 4 which introduces a 90° phase shift to produce the T signal. The Y signal from the input is fed to multiplier 5 and all-pass filter 6 (which is identical to filter 3) to produce the Δ signal. The three transmission signals are multiplexed at 7 and transmitted at 8.

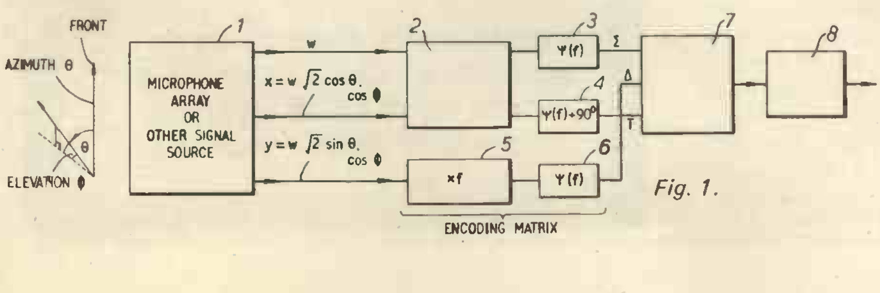


Fig. 1.

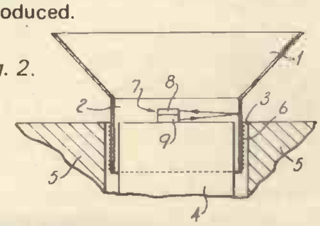
DRIVE UNIT IMPROVEMENT

Rank Wharfedale have filed a British patent application 2 083 974 on an interesting proposal for improving the performance of loudspeaker drive units. The idea is to compensate for the non-linearity which is caused by air trapped beneath the diaphragm. Under normal circumstances this air is compressed and rarified as the diaphragm moves. This produces non-linear response to a drive signal fed to the speaker coil. It's already been suggested to feed a direct current bias signal to the coil. But Rank suggests that this can create problems because of the heat generated by the continuous current flow. Instead, suggests Rank, the position of the speaker diaphragm and coil should be continually monitored and this position used to control a feedback signal.

Figure 2 shows one way of doing this. Light emitting diode 9 and photo transistor 8 are mounted on the central pole piece 4 of the speaker magnet. The internal surface of the coil former 2 is coated to make it diffusely reflective. So light from l.e.d. 9 is reflected back to the photo transistor 8. By making the reflected beam vary in dependence on the position of the coil former, the photo transistor 8 will produce a signal which represents displacement of the coil from its rest position. The patent describes several ways of achieving this, for instance by providing the coil former with a non-linear pattern of reflective and non-reflective areas.

Figure 3 shows a feedback circuit which can be used with an optical sensor of this type. Operational amplifier 14 takes the output of photo transistor 8 and itself feeds another op amp 15. This applies a compensation signal to the loudspeaker coil. The gain of op amp 14 can be pre-set to give the optimum level of compensation signal relative to the audio signal being reproduced.

Fig. 2.



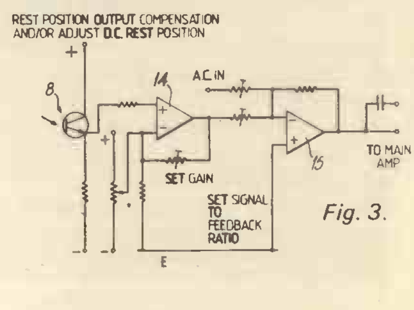


Fig. 3.

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Seat Belt Reminder

David Shortland

THE proposed legislation regarding the compulsory wearing of seat belts for people travelling in the front seats of cars becomes law in the New Year and many people who have never got into the 'clunk-click' habit could find their lapses not only dangerous but also expensive.

This project has been designed to give an audible warning to both front seat occupants to remind them to fasten their seat belts before driving off.

The system works when the ignition is on. The alarm on the driver's side is only inhibited when the seat belt is fastened or if a front door is opened. The alarm on the passenger's side which is also inhibited when the seat belt is fastened or a door opened can also be turned off by an inhibit switch. This allows the alarm to be disabled when there is no passenger in the front seat. However, the alarm will be retriggered if the passenger door is opened and then closed.

CIRCUIT DESCRIPTION

The circuit diagram of the Seat Belt Reminder is shown in Fig. 1. The switches S2 and S3 are both proximity switches which are fitted to the seat belts and are operated by magnets fitted to the tongues of the seat belts.

When the door switches and switch S3 (on the driver's seat belt) are both open, the inputs to IC3a are both high and the output IC3a pin 12 is low as is IC3c pin 11. The output (pin 8) of IC3c is high and IC4, a 555 timer connected as an astable multivibrator, is turned on triggering the audible warning device (WD1). When either the door switches or S3 are closed (i.e. if a door is opened or the driver's seat belt fastened) the output (pin 12) of IC3a is switched high. Whether or not the output (pin 8) of IC3c is switched low and the alarm inhibited depends upon the state of the other input (pins 9 and 10) of IC3c.

If it is high then the alarm is switched off and if it is low then the alarm will continue until the passenger seat belt is fastened, a door opened or the inhibit switch S1 pressed.

If when the ignition is first turned on, the door switch is open the two inverters IC2c and d are both high and their outputs are low. This sets the output (pin 1) of the latch circuit formed by IC2a and b high. The latch circuit is reset by pressing the inhibit switch S1, IC2a pin 1 goes low, and for the output to be switched high again S2 (the door switch) must be closed or the power to the unit switched off and then on again (via the ignition switch).

If we assume S1 has not been pressed and S2 and S3 are both open the three inputs (pins 3, 4 and 5) of IC3b are all high and its output (pin 6) is low. Closing any one of the three switches (S1, S2, or the door switch) will cause the output (pin 6) of IC3b to go high. If the output of IC3b pin 6 is low the output of IC3c pin 8 is high and the alarm will sound.

TRANSPORT ACT 1981

33A.—(1) The Secretary of State may make regulations requiring, subject to such exceptions as may be prescribed, persons who are driving or riding in motor vehicles on a road to wear seat belts of such description as may be prescribed.

(2) Regulations under this section:

(a) may make different provision in relation to different classes of vehicles, different descriptions of persons and different circumstances;

(b) shall include exceptions for:

(i) the users of vehicles constructed or adapted for the delivery of goods or mail to consumers or addressees, as the case may be, while engaged in making local rounds and deliveries;

(ii) the drivers of vehicles while performing a manoeuvre which includes reversing;

(iii) any person holding a valid certificate signed by a medical practitioner to the effect that it is inadvisable on medical grounds for him to wear a seat belt.

(3) Any person who drives or rides in a motor vehicle in contravention of regulations under this section will be guilty of an offence; but notwithstanding any enactment or rule of law no person other than the person actually committing the contravention shall be guilty of an offence by reason of the contravention.

In Part I of Schedule 4 to the Road Traffic Act 1972 (prosecution and punishment of offences) after the entry relating to section 33 there shall be inserted the following entry:

"33A.	Driving or riding in a motor vehicle in contravention of regulations requiring wearing of seat belts.	Summarily. £50

The above extracts have been taken from Chapter 56 of the Transport Act 1981.

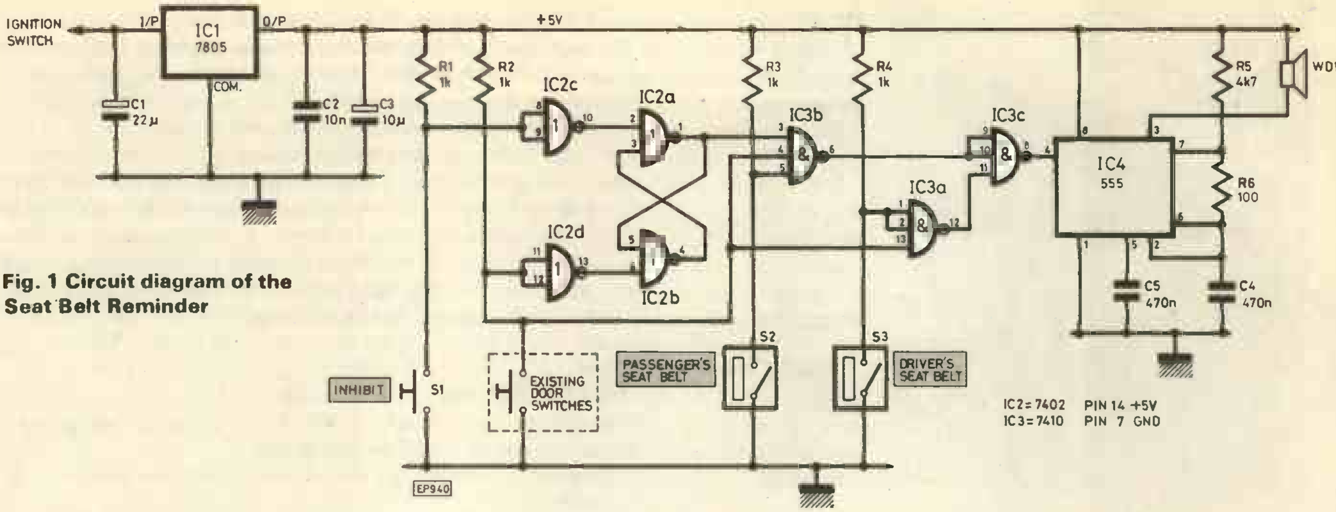

Fig. 1 Circuit diagram of the Seat Belt Reminder

CONSTRUCTION

The p.c.b. design for the Seat Belt Reminder is shown in Fig. 2 with the component layout shown in Fig. 3. The resistors should be mounted first and then the i.c. sockets followed the capacitors and the regulator. Carefully check the orientation of the electrolytic capacitors and the regulator. Also check the p.c.b. tracks to ensure there are no solder splashes.

The case should be drilled next as shown in Fig. 4 and rubber grommets fitted. The two proximity switches should then be fed through the holes in the case and soldered onto the board along with the supply wires and the door switch wire. The warning device should then be mounted in the top of the case and its two leads soldered to the board. The i.c.'s should then be fitted onto the p.c.b. and the p.c.b. mounted into the case.

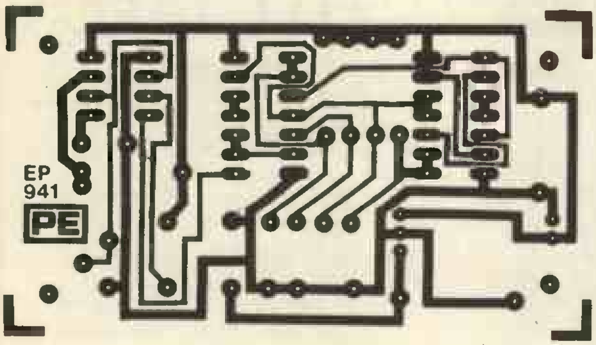

Fig. 2 P.c.b. design

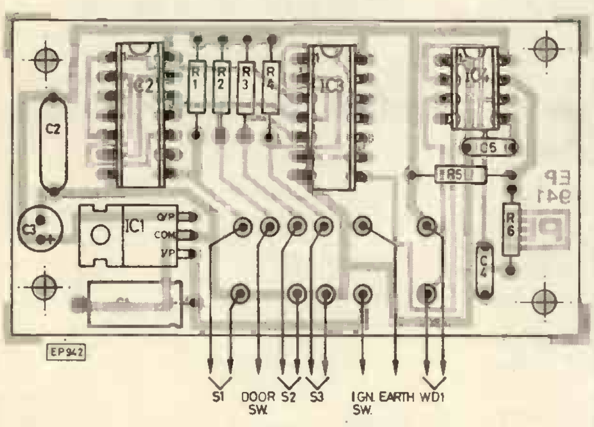

Fig. 3 Component layout

POWER	S1	DOOR S/W	S2	S3	ALARM
On	Open	Open	Open	Open	On
"	"	"	Closed	Closed	Off
"	"	"	"	Open	On
"	"	"	Open	Closed	On
"	"	Closed	"	Open	Off
"	Pressed	Open	"	Closed	Off
"	Open	"	"	"	Off
"	"	Closed/ Opened	"	"	On

TABLE 1

COMPONENTS . . .

Resistors

R1, R2, R3, R4	1k (4 off)
R5	4k7
R6	100

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

Capacitors

C1	22µ 25v elect.
C2	10n polyester C280
C3	10µ 50v elect. p.c.b. mounted
C4, C5	470n ceramic (2 off)

Integrated Circuits

IC1	7805
IC2	7402
IC3	7410
IC4	555

Miscellaneous

S1	push to make momentary switch
S2, S3	proximity switch (2 off)
WD1	Audible warning device
Case	R/S style 509–298
p.c.b.	
grommets	

Constructor's Note

A complete kit of parts for the Seat Belt Reminder is available from **Watford Electronics, 33/35 Cardiff Road, Watford, Herts WD1 8ED (0923 40588).**

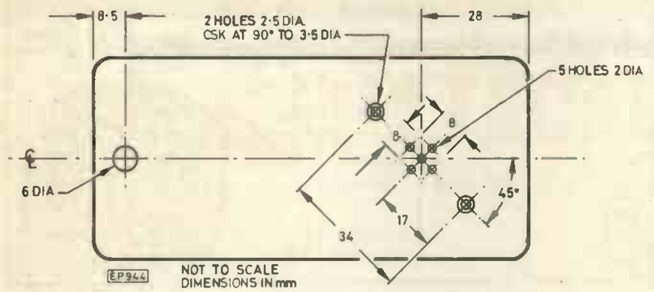

Fig. 4 Case drilling details

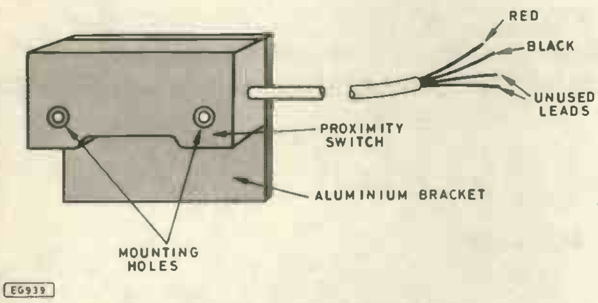

Fig. 5 Mounting bracket.

The actual method of mounting the proximity switches to the seat belts will depend upon the type of seat belts being used. *Note: Under no circumstances should the seat belt housing be drilled in order to fix the switches into position.*

It may be necessary with some seat belts to mount the switches on brackets to ensure the gap between the magnet and the switch is small enough. A suitable bracket is shown in Fig. 5.

The two unused wires on the switches should be trimmed before they are soldered to the p.c.b.

Before fitting the unit into a car connect the supply leads across the car battery. With the magnets removed from the proximity switches and with no earth on the door switch wire the alarm should sound. By following the procedure in Table 1 all the alarm facilities can be checked.

If the unit fails to operate correctly switch off and carefully check the orientation of the components. Remove IC2 and IC3 and with the supply reconnected check the supply rail is 5 volts to all the i.c.s. Next connect a link wire from pin 8 to IC3 to the supply rail this should sound the alarm. Insert IC3 and with S2 and S4 both open the alarm should sound. Finally, insert IC2 and check the output on IC2a pin 1 is high, pins 3, 4 and 5 of IC3b are high and IC3b pin 6 is low.

INSTALLATION

The unit can be sighted anywhere in the car but the following points should be taken into account.

1) The inhibit switch S1 should be within easy reach of the driver.
2) The leads of the proximity switches are only 300mm long and will need extending if the box is to be placed any distance away from the seat belts.

The proximity switches should be fitted to the seat belts using Superglue. The area on the seat belt under the switch should be smoothed before being glued. The magnet should be fitted to the seat belt tongue as shown in the photograph so that when the seat belt is engaged the gap between the magnet and the switch is less than 6mm to ensure correct operation.

Finally the door switch wire should be connected to either front door courtesy lights switch and the unit is then ready for use. ★

Space Watch...

THE DRUG POTENTIAL OF SPACE

A combination of technology from a Space organisation and a large Pharmaceutical group may within a few years have achieved the object of setting up space processing of drugs. There are a number of areas where the final chemical results required cannot be reached except in zero gravity. Some tens of millions of dollars and so far six years of moving forward is not regarded by either party as an experiment but rather as the foundation of a new industry. Both are satisfied that there are profits to be had in the venture. The electrophoresis processing unit in Shuttle mission 4 launched in June 1982 carried the first processing experiments.

The process of electrophoresis involves the separation of biological materials from their surrounding medium by passing fluids between walls having a potential difference between them. Different cells take up different charges and move in different paths as the medium is pumped. This method of separation has been in use for a very long time on Earth. However the advantages of the method cannot be fully realised under the effects of the Earth's gravity. The result is that only low grade and minute amounts of material of medical value are produced. Under zero gravity the situation is changed enormously. The convection currents and forces under normal earth conditions can prevent the necessary cell movements and changes.

Under the controlled conditions which can be found in zero gravity situations the value of the gains are 500 times the amount of the required commodity plus a bonus of an increase in purity of five times. The three types of unit devised are a production prototype for the payload bay of the shuttle, a mid-deck flight unit and a free-flying production version. A demonstration unit for verification was on Mission 4. It will also fly on Missions 6, 7 and 8. This unit is 6ft. high and can deal with 580 pounds weight having one processing chamber. The production units will have 24 chambers. By using a dye in the medium the astronauts will be able to monitor the processing. It is hoped that missions will by 1984 provide material which can be given to human patients as a final test of the validity and efficacy in normal gravity conditions.

BENEFITS

The planned programme will involve some forty different materials under examination for the space processing. The first of these have been selected on the grounds that they could benefit the greatest number of patients in special classes of disability.

Naturally there is a priority for those drugs which could provide for improved chemiotherapy particularly for cancer conditions. One of these is Antitryspin products. This material is able to inhibit the progress of emphysema. At the present time only small amounts are available for research purposes and are of low purity when produced in the normal gravity conditions on Earth. It is predicted that if the space processing is successful the number of patients who could benefit would be of the order of half a million.

Another substance which has already proved itself is Interferon. This fortifies the body against viral infections. It is now being developed for the treatment of cancer. Again the emphasis is on gravitational difficulties which result in low purity and small amounts. Again the estimate of purity of yield would increase the patient load to some 20 million per annum.

Growth hormone products are also in need of advanced yields in quantity and quality. This is particularly so in the case of the young where bone growth is inhibited and other deficiencies resulting in the quality and quantity of life. Another advantage is the improvement in healing of ulcers. Again only low purity material is available on Earth. The patient benefit could extend to three quarters of a million sufferers if it was available in the quantities that would be obtainable from space processing.

Beta cells are valuable for the treatment of diabetes. *There is a possibility of 1-dose cure.* It is thought that in excess of three million patients could be treated in a year. It has not been possible to isolate Beta cells in any quantity in normal gravity conditions. Here there is a great need for this section of the problem to be investigated.

Epidermal growth products are another useful area of research. They are important to the treatment of burns and general healing of wounds. Patient benefit could be over one million cases a year.

Finally in this short selection of the areas of interest to World Health are the Anti-haemophilia products. The present products are not only low purity but also lack the beneficial by-products. The need for this product is world wide.

The two companies are to have the benefit of free space on eight shuttle missions which is an indication of NASA's attitude to the peaceful use of space technology. The funding of the research is of course to be the responsibility of the user.

After two years it will be necessary for the developing group to have their own free space vehicle. It is possible there will be further information about the final production operation for inclusion in the next *SPACEWATCH.*

REACHING FOR THE STARS

In the last issue of *SPACEWATCH* I promised a survey of the achievements of the deep space probes Pioneer 10 and Pioneer 11. On March the 3rd this year Pioneer 10 completed the tenth year of its life. It has been a decade of success for the scientific world and was the most remote man-made device launched from its birthplace, Planet Earth. Its companion Pioneer 11 also shares in the honours.

On its birthday Pioneer 10 was at the heliocentric distance of 26·6926 astronomical units, 2·481 billion miles. It remains healthy. Its body of scientific equipment is in sound working order and it is returning data daily at the rate of 64 bits per second—collected by the 64 metre, deep space antennas of the Jet Propulsion Laboratory USA. The tragedy of this birthday was that Pioneer 10 will after this year be crying in the wilderness, unheard, its data radiating into empty space. A vehicle that has rewarded the designers and teams of researchers and maintenance engineers in a way that no human endeavour thought possible will soon be of no more use, not because it has failed; not because it is old; but because it is being *cut off* in its half life for the simple reason that the dollars are not to be made available. To throw away such a star performer is a tragedy of this age where everything is controlled by money. How little would be needed from each American citizen to provide the amount required. Perhaps there is a specialist organisation that could organise a "Save The Pioneer Fund". Surely this is a worthwhile cause when one considers the extra gain in facts and the employment of engineers. Is 3 Million Dollars too much to ask for such a thing?

Here is a catalogue of the achievements.

Firsts.

Flying through the asteroid belt.

The first planetary spacecraft to derive power from radioactive sources independent of distance from the Sun.

Established the environmental conditions round Jupiter and provided vital information for the design of later spacecraft.

Have extended the distance over which telemetry can operate successfully.

Determination of the vast distance over which the Solar Wind has effect.

Discovery of the large scale structure of the interplanetary magnetic field.

Discovered the ring and satellite features of Saturn not previously known.

Discovery of magnetic properties of Saturn.

And to this must be added what is but a short list of achievements. Major advances in the understanding of Jupiter and Saturn. The propagation of cosmic rays and solar energetic particles in the interplanetary medium. The acceleration of charged particles by interplanetary shock waves. Improved determination of the gravity fields of Jupiter and Saturn and the masses of their satellites. Improved knowledge of the hydrogen and helium abundance ratio in the atmospheres of Saturn and Jupiter.

Frank W. Hyde

Special Cassettes Offer!

V.H.S. VIDEO

V.H.S. E180 VIDEO CASSETTES (3 HOURS)

£7.65 each (minimum of 5); **£7.50 each** (min. 10); **£7.44 each** (min. 15); **£7.40 each** (min. 20) including VAT and postage.

Made for Videotone, these V.H.S. 3-hour tapes are of excellent quality and we are pleased to announce this new PE service.

Over the last couple of years PE offers arranged with Videotone have proved highly successful and we have now been able to arrange special prices (only available to PE readers) on these high quality tapes. The offer is a result of Videotone's direct selling policy; send in a current special PE coupon for prompt delivery of tapes.

We believe these tapes are excellent value and we are pleased to offer them to readers. They are covered by a money back guarantee (return within 21 days for refund). Not only are the tapes of high quality but the cassettes are of screw together construction and the case labels have space for notes on the recordings.

Send valid coupon to: **Videotone Ltd., 98 Crofton Park Road, Crofton Park, London SE4.**

BLOCK CAPITALS PLEASE

Please send me .... V.H.S. 3-hour Video tapes at £......... each. (£7.65 for 5 to 9, £7.50 for 10 to 14, £7.44 for 15 to 19, £7.40 for 20 or more; including VAT & postage.)

I enclose cheque/PO for £ ....

Name ....

Address ....

....

....

....

Coupon valid for posting before 10th September '82 (or one month later for overseas readers).

C90 AUDIO

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56p each (minimum of 5); **53p each** (minimum of 25). Prices include VAT and postage.

Made by a leading European manufacturer for Videotone, these tapes are of excellent quality and we are pleased to continue this PE service.

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We believe these tapes are the best value around and we are pleased to offer them to readers. They are covered by a money back guarantee (return within 21 days for refund). Not only are the tapes of high quality but the cassettes are of screw together construction and the case label has space for notes on the recordings.

Send valid coupon to: **Videotone Ltd., 98 Crofton Park Road, Crofton Park, London SE4.**

BLOCK CAPITALS PLEASE

Please send me .... C90LH Audio tapes at ....p each. (56p for 5 to 24, 53p for 25 or more; including VAT & postage.)

I enclose cheque/PO for £ ....

Name ....

Address ....

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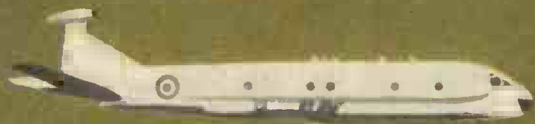
Coupon valid for posting before 10th September '82 (or one month later for overseas readers.)



SEARCHWATER

FRANK W. HYDE

CERTAIN requirements have been laid down for ideal equipment for peacetime as well as wartime surveillance. These demanding criteria are achieved by the Searchwater Radar System. They are achieved because Searchwater was designed to those standards. Most systems for one reason or another turn out to be modifications of an equipment which had another original purpose. Searchwater was deliberately developed against specific tasks. In this alone it is unique. The system has also been brought to operational condition in a short time and at a low cost, bearing in mind that demonstrated success sets it apart from all other systems. In short it leads the world but does its job without ballyhoo and "shouting from the roof tops". However, this brief article is an opportunity to bring to the notice of as many engineers as possible that contrary to the disparagements which forever appear in the media, British endeavour still leads the world. For obvious reasons of secrecy it is not possible to provide an extensive technical review of the system.

Because all the design requirements have been met and because after exhaustive tests the first users have discovered even more extensive capabilities in practical use, Searchwater has gone into service with the Royal Air Force in Nimrod Mark 2.

REQUIREMENTS

The main requirements for such a system are as listed below.

1 Detection and classification of surface craft in all weather conditions at ranges in excess of the radius of the effectiveness of hostile missiles.
2 To provide a measure of overlap in capability against other threats, detection ranges on submarine periscope and "snort" targets should be as great as possible in sea conditions up to the maximum in which submarines might operate.
3 The radar should have the capability to detect aircraft at long ranges although the characteristics of such targets are very different from shipping.
4 Classification performance should be as comprehensive as possible in order that in a wartime situation there could be no doubt as to whether the target is hostile and that it is a particular type of vessel before making an attack.
5 The radar must be able to operate in the presence of severe counter measures.
6 It must be possible to update methods of deception; this means active and passive deception measures.

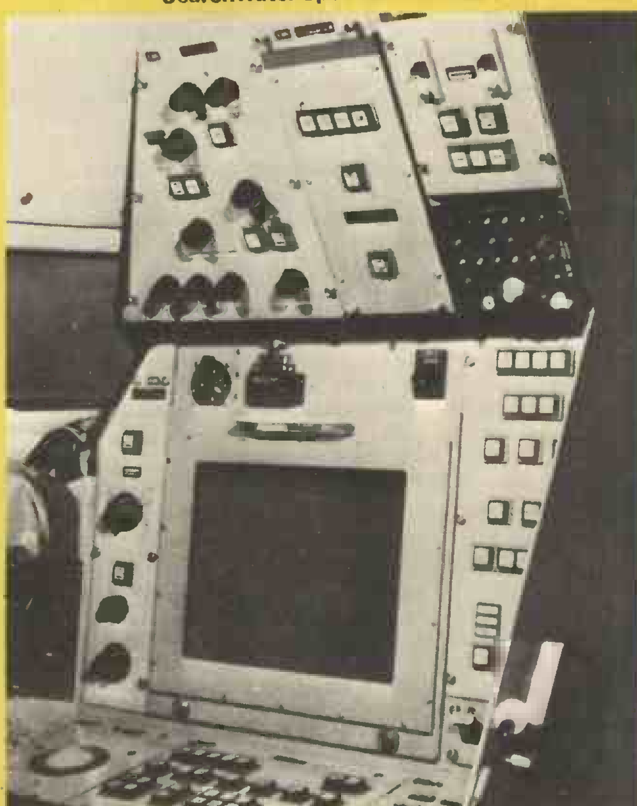
These parameters bring out the complementary measures which are desirable such as the ability to discriminate between real and false targets. This has to be true whether the deception is by way of disguising one craft to look like another, by the addition of reflecting devices or by electronic synthesis of false targets.

In maritime patrols there are long mission times and therefore operator fatigue must be taken into account. It follows that the parameters outlined for this equipment must lead to a considerable increase in operator load time. Therefore a maximum of automatic operation is required if such a system is to succeed.

PERFORMANCE

Searchwater provides, for all categories of target from periscopes to large surface vessels, a very high probability of

Searchwater operators console



...MARITIME RECONNAISSANCE RADAR OF THE FUTURE

detection combined with a very low false alarm rate in high sea states out to very long ranges. The mere increasing of sensitivity or the reduction of background noise level will *not* improve the target detection efficiency, especially if the sea is very rough and "clutter" return exceeds the receiver noise level. There are a variety of techniques which can be used to attempt improvements in this area.

In this equipment the domains of space, time, frequency and amplitude are all exploited; for example the dimensions of a patch of sea illuminated at any moment are kept small in azimuth by using a narrow beam width and in range by processing a narrow pulse generated by using compression techniques. Frequency agility is employed and the total number of returns during the time the aerial beam takes to pass a given point is integrated. Integration of information for the whole area over several aerial scans results in an improvement in target discrimination because the clutter characteristics change with time. In Searchwater this method of improvement is achieved by using a digital scan convertor for storage of information from scan to scan.

Immediately after the detection of the return signal a threshold is continuously adjusted using a control signal derived from the instantaneous clutter level so that, as near as possible, a constant false alarm rate is presented to the operator. The combination of all these techniques ensures that the display is virtually free of clutter and any new radar contact is immediately evident.

By using an integral real time digital computer many targets can be tracked automatically at one time. Various forms of high resolution display are available for the determination of the classification of data on targets being tracked. Integrated IFF identification, friend or foe) facilities provide another useful input. Information on the targets can be displayed readily in alpha-numeric form on a single radar display. After a short period of tracking the file on each target is so detailed that the vessels can be classified with great confidence without the need for visual confirmation.

The display is in television raster format on a black and white tube so that bright flicker-free information is shown to the operator. Radar controls, mainly push buttons, are arranged conveniently around the display and the operating routines are simple sequences of push button and roll ball movements.

No measurements are taken directly from the screen. The built-in computer takes care of many of the tasks automatically, consequently the operator can maintain a high level of efficiency for several hours at a time. This is in contrast to the more usual long persistence radar displays where operator performance is severely affected after about 30 minutes. There is also another relief for the operator in Searchwater in that there are built-in test equipments which enables automatic detection of faults and their diagnosis during operational flying. The modular construction and the use of software control allows easy incorporation of performace improvements and changes as may become necessary.

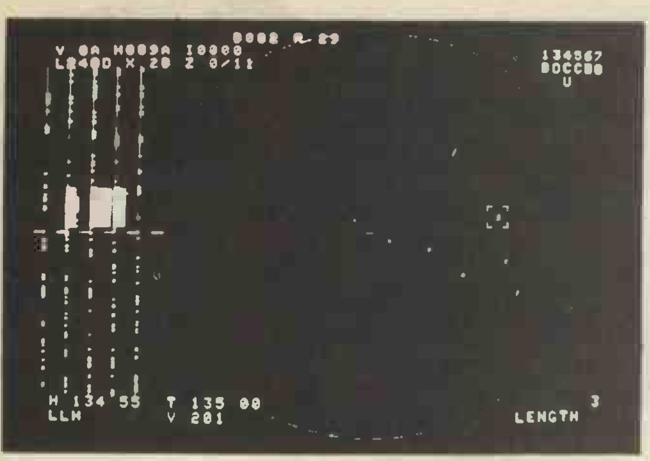
WHY

Airborne surveillance using long range aircraft equipped with a wide range of sensors is accepted by the NATO countries as the most effective means of obtaining up to date information to enable vital sea lanes to be protected. Threats to naval surface forces arise from three sources: submarines, aircraft and surface vessels.

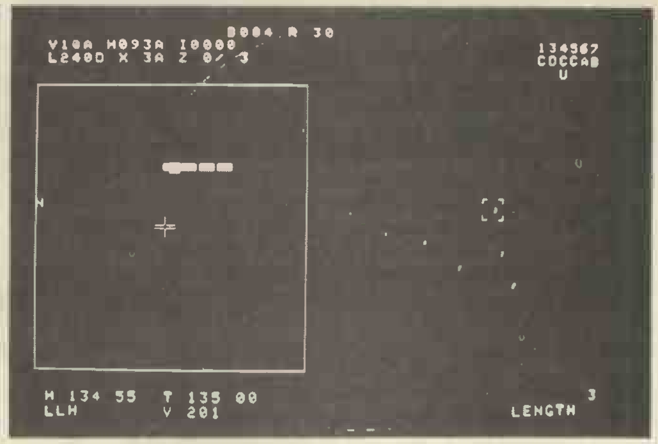
Opinion is divided as to which of these threats is the most dangerous. Whatever the opinions the fact remains that all the areas of threat must be taken into account if the philosophy of "sea control" is to be maintained. The matter presents problems because the characteristics of each target are different for each threat. This of course means that each is likely to need a different approach. The original intention was that Searchwater would fill the requirement for use in maritime airborne patrol. The result of this work has provided the most effective sensor system which is likely to emerge in the next decade.

Dealing with the maritime situation, it is clear that the major threat would come from frigates, destroyers and cruisers. Such craft are already fitted with surface to air missiles with ranges of engagement which preclude close examination and positive identification of the nature of the threat. Since development of missiles continues toward greater range and levels of operation, it becomes more important than ever to produce a system providing positive identification quickly. The same system is desirable in peacetime to reduce the flying time in identifying vessels by visual methods. Where there is a concentration of vessels it is extremely important to be able to recognise individual units from a place remote from the threat of missiles. The same criteria rule if there are many vessels strung out, for then the nearest approach must be outside the missile range of the nearest vessel.

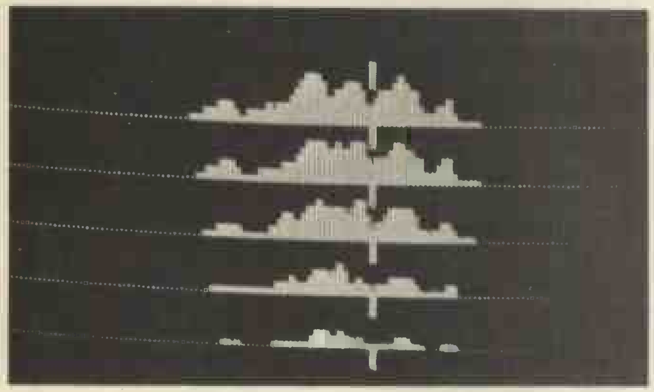
At such ranges optical, infra-red and electro-optical systems would be inadequate. Such a situation would arise in poor visibility with low grazing angles or because the inherent resolu-



PPI and A1 display, left hand display is a silhouette of the small square



PPI and B display, the large square is an enlargement of the small square



Searchwater A-scan display

tion of such system would be incapable of making positive identification.

IFF systems are not effective in situations of caution because they can only indicate that the ship is not an ally. If it is not identified as an ally there is no way of discovering whether it is a neutral vessel, a civil vessel or a hostile ship. The interrogation of electronic emissions is equally difficult. Experience has shown that the only positive system is one based on radar. To this end Searchwater has transcended all others.

ABILITY

The collaboration of EMIE and RSRE has been directed over a period of years to the identification and practical evaluation of those techniques most appropriate for the long range airborne surveillance and classification of marine targets; detection of small targets such as the snort of a submarine, its periscope or small fast patrol boats at long range in high seas.

The current state of the art is exemplified by the Searchwater which is highly flexible, based on frequency agile techniques using compression, pitch and roll stabilised scanning antennas with controllable tilt and automatic sector scan.

A Nimrod Mark 2 equipped with Searchwater and flying at 20,000ft can detect a submarine snort in rough seas at a range of 200 nautical miles. Since Nimrods are based on Ascension Island this could be one reason why Argentina did not risk its submarines or surface fleet in the South Atlantic. ★

BAZAAR

COMPONENTS 4166-2, 25-£10. Eproms 2716-10-£5 (require clearing) 8275-3-£6. 8202-1-5 Mr J. Walker, 7 Warnick Place, Peterlee, Co. Durham, Tel. P/lee 868 255 after 7 p.m.

UK101 8K cased, Cegmon fitted, p.s.u., cased, cassette, printer, sockets fitted. All manuals, cables. £150 extras, Mr H. Pye, 3 Thornfield Crescent, Little Hulton, Worsley, Manchester M28 6RF. Tel 061 799 9912

1000-2000MHz professionally made calibrated absorption wavemeter £35. Wanted Eddystone 880, non working considered. M. Mann, G4FFO, 45 Old School Lane, Milton, Cambridge, Tel: 0223 860150

TTY32 good condition off working circuit with tape reader and perforator on stand, paper and manuals. P. Knight, 7 Meadowlands, Seal, Sevenoaks, Kent 0732 62227

UK101 8K RAM complete with 20 inch TV set and cassette recorder plus 30 programs best offer J. Dilworth, 11 Abbey View, Monkstown, Co. Dublin, Eire. Tel: 800664 evenings

UK101 8K RAM, cased, 2000 Baud cassette, Wemon, MON 02, 2MHz, £130. Tel: Hemel Hempstead 3040.

TWO PSU's 13·5V one 5 amp at £7 Murphy. One 8 amp at £10 at £10 ICL. Both +.cge. or collect. Brian M. Kermode, 56 Brantwood Road, Bradford 9, Yorks.

AVO 72 Leather case, needs thick film resistor. AVO. Meter survey RADIAC. Needs batteries. Offers or w.h.y. W.H. Davis, Gate House, Little Barford, St. Neots, Cambs. PE19 4YB. Phone (0480) 72480.

WANTED ZX81 in return for an assortment of p.c.b.'s tubes, tuners. For b/w and colour TV's. Mr. T. Saunders, 24 Langdale Close, Lakes Estate, Bletchley, Milton-Keynes, MK2 3QA.

ARP QUARTET Polysynth perfect condition new must sell £295 o.n.o. Tejinderpal Sidhu, Amity, Strafford Road, Hounslow, Middlesex TW3 3EN. Tel: 01 570 7975.

BINATONE programmable colour t.v. game complete with two cartridge and adaptor, excellent condition, must sell £30. Tejinderpal Sidhu, Amity, Strafford Road, Hounslow, Middlesex. TW3 3EN. Tel: 01 570 7975.

4118 RAM 8 for £32. R. Boyce, Tel: Bracknell (0344) 57903.

RADIO and TV servicing 1958 to 1970 with Vol. one to seven £10 plus carriage. W. Edwards, 2 Beach Rd, Burton Bradstock, Bridport, Dorset. Tel: 030 889 625.

MICROTAN with Tanex and Keyboard. Fully expanded. Full document. p.s.u. avail. £200 o.n.o. Paul Simmonds, 80 St. Margarets Rd, Stanstead Abbotts, Nr. Ware, Herts SG12 8EN. (0920 870603).

LOWREY ORGAN LC88SG—1A. Auto rhythm bass etc. 6 years old. £750 o.n.o. Mr. D. Walkerdine. Tel: 0246 824016.

CLEARING Out ZX81 £20 + loads of electronic stuff cheap. Send s.a.e. please for list. No callers. G. Monaghan, 29 St John's Close, Linden Gardens, Leatherhead, Surrey.

URGENTLY require November 1975 copy of 'Practical Electronics' Your price paid. L. E. Fryer, 113 Ramsey Drive, Arnold, Nottingham. Nottingham 269023.

OSCILLOSCOPE New Heathkit Single beam 10MHz with trace doubler professionally built. Working, not calibrated £130 o.n.o. T. P. Hudson, 17 Sylvia Crescent, Testwood, Totton, Southampton SO4 3LP. Tel: Southampton 862577 Evenings.

PROFESS. Linear power supply. 10A 5V cont. fully over V/1 adj. to +7½V weight 14lbs. £27·50. N. R. Jones, Medway 666759 (evenings), Medway 43133 (day)

TELEPHONE MODEM: Computer Terminals Ltd. 1125 Telegraph converter. 100/300 Baud. Believed working. Offers please. Colin McCormick, 29 Randwick Park Road, Plymstock, Plymouth, Devon PL9 7QN. (0752) 47860.

8K UK101 12K basic Cegmon 32 x 48 display with new B1, B3 separate p.s.u. repeat key complete with case £220. Mr. T. Redding, 160 Stanhope Road, Smethwick, Warley, W. Midlands. 021 558 2694 9a.m. to 4p.m.

Audio Debug Probe...

CHRIS LARE

FAULT finding on audio circuits is not generally hard if a meter, 'scope and circuit diagram are available. Most equipment, and particularly that used for disco and P.A., is prone to failure at more inconvenient times when such aids are not available. On this note however, the lack of a circuit diagram is inexcusable, and it is good practice to glue a diagram to the inside of any equipment. The need for an audio probe arises once the equipment has failed, and on many occasions can enable the fault to be rectified with the minimum of difficulty.

In its basic form the audio probe is simply an audio amplifier which feeds an earphone. Using such a tool the path of the audio through the circuit can be followed and any breaks identified. However, such a probe will only assist in locating the faulty section, the actual fault being a chip failure, supply failure or a large d.c. offset caused by a leaky capacitor. In normal repair work the components in the faulty section are changed in order until the fault disappears, which is a tedious method, not to mention expensive in components.

The audio probe described here contains an amplifier in the conventional way, but also includes a three state l.e.d. voltage monitor. This monitor can be used to check supply rails and for any unusual d.c. offsets within a circuit, and thus narrows down the possible causes of a fault considerably.

SPECIFICATION

The probe was designed to be used with both single and dual rail audio systems, although its major use was intended to be op-amp based systems rather than power amplifiers.

In most audio circuits the signal should sit on a d.c. level which is very close to half the supply voltage. Accordingly the probe was designed to test for this condition by generating an internal half rail voltage and comparing the probe tip voltage with this internal reference. In order to make the probe suitable for both single and dual rail systems only two supply connections are used, these being connected to the lowest supply and the highest, which, in a dual rail system, will result in the internal reference being about 0 volts.

It is obvious that the internal circuit of the probe must be related to the supplies of the circuit under test and so no conventional regulation is performed within the probe. In order to avoid accidents if the probe is connected across a power amp supply an automatic shut down circuit operates which protects the probe from damage. Under normal circumstances an input supply voltage of less than 33 volts should be used, which is more than adequate for 30 volt op-amp supplies, or ± 15 volt supplies. The prototype also functioned happily with a single 5 volt supply.

The voltage display takes the form of three l.e.d.s indicating 'Low', 'Centre' and 'High'. The l.e.d. supply is individually regulated so that brightness does not vary with supply voltage.

CIRCUIT

The circuit consists of three sections, amplifier, voltage comparator and power supply control as seen in Fig. 1.

The probe input is connected to the main circuits via R1, which together with D1 and D2 protect the following stages from excessive voltages. The amplifier itself is a.c. coupled and the input is biased to half rail by R4. The first stage serves as a buffer, which feeds a small power amplifier circuit providing drive for the earphone. The amplifier is operated in Class B, with R9, D3 and R10 providing some base bias. The feedback of this amplifier is taken right from the output which helps cut down distortion, and at the same time gives a variable gain control via VR7. C2 obviously acts as a d.c. block for the output, which should ideally be a 600R earphone, although R11 and R12 can be dropped to 68R to drive lower impedances.

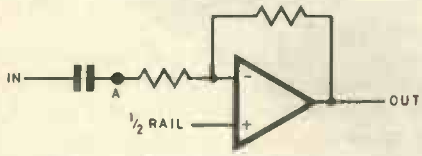
The voltage detector is based on a LM339 quad open collector output comparator. A reference chain (R14, 15 and 16) gives the internally derived centre point used for the probe voltage comparison. The top and bottom comparators detect high and low probe voltages and drive the relevant l.e.d.s directly. The centre two comparators are connected identically to the outer comparators, so that when neither of the outer two outputs are low (l.e.d. on) neither of the inner outputs are low, thus TR3 switches on and the green 'Centre' l.e.d. comes on. It is worth noting that it would have been possible to design the circuit using only two comparators but this method was adopted because it was more compact in terms of pcb space. Since only one l.e.d. can be on at one time a single current limit resistor was used from a simple regulated 5 volt supply.

R13 is used to provide a half level bias to the comparators when the probe is open circuit so that the green l.e.d. lights.

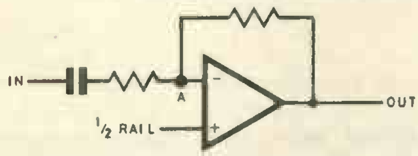
The supply control is very simple. D4 protects the probe against reverse supply connection, and TR6 provides the over voltage shutdown. Under normal circumstances D5 will not conduct, hence TR4 will be off, TR5 on, and thus TR6 will pass current to the circuit. If the input voltage exceeds

33 volts D5 will conduct, removing base drive from TR6 by means of TR4 and TR5, and the probe will shut-down. Obviously the maximum safe supply is determined by the breakdown voltage of TR6.

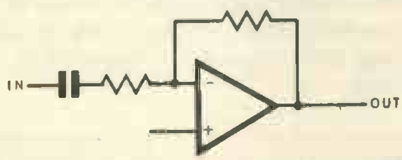
The supply required regulating to ensure that the l.e.d.s were visible with low voltages but did not overload the comparator output stages with high supply voltages.



Symptom: A not centre (low)
Output high
Likely: Capacitor leaky

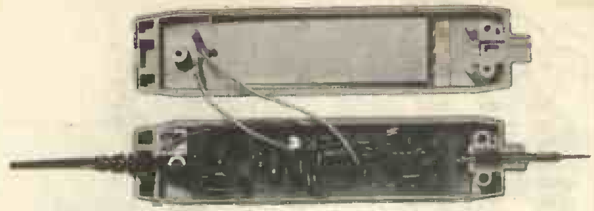


Symptom: A not centre
Likely: Feedback resistor fault



Symptom: Output d.c. level settles after switch on. Probe on non-inverting input cures problem
Likely: Non-inverting input not biased to half supply

Fig. 2. Simple faults



Showing Probe interior construction

CONSTRUCTION

The prototype was built into a standard probe case. The small size of this case means that most of the components were mounted vertically, although the power supply control parts were mounted flat allowing alternative potentiometers to be mounted above them if required.

The prototype board was produced with an etch resist pen, so it can be done, although a commercial board would obviously ease things considerably. It is suggested that whatever board is chosen it should be fitted into the case before board assembly commences. Apart from taking care to mount the vertical components so that no wires can touch no constructional points need be noted. Fig. 4 shows the suggested preform for the l.e.d. leads.

An enclosed skeleton potentiometer was used in the prototype for VR7. Three holes were drilled in the case and the preset glued down. Wires were then soldered onto the pins protruding through the case inside.

TESTING

It is as well to test the unit before final assembly. Connect a 15 volt supply to the unit and vary the probe voltage by means of an external potentiometer. Check that the green

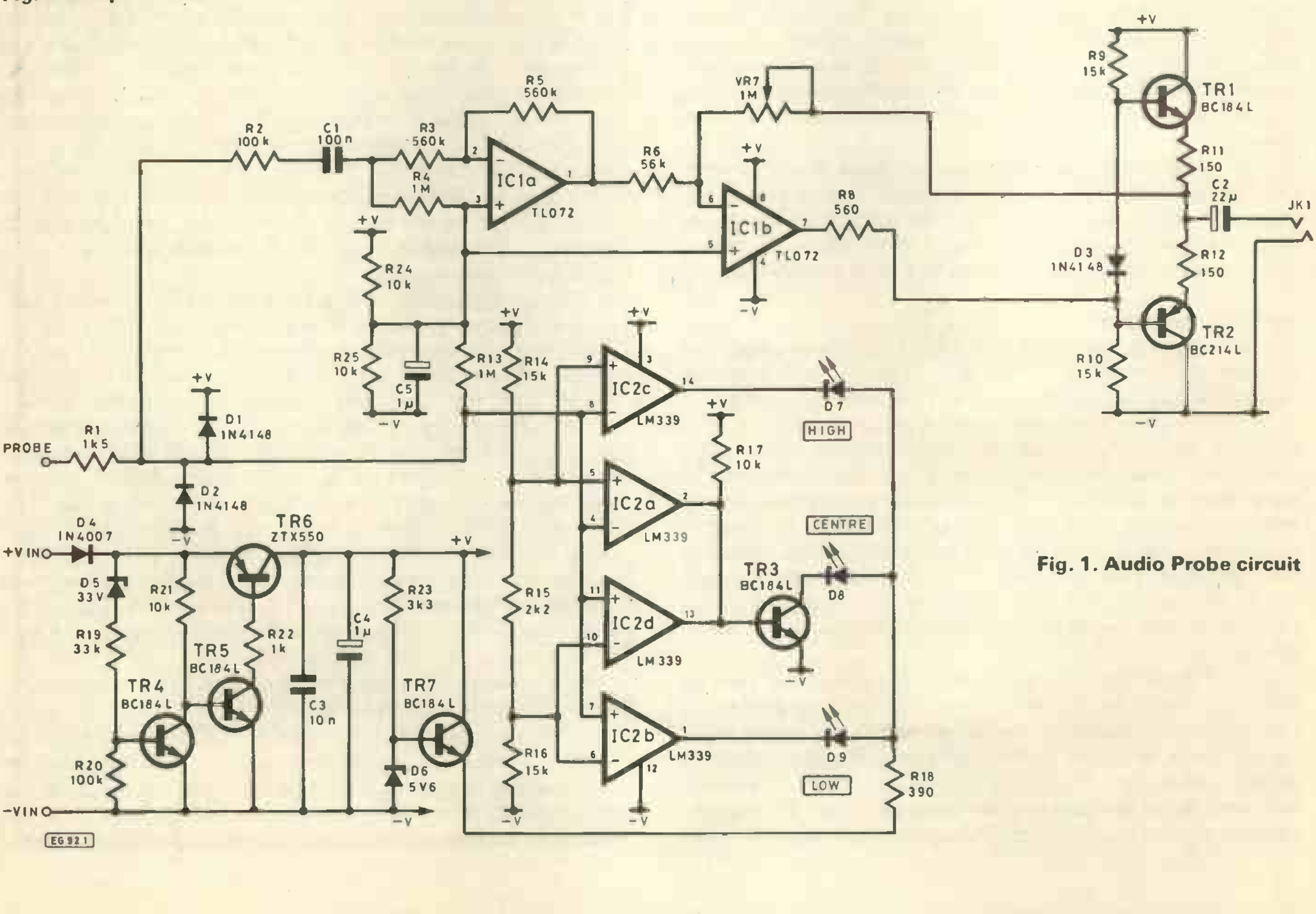


Fig. 1. Audio Probe circuit

l.e.d. centres at 7·5 volts and that both the high and low l.e.d.s come on correctly. Remove the potentiometer from the probe and connect in a signal level audio source to check the amplifier, adjusting the volume with VR7. Finally, slowly increase the supply voltage to 36 volts. Ensure the l.e.d.s go out when the supply exceeds some 33 volts, indicating that the protection circuit functions. If it does not appear to function do not increase the supply above 36 volts or the i.c.s in the probe will fail.

The board may be placed in the case and the top fitted. The best way seems to be to insert the l.e.d.s into their holes at the front of the lid and then press the rear of the lid into place. It may be necessary to remove one or more of the plastic pillars in the case which would otherwise foul against the jack socket or one of the transistors.

IN USE

The probe should always be used with a signal being input to the circuit under test. Firstly follow the signal using the amplifier until the problem area is located. Most frequently the output of the problem stage will have a d.c. offset present, and this can be traced back to the input, or a faulty output by means of the voltage level display. For example if the input of an inverting amplifier is biased slightly below half way and the output is high either the amplifier is suffering from high leakage current or a d.c. blocking capacitor is at fault. ★

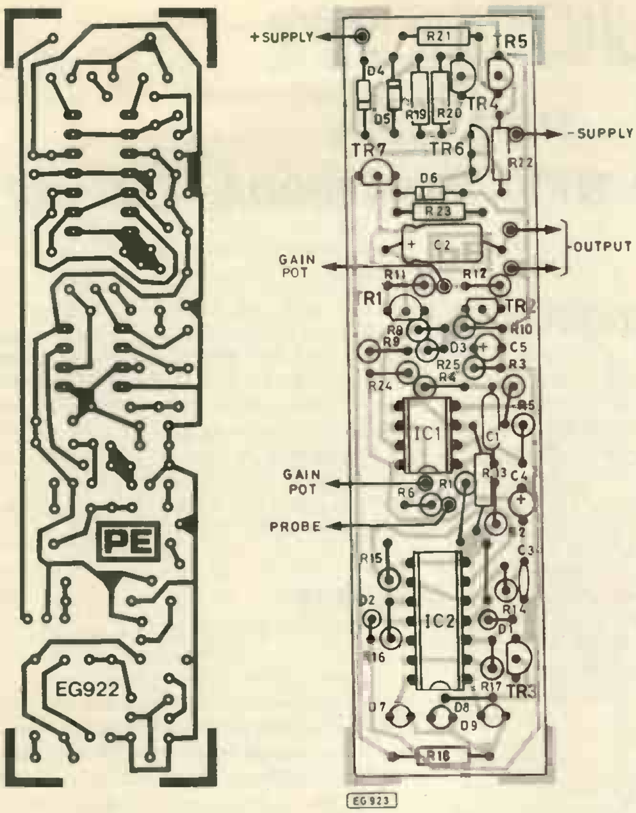


Fig. 3. Showing p.c.b. and board construction

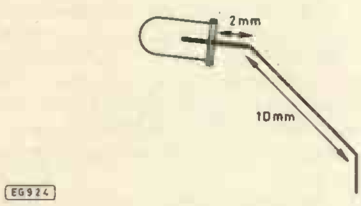
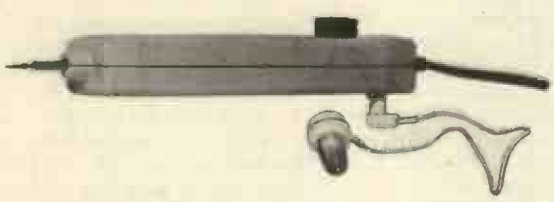
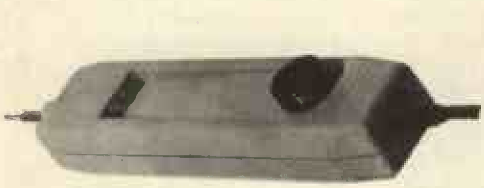


Fig. 4. L.e.d. leg bending details



Cross section view of Audio Probe showing earphone inserted



View of Probe top showing the three state l.e.d. voltage monitor

COMPONENTS ...

Resistors

R1	1k5
R2, 20	100k
R3, 5	560k
R4, 13	1M
R6	56k
VR7	1M skeleton preset enclosed
R8	560R
R9, 10, 14, 16	15k
R11, 12	150R
R15	2k2
R17, 21, 24, 25	10k
R18	390R
R19	33k
R22	1k
R23	3k3

All $\frac{1}{4}$ watt

Capacitors

C1	0·1µF polyester C280
C2	22µF 25 volt electrolytic
C3	0·01µF ceramic disc
C4, 5	1µF 35 volt tantalum

Semiconductors

D1, 2, 3	1N4148
D4	1N4007
D5	33 volt 1·3W Zener
D6	5·6 volt 400mW Zener
TR1, 3, 4, 5, 7	BC184L
TR2	BC412L
TR6	ZTX550
D7, 9	Red l.e.d. 1·25 mm
D8	Green l.e.d. 1·25 mm
IC1	TL072
IC2	LM339

Complete probe case with probe, supply wire and fittings, printed circuit board, 3·5 mm jack socket, wire.

SEMICONDUCTOR UPDATE

R.W. Coles

FEATURING MICRO/T-11 TDA 2009 TDA 2320A CDP 1871

PDP11 ON A CHIP

The Digital Equipment Corporation, or DEC to its friends, is probably the world's number one supplier of minicomputers. I am sure that most people will have at least heard of their major products, namely the PDP8, the PDP11 and the VAX range of minicomputers which feature 12, 16 and 32 bit word lengths respectively. Of the three families, the PDP11 is undoubtedly the most popular with a model to suit the majority of applications, from the tiny PDP11–03 with twin floppies to the powerful PDP11–70 with many megabytes of hard disc storage.

The DEC PDP11 family with its common instruction set and 16 bit bus has also influenced the microprocessor scene, since many chip designers have used its architecture as a model for their own more humble offerings. The Motorala 6800, for example, was an early attempt to put as many PDP11 features as possible onto an 8 bit NMOS chip. DEC themselves saw the advantages of an LSI implementation of their popular family, and soon brought out the LSI 11 multi-chip emulation which is used in their low-end systems such as the PDP11–03. The closest design engineers could get to this chip set however, was to purchase the DEC LSI 11/2 or the LSI 11/23 single board computers, since DEC never released the chips for sale to third parties.

With increasing competition from 16 bit microprocessors such as the Intel 8086 and the Motorala 68000, DEC realised that there is a large and expanding market for 16 bit single chip processors for which the LSI.11 boards cannot always compete, and so they went back to the drawing board and produced the MICRO/T–11 single chip PDP11 processor which looks much more like a "conventional" microprocessor than their earlier attempts. Once again, the first use of the T–11 is in a DEC single board computer called the SBC 11/21 which will compete directly with the popular Intel SBCs for applications in real time control and data processing, but this time they intend to sell the chips too, and that is exciting news.

Exciting, because for the first time it is possible to build a customised system which executes the full PDP11 instruction set, exciting too, because the T–11 is a "nice" processor with a lot of useful features which are unavailable from the competition. Perhaps most original is the user option of either a 16 bit or an 8 bit data bus; you tell the T–11 which of these you want via an external mode register during reset. A 16 bit bus is faster of course, because one memory access gets you one data or instruction word, but it does also mean that the memory array has to be arranged as a 16 bit x nK array so you may need, for example, 2 x 2716 EPROMs in parallel for your program memory. The 8 bit option would allow you to use, say, a single 2732 EPROM to store the same instructions, but the chip would in this case carry out two sequential reads to get a single word and therefore it does take longer. The 8 bit mode saves chips and wire for small systems while still providing the power of the PDP11 instruction set.

Another nice feature of the T–11 is an on-chip dynamic memory address multiplexing and refresh scheme for the simplest possible interface to 16 pin dynamic RAM chips, although once again a user option of static or dynamic memory support is provided. Add to this a comprehensive interrupt scheme with four prioritised inputs and 16 internally generated vectors, an internal clock generator which works up to 7·5MHz, easy interface to industry standard 8 bit peripheral chips, and the usual PDP11 feature of eight 16 bit general purpose registers, and you can see why the T–11 is likely to be a winner!

Despite its 16 bit operation and advanced features, the T–11 fits in a standard 40 pin package and uses a single 5 volt supply.

STEREO PAIR

Audio amplifier construction continues to get simpler, thanks to advanced integrated circuit technology. SGS ATES have recently introduced a pair of devices which make the assembly of a powerful stereo amplifier system an almost trivial activity.

Their TDA 2009 dual power amplifier device features two low distortion audio amplifiers in a single eleven pin MULTIWATT package. Each amplifier will provide at least 10 watts of output at 0·5%. THD, and can supply output currents of up to 3·5 amps. Relatively few external components are required and the TDA 2009 can be run from a single low voltage supply rail. The diminutive MULTIWATT package comes with a substantial heat sink tab and a mercifully low thermal resistance of 3°C per watt so that full power can be realised with the use of a simple external heat sink.

With a super power amplifier like the TDA 2009, you will probably also need a high quality preamplifier, so SGS–ATES have brought out the TDA 2320A to match. This device lives in an 8 pin diddy—d.i.p. and yet contains a matched pair of low noise preamplifiers for stereo audio amplification. Unlike its big brother, the TDA 2320A has a very low current consumption of about 0·8 milliamps, and will work from supply rails of 3 to 36 volts. Noise figures are low at about 1 microvolt r.m.s. and there should be no complaints about the THD of typically 0·03%.

At this rate, it can't be long before we find a stereo amplifier with 50 watts per channel taped to the front of *Practical Electronics* as a giveaway!

LOW KEY

For many microprocessor systems, a keyboard is an essential companion. Conventional QWERTY keyboards can be obtained ready built and with an encoder built in (at a price!) but many systems need a non-standard keyboard array. In this situation the designer can either wire up the switch matrix to a couple of 8 bit parallel ports and write a software routine to scan the keyboard and encode the result, or he can buy an LSI keyboard encoder chip to do the job for him. No problem so far, because NMOS encoders are available from Intel and others and these do an admirable job. But what if the system is battery powered and uses a CMOS micro? The NMOS encoder will take more current than the rest of the circuit put together, so until recently it was necessary to use a software solution or to build up a special encoder from CMOS logic chips.

One low power CMOS microprocessor family to suffer from this shortcoming has been the 1802 series from RCA, but not any longer, because RCA have now introduced the CDP 1871 which is a full-house CMOS keyboard encoder drawing only about 100 microamps at 5 volts. Inside the 1871 are all the counters and scanning circuitry to interface to an array of up to 53 ASC11 coded keys and up to 32 HEX coded keys, along with N-key lockout logic and debounce circuitry. The 1871 can be hooked directly on to the bus of most microprocessors where it can be addressed as either an I/O device or as memory. Two output flags are provided to inform the processor of the keyboard status. EFXA goes high to indicate that data is available and an additional flag, EFXB, is used to signify that the key is still pressed after it has been read. This last facility can be used to provide the auto-repeat function if required.

The 53 ASC11 key codes assume a conventional keyboard matrix with SHIFT and CONTROL keys, but the HEX keys generate a binary pattern between 80H and 9FH which can be used for arbitrary user defined applications.

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The modular design of our mixing desk enables the number of channels to be easily expanded using a backplane motherboard which allows each complete channel to simply plug in. Channel features include Pre Fade Listen, l.e.d. peak indication and equalisation.

The system, which is ideal for demo tape work or for producing professional audio visual tapes, uses four master channels for mixing down.

MICRO-PROFESSOR COMPETITION

PRACTICAL

ELECTRONICS

OCTOBER ISSUE ON SALE FRIDAY, SEPTEMBER 10th

CB Scanner

C. F. SHORTO and M. WARD

Micro Communications Equipment and Design Ltd.

THE concept of this CB Scanner design is to provide mic. controlled channel change and full 40 channel scan facilities. This enables a transceiver to have the following advantages:

1) The ability to change channel from the mic. which most motorists will find much safer than reaching across to the rig and in doing so probably obscuring the channel display anyway.

2) The disabled can sit back at home with the mic. on their lap and use the light touch of the channel buttons to change channels which is so much easier than reaching out and twisting the channel switch, this, will be quite an advantage to people who suffer with arthritis and rheumatism.

The design, as given here, fits Uniden, Audioline and Realistic types of CB transceivers although practically all CB transceivers produced to CB 27/81 specifications can be fitted with this unit, although slight modifications will be necessary.

A list of CB transceivers which can be fitted with the Scanner are detailed in Table 1. The prototype unit was designed with future modification for other CB transceivers in mind, however, it was felt that the Uniden 200 is probably the best CB transceiver on the market at this time, by virtue of its ability to withstand strong signals from adjacent channels (bleed over and de-sensing) although this is possibly because Uniden carried a proven design from previous a.m. transceivers with minor modifications, the similarity between the a.m. Cobra 19 G.T.L. and the Uniden 100 both in looks and circuitry bears this out, whereas many manufacturers started from scratch.

Harvard	**Max Com Apollo 16**
Rotel	**Midland 2001/3001/4001**
Yorks	**Harrier CB & CBX**
Amstrad	**Fidelity**
Cybernet 2000/3000	**Radiomobile**

TABLE 1

Audioline and Realistic use the Uniden chassis and are, therefore, effectively covered by this article.

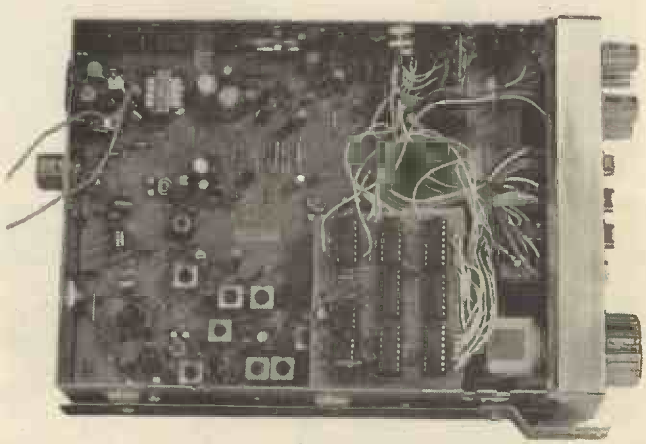
The full 40 channel squelch controlled pause scan facility provided by the Scanner enables the operator to monitor the entire CB bands, a single press of the scan button will set the unit in motion automatically checking each channel in succession and when it finds a signal strong enough to open the squelch, it will pause for 5 seconds or until the signal ceases whichever happens first. If the operator wishes to stop on a channel, at which the Scanner had paused, or to stop scanning and use the manual control, a further press of the scan button or a single press of the mic. button is required, the Scanner will single step the channels up or down by repeatedly pressing the up or down buttons, however, if you push and hold the up or down buttons the Scanner will automatically step-through the channels in that direction until the button is released, this enables fast channel change when a large amount of channels are to be bridged.

The 40 channel scan can be implemented without the use of the special microphone by simply wiring to a panel switch so that when switching to scan control the Scanner starts automatically and can be stopped by a single push of the mic. button.

CIRCUIT DESCRIPTION

The circuit diagram of the CB Scanner, is shown in Fig. 1. In order to produce a count from 1 to 40 a trick used by CB PLL chip manufacturers has been adopted, IC6 and 8 are BCD/binary up/down counters which actually count from 0 to 39 however, the code for 0 is converted into that of 40 by IC10 which adds the missing bit to make the zero appear as 4 in the most significant digit. IC7 and 9 are BCD to seven segment decoder/drivers, these i.c.s convert to output codes of the counters to drive the channel display of the CB transceiver, in the case of the Uniden chassis the PLL chip derives its channel selection code from the display drive lines and, therefore, interfaces readily with this circuit, most other makes of CB transceivers use a six bit BCD code with channel 40 represented by zero to derive their channel information, these can therefore be driven directly from the counter outputs.

It was thought reasonable that the transceivers, when under control from the Scanner, should be made to power up on the calling channel (14), the parallel load data inputs are therefore hard wired with the code for channel 14, when power is initially applied, C13 will charge through R14, but due to the delay in doing so a short positive pulse is applied to the parallel load input, thereby latching 14 into the coun-



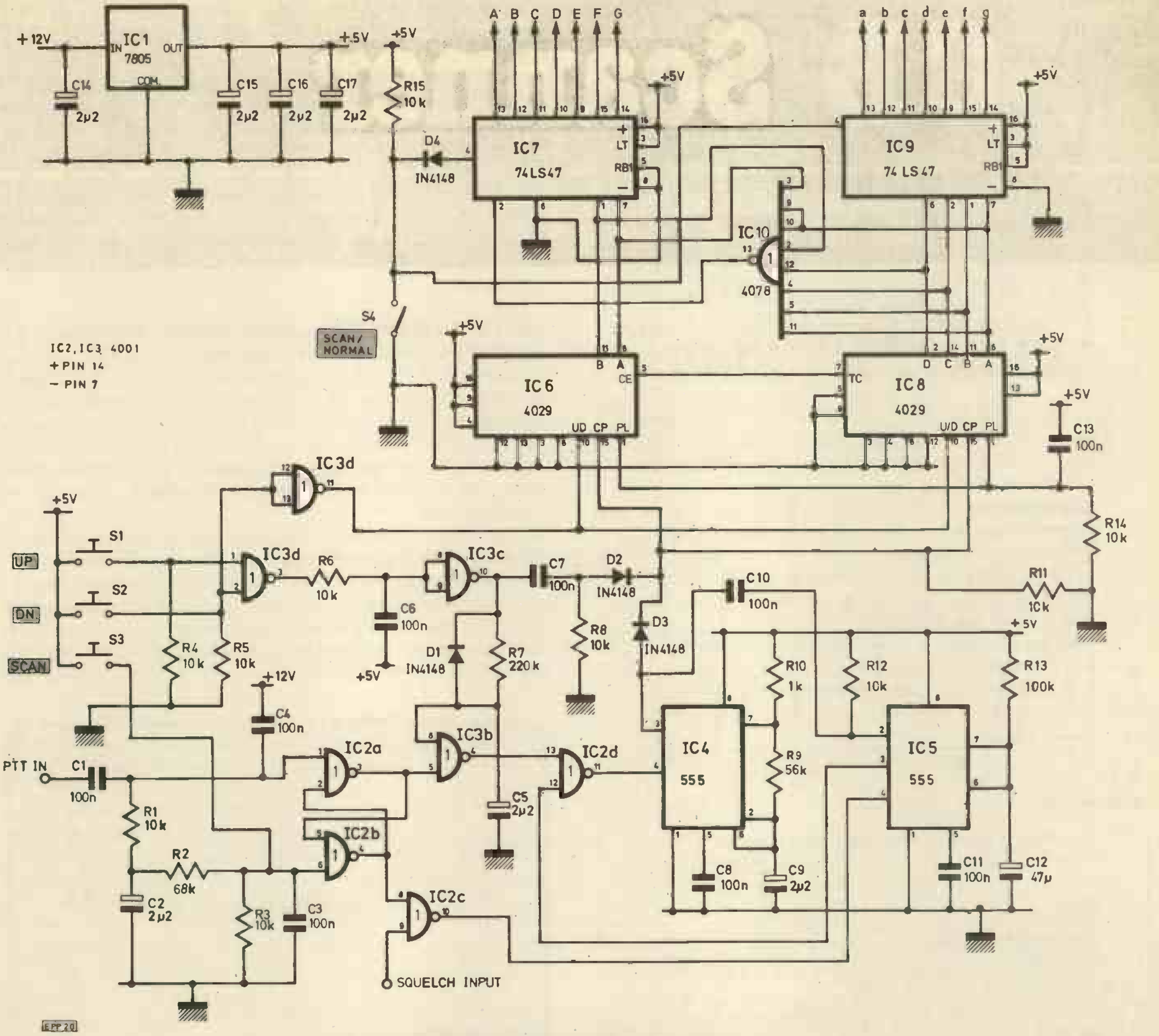


Fig. 1. Circuit diagram of the Scanner

ters from power up and then returning control of the counters to the clock inputs.

The two up and down buttons are gated together and fed through a short delay circuit formed by C6 and R6 and coupled via C7 and D2 to the clock inputs of the counters. If either up or down buttons are pressed a single pulse is placed on both counters, the terminal count (TC) output of IC8 will only enable IC6 to clock at the appropriate times. The up/down inputs of the counters normally reset in the up condition, however, if the down button is pressed the counters are put in the down mode until this button is released. If either the up or down buttons are held pressed for more than half a second C5 will charge through R7 and provide a logic 1 to the input of a NOR gate this, via a second NOR gate, will enable the clock oscillator formed by the IC4 to repeatedly clock the counters in the direction designated by the up/down buttons.

Two cross coupled NOR gates are used to form a simple latch, C4 ensures this latch powers up in the reset mode, if the scan button is momentarily pressed, the latch will be set (start scan). To reset the latch (stop scan) you may either press the mic. button which will pulse the reset input of the latch or press and hold the scan button, initially this will attempt to set the latch, however, this will have no effect as it is already set, then C2 will charge via R2 and will reset the latch via R1.

The latch when set will enable the clock oscillator IC4 which will clock the counters through all 40 channels in succession, also IC5 which is a 5 second delay circuit is enabled and when the squelch of the CB transceiver is opened by a signal, this delay circuit is triggered which holds the clock oscillator for 5 seconds or until the signal ceases whichever happens first. The Scanner is powered by a 5 volt supply via the regulator IC1.

CONSTRUCTION

The Scanner has been designed to fit into most CB transceivers, in order to do this it was necessary to design a double sided, through hole plated printed circuit board, the track patterns for which are shown in Figs. 2, and 3 with the

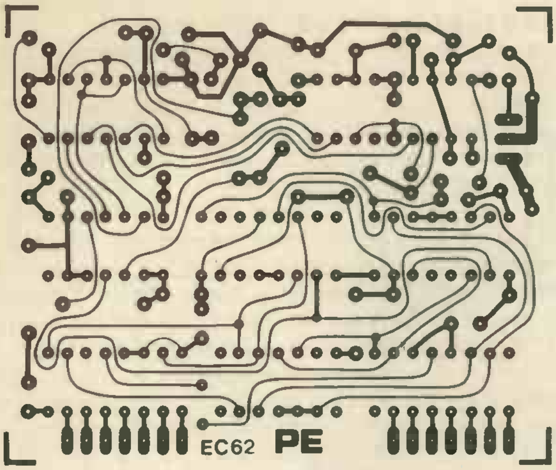
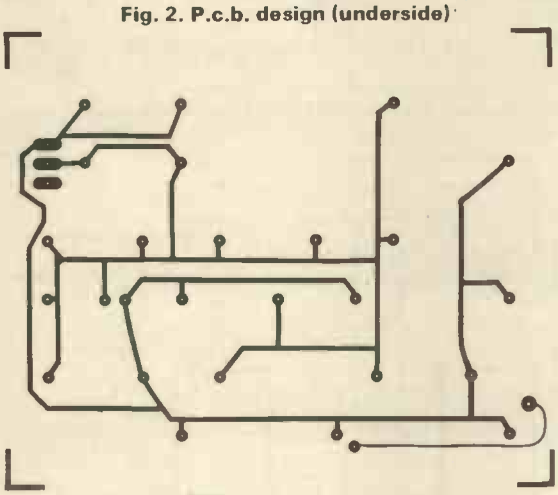


Fig. 2. P.c.b. design (underside)



EC63

Fig. 3. P.c.b. design (component side)

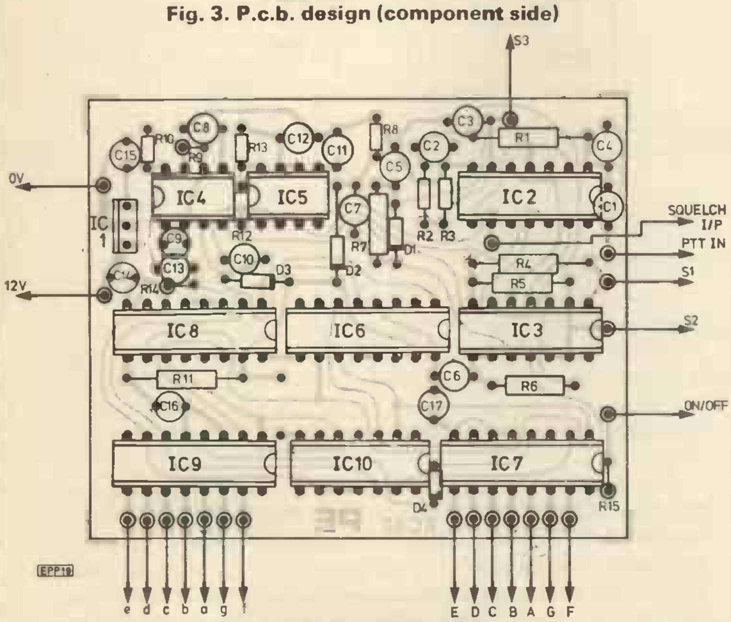


Fig. 4. Component layout

component layout shown in Fig. 4. No mounting holes have been provided although there is ample space for the constructor to include them if required, however, it is often difficult to find suitable mounting positions inside transceivers and the prototype was mounted between two pieces of $\frac{1}{2}$ in. thick foam rubber which provided support, insulation and some degree of shock resistance.

When assembling the components onto the p.c.b. the resistors and diodes should be fitted first followed by the i.c. sockets (if used) and then the capacitors and finally the regulator i.c. as it is the largest component. This order of assembly is not critical but fit the lowest height components first to enable the board to be turned over whilst soldering. One or two resistors will need to be stood on end and they should be left until later.

If i.c. sockets are not used the i.c.s should be inserted last, especially the 5 CMOS i.c.s which are to some extent static conscious and the normal precautions should be taken. If i.c. sockets are used the i.c.s can be left out until the board is finally wired into the transceiver and ready for testing.

INSTRUCTIONS TO MODIFY YAESU MIC YM = 35 TO WORK WITH SCANNING UNIT

To modify a YM = 35 microphone, first undo the 3 screws at the back of the mic. to allow access. Then carefuly lift out the push to talk switch and prise the white plastic piece that covers the mic. insert and the 3 push button switches (the white plastic will be tight as it is glued in one spot). Once this is removed follow the instructions in Fig. 5

If it is required to implement the use of the Scanner without the microphone control C3 should be omitted from the p.c.b. and the switching instructions shown in Fig. 6 should be implemented. When the button wired for scan selection is pressed the Scanner will auto start and pause under the control of the squelch as usual if it is required to stop on a channel currently being monitored by the Scanner a short press of the microphone switch will achieve this.

COMPONENTS . . .

Resistors

R1, R3, R4, R5, R6, R8, R11, R12, R14, R15	10k (10 off)
R2	68k
R7	220k
R9	56k
R10	1k
R13	100k

All resistors $\frac{1}{4}$W 10% carbon

Capacitors

C1, C3, C4, C6, C7, C8, C10, C11, C13	100n (9 off)
C2, C5, C9, C14, C15, C16, C17	2μ2 (7 off) tant. bead
C12	47μ

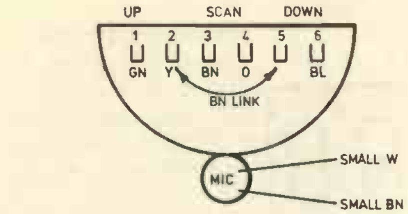
Semiconductors

D1–D17	1N4148 (17 off)
IC1	7805
IC2, IC3	4001 (2 off)
IC4, IC5	555 (2 off)
IC6, IC8	4029 (2 off)
IC7, IC9	74LS47 (2 off)
IC10	4078

Constructor's Note

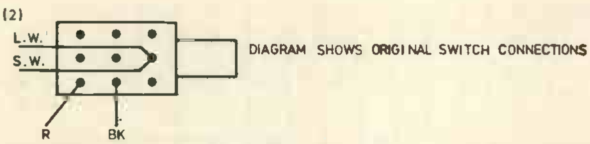
A complete kit of parts for the Scanner is available from Micro Communications Equipment and Design Ltd., 5 St. Patricks Avenue, Weymouth, Dorset DT4 9EQ. Tel. 03057 71355. (Price £12.00 plus 50p p.&p. plus V.A.T.) The p.c.b. is available separately (price £4.00 plus 50p p.&p. plus V.A.T.).

A suitable microphone (YM35) is available from South Midlands Communications Ltd., SM House, Osborne Road, Totton, Southampton.

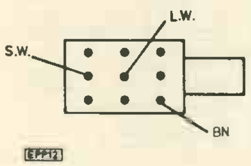


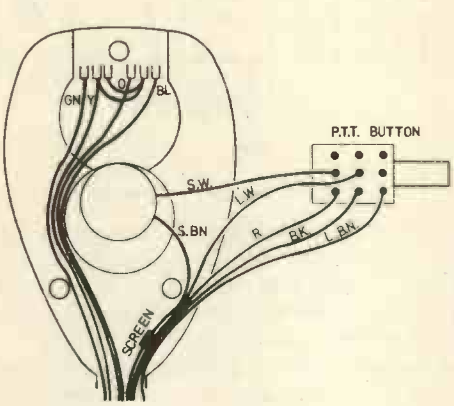
(1) REMOVE BROWN WIRE AND LINK A WIRE FROM THIS PIN 3 TO PIN 5

(2)



(3) REMOVE THE 2 WHITE LEADS (LARGE AND SMALL) AND CONNECT AS SHOWN IN DIAGRAM BELOW. ALSO CONNECT BROWN WIRE, REMOVED IN STEP (1), TO NEW POSITION SHOWN IN DIAGRAM BELOW.





YAESU MIC YM-35

MIC WHEN MODIFIED SHOULD HAVE WIRES AS ABOVE
TO MODIFY MIC AS BOUGHT FOLLOW THE FOLLOWING INSTRUCTIONS.

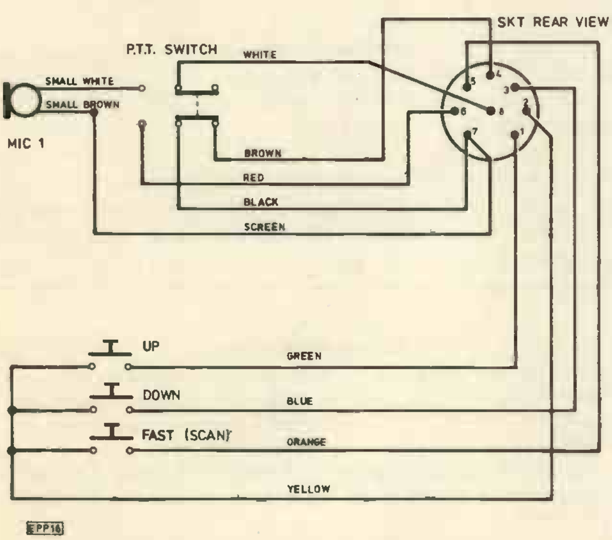


Fig. 5. Instructions to modify Yaesu mic.

FITTING INSTRUCTIONS

To fit the Scanner into Uniden type transceivers it is necessary to electrically isolate the channel switch contacts from the display and PLL chip inputs, to achieve this cut all the tracks leading to the switch display drive contacts ensuring that both display current limiting resistors and PLL chip inputs remain connected together. The pin connections of the channel switch are shown in Fig. 7, the letters refer to the segments of the displays, capitals being the most significant digit (MSD) and the lower case letters being the least significant digit (LSD). The three letters shown in brackets are segments of the least significant digit display, however when unmodified they only drive the display and the equivalent un-bracketed letters drive the PLL chip inputs. The difference between the two 'a' and 'd' contacts is that the top and bottom segments (wrap round) are displayed with 6s and 9s by the bracketed pins but the PLL chip will not decode this, the other contacts produce the same output with the exception of the wrap round on the 6s and 9s.

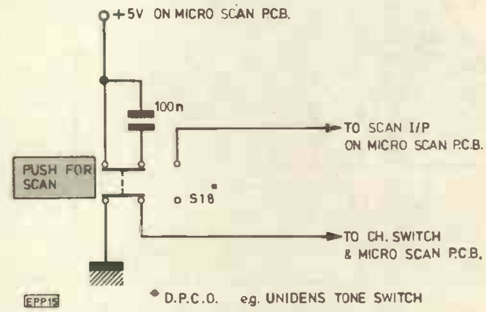


Fig. 6. Scan circuit without mic. control

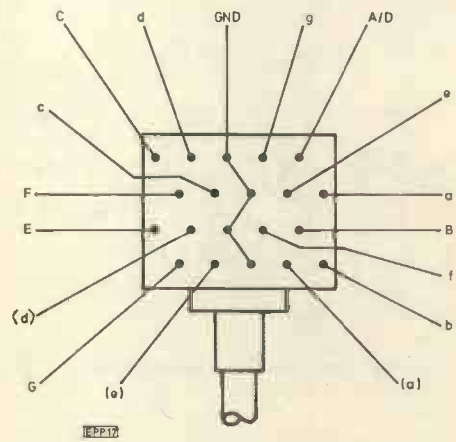


Fig. 7. Channel switch pin connections

These are now used for both display and PLL chip drive because the 74LS47 decoder drivers also omit the wrap round (although provided wrap round was never used on early Cobra/President type transceivers). The 'e' is a complete duplicate of its counter-part and may be disregarded thereby simplifying changeover from channel switch to Scanner control. The three display segments isolated from the bracketed letters are connected to their counterparts but on the PLL input side of the track cuts. Thirteen diodes are now required to bridge the tracks cuts, the cathodes of which are connected to the channel switch side.

One of the track cuts may be implemented by moving a wire link and replacing it with a diode, Figs. 8 and 9 clearly shows where cut tracks should be made and diodes fitted,

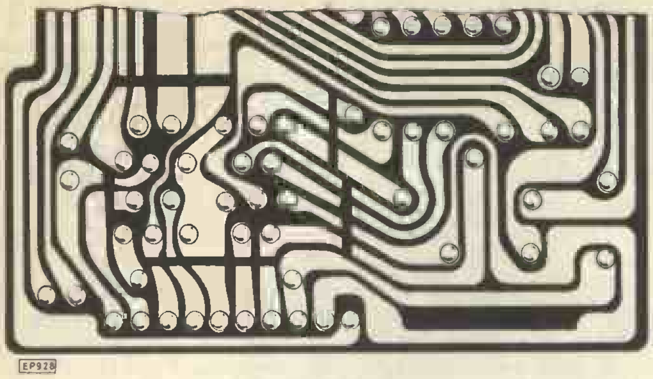


Fig. 8. Track cuts

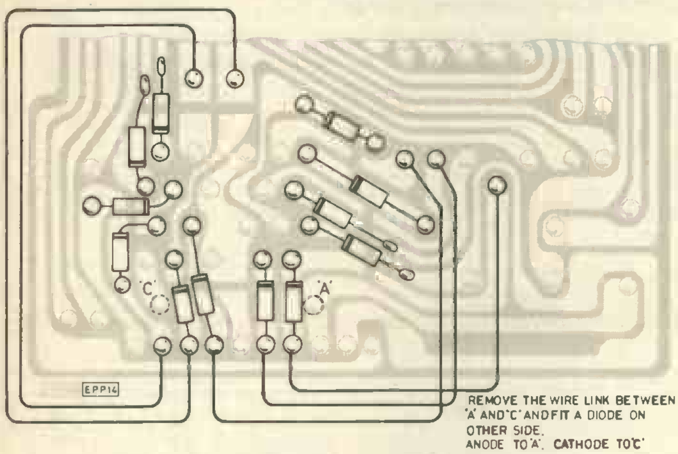


Fig. 9. Diode connections

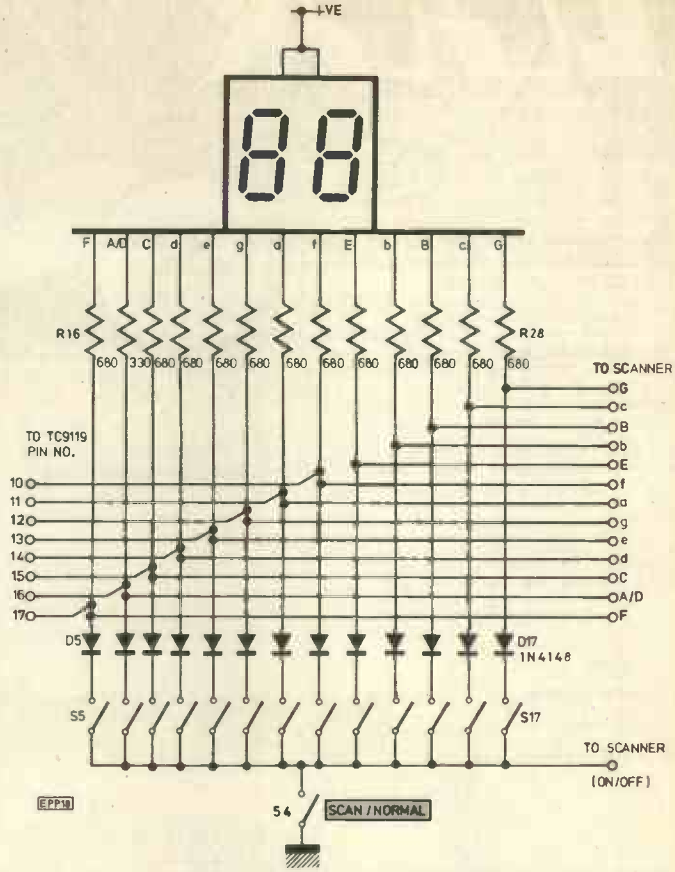


Fig. 10. Display connections

leads are run from the appropriate connections on the Scanner p.c.b. to the anode side of each diode thereby enabling the decoder driver i.c.s of the Scanner to drive both the display and the PLL chip. You can see from Fig. 10 which diode connects to which display segment.

As can be seen in Fig. 9 the four common connections of the channel switch are isolated from the main p.c.b. connection, this enables them to be switched to ground via an appropriate changeover switch when selecting between channel switch and Scanner control. The wiring of which is shown in Fig. 10 this also shows a connection to the Scanner to disable the outputs of the decoder drivers when in channel switch mode.

All that now remains is to connect the PTT Input, the squelch and the microphone buttons.

The connections for the squelch and PTT (Uniden 200) are shown in Figs. 11a and b.

To connect the microphone buttons to the Scanner you must run wires from the connections labelled 'up', 'down' and 'scan' to the appropriate pins on the mike socket and a +5V feed to the common of the buttons also on the mic. socket, details shown in Fig. 5.

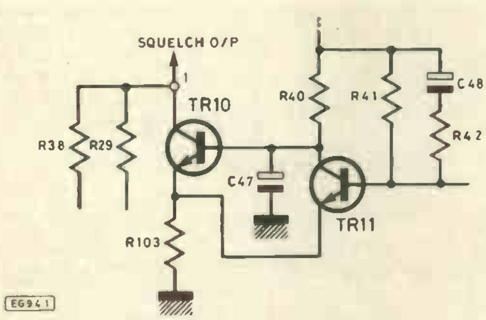


Fig. 11a. Squelch connections

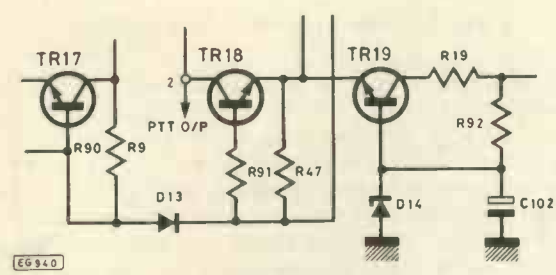


Fig. 11b. PTT connections. Fig. 11a and b show the necessary connections to a Uniden 200 rig from the Scanner. For other types of rigs not listed in Table 1 see the Advice note opposite.

ADVICE SERVICE

If you are unsure about the Scanner connections to your particular rig, then send a photostat copy of the circuit diagram together with a stamped addressed envelope to Micro Communications Equipment and Design Ltd., 5 St. Patricks Avenue, Weymouth, Dorset DT4 9EQ. The appropriate connections will be marked on the diagram and returned.

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS month's Micro-Bus looks at the sound facilities provided by the BBC Microcomputer, and shows how they can be used for electronic music synthesis. Among this month's other topics is the circuit for an analogue interface for the ZX81.

BBC MICRO SOUND

The BBC Microcomputer provides three tone channels, and a fourth channel which can be used for noise or pulsewaves. The four channels are summed and can be played simultaneously through an internal loudspeaker. Each channel can be set to one of 16 amplitudes, and the tone channels can be set to frequencies spanning about five octaves, in steps of a quarter of semitone (where 12 semitones is one octave). Furthermore, pitch and amplitude envelopes can be set up and specified for every sound played, providing effects such as tremolo and vibrato, and allowing an approximation to different musical instruments to be achieved.

The programmer is provided with access to the sound system from BASIC by means of two statements, SOUND and ENVELOPE, each of which takes a number of parameters to control the characteristics of the sounds produced. It would obviously be undesirable for the SOUND statement to hold up further execution of a program while a note of, say, a second's duration was played. The sound system on the BBC Micro therefore has a system of queues; rather than actually sounding a note, the SOUND command places the parameters for that note into a queue. Up to four notes can be queued on each sound channel before program execution is suspended, and various options in the SOUND statement allow several notes to be queued separately on the different channels, but sounded together as a single chord.

The ENVELOPE statement allows up to four envelopes to be set up, for use by subsequent SOUND statements. Six of the parameters, PS1–3 and NS1–3, provide three stages of variation in the frequency of the note chosen in the SOUND statement to give effects such as tremolo, and the change in pitch of a plucked string. The remaining parameters control the ADSR (attack, decay, sustain, release) amplitude envelope of the sound.

The parameters of the SOUND and ENVELOPE statements are summarised in the diagrams of Fig. 1, and the use of these statements is illustrated in the following two music programs.

Fig. 1(a). The BBC Microcomputer's SOUND statement enters the parameters of a sound into one of the four sound queues

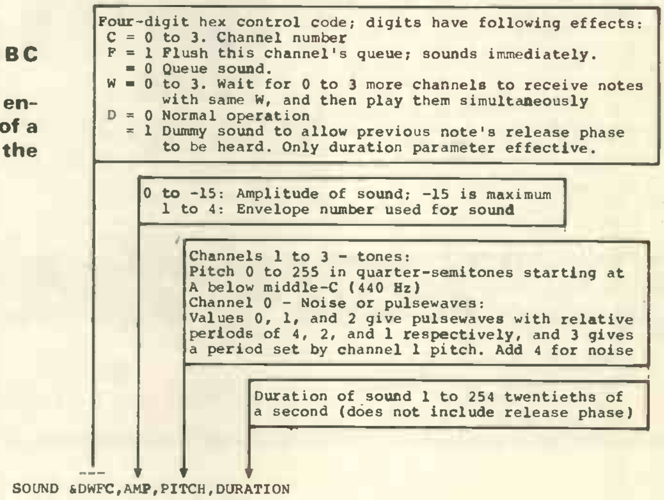
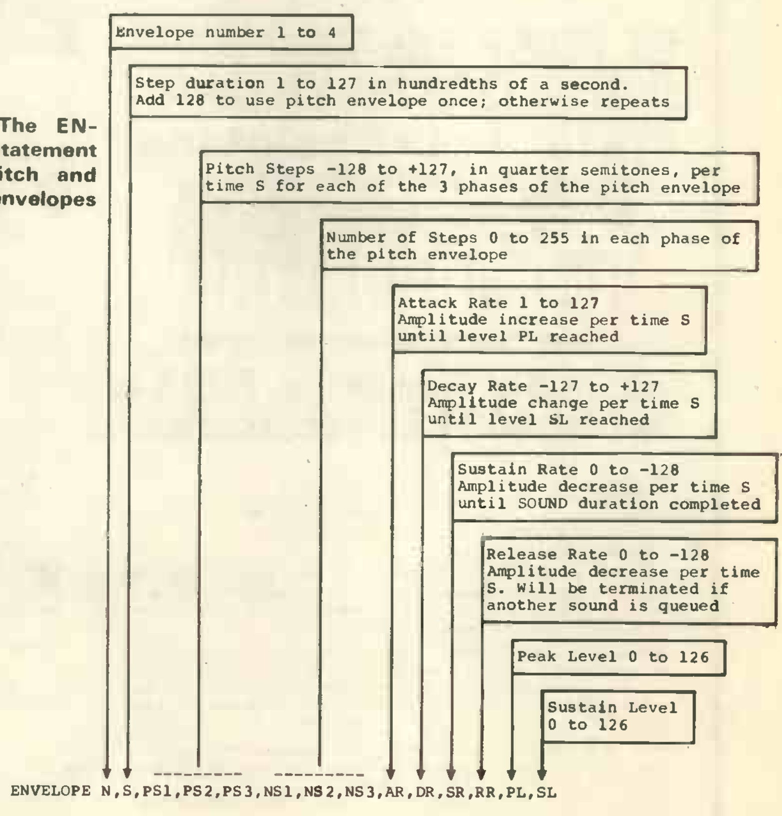


Fig. 1(b). The ENVELOPE statement sets up pitch and amplitude envelopes for sounds



```
  0 REM PIANO
 10 ONERRORGOTO100
 20 *FX11
 30 CH%=1
 40 ENVELOPE1,4, 1,-1,1,1,1,1, 120,0,-1,-1,120,120
 50 A$="1Q2W3ER5T6YU8I9O0P@^[\_"
 60 REPEAT
 70 A%=INSTR(A$,GET$)
 80 IFA% CH%=CH%MOD3+1:SOUNDCH%+16,1,A%*4,5
 90 UNTIL0
100 *FX12
```

Fig. 2. Program turns the BBC Micro into an electric piano

```
  0 REM COMPOSER
  1 ENVELOPE1,1,0,0,0,1,1,1, 126,-3,-3,-3,100,60
  2 ENVELOPE2,1,0,0,0,1,1,1, 126,-5,-5,-5,100,60
  3 ENVELOPE3,1,0,0,0,1,1,1, 126,-1,-1,-1,126,60
 20 INPUT"DELAY",D%:DUR%=5
 30 CH%=0:I%=0:INC%=-1:K%=0:REPEAT
 35 IFI%>8:INC%=-INC%
 36 IFI%<1:INC%=-INC%:K%=(K%+7)MOD12
 37 I%=I%+INC%
 40 ON(I%MOD4+1)GOTO50,60,70,80
 50 P%=12*(I%DIV4):GOTO90
 60 P%=3+12*(I%DIV4):GOTO90
 70 P%=7+12*(I%DIV4):GOTO90
 80 P%=10+12*(I%DIV4):GOTO90
 90 P%=P%+(INC%+1)/2*7
 95 CH%=(CH%+1)MOD2
 99 IFI%=1:SOUND&13,3,K%*4+(RND(2)-1)*48,2
100 SOUND&11+CH%,1,(P%+K%)*4,DUR%
101 IFCH%=1:SOUND&10,2,I%/2MOD3+4,10
110 NOW=TIME:REPEATUNTILTIME-NOW>D%
160 UNTIL0:END
```

Fig. 3. Program composes music on a BBC Micro

MICRO KEYBOARD

The surprisingly short program shown in Fig. 2 turns the BBC Microcomputer into an electronic keyboard instrument, which allows chords of up to three notes to be played. It was contributed by *Tim Dobson* of Warrington, and it uses the top two lines of the keyboard as a piano keyboard, as follows:

The top numeric row gives the black notes, and the row "QWERTY" gives the white notes, with "R" as middle-C. The program works by first specifying an envelope for the SOUND statement (line 40) with slight tremolo, a sharp attack phase, a flat decay phase, and slowly decaying sustain and release phases to give a piano-like sound. It then reads a key, using GET$, and looks up the key in a string containing all the valid keys of the keyboard, A$, using the INSTR function. This sets A% to the position of the key in the string, or 0 if the key is not found. If A% is non-zero it is used to sound a note on the next sound channel (line 80). The channel number, CH%, is cycled through the tone channel numbers 1, 2, and 3. The SOUND statement's first parameter sets F=1 to sound each note immediately.

The *FX11 call is used to turn off keyboard auto-repeat, which would otherwise cause strange effects if a key were held down. The ON ERROR statement, line 10, allows you to exit from the program by typing ESC, and the *FX12 then turns auto-repeat back on.

MUSIC COMPOSER

The second of the two music programs for the BBC Microcomputer actually composes music, according to a set of simple rules, to produce a tune with three parts and percussion.

The program shown in Fig. 3 begins by setting up the three envelopes used by the subsequent SOUND commands. All three envelopes have a flat pitch envelope, sharp attacks, and different decay rates in the decay, sustain, and release phases. The program next prompts for the "DELAY", which determines the speed of the tune; values of about 5 to 10 give the best results. The SOUND statements in lines 99 and 100 control the tones in the tune, and the one in line 101 gives percussive sounds using channel 0, the noise channel.

Many varied and interesting effects can be produced by varying the parameters in the program, but the program goes only a little way in illustrating the possibilities for music composition by computer.

ZX81 A/D INTERFACE

The addition of an analogue interface to a computer enables it to be used as a chart recorder, a slow oscilloscope, or in real-time control and data-logging applications. The following analogue-to-digital interface for the ZX81 uses the Ferranti ZN427 in conjunction with a CMOS analogue decoder to give 8 analogue input channels which can be read by programs. The design was submitted by *D. L. Brownlee* of Hatfield, and is based on a circuit for the UK101 published in the July 1981 *Practical Electronics*. What follows is based on his description.

CIRCUIT OPERATION

"In use, one of the eight inputs is first selected by executing: POKE 11000,N where N is the channel number, 0 to 7. Then the chosen input can be read by:
PRINT PEEK 11000 with readings between 0 and 255 corresponding to voltages between 0 and 5V.

"The circuit, shown in Fig. 4, comprises 7 i.c.s and a few ancillary components. The 74LS04 inverters and 74LS30 gate decode a block of 256 bytes containing the address with the convenient round number 11000. The remaining inverter, in conjunction with D1, disables the ROM when this addressed block is active. The A/D inverter chip's clock is derived by dividing down the ZX81's 3·2 MHz clock, using a 74SL93, to approximately 400kHz.

"On writing to the circuit, using a BASIC POKE statement, the lower four data lines are latched into a 74LS75 latch, and these are in turn decoded by a 4051 CMOS analogue switch to select one of 8 input channels. At the same time a latch, formed out of the two remaining NOR gates, is triggered to give a start-conversion pulse to the ZN427; the latch is reset by a pulse from the 74LS93 clock divider.

"On reading the A/D converter, with a PEEK instruction, the latch of the A/D converter is enabled by the RD signal to place the

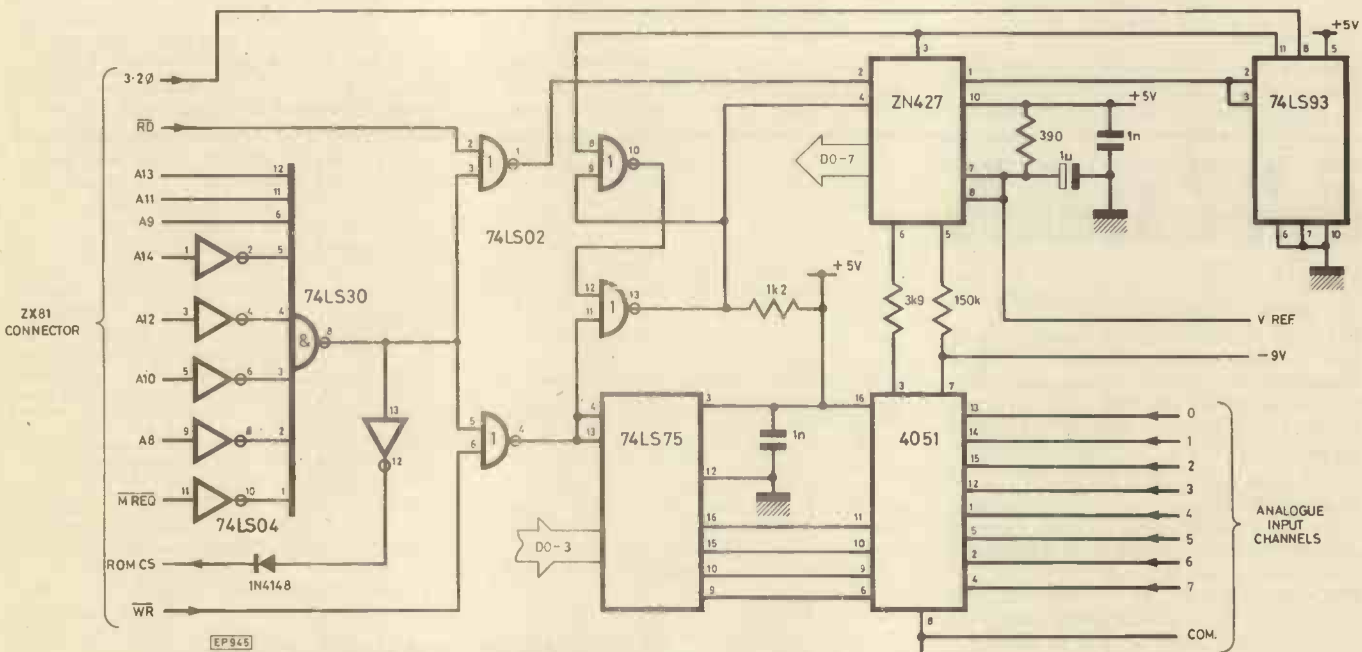


Fig. 4. Analogue interface for the ZX81 provides 8 analogue inputs

digital value of the last analogue input onto the data bus.

"The A/D converter and analogue switch both require a negative supply rail, not available from the ZX81. As the current consumption is small this can conveniently be obtained from a 9V battery."

If only one input channel is required, the circuit can be simplified by omitting the 4051 and 74LS75 i.c.s.

HAWK & SPARROW GAME

In the following game for the ZX81 you control a hawk chasing a sparrow, which tries to reach the safety of the right-hand side of the screen. The program, shown in Fig. 5, was devised by *J. W. H. King* of York.

On pressing "RUN N/L" the screen shows a horizintal line, representing the ground, a symbol representing the hawk near the top left-hand corner of the screen, and lower down to its right a smaller symbol representing the sparrow.

To move the hawk, key any number followed by N/L. The hawk will then move to the right by that number of spaces, and may also move up or down. Meanwhile the sparrow also moves to the right, but by a random number of positions, and up or down. To catch the sparrow you must move the hawk next to it, and both will fall to the ground with the message "CAUGHT" displayed. If, however, the sparrow manages to reach the right-hand side of the screen the message "SAFE" will be displayed, and the number of moves taken is indicated in the top left-hand corner. To restart the game type "0 N/L".

```
  4 CLS
  5 PRINT AT 1,13;"HAWK"
 10 FOR L=0 TO 30
 15 PRINT AT 20,L;CHR$ 3
 20 NEXT L
 25 LET A=19
 30 LET B=4
 35 LET P=14
 40 LET Q=0
 45 LET X=0
 50 LET C=A
 55 LET D=B
 60 LET E=P
 65 LET F=Q
 80 PRINT AT A,B;CHR$ 2;CHR$ 1
100 PRINT AT P,Q;CHR$ 132;CHR$
7
120 IF B=Q THEN GOTO 245
125 IF B-Q=1 OR -1 THEN GOTO 24
0
130 LET A=INT (RND*4)+16
140 LET B=B+INT (RND*5)
150 LET P=INT (RND*3)+14
160 INPUT R
165 IF B>=30 THEN GOTO 210
170 LET Q=Q+R
180 LET X=X+1
181 PRINT AT C,D;"  "
185 PRINT AT E,F;"  "
190 PRINT AT 3,4;X
200 GOTO 50
210 PRINT AT 12,13;"SAFE"
220 GOTO 290
240 IF A-P>=1 THEN GOTO 130
245 IF A-P>=2 THEN GOTO 130
250 PRINT AT A,B;"  "
260 PRINT AT P,Q;"  "
270 PRINT AT 19,B;CHR$ 136;CHR$
136
280 PRINT AT 12,12;"CAUGHT"
290 INPUT S
300 IF S=0 THEN GOTO 4
```

Fig. 5. ZX81 Hawk and Sparrow game

ZX81 ART

The following program, for a ZX81 with 16K of RAM, will allow you to design pictures on the computer screen and print them out on the ZX printer. Ten different pictures may also be stored in memory, and then saved to tape. The program was devised by *D. Wardle* of Norfolk, and a picture of his house produced by the program is shown in Fig. 6.

PROGRAM OPERATION

To use the program press RUN, enter any ZX81 character followed by NEWLINE, and the selected character will appear flashing on the screen, indicating that the program is in "Drawing Mode". To move the character type:

1 or 2 for horizontal movement,
3 or 4 for vertical movement,
and 5, 6, 7, or 8 for diagonal movement.

To change the drawing character press "9", type the new character, followed by NEWLINE, and the new character will appear at the last drawing position on the screen. To erase previously drawn characters enter a SPACE or null character, or to clear the screen completely press "C".

To save a picture in memory, press "A" when the program is in drawing mode; this will take about 40 seconds. The pictures are numbered in the order in which they are saved. To recall a previously saved picture press "B" followed by the picture number (1 to 10), and to return to drawing mode press "0".

When the program is waiting for a new drawing character, typing the function "PI" will reset the drawing counter; the next picture saved will be number 1. Typing the function "ARCCOS" will save the program, and all the saved pictures, on tape. To continue, press CONT and NEWLINE. When next loaded the program will be in character-entry mode.

```
  1 REM ART
 10 DIM S$(10,704)
 20 LET A=11
 30 LET B=16
 40 LET A$="00121212"
 50 LET B$="12001221"
 70 LET N=0
 80 INPUT V$
 90 IF V$="PI" THEN GOTO 70
 95 IF V$="ACS " THEN GOTO 460
100 IF INKEY$="" THEN PRINT AT
A,B;" ";AT A,B;V$
110 IF INKEY$="" THEN GOTO 100
120 IF INKEY$="A" THEN GOTO 320
130 IF INKEY$="B" THEN GOTO 410
140 IF INKEY$="C" THEN CLS
150 IF INKEY$="9" THEN GOTO 80
160 LET X=0
170 LET C$=INKEY$
180 IF CODE C$>=29 AND CODE C$<
=36 THEN LET X=VAL C$
190 IF X<1 OR X>8 THEN GOTO 100
200 LET D=0
210 IF A$(X)="1" THEN LET D=1
220 IF A$(X)="2" THEN LET D=-1
230 LET A=A+D
240 LET D=0
250 IF B$(X)="1" THEN LET D=1
260 IF B$(X)="2" THEN LET D=-1
270 LET B=B+D
280 IF ABS A>20 THEN LET A=20
290 IF ABS B>30 THEN LET B=30
300 PRINT AT A,B;V$
310 GOTO 100
320 FAST
330 LET N=N+1
340 FOR I=0 TO 21
350 FOR J=1 TO 32
360 LET S$(N,J+32*I)=CHR$ PEEK
(PEEK 16396+256*PEEK 16397+J+33*
I)
370 NEXT J
380 NEXT I
390 SLOW
400 GOTO 100
410 INPUT S
420 IF S=0 THEN GOTO 100
430 CLS
440 PRINT S$(S)
450 GOTO 410
460 PRINT AT 20,0;"START TAPE
PRESS CONT AND NEWLINE"
470 STOP
480 SAVE "AR█"
490 GOTO 80
```

Fig. 6. Art program turns a ZX81 into a sketchpad

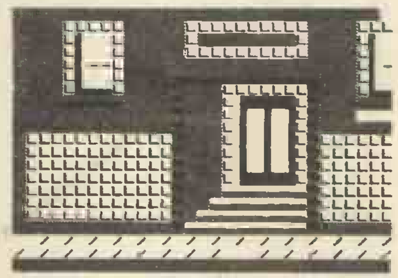


Fig. 7. Drawing generated using the Art program of Fig. 6

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"In use, the GB2 proves to be quite efficient. Bass is quite extended and clean with only a trace of cabinet resonance, whilst treble performance is well detailed. All in all these Videotones, with their detailed treble, give a lively and enjoyable performance."

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Type: Port loaded, two way, floorstanding/bookshelf model.
Recommended Amplifier power: 15–40 watts. In general they need between 10 and 15 watts r.m.s. per channel for every 1000 cu/ft. of room space.
Impedance: 8 ohms nominal.
Frequency response: 50–20kHz ±5dB.
Efficiency: 8·8 volts gives 90dB.
Distortion: Less than 1% 60Hz–20,000Hz for 5 volts input.
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Waveform Digitiser...

LYNDSAY ROBINSON B.A.Hons.

WAVEFORM Digitisers, or Transient Recorders as they are otherwise known, have been available on the professional market for some time. These devices are able to store a waveform in memory and replay it at a later time, and are particularly useful for capturing transient events, e.g. musical instrument waveforms, power supply glitches, etc., so that the stored waveform can then be displayed on an oscilloscope. It is also useful for recording very low frequency events, e.g. a temperature variation throughout the day, and then displaying this at a much higher frequency on the oscilloscope.

This Waveform Digitiser has a maximum input sampling rate of 100kilohertz and a memory capacity of one kilobyte. The total cost is approximately £50, and the design is based on a new (1982) Ferranti analogue to digital converter i.c., the ZN449.

SPECIFICATION

Memory—Static RAM (1 kilobyte)
Sampling rate—1 to 100kHz
Amplitude resolution—8 bits (0.4%)
Analogue to digital conversion time—9μs
Output display—Can be step or filtered waveform
Trigger facilities—Pretrigger
Post trigger
Manual trigger
Output trigger to oscilloscope for synchronised display
L.e.d. Indicators—Mains power on
Input overload
Trigger threshold
Trigger armed
End of memory
Input stage—Variable gain 1 to x100, a.c./d.c. 1MΩ input impedance
Slew rate—13V/μs
Adjustable d.c. offset
Single or repeat memory record or display BNC connectors

BASIC OPERATION

An analogue signal, either periodic or transient is converted into a digital signal and stored in memory. The stored signal can then be converted back into analogue for display on the oscilloscope. The digital signal can be stored indefinitely, unlike a conventional analogue storage scope, and be displayed on an ordinary oscilloscope.

APPLICATIONS

The unit can be used with experiments in Physics, Chemistry, Biology and Electronics. Any signal that varies with time and which can be converted to a voltage can be stored, providing the frequency of interest is below 50kHz. (Note that total record time=memory size/sampling time, where memory size is 1024 bytes).

The waveform can be replayed onto an oscilloscope or can be stored on paper by the use of an X/Y plotter. Signals that are too fast for this are recorded by the Digitiser. The stored signal could also be permanently stored on magnetic tape, by the use of a suitable serial interface. The minimum sample frequency on the Digitiser is one sample/second, but this can easily be reduced by the addition of more dividers (CMOS 4518).

Physics applications include temperature/time plots, measurement of stress, strain, pressure, volume, acceleration. Transient events, such as shock, can be stored and replayed later.

Fast chemical reactions can be measured. Some transient reactions can have their rates measured by the change in light absorption by the reaction medium, this change in light transmission can be measured and converted into a voltage.

Electronic uses of the Digitiser include measurement of a

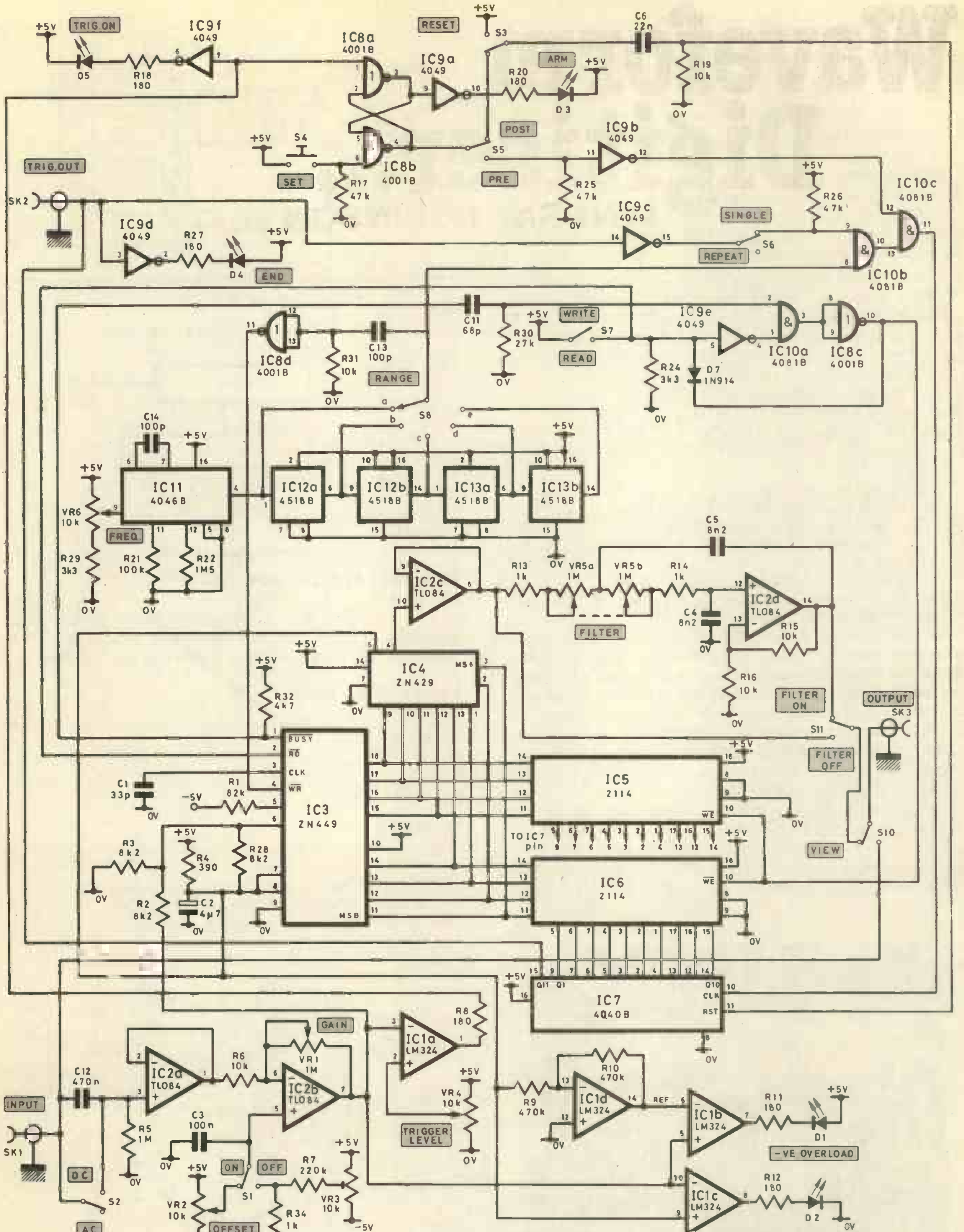


Fig. 1. Circuit of Waveform Digitiser

CR charge/discharge curve, power supply monitoring, switch and relay bounce, CSR turn-on time, etc.

Biomedical signals are difficult to display with an ordinary oscilloscope. Some signals have a very low frequency (less than 1Hz), and by recording on the Digitiser can then be replayed at a much higher frequency. By the use of artificial stimuli on muscle and nerve tissue, the resulting response action potential can be stored and displayed by the Digitiser.

INPUT STAGE

The input stage in Fig. 1 consists of a preamplifier, IC2 with a gain variable from x0 to x100. A high slew rate operational amplifier is used (13V/µs), a TL084, which is a BIFET op-amp with an input impedance of 10^{12}ohms. The input signal to the waveform digitiser can be either a.c. or d.c. coupled as selected by S2. There is also a variable d.c. offset control, VR2 that can be switched in and out of the circuit by S1, and this enables either a positive or negative level to be added to the input signal. The trigger circuit consists of a voltage comparator, IC1a, and a trigger level potentiometer, VR4. VR4 sets a threshold level for triggering the start of the counter for the memory addressing.

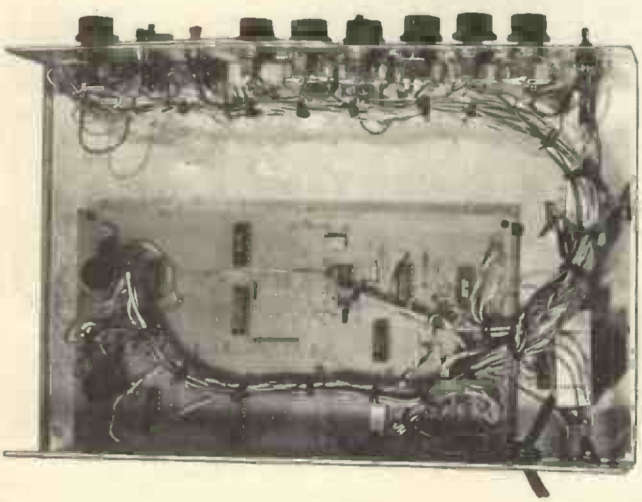
Overload l.e.d.s, D1 and D2, warn when the input signal to the analogue to digital converter, IC3, is either above +2·5V or below −2·5V.

ANALOGUE TO DIGITAL CONVERTER

The analogue to digital converter used is the Ferranti ZN449. This gives a digital output of 8 bits, has a guaranteed conversion time of 9µs, its own clock and 2·5V reference source. See Fig. 5 for timing diagram.

This ADC uses the successive approximation method, and the control pins are as follows. (See Fig. 2).

Pin 1 ($\overline{\text{BUSY}}$) this is low when the ADC is converting and goes high when the conversion has ended, and is used in the Waveform Digitiser to control the write signal to memory. Pin 2 ($\overline{\text{RD}}$) controls the tri-state output of the data outputs of the ADC, when this pin is low, the data can be read, i.e., enabling the tri-state outputs. Pin 3 (CLOCK) sets the frequency of the internal clock required for the successive approximation process, and is set to 1MHz with C1 on the Waveform Digitiser. Pin 4 ($\overline{\text{WR}}$) is the write signal, when low a start conversion initiates the analogue to digital conversion process, and so the $\overline{\text{BUSY}}$ must go low. In the Waveform Digitiser, the ADC is converting at the rate set by the clock oscillator, ICs 11, 12, 13. At the end of a conversion, the $\overline{\text{BUSY}}$ signal is sent to control logic to write the data into the memory.



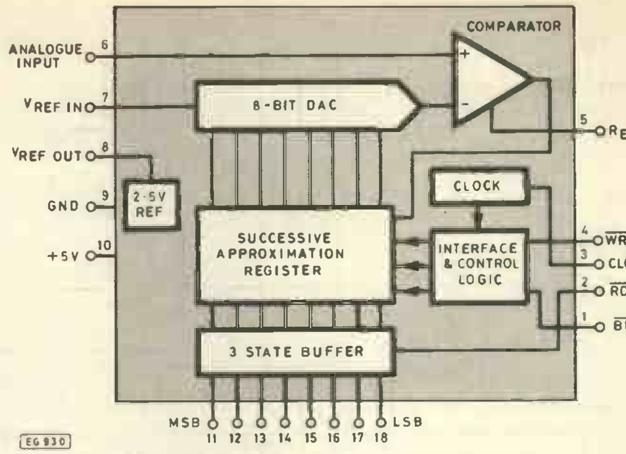


Fig. 2. Block diagram of ZN449 ADC

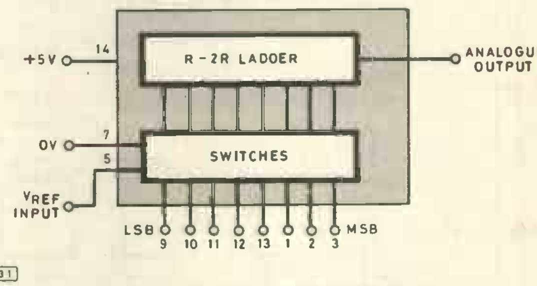


Fig. 3. Block diagram of ZN429 DAC

VARIABLE FREQUENCY CLOCK

The clock, i.c.s 11,12,13 sets the frequency for the number of conversions/second for the ADC in record (Write) mode, and when in the play (Read) mode, sets the output sample frequency. The maximum input conversion rate is 100kHz.

Table 1: Clock Range

a 1–10Hz
b 10–100Hz
c 100–1kHz
d 1kHz–10kHz
e 10kHz–100kHz

MEMORY

A kilobyte static RAM is used as the memory, and consists of two, 1K x 4 bit static RAMs, type 2114. The total memory used can be expanded by using additional 2114s and extending the counter range of the 12 bit counter, IC7. Four kilobytes of memory can be used with IC7 at present and more CMOS 4040s can be used if more memory is required to be addressed.

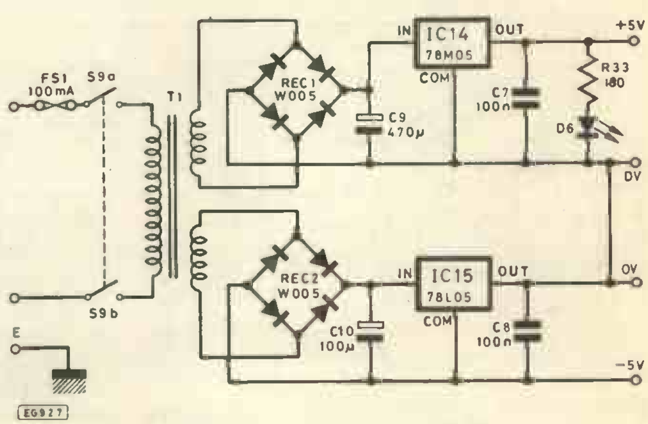


Fig. 4. Circuit of power supply

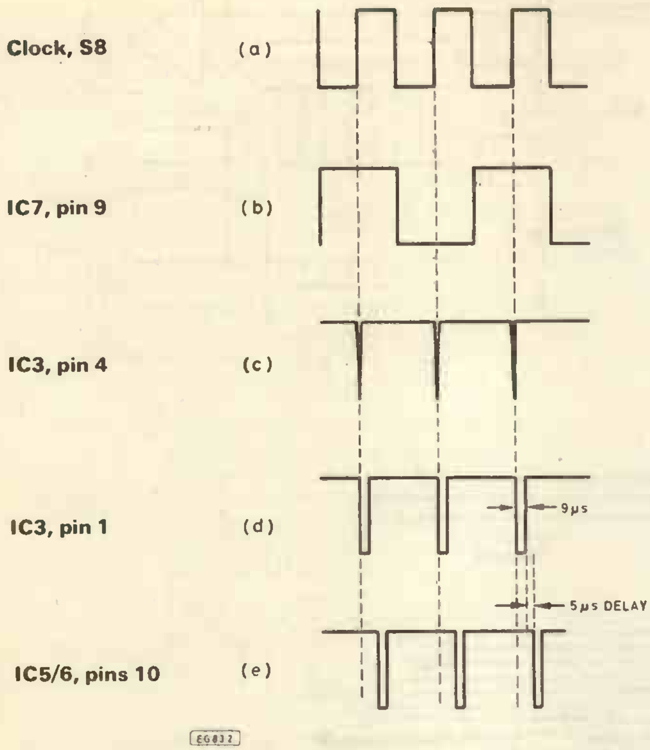


Fig. 5. Logic timing diagram

CONTROL LOGIC AND ADDRESS COUNTER

The control logic allows the following functions to be performed: 'Repeat' or 'Single', 'Write' or 'Read', 'Set' and 'Reset' of counter circuit, 'Post' or 'Pre' trigger control, oscilloscope 'Trigger Out', l.e.d. indication of memory 'End', trigger 'Armed', voltage 'Trigger Level', 'Overload' to ADC.

Read (Play) or Write (Record) is selected by S7 that sets either a 1 (read) or $\overline{WE}$ (write enable) pulse to the memory. The $\overline{WE}$ is derived from the $\overline{BUSY}$ signal from the ADC, and the data from the ADC is written into the RAM.

The Repeat/Single switch sets IC7 to either count continuously or terminate at count 1023.

The Set push switch arms the analogue trigger circuit (IC1a, IC8a, b) and when the trigger level is exceeded, the data will be loaded into memory.

Post trigger starts the addressing from count 0. In the Pre-trigger mode the counter is running continuously until a pre-trigger signal stops the counter. The signal that occured before the trigger can thus be stored. This is useful for analysing signals such as those caused by power supply transients; the momentary glitch can be observed at leisure in the stored mode.

The oscilloscope trigger control is a 5V CMOS compatible signal that is connected to the External Trigger input of the oscilloscope. This provides a stationary display on the 'scope.

The memory End l.e.d. is illuminated whenever the address count is at 1024 to 2048, and will light once per 1024 address counts in the Repeat mode. In the Single mode the l.e.d. will indicate that the memory is full and recording has stopped. The trigger Armed l.e.d. is lit when the analogue trigger circuit is in a waiting state, i.e. waiting to be triggered by an input signal. The voltage trigger l.e.d. will light when the threshold has been reached by the sample input, and this l.e.d. is used with the Trigger Level control to set its threshold.

COMPONENTS

Resistors

R1	82k
R2, 3, 28	8k2
R4	390
R5	1M
R6, 15, 16, 19, 31	10k
R7	220k
R8, 13, 14	1k
R9, 10	470k
R11, 12, 18, 20, 27	180
R17, 25, 26	47k
R21	100k
R22	1M5
R23, 32	4k7
R24	3k3
R29	3k3
R30	27k

All $\frac{1}{4}$W 10% carbon

Capacitors

C1	33p ceramic	C7, 8	0·1µ
C2	4µ7 elect 9V	C9	470µ elect 16V
C3	0·1µ polyester	C10	100µ elect 16V
C4, 5	8n2 10%	C11	68p
C6	22n polyester	C12	470n polyester
		C13, 14	100p ceramic

Integrated Circuits

IC1	LM324	IC9	4049B
IC2	TL084	IC10	4081B
IC3	ZN449	IC11	4046B
IC4	ZN429	IC12, 13	4518B
IC5, 6	2114	IC14	78M05
IC7	4040B	IC15	78L05
IC8	4001B		

Diodes

D1, 2, 4, 6	Red l.e.d.s
D3	Green l.e.d
D5	Amber l.e.d.

Potentiometers

VR1	1M linear
VR2, 4, 6	10k linear
VR3	10k sub-min horizontal preset
VR5a, b	1M linear dual gang

Switches

S1, 2, 5, 6	S.p.d.t.
S7	S.p.s.t.
S4	S.p.s.t.
S3	S.p.d.t.
S8	Singe pole 6 way rotary
S9	S.p.d.t. mains

Miscellaneous

BR1, BR2—bridge rectifiers W005, transformer T1, 0-9V, 0-9V 9VA, BNC sockets (3 off), knobs (5 off), l.e.d. clips (5 off), cabinet (Maplin type WB6), p.c.b., Veropins (46 off), p.c.b. mounting pillars, stick-on rubber feet (4 off).

D TO A CONVERTER AND OUTPUT FILTER

A Ferranti ZN429 digital to analogue converter i.c. is used to convert the stored signal back to the analogue form. This DAC has an 8 bit input, a settling time of 1µs and uses the voltage reference of the ZN449. The analogue output can be filtered, if required, to smooth the step waveform from the DAC output, by the filter as shown.

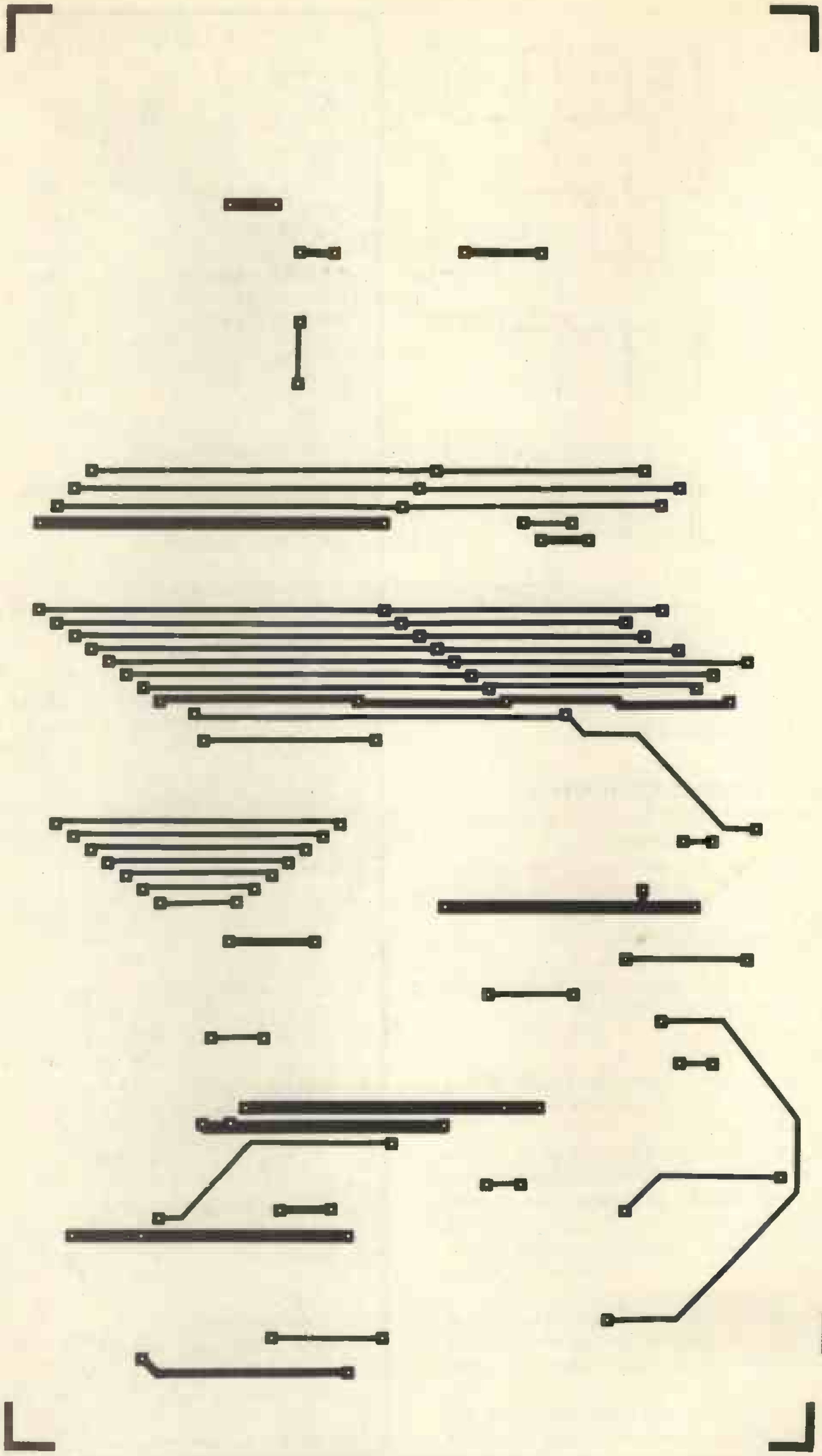


Fig. 6. Etching detail of board topside

POWER SUPPLY

This is a ±5V power supply, providing the 200mA required by the +5V circuits and 25mA required for −5V use. In the prototype two separate transformers were used for the power supply, but a transformer with two separate secondary windings is also suitable. (Fig. 4).

CONSTRUCTION

Assemble the components onto the printed circuit board as shown in Fig. 7. The prototype p.c.b. is double sided, with pins linking the two sides of the board.

Connect up the components starting with the resistors, diodes, capacitors.

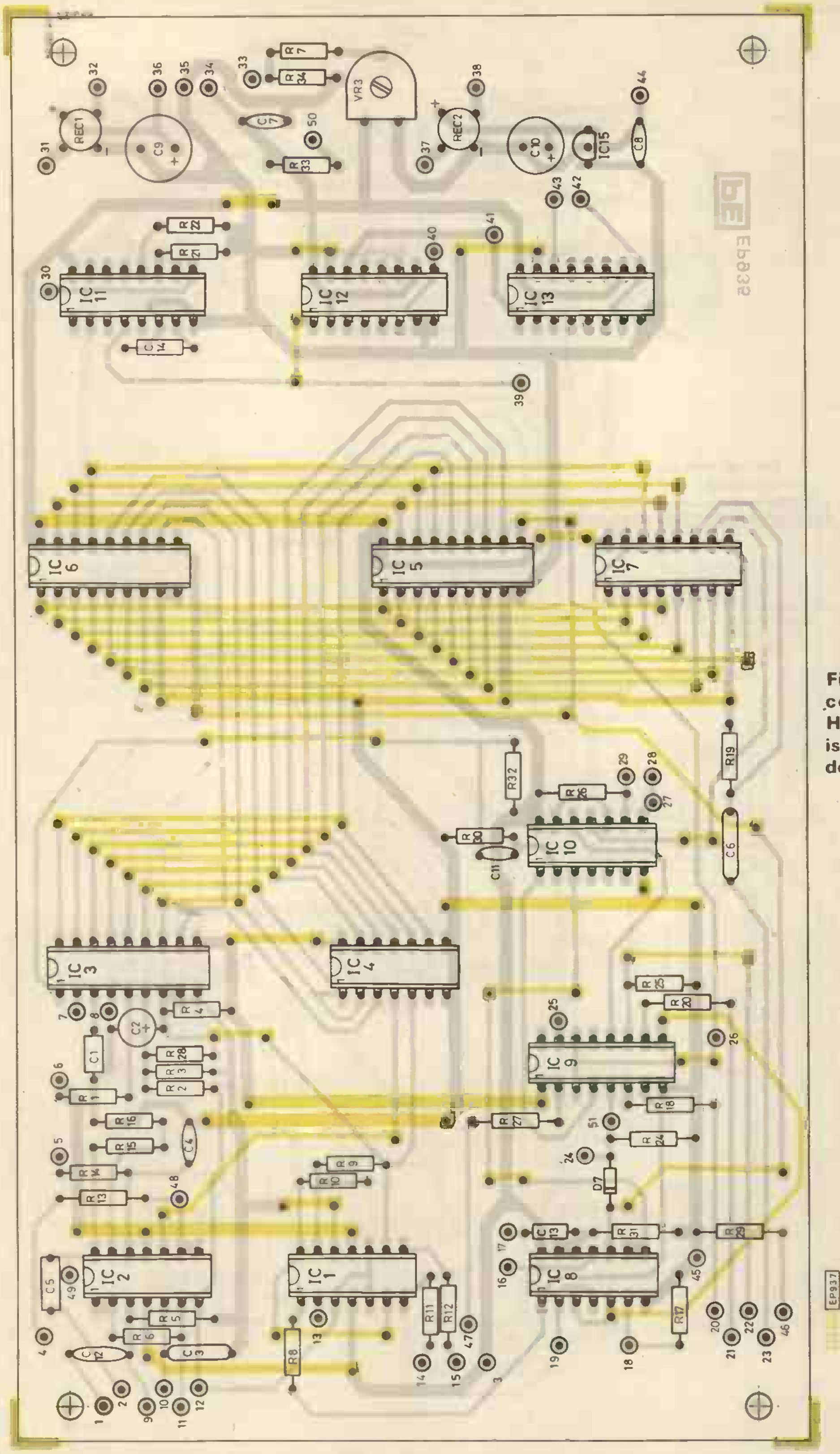


Fig. 7. Track layout and component overlay. Here the board topside is coloured and the underside tinted

The i.c.s can be soldered directly into place on the p.c.b. Take the usual precautions with CMOS i.e., earth yourself when handling and use a low leakage soldering iron. The terminal pins can now be connected to the p.c.b., these can most easily be inserted by pushing the pins gently into place and using the soldering iron to heat up the pin so it slides into position on the board.

The front panel controls are labelled as shown with any suitable dry transfer lettering. Note that the filter shown on the left hand side of the front panel is not in use any more, unless an input filter is required. The lettering can now be protected with clear laquer.

The p.c.b. can now be mounted in the box, together with the transformer, and front panel controls.

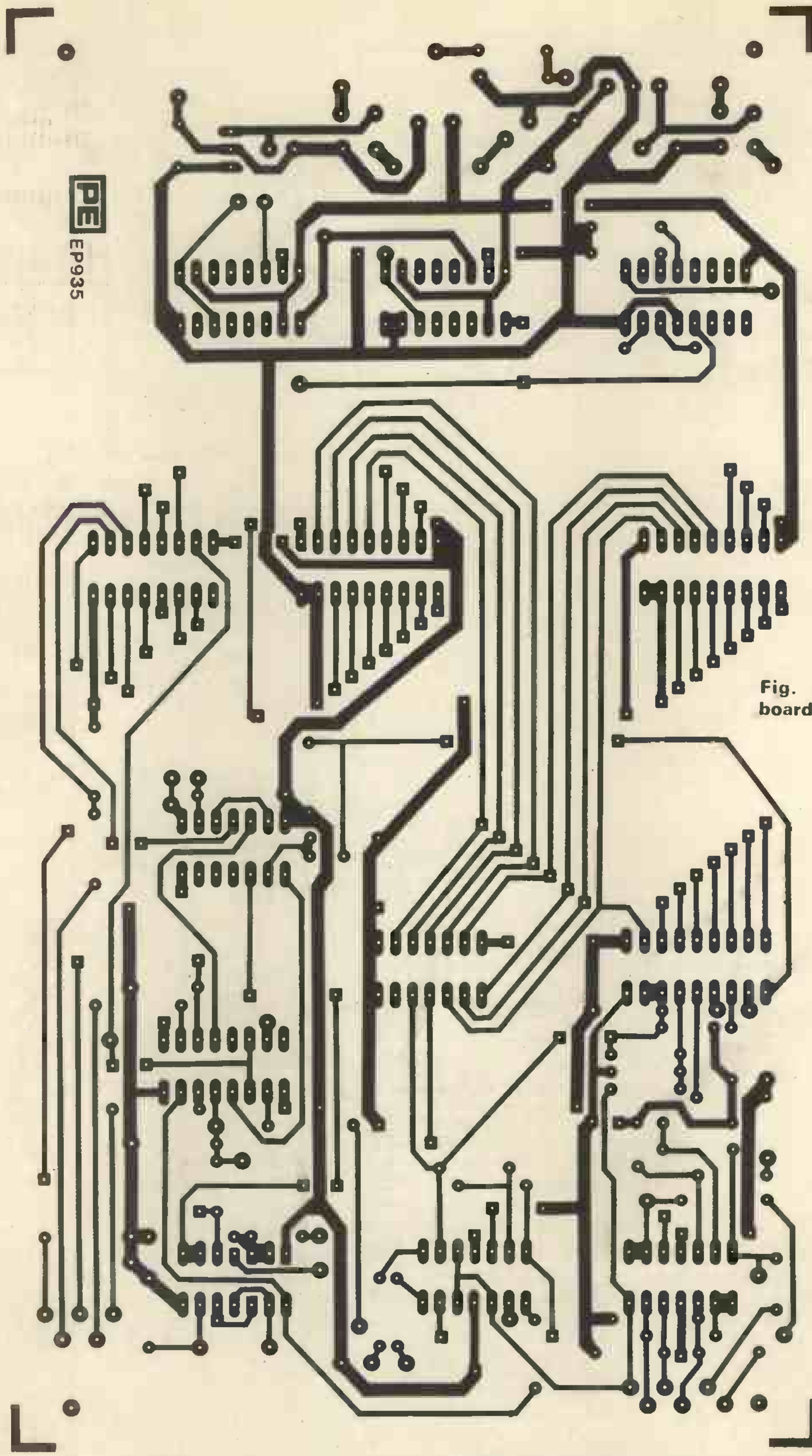


Fig. 8. Underside of board

SETTING UP

The Offset potentiometer is first set up. Connect the input of the Waveform Digitiser to ground, switch to d.c., switch Offset control to 'Off' and set the gain control to maximum. Adjust VR3 until the output of IC2b is 0V.

Set the Frequency control to maximum, and measure the output at IC11, pin 4. This should be 100kHz. Set the control to minimum, and the frequency should now be 10kHz. Adjust R21 if the upper limit is inaccurate and similarly R22 for the lower limit.

TESTING

Connect a signal generator to the input of the Waveform Digitiser, with a triangle wave of frequency 100Hz and amplitude approximately 1V.

Set the Digitiser controls as follows; 'A.c.' on, 'Offset' off,

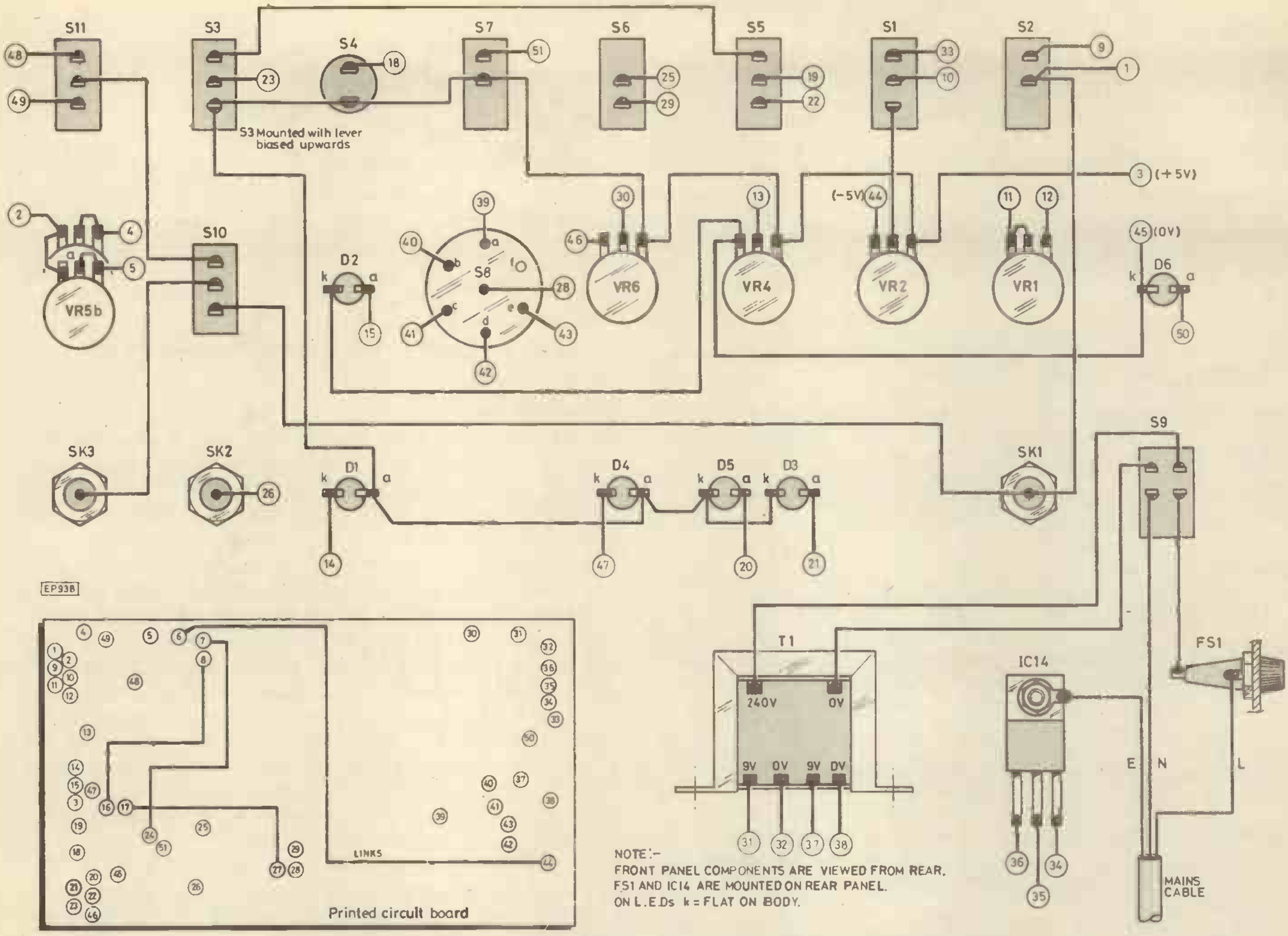


Fig. 9. Case mounted components and interwiring with numbered board pins

'Post' trigger, 'Trigger Level' mid point, 'Repeat', 'Write', 'Freq.' (100kHz), 'Filter' off, 'VIEW OUT' signal.

Connect Trigger out to an oscilloscope external trigger input, and connect the Output of the Waveform Digitiser to the CRO signal input. Adjust the Gain control potentiometer until the overload l.e.d.s just stop flickering. Now switch to Read, and check that the oscilloscope shows the stored triangle wave. This should be 2·5V amplitude, linear, and have no glitches.

The analogue trigger can be tested now. Set the controls as above with the Single setting used instead of Repeat. Reduce the signal generator amplitude to minimum, and press the Set push switch. The Waveform Digitiser is now waiting for a trigger signal, as indicated by the Arm l.e.d. Increase the signal generator output and the Trigger l.e.d. should light when the trigger threshold is crossed. Switch to Read and Repeat and the stored waveform should be displayed.

The Pre-trigger control can now be tested. Set to Pre-trigger, Write, Repeat, Freq. (1kHz). Set the signal generator to 100Hz and minimum amplitude. Press the Set switch and slowly increase the input signal amplitude over a period of about a second. Switch to Read and observe the output waveform is of a stationary waveform with increasing amplitude. Approximately 10 cycles will be seen.

The operation of the filter can be checked by switching it in and adjusting the frequency control until the output waveform is smoothed and the step response is eliminated.

FAULT FINDING

Check that the input signal is present on IC2, pins 1 and 7 and IC3, pin 6. The operation of the analogue trigger circuit can now be checked. IC1a is used as a comparator, and when the signal on pin 3, IC1 is above the voltage level set by VR4 then the output of pin 1, IC1 goes to logic 1 (CMOS logic 1 is 3·5V with 5V power supply). This signal then sets the latch IC8a,b. In the Post trigger mode, the output of IC8, pin 4 goes to C6,R19, which sends a rest pulse to the address counter IC7, so that the count starts at zero. On the negative edge of the pulse from IC8, pin 10, the data from the ADC is written into memory.

Check that the clock oscillator, IC11,12,13 is operating satisfactorily, pin 4 IC11 should give an output frequency of 100kHz with VR5 at maximum. Check that the decade dividers, IC12,13 are working.

Measure the clock frequency on pin 4, IC3 (ADC), this should be as on S8. Now test the frequency of pin 3, IC3, this should be 1MHz. If the ADC is working, then the $\overline{BUSY}$ output (pin 1) will have an output frequency as on S8. Check that the $\overline{READ}$ pin is at logic 0, the input waveform from the signal generator should now be seen at the output of the DAC, IC4, pin 4.

If the input waveform is seen at the DAC output, but is not stored in memory, then the following tests can be applied. Observe that the clock signal is present at pins 10 IC6/7, and that each of the address pins on IC5, 6 is correctly addressed.

Test for the $\overline{WE}$ (Write Enable) signal (pin 10, IC5, 6) from IC8 pin 10.

CONTROL FUNCTIONS

'ON' switch—connects mains supply.

'ON' l.e.d.—5V on.

AC/DC switch—a.c. coupled (3Hz) or d.c. coupled.

GAIN pot—Amplifier has unity gain bandwidth of 3MHz.

'IN' BNC socket—input impedance 1MΩ, signal greater than 50mV.

Offset **'ON/OFF'**—'On', ±5V d.c. offset, 'Off', OV offset.

'OFFSET' pot—sets d.c. offset level.

Filter **'ON/OFF'**-20—20kHz-12db/octave low pass filter.

'FILTER' pot—sets frequency of cut off.

Trigger **'PRE'** or **'POST'**—pretrigger records and displays the memory contents before a trigger threshold is crossed. Post-trigger records and displays the memory contents after the trigger point.

'TRIG LEVEL' pot—sets a level 0-+5V as threshold.

'ARM' l.e.d.-Digitiser is waiting for a trigger level to be crossed and for recording to be commenced. This is set by Set push button. When the threshold is crossed, the signal is recorded.

'ON' l.e.d. (Trigger)—lights when trigger threshold is crossed.

'SINGLE/REPEAT'—the first is a memory count of 0-1023. Repeat is continuous addressing of memory for read or write. 'End' l.e.d.—count 1023 reached.

'READ/WRITE'—Read—play, Write—record.

'FREQ' sets frequency of clock for read and write.

'RANGE' of clock. Five ranges reading clockwise

a 1–10Hz
b 10–100Hz
c 100–1kHz
d 1kHz–10kHz
e 10kHz–100kHz

'SET' press to set arm latch (state shown by arm l.e.d.)

'RESET'—resets addresser to count 0.

'OVERLOAD' +ve and −ve overange to analogue to digital converter shown by l.e.d.s.

'VIEW' switch—'In' from input BNC 'Out'—digital to analogue converter output.

'TRIG OUT'—to external trigger of oscilloscope.

'OUT' BNC socket 0—+2·5V.

Note: The third strip controls are redundant

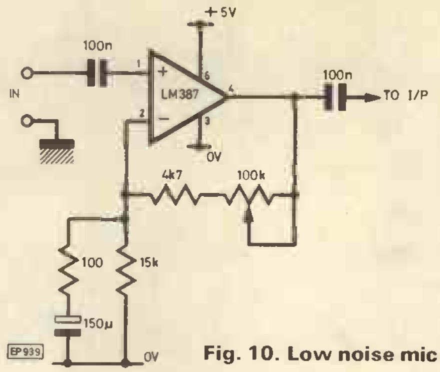


Fig. 10. Low noise mic pre-amp

OPERATION

To store a continuous waveform in the memory of the Waveform Digitiser, set the controls as follows: 'Post', 'Repeat', 'Write', 'View Out', Filter 'Off'. Set Gain and Offset as required, any overload will be indicated by the Overload l.e.d.s. Set clock rate as fast as possible, noting that:

Total time for event=1024/clock frequency

To view the stored waveform, switch to Read, and observe the waveform on an oscilloscope connected to the BNC output socket. Connect the external trigger output (Trig Out) of the Waveform Digitiser to the external trigger input of the oscilloscope, so that a stationary display is obtained.

Use of the Post trigger feature is similar to above. Set the switch to Single and adjust the trigger pot until a suitable trigger level is found. Press Set, and when the input signal crosses the threshold the signal will be stored in memory. The Post trigger is used for transient waveforms, and to view the signal, switch to Read and Repeat.

To use the Pre-trigger, switch to Pre, Repeat, Write, Set, and set a suitable trigger level. The pre-trigger event will be recorded when the threshold is crossed. Switch to Read and Post to observe the stored waveform.

The stored waveforms can be displayed at any convenient frequency, by adjusting the Freq and Range controls as required. Hence low frequency events, e.g. less than 10Hz can easily be displayed on the oscilloscope without flicker.

APPLICATIONS

One possible application of the Waveform Digitiser is in the storage of musical instrument sounds. The characteristic of any part of the waveform can be stored and later analysed, e.g. the start of the sound may be of particular interest in the case of a plucked instrument. In another example, the tonal characteristics of a piano waveform five seconds from the start of the note may wished to be stored. A suitable microphone pre-amplifier circuit is shown in Fig. 10

Transient sounds such as those from percussion instruments can be stored. The highest possible input sampling frequency is chosen so that the waveform fits into the memory space and that the greatest possible time resolution is obtained. For a 100kHz input sampling frequency, a sound of length 10ms would fill the kilobyte memory.

Another use of the Digitiser is in the display of the amplitude envelope of a note being played. By using a precision rectifier circuit to convert the a.c. input to d.c., the envelope can be recorded.

Another application is as a sequencer to store a pattern of notes as played by a sound synthesiser. Some circuit modification would be required, but basically, the synthesiser keyboard control voltage is stored by the Digitiser. The replayed voltages are then converted into frequency by the synthesiser's voltage controlled oscillators. ★

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COMBO AMPLIFIER

PART TWO

Fred Judd
E.A. Rule

THE Power Amplifier section of the Combo Amplifier is based on the very successful Winton amplifier design published in *Practical Wireless*, in March 79. The circuit has been modified to give increased power.

One of the most important requirements for an amplifier is that it is reliable, for if an amplifier breaks down in the middle of a concert it can cause all sorts of repercussions, so reliability is very high on the list. For this reason the power MOS-FET is the only choice, in the writers opinion, for the output devices. Two of the advantages of using power MOS-FETs are that they do not suffer from secondary break down or thermal runaway as normal bipolar transistors do, and this means that they are almost 'abuse proof'. They can be run into any type of load without fear of breaking down, and even if they are run into a load that would normally overrun the output stage, the only thing that happens is that they gradually produce less power output as they get hot until a balance is reached between the heating caused by the adverse load and the power delivered into it.

Bipolar devices subjected to the same conditions will almost certainly either suffer from secondary breakdown or thermal runaway, and even if protective circuits were used in such a design these would operate and shut the down output, which, as far as a concert is concerned would have the same effect as a failure.

Power MOS-FETs do not need protection, thus another possible cause of interruption is removed.

The circuit of the power amplifier and power supply is shown in Fig. 2.1. The signal from the control unit section is fed into TR1 via an RF filter C2 R4. TR1 forms one half of a differential pair TR1 and TR2 using low noise transistors type BC556, which in turn drive a second differential pair TR4 and TR5 type 2SC1775e. TR3 and D1 form an active collector load (current mirror) to maintain the pushpull action. Drive to the gates of the power MOS-FETs is taken direct from the second differential pair. The power MOS-FETs are protected from overdrive by diodes D2 to D5.

Because of the very low distortion obtained when using MOS-FETs, only 45dB of negative feedback is needed to obtain the required low distortion, and this is fed via R9 R8 C4 from the output back to the base of TR2. The use of less feedback means that, *at the overload point* the amount of distortion produced is less objectionable than would be the case with the 60dB or more often used in bipolar amplifiers. Yet another advantage of MOS-FETs!

Only minimal phase correction is needed (due to the excellent high frequency response, full power can be obtained at 100kHz) in the negative feedback loop and as a result the amplifier is unconditionally stable. Electronic decoupling is used in the supplies to the early stages of the power amplifier and these enable very low distortion to be maintained at all power outputs as well as improving the overall signal to noise.

As the MOS-FETs have a negative temperature coefficient, no adjustment is needed for setting the quiescent current, which will be around 50mA when cold, and after prolonged high power use the current will quickly return to a low level as thermal runaway is impossible with these devices.

HEAT SINKS

Normally, a heat sink is designed to prevent thermal runaway of the output devices and to maintain the devices used within their maximum power ratings. The requirements of heat sinks when using power MOS-FETs are different to that normally used with bipolar devices in as much as we are not concerned about thermal runaway. If fact, the design could come down to two requirements only. Will the power output required be maintained at the temperature the output devices are running at, and if the heat sink could be touched by someone, would it burn them! Of course, in practice we still want the devices to run as cool as possible for reliability and to maintain maximum power, and as commercial heat sinks are expensive it was decided to make these out of 1·2mm thick aluminium sheet. The method used is shown in Figs. 2.2 to 2.4, and these will enable the full power of the amplifier to be maintained under all practical conditions with a final temperature of around 60 to 80 deg C above ambient with continuous drive. As the power amplifier unit is mounted in the bottom of the speaker cabinet they are unlikely to be touched. Under normal music conditions it is doubtful if they will get anywhere near the maximum temperature.

Specification

Power Amplifier

Power output @ 1 kHz	60 watts
Power bandwidth — 1dB	20Hz to 50kHz
Frequency response, — 1dB	20Hz to 50kHz
Total Harmonic Distortion, 20Hz to 20kHz up to rated power	Less than 0·05%
Slew Rate	20Volts/microsec
Damping Factor	better than 50
Signal to noise (input shorted)	88dB (96dBA)
Stability	Unconditional
Input voltage for maximum power	100 millivolts

. . . into 8 Ohm load

POWER SUPPLY

To reduce the weight of the unit, and to obtain good regulation, a Toroidal type of transformer is used in the power supply. The output from this goes to a bridge rectifier REC1 and then to two 4700µ capacitors, C13 C14, which need a high ripple current rating for reliability. A Zener stabilised, ±15 volts supply is also provided for the control unit section, via R1, R2, D8, D9.

CONSTRUCTION

The power amplifier is mounted in the bottom of the speaker cabinet, and a simple construction can be used for the chassis which consists of one sheet of aluminium bent into an L shape. The dimensions are given in Fig. 2.5.

Mark out and drill all the holes with the aluminium sheet flat, and then bend as shown. Be sure you bend it the correct way. The same procedure is used for the heat sinks. Make sure that the heat sinks are free of all burrs, as these must fit flush to each other so that the heat from the transistors is transferred to the fins.

An improvement in heat dissipation of around 40% can be obtained by painting the heat sink fins matt black, although this was not done on the original prototype and no ill effects were noted.

The mains transformer and 4700µ capacitors are held in place with large cable ties RS 543-349.

The printed circuit board (Fig. 2.6) is mounted on the insulating pillars. The component layout is shown in Fig. 2.7.

FINAL WIRING

The wiring diagram is shown in Fig. 2.8. Wiring is not critical but 16/0·2mm (·5mm²) flex should be used and all leads to the power MOS-FETs should be kept as short as possible. It will be found that the best way to wire these is to fit the wires to the MOS-FETs first then place the p.c.b. in

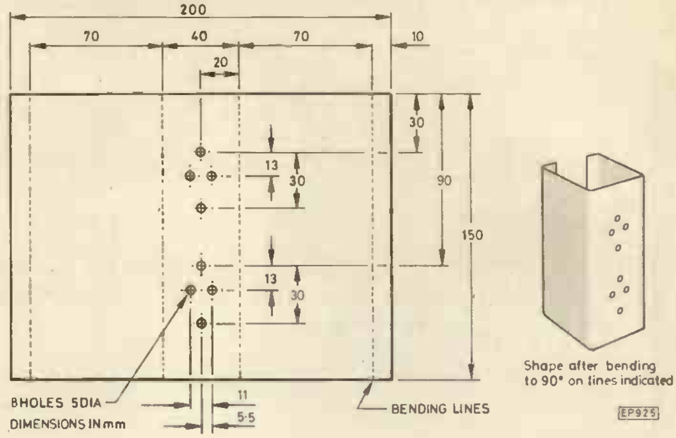


Fig. 2.2. Heatsink plate "A" drilling and bending details

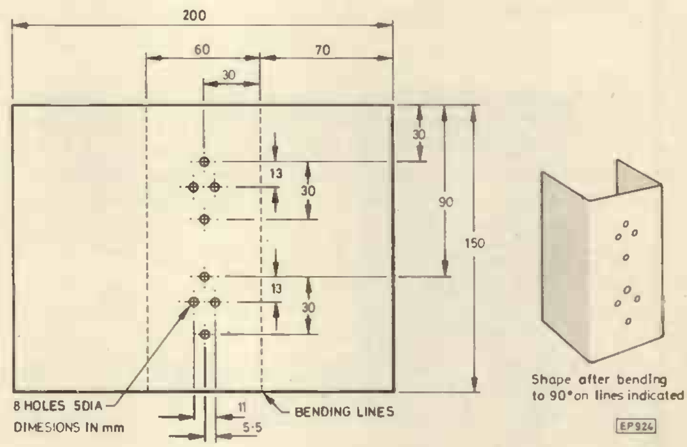
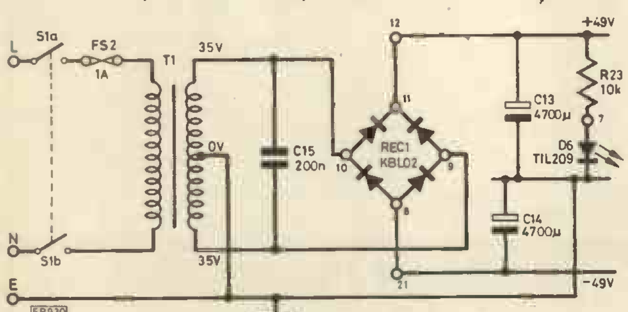
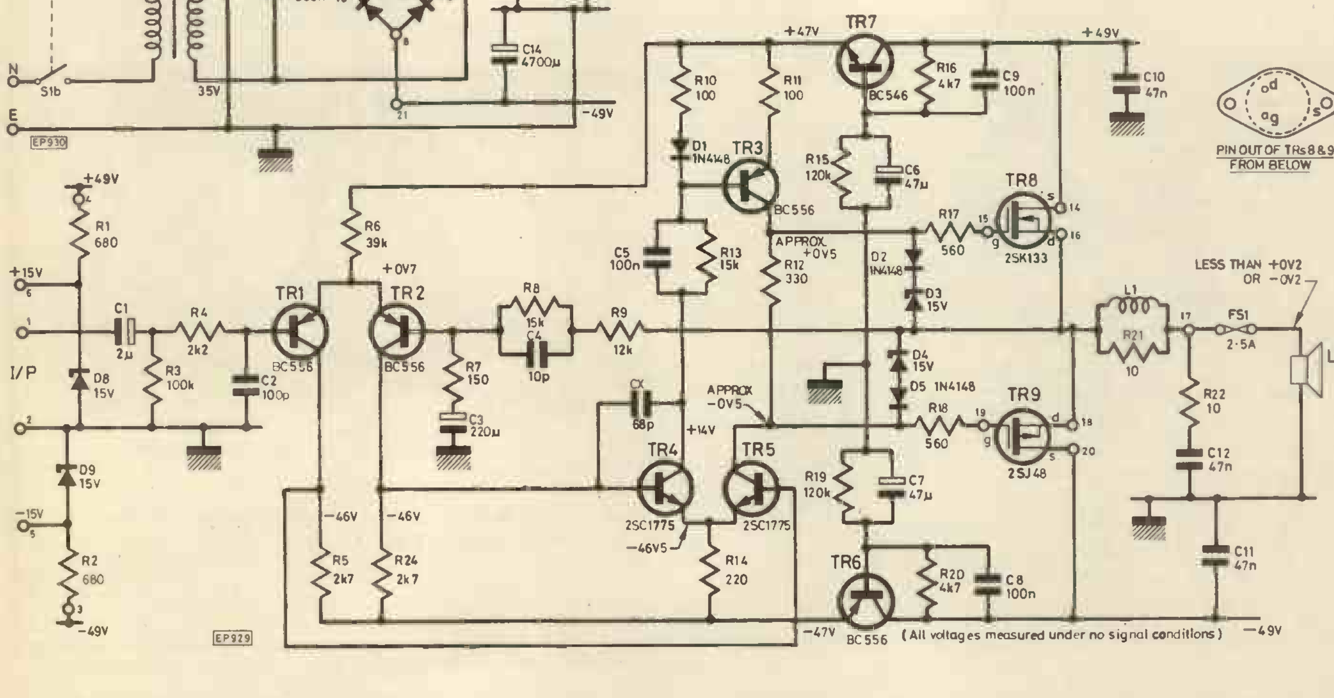


Fig. 2.3. Heatsink plate "B" drilling and bending details

Fig. 2.1. Circuit diagram of the power amplifier
Please note, there is no D7, and R13 should ideally be 18K





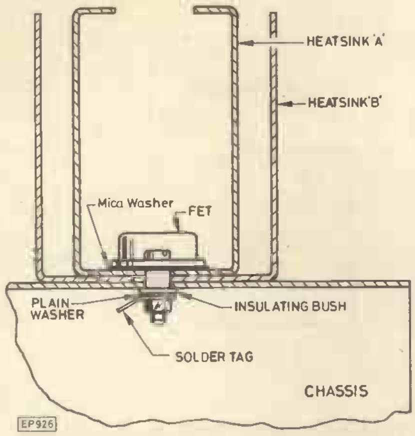


Fig. 2.4. Dual heatsink assembly. Heatsink compound should be used on both sides of the mica washer, and between plate A and plate B

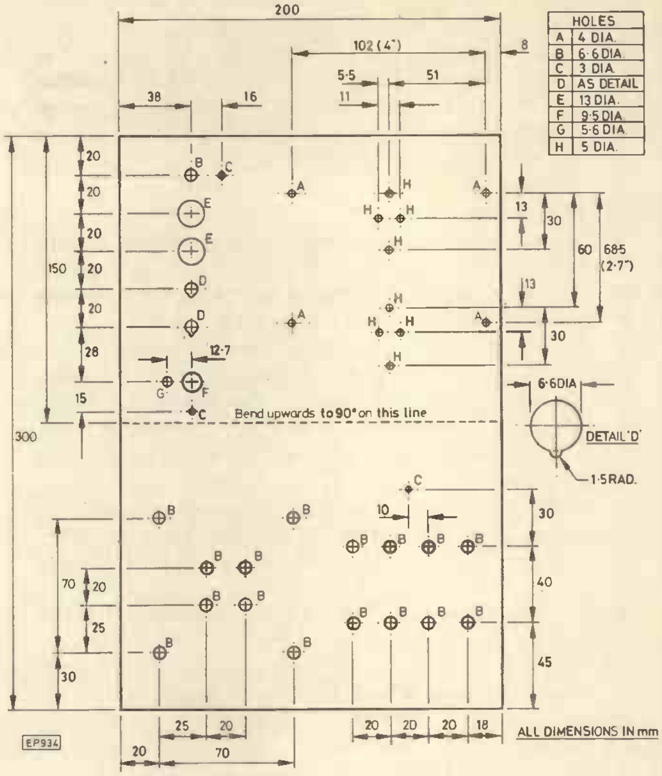
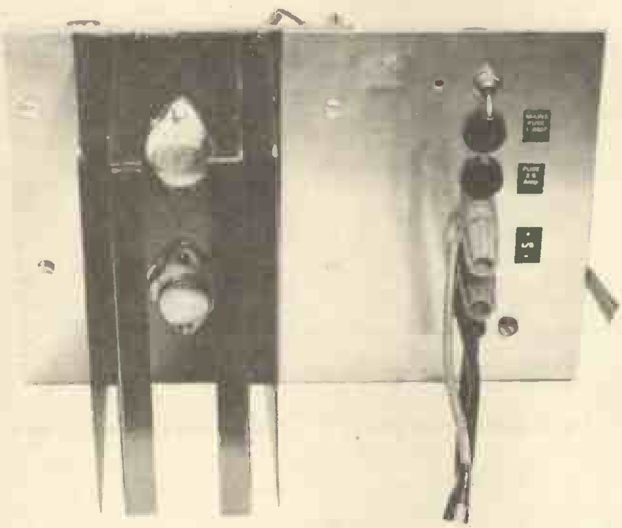
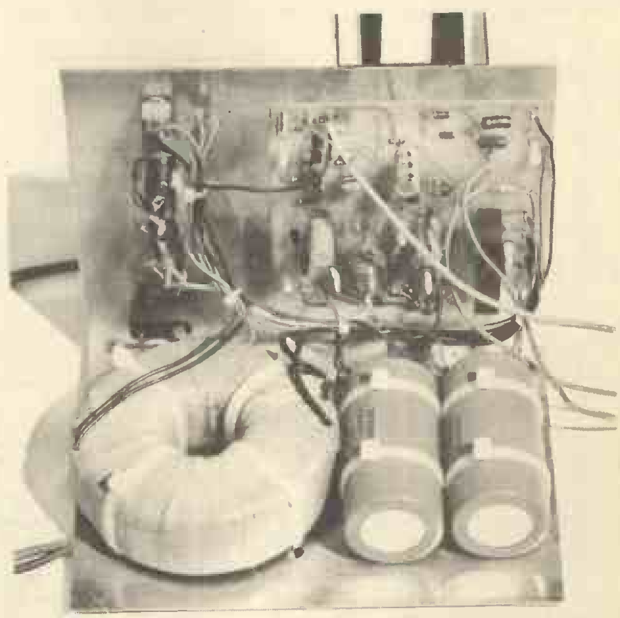
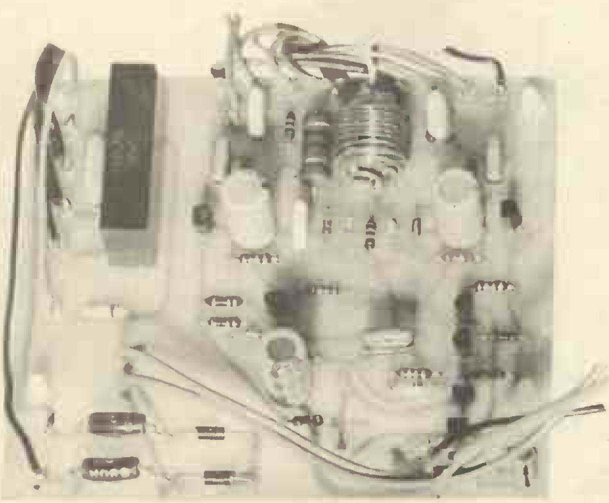


Fig. 2.5. Power amplifier support bracket dimensions







Photographs showing all aspects of the power amplifier and PSU

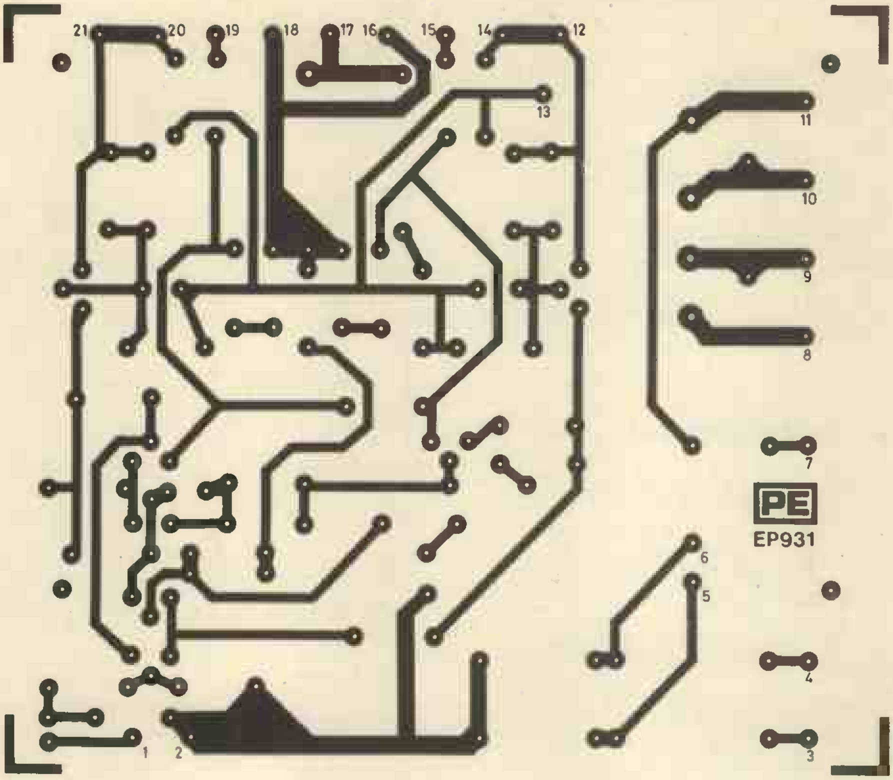


Fig. 2.6. Amplifier p.c.b. (actual size)

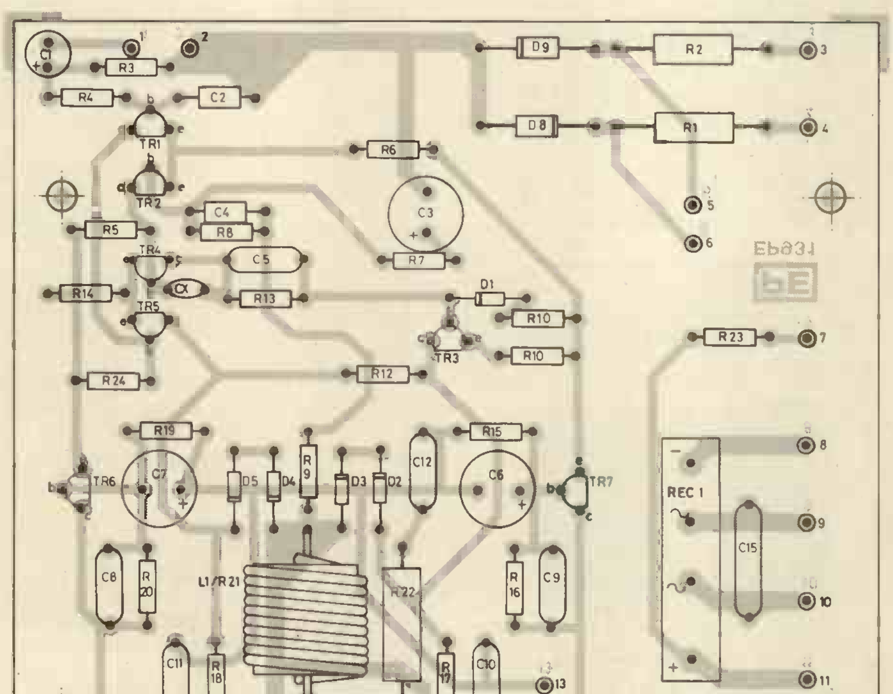


Fig. 2.7. Component layout

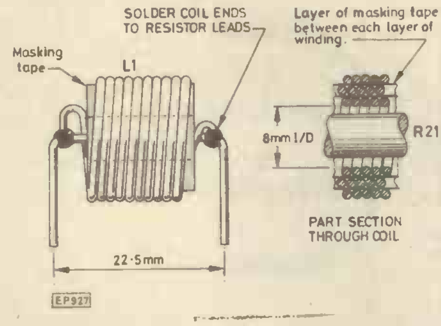


Fig. 2.8. How to make R21/L1 as a combined component

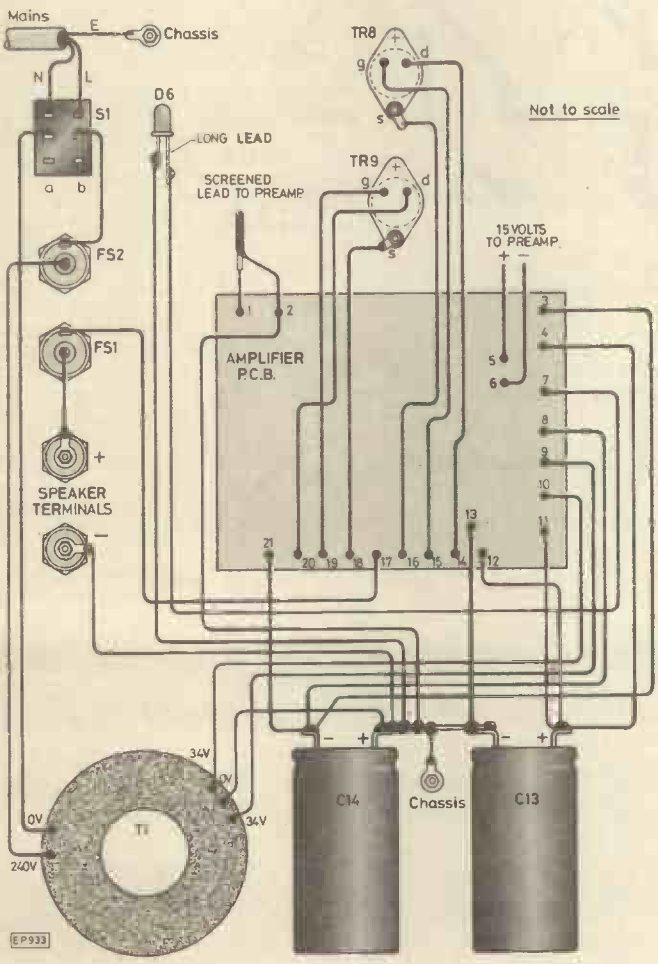


Fig. 2.9. Wiring diagram for this section of the Combo Amp.

COMPONENTS . . .

POWER AMPLIFIER

Resistors

R1, R2	680R	2·5 watt w/w (2 off)
R3	100k	
R4	2k2	
R5, R24	2k7	(2 off)
R6	39k	
R7	150	
R8	15k	
R9	12k	
R10, R11	100	(2 off)
R12	330	
R13	18k	
R14	220	
R15, R19	120k	(2 off)
R16, R20	4k7	(2 off)
R17, R18	560	(2 off)
R21, R22	10	1 watt 5% (2 off)
R23	10k	0·5 watt 5%

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

Diodes

D1, D2, D5	1N4148 (3 off)
D3, D4, D8, D9	15 volt Zener 400mW (4 off)
D6	TIL 209 l.e.d.
REC1	KBL-01/02 (4 off)

Capacitors

C1	2μ2	Elect. 63V
C2	100p	Polystyrene
C3	220μ	Elect. 16V
C4	10p	Polystyrene
C5, C8, C9	100n	Polyester (3 off)
C6, C7	47μ	Elect. 63V (2 off)
C10, C11	47n	Polyester (3 off)
C12		
C13, C14	4700μ	Elect.** (2 off)
C15	200n	Polyester
CX	68p	Polystyrene

**7A ripple current. 63V working.

Transistors

TR1, TR2	BC556b (2 off)
TR3	BC556a
TR4, TR5	2SC1775e (2 off)
TR6	BC556a or b
TR7	BC546a
TR8	2SK133
TR9	2SJ48

Miscellaneous

Printed circuit board. Aluminium for chassis etc. wire. printed circuit stand-offs. Cable ties.
T1 Mains transformer ILP type 52018.
A complete set of semiconductors are available from Hart Electronics.
L1 See Fig. 9 for details.
S101/102 DPDT Toggle RS 316-989
F1 fuse, 2·5 amp quick-blo. 20mm
F2 fuse 1amp SO-blo 20mm
Fuse holders RS 412-879
Cable clamp RS 544-263

position and wire the leads to the pins as shown, leave just enough slack wire to enable the p.c.b. to be removed and turned over for any service that may be required. When all the wiring is completed it can be held in place by the use of small cable ties. It is important to note the *common connections,* for example, C14 positive is the common connection for wiring from pins 2, speaker negative, l.e.d. and centre tap of transformer secondary. They should *not* be wired-pin 2 to l.e.d. negative, then to C14, or any other way other than shown if the specification for distortion and signal-to-noise is to be obtained.

TESTING

Before switching on, connect a 30/33 ohm wire wound resistor in series with each of the supply rails to the power amplifier, i.e. between pins 12, 21 and their respective leads to the power supply. This is to limit the current in case of a fault condition when first switching on. Switch on and check the voltages. Note, *do not connect the speaker* at this stage. If the voltages are correct and there is no d.c. voltage on the output terminals (and no smoke either) switch off, connect the speaker and try the unit out with a signal.

Leave the extra resistors in circuit while testing at *low power* as an extra precaution in case of possible faults. Once signals which sound okay at *low volume* have been obtained, the two 30/33R resistors can be removed and the supply connected direct.

Next Month: The cabinet and speaker construction will be dealt with. Also, various ways of using the Combo amplifier.

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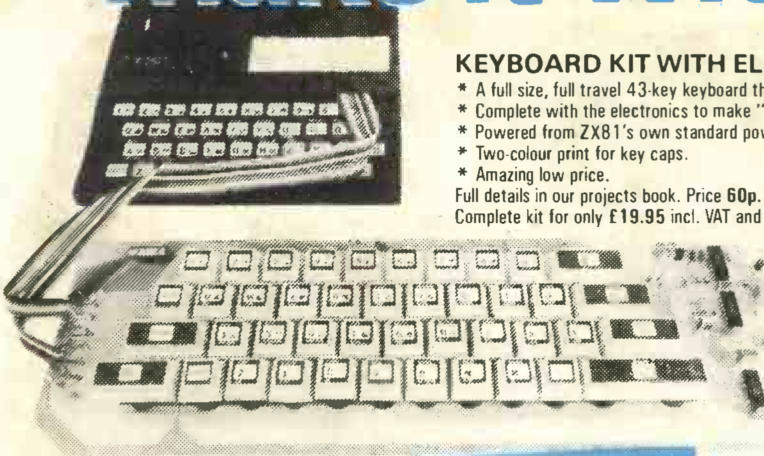

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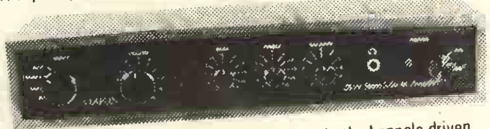

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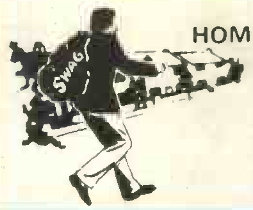

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